stormwateRx®
Reclaiming the world's water.®
122 Southeast 27th Avenue
Portland, OR 97214
www.stormwaterx.com
(800) 680-3543

Public Comment
Industrial General Permit
Deadline: 10/22/12 by 12 noon

RECEIVED
10-22-12
SWRCB Clerk

October 22, 2012

Ms. Jeanine Townsend
Clerk of the Board
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

RE: Comments on California Draft Industrial General Permit, July 16, 2012 Draft

Dear Ms. Townsend:

Thank you for the opportunity to comment on the July 16, 2012 Draft of the California National Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Industrial Activities. For over 6 years StormwateRx has offered technical expertise regarding industrial stormwater management and provided commentary to state regulatory agencies with regard to development of effective industrial stormwater permits. Our comments on this draft of the California permit are below.

**General**. The permit includes the filler words such as “all”, “appropriate”, “approximately”, “any” and “readily” throughout. These words add ambiguity and/or unnecessary verbage to the permit. For example, the phrase “includes a narrative assessment of all areas of industrial activity” has the same meaning as “includes a narrative assessment of areas of industrial activity.” If anything, including the word “all” in this and similar contexts leads one to assume there must be instances when “not all” might apply. This is a matter of semantics but removing these filler words would shorten and improve the collaborative intent of the permit without detracting from its usefulness and effectiveness.

**Section IV.B.3.c:** This section relates to permitee assurances that allowable non-stormwater discharges do not exceed water quality standards. This determination is difficult to perform given the wide range of allowable NSWDs. Considering the minor degree of pollutants contributed from the NSWDs, we suggest the Board categorically allow NSWDs of the types defined but better define whether chlorinated water would be allowable under this section.

**Section X. SWPPP Requirements:** This section prescribes in detail the many elements and considerations of the site specific SWPPP and requires that "A paper copy of the SWPPP shall be maintained at the facility." Despite the good intentions of requiring this level of documentation and record keeping within the SWPPP document, this section has possibly created more ambiguity and opportunities for citizen suit administrative-failure claims than any section of the permit. Examples of ambiguous requirements and opportunities for administrative failures include:

- "a list of significant materials handled and stored….locations where each material is stored, received, shipped, and handled….typical quantities and handling frequency.
- describes each industrial process; including manufacturing, cleaning, maintenance, recycling, disposal, and <u>any</u> other activities…
- areas protected by containment structures and the corresponding containment capacity…
- all industrial activities that generate a <u>significant</u> amount of dust…
- a description of materials that have spilled or leaked in <u>significant</u> quantities"…
- the source, quantity, frequency, and characteristics of the NSWDs…
- effectiveness of existing BMPs to reduce or prevent pollutants.", etc.

Ultimately demonstration of site stormwater performance will be quantified through the sampling and analysis process (XI.B) and site improvements will be defined through the exceedance response process (XII.) Considering the detailed requirements of the SWPPP defined in this draft permit, the SWPPP preparation and updating process will be onerous and expensive with little direct benefit to water quality that will not be detected and corrected through the monitoring and exceedance response processes. We suggest that the State advocate for permittees using their time and financial resources to implement BMPs that will produce real and measurable results in stormwater quality, rather than spending their time and financial resources chasing the documentation requirements of the SWPPP.

**Section X.A.** We suggest the operating hours of the facility be included in the basic SWPPP information.

**Section X.E.3.b.** This section says "Include any <u>structural control</u> measures that affect industrial storm water discharges…" The sentence can be improved and made more consistent with later references in XII.D by adding the word "treatment" to this sentence – i.e. "Include any <u>structural / treatment control</u> measures that affect industrial storm water discharges." The "oil/water" separator included in footnote 5 is one of many types of treatment control BMPs. We suggest the "oil/water separator" example in the footnote be augmented with one other example of a treatment BMP.

**Section X.H.2 Minimum BMPs:** The draft permit states that "The Discharger is not required to narratively describe the minimum BMP inspection results in the Annual Monitoring Report." This detail is relatively important to assuring adequate maintenance and performance of BMPs and could be included in the Annual Monitoring Report with little additional effort.

**Section X.H.7. Design Storm Standards for Treatment Control BMPs:**

**a.** Isopluvial maps for the 85th percentile are not readily available on the internet. The Board may want to add a reference indicating where these maps can be found.

**b.** Add same requirement that "All hydrologic calculations shall be certified by a California licensed professional engineer in accordance with Professional Engineers Act." The assumption might be made that a twenty-four hour rain event can be translated into an hourly intensity by dividing the inches in a twenty-four hour rain event by twenty-four. It should be clarified that this is not a correct way to calculate intensity. Regarding paragraph 7.b.ii. we suggest the Board clarify the sentence by making the following correct: "The maximum flow rate of runoff produced by the 85th percentile hourly rainfall intensity, as determined from local historical <u>fifteen minute or hourly</u> rainfall records, multiplied by a factor of two." Regarding paragraph 7.b.iii this is almost the same statement as described in 7.b.ii but in terms that are too vague to make any sense. The Board may consider removing this section from the permit language.

**c.** We suggest this paragraph be clarified such that in lieu of complying with the design storm standards for treatment control BMPs, the BAT/BCT Compliance Demonstration Technical Report must be submitted <u>AND</u> approved by the State.

**Section XI.A.1.c.** It is not apparent what the water quality benefit is of requiring permittees to submit a justification in the Annual Monitoring Report as to why samples are greater than 16 weeks apart. The requirement to submit documentation to this effect seems an administrative burden to the permittee and the State.

**Section XI.B.5.b.** Additional Parameters. We suggest the Board reiterate that selection of applicable additional parameters is not optional. For example: "Additional, applicable parameters <u>must be</u> selected by…."

**Table 4.** Additional Analytical Parameters: SIC 5093 Scrap and Waste Materials: The Board may want to differentiate between additional parameters typically generated by ferrous versus non-ferrous scrap metal recyclers. The State of Washington has produced some good sector specific stormwater quality data in the report entitled *Evaluation of Washington's Industrial Stormwater General Permit, EnviroVision and Herrera Environmental Consultants, November 2006* that provides a basis for other parameters including copper.

**Section XII.A.1.b.** Instantaneous Maximum NAL Exceedance. The Board many want to reword this section. The word "instantaneous" typically means a single occurrence and the definition provided herein says “And instantaneous maximum NAL exceedance occurs when two or more analytical results…”

**Section XII.C.2 and XII.C.3.c.ii.** It may be preferable for certain permittees to move to Structural/Treatment Controls during a Level 1 Status trigger. This paragraph could be modified to allow and possibly even to incent companies to step to Level 2 before the Level 2 Status is triggered.

**Section XII.D. Level 2 Status – Structural/Treatment Control:** This section provides no qualification as to what constitutes acceptable “treatment.” The permit needs to designate consequences for implementation of treatment that does not achieve the necessary pollutant reduction to pull the facility below the NALs or that does not achieve the level of reduction stated in the Level 2 ERA. Otherwise there may be a cost deferral incentive for companies that could elect unproven or under-performing treatment at the expense of the environment. We suggest the Board require supporting data from full scale applications of the proposed treatment as evidence the proposed treatment will meet NALs.

**Section XII.E.2.** We suggest the Board develop acceptance criteria for the Demonstration Technical Reports and allow facilities to return to Baseline Status only after the DTR is <u>approved</u> by the State.

**Section XII.E.3.a.i. BAT/BCT Compliance Demonstration Technical Report.** We suggest the Board provide a baseline cost basis for what would constitute an acceptable cost for achieving BAT/BCT (possibly on a $/pound.) The cost should be comparable to the cost to the public of remediating the same mass of pollutant from the environment once deposited by the permittee. The cost of environmental remediation would have a public funding component that should be addressed versus pollutant management onsite that would be the burden of the generator. Furthermore, some ground-truthing should be performed to qualify the total cost of application of technology with technology suppliers. It has been our experience that actual implementation cost for technology is lower than that provided by estimates before construction (see attached documents: 1) *Actual Cost and Performance for Boatyard Full Scale Stormwater Treatment BMPs*, letter to Gary Bailey, Washington Department of Ecology, July 31, 2009; 2) *Boatyard Stormwater Treatment Technology Cost Analysis*, Arcadis, June 27, 2008.)

**Section XII.E.4.b.** We suggest the Board clarify that pollutants in aerial deposition are from background aerial deposition, not from aerial deposition from pollutant sources originating at the facility.

If you should require clarification on any of these comments, please feel free to contact me at the address or phone shown above or by email at caln@stormwaterx.com. Thank you for the opportunity to comment on this important California Draft Industrial General Permit.

Sincerely,

Calvin P. Noling, PE
StormwateRx, LLC
*Reclaiming the World's Water.®*

stormwateRx™
Reclaiming the world's water.

www.stormwaterx.com
122 Southeast 27th Avenue
Portland, OR 97214
(800) 680-3543

July 31, 2009

Mr. Gary Bailey
Washington Department of Ecology
PO Box 47600
Olympia, WA 98504

RE: Actual Cost and Performance for Boatyard Full Scale Stormwater Treatment BMPs

Dear Mr. Bailey:

Please find attached actual cost and performance data for full scale Aquip Enhanced Stormwater Filtration System stormwater treatment BMPs and structural site improvements that have been made at a number of Puget Sound boatyards over the past year. We are submitting this information to aide the Boatyard General Permit renewal process discussions amongst the boatyard stakeholder groups.

StormwateRx is aware of seven boatyards in Washington that have made significant site upgrades and have installed or are in the process of installing full scale stormwater treatment BMPs. Four of these boatyards have completed these site improvements in time to capture at least one storm event this past winter and spring that can be used to contrast with pre-BMP site stormwater quality. We have provided cost information for site upgrades made at all seven yards.

We are also providing a summary of StormwateRx full scale Aquip Enhanced Stormwater Filtration System performance data for all industry sectors, and for the marine sector (boatyards and shipyards) for the boatyard parameters. These data were collected independent of the end-of-pipe DMR data referenced above and are presented in terms of influent and effluent sample pairs to give Ecology a better idea of what performance range can be expected from full scale Aquip Enhanced Stormwater Filtration Systems.

We have done our best in a short amount of time to fairly, completely and accurately present full scale cost and Aquip performance data in a way that allows direct comparison to the findings presented in the Boatyard Stormwater Treatment Technology Study (Taylor Associates, Inc., March 2008) and the Boatyard Stormwater Treatment Technology Cost Analysis (Arcadis, June 2008.)

You may contact us if you have questions about this submittal or desire more information. Good luck with the permit renewal process.

Sincerely,

Calvin P. Noling, PE
President

c : Northwest Marine Trade Association, Puget Soundkeeper Alliance

# Cost Summary

| Actual Costs and Net Present Value per Acre for Washington Boatyards to Make Site Improvements and Install Stormwater Treatment BMPs | | | | | | | | | Arcadis Report Table 6 |
|---|---|---|---|---|---|---|---|---|---|
| | StormwateRx Aquip Stormwater Treatment AND Site Improvements | | | | | | | | |
| **Present Value Analysis, $/acre** | **Boatyard #1** | **Boatyard #2** | **Boatyard #3** | **Boatyard #4** | **Boatyard #5** | **Boatyard #6** | **Boatyard #7** | **Average Actual** | |
| Capital Costs (Year 0) | $ 51,000 | $ 43,000 | $ 51,000 | $ 35,000 | $ 28,000 | $ 52,000 | $ 60,000 | $ 45,700 | $ 177,000 |
| Annual O&M Costs (Year 1 to 15) | $ 1,500 | $ 3,000 | $ 2,700 | $ 2,100 | $ 4,800 | $ 4,200 | $ 6,000 | $ 3,500 | $ 8,500 |
| Present Value of O&M | $ 13,700 | $ 27,300 | $ 24,600 | $ 19,100 | $ 43,700 | $ 38,300 | $ 54,600 | $ 31,600 | $ 78,000 |
| Net Present Value ($/acre) | $ 64,700 | $ 70,300 | $ 75,600 | $ 54,100 | $ 71,700 | $ 90,300 | $ 114,600 | $ 77,300 | $ 255,000 |

7% discount rate, 15 year project life (Arcadis)

## Actual Capital Cost for Site Improvements and Installation of Stormwater Treatment BMPs at Washington Boatyards

| Washington Boatyard | Stormwater Treatment BMP | | City | Year Online | Acres | Engineering Design, Engineering Report | Treatment Systems | Freight | Pump, Vault, etc. | Re-paving, Treatment system foundation, etc. | Installation: conveyance, electrical, etc. | Total Capital | $/acre (1) | Scope |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Boatyard #1 | Aquip | 110 | Seattle | 2008 | 3.00 | $ 13,941 | $ 51,000 | $ 1,920 | $ 6,199 | $ 65,541 | $ 15,000 | $ 153,601 | $ 51,000 | Retrofit to existing conveyance and catch basins, repaved wash rack area, constructed bioswale pretreatment for part of yard, Aquip stormwater filter with pump, bypass vault modifications |
| Boatyard #2 | Aquip | 50 | Bellingham | 2009 | 1.25 | $ 5,028 | $ 26,410 | $ 1,200 | $ 1,217 | | $ 20,000 | $ 53,855 | $ 43,000 | Retrofit to existing conveyance and catch basins, Aquip filter with pump. |
| Boatyard #3 | Aquip | 2 @ 50 | Seattle | 2008 | 1.65 | $ 6,007 | $ 48,549 | $ 2,400 | $ 4,860 | $ 12,420 | $ 10,000 | $ 84,236 | $ 51,000 | Retrofit to existing conveyance and catch basins, repaved wash rack area, 2 @ Aquip stormwater filters, 2 @ bypass vaults with pumps. |
| Boatyard #4 | Aquip | 110 | Seattle | 2009 | 2.13 | $ 5,400 | $ 56,610 | $ 1,500 | $ 3,420 | *$ 3,000* | *$ 5,000* | $ 74,930 | $ 35,000 | Retrofit to existing conveyance and catch basins, Aquip filter with pump in existing catch basin, above-ground pressure conveyance piping, connect gravity flow from filter to existing outfall, patch surface asphalt. |
| Boatyard #5 | Aquip | 50 | Seattle | 2008 | 0.80 | $ - | $ 19,800 | $ 648 | $ 800 | $ - | $ 970 | $ 22,218 | $ 28,000 | Retrofit to existing conveyance and terminal catch basin, Aquip filter with pump. |
| Boatyard #6 | Aquip | 50 | Kenmore | 2009 | 0.90 | $ 4,250 | $ 31,280 | $ 1,200 | *$ 2,500* | *$ 2,500* | *$ 5,000* | $ 46,730 | $ 52,000 | Trench drain, filter foundation, short conveyance, gravity outfall |
| Boatyard #7 | Aquip | 50 | Gig Harbor | 2009 | 0.63 | $ - | $ 33,120 | $ 950 | *$ 500* | *$ 2,500* | *$ 1,000* | $ 38,070 | $ 60,000 | Retrofit to existing conveyance and catch basins, short run of discharge piping, gravity flow to outfall |
| | | | | | | | | | | | | | | |
| Min | | | | | | | | | | | | | $ 28,000 | |
| Average | | | | | 1.48 | $ 4,946 | $ 38,110 | $ 1,403 | $ 2,785 | $ 14,327 | $ 8,139 | $ 67,663 | $ 45,700 | |
| Max | | | | | | | | | | | | | $ 60,000 | |
| | | | | | | | | | | | | | | |
| *Red* | *Estimate* | | | | | | | | | | | | | |
| Black | Actual cost | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| (1) Rounded to nearest $1,000 | | | | | | | | | | | | | | |

Data compiled by StormwateRx in consultation with boatyard stormwater treatment system owners

7/31/09

| StormwateRx Aquip O&M Cost Estimate | | | | | |
|---|---|---|---|---|---|
| **Washington Boatyard** | **Stormwater Treatment BMP, Size** | | **Boatyard Area (acres)** | **Total O&M - Annual** | **$/acre (1)** |
| Boatyard #1 | Aquip | 110 | 3.00 | $ 4,500 | 1,500 |
| Boatyard #2 | Aquip | 50 | 1.25 | $ 3,800 | 3,000 |
| Boatyard #3 | Aquip | 2 @ 50 | 1.65 | $ 4,500 | 2,700 |
| Boatyard #4 | Aquip | 110 | 2.13 | $ 4,500 | 2,100 |
| Boatyard #5 | Aquip | 50 | 0.80 | $ 3,800 | 4,800 |
| Boatyard #6 | Aquip | 50 | 0.90 | $ 3,800 | 4,200 |
| Boatyard #7 | Aquip | 50 | 0.63 | $ 3,800 | 6,000 |
| | | | | | |
| Min | | | | | 1,500 |
| Average | | | | | 3,471 |
| Max | | | | | 6,000 |
| | | | | | |
| | | | | | |
| (1) rounded to nearest $100 | | | | | |

# StorwateRx AQUIP®
# Aquip 50SBE
# DETAILED O&M COST ESTIMATE

**ANNUAL O&M COSTS:**

| DESCRIPTION | UNIT | QTY | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Routine (occurs every year) | | | | | |
| Raking top layer of media | 4 | EA | $20 | $80 | 1 labor hour per quarter |
| Montly inspections and maintenance | 6 | EA | $20 | $120 | 0.5 labor hours per month |
| Solids removal and disposal | 1 | LS | $100 | $100 | Solids removal (non-hazardous) from pre-treatment chamber |
| Metals breakthrough monitoring | 0 | EA | $200 | $0 | Determination in conjunction with compliance sampling |
| SUBTOTAL | | | | $300 | |
| Seasonal (occurs every other two-year interval, skipping intervals when full maintenance occurs, = 1/4 cost annually) | | | | | |
| Partial media replacement | 0.25 | LS | $1,700 | $425 | Material cost only, July 2009 Pricing, StormwateRx |
| Spent media disposal | 0.25 | LS | $150 | $38 | Landfill disposal fee |
| Labor | 1.5 | LS | $240 | $360 | 6 labor hours per maintenance cycle |
| SUBTOTAL | | | | $823 | |
| Full (occurs every other two-year interval, = 1/4 cost annually) | | | | | |
| Full media replacement | 0.25 | LS | $6,400 | $1,600 | Material cost only, July 2009 Pricing, StormwateRx |
| Spent media disposal | 0.25 | LS | $450 | $113 | Landfill disposal fee |
| Labor | 3 | LS | $20 | $60 | 12 labor hours per maintenance cycle |
| SUBTOTAL | | | | $1,773 | |
| Parts Replacement | 1 | LS | $160 | $160 | Pump replaced every 5 years |
| SUBTOTAL | | | | $3,055 | |
| Contingency | 25% | | | $764 | |
| **TOTAL CAPITAL COST (ROUNDED TO THE NEAREST $1,000)** | | | | **$3,800** | |

Notes:
Expected maintenance frequency extrapolated based on routine inspection of installed Aquip Stormwater Filters at Washington boatyards. Maintenance material costs based on StormwateRx July 2009 pricing. Maintenance labor requirements based on StormwateRx experience for similar sized systems installed at other facilities.

# StorwateRx AQUIP®
# Aquip 110SBE
# DETAILED O&M COST ESTIMATE

**ANNUAL O&M COSTS:**

| DESCRIPTION | UNIT | QTY | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Routine (occurs every year) | | | | | |
| Raking top layer of media | 8 | EA | $20 | $160 | 2 labor hours per quarter |
| Montly inspections and maintenance | 6 | EA | $20 | $120 | 0.5 labor hours per month |
| Solids removal and disposal | 1 | LS | $200 | $200 | Solids removal (non-hazardous) from pre-treatment chamber |
| Metals breakthrough monitoring | 0 | EA | $200 | $0 | Determination in conjunction with compliance sampling |
| SUBTOTAL | | | | $480 | |
| Seasonal (occurs every other two-year interval, skipping intervals when full maintenance occurs, = 1/4 cost annually) | | | | | |
| Partial media replacement | 0.25 | LS | $2,400 | $600 | Material cost only, July 2009 Pricing, StormwateRx |
| Spent media disposal | 0.25 | LS | $300 | $75 | Landfill disposal fee |
| Labor | 1.5 | LS | $240 | $360 | 6 labor hours per maintenance cycle |
| SUBTOTAL | | | | $1,035 | |
| Full (occurs every other two-year interval, = 1/4 cost annually) | | | | | |
| Full media replacement | 0.25 | LS | $6,400 | $1,600 | Material cost only, July 2009 Pricing, StormwateRx |
| Spent media disposal | 0.25 | LS | $900 | $225 | Landfill disposal fee |
| Labor | 4 | LS | $20 | $80 | 16 labor hours per maintenance cycle |
| SUBTOTAL | | | | $1,905 | |
| Parts Replacement | 1 | LS | $160 | $160 | Pump replaced every 5 years |
| SUBTOTAL | | | | $3,580 | |
| Contingency | 25% | | | $895 | |
| **TOTAL CAPITAL COST (ROUNDED TO THE NEAREST $1,000)** | | | | **$4,500** | |

Notes:
Expected maintenance frequency extrapolated based on routine inspection of installed Aquip Stormwater Filters at Washington boatyards. Maintenance material costs based on StormwateRx July 2009 pricing. Maintenance labor requirements based on StormwateRx experience for similar sized systems installed at other facilities.

# StormwateRx Aquip Enhanced Stormwater Filtration System Performance Data

## Full Scale

# Influent and Effluent Concentrations for StormwateRx® Full Scale Aquip® Enhanced Filtration Systems

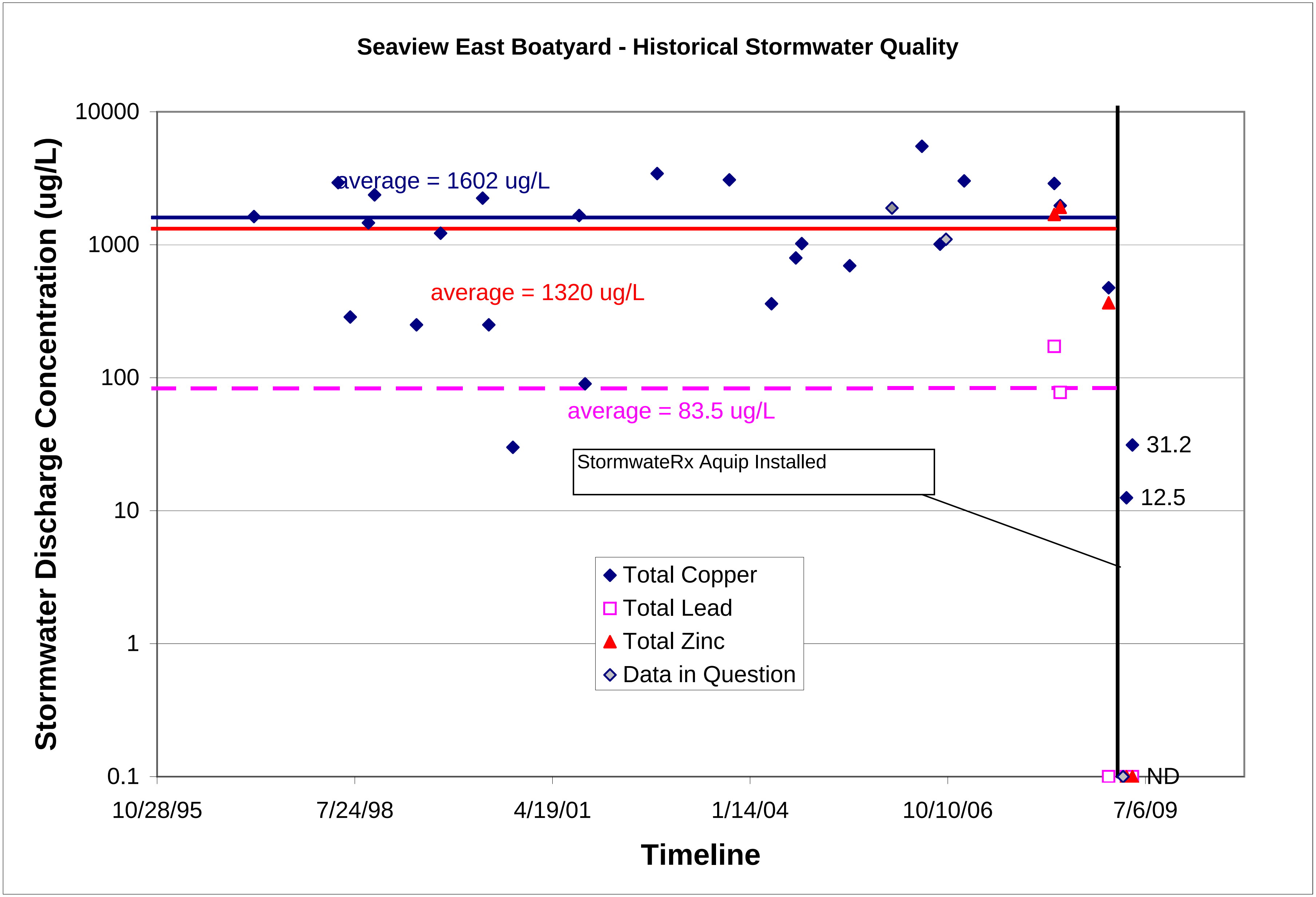
| Parameter | Sample Location | All Industrial Applications[1] | | Marine Applications[2] | |
|---|---|---|---|---|---|
| | | Number of Facilities | Average (Range) Number of Samples | Number of Facilities | Average (Range) Number of Samples |
| Suspended Solids (mg/L) | Influent | 8 | 419 (10.0-1590) n=11 | 2 | 43 (20.0-66.0) n=2 |
| | Effluent | | 8.47 (ND-20.0) n=11 | | 3.50 (ND) n=2 |
| Total Copper (µg/L) | Influent | 10 | 1310 (24.8-4780) n=20 | 4 | 1890 (184-4780) n=10 |
| | Effluent | | 54.0 (ND-208) n=20 | | 54.6 (5.80-146) n=10 |
| Dissolved Copper (µg/L) | Influent | 3 | 279 (13.1-766) n=3 | 1 | 766 n=1 |
| | Effluent | | 9.40 (2.00-16.0) n=3 | | 16.0 n=1 |
| Total Lead (µg/L) | Influent | 7 | 884 (10.4-5540) n=12 | 2 | 440 (10.4-661) n=3 |
| | Effluent | | 37.7 (ND-231) n=12 | | 17.1 (ND-1.3) n=3 |
| Dissolved Lead (µg/L) | Influent | 2 | 38.1 (2.70-73.5) n=2 | 1 | 73.5 n=1 |
| | Effluent | | 12.8 (0.50-25.0) n=2 | | ND n=1 |
| Total Zinc (µg/L) | Influent | 13 | 24000 (151-386,000) n=27 | 4 | 980 (304-1960) n=7 |
| | Effluent | | 1370 (5.40-9070) n=27 | | 45.0 (5.40-161) n=7 |
| Dissolved Zinc (µg/L) | Influent | 2 | 5500 (1320-9680) n=2 | 1 | 1320 n=1 |
| | Effluent | | 2730 (24.8-5430) n=2 | | 24.8 n=1 |

1 - Sampling from inlet and outlet of full-scale Aquip Enhanced Stormwater Filtration systems. Results through July 2009. Data compilec by StormwateRx.
2 - Marine applications include boatyards and shipyards
3 - All chemical analysis by third party certified analytical testing laboratory
4 - Average values may include non-detections; for the purposes of these average calculations, the non-detected values are assumed present at half the detection limit.

# <u>Performance and Cost Backup Data</u>

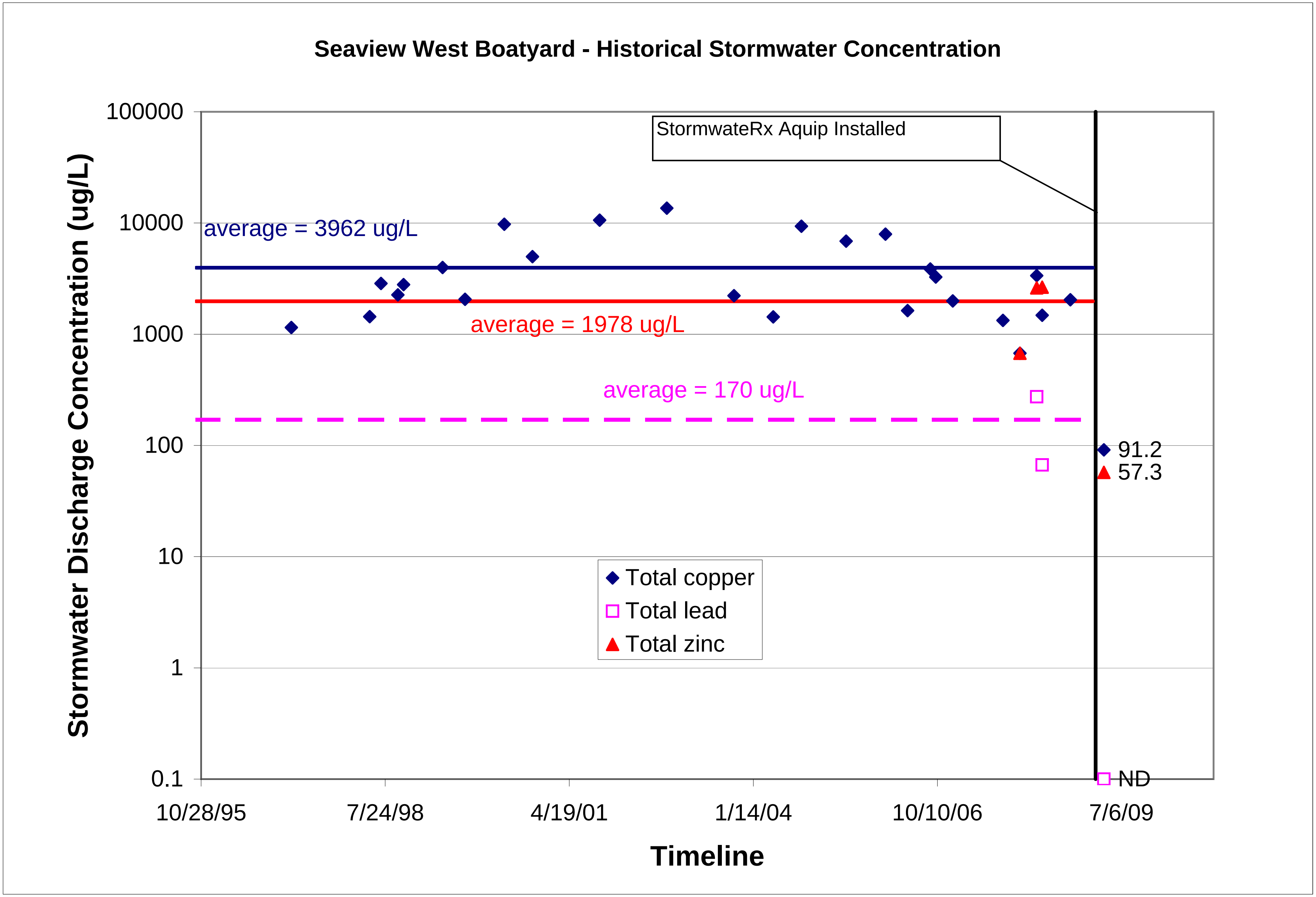
## Seaview Boatyard & Yacht Service

### Seaview East Boatyard, Seattle WA
### Seaview West Boatyard, Seattle WA




Data compiled by StormwateRx using WA Department of Ecology online DMR database, and additional data collected by Seaview Boatyards. StormwateRx does not guarantee the accuracy of these data. All data should be independently verified.

7/31/09




Data compiled by StormwateRx using WA Department of Ecology online DMR database, and additional data collected by Seaview Boatyards. StormwateRx does not guarantee the accuracy of these data. All data should be independently verified.

7/31/09

## TOTAL EXPENSE SUMMARY - STORMWATER RX SYSTEMS

| YARD | SYSTEM (PDR) | ENGINEERING | ADVERTISING | INSTALL LABOR | INSTALL (R&M) | BIOSWALE (R&M) | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| SEAVIEW EAST | 52,920.00 | 13,941.10 | 621.00 | 15,000.00 | 65,541.16 | 6,198.80 | 154,222.06 | 4-58 |
| SEAVIEW WEST | 50,949.00 | 6,006.63 | - | 10,000.00 | 17,280.28 | - | 84,235.91 | 2-40 |
| SEAVIEW FAIRHAVEN | 27,610.00 | 5,027.63 | - | 20,000.00 | 1,217.00 | - | 53,854.63 | 2-24 |
| SEAVIEW NORTH | - | 1,824.64 | - | | - | - | 1,824.64 | — |
| TOTAL | 131,479.00 | 26,800.00 | 621.00 | 45,000.00 | 84,038.44 | 6,198.80 | 294,137.24 | |

**PDR NOTE:**

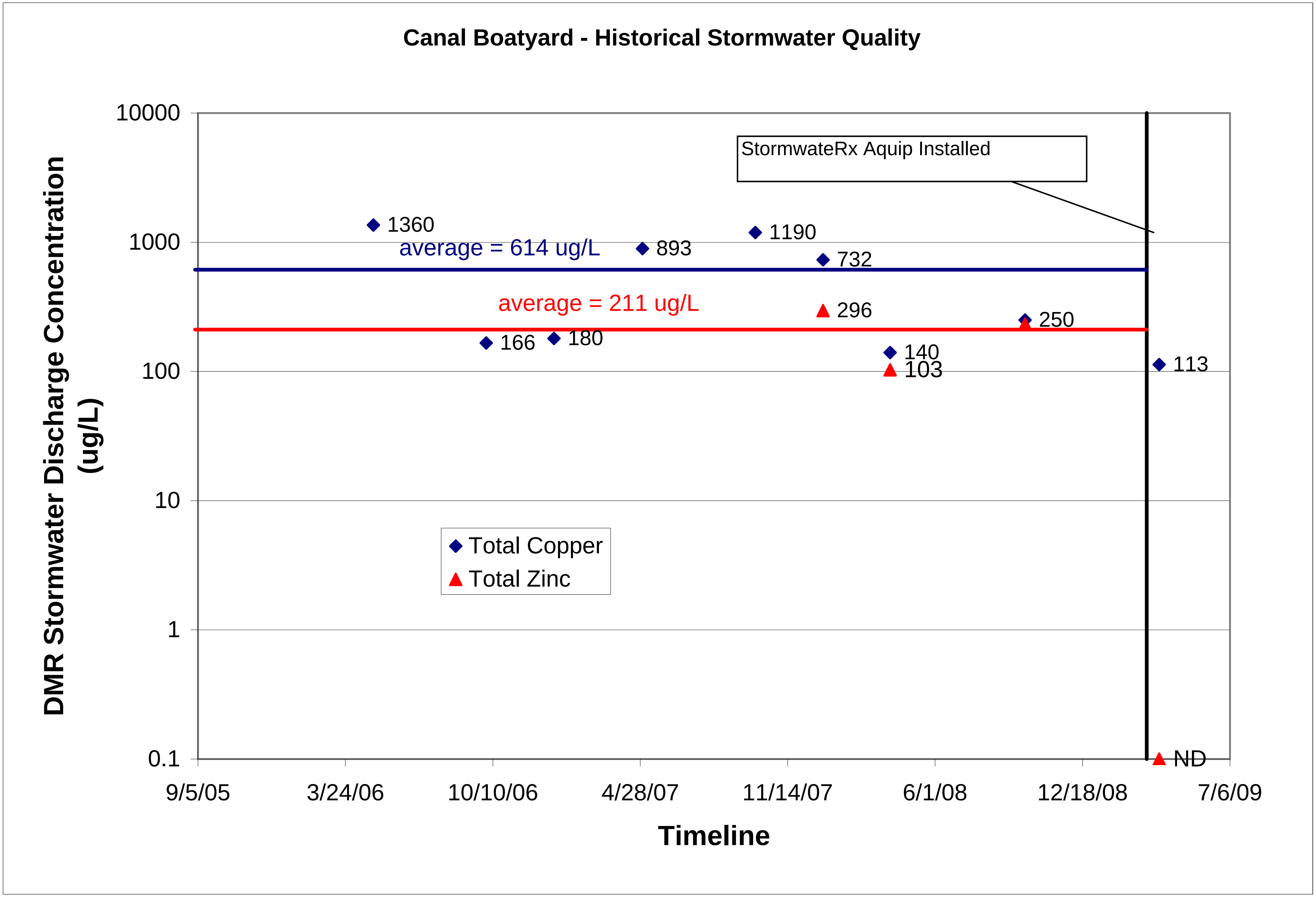
| | |
|---|---|
| TOTAL BILLED | 131,479.00 |
| TOTAL PAID TO DATE | 122,796.05 |
| UNPAID BALANCE | 8,682.95 |

* BMP UPGRADES.
— BIO SWALE
— REPAVE —

BDAND @ STORMWATERRX
.COM

# Performance Data

## Canal Boatyard, Seattle WA

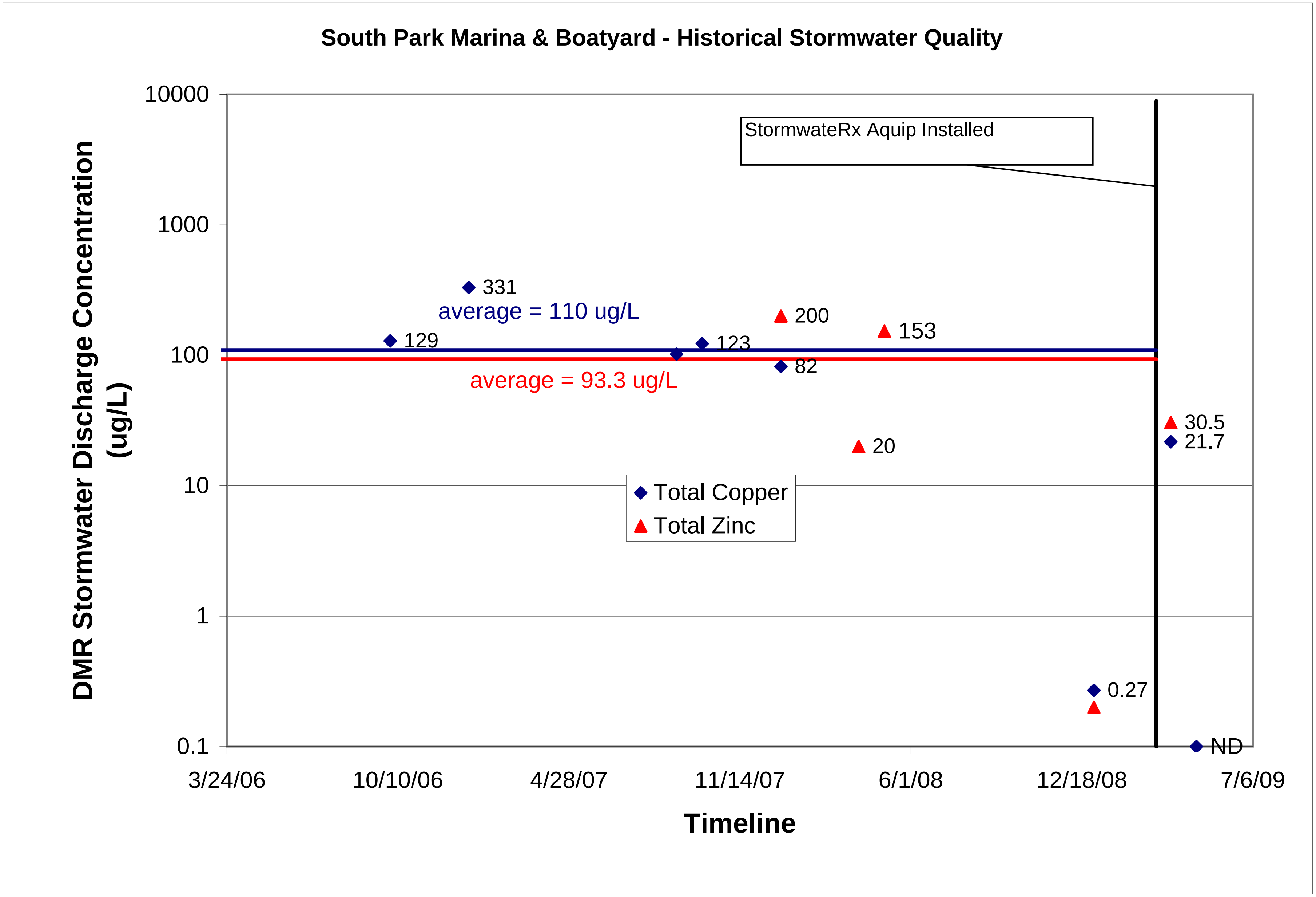



Data compiled by StormwateRx using Washington State Department of Ecology online DMR database.
StormwateRx does not guarantee the accuracy of these data. All data should be independently verified.

7/31/09

# Performance and Cost Backup Data

## South Park Marina & Boatyard




Data compiled by StormwateRx using Washington State Department of Ecology online DMR database.
StormwateRx does not guarantee the accuracy of these data. All data should be independently verified.

7/31/09

South Park Marina

8604 Dallas Ave S, Seattle, WA 98108, 762-3880

July 30,2009

Mr. Gary Bailey
Washington Department of Ecology
Water Quality Division
PO Box 47600
Olympia, WA 98504

RE: Stormwater Treatment BMP Cost Information

Dear Mr. Bailey

In anticipation of the next Boatyard General Permit, I am writing this letter to provide the Department of Ecology with actual costs for a boatyard to upgrade its stormwater treatment BMPs with treatment. South Park Marina & Boatyard elected to retrofit its 0.8 acre main boat workyard with a StormwateRx Aquip filtration system. The filter was installed in March 2009. Following is a summary of our costs to install our filter.

| | |
|---|---|
| Aquip stormwater filter | $19,800.00 |
| Tax | $1,782.00 |
| Freight | $648.00 |
| | $22,230.00 |
| Pump | $800.00 |
| PVC piping & installation | $300.00 |
| Electrical for pump | $500.00 |
| Misc parts | $170.00 |
| Total estimated installed cost | $24,000.00 |

This cost included a sketch showing how to integrate the system to our yard and which pump to purchase. The filter was relatively simple to install and is working well for us; the filter requires little time from our staff for inspection. The system has not required any maintenance so far. We are happy with the system and believe it a good investment to help us get our stormwater concentrations down and to protect the Duwamish Waterway consistent with our business philosophy.

I hope this information is valuable at the Department of Ecology moves toward finalizing and implementing the Boatyard General Permit. For the good of Puget Sound, we hope the Department elects to require other boatyards with whom

South Park Marina & Boatyard is competing, to upgrade its stormwater treatment BMPs promoting better stormwater quality.

Thank you,

Guy Crow

Guy Crow
Owner
South Park Marina & Boatyard

Infrastructure, environment, facilities

Imagine the result

**Northwest Marine Trade Association**

**Puget Soundkeeper Alliance**

**Washington State Department of Ecology**

# Boatyard Stormwater Treatment Technology Cost Analysis

June 27, 2008

ARCADIS

# 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


Our Ref.:
B0024602.0000.00004

Date:
June 27, 2008

# Table of Contents

## Tables



## Appendices



## Acronyms and Abbreviation

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

## Executive Summary

Three stormwater treatment technologies were tested for effectiveness in removing pollutants from boatyard stormwater in a pilot study, the results of which are presented in The Boatyard Stormwater Treatment Technology Study (Taylor Associates 2008). Cost estimates for each technology were developed to help determine if they should be considered 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 order-of-magnitude capital and operation and maintenance (O&M) cost estimates necessary for an AKART determination by the Washington State Department of Ecology (Ecology).

In order to develop a common basis of costing, a typical boatyard was considered to be two acres of flat, impervious surface with one stormwater outfall. Based on a survey of boatyards, the typical boatyard does not have all necessary infrastructure in place to effectively collect stormwater. The following four cost estimates were developed:

- StormwateRx® Aquip™ capital and O&M costs
- Siemens Water Technologies, Inc. Wastewater Ion Exchange System (WWIX) capital and O&M costs
- Water Tectonics, Inc. Wave Ionics™ Electro-Coagulation System capital and O&M costs
- Drainage improvement and infrastructure capital and O&M costs

A net present value (NPV) analysis was performed based on 15-year project life. The results of the NPV suggested that StormwateRx® Aquip™ and the Water Tectonics Wave Ionics™ systems had similar NPVs of approximately $220,000 to $230,000 for a typical 2-acre boatyard. The Siemens Water Technologies WWIX system NPV was over three times the cost of the other two technologies. Site improvements for a typical 2-acre boatyard are estimated to contribute to approximately one-half of the total cost to install and operate a stormwater treatment technology.

## 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 were developed in order to determine if they should 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 and necessary site drainage improvements for a typical boatyard to comply with the Boatyard General Stormwater Permit. The results, in conjunction with pilot study treatment results, will be used by the Washington State Department of Ecology (Ecology) to determine AKART for the Boatyard General Permit.

The costs presented in the report are based on installing and maintaining treatment systems and do not include the cost of implementing source control (operational or structural) best management practices (BMPs). Source control BMPs were assumed to have already been implemented at the boatyards. Typical site improvement costs for the purpose of promoting stormwater drainage to a treatment system are included in the analysis. Other site-specific costs, such as installing an outfall, are not included because they are not considered representative of a typical boatyard.

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

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

Boatyards have varying levels of existing stormwater infrastructure. A number of boatyards were surveyed for existing conditions. Approximately 60% did not have complete stormwater collection infrastructure. Of the boatyards that did not currently have complete stormwater infrastructure, 50% to 75% would need significant regrading 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 identified.

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 aboveground 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 existing outfall pipe that discharges to the receiving water.

The primary contaminants of concern in the stormwater from a typical boatyard are copper, lead and zinc. It is assumed for this analysis that each of the three stormwater treatment technologies is effective in treating these contaminants, even through the Boatyard Stormwater Treatment Technology Study (Taylor Associates 2008) demonstrated differing capabilities among the technologies.

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 BMP. Therefore, a flow rate of 70 gpm 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 area of the boatyard by 91%. The annual precipitation in Seattle, Washington, typically ranges from 37 inches to 39 inches. Therefore, the annual volume of water to be treated is estimated at 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 (NPV) 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

Section 5: References

## 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 aboveground 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 in height. The filtration chamber includes a 27-inch thick layer of 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 per 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., odd years 1, 3, 5, receive seasonal maintenance; even 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, raking 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. Routine maintenance is assumed to require a total of 60 hours per year and cost $1,800 annually. Solids removed from the pre-treatment chamber are assumed to be non-hazardous and cost $100 annually to dispose. 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, including collection, shipping, and laboratory analysis.

- **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 granular activated carbon (GAC) to remove organics and/or oxidizers prior to the ion exchange tanks. The second tank includes an ion exchange resin to remove lead. The third and fourth tanks contain ion exchange resins to 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 aboveground bag filters, flow through each of the WWIX tanks in series, and then flow by gravity to the outfall.

Siemens Water Technologies rents but does not sell the ion exchange tanks; this cost 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 are used to select the ion exchange resin, which may affect total 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 per 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 vary 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:

- **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. The regeneration cost for each tank 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 four labor hours per month which costs $1,440 annually.

- **Metals breakthrough monitoring.** Replacement of the tanks is based on when one or more metals are 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, including collection, shipping, and laboratory analysis. 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 aboveground 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 per 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 by adding a small chemical dosage 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 8 labor hours per month, which costs $2,880 annually. Solids removed from the cells are assumed to be non-hazardous and cost $200 annually to dispose.

- **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 is $1000.

## 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. It is assumed that a typical 2-acre boatyard has one existing outfall that can be utilized for stormwater discharge.

Permitting and site 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 regrading 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 regrading and resurfacing. For the purpose of this cost estimate, it is assumed that 50% of a typical boatyard requires regrading and resurfacing.

All of the cost estimates provided in this section are from the Heavy Construction Cost Data 2008 engineering 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.

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

- **Asphalt resurfacing.** Asphalt resurfacing will be needed if regrading 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 the heavy construction cost guide.

- **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 4-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 one hour each and be performed monthly.

## 4. Cost Analysis Results

### 4.1 Results

The total costs for the three candidate stormwater treatment technologies and typical site improvements are presented in Tables 1 through 4, following Section 5. An 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% that has been adjusted to account for the effect of expected inflation 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 NPV of each option.

**Table 5: 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 | $262,000 |
| Annual O&M Costs (Year 1-15) | $14,000 | $80,000 | $9,000 | $3,000 |
| Present Value of O&M Costs | $128,000 | $729,000 | $82,000 | $27,000 |
| **Net Present Value** | **$219,000** | **$810,000** | **$230,000** | **$290,000** |

Since the boatyards range in sizes from 0.2 acres to 5 acres, the total cost and NPVs 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.

**Table 6: 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 | $131,000/acre |
| Annual O&M Costs (Year 1 to 15) | $7,000/acre | $40,000/acre | $4,500/acre | $1,500/acre |
| Present Value of O&M Costs | $64,000/acre | $364,000/acre | $41,000/acre | $14,000/acre |
| **Net Present Value** | **$110,000/acre** | **$405,000/acre** | **$115,000/acre** | **$145,000/acre** |

The annual O&M costs show a large variation for the Siemens Water Technologies WWIX. This is because the system is rented from the vendor on an annual basis, instead of purchased in Year 0. This annual rental is approximately 50% of 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 Ionics™ 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 design, it may be cost effective to include additional equalization so that a smaller treatment system can be installed.

#### 4.2 Discussion

Some key findings of the cost analysis are:

- The StormwateRx® Aquip™ and the Water Tectonics Wave Ionics™ systems had similar NPVs of approximately $220,000 to $230,000 for a typical 2-acre boatyard.

- The Siemens Water Technologies WWIX system NPV 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® Aquip™ incorporates these processes in the same tank as the metals removal.

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

- The NPV analysis 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 structural BMPs on a 1-acre commercial site. Operational source control BMPs were not included in that capital cost estimate for a 1-acre commercial site. The differences in costs presented in this analysis result from the selection of BMPs and that the development costs in this analysis assume only 50% of the site requires regrading and resurfacing.

Although not considered in this cost analysis, there may be operational and structural BMPs that can be implemented in order to lower the cost of treatment BMPs. Boatyards may be able to save costs by removing portions of the site from industrial contact with rainfall or surface runoff. For example, galvanized structural materials can be converted to an inert condition through either material substitution or coating surfaces. Both site development costs and treatment costs could be reduced. The following conceptual examples illustrate the potential cost savings:

- If industrial activity is stopped on one half acre of the typical site that needs drainage improvements, there will be savings accrued by only needing to treat the runoff from 75% of the site and improve drainage on 25% of the site.

- If industrial activity is stopped on one acre of the typical site that needs additional drainage improvements, there will be savings accrued by only needing to treat the runoff from 50% of the site.

- If galvanized roofing is coated with an inert substance, the runoff from that roof would not need to be treated, therefore, reducing the treatment unit sizing and costs.

#### 4.3 Limitations

Each cost estimate includes a contingency to account for the uncertainty of the unit costs used in the estimate. However, there are some costs that have not been considered in this report. Some of these costs could 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 treatment requirements due to levels of pollutants significantly higher than in the pilot study boatyards.

- Additional site improvements costs incurred when the water level at the point of discharge is very close to the boatyard ground level. This is not considered typical for the boatyards.

- Additional site improvement costs incurred to promote effective stormwater drainage and collection. This is not considered typical for the boatyards.

- Additional site improvement costs incurred when unknown obstacles, such as contaminated soil, are encountered. This is not considered typical for the boatyards.

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.

## 5. References

Washington State Department of Ecology. 2005. Stormwater Management Manual for Western Washington. Publication Numbers 05-10-029 through 05-10-033. February.

Herrera Environmental Consultants, Inc. 2001. Cost Analysis – Washington Department of Ecology Year 2001 Minimum Requirements for Stormwater Management in Western Washington. Prepared for Washington State Department of Ecology and Washington State Department of Transportation. August.

RSMeans. 2007. Heavy Construction Cost Data 2008. 22nd Edition.

Taylor Associates, Inc. 2008. Boatyard Stormwater Treatment Technology Study. Prepared For Northwest Marine Trade Association, Puget Soundkeeper Alliance, Washington State Department of Ecology. March.

USEPA. 2000. A Guide to Developing and Document Cost Estimates During the Feasibility Study. Publication number EPA 540-R-00-002. July.

ARCADIS

**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 (ROUNDED TO THE NEAREST $1,000)** | | | | **$91,000** | |

**ANNUAL O&M COSTS:**

| DESCRIPTION | UNIT | QTY | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| Routine (occurs every year) | | | | | |
| Raking top layer of media | 12 | HR | $30 | $360 | 3 labor hours per quarter |
| Monthly inspections and maintenance | 48 | HR | $30 | $1,440 | 3 labor hours per month |
| Solids removal and disposal | 1 | LS | $100 | $100 | Solids removal (non-hazardous) from pre-treatment chamber |
| Metals breakthrough monitoring | 12 | EA | $200 | $2,400 | 1 sample per month, includes collection and sampling |
| SUBTOTAL | | | | $4,300 | |
| 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 | | | | $10,870 | |
| Contingency | 25% | | | $2,718 | |
| **TOTAL ANNUAL O&M COST (ROUNDED TO THE NEAREST $1,000)** | | | | **$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.

ARCADIS

**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 (ROUNDED TO THE NEAREST $1,000)** | | | | **$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 | | | | $30,570 | |
| Routine Maintenance | | | | | |
| Monthly inspections and maintenance | 48 | HR | $30 | $1,440 | 4 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 | | | | $63,370 | |
| Contingency | 25% | | | $15,843 | |
| **TOTAL ANNUAL O&M COST (ROUNDED TO THE NEAREST $1,000)** | | | | **$80,000** | |

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.

ARCADIS

**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 | $80,000 | $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 (ROUNDED TO THE NEAREST $1,000)** | | | | **$148,000** | |

**ANNUAL O&M COSTS:**

| DESCRIPTION | UNIT | QTY | UNIT COST | TOTAL | NOTES |
|---|---|---|---|---|---|
| System operations | | | | | |
| Electricity | 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 |
| Solids removal and disposal | 1 | LS | $150 | $200 | Solids removal (non-hazardous) from cells |
| Monthly inspections and maintenance | 96 | HR | $30 | $2,880 | 8 labor hours per month |
| SUBTOTAL | | | | $6,082 | |
| Parts replacement (based on 15 year project) | | | | | |
| Sand filter control | 1 | LS | $200 | $200 | |
| Pumps | 1 | LS | $300 | $300 | |
| Miscellaneous parts | 1 | LS | $500 | $500 | |
| SUBTOTAL | | | | $1,000 | |
| SUBTOTAL | | | | $7,082 | |
| Contingency | 25% | | | $1,771 | |
| **TOTAL ANNUAL O&M COST (ROUNDED TO THE NEAREST $1,000)** | | | | **$9,000** | |

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.

ARCADIS

**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 |
| Site Survey | 1 | LS | $5,000 | $5,000 | For existing site topography |
| 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 | $30 | $145,200 | 50% of site (Note 2), includes materials and construction |
| SUBTOTAL | | | | $159,473 | |
| Piping and Catch Basin Installation | | | | | |
| Trenching, 4' wide, 4 ft deep | 500 | LF | $7.15 | $3,575 | Includes excavation, backfill and removal of spoil |
| 8" HDPE pipe | 500 | LF | $17 | $8,500 | Includes materials and installation |
| 8" HDPE elbows | 3 | EA | $230 | $690 | Includes materials and installation |
| Asphalt patching of 4' wide trench | 222 | SY | $35 | $7,778 | Includes materials and installation |
| Catch basin, 48" riser, 4 ft deep | 4 | EA | $2,575 | $10,300 | Includes excavation, installation and removal of spoil |
| SUBTOTAL | | | | $30,843 | |
| SUBTOTAL | | | | $196,315 | |
| Mobilization and demobilization | 10% | | | $19,632 | |
| SUBTOTAL | | | | $215,947 | |
| Contingency | 10% | | | $21,595 | |
| SUBTOTAL | | | | $237,542 | |
| Design Cost | 10% | | | $23,754 | |
| **TOTAL CAPITAL COST (ROUNDED TO THE NEAREST $1,000)** | | | | **$262,000** | |

**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 (ROUNDED TO THE NEAREST $1,000)** | | | | **$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.