Quality Assurance Project Plan

Stormwater Quality Survey of Western Washington Log Yards

by
Steven Golding

Washington State Department of Ecology
Environmental Assessment Program
Olympia, Washington 98504-7710

December 2003

Publication No. 03-03-113

This plan is available on the Department of Ecology home page on the World Wide Web at http://www.ecy.wa.gov/biblio/0303113.html

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December 2003

Approvals

Approved by:	November 24, 2003
Keith Johnson, Client, WQ-Program Development Services Section	Date
Approved by:	November 24, 2003
Dewey Weaver, Stormwater Unit Supervisor, WQ-PDS Section	Date
Approved by:	November 25, 2003
Melodie Selby, Section Manager, WQ-PDS Section	Date
Approved by:	November 20, 2003
Steven Golding, Project Manager, Watershed Ecology Section	Date
Approved by:	November 17, 2003
Dale Norton, Unit Supervisor, Toxics Studies Unit	Date
Approved by:	November 20, 2003
Will Kendra, Section Manager, Watershed Ecology Section	Date
Approved by:	November 26, 2003
Stuart Magoon, Director, Manchester Environmental Laboratory	Date
Approved by:	December 2, 2003
Cliff Kirchmer, Ecology Quality Assurance Officer	Date

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Abstract

Effective April 2003, permittees under the Industrial Stormwater General Permit have been required to provide self-monitoring data for a limited number of water quality parameters. This survey-level study of western Washington log yards will provide independent data for a broad array of parameters. Discrete samples will be collected at six facilities during three storm events and at two times per event. The resulting data will provide a representation of water quality from typical western Washington log yards and a description of variability between facilities. The effectiveness of current required parameters and sampling time requirements for log yards under the Industrial Stormwater General Permit will be assessed.

Background and Problem Statement

Effective April 2003, permittees are required for the first time to report self-monitoring data under the Industrial Stormwater General Permit. Permit coverage is required for industrial facilities that have specific Standard Industrial Classification (SIC) codes, if they have stormwater discharge from their industrial areas to a receiving water of the state or to storm drains that discharge to a receiving water. Self-monitoring parameters for all industrial facilities include turbidity, pH, zinc, and oil and grease. Log yards are required, in addition, to monitor BOD_5. Other parameters dependent upon industrial groups include ammonia, phosphorus, copper, lead, and hardness. Facilities discharging to 303(d) listed waters are required to monitor for listed parameters. Landfills are also required to sample for specific additional parameters. Samples are required to be collected during the first hour of stormwater discharge from the facility.

Other than the limited set of parameters for monitoring required by the General Permit, little data are available to characterize the quality of stormwater discharged from western Washington log yards. One requirement of self-monitoring is that stormwater discharge samples be collected during the first hour of discharge. However, information has not been available to characterize stormwater discharge quality as a function of time.

This survey of stormwater from western Washington log yards is intended as the first of three one-year studies of different industry types. Log yards were selected as the first subject of study, and auto recyclers as the second, because a significant portion of permittees are of these industry types, both involve outdoor activities, and both have the potential for water quality problems associated with stormwater discharges. The subject of the third-year of study has not been determined, but the choice is expected to be made, in part, based on results of self-monitoring data.

Results from a study of runoff from 12 log sort yards on the Tacoma tideflats appeared in a 1985 technical memorandum (Norton and Johnson, 1985). Samples were collected one day per month during a six-month period. Results from a suite of metals analyses are summarized in Table 1.

Table 1. Summary of Results from Tacoma Tideflats Runoff, 1985.

	TSS (mg/L)	Arsenic (µg/L)	Zinc (µg/L)	Copper (µg/L)	Lead (µg/L)	Nickel (µg/L)	Antimony (µg/L)	Cadmium (µg/L)
Maximum	3,000	12,000	5,340	4,000	2,470	325	380	16
Minimum	11	32	170	84	9	6	<1	<0.2
Mean	719	2,784	1,430	702	425	73	67	2.2
Median	265	2,165	1,135	252	234	60	64	1.7

As shown in Table 1, metals concentrations were high in stormwater runoff from Tacoma area log sort yards. The Industrial Stormwater General Permit issued August 21, 2002 specifies benchmark concentrations for zinc, copper, and lead of 117, 63.6, and 81.6 µg/L respectively. Benchmark values are indicator values. Values at or below benchmark are considered unlikely to cause a water quality violation. The 1985 study data show all runoff samples exceeding what were to become zinc and copper benchmarks, and most exceeded the lead benchmark.

The study concluded that the use of ASARCO smelter slag for ballast at the yards appeared to be the major source of elevated metals seen in the runoff as well as nearshore surface water and sediment samples collected during the study. The current study will include log yards in the Tacoma area.

Beyond the study mentioned above and limited data from log yards outfalls associated with industrial NPDES permits, little information is available on metals concentrations in runoff from typical log yards across western Washington. The Industrial Stormwater General Permit issued in 2002 required permittees to monitor and report data from their stormwater discharges beginning in April 2003. Statewide results from log yards for the first required reporting period, April-June 2003, are summarized in Table 2.

Table 2. Summary of Results from Statewide Log Yards, April – June 2003.

	Turbidity (NTU)	pH (S.U.)	Zinc (µg/L)	Oil and Grease (mg/L)	BOD_5 (mg/L)
Maximum	2,470	9.3	4,640	48	191
Minimum*	1; ND	5.0	13; ND	1; ND	2.2; ND
Mean	121.6	6.5	411	3.4	29.6
Median	29	7.0	156	ND	14.6
Benchmark	25	6-9	117	15	30

* minimum reported value is listed as well as ND for "non-detected analyte"

Zinc, the only metal analyzed in both the 1985 study and reported in 2003, was found in similar maximum concentrations but lower mean and minimum concentrations in the statewide self-reported data. This is consistent with the statement that ASARCO slag may be responsible for elevated metals concentrations in runoff from log sort yards in the Tacoma tideflats.

A comparison of median and benchmark values shows that most log yards reported results above benchmark values for turbidity and zinc, while most were within benchmark values for oil and grease and BOD_5. If the value for total zinc exceeds the benchmark for two consecutive quarters, the permittee is required to sample for copper and lead as well as zinc.

Project Description

This is the first of three annual studies proposed to focus on three industrial groups, beginning with the log yard industry. In this study, individual samples will be collected at two times during each storm event, and a broad range of water quality parameters will be included. The data developed through this study will serve as the basis for a determination of the effectiveness of current self-reporting requirements for parameters to be sampled as well as the timing of sampling. This study will also provide information on a broad range of constituents in stormwater from western Washington log yards.

Six permitted facilities with log yards will be selected for a thorough evaluation of their stormwater discharge quality. This study will be limited to western Washington because it has a distinctly different climate and soil characteristic than the eastern portion of the state. The winter weather pattern of western Washington is typically of storm events that overlap, causing long periods of precipitation for days or even weeks at a time. Logistical limitations and resources require that this study include only the western portion of the state and be limited to six facility sites within 100 roadway miles of Olympia.

In order to assess the variability of pollutant concentrations between storm events, three storm events will be monitored at each facility. This assessment will provide for an indication of the efficacy of characterizing stormwater quality at each facility, with the current self-monitoring requirement of a single grab sample for each analyte per quarter.

Project Objectives

Objectives of the study include:

- Survey stormwater discharge quality from representative western Washington log yards.
- Replicate the sampling and analysis for parameters required for self-reporting while including additional parameters.
- Evaluate stormwater quality at two times during the first hour of discharge.
- Assess the efficacy of current required parameters and sampling time requirements for log yards under the Industrial Stormwater General Permit.

Responsibilities

- Steven Golding, Environmental Assessment (EA) Program, Project Manager. Prepares Quality Assurance (QA) Program Plan, collects data, prepares draft and final report. Phone 360-407-6701.

- Dale Norton, EA Program, Toxics Studies Unit Supervisor. Reviews QA Project Plan and report. Phone 360-407-6765.

- Stuart Magoon, Manchester Environmental Laboratory Director. As manager, oversees laboratory analyses and QA. Phone 360-871-8801.

- Cliff Kirchmer, Ecology Quality Assurance Officer. Reviews QA Project Plan. Phone 360-407-6455.

- Carolyn Lee, EA Program. Enters data into EIM database. Phone 360-407-6430.

Schedule

Field Work:	November 1, 2003 – April 30, 2004
Laboratory Analysis:	November 2003 – June 2004
Draft Investigative Report:	September 2004
Final Investigative Report:	November 2004

Project Costs

The total estimated laboratory cost is $24,196 as shown in Table 3.[1]
Estimated EA Program Staff Time = 0.4 FTE

Table 3. Estimated Lab Costs.

Parameter (analyte)	Cost each analysis	Number of						Total # of samples for analysis	Total cost
		Locations	Events	Samples	Field reps	Spikes/ dupes	Trnsfr blanks		
TSS	10	6	3	2	7	--	--	43	430
Hardness	12	6	3	2	7	--	--	43	516
Turbidity	9	6	3	2	7	--	--	43	387
BOD_5	49	6	3	2	7	--	--	43	2,107
NH_3	13	6	3	2	7	--	--	43	559
NO_3	13	6	3	2	7	--	--	43	559
Total P	16	6	3	2	7	--	--	43	688
O&G	50	6	3	2	7	--	--	43	2,150
Metals*	231	6	3	2	7	4	2	49	11,319
TPH-DX	102	6	1	1	1	--	--	7	714
TPH-GX	78	6	1	1	1	--	--	7	546
PAH	253	6	1	1	1	--	--	7	1,771
Daphnia bioassay**	438	6	1	1	1	--	--	7	3,063
Total Estimated Project Cost									24,809

* Priority Pollutant metals, total recoverable, low-level, non-Teflon bottles
** Acute test, contract laboratory estimated cost of $350 each plus 25% Manchester Laboratory quality control fee

Selection of Analytes

Analytes to be included in this project have been selected to represent a broad range of water quality parameters of potential concern.

- All parameters required for self-monitoring.
- All priority pollutant metals.
- Total suspended solids (TSS) and turbidity are parameters related to solids.
- Hardness is included because water quality criteria for many metals are hardness dependent.
- Nutrients including ammonia (NH_3), nitrate (NO_3) and total phosphorus (Total P) are a common pollutant in stormwater runoff.
- Total petroleum hydrocarbons associated with diesel (TPH-DX) and gasoline (TPH-GX) fuels as well as polynuclear aromatic hydrocarbons (PAHs) may be associated with industrial stormwater runoff.
- A daphnia *pulex* acute bioassay test indicates overall acute toxicity from these and other potential pollutants in the stormwater runoff being discharged.

[1] Costs include 50% discount for Manchester Laboratory

pH and temperature will be determined in the field. Results of measurements of pH will be compared with results of measurements using pH paper strips. This will provide an indication of the value of the use of pH strips as a potential, simple means of permittees obtaining a measure of pH.

Discharge flow will be estimated where possible to provide for calculations of estimated pollutant loadings.

Measurement Quality Objectives

Data quality should be consistent with obtaining reliable, representative data for purposes of comparison with self-monitoring data that have reduced data quality requirements. Data quality should also be sufficient to make comparisons with benchmarks specified in the General Permit as well as water quality criteria for metals.

Reporting limits and measurement quality objectives are included in Table 4. Required reporting limits are based on the more stringent of benchmark or acute freshwater criterion. Antimony and thallium required reporting limits are based on human health criteria.

All metals analyses in Table 4 are total recoverable with the exception of total mercury. A hardness of 20 mg/L was found to be typical from April-June 2003 self-monitoring under the Industrial Stormwater General Permit. Hardness-dependent metals criteria in Table 4 are based on this assumed hardness value. The required reporting limits that appear in the table are set at 10% of the benchmark or criterion.

Table 4. Benchmarks and Reporting Limits

Parameter	Accuracy (% deviation from true value)	Precision (RSD)	Bias (% of true value)	Required Reporting Limit (concentration units)
pH	+/- 0.1 SU	--	--	NA
TSS	25	10	5	1 mg/L
Hardness	25	10	5	1 mg/L
Turbidity	20	--	--	0.5 NTU
BOD_5	NA	--	--	1 mg/L
NH_3	25	10	5	0.01 mg/L
NO_3	25	10	5	0.01 mg/L
Total P	25	10	5	0.01 mg/L
Oil & Grease	20	--	--	5 mg/L
Arsenic (As)	25	10	5	36 µg/L
Silver (Ag)	25	10	5	0.022 µg/L
Antimony (Sb)	25	10	5	1.4 µg/L
Beryllium (Be)	25	10	5	--
Cadmium (Cd)	25	10	5	0.065 µg/L
Chromium (Cr)	25	10	5	1.5 µg/L
Copper (Cu)	25	10	5	0.46 µg/L
Mercury (Hg)	25	10	5	0.21 µg/L
Lead (Pb)	25	10	5	1.39µg/L
Nickel (Ni)	25	10	5	43.8 µg/L
Selenium (Se)	25	10	5	3 µg/L
Thallium (Tl)	25	10	5	0.17 µg/L
Zinc (Zn)	24	10	5	3.54 µg/L
TPH-DX	25	10	5	0.1 mg/L
TPH-GX	25	10	5	0.12 mg/L
PAH	40	10	20	5 µg/L mg/L
Daphnia acute bioassay	Not available	Not available	Not available	NA

Study Design

Three storm events will be sampled at each of the six log yards included in the study. Analytes for this study are to include those considered to be of potential concern for industrial stormwater discharges. Sampling visits will take place during the winter wet season, defined as being between November 1 and April 30. All samples will be collected as grab (individual) samples consistent with the requirements of the Industrial Stormwater General Permit:

- Each storm event must be preceded by at least 24 hours of no measurable precipitation.
- Each storm event must be an intensity of at least 0.1 inches of rain in a 24-hour period.
- The discharge must capture stormwater with the greatest exposure to significant sources of pollution. The discharge point believed to have the highest concentration of pollutants will be sampled.
- All grab samples must be taken within the first hour after discharge begins.
- All samples will be taken as close to the point of discharge as reasonably practical and can be achieved safely as required by the Industrial Stormwater General Permit and described in *How to Do Stormwater Sampling: A guide for industrial facilities* (Ecology, 2002).

Site Selection

Log yard sites to be selected for the study will be in western Washington, within a 100-mile driving radius of Olympia. The sites will be chosen with the criterion that they be scattered evenly across the study area. For small sample sizes, this method of site selection can be expected to result in a more even geographical distribution of sites than would be achieved with true random site selection.

The sites will be located within a driving distance of Olympia from which sampling personnel from headquarters can be prepared to arrive during a storm event and sample during the first hour of discharge. Log yard operators will be contacted before the study begins. Only those log yards agreeing to allow Ecology personnel to sample will be included in the study. Log yards chosen for the study will be categorized by characteristics including size, best management practices (BMPs), amount of site activity, and paved or unpaved surfaces.

Field Procedures

The project manager will identify the major discharge from each facility as defined by the Industrial Stormwater General Permit. In cases where there is more than one discharge, this will be the discharge with maximum exposure to ground disturbance or equipment operations or the discharge believed to have the highest concentration of pollutants. A sampling site will be determined for each facility. This site will be selected at a distinct discharge point when possible where the discharge is flowing rapidly and well-mixed. The location of each facility's sampling point will be determined with a portable GPS receiver. The same sampling site for each facility

will be maintained throughout the study. The project manager will document the way in which the discharge and sampling point was determined.

Samples will be collected directly into sample containers using powder-free nitrile gloves or with the container attached to a pole. Sampling containers will be held with container openings facing upstream to prevent contamination during sampling. The samples will be given a field identification, tagged, and kept cool at 4ºC. Chain-of-custody procedures will be observed, and samples will be delivered to the laboratory within the allowable holding times for each parameter.

A summary of parameters, collection containers, preservation, and holding times appears in Table 5.

Table 5. Sample Size, Container, Preservation, and Holding Time by Parameter.

Parameter (analyte)	Sample Size	Container	Preservation	Holding Time
TSS	1000 mL	1000 w/m poly	cool to 4ºC	7 days
Hardness	100 mL	125 mL n/m poly	cool to 4ºC, H_2SO_4 to pH<2	6 months
Turbidity	500 mL	500 mL w/m poly	cool to 4ºC	48 hours
BOD_5	2000 mL	1 gallon cubitainer	cool to 4ºC	48 hours
NH_3	125 mL	125 mL clear w/m poly	cool to 4ºC, H_2SO_4 to pH<2	28 days
NO_3	(2 bottles) 125 mL each	125 mL amber *and* clear w/m poly	cool to 4ºC, H_2SO_4 to pH<2 in clear	48 hours
Total P	125 mL	125 mL clear w/m poly	cool to 4ºC, H_2SO_4 to pH<2	28 days
Oil & Grease	500 mL (dirty or turbid) to 750 mL (clean)	1 L glass jar (narrow mouth)	cool to 4ºC, HCl to pH<2	28 days
PP Metals	500 mL	1 L HDPE	HNO_3 to pH<2	6 months
TPH-DX	1000 mL to 1 gallon	1000 mL to 1 gallon glass jar	cool to 4ºC, HCl to pH<2	7 days
TPH-GX	40 mL	40 mL vial with septum	cool to 4ºC	14 days
PAH	1 gallon	1 gallon organics-free glass jar	cool to 4ºC	7 days
Daphnia acute bioassay	1 gallon	1 gallon organics-free glass jar	cool to 4ºC	36 hours

Analytical Procedures

The samples will be analyzed at the Ecology Manchester Laboratory using the following analytical methods. A summary of laboratory procedures for the analysis of project samples appears in Table 6.

Table 6. Analytical Procedures and Anticipated Range of Results (sample matrix is water).

Analyte	Samples [number/ arrival date]	Anticipated Range of Results	Sample Prep Method	Analytical Method	Method Reporting Limit
TSS	43/ Nov '03-Apr-04	5-3,000 mg/L	--	Std Methods 2540	1 mg/L
Hardness	43/ Nov '03-Apr-04	1-300 mg/L	--	Std Methods 2340B	1 mg/L
Turbidity	43/ Nov '03-Apr-04	<1-2,500 NTU	--	Std Methods 2130	0.5 NTU
BOD_5	43/ Nov '03-Apr-04	<1-200 mg/L	--	EPA 405.1 or Std Methods 5210B	1 mg/L
NH_3	43/ Nov '03-Apr-04	not available	--	EPA 350.1	0.01 mg/L
NO_3	43/ Nov '03-Apr-04	not available	--	EPA 353.2	0.01 mg/L
Total P	43/ Nov '03-Apr-04	not available	--	EPA 365.3	0.01 mg/L
Oil & Grease	43/ Nov '03-Apr-04	<1-50 mg/L	--	EPA 1664 Rev. A	5 mg/L
PP Metals	49/ Nov '03-Apr-04	Zn: 2-6,000 µg/L As: 10-12,000 µg/L Cu: 10-4,000 µg/L Pb: 2-3,000 µg/L Ni: 1-400 µg/L Sb: <1-500 µg/L Cd: <0.2-20 µg/L	digested with mixture of nitric acid and hydrochloric acid	EPA 200 series	0.1 ug/L except Cr:0.5 Hg:0.05 Se:0.4 Zn:1
TPH-DX	7/ Nov '03-Apr-04	not available	--	(Ecology, 1997)	0.1 mg/L
TPH-GX	7/ Nov '03-Apr-04	not available	--	(Ecology, 1997)	0.12 mg/L
PAH	7/ Nov '03-Apr-04	not available	--	SW846, Method 3500, modified, 8310	1-5 ug/L
Daphnia acute bioassay	7/ Nov '03-Apr-04	not available	--	EPA 2021.0 and 2002.0	NA

NA – not available

Anticipated ranges of results are based on data summarized in the background portion of this report. Data within Ecology and outside sources for water quality parameters in log yard stormwater runoff are limited. Therefore, anticipated ranges are not available for some analytes.

The required reporting limits listed in Table 4 are met by the method reporting limits of Table 6 with the following exceptions:

- The required reporting limit of 0.022 µg/L for silver is not met by the method reporting limit of 0.1 µg/L. Although the acute freshwater criterion of 0.22 µg/L is not 10 times the method reporting limit, as would be desirable, it is about twice the limit.

- The required reporting limit of 0.065 µg/L for cadmium is not met by the method reporting limit of 0.1 µg/L. Although the acute freshwater criterion of 0.65 µg/L is not 10 times the method reporting limit, as would be desirable, it is about six times the limit.

Because this is a survey-level study, the method reporting limits for silver and cadmium, though not 10 times the criteria as would be desirable, are acceptable.

Quality Control Procedures

Field

Samples will be collected with proper technique as described in the *Field Procedures* section of this QA Project Plan. Documented calibration of pH meters before and after use each day will assure continuing calibration. Field replicates will be collected as shown in Table 3. Transfer blanks for metals will be prepared in the field by transferring deionized blank water to a sample container and transporting the blanks for analysis as samples.

Laboratory

One laboratory replicate will be analyzed per 20 samples. Spike and spike duplicate samples for metals samples will be performed. The laboratory will select check standards to be analyzed. Because the samples are expected to range considerably in concentration, particular reference concentrations are not being requested.

Data Reduction and Management Procedures

Data will be summarized, and a profile of log yard stormwater discharges included in the study will be developed. Mean and mode values will be determined to represent typical results. Results will also be summarized as top and bottom 25% quartile. An effort will be made to correlate results with the site characteristics listed in the *Site Selection* portion of this QA Project Plan as well as to precipitation patterns. Comparisons will be made of data from samples taken after 20 minutes of discharge to that taken after one hour. Data variability between the three storm events sampled at each facility will also be assessed.

Data Verification and Validation

Data generated in the laboratory will be verified by Manchester Laboratory, and a case narrative prepared and submitted to the project manager. Data will be reviewed for reasonableness and consistency and validated by the project manager. The project manager will confirm that the data meets the measurement quality objectives of the project.

Data Quality Assessment

The project manager will examine the complete data package to determine whether the data can be used to meet the project's objectives. Calibration, blank, surrogate and spike recoveries, and check standard results will be reviewed and compared with acceptance limits. Because this is a survey-level study with no regulatory or decision criteria, data quality will not be assessed relative to any water quality criteria.

Sampling and analytical precision will be assessed by calculating relative percent differences (RPDs) for field replicates and laboratory duplicates. Check standards will provide an indication of laboratory precision. Spike and laboratory control sample results may provide a measure of bias.

Data Reporting

The final report will include a map of the study area showing approximate locations of sites included in the study. Specific sites will not be identified in the study report. Aggregate results for each parameter as well as raw data will be presented. Pollutant concentrations between the 20-minute and one-hour collection times will be compared. Comparisons and correlations between water quality parameter concentration, site characteristics, and precipitation patterns will be made and discussed. Data will be compared with self-reporting data when available.

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