The Lower Nooksack River: Metals in Sediments Upstream and Downstream of the Ferndale Wastewater Treatment Plant

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The Lower Nooksack River: Metals in Sediments Upstream and Downstream of the Ferndale Wastewater Treatment Plant

by
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Abstract

During the fall of 2001, the Washington State Department of Ecology conducted a sediment study in the lower Nooksack River near the city of Ferndale. The primary objective was to determine if increased NPDES permit limits for metals in Ferndale's Wastewater Treatment Plant (WWTP) effluent increase accumulation of metals in the river sediments.

Nine sampling sites were selected in the vicinity of Ferndale's WWTP outfall. Sediments were collected from depositional areas and were analyzed for grain size, percent solids, total organic carbon, 13 priority pollutant metals, barium, manganese, and iron.

Total organic carbon values were low. Seven of the nine samples were composed primarily of coarse sediments. All 16 metals were found in low concentrations. Levels of lead and copper, the two metals raised in the 1999 NPDES permit, were well below sediment quality guidelines and typical background concentrations for freshwater sediment in Washington State. All other metals tested, except iron and nickel, were also below the sediment quality guidelines. Levels of iron and nickel appear to have no relationship to the location of the WWTP outfall site.

The results show no accumulation of metals due to the WWTP outfall. Therefore, the increased permit limits for the WWTP outfall do not appear to present a threat to the benthic community of the lower Nooksack River.

Acknowledgements

The author of this report would like to thank the following individuals for their contribution to this study:

- Mark Henderson for helping to develop the study and collect sediment samples.
- Dale Norton for successfully navigating the jet sled through fisherman baited waters.
- Manchester Environmental Laboratory staff for sample handling, tracking, and analyses.
- Cliff Kirchmer for guidance regarding quality assurance and quality control procedures.
- Joan LeTourneau for formatting and editing the final report.

Introduction

The Nooksack River originates in the Mt. Baker Snoqualmie Wilderness Area where it flows through national forest and into the foothills of northwest Washington State. Five miles upstream from where the Nooksack River enters Bellingham Bay, it flows through the city of Ferndale (Figure 1). Ferndale's Wastewater Treatment Plant (WWTP) is located adjacent to the Nooksack River, discharging treated effluent into the river through a side bank, single-port outfall (Figure 2). The WWTP treatment system consists of a main mixing lagoon, three auxiliary lagoons, a chlorine contact chamber, and a fabric effluent filter.

The influent for the plant comes from residential homes and small commercial establishments. Recomp of Washington is the only industrial contributor to the plant (Hoyle-Dodson, 1998). Recomp incinerates and composts municipal solid waste. They employ extensive water recovery and pretreatment processes; a small amount of overflow is generated and discharged to Ferndale's WWTP.

Ferndale's WWTP has limits for the maximum amount of cadmium, mercury, lead, and copper that remain in the discharged effluent. In 1999, the National Pollution Discharge Elimination System (NPDES) permit for Ferndale's WWTP raised the limits for copper and lead. The changes in permit metal limits are shown by the italicized areas of Table 1.

Table 1. Changes in effluent limits measured as the average monthly concentration (ug/L) (Ecology, 2001).

Permit	Copper	Lead	Cadmium	Mercury
NPDES permit limits - 1993	*11.08*	*2.29*	2.54	0.24
NPDES permit limits - 1999	*19*	*30*	2.54	0.24

The increase in metals limits was controversial with local environmental groups; however, the WWTP found it was impractical to decrease the source of metals to their plant, and the Washington State Department of Ecology (Ecology) found that previous limits were overly stringent (Ecology, 1999).

The 1995 Needs Assessments for the Nooksack/San Juan Watershed recommended a sediment characterization study with a focus on Ferndale's WWTP outfall (Carey and Coots, 2000). In 1997 a Class II inspection was conducted; it focused on performance and operation of the facility and did not include river sediment (Hoyle-Dodson, 1998).

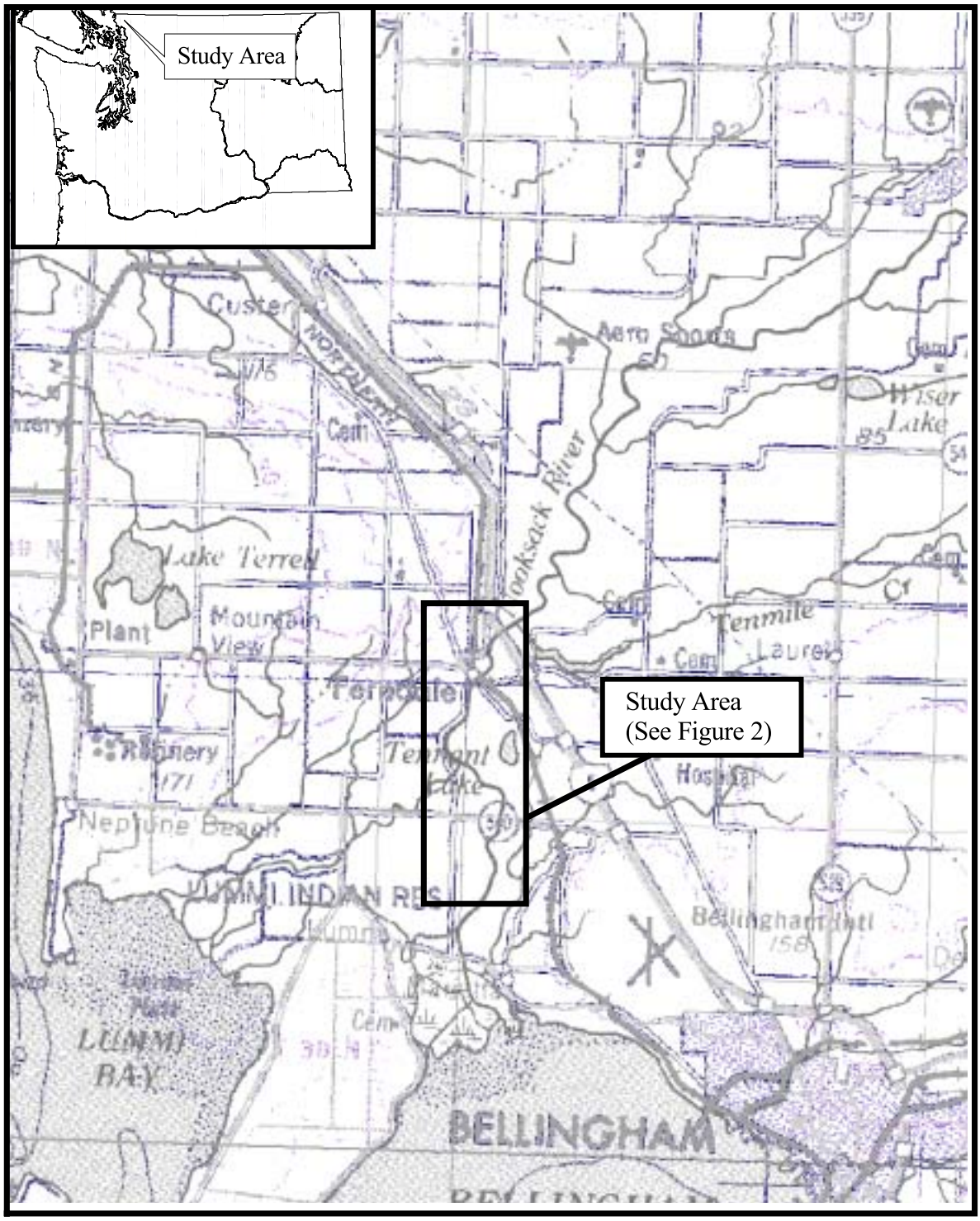
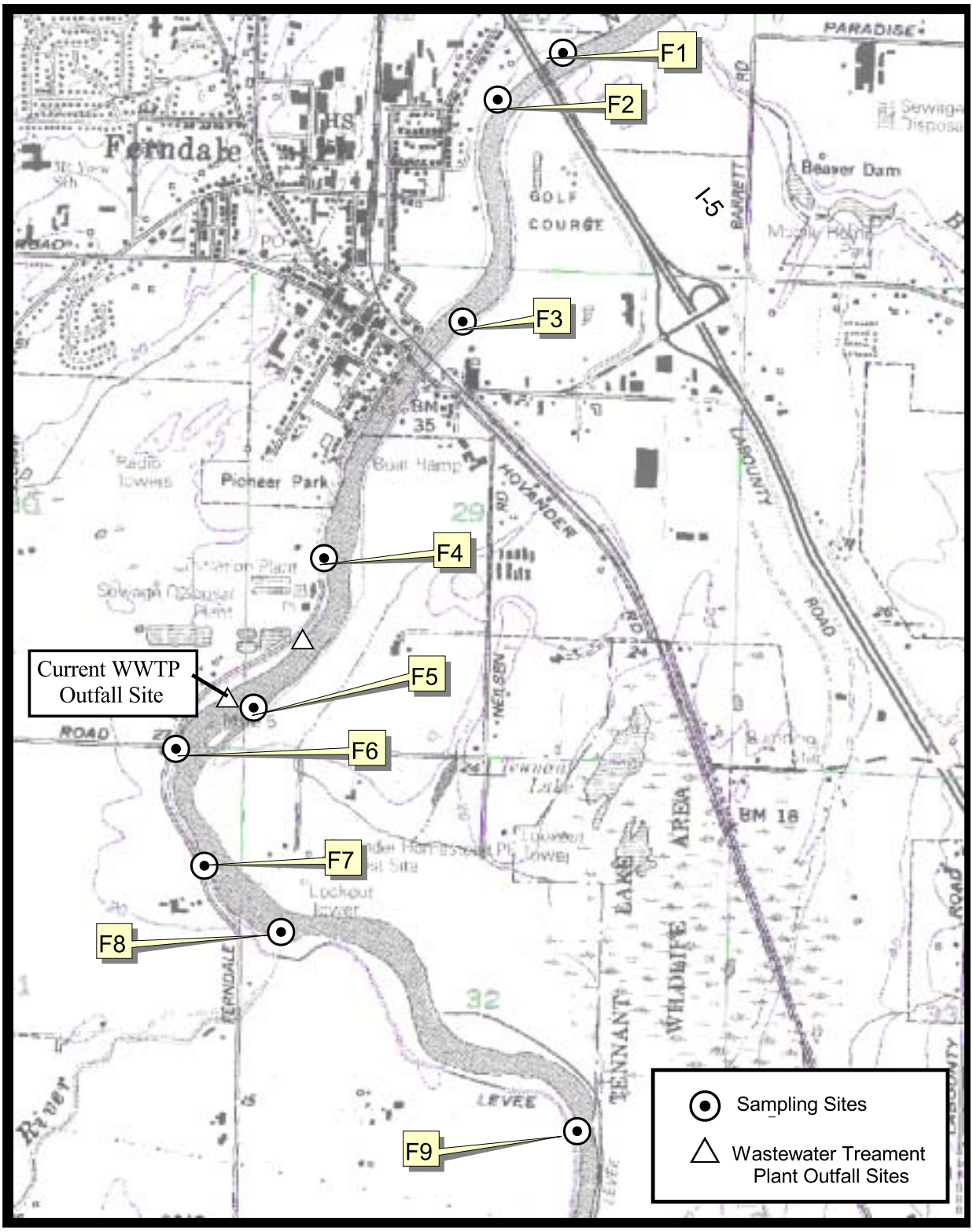


Figure 1: Nooksack River Study Area



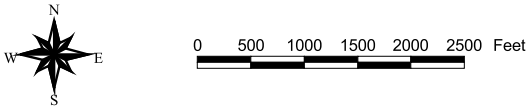


Figure 2. Sampling Sites

A review of Ecology's sediment database (SEDQUAL) found that historical sediment data in the lower Nooksack River were limited to two studies. Neither study showed a correlation between metals accumulation and Ferndale's WWTP (Table 2).

Table 2. Historic concentrations of selected metals in the lower Nooksack River (mg/kg, dw).

Location Relative to WWTP Outfall	n*	Cadmium	Copper	Lead	Zinc	Mercury	Arsenic
Above	4	1.4 (0.5u-2.1)	21.5 (13.5-24.7)	2.8 (1.7-3.9)	50.1 (37.7-62.3)	0.016 (n=1)	5.2 (n=1)
Below	7	1.1 (0.5u-1.7)	14.8 (12.5-17.7)	2.7 (1.3-4.7)	42.0 (57.2-29.7)	.006u (n=2)	1.7 (1.3-2.1) (n=2)

Sources: Ruiz, 1989; Berryman & Henigar, 1997
u - Analyte was not detected at or above the reported value
* - Sample size is as follows, unless otherwise noted

Objectives of Present Study

The primary objective of this study was to assess whether the new permit limits increased the accumulation of metals below the WWTP outfall. A secondary objective was to provide broader spatial coverage of metals concentrations in the lower Nooksack River sediments. To meet these goals, Ecology's Environmental Assessment Program sampled sediments at nine stations during October 2001. All stations were chosen for comparability with historic stations and in areas where depositional deposits could occur. All samples were analyzed for the four metals of concern in the permit, plus 12 other priority pollutant metals.

Methods

Site Selection

Nine stations in the lower Nooksack River were selected to compare with historical sediment data and to bracket the WWTP outfall. The historical stations and results are described in the Quality Assurance Project Plan for this study (Roose, 2001). Sampling sites are shown in Figure 2 and exact locations are in Table 3. The WWTP outfall site is located between station F5 and F6, approximately at river mile 4.9. All sites were selected for areas where flow was slow enough for fine grain particles to accumulate. To increase comparability with existing sediment data, sampling took place during fall low-flow conditions.

Table 3. Location of sediment stations.

Site ID	Longitude (deg/min)	Latitude (deg/min)	Approximate River Mile
F1	48° 51.291	122° 34.845	7.8
F2	48° 51.204	122° 35.019	7.3
F3	48° 50.806	122° 35.098	6.8
F4	48° 50.377	122° 35.456	5.5
F5	48° 50.107	122° 35.636	5.0
F6	48° 50.030	122° 35.842	4.8
F7	48° 49.823	122° 35.757	4.5
F8	48° 49.708	122° 35.545	4.3
F9	48° 49.366	122° 34.730	3.5

Datum – NAD27

Sampling Procedures

Samples were collected from Ecology's aluminum skiff using a 0.02 m^2 stainless steel Petite Ponar grab for eight stations. A hand held 0.02 m^2 Emery Pipe Dredge was used at site F5, because the water was too shallow to bring the skiff to the site. Sampling site positions were recorded using Global Positioning Systems and landmarks. A grab was considered acceptable if not over-filled with sediment, overlying water was present and not excessively turbid, the sediment surface was relatively flat, and desired depth penetration had been achieved. A field log was maintained during sampling (see Appendix).

After siphoning off overlying water, the top 2-4 cm of each grab was removed with stainless steel scoops, placed in a stainless steel bowl, and homogenized by stirring. Material touching the

sidewalls of the grab was not sampled. Each sample consisted of a homogenized composite of 3-4 individual grabs, all taken within the same 5'x 5' ft area. The homogenized sediment was placed in glass jars with Teflon lid liners cleaned to EPA QA/QC specifications (EPA, 1990).

Stainless steel implements used to collect and manipulate the sediments were cleaned by washing with Liquinox detergent, followed by sequential rinses with tap water, 10% nitric acid, and deionized water. The equipment was dried in the fume hood and wrapped in aluminum foil until use. Between-sample cleaning of the grab consisted of thorough brushing with on-site water.

Sediment samples were placed on ice immediately after collection and transported to Ecology's Manchester Environmental Laboratory within two days.

Laboratory Procedures

Manchester Laboratory analyzed all samples for total organic carbon (TOC), percent solids, and metals. Grain size was analyzed by Rosa Environmental & Geotechnical Laboratory, Seattle. Methods of analysis are listed in Table 4. Samples were analyzed for 16 metals to provide more background information for the lower Nooksack River sediments.

Table 4. Analyses, analytical methods, and laboratories.

Analysis (Chemistry)	Method	Laboratory
Thallium, lead, arsenic, chromium, selenium, cadmium, silver	ICP - MS EPA SW6020	Manchester
Antimony, copper, zinc, iron, barium, manganese, beryllium, nickel	ICP - EPA 200.7	Manchester
Mercury	CVAA - EPA245.5	Manchester
Total organic carbon	Combustion/CO2 - EPA (1996)	Manchester
Solids	Gravimetric - EPA (1996)	Manchester
Grain size (gravel, sand, silt & clay)	Sieve & Pipet - EPA (1996)	Rosa Environmental

Quality Assurance

Manchester Laboratory's standard quality assurance (QA) and quality control (QC) procedures were used for this project and are documented in their Quality Assurance Manual (Kirchmer et al., 1989). Laboratory QC samples for metals included analysis of surrogate spikes, method blanks, duplicate matrix spikes, and laboratory control samples.

Field QA consisted of one blind duplicate taken at station F7. The homogenized material collected for station F7 was split and submitted to the laboratory as station F10 with a random time. These results provide an estimate of total precision for sampling, handling, and analyses.

Data Quality

The case narratives from the laboratory indicate that QC was excellent and all results are usable as qualified (see Appendix). The measurement quality objectives described in the project plan (Roose, 2001) were met for all parameters except antimony and thallium. Antimony was estimated due to low laboratory control sample and matrix spike recoveries. Thallium was also qualified as an estimate at station F1.

The relative percent difference (RPD) between the duplicate and the original station are shown in Tables 5 and 6. The RPD is the range of the duplicate results expressed as a percent of their mean. The RPD was below 4% in all analyses, showing that sampling and analytical precision were excellent.

Table 5. Precision for blind field duplicate metals results.

	Antimony	Barium	Beryllium	Copper	Iron	Manganese	Nickel	Mercury	Zinc	Chromium	Arsenic	Selenium	Silver	Cadmium	Thallium	Lead
F7	4 uj	58.4	0.28	20.1	23100	370	95.2	0.43	52.9	38.4	5.32	0.40 u	0.10 u	0.15	0.10 u	3.87
F7 Dup	4 uj	54.4	0.25	20.0	21900	354	90.9	0.43	51.0	34.2	5.09	0.40 u	0.10 u	0.14	0.10 u	3.67
RPD %	0	2	3	0	1	1	1	0	1	3	1	0	0	2	0	1

uj - Analyte was not detected at or above the reported estimated result.

Table 6. Precision for blind field duplicate conventional results.

	% Solids	TOC @ 70°	TOC @ 104°	Gravel	Sand	Silt	Clay
F7	61.7	0.78	0.78	1.8	53.6	37.2	7.4
F7 Dup	61.8	0.76	0.76	0.8	53.3	38.5	7.5
RPD %	0	1	1	19	0	1	0

Results

Conventionals

Grain size, percent solids, and total organic carbon (TOC) results for each sample are displayed in Table 7. Seven of the nine samples were composed primarily of coarse sediments (greater than or equal to 56.6% sand + gravel). Station F5 had a relatively high percent of fines (silt & sand) at 69.8%. Average concentration of fines above the outfall was 25% while the average below the outfall was 31%. TOC values were low, ranging from 0.15-0.78%. The highest TOC value (0.78%) was at station F7, 1.5 miles downstream from the outfall.

Table 7. Results of conventional analyses.

Station ID	Sample No.	% Gravel (>2mm)	% Sand (2mm-62.5um)	% Silt (62.5-4um)	% Clay (<4um)	% Fines (silt + sand)	% Solids	% TOC @70°	% TOC @104°
F1	01418080	0.2	98	1.4	0.4	1.8	71.7	0.15	0.15
F2	01418081	0	94.6	4.9	0.6	5.5	75.8	0.18	0.18
F3	01418082	1.5	76.4	18.7	3.3	22	73	0.39	0.40
F4	01418083	17	59.4	21.5	2.1	23.6	70.8	0.66	0.69
F5	01418084	4.8	25.3	59.6	10.2	69.8	55.2	0.70	0.69
F6	01418085	0	67.4	27.2	4.9	32.1	63.9	0.60	0.60
F7	01418086	1.8	53.6	37.2	7.4	44.6	61.7	0.78	0.78
F7 Dup	01418089	0.8	53.3	38.5	7.5	46	61.8	0.76	0.76
F8	01418087	1.6	87.9	9.4	1.1	10.5	75.6	0.37	0.37
F9	01418088	0.2	64.1	30.8	4.9	35.7	65.6	0.67	0.67

Metals

The metals data are provided in Table 8. All metals were found in low concentrations. The levels of lead, cadmium, mercury, zinc, and copper are graphed with percent fines at each station in Figures 3-8. The correlation coefficient between percent fines and arsenic, copper, and lead was ≥ 0.93, indicating a strong relationship between these metals and sediment fines. A slight increase in concentrations for these three metals occurs just before the outfall (station F5); this is also where the highest percent fines are found for all stations.

Table 8. Results of metals analyses.

Parameter	Station ID																				Sediment Quality Guidelines
	F1		F2		F3		F4		F5		Outfall	F6		F7		F7R		F8		F9		
Antimony	4.0	uj	4.0	uj	4.0	uj	4.0	uj	4.0	uj		4.0	uj	4.0	uj	4.0	uj	4.0	uj	4.0	uj	3[a]
Arsenic	2.64		2.74		3.88		4.50		6.66			4.40		5.32		5.09		3.22		4.51		9.8[b]
Barium	36.1		34.7		45.1		45.9		69.3			50.7		58.4		54.4		39.5		49.1		NA
Beryllium	0.18		0.18		0.21		0.22		0.29			0.23		0.28		0.25		0.18		0.22		NA
Cadmium	0.12		0.12		0.13		0.15		0.15			0.13		0.15		0.14		0.12		0.14		0.99[b]
Chromium	29.3		32.9		30.4		33.6		29.6			35.7		38.4		34.2		26.8		31.1		43[b]
Copper	12.0		11.8		15.5		17.2		22.5			17.6		20.1		20.0		13.3		17.3		32[b]
Iron	18200		19400		**21200**		**21900**		**23200**			**21100**		**23100**		**21900**		19600		**20900**		**20000[d]**
Lead	2.12		2.30		2.95		3.31		4.25			3.44		3.87		3.67		2.56		3.50		36[b]
Manganese	371		372		380		388		367			339		370		354		459		360		1800[a]
Mercury	0.018		0.036		0.023		0.057		0.03			0.037		0.043		0.043		0.021		0.035		0.56[a]
Nickel	**84.5**		**105**		**99.3**		**99.2**		**69.9**			**104**		**95.2**		**90.9**		**92.7**		**89.0**		**46[a]**
Selenium	0.4	u	0.4	u	0.4	u	0.4	u	0.4	u		0.4	u	0.4	u	0.4	u	0.4	u	0.4	u	**5[c]**
Silver	0.1	u	0.1	u	0.1	u	0.1	u	0.1	u		0.1	u	0.1	u	0.1	u	0.1	u	0.1	u	**4.5[a]**
Thallium	0.1	u	0.1	u	0.1	u	0.1	u	0.1	u		0.1	u	0.1	u	0.1	u	0.1	u	0.1	u	NA
Zinc	39.3		40.8		45.3		47.4		51.0			49.8		52.9		51.0		40.7		47.4		**121[b]**

a=Lowest Apparent Effect Threshold (Cubbage et al., 1997)
b=Consensus-based Threshold Effect Concentrations (MacDonald et al., 2000)
c=British Columbia Freshwater Sediment Quality Working Guidelines (Nagpal et al., 1995)
d=Lowest Effect Level (Persaud et al., 1993)
Bold=Samples that exceeded the Sediment Quality Guideline
uj=The analyte was not detected at or above the reported estimated result.
u=The analyte was not detected at or above the reported value.

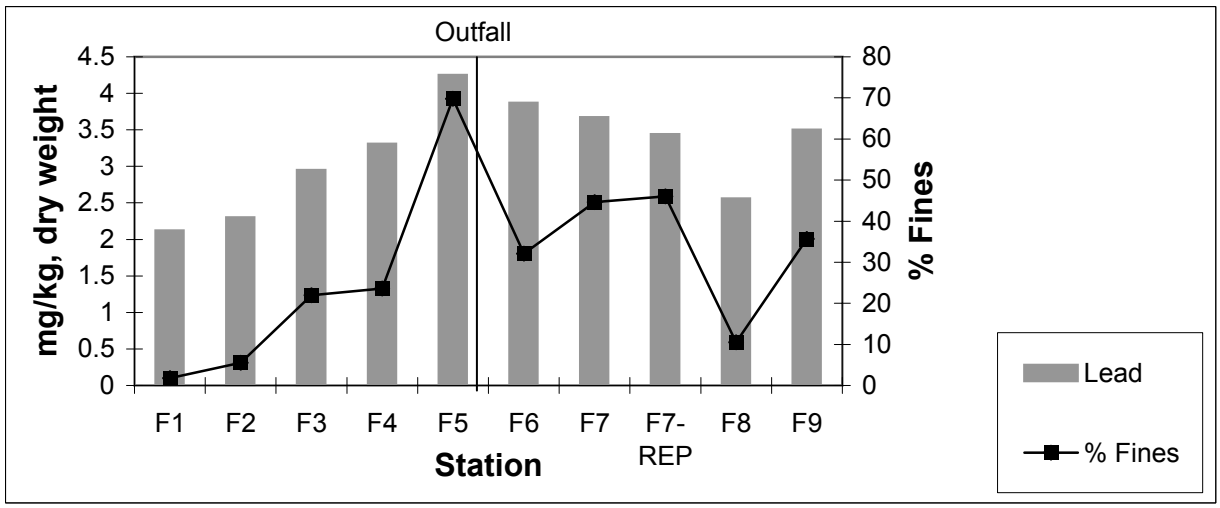


Figure 3. Concentrations of lead and percent fines in sediment at stations F1-F9.

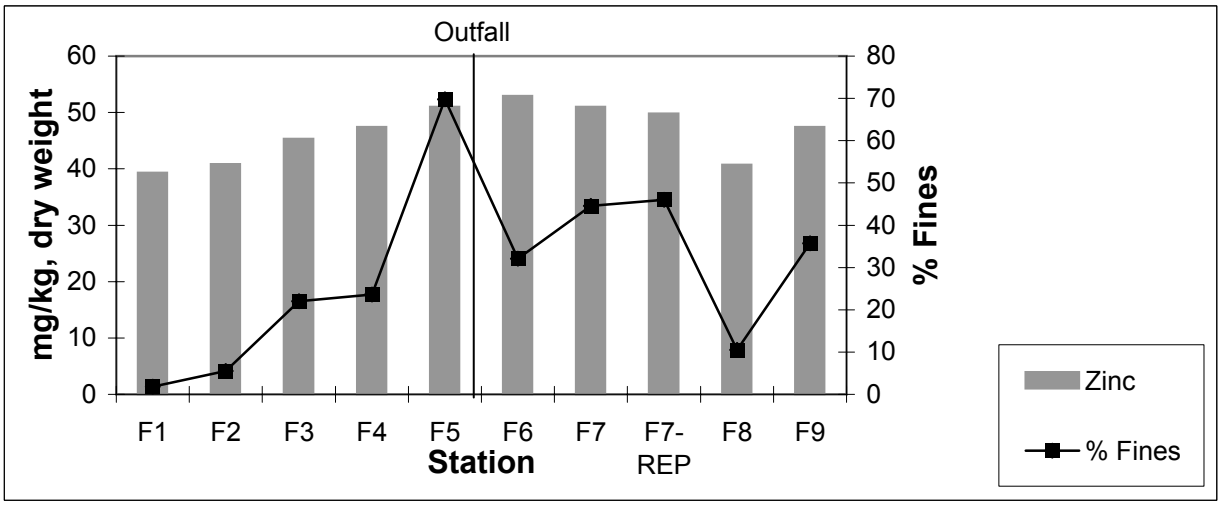


Figure 4. Concentrations of zinc and percent fines in sediment at stations F1-F9.

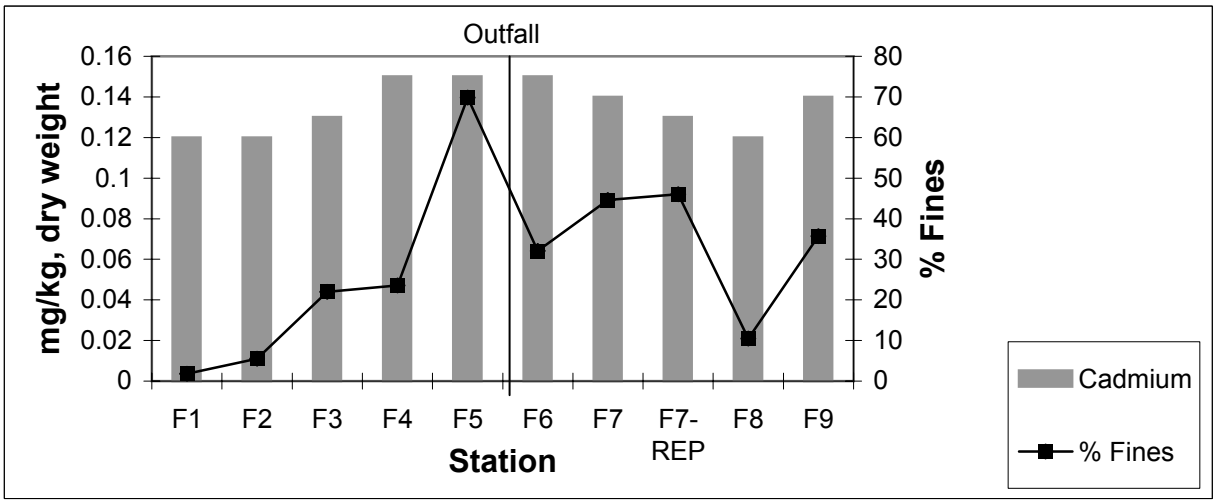


Figure 5. Concentrations of cadmium and percent fines in sediment at stations F1-F9.

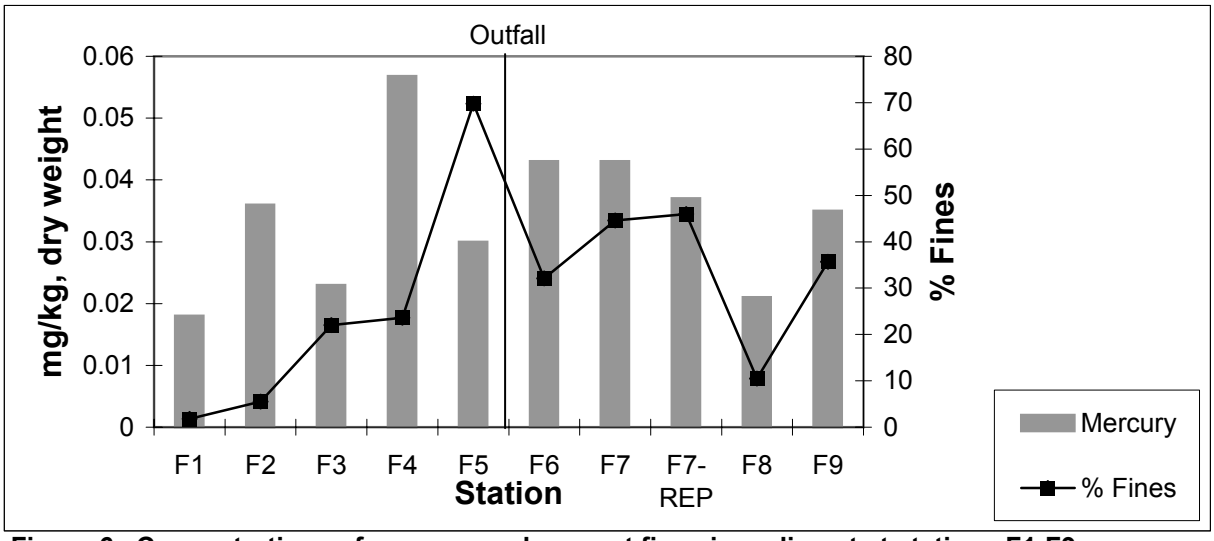


Figure 6. Concentrations of mercury and percent fines in sediment at stations F1-F9.

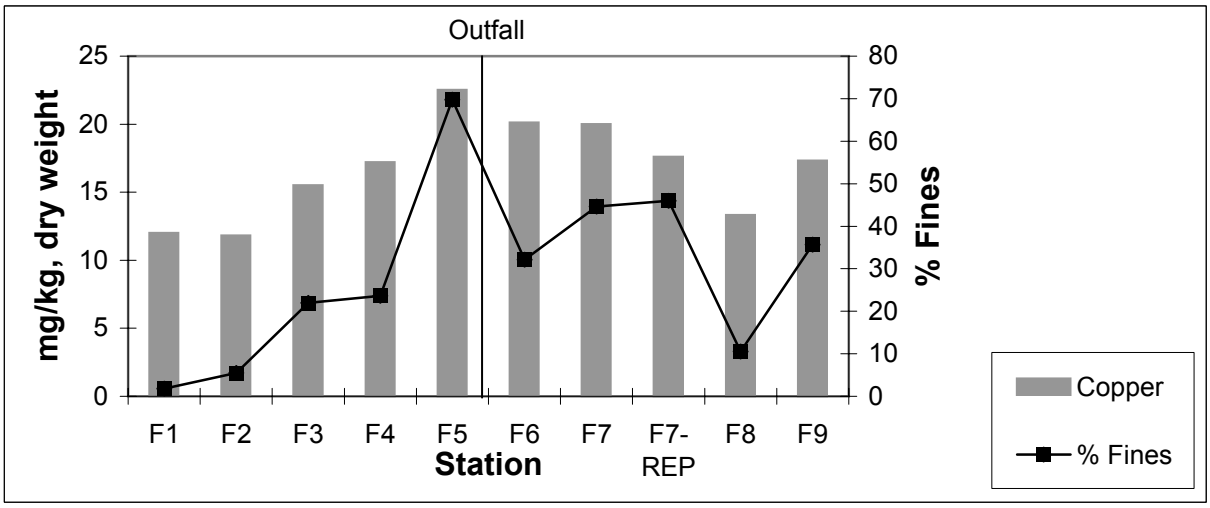


Figure 7. Concentrations of copper and percent fines in sediment at stations F1-F9.

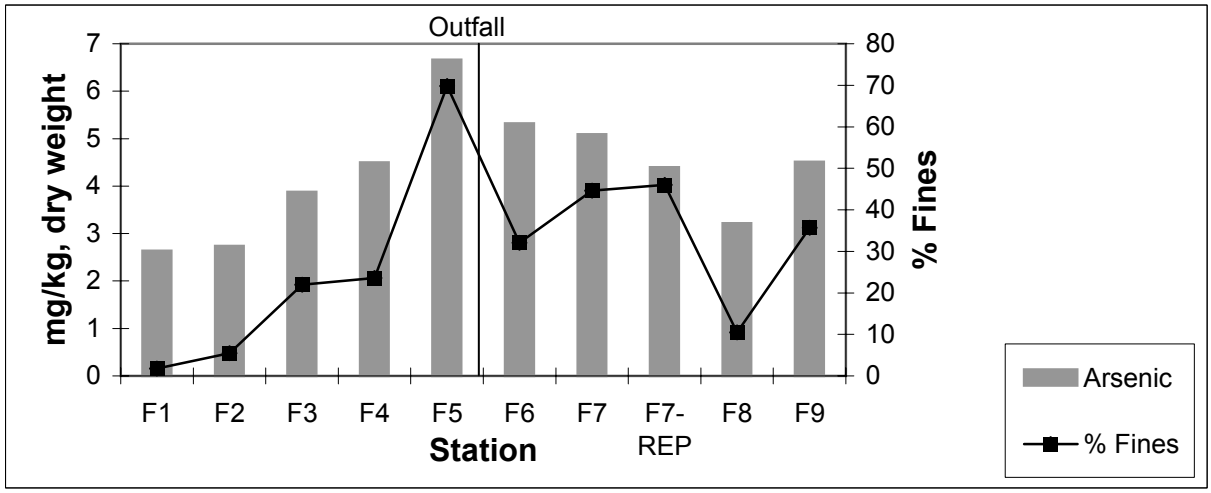


Figure 8. Concentrations of arsenic and percent fines in sediment at stations F1-F9.

The mean concentrations of lead, arsenic, and copper were all slightly higher below the outfall (Table 9). The concentrations of mercury were highest at station F4, while the mean concentrations above and below the outfall were close, with concentrations of 0.03 and 0.04 mg/kg, respectively. Stations F1 and F2, which bracketed Interstate 5, show an increase in mercury downstream of Interstate 5 from 0.018 to 0.036 mg/kg, dry weight. Cadmium levels in all samples were low with a small range of concentrations (0.12-0.15 mg/kg, dry weight).

Table 9. Comparison of historic concentrations (mean) of selected metals with results of current study (mg/kg, dw).

Study Year	Location Relative to WWTP Outfall	n=	Cadmium	Copper	Lead	Zinc	Mercury	Arsenic	Nickel
1989	Above[1]	1	0.5u	26.0	2.4	62.3	0.016	5.2	109.4
1996	Above[2]	3	1.7	20.0	2.9	46.1	na	na	na
Current Study	**Above**	**5**	**0.13**	**15.8**	**2.99**	**44.8**	**0.033**	**4.08**	**91.6**
1989	Below[1]	2	0.5u	15.0	1.8	54.4	.006u	1.70	159.8
1996	Below[2]	5	1.3	14.7	3.1	37.0	na	na	na
Current Study	**Below**	**4**	**0.14**	**17.7**	**3.40**	**48.0**	**0.034**	**4.54**	**92.0**

1 - Ruiz, 1989
2 - Berryman and Henigar, 1997
u - Analyte was not detected at or above the reported value
na - Results for these parameters were not analyzed
Bold - Current study

Since there are currently no standards for freshwater sediments, the sediment quality guidelines (SQG) listed in Table 8 are meant to aid in determining whether the metals concentrations in the lower Nooksack River represent a threat to the benthic community. The guidelines come from several sources. When multiple sources were available for a constituent, the lowest value was presented.

Metals in all samples were below the SQG except nickel and iron. The sample with the highest level of iron was just above the outfall and was barely above the SQG. The concentration of nickel was about two times the SQG at all stations. The average level upstream of the outfall was 91.6 mg/kg, dw, while average level downstream was 92 mg/kg, dw. This leads the author to conclude that the outfall is not contributing to this elevated concentration. Furthermore, the concentration of nickel was lower than the levels found in Ecology's 1989 study (Table 9).

Levels of lead and mercury in all samples were an order of magnitude below the SQG shown in Table 8. Copper levels ranged from 11.8-22.5 mg/kg, dw, while typical background

concentrations in Washington are around 24 mg/kg, dw (Table 10). The levels of arsenic ranged from 2.64-6.66 mg/kg, dw, well below the SQG value of 9.8 mg/kg, dw.

Table 10. Typical metal concentrations in Washington State freshwater sediments.

Metal	Freshwater Sediments Background (median) n=25-42
Zinc	84
Copper	24
Chromium	58
Nickel	--
Lead	41
Arsenic	3.4
Cadmium	0.5
Beryllium	--
Mercury	--
Silver	--

PTI, 1989

The findings of this current study are similar to the two previous studies conducted in the lower Nooksack River (Table 9). This indicates that the NPDES permit changes in 1999 appear to have no direct influence on the river sediments.

Conclusions and Recommendations

Ecology sampled sediment at nine sites in the lower Nooksack River during the fall of 2001. The focus of the study was to determine if NPDES permit modifications at Ferndale's WWTP were causing an increased accumulation of metals in the sediments of the lower Nooksack River. A secondary goal of the study was to provide broader spatial coverage of metals concentrations in the lower Nooksack River sediments.

All samples were analyzed for grain size, percent solids, total organic carbon, 13 priority pollutant metals, barium, manganese, and iron. Seven of the nine stations were composed primarily of coarse sediments. Results of metals analyses showed concentrations were low at all sites.

The levels of lead and mercury in all samples were an order of magnitude below the sediment quality guidelines (SQG). Ranging from 11.8-22.5 mg/kg, dry weight, the level of copper was similar to background concentrations for Washington State. The only metals that exceeded the SQG were iron and nickel.

There appears to be no relationship between the WWTP outfall and concentrations of metals in the lower Nooksack River sediments. Therefore, the increased permit limits for the WWTP outfall do not appear to present a threat to the benthic community of the lower Nooksack River.

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Appendix

Sediment Log and Case Narratives

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Sediment Log

Station	Grab No.	Sampling Equipment	Date	Time	Sediment Penetration (cm)	Sample Description
F1	1	Ponar	10/10/01	15:15	4	0.5 cm silt on top of sand
	2	Petite Ponar	10/10/01	15:15	6	Silty sand
	3	Petite Ponar	10/10/01	15:15	4	Silty sand w/ some leaf debris
F2	1	Petite Ponar	10/10/01	15:45	4	Brown silt overlaying black sand
	2	Petite Ponar	10/10/01	15:45	4	Brown silt overlaying black sand
	3	Petite Ponar	10/10/01	15:45	4	Brown silt overlaying black sand
F3	1	Petite Ponar	10/10/01	16:30	5	0.5 cm silt overlaying sand
	2	Petite Ponar	10/10/01	16:30	5	Silty sand
	3	Petite Ponar	10/10/01	16:30	8	Mostly silt with some sand
F4	1	Petite Ponar	10/10/01	17:00	5	2 cm silt overlaying med. size gravel
	2	Petite Ponar	10/10/01	17:00	7	Silt overlaying sand
	3	Petite Ponar	10/10/01	17:00	8	Silt overlaying sand
	4	Petite Ponar	10/10/01	17:00	8	Silt overlaying sand w/leaf material
F5	1	Pipe Dredge	10/11/01	8:45	3	Very silty brown-grey, muddy
	2	Pipe Dredge	10/11/01	8:45	4	Very silty brown-grey, muddy
F6	1	Petite Ponar	10/11/01	9:00	6	Grey sandy-silt
	2	Petite Ponar	10/11/01	9:00	6	Grey sandy-silt
	3	Petite Ponar	10/11/01	9:00	6	Grey sandy-silt
F7	1	Petite Ponar	10/11/01	9:45	4	Very silty w/ some large grain sand
	2	Petite Ponar	10/11/01	9:45	6	Silty-sand, no pebbles
	3	Petite Ponar	10/11/01	9:45	4	Silty-sand, no pebbles
	4	Petite Ponar	10/11/01	9:45	5	Silty-sand, no pebbles
F8	1	Petite Ponar	10/11/01	10:15	6	Silty layer over sand, mostly sand
	2	Petite Ponar	10/11/01	10:15	6	Silty layer over sand, mostly sand
	3	Petite Ponar	10/11/01	10:15	6	Silty layer over sand, mostly sand
F9	1	Petite Ponar	10/11/01	10:45	7	Silt overlaying fine grey sand
	2	Petite Ponar	10/11/01	10:45	7	2-4 cm silt overlaying fine grey sand
	3	Petite Ponar	10/11/01	10:45	6	2-4 cm silt overlaying fine grey sand

Recorders: Morgan Roose and Dale Norton

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State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East, Port Orchard WA 98366

November 6, 2001

Project: Ferndale WWTP

Samples: 41-8080-89

Laboratory: Rosa Environmental

By: Pam Covey

CASE SUMMARY

These samples required ten (10) Grain Size analyses on sediment samples using Puget Sound Estuary Protocol (PSEP) method for gravel, sand, silt and clay fractions only. One sample was analyzed in triplicate. The samples were received at the Manchester Environmental Laboratory and sent to the contract lab on October 16, 2001 for Grain Size analyses.

The analyses were reviewed for qualitative and quantitative accuracy, validity and usefulness. See narrative from Rosa for further explanation on sample analysis anomalies.

The results are acceptable for use as reported.

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State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East, Port Orchard WA 98366

November 26, 2001

TO: Morgan Roose

FROM: Kamilee Ginder, Chemist

SUBJECT: General Chemistry Quality Assurance Memo for Ferndale WWTP Sediment Study

SUMMARY

The data generated by the analysis of these samples can be used without qualification. All analyses requested were evaluated by established regulatory quality assurance guidelines.

SAMPLE INFORMATION

Samples for Ferndale WWTP Sediment Study project were received by Manchester Environmental Laboratory on 10/12/01 in good condition.

HOLDING TIMES

All analyses were performed within established EPA holding times.

ANALYSIS PERFORMANCE

Instrument Calibration

Instrument calibration was checked by initial calibration verification standards and blanks. All initial and continuing calibration verification standards were within control limits. A correlation coefficient of 0.995 or greater was met. Balances are professionally calibrated yearly and calibrated in-house daily. Oven temperature is recorded before and after each analysis batch.

Procedural Blanks

The procedural blanks associated with these samples showed no significant analytical levels of analytes.

Spiked Sample Analysis

Spiked sample analyses were performed to see if the sample matrix contributes bias to the sample results. Spiked sample analyses were performed where applicable with all spike recoveries within acceptance limits of ± 25%. Spiked sample analysis is performed at a frequency of at least 5%.

Precision Data

Duplicate sample results were used to evaluate precision on this sample set. Relative Percent Differences (RPD) for general chemistry parameters were within acceptance limits of ± 20% for duplicate analysis. Laboratory duplication is performed at a frequency of at least 10%.

Precision and accuracy specifications are based on sample concentrations greater than five times the reporting limit. For results near the reporting limit, the criteria are not guaranteed to be better than +/- the reporting limit.

Laboratory Control Sample (LCS) Analyses

Accuracy is evaluated through the use of a known laboratory control standard. LCS analyses were within the windows established for each parameter.

Other Quality Assurance Measures and Issues

The "U" qualification indicates that the analyte was not detected at or above the reporting limit.

Please call Jim Ross at (360) 871-8808 or Kamilee Ginder at (360) 871-8826 to further discuss this project.

cc: Project File

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East, Port Orchard WA 98366

November 21, 2001

TO: Morgan Roose

FROM: Jim Ross, Manchester Lab

SUBJECT: Metals Quality Assurance memo for Ferndale WWTP sediment study

Summary

All data for this project can be used without qualification except for antimony which is estimated due to low LCS and matrix spike recoveries and the thallium result for sample 418080 duplicate is qualified as estimated due to analyte carryover from the previous sample.

Sample Receipt

The samples were received by the Manchester Laboratory on 10/12/01 in good condition.

Holding Times

All analyses were performed within the specified holding time (28 days Hg, 180 days all other metals).

Instrument Calibration

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards and blanks were within the relevant control limits.

Procedural Blanks

No detectable quantities of requested analytes were found in the procedural blanks.

Spiked Sample Analyses

All spikes were recovered within acceptable limits (75-125%) except antimony.

Precision Data

Precision based on duplicate spike recoveries were acceptable for all analytes except manganese and iron. Precision for these analytes were acceptable based on duplicate sample analysis. None of the data is qualified as estimated values due to poor precision.

Laboratory Control Sample (LCS) Analyses

All LCS recoveries were acceptable except antimony.

Please call Jim Ross at (360) 871-8808 to further discuss this project.

REG Lab WMBE
Rosa Environmental & Geotechnical Laboratory, LLC

1001 SW Klickitat Way, Suite 107
Seattle, WA 98134
(206) 287-9122

Client: WA State Dept. of Ecology, Manchester	REGL Project No.: 1004-437
Client Project No.: Ferndale WWTP	

Case Narrative

1. Ten samples were received on October 17, 2001, and were in good condition.
2. The samples were tested according to Puget Sound Estuary Protocol (PSEP) methodology for gravel, sand, silt, and clay fractions.
3. One sample was chosen for the triplicate and is reported in the attached QA summary.
4. Testing was started on October 23, 2001, and completed on October 30, 2001.
5. Sample 01418080 was sandy and only had 2.2 grams of material in the fines portion (i.e. silt and clay fractions), PSEP requires 5 grams minimum. It would have been impossible to attain over 5 grams of the material due the sandy nature of the sample.
6. Sample 01418084 A & B were over 25 grams of material in the fines portion of the analysis. It would have been impossible to re-split the samples due to the small amount of material retained after the original homogenization.
7. There were no further anomalies to the samples or testing.

Released by: Sharon Davies Date: 11/1/01
Title: Laboratory Lead

Approved by: H Bay Date: 11/1/01
Title: Laboratory Manager