Quality Assurance Project Plan

Stormwater Quality Survey of Western Washington Construction Sites

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November 2003

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Approved by:	November 10, 2003
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Abstract

There is a need for systematic, representative data to characterize stormwater discharged from construction sites. This survey of 60 western Washington construction sites will provide a quantitative description of stormwater quality. Facilities are to be monitored during the wet season from November 1, 2003 to April 30, 2004. The impacts of construction site discharges on receiving water will be investigated. Site characteristics will be compared and correlated with stormwater discharge quality. Turbidity will be compared and correlated with total suspended solids and transparency tube results. Results will be summarized in a report intended for both technical and non-technical audiences.

Background/Problem Statement

Under the NPDES and State Waste Discharge General Permit program, the Washington State Department of Ecology (Ecology) has regulated discharges associated with construction activity since 1992. During this time, stormwater sampling and analysis has been conducted only on certain sites when it was necessary to address specific water quality issues. However, Ecology has not obtained systematically collected, representative data to characterize stormwater discharged from construction sites. Data to characterize these discharges would be useful to state and local government agencies involved in the permitting and inspection of construction activities as well as to construction operators and their consultants who develop Stormwater Pollution Prevention Plans.

Project Description

This study will provide a survey of stormwater discharge quality of western Washington construction sites during the winter wet season when discharges and potential impacts are greatest. Samples will be collected and measurements made from 60 construction sites in three site-size categories as well as from receiving waters upstream and downstream of discharges from the sites. The receiving water data will provide an indication of the potential impacts of construction site stormwater discharges.

Figure 1 shows the planned study area. 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. Western Washington has wet winters with saturated soils and a high potential for erosion problems. Most of the state's construction activity is taking place in western Washington. Also, logistical limitations favored limiting this study to the western portion of the state.

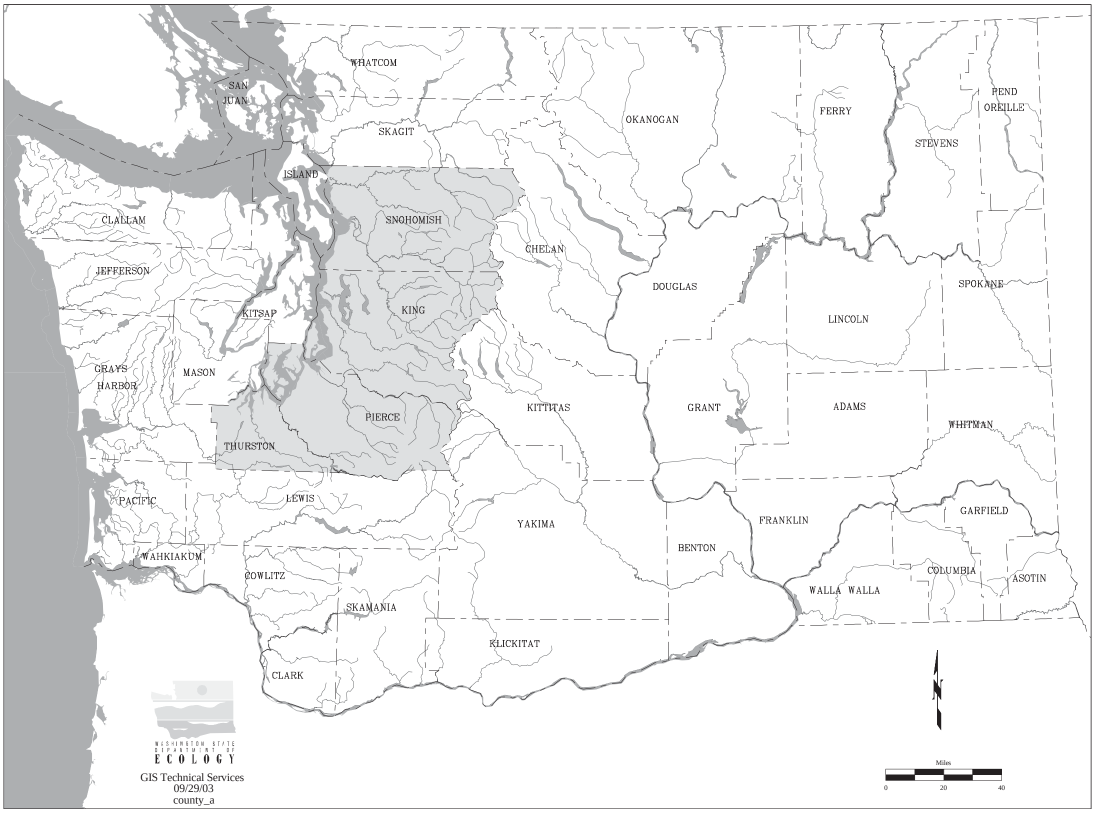


Figure 1. Study area. Shaded areas are counties to be included in the study.

Project Objectives

- Survey stormwater discharge quality from western Washington construction sites.
- Compare field turbidity results to those from the laboratory.
- Compare and correlate turbidity with total suspended solids (TSS) results.
- Relate and correlate site characteristics to stormwater discharge quality.
- Assess impacts of construction site discharges on receiving water turbidity.
- Summarize project results in report for technical and non-technical audience.

As well as serving as a survey, a secondary objective of this study is to investigate potential factors including site characteristics affecting stormwater quality. Comparisons and correlations will be made between turbidity, a measure of the cloudiness of a sample, and TSS, a measure of total non-filterable solids. The efficacy of the use of a simple transparency tube to provide indications of turbidity will be evaluated. Receiving water turbidity upstream and downstream of the site outflow will be measured to assess the potential impacts of construction site stormwater discharges.

Responsibilities

- EA Project Manager – Steven Golding (360-407-6701). Prepares Quality Assurance (QA) Project Plan, project oversight, draft and final report, and EIM data entry.
- WQP Field Sampler from NWRO – Cindy Callahan (425/649-7059). Conducts field sampling and on-site site evaluation.
- WQP Field Samplers from SWRO – Margaret Hill (360-407-0246), Roberta Woods (360-407-6269), and Gary Kruger (360-407-0238). Conducts field sampling and on-site site evaluation.
- EA Toxics Studies Unit Supervisor – Dale Norton (360-407-6765). Reviews QA Project Plan and report.
- Manchester Environmental Laboratory Director – Stuart Magoon (360-871-8801). Oversees laboratory analyses and quality assurance.
- Ecology Quality Assurance Officer – Cliff Kirchmer (360-407-6455). Reviews QA Project Plan.

Schedule

Field Work	November 2003 – April 2004
Laboratory Analysis	November 2003 – May 2004
Draft Investigative Report	July 2004
Final Investigative Report	September 2004

Project Costs

Estimated Lab Cost = $1,998 (162 turbidity samples @ $9 each; 54 TSS samples @ $10 each)[1]

Estimated EA Staff Time = 0.2 FTE

[1] Costs include 50% discount for Manchester Laboratory

Data Quality Objectives and Decision Criteria

This project is a screening level study. The intent is informative and descriptive as an indication of typical turbidity and solids concentrations associated with construction sites. Data quality objectives for this project reflect this.

Manchester Environmental Laboratory reports turbidity results with a detection limit of 0.5 NTU. Turbidity will be used in this study as a surrogate for suspended solids in receiving water because turbidity is a more sensitive indicator than is TSS. Many receiving waters have TSS concentrations below a detection limit that is typically 1 mg/L.

Hach Portable Model 2100P turbidimeters will be used for this study to provide for uniformity of results. The Hach 2100P is a ratio turbidimeter, with a two-detector optical system that compensates for color in the sample, light fluctuation, and stray light. The manufacturer states that it is a laboratory grade instrument, and it has correlated well with the Manchester Laboratory's Hach 2100N ratio turbidimeter (Coffin, 2003). The meter has a range of 0 – 1000 NTU, with a manufacturer-stated resolution of 0.01 NTU on its lowest range, an accuracy of +/- 2% from 0 – 1000 NTU, and a repeatability of +/- 1% of reading or 0.01 NTU, whichever is greater. Replicate turbidity measurements with several Hach 2100P units were within about 10% (Coffin, 2003). This is consistent with expected laboratory accuracy of 10% (based on +/- 5% precision at 95% confidence and EPA inter-laboratory data indicating a bias of 5%).

Water quality standards for core and non-core spawning and rearing waters (formerly Class AA and A waters) require turbidity not to exceed 5 NTU over background turbidity when background turbidity is 50 NTU or less, or a 10 % increase in turbidity when the background turbidity is more than 50 NTU. This also applies to waters for which char have been designated as the key aquatic life use.

For a receiving water with a background of 50 NTU, a 10% level of accuracy corresponds to +/- 5 NTUs. At a 10% level of accuracy, a determination of whether a receiving water of 50 NTU or lower is elevated by 5 NTU downstream of a stormwater discharge can be made. Turbidity in western Washington streams and rivers is generally found to be below 50 NTU (review of data from an EA website http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html). It is expected, therefore, that the accuracy of both portable and laboratory nephelometers (turbidimeters) will be adequate, in most cases, to determine whether receiving water background levels have been exceeded by more than 5 NTU.

The level of accuracy of turbidimeters will be established by conducting replicate field measurements and by obtaining laboratory turbidimeter results to compare with those from the field. In addition, turbidimeter readings will be compared with estimates from a simple transparency tube and correlations will be determined.

TSS concentrations of typical construction site stormwater discharges are expected to be higher than a 1 mg/L detection limit and well within reporting limits. Turbidity and TSS will both be used to characterize stormwater discharges in this study so that comparisons can be made and correlations determined.

Study Design

Sampling will take place between November 1 and April 30, during the winter wet season. The criterion for collection of a sample will be the occurrence of stormwater discharge from a site.

Criterion for Time of Sampling

In most parts of the United States, storm events are discrete, following periodic weather systems. For this reason it is commonly considered appropriate to sample during individual storm events. In western Washington, however, winter wet-weather storm events often overlap, so that long periods of precipitation, days and even weeks at a time, characterize the precipitation pattern. For this reason sampling during the wet season in western Washington can take place during long, continuous, or nearly continuous, precipitation events.

For some forms of stormwater sampling, the "first flush" or first discharge of stormwater after a period of dry weather is considered the worst case. The first period of precipitation after a period of dryness can wash off and entrain contaminants that have accumulated during the dry weather period. This "first flush" may contain high concentrations of pollutants. For construction sites, "first flush" is not considered to be necessarily the worst case, as soil erosion is the principal cause of high contaminant concentrations, particularly the soil particles affecting turbidity as measured in this study. This, in addition to the overlapping nature of storms in western Washington, is the basis for the decision that stormwater sampling for this project will take place not as associated with individual rain events or during any particular portion of a rain event. Instead, sampling will take place throughout the wet weather season at any time that a facility is discharging stormwater. Care will be taken to represent wet weather conditions by sampling throughout the wet season, including periods of intense rainfall events.

Site Selection

Sixty construction sites in four western Washington counties will be sampled. The counties, King, Snohomish, Pierce, and Thurston, represent a variety of geographic areas from Puget Sound to the Cascade Crest, and include construction sites from urban, suburban, and rural areas. The four counties include most construction permits issued in the state, roughly 580 of 800 sites.

Site selection will be stratified so that the number of sites to be sampled in each county is proportional to the number of permits in the county. This will provide for spatial representativeness. In addition, site selection will be stratified by site size, with equal numbers (20) sites selected in each of three size ranges. This will provide for sufficient data to characterize sites within all size categories. Within each county and size range, sites will be selected at random from those with construction permits listed in the Ecology WPLCS database. The county and latitude/longitude of each site will be noted. To prevent bias in site selection, no preference will be given to sites that discharge to surface water. Only active sites will be included in the study. An active site is defined for this study as one in a stage between initial ground clearing and final site stabilization.

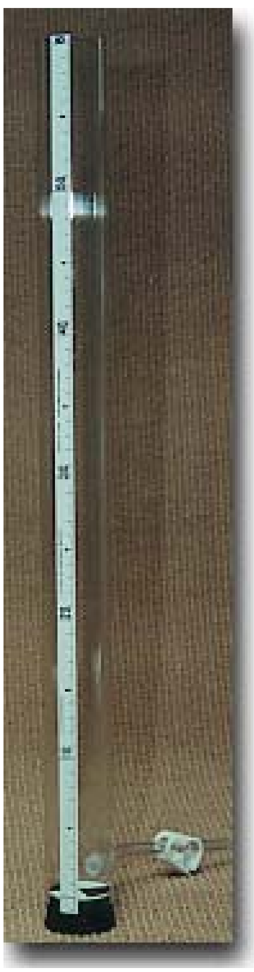
Sites will be categorized as being in one of three size ranges:

1. Less than 5 acres
2. 5 acres or larger but less than 20 acres
3. 20 acres and larger

Of the 60 sites sampled, there will be 20 from each of the three size ranges. In this way, sufficient data to represent each site range will be collected.

Cindy Callahan of the Ecology Northwest Regional Office will sample 21 construction sites in Snohomish and King counties. Margaret Hill, Roberta Woods, and Gary Kruger of the Southwest Regional Office will each sample 13 sites for a total of 39 sites in Pierce and Thurston counties. The efficacy of heavier sampling in Pierce and Thurston counties, made necessary by practical considerations, will be tested during report preparation by comparing data from these counties with the more northern counties of King and Snohomish.

Sampling Design



Field turbidity measurements will be made and grab samples will be collected for turbidity and TSS laboratory analyses at 45 sites. The remaining 15 sites will be sampled with a field turbidimeter only.

Field nephelometer results will be compared and correlated with laboratory turbidity results. Because field and laboratory turbidity measurements have been found in other parts of the state to have good agreement (Coffin, 2003), it is anticipated that a sample size of 45 for laboratory turbidity analyses will be adequate to develop a correlation for stormwater discharges between laboratory and field turbidity results. Correlations between field and laboratory turbidity analyses for receiving waters will be made with paired measurements and grab samples upstream and downstream of the discharges.

A transparency tube will also be used to make a quantified estimate of transparency from each discharge, by simple, visual means. A transparency tube is a simple field device used to estimate the transparency of a water column by noting the depth at which a black and white secchi disk affixed to the bottom of the clear tube is no longer visible. A comparison will be made between transparency tube results and conventional turbidity readings, and a correlation between the two will be developed.

Figure 2. A transparency tube.

In addition to determining turbidity and TSS of stormwater discharges from construction sites, receiving water turbidity upstream and downstream of each discharge will be measured to provide an indication of the impacts of discharges on receiving water turbidity. Turbidity downstream will be measured from the bank from which the discharge is taking place, sufficiently away from the bank to obtain samples where the receiving water is free-flowing rather than stagnant. Measurements will be taken 100 feet downstream from the discharge point, as determined by pacing, or as close to 100 feet as practical. Downstream turbidity will also be measured at a site along the bank, a distance three times the width of the receiving water from the discharge. For construction projects where stormwater discharges to a storm drain rather than directly to a receiving water, receiving water data will not be collected.

Table 1 summarizes measurements and samples for this project, including 20% of samples as replicates for quality assurance. Grab samples for laboratory analysis will be taken at 45 sites. Field turbidity measurements, but no grab samples, will be collected at 15 additional sites for a total of 60 sites sampled. Only one sample will be collected or field measurement made at each location where a sample is obtained, except when a field replicate is taken as a second sample or measurement. Note that all transparency determinations will be made twice, the second to be reported as a field replicate result.

Table 1: Sampling Summary

Construction site discharge	Number of samples		
	Small sites (< 5 acres)	Medium sites (5 acres to < 20 acres)	Large sites (20 acres or greater)
Turbidity, lab analysis	15	15	15
Turbidity, field rep (lab analysis)	4	4	4
TSS (lab analysis)	15	15	15
TSS, field rep (lab analysis)	3	3	3
Turbidity, field analysis	20	20	20
Turbidity, field rep (field analysis)	4	4	4
Transparency	20	20	20
Transparency, field rep	20	20	20

Receiving water (for all-sized construction sites)*	Number of samples		
	Upstream of discharge	100 feet downstream of discharge	3x stream width downstream of discharge
Turbidity, lab analysis	45	45	--
Turbidity, field rep (lab analysis)	13	13	--
Turbidity, field analysis	60	60	60
Turbidity, field rep (field analysis)	15	15	15

* If discharges from some sites enter a storm drain or the affected receiving water is otherwise unavailable for sampling, the number of sites for field analysis will be fewer than 60.

Assessment of Potential Correlations to Turbidity

The following site characteristics will be assessed for their correlation with turbidity:

1. Precipitation duration and intensity
2. Site size
3. Type of construction
4. Stage of project
5. Land drainage characteristics
6. Type of best management practices (BMPs)/treatment
7. Soil type

These variables will be assessed in the following ways:

1. Precipitation duration and intensity will be estimated for each site. The project manager will obtain weather information from the internet and/or government sources from which site-specific estimates of preceding weather and storm intensity will be developed.

2. Determinations of site size will be as reported on the permit application as "size of disturbance."

3. Type of construction site will be categorized as follows:
   - Residential, multiple unit (e.g., Subdivision)
   - Residential, single unit only
   - Commercial
   - Industrial
   - Highway/transportation
   - Utility
   - Other

4. Stage of project will be categorized in the field as follows:
   - Initial ground clearing, grubbing, or stump clearing
   - Cut and fill, or mass grading
   - Final grading, road, utilities construction
   - Exposed soil throughout most of site
   - Final stabilization of soils in place

5. Land drainage characteristics will be categorized in the field as follows:
   - Sloped, well-drained
   - Slightly sloped to flat, less than well drained
   - Slightly sloped to flat, well drained
   - Low, flat, often wet, poorly drained

6. Type of best management practices will be categorized in the field as
    - BMPs that include sedimentation control facility. This may include a settling basin or pond for larger sites, a sediment trap for smaller sites. (Functional/non-functional)
    - Erosion control such as mulch, fabrics, vegetation. (Functional/non-functional)
    - Chemical or electrical treatment. (Functional/non-functional)
    - No BMPs in place.

7. Soil type will be determined for GPS site locations from GIS or other mapping sources.

Field Procedures

The project lead will provide field personnel with a list of pre-selected sites by county and size range to be selected at random and visited. The list will be generated monthly by accessing the Ecology WPLCS database. The method used for making random selections will employ random number generation where each site chosen is from the population of all permitted construction sites. Table 1 summarizes the number of sample sites to be included by size category.

Sites will be visited throughout the wet weather period of November 1, 2003 to April 30, 2004. The criterion for sampling is the presence of a stormwater discharge from the site.

Field personnel will plan visits so that an equal number of visits to sites from the three size categories will be made during the study. Site visits will be unannounced to ensure that actual typical conditions are represented. Field personnel will notify the project lead of sites sampled every week so that the project lead can obtain timely weather information.

Samples will be taken where the discharge leaves the construction site or property upon which the site is located, the point where the stormwater discharge leaves a final treatment process, or where it enters a ditch or other conveyance to leave the site.

To supplement information appearing here, *Samplers' Summary Instructions* are included in Appendix B.

A discharge point representing the principal, or sole discharge, will be sampled at each construction site. In cases where there is more than one discharge, field turbidity measurements will be taken and recorded for the most significant discharges and, if the construction site is one of the 45 for which grab samples will be collected for laboratory analysis, grab samples will also be collected at the discharge with the highest estimated flow rate.

Turbidity will be determined in the receiving water upstream of the discharge and at two locations downstream, as described in the *Sampling Design* section of this QA Project Plan. Field personnel will note on the sampling form/checklist receiving water conditions, the distance from the site discharge to the two downstream sampling points, and the degree to which the discharge appears to be mixed with the receiving water.

Field data-collection personnel will fill out a copy of the form/checklist that appears in Appendix A of this project plan. Information to be included on the form and checklist includes latitude and longitude as measured by a portable GPS receiver, weather observations, site size, project stage, land characteristics, and type of BMPs and their functionality.

Field personnel will collect samples and replicates as shown in Table 1. Replicates for field turbidity measurements, as well as laboratory analysis of turbidity and TSS, will be grabbed as separate samples after the principal turbidity and TSS samples are grabbed. Field turbidity replicates and laboratory replicates will be collected from randomly chosen sites so that the three field personnel who will be collecting data from 13 construction sites will each collect replicate data for three of those sites, and the person collecting data from 21 construction sites will collect replicate data from four of those sites. At each construction site chosen for field replicate collection, all discharge and receiving water measurements and samples will be done twice, the second being a replicate. Note that the total number of actual replicates collected will be higher than the minimum, which is based on 20% of samples replicated as shown in Table 1.

Hach 2100P field turbidimeters to be used in the study will be new and calibrated by the manufacturer. The manufacturer recommends recalibration every three months or as needed. Because the study is of six months duration and the turbidimeters are not expected to be required to operate at their lowest sensitivity range (e.g. as in drinking water sampling), the meters will not be recalibrated during the study period.

The following procedure will be used to obtain field turbidity measurements. (Turbidimeter procedures are more completely described in the instrument manual):

1. Rinse a 1000 mL TSS bottle with the water to be sampled.
2. Obtain a sample in a 1000 mL TSS bottle from a well-mixed location.
3. Cap the bottle, shake vigorously, and pour immediately into clean turbidimeter cell. *From this point on, allow as little time for sample settling as possible.*
4. Quickly insert rubber stopper with syringe and pull a suction until visible bubbles are removed.
5. Wipe the cell with a clean lint-free cloth.
6. Apply a few drops of oil, just enough to dampen outside of cell. Wipe almost dry with lint-free cloth.
7. Cap cell and place in turbidimeter, with line on cell matching mark on meter.
8. Turn meter on.
9. Select AUTO-RNG and select SIGNAL AVERAGE.
10. Press READ. Write down the first four readings and turn meter off.

Ecology personnel will use a transparency tube at each site to determine the transparency of the site's discharge. This will be repeated for each discharge as a field replicate. The transparency tube is to be used outdoors but not in direct sunlight. It should be read either on a cloudy day or in the shade. The shade of one's body is adequate. The tube is filled with stormwater and while looking down at the disk, water is slowly released from the valve until the disk is no longer visible. The water depth is then read.

Samples will be collected directly into sample containers using powder-free nitrile gloves or with the container attached to a pole. The samples will be given a field identification, tagged, and kept cool. Chain-of-custody procedures will be observed, and samples will be delivered to the laboratory within the 48-hour holding time for turbidity analysis.

A summary of parameters, collection containers, preservation, and holding times appears in Table 2.

Table 2. Sample size, Container, Preservation, and Holding Time by Parameter

Parameter	Sample Size	Container	Preservation	Holding Time
Turbidity	100 mL	500 mL w/m poly	Cool to 4ºC	48 hours
TSS	1000 mL	1000 mL w/m poly	Cool to 4ºC	7 days

Analytical Procedures

The samples will be analyzed at the Ecology Manchester Laboratory using the following methods:

- Turbidity: *Standard Methods for the Examination of Water and Wastewater*, 19th Edition, 2130. A nephelometer is the instrument used in these methods.
- Total Suspended Solids: EPA Method 160.2 or *Standard Methods for the Examination of Water and Wastewater*, 19th Edition.

A summary of laboratory procedures for the analysis of project samples appears in Table 3.

Table 3. Laboratory Methods and Anticipated Range of Results

Analyte	Sample Matrix	Samples (Number/ Arrival Date)	Anticipated Range of Results*	Sample Prep Method	Analytical Method
Turbidity	Water	162/ Oct 03 – Apr 04	15 – 16,000	--	Standard Methods 2130B
TSS	Water	54/ Oct ’03 – Apr 04	12 – 40,000	--	Standard Methods 2540D

* Based on construction site monitoring, Kayhanian et al., 2001.

Quality Control Procedures

Field Quality Control

Each field nephelometer reading will be paired with a replicate field reading. This will enable precision of field turbidity measurements to be determined. Accuracy of the field nephelometer will be determined by comparing readings with laboratory turbidity results. All transparency tube readings will also be replicated in the field.

Field replicate samples for laboratory turbidity and TSS analyses will be collected for 20% of the samples (9 field replicate samples for 45 samples taken – see Table 1).

Lab Quality Control

One laboratory replicate will be analyzed per 20 samples. Turbidity will be calibrated with Gelex™ check standards that are calibrated to liquid control standards. Laboratory blanks will also be analyzed. The criterion for acceptable instrument calibration is +/- 10%.

Data Reduction and Management Procedures

Data will be grouped by site, and field and laboratory data will be compared and correlated to provide an assessment of the turbidity, solids, and transparency parameters included in the study. Turbidity related parameters will be plotted as dependent variables vs. turbidity, trends in the plots visually assessed, and correlation coefficients calculated.

Upstream and downstream turbidity will be compared and evaluated with respect to the Washington state water quality standard defining an exceedance as 5 NTU above background. A comparison will be made between turbidity measured at three times the stream width and that measured at a portion of receiving water where the discharge is believed to be well mixed.

Using the form/checklists filled out by field personnel, the project manager will group data by site characteristic and then compare and correlate turbidity/solids data to potentially relevant characteristics including preceding precipitation and storm intensity, size of site, stage of project, land drainage characteristics, best management practices, and soils type. The project manager will link mapped soil types to each site visited. The project manager will obtain weather information and prepare estimates of storm intensity as the project progresses and field personnel report the locations of sites visited.

Data Review and Validation

Data generated at Manchester Laboratory will be reviewed by laboratory staff who will prepare a case narrative and submit it to the project manager. All field and laboratory data will be reviewed by the project manager for reasonableness and consistency. Calibration, blank, and check standard results will be reviewed and compared with acceptance limits.

Data Quality Assessment

An indication of turbidity data bias may come from a comparison of field and laboratory results, but it is not expected that a definitive evaluation of bias will be able to be made. Correlations between turbidity, TSS, and transparency developed in this study may prove useful for future comparability of solids-related stormwater data.

Check standards will provide some indication of precision and even accuracy, at least as applied to the matrices of the standards. Variance between lab replicates and sample results will provide a means of assessing precision of laboratory analyses of turbidity and TSS. The relative percent difference (RPD) of field replicates and sample results will provide a means of assessing overall precision, including the effects of potential errors introduced from sampling as well as analysis.

Because this will be a survey study with data collection taking place over seven months, it is expected that the data set will be complete. Site locations will be selected at random so that any data lost from one site can be replaced by data from another.

Data Reporting

The final report will include a map of the study area showing approximate locations of sites included in the study. Aggregate results for each parameter, as well as results grouped by site size and other site characteristics, will be presented. Comparisons and correlations between turbidity-related parameters will be discussed, and correlation coefficients will be reported. Comparisons and correlations of results to site characteristics will be discussed. The distribution of sites from the WPLCS database by size will be determined and reported.

References

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Appendix A. Field Form and Checklist

Field Form and Checklist
Stormwater Quality Survey of Western Washington Construction Sites

Field Sampler ________________________________ Date _________
Site Name __________________________________ Time _________
Lat/Long _____________________GPS datum NAD27 Permit No. _____

Description of construction site sampling location (general, pond outfall, culvert size and fraction full, etc.)

____
____
____
____
____

Weather (current)____

Weather preceding visit (days of preceding dryness, number of days of precip, amount of precip, if known):

____
____
____

Type of site ___ residential, multiple unit (e.g., Subdivision)
___ residential, single unit only
___ commercial
___ industrial
___ highway/transportation
___ utility
___ other (describe) _________________________________

Size of site ___ small (less than 5 acres)
___ medium (5 or greater but less than 20 acres)
___ large (20 acres or greater)

Size of soil disturbance (acres or square feet) _______________(note if estimate or known)

Stage of project (check one that best describes overall stage of project):

1. ___ Initial ground clearing, grubbing, or stump clearing
2. ___ Initial installation of erosion/sediment control BMPs
3. ___ Rough/mass grading, cut and fill;
4. ___ Final/finish grading
5. ___ Temporary stabilization, including winter shut down

Land drainage characteristics (check one that best applies):
___ Sloped, well-drained
___ Slightly sloped to flat and less than well drained
___ Low, flat, often wet, poorly drained

Best Management Practices

1. Are storm drain inlets protected from sediment?
   __Yes __ No
   (Seven types of inlet protection BMPs listed in BMP C220; Stormwater Management Manual for Western Washington, Vol. II, page 4-77.)

2. Is runoff from the site being routed to one or more sediment ponds or basins?
   __Yes __No

3. Are most of the disturbed soils covered or otherwise protected from erosion?
   __Yes __No
   (Cover or protection may include mulch, plastic, vegetation, erosion control blankets. It does not include silt fences, straw bales or other sediment trapping measures.)

Turbidity data at site discharge(s) (for multiple discharges, rate in order from highest estimated flow (1.)):

1. ______NTU Is the discharge from pond, basin or trap?___Yes ___No
   ______NTU (Replicate of 1. for 20% of construction sites)
2. ______NTU Is the discharge from pond, basin or trap?___Yes ___No
3. ______NTU Is the discharge from pond, basin or trap?___Yes ___No
4. ______NTU Is the discharge from pond, basin or trap?___Yes ___No

Observations/Comments:
____
____

Transparency tube data for discharge sampling location with highest estimated flow (1., above):
______cm.
______cm. (Replicate sample. Do sampling reading again, each time)

Observations/Comments:____
____

Receiving Water Sampling: Name of waterbody: ________________________________

Description of **upstream sampling location**:______________________________________
____

Turbidity data collected at upstream (background) location:

1. ______NTU
2. ______NTU (Second measurement only if construction site is a site where replicates will be taken. Collect from discharge point as a separate sample.)

Observations/Comments about upstream sampling point:

____

Description of **downstream sampling locations:**

Description of sampling location and receiving water **100 feet downstream** of discharge point (include description of mixing, extraneous contributing flows between site discharge and sampling locations):

Estimated receiving water width (ft) ______

Turbidity data collected downstream – 100' from discharge point:

1. ______NTU
2. ______NTU (Second measurement only if construction site is a site where replicates will be taken. Collect from waterbody again as a separate sample.)

Observations/Comments:(Note: If alternate sampling location was required, report the approximate distance from discharge (ft.)

Description of sampling location and receiving water **downstream 3x channel width**:
Estimated distance along bank from discharge to 3x width (ft) ______

Turbidity data collected downstream – 3X stream width:

1. ______NTU
2. ______NTU (Second measurement only if construction site is one where replicates will be taken. Collect from waterbody again as a separate sample.)

Observations/Comments:

Observations/Comments - stage of project:

Observations/Comments: land drainage, soil type, degree of erosion, site condition:

Observation/Comments: Best Management Practices (BMPs), description, functionality:

Other Observations/Comments:

Appendix B. Samplers' Summary Instructions

Samplers' Summary Instructions
Stormwater Quality Survey of Western Washington Construction Sites

60 total construction sites:

- 45 sites with lab and field turbidity, transparency tube, and TSS samples
- 15 sites with only field turbidity samples and transparency tube

NWRO: 21 total sites sampled by Cindy Callahan

- Twelve sites will be sampled as follows:
    - **Discharge:** Field turbidimeter, transparency tube, and 1000 mL (TSS) and 500 mL (turbidity) bottle of discharge with the highest estimated flow for lab analyses. (Transparency tube always used in replicate, filling up again between measurements).
    - **Receiving Water:** For upstream and 100 feet downstream and 3x-width-downstream, measure with field turbidimeter. In addition, *for upstream and 100 feet downstream only*, 500 mL bottle for lab turbidity (but never TSS for receiving water).
    - Sample 4 of these twelve sites in **replicate** by collecting again, doing all of the above steps twice for all turbidity field measurements and bottles for lab analysis. (Note you have already done transparency tube as replicate in every case.)

- The remaining 9 sites to be measured with field turbidimeter (discharge and 3 waterbody locations) and transparency tube only, no lab sample bottles. Note: you may want to make these your Friday samples since lab must have samples by 3PM Friday and there is a 48 hour holding time for turbidity.

SWRO: 39 total sites sampled by Margaret Hill, Roberta Woods, Gary Kruger

Each person samples as follows**:**

- Eleven sites will be sampled as follows:
    - **Discharge**: Field turbidimeter, transparency tube, and 1000 mL (TSS) and 500 mL (turbidity) bottle of discharge with the highest estimated flow for lab analyses. (Transparency tube always used in replicate, filling up again between measurements).
    - **Receiving water**: For upstream and 100 feet downstream and 3x-width-downstream, measure with field turbidimeter. In addition, *for upstream and 100 feet downstream only*, 500 mL bottle for lab turbidity (but never TSS for receiving water).
    - Sample 3 of these eleven sites in **replicate** by collecting again, doing all of the above steps twice for all turbidity field measurements and bottles for lab analysis. (Note you have already done transparency tube as replicate in every case.)

- The remaining 2 sites to be measured with field turbidimeter (discharge and 3 waterbody locations) and transparency tube only, no lab sample bottles. (Note: These are samples you can get on Fridays since lab samples must be in by 3PM Friday, since turbidity holding time is 24 hours).

Samplers' Summary Instructions (cont'd)

Order of sampling

For receiving water, sample at the most downstream point first (3x width or 100 feet downstream, whichever is farther downstream) and work your way upstream, doing the upstream (background sample) last. In this way you won't stir up the receiving water. If you must disturb the receiving water, make sure to hold the bottle upstream of where you are causing a disturbance.

Order of turbidity measurements with Hach 2100P

Start with the cleanest sample, and work your way to the dirtiest:

1. Upstream sample
2. Two downstream samples
3. Discharge sample

Place a drop of oil on the glass cell, spread it, and dry lightly one time for each site location (each set of 4 samples).

Ordering bottles

Everyone: order your own 1000 mL and 500 mL w/m poly bottles. You'll be using one 1000 mL bottle and three 500 mL bottles (one discharge, one upstream, one 100 feet downstream) for each construction site. Submit lab forms for TSS and turbidity. Give each row on the sheet a different field station identification and lab log number. You'll be filling three rows (one for discharge location, one upstream, one downstream 100 feet) per construction site. For replicate sites, fill in three more rows with the word "rep" in the field station identification column.

Submitting bottles to lab with lab form

Put tags on bottles. For "station ID" use an abbreviation like "Sunvl" for "Sunnyville Heights" and add endings as follows: "Sunvl" for discharge, "Sunvlup" for upstream water sample, "Sunvl3x" for the sample along the bank 3x the stream width, and "Sunvl100" for the sample 100 feet downstream of the discharge.

The lab assigns each week of the calendar year a unique week number. Use lab log numbers as follows: The first two digits stand for the week beginning with "45" for the week of Nov 2. Then add the following numbers: Cindy: 4400-4430; Margaret: 4431-4454; Roberta: 4455-4478; Gary: 4479-4499.

For example, Gary can call his first discharge sample the *second* week of November, "464479" and he can call the upstream sample for that construction site, "464480". He can use the same "4479" number the next week, but preceded by the week number "47". The attached calendar shows the week numbers.

Lab Week # Calendar

November 2003

Week #	SUN	MON	TUE	WED	THUR	FRI	SAT
45	2	3	4	5	6	7	8
46	9	10	11	12	13	14	15
47	16	17	18	19	20	21	22
48	23	24	25	26	27	28	29
49	30						

December 2003

Week #	SUN	MON	TUE	WED	THUR	FRI	SAT
49		1	2	3	4	5	6
50	7	8	9	10	11	12	13
51	14	15	16	17	18	19	20
52	21	22	23	24	25	26	27
01	28	29	30	31			

January 2004

Week #	SUN	MON	TUE	WED	THUR	FRI	SAT
01					1	2	3
02	4	5	6	7	8	9	10
03	11	12	13	14	15	16	17
04	18	19	20	21	22	23	24
05	25	26	27	28	29	30	31

February 2004

Week #	SUN	MON	TUE	WED	THUR	FRI	SAT
06	1	2	3	4	5	6	7
07	8	9	10	11	12	13	14
08	15	16	17	18	19	20	21
09	22	23	24	25	26	27	28
10	29						

March 2004

Week #	SUN	MON	TUE	WED	THUR	FRI	SAT
10		1	2	3	4	5	6
11	7	8	9	10	11	12	13
12	14	15	16	17	18	19	20
13	21	22	23	24	25	26	27
14	28	29	30	31			

April 2004

Week #	SUN	MON	TUE	WED	THUR	FRI	SAT
14					1	2	3
15	4	5	6	7	8	9	10
16	11	12	13	14	15	16	17
17	18	19	20	21	22	23	24
18	25	26	27	28	29	30	