

How to do Stormwater Monitoring: A guide for construction sites



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1. Introduction

Federal and state law requires construction site operators to manage their stormwater on sites one acre and larger. The Department of Ecology (Ecology) administers these laws through the Construction Stormwater General Permit. For details on who needs a permit, see Ecology's publication: "How to Meet Ecology's Construction Stormwater General Permit Requirements: A Guide for Construction Sites." The permit requires you, as a construction site operator, to develop, use, and amend a Stormwater Pollution Prevention Plan (SWPPP). The purpose of the SWPPP is to reduce and prevent soil, dirt, and other common construction pollutants from washing off the site and reaching streams, rivers, and other local water bodies.

The specific permit requirements vary depending on the size of the construction site, but include performing site inspections and sampling stormwater leaving your site (see permit section *S4. MONITORING REQUIREMENTS*). You must record and report your monitoring results to Ecology. This guide is to help construction site operators conduct site inspections and stormwater sampling. As a result, you will be able to monitor your site in a way that will provide you and Ecology with meaningful results.

By visually inspecting the site and by sampling stormwater discharges, you can identify sources of pollutants that may enter surface waters. Your inspection and monitoring results will help you determine (1) if your SWPPP is adequate and (2) whether best management practices (BMPs) are working correctly, or if additional BMP maintenance or installation is necessary.

Your inspections and sampling must produce meaningful results to meet permit requirements. This requires some effort. This guide will take you step-by-step through the process of gathering and reporting inspection and water sampling data to accurately represent the quality of stormwater leaving your site.

GLOSSARY

Discharge point is the location where stormwater runs off the construction site.

Stormwater is rain, snow, or other precipitation that flows overland, through pipes, or into a stormwater drainage system and into a surface water body or infiltration facility. Other terms for stormwater include **stormwater runoff or runoff**.

Stormwater Pollution Prevention Plan (SWPPP) is a document that reflects the specific measures on the construction site to identify, prevent, and control the contamination of stormwater.

Surface waters of the state include rivers, lakes, ponds, streams, salt water, and wetlands in Washington.

Best management practices (BMPs) are the specific practices and physical structures used on the construction site to prevent pollution of stormwater.

2. Site Inspections

A. What to inspect and where

The permit requires physical inspections of the construction site. The inspector must visually inspect all:

- Areas disturbed by construction activities.
- Best management practices (BMPs).
- Stormwater discharge points-where stormwater runs off or leaves the site, including points where stormwater runs off into surface waters (streams, wetlands, etc.) within the property.

At these locations, inspectors must look for signs of soil erosion and any discharging stormwater for the presence of:

- suspended sediment
- turbidity
- discoloration
- oil sheen



The photos show examples of discolored and turbid stormwater discharges. Site inspections include looking for these types of discharges and correcting any problems.

Inspectors must evaluate the effectiveness of BMPs and **determine whether it is necessary to repair or maintain these BMPs, or install new BMPs to improve the quality of stormwater discharges.**

Based on inspection results, the permittee must correct any identified problems by:

- Reviewing the SWPPP to make sure it fulfills the SWPPP requirements in the permit (see Permit Section S9).
- Revising or updating the SWPPP within 7 days of the inspection.
- Doing SWPPP revisions related to common erosion and sediment control problems on-site.

Examples include:

- covering exposed soils with mulch, nets, blankets or plastic
- installing and maintaining silt fence
- check dams, or straw wattles.
- If the SWPPP revision involves new or modified structures that involve engineering designs, you must have the new or modified designs stamped by a Registered Professional Engineer.

Examples include:

- stormwater ponds
- sand filters
- chemical treatment systems
- Implementing and maintaining appropriate source control and/or treatment BMPs, as soon as possible, but no later than 10 days after the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when a permittee requests an extension within the initial 10-day response period.
- Documenting any BMP installation or maintenance in the site log book.

What does this mean in practice?

The following are a few examples of correcting problems identified during site inspections. These are only hypothetical scenarios to give you a sense of how to comply with the permit.

Scenario 1: Mud track-out

During site inspections, you notice mud tracked out onto an adjacent road by construction vehicles leaving the site.

Action: Assign someone on site to shovel and sweep the mud off the road one or more times per day to prevent further track out. If necessary, follow with street sweeping. Inspect the site entrance to ensure the rock pad is sufficient to prevent further mud track out onto the road. If the entrance pad needs additional rock, order the necessary materials and indicate the date the entrance will be fixed on the inspection checklist (site log book). Note the original condition of the road and action taken in your site inspection checklist. You must update the SWPPP within 7 days and complete repairs within 10 days.

Scenario 2: Silt fence

During site inspections, you notice a silt fence that is sagging and ripped. This has caused mud and muddy water to discharge off site.

Action: Assign someone to fix the fence as soon as possible. Obtain the necessary materials to fix the fence appropriately as soon as possible (within

10 days). Note the action taken and indicate date the fence will be fixed on the inspection checklist (site log book). You do not need to update the SWPPP, because the SWPPP already addressed the silt fence BMP, and you have identified no other BMP failures.

Scenario 3: Muddy water in stormwater pond

During a winter inspection, you notice the stormwater retention pond on site is almost full of cloudy, muddy water. The clay soil has not settled out. The weather forecast calls for rain for the next several days. This pond will likely release muddy stormwater off site and into a nearby stream without further treatment.

Action: Consider the following two options:

Option 1: Contact appropriate stormwater management company and order a portable settling tank to store or treat the muddy stormwater until it can be discharged.

Option 2: Pump the turbid stormwater to an upland undisturbed area with native soils and vegetation. Release the stormwater with perforated pipe at a controlled rate so that it can infiltrate into on-site soils.

The Certified Erosion and Sediment Control Lead (CESCL) should also investigate whether the site needs additional BMPs to prevent more muddy water from reaching the pond. Note the corrective actions taken on the inspection checklist. In both options, you must update the SWPPP within 7 days and have BMPs completed within 10 days.

B. When to conduct inspections

Inspectors must conduct site inspections once a week and within 24 hours of any stormwater discharge from the site. During periods of continuous discharge, the permit requires one inspection per week. On a site that is temporarily stabilized and inactive you only need to do site inspections once a month.

C. Who inspects?

The operator (permittee) must designate a person to conduct site inspections in the Stormwater Pollution Prevention Plan (SWPPP). The person inspecting the site must be knowledgeable in the principles and practices of erosion and sediment control. The permit requires certified inspection personnel to conduct inspections. (see below).

Certified Erosion and Sediment Control Lead (CESCL)

Construction sites that disturb one acre or more must have site inspections conducted by a *Certified Erosion and Sediment Control Lead* (CESCL). The CESCL must obtain certification through an Ecology-approved course. The CESCL must be on site or on call at all times. The following web page contains an updated list of Ecology-approved certification courses offered: <http://www.ecy.wa.gov/programs/wq/stormwater/cescl.htm>

D. Site inspection checklist

Ecology used the permit inspection requirements to develop a site checklist. The operator's inspector (CESCL) may use the checklist on the next two pages when conducting site inspections. You may also develop your own inspection checklist, but it must include all items specified on pages 11-12 of the Construction Stormwater General Permit. Keep completed checklists on site in your site log book and make them available to Ecology or local governments upon request. Do not mail them to Ecology unless requested.

**Construction Stormwater
SITE INSPECTION CHECKLIST**

Project _____ Permit No. _____ Inspector _____ Date _____ Time _____

Site BMPs	Overall Condition			Need Repair?		Comments/Observations
	G	F	P	Y	N	
Clearing Limits						
• Buffer Zones around sensitive areas	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
Construction Access/Roads						
• Stabilized site entrance	G	F	P	Y	N	
• Stabilized roads/parking area	G	F	P	Y	N	
•	G	F	P	Y	N	
Control Flow Rates						
• Swale	G	F	P	Y	N	
• Dike	G	F	P	Y	N	
• Sediment pond	G	F	P	Y	N	
• Sediment trap	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
Install Sediment Controls						
• Sediment pond/trap	G	F	P	Y	N	
• Silt fence	G	F	P	Y	N	
• Straw bale barriers	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
Preserve Vegetation/Stabilize Soils						
• Nets and blankets	G	F	P	Y	N	
• Mulch	G	F	P	Y	N	
• Seeding	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
Protect Slopes						
• Terrace	G	F	P	Y	N	
• Pipe slope drains	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
Protect Drain Inlets						
• Inserts	G	F	P	Y	N	
•	G	F	P	Y	N	
•	G	F	P	Y	N	
Stabilize Channels and Outlets						
• Conveyance channels	G	F	P	Y	N	
• Energy dissipators	G	F	P	Y	N	
•	G	F	P	Y	N	
Control Pollutants						
• Chemical Storage Area covered	G	F	P	Y	N	
• Concrete handling	G	F	P	Y	N	
•	G	F	P	Y	N	
Control De-watering						
•	G	F	P	Y	N	

G=Good F=Fair P=Poor Y=Yes N=No

**Construction Stormwater
SITE INSPECTION CHECKLIST**

Project _____ Permit No. _____ Inspector _____ Date _____ Time _____

Will existing BMPs need to be modified or removed, or other BMPs installed? YES NO
IF YES, list the action items to be completed on the following table:

Actions to be Completed	Date Completed/ Initials
1.	
2.	
3.	
4.	
5.	
6.	

Describe current weather conditions.

Approximate amount of precipitation since last inspection: _____ inches
and precipitation in the past 24 hours*: _____ inches
**based on an on-site rain gauge or local weather data.*

Describe discharging stormwater, if present. Note the presence of suspended sediment, "cloudiness", discoloration, or oil sheen.

Was water quality sampling part of this inspection? YES NO
If yes, record results below (attach separate sheet, if necessary):

Parameter:	Method (circle one)	Result	Units
Turbidity	tube, meter, laboratory		NTU (cm, if tube used)
pH	paper, kit, meter		pH standard units

Is the site in compliance with the SWPPP and the permit requirements? YES NO
If no, indicate tasks necessary to bring site into compliance on the "Actions to be Completed" table above, and include dates each job WILL BE COMPLETED.
If no, has the non-compliance been reported to Dept. of Ecology? YES NO
If no, should the SWPPP be modified: YES NO

Sign the following certification:
"I certify that this report is true, accurate, and complete, to the best of my knowledge and belief."

Inspection completed on: _____ by: (print+signature) _____

Title/Qualification of
Inspector: _____

3. Stormwater Sampling

A. Advance planning for stormwater sampling

Deciding what to sample

Before you begin your sampling, you'll need to determine the specific pollutants you are required to sample and test. Depending on the size and activities on your site, the Construction Stormwater General Permit requires testing water clarity (transparency or turbidity) and pH.

The two ways to measure water clarity are (1) using a transparency tube or (2) using a turbidity meter. Construction sites which disturb 1 or more acres, but less than 5 acres, can choose either one of these methods. **Note: Sites less than 5 acres are not required to sample stormwater until October 1, 2008, unless specifically directed by Ecology.** Sites which disturb more than 5 acres must use a turbidity meter (also called a turbidimeter).

If your site is doing **significant concrete work** or is using **engineered soils** such as Portland cement treated base (CTB), cement kiln dust (CKD), or fly ash, then you must sample for pH during this work. Significant concrete work means pouring 1000 cubic yards of concrete or using 1000 cubic yards of recycled concrete.

Table 1. Construction Stormwater Sampling Requirements*

Size of Soil Disturbance	Sampling w/ Turbidity Meter	Sampling w/ Transparency Tube	pH sampling
Less than 1 acre	No	No	No
1 to 5 acres	Beginning October 1, 2008 Yes, either meter or tube	Beginning October 1, 2008 Yes, either meter or tube	Beginning October 1, 2006 Yes
5 acres or more	Beginning October 1, 2006 Yes	No	Beginning October 1, 2006 Yes

*see information below for when and where to monitor turbidity, transparency and/or pH.

Ecology may require additional monitoring for construction sites that discharge to certain types of impaired (polluted) waterways, also known as 303(d) listed waterways, and/or with a Total Maximum Daily Load (TMDL). Refer to pages 24-26 for more information.

Where to sample

Take **turbidity and transparency** samples at *all* points where stormwater or non-stormwater (dewatering, etc.) is discharged from the construction site. If discharging to waterways (streams, wetlands, etc.) within the construction site limits, collect and sample the water before it enters the waterway. Common examples of sampling locations include: stormwater pond spillways or outfalls; ditches or storm drains carrying stormwater off site; and runoff from disturbed or exposed soil areas into adjacent ditches or streams. You must mark all discharge points in the field (flag, tape, stake, etc.) and show them on the Stormwater Pollution Prevention Plan site map.

It is not necessary to sample stormwater:

- If soil disturbing activities have not begun yet (e.g., prior to breaking ground).
- On portions of the site undisturbed by construction activity (e.g., areas of native vegetation that will not be disturbed).

Take **pH** samples in the sediment trap, stormwater retention pond or other suitable collection waters *prior to discharge from the site*. You must sample pH only if the stormwater is from an area with significant concrete work or engineered soil (CKD, CTD, etc.). Again, you must mark these sampling sites in the field and show them on the Stormwater Pollution Prevention Plan site map

Take sample as close to discharge point as is safe and reasonable. Use a pole or find a safe route to sample discharges. Contact your Ecology stormwater inspector if you have a question about sampling locations. Make sure you know the location of all your sampling points.

Typical stormwater sampling locations



Examples of typical stormwater discharge locations where the person monitoring would potentially take stormwater samples. **Top left:** Stormwater discharging from a pipe outlet. **Top right:** Stormwater drain outlet. **Bottom left:** Stormwater retention pond. **Bottom right:** Stormwater discharging in a ditch.

When to sample

Conduct sampling weekly and within 24 hours of a discharge:

- Turbidity/Transparency- Once a week when there is a discharge from the site. No discharge means no sampling. Be sure to record “No Discharge” on your monitoring records. You must still submit a DMR to Ecology even when there is no discharge to sample.
- pH - Once per week during pH sampling period.
 - For sites with **significant concrete** work (1000 cubic yards or more), the sampling period starts when concrete is first poured and exposed to precipitation and continues throughout and after the concrete pour and curing period until stormwater pH is 8.5 or less.
 - For sites with **engineered soils**, the sampling period begins when the area treated with soil amendments is first exposed to rain or precipitation and continues until the engineered soils are fully stabilized.

GLOSSARY

Significant concrete work is 1000 cubic yards or more of poured or recycled concrete.

Recycled concrete material is concrete that has been crushed and reused on-site as fill or aggregate material.

Engineered soils use amendments such as Portland cement treated base (CTB), cement kiln dust (CKD), or fly ash to achieve certain desirable soil characteristics.

Deciding how you will take the sample

The permit requires you to collect samples that are representative of the discharge from the construction site. A **representative sample** means the sample is similar in flow and characteristics (such as color, clarity, etc.) to the stormwater running off the site. The *Construction Stormwater General Permit* allows you to choose how to take the representative sample. You can choose to take (1) a single grab, (2) a time-proportionate, or (3) a flow-proportionate sample.

A grab sample is a single sample “grabbed” by filling up a container either by hand or with the container attached to a pole. A grab sample is the simplest type of sample to collect. **Ecology expects that most permit holders will choose to collect grab samples.**

Time-proportionate composite samples or flow-proportionate samples consist of taking several subsamples at intervals rather than a single grab sample. A time-proportionate sample is one made up of a number of small samples (subsamples) of equal volume collected at regular intervals and combined into a single large sample. A flow-proportionate sample is one made up of a number of subsamples where

each subsample collected represents an amount of stormwater that is proportional to the total flow.

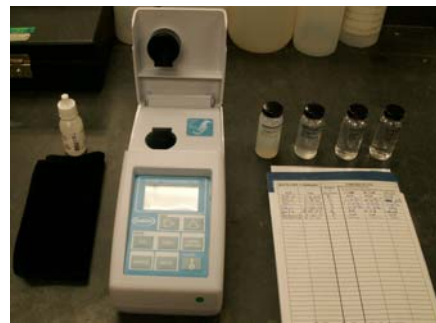
Time- proportionate and flow- proportionate samples provide the advantage of including a number of smaller samples (subsamples) in the single large sample. As a result, these samples represent the stormwater discharge better than with a grab sample.

Time- proportionate and flow- proportionate samples can be collected either by hand or automated equipment. Collecting them by hand is somewhat difficult and collecting them with automated equipment involves additional expenses. Flow- proportionate sampling also requires some knowledge of how to measure fluid flow. A reference for automatic stormwater sampling is the book *Automatic Stormwater Sampling Made Easy* (Thrush and De Leon, 1993) published by the Water Environment Federation. You can purchase a copy at: www.wef.org.

Obtaining supplies for sampling

Turbidity Meters (Turbidimeters)

You can purchase a turbidity meter at a scientific or laboratory supply store, or online catalogue for around \$800. Some equipment suppliers are listed on page 35. Most turbidity meters come with calibration samples.



Turbidity meter with calibration samples and notebook

Transparency Tubes

Transparency tubes are relatively inexpensive (about \$40) and can be purchased at laboratory or field supply stores or online at: <http://watermonitoringequip.com/pages/stream.html>

The permit requires use of a 1 ¾ inch diameter, 60 centimeter long transparency tube.



Transparency tube

pH meters

pH meters can be purchased from scientific or lab supply stores or online. Some equipment suppliers are listed on page 35.



pH meter with calibration samples

pH strips

pH strips are much less expensive than a meter and can be purchased from a local pet store or online. Some equipment suppliers are listed on page 35. Ecology recommends using one with a tighter range from 5.5 to 9.0, which is more typical of pH values found around construction sites.

pH test kits

pH test kits involve performing a test with chemicals provided to determine the pH. You can purchase pH test kits online, at pet stores, or laboratory supply stores. Some equipment suppliers are listed on page 35. You may choose either a kit that covers the range 5.5 to 9.0 or a wide-range test kit.

Gloves

You should wear disposable non-powdered gloves in order to avoid contaminating your samples and protect yourself from potential hazards in the water. Either latex or nitrile gloves will work. You can purchase gloves at grocery stores, pharmacies, or laboratory or medical supply stores.

Collection bottles

Use clean collection bottles with a screw-tight lid to capture the discharge. Large plastic bottles work well.

Scoops

In areas with low flow or shallow runoff, you may want to use a scoop to grab the sample. You can find scoops and dustpans with cleaning supplies at general stores and at many hardware or pet stores. Make sure you use a clean scoop for taking the sample. **Do not disturb sediment lying on the bottom with the scoop while taking the sample.**



Use scoops for sampling shallow flows

Pole

To reach difficult discharge points, you may want to attach your sample bottle to a pole with a grappling hook or some automobile hose clamps. Make sure you attach the bottle securely.

Clean rinse water

Use clean rinse water such as distilled water to wash sampling bottles between each use. You can purchase distilled water at most grocery or convenience stores.

Rite-in-the-Rain notebook or site inspection log book and pen

Make sure you bring an appropriate notebook or site inspection log book to record your results. You can purchase Rite-in-the-Rain notebooks and pens that are waterproof at <http://www.riteintherain.com/>. These products are also carried by many scientific equipment suppliers.

B. Conducting sampling at your site

Checklist for sampling

Keep all your sampling gear together in a field kit, so it is ready to go when you need to sample. You will need the following tools to conduct construction stormwater sampling:

- ✓ For turbidity sampling: turbidity meter (turbidimeter).
- ✓ For transparency sampling: transparency tube (1¾ inch diameter, 60 centimeters long).
- ✓ For pH sampling: pH strips, pH test kit, or pH meter.
- ✓ Clean collection or sample bottles.
- ✓ Distilled water for rinsing collection bottles.
- ✓ Non-powdered nitrile or latex gloves.
- ✓ Site log book to record measurements.
- ✓ Pole or scoop, if needed, for sampling difficult discharges.

If you plan to have a lab analyze your samples:

- ✓ Order clean sample jars from the lab. Be sure to have enough for all your sampling locations.
- ✓ Make sure you have ice and a cooler to store samples and can get them to the lab in time. See the section on using a lab (pgs.27-28) for more information on how soon to deliver samples to the lab.

How to fill sample bottles

This section provides some tips on collecting a sample properly. Collecting a grab sample can be as simple as holding a bottle under the stormwater falling from a pipe and filling the bottle properly. However, there are a few principles to follow to make sure you collect samples correctly.

Simple principles of good sample collection:

- **Wear clean powder-free gloves** when sampling
- **Use clean collection bottles**
- **Keep your hands away from the bottle opening.** This will prevent you from contaminating the sample with dirt or other particulates.
- **Always hold the bottle with its opening facing upstream** (into the flow of water) so that the water enters directly into the bottle. Make sure the water going into the bottle does not first flow over the top of the bottle or your hands.
- **Stand downstream.** If you need to step in the flow to sample the water, make sure the area is safe first. Next, make sure you sample upstream of your body including your feet. This will make sure any soil disturbed by stepping in the water does not influence your results.
- **Do not set container lids on the ground.** This may introduce dirt into your sample causing a higher result.
- **Label samples for labs immediately.** Make sure you cap the bottle or container and label the sample correctly. Place samples headed for a lab in a cooler filled with ice until the samples arrive at the lab.

Sampling as stormwater discharges from a pipe or in a ditch

If stormwater discharges from your site through a pipe or ditch, you can sample the water before it reaches the receiving water (creek, stream, lake, etc.) or storm drain. When sampling in a ditch, hold the bottle with the opening facing upstream and be sure not to overfill the bottle. Be sure you do not disturb sediment at the bottom of the ditch with your feet or the collection bottle. You may need to fasten the collection bottle to a pole to reach the pipe or ditch.



Sampling in a ditch with a collection bottle attached to a pole



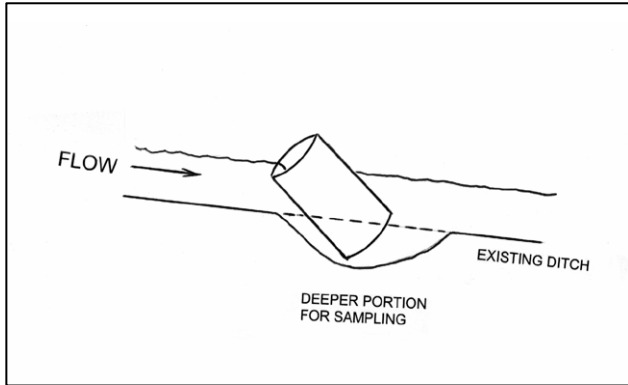
Sampling from a pipe discharge

Sampling from a stormwater detention pond or other BMP

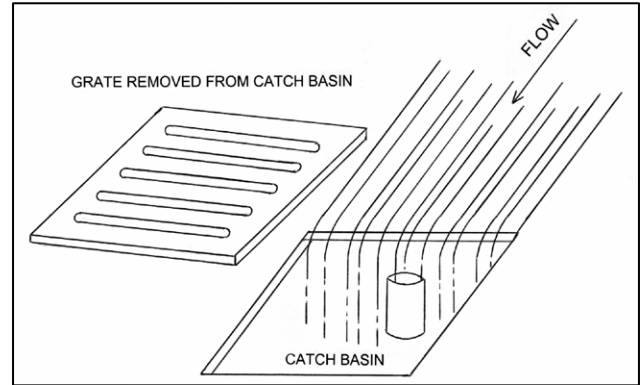
For a detention pond or other treatment system, sample the stormwater flow discharge point after flowing through the pond or other treatment system (e.g., spillway). Keep in mind, ponds may hold stormwater for a time before discharge begins. The permit requires sampling from detention ponds only if stormwater discharges from the pond.

Sampling shallow stormwater discharges

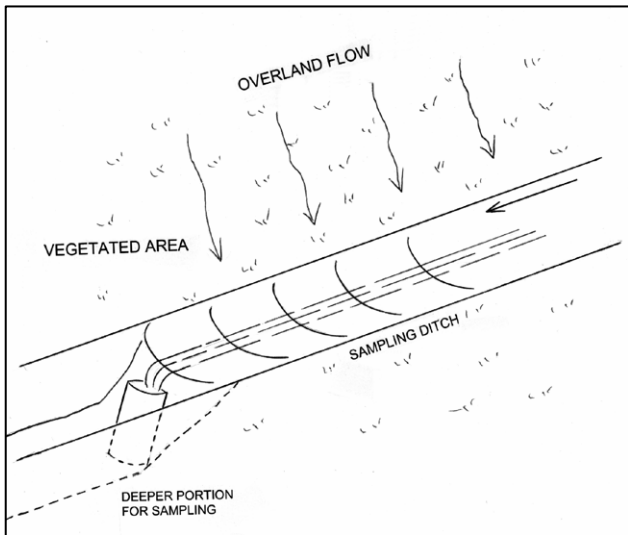
Shallow stormwater runoff can present a challenge for collecting samples. As mentioned previously, you can use a scoop to grab these samples. The following illustrations also provide ways to sample shallow flows:



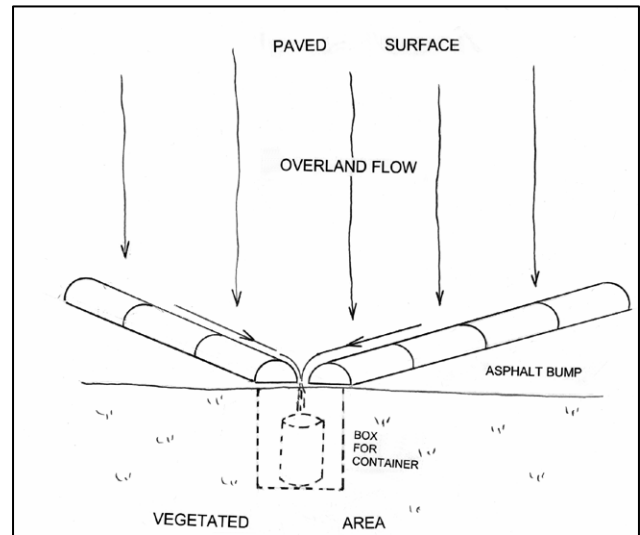
Above: Deepening an existing ditch before a rain event can allow samples to be collected directly into bottles in some cases. Be careful not to stir up solids from the sides or bottom of the ditch.



Above: Runoff entering a catch basin can sometimes be collected directly into bottles by removing the grate and allowing the runoff to fall into the bottles.



Above: Overland flow from vegetated areas can be sampled by constructing a shallow ditch to intercept the runoff and a deepened area to place bottles to catch the runoff. This construction should be performed before a rain event.



Above: Overland flow on paved areas can be sampled by constructing asphalt or concrete bumps to collect and concentrate the flow. A box positioned below ground surface in the paved area or the edge of an unpaved area can provide a place to collect samples directly into bottles.

Turbidity

Turbidity is one way to measure water clarity. A field turbidity meter measures the reflection of light off particles in the water column. The unit of measurement from a field turbidity meter is called a Nephelometric Turbidity Unit or NTU. Higher values indicate more turbid, or muddier water. Low values indicate less turbid, or clearer water.

Turbidity meters can provide a very accurate measure of turbidity. **You must calibrate the meter before you use it in the field.** Calibration samples come with the turbidity meter. There are several brands of meters. Follow the instructions provided with your turbidity meter to calibrate it and use it in the field. The manufacturer's instructions will also indicate how often you should calibrate your meter. Clean the sample vials and thoroughly rinse with distilled water in the lab and allow to air dry before taking them into the field. Some meters supply a dust free cloth that can be used to wipe excess water from the vial prior to measurement in the meter. **Do not use paper towels. Fibers or other materials on these vials can bias the results.**

To take the sample:

1. Make sure you put on gloves to prevent contamination of the sample.
2. Using a large mouth bottle, collect a sample and cap it. Do not stir up sediment at the bottom of the water column. Stand downstream of the collection bottle and point the mouth of the bottle into the flow.
3. Gently mix the collection bottle without adding air bubbles.
4. Fill the sample vial.
5. Hold up the sample vial to insure that it is free of scratches and materials. Handling the vial can introduce material to the outside of the vial. Be sure to hold the vial only at the very top to keep it clean. Use a few drops of silicone oil on the outside to eliminate microscopic scratches and condensation. Wipe gently with a velvet cloth, which won't leave lint.
6. Set up the meter on a level surface and turn it on.
7. Follow the directions to line up the vial correctly for the meter you are using. Insert the vial in the meter. Close the lid and press read. Be careful not to bump or move the turbidity meter while it is taking its reading.
8. Record the value in the site log book.
9. Quickly rinse the glass vial with distilled water. If you choose, you may take another sample. Remix the remaining sample and fill the vial as before. Average the results. Averaging is an option, not a requirement.
10. Record all values in your field notebook.

Transparency

Transparency uses visual means to determine the clarity of the water. Less light can penetrate through cloudier water. One way to measure transparency is with a transparency tube, which operates on this same principle. At the bottom of the tube is a black and white disk called a secchi disk.

Sample water from the site will be put into the tube and released through the exit tube until the pattern of the secchi disk is clearly visible. At this point, the release will be closed and the measurement taken in centimeters of the depth of the water in the tube.

To take the sample:

1. Put on protective gloves before sampling.
2. Capture the stormwater discharge using clean collection bottle and capped with a lid. While collecting the sample, do not disturb sediment lying at the bottom of the water column. Avoid capturing large objects such as sticks, leaves and floating debris.
3. Check to make sure the exit tube is closed on the transparency tube.
4. Gently shake the sample bottle without adding air bubbles.
5. Fill the tube with the sample. While holding the tube upright, look down into the tube.
6. Sunlight can influence your ability to see the secchi disk. If it is a bright day, stand out of direct sunlight. Use a shady area or the shade of your body to cast a shadow on the tube.
7. Begin to slowly release water using the exit tube clamp until the secchi disk design (a black and white disk at the bottom) is visible. When the design is visible, stop releasing the water.
8. Record the height of the water in the tube in centimeters. Empty the tube contents and rinse it. If you choose, repeat the measurement and average the two readings. Again, the permit does not require multiple samples at each location.



The secchi disk is the black and white disk located at the bottom of the transparency tube. Photo courtesy of: http://www.wildco.com/ow_prdct_mdl.asp?prdct_mdl_cd=58T

pH

pH is the second parameter the construction stormwater permit requires you to measure. pH measures how acidic or basic a solution is. The pH scale goes from 1.0 to 14.0 standard units. A value of 7.0 is neutral. You can measure pH in three ways (1) with a pH meter, (2) with pH strips, or (3) with a pH test kit. If you choose or are required to use a pH meter, be sure to calibrate it before using it in the field. pH meters come with a set of standards used for calibration. Follow the directions to calibrate your pH meter as often as recommended.

Using a pH meter

To take the sample:

1. Follow the manufacturer's directions (see also Ecology's video: *How to Sample Stormwater*).
2. Turn on the pH meter. pH meters or pens have a probe or sensor on the end.
3. Put the probe or sensor directly in the stormwater flow. Alternatively, use a clean, large-mouthed bottle to capture a sample.
4. Leave the probe in the water for 5-10 seconds and allow it to register the final reading.
5. Record the digital reading of the pH. Do not move the probe or the sample bottle while the probe is registering.

Using pH strips

To take the sample:

1. Be careful to touch only the plain-colored tip of the pH paper with your finger. Wear gloves to protect your skin from potentially high pH water (very alkaline).
2. Dip the pH strip into the middle of the stormwater flow for a few seconds.
3. Remove the strip.
4. The color will appear on the strip almost immediately.
5. Find the best match of the sample strip to the color chart included with the strips.
6. This will be the pH reading you record.



A pH strip matched to the color chart provided in the pH kit.

Using a pH Test Kit

pH test kits vary depending on manufacturer, but most follow a few simple steps. Make sure you consult the instructions for your pH test kit before you sample.


To take the sample:

1. Collect a sample from the appropriate discharge area such as the stormwater retention pond.
2. Pour the sample into the clean tube provided.
3. Add several drops of the pH indicator chemical provided with the kit.
4. Compare the color of the resulting water to the chart provided with the kit.
5. This color will match a pH on the chart; record this value.

Benchmark values

The *Construction Stormwater General Permit* sets **benchmark values** for turbidity/transparency and pH. A benchmark is **not** a numerical water quality standard. Instead, a benchmark gives an indication of whether your BMPs are working to prevent pollutants from contaminating stormwater on site. If sampling indicates stormwater leaving your site is above a benchmark, then you are required to take additional steps to prevent polluted runoff from leaving your site. Failure to take such action(s) violates the permit.

What are benchmarks?



25_{NTU} Benchmark *Increasing turbidity* → 250_{NTU} Benchmark

- Benchmark values are not water quality standards and are not permit limits. They are indicator values.
- Comparing your water sample results to benchmarks indicates how BMPs are performing. They indicate the risk of stormwater leaving your site has to violate water quality standards.
- Failure to complete the corrective actions required when your samples are at or above the 25 or 250 NTU benchmarks violates your permit.
- Values at or below the 25 NTU benchmark are *unlikely* to cause a water quality violation (Green).
- Values at or above the 250 NTU benchmark are *likely* to cause a water quality violation (Red).

Benchmark Exceeded and Turbidity is 26-249 NTU or Transparency 7-32 cm

If your turbidity or transparency samples are in these ranges, the Certified Erosion and Sediment Control Lead (CESCL) for the site must take all of the actions listed:

1. Review the SWPPP to make sure it fulfills the SWPPP requirements in the permit (see Permit Section S9).
2. Revise or update the SWPPP within 7 days of the sample that exceeded the benchmark, if necessary.
 - a. The CESCL can perform SWPPP revisions related to common erosion and sediment control problems on site. Examples include: covering exposed soils with plastic, mulch, nets, or blankets; inserting and maintaining check dams and straw wattles.

- b. If the SWPPP revision involves new or modified engineering designs, you must have the new or modified designs stamped by a Registered Professional Engineer. Examples include: stormwater ponds, sand filters, and chemical treatment systems.
3. Implement and maintain appropriate source control or treatment BMPs fully as soon as possible, but no later than 10 days after the discharge that exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when a permittee requests an extension within the initial 10-day response period.
4. Document any BMP maintenance or added BMPs in the site log book.

Benchmark Exceeded and Turbidity is 250 NTU or greater or Transparency 6 cm or less

If sampling indicates a turbidity of 250 NTU or higher, or transparency is 6 cm or less, then you must notify the appropriate Ecology regional office by phone within 24 hours of analysis. The CESCL must also take all of the actions listed:

1. Review and change the SWPPP within 7 days of the sampling that exceeded the benchmark.
2. Implement and maintain appropriate source control or treatment BMPs fully as soon as possible, but no later than 10 days after the discharge that exceeded the benchmark. If installation of necessary treatment BMPs is not feasible within 10 days, Ecology may approve additional time when an extension is requested by a permittee within the initial 10-day response period.
3. Document any BMP maintenance or added BMPs in the site log book.
4. Sample the discharge daily until one of the following conditions is met:
 - a. Turbidity is 25 NTU or below.
 - b. Transparency is 31 cm or greater.
 - c. The CESCL demonstrates the site meets the water quality standard for turbidity.
 - d. The discharge stops or is eliminated.

Benchmark for pH 8.5 or above

If the stormwater pH values are 8.5 or above, you must:

1. Prevent high pH (alkaline) water from entering storm sewer systems or surface waters.
2. Adjust, or neutralize high pH with treatment such as CO₂ sparging or dry ice, if necessary. Any other treatment requires prior approval from Ecology.

What to look for when a sample exceeds the benchmark:

If you have a sample that exceeds the benchmarks mentioned above, the construction stormwater permit requires you to review the SWPPP and change practices on your site. How does this work in practice? What do you look for and change? Think about the list of SWPPP elements and the potential sources of turbidity and high pH. The following list provides questions to ask yourself as you attempt to uncover the source of pollution:

- Are there uncovered soils or stock piles?

- Are silt fences ripped or sagging? Do silt fences need repair?
- Is mud tracking out onto roads?
- Is excessive sediment built up behind check dams?
- Do you need to limit the number of access points to the construction site?
- Are slopes protected from erosion?
- Is concrete truck wash water being controlled to prevent stormwater contamination?
- Are on-site ditches and waterways stabilized and protected from erosion?
- Do you need to divert runoff around uncovered areas or slopes?
- Are all storm drain catchments protected? Do they need to be cleaned out?
- Do stormwater outlets need additional armoring with quarry spalls?
- How full are your stormwater retention or detention ponds?
- Are your ponds providing adequate treatment? Or do you need to implement sand filtration or chemical treatment?

303(d) water bodies

The 303(d) list contains water bodies designated as impaired (polluted) by the state and federal government. These water bodies do not meet Washington State water quality standards. If your site discharges to a waterway on the 303(d) list for turbidity, fine sediment, phosphorous, or high pH, some additional sampling requirements apply to your site. To check if your site discharges to an impaired waterway on the 303(d) list, visit the following web site:

<http://www.ecy.wa.gov/programs/wq/stormwater/construction/impaired.html>

303(d) listing for turbidity, fine sediment, or phosphorus

If you discharge to a waterway which is on the 303(d) list for turbidity, fine sediment, or phosphorus, you must measure both the background turbidity **and** the turbidity of your site's stormwater discharge. In addition, all sites discharging to these impaired waters must measure using a turbidity meter, regardless of the size of the site.

Where is background turbidity measured?

You must measure background turbidity in the waterway that receives runoff from your site at a location up-gradient (upstream) or outside of the area of influence of the discharge from the construction site. Background turbidity may change from day to day. As a result, **you must measure background turbidity each time you measure discharge turbidity.**

If your site discharges to a wetland, lake, or estuary, you must measure background turbidity at a location that is not affected by the stormwater discharge. When you cannot find a location unaffected by the stormwater discharge (i.e., the entire wetland appears uniformly muddy from the stormwater discharge), you may need to measure the background turbidity in a nearby, similar waterway or watershed. Contact a stormwater inspector in the Ecology regional office, if you have questions about where to sample.

Where is your site's discharge turbidity measured?

You must measure the turbidity of your site's stormwater discharge at one of the following two locations.

Option 1: Measure turbidity of the discharge at the point where your discharge enters the 303(d) listed waterway, inside the area of influence of the discharge.

Option 2: Measure turbidity of the discharge at the point where your discharge leaves the construction site. This is typically the stormwater outfall from a pond, culvert, or other drainage feature. In some cases, it will be the location where stormwater from the construction site leaves the property boundary and enters a roadside ditch or municipal storm drain.

Contact a stormwater inspector in the Ecology regional office, if you have questions about where to sample.

What is the water quality standard for turbidity, phosphorous, and fine sediment?

If your site discharges to a waterway on the 303(d) list for turbidity, phosphorous, or fine sediment, your site must meet the turbidity water quality standard. The standard applies as follows:

1. If background water turbidity is *50 NTU or less*, your discharge turbidity cannot be greater than 5 NTU over background turbidity.
2. If background water turbidity is *greater than 50 NTU*, your discharge turbidity cannot cause more than a 10 percent increase in turbidity, over the background turbidity.
3. If your discharge is less than 5 NTU as it leaves the site, you do not need to sample the receiving water to determine background turbidity.

If you exceed the 303d turbidity standard, you must take all of the following actions:

1. Notify the appropriate Ecology regional office by phone within 24 hours of the analysis.
2. Review the SWPPP to make sure it fulfills the SWPPP requirements in the permit (see Permit Section S9).
3. Revise the SWPPP within 7 days of the sample that exceeded the standard.
4. Implement and maintain appropriate source control or treatment BMPs fully, as soon as possible, but no later than 10 days after the sample that exceeded the standard.
5. Document BMP maintenance or added BMPs in the site log book.
6. Sample daily until discharge meets water quality standard for turbidity.

303(d) listing for pH

If your site discharges to a waterway listed for pH, you must measure pH with a pH meter to ensure that it is within the range of 6.5 to 8.5 standard units. You may measure at either of the following locations:

Option 1: Measure pH at the point of discharge into the waterway, inside the area of influence of the discharge.

Option 2: Measure pH at the point where the discharge leaves the site. This is typically the stormwater outfall from a pond, culvert, or other drainage feature. In some cases, it will be the location where stormwater from the construction site leaves the property boundary and enters a roadside ditch or municipal storm sewer system (drain).

Contact a stormwater inspector in the Ecology regional office, if you have questions about where to sample.

If pH is below 6.5 or above 8.5, you must take all of the following actions:

- Notify the appropriate Ecology regional office by phone within 24 hours of the analysis.
- Review the SWPPP to make sure it fulfills the SWPPP requirements in the permit (see Permit Section S9).
- Revise the SWPPP within 7 days of the sample that exceeded the standard.
- Implement and maintain appropriate source control or treatment BMPs fully, as soon as possible, but no later than 10 days after the sample that exceeded the standard.
- Document BMP maintenance or added BMPs in the site log book.
- Sample daily until discharge meets water quality standard for pH (in the range of 6.5 to 8.5) or the discharge stops or is eliminated.

Total Maximum Daily Load (TMDL)

Some impaired waters have a Total Maximum Daily Load (TMDL)-a water cleanup plan. To improve water quality, a TMDL sets allowable levels of discharges called **waste load allocations (WLAs)**. These allocations usually identify sources or types of dischargers and establish limits on the amount of pollution a waterway with a TMDL can receive. If your site discharges to a **TMDL for turbidity, fine sediment, high pH, or phosphorous that is approved before you submit a permit application, your monitoring conditions may be different.** The following are some potential conditions, you may face:

If the TMDL has **specific waste load allocations** or other requirements for construction stormwater discharges and other discharges covered by the construction stormwater permit, the discharges must be consistent with the established WLA or other requirements. In addition, you must:

- Sample discharges weekly, or as specified by the TMDL.
- Use analytical methods set out in the latest *Guidelines Establishing Test Procedures for the Analysis of Pollutants* (40 CFR Part 136). The permit does not require turbidity and pH methods to be accredited or registered.

If the TMDL does not have a specific WLA for construction stormwater, then follow the Construction General Permit's regular monitoring and SWPPP conditions.

To determine if your site discharges to a waterway with a TMDL, you may contact Ecology at (360) 407-6600 and ask to speak with a construction stormwater permit manager.

Keeping records

Record your results

Keep a field notebook to record results of stormwater sampling. For each measurement or sample taken, you must record the following information:

1. Date, place, method, and time of sampling or measurement.
2. The individual who performed the sampling or measurement.
3. The dates the analyses were performed.
4. The individual who performed the analyses.
5. The analytical techniques or methods used.
6. The results of all analyses.

General requirements

As the operator, you must keep all monitoring information including site inspection reports, calibration and sampling results, the SWPPP and any other relevant documents during the life of the construction project and for 3 years following the end of permit coverage.

Report high turbidity by phone

Remember, if you get a high result, call the Ecology regional office within 24 hours stating, "I'm reporting a high turbidity construction stormwater discharge of (your sample result) NTUs." Include the following information:

1. Your Name / Phone Number
2. Permit Number
3. City / County of Project
4. Date / Time of Call
5. Date / Time of Sample
6. Project Name

Ecology regional offices and phone numbers

Central Region (Okanogan, Chelan, Douglas, Kittitas, Yakima, Klickitat, Benton):
509-575-2490

Eastern Region (Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman): 509-329-3400

Northwest Region (Kitsap, Snohomish, Island, King, San Juan, Skagit, Whatcom):
425-649-7000

Southwest Region (Grays Harbor, Lewis, Mason, Thurston, Pierce, Clark, Cowlitz, Skamania, Wahkiakum, Clallam, Jefferson, Pacific): 360-407-6300

Discharge Monitoring Reports

Those sites that conduct water quality sampling for turbidity, transparency, pH or 303(d) and TMDL listed water bodies must submit the results monthly on a Discharge Monitoring Report (DMR) form to Ecology.

C. Using a lab to analyze samples

Contact the lab in advance

The field sampling in the *Construction Stormwater General Permit* is easy to conduct. However, some sites may choose to have a lab analyze their turbidity samples. You must conduct pH testing in the field, because pH samples do not hold for more than 15 minutes. As a result, labs cannot accurately analyze pH samples within such a short time frame.

If you choose to use a lab to analyze your turbidity samples, you should contact the lab well ahead of time. They will provide you with the clean sampling bottles you will need. The lab can provide you with helpful information specific to their needs. Issues you may want to discuss with the lab include:

- The **type and size of bottle** that the lab will supply for each type of sample they test.
- **How full** to fill the bottle.
- **Any safety concerns** with materials supplied by the lab.
- **What you need to know about preserving your samples:** Make a note of the preservation method. For turbidity, chilling is required with ice.
- **The kind of labels** the lab will supply for the bottles and will they instruct you about how to fill out the labels. The labels or tags you use to identify the samples you take must be waterproof, and the ink you use to write on them must be waterproof.
- **A description of forms** or other paperwork to submit to the lab with the samples and how to fill them out.
- **Whether the lab will supply pH paper** as well as sample bottles, tags, or labels for the bottles, and blank forms.
- **How the lab will deliver bottles** and other supplies to you. You may need to pick them up from the lab.
- **The holding times** for each water quality parameter to be sampled and tested. A holding time is the maximum time allowed between taking the sample and doing the lab analysis. If you exceed holding time, the sample analysis is not acceptable.
- **How and when you will deliver samples to the lab.** Plan with the lab how you will get the samples to them in time to begin analysis before the parameter with the shortest holding time reaches that holding time. The fastest way to deliver samples to the lab may be to do so in person, but it may be possible to ship samples (iced in coolers) and still meet holding times. If you deliver samples in person, you can pick up bottles and supplies for the next quarter at the same time.

Table 2. Holding times and preservation for turbidity samples

Parameter	Bottle Type	Minimum Sample Required	Holding Time	Preservation
Turbidity	500 mL wide-mouthed poly	100 mL	48 hours	Cool to 4° C

The table shows sampling information for turbidity under the *Construction Stormwater General Permit*.

Sampling requirements tend to use scientific words and units of measure. Temperature is measured in degrees Celsius, "C." Thermometers that we typically use in the United States measure in Fahrenheit, "F" and 4° C is about 39° F. For your purposes, "Cooling to 4° C" means putting the samples on crushed ice or packed with blue ice in an ice chest, so they will be kept just above freezing. Be sure to have the lab explain any words or expressions that you do not understand.

Select a laboratory to test your sample

Select a laboratory that will be able to analyze your samples within the holding time required (see section above).

Appendices

Proper and Improper Methods of Sampling

DO



Do attach a bottle to a pole for sampling hard-to-reach places such as ditches. This example shows a boathook with the bottle attached to it with filament strapping tape.

DO



If the water is too shallow to sample with the bottle upright, try taping it on sideways, but tilted up slightly.

DON'T



Do not touch the openings of bottles. Keep bottles clean to prevent contamination.

DON'T



Do not allow bottle lids to touch ground. Keep lids clean to prevent contamination.

DO



Do sample with the opening of the bottle facing upstream, into the flow, so the water will enter directly into the bottle. This is true when sampling either by hand or with a pole. **Do** sample water that is rapidly flowing rather than stagnant.

DON'T



Do not sample with the opening of the bottle facing downstream, when using a pole or sampling by hand. Water flowing past your container, pole, or hand and into the container can be contaminated by such contact.

Equipment suppliers

This is a partial list of scientific equipment supply companies from which to purchase stormwater sampling equipment. For additional supply companies, see the EPA web page at:

<http://www.epa.gov/owow/monitoring/volunteer/stream/appendb.html>

Aquatic Research Instruments

P.O. Box 2214
Seattle, WA 98111
206-789-0138
water samplers

Cole-Parmer Instruments, Inc.

625 East Bunker Court
Vernon Hills, IL 60061
800-323-4340
http://www.coleparmer.com/index_enviro.asp
pH strips and meters, turbidimeters

Instrumentation Northwest

8902 122nd Ave NE
Kirkland, WA 98033-5827
425-822-4434
<http://www.inwusa.com/products.htm>
pH meters, turbidimeters, and rentals of equipment

Pollardwater.com17515 NE 67th Court

Redmond, WA 98052

800-437-1146 x209

425-861-8755 x209 Local WA

425-861-7235 Fax

<http://www.Pollardwater.com/>**Water Monitoring Equipment & Supply**

P.O. Box 344

Seal Harbor, ME 04675

207-276-5746

<http://www.watermonitoringequip.com/pages/home.html>*Transparency tubes, turbidity meters***Ecology Regional Contacts**

If you have questions or need to report a high turbidity sample, contact the construction stormwater inspector in the regional office for your county.

Central Regional Office **509-575-2490***Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima***Eastern Regional Office** **509-329-3400***Adams, Asotin, Benton, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Stevens, Spokane, Walla Walla, Whitman***Northwest Regional Office** **425-649-7000***Island, King, Kitsap, Snohomish***Southwest Regional Office** **360- 407-6300***Clallam, Cowlitz, Grays Harbor, Jefferson, Lewis, Mason, Pacific, Pierce, Thurston***Bellingham Field Office** **360- 715-5200***Whatcom, Skagit, San Juan***Vancouver Field Office** **360-690-7171***Clark, Skamania, Wahkiakum*

References

Manchester Environmental Laboratory. 2005. "Lab Users Manual." 8th Edition. Washington State Department of Ecology.

Thrush, C. and D.B. DeLeon. 1993. Automatic stormwater sampling made easy. Alexandria, VA. Water Environment Federation.

U.S. Environmental Protection Agency. November 1997. Appendix B: Scientific Supply Houses in "Monitoring Water Quality." Publication # EPA 841-B-97-003.