Laboratory Week 2

Environmental Science 101, Pollutant Movement through Air, Land and Water

Stream flow and contaminant spill

Purpose:

1. Demonstrate stream sampling protocol.
2. Demonstrate the measurement of stream velocity and discharge.
3. Obtain stream water samples for analysis in next week's lab.
4. Measure the advection and dispersion of a mock contaminant spill into Potash Brook.

1. Stream sampling to obtain samples for laboratory analysis.

SOME COMMON QUALITY ASSURANCE SAMPLES		
Sample Type	**Description**	**Application**
Quality Assessment		
Field Blank	Deionized water treated as a sample	Used in estimating contamination from sample collection and processing
Field Duplicate	Duplicate lake or stream sample	Used in estimating combined sampling and lab precision
Audit Sample	Synthetic sample prepared by QC officer from outside source	Used in estimating accuracy and precision of lab
Quality Control		
Calibration Blank	Reagent-grade deionized water used to zero the instrument	Used in identifying instru-ment signal drift; can be compared to field blank to detect contamination of sample
Quality Control Check Sample	Standard solution (source other than calibration standard)	Used in determining accuracy and consistency of instrument calibration
Laboratory Duplicate (split sample)	Sample split in two at the lab	Used to test precision of lab measurements
Matrix Spike	Subsample spiked with known concentration of analyte (substance being measured)	Used in determining interference effects in the sample

Simple precautions need to be taken when sampling a stream for any type of analysis.

Container: The sample bottles must be clean and appropriate for the type of analysis to be performed. For example, samples to be measured for organic pollutants are usually taken in amber glass bottles. This limits degradation by light and possible sorption by a plastic container. On the other hand, samples for metals are usually taken in plastic to avoid possible sorption by glass. Samples for mercury must be in special precleaned bottles, usually Teflon, and these bottles must be kept sealed in plastic bags to avoid any sorption of mercury from the air.

Sampling: Avoid any contact with stream surfaces as this will stir up sediment and contaminate the sample. Always rinse the bottle and cap, preferably three times, with the stream water before filling. If volatile organic compounds are to be analyzed, fill the container completely to avoid any headspace in which the compound might segregate. Always note the time and date of sampling and give the sample a unique identification. Many analyses are time sensitive and need to be performed within a certain time limit. Keep the samples cool and refrigerate after returning them to the lab.

2. Measuring velocity (V) and discharge (Q).

Background: Velocity is the average water velocity (L/T) and discharge (L^3/T) is velocity multiplied by the cross-sectional area of the river. Velocity is needed to calculate the flux density (J) of a chemical. Discharge is necessary in order to calculate the total flux (J_{tot}) of a chemical.

Common units of V are meters per second (ms^{-1}) or fts^{-1} [$1\ ms^{-1} = 3.284\ fts^{-1}$].

Common units of Q are cubic meters per second (m^3s^{-1}), liters per second, or cubic feet per second [$1\ m^3s^{-1} = 10^3\ Ls^{-1} = 35.31\ ft^3s^{-1}$].

Methods:

The most reliable method for determining discharge is to install a weir or flume that allows one to directly measure the volume of water passing through. If a datalogger and sensors are used, a complete record of discharge can be obtained. This is expensive, however, and not all stream channels can be easily gauged. The USGS maintains a number of weirs and data is available via the web. These data can be used to estimate discharge in other, nearby and similar watersheds if the watershed area is known.

Measuring stream velocity is not as easy as it might seem because the velocity changes with depth and lateral position in the stream. Various velocity meters are available and some work better than others. We will demonstrate the use of one or two of these. Another low-tech method is to float an object in the stream (something that won't be affected by wind) and measure its rate of travel. This velocity will be somewhat faster than that measured by a meter (meter V = 0.8 x surface V in a rough channel and 0.9 x surface V in a smooth channel). If we have time, we'll have a race.

Velocity meter operation: The meter should be placed at half-depth to obtain an average stream velocity. For streams wider than 2 ft, readings should be taken 1 ft apart. The dimensions of the stream channel need to be measured and the discharge is the sum of V x cross sectional area. Thus, your calculated discharge is the sum of a number of cross sectional segments.

3. Obtain stream water samples for analysis in next week's lab.

Besides the samples collected below, collect one sample per group from your station just after disturbing the stream bottom (to obtain a sample with a high sediment load). **Do this after all groups have completed the tracer experiment.**

4. Measure the advection and dispersion of a mock contaminant spill into Potash Brook.

Background: A contaminant will move downstream via advection and its concentration will decrease via dispersion. With increasing distance from the spill, the result is a widening area of contamination but lower concentration (see Fig. 2-4 in the text). In other words, the mass of the spill is spread out and eventually the concentration will probably not be detectable above background. Chemical transformations (e.g. volatilization or degradation) will, of course, affect concentration but we won't consider those in today's lab because we are using a "conservative" tracer. These tracers are substances that are not significantly transformed as they move through the stream. Examples are monovalent anions such as chloride and bromide, and fluorescent dyes such as fluorescein and rhodamine WT.

NaCl and KCl are convenient tracers to use because one can measure changes using a portable conductivity meter. Water conducts electricity directly proportional to the dissolved anion concentration (although the relationship is not linear at low pH). A problem with doing a tracer study in Potash Brook is the fact that it appears to have extremely high concentrations of Na^+ and Cl^-. Finding the source of this salt would make an interesting addition to a project. We will be adding 2 L of 2 *M* KCl and taking samples over time at 5 stations along the stream. If we get good results, we will be able to calculate both the V and the dispersion coefficient (D) between each station.

Method: The tracer will be dumped into the stream at time 0. Four to six stations will be situated between 4 and 100 m downstream. Each station will have a group of four workers that will include a timer/recorder, a sampler, a bottle handler, and a conductivity tester. The sampler and conductivity tester should be positioned so that she or he will not disturb the stream during sampling. Each group will take ten samples at different time intervals as suggested in the table below. These times were calculated to sample both the rise and fall of the moving spill, based on previous velocity measurements. If the conductivity begins to increase before the second sampling time, start sampling sooner.

The final step will be to get an exact measurement of the distance between the spill site and each station. Chemical analysis of the samples will be provided.

Be sure to use a unique sample identifier for each individual sample. This should include your group name, lab name, date, and sample number.. For example, your first sample might be: Tom, Dick, and Harry (or TDH)----Potash Tracer Test---- date: 09-07-2001---- sample 01.

Suggested sampling times

Station	**4 m**	**8 m**	**30 m**	**60 m**	**100 m**
sampling time **1**	0 seconds	0 seconds	0 minutes	0 minutes	0 minutes
2	10	20	1	2	4
3	20	40	1	4	7
4	30	60	2	6	9
5	40	80	3	8	11
6	50	100	4	10	13
7	60	120	6	12	15
8	70	140	7	14	17
9	80	160	8	16	20
10	90	180	9	18	24

Station:____	**Time**	**Conductivity**
sampling time **1**		
2		
3		
4		
5		
6		
7		
8		
9		
10		