Water sampling in mine shafts should be correlated with major changes in the water level in the shafts. These changes may easily be determined by measuring the distance from the ground surface or some reference point to the water level. Where extensive underground mining has been conducted, sudden unexplained flow increases at openings or adjacent to the mine area may be the result of subsidence activity. The subsiding material displaces water that must flow out.

Springs and Seeps

Springs and seeps, when they occur, provide a means of assessing groundwater quality. It is essential that ground water from springs be identified as to the geologic horizon from which the water discharges. Map location and elevation should be noted. Collect samples from springs and seeps as near as possible to the point of discharge before surface contamination can occur. Reference the location of the discharge to area maps and geologic cross-section materials for more meaningful evaluation.

Sampling

A great variety of water sources must be sampled by inspection personnel. Therefore, a knowledge of many water-quality sampling techniques will be useful. Collecting a sample from a discharge pipe requires one technique, whereas collecting a sample from a flowing stream requires another.

The purpose of this section is to describe sampling techniques most likely to be used by mining and reclamation inspectors. Brief mention will also be made of some other sampling methods that inspectors should know about. The decision on what method to use will be dictated by the existing field conditions and the judgment of the inspector. Always give highest priority to recognized, accepted practices, particularly when the data may result in enforcement actions.

Wells, springs, seeps, and other difficult-to-sample sources may require makeshift sampling techniques. Once a sample is obtained from any source, the processing and preservation techniques are identical to those described in the next section, "Sample Preparation, Treatment, Documentation, and Field Analysis."

The sampling method used should be stated on the sample label and eventually reported with the analytical results.

Guidelines for Representative Samples

A sample is worthless unless it adequately represents the water in the stream or impoundment being sampled. To obtain representative samples, follow these guidelines:

1. Collect the sample where the water is well mixed, if possible immediately downstream from a point of hydraulic turbulence such as a waterfall or flume. Samples may also be collected from free-falling water (as in a small waterfall); however, care should be taken to move the sampling device through the full thickness of the falling water at several points so that a fully representative sample is obtained.
2. Avoid sampling where floating solids and oil tend to accumulate, such as downstream from certain types of weirs and flumes.
3. In a well-mixed stream, collect the sample in the center of the channel at from 4/10 to 6/10 of its depth where the velocity of flow is average or higher than average. This depth avoids the inadvertent collection of part of the stream bottom or top-floating materials such as oil, grease, or debris. In streams that may not be well mixed, force the mouth of the sampling vessel across the entire cross section of the stream to the fullest extent possible without collecting bottom materials or surface scum and debris. If the surface scum, oil, or grease is flowing with the stream (not just accumulated in a stagnant area) there may be need to include a representative portion of these materials in the sample—but only if the analysis is to include these parameters.
4. To avoid contaminating the sample, collect samples with the mouth of the sample bottle pointed upstream. Keep hands and other potential contaminants away from the mouth of the bottle.
5. Do not walk on, or in any way disturb, the stream bottom upstream from the sampling site.
6. Do not sample backwaters or deep standing pools found along the stream.
7. Do not sample streams immediately below tributaries or other significant points of inflow. Sample far enough downstream for thorough mixing to have occurred, or sample both main stream and tributary just above their confluence.
8. Wide shallow streams should be sampled using the equal width increment (EWI) technique described later in this section. Shallow lakes or impoundments should be sampled at several points and the samples analyzed either as individual samples or as a composite sample.
9. Water quality can vary with depth so deep lakes or streams should be sampled with depth-integrating samplers, or samples should be taken at different depths for analysis as individual or composite samples.
10. Collect sufficient sample volume to allow duplicate analyses and quality assurance testing. The required sample volume is the sum of the volume required for each analysis requested. Refer to the laboratory director for minimum volumes to be collected.
11. Not all sample containers should be filled to the same level. Sample bottles should be filled completely if the samples are to be analyzed for O_2, CO_2, H_2S, free chlorine, volatile organics, oil and grease, pH, SO_2, NH_3, NH_4^+, Fe^{++}, and acidity or alkalinity. Full bottles must be protected from freezing. When sampling for bacteria or suspended solids, it is desirable to leave an airspace in the sample container to facilitate mixing before subsampling in the laboratory. In depth-integrated sediment samples it is essential that the sample bottles not be filled more than ¾ full.
12. If samples are taken from a closed conduit via a valve or faucet, allow sufficient flushing time to insure that the sample is representative of the supply, taking into

account the diameter, length of the pipe to be flushed, and the velocity of the flow.

13. Maintain an up-to-date log book in which to note possible interferences, environmental conditions, and problem areas.

Streams

Grab Samples

Grab sampling, collecting a single-point, instantaneous sample, is generally not considered a good method for sampling a flowing stream unless the stream is very narrow (5 feet or less) or very shallow (10 inches or less). But since most mine effluents are smaller than this, grab sampling will of necessity be the method most commonly used by mine inspectors. Normally a grab sample should be collected near the center of the main flow of the stream. When the stream is not well mixed, some attempt should be made to make the sample as representative as possible by moving the collecting bottle across flowing portions of the stream. More information relevant to grab samples can be found in the first seven guidelines for representative samples in the preceding section.

Point Sampling

For streams with a stable cross section and a rather uniform lateral distribution of suspended solids, sampling at a single vertical (near the center of the stream) will usually be adequate.

Equal Width Increment (EWI) Samples

To collect an equal width increment (EWI) sample, the width of a stream is divided into segments, each segment is sampled and its discharge is measured, then volumes of these samples are measured out proportional to the flow of their respective stream segments. The samples are combined to give the composite EWI sample.

Depth Integrated Samples

For a sample from a deep stream, lake, or impoundment to be representative, it usually must be depth-integrated. Samples for total suspended solids or other constituents, such as total iron and total manganese, may be collected with a US-DH-48 depth-integrating suspended-sediment sampler or similar sampler when the water is deep enough. If a Teflon nozzle and O-ring are used with the DH-48 sampler, the sample can be analyzed for almost any chemical pertinent to coal mining situations. However, if nozzles and fittings are of other materials — brass, aluminum, etc. — analysis may be somewhat restricted. More than one bottle of water may be required, depending upon the laboratory determinations to be made and the preservation techniques employed in the field. The following procedure should be used when collecting samples for subsequent analyses:

- Place a clean bottle in the US-DH-48 sampler.
- Lower the sampler into the water and collect a small amount of sample.
- Rinse bottle thoroughly and discard the water, making sure no solids remain.
- Replace bottle, lower sampler at a uniform rate from the surface to the bottom, then raise it at a uniform rate. DO NOT STRIKE BOTTOM.
- Repeat previous step at all verticals necessary for representative sample.
- Fill the bottle no more than ¾ full. If it is filled beyond that volume, all water must be discarded and a new sample collected.

High velocity, floating debris, very shallow water, or other conditions may preclude the use of a sediment sampler. In that case, grab samples should be collected in a clean, rinsed container. When grab samples are collected in wide, relatively shallow streams, it is important that several verticals be sampled because the distribution of suspended solids is probably uneven. A single bottle may be filled through quick dips at several verticals, avoiding the necessity of compositing samples or collecting multiple samples.

Flow Proportional Compositing

A flow-proportional composite sample should represent the total volume of water flowing past the sampling site during a given period of time. This composite sample is composed of a number of discharge-weighted subsamples collected at uniform time intervals, perhaps a day or a week apart. For example, the composited portion of a subsample collected at a discharge of 15 ft^3/s would have 5 times the volume of the composited portion of a subsample collected at a discharge of 3 ft^3/s.

Sequential Compositing

A series of small samples collected at uniform time intervals is combined to produce a sequential-composite sample representative of the period of time over which the individual samples were collected. The main advantage of sequential compositing is economy. However, this type of sampling is limited by its "averaging" effect, which tends to mask the influences of significantly large changes in both streamflow and water quality.

Springs, Seeps, and Very Shallow Streams

Unless pools are present, samples cannot be dipped in the normal way from springs, seeps, and very shallow streams. Water may be collected with a syringe from shallow water as long as it does not draw up particulate matter from the bottom. It is frequently necessary to place a clean flat rock or piece of glass on the stream bottom, so the syringe tip will not be close to the loose bottom materials. Sometimes it is necessary to excavate a small pool or depression so the water will be deep enough to sample. After disturbing the stream bed in any way it will be necessary to let the flowing stream wash itself clean of sediment and turbidity before samples are taken.

Water flowing over a smooth rock face can be especially difficult to sample; however, a straw or a stick can usually be used to lead it to the sample container.

Springs and seeps in unconsolidated material may sometimes be sampled using a slotted pipe as described in the later section on sampling equipment.

Lakes, Ponds, and Impoundments

Shallow lakes and impoundments should be sampled at several points and the samples analyzed either as individual samples or as a composite sample. Water quality can vary with depth so deep lakes should be sampled with depth-integrating samplers, or samples should be taken at different depths for analysis as individual or composite samples.

Wells

Because the quality of the water standing in an unused well may not be representative of the quality of the water in the aquifer, a well must be pumped or bailed until the temperature, pH, and specific conductance are constant. Usually the last parameter to attain a reproducible reading and consequently, the most sensitive test for wells, is pH. Standby or little-used wells may require a lengthy period of pumping before the quality of the discharge stabilizes.

It may be impossible to obtain stabilized readings of pH, specific conductance, and temperature — even after lengthy pumping or bailing. If this is the case, a more practical option would be to pump for a specific period of time, say one hour, before collecting the samples.

Perhaps the easiest way to collect samples from existing wells with plumbing is, after sufficient pumping, to take the sample from a faucet or hose. However, if the pump intake is near the water surface or if there are air leaks in the pumping system, dissolved-oxygen contamination may result in the precipitation of metals even before the sample is collected. Water softeners, iron-removal filters, and storage tanks are sources of contamination and chemical change to water from a plumbing system. If it is impossible to avoid them, the installation of observation wells may be necessary. There are few well-defined criteria for sampling wells. Sampling technique will have to be adapted to existing field conditions.

Sample Preparation, Treatment, Documentation, and Field Analysis

Samples must be properly collected, preserved, and identified if they are to serve their intended purpose. Some parameters must be measured in the field; others can be determined in the laboratory.

Sample Preparation

- For suspended solids, cap and chill sample.
- At least two bottles will be needed if both "dissolved" and "total" constituents are to be determined (for example, dissolved iron and total manganese). For the "dissolved" constituents, a small part of the sample must be passed through a 0.45-micron membrane filter as follows:
  - Use a 50-milliliter plastic hand syringe and draw a few milliliters of sample water into the syringe for rinsing. Discard this rinse water.
  - Draw 50 milliliters of sample water.
  - Insert syringe outlet tip into the upper surface of membrane filter holder. Force sample through filter into sample bottle.
  - If metals are to be determined, acidify samples immediately with concentrated nitric acid (HNO_3) at the approximate ratio of 1 milliliter of nitric acid per 16-ounce (pint) sample.
  - Rinse filter holder and syringe with deionized water.

Recording Field Data and Identifying Sample

The inspector should keep a log or field-data sheet describing in detail the methods used in sample collection and the physical and climatic conditions under which the sample was collected. The log should contain:

- Field data such as pH, visible turbidity, specific conductance, temperature, etc.
- Name or initials of the individual collecting the sample
- Exact sample location (map location, longitude-latitude, or other)
- Date and time of sampling
- General climatic conditions
- Names of any witnesses to the sampling
- Flow rate including a description of the method used to determine it
- Sample identification number
- Name of mine and company.

Sample treatment:

RU—raw, unacidified	FU—filtered, unacidified
RA—raw, acidified	FA—filtered, acidified
RC—raw, chilled	FC—filtered, chilled

The sample container should be labeled with a waterproof marking pen on a pressure-sensitive label. Use permanent gummed labels. The sample container label should contain:

1. Sample identification
2. Time (military)
3. Date of collection
4. Name or initials of the person collecting the sample
5. Sample treatment (preservation)
6. Discharge (ft^3/s or gal./min.)
7. Presence of a calcium-based (or other) treatment system (so that the analyst can determine if there is a potential gypsum suspended-solids problem)
8. Remarks

The name of the coal company and location should not appear on the sample containers; rather, they should be kept in a separate log.

Upon completion of sampling and field-data recording, the samples should be transferred to the laboratory under appropriate conditions. For example, a chilled "C" sample should be shipped in an ice chest. The acid-preserved samples may also be stored in the ice chest as a matter of convenience. A chain of custody form (see Appendix D-11, 12, and 13) should be filled out by the individual doing the sampling and signed by each individual accepting custody of the sample. The samples should be locked in the shipping container or it should be sealed with pressure-sensitive, permanent printed tape to guarantee their security. If sealing tape is used, the laboratory manager responsible for the analysis must sign the chain of custody form stating that the tape sealing the container has not been tampered with.