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TITLE: **Ground Water Sample Filtration**

DATE EFFECTIVE: June 2001

QUESTION: When sampling ground water from monitoring wells, should the ground water samples be field filtered when sampling for metals?

BACKGROUND: Ground water samples collected from monitoring wells may contain noticeable amounts of sediment or particulate matter, often referred to as turbidity[1]. This condition may be unavoidable when monitoring some geologic environments. The sediment may include particles that are too large to be mobile in the subsurface. The presence of these larger particles is due to the effects of well construction, chemical precipitation produced upon exposure of ground water to the atmosphere, or excessive agitation of the well column during pumping.

Turbidity is an important field concern for samples to be analyzed for metals[2]. Since a goal of monitoring is to collect samples representative of natural ground water conditions, laboratory analyses of samples should quantify only metals that are dissolved, occur as mobile precipitates, or are adsorbed onto mobile particles. The inclusion of large, immobile particles in a ground water sample can result in a sample that is not representative of natural ground water conditions. For this reason, an unfiltered sample may not accurately characterize ground water quality if it contains an elevated concentration of immobile particles.

Filtering the ground water samples can remove the immobile particles, but it has several drawbacks. Filtering can cause a false negative due to the removal of contaminants, including metals, from the sample. Metals that are adsorbed to mobile particles may be

[1]As defined by the Water Quality Association (1999), turbidity, measured in nephelometric turbidity units (NTUs), is a measurement of the amount of small particles of solid matter suspended in water. Turbidity scatters and absorbs light rays making the water opaque. However, it should be noted that turbidity cannot be directly equated to suspended solids because white particles reflect more light than dark-colored particles and many small particles will reflect more light than an equivalent large particle. Turbidity is measured with a nephelometer, which passes light through a water sample and measures the amount of light deflected by particles suspended in the sample.

[2]The term, “metals” includes elements with high luster and high electrical and thermal conductivity (such as cadmium, nickel, and zinc) as well as “metalloids,” elements with an intermediate luster and intermediate electrical and thermal conductivity.

removed either by adsorption to the filter material or by mechanical separation by the filter. Clogging of filter pores may remove even more suspended sediments from the sample. Conversely, in some instances, contaminants can leach off the filtration apparatus into the samples, causing a false positive reading.

ANSWER: When characterizing the ground water, the goal is to collect samples that represent the in-situ ground water with respect to its entire mobile contaminant load, including both the dissolved and adsorbed fractions, while reducing the occurrence of normally immobile particles.

Ohio EPA prefers that ground water samples not be filtered. The following guidelines should be followed to ensure a sample representative of actual ground water conditions. The goal is to minimize disturbance of the water column and the sample to prevent large, immobile particles from entering wells and ground water samples and altering actual ground water conditions.

Monitoring Well Installation, Construction, and Development

Refer to Ohio EPA's Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring (1995) for appropriate well construction methods. The well borehole should be big enough for the casing installed. Boreholes should be cleaned out before installation of the screen and filter pack. The distance between the well casing and the borehole wall should be approximately two to four inches.

Select the correct screen size and filter pack grain size for the grain size of the in-situ soils in accordance with manufacturer's guidelines. Install the filter pack with a tremie pipe. When driven casing or hollow-stem augering is used to penetrate non-cohesive formations, the filter pack should be tremied as the casing and auger are pulled back in one to two foot increments to ensure proper filter pack placement. When installing wells through cohesive formations, the tremie pipe can be used after removal of the drilling device. Make regular measurements with a weighted tape during filter placement to determine when the desired height has been reached, and to lessen the possibility of bridging of filter materials.

Follow manufacturers' guidelines for hydrating the annular seal materials. Install the annular seal materials with a tremie pipe.

Develop the well to remove fines from the borehole to the maximum extent possible by pumping. Avoid surging the well by limiting the amount of water or air that is forced into the well.

Sample Collection

Use a positive displacement pump such as a bladder or low-speed submersible pump in a well at the desired sampling point and purge at a low rate until stabilization of indicator parameters (temperature, pH, specific conductance, Eh, dissolved oxygen, or turbidity) is achieved. Note that turbidity may continue to drop after other indicator parameters have stabilized. Avoid surging of the water column.

The flow rate should be as close as possible to the natural ground water flow rate. If the natural ground water flow rate cannot be determined, a flow rate of 100 to 500 ml/min is generally considered a low-flow pumping rate.

Avoid using a bailer, a suction lift pump (peristaltic or centrifugal), or pumping at a high rate because each can cause turbidity or alter the ground water chemistry.

Deciding Whether to Field Filter

Determine the turbidity with a nephelometer to evaluate the potential for particle mobility in the saturated zone being sampled. Water below five NTUs of turbidity should not be filtered. This is based on the assumption that any immobile component of turbidity present will contain an insignificant amount of immobile particles. If the water exceeds five NTUs, field filtering using appropriate methods may be appropriate, but only if the geology and subsurface conditions are unlikely to exhibit sediment particle mobility. Professional judgement should be used to determine the likelihood that sediment particles in the ground water are mobile, based on a knowledge of the site-specific variables that dictate mobility, including: ionic strength; ionic composition; flow velocity; the quantity, nature, and size of suspended particles; geologic composition and structure; and ground water chemistry. The following methods may be used to evaluate the mobility of sediment particles in the ground water: 1) compare turbidity at an apparent “contaminated” well to suspended solids at a background well because a contaminant plume can alter geochemical conditions and cause mobile particles; 2) compare sample particles to materials used in well construction (e.g., bentonite) using scanning

electron microscopy/energy-dispersive x-ray spectroscopy (SEM/EDX); 3) measure the size of particles in samples–anything over about two microns is most likely not mobile.

It is important to employ consistent sampling methods at a property when deciding whether or not to filter ground water samples. The sampler must remain flexible and must employ the sampling methods appropriate for the current ground water conditions. The sampler must evaluate the entire property and determine what method will provide the most useful and consistent data in the long run.

Recommended Filtering Procedure for Ground Water with Turbidity >5 NTUs

Use an in-line filtering technique to minimize aeration of the ground water.

Filter the sample using a polycarbonate or cellulose acetate filter.

Pre-wash the filter by running a little of the ground water to be sampled through the in-line filter prior to collecting the water sample.

While a 0.45 micron size filter is recommended, a filter with a larger pore size may be used based upon site conditions.

CONTACT: For further information regarding this issue, please contact the VAP Staff at (614) 644-2924.