U.S. Geological Survey Proposal

D: Surface Water Near Deer Trail, Colorado

D-1: Stream-Bed Sediment Quality

Question:

Are biosolids applications on the Metro properties near Deer Trail adversely affecting the quality of the surface water in the vicinity?

Concerns:

Biosolids applied to the land surface could affect surface-water quality directly through 1) contaminated inflow or 2) runoff over contaminated soils or sediments (remobilization). Biosolids can also affect surface-water quality indirectly through 1) plowing that mobilizes or changes surface constituents or surface characteristics, 2) inflow, baseflow, or recharge to surface water from contaminated ground water, or 3) contributions to natural processes such as nitrification.

Contaminated surface water could contaminate downstream, previously uncontaminated 1) surface water (ponds or streams), 2) stream-bed sediments, 3) alluvial aquifers, or 4) bedrock water-supply aquifers in aquifer-recharge zones.

Objectives:

To determine whether concentrations of nitrate, arsenic, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium, zinc, plutonium, and gross alpha and beta radioactivity, and organic carbon in bed sediments derived from (or transported through) biosolids-application properties are significantly higher than in bed sediments derived from nearby farmed properties without biosolids.

Approach:

Sediment deposited in stream channels or low-lying areas will be sampled to evaluate the potential for downstream surface-water contamination from biosolids applications. Sediment chemistry will be used as an indirect, qualitative measure of surface-water quality because: 1) In general, the stream channels in this area only have flow after rainfall when sampling the stream water is not practical; 2) Concentrations of heavy metals and plutonium are likely to be highest in the bed sediment; and 3) Bed sediments can be remobilized during subsequent rainfall runoff and transported downstream.

As many as three times the first year and four times per year thereafter, recently deposited bed sediment from paired drainages will be sampled after rainfall for heavy metals, organic carbon, and nutrients. Analyses will include arsenic, cadmium, copper, chromium, lead,

mercury, molybdenum, nickel, selenium, zinc, total nitrogen, and total phosphorous. Once each year, recently deposited bed sediment from paired drainages also will be sampled for radionuclides. Analyses will include plutonium and gross alpha and beta radioactivity. Samples will be collected using appropriate USGS protocols. Sufficient field blanks will be analyzed to enable sample bias (laboratory plus field) to be evaluated with at least 90 percent confidence after 5 years of monitoring. Sufficient field replicates will be analyzed to enable sample variability (laboratory plus field) to be evaluated with at least 90 percent confidence after 5 years of monitoring.

Sediment data will be maintained in a USGS data base and reviewed within one month of receipt from the laboratory. A newsletter will be distributed quarterly (every 3 months) to all stakeholders and interested parties; monitoring progress will be described every quarter, and reviewed hydrologic and chemical data will be included in the newsletter every other quarter. Reviewed data also will be available in electronic format. Data will be compiled into annual summaries and distributed with preliminary, reviewed interpretations at annual stakeholder meetings. Progress and scope of work will be reviewed at the annual meetings, at which time the scope of work and budget for the next year can be revised.

Data will be statistically analyzed to determine if concentrations of metals or radionuclides are significantly higher in bed sediments from biosolids-application properties than concentrations in sediment from non-biosolids properties. All results of the statistical tests will have full technical review before release, and will be released with the alpha, beta, and theta levels used for the testing. Data and interpretations will be published in a report following about 5 years of monitoring.

Monitoring sites:

Long-term monitoring sites will be selected both on and off the Metro property on the basis of field characteristics. Geology, drainage area, land use, rainfall, and channel morphology will be criteria used to identify comparable drainages for paired sampling.

Benefits:

This approach will yield data useful for objectively evaluating bed-sediment chemistry (metals and plutonium) and the potential for downstream contamination. Monitoring bed-sediment quality is a more cost-effective approach than sampling surface-water runoff because less equipment is required and more representative information can be obtained from the samples. “Background” (pre-biosolids) sediment or water chemistry can’t be determined because biosolids have been applied at this site for several years, but the inter-basin comparison means “background” sampling data are not needed to determine effects from biosolids applications.

Limitations:

This approach will not enable inferences about all aspects of surface-water quality, nor predict surface-water concentrations. Nutrient concentrations associated with the sediment can be measured, but are unlikely to represent or indicate stream concentrations, or possibly even runoff-sediment chemistry. This approach also will not evaluate sedimentation rates or quantity of bed sediment transported by runoff, although the USGS could (for an additional charge) determine sediment transport directly through field measurements or indirectly through air-photo comparisons.

Air-transported material also can affect surface-water and bed-sediment concentrations; the USGS has a number of possible approaches to monitor the chemistry and amount of air-transported material, and could provide this monitoring in this area for an additional cost. This approach does not include air monitoring at the sites, so only limited inferences about the processes controlling surface-water and bed-sediment concentrations could be made.

Sediment chemistry and deposition will not be uniform throughout the area. Sampling a single drainage pair per storm will enable useful comparisons, but give little insight into the variability of sediment chemistry throughout the area. Sampling additional drainage pairs after the same storm would enable a more significant (and quantitative) evaluation of runoff-sediment chemistry.

In general, comparing bed-sediment chemistry downgradient of Metro property to bed-sediment chemistry upgradient of Metro property in the same drainage is 1) often not feasible because many of the drainages head (begin) on Metro property, and 2) unlikely to result in an unbiased evaluation because the comparison criteria (such as same geology, land use, and drainage area) can't be met.

Access issues could seriously undermine this approach. The USGS sampling team would need to be able to access private property neighboring the Metro properties to collect the sediment samples from the non-biosolids drainages. In addition, USGS sampling teams would have to access the area fairly soon after rainfall had caused flow in the drainages if nutrient and organic carbon samples are to be representative because concentrations (especially nitrogen) will change rapidly. Vehicular access to the drainages in this area is often limited, but can be nonexistent and unsafe after heavy rain.

Trends and statistical tests, as well as sampling and laboratory bias and variability, can be calculated each year but can't be effectively evaluated until the end of about 5 years because of the number of samples needed for a viable statistical evaluation.

Schedule of initial monitoring:

Monitoring sediment chemistry in the vicinity of the Metro properties can begin within one month after the contract is finalized with a signed funding agreement, but the monitoring schedule is weather dependent. The storms likely to produce runoff and sediment deposition will probably happen during the spring and summer.