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Program Overview

Metro Wastewater Reclamation District (Metro District) applies biosolids to their properties near Deer Trail, Colorado. These biosolids applications could affect the quality of water in alluvial and bedrock aquifers, streambed sediments, soils, and crops. Water quality can be directly affected through:

- Contaminated recharge water, or
- Infiltration of water through contaminated soils or sediments (remobilization).

Continued on page 3

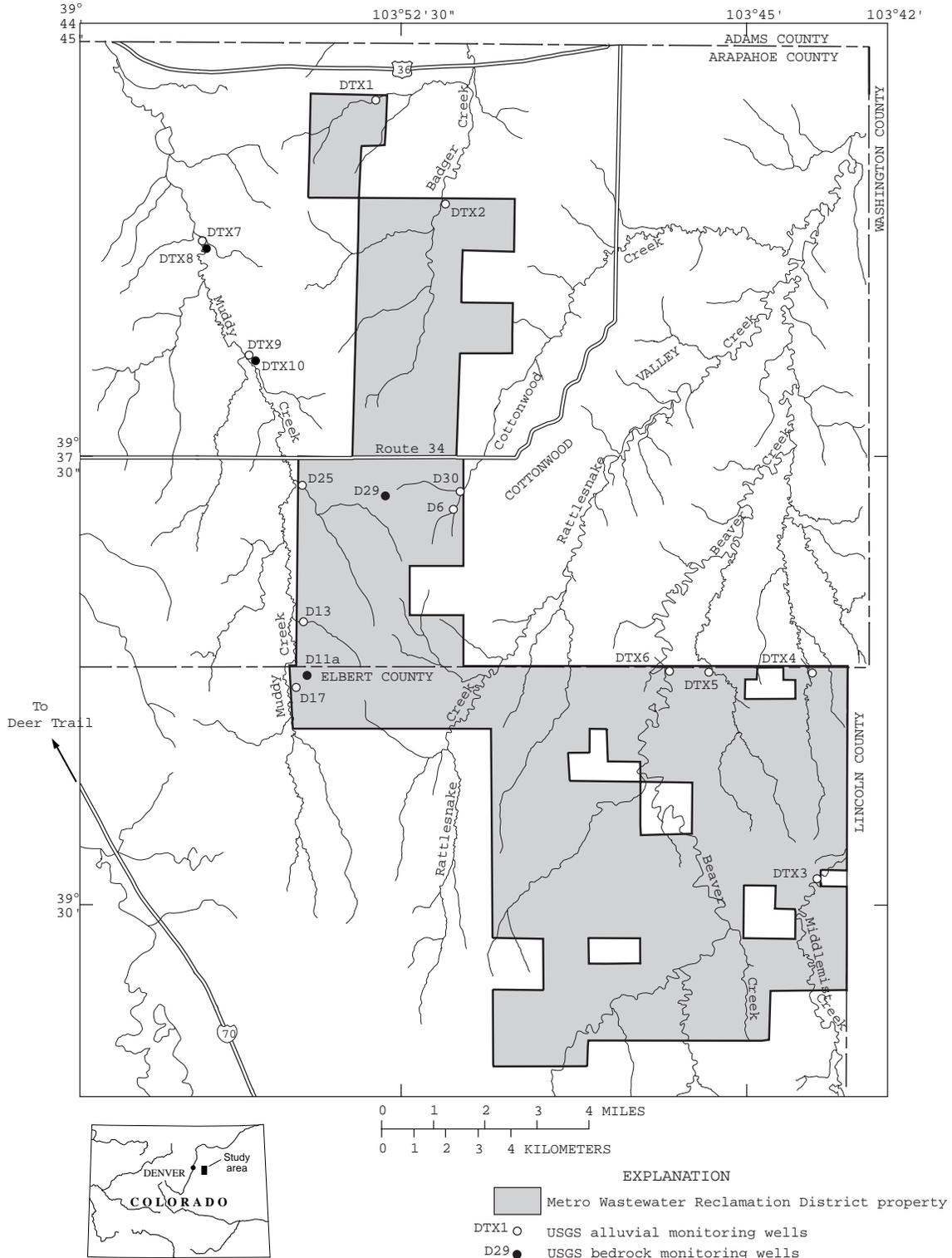
USGS

The U.S. Geological Survey is a science organization that provides the Nation with reliable, impartial information to describe and understand the Earth. The USGS home page: <http://www.usgs.gov>

How can I get a copy of this Quarterly Report, get on the mailing list, or have the mailing list corrected? Contact Tracy Yager. See page 12.



Water levels in the wells are measured monthly.



USGS Expanded Monitoring Program sites (ground water, only) and Metro District's biosolids-application properties near Deer Trail, Colorado

Program Overview

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Water quality can be indirectly affected through:

- Plowing that mobilizes or changes subsurface chemical constituents, or
- Contributions to natural processes such as nitrification.

Contaminated ground water or surface water could contaminate:

- Other aquifers, such as bedrock water-supply aquifers or alluvial aquifers,
- Other surface-water bodies (ponds or streams), or
- Streambed sediments.

Biosolids must meet metals and radioactivity regulations, or else agronomic loading rates will be incorrect and soils could be overloaded. Soil quality could either be improved by biosolids applications through increased nutrients and organic matter, or degraded through excessive nutrients or metals.

The U.S. Geological Survey (USGS) has designed and begun a new monitoring program to address concerns from a stakeholder group about the biosolids and the quality of the environment in the vicinity of the biosolids-application areas. The new USGS monitoring program near Deer Trail is referred to as the "USGS Expanded Monitoring Program" and began in January 1999.

This monitoring program is distinct from, but builds on, another

USGS program that monitored shallow ground-water quality on the Metro District Central Farm from 1993-1998. The new program (1999-2005) considers environmental-quality issues for shallow and deep ground water, surface water (bed sediments), soils, crops, and the biosolids. The new expanded monitoring program includes all three Metro District properties (North, Central, and South Farms) and related private-property locations. Both programs, however, use USGS and Metro District funds. In addition, the new monitoring program also uses funds from the North Kiowa Bijou Ground Water Management District. Both programs are designed, carried out, and interpreted independently by USGS, and quality-assured USGS data and reports will be released to the public and the Metro District at the same time. By definition and design, all USGS monitoring programs are independent and unbiased.

The objectives of the new Expanded Monitoring Program are to: (1) Evaluate the combined effects of biosolids applications, land use, and natural processes on alluvial aquifers, the bedrock aquifer, streambed sediments, soils, and crops by comparing chemical data to

- State or Federal regulatory limits,
- Data from a site where biosolids are not applied (a control site), or

- Earlier data from the same site (trends).

(2) Monitor biosolids for metals and radioactivity, and compare the concentrations with regulatory limits. (3) Determine the aquifer hydrology in this area.

The approach is unique for each component of the Expanded Monitoring Program. However, appropriate USGS methods and technologies will be applied to each component.

Quarterly reports such as this one will be distributed to the stakeholders and other concerned people, as well as available to the general public on the internet (<http://webserver.cr.usgs.gov>).

Each quarterly report will summarize progress from the previous quarter and plans for the current quarter; chemical data will be included every other quarter. A USGS report will be prepared annually and made available after each year of the monitoring program: the reports will include data for that year, any interpretations for that year, and statistical analysis for the data to date. A comprehensive USGS report will be prepared and available after five years of monitoring that includes complete statistical analyses and interpretations. In addition, the USGS will meet with the stakeholders once a year to discuss the Expanded Monitoring Program results and to consider possible changes to the Expanded Monitoring Program.

Questions & Answers

Q: Why are no sampling sites located on Rattlesnake Creek?

A: Only a small part of the Rattlesnake drainage basin has biosolids applied. In contrast, a large part of Badger Creek, Beaver Creek, and Muddy Creek drainage basins have biosolids applied. Monitoring on Rattlesnake Creek can be added if the stakeholders agree this area is a priority concern.

Q: Will there be any background water sampling for plutonium?

A: The monitoring wells will be sampled for plutonium in July 1999, which is before any transfer of water from the Lowry Landfill through the Metro wastewater treatment plant. These ground-water samples could indicate background concentrations of plutonium. You may expect to see these data in about 6 months.

Alluvial Ground Water

Approach

Six new monitoring wells will be installed near the Metro District property boundaries in the major alluvial aquifers. These six wells plus five existing USGS monitoring wells will be sampled approximately quarterly for full inorganic chemistry and annually for radioactivity. Data will be reviewed and statistically tested for exceedance of regulations and trends.

Progress Last Quarter (April–June 1999)

Ground-water levels were measured April 12–13, May 7, and June 7, 1999. Ground water was sampled for chemistry April 12–21, 1999. A ground-water sampling "Open House" was held April 16 at the site. The new well locations were surveyed during June. Permits were filed for the new monitoring wells. Continuous recorders were installed at well DTX2 to measure water levels, precipitation, water temperature, and air temperature. Ground-water data were compiled and reviewed.

Plans for the Current Quarter (July–September 1999)

Ground-water levels will be measured the first week of each month. Ground water will be sampled in early July, weather permitting. The USGS is planning to have a "Sampling Open House" in July (held July 9, 1999). The remaining instrumentation sites (including rain gages and continuous recorders) will be installed. All data obtained from the program to date

will be compiled, reviewed, and evaluated. USGS will present the status and results from this effort at the first annual stakeholders meeting (scheduled for July 15, 1999, in Kiowa, Colorado).

Bedrock Ground Water

Approach

A structure map of the base of the bedrock aquifer will be compiled and used to determine locations for two sets of new, paired wells (one alluvial well and one nearby dual-completion bedrock well comprise each pair). The well pairs will be installed where both the Muddy Creek alluvial aquifer and the Laramie-Fox Hills aquifer are present (along the margin of the bedrock aquifer) near the Metro

District properties. Water-level data from each well pair will be used to determine aquifer hydrology and interaction at those two locations. The two new bedrock wells, along with an existing USGS bedrock well, will be sampled approximately quarterly for full inorganic chemistry and annually for radioactivity. Data will be reviewed and statistically tested for exceedance of regulations and trends.

Progress Last Quarter (April–June 1999)

Ground-water levels were measured April 12–13, May 7, and June 7, 1999. Ground water was sam-

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Rock cores were taken from the boreholes when the wells were drilled. Pieces of the rock cores were analyzed for chemistry (see page 9).

Bedrock Ground Water

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pled for chemistry April 12-21, 1999. A ground-water sampling "Open House" was held April 16 at the site. The new well locations were surveyed during June. Permits were filed for the new monitoring wells. A project poster was prepared that shows the steps in the ground-water component of the monitoring program. Data were compiled and reviewed.



Field visits and oil and gas logs were used to compile the structure map

Plans for the Current Quarter (July-September 1999)

Ground-water levels will be measured the first week of each month. Ground water will be sampled in early July, weather permitting. The USGS is planning to have a "Sampling Open House" in July (held July 9, 1999). All data obtained from the program to date will be compiled, reviewed, and evaluated. USGS will present the status and results from this effort at the first annual stakeholders meeting (scheduled for July 15, 1999, in Kiowa, Colorado).



Metro District staff surveyed the new USGS monitoring wells in June to provide an elevation datum for the water levels



USGS staff review all data received from the lab, then enter the data into databases for further evaluation

Surface-Water Sediments

Approach

Surface-water contamination is a concern for the stakeholders, but

streams flow off the Metro District properties only during runoff when surface-water sampling is impractical. Therefore, possible surface-water contamination from metals will be evaluated by sampling stream-

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Surface-Water Sediments

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bed sediments soon after storms. Two small drainage basins will be selected for similar characteristics but different land use—one drainage in a biosolids-application field and another drainage in a farmed field (not on the Metro District properties) that does not receive biosolids. A downstream location in each of the two drainage basins will be sampled after the same storms, three to four times per year for inorganic constituents (including metals, total nitrogen, and total phosphorous) and organic carbon, and one time per year for radioactive constituents. Data will be reviewed and statistically tested to determine if concentrations are significantly different between the two drainage basins.

Progress Last Quarter (April-June 1999)

Maps, aerial photographs, and sampling equipment were obtained. Information about the study area was compiled, and three pairs of surface-water drainages were selected for possible sampling.

Plans for Current Quarter (July-September 1999)

Final selection of the drainage pair to be sampled will be made after the annual stakeholder meeting (scheduled for July 15, 1999). Sampling may take place, depending on the weather.

Biosolids

Approach

Biosolids samples will be taken as a 24-hour composite from the Metro District plant and analyzed by USGS. Biosolids will be sampled and analyzed once each quarter during most of the program, and once each month for six months when the Lowry landfill water transfer begins. Data will be reviewed and compared to Federal regulatory limits.

Progress Last Quarter (April-June 1999)

The second quarterly composite sample of biosolids was received from the Metro District on June 15, 1999. The sample represented a 24-

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Equipment and supplies are carefully prepared for sampling in the USGS laboratory

Biosolids

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hour composite from the main conveyor belt at the Metro facility. The material was placed in two acid-washed, one-gallon plastic bottles and transported to the USGS in Lakewood. There the material was air-dried prior to grinding to less than 150 micrometers.

Determinations for gross alpha, gross beta, plutonium, arsenic, selenium, and mercury on the first quarter's biosolids sample (collected March 26, 1999) were completed during this quarter (April–June). The results of these analyses are included in this report (on page 10), along with a comparison to the maximum concentration of these parameters allowable for classification as Grade I biosolids.



Streambed-sediment sampling locations were selected by comparing geology, land use, soils, drainage area, relief, presence of ponds, stream order, slope, and aspect

Plans for Current Quarter (July–September 1999)

The June biosolids sample will be submitted to the USGS laboratories for chemical analysis. At least a portion of the results should be complete by the end of September. Analysis of the March biosolids sample will be completed. The third quarterly sample of biosolids material will be collected, dried, and prepared for analysis.

Soils

Approach

One "application field" will be located on the Metro District property in Arapahoe County and one "application field" will be located on the Metro District property in Elbert County. Each application field will consist of three plots of at least 20 acres and will be approximately the same size and shape. The up-gradient plot will not have biosolids applied. The middle plot will have biosolids applied in the normal fashion. The down-gradient plot will not have biosolids applied. All three plots at each application field will be farmed in the normal fashion and have crops planted and harvested. Soils from each plot of the application fields will be sampled before biosolids application and after each harvest. Samples will be analyzed for arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, plutonium, and gross alpha and beta activity. Data will be statistically analyzed after 5 years to determine if concentration change with time.

Progress Last Quarter (April–June 1999)

USGS continued to work with Metro personnel to identify acceptable sites for soil monitoring.

Plans for Current Quarter (July–September 1999)

Site locations will be finalized. Composite soil samples will be collected from the control sites (no biosolids ever applied) and the sites receiving biosolids. The soil sample will be dried and ground, then submitted to the USGS laboratories for chemical analysis.

Crops

Approach

Crops from the two USGS soil application fields will be chemically analyzed after harvest. Analyses will include arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc.

Progress Last Quarter (April–June 1999)

No activity scheduled until harvesting of the first crop grown on the soil monitoring fields in 2000.

Plans for Current Quarter (July–September 1999)

No activity scheduled until harvesting of the first crop grown on the soil monitoring fields in 2000.

If you have questions about the Expanded Monitoring Program, please contact Tracy Yager (see page 12). Commonly asked questions will be included in each Quarterly Report.

Chemical data from U.S. Geological Survey monitoring wells near Deer Trail, Colorado, March and April 1999

[Standards from Colorado Department of Public Health and Environment, 1997, Basic standards for ground water, 5 CCR 1002-41: July 14, 1997, 56 p. Data are preliminary and subject to revision. All data from filtered samples; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than]

Well	Sample date	Nitrate plus nitrite as nitrogen, mg/L	Arsenic, µg/L	Cadmium, µg/L	Chromium, µg/L	Copper, µg/L	Mercury, µg/L	Lead, µg/L	Molybdenum, µg/L	Nickel, µg/L	Selenium, µg/L	Zinc, µg/L
D6	03/19/99	11	3	<7	18	29	<.1	<7	<7	23	8	31
D6	04/12/99	11	2	<2	<2	11	<.1	<2	<2	6	7	9
D13	03/22/99	<0.05	<1	<1	11	2	<0.1	<1	<1	3	<1	1
D13	04/20/99	<0.05	<1	<1	<1	4	<0.1	<1	<1	3	<1	3
D17	03/22/99	1.2	2	<1	3	<1	<0.1	<1	6	1	9	<1
D17	04/20/99	1.6	2	<1	<1	<1	<0.1	<1	6	1	8	<1
D25	03/18/99	7.4	3	<2	<1	8	<0.1	<2	11	20	3	25
D25	04/16/99	6.3	2	<2	27	7	<0.1	<2	11	16	2	5
D29	03/23/99	<0.05	1	<2	<1	8	<0.1	<2	<2	22	3	14
D29	04/16/99	<0.05	<1	<2	18	7	0.1	<2	<2	18	<1	8
D30	03/22/99	0.06	1	<2	<2	9	<0.1	<2	3	14	2	10
D30	04/12/99	<0.05	<1	<2	<2	7	<0.1	<2	<2	12	<1	10
DTX1	03/24/99	1.2	2	<2	4	7	<0.1	<2	5	21	2	6
DTX1	04/20/99	1.2	1	<2	<1	9	<0.1	<2	5	13	3	6
DTX10a	03/25/99	<0.05	<1	<2	<1	6	<0.1	<2	3	16	1	10
DTX10a	04/19/99	<0.05	1	<2	<1	6	<0.1	<2	2	10	2	5
DTX2	03/25/99	<0.05	2	<2	7	6	<0.1	<2	<2	17	<1	6
DTX2	04/19/99	<0.05	1	<2	<1	8	<0.1	<2	<2	13	2	6
DTX3	03/19/99	4.1	<1	<1	13	3	<0.1	<1	<1	5	14	2
DTX3	04/20/99	4.3	<1	<1	<1	4	<0.1	<1	<1	2	16	2
DTX4	03/19/99	0.08	1	<2	9	6	<0.1	<2	<2	20	1	4
DTX4	04/13/99	0.36	<1	<2	<1	8	<0.1	<2	<2	16	1	6
DTX5	03/18/99	<0.05	<1	<2	4	7	<0.1	<2	<2	24	2	5
DTX5	04/13/99	<0.05	<1	<2	<2	8	<0.1	<2	<2	13	<1	5
DTX6	03/18/99	0.24	<1	<2	1.2	7	<0.1	<2	<2	7	3	6
DTX6	04/13/99	0.22	<1	<2	1	11	<0.1	<2	<2	13	<1	7
DTX8a	03/24/99	0.06	<1	<1	<1	2	<0.1	<1	2	4	<1	2
DTX8a	04/19/99	0.06	<1	<1	<1	3	<0.1	<1	1	1	<1	2
Human Health Standard		10	50	5	100	1,000	2	50	None	100	50	5,000
Agricultural Standard		100	100	10	100	200	10	100	None	200	20	2,000

Chemical data from rock cores from U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 1999

[ppm, parts per million; <, less than]

Well number	Geologic unit	Lithology	Interval sampled, in feet below land surface	Date of core	Date of sample	Date of analysis	Nitrate plus nitrite as nitrogen, ppm	Total nitrogen, ppm	Arsenic, ppm	Cadmium, ppm	Chromium, ppm	Copper, ppm	Mercury, ppm	Lead, ppm	Molybdenum, ppm	Nickel, ppm	Selenium, ppm	Zinc, ppm
DTX3	Pierre	Black shale	14.20-14.86	02/12/99	04/01/99	06/29/99	<1	850	32	0.26	80	25	0.05	23	6	34	3.1	108
DTX8	Fox Hills	Gray sand and silt with shale	163.33-163.92	03/02/99	04/01/99	06/29/99	<1	360	11	<0.05	73	8	0.02	14	<2	13	0.2	57
DTX8	Fox Hills	Gray sand and silt with shale	160.60-161.19	03/02/99	04/01/99	06/29/99	<1	370	7.8	0.07	52	9	0.04	16	3	16	0.5	62
DTX8	Fox Hills	Hard black shale with sand, silt	138.52-139.10	03/02/99	04/01/99	06/29/99	<1	750	9.3	0.13	53	19	0.05	21	3	27	0.7	97
DTX10	Fox Hills	Hard black clay with shale, sand, silt	109.92-110.75	02/24/99	04/01/99	06/29/99	1	470	11	0.1	30	12	0.03	15	2	18	0.6	72
DTX10	Fox Hills	Black shale with sand, silt, fossil fragments	102.54-103.14	02/24/99	04/01/99	06/29/99	<1	400	18	0.07	31	13	0.04	16	4	18	0.4	70
DTX10	Fox Hills	Gray sand and silt with shale	85.6-86.4	02/24/99	04/01/99	06/29/99	<1	450	15	0.11	42	16	0.04	18	3	20	0.4	78
DTX10	Fox Hills	Shale, clay, sand, silt	82.14-82.75	02/24/99	04/01/99	06/29/99	<1	500	8.6	0.08	42	12	0.03	16	3	18	0.2	77

Trace-element concentrations in biosolids, mg/kg, dry weight basis

[Standards from Colorado Department of Public Health and Environment, 1998, Biosolids regulation (Regulation no. 64): January 12, 1998, 53 p.; mg/kg, milligram per kilogram]

	March 1999	Maximum allowable for Grade 1
Arsenic	1.9	41
Cadmium	4.0	39
Copper	630	1500
Lead	77	300
Mercury	2.2	17
Molybdenum	31	No standard set for Grade I. 75 for Grade II
Nickel	30	420
Selenium	7.7	100
Zinc	630	2800

Radiochemical determinations for biosolids, pCi/g

[Standards from Colorado Department of Public Health and Environment, 1998, Biosolids regulation (Regulation no. 64): January 12, 1998, 53 p.; pCi/g, picocurie per gram]

	March 1999	Maximum allowable for Grade 1
Gross alpha	19	40
Gross beta	24	No standard set
Plutonium 238	Not detected at 0.06	No standard set
Plutonium 239+240	Not detected at 0.06	No standard set



Instrumentation was installed to continuously measure precipitation, water levels, and temperature at 3 well sites



Preparation for the sampling trips is done inside the USGS laboratories using clean-hands procedures

Definitions

Biosolids—Treated solid waste from a wastewater-treatment facility

Core—The soils and rock removed intact in a tube from the borehole when drilling a well

Less than (<)—A designation for analytical results to indicate that a constituent was not present or was present at very low levels that the laboratory could not reliably determine. Note that the actual amount of this constituent in that sample is unknown and could be any amount between zero and the “less than” value.

Picocurie (pCi)—A unit of measurement of radioactivity. One curie is defined as the amount of a radionuclide in which the decay rate is 37 billion (37,000,000,000) disintegrations per second. One picocurie is one trillionth (1/1,000,000,000,000) of a curie.

Radionuclide—A radioactive atom characterized by a given number of neutrons and protons in its nucleus. For example, plutonium concentrations include plutonium-238 or plutonium-239, which are specific isotopes.

Stakeholder—Any person or group (including the Metro District) interested or concerned about the Expanded Monitoring Program.

Contacts

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*First annual
stakeholder meeting
was held July 15, 1999. You
may call Tracy Yager for
more information.*

*Prepared by Tracy Yager, Dave Smith,
and Jim Crock
August 1999*