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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).

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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 national USGS home page: <http://www.usgs.gov>

This USGS program:

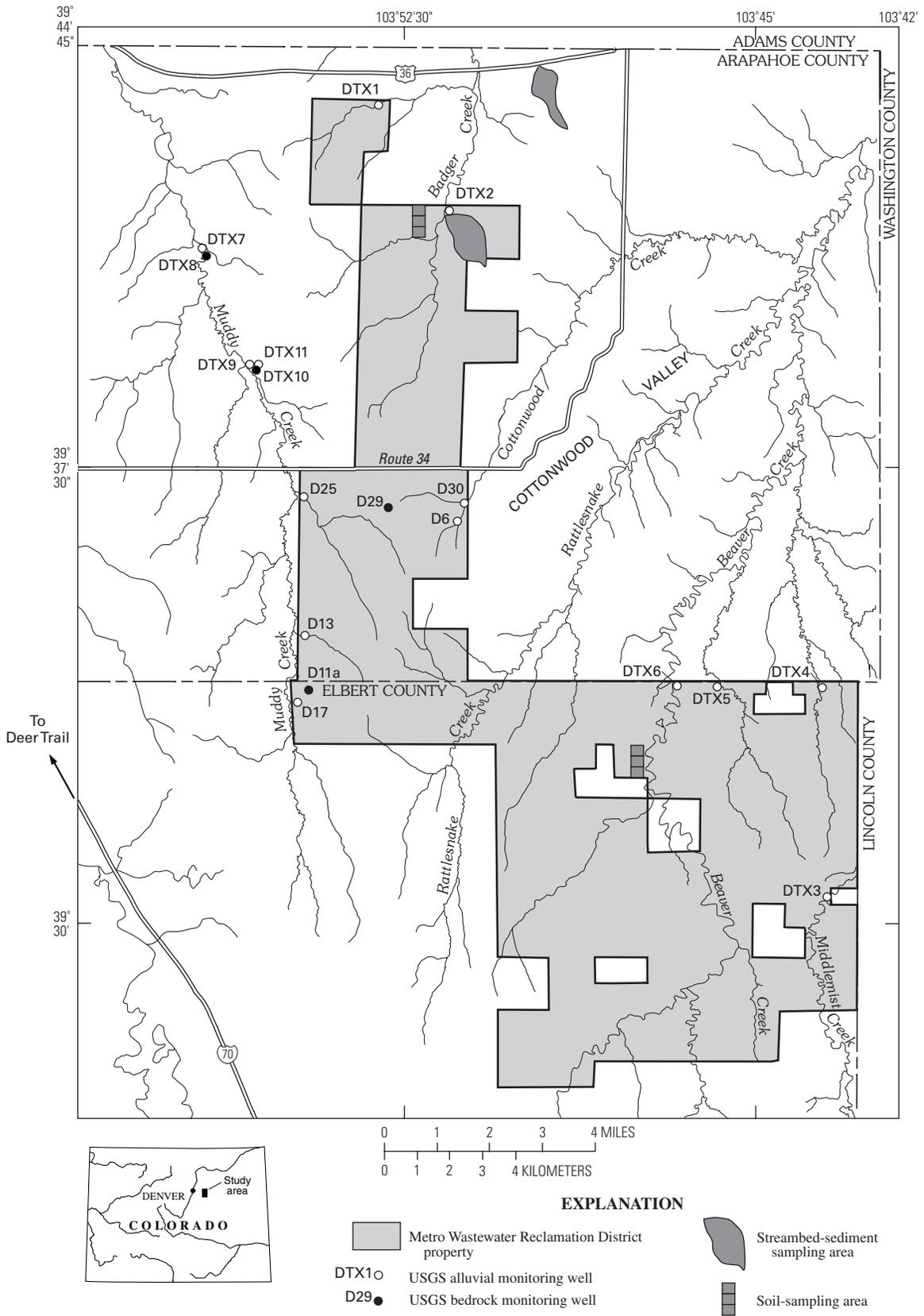
The Internet address for this program, including links for data and reports, is:
<http://co.water.usgs.gov/projects/CO406/CO406.html>

The Internet address for just the data is:
<http://co.water.usgs.gov/projects/CO406/data.html>
or <http://water.usgs.gov/co/nwis>



Photograph provided by Metro Wastewater Reclamation District

USGS monitoring well DTX6 was vandalized between October 21, 2002, and November 6, 2002. The well cover and lock were shot by at least 7 bullets. The bullets mangled the lock and pierced the well cover, casing, and sampling tube. Black powdery residue was observed inside the well casing. Water-quality results from the January 2003 sampling trip will determine if this well will have to be removed from the sampling program because of this vandalism.



USGS Expanded Monitoring Program sites and Metro District's biosolids-application properties (1999 property boundaries) near Deer Trail, Colorado

Program Overview

Continued from page 1

Water quality can be indirectly affected through:

- Tilling 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 groundwater 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), biosolids, soils, and crops. 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 Groundwater 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.

Progress reports such as this one were prepared quarterly for the first 2.5 years of the program and now are prepared twice each year and distributed to the stakeholders and other concerned people, as well as available to the general public on the Internet (<http://co.water.usgs.gov>). Each progress report will summarize progress from the previous quarters and plans for the current quarters; chemical data will be included twice each year. 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: Are the USGS Expanded Monitoring Program near Deer Trail annual data reports for 1999, 2000, and 2001 available to the public?

A: The annual data report for 1999 is complete and at the printer. All stakeholders currently on the mailing list for these progress reports will receive a copy of the annual report for 1999 by mail. This report also will be available on the Internet. The annual data report for 2000 is being reformatted for approval and printing, and a final version is not yet available. Two more USGS reviews of the annual report for 2001 were completed, and this report is being revised according to the USGS review comments.

Q: Is the USGS still monitoring or otherwise working at the Lowry Landfill Superfund Site?

A: No, the last USGS work related to the Lowry Landfill Superfund Site was finished in July 2002. The last samples collected by the USGS at this site were for radionuclides at the Lowry Landfill Superfund Site treatment plant on July 5, 2001. The USGS does not have any further work at the Lowry Landfill Superfund Site at this time.

Alluvial Ground Water

Approach

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

Progress Last Period (July–December 2002)

Ground-water levels were measured July 2, August 7, September 6, October 4, November 6, and December 5, 2002. Ground water was sampled for chemistry in July and October 2002. Ground-water data were compiled and reviewed. The hydrogeology report for ground water 1993–99 (which includes data and interpretations for some sites included in the expanded monitoring program) was prepared for final approval. The annual reports for 1999 and 2000 were reformatted for the printer. A reviewed draft of the annual report for 2001 was completed and presented to stakeholders in September.

Plans for the Current Period (January–June 2003)

Ground-water levels will be measured the first week of each month. Ground water will be sampled the first month of each quarter, weather permitting. Data will be compiled and reviewed. The annual report for 1999 will be printed and distributed. Changes suggested by review comments will be incorporated into the various draft reports, and the annual report for 2000

will be submitted for USGS approval. A draft annual report of 2002 data will be started. The hydrogeology report for ground water 1993–99 was submitted for USGS approval in January 2003.

Bedrock Ground Water

Approach

A structure map of the base of the bedrock aquifer was 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 were 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 (DTX8, DTX10), along with one USGS bedrock well from the previous project (D29), will be sampled approximately quarterly for full inorganic chemistry and annually for radioactivity. Data will be reviewed and statistically tested for exceedance of regulatory limits and for trends.

Progress Last Period (July–December 2002)

Ground-water levels were measured July 2, August 7, September 6, October 4, November 6, and December 5, 2002. Ground water was sampled for chemistry in July and October 2002. The hydrogeology report for ground water 1993–99 (which includes the

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The continuous-recorder water-level instrument in well DTX5 provided erratic data during fall 2002. The only explanation found so far is that the site was covered by fine dirt after a new road was built nearby. The MWRD has since moved the road, and the instrument is once again providing reasonable data.

Bedrock Ground Water

Continued from page 4

structure maps and data and interpretations for some sites included in the expanded monitoring program) was prepared for final approval. The annual reports for 1999 and 2000 were reformatted for the printer. A reviewed draft of the annual report for 2001 was completed and presented to stakeholders in September.

Plans for the Current Period (January-June 2003)

Ground-water levels will be measured the first week of each month. Ground water will be sampled the first month of each quarter, weather permitting. Data will be compiled and reviewed. The annual report for 1999 will be printed and distributed. Changes suggested by review comments will be incorporated into the various draft reports, and the annual report for 2000 will be submitted for USGS approval. A draft annual report of 2002 data will be started. The hydrogeology report for ground water 1993-99 was submitted for USGS approval in January 2003.



Alluvial and bedrock ground water was sampled by the USGS during July and October 2002. Samples were collected using the USGS clean-hands protocol.



The USGS samples well DTX2 quarterly. This well is located in the Badger Creek flood plain and is equipped with continuous-recorder instrumentation for ground-water level, water temperature, air temperature, and precipitation.



Streambed-sediment samples were collected from the biosolids-applied site July 7 and August 5, 2002.

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 sur-

face-water sampling is impractical. Therefore, possible surface-water contamination from metals will be evaluated by sampling streambed sediments soon after storms. Two small drainage basins were selected for similar charac-

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Surface-Water Sediments

Continued from page 5

teristics 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 part of 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 Period (July-December 2002)

The site was carefully monitored for runoff-producing rainfall. Runoff

was sufficient to enable streambed-sediment sampling twice in the designated basins: July 7 and August 5, 2002. The annual reports for 1999 and 2000 were reformatted for the printer. A reviewed draft of the annual report for 2001 was completed and presented to stakeholders in September.

Plans for the Current Period (January-June 2003)

The site will be monitored for runoff-producing rainfall. Sampling may take place, depending on the weather. Data will be compiled and reviewed. The annual report for 1999 will be printed and distributed. Changes suggested by review comments will be incorporated into the various draft reports, and the annual report for 2000 will be submitted for USGS approval. A draft annual report of 2002 data will be started.

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 6 months when the Lowry Landfill Superfund Site water transfer begins. Data will be reviewed and compared to Federal regulatory limits.

Progress Last Period (July-December 2002)

Quarterly samples of biosolids were collected in July and October 2002. Each sample was a 24-hour composite from the conveyor belt at the Metro District facility. The material was

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Streambed-sediment samples were collected July 7 and August 5, 2002, from the control site where no biosolids are applied. The USGS observed that precipitation caused sufficient hillslope runoff to create fresh streambed-sediment deposits twice during the July-December 2002 monitoring period despite the drought affecting Colorado.

Biosolids

Continued from page 6

placed in two acid-washed, one-gallon plastic bottles and transported to the USGS in Denver. There, the sample was air-dried then ground to less than 150 micrometers. The samples were submitted to the laboratories for chemical analyses. A reviewed draft of the annual report for 2001 was completed and presented to stakeholders in September.

Plans for the Current Period (January-June 2003)

Quarterly biosolids samples will be collected in January and April 2003. Samples will be dried, ground, and submitted to the laboratories. Data will be compiled and reviewed. The annual report for 1999 will be printed and distributed. The annual report for 2000 will be submitted for USGS approval.



For this surface-water program, the USGS samples only fresh streambed sediment deposited from hillslope runoff during the previous 24 hours. The two drainage basins sampled both have areas where the runoff channel is flattened from tilling.

A draft annual report of 2002 data will be started.

Soils

Approach

One site was selected for characterizing and monitoring the chemical composition of soil on the Metro District property in Arapahoe County, and one site was selected on the Metro District property in Elbert County. Each site consists of three 20-acre (933 feet by 933 feet) fields separated by 100-foot buffer zones. The center 20-acre field at each site will have biosolids applied after the initial soil sampling. The other two 20-acre fields at each site will not have biosolids applied and will be used as “control” fields to monitor the natural variability of soil composition for the duration of the study. All three 20-acre fields at each site will be farmed in the normal fashion and have crops planted and harvested. Soils from each of the six fields will be sampled before biosolids are applied to the two center fields and then again 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 examined after 5 years to determine if concentration has changed with time.

Progress Last Period (July-December 2002)

Soil samples were collected from the Elbert County site on September 19, 2002, and from the Arapahoe County site on October 17, 2002. The samples were dried at the USGS laboratories in Denver. A reviewed draft of the annual report for 2001 was completed and presented to stakeholders in September.

Plans for the Current Period (January-June 2003)

Soil samples will be submitted for chemical analysis. Data will be com-

pleted and reviewed. The annual report for 1999 will be printed and distributed.

Crops

Approach

Crops from each of the six 20-acre soil-monitoring fields will be chemically analyzed after harvest. Analyses will include arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.

Progress Last Period (July-December 2002)

Wheat samples were collected from both the Arapahoe and Elbert County sites during July 2002.

Plans for the Current Period (January-June 2003)

The samples collected during 2002 will be dried, ground, and submitted to the laboratories for chemical analysis. Data will be compiled and reviewed. The annual report for 2000 will be submitted for USGS approval. A draft annual report of 2002 data will be started.

If you have changes to the mailing list, please contact the Elbert County Environmental Health Officer (see page 12) or Tracy Yager (see page 12). Elbert County maintains the mailing list for these reports and for all meeting notices.

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

USGS ground-water data, July–December 2002

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

Well (page 2)	Sample date	Time	Nitrate plus										
			nitrite as nitrogen, mg/L	Arsenic, µg/L	Cadmium, µg/L	Chromium, µg/L	Copper, µg/L	Lead, µg/L	Mercury, µg/L	Molybdenum, µg/L	Nickel, µg/L	Selenium, µg/L	Zinc, µg/L
DTX3	07/09/02	1025	5.6	<2	<0.04	<0.8	6.6	<0.08	<0.01	0.6	2.37	16	3
DTX3	10/21/02	1025	4.96	<2	<0.04	<0.8	5.5	<0.08	<0.02	0.5	8.38	18	3
D17	07/08/02	1300	1.1	<2	0.05	<0.8	0.9	<0.08	<0.01	5.4	0.61	7	1
D17	10/17/02	1330	0.826	E2	E0.03	<0.8	1.0	<0.08	<0.02	5.4	2.79	8	<1
DTX5	07/11/02	1140	<0.037	<2	0.09	<0.8	14.3	<0.20	<0.01	1.1	13.1	<2	8
DTX5	10/21/02	1225	<0.048	<2	<0.07	E0.5	9.6	<0.16	<0.02	0.9	17.9	<3	5
DTX6	07/11/02	1345	0.20	<2	<0.07	<0.8	19.2	<0.20	<0.01	0.8	11.7	E1	11
DTX6	10/21/02	1415	0.197	<2	<0.07	E0.6	13.3	<0.16	<0.02	E0.7	14.2	E3	8
D13	07/08/02	1420	<0.037	<2	<0.04	<0.8	3.2	<0.08	<0.01	1.1	<0.06	<2	2
D13	10/22/02	1205	<0.048	E1	<0.04	<0.8	3.9	0.13	<0.02	1.4	6.52	3	2
D29	07/08/02	1100	0.051	E2	<0.07	<4.0	10.2	0.18	<0.01	1.6	1.40	3	7
D29	10/16/02	1100	<0.048	<2	<0.07	E0.5	10.1	E0.15	<0.02	4.0	18.1	<3	7
D6	07/09/02	1235	17	5	E0.17	<0.8	75.6	<0.60	E0.01	3.1	13.9	19	45
D6	10/17/02	1030	17.6	E3	E0.13	<1.6	43.7	<0.56	<0.02	3.6	30.6	19	33
D30	07/11/02	0955	<0.037	<2	E0.04	<0.8	19.6	<0.20	<0.01	2.6	14.7	<2	12
D30	10/17/02	1150	<0.048	<2	0.08	E0.5	12.3	<0.16	<0.02	2.0	20.9	<3	9
D25	07/12/02	1200	5.5	4	0.25	<0.8	19.3	<0.20	<0.01	13.6	19.4	3	12
D25	10/18/02	1255	1.40	2	0.19	E0.6	13.5	<0.16	<0.02	8.6	25.6	<3	8
DTX10A	07/10/02	1120	<0.037	<2	<0.07	<0.8	11.9	<0.20	<0.01	1.3	11.4	<2	7
DTX10A	10/18/02	1045	<0.048	<2	<0.07	E0.5	8.7	<0.16	<0.02	1.4	11.2	<3	6
DTX8A	07/12/02	1005	<0.037	<2	<0.04	<0.8	5.0	<0.08	<0.01	0.6	3.41	<2	5
DTX8A	10/22/02	1035	<0.048	<2	<0.04	<0.8	3.9	<0.08	<0.02	0.7	4.89	<3	3
DTX2	07/10/02	1325	<0.037	E1	E0.04	<0.8	13.4	<0.20	<0.01	1.6	16.1	<2	9
DTX2	10/16/02	1350	<0.048	E1	0.13	<0.8	8.8	<0.16	<0.02	2.75	16.8	<3	8
DTX1	07/10/02	1505	1.3	E2	0.12	<0.8	15.3	<0.20	<0.01	7.0	20.6	<2	9
DTX1	10/16/02	1515	1.47	3	0.13	<0.8	9.9	<0.16	<0.02	6.8	21.6	E2	6
Human Health Standard			10	10	5	100	1,000	50	2	None	100	50	5,000
Agricultural Standard			100	100	10	100	200	100	10	None	200	20	2,000

USGS streambed-sediment data for radioactivity, 2002

[Data are preliminary and subject to revision. pCi/g, picocuries per gram; analytical uncertainty (defined on page 12) reported is the two-sigma total propagated analytical uncertainty]

Site (page 2)	Sample date	Alpha radioactivity, pCi/g	Alpha radioactivity, analytical uncertainty, pCi/g	Beta radioactivity, pCi/g	Beta radioactivity, analytical uncertainty, pCi/g	Beta radioactivity, analytical uncertainty, pCi/g	Plutonium 238, analytical uncertainty, pCi/g	Plutonium 238, minimum detectable concentration, pCi/g	Plutonium 238, analytical uncertainty, pCi/g	Plutonium 238, minimum detectable concentration, pCi/g	Plutonium 239+240, analytical uncertainty, pCi/g	Plutonium 239+240, minimum detectable concentration, pCi/g
Biosolids applied	06/04/02	12.2	4.0	15.9	3.1	-0.00069	0.00099	0.01980	0.013	0.015	0.014	0.012
No biosolids	06/04/02	10.0	3.2	12.9	2.7	0	0.0096	0.0106	0.012	0.014	0.011	0.011

USGS streambed-sediment data, 2002

[Data are preliminary and subject to revision. mg/kg, milligrams per kilogram; g/kg, grams per kilogram; µg/g, micrograms per gram; J, method blank contamination with the target analyte at a reportable level; <, less than]

Site (page 2)	Sample date	Total nitrogen, mg/kg	Phosphorous, mg/kg	Carbon, inorganic, g/kg	Carbon, total, g/kg	Carbon, organic, g/kg	Aluminum, µg/g	Arsenic, µg/g	Cadmium, µg/g
Biosolids applied	06/04/02	1,500	880	4.6	19	14	22,000	6.6	0.2
Biosolids applied	07/07/02	1,510	625	3.6	15	11	25,400	17.1	0.2
Biosolids applied	08/05/02	1,900	700	1.9	22	20	23,000	5.9	0.2
No biosolids	06/04/02	710	680	5.4	13	7.3	20,000	5.8	0.1
No biosolids	07/07/02	794	589	4.7	11	6.2	25,800	17.8	<0.1
No biosolids	08/05/02	440	390	4.5	11	6.6	17,000	5.1	<0.1

Site (page 2)	Sample date	Chromium, µg/g	Copper, µg/g	Lead, µg/g	Mercury, µg/g	Molybdenum, µg/g	Nickel, µg/g	Selenium, µg/g	Zinc, µg/g
Biosolids applied	06/04/02	21	17	18	0.04	0.5	16	0.9	66
Biosolids applied	07/07/02	24	16	16	<0.02	0.33	17	11	70
Biosolids applied	08/05/02	23	15	20	<0.04	10.34	15	<0.6	65
No biosolids	06/04/02	21	11	15	0.01	0.4	15	0.6	57
No biosolids	07/07/02	26	14	16	<0.02	<0.25	18	11	72
No biosolids	08/05/02	19	10	14	<0.01	10.31	13	<0.6	48



The annual stakeholder meeting was held September 25, 2002, at the Agate school. USGS scientist and project manager Tracy Yager presented an overview of the monitoring program and updates on the ground-water and streambed-sediment monitoring components of the program.



USGS scientist Dave Smith presented updates on the biosolids, soils, and crops monitoring components at the annual stakeholder meeting on September 25, 2002.



USGS data for 2001 were presented at the annual stakeholder meeting September 25, 2002, in Agate, Colorado.

Definitions

Analytical uncertainty—The possible range of the true value or error term contributed by bias and variability of the laboratory measurement technique. All laboratory data have associated uncertainty. Each sample value should be thought of as a range in concentration defined by the reported value plus or minus the analytical uncertainty. The true concentration usually is somewhere in this range, but not a precisely known point. For most analyses, the analytical uncertainty is not calculated for each sample but is estimated from bias and variability data derived from analyses of quality-assurance samples like blanks and replicates. For radioactivity data, the analytical uncertainty is calculated individually for each sample for each analyte based on analytical and statistical variables.

Biosolids—Solid organic matter recovered from a sewage-treatment process that meets regulatory criteria for beneficial use, such as for fertilizer. Metro District applies Grade I, Class B biosolids at Deer Trail. Regulations require that land-applied biosolids must meet or exceed Grade II, Class B. Grade I exceeds Grade II.

Composited sample—A sample made by combining individual subsamples into a single sample. Each streambed-sediment sample from this program usually is a field-composited sample because the sample contains sediments from more than one depositional area of the streambed.

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.

Runoff—The rain that hits the ground and flows over the land surface into valleys instead of infiltrating into the soil. Runoff can wash particles of soil, rock, plants, and biosolids from the land surface into the streambeds of the valleys.

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

Contacts

USGS: Tracy Yager, 303-236-4882, ext. 225 (*email*: tjyager@usgs.gov)
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(*email*: DHumble@mwr.districtofcolorado.gov)

Elbert County Environmental Health Officer: 303-621-3144
(*email*: elconurse@bewellnet.com)

State Biosolids Contact: Wes Carr, 303-692-3613

U.S. Environmental Protection Agency: Bob Brobst, 303-312-6129

***Fourth annual stakeholder
meeting:
was held September 25, 2002, at
the school in Agate, Colorado***

Prepared by Tracy Yager, Dave Smith, and
Jim Crock (USGS) in cooperation with
Metro Wastewater Reclamation District,
February 2003

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