Expanded Monitoring Program

Near Deer Trail, Colorado

Quarterly Report
October–December 1999

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USGS

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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.

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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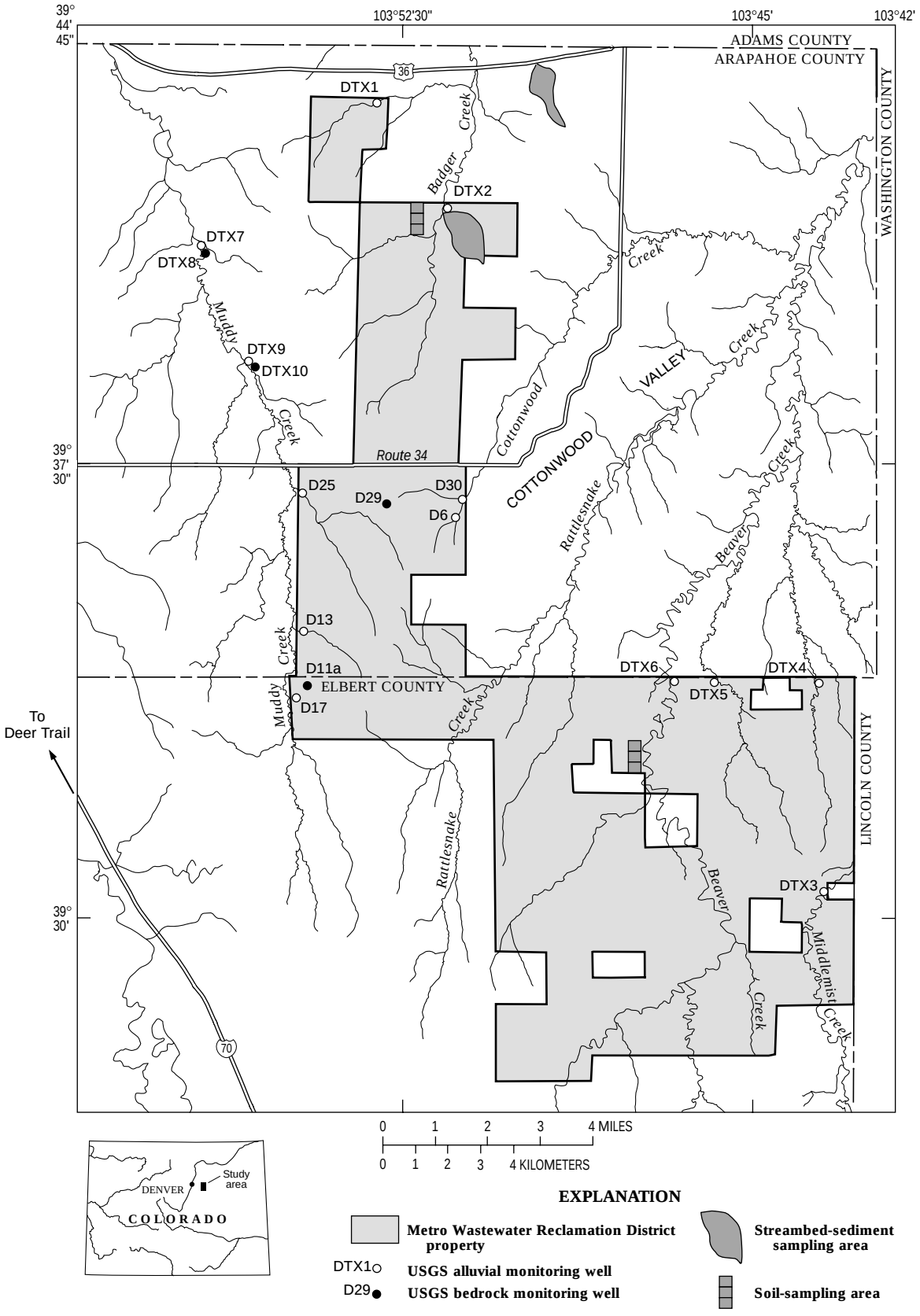
USGS arranged a tour of the Lowry Superfund site with the Deer Trail and Agate Soil Conservation Districts. The tour was led by Marc Herman, U.S. Environmental Protection Agency Remedial Project Manager, on December 17, 1999.



USGS Expanded Monitoring Program sites 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 is this monitoring program concerned with the Lowry Superfund Site?

A: Treated ground water from the Lowry Superfund Site will be piped to the Metro Wastewater Reclamation District treatment plant (Denver, Colorado) for further treatment. Some stakeholders are concerned that biosolids from the Metro District plant that are applied near Deer Trail, Colorado, will be contaminated from the Lowry site. Metro District could begin receiving the Lowry water in March 2000.

Q: Why are negative activity concentrations reported for the radionuclide data?

A: Radionuclide data are produced from instruments that detect radioactive decay (disintegrations) in a sample as counts per minute. Negative activity concentrations mean the sample counts were less than the laboratory background counts that day. Background counts are subtracted from the sample counts, then the resulting value is converted to activity-concentration units of picocuries per liter.

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 (October-December 1999)

Ground-water levels were measured October 4, November 3, and December 1, 1999. Ground water was sampled for chemistry November 8-17, 1999. Much time was spent troubleshooting the old pressure transducer (used to continuously measure water levels) at well DTX5; a new pressure transducer was installed in November 1999 in this well. Ground-water data were compiled and reviewed. All equipment, computers, and databases were checked for Y2K compliance; no problems were found.

Plans for the Current Quarter (January-March 2000)

Ground-water levels will be measured the first week of each month. Ground water will be sampled in early January, weather permitting. All data obtained from the program to date will be compiled, reviewed, and evaluated. The first annual report will be planned and written.

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 (DTX8, DTX10), along with an existing USGS bedrock well (D29), 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 (October -December 1999)

Ground-water levels were measured October 4, November 3, and December 1, 1999. Ground water was sampled for chemistry November 8-17, 1999. Ground-water data were compiled and reviewed. All equipment, computers, and databases were checked for Y2K compliance; no problems were found.

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USGS made a number of presentations related to this program. One such presentation was made to the Upper South Platte Watershed Association meeting in Limon, Colorado, the evening of September 30, 1999.

Bedrock Ground Water

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USGS made 5 presentations related to this project to various groups of stakeholders: the Upper South Platte Watershed Association in Limon, Colo. (September 30, 1999), USGS colleagues in Sacramento, Calif. (November 17, 1999), Colorado USGS management in Denver, Colo. (November 22, 1999), Deer Trail Soil Conservation District (SCD) in Deer Trail, Colo. (November 23, 1999), and Agate SCD in Agate, Colo. (December 1, 1999).

Water standing in the well is always pumped out before sampling. This water is called "purge water" and can be quite murky, as at well D29.

Ground water is pumped into USGS vehicles for processing to minimize wind-born contamination and to keep the samples out of sunlight.

Bottles of ground-water sample are filled and processed (including filtering) inside a special "clean room" chamber inside the truck to further minimize contamination.

Plans for the Current Quarter (January-March 2000)

Ground-water levels will be measured the first week of each month. Ground water will be sampled in early January, weather permitting. All data obtained from the program to date will be compiled, reviewed, and evaluated. The first annual report will be planned and written.

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

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Surface-Water Sediments

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be evaluated by sampling streambed 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 (October-December 1999)

The site was carefully monitored for runoff-producing rainfall. No such rainfall was detected, so no samples were collected. Analytical data were compiled and reviewed.

Plans for Current Quarter (January-March 2000)

The site will be monitored for runoff-producing rainfall. Sampling may take place, depending on the weather. All data obtained from the program to date will be compiled, reviewed, and evaluated. The first annual report will be planned and written.

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 (October-December 1999)

The quarterly composite sample of biosolids was received from the Metro District on December 2, 1999. The sample was a 24-hour

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Crops from each of the six 20-acre (soil monitoring) fields will be chemically analyzed after harvest later in 2000.

Biosolids

Continued from page 6

composite from the 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 sample was air-dried and then ground to particles smaller than 150 micrometers. Chemical analyses were completed on the second and third quarterly biosolids samples. The biosolids data were compiled and reviewed.

Plans for Current Quarter (January-March 2000)

The December biosolids sample will be submitted to the USGS laboratories for chemical analysis. A quarterly sample of biosolids material will be collected, dried, and prepared for analysis. All data obtained from the program to date will be compiled, reviewed, and evaluated. The first annual report will be planned and written.

Water levels are sometimes measured in the monitoring wells during and after sampling to see if the aquifer water level has decreased in the vicinity of the well during pumping.

Soils

Approach

One site will be selected for characterizing and monitoring the chemical composition of soil on the Metro District property in Arapahoe County, and one site will be selected on the Metro District property in Elbert County. Each site will consist 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 varibility 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 Quarter (October–December 1999)

Soil subsamples from August sampling were sieved, ground, then composited for each 20-acre field. The composited samples were submitted to USGS laboratories for analysis.

Plans for Current Quarter (January-March 2000)

All data obtained from the program to date will be compiled, reviewed, and evaluated. The first annual report will be planned and written.

Crops

Approach

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

USGS ground-water data, July–December 1999

[Standards from Colorado Department of Public Health and Environment, 1997, Basic standards for ground water, 5CCR 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; (a), data not yet received from laboratory; (b), value estimated by laboratory]

Well	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
D6	07/06/99	1800	12	<2	<7	<1.0	34	<7	<0.1	<7	15	8	33
D6	11/12/99	1030	12	1(b)	<6	<1.0	27	<6	<.2	<6	19	6	29
D13	07/07/99	1445	(a)	1	<1	2.0	2	<1	<.1	1	4	<1	1
D13	11/17/99	1340	<.037	<2	<1	<.80	2	<1	<.2	1	5	<2	2
D17	07/06/99	1530	3.5	2	<1	<1.0	<1	<1	<.1	7	<1	8	<1
D17	11/09/99	1040	2.9	1(b)	<1	<.80	<1	<1	<.2	6	2	9	<1
D25	07/07/99	1310	(a)	6	<3	19	11	<3	<.1	13	17	6	10
D25	11/08/99	1430	3.4	2	<2	<1.0	7	<2	<.2	10	16	<2	6
D29	07/06/99	1230	<.050	2	<2	<1.0	8	<2	<.1	<2	14	<1	9
D29	11/09/99	1500	<.037	<2	<2	2.7	6	<2	<.2	<2	16	<2	13
D30	07/12/99	1320	<.050	<1	<2	9.5	8	<2	<.1	4	8	<1	7
D30	11/12/99	1230	<.037	<2	<1	<1.0	7	<1	<.2	2	10	<2	6
DTX1	07/07/99	1015	(a)	2	<2	14	7	<2	<.1	5	13	4	5
DTX1	11/08/99	1215	1.9	<2	<2	<1.0	6	<2	<.2	5	16	<2	6
DTX10a	07/12/99	1545	<.050	<1	<2	5.7	5	<2	<.1	<2	4	<1	4
DTX10a	11/16/99	1650	<.037	<2	<1	1.0	4	<1	<.2	1	3	<2	3
DTX2	07/12/99	1015	<.050	<1	<2	11	6	<2	<.1	<2	9	<1	6
DTX2	11/08/99	1010	<.037	<2	<2	1.5	5	<2	<.2	<2	13	<2	7
DTX3	07/09/99	1530	2.8	<1	<1	<1.0	2	<1	<.1	<1	2	8	1
DTX3	11/17/99	1200	1.6	<2	<1	<.80	2	<1	<.2	<1	3	4	1
DTX4	07/09/99	1315	.13	2	<2	11	6	<2	<.1	<2	11	2	4
DTX4	11/16/99	1040	<.037	<2	<1	1.0	4	<1	<.2	<1	12	<2	3
DTX5	07/08/99	1500	.10	1	<1	8.2	5	<1	<.1	<1	8	1	3
DTX5	11/16/99	1320	<.037	<2	<1	2.1	4	<1	<.2	1	6	<2	3
DTX6	07/08/99	1230	.32	1	<2	11	8	<2	<.1	<2	5	4	6
DTX6	11/17/99	0950	.28	<2	<2	<1.0	6	<2	<.2	<2	10	<2	6
DTX8a	07/08/99	1000	<.050	<1	<1	<1.0	2	<1	<.1	<1	3	<1	2
DTX8a	11/12/99	1430	<.037	<2	<1	<.80	2	<1	<.2	<1	3	<2	2
Human Health Standard			10	50	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 radionuclide data for monitoring wells, 1999

[Standards from Colorado Department of Public Health and Environment, 1997, Basic standards for ground water, 5CCR 1002-41: July 14, 1997, 56 p. Data are preliminary and subject to revision. All data from filtered samples; pCi/L, picocuries per liter; <, less than; (c), Laboratory problem--no data; analytical uncertainty (defined on page 12) reported is the two-sigma total propagated analytical uncertainty]

Well	Sample Date	Alpha radioactivity, pCi/L	Alpha radioactivity, analytical uncertainty, pCi/L	Beta radioactivity, pCi/L	Beta radioactivity, analytical uncertainty, pCi/L	Plutonium-238, pCi/L	Plutonium-238, analytical uncertainty, pCi/L	Plutonium 239+240, pCi/L	Plutonium 239+240, analytical uncertainty, pCi/L
D6	07/06/99	110	74	52	68	(c)	(c)	(c)	(c)
D13	07/07/99	11	5.3	11	4.6	–0.001	0.002	0	0.006
D17	07/06/99	5.6	3.5	<4.0	2.1	–.002	.007	.002	.006
D25	07/07/99	81	38	71	21	.001	.016	–0.011	.011
D29	07/06/99	<3.0	8.9	26	16	0	1.0	0.012	.022
D30	07/12/99	22	19	42	19	–.016	.016	.006	.021
DTX1	07/07/99	55	19	46	15	–.001	.014	.006	.012
DTX10a	07/12/99	5.6	9.4	21	11	–.008	.011	0	.024
DTX2	07/12/99	31	16	47	15	(c)	(c)	(c)	(c)
DTX3	07/09/99	7.7	4.0	18	4.0	0	.007	–0.001	.002
DTX4	07/09/99	18	9.4	34	11	–.002	.004	.001	.011
DTX5	07/08/99	27	12	24	8.4	(c)	(c)	(c)	(c)
DTX6	07/08/99	37	19	36	15	(c)	(c)	(c)	(c)
DTX8a	07/08/99	8.8	5.9	7.2	6.1	.001	.004	–0.002	.002
Human Health Standard		15		none found		none found		none found	
Agricultural Standard		none found		none found		none found		none found	

USGS radionuclide data for streambed sediments, 1999

[Data are preliminary and subject to revision. The DTX2 drainage receives biosolids; no data from the control drainage. Data from the laboratory duplicate are provided to show the range in values for a single streambed-sediment sample. pCi/g, picocuries per gram; analytical uncertainty (defined on page 12) reported is the two-sigma total propagated analytical uncertainty]

Site	Sample date	Alpha radioactivity, pCi/g	Alpha radioactivity, analytical uncertainty, pCi/g	Beta radioactivity, pCi/g	Beta radioactivity, analytical uncertainty, pCi/g	Plutonium-238, pCi/g	Plutonium-238, analytical uncertainty, pCi/g	Plutonium 239+240, pCi/g	Plutonium 239+240, analytical uncertainty, pCi/g
DTX2	08/31/99	29.6	9.1	31.5	5.5	0.0022	0.0044	0.010	0.010
DTX2 lab duplicate	08/31/99	19.6	6.1	35.4	6.5	.0056	.0093	.0076	.0089

USGS trace-element data for Metro District 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]

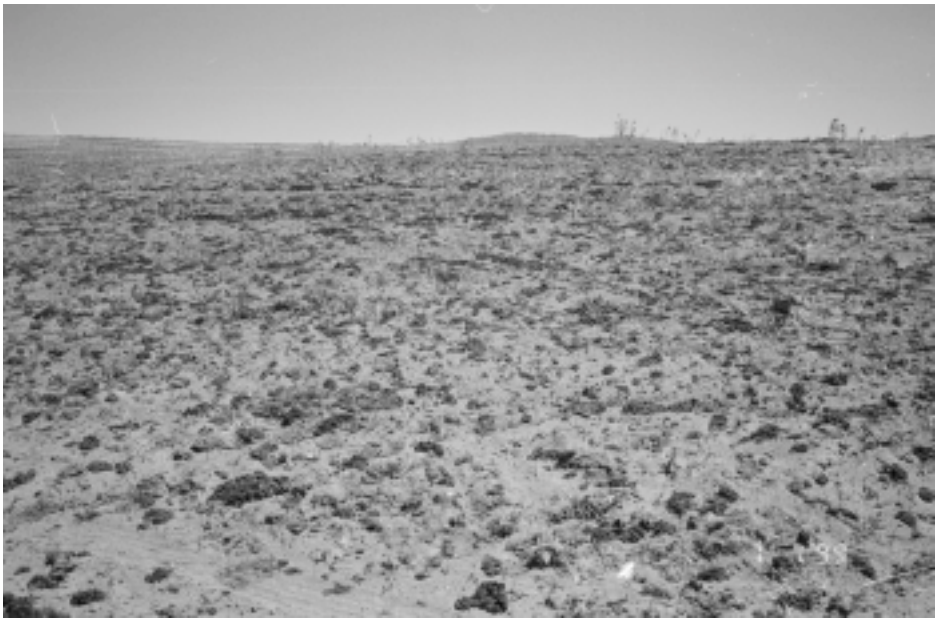
	June 1999	September 1999	Maximum allowable for Grade 1
Arsenic	2.6	2.9	41
Cadmium	3.3	3.1	39
Copper	570	580	1500
Lead	120	120	300
Mercury	1.8	1.8	17
Molybdenum	24	23	No standard set for Grade I. 75 for Grade II
Nickel	40	30	420
Selenium	13	15	100
Zinc	700	710	2800

USGS radionuclide data for Metro District 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]

	June 1999	September 1999	Maximum allowable for Grade 1
Gross alpha	37	27	40
Gross beta	39	30	No standard set
Plutonium 238	Not detected at 0.06	Not detected at 0.06	No standard set
Plutonium 239+240	Not detected at 0.06	Not detected at 0.06	No standard set

Biosolids are transported from the Metro District plant in Denver, Colorado, to the Metro District properties near Deer Trail, Colorado, in large trucks. At the Metro District farm, biosolids are emptied from the trucks then transferred into spreader vehicles that apply the biosolids to the fields.



Biosolids (which show as dark clumps in the above photo) are sprinkled on the Metro District farm fields, not applied as a thick cover. Application rates are determined by soil properties and expected uptake of nutrients by the crop that will be grown on the field.

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 likes blanks and replicates. For radionuclide 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.

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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Second annual stakeholder meeting
needs to be scheduled soon. September is a possibility.

Prepared by Tracy Yager, Dave Smith, and Jim Crock (USGS) in cooperation with Metro Wastewater Reclamation District, February 2000

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