



science for a changing world

Expanded Monitoring Program

Near Deer Trail, Colorado

Program Overview

The Metro Wastewater Reclamation District (Metro District) applies biosolids throughout their properties (the MetroGro Farm) near Deer Trail, Colorado (see page 2). These biosolids applications could affect the quality of water in alluvial and bedrock aquifers, streambed sediment, soil, dust, and crops.

Water quality can be directly affected through:

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

Water quality can be indirectly affected through:

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

Contaminated groundwater 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 regulatory standards, and the biosolids chemical data need to be accurate 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 a 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 USGS monitoring program near Deer Trail is referred to as the "USGS Expanded Monitoring Program" and began in January 1999. The first phase of monitoring ended in 2003. All data and interpretive reports from the 1999-2003 monitoring period were published by January 2005 and are available to the public. An interim monitoring period (2004 through mid-2005) continued the monitoring while reports were completed, results were presented, and a new phase of the monitoring program was negotiated for 2005-2011. The current monitoring program is scheduled to end in December 2011.

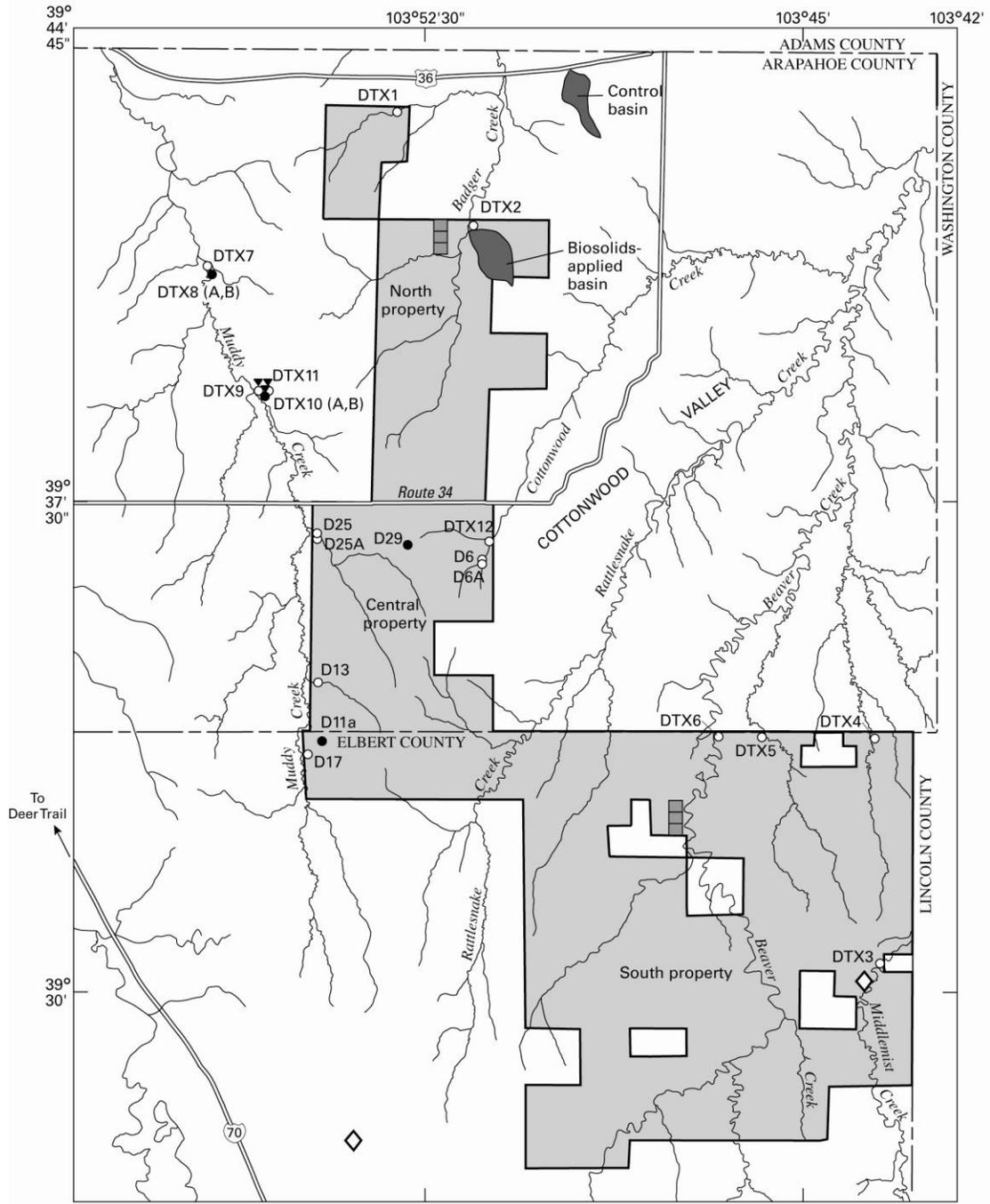


USGS
The U.S. Geological Survey is a science organization that provides the Nation with reliable, impartial information to describe and understand the Earth. The national USGS home page: <http://www.usgs.gov>

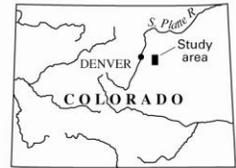
This USGS Program:

The Internet address for this program, including links for reports, is:

<http://co.water.usgs.gov/projects/CO406/index.html>



Base from U.S. Geological Survey 1:50,000 quadrangles, Elbert County and Arapahoe County



EXPLANATION

- Metro Wastewater Reclamation District property (MetroGro Farm, 1999 boundaries)
- Streambed-sediment sampling area
- DTX1○ USGS alluvial-aquifer monitoring well and identifier
- D29● USGS bedrock-aquifer monitoring well and identifier
- DTX11⊕ Monitoring well with continuous recorder and identifier
- ◇ Dust-sampling location
- Soil- and crop-sampling area

Location of study area and U.S. Geological Survey monitoring sites near Deer Trail, Colorado, 2010. (Metro Wastewater Reclamation District property boundaries shown are from 1999.)

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Each USGS monitoring program builds on the previous monitoring program. Results from the previous monitoring program are used to determine priorities for the next phase of study. The USGS Expanded Monitoring Program is distinct from, but builds on, another USGS program that monitored shallow groundwater quality on the Metro District central property from 1993–1998. The newer program (1999–2011) considers environmental-quality issues for shallow and deep groundwater, surface water (streambed sediment), biosolids, soil, and crops. The expanded monitoring program includes all three Metro District properties (north, central, and south) and related private-property locations. Both programs, however, are supported by the Metro District and USGS. The first phase of the newer monitoring program also was supported by the North Kiowa Bijou Groundwater Management District in 1999. Both programs are designed, carried out, and interpreted independently by the USGS, and quality-assured USGS data and reports are 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 USGS 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 sediment, soil, dust, 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 chemistry, and compare the concentrations with regulatory limits.
- (3) Determine the aquifer hydrology in this area.
- (4) Develop a biosolids signature for water and soil.

The approach is unique for each component of the monitoring program. However, appropriate USGS methods and technologies are 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 approximately once each year. The progress reports are distributed to the stakeholders and other concerned people and are available to the general public on the Internet (<http://co.water.usgs.gov>). Each progress report summarizes progress from the previous period and plans for the current period; chemical data are included when available. USGS reports will document all methods and data for the monitoring program. A comprehensive USGS report is planned for completion after 2010 that includes statistical analyses and interpretations. In addition, the USGS meets with the stakeholders once a year to discuss the USGS Expanded Monitoring Program results and to consider possible changes to the Expanded Monitoring Program.

Progress Last Period (January–December 2010)

The annual stakeholder meeting was held September 22, 2010, at the Metro District shop building near Deer Trail, Colorado. The USGS completed the Expanded Monitoring Program data report for 2007 and 2008 (USGS Data Series 589). Please refer to the project web site (provided on page 1 of this Progress Report) to access this and other USGS reports at the “Publications” link. The USGS prepared 12 proposals for possible additional work at the MetroGro Farm and neighboring area for 2011 through 2017 and one proposal for interim monitoring during 2011. Discussions were held with the Metro District and other stakeholders about monitoring priorities and the proposals at various meetings during 2010. The Metro District agreed to the proposal for interim monitoring during 2011 but did not make a decision on USGS monitoring beyond 2011. Presentations about the USGS Expanded Monitoring Program and research on organic wastewater compounds were given to East Adams Conservation District (August 16, 2010) and to the Colorado Department of Public Health and Environment (October 22, 2010). A report about nitrogen sources at the MetroGro Farm was started.

Information for the Current Period (January–December 2011)

An annual stakeholder meeting scheduled for September 21, 2011, will be attended by the USGS to provide updates on progress and findings. The USGS data report for the 2009 through 2010 Expanded Monitoring Program data was written and put into review. The USGS report about nitrogen sources was completed and put into review. The presentation that was given to the Colorado Department of Public Health and Environment on October 22, 2010, was given to the Colorado Water Quality Control Commission on April 11, 2011, and to the Metro District on

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June 8, 2011. The USGS interpretive report for 2004 through 2010 is in progress. The USGS has revised the proposals for additional monitoring for 2012 through 2018 and met with the Metro District to discuss, although the Metro District has not decided whether to continue USGS monitoring after 2011.

Questions & Answers

Q: Is the USGS still monitoring near Deer Trail, Colorado?

A: The USGS monitoring near Deer Trail is scheduled to end in December 2011. In 2011, the only USGS monitoring in this area consists of collecting groundwater-quality samples twice from five shallow wells and measuring depth to groundwater at selected wells periodically. The water-quality samples will be analyzed for inorganic constituents. The first of these two samples was collected in early July. The second sample is planned for collection in the fall of 2011.



Q: Why are there no USGS continuous-recorder data for precipitation, air temperature, depth to groundwater, or groundwater temperature available from this area on the internet anymore?

A: The USGS shut down all but one continuous-recorder site and no longer is collecting or providing year-round data for the study area. At this time, one site remains operable and could be used to collect additional continuous-recorder data.

Q: What happens after 2011?

A: The USGS plans to have all reports for the biosolids-application area near Deer Trail completed and available on the Internet. The USGS has been in discussion with the Metro District and various stakeholders during 2010 and 2011 about a possible next phase of study for 2012 through 2018. However, no work has been scheduled with the USGS for this area after 2011 (as of August 2011).

Groundwater

Approach

Five USGS monitoring wells installed near the Metro District property boundaries in some of the major alluvial aquifers were sampled approximately quarterly for full inorganic chemistry through 2010 and will be sampled twice in 2011. These wells also were sampled in 2005 for organic wastewater compounds. One of these wells (D6) and three upgradient wells were sampled in 2005 for nitrogen isotopes. Possible nitrogen source materials such as biosolids, soil, and rock, also were analyzed in 2005 for nitrogen isotopes. Additionally, other USGS monitoring wells in the study area were sampled each year when streambed-sediment samples were not available. Two USGS monitoring wells installed downgradient from the Metro District property in the bedrock aquifer were sampled annually for full inorganic chemistry through 2010. Depth to water was measured approximately monthly at selected USGS monitoring wells through 2010. At two sites, depth to groundwater, precipitation, and other related parameters were recorded hourly or more frequently. Chemical data are reviewed and evaluated for exceedance of regulatory limits and for trends. Data also are evaluated for a possible biosolids signature and for groundwater hydrology.



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Progress Last Period (January–December 2010)

Depth to groundwater was measured monthly. Groundwater was sampled quarterly for routine inorganic chemistry at five shallow wells and annually at two downgradient bedrock-aquifer wells. Groundwater data were compiled and reviewed.

Information for the Current Period (January–December 2011)

A USGS interpretive report containing the water-quality data for 1993–1999 was written and put into review. Depth to groundwater will be measured approximately monthly during the spring and summer. Groundwater at five sites will be sampled twice and analyzed for inorganic constituents. Data will be compiled and reviewed.

USGS groundwater data for samples collected January through December 2010

[Data are preliminary and subject to revision. Standards from Colorado Department of Public Health and Environment, 2009, The basic standards for groundwater, 5CCR 1002-41: October 13, 2009, variously paginated. All data from filtered samples; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; E,n, value estimated by laboratory at less than the reporting limit]

Well	Sample date	Nitrate + 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
DTX1	01-26-2010	3.98	2.3	0.14	0.88	< 7.0	< 0.21	< 0.010	1.7	14.7	12.2	< 19.6
DTX1	04-20-2010	4.12	1.6	< .20	< 1.2	< 10.0	< .30	< .010	1.6	5.6	8.9	< 28.0
DTX1	09-07-2010	4.50	1.5	.14	< .24	< 2.0	< .06	< .010	1.5	4.0	10.8	< 5.6
DTX1	11-16-2010	4.32	2.0	.16	< .60	< 5.0	< .03	< .005	1.7	4.1	9.2	< 14.0
DTX2	01-26-2010	E,n .03	.88	E,n .03	.39	< 3.0	< .09	< .010	1.7	16.5	.30	< 8.4
DTX2	04-20-2010	.06	.58	< .16	< .96	< 8.0	< .24	< .010	1.9	11.3	E,n .19	< 22.4
DTX2	09-07-2010	< .04	.74	.04	< .24	< 2.0	< .06	< .010	1.6	5.7	.15	< 5.6
DTX2	11-16-2010	< .02	1.1	E,n .06	.48	< 1.5	< .04	< .005	2	5.6	.27	< 4.2
DTX8A	04-20-2010	< .04	.17	< .06	< .36	< 3.0	< .09	< .010	.5	1.5	< .12	< 8.4
DTX10A	04-21-2010	< .04	E,n .26	< .20	< 1.2	< 10.0	< .30	< .010	1.1	8.1	< .40	< 28.0
D6	01-27-2010	51.6	1.2	< .30	E,n 1.6	< 15.0	< .45	< .010	3.0	17.4	80.6	< 42.0
D6	04-21-2010	53.8	1.1	< .40	< 2.4	< 20.0	< .60	< .010	3.0	17.0	73.5	< 56.0
D6	09-08-2010	50.4	1.3	E,n .09	< .84	< 7.0	< .21	< .010	3.4	9.3	84.8	< 19.6
D6	11-17-2010	48.0	1.4	< .11	1.1	< 3.5	< .10	< .005	3.7	10.0	67.7	< 9.8
D17	01-26-2010	1.01	1.6	.03	< .12	< 1.0	< .03	< .010	5.5	1.6	8.9	< 2.8
D17	04-21-2010	1.07	1.5	.03	< .12	< 1.0	< .03	< .010	5.4	.68	9.0	< 2.8
D17	09-07-2010	1.15	1.4	.02	< .12	< 1.0	< .03	< .010	5.8	.62	8.2	< 2.8
D17	11-16-2010	1.17	1.4	.03	< .06	< .50	< .01	< .005	5.7	.50	8.1	< 1.4
D25	01-27-2010	.10	1.8	.21	E,n .64	< 6.0	< .18	< .010	5.8	17.0	.65	< 16.8
D25	04-22-2010	.53	1.6	E,n .16	< 1.2	< 10.0	< .30	< .010	6.0	16.7	1.1	< 28.0
D25	09-08-2010	.44	1.4	.19	< .24	< 2.0	< .06	< .010	7.2	4.2	.58	< 5.6
D25	11-17-2010	.28	1.9	.20	< .60	< 5.0	< .03	< .005	6.8	4.1	.65	< 14.0
Human Health or Drinking Water Standard		10	10	5	100	1,000	50	2	35	100	50	5,000
Agricultural Standard		100	100	10	100	200	100	10	None	200	20	2,000

Surface Water (Streambed Sediment)



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 was evaluated by sampling streambed sediments soon after storms. Two small drainage basins were selected for similar characteristics but different land use—one drainage basin in a biosolids-application field and another drainage basin 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 was sampled after the same storms once each year (if samples could be collected) for inorganic constituents (including metals, total nitrogen, and total phosphorous) and organic carbon. Data were reviewed and statistically tested to determine if concentrations are significantly different between the two drainage basins.

Progress Last Period (January–December 2010)

Because the land use at the control site (see page 2) changed, rainfall was no longer monitored at the sampling locations (shown on page 2), and streambed sediment was not sampled during this period.

Information for the Current Period (January–December 2011)

The former control site (see page 2) is no longer farmed, so it is not an appropriate control for the biosolids-site samples. Therefore, there are no plans to collect additional streambed-sediment samples at this time.

Biosolids



Approach

Biosolids samples were collected as one- to two-day composites from the centrifuges at the Metro District plant and analyzed for trace elements through the USGS. The material was placed in one-gallon plastic or glass bottles and transported to the USGS in Denver. There, the samples were air-dried then ground to less than 150 micrometers. Biosolids were sampled and analyzed by the USGS at least monthly from 1999–2010. One sample each year also was analyzed for plutonium. Data were reviewed and compared to Federal and State regulatory limits.

Progress Last Period (January–December 2010)

Biosolids samples were collected each month during 2010 and submitted for inorganic analyses. Inorganic chemical analyses were completed and compiled for all biosolids samples collected through December 2009. The USGS released a comprehensive data report containing analytical data for biosolids samples from 2009 (USGS Open File Report 2010-1162); this report is available at the USGS website listed on page 1. The USGS continued to research the fate and transport of organic wastewater compounds (emerging contaminants) related to land application of biosolids.

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Information for the Current Period (January–December 2011)

Analyses for the 2010 biosolids samples were completed. The USGS released a comprehensive data report containing analytical data for biosolids samples from 2010 (USGS Open File Report 2011-1146); this report is available at the USGS website listed on page 1. No biosolids samples are planned for collection or analysis in 2011.

USGS biosolids data for treatment-plant samples collected January through December 2010

[Data are preliminary and subject to revision. Table 1 and Table 3 standards from Colorado Department of Public Health and Environment, 2008, Biosolids regulation, 5CCR 1002-64: January 14, 2008, variously paginated; ppm, parts per million; %, percent]

Sample date	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Lead, ppm	Mercury, ppm	Molybdenum, ppm	Nickel, ppm	Selenium, ppm	Sulfur, %	Zinc, ppm
January 2010	1.40	1.8	594	31.6	1.05	14.9	17.6	9.7	1.55	712
February 2010	1.36	1.7	590	35.9	1.52	14.7	18.2	9.6	1.61	714
March 2010	1.35	1.9	607	35.7	0.92	13.2	18.1	9.4	1.51	687
April 2010	1.43	1.8	614	35.1	1.26	11.9	18.0	9.8	1.52	669
May 2010	1.44	1.9	684	42.6	1.30	14.6	18.7	11.3	1.63	749
June 2010	1.49	1.8	684	38.3	1.37	13.6	17.8	13.6	1.71	775
July 2010	1.85	1.9	671	43.0	1.18	17.7	18.5	15.4	1.88	810
August 2010	1.67	1.9	714	49.0	1.31	18.6	19.0	14.0	1.89	848
September 2010	1.59	1.7	665	48.3	1.28	21.2	20.2	10.9	1.78	848
October 2010	1.69	2.7	933	63.0	1.64	33.8	28.1	11.2	1.92	1,090
November 2010	1.60	2.2	711	43.4	1.62	26.5	21.8	9.4	1.76	846
December 2010	1.27	2.4	712	46.5	1.23	22.9	19.1	10.4	1.77	821
Table 3 Pollutant Concentration Limits	41	39	1,500	300	17	75 (Table 1 Standard)	420	100	None	2,800

USGS biosolids data for plutonium in treatment-plant samples collected 2009–2010

[Data are preliminary and subject to revision; pCi/g, picocuries per gram; ±, plus or minus the analytical uncertainty; analytical uncertainty is the 1-sigma total combined standard uncertainty provided by the laboratory]

Sample date	Plutonium 238, pCi/g	Plutonium 238, minimum detectable concentration, pCi/g	Plutonium 239+240, pCi/g	Plutonium 239+240, minimum detectable concentration, pCi/g
June 2009	0.014 ± 0.022	0.10	-0.004 ± 0.007	0.10
January 2010	0.005 ± 0.009	0.10	0.014 ± 0.009	0.10

Soil

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 (see page 2). Each site consists of three 20-acre (933 feet by 933 feet) fields separated by 100-foot buffer



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zones. The center 20-acre field at each site receives biosolids applications. The other two 20-acre fields at each site do not have biosolids applied and are 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 are farmed in the normal fashion and have crops planted and harvested. Plans were to sample soil from each of the six fields in 2010. Samples would be analyzed for arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc. Data would be examined to determine if concentrations changed with time.

Progress Last Period (January–December 2010)

The sampling fields (see page 2) received few biosolids applications since the last soil sampling in 2002. Therefore, the USGS determined that sampling soil in 2010 was premature and collected no soil during this period. The sampling fields were maintained as described in the approach so soil can be sampled in future years.

Information for the Current Period (January–December 2011)

No additional work is planned for this study component during this period.

Crops

Approach

Crops from each of the two soil-sampling areas (six 20-acre fields; see page 2) were chemically analyzed after harvest. Analyses included arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc.



Progress Last Period (January–December 2010)

Crop samples (wheat from the 2010 harvest) were received in July from the soil-monitoring fields in Arapahoe County. Samples were processed for analysis.

Information for the Current Period (January–December 2011)

The crop samples provided to the USGS from the Arapahoe County soil-monitoring fields in 2010 were analyzed. Data were compiled and reviewed. Crop samples (wheat from the 2011 harvest) were received in August from the Metro District for soil-monitoring fields in Elbert County.

USGS data for harvested wheat-grain samples collected summer 2010

[Data are preliminary and subject to revision; reported as dry weight; ppm, parts per million; no data available for mercury; <, less than]

Sample description	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Lead, ppm	Molybdenum, ppm	Nickel, ppm	Selenium, ppm	Zinc, ppm
Arapahoe County north field (control)	0.01	<0.001	<0.05	<0.04	1.0	<0.3	0.78	11.6
Arapahoe County middle field (biosolids applied)	.02	<.001	<.05	<.04	1.4	<.3	.43	17.6
Arapahoe County south field (control)	.02	<.001	<.05	<.04	1.3	.3	.59	15.9

Dust

Approach

A monitoring component for dust was added to the program in 2006 because dust quantities and contamination from biosolids-applied farmland are concerns for some stakeholders. The USGS met with selected stakeholders on January 13, 2006, to evaluate dust-sampling sites. Two farmed fields were selected for similar characteristics—one field in a biosolids-applied area and another farmed field (not on the Metro District properties) upwind that did not receive biosolids. Dust traps were installed adjacent to each field. The dust traps at both fields were sampled at the same time for dust quantity and inorganic constituents. Dust samples were collected approximately monthly during late winter through spring (the reported windiest time of the year) for two consecutive years (2006 and 2007).



Progress Last Period (January–December 2010)

No activities for this study component took place during 2010. The USGS report about the dust results (USGS OFR 2008-1361) is available at the USGS website listed on page 1.

Information for the Current Period (January–December 2011)

This study component is complete. No additional work is planned.

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 is 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 plutonium 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 Table 3, Class B biosolids near Deer Trail. Regulations require that land-applied biosolids must meet or exceed Table 1, Class B requirements. Table 3 Ceiling Concentration Limits are stricter than Table 1 Ceiling Concentration Limits.



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.

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Organic wastewater compounds—Chemicals that are used every day in homes, industry, and agriculture that may be found in small concentrations in biosolids, in water released from wastewater treatment plants, or in other water impacted by humans. These chemicals include detergents, disinfectants, fragrances, fire retardants, pharmaceuticals, hormones, and pesticides.

Proposal—A document prepared by the USGS that outlines USGS work that could be done to address a question or concern. For the Expanded Monitoring Program, the USGS prepared separate proposals for each monitoring component (such as groundwater or crops) and usually prepared multiple proposals for the same monitoring component to provide different study options or address different questions or concerns.

Runoff—The water from precipitation that 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

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***Annual stakeholder
meeting
is planned for September 21,
2011,
at the Metro Wastewater
Reclamation District property
near Deer Trail, Colorado***

*Prepared by Tracy Yager and Jim Crock
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