

## What is the Big Dry Creek Watershed Association?

The Big Dry Creek Watershed Association (BDCWA) is a non-profit corporation consisting of individuals and entities who dedicate time and resources to developing a sound scientific understanding of water quality, flow, aquatic life and habitat conditions in the Big Dry Creek watershed and act to improve these conditions.

The Big Dry Creek Partnership, which included the Cities of Broomfield, Northglenn and Westminster and Rocky Flats Environmental Technology Site (RFETS), founded the BDCWA in 1997. These entities have been heavily involved in monitoring stream conditions for many years. Since 1997, the Association has expanded to include representatives from other cities, counties, farmers, ditch companies, citizens and regulatory and resource agencies. The BDCWA is open to those interested in cooperatively working towards understanding and prioritizing efforts to improve basin conditions.

In 2004, the BDCWA formed a non-profit corporation with a Board of Directors consisting of representatives of the cities of Westminster, Thornton and Northglenn, the City and County of Broomfield, Weld County and Adams County. Activities of the BDCWA during the last ten years have been funded through the contributions from these entities, as well as the U.S. Department of Energy, the Woman Creek Reservoir Authority, the Colorado Water Conservation Board, the U.S. Environmental Protection Agency's 319 program (as administered by the Colorado Department of Public Health and Environment) and the Regional Geographic Initiative grant program.

For more information on the Big Dry Creek Watershed Association, please visit The BDCWA's web page at [www.bigdrycreek.org](http://www.bigdrycreek.org) or contact Jane Clary, Watershed Coordinator, Wright Water Engineers, Inc., 303-480-1700 or [clary@wrightwater.com](mailto:clary@wrightwater.com).



Big Dry Creek Watershed Association  
c/o Wright Water Engineers, Inc.  
2490 W. 26th Ave., Suite 100A  
Denver, CO 80211

Phone: 303-480-1700  
Fax: 303-480-1020  
[www.bigdrycreek.org](http://www.bigdrycreek.org)  
Email: [clary@wrightwater.com](mailto:clary@wrightwater.com)



# STATE OF THE WATERSHED

Newsletter of the Big Dry Creek Watershed Association

Volume 8

## Big Dry Creek 2005 Water Quality Review

During 2005, the cities of Broomfield, Northglenn, Thornton and Westminster (Cities) worked together to collect water quality and flow data along the main stem of Big Dry Creek. Water quality samples were analyzed for a variety of constituents, resulting in over 4,000 records being added to the Big Dry Creek Watershed Association (BDCWA) database in 2006. Metals were monitored on a quarterly basis with the exceptions of iron and selenium, which were monitored monthly. All other constituents were monitored on a monthly basis. The Cities also helped to fund operation of the U.S. Geological Survey (USGS) gauging station (#6720820) at Westminster behind Front Range Community College. Key findings related to the 2005 data are provided below.

### Overview

Attainment of stream standards is evaluated based on comparison of specific statistical values to chronic stream standards and determining whether acute standards are exceeded in any samples. For most constituents, the relevant statistic for comparison to the chronic standard is the 85th percentile value. Exceptions include use of the 50th percentile value for metals with standards in the total recoverable form, the geometric mean for *E.*

*coli* and fecal coliform, and the 15th percentile value for dissolved oxygen (DO) and the lower acceptable range for pH. (It should be noted that from a regulatory perspective, five years of data would be used in such a comparison.)

Segment 1 (the main stem) of Big Dry Creek is listed on the 2006 303(d) list for Colorado for non-attainment of stream standards for *E. coli* and selenium. Currently, each of these constituents has a temporary modification to the stream standard. Additionally, a portion of the stream downstream of the Weld County line is listed on the Monitoring and Evaluation (M&E) portion of the 303(d) list for total recoverable iron. Based on review of the 2005 BDCWA data set, Segment 1 of Big Dry Creek does not attain the currently assigned acute or chronic standards for dissolved selenium at monitoring location bdc1.5 downstream of Front Range Community College. Although the stream segment as a whole attained the temporarily modified chronic stream standard for dissolved selenium, it did not meet the underlying (unmodified) chronic standard at any in-stream monitoring location. The stream segment met both the underlying and temporarily modified *E. coli* standard; however, several

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## Thank You to Hallie Mahan

In June, the Big Dry Creek Watershed Association thanked Hallie Mahan of the City and County of Broomfield for her effective leadership of the BDCWA. Hallie was instrumental in formation of the organization in 1997 and served as its inaugural chairperson following incorporation of a 501(c)(3) in 2004. Hallie retired after 22 years of service as the Environmental Laboratory Supervisor for the City and County of Broomfield. Hallie's expertise in water quality and regulatory issues will be greatly missed. A luncheon was held in her honor in May and attended by BDCWA members.



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### Next Watershed

#### Association Meeting:

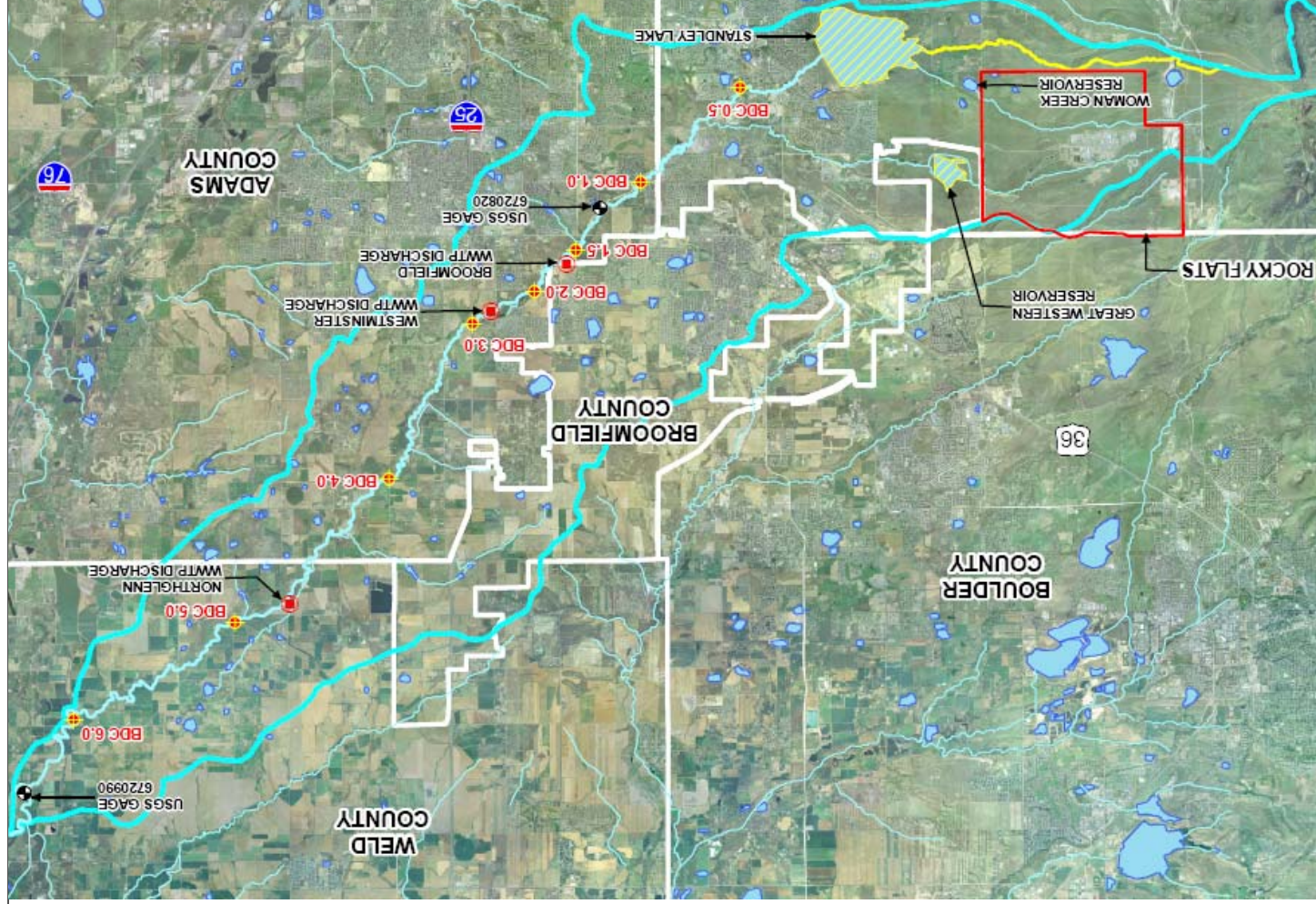
**Topic:** *E. coli* in the Big Dry Creek Watershed

**Time:** September (date to be announced)

**Place:** Broomfield Water Treatment Facility, 4395 W. 144th Ave.

All Watershed Association meetings are open to the public.

Contact Jane Clary with questions. 303-480-1700



The Big Dry Creek Watershed covers 10-square miles from Rocky Flats to its confluence with the South Platte River near Fort Lupton. Monitoring locations are designated as "BDC" on this map.

## Big Dry Creek Water Quality (continued)

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individual monitoring locations (i.e., bdc1.5, bdc2.0 and bdc6.0) exceeded the underlying standard. One location on the stream, bdc6.0, does not meet the stream standard for total recoverable iron; however, the stream as a whole meets the standard. All other constituents attained the stream standards during 2005. More information on these constituents follows.

**Selenium**  
Dissolved selenium concentrations during 2005 exceeded the underlying chronic stream standard of 4.6 µg/L at all locations on the creek, based on comparison of the 85th percentile value at each monitoring location to the stream standard. The 85th percentile value met the temporary modification to this standard of 11 µg/L, which was assigned by the CWCOC in 2004, at all locations except bdc1.5. Two exceedances of the acute dissolved selenium standard also occurred at bdc1.5 during December and February. In the December sample, both the sample and its duplicate showed identical values of

20 µg/L. During 2003 and 2004, similar trends were present on the stream. Monitoring location bdc1.5 is located just downstream of Front Range Community College, upstream of both the wastewater discharges and agricultural influences. Seasonal variation in selenium concentrations during 2005 was apparent with lower concentrations during the irrigation season (April-October) and higher concentrations during the non-irrigation season (November-March).

Future changes to selenium standards on Big Dry Creek are a long-range issue since the temporary modification for the selenium standard is in place until 2010. Revised selenium criteria, whatever they may ultimately be, would not be adopted into Colorado's Basic Standards until 2010 and would not be incorporated into Big Dry Creek's Stream Standards until 2014. EPA's revised criteria for selenium were issued in draft form in 2004 and are tentatively scheduled to be finalized in 2008. Selenium was listed as a "low priority"

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also exhibits a seasonal trend, concentrations in the winter months still remain above the underlying stream standard at this location.

### Iron

Total recoverable iron concentrations during 2005 attained the stream standard of 1 mg/L based on the 50th percentile value for the overall stream. Nonetheless, about 25 percent of the samples collected (i.e., 24 out of 95 samples) exceeded the standard, with the elevated concentrations generally corresponding to storm events during April, May and June, with concentrations increasing in a downstream direction during these storm events. Total recoverable iron and total suspended solids (TSS) both increase in a downstream direction and are well correlated to each other, as has been the case in previous years.

The CWCOC has placed Segment 1 of Big Dry Creek on the Monitoring and Evaluation List because one location on the stream, bdc6.0, does not meet the stream standard. The 50th percentile value for 2001 through 2005 at bdc6.0 is 1.4 mg/L, exceeding the stream standard. Although the highest concentrations (5-13 mg/L) over the past five years at bdc6.0 occurred during the April to July time period and are believed to be associated with sediment loads occurring during summer storm events and irrigation activities, concentrations at this site are elevated above the standard throughout all months of the year, even in the absence of these activities. The stream in the lower watershed is actively eroding and has multiple unstable banks. Iron that naturally occurs in the streambanks is expected to be the probable source of elevated iron in the lower watershed.

## Draft E. coli TMDL Released for South Platte Segment 14

**Ammonia and Nitrate**  
Unionized ammonia concentrations were well below stream standards in 2005. Although the unionized concentrations of ammonia are low, the total ammonia concentrations were elevated at bdc2.0 during January and February of 2005. Total ammonia stream standards are expected in the future. Although Big Dry Creek does not have a drinking water classification or a corresponding in-stream nitrate standard, the Middle South Platte River Segment 1 downstream of Big Dry Creek has a drinking water classification and a nitrate standard of 10 mg/L. This standard is applied based on a single day combined total of nitrite and nitrate at the point of intake to the domestic water supply. Nitrate grab samples collected at the farthest downstream sampling point (bdc6.0) in the Big Dry Creek monitoring program shows that nitrate concentrations averaged 6.8 mg/L over the last five years.

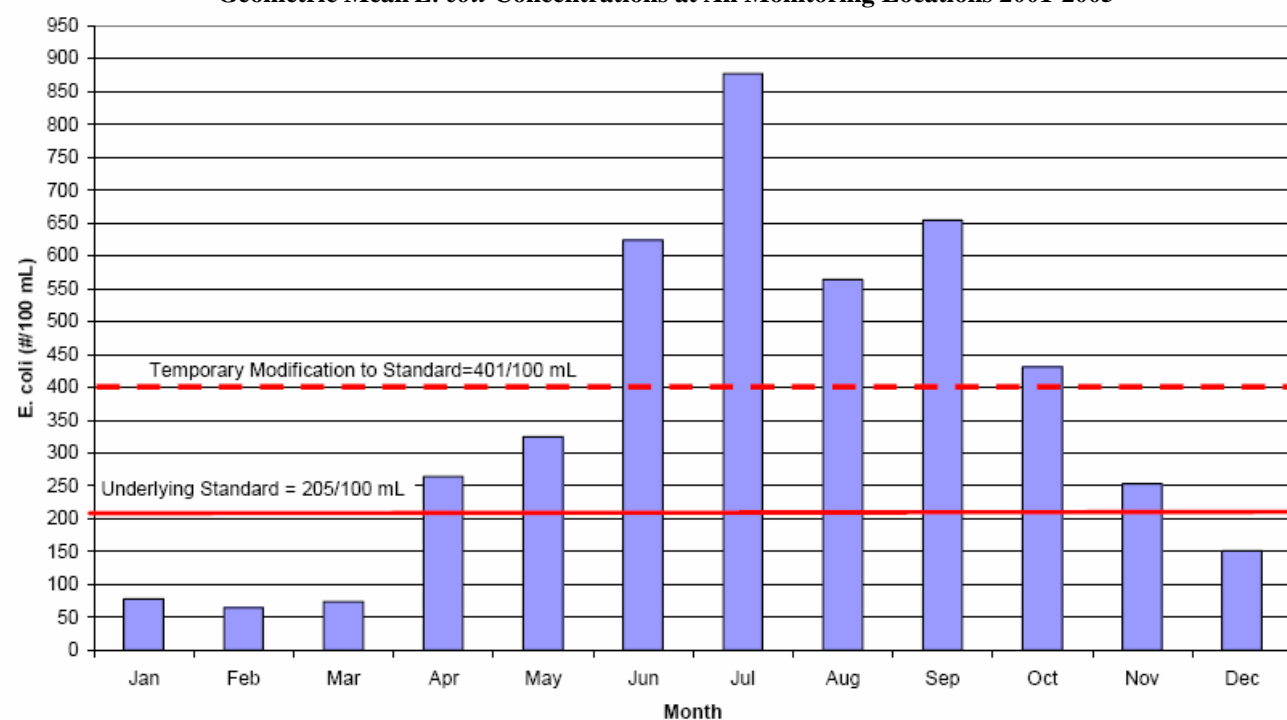
### Flow

During 2005, average daily flows at the USGS Westminster gauge ranged from 1 cfs to 224 cfs, with an average of 21 cfs. Flows measured at the Westminster gauge suggest gradual recovery from drought conditions. Average daily flows for the Fort Lupton gauge ranged from 2 cfs to 325 cfs, with an average of 32 cfs. Average flows during 2005 were somewhat lower than during 2003 and 2004, though still somewhat higher than 2002. During 2005, there were several high flow events associated with storms.

This basically means that a limit of 126 colony forming units/100 mL is proposed to be assigned to these sources: Colorado Discharge Permit System (CDPS) permitted discharges, wildlife, humans and pets in the riparian zone, and tributaries to Segment 14. Although the source of *E. coli* has not been clearly defined, the primary source of conveyance of *E. coli* has been identified as the stormwater collection system, during both dry and wet weather events.

The initial focus to reduce *E. coli* is on dry weather flows from stormwater outfalls and to continue monitoring. Implementation of the TMDL will be an iterative process involving CDPS permittees that discharge to Segment 14 and other non-point source pollution programs. Once all dry weather flows from stormwater collections systems are considered to be controlled, then the TMDL will be re-evaluated. The draft TMDL was noticed for public comment on July 1, 2006.



Geometric Mean *E. coli* Concentrations at All Monitoring Locations 2001-2005

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on the 2006 303(d) list. Nonetheless, because Big Dry Creek has a temporary modification in place, the BDCWA must work towards developing a better scientific understanding of sources and impacts of selenium on the creek. The monthly water quality monitoring data and fish tissue sampling help to support this effort. The BDCWA has also sponsored a special study for purposes of selenium source identification in the watershed (see p. 3 of this newsletter).

#### Bacteria

Currently, a dual standard for fecal coliform and *E. coli* is in place for Segment 1 based on changes to the Basic Standards in 2001. *E. coli*, which is a subset of fecal coliform, is believed to be a better predictor of potential human health impacts from waterborne pathogens. In the next triennial review, the CWQCC anticipates moving to *E. coli* as the sole pathogen indicator. The dual standards are established as an interim transitional step. The BDCWA now has six years of *E. coli* data, so primary emphasis regarding trend analysis in this memorandum is focused on *E. coli*. Additionally, *E. coli* and fecal coliform trends from 2000-2005 appear to be comparable. Based on review of geometric mean concentrations from 2000-2005, the following observations are noteworthy:

- ◆ Geometric mean concentrations for both *E. coli* and fecal coliform are consistently the lowest in grab samples from the Broomfield and Westminster wastewater treatment plant (WWTP) effluent. (The Northglenn WWTP did not discharge to Big Dry Creek in 2005.) For the six-year time period, wastewater grab samples were well below the stream standard. For this reason, elevated geometric

mean concentrations at in-stream locations below the discharges cannot be attributed to WWTP discharges during the vast majority of the sampling events.

- ◆ The highest concentrations of both *E. coli* and fecal coliform are present at bdc2.0, below the Broomfield WWTP. Monitoring station bdc6.0 in the agricultural area upstream of the confluence with the South Platte River also has concentrations above stream standards for both *E. coli* and fecal coliform.
- ◆ During 2005, geometric mean concentrations of fecal coliform were below the underlying stream standard at all locations except bdc2.0 and bdc6.0. Concentrations at bdc1.5 also approached the stream standard. All locations met the temporarily modified standard of 380/100 mL during 2005.
- ◆ During 2005, geometric mean concentrations of *E. coli* were below the underlying stream standard at all locations except bdc1.5, bdc2.0 and bdc6.0. All locations met the temporarily modified standard of 401/100 mL during 2005.
- ◆ For most locations on the stream, *E. coli* concentrations are about one-quarter to one-half of those measured during drought conditions in 2002, with the exception of bdc1.5, which appears to be less variable over time.
- ◆ Seasonal variation is evident for the six-year *E. coli* data set, with geometric mean concentrations above the underlying stream standard during April through November and above the temporarily modified standard for June through October (see chart above). Although bdc6.0

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## Special Study: Big Dry Creek Selenium Exploration

The main stem of Big Dry Creek has elevated selenium concentrations throughout the entire stream segment, which reaches from below Standley Lake to its confluence with the South Platte River in Fort Lupton. In the Colorado Water Quality Control Commission's 2004 review of the stream standards assigned to this reach, the Commission found that "the selenium standards in Big Dry Creek are presently exceeded and that there is significant uncertainty regarding the appropriate long-term underlying selenium standards." The City and County of Broomfield and the BDCWA committed to develop additional data and information regarding the extent to which existing quality is the result of natural or irreversible human induced conditions. The Commission also recognized that the level of water quality necessary to protect current and/or future uses from selenium is currently under review by the U.S. Environmental Protection Agency and that table value standards (TVS) for selenium may change in the future. Therefore, the Commission adopted a temporary modification of existing quality based on uncertainty for selenium (ac/ch), with an expiration date of 02/28/2010. This has the effect of temporarily increasing the chronic dissolved standard from 4.6 µg/L to 11 µg/L for the main stem of Big Dry Creek. The acute standard is 17 µg/L.

To develop a better understanding of selenium concentrations in Big Dry Creek, as well as to identify potential sources of selenium in the watershed, the Big Dry Creek Watershed Association (BDCWA) has conducted research and field sampling. In the spring of 2006, a technical memorandum was completed that summarized the results of these efforts, which included review of geologic conditions, biological data, and groundwater data, as well as supplemental sampling of tributaries, springs, wells and ponds throughout the Big Dry Creek watershed, among other activities. Based on the body of data assimilated, analyzed and presented in the technical memorandum, elevated selenium in the Big Dry Creek watershed is believed to be due primarily to naturally occurring conditions in the watershed. In particular, the data indicate that the reach of the stream with the highest concentrations of selenium is most likely attributable to elevated selenium in groundwater contributing to stream flows. The dominant land use adjacent to this stream reach is unirrigated open space. Although land use in the lower watershed is irrigated agriculture, selenium concentrations do not increase or show significant seasonal patterns in this portion of the stream. Selenium concentrations in Big Dry Creek appear to be diluted by wastewater discharges from Broomfield and Westminster, as well as from releases from Standley Lake during the irrigation season. A few highlights from the technical memorandum follow.

There is not a statistically significant upstream to downstream trend for selenium concentrations. However, the highest concentrations are consistently recorded upstream of the wastewater treatment plants. There is a statistically significant difference between locations upstream of the WWTPs relative to

downstream, with the upstream locations being higher; however, Least Significant Difference analysis refined this conclusion by showing that the mean concentration for bdc1.5 was significantly different from other locations on the creek, but that there was not a significant difference among the mean concentrations for the other locations.

Seasonal variation in selenium concentrations is statistically significant based on analysis of the irrigation (April through October) versus non-irrigation (November through March) seasons. During the irrigation season, the mean selenium concentration for the stream as a whole was 5.1 µg/L, and during the non-irrigation season, the mean concentration was 8.5 µg/L. This trend is most evident at the three monitoring locations (bdc0.5, bdc1.0, bdc1.5) between Standley Lake and the Broomfield WWTP and is less evident at the stations below the Broomfield and Westminster WWTP discharges (bdc2.0 through bdc6.0). During the irrigation season, stations upstream of the WWTPs averaged 4.4 µg/L and stations downstream averaged 5.6 µg/L. During the non-irrigation season, stations upstream averaged 11.2 µg/L and stations downstream averaged 6.7 µg/L. During the irrigation season, the upstream sites benefit from the diluting flows released from Standley Lake. During the non-irrigation season, there is typically very little flow in the creek at the upstream monitoring locations and selenium concentrations increase significantly. This seasonal trend is less defined below the WWTPs due to the more consistent flows in the creek from the wastewater discharges.

Closely related to seasonal variation is the relationship between flow and selenium. As would be expected, flows during the irrigation season are roughly double the non-irrigation season flows on average. Flows downstream of the WWTPs are higher than above the WWTPs. This difference is most pronounced during the non-irrigation season. In general, lower flows have higher selenium concentrations. However, there is significant variation in selenium concentrations at low flows (e.g., at very low flows, there can be very high and very low selenium). Due to this variation, flow alone is not a strong predictor of selenium concentration—other variables influence selenium concentration in addition to flow.

The highest in-stream concentrations of selenium are consistently present at station bdc1.5 near 120th and Federal, just downstream of Front Range Community College. Four exceedences of the acute selenium standard have also occurred at this station, ranging from 19-20 µg/L, once or twice per year. The land adjacent to both sides of the stream segment between bdc1.0 and bdc1.5 is Westminster Open Space and is primarily unirrigated. Two groundwater monitoring wells located between Big Dry Creek and Front Range Community College show elevated dissolved selenium concentrations averaging from 34 to 92 µg/L. Three other wells in the same

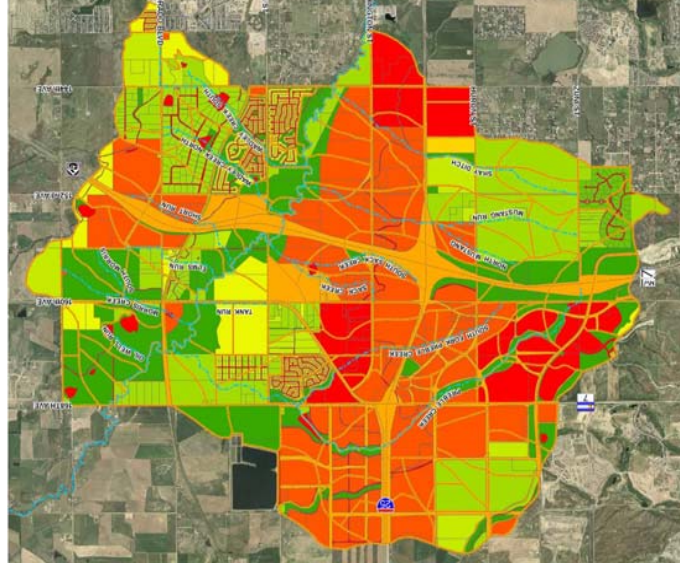
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## Big Dry Creek Northern Area Tributaries Update Underway

The project criteria being followed in this project are essential for Big Dry Creek and are consistent with the findings and recommendations of the Lower Big Dry Creek Hydro-logic Study sponsored by the BDCWA last year. A few representative examples of UDFCD criteria being followed in the planning process include:

- ◆ “A well-planned major drainage system can reduce or eliminate the need for underground storm sewers, and it can protect the urban area from extensive property damage, injury, and loss of life from flooding. The practice of straightening, narrowing, and filling major drainage ways such as gulches, dry streams, and other natural channels is not recommended for general use in drainage way master plans.”
- ◆ “Preservation of floodplains is a policy of UDFCD to manage flood hazards, preserve habitat and open space, create a more livable urban environment, and protect the public health, safety, and welfare.”
- ◆ “Channel modifications that create unnecessary problems downstream should be avoided, both for the benefit of the public and to avoid damage to private parties. Problems to avoid include land and channel erosion and downstream sediment deposition, increase of runoff peaks, and debris transport, among others.”

If you would like to be included in the planning process, please contact Jane Clary 303-480-1700 at Wright Water Engineers to be placed on the project mailing list. Also see the project website accessed from [www.bigdrycreek.org](http://www.bigdrycreek.org).

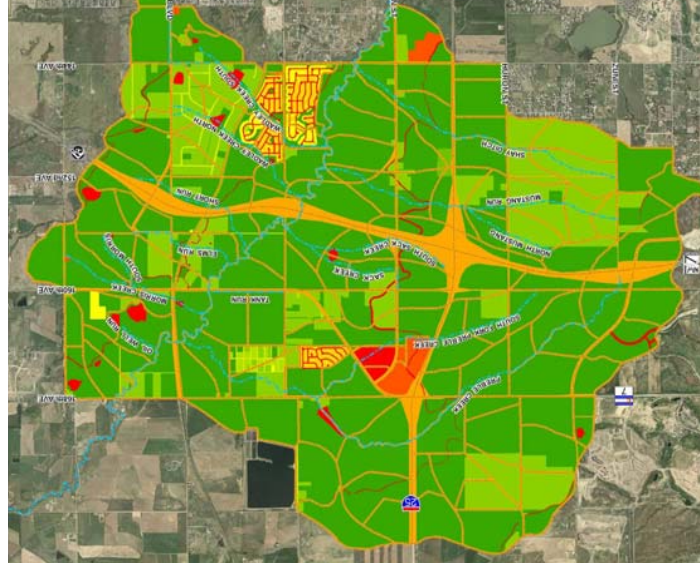


Green colored areas have low imperviousness, enabling stormwater to readily infiltrate into the ground. Red-colored areas have high imperviousness associated with development along the I-25/NW Parkway/E-470 corridors. The map to the left represents existing conditions in the study area and the map to the right represents expected future conditions. UDFCD policies

The Big Dry Creek Northern Area Tributaries Outfall Systems Plan Update is well underway. The purpose of the project is to update the Big Dry Creek Northern Tributaries Outfall Systems Plan (Wright Water Engineers, Inc. 1989), which was originally completed to provide an overall coordinated plan for drainage improvements for the northern tributaries to Big Dry Creek. Recent and on-going urbanization in the study area drives the need for this update. The project is sponsored by the Urban Drainage and Flood Control District (UDFCD), Adams County, the City and County of Broomfield, the City of Thornton and the City of Westminster.

The vicinity of the project study area is roughly Hwy 7/168th Ave. on the north, 136th Avenue on the South, Holly St. to the east and Zuni St. to the west. The plan focuses on the following tributaries to Big Dry Creek: Wadley Creek South, Wadley Creek North, Sack Creek, Sack Creek South, Preble Creek, South Fork Preble Creek, Mustang Run, North Mustang Run, Shay Ditch, Short Run, Morris Creek, Morris Creek South, Elms Run, Tank Run and Oil Run.

The project is being conducted in a sequential manner. The first phase includes all studies and data gathering needed to prepare the Alternatives Evaluation Report, which will serve as the basis for the Project Sponsors selecting a preferred alternative. The second phase of the project will comprise a preliminary design for the selected alternative that will culminate in the Preliminary Design Report. The Alternatives Evaluation Report is now complete and Project Sponsors are in the process of selecting their preferred alternative.



Summary of Big Dry Creek Dissolved Selenium Concentrations (µg/L)

Sample Type	# Samples	Average	85th %	Max	St. Dev
Groundwater	32	24.64	43.70	96.20	24.56
Reservoir/Pond	118	4.27	8.36	18.00	4.10
Stormwater	2	3.75	NA	4.50	1.06
Stream	215	6.42	9.00	20.00	3.14
Wastewater	53	3.76	5.00	6.00	1.10

area have low concentrations of selenium. On the north side of the creek, one residential underdrain sample also showed elevated selenium (70 µg/L). Surficial geology in this reach of stream consists primarily of alluvial deposits with the exception of several discontinuous outcrops of the Araphoe Formation (TKda) bedrock on the south side of the stream, which may help to explain the large variation in groundwater concentrations in the five wells behind Front Range Community College. These bedrock outcrops and weathered material originating from these outcrops are believed to be the naturally occurring source of selenium along Big Dry Creek. Because groundwater appeared to be a likely potential source of selenium to Big Dry Creek, an approximate groundwater contour map was developed based on surveying stream flow elevations relative to the groundwater level elevations in the existing monitoring wells behind Front Range Community College during April 2006. The results of the water elevation measurements in the monitoring wells relative to the surface water elevation in the creek show that the groundwater is higher in elevation than the creek during this time of year; therefore, inflows of groundwater to the creek are likely in this area.

Analysis of grab samples from the Broomfield and Westminster WTPs show that these discharges average 4.01 µg/L and 3.47 µg/L, respectively. Based on these grab samples, the WTPs have occasionally exceeded the instream standard with maximum concentrations of 6 µg/L. Other occasionally elevated concentrations have also been collected in wastewater composite samples collected by the cities as part of their discharge monitoring reports (DMRs). These relatively isolated elevated concentrations typically appear to be associated with large precipitation events and are hypothe-



Alkali flats behind Front Range Community College are evidence of high groundwater in an untrigged area adjacent to Big Dry Creek, just upstream of an instream location with high selenium concentrations.

As part of data exploration, WWE also reviewed the results of biological monitoring conducted by Aquatics Associates in the watershed since 1997. Statistically significant relationships between fish index of biologic integrity (IBI) scores and selenium concentrations were not evident. Limited fish tissue sampling suggests that Big Dry Creek would not meet EPA's proposed fish tissue criterion for selenium. Aquatics Associates (2005) has stated that flow conditions, high turbidity and habitat preferences appear to be the predominant influences on the fish community.

Based on exploration of water quality data from Big Dry Creek, ponds and reservoirs, groundwater, review of geologic conditions and review of Rocky Flats data, selenium is believed to be naturally occurring in the Big Dry Creek watershed. Available biological data show that fish continue to reproduce and live in Big Dry Creek despite selenium concentrations that exceed the stream standard throughout the creek. Because available data do not show a discernable relationship between ambient selenium concentrations and fish communities, it is unclear whether the fish communities would benefit from reduced selenium concentrations, even if it were possible to reduce the selenium concentrations.