

TOTAL MAXIMUM DAILY LOAD ASSESSMENT**Cadmium**

**S. Platte River - Segment 15
Denver County, Colorado
October, 2005**

TMDL SUMMARY	
Waterbody Name/Segment Number	Mainstem of the South Platte River from the Burlington Ditch diversion in Denver, Colorado, to a point immediately below the confluence with Big Dry Creek. COSPUS15
Pollutant/Condition Addressed	cadmium
Affected Portion of Segment	S. Platte River between Burlington Ditch and Metro Wastewater Reclamation District discharge
Use Classification/ Designation	Aquatic Life Warm 2, Recreation 1a, Water Supply, Agriculture
Waterbody Antidegradation Designation	Use Protected
Water Quality Target	Attainment of assigned numeric water quality standards for cadmium within the affected reach of segment 15.
TMDL Goal	Attainment of the assigned Aquatic Life Use designation

I. EXECUTIVE SUMMARY

Aquatic Life Use-based water quality standards for cadmium are not attained in that portion of the South Platte River between the Burlington Ditch headgate and the Metro Wastewater Reclamation District discharge. Surface water and ground water data in this area indicate that a groundwater plume originating under or near the Globeville ASARCO Facility is the source of cadmium loading. Upstream cadmium concentrations and point source discharges do not cause or contribute significantly to the cadmium impairment. Remediation at the Globeville site is addressed in a Stipulated Agreement between ASARCO and the State of Colorado.

This Total Maximum Daily Load (“TMDL”) derives load allocations for dissolved cadmium species as appropriate for the standards that are currently exceeded. Instream compliance points are established for determination of post-remediation attainment status.

II. INTRODUCTION

Section 303(d) of the federal Clean Water Act (“CWA”) requires States to periodically submit to the U. S. Environmental Protection Agency (“EPA”) a list of water bodies that are water quality impaired. Water quality limited segments are those water bodies that, for one or more assigned use classifications or standards, the classification or standard is not fully achieved. This list of water bodies is referred to as the “303(d) List”. In Colorado, the agency responsible for developing the 303(d) List is the Water Quality Control Division (“WQCD”). The List is adopted by the Water Quality Control Commission (“WQCC”) as Regulation No. 93. The WQCC adopted the current 303(d) List in March of 2004.

The WQCD is required to produce a Total Maximum Daily Load (“TMDL”) assessment for water bodies included on the 303(d) List. A TMDL quantifies the amount of a pollutant that an impaired waterbody can assimilate without violating applicable water quality standards. Furthermore, the TMDL apportions the allowable quantity of a pollutant among the significant known pollutant sources. A TMDL is comprised of: the Load Allocation (“LA”), which is the portion of the pollutant load attributed to natural background or the nonpoint sources; the Waste Load Allocation (“WLA”), which is the portion of the pollutant load associated with point source discharges; and a Margin of Safety (“MOS”), which accounts for uncertainty in the pollutant load calculations. A TMDL may also include an allocation reserved to accommodate future pollutant sources. A TMDL is expressed as the sum of the LA, WLA, and MOS.

Segment 15 of the South Platte River, which is that portion between the Burlington Ditch headgate and the confluence with Big Dry Creek, was first identified as water quality impaired on the 1992 303(d) List. The 1992 List identified dissolved oxygen and “other” constituents as the causes of impairment. The 1994 303(d) List was amended to specify “metals” and unionized ammonia in lieu of “other” constituents. Additional specifics were added to the 1996 listing for segment 15; as cadmium was specifically identified as a parameter exceeding water standards. The cadmium listing has been retained on successive (1998, 2002 and 2004) 303(d) Lists.

The South Platte River cadmium TMDL was assigned a ‘high’ priority for completion on the 2004 303(d) listing. Completion of the TMDL at this time is consistent with that prioritization.

III. WATERSHED DESCRIPTION

The segment is located in east central Colorado, and is part of the Platte River drainage. The headwaters are high in the Southern Rocky Mountain Range on the Continental Divide, and drain eastward through the Denver metropolitan area. Segment 15 of the South Platte River includes that portion of the mainstem between the Burlington Ditch headgate and the Big Dry Creek confluence. It is a part of the South Platte Basin Hydrologic Unit 10190003.

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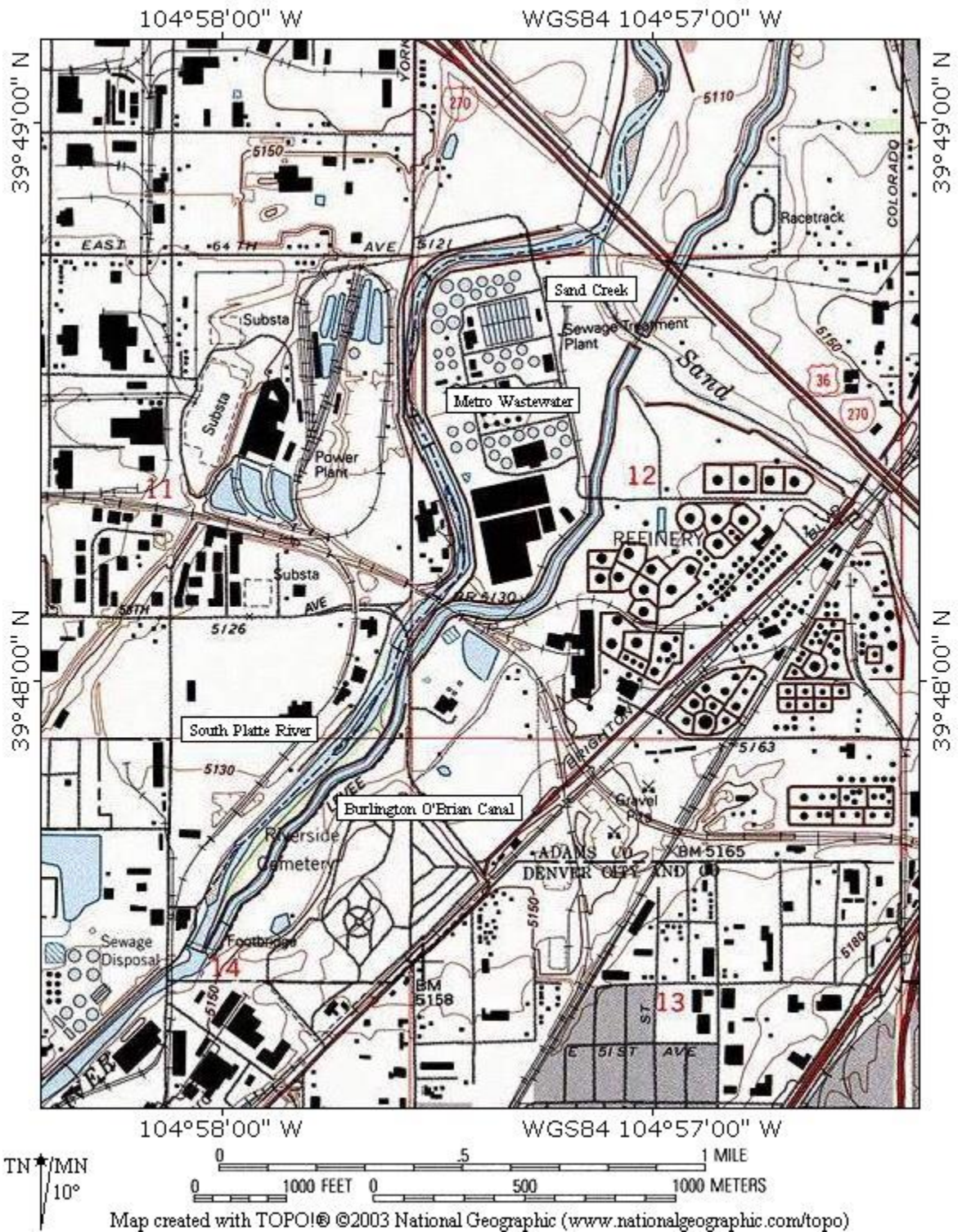


Figure 1. Affected Portion of Segment 15 of the South Platte River

That portion of Segment 15 that fails to attain assigned water quality standards for cadmium extends from the Burlington Ditch headgate to a point immediately above the Metro Wastewater Reclamation District (“MWRD”) outfall. The Aquatic Life Use-based chronic cadmium standard is exceeded in the South Platte River mainstem from about 58th Avenue until diluted by the MWRD discharge, approximately one mile downstream. MWRD discharges to the South Platte downstream of the weir at 64th Avenue. The portion of the South Platte River within which cadmium concentrations exceed the standard is shown in Figure 1.

Flows in the South Platte River are highly regulated; it is subject to a number of diversions as it flows through the metropolitan area, including a major diversion to the Burlington Ditch (also called the O’Brian Canal) at 52nd Avenue. Numerous other ditches divert flows for agricultural and domestic water supply uses. Frequently most of the flow at the upper end of Segment 15 is diverted, leaving relatively little flow below the Burlington Ditch. A mile and a half below the Burlington Ditch headgate is the Xcel Energy Cherokee Power Plant discharge point. Another half mile downstream is the MWRD discharge. A contaminated groundwater plume intersects the river near the Cherokee Power Plant outfall. The source of contamination had been thought to be associated exclusively with the ASARCO Globeville Plant. More recent investigations suggest that at least a portion of the cadmium entering the affected reach may originate at a site located adjacent to the Globeville site, the Argo site. Although the relative cadmium contribution associated with each site has not been quantified, the TMDL may proceed as it examines the loading of cadmium within the South Platte River mainstem and cadmium loading associated with any contaminated groundwater plumes are aggregated into a seepage component in the TMDL.

Figure 2 shows the Globe Plant, groundwater plume and affected portion of the South Platte River.

Much of the chemical and flow data for this TMDL were supplied by ASARCO, City of Thornton, MWRD, USGS and Xcel Energy and were compiled by SPCURE (*Cadmium TMDL Study – February 2000 – March 2001 for the South Platte River Segment 15 Upstream of the Metro District*, SPCURE, 2001). More current data was supplied by MWRD for the 64th Avenue sampling location.

IV. WATER QUALITY STANDARDS

The Colorado WQCC designated segment 15 for Warm Water Class 2 Aquatic Life Use. Both acute and chronic Aquatic Life Use-based cadmium standards are assigned. These are expressed as the dissolved fraction of the total amount of cadmium present. The assigned standards are Table Value Standards (“TVS”), applied on a statewide basis where there is an Aquatic Life Use designation and no ambient-based or site-specific standards adopted, and are hardness-based.

The SPCURE has compiled data for several sampling locations between the Burlington Ditch headgate and 64th Avenue. Cadmium levels exceed standards at two sampling stations within segment 15: above the Xcel Cherokee outfall and at 64th Avenue. The Xcel Cherokee discharge has a significant effect on hardness levels above and below the discharge point (the discharge averages 711 mg/l hardness as calcium carbonate). Aquatic Life Use-based standards are therefore calculated for both above and below the discharge point and the results are tabulated below. Mean hardness values for each location are used to calculate the standards.

Location	hardness*	standard	
		acute	chronic
above Cherokee discharge point	300	14.0	5.0
64 th Avenue	362	17.2	5.8

* mg/l as calcium carbonate

Acute standards are calculated on a sample specific basis. At 300 mg/l hardness the acute standard is 14.0 ug/l. At 362 mg/l hardness the acute standard is 17.2 ug/l.

V. PROBLEM IDENTIFICATION

Section II. INTRODUCTION, briefly discusses the history of Segment 15 of the South Platte River in terms of 303(d) listing. Exceedences of numeric cadmium standards were documented and resulted in the specific identification of cadmium on the 1996 303(d) List. Subsequent monitoring has continued to indicate non-attainment of assigned cadmium standards, resulting in the inclusion of this parameter on successive 303(d) Lists.

Elevated dissolved cadmium concentrations are documented at two locations which define the affected reach: a sampling point located approximately 100 feet above the Xcel Cherokee outfall and a sampling point at 64th Avenue. See Figures 2 and 3 for the locations of these sampling points.

Attainment of Aquatic Life Use-based chronic standards expressed as the dissolved metal fraction is evaluated by comparison of the 85th percentile value for the ranked ambient water quality data against the chronic standard. Table 1 identifies a concentration of 5.0 ug/l as the chronic standard at the location above the Xcel Cherokee outfall. Data summarized in Table 2 indicates that the 85th percentile value for 12 sampling events occurring in 2001 and 2002 at that location is 5.5 ug/l. A chronic standard of 5.8 ug/l is calculated for the 64th Avenue location. The dataset for a six-year period of record (1999 through 2004, n=143) at this location yields an 85th percentile value of 17.5 ug/l. Sampling was performed bi-monthly at this location.

location	ambient concentration	standard	
		acute	chronic
above Cherokee discharge point	5.5	14.0	5.0
64 th Avenue	17.5	17.2	5.8

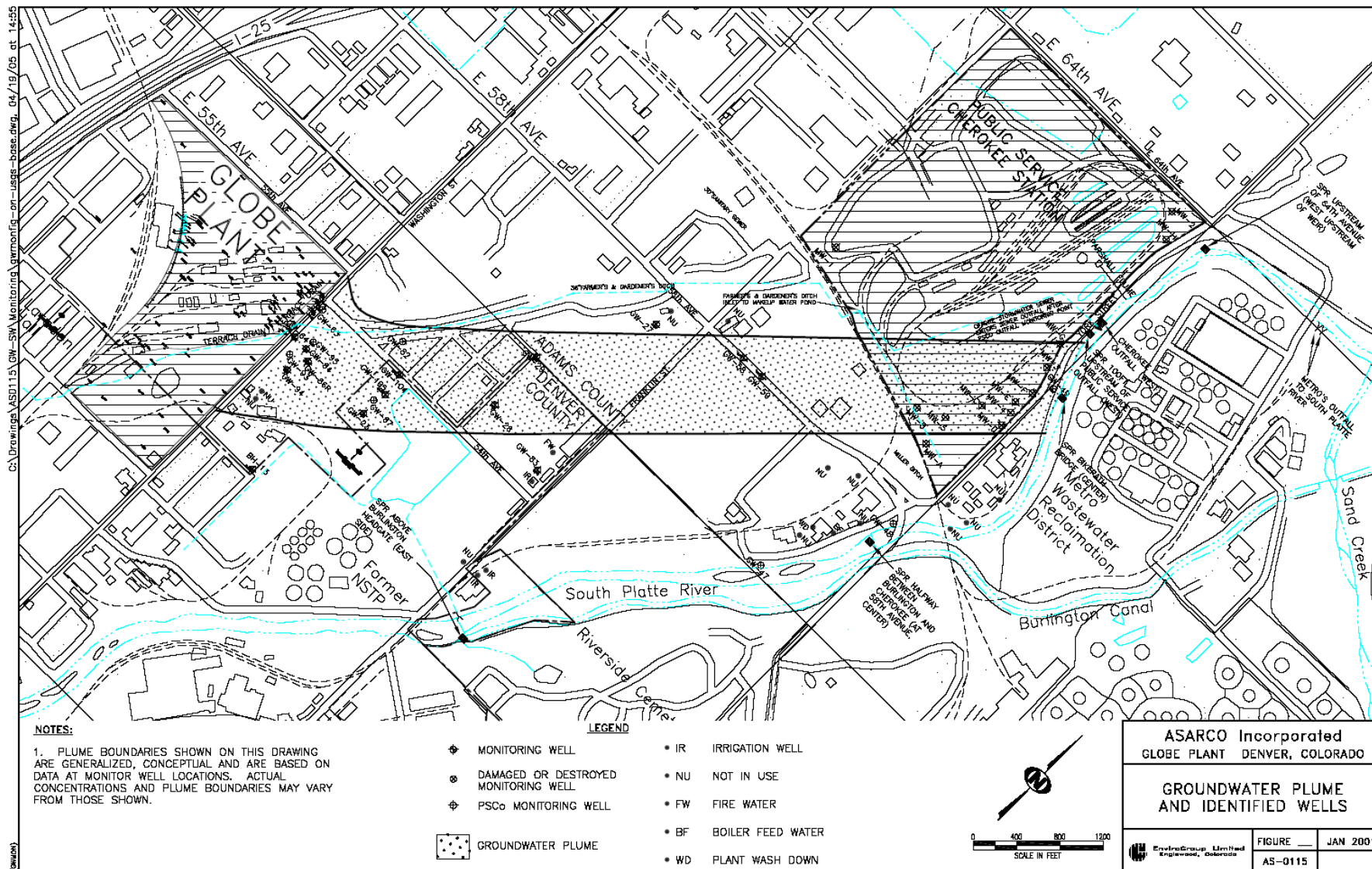


Figure 2. ASARCO Globe Plant Ground Water Plume (approximate) and South Platte River

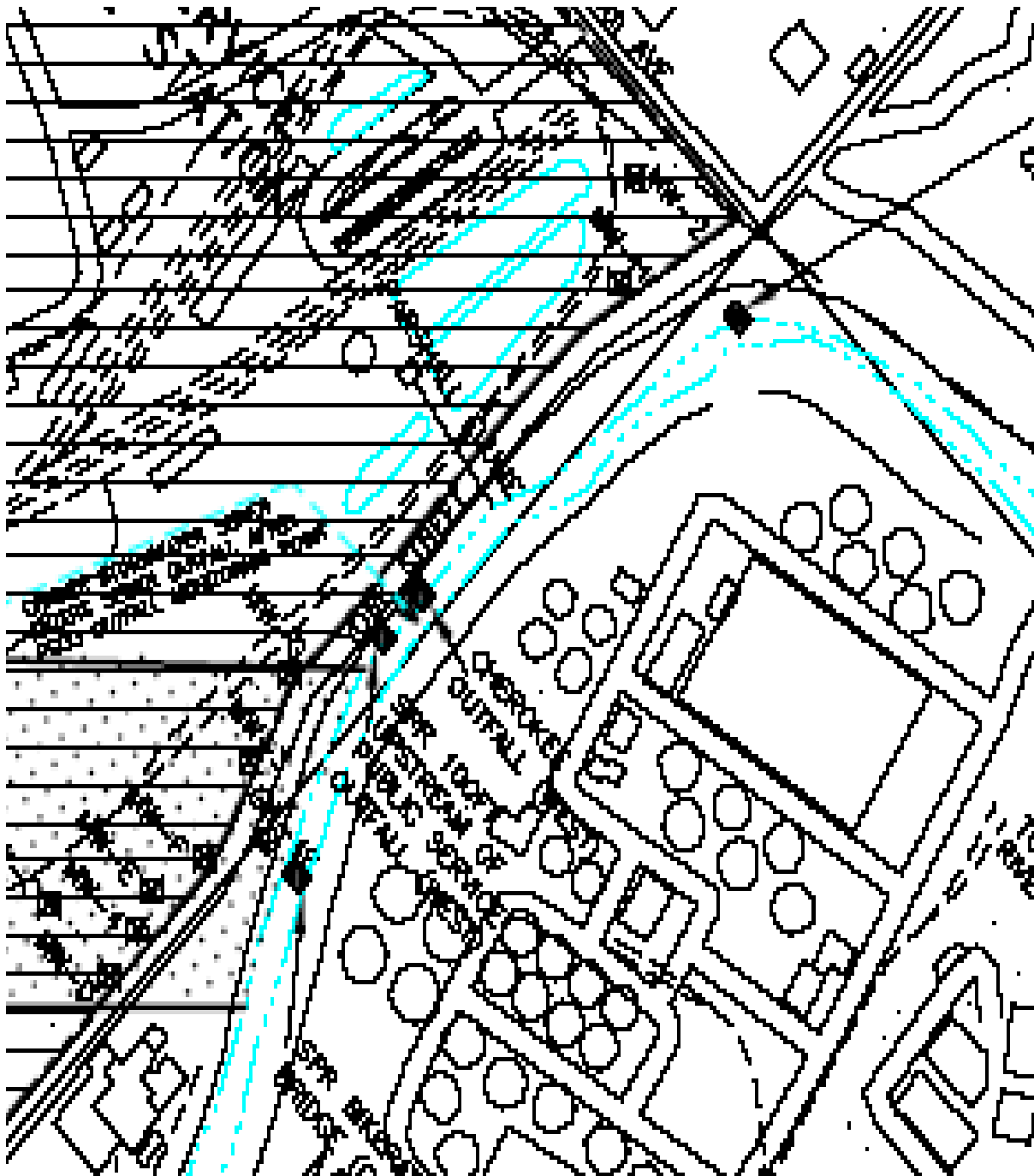


Figure 3. Ground water plume (approximate) and water sample locations

Assessment of the 64th Avenue dataset on a monthly basis, as shown in Table 3, indicates that March is the only month during which the chronic standard is attained.

	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
ave hardness*	464	417	341	329	338	241	281	287	345	353	547	463
standard**	6.2	6.2	5.5	5.4	5.5	4.3	4.8	4.9	5.6	5.7	6.2	6.2
ambient***	21.0	18.0	4.6	6.8	13.8	5.7	8.5	7.4	14.0	16.9	22.7	22.4

* hardness as mg/l CaCO₂

** standard based upon capped hardness (400 mg/l) where indicated by bold

*** 85th percentile value,

Attainment of acute standards is assessed by comparison of the sample result to the acute standard that is calculated using the hardness value associated with the sampling event. Examination of the 64th Avenue dataset indicates acute standards were exceeded for 16 of the 143 sampling events conducted during the same six-year period of record.

The Aquatic Life Use-based chronic standard for cadmium is exceeded at the sampling point above the Xcel discharge point. Both acute and chronic standards are exceeded at the 64th Avenue sampling location. Non-attainment occurs regardless of month (except for March).

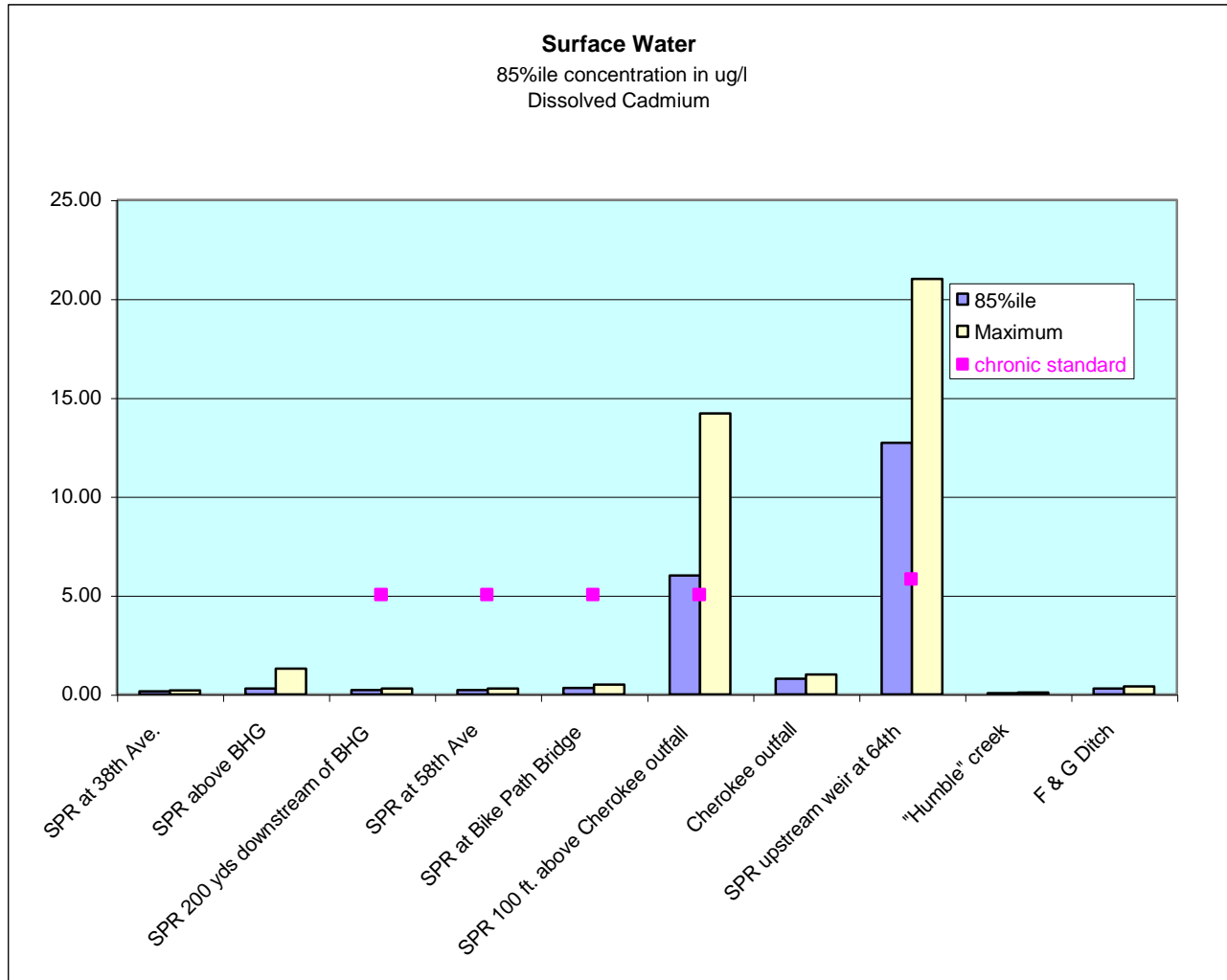
VI. WATER-QUALITY GOALS

The water quality goal is attainment of the acute and chronic Aquatic Life Use-based water quality standards for dissolved cadmium at 64th Avenue, above the MWRD outfall. The TDML is written to this location because of the relative proximity of the two sampling locations, and because of the greater frequency and magnitude of exceedences that occur at the 64th Avenue location.

VII. POLLUTANT SOURCE ANALYSIS

As part of the TMDL assessment, all significant pollutant sources must be considered and contributions from significant sources must be quantified. Based upon this information, the TMDL assigns pollutant loading reductions to each significant source. Pollutant sources may include discharges of a pollutant from a pipe or other discrete discharge structure (point-sources), or diffuse discharges (nonpoint sources).

Figure 4. Surface Water Dissolved Cadmium Concentrations



Identification of Sources:

Figures 4 and 5 are graphs of surface water and ground water dissolved cadmium concentrations produced from the data provided by SPCURE. A review of this information indicates the observed instream cadmium concentrations are the result of groundwater entering the stream within the reach from approximately 58th Avenue to 64th Avenue. Data indicates that the source is a ground water plume associated with the former cadmium processing facility at the ASARCO Globe Plant. This plant is located at East 55th Avenue and Washington Street (Figure 2). Additionally, this is some evidence which suggests additional cadmium may be contributed from a site adjacent to the Globeville site, this known as the Argo site.

Figure 4 illustrates instream cadmium levels, both 85th percentile and maximum values, for various locations on the South Platte River. Cadmium concentrations at locations upstream of the Burlington Ditch headgate (~ 0.02 ug/l) are not significant. Cadmium levels increase substantially and, in fact, periodically exceed the chronic standard at a point upstream of the Xcel Cherokee power plant discharge. Instream concentration is diluted by cooling water from the power plant at 62nd Avenue. However, any dilution effect is offset by groundwater contribution throughout the reach and the chronic standard and, on occasion, the acute standard is exceeded. Cadmium concentrations are once again diluted, and consequently attain standards, below the MWRD discharge. Metro's discharge point is below 64th Avenue, upstream of the South Platte confluence with Sand Creek.

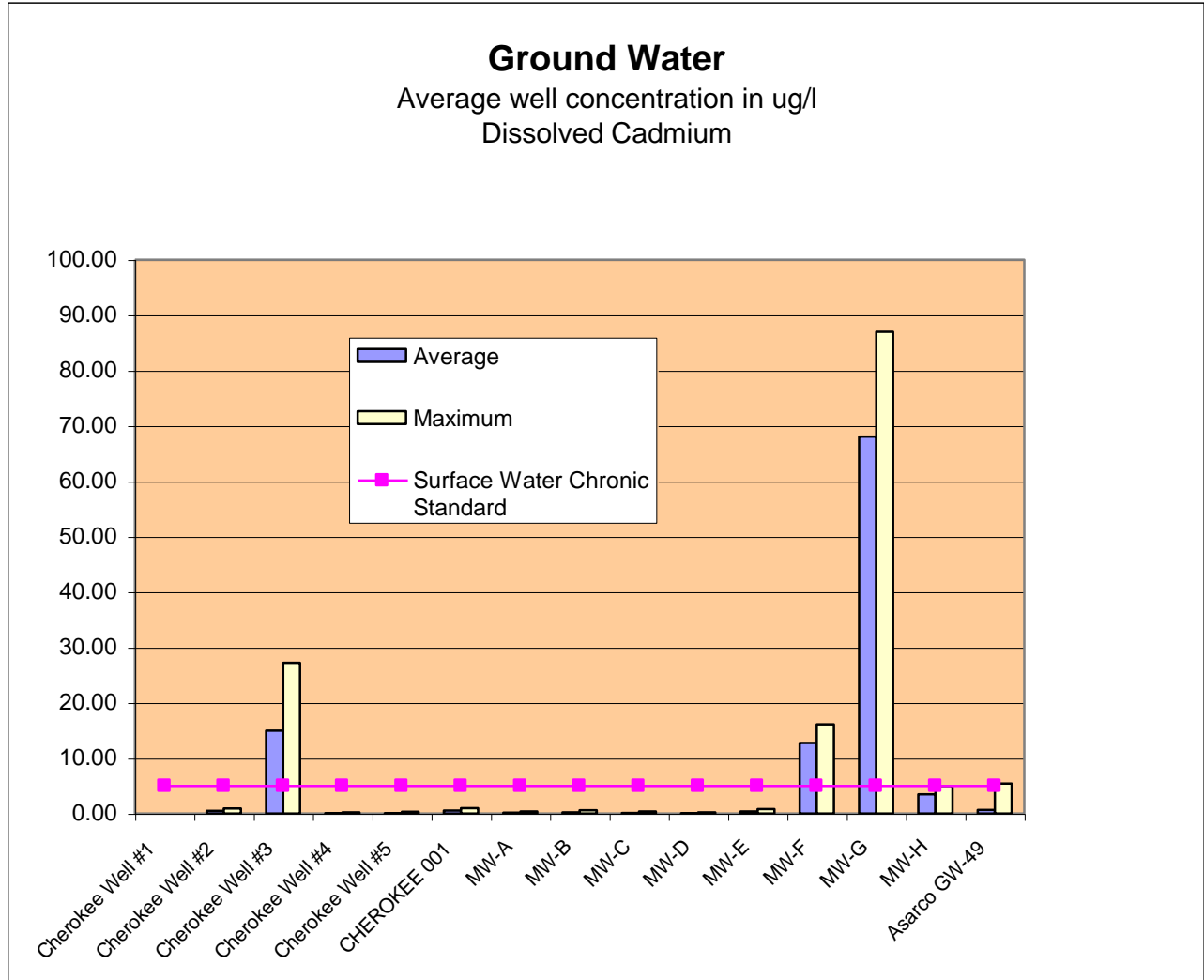
The Xcel Cherokee power plant is the only point source discharge in the section of Segment 15 between the Burlington Ditch headgate and the MWRD outfall. A Colorado Discharge Permit System ("CDPS") permit, CO-0001104, is issued to the facility. The discharge consists of stormwater and cooling water. The discharge may also contain overflow water from the raw water pond. Raw water for cooling comes from Clear Creek and from Farmer's and Gardener's Ditch Company's ("F&G Ditch"). The average dissolved cadmium discharge concentration from the Cherokee facility's cooling water discharge is estimated at 0.43 ug/l (n=22) for the period from February 2000 through March 2001. Because many sample results are reported at a level below the analytical detection limit the 0.43 ug/l value should be considered an approximation. Effluent data for the Xcel facility was extracted from EPA's STORET database for the period from 2001 through 2003.

Fuel coal used at the Cherokee Power Plant has been investigated as a possible source of cadmium. Leachate studies on samples from the coal pile yielded analytical results that were below detection limits for cadmium.

Figure 4 also includes data for a tributary stream labeled "Humble Creek" and F&G Ditch. Analytical results for both indicate neither to be a significant source of cadmium.

Figure 5 shows the average and maximum well concentrations of dissolved cadmium. This data was also extracted from the SPCURE Report *Cadmium TMDL Study – February 2000 – March 2001 for the South Platte River Segment 15 Upstream of the Metro District*. Cherokee Well #3, Well MW-F and Well MW-G exhibit elevated dissolved cadmium concentrations. Well MW-G consistently exceeds 50 ug/l. In fact, the average for this monitoring well approaches 70 ug/l with maximum value of 87 ug/l. These wells are located on the west side of and adjacent to the South Platte River. All three wells are near the southeastern corner of the Cherokee Power Plant where the edge of the ASARCO Globe Plant ground water plume intersects the River. Monitoring well locations are shown on Figure 3.

Figure 5. Ground Water Dissolved Cadmium Concentrations



Instream flow measurements at locations upstream of the Burlington Ditch headgate, and at 64th Avenue and further downstream, indicate the reaches above and below the affected stretch are gaining groundwater. The rate of groundwater accretion through seepage into the river’s channel exceeds the rate of loss.

Contributions of cadmium from upstream segments are insignificant relative to the ground water source. Surface and ground water samples indicate that the primary source of cadmium to be the ASARCO Globe Plant site, and perhaps adjacent properties..

VIII. TECHNICAL ANALYSIS

Hydrology:

The U. S. Geologic Survey operates a stream gaging station (USGS station 06714215) located at 64th Avenue. Chronic low flows (the 30E3 or the lowest thirty day average flow within a three year recurrence interval) were calculated using an EPA statistical software package (Dflow). Monthly chronic low flows are tabulated below.

	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
30E3	7.2	7.2	7.2	7.2	9.1	9.6	11.0	12.0	7.2	7.2	7.2	7.2

*cubic feet per second

Much of the flow in the South Platte River above the 303(d) Listed reach is diverted at the Burlington Ditch. Below the affected stretch, the MWRD discharge represents the greatest portion of the flow. Between the Burlington Ditch headgate and the MWRD discharge point is a single discharger, Xcel's Cherokee power plant. The power plant has a discharge design capacity of 8.5 cubic feet per second ("cfs"). The average discharge volume from the power plant is a little less than half of its capacity, or 3.77 cfs.

Although there are no direct measurements of seepage, estimated monthly seepage rates are available for portions of the stream both upstream and downstream of this section. Monthly seepage rate estimates for the upstream segment are identified in the *South Platte River Segment 14 Nitrate TMDL Assessment*. These seepage values range from a low of 1.53 cfs per mile in March to a high of 3.23 cfs per mile in August. Monthly seepage rate estimates for the downstream portion of the segment are included in the *Segment 15 Water Quality Model Recalibration for 2001 and Use of the Model in Support of Permitting for Ammonia, CBOD, and Dissolved Oxygen*. These seepage rate estimates vary from a low of 2.3 in March to a high of 5.16 in June. Interpolating between these two rates for each month results in seepage estimates between 2 and 4 cfs per mile.

Water Quality:

Summary surface water quality data is presented in Tables 1 and 2, and Figure 4. Ground water quality data is presented in Figure 5. Data was not available for seepage entering the stream at various locations. However, the influence of the seepage into the stream is evident from the surface water quality data and cadmium levels in the alluvial monitoring wells.

Methodology:

The assessment determines the allowable concentration of dissolved cadmium that will allow the standards to be maintained in the receiving stream. It is comprised of the Load Allocation ("LA"), which is that portion of the pollutant load attributed to natural background or the non-point sources, the Waste Load Allocation ("WLA"), which is that portion of the pollutant load associated with point source discharges, and a Margin of Safety ("MOS"). The TMDL may be expressed as the sum of the LA, WLA and MOS, or

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

The Cherokee Power Plant is the only identified point source discharge to this segment and comprises the WLA.

The upstream load, referred to as the "background load", and the load associated with ground water or seepage entering the river within the affected stretch are considered non-point sources. They are considered part of the LA component.

The MOS used in this TMDL analysis is implicit and resides in the conservative assumptions used in the WLA and LA calculations.

Loading from both the different sources comprising the WLA and LA components is calculated on a monthly basis. The contributions from the three sources described, background, Xcel, and seepage, are identified in Table 6. Loads at 64th Avenue were calculated using monthly 30E3 flows (Table 4) and ambient cadmium concentrations reported for that location (Table 3). The maximum allowable instream load that would attain the standards is calculated using the same monthly flows and the hardness-based standards displayed in Table 3. Background flows are calculated by subtracting the 3.8 cfs average discharge value for Xcel's Cherokee plant from the monthly 30E3. The difference between the known loading from background and Xcel's discharge, and the known load at 64th Avenue, is attributed to groundwater seepage.

Upstream or background loads and the loading represented by Xcel's discharge are minor in comparison to the contribution through seepage. The aggregated contribution from upstream and from Xcel comprise between one and five percent of the total cadmium load on a monthly basis. The remaining 95 to 99 percent of the cadmium load is transported into the South Platte via groundwater. The necessary load reduction represents the percentage of the current cadmium load that would need to be removed in order to attain the standard. The standard is attained during March. A loading reduction of between 19 and 73 percent is necessary in order to attain the chronic standard during the remainder of the year.

Table 5. Cadmium Loads at 64th Ave by Month (lbs/day)

	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
background load	.004	.004	.004	.004	.006	.006	.008	.009	.004	.004	.004	.004
Cherokee (Xcel) load	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009
load from seepage	.81	.69	.17	.25	.68	.29	.48	.46	.53	.65	.87	.86
existing total load	.82	.70	.18	.26	.69	.30	.50	.48	.54	.66	.88	.87
maximum allowable load	.24	.24	.21	.21	.27	.22	.29	.32	.22	.22	.24	.24
necessary load reduction (%)	71	65	--	19	61	27	42	33	59	67	73	72

IX. TMDL ALLOCATION

The sources contributing to the cadmium load in Segment 15 of the South Platte River have been identified and categorized for the purpose of load allocation. Groundwater seepage is the primary source and a reduction in the concentration of cadmium in that seepage will have to occur in order to assure attainment of cadmium standards. No reduction in loading from the other identified sources, Xcel Cherokee and background, are necessary in order to attain standards. In fact, even were the Cherokee plant to discharge at its design capacity, it would represent no more that about five percent of the total load (April). See Appendix B. Table 6 presents the existing loading from seepage, the maximum allowable contribution from the source necessary to meet standards, and the percent loading reduction specific to this component.

Table 6. Necessary Reductions in Cadmium Loads from Seepage by Month (lbs/day)

	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
load from seepage	.81	.69	.17	.25	.68	.29	.48	.46	.53	.65	.87	.86
maximum allowable load from seepage	.23	.23	.20	.20	.26	.21	.27	.30	.21	.21	.23	.23
necessary load reduction	72	67	--	20	62	28	44	35	60	68	74	73

reduction (%)												
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Waste Load Allocation

Data analysis indicates that the restriction of cadmium releases via ground water will have the greatest impact in terms of meeting in-stream cadmium standards. Allocations for Xcel Energy, and possibly for upstream discharges, are not appropriate because of the relatively insignificant contributions such discharges represent and, in Xcel’s case, the discharge concentration is well below the water quality standards for cadmium.

Load Allocation

As noted, the upstream or background loading is insignificant relative to the load represented by groundwater seepage. Because the only source, which, if controlled, would allow attainment of cadmium standards, is the seepage component, the only load reduction assigned is to that component.

Margin of Safety

The margin of safety is the TMDL component that accounts for unknowns or uncertainties in the development of the TMDL. The margin of safety may be explicit (a separate value in the TMDL) or implicit (included in factors determining the TMDL). The margin of safety in this TMDL is implicit and is the result of incorporating the following conservative assumptions:

- The ambient in-stream conditions are characterized using the 85th percentile value for the data. This statistic provides a relatively conservative estimate of instream loading.
- Collection of sampling data used to characterize background conditions was restricted to flow periods where the in-stream flows were less than 100 cfs. This provides a somewhat conservative estimate of upstream conditions.
- The mass balance equation is not adjusted to account for the volume of seepage inflow. Thus the background flow is overestimated, again tending to overestimate the loading from upstream sources.
- The use of the 30E3 low flow statistic is an inherently conservative approach intended to be protective of the standards under all but the most extreme low flow conditions.

Post-Implementation Monitoring

Water-quality monitoring will determine the extent to which the implementation plans achieve the compliance goals. Monthly sampling at 64th Avenue on the South Platte River and the contaminated ground water adjacent to the South Platte River will demonstrate the effectiveness of the load allocations.

X. PUBLIC PARTICIPATION

The cleanup of the Globeville Site has been the purview of the Hazardous Materials and Waste Management Division (HMWMD) of CDPHE and numerous meetings have occurred with local community members in that forum. However, the focus of most of those meetings has been on the affects on human health from air pollution and other media, not water quality. This TMDL is written to protect assigned use classifications for this segment, specifically the assigned aquatic life use classification.

An additional public meeting addressing TMDL development was convened with SPCURE and ASARCO on August 16, 2005. Several questions, addressed in Section XI below, were raised at that meeting.

A thirty-day public review and comment period will be provided. Subsequent to closure of the public comment period any such comments will be summarized and the WQCD response provided as part of the TMDL prior to submittal to EPA.

XI. RESPONSE TO PUBLIC COMMENT

A commenter noted that the statewide cadmium standard was revised in the Colorado *Basic Standards and Methodologies for Surface Water, Regulation No. 31* (5 CCR 1002-31) in July 2005. This change results in the cadmium standard becoming more stringent. This would, in turn, require recalculation of the TMDL.

At this point EPA has not approved the 2005 changes to the Basic Standards. Moreover, before the modified standard becomes the applicable standard for segment 15, it must be incorporated into the basin specific standards for the South Platte basin (Regulation 38). The next South Platte basin Rulemaking Hearing is scheduled for 2009. Additionally, segment 15 was included on the 1998 303(d) List for cadmium. A 1999 Settlement Agreement between the state, EPA and Earthjustice includes a commitment on the part of the Division to complete TMDLs for all of the 1998 303(d) Listings by June 30, 2008. Therefore the Division has opted to promulgate the TMDL at this time, recognizing that there may be a need to revisit the TMDL at some point in the future.

Concerns were raised at the August 16, 2005 meeting with respect to the potential use of the background loading component being cited as a basis for assigning permit limits for cadmium to upstream dischargers. The assessment performed in developing this TMDL utilizes the same procedures, as would the development of a water quality assessment performed in support of permit limit development. It is specific for the affected portion of segment 15, however, and may not be representative of upstream reaches of the South Platte River. Moreover, the TMDL demonstrates that any cadmium load arising as a result of upstream discharge is not significant relative to the groundwater seepage component. Therefore, the potential for an upstream discharge to cause or contribute to non-attainment of assigned cadmium standards is not supported by this TMDL.

XI. REFERENCES

Lewis, William M. Jr. and James F. Saunders, III: *Analysis of Total Maximum Daily Load (TMDL) for Nitrate in the Urban Region of the South Platte River, with Emphasis on Segment 14*. RPT 70, May 16, 2003.

Lewis, William M. Jr. and James F. Saunders, III: *Segment 15 Water Quality Model Recalibration for 2001 and Use of the Model in Support of Permitting for Ammonia, CBOD, and Dissolved Oxygen*, RPT 154a, July 15, 2002.

Lewis, William M. Jr. and James F. Saunders, III: *South Platte Segment 15 Water Quality Assessment, Analysis and Modeling in Support of Permitting on Lower Sand Creek and the Upper Portion of Segment 15, South Platte River*. RPT 91, May 24, 2001.

South Platte Coalition for Urban River Evaluation: *Cadmium TMDL Study, February 2000 – March 2001 for the South Platte River Segment 15 Upstream of the Metro District*, August 15, 2001.

WQCC: Colorado Department of Public Health and Environment, Water Quality Control Commission, *1998 303(d) List of Impaired Waters*, 1998.

WQCC: Colorado Department of Public Health and Environment, Water Quality Control Commission, *Classifications and Numeric Standards for South Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin*, Regulation No. 38, Effective: October 30, 2001.

WQCC: Colorado Department of Public Health and Environment, Water Quality Control Commission, *The Basic Standards for Methodologies for Surface Water*, Regulation No. 31, 5 CCR 1002-31, Effective March 20, 2001.

WQCD: Colorado Department of Public Health and Environment, Water Quality Control Division, *Colorado Total Maximum Daily Load and Wasteload Allocation Guidance*, Prepared by the WQCD, Groundwater and Standards unit, Revised November 1991.

WQCD: *South Platte River Segment 14 Nitrate TMDL Assessment*, July, 2003.

Appendix A

ACRONYMS

ac	Acute
Cd	Cadmium
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
ch	chronic
EPA	Environmental Protection Agency
HMWMD	Hazardous Materials and Waste Management Division
HUC	Hydrologic Unit Code
LA	Load Allocation
mg/l	milligrams per liter
MGD	Million gallons per day
MOS	Margin of safety
MWRD	Metropolitan Wastewater Reclamation District
PSCo	Public Service Company
SEO	State Engineer's Office
SPCURE	South Platte Coalition for Urban River Evaluation
TMDL	Total Maximum Daily Load
TVS	Table Value Standard
ug/l	micrograms per liter
USGS	United States Geological Survey
WLA	Waste Load Allocation
WWTF	Wastewater treatment facility
WWTP	Wastewater treatment plant
WQCC	Water Quality Control Commission
WQCD	Water Quality Control Division
Xcel	Xcel Energy Cherokee Power Plant (formerly PSCo)

ALTERNATE LOAD ALLOCATIONS

Option A. load from Exel remains constant (i.e. existing loading)												
	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cherokee (Xcel) load	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009	.009
load from seepage	.81	.69	.17	.25	.68	.29	.48	.46	.53	.65	.87	.86
maximum allowable load from seepage	.23	.23	.20	.20	.26	.21	.27	.30	.21	.21	.23	.23
necessary load reduction (%)	72	67	--	20	62	28	44	35	60	68	74	73

Option B. Load from Xcel increases (i.e. discharge at design flow)												
	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Cherokee (Xcel) load	.018	.018	.018	.018	.018	.018	.018	.018	.018	.018	.018	.018
load from seepage	.81	.69	.17	.25	.68	.29	.48	.46	.53	.65	.87	.86
maximum allowable load from seepage	.22	.22	.19	.19	.24	.19	.26	.29	.20	.20	.22	.22
necessary load reduction (%)	73	68	--	25	65	35	46	37	62	69	75	74