RECORD OF DECISION

OPERABLE UNIT 12
CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE, COLORADO

September 2009

U.S. Environmental Protection Agency
1595 Wynkoop Street
Denver, CO 80202

RECORD OF DECISION

OPERABLE UNIT 12
SITE-WIDE SURFACE AND GROUNDWATER
CALIFORNIA GULCH SUPERFUND SITE
LEADVILLE, COLORADO

The U.S. Environmental Protection Agency (USEPA), with the concurrence of the Colorado Department of Public Health and Environment (CDPHE), presents this Record of Decision (ROD) for Operable Unit 12 (OU12) of the California Gulch Superfund Site (Site) in Leadville, Colorado. The ROD is based on the Administrative Record for OU12, including the Remedial Investigation and Feasibility Study (RI/FS), the Proposed Plan, the public comments received, and USEPA responses. The ROD presents a brief summary of the Site characterization, past response actions, actual and potential risks to human health and the environment, and the Selected Remedy. USEPA followed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, the National Contingency Plan (NCP), and USEPA guidance (USEPA, 1999) in preparation of the ROD. The three purposes of the ROD are to:

1. Certify that the remedy selection process was carried out in accordance with the requirements of CERCLA, 42 U.S.C. 9601 et seq., as amended, and, to the extent practicable, the NCP;
2. Outline the components and remediation requirements of the Selected Remedy; and
3. Provide the public with a consolidated source of information about the history, characteristics, and risk posed by the conditions at OU12, as well as a summary of the cleanup alternatives considered, their evaluation, the rationale behind the Selected Remedy, and the agencies' consideration of, and responses to, the comments received.

The ROD is organized into three distinct sections:

1. The Declaration Section functions as an abstract and data certification sheet for the key information in the ROD and includes the formal authorizing signature page for the ROD.
2. The Decision Summary provides an overview of the characteristics of OU12, alternatives evaluated, and the analysis of those options. It also identifies the Selected Remedy and explains how the remedy fulfills statutory and regulatory requirements.
3. The Responsiveness Summary serves the dual purposes of: (1) presenting stakeholder concerns about OU12 and preferences regarding the remedial alternatives; and (2) explaining how those concerns were addressed and how the preferences were factored into the remedy selection process.

DECLARATION

DECLARATION

SITE NAME AND LOCATION

Operable Unit 12
California Gulch Superfund Site
Leadville, Colorado
CERCLIS # COD980717938

STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for OU12 of the Site in Leadville, Colorado. The US Environmental Protection Agency selected the remedy in accordance with CERCLA, as amended, and to the extent practicable, the NCP. This decision is based on the information in the Administrative Record file for OU12. The State of Colorado (the State) concurs with the Selected Remedy.

ASSESSMENT OF SITE

The response action selected in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances and pollutants or contaminants from OU12.

DESCRIPTION OF SELECTED REMEDY

The Site was added to the National Priority List (NPL) in 1983. USEPA has divided the Site into 11 geographic operable units, as well as an additional Operable Unit (OU12) to address Site-wide surface and ground water. In that OU12 geographically encompasses the entire NPL Site, it includes 18 square miles. Within OU12 are the towns of Leadville and Stringtown, portions of the Upper Arkansas River Valley below the confluence of California Gulch with the Arkansas River as well as California Gulch, Stray Horse Gulch, portions of Evans Gulch, and minor tributaries to these drainages. An additional geographic constraint was imposed on OU12 ground water. OU12 groundwater only includes the shallow alluvial aquifer not to exceed a depth of 250-feet or contact with bedrock, whichever is the lesser depth below the ground surface.

Investigation of the Site began in the mid-1980s and continues up through 2009. A complete list of investigative reports relevant to OU12 can be found in the OU12 Remedial Investigation Report (RI; USEPA, 2007a) and in the Administrative Record for OU12.

The cleanup plan for OU12 is one of the many remedies either completed or being implemented in each of the operable units in the Site. Pursuant to the agreement reached between USEPA, the State, ASARCO and Resurrection in a 1994 Consent Decree (USDC, 1994), the remedies for OUs 2 through 11 targeted the source materials such as mine waste rock and mill tailing. Although mine wastes are considered source materials for contamination of surface and ground water, they are not considered to be principle threat wastes.

As of fall 2003, response actions designed to reduced metal loading to surface and ground water had occurred in all areas identified as major sources (waste rock piles; fluvial and mill tailing;

and water treatment plants for the Yak Tunnel and Leadville Mine Drainage Tunnel (LMDT—not officially part of the site). These response actions were conducted within individual OUs under records of decision or action memoranda.

These actions resulted in improvements to surface and groundwater quality within the individual OUs and also resulted in improvements to Site-wide surface and ground water. The underlying objective of these prior response actions with respect to surface and ground water was to:

1. Prevent unacceptable exposure of aquatic organisms in the Arkansas River to contaminants of concern (COCs).

2. Prevent unacceptable human exposure to COCs in surface and ground water.

The OU12 Remedial Investigation (as well as the results of subsequent water quality monitoring) indicates that the first objective has been met with an acceptable level of confidence. However, the second objective has not been met because contaminant levels in surface and shallow alluvial groundwater still exceed federal MCLs and formal institutional controls (ICs) to restrict human exposure to COCs in surface and ground water have not been established.

Since the shallow groundwater that is impacted within the Superfund Site has not been classified by the State and is considered a potential drinking water source, the applicable or relevant and appropriate requirements (ARARs) are the federal maximum contaminant levels (MCLs) for drinking water. Due to the amount of waste left in place, EPA does not expect the shallow aquifer to meet MCLs for cadmium or lead within a reasonable time. Therefore, the groundwater portion of the remedy will be considered a non-restoration remedy.

It is expected that long-term monitoring will show that surface and ground water quality continues to improve. Stabilization of recently completed remedies as well as the upcoming completion of several other remedies is expected to further reduce the leaching of contaminants to Site water. EPA expects that the surface water standards established by the State of Colorado will be met in a reasonable time. Therefore the surface water portion of the remedy would be considered a restoration remedy.

For these reasons, USEPA will implement additional response actions consisting of long-term monitoring, a technical impracticability (TI) waiver for specific MCLs, and ICs under this OU12 ROD. These response actions are summarized below:

- No Action (no additional active remediation) for Site-wide surface or ground water.

- Implement IC's to restrict the use of surface and ground water. This will minimize the likelihood of adverse human health effects from the consumption of contaminated Site water. Because Arkansas River water meets drinking water standards, the ICs will not apply to the River.

- TI waiver for cadmium and lead for drinking water MCLs which are ARARs for the OU12 groundwater.

- Collect long-term monitoring data and review such data as it is acquired with formal remedy review no less often than each five-years, as required under Superfund.

If, as a result of a Five-Year Review, USEPA and the State determine the remedy is not protective, USEPA and the State would consider implementing one of the other alternatives described in the OU12 Proposed Plan, in whole or in part or other appropriate alternatives as conditions warrant. Such conditions might include a declining trout population in the Arkansas River (when compared with conditions above California Gulch) or other measures of the health of the aquatic ecosystem, including surface water quality standards.

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a Site wherever practicable (NCP 300.430(a) (1) (iii) (A)). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

Mine waste, soils contaminated with mine waste, and contaminated surface and ground water are not considered to be principal threat waste.

Based on the information currently available, USEPA and the State believe the Selected Remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The USEPA expects the Selected Remedy to satisfy the following statutory requirements of CERCLA §121(b): (1) be protective of human health and the environment; (2) comply with ARARs (or justify a waiver); (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element, or explain why the preference for treatment will not be met.

STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with federal and State requirements that are applicable or relevant and appropriate to the response action, is cost effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable. The selected remedial alternative complies with ARARs (except in the instance in which ARARs are waived), is cost effective, and utilizes permanent solutions to the maximum extent practicable. The remedy does not satisfy the statutory preference for treatment of groundwater as a principal element of the remedy because treatment would result in extraordinarily high

costs with no significant increase in protectiveness. Because this remedy will result in hazardous substances or pollutants or contaminants remaining in OU12 above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of response action to ensure that the remedy is, or will be, protective of human health and the environment. This remedy is acceptable to both the State and the community.

DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for the Site.

- Contaminants of concern and their respective concentrations (Section 7.3 and 5.2, respectively).
- Baseline risk represented by the COCs (Section 6.0).
- Cleanup levels established for COCs (expressed as numerical criteria and other measures of ecological health) and the basis for these levels (Section 7.4).
- Current and reasonably anticipated future land use assumptions used in the baseline risk assessment and ROD (Section 6.0).
- Potential land use that will be available at OU12 as a result of the Selected Remedy (Section 11.1).
- Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 11.2).
- Key factor(s) that led to selecting the remedy (Section 12.1).

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1.0 SITE NAME, LOCATION AND DESCRIPTION

Site Name: Operable Unit 12
California Gulch Superfund Site
Site Location: Leadville, Colorado
National Superfund electronic database identification number: CERCLIS No. COD980717938
Lead Agency: US Environmental Protection Agency (USEPA)
Support Agency: Colorado Department of Public Health and Environment (CDPHE)

Cleanup funding: Superfund Trust Fund/Enforcement/PRP Settlement

Site Description:

The California Gulch Superfund Site (Site) is comprised of approximately 18 square miles of mountainous terrain in Lake County, Colorado, approximately 100 miles southwest of Denver (Figure 1-1). The Site is divided into 11 Operable Units (Figure 1-2) as well as an additional Operable Unit (OU12) to address Site-wide surface and ground water. The Site includes the towns of Leadville and Stringtown, and portions of the Upper Arkansas River Valley below the confluence of California Gulch with the Arkansas River. Elevations range from approximately 9,515 feet above Mean Sea Level (MSL) at the confluence to approximately 12,500 feet above MSL at the eastern Site boundary.

Specific mine waste features and larger areas of the Site have historically been the major contributors (source areas) of metal load to surface and ground water. The primary contributors of the metal load include:

- Yak Tunnel (USEPA, 1987)
- Malta Tailing Impoundment (Golder, 1996a)
- Starr Ditch - Stray Horse Gulch surface runoff (USEPA, 1987; Golder, 1996b)
- Apache Tailing Impoundment (USEPA, 1987; Golder, 1996a)
- Oregon Gulch Tailing Impoundment (USEPA, 1987; Golder, 1996a and b)
- Colorado Zinc Tailing Impoundment (Golder, 1996a)
- Fluvially deposited mine wastes in Lower California Gulch (Golder, 1996a).

Metal loading from these areas occurred through surface and shallow ground water resulting in increased metal concentrations in the Arkansas River and associated adverse effects on aquatic organisms. Prior response actions have resulted in a reduction in metal loading from these areas to surface and ground water. The Leadville Mine Drainage Tunnel ("LMDT") was also identified as a significant metal loader to the Arkansas River prior to treatment of tunnel discharges.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

The Site is located in a highly mineralized area of the Colorado Rocky Mountains. Mining, mineral processing, and smelting activities have produced gold, silver, lead and zinc for more than 140 years. Mining began in the Leadville area in 1859 when prospectors working the channels of Arkansas River tributaries discovered gold at the mouth of California Gulch. Initial activities consisted only of small-scale placer mining until 1868, when the first gold ore veins were discovered along California Gulch. By 1872, however, problems with water, transportation and labor made ore removal so difficult that most miners had left the area. In 1874, silver-bearing lead carbonate was discovered, and mining in the Leadville district boomed.

Extensive replacement deposits of lead, silver and gold ores associated with fissure veins were discovered and mined. Zinc and manganese, which were of little value in the early days, were later mined extensively. As surface veins diminished, miners tunneled deeper into the mountains. Underground mines were developed east and southeast of Leadville. As mines were developed, waste rock was excavated along with the ore. The waste rock was placed near the mine entrance, and the ore was transported to the mill. At the mill, ores were crushed and separated into metallic concentrates and waste products by physical processes. The metallic concentrates were then shipped elsewhere or further processed at a smelter in the area. The waste products (mill tailing) were generally placed near the mill in a tailing pond. In the smelters, the high-grade ores were refined and concentrated into higher-grade products. Waste products from the smelters included slag and flue dust, and off-gases. Forty-four known smelters were located in the Leadville district (Woodward-Clyde, 1994a).

The USEPA proposed adding the Site to the National Priorities List (NPL) on December 30, 1982. The Site was formally listed on September 8, 1983. The following is a brief chronological summary of the major regulatory actions taken at the Site.

- 1982 – California Gulch Site proposed for the NPL.
- 1983 – California Gulch Site formally added to the NPL.
- 1986 – USEPA emergency workers extended public water supply system lines to residences using private wells (CDM, 1997).
- 1987 – USEPA began an investigation of mine wastes. Approximately 2,000 mine waste piles within the Site were screened to identify those larger than 100,000 cubic yards. Further screening was based on proximity to populated areas, roadways, and surface water, and potential pile instability. Forty-five waste deposits were selected for field inspection and sampling based on access, size, waste type, stability, and proximity to residential areas and/or watercourses. Eleven of these sites were mine waste piles, with the remainder being slag piles and tailing impoundments (Woodward-Clyde, 1994).

- 1994 – The United States, the State of Colorado and the major remaining Potentially Responsible Parties (PRPs), ASARCO, Resurrection Mining Company, and Newmont Mining Company (Res/Newmont) entered into a Consent Decree (1994 CD). The 1994 CD divided the Site into 12 OUs for cleanup of geographically based areas.

- 1988 through 2005 – Records of Decision were signed for OU1, OU2, OU3, OU4, OU5, OU6, OU7, OU8, OU9, OU10 and OU11. Operable Unit boundaries are illustrated on Figure 1-2.

- 2008 – As a result of the ASARCO bankruptcy filing in 2005, the United States, State of Colorado and ASARCO entered into 2 Consent Decree settlements with ASARCO which resolved all federal and State claims against ASARCO Site-wide. In addition, the United States, State of Colorado, Resurrection Mining Company, and Newmont Mining Company entered into a Consent Decree that established Res/Newmont's responsibilities Site-wide.

Based on the 1994 CD, other Consent Decree Settlements entered in 1993 with HECLA Mining Company, Denver and Rio Grande Western Railroad Company ("D&RG"), Leadville Silver and Gold, and Leadville Corp., and the 2008 Consent Decrees with Asarco and Res/Newmont the PRPs agreed to perform certain work in OUs that included primary sources for metal loading to surface and ground water or cashed out on their potential liability at specific OUs. The operable units and party that will perform future work in that OU include:

- OU1 Yak Tunnel – Res/Newmont responsible for all future operation and maintenance pursuant to a 2008 Consent Decree.
- OU2 Malta Gulch – USEPA (conducting work with funds from 1993 cash-out settlement with HECLA).
- OU3 D&RG Slag Piles – Union Pacific Railroad as successor of D&RG.
- OU4 Upper California Gulch – Res/Newmont responsible for all future operation and maintenance pursuant to 2008 Consent Decree.
- OU5 ASARCO Smelter/Slag/Mill Sites (Colorado Zinc Tailing Impoundment); Arkansas Valley Smelter; and Elgin Smelter, Grant/Union Smelter, Western Zinc Smelter and Arkansas Valley South Hillside Slag Pile (EGWA) – USEPA/State cashout settlement with ASARCO in 2008.
- OU6 Stray Horse Gulch – Designated an orphan share in the 1994 CD. USEPA and State are performing work in this OU.
- OU7 Apache Tailings Impoundment – USEPA/State cashout settlement with ASARCO in 2008.
- OU8 Lower California Gulch – Res/Newmont responsible for all future operation and maintenance pursuant to 2008 Consent Decree.
- OU9 Residential Populated Areas – USEPA/State cashout settlement with ASARCO in 2008.
- OU10 Oregon Gulch – Res/Newmont responsible for all future operation and maintenance pursuant to 2008 Consent Decree.

- OU11 - fluvially deposited mine wastes and other material along the Arkansas River below California Gulch – USEPA/State cashout settlements with ASARCO and Res/Newmont in 2008.
- OU12 - USEPA/State cashout settlements with ASARCO and Res/Newmont in 2008.

Response actions conducted under at OUs 1,2, 4, 5, 6, 7, 8 and 10 were intended to reduce metal loading to surface and ground water. The work in OU3 and OU9 was performed to reduce direct human contact with mine and smelter wastes and soils contaminated with such wastes.

Although not officially part of the Site, the LMDT was also identified as a significant metal loader to the Arkansas River prior to initiation of water treatment by the United States Bureau of Reclamation (USBOR) in 1992.

Discharges from the Yak Tunnel and LMDT have not been identified as a major contributor to contamination in the Arkansas River since the inception of water treatment at the tunnel portals in 1992.

3.0 COMMUNITY PARTICIPATION

The Focused Feasibility Study (FFS; USEPA, 2007b), Proposed Plan and numerous other documents for OU12 were made available to the public over the course of investigative and remedial work conducted at the Site since 1983. The FFS and Proposed Plan were made available in January 2007 and May 2009, respectively. They can be found in the Administrative Record file and the information repository maintained at the USEPA Docket Room in Region 8 and at the Lake County Public Library. The notice of the availability of the FFS and Proposed Plan was published in the Leadville Herald Democrat on January 6, 2007 and May 5, 2009, respectively. A public comment period was held from May 7, 2009 to June 5, 2009. In addition, a public meeting was held on May 20, 2009 to present the Proposed Plan to the community. At this meeting, representatives from USEPA and CDPHE answered questions about OU12 and the remedial alternatives. USEPA's response to the comments received during this period is included in the Responsiveness Summary, which is part of this ROD.

4.0 SCOPE AND ROLE OF OPERABLE UNIT OR RESPONSE ACTION

USEPA has organized work at the Site into 12 operable units. The operable units are listed below and grouped according to the status of response action:

Implemented Response Actions:

- OU1 – Yak Tunnel/Water Treatment Plant
- OU2 – Malta Gulch Fluvial Tailing/Leadville Corporation Mill/Malta Gulch Tailing Impoundment
- OU3 – D&RGW Slag Piles/Railroad Easement/Railroad Yard and Stockpiled Fine Slag
- OU4 – Upper California Gulch
- OU6 – Starr Ditch/Penrose Dump/Stray Horse Gulch/Evans Gulch
- OU7 – Apache Tailing Impoundments
- OU8 – Lower California Gulch
- OU9 – Residential Populated Areas
- OU10 – Oregon Gulch

Response Actions being Implemented

- OU5 – ASARCO Smelter/Slag/Mill Sites and AV/CZL Smelters
- OU11 – Arkansas River Valley Floodplain

Activities Proposed Under this ROD:

- OU12 – Site-wide Surface and Ground Water

Pursuant to the 1994 CD, USEPA and the State agreed that the decision on remediation of Site-wide Surface Water and Ground Water (OU12) would be made only after remedies for source remediation were selected and implemented at OUs 2 through 11. Source remedies were designed to minimize human and ecological exposure to mine wastes where such risks were outside the acceptable risk range and/or minimize the discharge of acid mine drainage to surface or ground water within a given operable unit. The intent of this approach to remediation of the Site is to lower human health and ecological risks resulting from direct contact with mine wastes to below a level of concern through response actions within individual operable units. In addition, improvements in Site-wide surface and ground water (OU12) were also achieved through source remediation work in individual operable units.

USEPA and the State have monitored these improvements in Site-wide surface and ground-water quality as source control response actions have been implemented. The clean-up plan for OU12 will ensure that Site-wide surface and ground water will not pose ecological or human health risks above a level of concern.

5.0 SITE CHARACTERISTICS

5.1 PHYSICAL SETTING

5.1.1 Site Physiology

The Site lies in the Southern Rocky Mountain Physiographic Province of the United States, which is characterized by fault-block mountain ranges separated by intermontane valleys. Leadville is located on the east side of the Arkansas River Valley near the confluence of Evans Gulch with the Arkansas River.

The Site is comprised of approximately 18 square miles in Lake County, Colorado, approximately 100 miles southwest of Denver (Figure 1-1). It includes the towns of Leadville and Stringtown, and portions of the Upper Arkansas River Valley below the confluence of California Gulch with the Arkansas River. Elevations range from approximately 9,515 feet above MSL at the confluence to approximately 12,500 feet above MSL at the eastern Site boundary.

5.1.2 Geology and Hydrogeology

The 1994 CD restricts OU12 to the shallow alluvial aquifer not to exceed a depth of 250 feet or contact with bedrock, whichever is the lesser depth below the ground surface (See Section 1.6). Therefore, the discussion of Site geology and hydrogeology focuses on unconsolidated alluvium.

Throughout much of the Site, bedrock is overlain by unconsolidated glacial deposits up to 1,000 feet thick derived from various types of lithologies in the Mosquito Range including porphyry, rhyolite, granite, quartzite, dolomite, limestone and sandstone. Sediments are poorly sorted, loose and porous and were transported and deposited by glacial and fluvial processes. Shallow alluvium was heavily disturbed by mining and other anthropogenic activities, particularly along the California Gulch drainage. Disturbed alluvial fill is composed of backfill material and deposited sediment disturbed during up-stream mining activities (SWC, 2005).

Within the Arkansas Valley, sediments are comprised of Holocene stream terrace, stream channel, and floodplain deposits (Golder, 1996b). At the confluence between California Gulch and Arkansas River as well as throughout the Arkansas River Valley, undisturbed glacial deposits extend to depths in excess of 2,000-feet (Tweto, 1974).

The alluvial aquifer is largely contiguous and primarily under unconfined conditions although perched ground water can occur locally. Depth to ground water varies from less than one foot near California Gulch to approximately 250 feet at higher elevations, and saturated thickness ranges from 0 to over 500 feet in the alluvial aquifer above the bedrock contact. Lithologic variability, variable recharge rates and interactions with surface water and/or ground water cause local variation in ground water flow direction and hydraulic gradient (Golder, 1996a).

As in most unconfined, shallow groundwater systems, ground water flow mimics overlying general topography.

The potentiometric surface is highest on the east and lowest on the west Site boundary, with ground water flow perpendicular to ground water elevation contours. Based on water level data presented in the OU12 Groundwater/Surface Water Data Evaluation Report (TetraTech, 2005) the hydraulic gradient in June 2005 in Stray Horse and Lower California Gulches was 0.083 ft/ft and 0.0277 ft/ft, respectively. Ground water elevation contours in the lower half of California Gulch suggest the potential for groundwater movement away from the active floodplain (TetraTech, 2005). However, extensive groundwater movement away from the California Gulch floodplain is not indicated by groundwater chemical data.

An upward vertical hydraulic gradient has been observed within the alluvial aquifer between Apache Tailings (OU7) and the CZL Smelter (OU5) (SWC, 2005). West of the CZL area, a downward hydraulic gradient has been observed (SWC, 2005). However, groundwater sampling data from deeper alluvial wells do not show adverse impacts from Site contaminants.

It is likely that the disturbed alluvium in Lower California Gulch acts as a preferential groundwater pathway which appears to counteract the downward vertical hydraulic potentials. Further, most of the groundwater contamination occurs within 30 feet of the surface and no deeper than 50 feet (SWC, 2005). An alternative explanation for the apparent vertical hydraulic gradients is that some shallow wells are in locally perched portions of the alluvial aquifer (SWC, 2005).

5.1.3 Climate

The topographic features of Lake County strongly influence the climatic variations in the Leadville area. The elevation of the City of Leadville is approximately 10,000 ft above MSL. Normal temperature extremes range from –30°F to 86°F, with an average minimum temperature of 21.9^{o}F. Average annual precipitation is 18 inches with the wettest months being July and August and the driest months being December and January. Summer precipitation is usually associated with convective showers. The annual peak snowmelt usually occurs in June. The average frost-free season is 79 days. The wind is predominantly from the northwest and ranges from calm to 30 miles per hour (Golder, 1996a).

The National Weather Service operates a meteorological station at the Leadville airport two miles southwest of Leadville. Additional weather observations were measured at the Yak Tunnel meteorological station near the Yak Tunnel Water Treatment Plant. The Final Air Monitoring Report (Woodward-Clyde, 1992) provides an evaluation of local meteorological data.

5.2 SURFACE WATER AND RELATED MEDIA

5.2.1 Surface Water Hydrology

The Site lies primarily within two main drainages that are tributaries to the Arkansas River: Evans Gulch and California Gulch (Figure 5-1).

Evans Gulch lies north of California Gulch and contains two sub-drainage basins, Lincoln Gulch and South Evans Gulch. The majority of Evans Gulch lies outside of the Site. Evans Gulch serves as the municipal water supply for Leadville via the Parkville Water District. Evans Gulch experienced peak flows of 65.5 cubic feet per second (cfs) during the 1995 spring runoff event sampled under the USBOR hydrologic measurement program (USBOR, 1996).

California Gulch receives water from numerous ephemeral streams within the Site including Malta Gulch, Airport Gulch, Pawnee Gulch, Georgia Gulch, Oregon Gulch, and Stray Horse Gulch via Starr Ditch (Figure 5-1). It also receives discharges from the Leadville Wastewater Treatment Plant and the Yak Treatment Plant which are the major sources of flow in California Gulch besides snow melt and precipitation events.

The California Gulch watershed contains approximately 11.5 square miles and comprises the main drainage basin contributing Site surface water to the Arkansas River. Based on available flow data from 1991 to 2005, the mean runoff flow in California Gulch is 2.27 cfs, with a peak flow of 17.16 cfs (USEPA, 2007a). Exchange between ground water and surface water in California Gulch is an important aspect of the hydrology of the system and impacts both surface and groundwater quality. Figure 5-2 shows the segregation of California and Stray Horse Gulches into inferred losing and gaining reaches.

The OU12 RI (USEPA, 2007a) examined the timing of peak runoff at various sampling stations in California Gulch to investigate the relationship between runoff and elevation within the watershed. The data indicate that peak measured snow water equivalent is not the sole predictor of the magnitude of peak flows or peak metal loads (temperature variation and rainfall are obvious mitigating factors). However, it is clear that relatively large snow packs yield, in most cases, relatively high flows and metal loads during spring runoff (USEPA, 2007a).

The Arkansas River main stem is formed by the confluence of Tennessee Creek and the East Fork of the Arkansas River northwest of Leadville. California Gulch is a tributary to the Arkansas River below station CG-6 (Figure 5-1). In the vicinity of OU12, average flow in the Arkansas River varies from 73 cfs at USGS station 07081200 to 234 cfs at USGS station 07083700. The stream gage at USGS station 07081200 is located down-stream of the Tennessee Creek/East Fork confluence, and up-stream of the California Gulch/Arkansas River confluence. Thirty years of records are available for this station, encompassing water years (WY) 1968-1983 and 1991-2004. USGS station 07083700 is located several miles down-stream from the California Gulch/Arkansas River confluence, near where Highway 24 crosses the Arkansas River. The 13-year period of record for this station includes WY 1965-1967 and 1975-1984. Several tributaries contribute flow to the Arkansas River between the two gages, including California Gulch, Iowa Gulch, and most significantly, the Lake Fork of the Arkansas River.

It should be noted that between 1995 and 2005 the annual mean discharge at USGS station 07081200 was below average in 1998 and from 2000-2005. These below average flows (in the Arkansas River and throughout the watershed) may have decreased metal loads from California Gulch as well as the ability of the Arkansas River to dilute metal loads from California Gulch. 2006-2008 were more normal or above average precipitation years.

5.2.2 Water Quality Trends at Key Monitoring Points

Surface Water

The OU12 RI (USEPA, 2007a) examined water quality trends at selected monitoring points illustrated on Figure 5-3. The following description is summarized from the RI report.

Two Arkansas River monitoring stations were chosen to represent conditions below California Gulch (AR-3A) and at a suitable reference location (AR-1). Although a steady decline in dissolved zinc and cadmium has occurred at AR-3A since 1995, peak concentrations remain higher than the reference location. Annual peak dissolved zinc and cadmium concentration trends for station AR-3A is illustrated on Figures 5-4 and 5-5. Declining peak zinc and cadmium concentration trends are evident on both of these graphs. Based on a best fit line, peak zinc and cadmium concentrations have declined at station AR-3A by approximately 60 percent. A relatively high cadmium value was reported in 2000 for AR-3A may be erroneous by an order of magnitude. However, insufficient evidence of this possible error exists to support exclusion of this datum.

Monitoring station CG-6, located in Lower California Gulch just before the Arkansas River confluence, was selected to represent the overall water quality trends for California Gulch and its tributaries. Several measures of water quality are used to describe trends at CG-6 including:

- Zinc and cadmium loading with concurrent flow (Figures 5-6 and 5-7).
- Peak and average zinc and cadmium concentrations (Figures 5-8 and 5-9).

Figures 5-6 and 5-7 show similar patterns. Zinc and cadmium loading has declined over the period when major response actions were implemented within the Site (1998 through 2002). This decline in loading occurs under similar flow conditions, particularly after completion of the Apache Tailings (OU7) response action. However, it is likely that the prominent decline in loading under consistent flow conditions observed beginning in 2002 is also attributable to long-term stabilization of previously completed response actions higher in the watershed (e.g. OU6 - Stray Horse Gulch).

Drier than average conditions existed during a large part of the monitoring period over which these declining trends were observed. It is possible that decreased snow pack from 2000-2005 has been responsible, to some degree, for the decrease in observed impacts to California Gulch and the Arkansas River. The relative degree to which response actions and decreased snow pack influence observed trends in concentration and loading have not been quantified. However, water quality monitoring since 2005 did not show excessive impacts from increased precipitation.

A straight line was fitted to peak and average spring zinc and cadmium concentration data (Figures 5-8 and 5-9). The best fit line has a negative slope for both zinc and cadmium. Based on the best fit line, peak zinc and cadmium concentrations have declined by 86% and 98% respectively between 1995 and 2005. A larger decline was noted in average zinc and cadmium concentrations.

Water quality trends in the tributaries to Lower California Gulch were also examined, including Stray Horse Gulch, Upper California Gulch and Oregon Gulch. In the case of Stray Horse Gulch (OU6) a decline in contaminant loading was observed over the monitoring period (1995-2005) with an abrupt decline in loading coinciding with the completion date of response actions in Stray Horse Gulch (January 2000).

In the case of Upper California Gulch (OU4), during the period between early 2002 and mid-2004, peak zinc loading equaled or exceeded loading rates measured between 1995 and 1997 under roughly equal flow conditions. Cadmium loading trends show a pattern similar to zinc. Although several response actions have been completed, the data suggest that little improvement in water quality has been achieved in OU4. Under OU4, EPA and the state are considering further actions to address this issue.

In the case of Oregon Gulch, peak loading rates have declined since completion of response actions in 1998. However, this appears to be largely attributable to lower peak flows since that time. The magnitude of recent (2003-2005) peak metal loads suggests that response actions at this location have had only a modest effect on surface water quality. Resurrection/Newmont performed additional work in Oregon Gulch which appears to have mitigated metal loading from Oregon Gulch.

Metal loading trends in surface water were examined for areas proximal to specific mine waste features including:

- Oro City (OU4)
- Apache Tailing (OU7)
- CZL Smelter/Slag/Mill Sites (OU5)

To examine the recent effect of these waste features on California Gulch water quality, the change in zinc load across each area was examined for specific dates where sufficient data exist. In the case of Oro City, a decrease in loading from up-stream to down-stream monitoring stations was observed on three of five dates examined. However, this change in loading appears to simply reflect the amount of water flowing in the channel at each monitoring station. The observed change in channel flow likely results from a free exchange of surface water and shallow ground water (water flowing in coarse alluvium immediately under and adjacent to the channel) as both travel down-stream. This suggests no detectable addition of metal load from this mine waste area on the dates examined.

In the case of Apache Tailing, metal loading increased from the up-stream to the down-stream monitoring stations in five of six dates examined. Unlike the condition near Oro City, observed trends appear to be independent of flow and result largely from an increasing zinc concentration in surface water passing Apache Tailings. This suggests that Apache Tailings contributed metal loads to surface water on the dates examined. However, based on loading trends for individual monitoring stations, the remedy appears to be effective in reducing metal loading from this source. It is likely that additional improvements will be observed as the remedy stabilizes.

In the case of the CZL Smelter, metal loading decreased or remained the same from the up-stream to the down-stream monitoring stations in eight of the eleven dates examined. However, this change in loading appears to depend largely on the amount of water

flowing in the channel at each monitoring station. Additional analysis in 2008 indicated under high flow, some increase in loading did occur across the CZL area. Response actions scheduled for 2009 should help mitigate this issue.

This situation is similar to that noted near Oro City and indicates little or no detectable addition of metal load from this mine waste area on the dates examined.

Ground Water

TetraTech RMC (2005), under contract to the CDPHE, developed inferred extent of contamination maps for zinc and cadmium using June 2005 alluvial groundwater quality data (Figures 5-10 and 5-11).

Alluvial groundwater contamination at the Site is strongly related to (1) source areas, and (2) the alluvium associated with the major Site surface water drainages. Contaminant concentrations in groundwater are highest in the immediate vicinity of mine waste piles, and then rapidly decrease away from source areas (TetraTech RMC, 2005). For cadmium and zinc, a thin sinuous plume is present in California Gulch alluvium suggesting that groundwater preferentially migrates within the high-transmissivity disturbed alluvium (TetraTech RMC, 2005). Many of the source areas are immediately adjacent to the California Gulch channel. Consequently, groundwater contamination associated with the individual source areas can readily enter the California Gulch alluvium and migrate down-stream.

Although both upward and downward vertical hydraulic gradients have been observed within the alluvial aquifer, water quality of samples from lower California Gulch indicate that elevated concentrations of dissolved metals are limited to wells that are screened in disturbed alluvium or the top 50-feet of undisturbed alluvial aquifer. Ground water sampling data from deeper alluvium do not suggest significant downward migration of impacted California Gulch surface water or shallow alluvial water.

5.3 REMAINING SOURCES FOR METAL LOADS

Metal loading trends at individual surface water monitoring stations provide an indication of the effectiveness of up-stream response actions. However, such analyses usually measure the cumulative effect of multiple mine waste deposits, both remediated and unremediated. An increase or decrease in metal loading across monitoring stations up- and down-stream of specific mine waste deposits on specific dates provides a better indication of the contribution of an individual mine waste feature. Based on those analyses, several mine waste deposits, stream reaches or tributaries were identified as either:

- Demonstrating a relatively small long-term decline in metal loading to surface water, or
- Demonstrating an increase in metal loading from the up-stream to the down-stream side of the mine waste feature.

Mine waste deposits, stream reaches or tributaries meeting either of these two criteria include:

1. Upper California Gulch (OU4) has been subjected to multiple response actions. However, during the period between 2002 and 2005, peak zinc and cadmium loading rates were higher than they were prior to implementation of response actions under similar flow conditions. EPA and the State are considering actions under OU4 to mitigate this problem.

2. The Apache Tailing Impoundment has undergone a comprehensive response action completed in early 2002. Although there has been a marked reduction in metal loading to both surface and ground water at monitoring stations proximal to the remediated tailings, this mine waste feature continues to contribute metal load to California Gulch. Increasing metal loads were observed when comparing data from up-stream and down-stream monitoring stations on the same date.

3. Oregon Gulch has been subjected to a comprehensive response action completed in 1998. The magnitude of recent (2003-2005) peak metal loads suggests that the response actions at this location have had only a modest effect on surface water quality. Additional response actions by Resurrection/Newmont in 2006 has greatly reduced metal loading from Oregon Gulch.

In addition to these three features, the CZL tailings deposit remains an area that is suspected of contributing a relatively large metal load. This conclusion is not entirely substantiated by the OU12 data set (1995-2005). However, the third California Gulch 5-Year Review Report (USEPA, 2007c) identifies this feature as an area of potential concern based on spring 2006 data as well as the results of a field inspection. Response actions planned for 2009 to complete the OU5 remedy should help address this issue.

Impact of metal loading on down-stream toxicity

Several factors may influence the degree to which metal loading from a given location will affect down-stream toxicity including:

- Timing of metal load.
- The effect of mechanisms that result in reduced metal loads as a function of distance between the metal loader and the point of exposure for aquatic organisms.
- The effect of hardness contributed by the Yak Treatment Plant.

Each of these factors is discussed below.

1. *Timing of Metal Load*
   The date of peak metal loading at a point relatively high in the California Gulch watershed was compared with the date of peak metal concentration in the Arkansas River. This comparison revealed that for the two years examined (2003 and 2005), peak metal loading from Upper California Gulch (OU4) occurred approximately four weeks after maximum metal concentrations occurred in the Arkansas River.
   The 2005 data suggests that during the time of peak metal concentrations in the Arkansas River, the contribution of metal loading from OU4 was negligible.

   The relationship between peak zinc and cadmium concentration in the Arkansas River and release of metals from sources high in the watershed may be dependent on specific snow pack conditions in any given year. However, data suggest that sources lower in the watershed (OUs 7, 8, and 10) have a greater impact on peak metal concentrations in the Arkansas River than sources high in the watershed.

2. *Distance of the Source from the Arkansas River*
   The spatial distribution of daily zinc and cadmium loads along California Gulch was examined for May 22, 2003. The purpose of this exercise was to determine how the California Gulch metal load varied from the headwaters to the Arkansas River confluence. Data show that metal load conveyed by California Gulch varied by a factor of four along the drainage with the highest load measured at the headwaters. Zinc load discharged to the Arkansas River (as measured at CG-6) was 56% of the zinc load measured at the headwater monitoring station.
   The mechanisms responsible for the observed reduction in metal loads along the drainage most likely include losses to ground water. Geochemical processes may also play a role.

   The relationship between degree of metal load reduction and travel distance is less definitive than the relationship between elevation and timing of peak metal load. However, effects of metal load reduction over distance should be taken into account when ranking the relative impact of remaining sources for metal loading on aquatic toxicity in the Arkansas River.

   It is not clear that reducing daily metal loading high in the watershed will have an appreciable effect on concurrent aquatic toxicity in the Arkansas River. However, it is likely that metal loads in surface water lost to ground water ultimately report to the Arkansas River.

3. *Effects of Yak Treatment Plant Effluent*
   Through the addition of lime, the Yak Treatment Plant effluent has a higher pH and hardness than the receiving water, California Gulch, thereby increasing its hardness and pH. Aquatic toxicity to trout caused by dissolved zinc and cadmium is mitigated by hardness.

A relationship between hardness at CG-6 and treatment plant operation was noted indicating that hardness added by the treatment plant reports to the Arkansas River. The data also suggest that under certain hydrologic regimes, hardness originating from Yak Treatment Plant effluent results in an increase in hardness at AR-3A thereby mitigating, to some degree, the toxic effects from zinc and cadmium.

While hardness introduced into California Gulch may have some beneficial effects, the additional metal load mobilized by the volume of Yak Treatment Plant effluent may have the opposite effect with respect to aquatic toxicity. Table 6-9 illustrates this issue.

5.4 CONCEPTUAL SITE MODEL

A conceptual Site contaminant transport model (CSM) is shown in Figure 5-12. The primary contaminant transport mechanisms of concern as illustrated in the CSM include:

- Leaching of contaminants from mine waste to surface and ground water.
- The exchange of surface and ground water and associated contaminant loads.

California Gulch receives water from numerous ephemeral tributaries within the Site including Malta Gulch, Airport Gulch, Pawnee Gulch, Georgia Gulch, Oregon Gulch, and Stray Horse Gulch via Starr Ditch (see Figure 5-1). Mine wastes in the tributaries and California Gulch release metals to surface and ground water. As previously mentioned, groundwater and surface water interaction plays an important role in determining water quality conditions in California Gulch and the Arkansas River. The impact that this interaction has is spatially variable, as shown in Figure 5-2, and varies temporally with changes in the hydrology of the system. Ground and surface water interaction is important in the main stem of California Gulch as well as its many tributaries. Widespread contamination of the shallow alluvial aquifer is generally not present at the Site. Rather, plumes associate with the source areas appear to be limited in areal extent. The groundwater contamination plume can best be characterized as a thin, sinuous longitudinal zone of contamination that appears to be limited in width. This zone of contamination is largely limited to the shallow alluvium in California, Oregon, and Stray Horse Gulches.

The tributaries listed above as well as the Leadville Wastewater Treatment Plant outfall, Leadville Storm Drain and the Yak Water Treatment Plant are the dominant surface water inputs to California Gulch. Further, these inputs vary in their relative impacts on the surface water quality of California Gulch as the hydrology of the system changes throughout the year. It should also be noted that the Yak Treatment Plant is not always operating and therefore does not always provide flow to California Gulch. All surface water and most ground water ultimately discharges to the Arkansas River.

Humans may be exposed to contaminated ground or surface water. Aquatic organisms are exposed to contaminated surface waters. This is discussed further in Section 6.0, Summary of Site Risks.

6.0 SUMMARY OF SITE RISKS

The USEPA has prepared a number of documents to investigate and characterize the risk that mining-related contaminants in ground and surface water from OU12 may pose to humans and ecological receptors.

6.1 RISKS TO HUMANS

6.1.1 Risks to Residents from Ingestion of Water

USEPA (1996a and b) concluded that ingestion of drinking water from the shallow alluvium would result in risks to residents above a level of concern (including adverse health effects associated with lead). However, the risk assessments stated that it is not believed that shallow groundwater from this area is currently used for drinking water. Based on recent data (2001-2005), average concentration values of dissolved metals have decreased in two of the three indicator monitoring wells considered in the risk assessments (USEPA, 2007a). However, average levels are still above a level of potential health concern for most metals in most of the wells (Table 6-1). Table 6-8 provides the cancer and non-cancer risks calculated in the human health baseline risk assessment. It should be noted that the area of concern is a relatively small area of the site and largely limited to the shallow alluvium in California, Stray Horse, and Oregon Gulches. As mentioned above it is not believed that contaminated groundwater is being used by residents and that there are no current risks from groundwater.

Surface water near California Gulch and the Arkansas River near AR-3A is not currently used as a source of drinking water. Risk to hypothetical future residents from ingestion of surface water in these areas was evaluated in the OU12 RI (USEPA, 2007a). Table 6-2 presents the long term average concentration (2001-2005) for several metals of potential human health concern, and compares these levels to applicable federal regulations or guidelines for drinking water. As seen, while concentration values in California Gulch frequently exceed federal regulations or guidelines for several metals (cadmium, copper, lead, zinc), concentration values in the upper Arkansas River are currently within federal drinking water requirements for all of these metals. In 2007, the State of Colorado promulgated new water quality standards for the Arkansas River below the confluence of California Gulch. In this standard setting procedure, the state recognized that due to the impacts of historical mining activities, no numeric water quality standards were set for California Gulch and its tributaries.

6.1.2 Risks to Ranchers from Ingestion of Soil Contaminated by Irrigation

Water from the upper Arkansas River has been used for many years to irrigate upland meadows along the river. Contaminants in the water have bound to the soil and increased the concentration of metals in the soil. Potential risks to current or future ranchers from incidental ingestion of contaminated soil while working in the field were evaluated in USEPA (2004a) and were found to be below a level of concern for both cancer and non-cancer effects at all locations along the upper river (Table 6-3).

6.2 Risks to Ecological Receptors

6.2.1 Methods for Evaluating Ecological Risk

Risks to ecological receptors are generally evaluated using a Hazard Quotient approach.

That is, the Site related exposure is compared to a safe dose or a safe concentration, which are referred to as toxicity reference values (TRVs):

$$HQ = \text{Site Exposure} / TRV$$

As above, if the HQ does not exceed 1, then it is believed that there is no unacceptable risk. When the HQ exceeds 1, then there may be risk in some receptors, with the magnitude of the risk being related to the frequency and magnitude of the exceedences. In general, if exceedences are infrequent and relatively small, risks to the population are likely to be within acceptable limits, although this must be evaluated on a case by case basis.

Whenever possible, risk predictions for ecological receptors that are based on the HQ approach should be compared and contrasted with other lines of evidence. This is because there are sources of uncertainty in the HQ approach, and in some cases calculated HQ levels may be above 1 when actual effects on the exposed organisms are not substantial. Other lines of evidence that should be considered, when available, include Site-specific toxicity tests and observations of number and diversity of ecological receptors at the Site. Because there are limitations and uncertainties with these other lines of evidence as well, it is generally best to rely upon a weight of evidence approach in which all of the information is considered, taking the strengths and weaknesses of each approach into account.

6.2.2 Risks to Terrestrial Receptors

6.2.2.1 Risks to Plants from Irrigation with Contaminated Surface Water

As noted above, water from the upper Arkansas River has been used to irrigate upland meadows along the river for many years. USEPA (2003a) evaluated risks to plants from mining-related contaminants that have accumulated in soils that have historically been irrigated with contaminated surface water. The assessment was based primarily on Site-specific phytotoxicity tests, in which several different species of plants (alfalfa, wheat grass, yarrow) were grown in soil samples collected from impacted meadows along the upper Arkansas River. The concentration of metals and pH in the soils were measured and used to construct a mathematical model to predict phytotoxicity based on bulk soil chemistry. The resulting model took the following form:

$$\text{Mean Phytotoxicity Score} = 2.07 + 0.205 \cdot PC_1 - 0.235 \cdot pH + 0.00001 \cdot Ca$$

where:

$$PC_1 = 0.7946 \cdot \log(Zn) + 0.9959 \cdot \log(Cd) + 0.9219 \cdot \log(Cu) + 0.5610 \cdot \log(Pb) - 6.6360$$

As seen, phytotoxicity is related to the concentration of multiple metals in soil (zinc, cadmium, copper, and lead), as well as pH and calcium[1].

Based on this equation, measured levels of metals and pH in soil were used to predict phytotoxicity at 126 soil sampling stations located across the irrigated meadows in the upper reach of the Arkansas River (Table 6-4).

As seen on the table, 70 stations were predicted to have none to minimal phytotoxicity (mean MPS < 0.5), but there were a number of stations (total = 56) where the predicted MPS was above 0.5. Elevated metals were the primary phytotoxicity risk driver in 30 stations, while metals plus low pH was the driver in 15 stations, and elevated calcium was the driver in 11 stations.

In interpreting these risks, it is important to recognize that most of the soil contamination causing phytotoxicity under pre-remedial conditions was most likely deposited in the soils in the past, when contaminant levels in the river were higher.

Risk to plants along the Arkansas River, although caused by historical irrigation by Site-wide surface water, will be remediated under the remedy for OU11 described in the 2005 record of decision (EPA, 2005a). This clean up work is expected to be finished in 2009.

6.2.2.2 Risks to Herbivores from Ingestion of Contaminated Plants and Soil

USEPA (2003a) evaluated the risks to several different types of herbivore (horse, cattle, deer, vole) from ingestion of plants and soil in areas impacted by historic irrigation of meadows with contaminated surface water. The assessment method was based on the Hazard Quotient (HQ) approach, in which the total dose ingested from the Site is compared to a suitable toxicity reference value (TRV):

$$HQ = \text{Dose from Site (mg/kg-day)} / \text{TRV (mg/kg-day)}$$

Total dose was calculated as the sum of the dose from ingestion of soil and ingestion of plant material. Intakes of plants and soils for each species were based on intake factors recommended for use by USEPA. The concentration values of metals in soil were based on direct measurements. The concentration levels in plant tissues were based on Site-specific uptake models which were in turn based on Site-specific measurements of metals in plant tissues coupled with measurements of metals and other soil properties (pH, TOC) in co-located soil samples. The resulting uptake equations are shown below:

$$\ln(\text{As in tissue}) = 0.63 - 0.251 \cdot pH$$

$$\ln(\text{Cd in tissue}) = 5.01 - 0.989 \cdot pH$$

$$\ln(\text{Cu in tissue}) = 2.84 - 0.328 \cdot pH$$

$$\ln(\text{Pb in tissue}) = -2.97 + 0.328 \cdot pH$$

$$\ln(\text{Zn in tissue}) = 6.85 - 0.857 \cdot pH + 0.355 \cdot Zn(soil)$$

[1] Toxic levels of calcium in the soils are thought to derive primarily from over-liming of impacted soils in an attempt to increase soil pH rather than a direct effect of mine wastes.

Although the predictiveness was not high for any of the models (R^2 = 0.11 to 0.62), these models were used to estimate plant tissue concentrations at 126 sampling stations in the irrigated meadows, and these were used to estimate risks from plant intake (Table 6-5).

As seen, at most stations (91%), HQ (total) values were below a level of concern (HQ ≤ 1) for all chemicals and all receptors.

However, at 11 sampling locations, HQ (total) values were above 1 for at least one receptor, with values ranging from 2 to 20. These locations occurred throughout the upper Arkansas River, with the highest values occurring primarily within the first two miles below California Gulch.

In most cases, risks were dominated by ingestion of soil, with plant ingestion contributing significant risk at only two stations. The chemical in soil that usually had the highest predicted risk was lead, with contributions from zinc and mercury in some locations. At the two stations where plant intake was above a level of concern, the primary chemical contributing to risks was zinc.

As noted above, it is considered likely that most of these risks are attributable to contamination that was deposited in the soil in the past, when contaminant levels in the river were higher.

Risk to herbivores along the Arkansas River, although caused by historical irrigation by Site-wide surface water, will be remediated under the remedy for OU11 described in the 2005 record of decision (EPA, 2005a). As noted above, this remediation will be completed in 2009.

6.2.2.3 Risks to Wildlife from Ingestion of Aquatic Prey Species

None of the risk assessments performed by USEPA to date provide an assessment of risks to terrestrial receptors from ingestion of potentially contaminated aquatic prey items. This is not considered to be a major omission or source of uncertainty, since none of the metals of concern at this Site tend to strongly accumulate in the tissues of aquatic species such as fish or aquatic invertebrates, and ecological risk assessments at other mining sites indicates that exposure of terrestrial receptors is usually most strongly determined by ingestion of contaminated soils or sediments rather than ingestion of aquatic prey items.

6.2.3 Risks to Aquatic Receptors

The upper Arkansas River is suitable habitat for a wide range of aquatic macroinvertebrates (annelids, crustaceans, water mites, insects, mollusks, and flatworms) and for several species of fish, including four species of salmonids (brown trout, rainbow trout, cutthroat trout, brook trout) and two species of sucker (white sucker and long-nose sucker) (USEPA 2004b).

In 1995, USEPA prepared a baseline aquatic risk assessment for the Site that provided an evaluation of risks to fish and benthic invertebrates (Weston 1995). At this time, USEPA established a set of three assessment endpoints for the Site using USEPA's Biological Technical Assistance Group (BTAG) process, as follows (Weston 1995):

1. Attaining and maintaining a trout population density and diversity below the confluence with California Gulch within the Site boundaries comparable to that observed at reference locations up gradient of the confluence of California Gulch with the Arkansas River.
2. Maintaining an adequate prey base for trout comparable to that observed in the reference area locations.
3. Maintaining an aquatic community comparable to reference area locations.

The 1995 aquatic evaluation employed the HQ approach as well as observations of fish and benthic density and diversity of receptors present in order to draw conclusions about the upper Arkansas. These data are generally evaluated by comparison to a suitable reference location. The chief conclusions were as follows (Weston 1995):

- Based on historic data (before the Yak Tunnel treatment plant came online in 1992), California Gulch adversely influenced the upper Arkansas. Impacts were most severe near the confluence (AR-3A), and became less severe with increasing distance down-stream, with effects extending to station AR-5 (See Figure 5-3).
- Based on water quality conditions between 1992 and 1994, conditions in the river were improved, but discharges of metals from California Gulch continued to result in conditions that were of concern, especially near the confluence. Risks about two miles down-stream appeared to be low.
- The chemical in water that yielded the highest HQ values was zinc, and this appeared to be the chief reason for concern. Levels of cadmium, copper, and lead occasionally yielded HQ values above 1, but were typically lower risks than zinc.

Since the 1995 risk assessment, USEPA and the State have worked to collect additional data to help strengthen and update the assessment of risks to aquatic receptors in the river. This has included collection of the following:

- Additional surface water quality monitoring data from California Gulch and the upper Arkansas River.
- A series of Site-specific toxicity tests for brown trout fry, along with a series of laboratory-based toxicity studies of the effect of zinc on brown trout fry.
- On-going population surveys for trout and benthic organisms.

As these new data have become available, USEPA has utilized the data to update and refine evaluations of risks to the aquatic ecosystem, using a weight-of-evidence approach to synthesize information from all available sources. The following sections summarize these more recent risk evaluations.

6.2.3.1 Risks to Benthic Invertebrates

An updated evaluation of risks to benthic invertebrates was presented in USEPA (2004a). Each of the three lines of evidence was utilized, as summarized below.

Predictive Approach

USEPA (2004) derived acute and chronic genus sensitivity distributions (GSDs) for zinc and cadmium, based on the list of aquatic macroinvertebrates species known or suspected to be present in the upper Arkansas River. The genus mean values used to define the GSDs were derived simply by calculating the geometric mean of all species-specific TRVs available for a genus.

Because the Site-specific GSDs for invertebrates lack values for a number of genera present at the Site, results were evaluated for both the Site-specific, as well as the "all-TRV" GSDs (even though some genera in the all-TRV distribution may not occur at the Site).

These GSDs were used to evaluate risks to benthic organisms by comparison to the distribution of water concentration values at AR-1, AR-3A&3B and AR-5. The fraction of genera likely to be impacted is assessed by observing the degree of vertical overlap between the GSD and the concentration curves.

Figure 6-1 presents the results for exposure of aquatic invertebrates to zinc based on 1997-2002 data. For acute toxicity, there is some overlap of the all-TRV GSD with zinc concentrations at station AR-3A+3B and station AR-5, however, there is little overlap of the Site-specific GSD with surface water concentrations. This suggests that acute effects of zinc are not likely to be of significant concern. For chronic effects, both the all-TRV and the Site-specific GSDs overlap substantially with the surface water concentration values, including the distribution at station AR-1. These results indicate that longer-term exposures to zinc (such as are likely to occur in spring) may cause adverse effects on some invertebrates. Confidence in this conclusion is decreased somewhat by the observation that the Site-specific chronic GSD for zinc predicts that only the most resistant benthic organisms should be able to survive in the river, even at station AR-1. Because field observations indicate that the benthic community is abundant and diverse at both AR-1 and AR-3A (see below), this suggests that the chronic zinc TRVs for benthic organisms may be somewhat too conservative at this Site.

Figure 6-2 presents the results for exposure of invertebrates to cadmium based on 1997-2002 data. For acute toxicity, there is very little overlap of either the all-TRV or the Site-specific GSD with cadmium concentrations at any station, including station AR-3A+3B and station AR-5. This suggests that acute effects of cadmium are not likely to be of significant concern. For chronic effects, both the all-TRV and the Site-specific GSDs overlap somewhat with the surface water concentration values, including the distribution at station AR-1. These results indicate that longer-term exposures to elevated levels of cadmium (such as are likely to occur in spring) may cause adverse effects on some invertebrates.

It is important to note that the risk evaluations above (as presented in USEPA 2004) are based on data collected in the 1997-2002 period. Figures 6-3 and 6-4 shows the results based on more recent surface water data (2003-2005). As seen by comparing Figure 6-3 to Figure 6-1, the distribution of zinc concentrations for station AR-3A has tended to shift to the left (toward lower concentration values) in recent years, but overlap of the concentration distributions with the acute and chronic GSDs still exist. Similarly, comparison of Figure 6-4 to Figure 6-2 shows that the distribution of cadmium concentrations has tended to shift to the left (toward lower concentration values), but in this case there is essentially no overlap between the concentration distribution and the

acute GSDs, and only minimal overlap with the chronic GSDs. This indicates that recent levels of cadmium in the upper Arkansas River are unlikely to be of concern to benthic organisms.

Site-Specific Toxicity Tests

Clements (2004) performed a study in which plastic trays containing pebble and cobble substrate were placed in the upper Arkansas River at station AR-1 in the spring (April 1, 2001) and allowed to colonize with benthic organisms. After 35 days of colonization, the trays were removed and placed at a series of other locations along the river, including station EF-1 (an up-stream station located on the East Fork of the Arkansas River), AR-1 (the same station as where colonization occurred), AR-3A (down-stream of California Gulch) and AR-5, Figure 6-19. After 4 days in the new locations (corresponding to May 5 to May 9, 2001), the trays were removed and a number of indices of benthic community density and diversity were measured. Water quality measurements at AR-3A collected in this time frame are summarized below:

Date	Zinc (ug/L)	Hardness (mg/L)
Study May 9, 2001	1269	46

The results are shown in Figure 6-5. Inspection of this figure reveals that trays placed at station AR-3A tended to have fewer numbers of mayflies, stoneflies and caddisflies, but that the total number of organisms and the total number of species were decreased by only a small amount.

Site-Specific Demographic Studies

Chadwick (2003) performed surveys of benthic community status at a number of stations along the upper Arkansas River from 1994 to 2001. Figures 6-6 and 6-7 show the results for diversity and density of *Ephemeroptera*, *Plecoptera* and *Trichoptera*, while

Figures 6-8 and 6-9 show the diversity and density for the entire community. Inspection of these figures reveals the following main conclusions:

- As seen in Figures 6-6 and 6-7, there is a tendency for the diversity and density of *Ephemeroptera* (mayflies) to be lower at stations down-stream of California Gulch (station AR-3A and beyond) than at the up-stream reference stations, both in spring and fall. The number of species of *Plecoptera* (stone flies) and *Trichoptera* (caddis flies) do not show a clear pattern of difference between stations that are up-stream and down-stream of California Gulch.
- As seen in Figures 6-8, the total number of species of BMI shows little difference at stations up-stream and down-stream of California Gulch, especially when measured in the fall.
- As seen in Figure 6-9, the total density of BMI organisms per unit area tends to be higher at stations down-stream of California Gulch than at up-stream stations.

Taken together, these observations indicate that the density of some species of invertebrates (mainly mayflies) is reduced below California Gulch, but that the overall density and diversity of the benthic community does not appear to be substantially altered.

Weight of Evidence Conclusion for BMI

Based on the three lines of evidence reviewed above, USEPA (2004) concluded that survival and reproduction of some species of benthic macroinvertebrates are likely to be decreased by concentrations of zinc and cadmium that often occur below California Gulch in the spring. This in turn leads to a tendency for reduced numbers of sensitive taxa (mainly mayflies) in the river below the confluence with California Gulch than above. However, the overall density and diversity of the benthic community does not appear to be substantially impaired, and it seems likely that availability of benthic prey items is not limiting for fish.

6.2.3.2 Risks to Trout

The trout population in the upper Arkansas River is composed primarily of brown trout, with rainbow trout, cutthroat trout and brook trout occurring in lower numbers (USEPA 2004). As discussed in Weston (1995), Redente et al. (2002) and USEPA (2004), the chemicals of chief concern to trout at this Site are zinc, and to a lesser extent, cadmium. The relative sensitivity of these trout species to zinc and cadmium based on the most recent assessment of available toxicity data (GEI, 2006) are summarized below:

Species	Zinc SMAV[1]	Cadmium SMCV[2]
Brown trout	647	3.77
Rainbow trout	582	1.08
Cutthroat trout	368	SMCV Not Determined
Brook trout	1691	2.66

[1] Species Mean Acute Value (ug/L)
[2] Species Mean Chronic Value (ug/L)

Because brown trout are the predominant species in the river, USEPA has focused primary attention on this species. Updated assessments of risks to brown trout were provided initially in USEPA (2004) and an updated evaluation was provided in USEPA (2005b). Each of the available lines of evidence was utilized in assessing risks, as summarized below.

Predictive Approach for Zinc

The USEPA and CDOW have each performed a number of studies on the toxicity of zinc to brown trout fry. These studies have been summarized in USEPA (2005b). Studies performed by CDOW have been performed using laboratory water, while the studies

performed by USEPA have used Site waters (either AR-1 water spiked with zinc, or various concentrations of CG-6 water diluted with AR-1 water).

Because risk to trout from zinc depends both on zinc concentration and on hardness (increasing hardness tends to decrease toxicity), exposure is expressed in terms of the Hazard Quotient (HQ), which is calculated as:

$$HQ_{C,H} = C / TRV_H$$

where:

$HQ_{C,H}$ = Hazard Quotient at a zinc concentration of C and a hardness of H

C = Concentration of zinc (ug/L)

H = Hardness of the water (mg/L)

TRV_H = Toxicity Reference value for zinc at hardness H

Based on a large number of acute and chronic mortality studies in brown trout fry, CDOW has proposed the following equation for the chronic TRV for zinc in brown trout:

$$TRV_H \text{ (ug/L)} = \exp[1.763 + 0.9634 \cdot \ln(H)]$$

Table 6-6 summarizes HQ values derived using this TRV equation as a function of zinc and hardness levels.

When the results of CDOW laboratory studies and USEPA field studies are compared using HQ as the metric of exposure, the results are highly consistent, indicating that results from both laboratory studies and field studies may be combined to derive a Site-specific exposure-response model of the following form (USEPA 2005):

$$\text{Response (fraction mortality)} = 0.022 + 0.978 \cdot \Phi[-1.564 + 1.462 \cdot \ln(HQ)]$$

where Φ represents the standard normal cumulative distribution function.

Figure 6-10 (Panel A) shows a graph of HQ values plotted as a function of time for station AR-3A and (for comparison) station AR-1. As seen, in the past, elevated HQ values occurred relatively often, but the frequency and magnitude of HQ values above 1.0 have been decreasing in recent years, and values greater than 1.0 have been uncommon in the past two years. Figure 6-10 (Panel B) shows the predicted percent mortality in brown trout fry for these same data. As seen, predicted mortality at station AR-3A was quite high (~70%) during high flow years, but has been mainly below 10% in the last several years.

Timing of Maximum HQ Values

As shown in Figure 6-10, maximum HQ values generally tend to occur in the spring (April-June). This timing of peak HQs depends on the relative flow regimes in California Gulch and the Arkansas River, with peak HQs tending to occur when flow (load) from California Gulch is increasing as spring runoff begins, but before flow in the Arkansas River rises to a level where the impacts are mainly diluted. Figure 6-11 illustrates this pattern for the years 2003 and 2004. As seen, although there were differences in the timing of the flows and the amount of zinc load being delivered to AR-3A, in both cases HQ values at AR-3A began to rise in association with

the increase in loading from California Gulch, and decreased as flow from the upper Arkansas increased about 2-4 weeks later.

Predictive Approach for Cadmium

Neither USEPA (2004) nor USEPA (2005b) performed a detailed analysis of risks to brown trout from cadmium. However, based on the data evaluation presented in GEI (2006), the brown-trout specific chronic TRV for cadmium may be expressed as:

$$\text{Chronic TRV (Cd)} = \exp[0.7998 \cdot \ln(H) - 1.801]$$

Using this TRV, the frequency of chronic HQ values for cadmium above 1.0 at station AR-3A are as shown below:

Year	Number of Samples	
	Total	HQ > 1.0
2000	25	1
2001	49	0
2002	7	0
2003	22	0
2004	79	0
2005	77	0

As seen, risks from cadmium are generally below a level of concern for brown trout.

Site-Specific Toxicity Studies

As noted above, USEPA has performed a series of flow-through toxicity tests using Site-specific waters (USEPA 2005), and these results have been incorporated into the Site-specific exposure-response model described above.

Site-Specific Demographic Studies

Fish population surveys have been performed by Chadwick Ecological Consultants and CDOW at a number of stations along the upper Arkansas River from 1994 to 2002 (Chadwick, 2003, Nehring and Policky 2003). The results of surveys based on a count of all fish (all species, all sizes) are shown in Figure 6-12 (spring surveys (Chadwick, 2003)) and in Figure 6-13 (late summer/fall surveys (Chadwick 2005)).

The results for brown trout greater than or equal to 15 cm in length are shown in Figure 6-14 (Nehring and Policky 2003).

Inspection of these figures reveals the following main conclusions:

- There is variability between years and between seasons (spring vs. fall) in the number of fish present at a station. This highlights the need to make comparisons between stations based on a broad database rather than just a few selected periods of observation.
- In general, the density and biomass of fish at station AR-3A and further down-stream has tended to be lower than for station AR-1. However, in recent years,

there has been an apparent increasing trend in the number and biomass of fish at station AR-3A and further down-stream, and the most recent values are now similar to the values at the up-stream reference station AR-1.

Figure 6-15 plots the ratio of brown trout density and biomass at station AR-3A compared to station AR-1. As seen, in recent years, station AR-3A is equivalent to or higher than station AR-1.

Taken together, these data suggest that fish density were previously impacted by releases entering the river at California Gulch, but that that conditions have been improving in recent years. However, it is important to remember that fish density in a particular location is a function of many different variables, so it is difficult to quantify the degree to which past reductions and current trends toward recovery in fish density can be attributed to mining-related contaminants.

Correlation Analysis

One approach that is sometimes helpful in evaluating the relative contribution of mining wastes to impacts on fish populations is correlation analysis. In this approach, the degree of correlation between some measure of fish density and some measure of mining contamination is calculated. If the degree of correlation is high, it may reasonably be concluded that mining contamination is a dominant factor in determining fish density. If the correlation is weak or absent, it may be concluded that the impact of mining contamination is not dominant but is the same or less than other important variables.

However, establishing a quantitative correlation between Site-specific demographic data on density and biomass and various measures of exposure to zinc is complicated by a number of issues, including:

- There are many factors besides mining contamination (flow, temperature, disease, predation, etc) that influence trout density and biomass, and so there is variability in population metrices as a function of year.
- It is not certain which metric of exposure (max HQ, average HQ, frequency of HQs > 1, etc) is the most meaningful index of toxicity.
- It is not certain if effects of exposure in the spring of year 1 are most apparent in demographic data collected later in the same year, or whether effects would be manifest in the following year(s).

Table 6-7 presents the results of a screening-level correlation analysis performed to investigate the strength of the relationships between various measures of exposure and various measures of population status. In this table, the values shown are the correlation coefficients (r) between the specified measure of exposure and the specified measure of population status. The value of (r) can range from -1 to +1. If (r) is negative, then an increase in the exposure metric is associated with a decrease in the population metric. If r is positive, an increase in exposure is associated with an increase in the population metric. If r is zero (or close to zero), then there is little or no correlation between exposure and population status.

As seen in Panel A, when various metrices of population status at station AR-3A are correlated with various metrices of exposure at station AR-3A with no off-set in time, all of the correlation constants (R) are negative, with values ranging from -0.44 to -0.75. No significant strengthening of the correlations is noted when the correlation is off-set by 1 year or 2 years (Panels B and C). When the population metrices at station AR-3A are normalized by dividing by the corresponding metrices for station AR-1 in the same year (Panels D, E, and F), the metrices remain mainly negative, although there is some decrease in power due to a decrease in the number of paired data points[2]. When both the population metrices and the exposure metrices are normalized by dividing by the corresponding values from station AR-1 (Panels G, H and I), the pattern remains generally similar. Taken together, this pattern strongly supports the existence of an inverse relationship between exposure and population status, but does not allow identification of any one metric of population status and/or exposure as the most meaningful for predicting the effect of exposure on population status.

Weight of Evidence Conclusion for Brown Trout

Based on the lines of evidence reviewed above, USEPA (2004) concluded that survival of brown trout fry was likely decreased by historical concentrations of zinc and cadmium that occurred below California Gulch in the spring. This, in turn, was a likely contributing factor to lower-than-expected fish density below California Gulch (compared to above). In recent years, the level of predicted risk to fish has been decreasing and the observed number of fish has been increasing at station AR-3A. This is consistent with the hypothesis that remedial activities at the Site have decreased releases to the river. However, additional years of observation are needed to determine whether this apparent trend toward recovery is actually a consequence of decreased Site releases or is related to other variables.

Figures 6-16 through 6-18 show data collected on fish density, bio-mass, and percent mortality to brown trout fry updated through 2008. Figures 6-20 through 23 provide additional time-trends of contaminants in the Arkansas River.

In 2007, the State of Colorado promulgated water quality standards for segments 2b and 2c of the Arkansas River. These segments are directly downstream from the confluence of California Gulch. These standards are as follows:

Cd(acute) = 1.136672-(ln(hardness)*0.041838)*e(0.9151*(ln(hardness)-3.6236)
Cd(chronic) = 1.101672-ln(hardness)*0.041838)*e(0.7998*ln(hardness)-3.1725)

Zn(acute) = 0.978*e(0.8537*ln(hardness)+2.2178)
Zn(chronic) = 0.986*e(0.8537*ln(hardness)+2.0489)

Attainment of these standards will be evaluated on an on-going basis and during the five-year review process.

7.0 REMEDIAL ACTION OBJECTIVES

7.1 INTRODUCTION

Previous human health risk assessments (USEPA 1996a and b) concluded that contaminants in Site-wide surface and ground water may pose unacceptable human health risks should contaminated Site water be consumed in the future.

An Aquatic Baseline Risk Assessment (USEPA, 1995) identified three assessment endpoints. These are "*explicit expressions of the environmental value that is to be protected*" and include:

- Trout Population Density and Diversity
- Prey Base for Trout
- Maintenance of Aquatic Community Relative to Reference Locations

These ecological risk assessment endpoints have been the focus of risk characterization. As discussed in Section 6.0, current Site conditions may be protective of these environmental values.

7.2 MEDIA OF CONCERN

By definition (See Section 1.6), the OU12 media of concern are surface and ground water (Site water). However, sources for contamination of these media include mine wastes that generate acid rock drainage (ARD). Therefore, remedial alternatives developed and evaluated for OU12 consider not only direct treatment of Site water but also actions that address sources for ARD.

The OU12 RI (USEPA, 2007a) identified several mine waste features that are considered to be the most significant remaining sources for ARD including:

- Upper California Gulch (OU4)
- Apache Tailing (OU7)
- Oregon Gulch (OU10)

Of these, OU7 and OU10 were considered to have a relatively greater adverse effect on water quality in the Arkansas River than OU4 during the period when aquatic toxicity is highest (sensitive period). This conclusion was based on an examination of runoff timing showing that sources for ARD lower in the watershed have a greater impact on Arkansas River water quality during the sensitive period than sources higher in the watershed (Section 5.3). It should be noted that since the publication of the RI, additional work in OU10 appears to have mitigated metal loading problems there.

7.3 CONTAMINANTS OF CONCERN

Available data on levels of mining-related contaminants in the upper Arkansas River indicate that a number of metals and other inorganics are elevated, including aluminum,

arsenic, cadmium, copper, iron, lead, manganese, sulfate and zinc. Risk evaluations based on these data suggest that zinc and cadmium are likely to be the two chemicals that contribute the greatest level of risk to aquatic receptors (USEPA, 2007a).

The risk assessment concluded that ingestion of drinking water from the shallow alluvium would cause substantial increases in blood lead levels in children, and would be of potential health concern. Risks would also be above a level of concern to residents for both non-cancer and cancer effects due to the presence of multiple metals, including arsenic, cadmium, zinc, and manganese. However, the risk assessment concluded that current or future consumption of alluvial ground water was unlikely.

Surface water in California Gulch and the Arkansas River near AR-3A is not currently used as a source of drinking water. However, concentration values in California Gulch frequently exceed federal regulations or guidelines for several metals (cadmium, copper, lead and zinc) (USEPA, 2007a). Concentration values in the upper Arkansas River are currently within federal drinking water requirements for all of these metals (Section 6.1.1).

Based on the above discussion, media-specific COCs include:

Chemical/ Population-Specific Medium	Arsenic	Cadmium	Copper	Lead	Manganese	Zinc
Surface Water – Human		●	●	●		●
Surface Water – Ecological		●				●
Ground Water - Human	●	●		●	●	●

Although there is a wide range of COCs, zinc and cadmium are considered reasonable indicator parameters with respect to OU12 ground water, OU12 surface water, as well as human health and the environment in the vicinity of OU12.

7.4 REMEDIAL ACTION OBJECTIVES

Based on the forgoing, the Remedial Action Objective (RAOs) for OU12 include:

1. Prevent unacceptable exposure of aquatic organisms in the Arkansas River to COCs.

2. Prevent unacceptable human exposure to (COCs) in surface and ground water.

Compliance with RAOs under the selected remedy is discussed in Section 12.

8.0 DESCRIPTION OF ALTERNATIVES

This section provides a brief explanation of the remedial alternatives developed for OU12. Remedial alternatives described below were retained after preliminary screening in the FFS and were evaluated using the nine criteria required by the NCP. The retained alternatives include:

Surface Water

- SW1 – No Action
- SW1a – No Additional Action with ICs and Monitoring
- SW2 – Route Yak Treatment Plant Effluent Discharge Below OU5 with ICs and Monitoring
- SW3a – Route Leadville Storm Sewer Discharge Below OU5 with ICs and Monitoring
- SW3b – Route Yak Treatment Plant Effluent to New Storm Sewer Constructed Under Alternative 3a with ICs and Monitoring
- SW4 – Construct In-Stream Detention Facilities with ICs and Monitoring
- SW5 – Relocate California Gulch/Arkansas River Confluence with ICs and Monitoring
- SW6 – Consolidate and Cover Mine Waste Piles with ICs and Monitoring
- SW7 – Site-wide Water Treatment Facility with ICs and Monitoring

Ground Water

- GW1 – No Action
- GW1a – No Additional Action with ICs, Monitoring, and a TI Waiver
- GW2 – Intercept and Treat Contaminated Ground Water at Mouth of California Gulch with ICs and Monitoring
- GW3 – Dewater Capped Apache and Oregon Gulch Tailing with ICs and Monitoring

8.1 SURFACE WATER

8.1.1 Alternative SW1 – No Action

- Estimated capital and operating cost: $0
- Implementation time: Immediate

The No-Action Alternative takes no action under OU12. However, previously completed response actions and response actions to be completed under existing Records of Decision will be maintained.

8.1.1a Alternative SW1a – No Additional Action, ICs, and Monitoring.

- Estimated capital and operating cost - $1,340,000
- Implementation Time: Immediate

Under this alternative, no additional response actions aimed at reducing metal loading would occur (under OU12). Institutional controls to restrict use of surface water for human consumption and monitoring would be implemented. Previous response actions would be maintained.

8.1.2 Alternative SW2 – Route Yak Treatment Plant Effluent Discharge Below OU5 with ICs and Monitoring

- Estimated capital and operating cost: $5,320,000
- Implementation time: 1-year

Yak Treatment Plant effluent would be conveyed by gravity to a point below OU5 in a buried pipeline. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

Currently, the effluent discharges at the Yak plant site. The relocated discharge point would be below the area(s) where most contaminant loading occurs in California Gulch, thereby eliminating most of the contaminant load generated as the effluent travels down the California Gulch channel.

The new pipeline would be 10-inch polyvinyl chloride (PVC) and connect to the existing effluent line. The pipe size is based on conveying up to 1,300 gallons per minute (gpm). The current capacity of the Yak Treatment Plant is 1,000 gpm.

The alignment of the Yak Treatment Plant pipeline extension would generally follow the alignment of the existing California Gulch channel, maintaining a minimum slope of 1% and remaining on the south side of Highway 24.

8.1.3 Alternative SW3a – Route Leadville Storm Sewer Discharge Below OU5 with ICs and Monitoring

- Estimated capital and operating cost: $9,589,000
- Implementation time: 1-year

Existing City of Leadville storm sewers would be extended to a point below OU5 in a buried pipeline. The relocated discharge point would be below the area(s) where most contaminant loading occurs in California Gulch, thereby eliminating most of the contaminant load generated as storm water travels down California Gulch. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

The diameter of pipeline extensions are assumed to be equal to existing pipe sizes at their current points of discharge (36-inch from Starr Ditch at Monroe St. and 42-inch at Highway 24, west of McWethy St.). Where the two storm discharges converge, the combined pipeline size will be increased to a 54-inch diameter, the smallest standard pipe size that has a capacity greater than the sum of the two smaller pipe capacities.

Alignment of storm sewer pipeline extensions would generally parallel Highway 24 and the California Gulch channel, remaining on the south side of the highway. The pipeline would extend from the existing Starr Ditch discharge at Highway 24 and Monroe St. to a point just across Highway 24 from the CZL site.

8.1.4 Alternative SW3b – Route Yak Treatment Plant Effluent to New Storm Sewer Constructed Under Alternative 3a with ICs and Monitoring

- Estimated capital and operating cost: $10,160,000.
- Implementation time: 1-year

This alternative combines Alternatives SW2 and SW3a. The City of Leadville storm sewer would be extended, as described in Alternative SW3a. In addition, the effluent pipeline from the Yak Treatment Plant will be extended and discharge into this new storm sewer. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

The flow contribution from the Yak Treatment Plant discharge is small in comparison to the storm sewer pipeline capacity (2% or less). Therefore, it is assumed that the storm sewer pipe sizes identified in Alternative SW3a have adequate capacity for both the storm flows and the Yak Treatment Plant discharges occurring simultaneously.

The alignment of the Yak Treatment Plant extension portion of the pipeline would generally follow the California Gulch channel alignment from the Yak Treatment Plant until it joined the storm sewer just above the confluence of California Gulch and Oregon Gulch. The alignment of the combined pipeline extensions would follow the alignment described in Alternative 2.

8.1.5 Alternative SW4 – Construct In-Stream Detention Facilities with ICs and Monitoring

- Estimated capital and operating cost: $11,210,000
- Implementation time: 2-years

Lined, in-stream detention ponds would be constructed to attenuate California Gulch flows during periods when such flows would be expected to cause HQ>1 in the Arkansas River. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

Two ponds would be constructed under this alternative; just below the capped Apache Tailings and at the confluence of Oregon and California Gulches. The ponds would include automated outlet works to pass varying flows based on pre-set criteria.

The pond liner system would include a PVC or High Density Polyethylene (HDPE) membrane sandwiched between a drainage composite and non-woven geotextile. The design includes an under drain to relieve hydrostatic pressure from high ground water levels in the vicinity of the California Gulch channel. A 12-inch top layer of gravel is provided to protect the liner system.

The dams would be constructed of locally available fill and include a spillway and automated outlet works. The outlet works will include programmable controls allowing pond discharge to vary as a function of impounded water level.

Conceptual pond dimensions were based on the following general criteria:

- Maximize detention between the western limit of the capped Apache Tailing and the Colorado Mountain College access road.
- Do not encroach on existing roadways or developed properties.

8.1.6 Alternative SW5 – Relocate California Gulch/Arkansas River Confluence with ICs and Monitoring

- Estimated capital and operating cost: $7,824,000
- Implementation time: 1-year

Flows in California Gulch would be diverted before the Arkansas River confluence and conveyed in a pipeline to a point below Lake Fork Creek. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

A diversion structure will be constructed on California Gulch several hundred feet up-stream of the Arkansas River confluence. The diversion structure and 30” RCP, Class III pipe is sized to convey a combination of a 5-year, 24-hour storm event and snowmelt totaling 29.2 cfs (USEPA, 2003b). Flows exceeding this magnitude will be bypassed and continue to the Arkansas River. A buried pipeline, rather than an open channel, was selected for conveyance to avoid intercepting natural surface flows crossing the alignment.

The pipeline alignment will begin at the diversion structure, then run south, parallel to and west of Highway 24 and the existing railroad alignment. The pipeline will turn west, away from the highway and railroad, and discharge to the Arkansas River at a point just down-stream of the confluence of Lake Fork Creek.

8.1.7 Alternative SW6 – Consolidate and Cover Mine Waste Piles with ICs and Monitoring

- Estimated capital and operating cost: $58,694,000 to $145,634,000
- Implementation time: 3-years

Mine wastes having the potential to generate ARD would be consolidated and covered. Mine wastes that have already been reclaimed under prior response actions are excluded from this alternative. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

For the purpose of developing a reasonable range of costs, two capping methods were considered as the basis for cost endpoints. Method 1 assumes all relevant mine wastes would be consolidated and capped using the design employed in OU6 under prior response actions (synthetic liner/dolomite cap) and described in the OU6 Focused Feasibility Study (USEPA, 2002). Method 2 assumes all mine wastes will be graded, top soiled and vegetated in-place with adjoining stream channel restoration. The design for this alternative method is described in the Final Design for the ARGO Tunnel Mill Site Reclamation Project (CDPHE, 2002).

This alternative assumes that all ARD-generating mine wastes would be subjected to remedial action. However, any remedy involving the reclamation of ARD-generating mine wastes either through relocation and/or capping would likely involve only a portion of the mine waste quantities identified in the OU12 FFS (USEPA, 2007b). The relative degree to which individual mine waste deposits contribute to metal loading in the Arkansas River would be used to prioritize mine wastes for remedial action. This prioritization may be accomplished through the use of a predictive contaminant fate and transport model developed by the CDPHE in 2007.

8.1.8 Alternative SW7 – Site-wide Water Treatment Facility with ICs and Monitoring

- Estimated capital and operating cost: $32,944,000
- Implementation time: 3-years

A lime lagoon treatment facility would be constructed in Lower California Gulch capable of treating the 5-year, 24-hour storm flow combined with snow melt totaling 29.2 cfs (USEPA, 2003b). Flows exceeding this design criterion would by-pass the treatment facility. Institutional controls to restrict use of surface water for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring would be implemented.

In this treatment scheme, raw water is conveyed to a system of lagoons where it is treated with lime prior to entering the lagoon system. The lime forms metal hydroxide compounds, which settle in the lagoons as sludge. The pH of clarified effluent is adjusted

to near neutral prior to discharge. Periodically, sludge is removed from the pond for disposal. For this evaluation, it is assumed that sludge will be disposed yearly.
The proposed system consists of two-stage lime addition in parallel trains. Design criteria are summarized below:

Criteria	Design Value
Flow Peak Average Minimum	 29.2 cfs 5.4 cfs 4.5 cfs
Number of stages	2
Number of trains	2
Detention time, total	4 hrs
Detention time per stage	2 hrs
Sludge storage volume	1 year's production at average flow
Minimum aspect ratio of lagoons (L/W)	2.5:1
Lagoon side slopes	3:1
Assumed liquid depth	13 ft (plus 3 ft of ice during winter)
Freeboard	3 ft
Target pH, 1st stage	6.5
Target pH, 2nd stage	10
Assumed lime dose	800 mg/l
Assumed sludge concentration	4% (by weight)

The conceptual design for this facility was described in a report entitled:

Lagoon Treatment Facility Feasibility Study, Preliminary Draft, May 2003, HDR Engineering, Inc.

Certain elements of the conceptual design described in the above-referenced document are not part of alternative SW7 including:

- Conveyance and treatment of water extracted from the LMDT.
- Treatment of Yak Tunnel discharge.

Remedy elements beyond those identified in USEPA (2003b) include:

- Periodic inspection, maintenance and Five-Year Review.
- ICs to restrict use of surface water and protect the engineered remedy.
- Long-term monitoring of surface water, ground water and aquatic organisms.

Possible disposal options for treatment residuals would include transportation to an existing solid waste disposal facility or the construction of a dedicated disposal facility

within the Site. Potential on-Site disposal facilities are discussed in the *Final Sitewide Repository Screening Report* (USEPA 2003c).

8.2 GROUND WATER

8.2.1 Alternative GW1 - No Action

- Estimated capital and operating cost: $0
- Implementation time: Immediate

The No-Action Alternative takes no action under OU12. However, previously completed response actions and response actions to be completed under existing RODs will be maintained.

8.2.1a Alternative GW1a – No Additional Action, Monitoring, with ICs, and a TI Waiver

- Estimated capital and operating cost - $1,340,000
- Implementation Time: Immediate

Institutional Controls to restrict use of groundwater for human consumption and monitoring of the shallow aquifer will be implemented to provide protectiveness and evaluate the long-term trends in groundwater contaminant levels. Previously completed source control response actions would be maintained and a technical impracticability (TI) waiver for drinking water maximum contaminant limits (MCLs) for cadmium and lead would be granted. Since a TI waiver is being granted for this remedy, the remaining components (ICs, monitoring, and previous source control) would be considered the alternative remedial strategy.

8.2.2 Alternative GW2 – Intercept and Treat Contaminated Ground Water at Mouth of California Gulch with ICs and Monitoring

- Estimated capital and operating cost: $30,885,000
- Implementation time: 1-year

Contaminated alluvial groundwater entering the Arkansas River Valley from Lower California Gulch would be intercepted to prevent discharge to the Arkansas River. A ground-water recovery well array would be constructed near the mouth of California Gulch. Recovered groundwater would be conveyed to the Yak Treatment Plant prior to discharge to California Gulch. For costing purposes, the well array is assumed to consist of five wells discharging a total of 50 gpm. This flow is delivered to the treatment facility via a lift station and pressurized pipeline. Institutional Controls to restrict use of groundwater for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring of the shallow aquifer will be implemented to provide protectiveness and evaluate the long-term trends in groundwater contaminant levels.

8.2.3 Alternative GW3 – Dewater Capped Apache and Oregon Gulch Tailing with ICs

- Estimated capital and operating cost: $30,303,000
- Implementation time: 2-years

Contaminated groundwater underneath the Apache and Oregon Gulch Tailing would be collected and treated prior to discharge to California Gulch. Under drains would be installed below the water table under these two capped tailing deposits to lower the water table. Ground water would be collected and conveyed to the Yak Treatment Plant. Institutional Controls to restrict use of shallow groundwater for human consumption as well as to prevent disturbance of engineered components of the remedy and monitoring of the shallow aquifer will be implemented to provide protectiveness and evaluate the long-term trends in groundwater contaminant levels.

Dewatering would be achieved at the Oregon Gulch Mine Tailing and Apache Tailing through horizontal drains installed from a bench at the toe of each embankment with a spacing that provides for adequate coverage of the tailings footprint. The recovered ground water, or ARD, would be conveyed to the Yak Treatment Plant in pressurized pipelines.

9.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 300.430(e)(9) of the NCP requires that the USEPA evaluate and compare the remedial cleanup alternatives using the nine criteria listed below. The first two criteria, (1) overall protection of human health and the environment and (2) compliance with applicable or relevant and appropriate requirements (ARAR), are threshold criteria that must be met for the Selected Remedies. The Selected Remedies must then consider the remaining 5 balancing and 2 modifying criteria. A summary of the comparative analysis of surface and groundwater alternatives is presented on Tables 9-1 and 9-2, respectively.

9.1 NCP CRITERIA

9.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each alternative can adequately protect human health and the environment. Protection includes both the short- and long-term protection from unacceptable risks posed by hazardous substances or pollutants or contaminants present at the Site by eliminating, reducing, or controlling human and environmental exposures.

Surface Water

No additional protection is achieved under Alternative SW1. Alternatives SW2, 3a and 3b may provide some additional protection through a reduction in metal loading to the Arkansas River. However, the reduction in metal loading to the Arkansas River compared to the total metal load would be relatively small. These alternatives, and alternative SW1a, will provide protection beyond that afforded by alternative SW1 through implementation of ICs restricting the use of surface water for human consumption.

The beneficial effects of SW5 are expected to be modest when compared with the remaining alternatives (SW4, 6 and 7). As with all action alternatives, SW5 provides additional protection through the implementation of ICs restricting use of Site waters.

Alternatives SW4, 6, and 7 are expected to provide an increasing level of protection. The potential benefit of SW4 has been quantified while an estimate of SW6 performance is problematic due to the absence of waste-pile-specific ARD generation information. Nevertheless, the comprehensive nature of Alternative SW6 suggests that the resulting reduction in peak loading from California Gulch would be greater under Alternative SW6 than under SW4. Partial implementation of Alternative SW6 (remediation of prioritized waste deposits) would result in a lesser benefit when compared with the full implementation of the alternative. Alternative SW7 is expected to provide the greatest level of additional protection of all the alternatives. Treating California Gulch flows would ensure that metal loading to the Arkansas River is minimized.

Ground Water

No additional protection is achieved under Alternative GW1. Alternatives GW2 and GW3 offer an increasing level of protection to the aquatic environment. Both alternatives offer an equal level of additional protection of human health through ICs restricting use of Site waters. Alternative GW1a also offers additional protection of human health over GW1 through the addition of ICs restricting use of shallow groundwater for human consumption.

9.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking waivers.

Surface Water

It is expected that Alternative SW1a will attain surface water quality standards (WQSs) in a reasonable time frame. The relative ability of the other surface water alternatives to accelerate attainment of chemical-specific ARARs is identical to the ranking provided in Section 9.1.

All of the alternatives (with the exception of SW-1) are expected to comply with action- and location-specific ARARs. Compliance with action-specific ARARs will be achieved through compliance with Solid Waste regulations, implementation of engineering controls during remedial construction and implementation of ICs meeting the requirements of the State Environmental Covenant Law. Location-specific ARARs will be met through compliance with the substantive requirements of permits for the protection of sensitive areas such as wetlands and cultural resources.

Ground Water

Site-wide attainment of ground WQSs is unlikely to occur in a reasonable time frame under any alternative (Section 12.2).

All of the alternatives (except GW1) are expected to comply with action- and location-specific ARARs. Compliance with action-specific ARARs will be achieved through compliance with, Solid Waste regulations, implementation of engineering controls during remedial construction and implementation of IC's meeting the requirements of the State Environmental Covenant Law. Location-specific ARARs will be met through compliance with the substantive requirements of permits for the protection of sensitive areas such as wetlands and cultural resources.

9.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on-Site following remediation and the adequacy and reliability of controls.

Surface Water

Each action alternative would require near perpetual operation or maintenance in order to maintain protectiveness. Alternative SW6 (consolidation and capping of mine waste) offers the highest degree of permanence given the proposed action would require no operation and less maintenance than the other action alternatives. Residual risks under the action alternatives are similar and involve the likelihood of HQ>1 at the point(s) of compliance in the Arkansas River during brief time periods during spring run-off. The degree of residual risk cannot be quantified for Alternatives SW2, 3a and 3b without treatability studies. However, given the relatively small residual risks measured during extensive sampling from 2003-2008, the amount of residual risk would be no higher and likely less than the existing residual risk. Of the remaining action alternatives, the inferred degree of residual risk is highest under alternative SW5 and declines in the following order; SW4, SW6, and SW7.

Ground Water

Each action alternative would require near perpetual operation or maintenance in order to maintain protectiveness. Residual risks under the action alternatives for ground water are similar to those for surface water and involve the likelihood of HQ>1 at the point(s) of compliance in the Arkansas River and the inability to achieve ground WQSs in a reasonable time frame. The degree of residual risk is inferred to be somewhat greater under alternative GW2 than GW3.

9.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. Alternatives are assessed for the degree to which they employ recycling or treatment that reduces toxicity, mobility, or volume.

Surface Water

Alternative SW7 is the only alternative that involves treatment. A reduction in waste toxicity and mobility through treatment would be achieved by converting dissolved

metals into solid metal compounds. Treatment residuals would be properly disposed in a controlled Subtitle D landfill. The generation of solid waste (treatment residuals) would result in an increase in waste volume under this alternative.

Ground Water

Alternatives GW2 and GW3 involve treatment of extracted ground water. A reduction in waste toxicity and mobility through treatment would be achieved by converting dissolved metals into solid metal compounds. Treatment residuals would be properly disposed in a controlled Subtitle D landfill. The generation of solid waste (treatment residuals) would result in an increase in waste volume under this alternative. Both action alternatives offer the same level of reduction in toxicity, mobility and volume.

9.5 SHORT-TERM EFFECTIVENESS

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community and the environment during construction and operation of the remedy until cleanup levels are achieved.

Surface Water

All of the action alternatives create a roughly equal level of risk to the community and this risk is easily mitigated and should remain below a level of concern. Alternative SW6 is the only alternative involving disturbance of mine waste. Therefore, it creates more short-term risk than the other alternatives, primarily to workers as unremediated mine wastes exist largely in unpopulated areas. Impacts to cultural resources and adverse environmental impacts are greatest under Alternative SW6 with lesser impacts under SW4. Still lower and a roughly equal level of impact is created by the remaining action alternatives.

Ground Water

All of the action alternatives create a roughly equal level of risk to the community. This risk is easily mitigated and should remain below a level of concern. Impacts to cultural resources and adverse environmental impacts are expected to be minimal.

9.6 IMPLEMENTABILITY

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

Surface Water

All of the alternatives are considered to be technically implementable. All of the action alternatives include ICs restricting the use of surface water. The implementability of institutional controls is high. Local officials have expressed willingness to work with EPA and the State on implementing institutional controls restricting use of surface water.

Ground Water

All of the alternatives are considered to be technically implementable. All of the action alternatives include ICs restricting the use of shallow ground water. The administrative implementability of these ICs is high. The action alternatives presume that treatment of recovered ground water would occur at the Yak Treatment Plant. This facility is not owned by USEPA. Therefore, the administrative implementability of the treatment portion of the alternatives is low. Since the selected remedy calls for a TI waiver for MCLs for cadmium and lead, it should be noted here that GW2 and GW3 while potentially reducing the area of non-attainment of MCLs, neither remedy would achieve substantial reduction of the needed area for the TI waiver. In addition, GW2 and GW3 were included for their potential to reduce metal loading to surface water. Neither remedy would substantially reduce this loading.

9.7 COST

Surface Water

The 30-year net present value of the alternatives is ranked as follows from low to high:

SW1, SW1a, SW2, SW5, SW3a, SW3b, SW4, SW7, SW6

Partial implementation of Alternative SW6 was considered for an OU12 remedy. In that case, the cost would be roughly proportional to the quantity of mine waste targeted for remedial action.

Ground Water

The 30-year net present value of the alternatives is ranked as follows from low to high:

GW1, GW1a, GW3, GW2

It should also be noted that while GW2 and GW3 would reduce metal loading to surface water and possibly reduce the area needed for a TI waiver, both reductions would be relatively small, especially in consideration of the rather large cost for both remedies.

9.8 STATE ACCEPTANCE

The State has been consulted throughout this process and concurs with the Selected Remedy.

9.9 COMMUNITY ACCEPTANCE

Public comment on the FFS and Proposed Plan was solicited during a formal public comment period extending from May 7 through June 5, 2009. The community is generally supportive of the selected remedy. Written comments and comments received during the public comment period generally pertained to clarification of specific issues associated with the selected remedy.

The Responsiveness Summary addresses all comments received during the public comment period.

10.0 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that USEPA will use treatment to address the principal threats posed by a Site wherever practicable (NCP 300.430(a) (1) (iii) (A)). Identifying principal threat wastes combines concepts of both hazard and risk. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur. Conversely, non-principal threat wastes are those source materials that generally can be reliably contained and that would present only a low risk in the event of exposure.

Mine wastes, soils contaminated with mine wastes, and contaminated surface and ground water at the Site are generally considered to be characterized as having low toxicity. Therefore, the wastes at this Site are not considered to be Principal Threat wastes.

11.0 SELECTED REMEDY

11.1 DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for OU12 surface and ground water includes:

- Alternative SW1a – No Additional Remedial Construction with ICs and Long-Term Monitoring
- Alternative GW1a –No Additional Remedial Construction with ICs and Long-Term Monitoring, and Technical Impracticability Waiver for MCLs.

The Selected Remedy for Site-wide surface and groundwater includes no additional remedial construction. However, ICs will be implemented to restrict the use of surface and alluvial groundwater within the NPL Site boundaries (Restricted Area). This will minimize the likelihood of adverse human health effects from the consumption of contaminated Site water. Because Arkansas River water meets drinking water standards, the ICs will not apply to the River.

Institutional controls will be implemented as environmental covenants on specific parcels, a Lake County Ordinance, Parkville Water District Rules and Regulations, or Colorado State Engineer notice. It is expected that the final ICs will be a combination of one or more of these specific ICs.

A technical impracticability (TI) waiver is needed for shallow groundwater. Since the shallow groundwater does not have a classified use, the default ARAR or standard is the federal drinking water MCLs. Due to the large volume of waste left in place, particularly at capped tailing and/or waste rock piles, it is not expected that specific MCLs (for metals) will be met in a reasonable time frame. The two metals that will not meet MCLs

are lead and cadmium. An expanded analysis of the TI waiver is included as an appendix to this Record of Decision.

Because the MCLs for cadmium and lead will not be met, the groundwater portion of the remedy will be considered a non-restoration remedy. Because EPA expects the surface water standards to met, the surface water portion of the remedy will be considered a restoration remedy.

The remedy will also include long-term monitoring of the following environmental media as discussed in Section 11.3:

- Surface Water
- Ground Water
- Aquatic Organisms

Based on the information currently available, USEPA and the State believe the Selected Remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The USEPA expects the Selected Remedy to satisfy the following statutory requirements of CERCLA §121(b): (1) be protective of human health and the environment; (2) comply with ARARs (or justify a waiver); (3) be cost-effective; (4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and (5) satisfy the preference for treatment as a principal element, or explain why the preference for treatment will not be met.

11.2 SUMMARY OF ESTIMATED REMEDY COSTS

The detailed cost estimate and net present value (NPV) analysis for the Selected Remedy is presented in Table 11-1. The 30-year NPV of capital and operating costs for the entire remedy is $3,785,000

Capital costs associated with the remedy are limited to legal fees and other costs, such as surveying, or map creation needed for the development of the ICs for the portions of Site surface water and shallow alluvial groundwater where MCLs are exceeded.

Annual costs associated with enforcement of ICs are assumed to require 20% of the initial capital cost. Annual costs associated with long-term monitoring are based on actual annual costs provided by USEPA and Resurrection Mining Company. Also, included in operation and maintenance is the incremental cost associated with performing the portion of five-year reviews associated with OU12.

USEPA guidance (USEPA, 2000) requires use of a 7% discount factor when calculating net present value of capital, operation and maintenance costs for all non-Federal Facilities. However, USEPA also suggests using current discount rates published by the Office of Management and Budget (OMB) for Federal Facility Sites. The OMB recommends a nominal and real (inflation-subtracted) discount rate of 4.9% and 2.8%,

respectively, for projects with durations exceeding 30-years (OMB, 2008). These lower discount rates (reflecting real interest rates on treasury notes and bonds) would result in a significantly higher present worth cost. However, OU12 is not a federal facility and so the 7% discount rate is used.

11.3 CONTINGENCY MEASURES AND LONG-TERM MONITORING

USEPA has concluded that drier than average conditions have existed during a large part of the monitoring period over which the declining contaminant trends and increasing trout populations were observed (Sections 5.0 and 6.0). Therefore, USEPA and the State will continue to monitor water quality and the health of aquatic organisms under the OU12 remedy. The specific monitoring regime under the OU12 remedy will be developed during the remedial design in the form of a Monitoring Plan. However, any Monitoring Plan will include the following overall objectives by medium.

Surface Water

Monitor surface water quality at a single point of compliance (POC) and a suitable reference location for OU12. The POC for OU12 will be located in the Arkansas River between the confluences with California Gulch and the Lake Fork of the Arkansas River. The reference location will be on the Arkansas River up-stream of California Gulch. Analytes monitored will allow for comparison with zinc and cadmium WQSs and will permit calculation of a Hazard Quotient (HQ) for brown trout.

Ground Water

The likelihood of meeting ground WQSs throughout the Site in a reasonable time frame is considered to be low. This is due to wastes remaining in-place and other Site-specific conditions discussed in Section 12.2 as well as the OU12 RI (USEPA, 2007a).

Therefore, and in accordance with USEPA guidance (OSWER Directive 9283.1-2), an Area of Attainment will be established within which ground WQSs will be achieved in a reasonable time frame (if not currently achieved). The Area of Attainment will exclude areas in or near wastes that remain in-place (including disturbed alluvium in Lower California Gulch (OU8)). Given these limitations and the fact that alluvial ground water flows towards the Arkansas River (Section 5.4), monitoring points intended to assess the Area of Attainment will be located within the Arkansas River flood plain alluvium below OU8.

Chemical analyses of ground water samples collected at monitoring points will be analyzed for the following chemicals, at a minimum:

- Arsenic
- Cadmium
- Lead
- Manganese
- Zinc

Aquatic Organisms

Monitoring of aquatic organisms will include but not be limited to demographic studies of trout and their prey base at the POC and a suitable reference location.

Should conditions develop that call into question the ecological protectiveness of the OU12 remedy, USEPA and the State would consider implementing one of the other alternatives described in the Proposed Plan, in whole or in part, or other alternatives will be developed as conditions warrant. Such conditions would be detected during analysis of long-term monitoring data and might include a declining trout population in the Arkansas River (when compared with conditions at a reference location) or other measures of the health of the aquatic ecosystem.

It is expected that long-term monitoring will show that surface and groundwater quality continues to improve. Stabilization of recently completed remedies as well as the upcoming completion of the OU5 remedy is expected to further reduce the leaching of contaminants to Site water.

Long-term monitoring data will be reviewed as it is acquired with formal remedy review at five-year intervals as required under Superfund.

12.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, USEPA must select a remedy that is protective of human health and the environment; that complies with ARARs or justifies a waiver; is cost-effective; and utilizes permanent solutions, alternative treatment technologies, or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against off-Site disposal of untreated wastes. The following sections discuss how the Selected Remedy meets these statutory requirements.

12.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Improvements in water quality observed in connection with existing response actions would be maintained with some additional improvement anticipated as response actions stabilize and selected remedies are completed in OU5 and OU6. The OU12 RI Report (USEPA, 2007a) concluded that the overall density and diversity of the benthic community does not appear to be substantially impaired at present, and it seems likely that availability of benthic prey items is not limiting for fish. Therefore, the Selected Remedy is considered to be protective of the environment.

However, the persistence of contaminants in alluvial ground water and California Gulch flows above federal regulations or guidelines requires action under the selected remedy to minimize risk to humans who may ingest these waters. These actions include ICs to

minimize the potential for human exposure to contaminated Site waters in perpetuity or until applicable numeric criteria are achieved through continued operation of remedies implemented in OUs 1 through 11.

12.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The Selected Remedy will not comply with all ARARs identified in Tables 12-1 through 12-3. A waiver of specific drinking water MCLs in the shallow alluvium of Stray Horse, California, and Oregon Gulches, as well as a portion of the Arkansas Valley flood plain will be necessary. Since no remedial construction will occur under this alternative, location-specific ARARs are not triggered. The following summarizes the chemical-specific ARARs for the Selected Remedy.

<u>Potential Chemical-Specific ARARs</u>

- Surface Water - Federal and State Water Quality Criteria – Seasonal temporary modifications to table value standards became effective for Segment 2b 2c of the Arkansas River in November 2007 as described in *"Proponents' Prehearing Statement to the Colorado Water Quality Control Commission"* (CWQCC, 2007). This includes a standard for zinc and cadmium for the months of April and May. For the remainder of the year, hardness dependent concentration values for zinc and cadmium will replace table value standards as the WQSs for Segment 2b and 2c (equations provided on page DS-50).

  The seasonal temporary modifications to table value standards for zinc and cadmium were calculated as the 85th percentile of all available water quality data during the months of April and May from 2000-2006 (CWQCC, 2007). Water quality would be considered to have attained this standard if 85% of the measurements are equal or less than the following chemical-specific concentrations.

  - Zinc – 649 ug/L
  - Cadmium – 1.34 ug/L

  The hardness dependent zinc and cadmium concentration values (intended to replace table value standards) are established using the Recalculation Procedure described in CWQCC (2007). These calculated concentration values are based on acute exposure of aquatic organisms and would be applicable to Segment 2b during the period June through March of each year (June through December for one year and January through March of the following year).

  It is possible that water quality conditions in Segment 2b currently attains the WQS at an attainment frequency of not less than 85%. This is based on the water quality trends described in the OU12 RI Report (USEPA, 2007a). If current conditions do not meet the new standards, it is considered likely that attainment of

the new standards at a frequency of not less than 85% would be achieved in a reasonable time frame.

Based on current data and the decreasing metal loading to the Arkansas River from the Site, EPA expects to meet surface water quality standards within a reasonable time-frame.

The State of Colorado promulgated standards for segments 2b and 2c of the Arkansas River. These segments are directly downstream from the confluence of California Gulch. These standards are as follows:

Cd(acute) = 1.136672-(ln(hardness)*0.041838)*e(0.9151*(ln(hardness)-3.6236)
Cd(chronic) = 1.101672-ln(hardness)*0.041838)*e(0.7998*ln(hardness)-3.1725)

Zn(acute) = 0.978*e(0.8537*ln(hardness)+2.2178)
Zn(chronic) = 0.986*e(0.8537*ln(hardness)+2.0489)

Attainment of these standards will be evaluated on an on-going basis and during the five-year review process.

- Federal and State Standards for Ground Water – Chemical-specific ground WQSs exist for several of the contaminants of potential concern including arsenic, cadmium and lead as summarized below.

Chemical	Arsenic	Cadmium	Lead
Water Quality Standard microgram/Liter	10/0	5/5	15/0
ARAR	MCL/MCLG	MCL/MCLG	MCL/MCLG

It is unlikely that the WQSs in the shallow alluvial aquifer throughout the Site will be met in a reasonable time frame. This is due to wastes remaining in-place and other Site-specific conditions including:

- The free exchange of metal-impacted surface water and alluvial ground water (Section 5.1.2).
- The presence of widespread disturbed and saturated alluvium in Lower California Gulch (and elsewhere in the Site) acting as a low-grade reservoir of metals with the potential to desorb or otherwise be mobilized into alluvial ground water (Section 5.3)

Since shallow groundwater is not expected to meet ARARS within a reasonable time-frame, EPA is issuing a technical impracticability waiver for a small portion of the Site for cadmium and lead. There are no current exceedances of the arsenic MCL. The TI

waiver analysis and a map showing the area included in the TI waiver is included as an appendix to this ROD.

Location Specific ARARs

The selected remedy involves no construction, therefore, location specific ARARs do not apply to the selected remedy.

Action Specific ARARs.

The selected remedy will comply with all action specific ARAR's. Environmental covenants are required whenever contamination is left in place, such as mine waste. Compliance with this ARAR will be achieved through the promulgation of a Lake County Ordinance or creation and recording of environmental covenants on individual properties.

12.3 COST-EFFECTIVENESS

In USEPA's judgment, the Selected Remedy is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness (NCP 300.430(f) (1) (ii) (D))". This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment as well as ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the Selected Remedy is $3,785,000.

12.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT (OR RESOURCE RECOVERY) TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE (MEP)

No permanent solutions or alternative treatment technologies exist to address mine wastes that contribute to contamination of California Gulch flows. Metals cannot be destroyed through treatment, and while removal of mine wastes would provide a permanent solution for current waste sites, the disposal site would require maintenance in perpetuity. In-place capping of mine wastes would also require perpetual maintenance. In addition, perpetual operation of the Yak Tunnel Treatment Facility (OU1 Remedy) is required to prevent contaminated Yak Tunnel discharge from impacting Site surface waters.

As discussed in Section 11.2, impacts to alluvial ground water originate from several sources including infiltration of contaminated surface water, dissolution of contaminants in saturated alluvium/mine wastes and recharge from underlying and potentially contaminated bedrock aquifer(s). The limitations on permanent solutions for surface water contamination apply to ground water contamination given the interaction between surface and ground water. In addition, any aggressive active treatment of ground water would not be considered a permanent solution given the likely need for near perpetual operation of a treatment facility.

Of those alternatives that are protective of human health and the environment and comply with ARARs, USEPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against off-Site disposal and considering State and community acceptance.

12.5 PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

As discussed in the preceding section, no treatment technologies exist to address mine wastes that contribute to contamination of California Gulch flows and ground water.

Perpetual treatment of contaminated surface and ground water (beyond the continued operation of the Yak Tunnel Treatment Facility) was considered in the OU12 FS (USEPA, 2007b). However, USEPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element considering State and community acceptance.

12.6 FIVE-YEAR REVIEW REQUIREMENTS

Because this remedy will result in hazardous substances or pollutants or contaminants remaining in OU12 above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five-years after initiation of response action to ensure that the remedy remains protective of human health and the environment.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES FROM PREFERRED ALTERNATIVE OF PROPOSED PLAN

The Proposed Plan for OU12 was released for public comment in May 2009. The Proposed Plan identified Alternatives SW1a and GW1a as the Preferred Alternative in combination with ICs restricting the use of certain Site waters and the implementation of Long-Term Monitoring of surface water, ground water and aquatic organisms (in the Arkansas River). USEPA reviewed all written and oral comments submitted during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

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Responses to Comments Received on the Proposed Plan
- Site Wide Water Quality (Operable Unit 12)
California Gulch NPL Site

Comments are presented in standard type. Responses are provided in italics.

Comments Received during May 20, 2009 Proposed Plan Public Meeting

1. In response to a comment concerning a technical impracticability (TI) waiver and restrictions on drilling wells near California Gulch and other areas, Ken Olsen, Chairman of the Lake County Board of County Commissioners expressed concern over preventing well drilling.

EPA and the State can not prohibit people from drilling wells on their property. Parkville Water District does have a prohibition against drilling domestic wells covering most of the area where EPA and the State would want to prevent ingestion of shallow groundwater. In addition, EPA and the State intend to work with the State Engineer's office to inform people where shallow groundwater is contaminated. When someone gets a permit they would know they are in an area of potential contamination. In addition, Mr. Olsen on behalf of the County Commissioners indicated that they would work with the EPA on implementing institutional controls for OU12.

2. There was also some concern about the size of the area indicated needing an institutional control (IC) and TI waiver.

EPA and the State pointed out that the area needing an IC and TI waiver was fairly small and mostly near California Gulch, waste rock piles in operable unit 6, and Oregon Gulch (OU10).

3. Bill Klauber commented that given the remaining issues with water quality, perhaps it was premature to issue a final Record of Decision for OU12.

EPA and the state acknowledged that there are some remaining issues with water quality but that our general response would be the same with or without a decision document. We will continue to monitor water quality and take action as appropriate if it is deemed necessary (i.e., during the five-year review process, etc.)

Comments received from Bernard Smith via E-mail):

Bernard Smith was under the impression that the preferred alternative included rerouting the outfall of California Gulch to the Arkansas River at an area below the Lake Fork.

Doctor Smith also indicated that his preferred alternative included alternatives SW-3a and SW-3b for surface water and GW-3 for groundwater. In summary these alternatives would reroute storm-water from Harrison Street down to a point below Operable Unit 5 and would also reroute the Yak Tunnel Water Treatment Plant effluent to the same area for SW-3a and SW-3b. GW-3 would pump and treat shallow groundwater near the mouth of California Gulch.

EPA responded by e-mail that rerouting California Gulch was not part of the preferred alternative and that the other alternatives that Dr. Smith wanted would be considered if the preferred alternative was determined to not be effective.

California Gulch Superfund Site
Leadville, Colorado
Operable Unit 12
Technical Impracticability Waiver Analysis for
Shallow Groundwater

Site Background

The Site is comprised of approximately 18 square miles in Lake County, Colorado, approximately 100 miles southwest of Denver. The NPL Site includes the towns of Leadville and Stringtown as well as surrounding areas.

Mining, mineral processing, and smelting activities in the area produced gold, silver, lead and zinc for more than 140 years. Mining began in the Leadville area in 1859 when prospectors working the channels of Arkansas River tributaries discovered gold at the mouth of California Gulch. Wastes generated during the mining and ore processing activities (mine waste) contain metals at levels that pose a threat to human health and the environment.

The California Gulch Site was added to the NPL in 1983.

In 1994, as part of a Consent Decree Settlement, EPA divided the NPL Site into 11 geographically-based areas, called operable units. The operable units include:

- OU1 Yak Tunnel
- OU2 Malta Gulch
- OU3 D&RG Slag Piles
- OU4 Upper California Gulch
- OU5 Smelter/Slag/Mill Sites (Colorado Zinc Tailing Impoundment); Arkansas Valley Smelter; and Elgin Smelter, Grant/Union Smelter, Western Zinc Smelter and Arkansas Valley South Hillside Slag Pile (EGWA).
- OU6 Stray Horse Gulch
- OU7 Apache Tailings Impoundment
- OU8 Lower California Gulch
- OU9 Residential Populated Areas
- OU10 Oregon Gulch.
- OU11 Upper Arkansas River Floodplain

Operable Unit 12 (OU12) encompasses the entire Site and was designated to address Site-wide surface and ground water quality after response actions to clean up the sources for surface and ground water contamination had been implemented at other OUs.

Although OU12 encompasses the entire NPL Site, a geographic limit was placed on OU12 ground water. Site-wide ground water is defined as being the shallow alluvial

aquifer not to exceed a depth of 250-feet or contact with bedrock, whichever is the lesser depth below the ground surface.

Investigation of the NPL Site began in the mid-1980s. The results of Site-wide surface and ground water quality studies and studies of the health of aquatic organisms are summarized in the OU12 Remedial Investigation Report. The OU12 Focused Feasibility Study summarized and compared various cleanup alternatives. This document addresses a technical impracticability waiver for portions of OU12 shallow groundwater.

Site Characteristics

Operable Unit 12 encompasses surface and ground water within the entire Superfund Site. Site-wide water quality has been affected by mine wastes that leach chemicals that are toxic to humans and aquatic animals (examples include cadmium and zinc). The mine wastes include waste rock, mill tailing and some smelter wastes. The wastes occur in piles located primarily in non-residential areas. Some of the wastes originally placed in or near to stream channels have been washed down stream.

EPA, the State, and Responsible Parties have performed investigations related to OU12. EPA published the combined results of these investigations in the OU12 Remedial Investigation Report. The Report examined groundwater quality trends at specific locations in the Site.

Water quality trends were examined over a period of ten years, from 1995 to 2005. Increasing or decreasing contaminant trends give an indication how effective the past response actions have been in controlling leaching from mine wastes.

Specific ARARs or media cleanup standards for this TI Waiver.

Region 8 EPA is proposing to waive the MCLs for metals, specifically cadmium and lead at specific portions of the OU12 shallow groundwater.

Spatial Area over which the TI Waiver will apply

The areal extent of this TI waiver is shown in the attached map. The waiver would apply in the shallow groundwater (maximum depth of 50').

Site Conceptual Model

The site conceptual model is attached and is included in the OU12 Remedial Investigation Report. It has been recognized since the first investigations that mining related wastes left on site were sources of metal contamination to surface and groundwater—primarily through snow melt, rain water infiltration, or surface water contact with source areas.

Evaluation of Restoration Potential

Identification of contamination sources, response actions to date, and analysis of the performance of any ongoing or completed remedial actions.

The areas identified as the primary loaders of metals to surface and groundwater were identified in several investigations and are as follows:

- Yak Tunnel Discharge (OU1)
- Malta Tailing Impoundment (OU2)
- Starr Ditch - Stray Horse Gulch surface runoff (OU6)
- Apache Tailing Impoundment (OU7)
- Oregon Gulch Tailing Impoundment (OU10)
- Colorado Zinc Tailing Impoundment (OU8)
- Fluvial Deposit in Lower California Gulch (OU8)

Response actions to address the sources of contaminants from mine wastes and mine drainage tunnels to surface and ground water have been completed in OUs 1, 2, 4, 7, 8, and 10. In the case of OUs 5 and 6, the response actions are on-going. Surface water and groundwater interact with each other, especially in shallow areas. Therefore, source remediation to address surface water contamination has reduced metal concentrations in groundwater wells throughout the site.

Although not officially part of the Site, the Leadville Mine Drainage Tunnel (LMDT) was also identified as a significant source of contaminants to the Arkansas River prior to initiation of water treatment by the United States Bureau of Reclamation in 1992.

Discharges from OU 1 (Yak Tunnel) and LMDT have not been identified as major contributors to contamination in the Arkansas River since the beginning of water treatment at the tunnel portals in 1992.

The general response actions conducted to date are summarized below:

Water Treatment – OU1, OU6

Consolidate, relocate and/or cover mine wastes – OU2, OU4, OU5, OU6, OU7, OU8, OU9, OU10

Storm water diversions – OU4, OU5, OU6, OU7, OU8, OU10

In-Situ Treatment of soils/mine waste – OU11

The Yak Tunnel was identified as contributing 80% of the metal load to Lower California Gulch. The other contributors were either very large tailing piles or impoundments or sulfidic waste rock piles which generated millions of gallons of acid rock drainage during storm or snow-melt events each year.

At the time of the OU12 RI/FS, response actions were completed that reduced metal loading to both surface and groundwater in all the major source areas.

Metal levels in ground water have shown decreasing trends in monitoring wells near specific mine waste features such as Apache Tailing Impoundment and Oregon Gulch Tailing Impoundment. The decrease in cadmium concentrations in ground water near these features ranged between 80-85% from 1995 to 2008. Groundwater data from the appropriate locations provides demonstration of this decrease.

Cadmium at monitoring well AP1TMW16s, below the Apache Tailing Impoundment, decreased from 220ug/L to 44.2 ug/L and decreased from 700 ug/L to 108 ug/L at OG1TMW3, below the Oregon Gulch Tailing Impoundment.

While there are response actions planned for OUs 5, 11, and possibly 6, these response actions are not specifically designed to significantly reduce metal contamination in groundwater, although some improvement in groundwater quality is expected.

Predictive analysis of the timeframes to attain required clean up levels and demonstration that no other remedial technologies could reliably, logically, or feasibly attain clean up levels at the site within a reasonable timeframe.

Source control remedies such as capping can leave large amounts of waste in place. This left-in-place-waste can still impact surface and groundwater due to it's proximity to those water bodies. The metals left behind are slowly flushed out and water quality improves with time.

An example of this is the Oregon Gulch tailing impoundment (OU10). This tailing impoundment is very large (485,000 cubic yards, 14.2 acres) and has been capped in place with seep collection at the toe of the impoundment. The downstream well that monitors groundwater associated with this pile has shown a 10-fold reduction in metal contamination since implementation of the remedy. The well still has elevated metal contamination but it is expected that additional improvements will be realized.

A similar situation exists throughout Lower California Gulch (OU8) and to a lesser extent in Upper California Gulch (OU4) and Stray Horse Gulch (OU6). The result is that groundwater quality has greatly improved since the inception of remedial actions (1992) and continues to improve with time—this trend is expected to continue.

Even though all planned response actions to remediate metal loading to shallow groundwater have been implemented, the shallow groundwater in California Gulch (OU4 and 8), Stray Horse Gulch (OU6), and Oregon Gulch (OU10) is contaminated with elevated levels of heavy metals.

Since the shallow aquifer has not been specifically classified by the State and is considered a potential drinking water source, the maximum contaminant level (MCL) for drinking water are default Applicable or Relevant and Appropriate Requirements (ARARs). For the California Gulch Superfund site, the metals of concern in that category are cadmium and lead.

In general, investigations have shown that the top 35-50' of the shallow aquifer (particularly in Lower California Gulch) is contaminated with metals. Below about 50' the water meets the MCLs and in some cases, local residents and at least one business uses well water. EPA tests the areas of the shallow aquifer 50' or lower below ground surface at least twice a year and has not detected areas of concern.

The areas where the MCLs are exceeded in the shallow aquifer are either within, next to, or immediately downstream of tailing piles or historically impacted mine waste areas. The most heavily impacted areas are Apache Tailing pile (OU7—capped in 2001), Oregon Gulch Tailing impoundment (OU10--capped in 1998), the Yak Tunnel Surge pond (OU1—constructed on a tailing impoundment), Stray Horse Gulch waste rock piles (OU6), the Colorado Zinc Lead (CZL) mill tailing impoundment (in OU8--removed to the Oregon Gulch cap in 1998), miscellaneous waste deposits throughout the Site, and fluvial deposits in the flood plain (OU11) of the Arkansas River from historic mining practices.

Exceedance of the federal lead action level and State MCL (15 ug/L) only occurs in a few locations, generally the Apache Tailing pile (OU7), the Yak Tunnel surge pond (OU1), the CZL tailing impoundment, and a fluvial deposit in the flood plain of the Arkansas River near the confluence with California Gulch.

The cadmium MCL is 5 ug/L (both State and federal) and is exceeded at more locations but generally in the same areas as lead (i.e., under or near tailing, waste rock, and fluvial deposits).

It is possible with time that MCLs would be met within a reasonable time (i.e. 100 years) in shallow groundwater where relatively small amounts of waste were deposited (e.g., lower California Gulch). However, for the larger tailing and waste rock piles such as Apache Tailing, Oregon Gulch, the Yak Tunnel surge pond, OU6 waste rock, MCLs will not be met within the capped piles or waste rock within a reasonable time frame.

Due to the large extent of waste left in place, large scale-high cost excavation of waste would have to occur to have any reasonable chance of MCLs being met within a reasonable time frame (100 years). Likely costs would be in the hundreds of millions of dollars.

Cost Considerations

The OU12 Feasibility study estimated that removing or capping all mine waste piles throughout the Site that have not already been addressed would have a capitol cost of $142 million. To remove all waste in OU1 (Yak Tunnel), the surge pond and other large areas would have to be moved. This could potentially affect the operations of the treatment plant and the plant itself might have to be torn down and moved. The likely costs would be very high, with a minimum of $50 million in capitol costs—with actual costs likely to be much higher. The operations and maintenance costs would be minimal compared to the initial capitol costs. Given the disruption to operations at the treatment plant and likely inability to continue treating water discharging from the Yak Tunnel, this remedy is not a practical or logical alternative.

For OU7 (Apache Tailing Impoundment) and OU10 (Oregon Gulch Impoundment), excavation of the capped tailing piles would be required for there to be any hope of MCLs being met. However, a location to move the piles would have to be found and a repository built.

The estimated capitol costs, in 2000 for removal of the Apache Tailing pile (OU7) was $11 million to $13 million. Estimated O&M costs were around $85,000 although based on current management of the capped pile, this estimate is probably high.

The Oregon Gulch (OU10) feasibility study did not advance a remedy that involved complete removal. However, given the size of the tailing pile, estimated cost would be similar to that of OU7.

To have a reasonable chance of meeting MCLs in lower California Gulch, waste rock, mine waste, etc would have to be removed down to a depth of 50' by 100-200' wide for approximately 4 miles. The disruption and damage to the drainage itself would be enormous. Although EPA did not do a cost estimate, this alternative is not a realistic alternative due to costs, potential damage to the drainage, and general disruption to the community.

A very large (likely several hundred acres in size) repository would be required to hold all the excavated waste if all these response actions were to take place.

Total cost of all excavation and removal remedies would be at a minimum $200 million and much likely higher. In addition, there is also no guarantee that the MCLs would be met in all areas, even if the excavations and removals were to be implemented.

Given the large area (several square miles) over which MCLs are exceeded, there is no other known technology that could effectively reduce metal levels in the affected areas to meet the required standard.

Additional information

Residents of Leadville and nearby areas of Lake County are served by Parkville Water District for their drinking water. Areas not served by Parkville use well water. Testing has revealed no drinking water wells exceeding MCLs since the mid-1980s.

Therefore, EPA is granting/extending a waiver of MCLs for lead and cadmium in the shallow alluvial aquifer down to a depth of 50' in California Gulch, Oregon Gulch, and Stray Horse Gulch and a small area of the Arkansas Valley Flood plain near the confluence of California Gulch (see attached map).

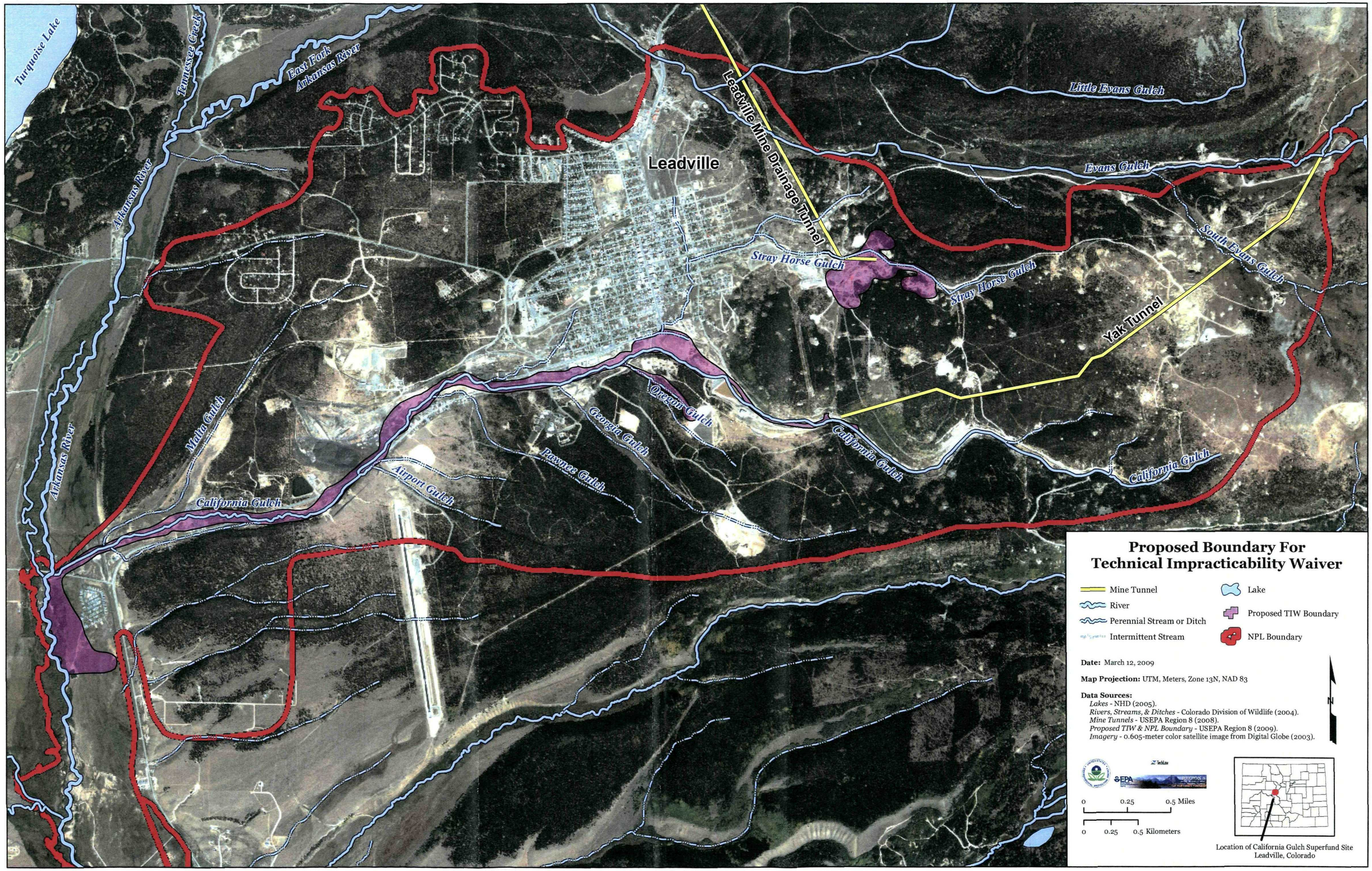

Turquoise Lake
Tennessee Creek
East Fork Arkansas River
Arkansas River
Leadville
Leadville Mine Drainage Tunnel
Little Evans Gulch
Evans Gulch
South Evans Gulch
Stray Horse Gulch
Stray Horse Gulch
Yak Tunnel
Oregon Gulch
Georgia Gulch
California Gulch
California Gulch
California Gulch
Pawnee Gulch
Airport Gulch
Malta Gulch
Arkansas River
Proposed Boundary For
Technical Impracticability Waiver
Mine Tunnel
River
Perennial Stream or Ditch
Intermittent Stream
Lake
Proposed TIW Boundary
NPL Boundary
Date: March 12, 2009
Map Projection: UTM, Meters, Zone 13N, NAD 83
Data Sources:
Lakes - NHD (2005).
Rivers, Streams, & Ditches - Colorado Division of Wildlife (2004).
Mine Tunnels - USEPA Region 8 (2008).
Proposed TIW & NPL Boundary - USEPA Region 8 (2009).
Imagery - 0.605-meter color satellite image from Digital Globe (2003).
N
0 0.25 0.5 Miles
0 0.25 0.5 Kilometers
Location of California Gulch Superfund Site
Leadville, Colorado

Table 6-1

Ground Water Quality for Selected Wells

Chemical	Risk-Based Conc. (ug/L)	OG1TMW3 (Near Oregon Gulch Tailings)		AP1TMW1 (Near Apache Tailings)		CZ1TMW1 (Near Stringtown)	
		1991-1995	2001-2005	1991-1995	2001-2005	1991-1995	2001-2005
Arsenic	5.7	200	12	3.3	0.50	2.4	3.0
Cadmium	18	440	220	290	71	110	130
Lead	15	31	11	620	220	1.9	29
Manganese	380	1,800,000	840,000	250,000	120,000	22,000	17,000
Zinc	4,700	800,000	290,000	160,000	55,000	46,000	41,000

Concentration values rounded to two significant figures.
Based on dissolved fraction (non-detects evaluated at ½ the detection limit).
Risk-based concentration from EPA, 1996b.

Table 6-2

Comparison of Metals in Surface Water with Federal Drinking Water Requirements and Guidelines

Analyte	Location	Regulatory Value (ug/L)	Long-term Mean (ug/L)	Frequency of Values > Regulatory Value
Arsenic	AR-1	10[a]	2.8	0.0%
	AR-3A		2.2	0.0%
	CG-6		3.1	0.0%
Cadmium	AR-1	5[a]	0.2	0.0%
	AR-3A		0.7	0.4%
	CG-6		15.0	68.6%
Copper	AR-1	1,300[b]	1.6	0.0%
	AR-3A		1.7	0.0%
	CG-6		16.4	46.6%
Lead	AR-1	15[b]	0.2	0.0%
	AR-3A		0.5	0.0%
	CG-6		19.0	9.9%
Zinc	AR-1	5,000[c]	72.7	0.0%
	AR-3A		306	0.0%
	CG-6		5386	47.8%

[a] Maximum Contaminant Level (MCL)

[b] Lead and copper are regulated by a Treatment Technique that requires systems to control the corrosiveness of their water.

[c] Secondary MCL

Table 6-3

Potential Risks to Current or Future Ranchers

Risk Category	Value
Total non-cancer HQ	3E-01 – 9E-03
Total cancer risk	6E-05 – 2E-06
Risk from lead (P10)	0.1% - 2.4%

Table 6-4

Predicted Phytotoxicity for the Upper Arkansas

Mean Phytotoxicity Score	Interpretation	Number of Stations	Estimated total Acreage
<= 0.5	Minimal	70	1032
0.5-1.0	Moderate	33	883
1.0-1.5	High	18	111
> 1.5	Severe	5	2.8

Table 6-5

Estimated Risks to Herbivores from Ingestion of Contaminated Plants and Soil

Receptor	Frequency of HQ Values for Herbivores (Soil plus plant intake)					
	HQ(total) ≤ 1		HQ(total) = 2 - 4		HQ(total) ≥ 5	
	Count	%	Count	%	Count	%
Horse	115	91%	10	8%	1	1%
Cattle	121	96%	4	3%	1	1%
Deer	123	98%	2	2%	1	1%
Vole	122	97%	2	2%	2	2%
Most Sensitive	**115**	**91%**	**9**	**7%**	**2**	**2%**

Table 6-6. Chronic HQ Values for Zinc

Zinc	Hardness (mg/L)																	
(ug/L)	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190
100	0.80	0.54	0.41	0.33	0.28	0.24	0.21	0.19	0.17	0.15	0.14	0.13	0.12	0.11	0.11	0.10	0.10	0.09
125	1.00	0.67	0.51	0.41	0.35	0.30	0.26	0.23	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.13	0.12	0.11
150	1.20	0.81	0.61	0.49	0.41	0.36	0.31	0.28	0.25	0.23	0.21	0.20	0.18	0.17	0.16	0.15	0.14	0.14
175	1.39	0.94	0.72	0.58	0.48	0.42	0.37	0.33	0.30	0.27	0.25	0.23	0.21	0.20	0.19	0.18	0.17	0.16
200	1.59	1.08	0.82	0.66	0.55	0.48	0.42	0.37	0.34	0.31	0.28	0.26	0.24	0.23	0.22	0.20	0.19	0.18
225	1.79	1.21	0.92	0.74	0.62	0.54	0.47	0.42	0.38	0.35	0.32	0.30	0.28	0.26	0.24	0.23	0.22	0.20
250	1.99	1.35	1.02	0.82	0.69	0.60	0.52	0.47	0.42	0.39	0.35	0.33	0.31	0.29	0.27	0.25	0.24	0.23
275	2.19	1.48	1.12	0.91	0.76	0.66	0.58	0.51	0.46	0.42	0.39	0.36	0.34	0.31	0.30	0.28	0.26	0.25
300	2.39	1.62	1.23	0.99	0.83	0.72	0.63	0.56	0.51	0.46	0.43	0.39	0.37	0.34	0.32	0.30	0.29	0.27
325	2.59	1.75	1.33	1.07	0.90	0.77	0.68	0.61	0.55	0.50	0.46	0.43	0.40	0.37	0.35	0.33	0.31	0.30
350	2.79	1.89	1.43	1.15	0.97	0.83	0.73	0.65	0.59	0.54	0.50	0.46	0.43	0.40	0.38	0.35	0.34	0.32
375	2.99	2.02	1.53	1.24	1.04	0.89	0.79	0.70	0.63	0.58	0.53	0.49	0.46	0.43	0.40	0.38	0.36	0.34
400	3.19	2.16	1.63	1.32	1.11	0.95	0.84	0.75	0.68	0.62	0.57	0.53	0.49	0.46	0.43	0.41	0.38	0.36
425	3.39	2.29	1.74	1.40	1.18	1.01	0.89	0.80	0.72	0.66	0.60	0.56	0.52	0.49	0.46	0.43	0.41	0.39
450	3.59	2.43	1.84	1.48	1.24	1.07	0.94	0.84	0.76	0.69	0.64	0.59	0.55	0.51	0.48	0.46	0.43	0.41
475	3.79	2.56	1.94	1.57	1.31	1.13	1.00	0.89	0.80	0.73	0.67	0.62	0.58	0.54	0.51	0.48	0.46	0.43
500	3.98	2.70	2.04	1.65	1.38	1.19	1.05	0.94	0.85	0.77	0.71	0.66	0.61	0.57	0.54	0.51	0.48	0.46
525	4.18	2.83	2.15	1.73	1.45	1.25	1.10	0.98	0.89	0.81	0.74	0.69	0.64	0.60	0.56	0.53	0.50	0.48
550	4.38	2.97	2.25	1.81	1.52	1.31	1.15	1.03	0.93	0.85	0.78	0.72	0.67	0.63	0.59	0.56	0.53	0.50
575	4.58	3.10	2.35	1.90	1.59	1.37	1.21	1.08	0.97	0.89	0.82	0.76	0.70	0.66	0.62	0.58	0.55	0.52
600	4.78	3.24	2.45	1.98	1.66	1.43	1.26	1.12	1.01	0.93	0.85	0.79	0.73	0.69	0.65	0.61	0.58	0.55
625	4.98	3.37	2.55	2.06	1.73	1.49	1.31	1.17	1.06	0.96	0.89	0.82	0.76	0.71	0.67	0.63	0.60	0.57
650	5.18	3.51	2.66	2.14	1.80	1.55	1.36	1.22	1.10	1.00	0.92	0.85	0.79	0.74	0.70	0.66	0.62	0.59
675	5.38	3.64	2.76	2.23	1.87	1.61	1.41	1.26	1.14	1.04	0.96	0.89	0.83	0.77	0.73	0.68	0.65	0.61
700	5.58	3.77	2.86	2.31	1.94	1.67	1.47	1.31	1.18	1.08	0.99	0.92	0.86	0.80	0.75	0.71	0.67	0.64
725	5.78	3.91	2.96	2.39	2.01	1.73	1.52	1.36	1.23	1.12	1.03	0.95	0.89	0.83	0.78	0.74	0.70	0.66
750	5.98	4.04	3.07	2.47	2.07	1.79	1.57	1.40	1.27	1.16	1.06	0.98	0.92	0.86	0.81	0.76	0.72	0.68
775	6.18	4.18	3.17	2.55	2.14	1.85	1.62	1.45	1.31	1.20	1.10	1.02	0.95	0.89	0.83	0.79	0.74	0.71
800	6.38	4.31	3.27	2.64	2.21	1.91	1.68	1.50	1.35	1.23	1.13	1.05	0.98	0.92	0.86	0.81	0.77	0.73
825	6.58	4.45	3.37	2.72	2.28	1.97	1.73	1.54	1.39	1.27	1.17	1.08	1.01	0.94	0.89	0.84	0.79	0.75
850	6.77	4.58	3.47	2.80	2.35	2.03	1.78	1.59	1.44	1.31	1.21	1.12	1.04	0.97	0.91	0.86	0.82	0.77
875	6.97	4.72	3.58	2.88	2.42	2.09	1.83	1.64	1.48	1.35	1.24	1.15	1.07	1.00	0.94	0.89	0.84	0.80
900	7.17	4.85	3.68	2.97	2.49	2.15	1.89	1.68	1.52	1.39	1.28	1.18	1.10	1.03	0.97	0.91	0.86	0.82
925	7.37	4.99	3.78	3.05	2.56	2.21	1.94	1.73	1.56	1.43	1.31	1.21	1.13	1.06	0.99	0.94	0.89	0.84
950	7.57	5.12	3.88	3.13	2.63	2.26	1.99	1.78	1.61	1.47	1.35	1.25	1.16	1.09	1.02	0.96	0.91	0.87
975	7.77	5.26	3.99	3.21	2.70	2.32	2.04	1.82	1.65	1.50	1.38	1.28	1.19	1.12	1.05	0.99	0.94	0.89
1000	7.97	5.39	4.09	3.30	2.77	2.38	2.10	1.87	1.69	1.54	1.42	1.31	1.22	1.14	1.08	1.01	0.96	0.91

Table 6-7. Screening-Level Correlation Analysis Between Water Quality and Trout Population Indices for the Upper Arkansas River

Panel	Time Lag	Population Metric (Station AR-3A)	Exposure Metric (Station AR-3A)	N	R
A	None	Density (Length >= 10)	Maximum HQ	8	-0.67
		Density (Length >= 15)	Maximum HQ	7	-0.61
		Biomass	Maximum HQ	7	-0.69
		Density (Length >= 10)	Average HQ	8	-0.56
		Density (Length >= 15)	Average HQ	7	-0.57
		Biomass	Average HQ	7	-0.72
		Density (Length >= 10)	Freq>1	8	-0.53
		Density (Length >= 15)	Freq>1	7	-0.58
		Biomass	Freq>1	7	-0.75
		Density (Length >= 10)	Freq>2	8	-0.44
		Density (Length >= 15)	Freq>2	7	-0.51
		Biomass	Freq>2	7	-0.59
B	Off-set by 1 yr	Density (Length >= 10)	Maximum HQ	5	-0.59
		Density (Length >= 15)	Maximum HQ	4	-0.14
		Biomass	Maximum HQ	4	-0.70
		Density (Length >= 10)	Average HQ	5	-0.69
		Density (Length >= 15)	Average HQ	4	-0.20
		Biomass	Average HQ	4	-0.85
		Density (Length >= 10)	Freq>1	4	-0.56
		Density (Length >= 15)	Freq>1	4	-0.04
		Biomass	Freq>1	4	-0.77
		Density (Length >= 10)	Freq>2	4	NA
		Density (Length >= 15)	Freq>2	4	NA
		Biomass	Freq>2	4	NA
C	Off-set by 2 yrs	Density (Length >= 10)	Maximum HQ	5	-0.52
		Density (Length >= 15)	Maximum HQ	5	-0.40
		Biomass	Maximum HQ	5	-0.87
		Density (Length >= 10)	Average HQ	5	-0.52
		Density (Length >= 15)	Average HQ	5	-0.34
		Biomass	Average HQ	5	-0.66
		Density (Length >= 10)	Freq>1	5	-0.33
		Density (Length >= 15)	Freq>1	5	0.06
		Biomass	Freq>1	5	-0.51
		Density (Length >= 10)	Freq>2	5	-0.61
		Density (Length >= 15)	Freq>2	5	-0.59
		Biomass	Freq>2	5	-0.71

Panel	Time Lag	Population Metric (Station AR-3A / AR-1)	Exposure Metric (Station AR-3A / AR-1)	N	R
D	None	Density (Length >= 10)	Maximum HQ	3	--
		Density (Length >= 15)	Maximum HQ	6	-0.81
		Biomass	Maximum HQ	6	-0.75
		Density (Length >= 10)	Average HQ	3	--
		Density (Length >= 15)	Average HQ	6	-0.72
		Biomass	Average HQ	6	-0.69
E	Off-set by 1 yr	Density (Length >= 10)	Maximum HQ	2	--
		Density (Length >= 15)	Maximum HQ	3	--
		Biomass	Maximum HQ	3	--
		Density (Length >= 10)	Average HQ	2	--
		Density (Length >= 15)	Average HQ	3	--
		Biomass	Average HQ	3	--
F	Off-set by 2 yrs	Density (Length >= 10)	Maximum HQ	2	--
		Density (Length >= 15)	Maximum HQ	4	-0.66
		Biomass	Maximum HQ	4	-0.78
		Density (Length >= 10)	Average HQ	2	--
		Density (Length >= 15)	Average HQ	4	-0.59
		Biomass	Average HQ	4	-0.69

Panel	Time Lag	Population Metric (Station AR-3A / AR-1)	Exposure Metric (Station (AR-3A)	N	R
G	None	Density (Length >= 10)	Maximum HQ	3	--
		Density (Length >= 15)	Maximum HQ	7	-0.66
		Biomass	Maximum HQ	7	-0.69
		Density (Length >= 10)	Average HQ	3	--
		Density (Length >= 15)	Average HQ	7	-0.71
		Biomass	Average HQ	7	-0.74
		Density (Length >= 10)	Freq>1	3	--
		Density (Length >= 15)	Freq>1	7	-0.67
		Biomass	Freq>1	7	-0.73
		Density (Length >= 10)	Freq>2	3	--
		Density (Length >= 15)	Freq>2	7	-0.66
		Biomass	Freq>2	7	-0.65
H	Off-set by 1 yr	Density (Length >= 10)	Maximum HQ	3	--
		Density (Length >= 15)	Maximum HQ	5	-0.75
		Biomass	Maximum HQ	5	-0.97
		Density (Length >= 10)	Average HQ	3	--
		Density (Length >= 15)	Average HQ	5	-0.23
		Biomass	Average HQ	5	-0.45
		Density (Length >= 10)	Freq>1	3	--
		Density (Length >= 15)	Freq>1	6	-0.39
		Biomass	Freq>1	6	-0.49
		Density (Length >= 10)	Freq>2	3	--
		Density (Length >= 15)	Freq>2	6	-0.50
		Biomass	Freq>2	6	-0.47
I	Off-set by 2 yrs	Density (Length >= 10)	Maximum HQ	3	--
		Density (Length >= 15)	Maximum HQ	6	-0.72
		Biomass	Maximum HQ	6	-0.65
		Density (Length >= 10)	Average HQ	3	--
		Density (Length >= 15)	Average HQ	6	-0.72
		Biomass	Average HQ	6	-0.73
		Density (Length >= 10)	Freq>1	3	--
		Density (Length >= 15)	Freq>1	6	-0.62
		Biomass	Freq>1	6	-0.50
		Density (Length >= 10)	Freq>2	3	--
		Density (Length >= 15)	Freq>2	6	-0.65
		Biomass	Freq>2	6	-0.71

Cells containing "--" did not have at least 4 matched data pairs in the data set.
Cells containing "NA" do not have a correlation value because the denominator was equal to zero

TABLE 5-8: POTENTIAL RISKS FROM SELECTED GROUNDWATER WELLS

Chemical of Potential Concern	Well OG1TMW3 (Near Oregon Gulch Tailings)			Well AP1TMW1 (Near Apache Tailings)			Well CZ1TMW1 (Near Stringtown)		
	Conc (µg/L)[a]	RME HQ	RME Risk	Conc (µg/L)[a]	RME HQ	RME Risk	Conc (µg/L)[a]	RME HQ	RME Risk
Arsenic	420	38	7E-03	360	33	6E-03	50	5	9E-04
Cadmium	430	24		300	17		310	17	
Zinc	700,000	150		280,000	60		60,000	13	
Copper	4,900	3		1,000	0.6		370	0.2	
Manganese	1,700,000	4,600		470,000	1,300		34,000	90	
Silver	ND[b]	--		ND	--		10	0.1	

[a] All values rounded to two significant figures
[b] ND = Not detected

Table 6-8 (Table 5-8 form the 1996 Human Health Baseline Risk Assessment.)

Table 4-1

Effects of Yak Plant Discharge on HQ at AR-3A

March, 2005

Date	Yak Plant Status	CG-6			HQ	
		Flow -cfs	Zinc – ug/L	Hardness Mg/L	AR-3A	AR-1
3/13/05	OFF	0.9	170	198	0.12	0.02
3/16/05	ON	1.5	725	607	0.42	0.02

From OU12 RI report showing effects of Yak Tunnel Treatment Plant being turned off and on at low flow.

Hardness at AR-3a on 3/13/2005 was 131 mg/L and on 3/16/2005, 238 mg/L.

At low flow, the Yak Treatment plant does add some hardness at station AR-3a.

Table 6-9

Table 9-1

Comparative Analysis of Surface Water Alternatives Using NCP Criteria

Evaluation Criteria	SW1 - No action	SW1a - No Additional Action with Institutionl Controls and Monitoring	SW2- Route Yak Plant discharge below OU5 with IC	SW3a - Route Leadville storm sewer discharge below OU5 with IC	SW3b - Route Yak Plant effluent to new storm sewer constructed under Alternative 3a with IC	SW4 - Construct in-stream detention facility with IC	SW5 - Relocate California Gulch/Arkansas River confluence with IC	SW6 - Consolidate and cover mine waste piles with IC	SW7 - Site-wide Water Treatment Facility with IC
Effectiveness									
Overall Protection of Human Health and Environment	Maintains improvements in water quality resulting from prior response actions. However, the lack of ICs to restrict use of Site water reduces the protectiveness of this alternative for humans.	Maintains improvements in water quality resulting from prior response actions. IC restricting use of Site waters will protect human health. Monitoring would ensure continued protectiveness or need for further action.	Potential for further reduction in metal loads to the Arkansas River. Level of improvement cannot be quantified without treatability study. IC restricting use of Site waters will protect human health.	See Alternative SW2	See Alternative SW2	Reduction in metal loading in California Gulch of up to 57% would be achieved under a reoccurrence of the worst case condition between 2002 and 2005. IC restricting use of Site waters will protect human health.	Reduction in zinc concentration below mixing zone of relocated confluence estimated at 19% based on the sole set of paired flow and concentration data (for a single day in 2001) during the period 2000-2005. However, limited available data introduces significant uncertainty into this estimate of remedy performance. IC restricting use of Site waters will protect human health.	Although difficult to quantify, the comprehensive nature of this alternative is expected to result in a large decline in metal loading to California Gulch. Similar response actions in OU6 (in combination with storm water management and ARD collection and treatment) resulted in a 99% decline in metal loading to Stray Horse Gulch. ICs restricting use of Site waters will protect human health.	Treatment of California Gulch flows is expected to result in the greatest decline in metal loading to the Arkansas River. ICs restricting use of Site waters will protect human health.
Compliance with ARARs	Compliance with current and proposed chemical-specific ARARs for surface water expected in a reasonable time frame. Location- and action-specific ARARs do not apply to No-Action Alternative.	Compliance with current and proposed chemical-specific ARARs for surface water expected in a reasonable time frame. Location- and action-specific ARARs do not apply.	The potential benefit of this alternative on water quality is uncertain. However, It is expected that current and proposed chemical-specific ARARs for surface water would be met in shorter time frame than under Alternative SW1a. This alternative will comply with location- and action-specific ARARs.	See Alternative SW2	See Alternative SW2	Likelihood of compliance with current and proposed chemical-specific ARARs for surface water is considered to be high. Compliance with chemical-specific ARARs for ground water not expected in a reasonable time frame. This alternative will comply with location- and action-specific ARARs.	Compliance with current and proposed chemical-specific ARARs for surface water expected in a reasonable time frame. It is expected that these ARARs would be met in shorter time frame than under Alternative SW1. Compliance with chemical-specific ARARs for ground water not expected in a reasonable time frame. This alternative will comply with location- and action-specific ARARs.	Based on the comprehensive scope of this alternative, the likelihood of compliance with current and proposed chemical-specific ARARs is considered to be high. This alternative will comply with location- and action-specific ARARs.	Likelihood of compliance with current and proposed chemical-specific ARARs is considered to be high. Compliance with chemical-specific ARARs for ground water not expected in a reasonable time frame. This alternative will comply with location- and action-specific ARARs.
Long-Term Effectiveness	Water quality improvements achieved to date would be maintained. Residual risks include potential for HQ>1 at Arkansas River point(s) of compliance (POC) and the potential for human exposure to Site waters resulting in risks above a level of concern.	Water quality improvements achieved to date would be maintained. Would be protective of human health and the environment.	Remedy components, including ICs would require near perpetual operation and maintenance. Residual risks include potential for HQ>1 at Arkansas River POC.	See Alternative SW2	See Alternative SW2	Remedy components, including ICs would require near perpetual operation and maintenance. Residual risks include potential for HQ>1 at Arkansas River POC during flow conditions that overwhelm the detention capacity.	See Alternative SW2	permanence through relatively minimal maintenance of final cover material. Full protection would be achieved several years after remedial action. Residual risks would include a low probability of HQ>1 in the Arkansas River. ICs would require enforcement until risks from Site waters were	Remedy components, including ICs would require near perpetual operation and maintenance. Little residual risk would remain.
Reduction of Toxicity, Mobility and Volume Through Treatment	No reduction in toxicity, mobility or volume as no treatment is proposed under this alternative.	No reduction in toxicity, mobility or volume as no treatment is proposed under this alternative.	See Alternative SW1.	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	A reduction in waste toxicity and mobility would be achieved through the fixation of dissolved metals. The generation of solid waste (treatment residuals) would constitute an increase in waste volume.
Short Term Effectiveness	Involves no further remedial action		Does not result in disturbance of mine wastes. Protection achieved upon completion of remedial action.	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	Risks to the community above a level of concern are not anticipated as most unremediated mine wastes are remote from populated areas. Some short-term risks will be posed to workers. Cultural impacts would be significant as all remaining mine waste features would be disturbed or destroyed.	See Alternative SW2
Implementability									
Technical Feasibility	No Action Required	Monitoring is underway at the site, continued monitoring is technically feasible.	Pipeline technology is well established and proven technology.	See Alternative SW2	See Alternative SW2	Technical elements of the remedy are readily available proven technologies. However, a slope stability study would be required to support liner system design where slopes exceed 3:1.	Pipeline technology is well established and proven technology.	The technologies proposed under this alternative are identical to those implemented successfully under prior response actions.	Alkaline water treatment technology is well established and proven.
Administrative Feasibility	No Action Required	Institutional Controls have been passed by Lake County for other	No clear mechanism available to restrict use of Site waters.	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2
Availability of Services and Materials	No Action Required	the site and is expected to continue.	Services and materials are readily available	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2
Acceptance	Assessed during FFS comment period	period.	Assessed during FFS comment period	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2
Anticipated Community Acceptance	Assessed during FFS comment period	Assessed during FFS comment period.	Assessed during FFS comment period	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2	See Alternative SW2
Cost									
Capital Costs	$0	$5,000	$1,528,000	$5,304,000	$5,800,000	$6,858,000	$3,746,000	$54,970,000	$142,003,000	$18,386,000
30-Year Net Present Value Annual Costs	$0		$3,560,000	$3,560,000	$3,560,000	$4,033,000	$3,560,000	$3,602,000	$3,602,000	$14,038,000
30-Year Net Present Value Periodic Costs	$0		$232,000	$734,000	$800,000	$319,000	$518,000	$122,000	$29,000	$520,000
30-year Net Present Value Total Costs	$0	$1,340,000	$5,320,000	$9,598,000	$10,160,000	$11,210,000	$7,824,000	$58,694,000	$145,634,000	$32,944,000

Table 9-2
Comparative Analysis of Ground Water Alternatives Using NCP Criteria

Evaluation Criteria	GW1 - No Action	GW1a - No Addition Action, Institutional Controls, Monitoring, and a Technical Impracticability Waiver for Groundwater	GW2 - Intercept and treat contaminated groundwater at the mouth of California Gulch with IC	GW3 - Dewater capped Apache and Oregon Gulch Tailing with IC
Effectiveness				
Overall Protection of Human Health and Environment	Maintains improvements in water quality resulting from prior response actions, the lack of ICs to restrict use of Site water reduces the protectiveness of this alternative for humans.	Maintains improvements in water quality resulting from prior response actions. Expect further improvements with time from prior remedies. Instutional Controls to prevent use of shallow groundwater for human consumption would be protective of human health. Remedy is protective of human health and the environment.	An average 13% reduction in zinc loading to the Arkansas River is estimated under a reoccurrence of worst case conditions during the period 2002-2005. However, considerable measurement error is suspected to be associated with this estimate. ICs restricting use of Site waters will protect human health.	Reduction in metal loading in California Gulch of up to 48% may be achieved under a reoccurrence of the worst case condition between 2002 and 2005. Actual reduction in metal loading is likely to be less than 48%. IC restricting use of Site waters will protect human health.
Compliance with ARARs	Compliance with current and proposed chemical-specific ARARs for surface water expected in a reasonable time frame. Compliance with chemical-specific ARARs for ground water not expected in a reasonable time frame. Location- and action-specific ARARs do not apply to No-Action Alternative.	Surface water is expected to meet ARARs within a reasonable time-frame. Due to volume of waste left in place, not expected to meet MCLs in shallow groundwater. Technical impracticability waiver needed because MCLs not expected to be met.	The potential benefit of this alternative on surface water quality is uncertain. In addition, the effect on Site-wide groundwater quality is expected to be negligible. Therefore, it is not possible to predict the degree of compliance with chemical-specific ARARs beyond that achieved under Alternative GW1. This alternative will comply with location- and action-specific ARARs.	The potential benefit of this alternative on surface water quality is expected to be significant. However, it is not clear whether current or proposed chemical-specific ARARs for surface water would be met shortly after remedial action. It is expected that these ARARs would be met in shorter time frame than under Alternative SW1. Compliance with chemical-specific ARARs for ground water not expected in a reasonable time frame. This alternative will comply with location- and action-specific ARARs.
Long-Term Effectiveness	Water quality improvements achieved to date would be maintained. Residual risks include potential for HQ>1 at Arkansas River POC and the potential for human exposure to Site waters resulting in risks above a level of concern.	Expect continued improvement in groundwater quality. Expect that institutional controls restricting use of shallow groundwater will protect human health . Do not expect shallow groundwater to be issue to surface water for long-term effectiveness.	Remedy components, including ICs would require near perpetual operation and maintenance. Residual risks include potential for HQ>1 at Arkansas River POC.	Remedy components, including ICs would require near require perpetual operation and maintenance. However, the possibility exists for elimination of the water treatment portion of the remedy after years or decades of operation. Residual risks include potential for HQ>1 at Arkansas River POC.
Reduction of Toxicity, Mobility and Volume Through Treatment	No reduction in toxicity, mobility or volume as no treatment is proposed under this alternative.	No reduction in toxicity, mobility or volume as no treatment is proposed under this alternative.	A reduction in waste toxicity and mobility would be achieved through the fixation of dissolved metals. The generation of solid waste (treatment residuals) would constitute an increase in waste volume.	See Alternative GW2
Short Term Effectiveness	Involves no further remedial action	No immediate reduction in contamination in shallow groundwater. Institutional control would provide restrictions to use of shallow groundwater for human consumption.	Does not result in disturbance of mine wastes. Protection achieved several years after completion of remedial action.	Does not result in disturbance of mine wastes. Protection achieved upon completion of remedial action.
Implementability				
Technical Feasibility	No Action Required	Monitioring on-site is ongoing	Extraction wells, lift stations and pipelines are proven technologies. The Yak Treatment Plant has been proven to be effective at treating ARD.	Qualified contractor indicated technical feasibility based on available information.
Administrative Feasibility	No Action Required	TI wavier and Instituitonal Controls should be feasible--Institutional contols passed by Lake County on other operable units.	EPA does not own the Yak Treatment Plant. No clear mechanism available to restrict use of Site waters.	See Alternative GW2
Availability of Services and Materials	No Action Required	Monitioring on-site is ongoing	Services and materials are readily available	See Alternative GW2
Anticipated State Acceptance	Assessed during FFS comment period	Assessed during FFS comment period	Assessed during FFS comment period	See Alternative GW2
Anticipated Community Acceptance	Assessed during FFS comment period	Assessed during FFS comment period	Assessed during FFS comment period	See Alternative GW2
Cost				
Capital Costs	$0	$5,000	$2,928,000	$2,721,000
30-Year Net Present Value Annual Costs	$0		$25,905,000	$25,790,000
30-Year Net Present Value Periodic Costs	$0		$2,052,000	$1,792,000
30-year Net Present Value Total Costs	$0	$1,340,000	$30,885,000	$30,303,000

Total 30-year Net Present Value (NPV):

Item	Cost
Capital Costs	$50,000
Operation and Maintenance Costs	$3,735,000
Total	**$3,785,000**

Table 11-1
Selected Remedy Cost Estimate
Alternatives SW1a and GW1a, TI Waiver, with ICs and Long-Term Monitoring

Description: The Preferred Alternative for Site-wide surface and ground water involved no remedial construction. However, IC's will be implemented to restrict the use of surface and ground water. This will minimize the likelihood of adverse human health effects from the consumption of contaminated Site water. Because Arkansas River water meets drinking water standards, the ICs will not apply to the River. Long-term monitoring of surface and ground water at Points of Compliance is part of the remedy. Additional monitoring of aquatic organisms (population/diversity) will also be part of the remedy. This monitoring will be detailed in a Monitoring Plan to be developed as part of the remedial design. Costs for this component of the remedy are based on historical monitoring costs.

Capital Cost Summary:

Capital costs for this remedy are limited to legal fees associated with establishing ICs restricting the use of Site surface and ground water. The ICs will take the form of a Lake County Ordinance. Professional judgment is the basis for a capital cost estimate of $50,000.00.

Annual and Periodic Operation and Maintenance (O&M):

Annual costs associated with enforcement of ICs are assumed to require 20% of the initial capital cost. Annual costs associated with long-term monitoring are based on actual annual costs provided by USEPA and Resurrection Mining Company ($210,000.00). Included in O&M are the periodic incremental costs associated with performing the portion of five-year reviews associated with OU12 ($10,000.00).

A summary of 30-year Net Present Value (NPV) of O&M costs based on an annual discount rate of 7% as required by USEPA Guidance (EPA, 2000) for non-federal facilities is provided in the following table:

Item/Description	Quantity	Unit	Unit Cost	Total Cost	Notes
OPERATION & MAINTENANCE COSTS					
Annual Costs					
Long-term Monitoring (avgerage annual cost)	1	LS	$ 210,000.00	$ 210,000	Quote from USEPA and Resurrection Minig Co. (04/07)
Enforcement of County Ordinance	0.2	Capital Cost	$ 50,000.00	$ 10,000	Professional judgement.
Annual Cost Subtotal				$ *220,000*	
Periodic Costs					
5-year Review (Every 5 years beginning 2012)				$ 10,000	
O&M COSTS NPV (7% discount rate over 30 years)				$ 3,734,576	Percentage based on EPA FS costing guidance.
Calculated to Year 2037					All O&M Costs have a 10% Administration and 25% Contigency added.
			TOTAL COSTS (NPV)	$ 3,734,576	

Table 12-1
Chemical-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
FEDERAL				
Clean Water Act 33 USC 1251, et seq.	Requires EPA to establish Ambient Water Quality Control Criteria (AWQC) and standards, respectively, for surface water based on use classifications and the criteria stated under Sections 304(a) and 303 of the Clean Water Act.	No	Yes	Federal Water Quality Criteria are potentially relevant and appropriate.
Clean Air Act (42 USC Sect. 7401-7642) National Ambient Air Quality Standards (40 CFR Part 50)	Establishes ambient air quality standards for certain "criteria pollutants" to protect public health and welfare.	No	No	National Ambient Air Quality Standards (NAAQS) are implemented through the New Source Review Program and State Implementation Plans (SIPs). The Federal New Source Review program address only major sources. Current air emissions from undisturbed mine waste are below a level of concern per EPA's Baseline Human health Risk Assessment, Part A (1996). Emissions associated with remedial action are addressed under Action-specific ARARs.
National Emissions Standards for Hazardous Air Pollutants (40 CFR Part 61)	Establishes emission standards for certain industrial pollutants and sources.	No	No	NESHAPs are a subset of the Clean Air Act. NESHAP's is not considered to be ARAR as discussed above.
National Primary Drinking Water Standards 40 CFR Part 141FR 8750 (1990)	Established maximum contamination levels (MCLs) for specific contaminants which are health-based standards for public drinking water systems	No	Yes	MCLs are applicable for drinking water at the tap and may be relevant and appropriate for drinking water sources.
National Secondary Drinking Water Standards 40 CFR Part 143	Establishes secondary maximum contaminant levels (SMCLs) which are non-enforceable guidelines for public drinking water systems to protect the aesthetic quality of the water.	No	No	SMCLs are potentially to be considered (TBC).
Maximum Contaminant Level Goals (MCLGs) PL No. 99-339, 100 Stat. 642 (1986), FR 8750 (1990)	Establishes drinking water quality goals set at a level at which no adverse health effects may arise with an adequate margin of safety.	No	Yes	MCLGs may be may be relevant and appropriate for drinking water sources.

Table 12-1
Chemical-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
RCRA Land Disposal Restrictions (LDRs) (40 CFR Part 268)	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may continue to be land disposed.	No	No	RCRA LDRs are not applicable because the mine wastes have been identified as extraction or beneficiation wastes that are specifically exempted from the definition of a hazardous waste. Further, waste placement pre-dates the RCRA.
Identification and Listing of Hazardous Wastes 40 CFR Part 261	Identifies those solid wastes which are subject to regulation as hazardous wastes under Parts 262 through 265, 268, and Parts 270, 271, and 124, and which are subject to the notification requirements of Section 3010 of Resource Conservation and Recovery Act of 1976 (RCRA).	No	No	Mine wastes are not hazardous wastes because the materials have been identified as extraction or beneficiation wastes that are specifically exempted from the definition of a hazardous waste. Further, waste placement pre-dates the RCRA.
STATE				
Colorado Water Quality Control Act 5-CCR-1002.31 - Basic Standards and Methodologies for Surface Water	Establishes Statewide Water Quality Standards	Yes		State Water Quality Standards are potentially applicable.
Classification and Numeric Standards for the Arkansas River Basin 5 CCR 1002-32	Establishes Water Quality Standards for specific stream segments	Yes		Applicable Waste Quality Standards have been established for the on-Site segments of the Arkansas River and California Gulch
Colorado Water Quality Control Act 5-CCR-1002.41 - Basic Standards for Groundwater	Classifies groundwater and adopts water quality standards to protect existing and potential beneficial uses.	Yes		The groundwater below California Gulch is currently unclassified and therefore the statewide "Interim Narrative Standards" may be applicable.
Primary Drinking Water Regulations 5-CCR 1003-1	Establishes health-based standards for public water systems (MCL's).	No	Yes	State drinking water standards are applicable for drinking water at the tap and relevant and appropriate at the source
Colorado Air Pollution Prevention and Control Act (5 CCR 1001-14 and 5 CCR 1001-10 Part C (I) & (II) Regulation 8)	No	No	No	Current air emissions from undisturbed mine waste are below a level of concern per EPA's Baseline Human health Risk Assessment, Part A (1996). Emissions associated with remedial action are addressed under Action-specific ARARs.

Table 12-2
Location-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Federal				
E.O. 11988 Protection of Floodplains (40 CFR 6.302 and Appendix A)	Limits activities in floodplains. Floodplain is defined as "the lowland and relatively flat areas adjoining inland and coastal waters including flood prone areas of off-shore islands, including at a minimum, that area subject to a one percent or greater chance of flooding in any given year." Federal agencies must evaluate the potential effects of actions taken in a floodplain and avoid adverse impacts from remedial activities.	Yes		Portions of OU12 lie within a 100-year floodplain. If remedial activities are conducted within the floodplain, this regulation will be applicable.
E.O. 11990 Protection of Wetlands (40 CFR 6.302(a) and Appendix A)	Minimizes adverse impacts on areas designated as wetlands.	Yes		Wetlands are present in portions of OU12 as defined in a 1992 study by Woodward Clyde. Regulations are applicable only if remedial activities impact the wetlands areas.
Clean Water Act Section 404 (33 USC 1251, et seq; 40 CFR 230, 231)	Requires federal agencies to avoid, to the extent possible, adverse impacts associated with destruction or loss of wetlands. Regulates the discharge of dredged or fill material into waters of U.S. Consultation with the Regional Response Team required.	Yes		Wetlands are present in portions of OU12 as defined in a 1992 study by Woodward Clyde. Regulations are applicable only if remedial activities impact the wetlands areas.
Endangered Species Act (16 USC 1531 et seq; 50 CFR 200, 50 CFR 402	Protects endangered species and threatened species and preserves their habitat. Requires coordination with Federal agencies for mitigation of impacts.	No	No	Provides protection for threatened and endangered species and their habitats. However, site-specific studies did not document the presence of threatened or endangered species. If threatened or endangered species are encountered during remedial activities in OU12, then requirements of the Act would be applicable.

Table 12-2
Location-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Fish and Wildlife Coordination Act (16 USC 661 et seq; 40 CFR 6.302(g))	Requires coordination with federal and State agencies on activities affecting/modifying streams or rivers if the activity has a negative impact on fish or wildlife.	Yes	No	Requires coordination with Federal and State agencies to provide protection of fish and wildlife in water resource development programs; regulates actions that impound, divert, control, or modify any body of water. If it appears that remedial activities may impact wildlife resources, EPA will coordinate with both the U.S. Fish and Wildlife Service and the Colorado Department of Natural Resources.
Rivers and Harbors Act of 1899; Section 10 (33 USC 403, 33 CFR 320-330)	Section 10 permit required for structures or work in or affecting navigable waters.	Yes		Some of the surface water in OU12 may be considered navigable waters.
Migratory Bird Treaty Act 16 USC 703 *et seq.* 50 CFR 10.13	Protects almost all native birds and certain migratory birds, their nests and eggs from unregulated takes	Yes		Response actions will be planned and implemented to avoid contact with listed birds and nests.
National Historic Preservation Act (NHPA) (16 USC 470 et seq.; 40 CFR 6.301(b); 36 CFR Part 63, Part 65, Part 800)	Requires the preservation of historic properties included in or eligible for the National Register of Historic Places and to minimize harm to National Historic Landmarks.	Yes		This Act is applicable as OU12 lies within the Leadville National Historic Landmark District. A Programmatic Agreement has been entered into between the EPA, the Advisory Council on Historic Preservation, and the Colorado State Historic Preservation Officer in accordance with Sections 106 and 110(f) of NHPA.
The Historic and Archeological Data Preservation Act of 1974 (16USC 469; 40 CFR 6.301(c))	Establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity program.	Yes		Establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity program. A cultural resource survey was completed in OU12 to identify historic properties which may be affected by remedial activity.

Table 12-2
Location-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
E.O. 11593 Protection and Enhancement of the Cultural Environment (16 USC 470)	Federal agencies directed to institute procedures to ensure programs contribute to the preservation and enhancement of non-Federally owned historic resources. Consultation with the Advisory Council on Historic Preservation required.	Yes		This Act is applicable as OU12 lies within the Leadville National Historic Landmark District. A Programmatic Agreement has been entered into between the EPA, the Advisory Council on Historic Preservation, and the Colorado State Historic Preservation Officer in accordance with Sections 106 and 110(f) of NHPA.
The Archeological Resources Protection Act of 1979 (16 USC 470aa-470ll)	Requires a permit for any excavation or removal of archeological resources from public lands or Indian lands.	No	Yes	May be relevant and appropriate if any remedial activity involves removal of archeological resources; substantive requirements need to be met.
The Historic Sites Act of 1935 (16 USC 461-467)	Enables the National Park Service to preserve historic resources for public use.	No	No	May be "applicable" if remedial activities impact areas eligible for inclusion in the Nation Register of Historic Places.
Wilderness Act (16 USC 1311, 16 USC 668; 50 CFR 53, 50 CFR 27)	Limits activities within areas designated as wilderness areas or National Wildlife Refuge Systems.	No	No	The site is not within a Federally-owned area designated as a wilderness area or a National Wildlife Refuge System.
Wild & Scenic Rivers Act (16 USC 1271; 40 CFR 6.302(e))	Protects rivers that are designated as wild, scenic, or recreational.	No	No	The Arkansas River is not listed as a Wild and Scenic River.
Resource Conservation and Recovery Act (RCRA), Subtitle D (40 CFR 258.10-15)	Facilities where treatment, storage, or disposal of solid waste will be conducted must meet certain location standards. These include location restrictions on proximity to airports, floodplains, wetlands, fault areas, seismic impact zones, and unstable areas.	Yes		Applicable if interim storage, treatment, and disposal is conducted as part of an OU12 remedial action.
State				
Colorado Historical, Prehistorical and Archeological Resources Act (Colorado Revised Statutes, Title 24, Article 80, Sections 401-411)	Establishes procedures and requires a permit for investigation, excavation, gathering, or removal from the natural State of any historical, prehistorical, or archeological resources on State lands for the benefit of recognized scientific or educational institutions. Also requires an excavation permit and notification if human remains are found on State land.	No	No	No State lands included.

Table 12-2
Location-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Register of Historic Places (Colorado Revised Statues, Title 24, Article 80, Sections 101-108)	Establishes requirements for protecting properties of historical significance.	Yes		May be applicable if remedial actions impact any property listed on the Register of Historic Places.
Colorado Non-game, Endangered, or Threatened Species Act (Colorado Revised Statutes, Title 33, Article 2, Sections 101-108)	Protects endangered and threatened species and preserves their habitats. Requires coordination with the Division of Wildlife if remedial activities impact on State-listed endangered/threatened species or their habitat.	No	No	Standards for regulation of non-game wildlife and threatened and endangered species. Site-specific studies did not document the presence of threatened or endangered species. If threatened or endangered species are encountered during remedial activities at OU12, then requirements of Act will be applicable.
Colorado Species of Special Concern and Species of Undetermined Status (Colorado Division of Wildlife Administrative Directive E-1. 1985, modified)	Protects animals listed on the Colorado Division of Wildlife generated list. Coordination with the Division of Wildlife is strongly urged if animal species are to be impacted.	No	No	Protects species listed on the Colorado Division of Wildlife generated list. Urges coordination with the Division of Wildlife if wildlife species are to be impacted. No evidence of species of special concern have been identified at this site.
Colorado Natural Areas (Colorado Revised Statutes, Title 33, Article 33, Section 104)	The Colorado Natural Areas Program maintains a list of plant species of special concern for the State. Although not protected by State statute, coordination with Division of Parks and Outdoor Recreation is recommended if activities will impact listed species.	No	No	Maintains a list of plant species of "special concern". Although not protected by State statute, coordination with Division of Parks and Outdoor Recreation is recommended if activities will impact listed species.
State Solid Waste Disposal Sites and Facilities Act (Colorado Revised Statutes, Title 30, Article 20, Sections 101-118; 6 CCR 1007-2)	Establishes regulations for solid waste management facilities including location standards.	Yes		Applicable if remedial activities involve the disposal of solid waste materials. Permits are not required for onsite activities at a site listed on the NPL.
Colorado Wildlife Act (Colorado Revised Statutes, Title 33, Article 1, Sections 101-120)	Establishes provisions governing the taking, possession, and use of wildlife and migratory birds.	No	No	Remedial actions being considered will not involve any taking, possession, or use of wildlife and migratory birds.

Table 12-3
Action-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Federal				
Clean Water Act 33 USC 1251, et seq.	Requires EPA and States to establish Ambient Water Quality Control Criteria (AWQC) and standards, respectively, for surface water based on use classifications and the criteria Stated under Sections 304(a) and 303 of the Clean Water Act.	Yes	Yes	Federal (or State) freshwater AWQCs may be relevant and appropriate to discharges from water treatment facilities if they are a part of the remedial action in OU12. Controls on non-point source discharges during construction are potentially applicable. Such discharges would be mitigated through an Erosion Control Plan.
Clean Air Act (42 USC Sect. 7401-7642) New Source Performance Standards (40 CFR 60)	Establishes emission standards for certain categories of industrial stationary sources.	No	No	National Ambient Air Quality Standards (NAAQS) are implemented through the New Source Review Program and State Implementation Plans (SIPs). The federal New Source Review program address only major sources. Emissions associated with the remedial actions considered in this ROD will be limited to fugitive dust emissions associated with earth moving activities during construction and will occur in isolated areas over a short period of time. Remedial work in OU12 would be completed in industrial zoned areas significant distances from residential areas. These remedial activities would not constitute a major source. Therefore, attainment and maintenance of NAAQS pursuant to the New Source Review Program are not ARARs. See Colorado Air Pollution Prevention and Control Act concerning the applicability of requirements implemented through the SIP.
Solid Waste Disposal Act (SWDA) as amended by the Resource Conservation and Recovery Act of 1976 (RCRA) (42 USC Sect. 6901-6987) Criteria for Classification of Solid Waste Disposal Facilities and Practices (Subtitle D) (40 CFR Parts 257)	Establishes criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health.	Yes		May be applicable to stockpiling, treatment, and disposal of non-hazardous solid waste. Selected portions of Part 257 pertaining to floodplains and air are applicable. These provisions establish criteria for classification of solid waste disposal facilities and practices. Permits are not required for on-site activities at a site listed on the NPL.
Solid Waste Closure (40 CFR 259.60 b, c, h, I, j)	Placement of cap over solid waste landfill.	Yes		May be applicable to remedial activities involving the construction of a non-hazardous landfill. Permit not required for CERCLA Sites.

Table 12-3
Action-Specific ARARs

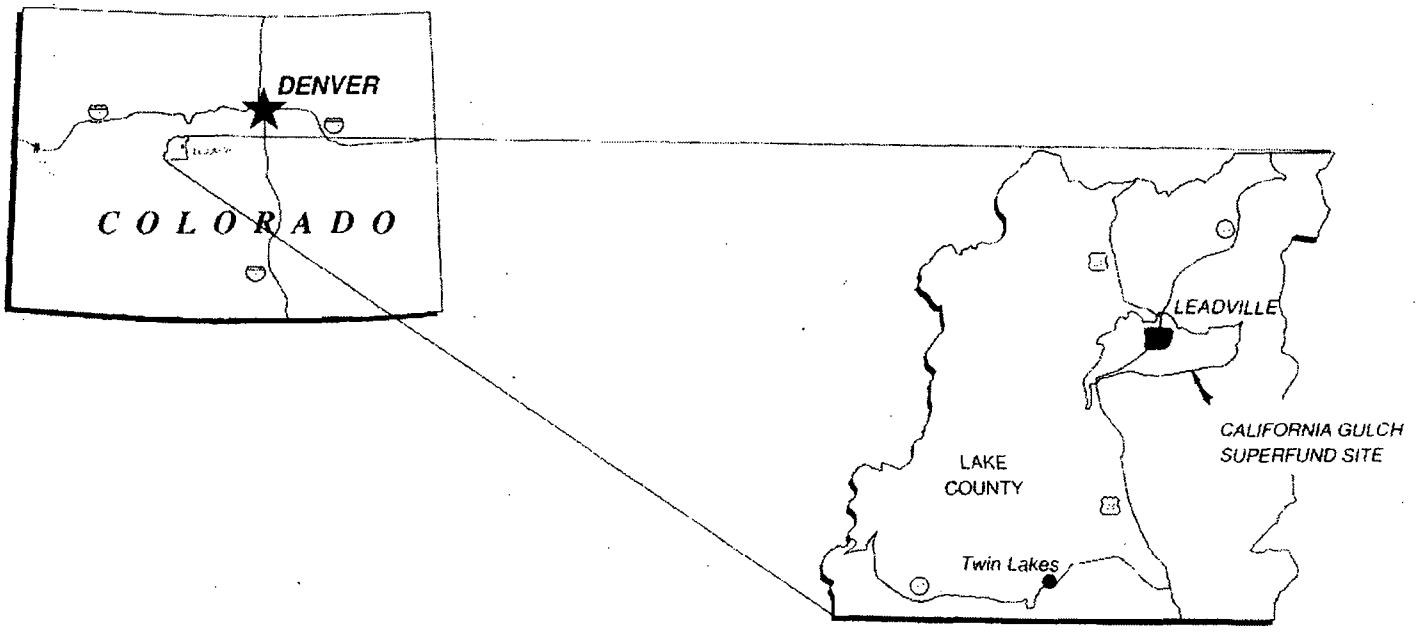
Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Identification and Listing of Hazardous Wastes (Subtitle C) 40 CFR Parts 261	Defines those solid wastes which are subject to regulation as hazardous wastes under 40 CFR Parts 262-265 and Parts 124, 270, and 271.	No	No	The State is authorized to implement this portion of RCRA and therefore, the potential ARARs arise under the State regulations.
Standards Applicable to Generators of Hazardous Waste (Subtitle C) 40 CFR Parts 262	Establishes standards for generators of hazardous waste.	No	No	The State is authorized to implement this portion of RCRA and therefore, the potential ARARs arise under the State regulations.
Standards Applicable to Transporters of Hazardous Waste (Subtitle C) 40 CFR Parts 263	Establishes standards which apply to persons transporting hazardous waste within the United States if the transportation requires a manifest under 40 CFR Part 262.	No	No	The State is authorized to implement this portion of RCRA and therefore, the potential ARARs arise under the State regulations.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (Subtitle C) 40 CFR Parts 264	Establishes minimum national standards which define the acceptable management of hazardous waste for owners and operators of facilities which treat, store, or dispose hazardous waste.	No	No	The State is authorized to implement this portion of RCRA and therefore, the potential ARARs arise under the State regulations.
Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (Subtitle C) 40 CFR Parts 265	Establishes minimum national standards which define the acceptable management of hazardous waste during the period of interim status and until certification of final closure or if the facility is subject to post-closure requirements, until post-closure requirements, until post-closure responsibilities are fulfilled.	No	No	The State is authorized to implement this portion of RCRA and therefore, the potential ARARs arise under the State regulations.
Land Disposal 40 CFR Parts 268	Prohibits land disposal of RCRA hazardous waste without treatment.	No	No	No hazardous wastes will be land disposed on-site under any of the remedial alternatives. Nothing in these regulations are relevant and appropriate to the remedial alternatives.
Hazardous Materials Transportation Act (49 USC Sect. 1801-1813; 49 CFR Parts 107, 171-177)	Regulates transportation of hazardous materials.	Yes		Applicable if remedial action entails the transportation of hazardous materials.
National Pollutant Discharge Elimination System 40 CFR Parts 122, 125	Requires permits for the discharge of pollutants from any point source into waters of the United States.	No	No	The State of Colorado has an approved program, so the State program provides any potential applicable or relevant and appropriate provisions.
State				
Environmental Covenants (CRS 25-15-317-327)	Requires environmental covenant whenever contamination left in place requires restrictions on land use.	Yes		Potentially Applicable.

Table 12-3
Action-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Colorado Water Quality Control Act 5-CCR-1002.31 - Basic Standards for Surface Water	Assigns State-wide Water Quality Standards.	Yes		State freshwater AWQCs may be applicable to discharges from water treatment facilities if they are a part of a remedial action in OU12. Non-point source discharges during construction would be mitigated through an Erosion Control Plan. CRS 28-8-101, Colorado Discharge Permit System Regulations (5-CCR -1002.61) and Regulations for Effluent Limitations (5-CCR-1002-62) are also potentially applicable to control discharges from treatment facilities.
Colorado Water Quality Control Act 5-CCR-1002.22 - Wastewater Treatment Works siting requirements	Requires Water Quality Control Division approval of the locations of wastewater treatment facilities, before commencing construction.	No	Yes	Applicable to domestic wastewater plants, but substantive requirements may be relevant and appropriate to industrial wastewater plants.
Colorado Water Quality Control Act 5-CCR-1002.82 Certification of Federal Licenses and Permits (401 Certifications)	Requires Water Quality Control Division certification that Federal licenses and permits will not cause the violation of water quality standards.	No	Yes	Licenses and Permits are not required for remedial actions in the NPL Site. However, Water Quality Control Division requirements may be relevant and appropriate.
Colorado Discharge Permit System 5CCR 1002-61	Requires permits for the discharge of pollutants from any point source into waters of Colorado.	Yes		Substantive requirements may be applicable if response actions create point source discharges. Permits not required for on-Site activities at a site listed on the NPL.
State Solid Waste Disposal Sites and Facilities Act (CRS 30-20-101 to 118) Colorado Solid Waste Management Regulations (6CCR 1007-2)	Establishes policy for licensing, locating, constructing, and operating of solid waste facilities.	No	Yes	May be relevant and appropriate to stockpiling and disposal of non-hazardous solid waste. Permits not required for on-Site activities at a site listed on the NPL.
Colorado Mined Land Reclamation Act (CRS 34-32-101 to 125) Mineral Rules and Regulations (2-CCR-407-1)	Regulates all aspects of land use for mining, including the location of mining operations and related reclamation activities and other environmental and socio-economic impacts.	No	Yes	May be relevant and appropriate to remedial activities involving drilling, water control measures, and treatment and disposal of waste piles. Permit not required for CERCLA sites.

Table 12-3
Action-Specific ARARs

Standard, Requirement or Criteria	Description	Potentially Applicable	Potentially Relevant and Appropriate	Comment
Colorado Air Quality Control Act (5-CCR-1001-1, 3, 4, 5, 8, 10)	Establishes emissions standards for PM10 and lead.	Yes		Pursuant to the Colorado Air Pollution Prevention and Control Act, applicants for construction permits are required to evaluate whether the proposed source will exceed NAAQs. Applicants are also required to evaluate whether the proposed activities would cause the Colorado ambient standard for PM10 to be exceeded. The remedial actions considered in this ROD would be completed in industrial zoned areas significant distances from residential areas. Colorado regulates fugitive emissions through Regulation No. 1. Compliance with applicable provisions of the Colorado Air Quality requirements will be achieved by adhering to a fugitive emissions control plan prepared in accordance with Regulation No. 1. Regulation 8 sets emission limits for lead. Applicants are required to evaluate whether the proposed activities would result in the Regulation 8 lead standard being exceeded. The remedial actions considered in this ROD are not expected to exceed the emission levels for lead, although some lead emissions may occur. Compliance with Regulation 8 will be achieved by adhering to a fugitive be achieved by adl accordance with Regulation No. 1. The substantive requirements of Regulation 3 are potentially applicable.
Colorado Noise Abatement Act (CRS 25-12-101 to 108)	Establishes maximum permissible noise levels for particular time periods and land use zones.	Yes		Applicable to remedial activities involving construction activities.
Regulations on the Collection of Aquatic Life (2-CCR-406-8, Ch.13, Article III, Section 1316)	Requirements governing the collection of wildlife for scientific purposes.	No	No	Remedial actions will not trigger the need for biological monitoring.
Colorado Hazardous Waste Regulations (6 CCR 1007-3, Part 264:	Regulates the handling, transportation and storage of hazardous wastes	No	Yes	The wastes have been determined to be Beville exempt and therefore the hazardous waste regulations are not applicable. Specific provisions of the hazardous waste regulations may be relevant and appropriate in certain circumstances regarding response actions involving mining wastes that are Beville exempt.

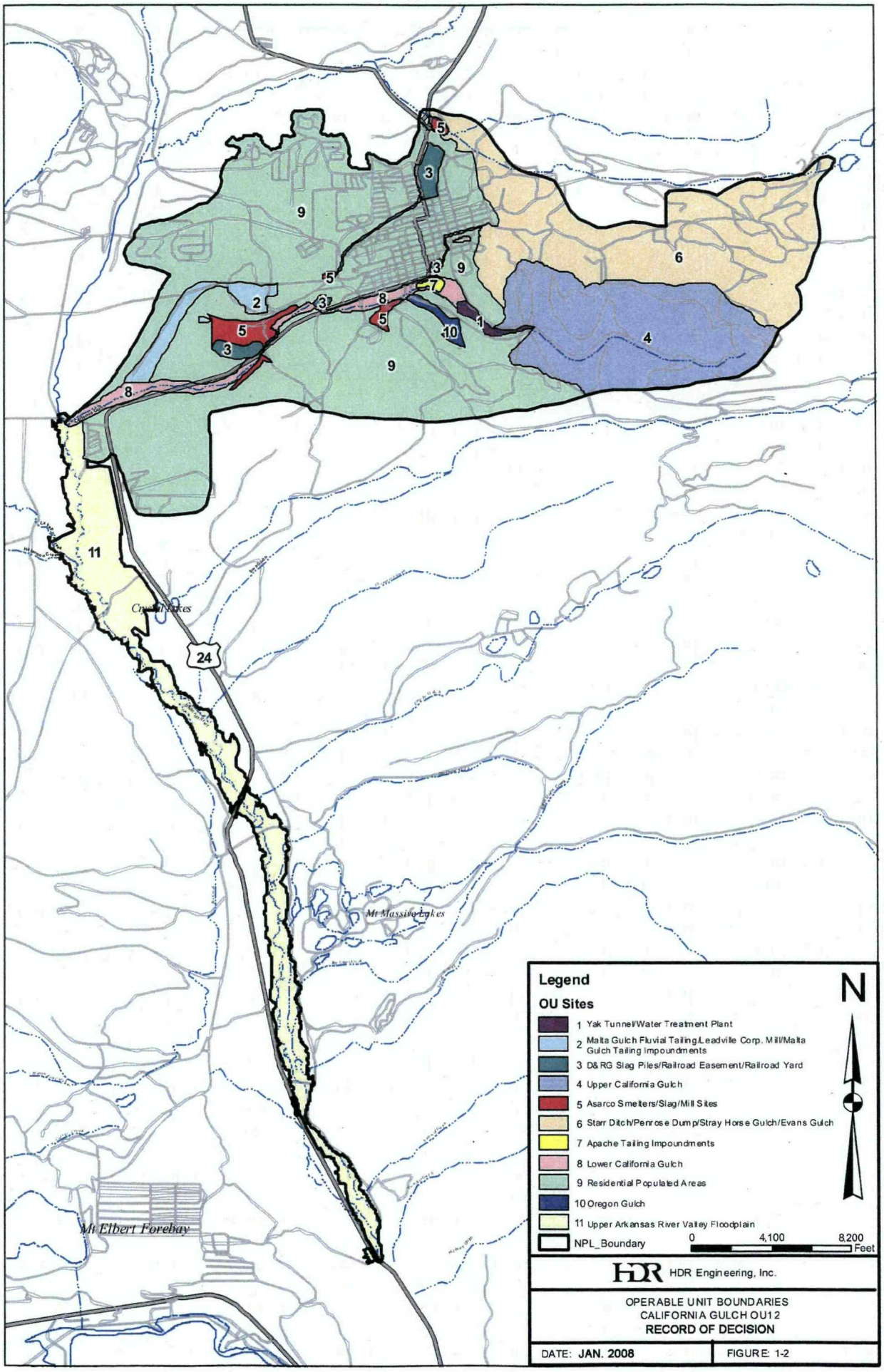


NOTES:
1. Figure after CDM Federal Programs Corporation Engineering Evaluation/Cost Analysis for Stray Horse Gulch OU6, California Gulch NPL Site, Leadville, Colorado, June 1997.

HDR Engineering, Inc.

SITE LOCATION MAP
CALIFORNIA GULCH OU12
RECORD OF DECISION

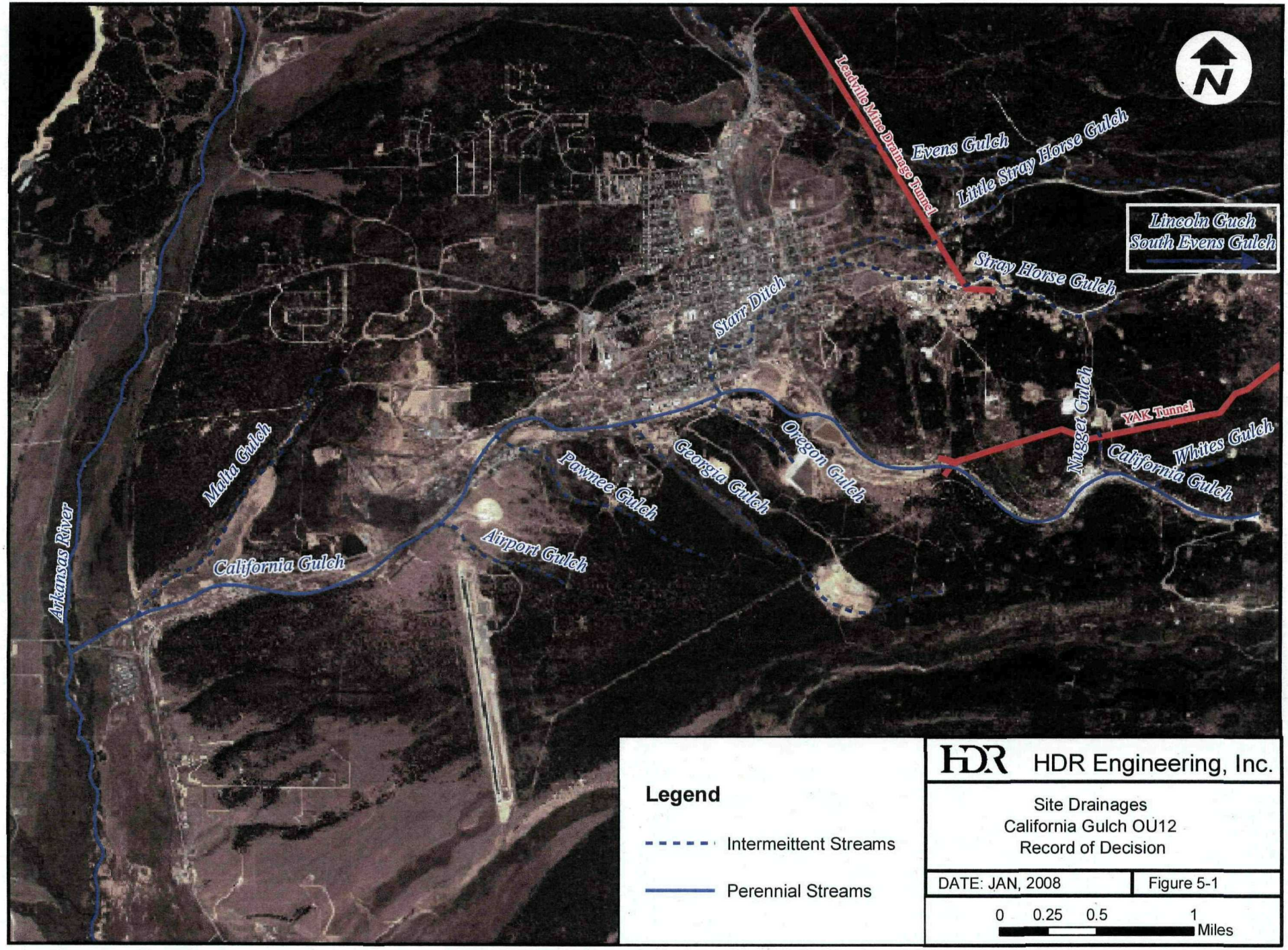
DATE: **JAN. 2008** | FIGURE 1-1

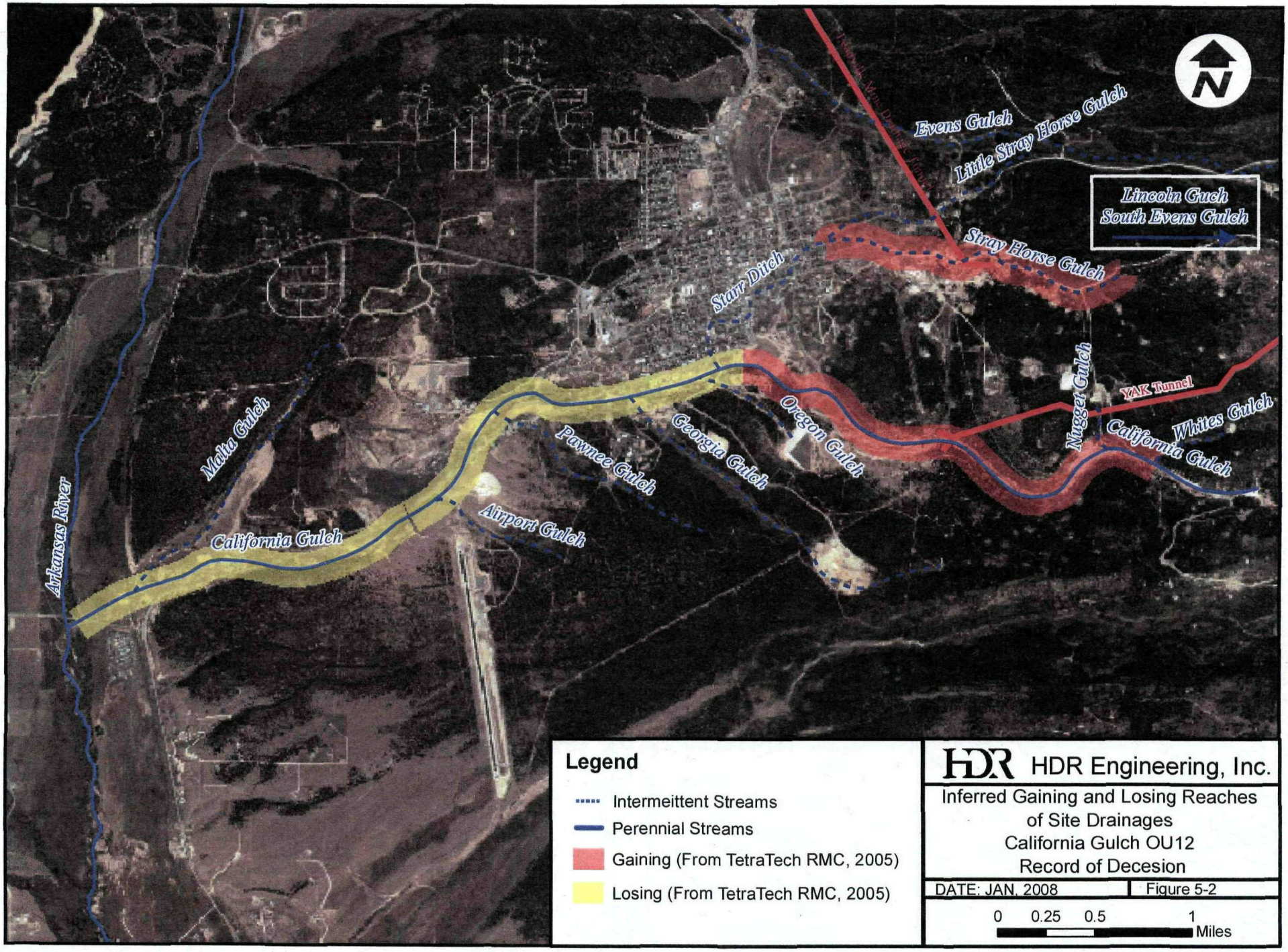


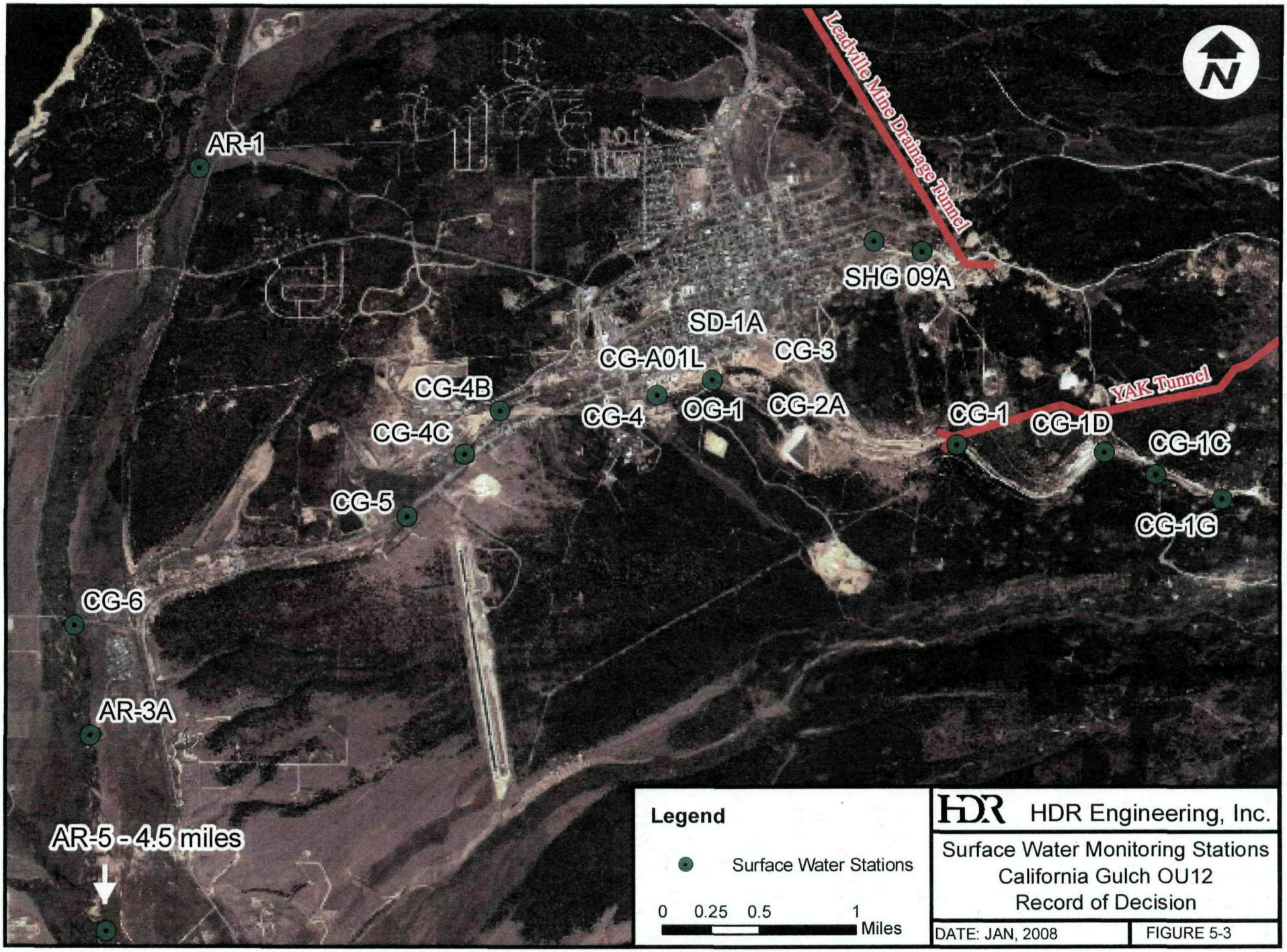
HDR Engineering, Inc.

OPERABLE UNIT BOUNDARIES
CALIFORNIA GULCH OU12
RECORD OF DECISION

DATE: **JAN. 2008** | FIGURE: 1-2


Leadville Mine Drainage Tunnel
Evens Gulch
Little Stray Horse Gulch
Lincoln Gulch
South Evens Gulch
Stray Horse Gulch
Starr Ditch
Nugger Gulch
YAK Tunnel
Whites Gulch
California Gulch
Oregon Gulch
Georgia Gulch
Pawnee Gulch
Airport Gulch
Malta Gulch
California Gulch
Arkansas River
N
Legend
Intermeittent Streams
Perennial Streams
HDR
HDR Engineering, Inc.
Site Drainages
California Gulch OU12
Record of Decision
DATE: JAN, 2008
Figure 5-1
0 0.25 0.5 1
Miles


Evens Gulch
Little Stray Horse Gulch
Lincoln Gulch
South Evens Gulch
Stray Horse Gulch
Starr Ditch
Nugger Gulch
YAK Tunnel
Whites Gulch
California Gulch
Oregon Gulch
Georgia Gulch
Pawnee Gulch
Airport Gulch
Malta Gulch
California Gulch
Arkansas River
N
Legend
Intermeittent Streams
Perennial Streams
Gaining (From TetraTech RMC, 2005)
Losing (From TetraTech RMC, 2005)
HDR Engineering, Inc.
Inferred Gaining and Losing Reaches
of Site Drainages
California Gulch OU12
Record of Decesion
DATE: JAN. 2008
Figure 5-2
0 0.25 0.5 1
Miles



HDR Engineering, Inc.

Surface Water Monitoring Stations
California Gulch OU12
Record of Decision

DATE: JAN, 2008 | FIGURE 5-3

Figure 5-4
Peak Concentration vs. Time at Station AR-3A, 1995-2008
Zinc, Dissolved

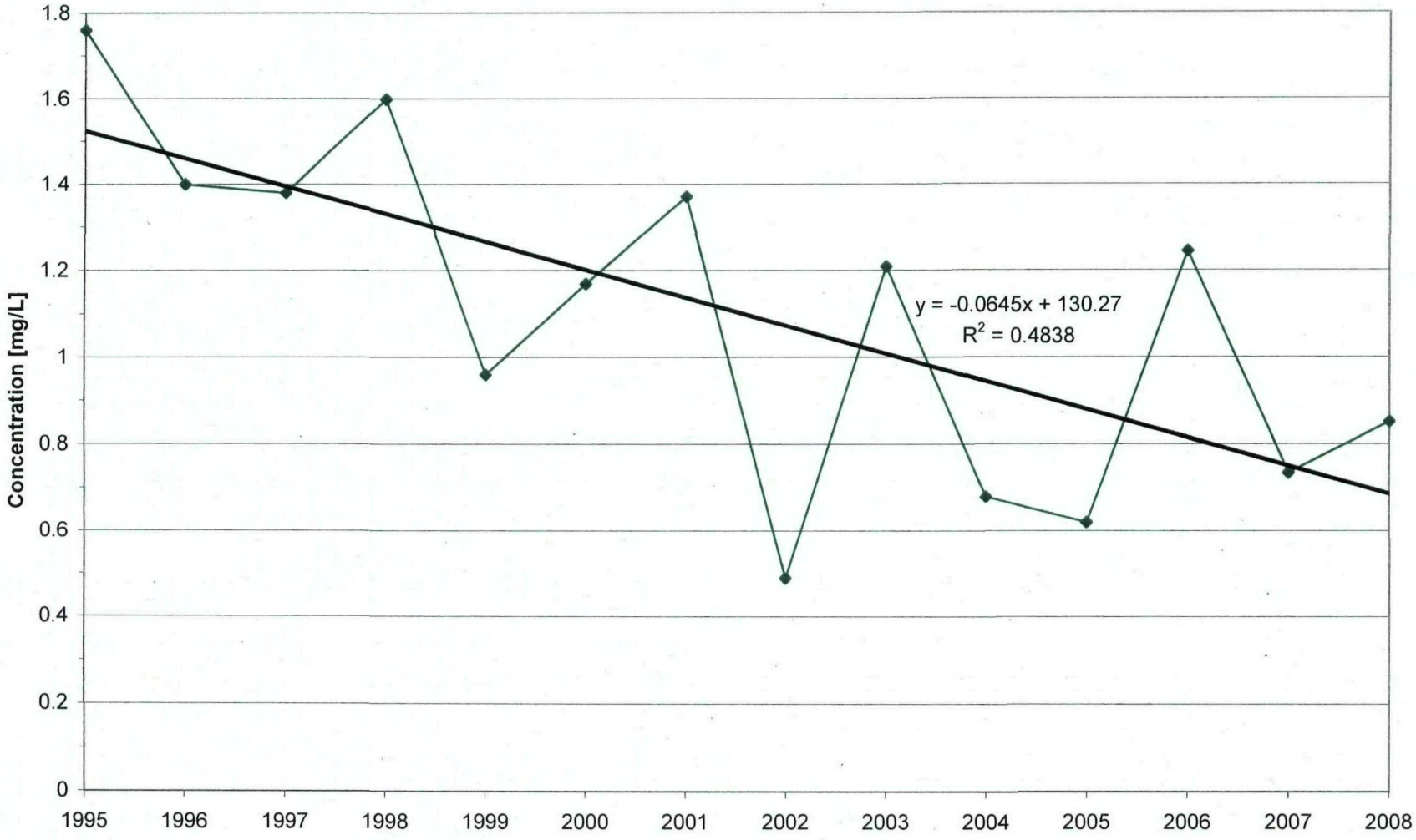


Figure 5-5
Peak Concentration vs. Time at Station AR-3A, 1995-2008
Cadmium, Dissolved

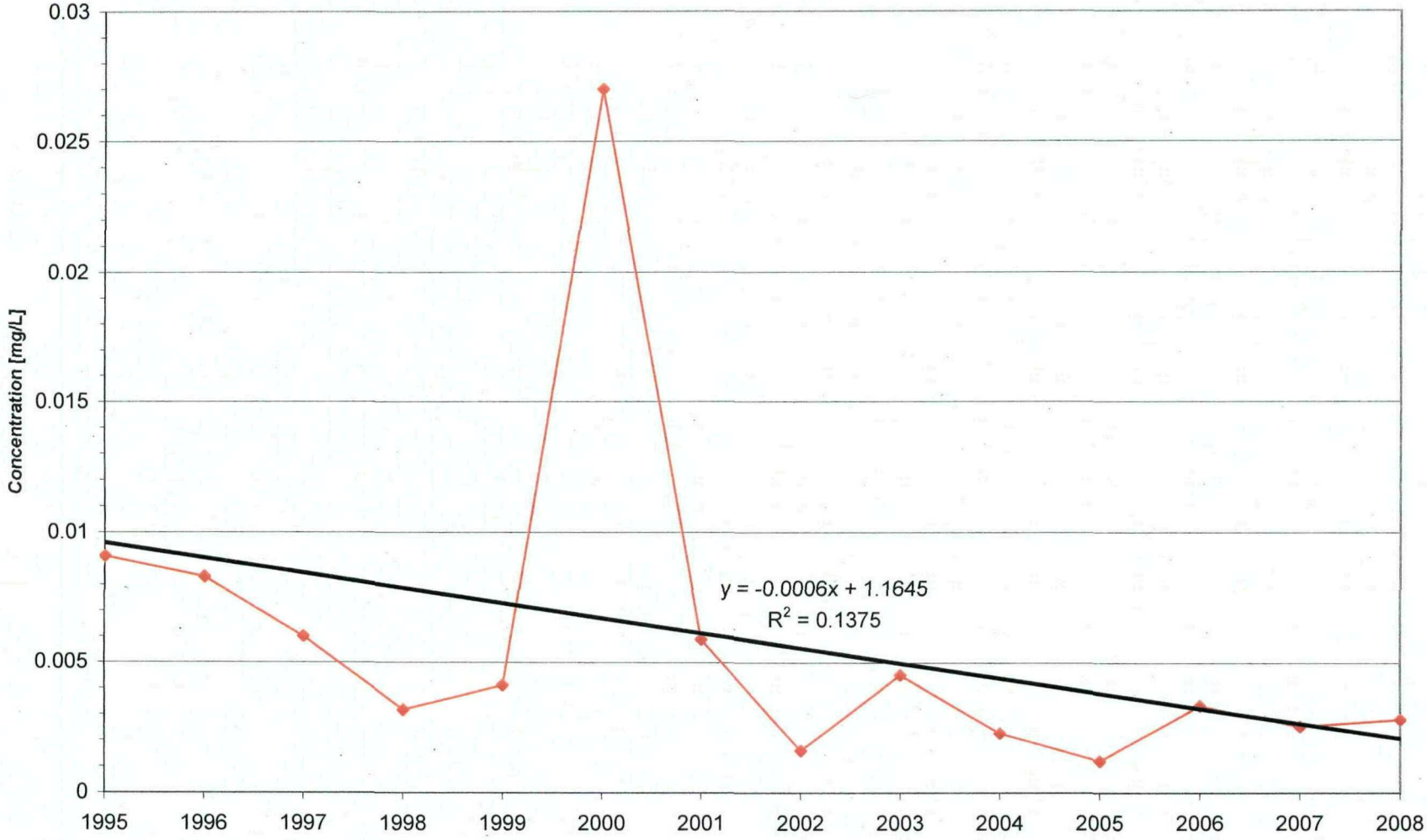


Figure 5-6
Daily Average Loading and Flow vs. Time at Station CG-6, 1995-2008
Zinc, Dissolved

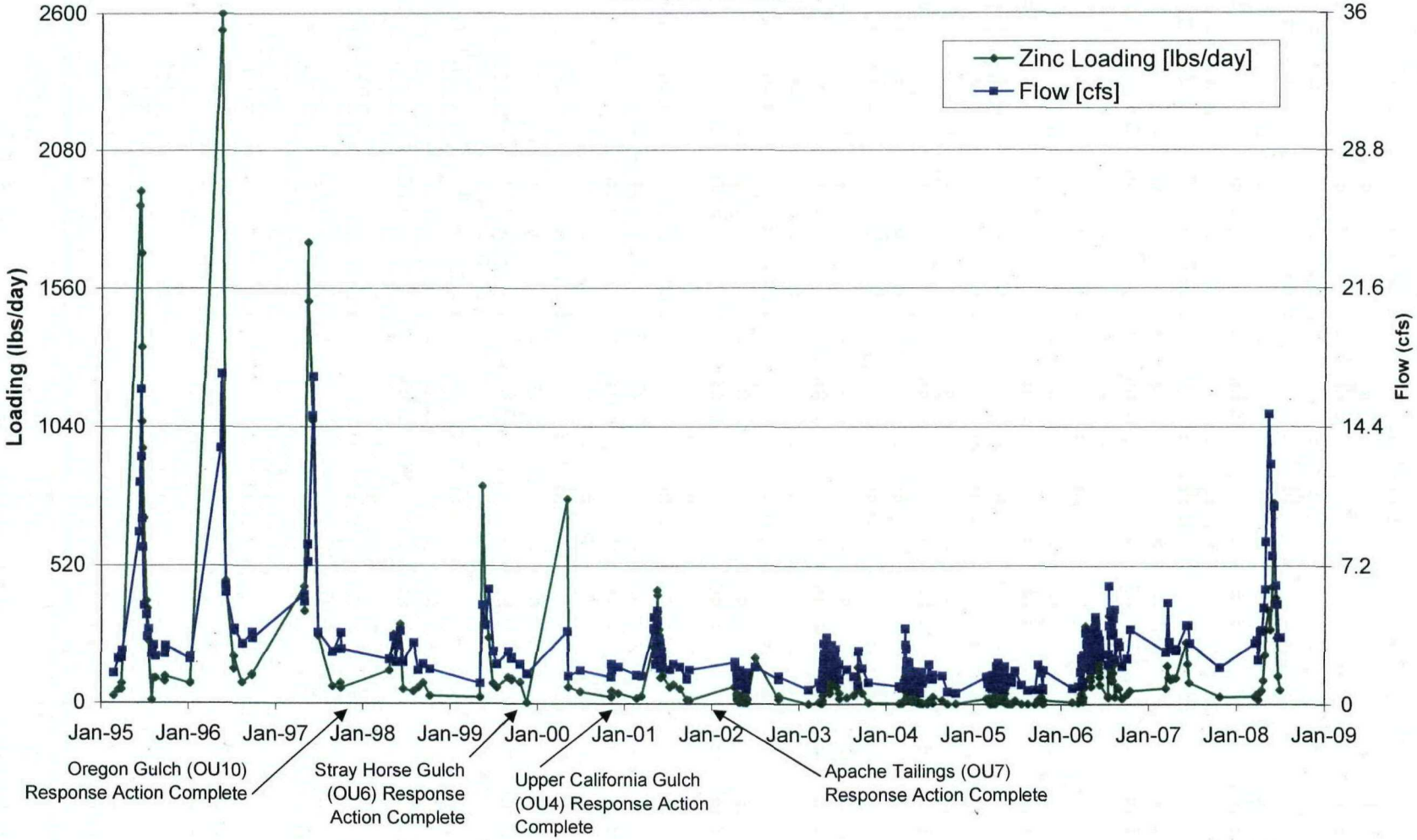


Figure 5-7
Daily Average Loading and Flow vs. Time at Station CG-6, 1995-2008
Cadmium, Dissolved

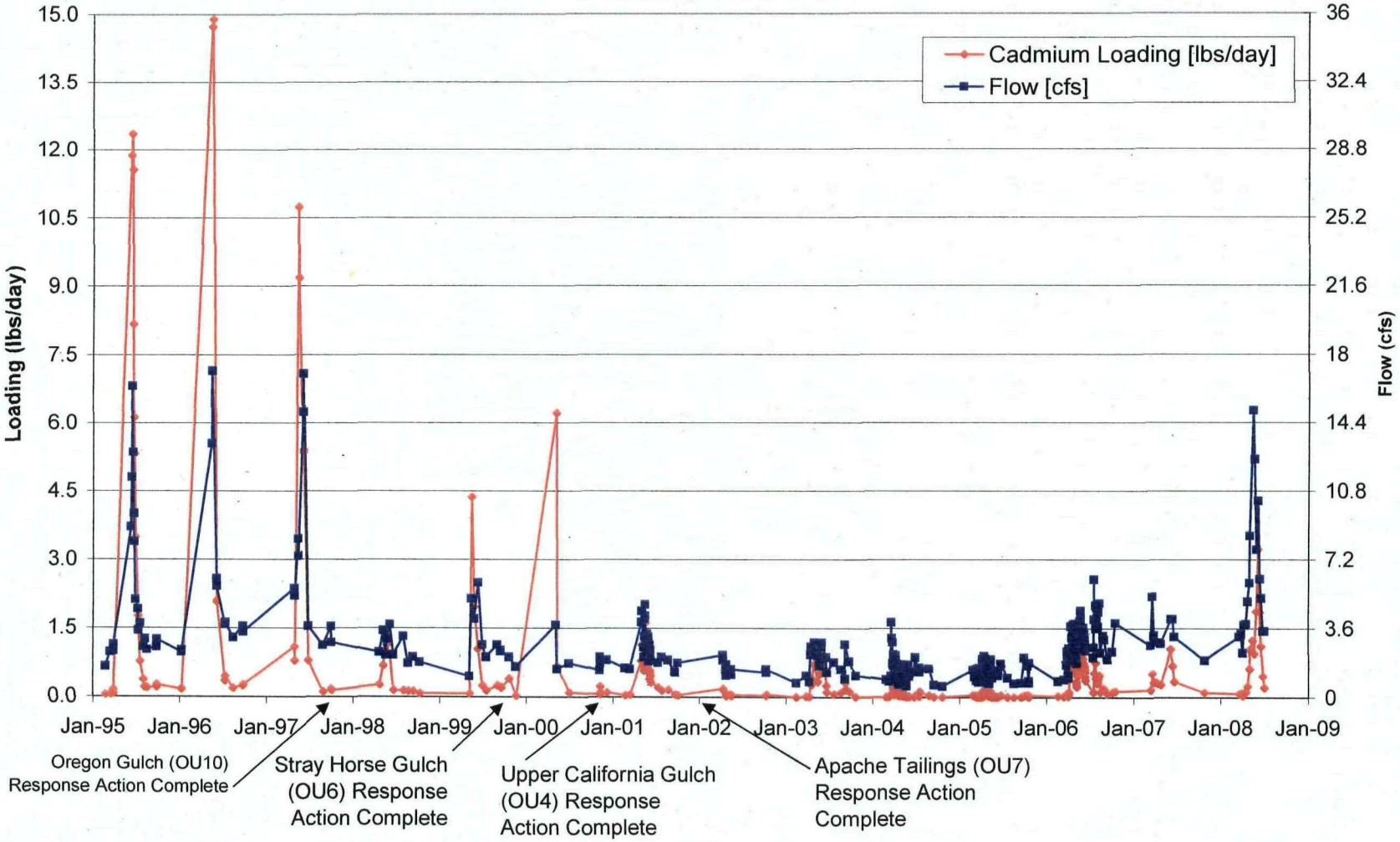


Figure 5-8
Average and Maximum Spring Concentration of Zinc at CG-6, 1995-2008

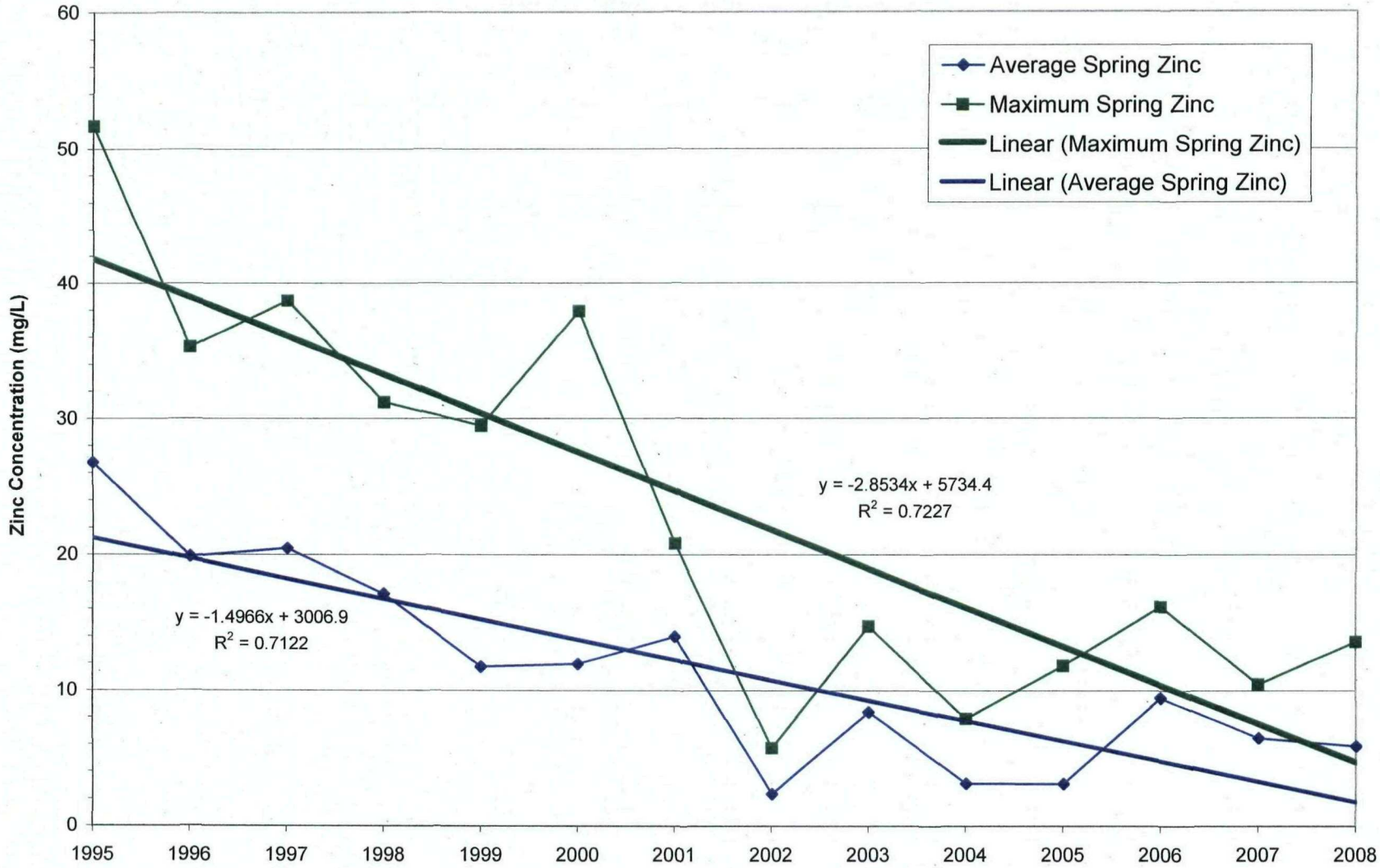
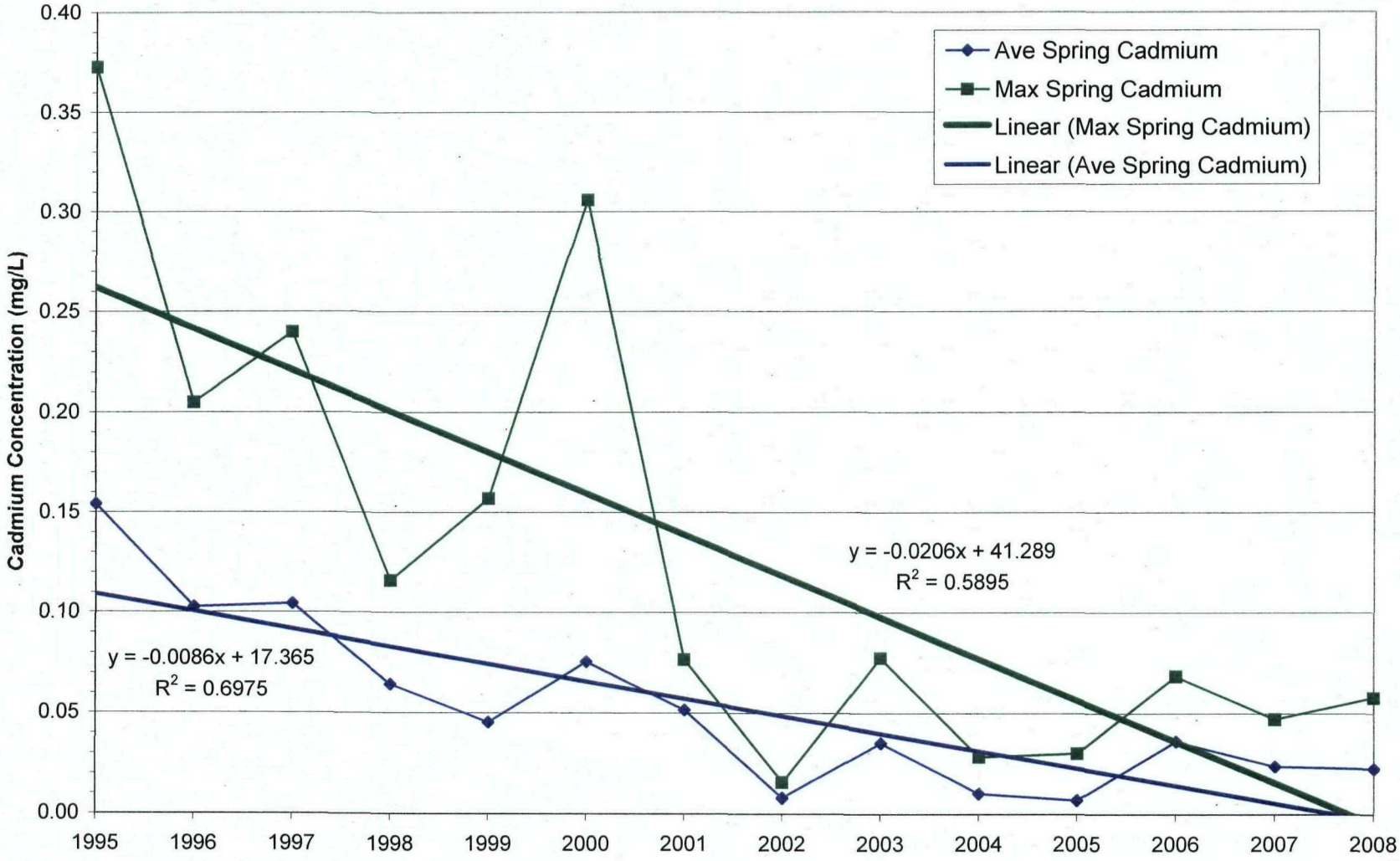
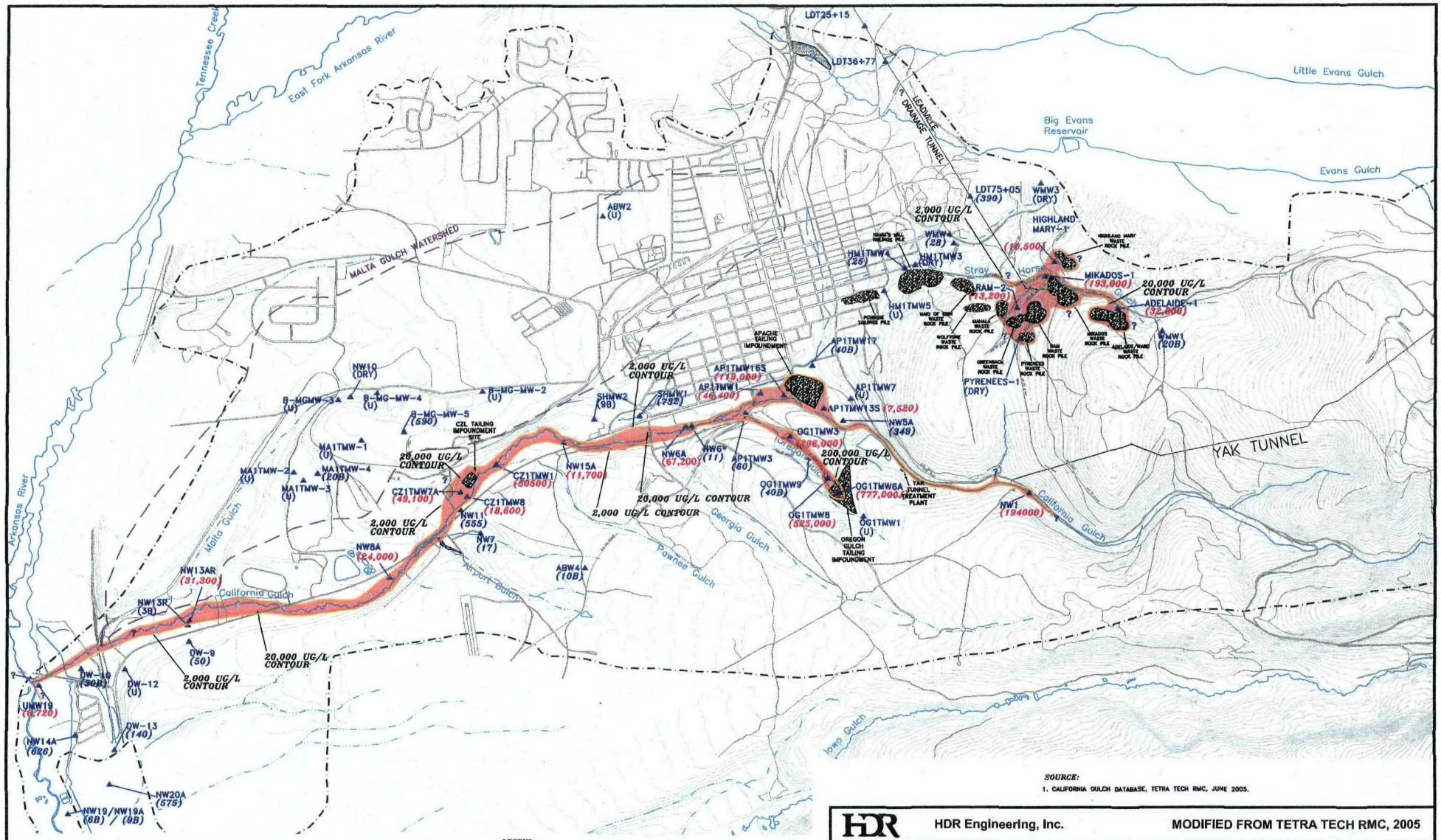


Figure 5-9
Average and Maximum Spring Concentration of Cadmium at CG-6, 1995-2008





SOURCE:
1. CALIFORNIA GULCH DATABASE, TETRA TECH RMC, JUNE 2005.

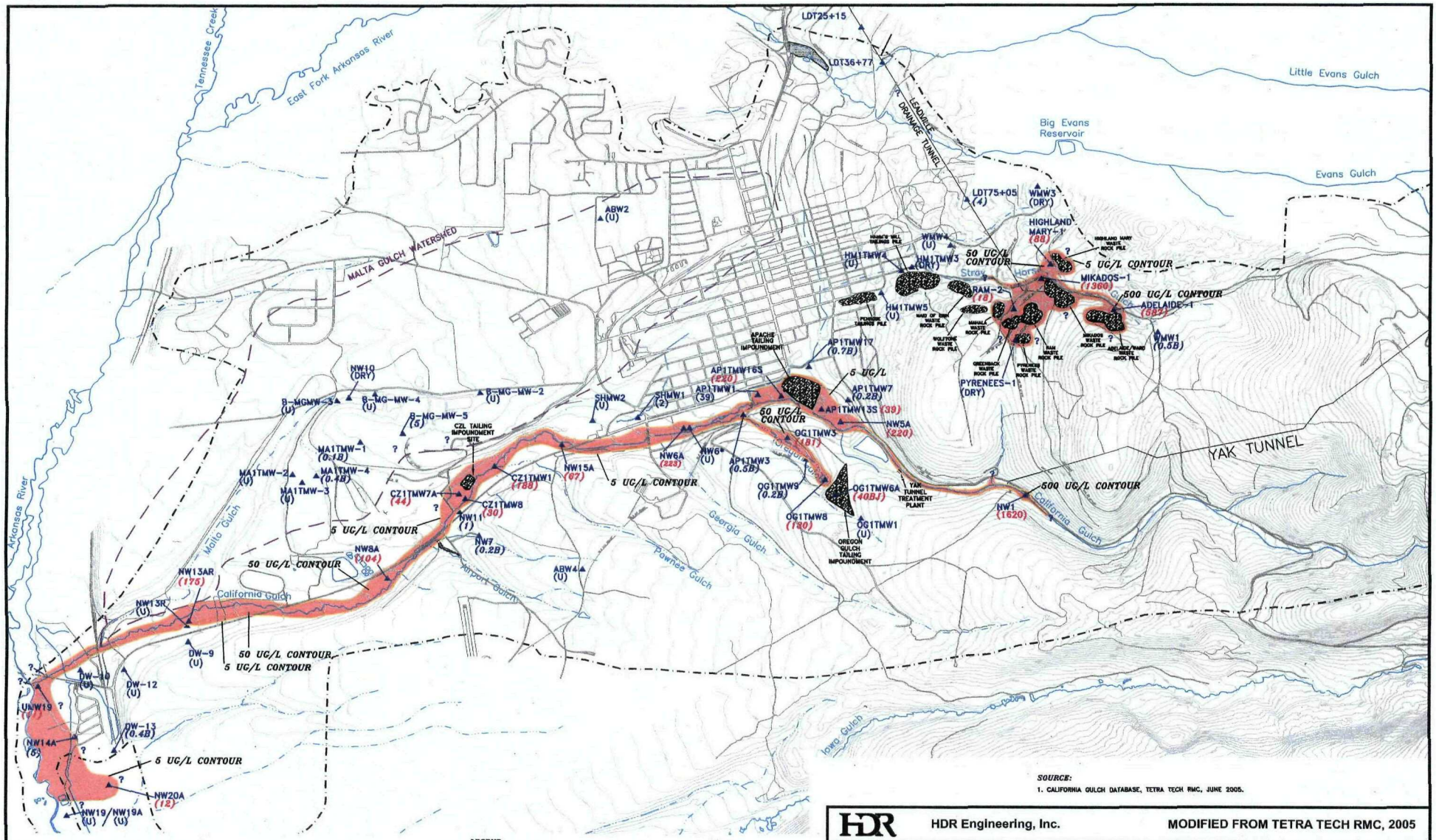
HDR Engineering, Inc.

MODIFIED FROM TETRA TECH RMC, 2005

INFERRED ALLUVIAL GROUNDWATER ZINC
EXTENT OF CONTAMINATION MAP - CALIFORNIA GULCH OU12
RECORD OF DICISION

DATE: JANUARY 2008

FIGURE 5-10



LEGEND:

UMW19 ▲ LOCATION OF MONITORING WELL OR PIEZOMETER

(11) CADMIUM CONCENTRATION FROM MOST RECENT SAMPLING EVENT IN ug/L (SEE TEXT).
RED VALUES EXCEED THE PRG (5 ug/L).
"U" INDICATES VALUE WAS BELOW MINIMUM DETECTION LIMIT (MDL) OF 0.1 ug/L.
"B" INDICATES VALUE WAS BETWEEN MDL AND PRACTICAL QUANTITATION LIMIT (5X MDL).
"J" INDICATES VALUE WAS ESTIMATED.

* CADMIUM CONCENTRATION NOT USED FOR CONTOURING

WASTE ROCK/TAILINGS PILE

SOURCE:

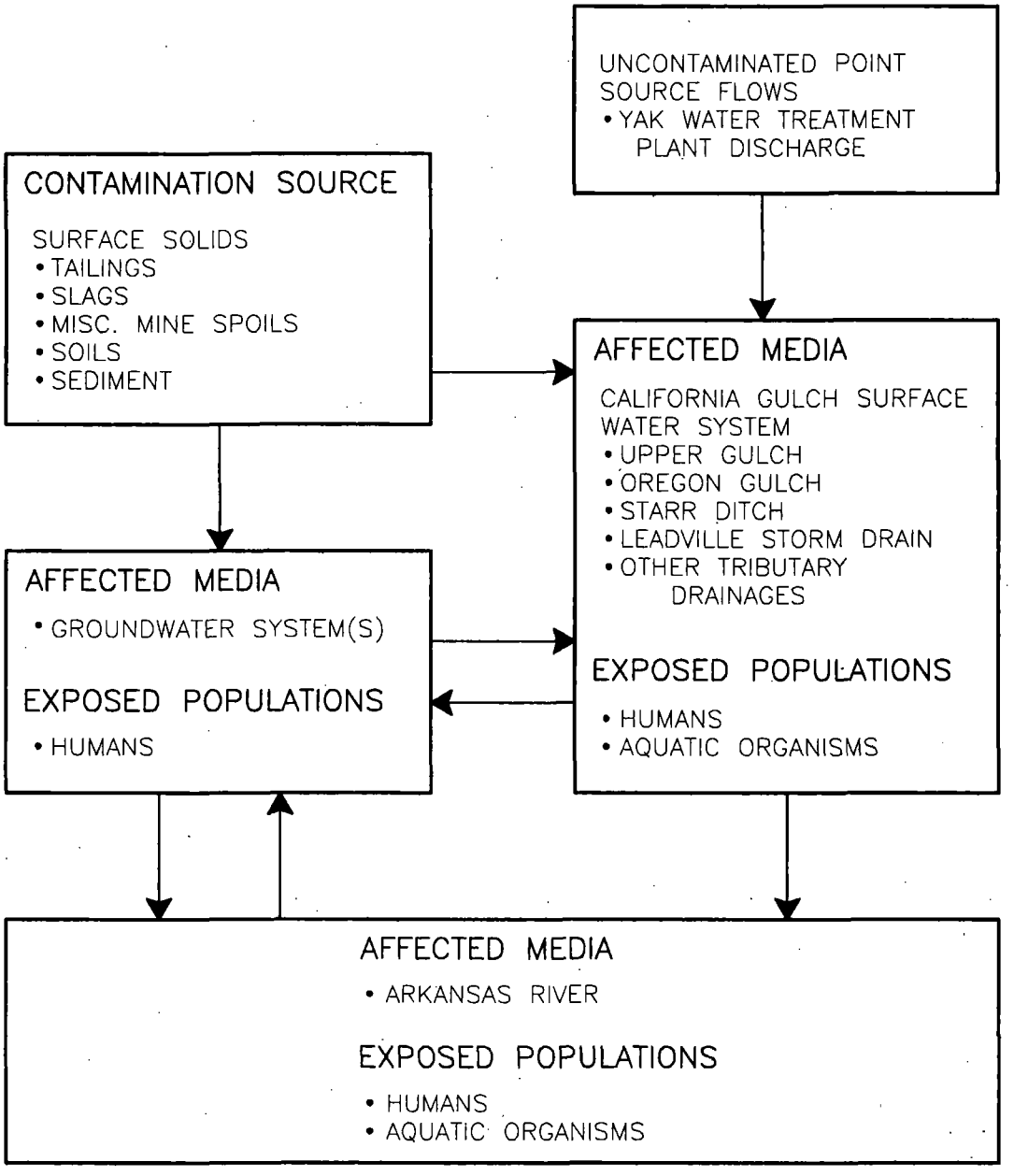
1. CALIFORNIA GULCH DATABASE, TETRA TECH RMC, JUNE 2005.

HDR Engineering, Inc. — MODIFIED FROM TETRA TECH RMC, 2005

INFERRED ALLUVIAL GROUNDWATER CADMIUM EXTENT OF CONTAMINATION MAP - CALIFORNIA GULCH OU12 RECORD OF DECISION

DATE: JANUARY 2008

FIGURE 5-11



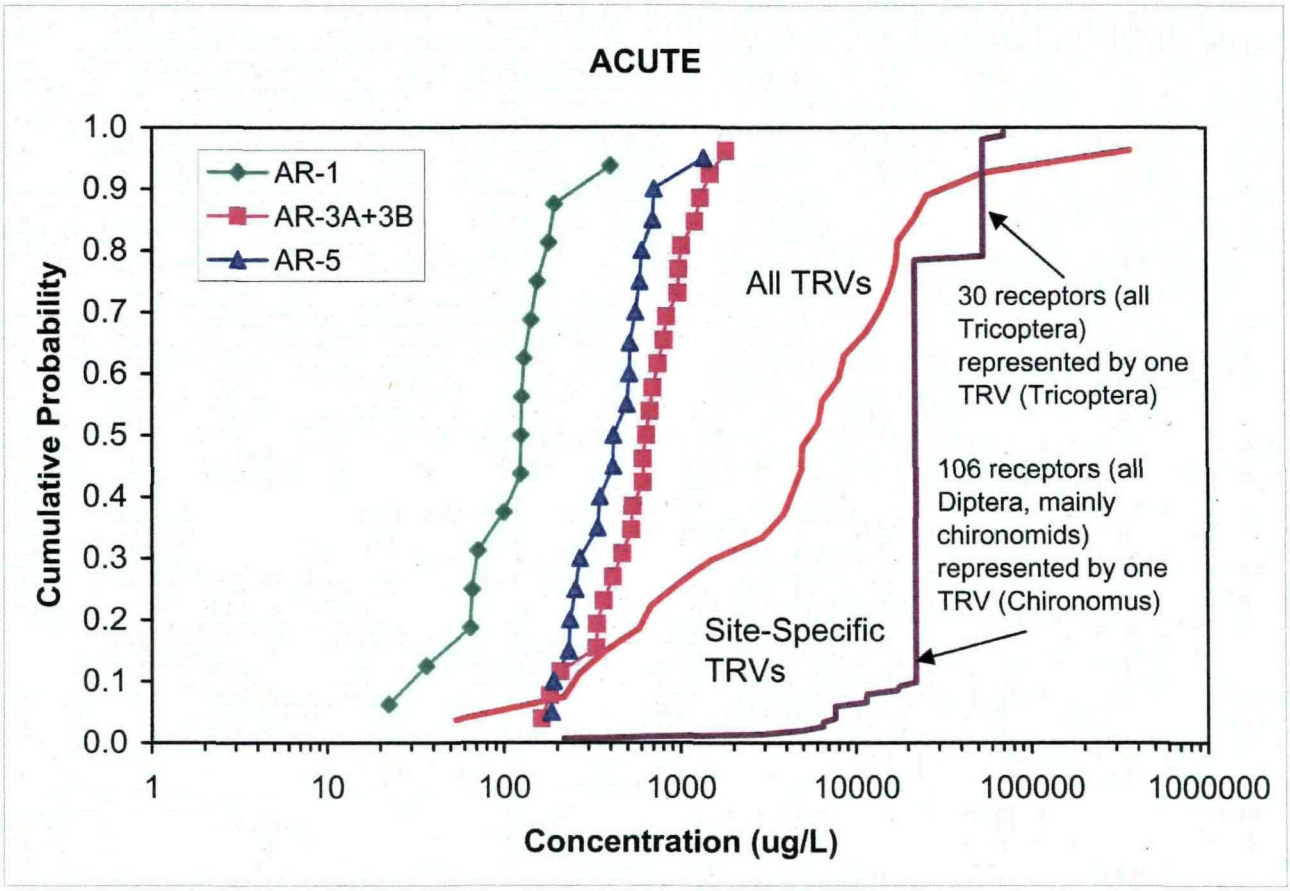
MIGRATION ROUTES

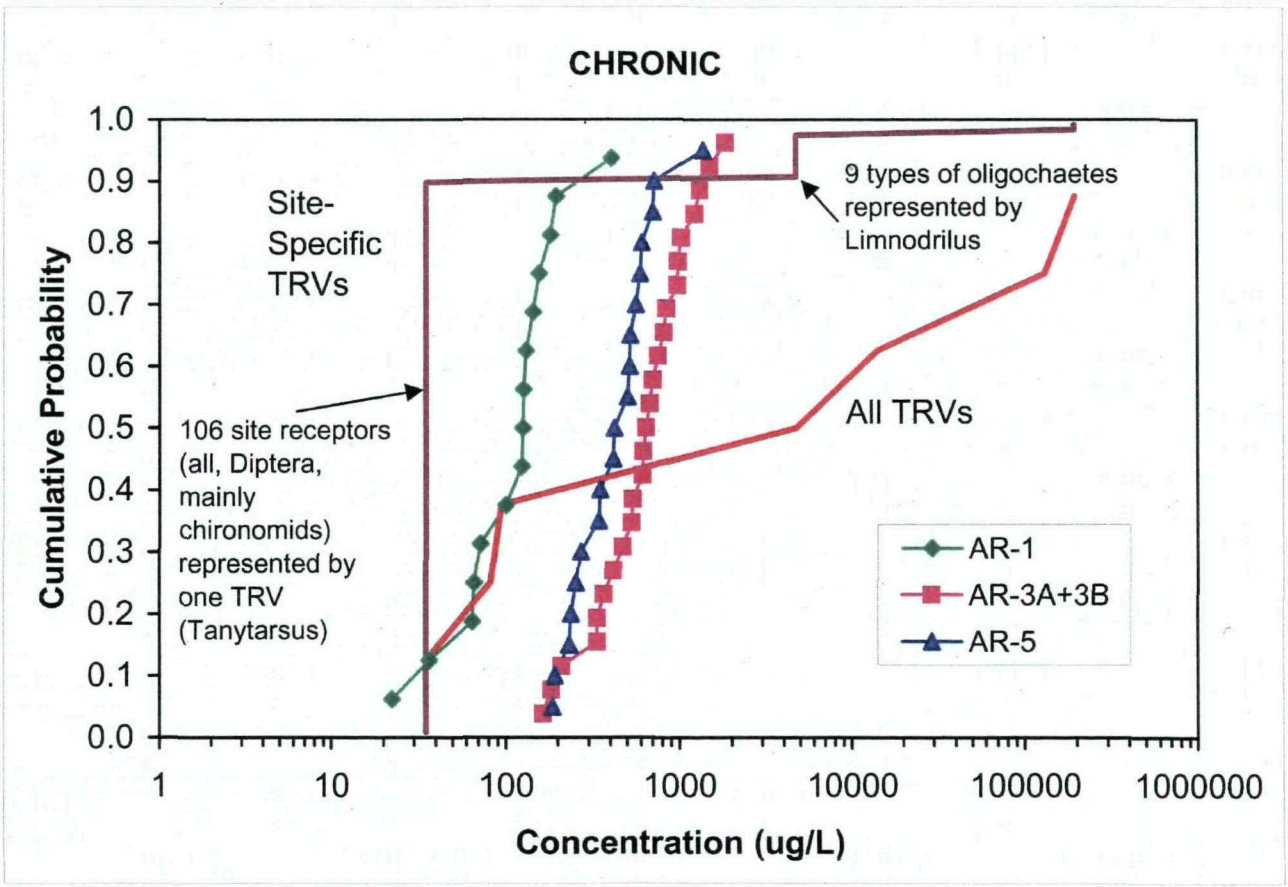
HDR Engineering, Inc.

Conceptual Site Contaminant Transport / Exposure Model California Gulch OU12 Record of Decision

Date: February 2008 | **Figure 5-12**

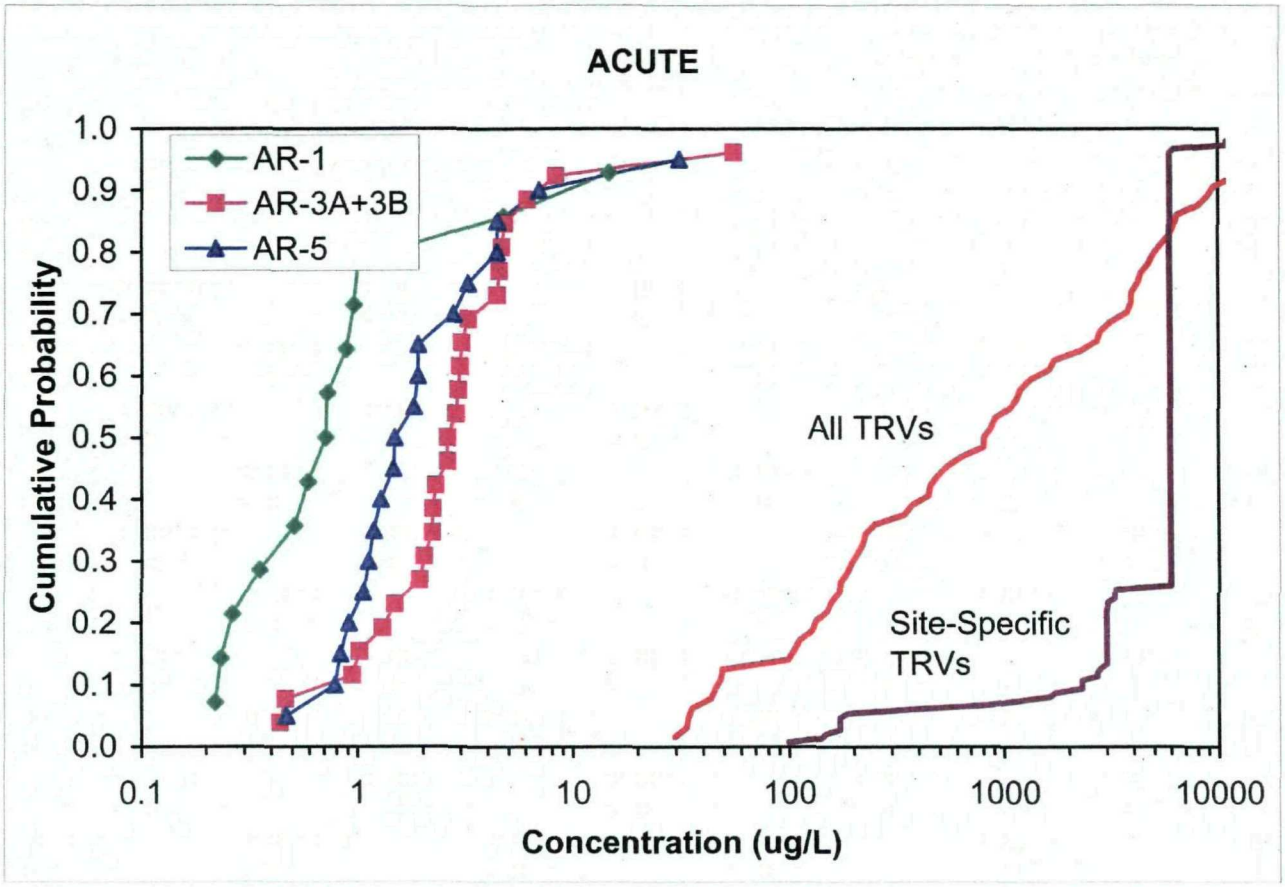
Figure 6-1. Zinc Concentration Data (Spring) vs. GSDs for Invertebrates 1997-2002

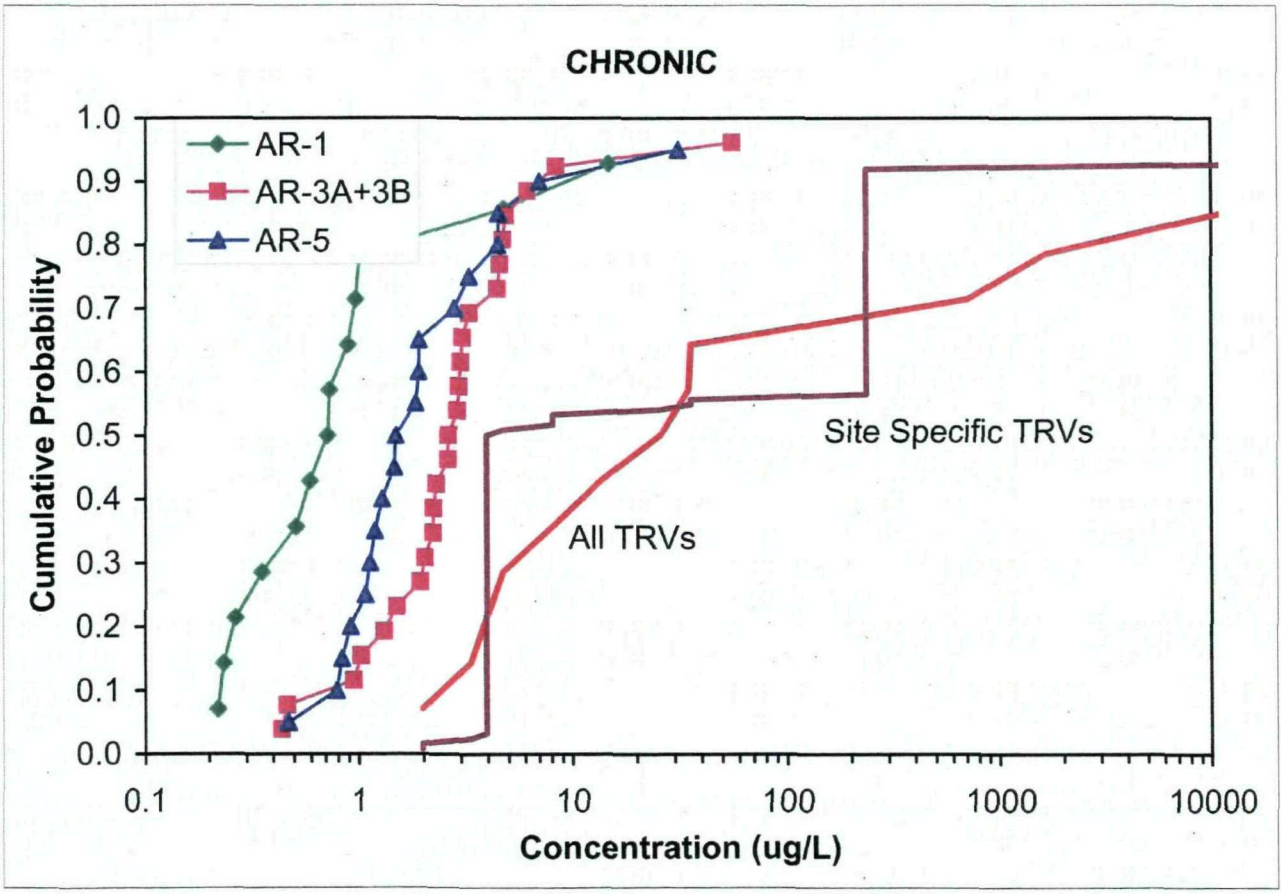




All concentration data and TRV values are based on a hardness of 100 mg/L

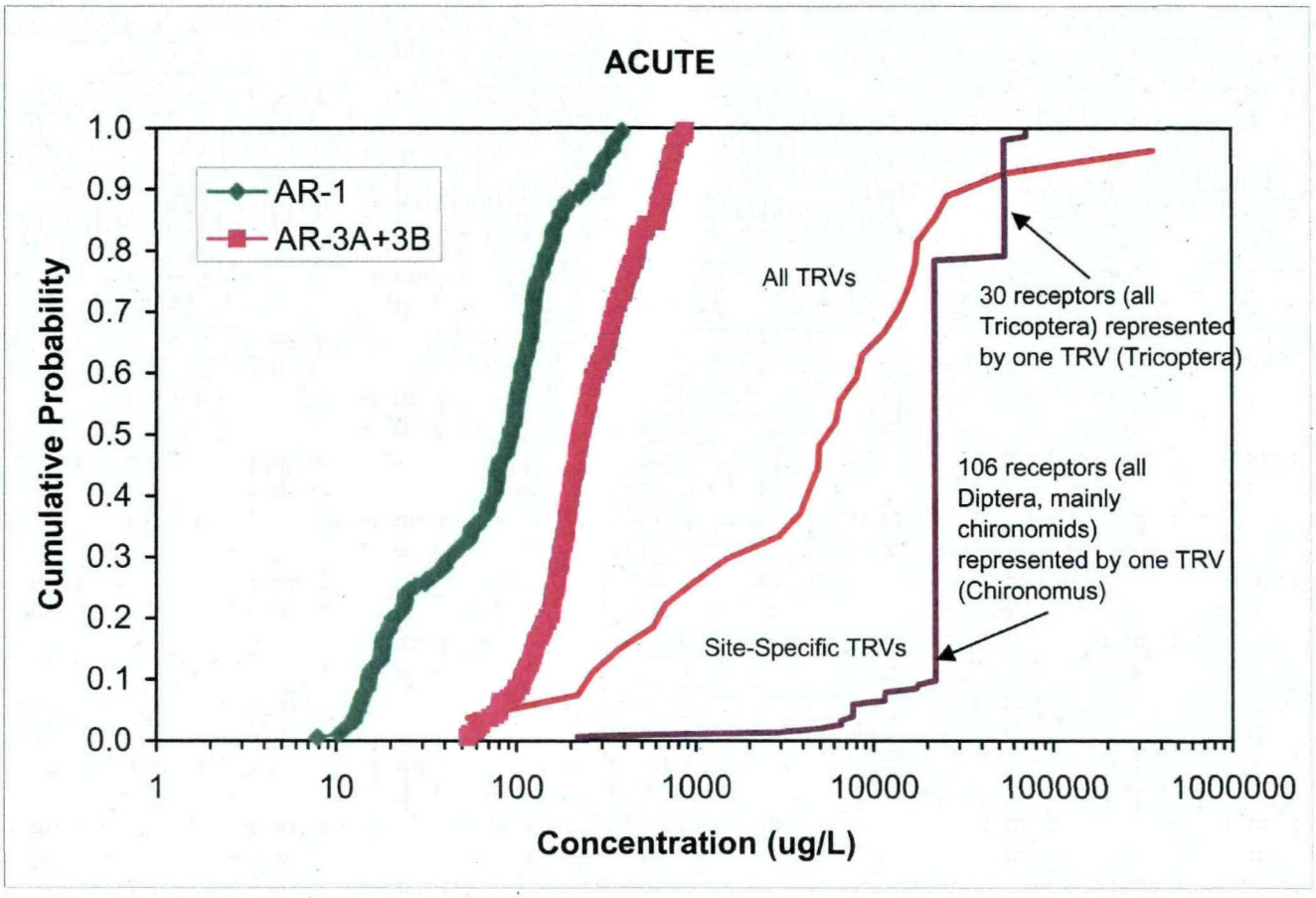
Figure 6-2. Cadmium Concentration Data (Spring) vs. GSDs for Invertebrates

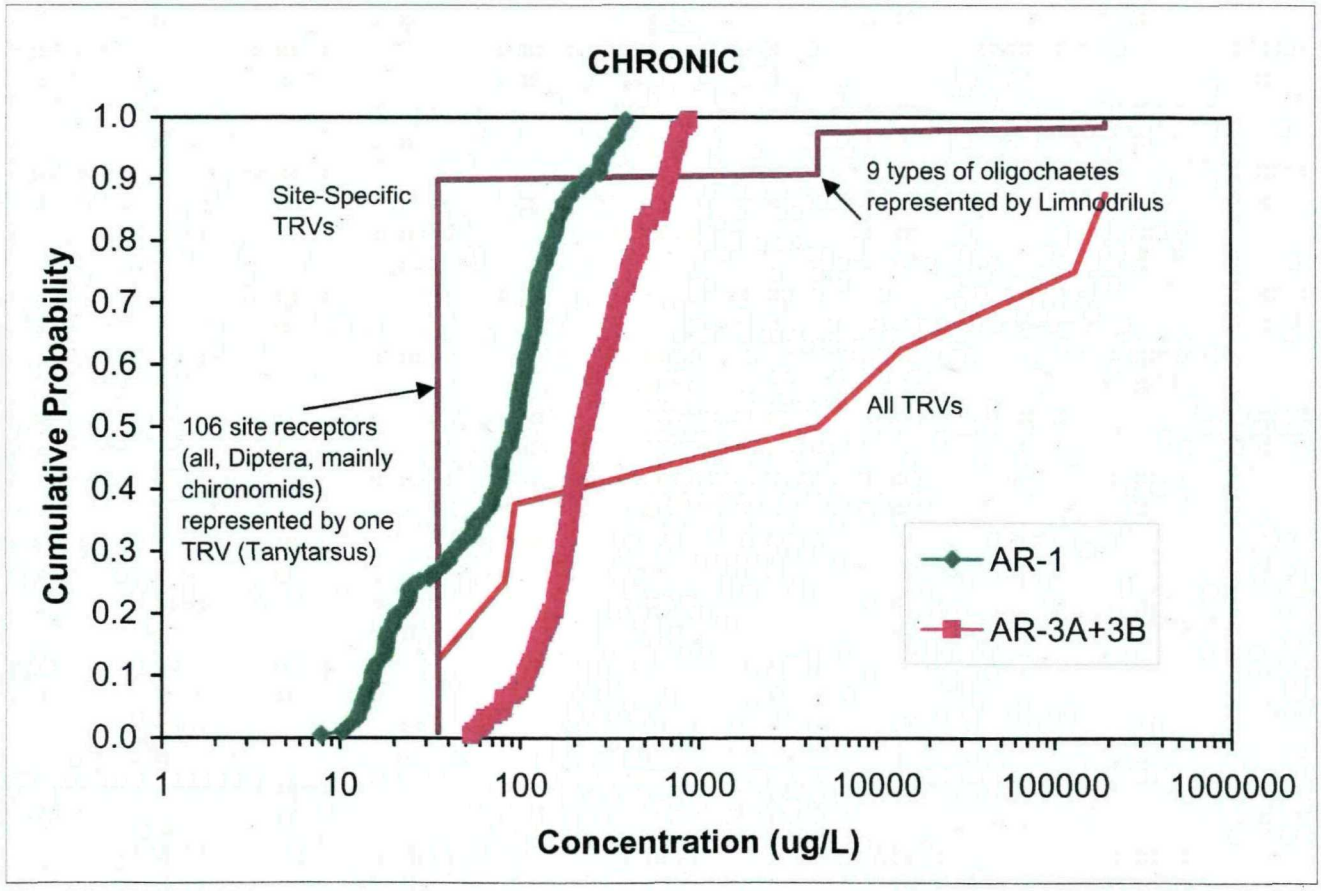




All concentration data and TRV values are based on a hardness of 100 mg/L

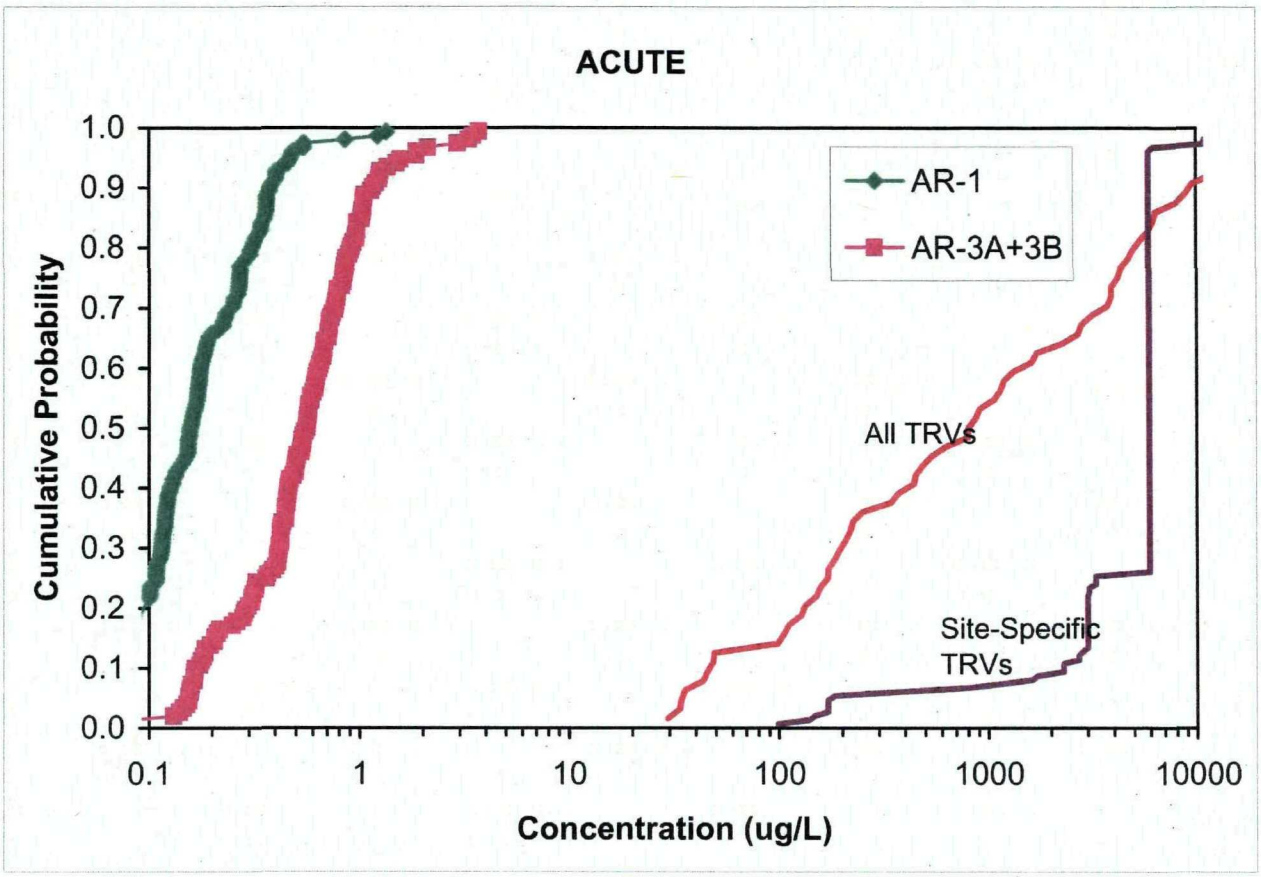
Figure 6-3. Zinc Concentration Data (Spring) vs GSDs for Invertebrates 2003-2005

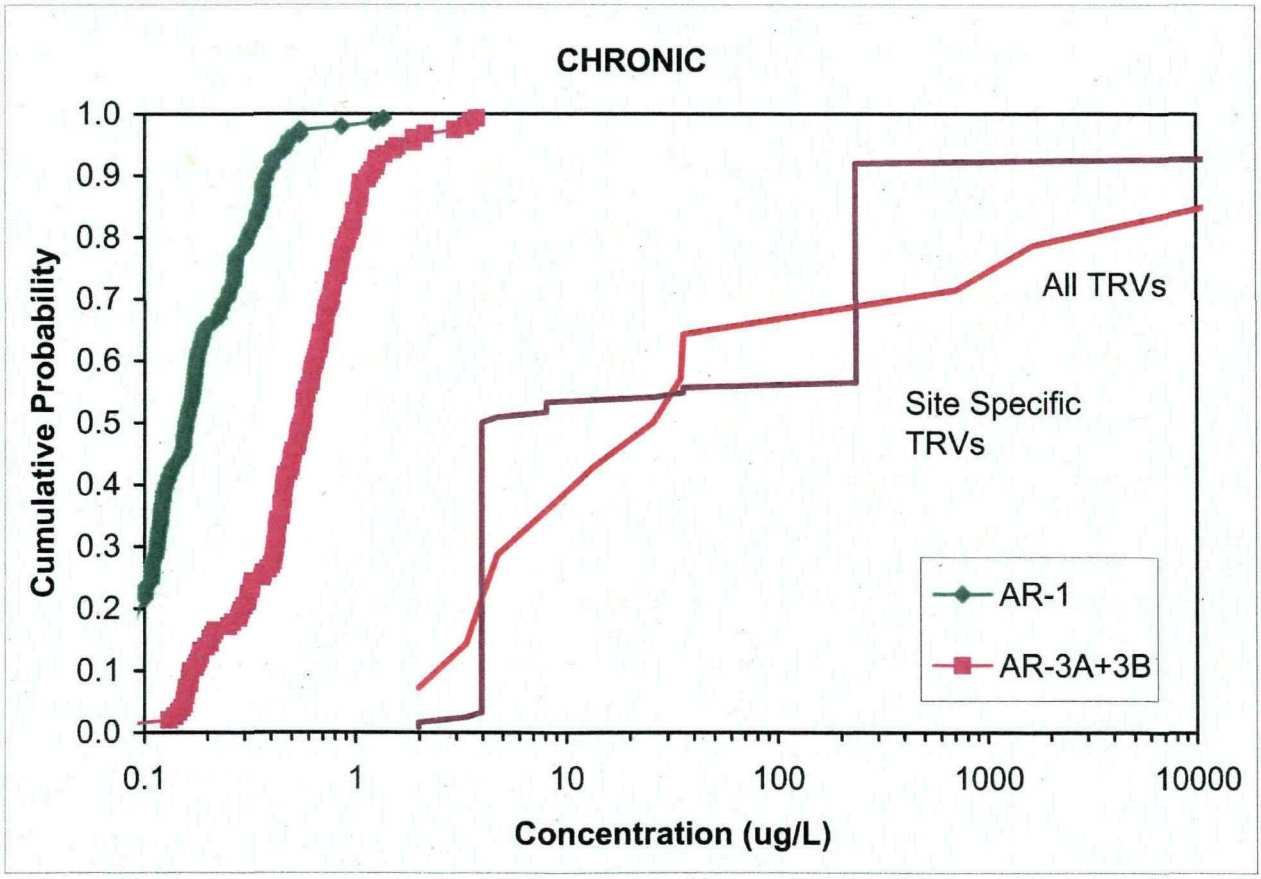




All concentration data and TRV values are based on a hardness of 100 mg/L

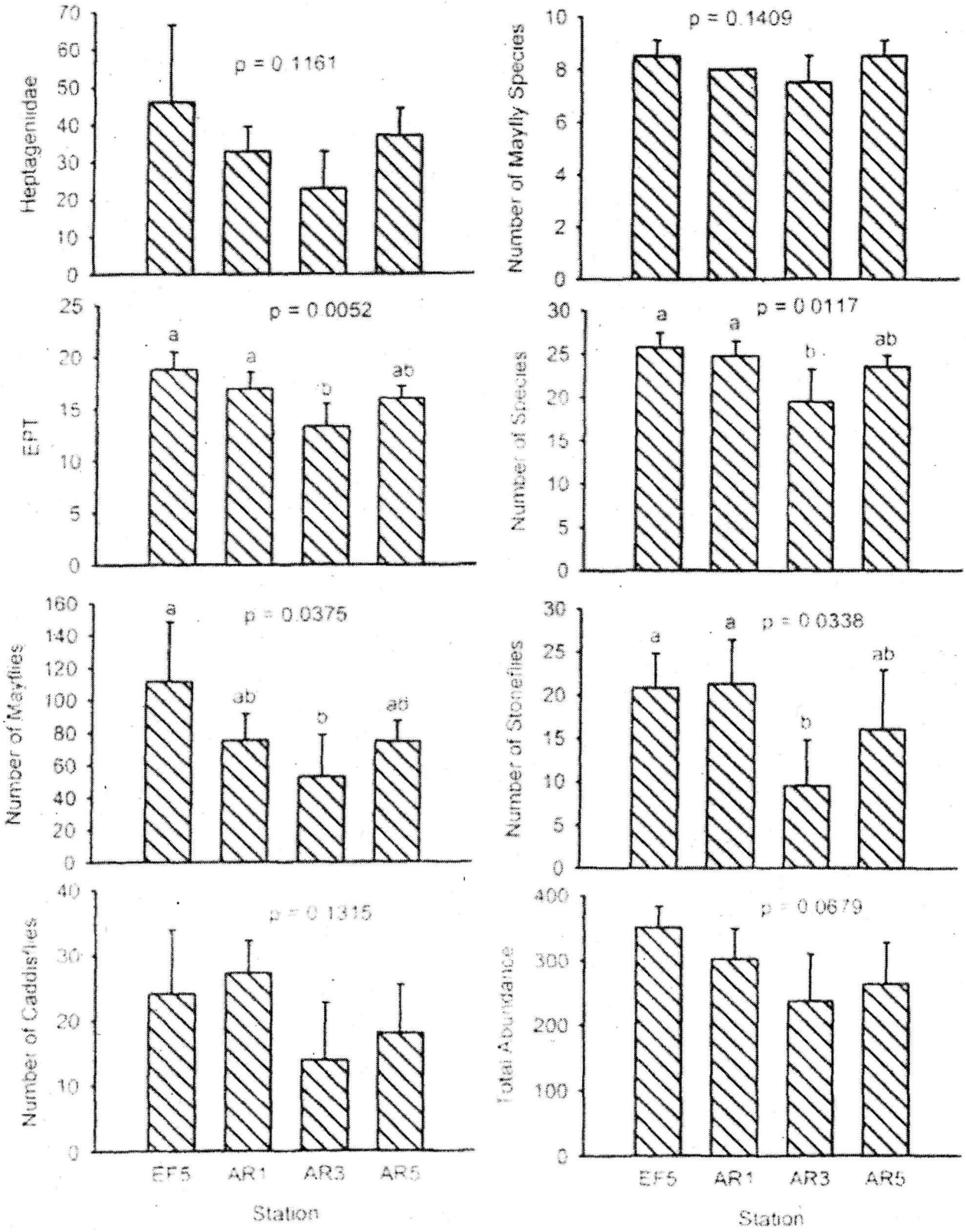
Figure 6-4. Cadmium Concentration Data (Spring) vs GSDs for Invertebrates 2003-2005





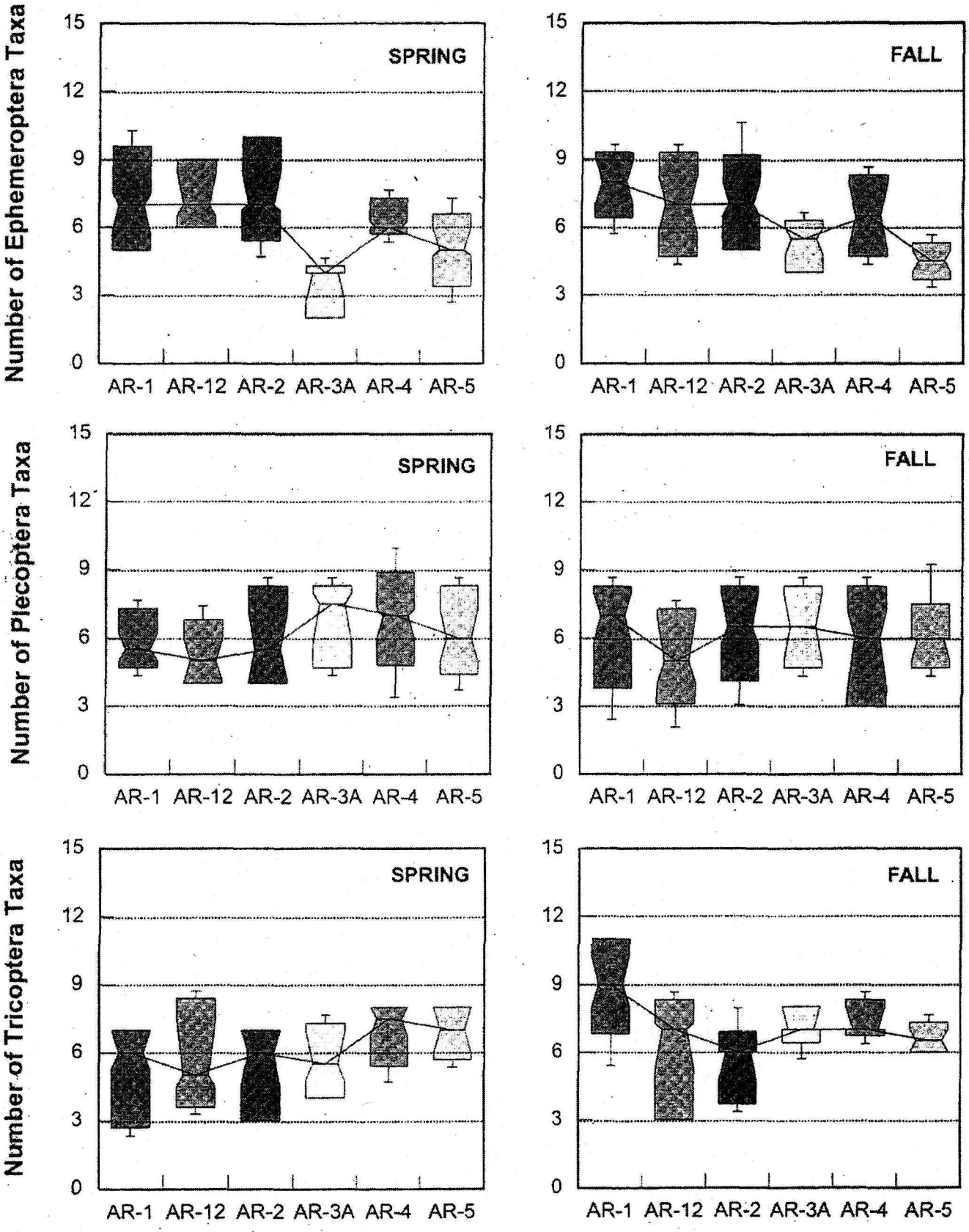
All concentration data and TRV values are based on a hardness of 100 mg/L

Figure 6-5. Effect of BMI Community Transplantation



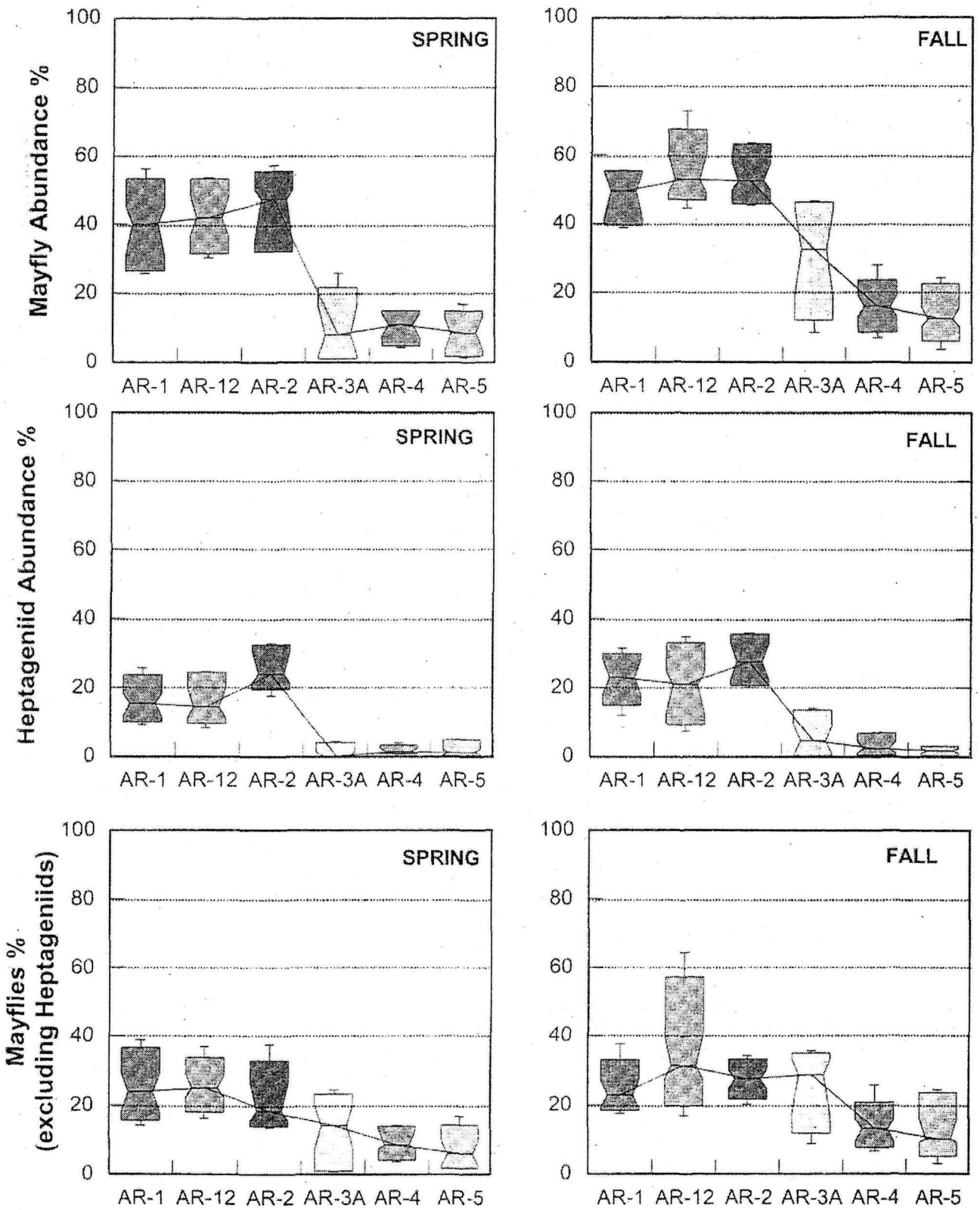
Source: Clements (2003)

Figure 6-6. EPT Diversity in the Upper Arkansas River



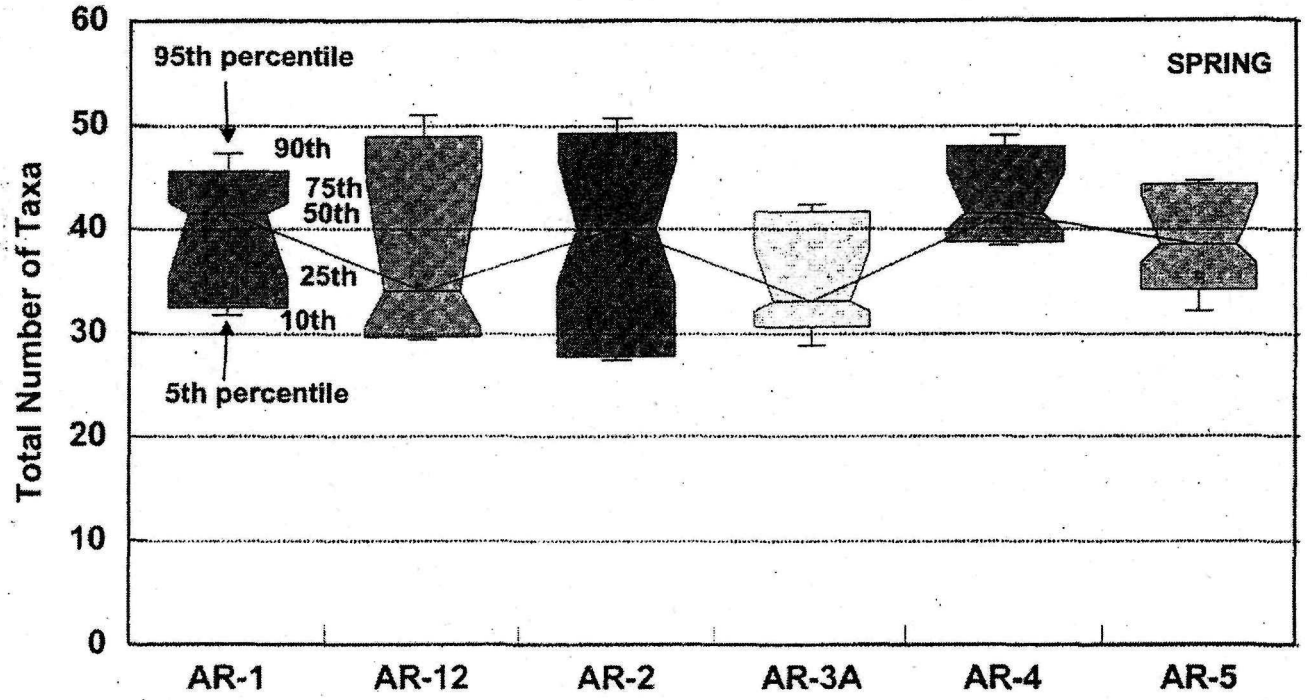
Source: Chadwick (2003)

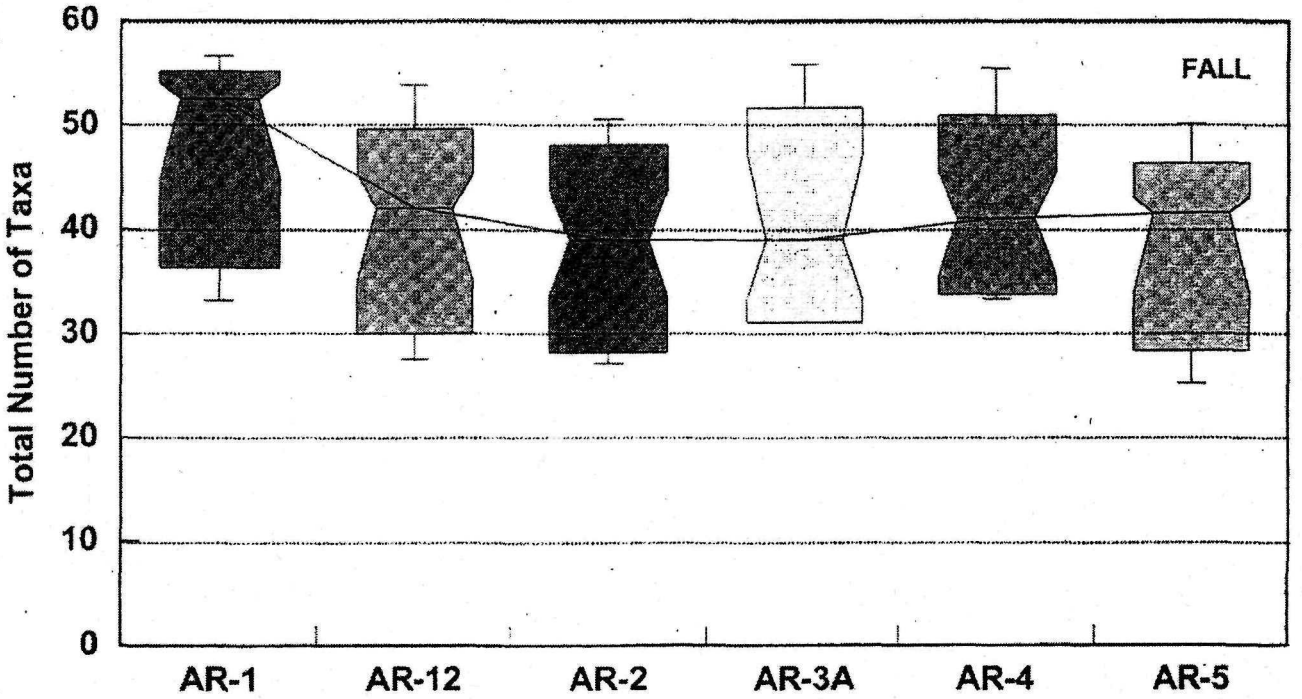
Figure 6-7. Mayfly Abundance in the Upper Arkansas River



Source: Chadwick (2003)

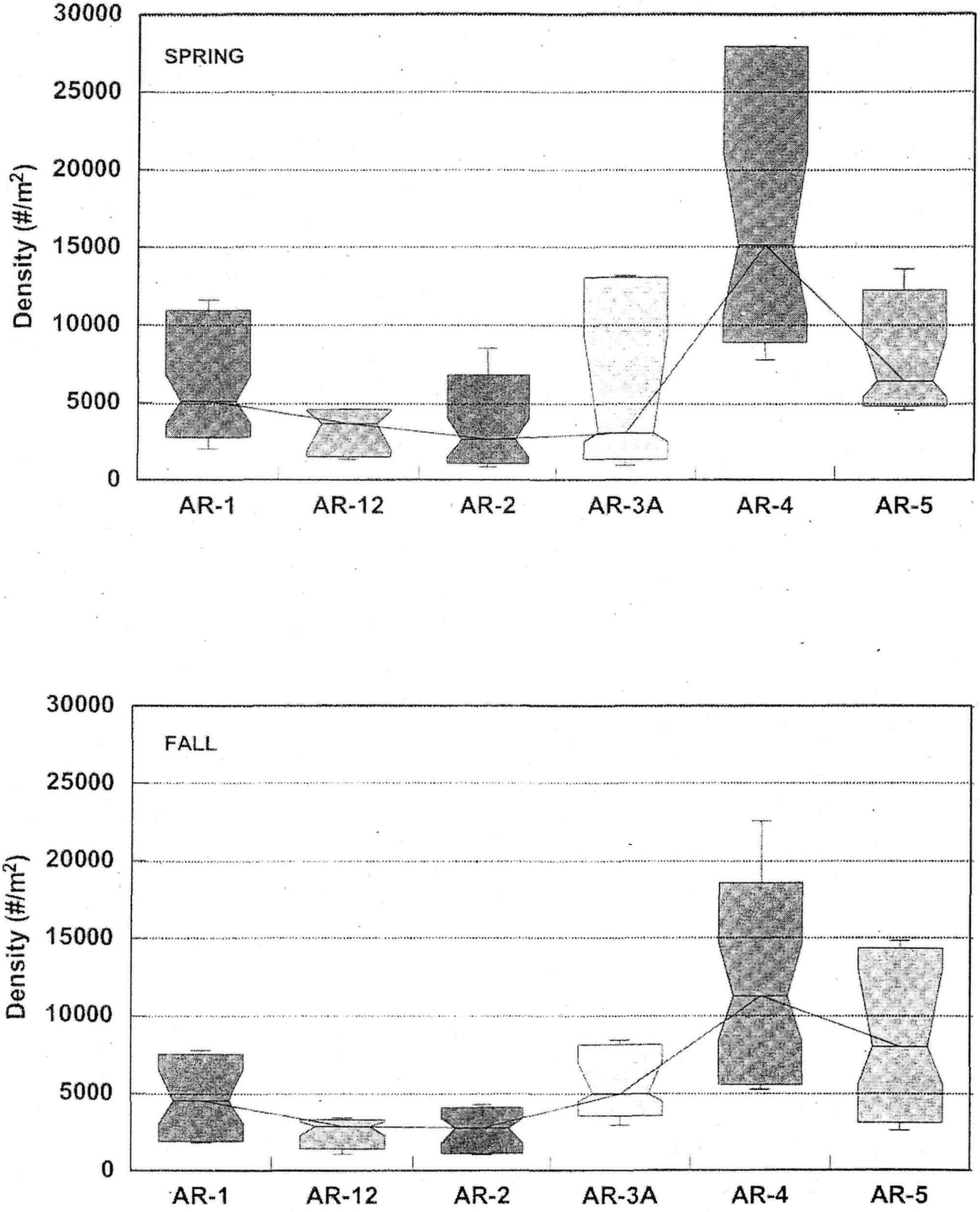
Figure 6-8. BMI Diversity in the Upper Arkansas River





Source: Chadwick (2003)

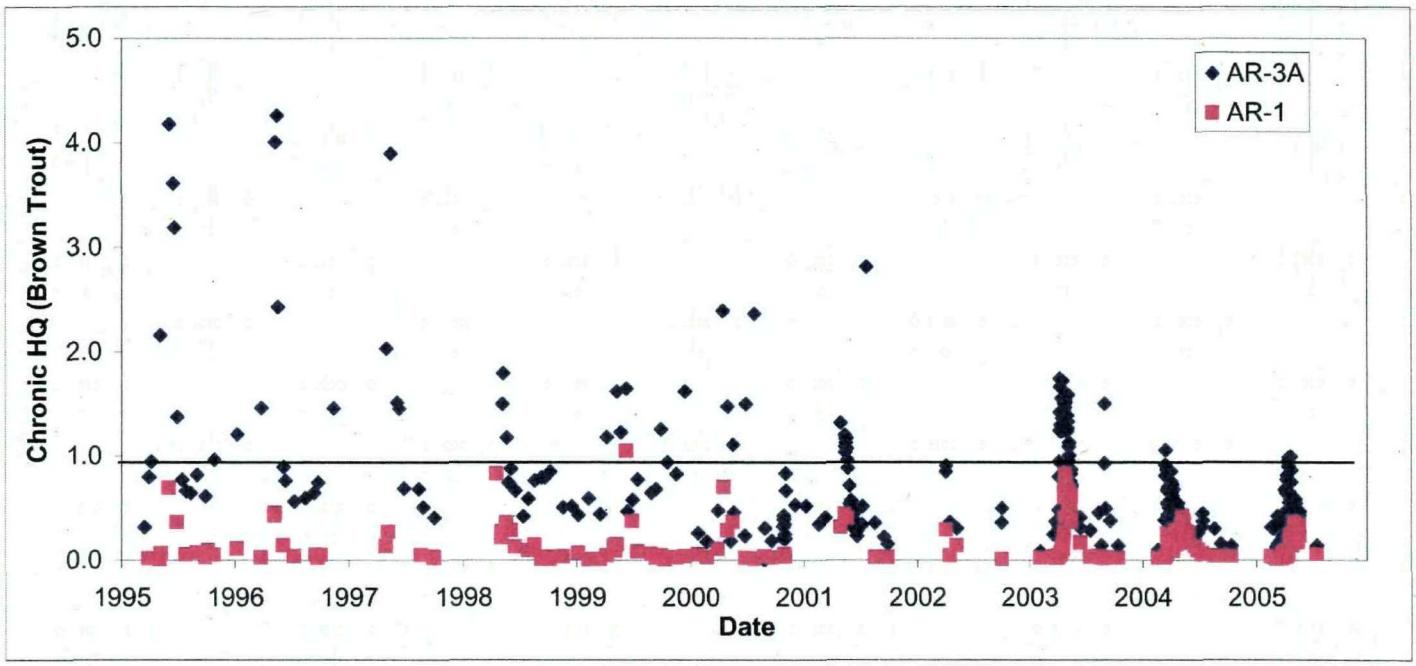
Figure 6-9. BMI Density in the Upper Arkansas River



Source: Chadwick (2003)

Figure 6-10. Time Trends in Predicted Toxicity to Brown Trout from Zinc Station AR-3A vs. AR-1

Panel A: Trends in HQ



Panel B: Trends in Predicted Mortality

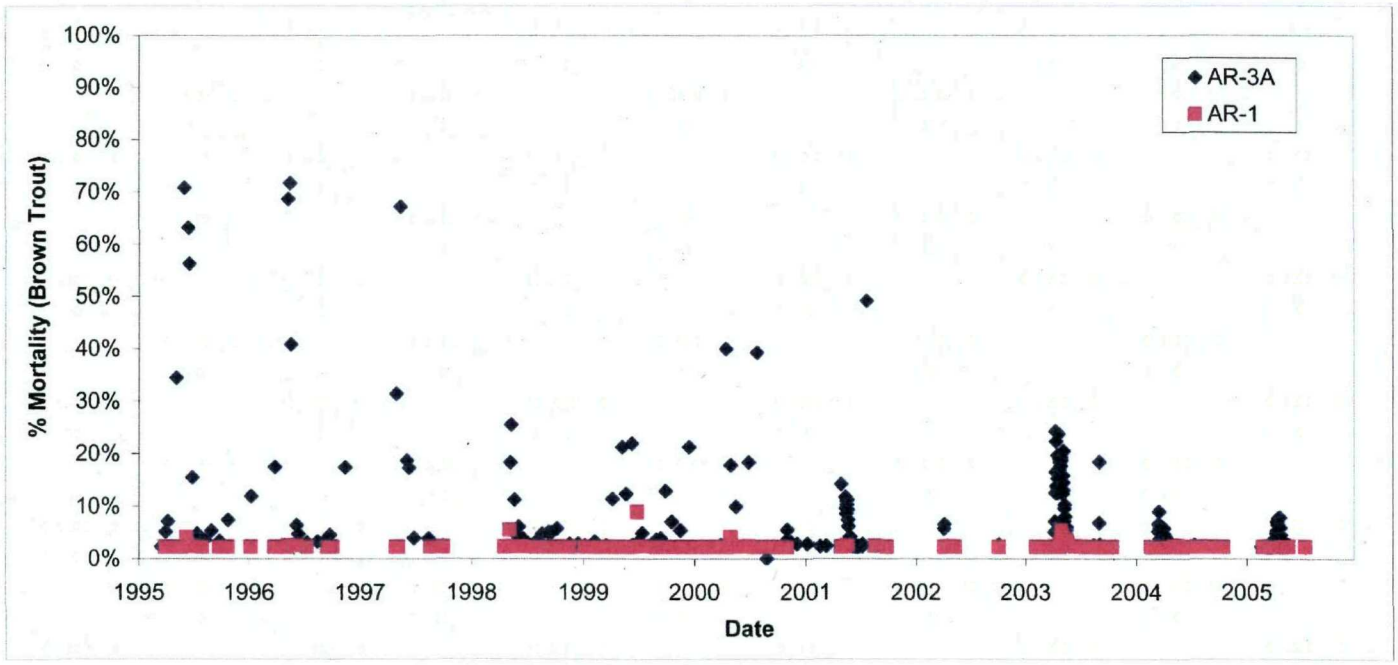
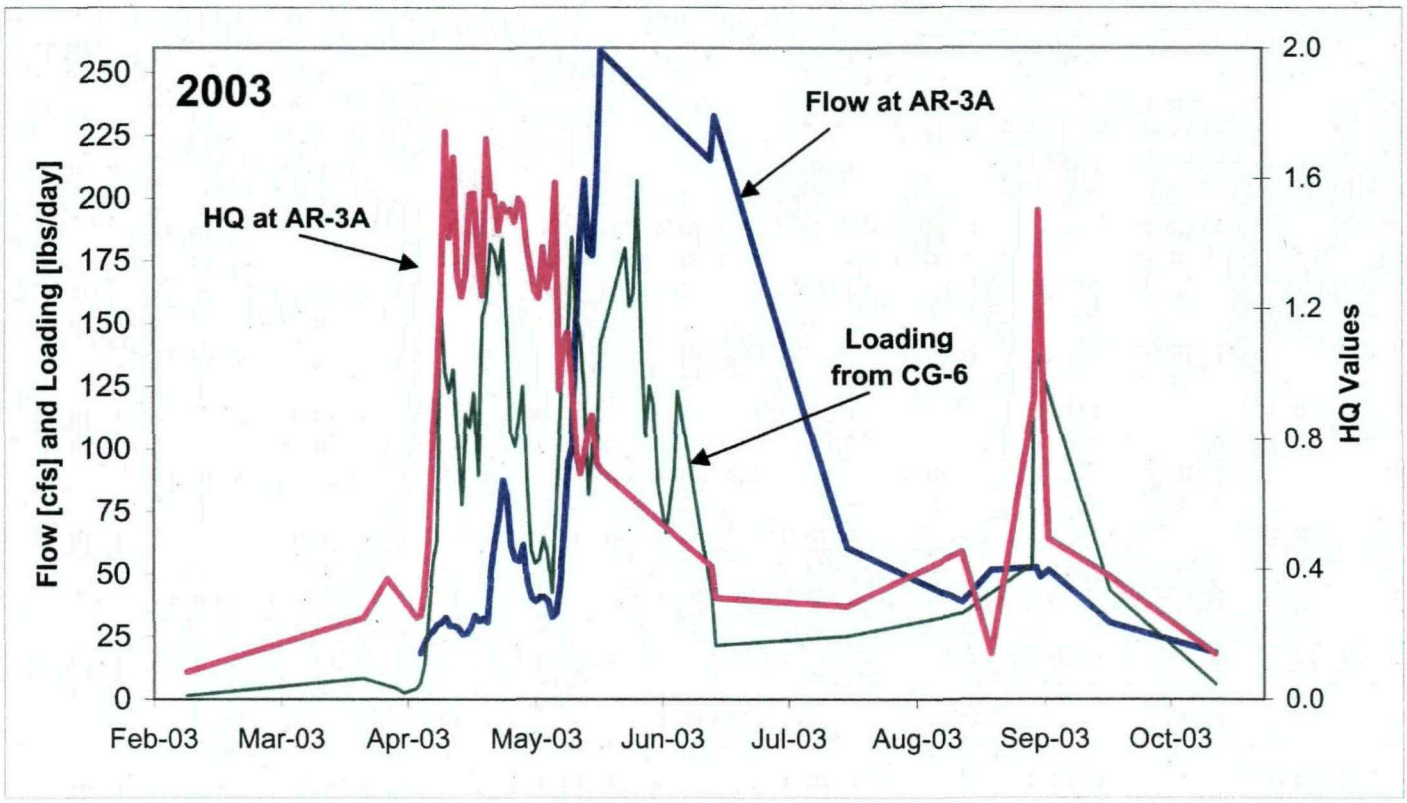


Figure 6-11. Timing of Maximum HQ Values



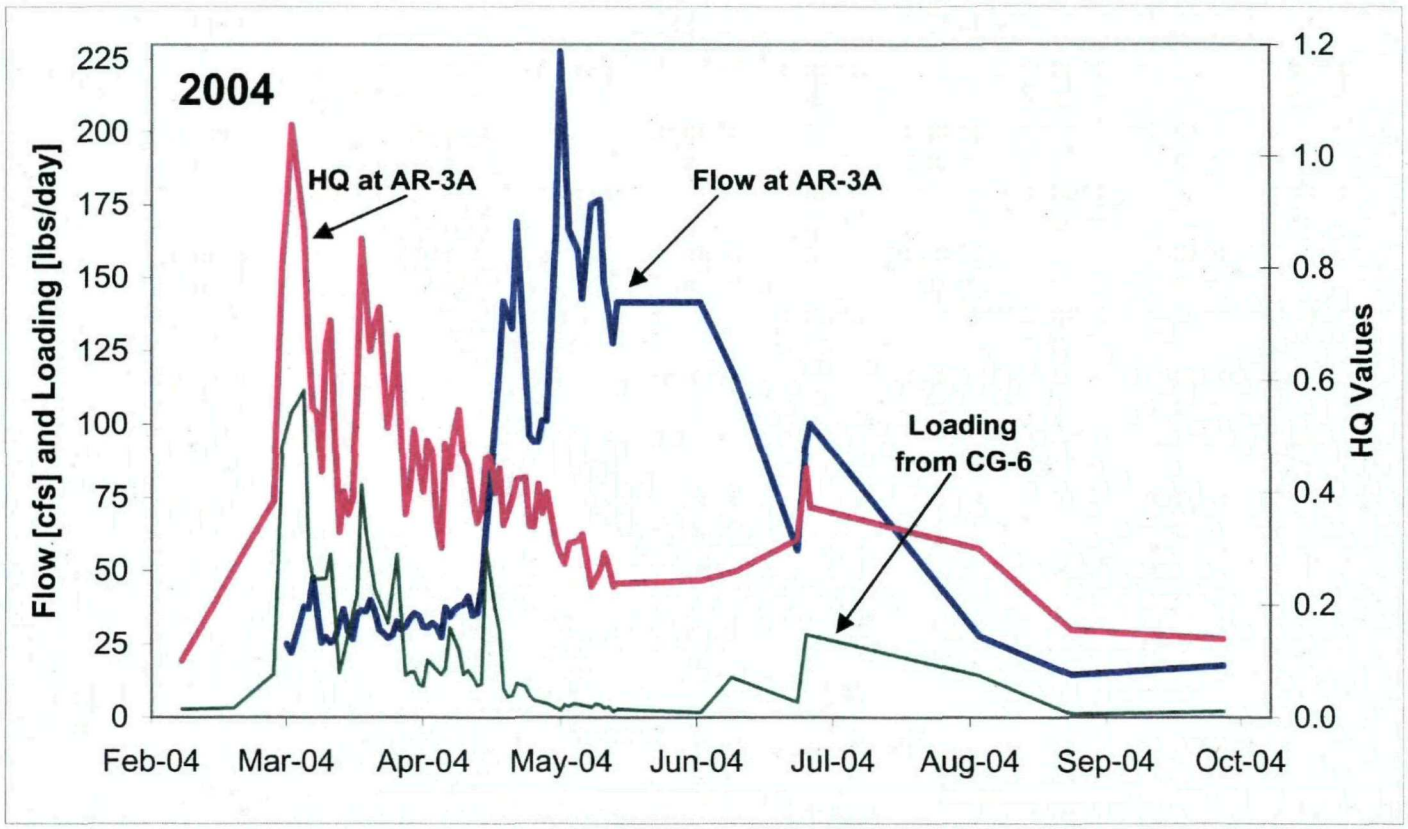
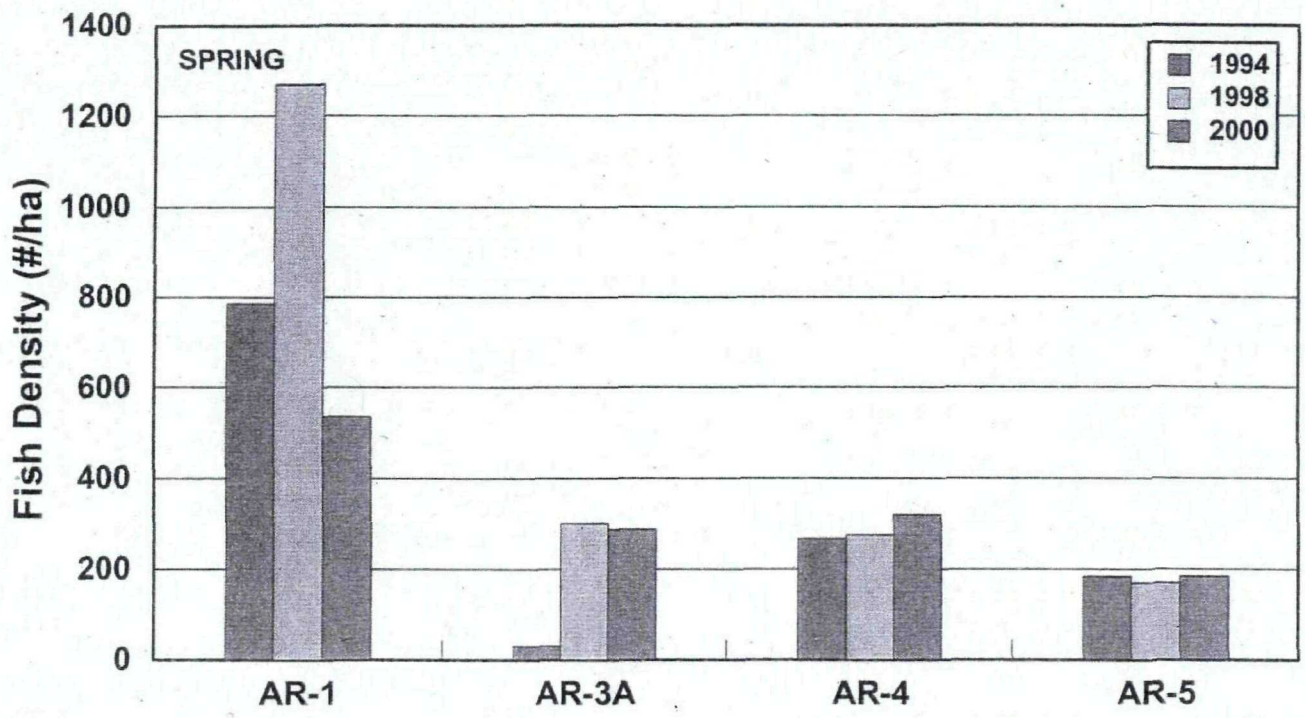
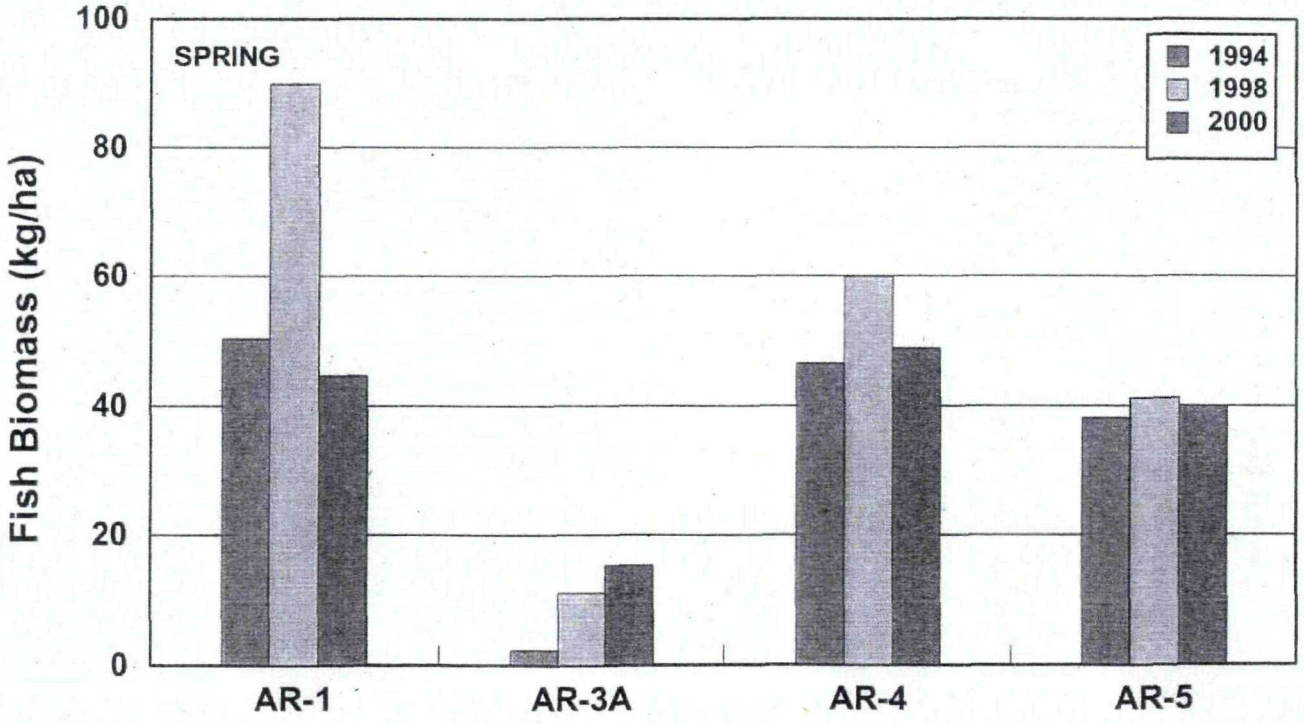


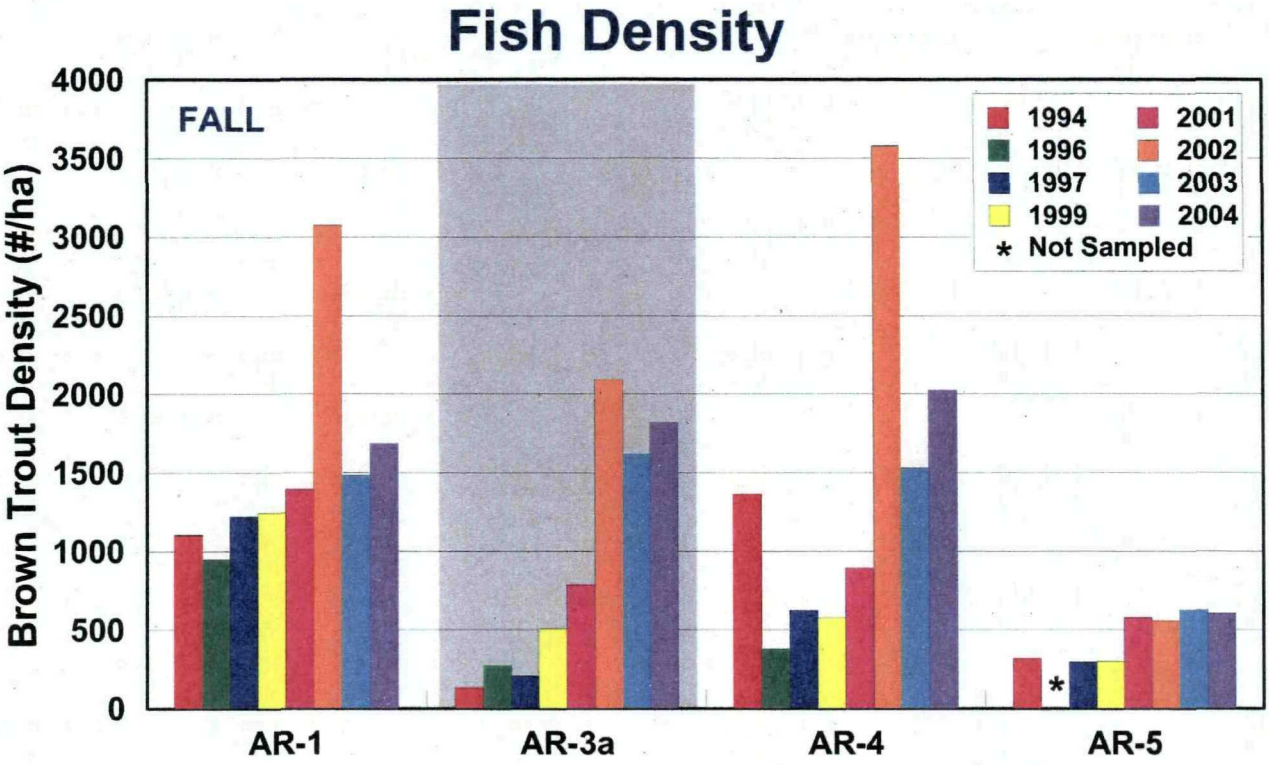
Figure 6-12. Fish Density in the Upper Arkansas River (Spring)

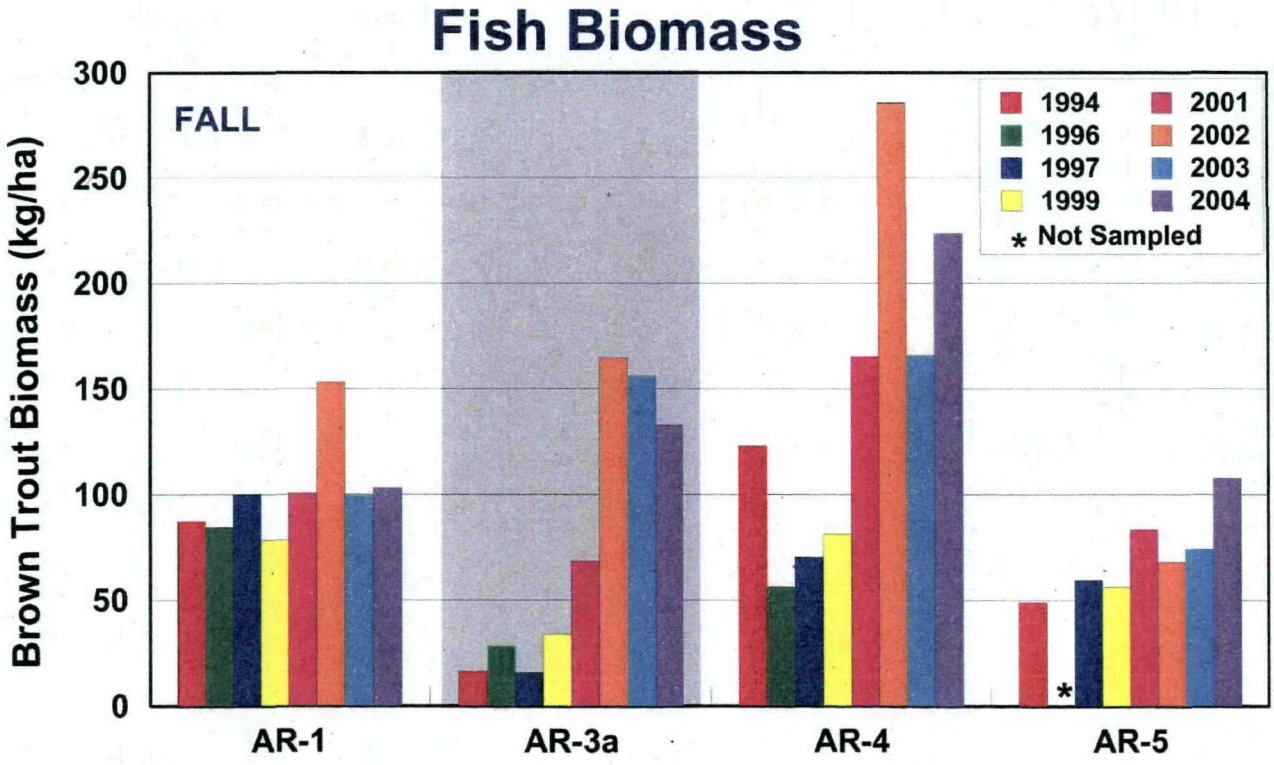




Source: Chadwick (2003)
Data are for all species (predominantly brown trout) and all sizes.

Figure 6-13. Fish Density in the Upper Arkansas River (Fall)

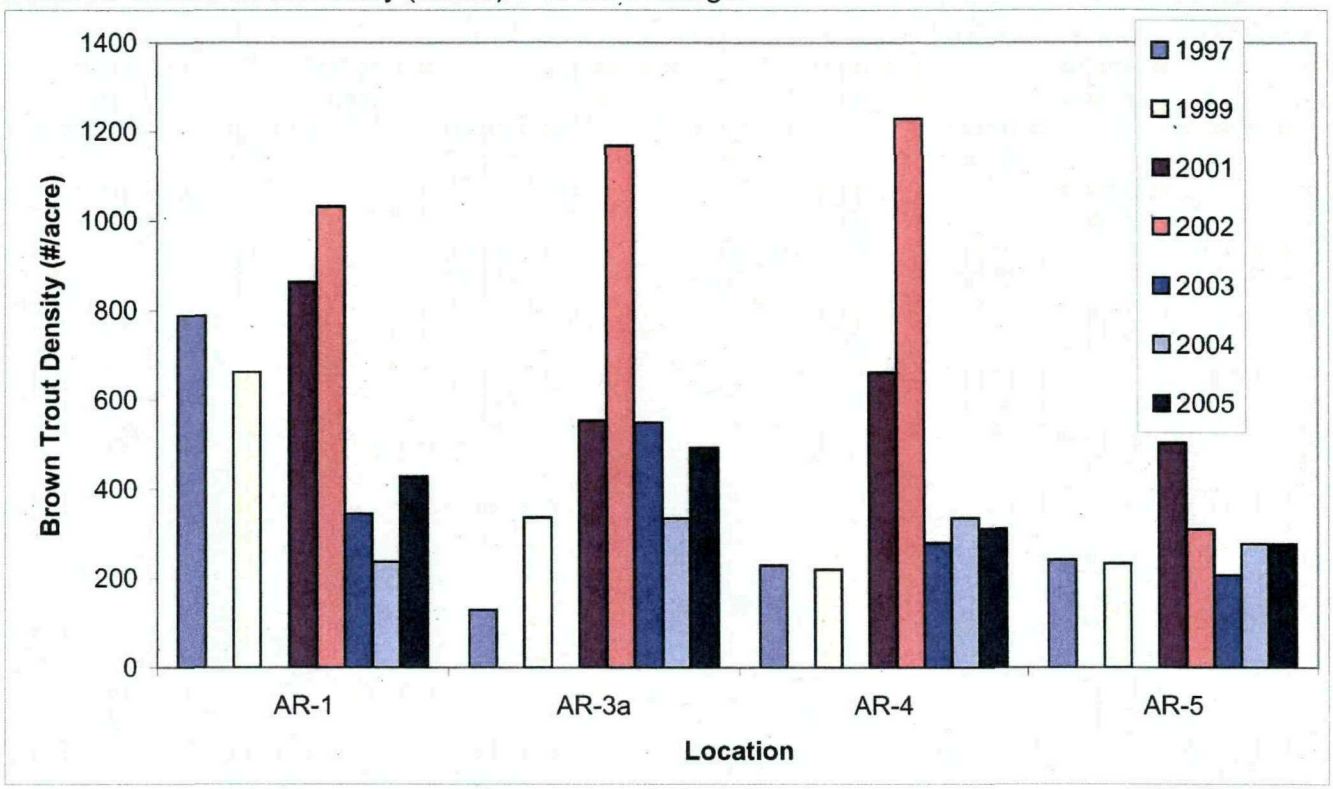




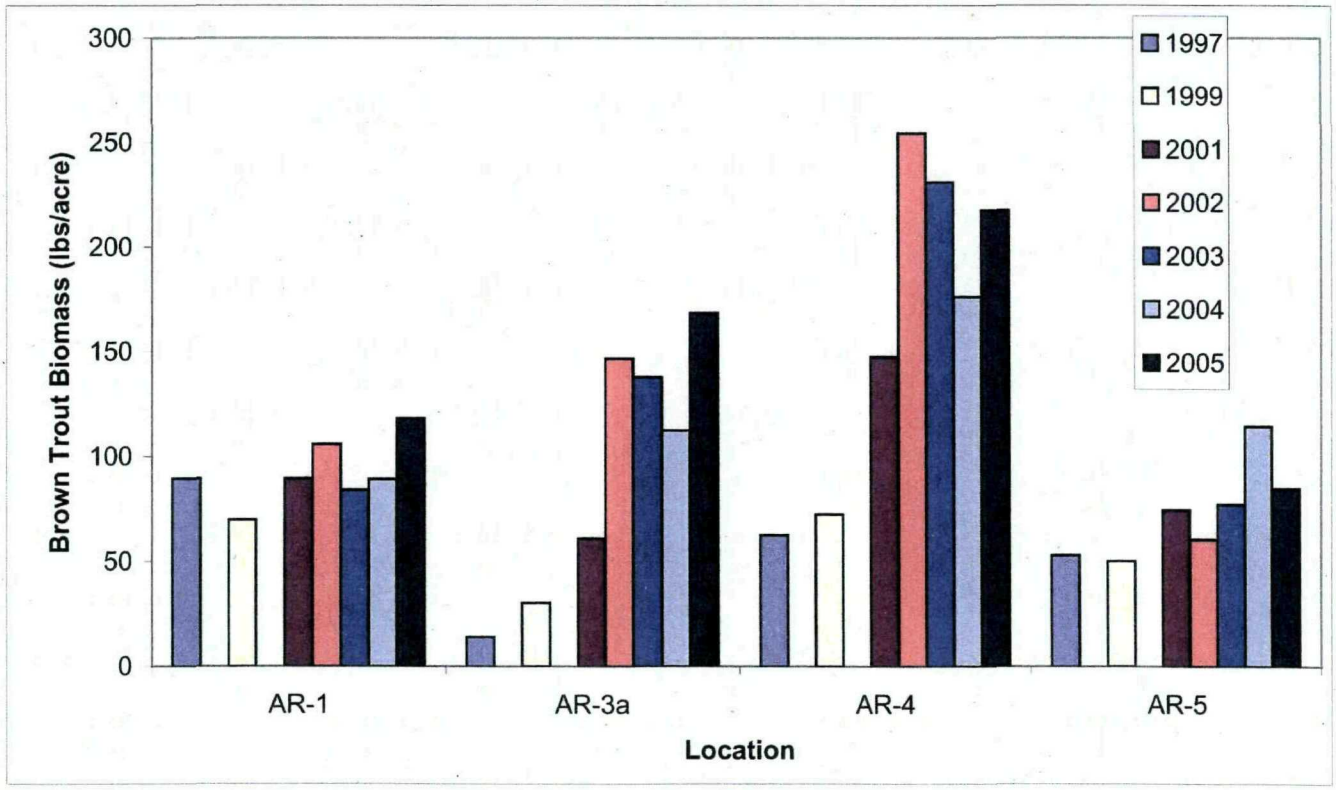
Source: Chadwick (2005)
Data are for all species (predominantly brown trout) and all sizes

Figure 6-14. Brown Trout Population Data in the Upper Arkansas River (Summer)

Panel A. Brown Trout Density (#/acre) > 15 cm in Length



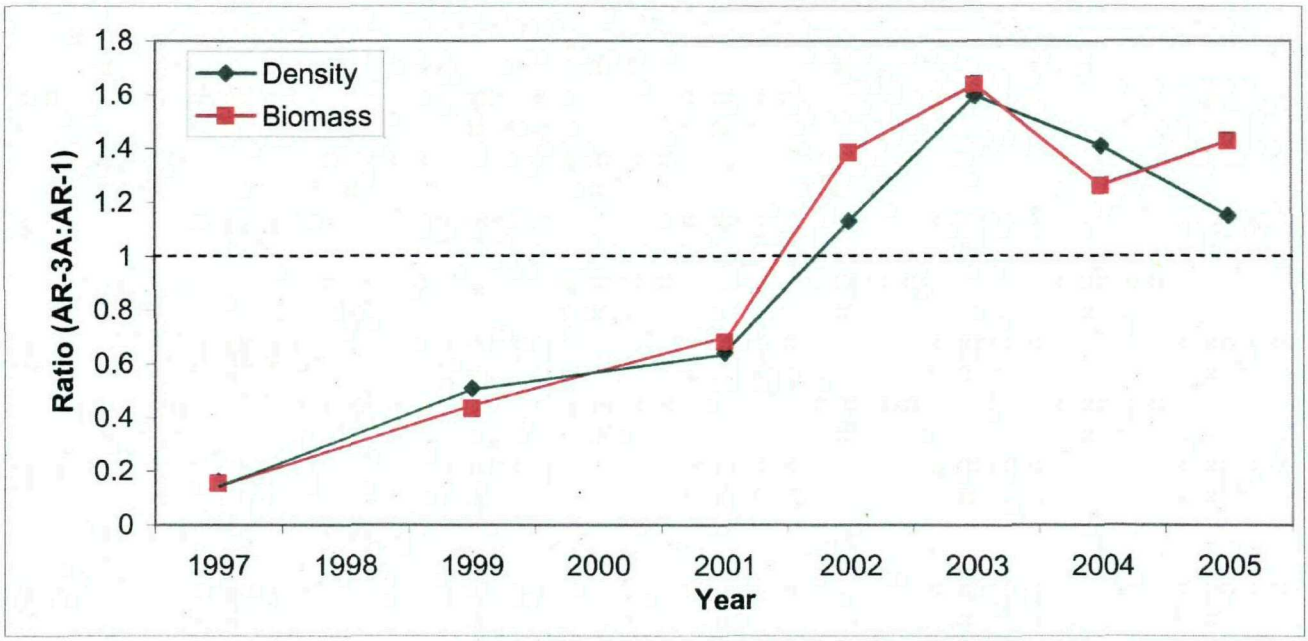
Panel B. Brown Trout Biomass (lbs/acre)



Density and biomass data for 1997-2002 were provided by Nehring and Policky (2003).

Density and biomass data for 2003-2005 were compiled based on the raw data provided by Chadwick Ecological Consultants, Inc.

Figure 6-15. Ratio of Brown Trout Density and Biomass at Station AR-3A Compared to Station AR-1 (Summer)



Density Length >= 15 cm

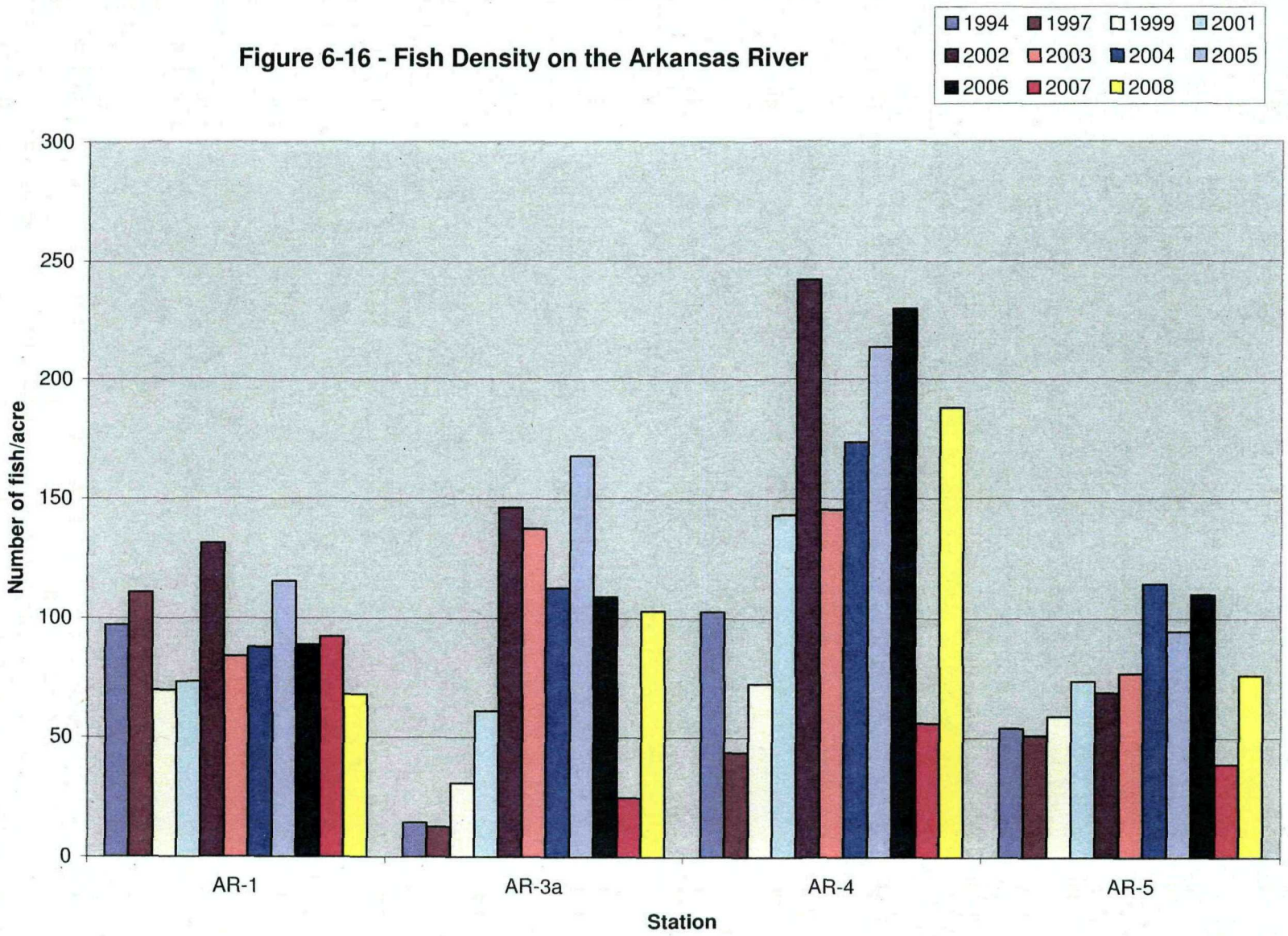
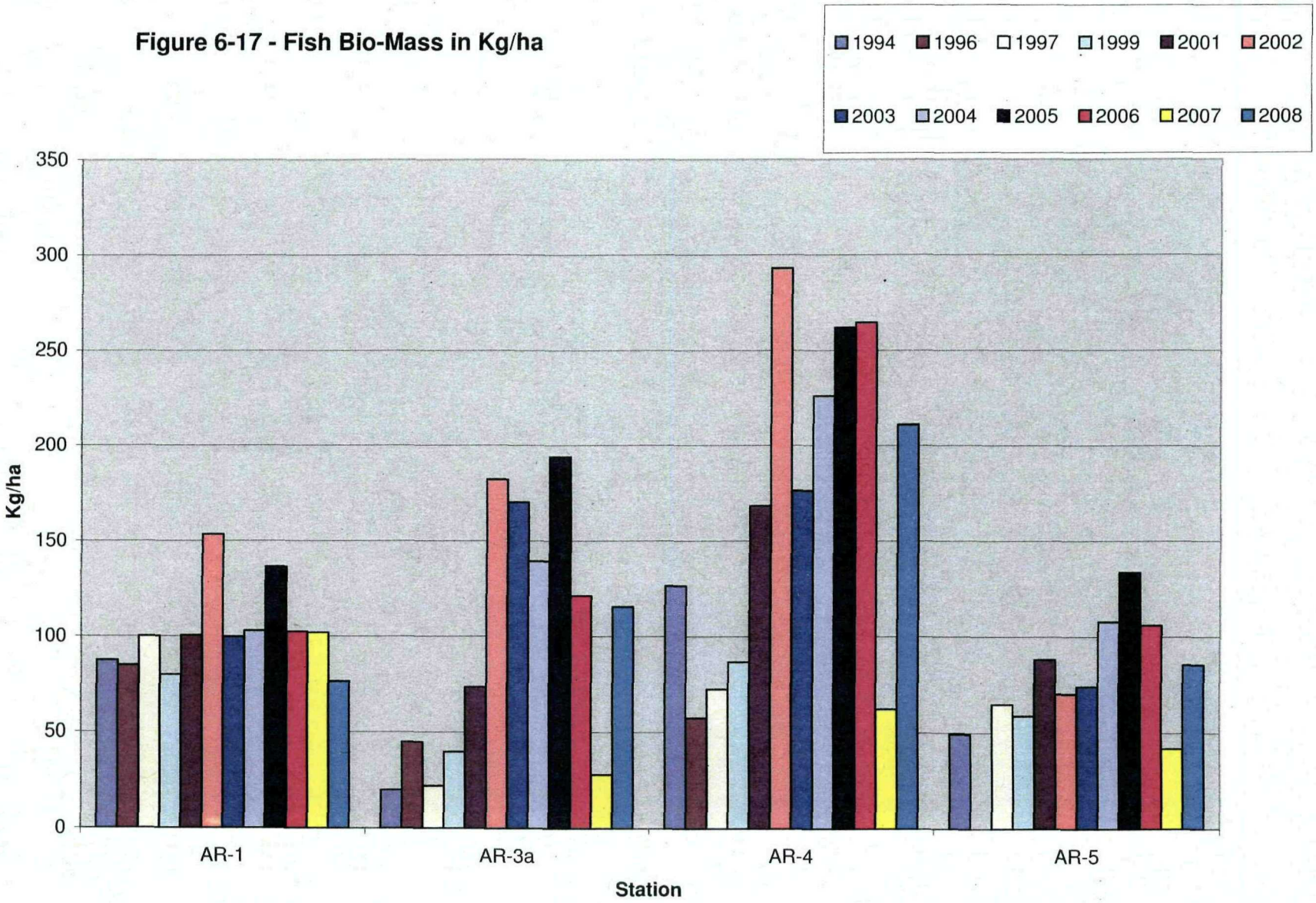


Figure 6-16 - Fish Density on the Arkansas River
1994
1997
1999
2001
2002
2003
2004
2005
2006
2007
2008
300
250
200
150
100
50
0
Number of fish/acre
AR-1
AR-3a
AR-4
AR-5
Station

Figure 6-17 - Fish Bio-Mass in Kg/ha



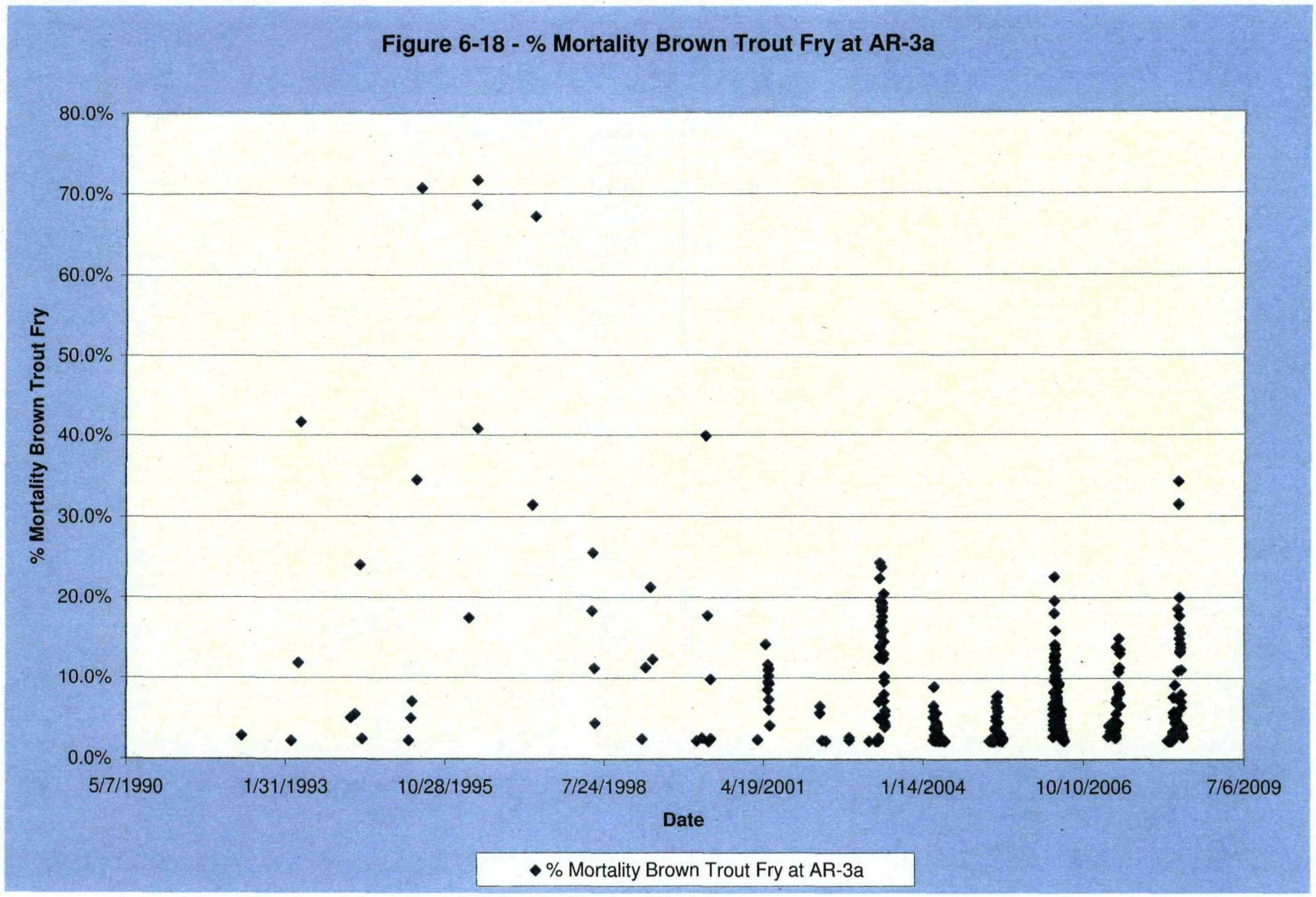


Figure 6-18 - % Mortality Brown Trout Fry at AR-3a
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
% Mortality Brown Trout Fry
5/7/1990
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
Date
% Mortality Brown Trout Fry at AR-3a

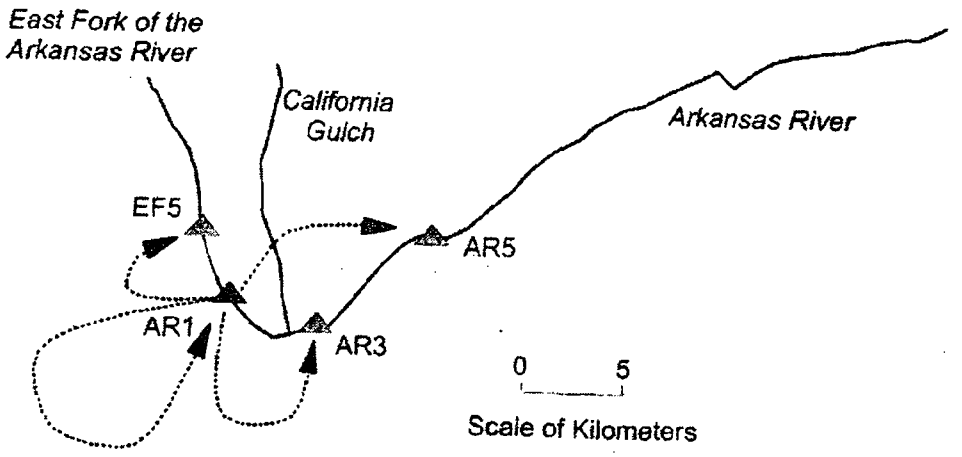
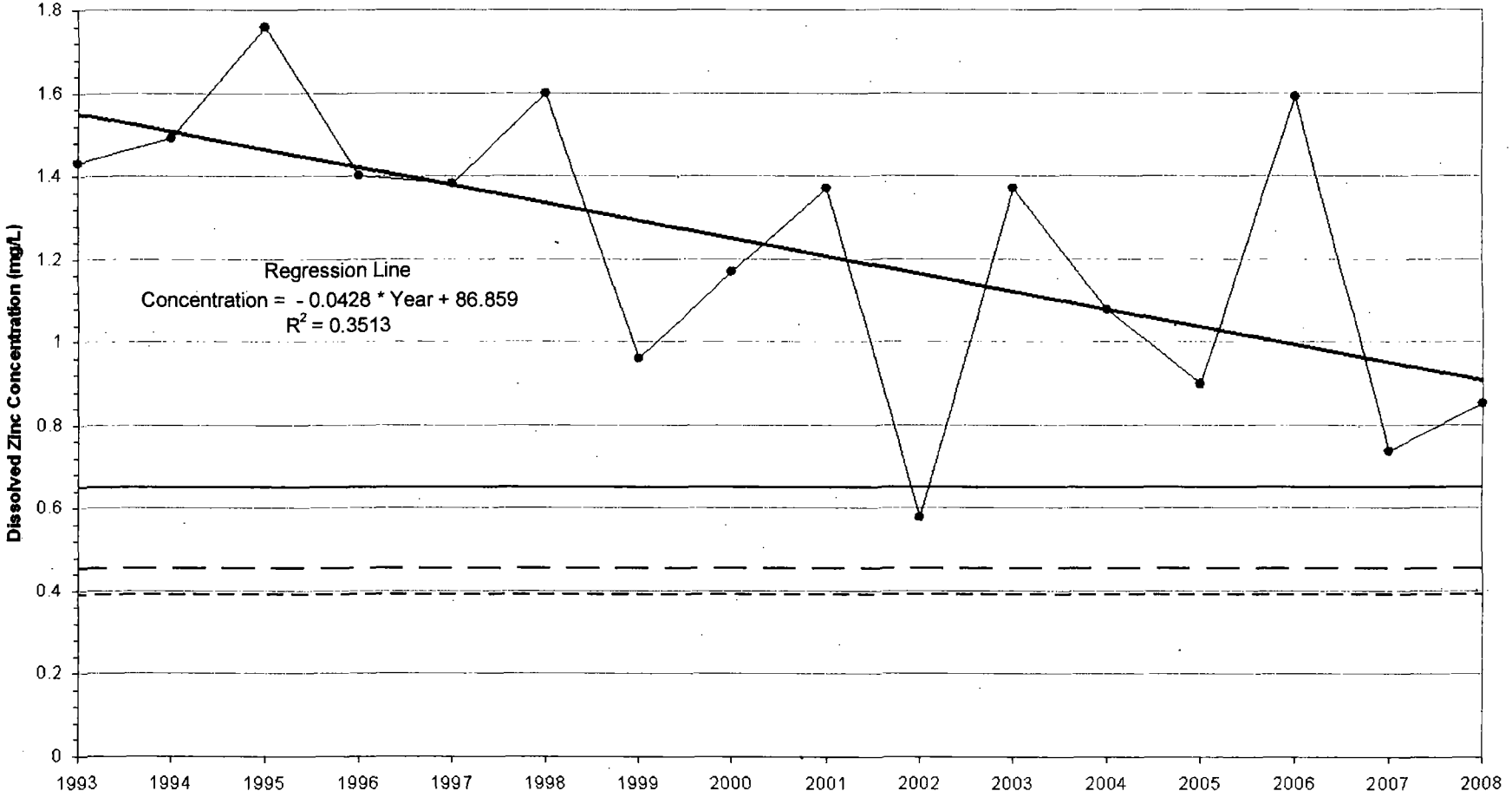


Figure 6-19

Location of study areas for Clement's 2004 Study



LEGEND:

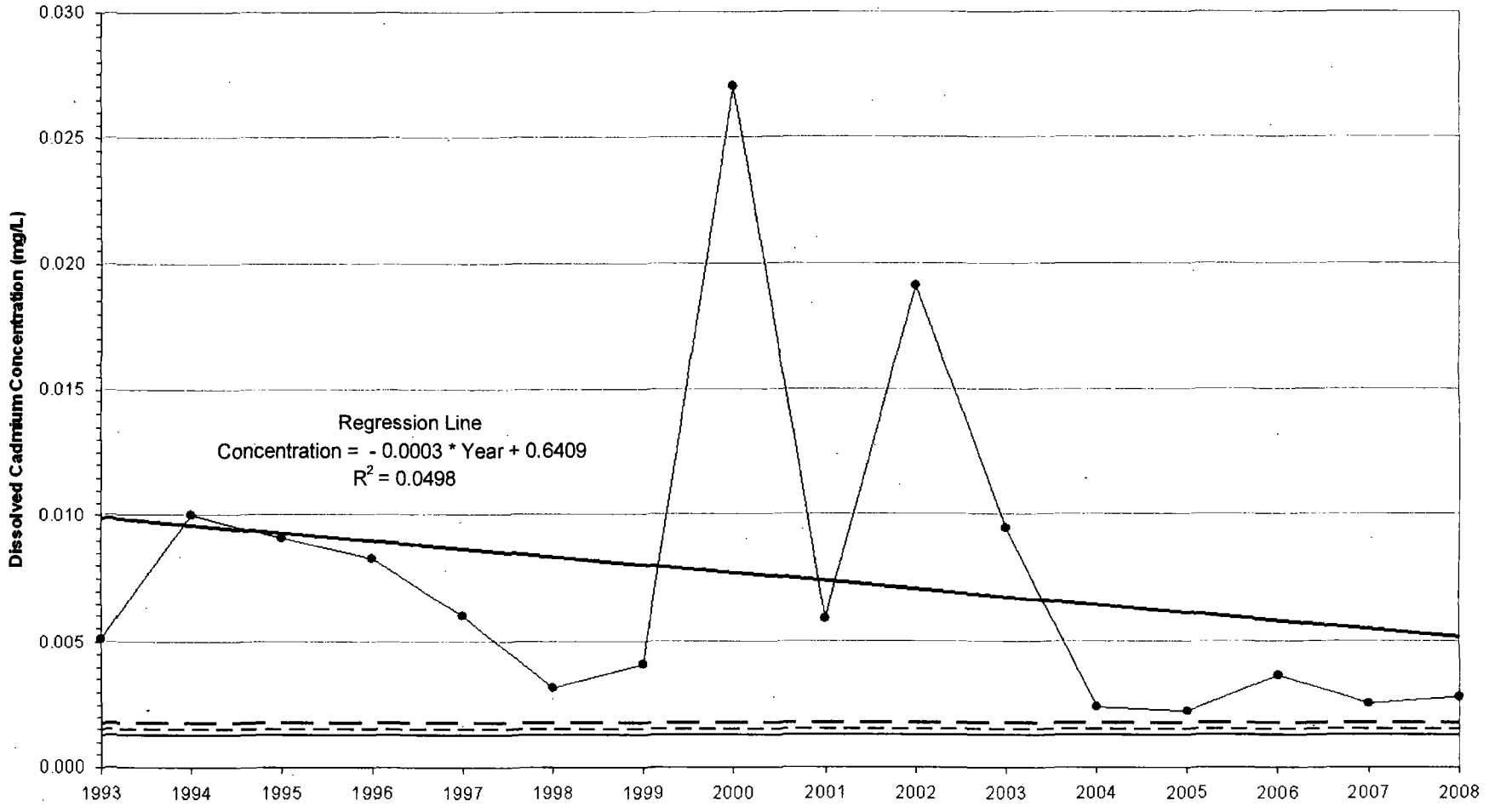
- ● Peak Zinc Concentration
- — — Acute Hardness-Based Zinc Standard (0.458 mg/L)
- – – – Chronic Hardness-Based Zinc Standard (0.389 mg/L)
- ——— Chronic Temporary Modified Zinc Standard (0.649 mg/L)
- ▬▬ Linear Regression Line

Notes: Hardness-based standards from CDPHE Water Quality Control Commissions Regulation No. 32, Classifications and Numeric Standards for Arkansas River Basin (Segment 2b), Effective March 30, 2009.
Standards based on flow weighted average daily hardness for April and May of 100 mg/L, 2003 through 2008.

P:\133-23356-08001 Cal Gulch\CAD\AR-3A April_May_Figs_2008.dwg

CALIFORNIA GULCH NPL SITE 2008 Arkansas River Water Quality	TETRA TECH
PEAK DISSOLVED ZINC IN THE ARKANSAS RIVER BELOW CALIFORNIA GULCH (AR-3A)	FIGURE:
Date: 04/21/09 By: MAM	6-20
Source: P:\23356-08001 Cal Gulch\Deliv.\Trend\Updated_RI_Eval._Charts.xls	

P:\133-23356-08001 Cal Gulch\CAD\AR-3A April_May_Figs_2008.dwg



LEGEND:

- ● Peak Cadmium Concentration
- ▬ Linear Regression Line
- — — Acute Hardness-Based Cadmium Standard (0.00170 mg/L)
- – – – Chronic Hardness-Based Cadmium Standard (0.00151 mg/L)
- ——— Chronic Temporary Modified Cadmium Standard (0.00134 mg/L)

Notes: Hardness-based standards from CDPHE Water Quality Control Commissions Regulation No. 32, Classifications and Numeric Standards for Arkansas River Basin (Segment 2b), Effective March 30, 2009.
Standards based on flow weighted average daily hardness for April and May of 100 mg/L, 2003 through 2008.

P:\133-23356-08001 Cal Gulch\CAD\AR-3A April_May_Figs_2008.dwg

CALIFORNIA GULCH NPL SITE
2008 Arkansas River Water Quality

PEAK DISSOLVED CADMIUM IN THE ARKANSAS RIVER BELOW CALIFORNIA GULCH (AR-3A)

Date: 04/21/09 | By: MAM

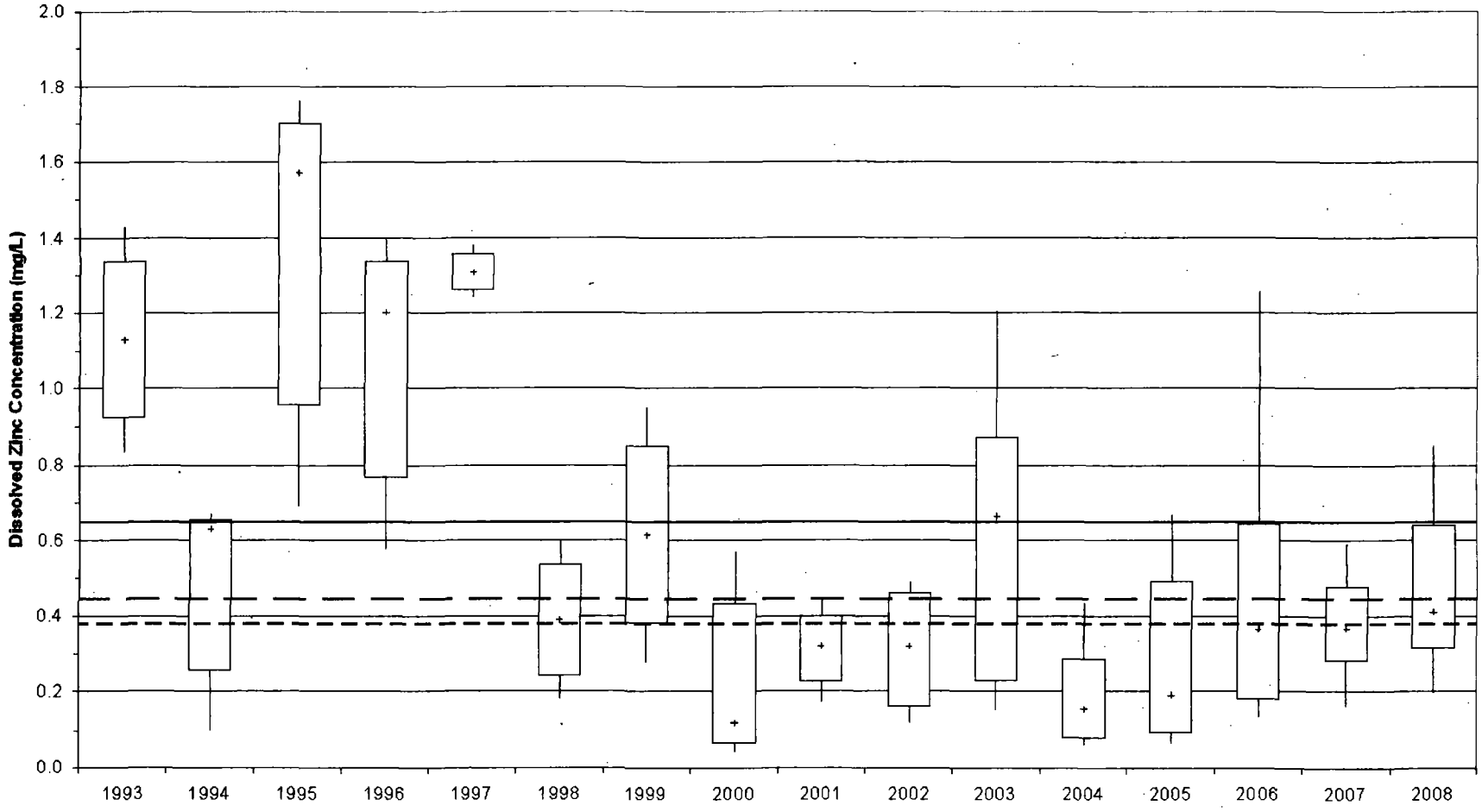
Source: P:\23356-08001 Cal Gulch\Deliv.\Trend\Updated_RI_Eval._Charts.xls

TETRA TECH

FIGURE:

6-21

P:\133-23356-08001 Cal Gulch\CAD\AR-3A April_May_Figs_2008.dwg



LEGEND:

— — Acute Hardness-Based Zinc Standard (0.458 mg/L)
– – – Chronic Hardness-Based Zinc Standard (0.389 mg/L)
——— Chronic Temporary Modified Zinc Standard (0.649 mg/L)

Maximum
85th Percentile
+ Median
15th Percentile
Minimum

Notes: Hardness-based standards from CDPHE Water Quality Control Commissions Regulation No. 32, Classifications and Numeric Standards for Arkansas River Basin (Segment 2b), Effective March 30, 2009.
Standards based on flow weighted average daily hardness for April and May of 100 mg/L, 2003 through 2008.

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CALIFORNIA GULCH NPL SITE
2008 Arkansas River Water Quality

DISSOLVED ZINC IN THE ARKANSAS RIVER BELOW CALIFORNIA GULCH (AR-3A)

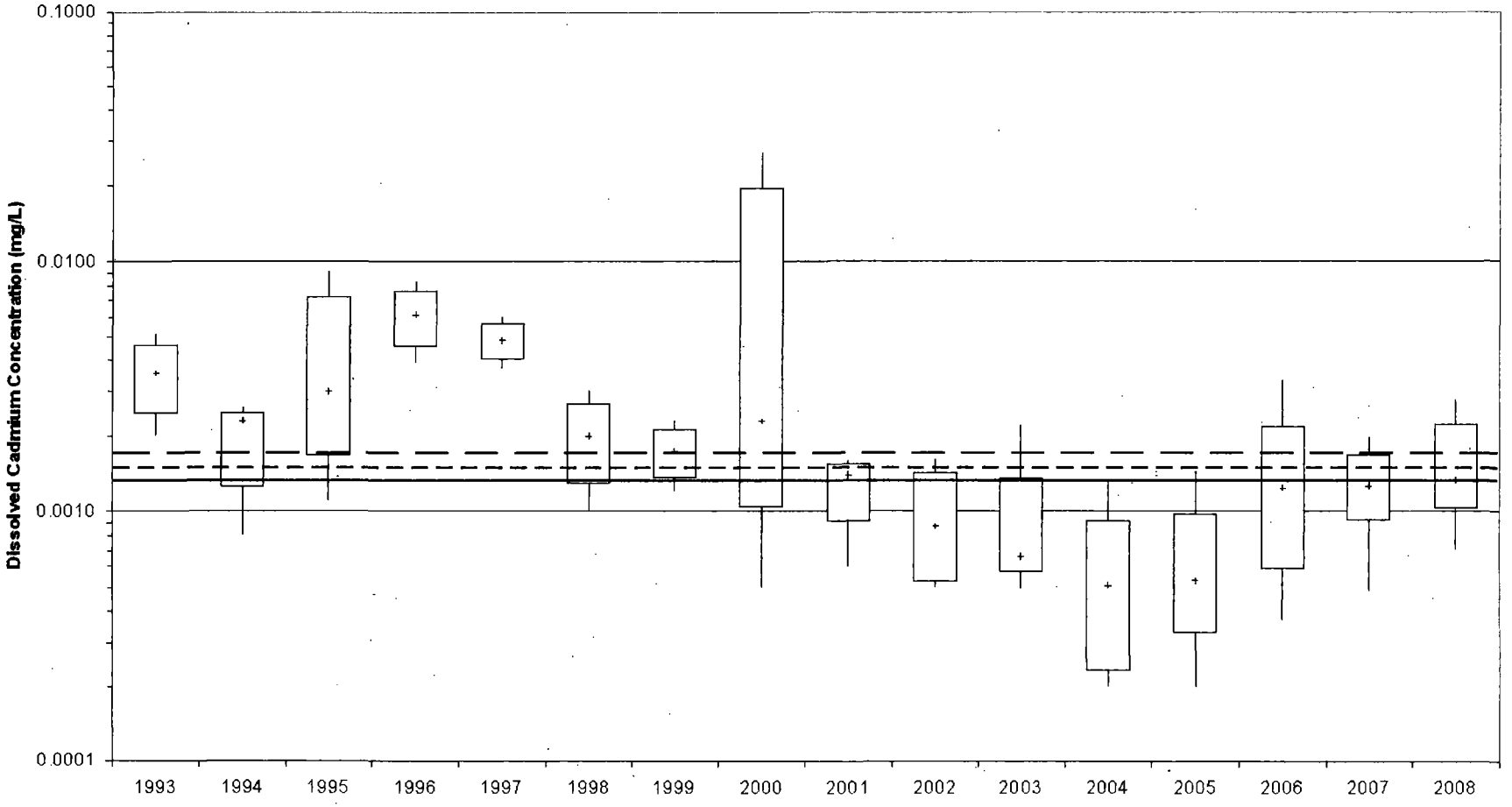
Date: 04/21/09 | By: MAM

Source: P:\23356-08001 Cal Gulch\Deliv.\Trend\1993-2008 AR3a April-May.xls

TETRA TECH

FIGURE:
6-22

P:\133-23356-08001 Cal Gulch\CAD\AR-3A April_May_Figs_2008.dwg



LEGEND:

— — Acute Hardness-Based Cadmium Standard (0.00170 mg/L)
– – – Chronic Hardness-Based Cadmium Standard (0.00151 mg/L)
——— Chronic Temporary Modified Cadmium Standard (0.00134 mg/L)

Maximum
85th Percentile
+ Median
15th Percentile
Minimum

Notes: Hardness-based standards from CDPHE Water Quality Control Commissions Regulation No. 32, Classifications and Numeric Standards for Arkansas River Basin (Segment 2b), Effective March 30, 2009.
Standards based on flow weighted average daily hardness for April and May of 100 mg/L, 2003 through 2008.

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CALIFORNIA GULCH NPL SITE
2008 Arkansas River Water Quality

DISSOLVED CADMIUM IN THE ARKANSAS RIVER BELOW CALIFORNIA GULCH (AR-3A)

Date: 04/21/09 | By: MAM

Source: P:\23356-08001 Cal Gulch\Deliv.\Trend\1993-2008 AR3a April-May.xls

TETRA TECH

FIGURE:
6-23

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