FRENCH GULCH

TMDLS FOR CADMIUM, COPPER, AND ZINC

HEADWATERS TO HASSAYAMPA RIVER
HUC# 15070103-239

6/20/2005

Open File Report 05-05

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LIST OF ABBREVIATIONS

ADEQ	Arizona Department of Environmental Quality
AgI	agriculture-irrigation watering
AgL	agriculture-livestock watering
A&Ww	aquatic and wildlife-warm
BLM	Bureau of Land Management
BMP	Best Managements Practices
cfs	Cubic Feet per Second
EPA	U.S. Environmental Protection Agency
°F	Fahrenheit
FBC	Full Body Contact
FC	Fish Consumption
ft msl	Feet (above) Mean Sea Level
gpm	Gallons per Minute
LA	Load Allocation
lat	latitude
long	longitude
mg/L	Milligrams per Liter
MDL	Method detection limit
MOS	Margin of Safety
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
SAP	Sampling and Analysis Plan
TASOW	Task Assignment Scope of Work
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WLA	Waste Load Allocation

EXECUTIVE SUMMARY

French Gulch, located between the towns of Prescott and Wickenburg, first appeared on the Arizona Department of Environmental Quality's (ADEQ's) list of water quality limited waters (303(d) List) in 1994. The French Gulch TMDL investigation commenced in 2001 in response to the 1998 listing which showed exceedances of cadmium, copper, manganese, pH, and zinc surface water quality standards. This TMDL investigation assesses the loading of French Gulch from its headwaters to its confluence with the Hassayampa River.

Currently, French Gulch is listed for exceedances of cadmium, copper, and zinc. Sampling in support of source and critical condition identification was slowed because of drought conditions, thus this project has spanned several assessments.

Sources

For this TMDL investigation, samples were collected to support identification of sources of pollutant loading; to support the identification of critical conditions for loading; and to calculate pollutant loads and allocations for the identified load sources. Sources of pollutant loading for French Gulch include only nonpoint source contributions from springs, inactive and abandoned mine workings, in-stream precipitates, ranching, and background. The metals, cadmium, copper, and zinc increase in French Gulch within the Zonia mine area with metal transport declining downstream in the Placerita Gulch area. This investigation results in TMDLS for three distinct areas: the headwaters of French Gulch, the Zonia mine area, and the Placerita Gulch area.

Model Approach

Tetra Tech Incorporated (Tetra Tech), ADEQ's modeling contractor, was engaged to develop TMDLs for French Gulch. Tetra Tech's modeling approach which was based on availability of data and the ability to represent critical hydrologic and loading conditions, used LSPC, MINTEQA2, and load duration curves. The Loading Simulation Program – C++ (LSPC) was used to simulate nonpoint source flow and pollutant loading as well as in-stream flow and pollutant transport. LSPC was applied to address time variable flow simulation and to generate flow duration curves for the load duration model. When necessary, dissolved metal concentration simulations were determined by a modification of MINTEQA2.

Critical Conditions

Critical hydrologic conditions within the three distinct areas vary within the French Gulch watershed, occurring under high, mid-range, and low flows. The greatest reductions required to meet water quality criteria occur, in most cases, at the highest flows within the Zonia mine area.

Load Reductions

Load reductions within the French Gulch watershed are necessary in the headwaters area, the Zonia mine area, and the Placerita Gulch area. The headwaters requires an 76.09% reduction for copper and a 29.18% reduction for zinc. Exceedances in copper and zinc in the headwaters area are related to the lower hardness which contributes to lower standards. The

highest loading of copper requiring a load reduction of 99.00% occurs in the Zonia Mine area. The highest cadmium and zinc load reductions for this area are 51.40% and 82.48%, respectively. In the Placerita Gulch area, the greatest necessary reductions are 86.98% for copper and 77.18% for zinc.

Monitoring/Implementation

ADEQ is required to establish a TMDL implementation plan that explains how the allocations and any reductions in existing pollutant loadings will be achieved (A.R.S. § 49-234G). ADEQ intends to develop a comprehensive management strategy to improve water quality. Throughout the development of the implementation plan, stakeholder involvement will be actively sought by ADEQ. As there are no point source discharges in the French Gulch watershed, the achievement of surface water quality standards will occur through voluntary efforts. Since 2000, the Zonia Mine has voluntarily produced well water from the Clear Springs area effectively reducing loading in French Gulch; however, additional reductions are necessary.

Two public meetings were held to provide information regarding the investigation and its results; and to encourage participation from stakeholders and private landowners. The first public meeting was held in Walnut Grove, Arizona on April 20, 2004. In the second public meeting, held on September 14, 2004 in Walnut Grove, Arizona, ADEQ introduced the availability of 319(h) grant funding for the purpose of implementing watershed restoration plans. Future monitoring activities were also discussed. ADEQ encourages additional water quality sampling and flow measurement in the French Gulch watershed. The results from such monitoring will contribute to future evaluations of the water quality of French Gulch.

1 PROJECT BACKGROUND

Numerous investigations by the Arizona Department of Health Services, the U.S. Environmental Protection Agency (EPA), and ADEQ have documented the chronic pollution trends at Zonia Gulch Springs and French Gulch Springs. An EPA investigation in 1989 and an ADEQ investigation in 1992 recorded discharges of toxic leachate from the Southwest Leach Basin of Zonia Mine directly into French Gulch. These discharges caused violations of surface water quality standards in reaches of French Gulch below Zonia Mine. (ADEQ, 1992) An ADEQ Staff Report, 1992 concluded that "the patterns of water quality data are unmistakable. Upstream (of Zonia Mine) water quality is in compliance". On November 1, 1992, the United States Environmental Protection Agency (EPA) issued a Notice of Finding of Violation and Order for Compliance against the Zonia Company of Prescott, Arizona.

French Gulch first appeared on Arizona's 303(d) list of water quality limited waters in 1994 for exceedances of beryllium, cadmium, copper, manganese, mercury, pH, zinc, and TDS and in 1998 for exceedances of cadmium, copper, manganese, pH, and zinc. In 2002, after adoption of the State's Impaired Waters Identification Rule, French Gulch was listed for copper, manganese, and zinc; cadmium and pH were delisted because there were no exceedances in 141 samples.

Water quality sampling for the French Gulch TMDL commenced in January 2001. Between November 2001 and January 2003, only one event was sampled. In February 2003, sampling for this project was resumed and continued through April 2004. In December 2003, ADEQ hired Tetra Tech to perform a historic data review and to create a watershed loading model which was completed in the summer of 2004.

2 SETTING

2.1 Geography

French Gulch, a tributary to the Hassayampa River in the Middle Gila Basin, rises in the Weaver Mountains near Kirkland Junction in Yavapai County (Figure 2-1). The terrain consists of a series of rugged gulches, with elevations ranging from 5,100 feet mean sea level (ft msl) at its headwaters to 3,450 ft msl at its confluence with the Hassayampa River. The headwaters of French Gulch are located approximately 20 miles northeast of Wickenburg and approximately 25 miles southeast of Prescott. French Gulch flows in a northeasterly direction for 2.3 miles before flowing southeast 7.5 miles to its confluence with the Hassayampa River. Several inactive mines are located throughout the French Gulch watershed area. The Zonia Mine, an inactive open pit and copper leach operation, is located along its headwaters.

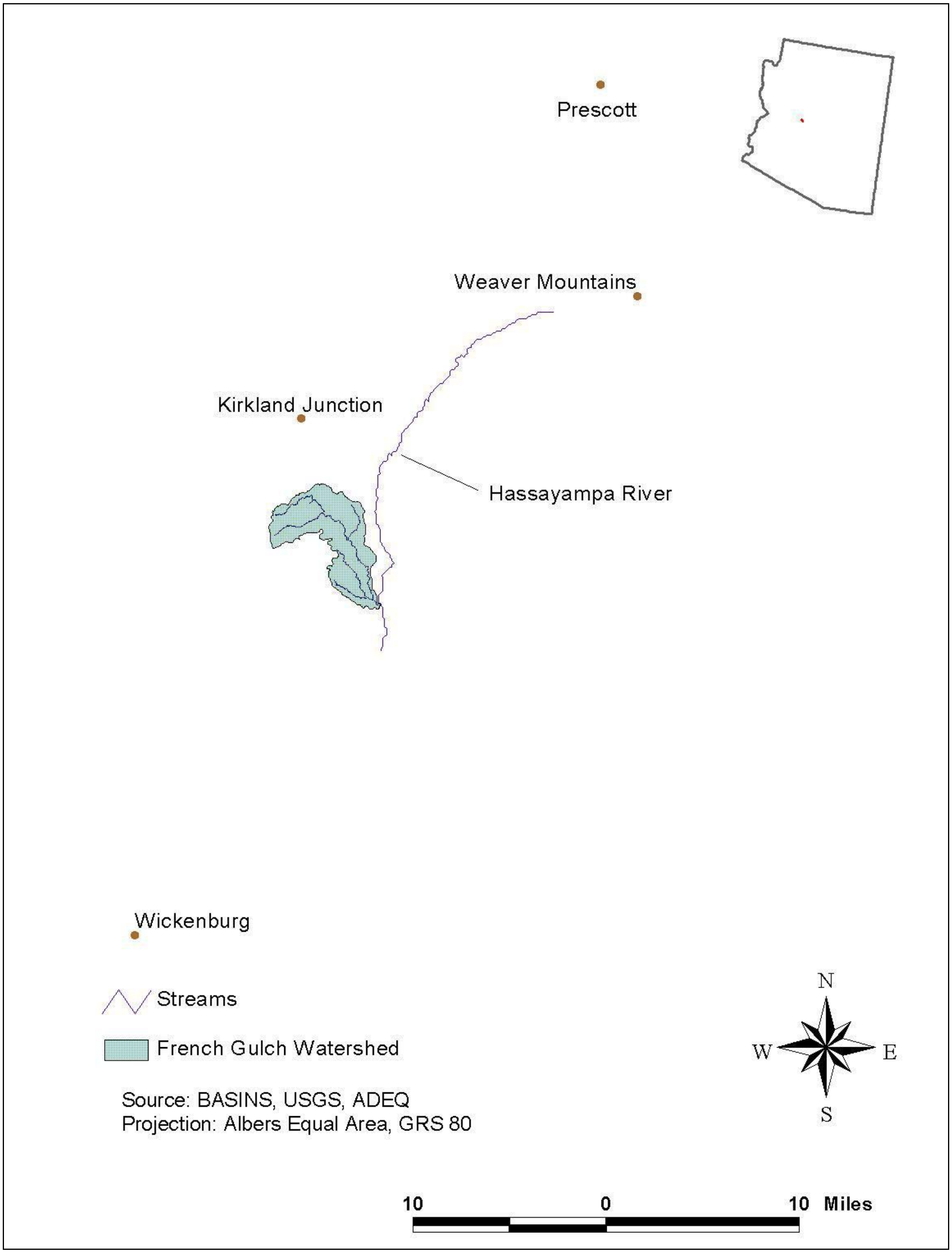

Figure 2-1. French Gulch Index Map (Tetra Tech, 2004)

2.2 Climatology

The French Gulch watershed receives an average annual precipitation of 10 to 20 inches, predominantly as rain. The region receives precipitation according to a bimodal pattern, with most of the rain occurring from mid-July through mid-September as short-lived intense monsoon thunderstorms, and gentler storms of longer duration occurring during winter months (Sellers, 1974). The average high temperature for Prescott is 88° Fahrenheit (°F), and the average low temperature is 23°F. The average high temperature for Wickenburg is 103°F with an average low of 32°F. Although the French Gulch watershed receives minimal snowfall, to date, no known measured snowfall records exist. Minimal snowfall within the Zonia mine site allows for subsurface saturation. The measured snowfall average for Prescott is 25.49 inches and 0.28 inches for Wickenburg.

Two rain gages, installed by ADEQ for this project, were placed along French Gulch; one was situated in the upper watershed and the other was situated in the lower portion of the watershed. Precipitation data is available for the period 1971 to 2003 through meteorological stations located in Prescott (#026796) and Wickenburg (#02987). The Flood Control District of Maricopa County also has a precipitation station located in Wilhoit (#5365), approximately 1.9 miles from French Gulch. The Wilhoit gage has a continuous period of record from 7/01/1985 to present. Because it is the closest gage to French Gulch, its records were used to augment the ADEQ gage records used in modeling.

Below normal rainfall between 1996 to present indicate drought conditions within Yavapai County (Fogarty, 2004). Prescott and Wickenburg received 87% of normal rainfall between 1996 and 2002. The average annual precipitation in Prescott between 1971 and 2000 was 19.19 inches as compared to Wickenburg which received 12.25 inches.

2.3 Hydrology

The French Gulch watershed drains approximately 16 square miles with an overall drop in elevation of 1,650 ft. From its headwaters in the Weaver Mountains near Kirkland Junction, AZ, it flows 2.3 miles in a northeasterly direction before flowing southeasterly for 7.5 miles to its confluence with the Hassayampa River. Four tributaries feed into French Gulch: Zonia Gulch, Placerita Gulch, an unnamed tributary and a western unnamed tributary. Zonia Gulch is no more than one third mile in length and it confluences with French Gulch about 2 miles downstream of the headwaters. Placerita Gulch joins French Gulch approximately 3 miles downstream from its headwaters. 2.5 miles downstream of Placerita Gulch, an unnamed tributary, feeds into French Gulch. Hodgkins Gulch and a western unnamed tributary merge, draining into French Gulch 0.5 miles upstream of the confluence of French Gulch and the Hassayampa River (Figure 2-2). Except for a short stretch of perennial flow produced by Clear Springs downstream of the Zonia Gulch confluence, most of French Gulch is intermittent.

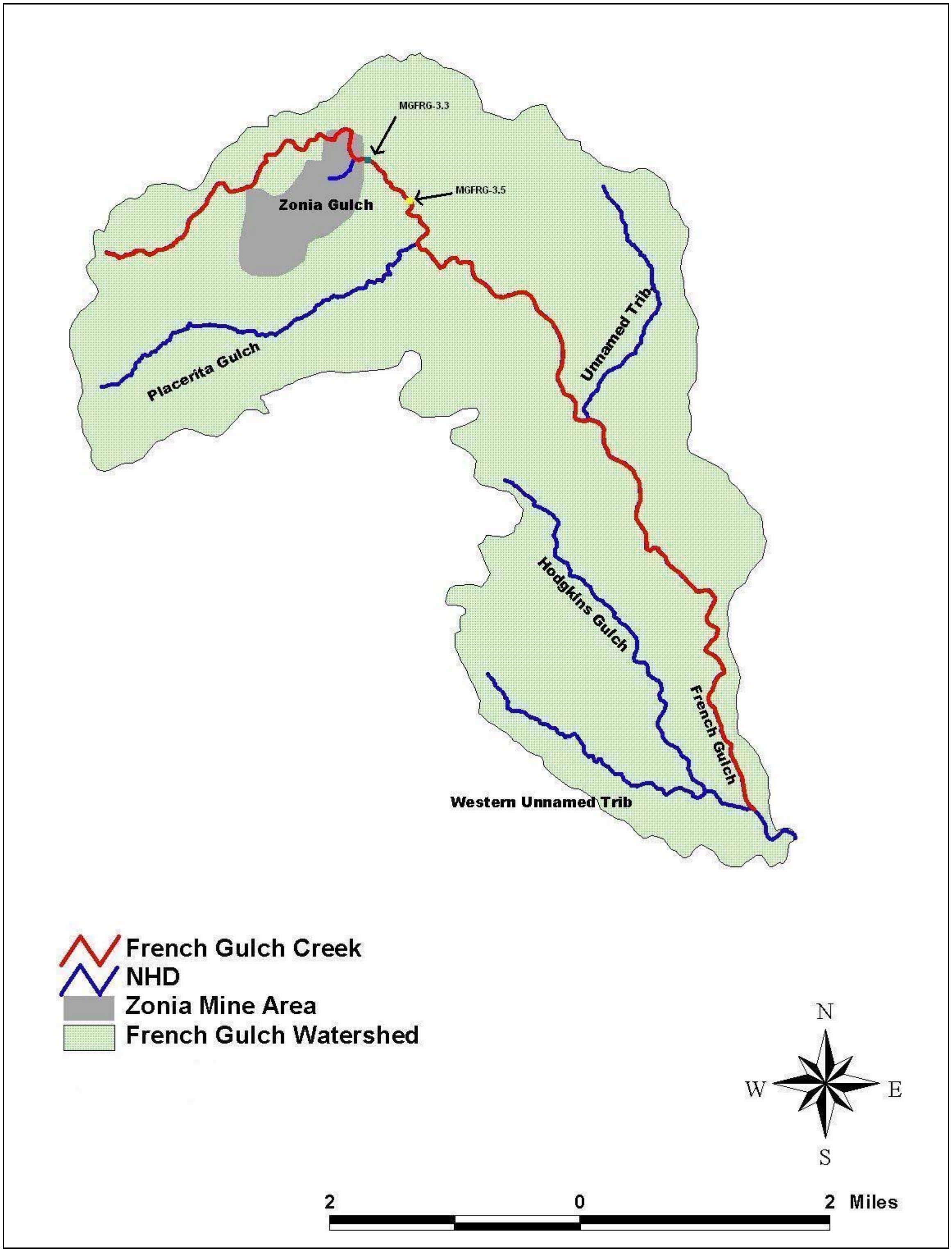

Figure 2-2. French Gulch Watershed Map (Tetra Tech, 2004)

French Gulch and Zonia Gulch springs emanate from the greenstone-andesite intrusive, which serve as barriers to groundwater flow and force groundwater moving along fractures and structural features to the surface after regional precipitation. These springs are water sources of Zonia Gulch and French Gulch (Tetra Tech, 2004a). Through personal communication with Arimetco staff, ADEQ staff learned that in 2000, Arimetco installed three production wells at the confluence of Zonia Gulch and French Gulch (Figure 2-3). Arimetco installed these to draw down and ultimately eliminate the drainage causing exceedances of the surface water quality standards. Thus, these wells have recently altered the hydrology of French Gulch by eliminating the perennial segment of Zonia Gulch and significantly reducing the perennial flow of French Gulch and affecting the groundwater flow pattern of the area. (Tetra Tech, 2004a)

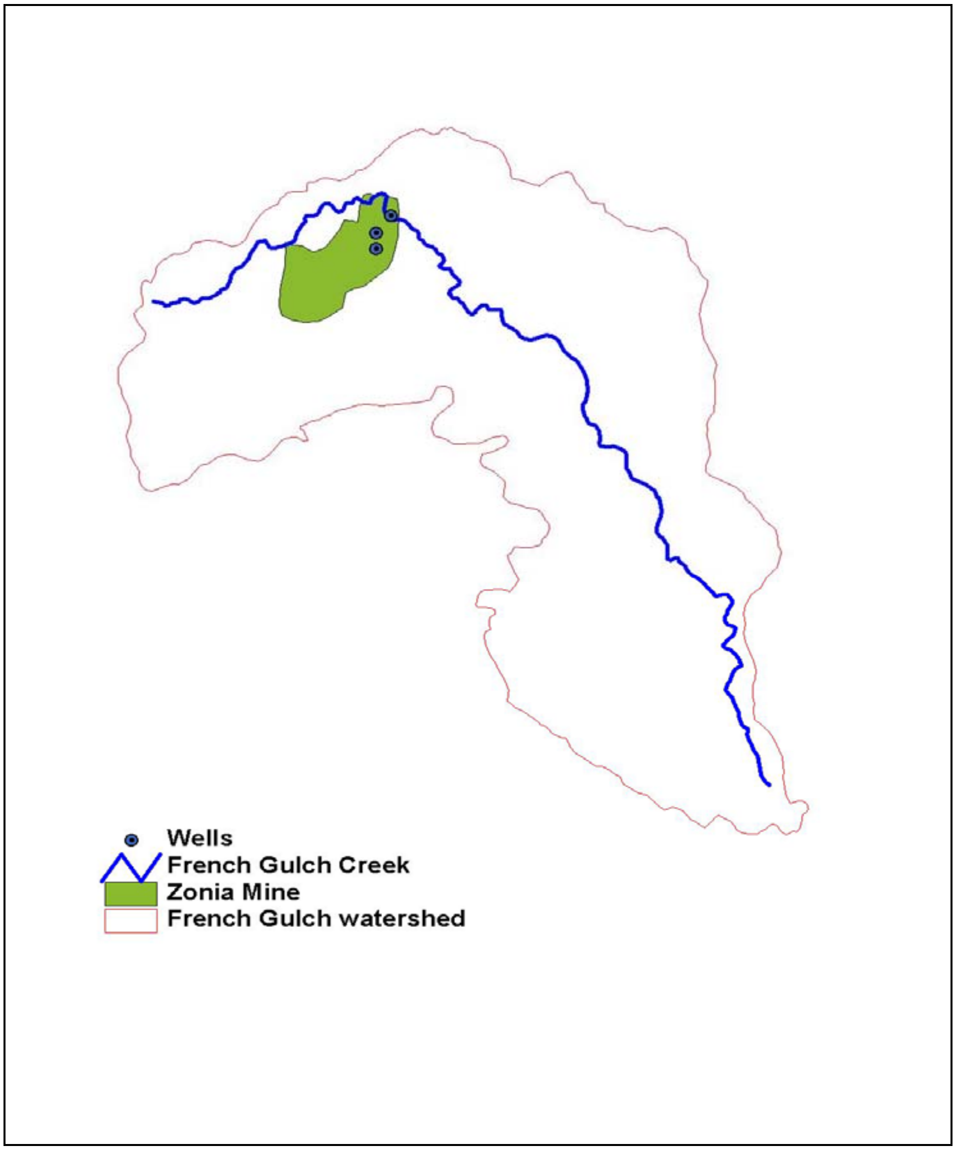

Figure 2-3. Zonia Mine well production

Below the confluence of Zonia Gulch and French Gulch, Clear Springs also flows into French Gulch. In the area of Clear Springs and French Gulch, flow in the creek increases. This increase in flow may be due to springs alongside the creek, and the subsurface as the creek flows downstream. Recently, French Gulch above Placerita Gulch has had flow. The most downstream station on French Gulch, upstream from the confluence with the Hassayampa River, has been recorded as dry most of the time; however, water quality samples were collected at this site in 2003. (Tetra Tech, 2004a)

There are no USGS gage stations on French Gulch. However, there are two USGS gages, #09502960 and #09503300, near Prescott. USGS gage #09502960 is located on Granite Creek below Watson Lake. The Flood Control District of Maricopa County installed a gage (#5352) on September 23, 1991, on the bridge along the Hassayampa River at Wagoner Road, approximately 3 miles east of French Gulch.

Historically French Gulch flows have been measured by Schmidt and Associates, the Zonia Mine, and ADEQ. Schmidt and Associates collected six instantaneous flow measurements during 1989 and 1991 at different locations along French Gulch and between 1993 and 2002 the Zonia Mine Company has collected 60 observed flow measurements along French Gulch. (Tetra Tech, 2004a) Stream flow measurements taken by ADEQ at designated sampling points date from late 2001 to present. Measured flows range from 0.003 to 6.834 cfs. No flow measurements were obtained between March 21, 2002 and February 26, 2003 due to little or no flow conditions. Stream level loggers were installed by ADEQ in May, 2003 above the Zonia Mine, below Zonia Gulch, and 0.5 miles above the confluence of French Gulch and the Hassayampa River. The fourth stream level logger was installed in December, 2003 along French Gulch below Placerita Gulch. No flow data exists for the unnamed Tributary and the Western unnamed Tributary.

2.4 Geology

The geology of the area consists of an elongated strip of Precambrian schistose lithology, about one mile wide and six miles long, that bisects a pluton of Precambrian granite (Halpenny, 1982). The northeast trending strip, referred to as the “Zonia copper deposit”, aligns southwest to northeast, containing several mines and shafts collectively known as the Placerita Mining District. The strip crosses French Gulch at the Zonia Mine. Northeast of the Zonia Mine, gravel and conglomerates of late Tertiary age prevail, while to the southwest, the schist is overlain by a thick sequence of volcanic rocks of Quaternary age. (Cameron, 1975) Homestake Mining Company’s 1975 final report on the Zonia copper deposit further describes the geology as,

> The strips of igneous and sedimentary rocks have undergone hydrothermal alteration and strong dynamic-weak thermal metamorphism. The low grade metamorphism affected all rock types, except the diabase, Tertiary alluvium, and Quaternary basalt, in only slightly different manners. Dominant metamorphic minerals

> include chlorite and sericite. Hydrothermal solutions have altered the intrusive quartz monzonite porphyry and enclosing wall rocks. Mineralization in the porphyry and adjacent greenstones includes chlorite, sericite, epidote, pyrite, calcite, quartz, magnetite, chalcopyrite, k-feldspar, biotite and molybdenite. Siderite, up to 20%, occurs over large areas and is a product from metamorphic and/or hydrothermal alteration. Chalcopyrite is the dominant, perhaps only, primary copper mineral.

The copper ore deposit occurs as a lenticular or lensoidal stratabound accumulation of chalcopyrite and pyrite at the contacts of individual rhyolitic units as disseminated minerals within the tuffs, and along the contact of the mafic and felsic sections (Lundin, 1985).

The soils in the French Gulch drainage consists of two main series: first, all of the headwaters, all of the Zonia Mine area, and 1½ miles downstream of the Zonia confluence, are soils of the Moano, a very rocky type of loam found on 15 to 60 percent slopes: second, nearly all of the soils in the remainder of the drainage belong to the Barkerville cobbly sandy load, which is found on 20 to 60 percent slopes. The Moano very rocky load complex is about 70 percent Moano general loam, 20 percent rock outcrops, and 10 percent gravelly clay loam, and narrow areas of Lynx soils in the drainage ways. The Moano complex's soils are well-drained, shallow (6 to 20 inches to bedrock), of moderate permeability, of rapid runoff potential, and present a hazard of erosion that is moderate to high. For the Barkerville cobbly sandy loam, the complex can be described as shallow (20 to 40 inches to bedrock), or shallow over weathered bedrock, well-drained soils. This soil is on granite hills and mountains dissected by numerous drainage ways. Runoff is rapid and the hazard of erosion high (Final Report IX – FY 90 –27, Zonia Company Mine, 1991). Soils could be one of the sources for metals loadings into French Gulch Creek during summer months and winter seasons (Tetra Tech, 2004a).

2.5 Vegetation/Wildlife

The vegetation within the first three miles of French Gulch is considered Interior Chaparral-Mixed Evergreen Sclerophyll, with a heavy industrial mine area on the south bank. The central section of French Gulch flows through Interior Chaparral-Shrub Live Oak Pointleaf Manzanita and the bottom portion of the stream returns to Interior Chaparral mixed Evergreen Sclerophyll. Chaparral is a dry climate adapted woody evergreen shrub that consists almost solely of small leathery leaves (Dimmit, 2000).

Wildlife includes red-tailed hawk, great horned owl, mule deer, turkey, antelope, javelina, and cottontail rabbit. Although no threatened and endangered species have been identified within the French Gulch watershed, none exist in areas adjacent to the French Gulch watershed (Fletcher, 2004).

ADEQ conducted two preliminary biological evaluations (site MGFRG-3.3 and site MGFRG-3.5, see Figure 2-2) along French Gulch on May 5th, 2004, to identify potential water quality impacts to aquatic life. The upstream biological sample site (site MGFRG-3.3) was located approximately 300 ft. downstream of Clear Springs. The downstream site (site MGFRG-3.5) was located in a temporary pool with a small run located approximately 0.27 mi or 1400 ft. downstream of site MGFRG-3.3 on French Gulch.

Site MGFRG-3.3 was influenced by additional seepage from the banks with a bryophyte (moss) present in some bank areas. No macrophytes, fish, crayfish, or frogs were present. Sand cased caddis flies were abundant at this site, however no mayflies or other insects were found at this location. Previous water samples from this reach indicated standards exceedances for the metals, copper and zinc as well as detectable levels of cadmium. Hydrolab measurements collected on May 24, 2004, reflected high conductivity and salt content in the spring fed water, also indicated by white salt crusts along banks throughout the reach.

The overall habitat was more wetland-like than riffle-pool dominated as in other larger desert streams. Habitat was adequate but not preferable for growth and habitation by clean water insects. Canopy cover was estimated at 75% consisting of an interior riparian deciduous forest of cottonwood, willow, and ash dominated by the exotic tree species, Salt Cedar. Riparian condition was rated as “functional at risk-upward trend”; the abundant Salt Cedar provided good bank protection and floodplain roughness, though there were excess fines in the streambed and low regeneration potential for the native tree species. There is abundant riparian vegetation and generally good channel stability along this whole reach of French Gulch, which, given sufficient clean water should support a viable aquatic community.

No measurable flow was obtained at site MGFRG-3.5. The pool was disconnected from seepage and upwelling areas of site MGFRG-3.3. A manganese bed veneer, as well as numerous white, crusty, salt deposits, were visible at site MGFRG-3.5. No fish, crayfish, or frogs were present. A thin coating of diatoms as well as green algae on all substrates were located within the pool. Habitat was poor when compared with site MGFRG-3.3. Canopy cover was estimated at 10% and the vegetation was primarily Salt Cedar at this location.

These preliminary data suggest that the impaired condition of the macro invertebrate community and lack of mayflies at site MGFRG-3.3 is best explained by chemical differences and not habitat. The synergistic effects of a combination of heavy metals at the spring fed site MGFRG-3.3 seems to explain the lack of mayflies and lack of diversity in the macroinvertebrate community at site MGFRG-3.3. The presence of mayflies at site MGFRG-3.5 suggests that a colonization source is present. The conditions are not favorable for establishment of a diverse invertebrate community at site MGFRG-3.3.

2.6 Land Ownership/Use

Land ownership in the French Gulch watershed is roughly 50% private and 50% public land owned by the US Bureau of Land Management (BLM) and State Trust (Figure 2-4). French Gulch begins on State Land, flows through Zonia mine, then flows through BLM and private lands below the Zonia Gulch confluence (ADEQ, 1993) (see Figure 2-4).

The Zonia Mine is an inactive heap leach and in situ leach facility located in the upper reaches of French Gulch (Sections 11, 12, 13, and 14, Township 11 N, Range 4 W). Mining activity began during the 1880's with the production of high grade copper ores which were shipped for smelting (Homestake). McAlester Fuel put an open pit copper mine and heap leaching plan in operation in the 1960's and later added in situ leaching. No tailings piles are located on the property; the piles that can be seen along French Gulch on the northern most portion of the Zonia Mine site are unprocessed waste rock. The Zonia Mine is currently not operating except for the pumping of wells #5, #6, and #9 in order to curtail exceedances along French Gulch. Pumping of wells #5 and #6 began in 1973 to eliminate the flow of Zonia gulch which is being diverted to the southwest holding pond. Pumping of well #9 began in 2001 to eliminate flow from the Zonia Mine property. This water is drained into a pond referred to as "French Gulch Diverted."

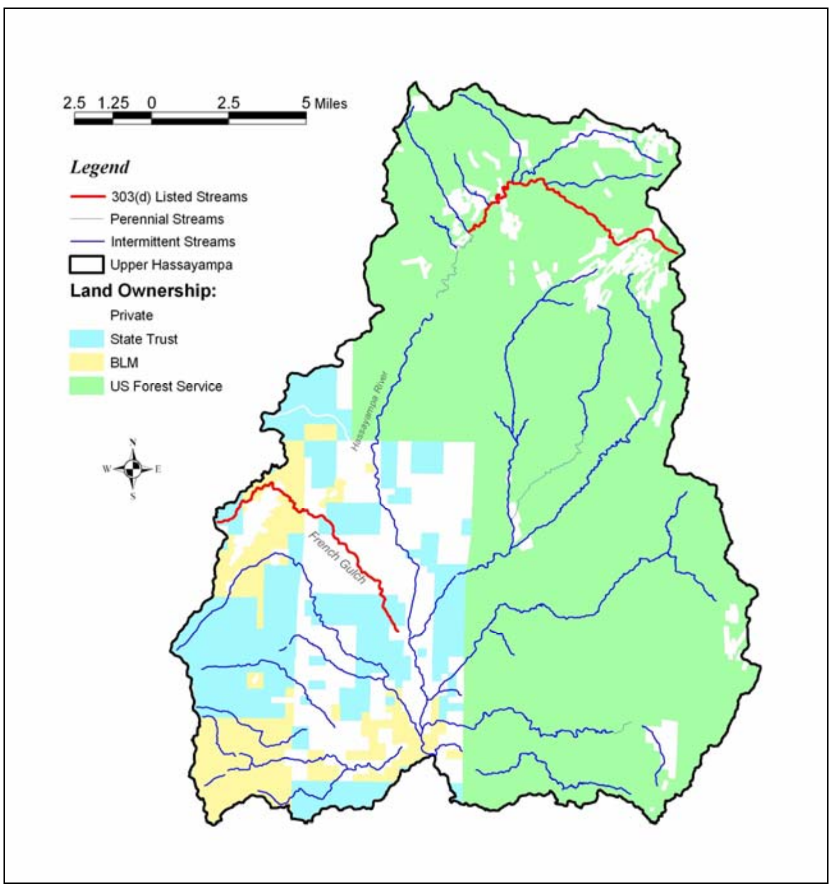

Figure 2-4. Land Ownership

Land use within the watershed includes ranching and mining operations both along French Gulch and along Placerita Gulch (Figure 2-4). The Zonia Mine, which is the most significant mine in the watershed, is inactive. There are several mining claims in the French Gulch watershed. Inactive mine adits were noted in an unnamed tributary to Placerita Gulch in March of 2004. Casual use mining for the extraction of gold, using dry panning and metal detectors, can be seen today. The Bureau of Land Management (BLM) considers casual use as "activities ordinarily resulting in only negligible disturbance of the Federal lands and resources. For example, activities are generally considered casual use if they do not involve the use of mechanized earth moving equipment or explosives or do not involve the use of motorized vehicles in areas designated as closed to off-road vehicles…" (BLM, 2004).

3 NUMERIC TARGETS

3.1 Clean Water Act Section 303(d) List

French Gulch (HUC# 15070103-239), from its headwaters to its confluence with the Hassayampa River, is listed as "impaired" by the State of Arizona according to the provisions of the Clean Water Act Section 303(d). (ADEQ, 2004) Total Maximum Daily Load (TMDL) allocations must be developed for those waters listed on the 303(d) list. TMDLs determine the amount of given pollutant(s) that the water body can withstand without creating an impairment of that surface water's designated use(s).

ADEQ first listed French Gulch for non-attainment of Aquatic and Wildlife ephemeral and Partial Body Contact designated use standards for beryllium, cadmium, copper, manganese, mercury, low pH, zinc, and TDS in 1994. Historical listing data and a sample site location map are located in Appendix A. Since 1994, the listed parameters have varied according to available data, assessment criteria, and with changes in applicable standards that have occurred. The French Gulch assessment and listing history is listed in Table 3-1.

Table 3-1. French Gulch Assessment and Listing History

Year	Designated Uses[1]	Impaired Parameters (t=total metals; d=dissolved metals)
1994	A&Ww, FBC, AgL, AgI, partial FC, PBC	Beryllium^{t}, cadmium^{t}, copper^{t,d}, manganese^{t}, mercury^{t}, low pH, TDS[1], zinc^{d}
1996	A&Ww, FBC, partial FC, AgI, AgL	Beryllium^{t}, cadmium^{t}, copper^{t,d}, manganese^{t}, pH, TDS[2], turbidity, zinc^{t}
1998	A&We, PBC	Cadmium^{t,d}, copper^{d}, manganese^{t}, pH, zinc^{d}
2000	A&Ww, PBC,	Cadmium^{t,d}, copper^{d}, manganese^{t}, pH, zinc^{d}
2002	A&Ww, FBC, FC, AgI, AgL	Copper^{t,d}, manganese^{t}, zinc^{d}
2004	A&Ww (acute), A&Ww (chronic), FBC, FC	Cadmium^{d}, copper^{d}, zinc^{d}

[1]A&Ww =Aquatic & Wildlife (warm); A&We=Aquatic and Wildlife (ephemeral); AgI=Agriculture use-Irrigation; AgL=Agriculture use-Livestock; PBC=Partial Body Contact; FBC=Full Body Contact; FC=Fish Consumption
[2]TDS=total dissolved solids

3.2 Beneficial Use Designations

ADEQ codifies water quality regulations in AAC Title 18, Chapter 11 (ADEQ, 1996). Designated beneficial uses, such as fish consumption, recreation, agriculture, and aquatic biota, are described in AAC R18-11-104 and are listed for specific surface waters in Appendix B of AAC R18-11. French Gulch is currently protected for the following designated uses: Aquatic and Wildlife-warm water fishery (A&Ww); Fish Consumption (FC); and Full Body Contact (FBC).

In March 2002, a series of amendments were made to Arizona's Water Quality Standards; one of which affected the designated uses assigned to tributaries. Because of this change, the Agricultural Irrigation (AgI) and Agricultural Livestock (AgL) uses were removed from French Gulch. During the 2005 triennial review, the designated uses for French Gulch will be evaluated because of the prevalence of livestock seen within the vicinity of French Gulch throughout this investigation.

3.3 Applicable Water Quality Standards

The French Gulch TMDLs and allocations must be set at levels that will provide for the attainment of the surface water quality standards for the designated uses of French Gulch. The State of Arizona's surface water quality standards are listed in Title 18, Chapter 11, Article 1 of the Arizona Administrative Code. The most stringent surface water quality standards for dissolved cadmium, dissolved copper, and dissolved zinc are those protecting warm water aquatic and wildlife (A&Ww) from chronic exposure. The water quality standards for dissolved cadmium, copper, and zinc are hardness-based and thus, they vary with the observed hardness at the time of sampling. For assessment purposes, applicable hardness values range from 25-400 mg/L and are calculated from total calcium and magnesium concentrations. Table 3-2 shows the applicable water quality standards for French Gulch.

TABLE 3-2. Designated uses and corresponding water quality standards for French Gulch

DESIGNATED USE	A&Ww ACUTE (μg/L)	A&Ww CHRONIC (μg/L)	FBC (μg/L)	FC (μg/L)
Cadmium, Dissolved	$(e^{(1.128[\ln(Hardness*)] - 3.6867)}) \times (1.136672 - \ln(Hardness) \times (0.041838)$	$(e^{(0.7852[\ln(Hardness*)] - 2.715)}) \times (1.101672 - \ln(Hardness) \times (0.041838)$	NNS	NNS
Copper, Dissolved	$(e^{(0.9422[\ln(Hardness*)] - 1.7)}) \times (0.96)$	$(e^{(0.8545[\ln(Hardness*)] - 1.702)}) \times (0.96)$	NNS	NNS
Zinc, Dissolved	$(e^{(0.8473[\ln(Hardness*)] + 0.884)}) \times (0.978)$	$(e^{(0.8473[\ln(Hardness*)] + 0.884)}) \times (0.978)$	NNS	NNS

NNS=no numerical standard
*Hardness is expressed as mg/L $CaCO_3$ as calculated by the laboratory

Table 3-3 lists the cadmium, copper, manganese, and zinc water quality standards for AgL. By meeting the most stringent standards currently assigned to French Gulch, the AgL standards will be met.

TABLE 3-3. AgL Standards for French Gulch Pollutants

STANDARDS	AgL (μg/L)
Cadmium, Total	50
Copper, Total	500
Manganese, Total	NNS
Zinc, Total	25000

4 WATER QUALITY DATA

The following subsections are excerpts from the water quality literature and data review that was prepared by Tetra Tech and included in the *Existing Data Review Report for French Gulch Creek* commissioned by ADEQ in December, 2003. The *Existing Data Review Report for French Gulch Creek* was the first step in the construction of a numeric model for the French Gulch watershed that would allow for the calculation of TMDLs and load allocations.

Surface water and groundwater quality data is critical for a number of steps in the TMDL process. Water quality data will be used to determine the extent, frequency and conditions under which the stream impairment occurs, as well as to define background water quality. (Tetra Tech, 2004a) Data are available from three primary sources: ADEQ, Zonia Mine Company, and Schmidt and Associates.

4.1 ADEQ 1989-1992 Study

In-stream monitoring data was conducted between May 1989 and March 1992 by ADEQ. This study focused on identifying possible sources and transport paths of high metal concentrations observed in perennial segments of French Gulch. This study revealed high concentrations of trace metals in the samples collected from Zonia Gulch springs. Zonia Gulch springs was a source for Zonia Gulch Creek flow before Arimetco, Inc. began to pump wells to draw down the water table in order to intercept high metal concentration plumes in the groundwater in 2000. The sampling results from this earlier study were not collected under the same conditions as seen today and thus their degree of applicability needs to be ascertained; however if pumping ceased and full recovery occurred, results from the former study would be applicable without exception. After the wells were installed, ADEQ reported decreasing flows in Zonia Gulch Creek. This implies that a temporal and spatial pattern of current groundwater flow generating Zonia Gulch springs probably is not the same now as it was at the time this study was conducted in the early 1990's. Therefore, water quality data collected by this study should be treated carefully, if the data is used to estimate present water quality conditions. However, the implication of Zonia Mine as a possible source of metal transport to French Gulch creek must be considered. (Tetra Tech, 2004a)

4.2 Schmidt and Associates 1989 Study

A total of five monitoring locations were established on French Gulch and Zonia Gulch Creek between June and July of 1989. Samples collected for this project showed metals concentration inputs from Zonia Gulch Creek are similar to the ADEQ study conducted from 1989 to 1992. Sulfate shows high concentrations throughout the locations and follows a very similar declining trend for specific conductivity in a downstream direction. Considering the high sulfate concentrations, specific conductivity measured at each location is probably measuring conductivity of instream sulfate species. This data also should be used carefully since they were sampled before the wells drew down the water table and changed the hydrology of the Zonia Mine area. (Tetra Tech, 2004a)

4.3 Zonia Mine Study

The Zonia Mine study contains the highest frequency of water quality sampling among the available studies. For that reason, magnitudes of metals concentrations in French Gulch Creek were compared with daily rainfall events to investigate general transport paths of metals. Observed instream high metals concentrations occur under both high and low rainfall intensity or no rain events. This indicates that either surface runoff, interflow, or groundwater contributions, or all of these media affect metals transport. (Tetra Tech, 2004a)

The data set from Zonia Mine Company is available from 1993 to 2003 and was separated into two data sets. One contains samples collected before January 1, 2000, and the other contains samples collected after that period. The purpose for this is to show the effect of the pumping of the wells on the water quality data.

4.3.1 Zonia Data set 1(1993-1999)

The results of this data set show the adverse effect of the inflow of Zonia Gulch Creek on water quality conditions in French Gulch Creek. The concentrations of French Gulch Creek before the confluence of Zonia Gulch Creek are low. However, after Zonia Gulch Creek flows into French Gulch Creek, metals concentrations in French Gulch Creek increase by approximately four-fold. The concentrations then decline rather quickly before French Gulch merges with Placerita Gulch Creek. (Tetra Tech, 2004a)

4.3.2 Zonia Data set 2(2000-2003)

The data from before and after the confluence of Zonia Gulch Creek to French Gulch shows reductions from January 2000 to May 2000 except for total cadmium. The next available observed data, July 2003, exhibits a dramatic decline for all metals concentrations, and subsequent samples show similar concentrations. This is probably due to pumping well operations in the Zonia Mine area. ADEQ reported a reduction of flow in both Zonia and French Gulch during this period. This implies an alternating of metal transport paths from the mining vicinity area to French Gulch.

4.4 ADEQ TMDL Investigation (2001-2004)

The ADEQ TMDL Program collected additional water quality data to provide for source identification and TMDL and load allocation calculation. Water quality samples were collected on an event basis from March 2001 until April 2004 at 11 sites and wells #5, #6, and #9, to systematically monitor conditions along the listed reach to determine the extent, frequency and conditions under which impairment occurs as well as identify background water quality (Appendix B). Sites were established at the beginning and end of the reach; upstream and downstream of potential point and non point sources; and, at several other accessible monitoring locations.

5 SOURCE ASSESSMENT

A preliminary review of the French Gulch data indicate that metals including copper, cadmium, and zinc increase significantly in French Gulch (above background levels) at the Zonia Mine site. Tetra Tech’s final source assessment concluded that French Gulch is impacted by sources that function as nonpoint sources (Tetra Tech, 2004). The results clearly show problematic water quality conditions in a segment of French

Gulch in close proximity to the mining site. Concentrations then rapidly decline around Placerita Gulch in the downstream sections of French Gulch. Based upon a preliminary review of the French Gulch data, the decline of trace metal concentrations in the downstream portions of French Gulch near Placerita Gulch suggests that reactive transport is likely occurring in French Gulch below the Zonia Mine site. These reactions probably include precipitation from over saturation of the chemical and/or adsorption of the chemical to sediment particles and dissolved organic material in water column and sediment. Pumping of the wells also provides fewer opportunities for metals to be transported downstream. Inflow from Placerita Gulch and groundwater could further dilute metals concentrations in the downstream portions of French Gulch under high flow conditions, especially during the winter season. (Tetra Tech, 2004a)

Transport of metals from the Zonia mine site is most likely the main source of observed high metals concentrations in French Gulch. (Tetra Tech, 2004c)

Currently, there are no known point source discharges in the French Gulch watershed (Tetra Tech, 2004a).

5.1 Zonia Mine

Mined exclusively for copper, the Zonia Mine began operation in the 1870's. Extensive drilling operations ensued throughout an area of approximately 436 acres in search of high grade copper ore deposits. Approximately 400 drill holes have been drilled during Zonia's active operations by various entities. In the early 1900's, Zonia, owned by Boston & Arizona Copper Company, operated as an open pit mine which included milling and smelting on its property. In 1966, owned by McAlester Fuel Company, the Zonia Mine's copper production came from both open pit mining and heap-leaching processes. Between April 1973 and May 1974, McAlester Fuel Company detonated three blasts to fragment the ore in order to construct two in situ basins for leaching. These in situ leach basins were called Leach Basins 5 and 6 and were located in the headwaters of Zonia Gulch. The combined blasts mixed 4.14 million pounds of ammonium nitrate and fuel oil. Dilute sulfuric acid was applied and leach solutions were collected at the base of the ore body. The solution was pumped to the surface through a recovery well. In addition to declining copper prices, the attempted fragmentation of the ore body was unsuccessful and production was ceased at Zonia Mine in 1975. (Paydirt, 1973) A thorough and concise history of Zonia Mine gleaned via newspapers, documented studies, and Arimetco, Inc. can be found in Appendix C. The chronological events and relevant operations associated with Zonia Mine are detailed in this summary.

French Gulch flows northeast from its headwaters adjacent to the southwestern corner of the Zonia Mine property line. It continues northeast for approximately 2 miles and flows southeast crossing the Zonia Mine property. Two ponds, the Southwest Holding Pond and French Gulch Diverted, are located on the Zonia Mine property (Figure 5-1). Wells #5 and #6 are pumped and transported via rubberized piping to the Southwest Holding Pond. Well #9 is pumped and transported to French Gulch

Diverted. Currently, there is insufficient data describing the ponds interaction with groundwater in the system and its potential water quality impact. These ponds are not anticipated to have a major impact on the overall hydrology of the system. Because McAlester Fuel Company implemented in situ leaching processes, there are no tailings piles located on the mine property. There are, however, two waste rock piles, located on the mine property along French Gulch. These resulted from displacement of surface rock for leach pad development.

Figure 5-1. Zonia Mine Holding Ponds

The upwelling of Clear Springs originates approximately 85 yards below the confluence of Zonia Gulch with French Gulch, just off of the Zonia Mine's property. This upwelling contributes in the formation of the short stretch of perennial flow in French Gulch. Flow increases due to additional seepage from the banks. The effect of the Zonia Mine on French Gulch and Zonia Gulch Springs has been identified through studies conducted by the Bureau of Land Management (BLM), the Arizona Department of Health Services (ADHS), and the Arizona Department of Environmental Quality (ADEQ). Environmental interest in the mine surfaces in a 1979-1980 watershed survey by the BLM, which observed and reported to ADHS water pollution in French Gulch below the Zonia mine. ADEQ conducted further investigations referring to sources and transport of metals and other chemical constituents identified in French Gulch during 1991 to 1993. These studies concluded that French Gulch and Zonia Gulch springs contain extremely high concentrations of metals, similar to the ones found in Southwest Holding Pond in the Zonia mine site. Both rainwater infiltration and gradient-induced groundwater movement play a role in dissolving metal from these basins and their surroundings. Groundwater then transports them to their points of emergence at the springs. Runoff from the surface of the basins, open pit, and process areas could carry enriched levels of metals. From 1980 to 1990 concentrations of most species of toxic metals and of acidic species increased in the water of the two springs. The springs have been reported to be perennial in measurements taken in 1980-198l though there was considerable variation in flow. (Tetra Tech, 2004a)

Arimetco, Inc, a present responsible party, began operating three production wells in 2000 and 2002, in order to draw down the water table and ultimately eliminate the drainage causing exceedances of the surface water quality criteria. These three pumps have altered the hydrology of the French Gulch watershed and reduced the observed flow in French Gulch. This probably affects discharges of metals from the mine site as well. (Tetra Tech, 2004a) In Tetra Tech's *Existing Data Review Report for French Gulch Creek*, Tetra Tech noted, "The results show measurements collected near the Zonia Mine area, including samples from wells (MGFRG #5, #6, and #9), exhibit extremely high concentrations. In addition to geometric mean values from the wells, all parameter values collected from 'French Gulch (FG) below Zonia Gulch' are consistently higher than the rest of the sampling locations." The parameters Tetra Tech was referring to included total and dissolved cadmium, copper, and zinc; sulfate; and, specific conductivity. The report continues to state that concentrations found in wells #5 and #6 are an order of magnitude higher than the concentration found in well #9. They attribute this to the location of the wells; wells #5 and #6 pump water from the mine area and well #9 could draw water from outside the mine area, thus benefiting from dilution.

Prior studies and sampling results did not define any adverse impacts from the other inactive mines in the area. However, active and inactive mine adits and placer mining in the lower sections of the watershed could also be impacting water quality conditions in French Gulch and its tributaries. Metals enrichment is most likely occurring because of meteoric and groundwater interaction with the orebody that was heavily fractured during mining. This makes a difference when groundwater becomes surface water.

5.2 Placerita Gulch

Precious metal and copper mining have taken place since the 1870's along French Gulch near the confluence of Zonia and Placerita Gulches. Inactive mine adits can be found throughout the Placerita Gulch watershed. During storms, these adits may discharge; however, during the timeframe of this project, no flow was observed from these adits. Casual use mining for the extraction of gold, using dry panning and metal detectors can be seen today. Currently, there is one permit holder with a notice to conduct placer mining in Placerita Gulch. (Tetra Tech, 2004a)

5.3 Miscellaneous Non-Point Sources

Ranching is prevalent throughout the French Gulch watershed; however, impacts from ranching would be primarily limited to stream sediments and nutrients, which are not an environmental concern for French Gulch (Tetra Tech, 2004a). Other nonpoint source contributions may come from disturbances from abandoned mine workings; in-stream precipitates from historic mining activities which are present below Clear Springs and disappear below the French Gulch and the Placerita Gulch confluence; and background.

6 FRENCH GULCH MODEL

A Total Maximum Daily Load (TMDL) is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs can be expressed in terms of mass per time (mg/day) or by other appropriate measures. TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources, and natural background levels. In addition the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving water body. Conceptually, this definition is denoted by the equation:

$$TMDL = \Sigma\, WLA + \Sigma\, LA + MOS$$

(Tetra Tech, 2004c)

Information collected during the TMDL investigation from monitoring locations and wells #5, #6, and #9 were used to determine the extent, frequency, and conditions under which stream impairment occurs, as well as to define background water quality. Additional data from ADEQ and Zonia mine were also used to support water quality analysis. (Tetra Tech, 2004a)

Model selection was based on availability of data and the ability to represent critical hydrological conditions. It was determined that a multi-faceted approach was necessary in developing the French Gulch TMDLs as listed below.

- Hydrologic simulation using a watershed model
- Dissolved metal concentration simulations by modified MINTEQA2
- TMDL calculations by Load Duration Spread sheet model (Tetra Tech, 2004b)

6.1 Watershed Model

LSPC, an advanced watershed modeling system developed through a joint effort between EPA and Tetra Tech, was applied to address time variable flow simulation from delineated subwatersheds based on topography, land uses, and subsurface storages. This model was later used to generate flow duration curves for the load duration model. (Tetra Tech, 2004c)

The graphical interface supports basic geographic information systems (GIS) functions, including electronic geographic data importation and manipulation. Key data sets include stream networks, land use, flow and water quality monitoring station locations, weather station locations, and permitted facility locations. The data storage and management system functions as database, and supports storage of all data pertinent to TMDL development, including water quality observations, flow observations, permitted facility DMRs, as well as stream and watershed characteristics used for modeling. The system also includes functions for inventorying the data sets. The Dynamic Watershed Model, also referred to as the Hydrological Simulation Program - C++ (HSPC), simulates nonpoint source flow and pollutant loading as well as in-stream flow and pollutant transport, and it is capable of representing time-variable point source contributions. The data analysis/post-processing system conducts correlation and statistical analyses and enables the user to plot model results and observation data. (Tetra Tech, 2004c)

Application of LSPC to French Gulch involves two steps:

1. Subdivision of the French Gulch watershed into subwatersheds
2. Simulation of hydrologic processes in French Gulch

Subwatersheds were delineated for the French Gulch watershed based on the location of water quality and flow sampling points and critical sources, stream connectivity, and available Digital Elevation Model data. The French Gulch Watershed was divided into twenty-six subwatersheds for hydrologic simulation (Figure 6-1). These subwatersheds were used to simulate hydrologic processes for smaller regions of the watershed. Simulated flows from these subwatersheds were used to evaluate TMDLs using load duration methods. (Tetra Tech, 2004b)

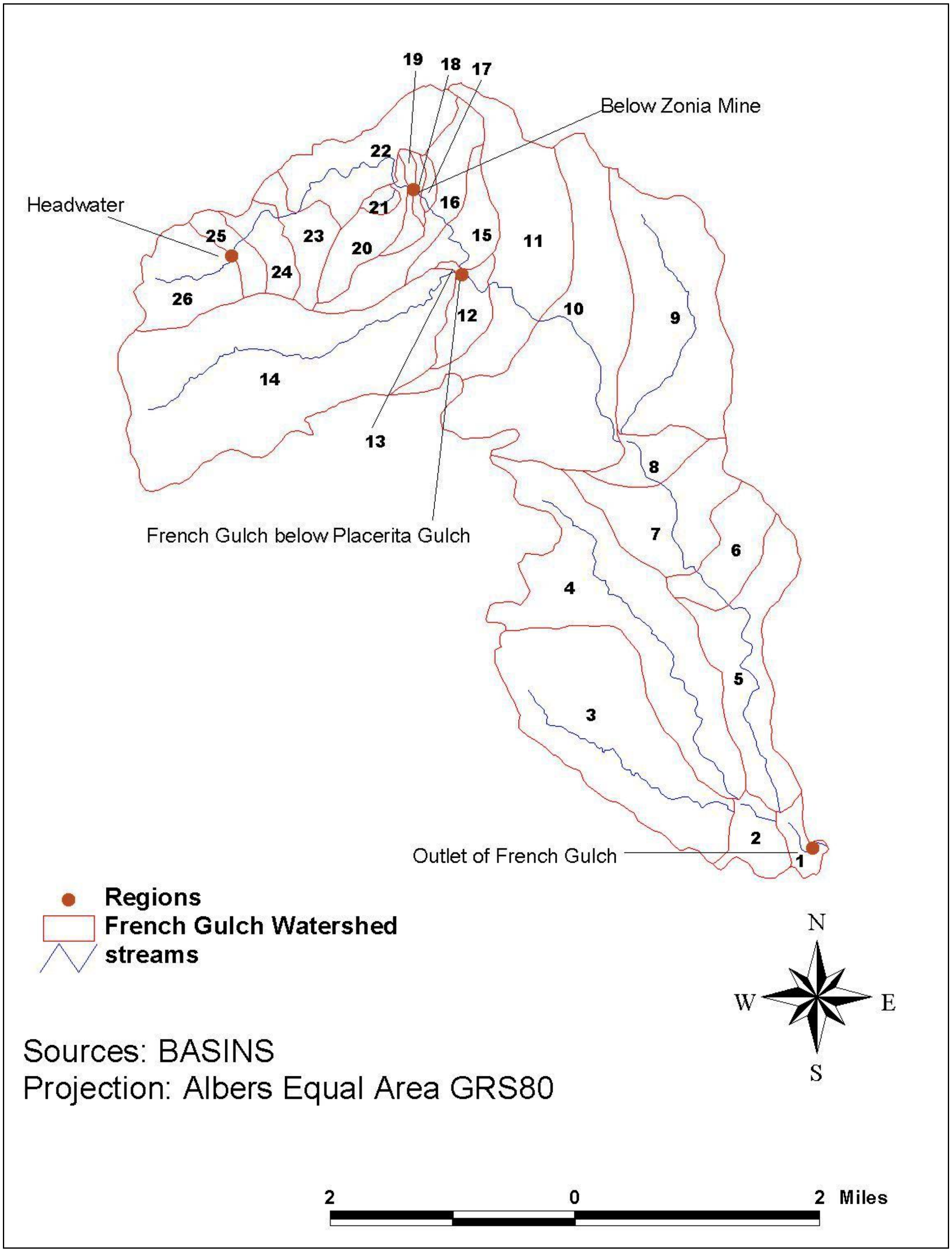

Figure 6-1. Loading Analysis for the Four Major Regions in the Watershed.

6.2 Flow Duration Curves

The development of loading values began by creating flow duration curves. A flow duration curve displays the cumulative frequency distribution of daily flow data (simulated flow from the watershed model, in this case) at a select location over a specified period of record. The curve relates flow values simulated at an outlet of a stream segment to the percent of time the flow values were equaled or exceeded. Flows are ranked from low, which are exceeded most of the time, to high, which are exceeded rarely (Tetra Tech, 2004c.)

6.3 Modified MINTEQA2 Geochemistry Model

Reviewing historical and recent water quality data collected by various agencies revealed there are more total metal concentration samples than dissolved metal concentration samples. To utilize all available data and to determine the French Gulch TMDLs, EPA's MINTEQA2 was implemented to supplement the available total metals data with estimated dissolved metals data. The MINTEQA2 model interface was modified to facilitate the use of observation data sets from multiple agencies. Total metal concentrations, pH, and water temperatures collected simultaneously were used to estimate dissolved metals concentrations when the dissolved metals were not available for TMDL analysis. (Tetra Tech, 2004c)

Using the Newton-Raphson approximation method, the model solved mass balance (linear) and mass action equations (nonlinear). The results from this model were used as inputs to the load duration curves discussed above to estimate TMDL values.

pH simulations using the modified MINTEQA2 were also performed to ensure that French Gulch didn't violate pH criteria under TMDL conditions. Inputs for the model included the geometric mean for the available alkalinity data from EPA's STORET data within the Hassayampa watershed. There were no alkalinity values in the data provided by ADEQ. (Tetra Tech, 2004c)

6.4 Load Duration

Flow duration curves are transformed into load duration curves by multiplying the flow values along the flow duration curve by the target (allowable) metal concentration and the appropriate conversion factors. The allowable load is based on the water quality numerical criterion for dissolved metals that is based on hardness, less the margin of safety, and flow values from the flow duration curve. Observed loads are also plotted by multiplying observed concentrations by corresponding flow values (for each discrete observation). Existing loads that plot above the allowable load indicate a violation of water quality criterion, while loads falling below the allowable load represent compliance. (Tetra Tech, 2004b)

In using load duration curves, it is assumed that loading and flow have a direct relationship. Loading can be expressed in two ways: 1) loading points and 2) loadings curve. Both loading expressions are developed by multiplying all points on a flow duration curve by the target (allowable) metal concentration. In the loading point method, the allowable load is based on the water quality numerical criterion for dissolved metals (based on observed hardness). Observed loading points are also plotted by multiplying observed concentrations by corresponding flow values (for each discrete observation). Existing loads that plot above the allowable load indicate a violation of the water quality criterion, while loads falling below the allowable load represent compliance. In the loading curve method, the standard, using a representative hardness value, will be multiplied by the flow to generate the standard loading curve. Observed loading points multiplied by the flow were fit through by the trend line to generate an existing load curve. Differences between the standard loading curve and observed loading curve require reductions. (Tetra Tech, 2004c)

In order to develop TMDLs for the French Gulch watershed, a loading analysis was performed using the results of the LSPC hydrologic modeling. Two approaches were used to generate TMDLs. One approach presents a loading analysis by pollutant for the 4 major regions in the watershed. The other approach presents the loading analysis by pollutant for all the subwatersheds with available monitoring data (Figure 6-1). (Tetra Tech, 2004c)

The estimated loadings at the four regions in the watershed (regional loading analysis) included: the headwaters of French Gulch, below the Zonia Mine including subwatersheds contributing to the regional outlet, below Placerita Gulch including subwatersheds contributing to the regional outlet, and all subwatersheds contributing to the outlet of French Gulch. The only difficulty with this regional approach is that the information is not always consistent, since some watersheds have no existing data (and thus required reduction percentages are not available), and required reductions vary so drastically from one flow condition to the next (particularly for the flow conditions of interest to ADEQ). The alternative approach presents load-duration curves and TMDL information by pollutant for all subwatersheds with monitoring data (subwatershed loading analysis). (Tetra Tech, 2004c)

6.5 Calibration and Validation of Model

After the initial LSPC model configuration, which involved assembling pertinent watershed, stream, and meteorological data and parameters, model calibration ensued. The calibration step consisted of fine-tuning the model to ensure that model simulations were capable of estimating historical observations. Model calibration addressed flow. Model validation was then performed to test the calibrated model's performance. The validation step is important to affirm model credibility and to help evaluate the impact of model uncertainty on predictions. Documentation of predictive uncertainty provides important information for establishing the Margin of Safety (MOS) for the TMDL analysis. (Tetra Tech, 2004c)

Once the model was validated, it was run to simulate current flow conditions under a variety of meteorological conditions. Long-term flow estimates were developed for use in flow and loadings development at each monitoring station with available hardness data. Loading values were ultimately developed using the modeled flow and total and dissolved metals observations and simulated dissolved metal concentrations (for corresponding days from the modeled flow record), as well as the

ADEQ dissolved and total metals water quality criteria. ADEQ dissolved metals criteria are hardness based, and were considered during the analysis. (Tetra Tech, 2004c)

6.6 Representation of Structures with a Groundwater Component

6.6.1 Zonia Mine Ponds

The Southwest Holding Pond (as shown in Figure 5-1) is approximately 5 acres and the other pond known as French Gulch diverted (where well #9 drains) is approximately one acre. The drainage areas of these ponds are assumed to be slightly larger than the ponds themselves, based on available information. As such, they are not anticipated to have a major impact on the overall hydrology of the system (due to their small drainage area in relation to the overall area of the watershed). The ponds were not modeled explicitly due to their size. It is possible that the ponds influence water quality conditions in French Gulch, however there are insufficient data currently describing the ponds interaction with groundwater in the system (and the potential water quality impact). Quantitative data characterizing the nature of subsurface transport in the system (from both a hydrologic and water quality standpoint) would be necessary for a more detailed representation in the model. (Tetra Tech, 2004c)

6.6.2 Zonia Mine's Active Production Wells

Three active wells, #5, #6, and #9, currently being operated by Zonia Mine Company, were identified within the watershed (Figure 2-3). Wells #5 and #6 began operation at an unknown date in 1993. Well #9 went into operation on June 28th, 2001. The maximum pumping capacity of these three wells reported by the Zonia Mine company are 40 gallons per minute (gpm) for well #5, 30 gpm for well #6, and 15 gpm for well #9. Pumping schedules for these wells are as follows: approximately 1.5 hours Monday through Friday for wells #5 and #6, and 24 hours and 7 days a week for well #9. Although pump #9 may not always continually operate 24 hours, 7 days a week, Tetra Tech did not have any detailed additional information to quantitatively incorporate this information, other than knowing the pumping schedule operating 24 hours, 7 days a week. (Tetra Tech, 2004c)

These values convert to daily averages of 0.033 cfs for well #9, 0.00557 cfs for well #5 and 0.00418 cfs for well #6. These wells could affect the hydrologic conditions of the watershed and flows observed in French Gulch, especially during the periods with low rainfall events. In order to identify whether historical low rainfall periods were observed during the last nineteen years of the modeling period (1985-2004), precipitation data were assessed and annual precipitation was generated and shown in Figure 6-2. (Tetra Tech, 2004c)

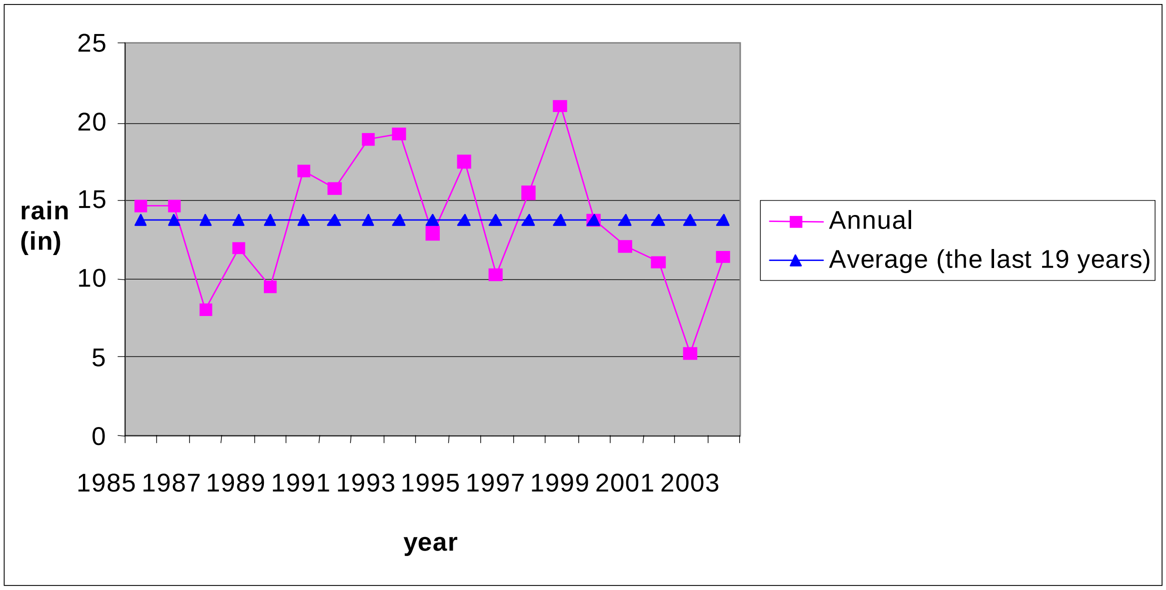

Figure 6-2. Annual Precipitation in the French Gulch Watershed (Tetra Tech, 2004c)

As Figure 6-2 demonstrates, the last four years of annual rainfall (2000-2004) has been continuously lower than the average rainfall of the last 19 years. Figure 6-3 shows monthly rainfall before and after 6/28/2001 (the time when well #9 went into operation). This figure clearly shows occurrences of lower rainfall amounts in the last three years (2001-2004). This probably indicates the dry condition of the French Gulch Watershed, and further reductions of flow from French Gulch by these wells. (Tetra Tech, 2004c)

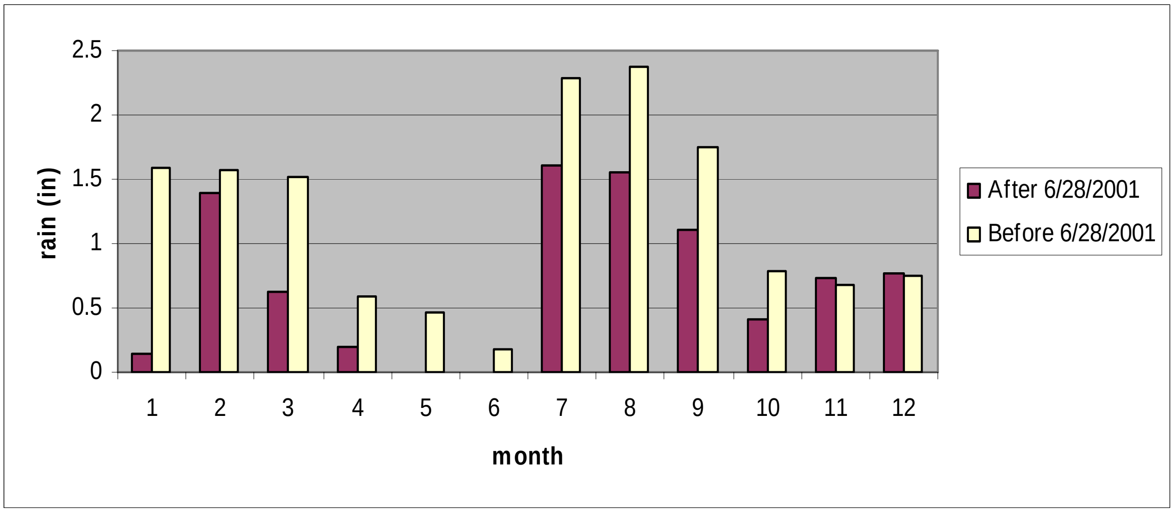

Figure 6-3. Monthly Precipitation in the French Gulch Watershed (Tetra Tech, 2004c)

Considering this meteorological and human induced effect on the French Gulch watershed, flow calibrations (and validations) were performed, in addition to adjusting the hydrologic parameters within the LSPC model, by the estimated well discharges (subtracted explicitly from the simulated flows by LSPC). In order to subtract the estimated well discharges from the LSPC flow results, the aerial extent of the wells effect within the watershed needed to be estimated. These estimated ranges of influence were calculated using the Theis solution. This concept assumes no existence of the exterior boundary and nonleaky homogeneous aquifer. (Tetra Tech, 2004c)

The lateral extent of a cone of depression at any given time and its rate of growth are independent of the pumping rate (Willis D. Weight and John L. Sonderegger, 2000). Aquifer hydraulic parameters, such as hydraulic conductivity and storage coefficients, were used from the study conducted in the vicinity of the Zonia Mine, by the Water Development Corporation (Ground-water conditions in the vicinity of the Zonia Mine, 1972): 500 gpd/foot for hydraulic conductivity, and 0.005 for the storage coefficient. (Tetra Tech, 2004c)

According to the precipitation data, the longest continuous non-rainfall days in the watershed was 73 days (between 2001 and 2004). During this period, there was no recharge effect from rainfall to groundwater storage, thus, the aerial effect by these wells continuously enlarged outwardly for this driest period observed after 2001. The calculated range of influence by the equation (a) during this period was estimated to be a radius of 450 meters for well #9. (Tetra Tech, 2004c)

Since wells #5 and #6 aren't operated continuously, operational hours were converted so continuous non-rainfall days (1.5hours*73days/24hours=5days) could be estimated for comparison. The ranges of influence for these wells were calculated as a radius of 112 meters. Figure 6-4 shows the range of influence for all three wells during this period. As the figure shows, the perimeter of the range of influence of well #9 extends to subwatershed 22 and continues to affect the downstream portion of French Gulch. On the other hand, it is probably reasonable to determine that the effect of well #5 and # 6 are contained within subwatershed 21 (Zonia Gulch Watershed). (Tetra Tech, 2004c)

Thus, the daily average of 0.033cfs (from well #9) was subtracted from subwatershed 22, and the sum of wells #9, #5, and #6 (0.04275cfs) was subtracted from subwatershed 20 through subwatershed 1, beginning from 6/28/2001 (when well #9 went into operation). Subtractions of flow were not made to tributaries since the ranges of influence from the wells do not affect tributaries. The sum of wells #5 and #6 (0.00975 cfs) was subtracted from the estimated flow of subwatershed 21 (as the effects of wells #5 and #6 are contained within this subwatershed), beginning from 1/1/1993, as no exact date was identified when these two wells went into operation in 1993. (Tetra Tech, 2004c)

The actual ranges of influence by these wells can be larger or smaller than the estimated values provided in this document. However, establishing detailed relationships between the recharge effect from rainfall and hydrogeology of the studied area requires more extensive subsurface data. To approximate the well effects to surface water flows in French Gulch, a combination of hydrologic parameter adjustments of the LSPC model (as discussed previously) and subtractions of well discharges from the model results (at specified subwatersheds and dates) should be reasonable to calibrate the model.

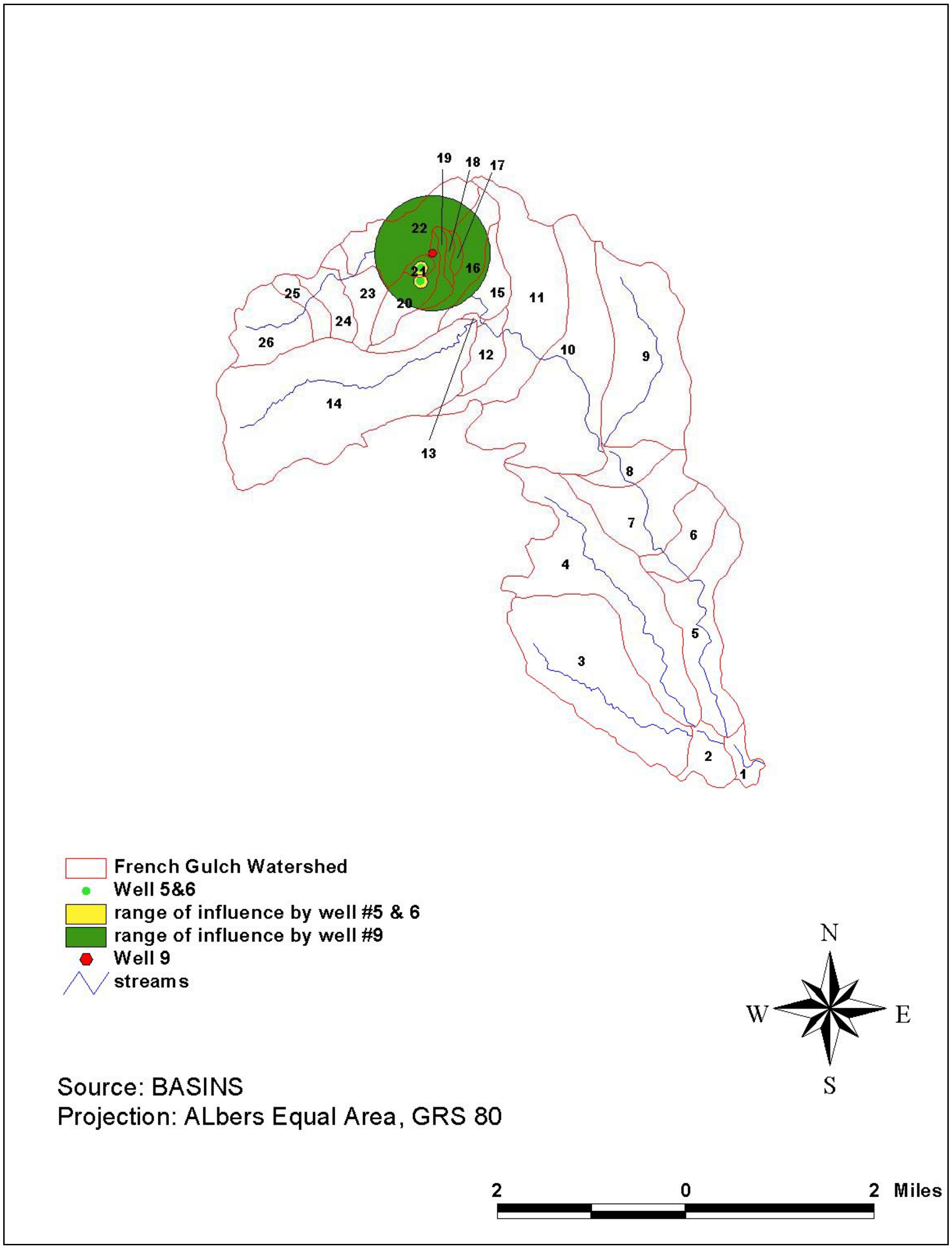

Figure 6-4. Range of Influence by the wells During Non Rainfall Events.

7 Simulations

7.1 Evaluation of all Previously Listed Parameters

Since 1994, French Gulch has been listed as exceeding water quality standards for nine parameters: Be, Cd, Cu, Mg, Hg, pH, TDS, turbidity, and Zn with copper being the one parameter consistently remaining on the list since 1994. Changes in designated use, standards, and data availability have controlled which parameters were listed and when they were listed. The French Gulch TMDL was initiated based on the 1998 listing; during the data collection phase, the 2002 listing was approved and the 2004 listing will be approved by the time the French Gulch TMDL is approved. During the lifetime of this project, manganese and pH were removed from the list. Cadmium was removed and in 2004 re-added. Because of these fluctuations, Tetra Tech was tasked with using the model to evaluate all previously listed parameters. Through this task, ADEQ was aiming to identify parameters that have occasional critical condition related exceedances and those parameters that meet standards for flows sampled, but are projected to exceed standards at flows not sampled, which are usually higher and in response to storms.

TMDL targets for French Gulch were selected based on Arizona’s aquatic wildlife and warm water (A&Ww) criteria, which regulate dissolved metal concentrations for copper, cadmium, and zinc derived from simultaneously collected hardness values (as calcium carbonate (mg/L)). pH and total manganese are regulated according to agricultural irrigation and livestock watering (AgI + AgL) criteria. (Tetra Tech, 2004c)

Additionally, all available standards for Beryllium (Be), TDS, Mercury (Hg) and Turbidity (all previously listed parameters) were analyzed. When Tetra Tech analyzed all the Be and Hg data (1989-present) and their standards, the data showed the WQ samples were either below detection limits or were below the current standards. There are no TDS or turbidity standards (narrative or numeric) for French Gulch based on Tetra Tech’s review. (Tetra Tech, 2004c)

pH simulations using the modified MINTEQA2 were also performed to ensure that French Gulch did not violate pH criteria under TMDL conditions. Inputs for the model included the geometric mean of the available alkalinity data from EPA’s STORET data within the Hassayampa watershed. There were no alkalinity values in the data provided by ADEQ. The geometric mean of 5.19 mg as CaCO3/L was used for MINTEQA2. (Tetra Tech, 2004c)

7.2 Modeled Flows and Seasonality

The French Gulch model used all available flow and concentration values collected in the French Gulch watershed (Appendix D). These data were collected over numerous years, throughout all seasons, and varied flow conditions. Because of this, seasonal variations were inherently considered in the calculation of loads and allocations. Load duration curves are based on flow duration curves and therefore make it possible to determine the flows at which exceedances occur and the frequency of exceedances for all flows. Flows and concentrations can be measured or modeled. Large data sets with a varied distribution of flows will give greater confidence in the load duration curve generated.

8 Loads, TMDLs, and Allocations

8.1 Existing Loads and Load Capacity

Load duration curves and loading tables were generated by Tetra Tech for each of the four regions (Appendix E) and for each subwatershed (Appendix F). With each of the regional curves, they included a summary table with the recurrence interval (percentile), allowable load, existing load, % reduction, TMDL, LA, and MOS. With each of the subwatershed curves, they included % reduction, existing load, TMDL, LA, and MOS when exceedances were found. The “Interval” column shows the flow percentile based on the model flow results starting from the 0.015 to the 90th percentile of flow. (Results for each 10th percentile have been displayed as well as the 100 year frequency rainfall event and the two year frequency rainfall event. The first two rows in the column are the percentile under the 100 year frequency rainfall event (0.015) and the two year frequency (0.120-0.150) rainfall event (the bankfull condition in French Gulch). These rainfall events are identified based on NOAA’s point precipitation frequency estimate for the Wilhoit gage. According to this data, the 100 year frequency rainfall for 24 hour will be 4.56 (in), which is similar to the 4.21 (in) rainfall observed on 9/26/1997 from ADEQ precipitation data. The other extreme condition, the two-year frequency rainfall for 24 hours will be 2.07(in) from the NOAA data. This rainfall amount is similar to 2.05(in) rainfall observed on 9/23/1993 from the ADEQ precipitation data. (Tetra Tech, 2004c)

The “Existing” column presents loadings based on a trend line developed to create a continuum of existing loads with the available highest concentration of monitoring data (when there was more than one sample within an event at a specific site). The highest concentration was selected to protect water quality criteria under the most stringent conditions. The trend line was created where there were sufficient observations (i.e., more than 3 observation points) data were available. (Tetra Tech, 2004c)

The “Allowable” column presents loads for the water quality criteria over specified flow percentiles from the “Interval” column. This “Allowable” column was calculated using the lowest available hardness value (to be conservative) based on the observed data at each location. (Tetra Tech, 2004c) Hardness values less than 25 were set at 25 and hardness values greater than 400 were set at 400, consistent with the State of Arizona’s Surface Water Quality Standards.

The allowable load or load capacity was determined by multiplying the most stringent water quality criteria for each parameter, the A&Ww-chronic, by flow, by a unit conversion factor. To meet water quality standards, the TMDL can not be set higher than the load capacity (allowable load). The French Gulch TMDLs have been set at the load capacity. Considering the TMDL equation

$$TMDL = \Sigma\ WLA + \Sigma\ LA + MOS,$$

this means the WLAs, LAs, and MOS must be subtracted from the (load capacity) TMDL.

Where the two values described above, "allowable" and "existing" values are available, required load reductions can be presented for all flow conditions (as well as the flow regimes of interest to ADEQ – extremely high, bankfull, and baseflow). However, in situations where no existing data are available to develop existing loads, these reductions cannot be identified, and only the water quality criteria loads can be presented. For the regions where reduction percentages are not specified using this regional loading analysis (Appendix E), the subwatershed loading analysis (Appendix F), should be referred to as alternate TMDLs for these regions where the contributing subwatersheds require reductions. (Tetra Tech, 2004c)

Table 8-1. Loading Areas for French Gulch TMDL Calculations

Parameter	Region	TMDL Calculations based on results from:
Cadmium	Headwater	Subwatershed 26 and above
	Below Zonia Mine	Subwatershed 19 and above
	Below Placerita Gulch	Subwatershed 13 and above
	Outlet	Subwatershed 1, insufficient data for TMDL calculation
Copper	Headwater	Subwatershed 26 and above
	Below Zonia Mine	Subwatershed 19 and above
	Below Placerita Gulch	Subwatershed 13 and above
	Outlet	Subwatershed 1, insufficient data for TMDL calculation
Zinc	Headwater	Subwatershed 26 and above
	Below Zonia Mine	Subwatershed 19 and above
	Below Placerita Gulch	Subwatershed 13 and above
	Outlet	Subwatershed 1, insufficient data for TMDL calculation

8.2 Margin of Safety

The French Gulch TMDLs have been calculated using an explicit 20% MOS. Because the Arizona Department of Health Services Laboratory has confirmed the precision of measurement of the parameters of concern is plus or minus 5%, an explicit MOS of 5% was applied to account for this error. The other 15% was applied to account for field conditions and decisions made during modeling. The field conditions include sampling during drought conditions and the use of the grab sample collection method. The decisions made during modeling include,

- the combination and application of meteorologic information from the French Gulch watershed and the Wilhoit gage station;
- the computation of hourly evapotranspiration;
- use of a surface water flow model to model a system complicated by groundwater inputs;
- a decision not to explicitly model the Southwest Holding Pond nor French Gulch Diverted;
- the use of estimated well operation records;
- subsurface geology estimations, i.e. non-leaky, homogeneous aquifer; and,
- a dynamic model simulating daily flows over a wide range of hydrologic conditions, and simulating dissolved metal concentrations (Tetra Tech, 2004c).

Tetra Tech used a 5% MOS to yield the results found in Appendices E and F, which have been taken directly from Tetra Tech's *Final Model Development Report*. Because of the aforementioned reasons, ADEQ has decided to use a 20% MOS for the French Gulch TMDLs. The re-calculated results can be found in Appendix G.

A non-quantifiable implicit MOS was also applied through numerous ways including,
- deriving TMDLs for discrete and logical subsections of the French Gulch watershed in lieu of calculating one set of TMDLs for the end of the listed reach;
- setting the TMDLs so that the most stringent water quality criteria will be met; and
- the use of conservative assumptions made during modeling (i.e., using the highest concentration data when there was more than one sample at a specific site for the same event; using the lowest available hardness value to calculate allowable load).

In summary, a 20% explicit MOS was used to account for the dynamic model simulating daily flows over a wide range of hydrologic conditions, and simulating metals dissolved concentrations. (Tetra Tech, 2004c) The use of conservative assumptions during modeling and TMDL calculation provided for an implicit MOS.

8.3 Wasteload Allocations

There are no AZPDES permitted point sources in the watershed; therefore, no waste load allocations (WLAs) were made for French Gulch. The WLA is zero, as shown in Table 8-2.

8.4 Load Allocations

With no allowance for WLA, the TMDL equation for French Gulch becomes

$$\text{TMDL} = \Sigma \text{ LA} + 20\% \text{ (TMDL)}.$$

Because the TMDL has been set to equal the load capacity, this results in

$$80\% \text{ TMDL} = \Sigma \text{ LA}.$$

Table 8-2 presents the LAs for French Gulch.

8.5 Load Reductions

For the French Gulch TMDLs, where the WLA is zero, the sample exceeds standards and requires a load reduction when the existing load is greater than the LA. To calculate the load reduction:

LR = Existing Load – LA

To calculate what percentage of the existing load this is, the percent %-reduction can be found:

% Reduction = (LR/Existing Load)*100

There could be a situation where the existing load is less than the allowable load (load capacity), however when a 20% MOS is added to the existing load the total exceeds the TMDL. In this case a load reduction will be required as the MOS is necessary.

The load calculations found in Appendix G have been calculated as specified above. Tetra Tech used a different method to calculate the %-reductions found in Appendices E and F. ADEQ chose to use the method listed above to allow for a MOS. The %-reductions associated with the French Gulch TMDLs can be found in Table 8-2.

8.6 French Gulch TMDLs

TMDLs identify the total amount of pollutant that can be assimilated by the receiving system while still achieving water quality standards. The pollutants requiring TMDLs for French Gulch are cadmium, copper, and zinc. Table 8-2 lists the interval, flow, existing loads, allowable loads (load capacity), TMDL, MOS, WLA, LA, and %-reduction for each pollutant within the French Gulch watershed where a load reduction is necessary.

As previously stated, load duration curves were developed for each of the four regions and each of the subwatersheds. The model estimated loads for flows up to and including the 100-yr return interval. Results for each 10th percentile flow, the bankfull flow (0.12 – 0.15), and the 100-year rainfall event (0.015) were presented. Because of the infrequency of flows above bankfull, the 0.015 event was not used for TMDL calculation.

Reviewing the necessary reductions in Appendix G, it is apparent that loading in French Gulch is not linear. As an example, cadmium loading in Region 2 requires no reduction at the 90th percentile flow, a 51.40% reduction at the 80th percentile flow, 17.46% reduction at the 60th percentile flow, a 45.76% reduction at the 20th percentile flow, and no reduction at the 0.15 percentile flow. Because the TMDLs must protect French Gulch from exceedances of water quality standards at all flows and because loading fluctuates with flow in a non-linear manner, a decision was made to present TMDLs for each interval where a load reduction is necessary. (Appendices E and F) Flows that fall between two of the modeled intervals will need to meet the TMDL and allocations assigned to the next higher (more frequent) flow interval; i.e., in Region 2, cadmium loads for flows between the 80th and 70th percentiles will be need to meet the TMDL and allocations assigned to the 80th percentile.

Table 8-2: French Gulch Loads, TMDLS, and Allocations

Parameter	Loading Area	Interval (percentile)	Flow (cfs)	Existing (mg/day)	Load Capacity is equal to TMDL (mg/day)	MOS (mg/day)	WLA (mg/day)	LA (mg/day)	% reduction
		10	1.18E-01	6.81E+02	4.92E+02	9.84E+01	0	3.94E+02	42.14%
		20	4.41E-02	2.71E+02	1.84E+02	3.67E+01	0	1.47E+02	45.76%
		30	2.84E-02	1.58E+02	1.18E+02	2.36E+01	0	9.44E+01	40.25%
		40	2.20E-02	1.08E+02	9.17E+01	1.83E+01	0	7.33E+01	32.13%
		50	1.87E-02	8.02E+01	7.77E+01	1.55E+01	0	6.21E+01	22.57%
		60	1.56E-02	6.30E+01	6.50E+01	1.30E+01	0	5.20E+01	17.46%
		70	1.09E-02	5.13E+01	4.53E+01	9.05E+00	0	3.62E+01	29.43%
Cd	**Region 2**	80	6.27E-03	4.30E+01	2.61E+01	5.21E+00	0	2.09E+01	51.40%
	Region 1	0.12	1.50E+01	6.49E+04	1.94E+04	3.88E+03	0	1.55E+04	76.09%
		0.15	5.74E+01	7.35E+07	9.16E+05	1.83E+05	0	7.33E+05	99.00%
		10	1.18E-01	2.52E+04	1.89E+03	3.77E+02	0	1.51E+03	94.01%
		20	4.41E-02	6.76E+03	7.04E+02	1.41E+02	0	5.63E+02	91.67%
		30	2.84E-02	3.13E+03	4.53E+02	9.05E+01	0	3.62E+02	88.43%
		40	2.20E-02	1.81E+03	3.52E+02	7.03E+01	0	2.81E+02	84.48%
		50	1.87E-02	1.19E+03	2.98E+02	5.96E+01	0	2.38E+02	80.00%
		60	1.56E-02	8.38E+02	2.49E+02	4.99E+01	0	1.99E+02	76.25%
		70	1.09E-02	6.26E+02	1.74E+02	3.47E+01	0	1.39E+02	77.80%
	Region 2	80	6.27E-03	4.85E+02	1.00E+02	2.00E+01	0	8.00E+01	83.51%
		0.135	1.62E+02	7.11E+07	1.16E+07	2.31E+06	0	9.26E+06	86.98%
		10	2.50E-01	3.29E+04	1.79E+04	3.58E+03	0	1.43E+04	56.53%
Cu	**Region 3**	20	1.16E-01	9.57E+03	8.30E+03	1.66E+03	0	6.64E+03	30.62%
	Region 1	0.12	1.50E+01	9.22E+05	8.16E+05	1.63E+05	0	6.53E+05	29.18%
		0.15	5.74E+01	4.48E+07	1.20E+07	2.39E+06	0	9.57E+06	78.64%
		10	1.18E-01	1.13E+05	2.47E+04	4.94E+03	0	1.98E+04	82.48%
		20	4.41E-02	4.20E+04	9.22E+03	1.84E+03	0	7.37E+03	82.45%
		30	2.84E-02	2.35E+04	5.94E+03	1.19E+03	0	4.75E+03	79.79%
		40	2.20E-02	1.56E+04	4.61E+03	9.22E+02	0	3.69E+03	76.35%
		50	1.87E-02	1.14E+04	3.91E+03	7.81E+02	0	3.12E+03	72.63%
		60	1.56E-02	8.76E+03	3.27E+03	6.54E+02	0	2.62E+03	70.09%
		70	1.09E-02	7.04E+03	2.27E+03	4.55E+02	0	1.82E+03	74.15%
	Region 2	80	6.27E-03	5.82E+03	1.31E+03	2.62E+02	0	1.05E+03	81.96%
Zn	**Region 3**	90	6.48E-04	1.77E+03	5.06E+02	1.01E+02	0	4.04E+02	77.18%

8.7 Critical Conditions

Based on the results of the regional and subwatershed loading analysis, it is clear that most of the exceedances occur under relatively high flow conditions. This is probably due to the "wash-off" effect from the land surface by a higher rainfall event generating these high flow conditions in the Creek. This high rainfall event could also contribute to the subsurface metal loadings. During dry periods, aquifer or water pockets exist in unsaturated zones of soil in the subsurface which may not be connected efficiently to transport dissolved metals to French Gulch or its tributaries. However, chemical reactions are probably taking place in this unsaturated area with limited moisture available. Under heavy precipitation events, soils with these perched water zones or moisture areas become more saturated and may transport dissolved metals to surface water more efficiently through interflow and groundwater paths. (Tetra Tech, 2004c)

The high loadings of metals, and subsequently required high load reductions occurs around the Zonia Mine area (subwatershed 19), particularly during high rainfall events. However, the exceedance of water quality criteria also occurs in the headwaters region for copper and zinc. These metals concentrations are significantly lower than metals concentrations in the vicinity of the Zonia Mine. Metals exceedances in the headwaters area is to some degree attributable to the relatively lower hardness values of that region, which contributes to lower standards (i.e. more stringent standards) for these metals. Heavily mined areas tend to have higher hardness values due to the dissolution of calcium and magnesium from surrounding rocks exposed to acidic water. Because the headwater region was not extensively mined, or the mine effect is minimum, hardness values tend to be lower, which leads to stricter standards for the hardness based metal standards. (Tetra Tech, 2004c)

In most cases, rainfall runoff does appear to help to dilute high concentrations found at baseflow and low flow; however, significant reductions are also necessary at mid-range and low flows.

8.8 Linkage Analysis

Disturbances caused by historic mining activities at the Zonia Mine appear to have caused the majority of the metals loading in French Gulch. Downstream of the Zonia Mine, assimilation of the metals is occurring; however, this assimilation is not great enough to eliminate exceedances. Reduction of metals in the area of Zonia Mine, especially immediately downstream at Clear Springs (subwatershed 19), is therefore necessary for attainment of standards.

9 IMPLEMENTATION AND MONITORING

As there are no permitted point source discharges in the French Gulch watershed, the achievement of surface water quality standards will occur through voluntary efforts. Since 2000, the Zonia Mine has voluntarily produced well water from the Clear Springs area effectively reducing loading in French Gulch; however, additional reductions are necessary.

In the second public meeting, availability of 319(h) grant funding for the purpose of implementing watershed restoration plans was introduced. Attendees were informed that applicants requesting 319(h) funding for water quality improvement projects at French Gulch will be given priority. Attendees discussed possible remedial alternatives and the need for stakeholder involvement. Future monitoring activities were also discussed. Cooperation of state and federal agencies and private land owners will be paramount in the implementation activities that support the French Gulch TMDLs.

This TMDL investigation shows reductions for copper and zinc are necessary in the uppermost portion of French Gulch (subwatershed 26); however, there was not enough data to create regional load duration curves for cadmium, copper, or zinc in the uppermost region (above Zonia Mine). It would be ideal to be able to collect a sufficient number of samples and flow measurements to allow for the development of these load duration curves and any of the others that were not developed. ADEQ encourages additional water quality sampling and flow measurement in the French Gulch watershed. The results from such monitoring will contribute to future evaluations of the water quality of French Gulch.

Pursuant to A.R.S. § 49-234J, ADEQ is required to conduct an effectiveness investigation for French Gulch five years after the adoption of the TMDLs. The purpose of this investigation will be to determine if the improvements have been effective and if water quality in French Gulch has improved (i.e. meets water quality standards). Additional monitoring results collected in the time period between the approval of these TMDLs and the commencement of effectiveness monitoring will be used in the evaluation of best management practice effectiveness. An additional goal would be to collect sufficient credible data to allow for the calculation of allocations and TMDLs for cadmium, copper, and zinc for all of the regions.

10 PUBLIC PARTICIPATION

Stakeholder participation was encouraged and received throughout the development of this TMDL. Involved parties include BLM, ADEQ, Zonia Mine, local public officials, and citizens. The first public meeting was held in Walnut Grove, Arizona on April 20, 2004 with approximately thirty people in attendance. The second public meeting was also held in Walnut Grove, Arizona on September 14, 2004 with approximately ten people in attendance. This draft TMDL report will be made available for a 30-day public comment period. Public notice of the availability of the draft document will be made via a posting in The Daily Courier, a newspaper of general circulation; via letters; via email notifications; via phone calls; and via webpage postings. Responses to comments received during the 30-day public notice period will be posted in the A.A.R. (Arizona Administrative Register) and a 45-day public review period will follow the notice. After this period, this report will be submitted to the EPA for final approval. Responses to questions and comments received during the public notice phase will be submitted to the EPA with this report.

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APPENDIX A
SUMMARY OF LISTING DATA - 1994

SUMMARY OF LISTING DATA - 1994[1]

	Be T, µg/L		Cd T, mg/L		Cu T, mg/L		Cu D, mg/L		Mn T, mg/L		HgT, µg/L		Low pH, SU		Zn D, mg/L		TDS, mg/L	
Site ID	Value	Std	Value	Std	Value	Std	Value	Std	Value	Std	Value	Std	Value	Std	Value	Std	Value	Std
LP-9[2]			1.18	0.05	1,290	0.50			663	10	1.1	0.60					15,210	1,000
CD-1[2]			1.36	0.05	1,420	0.50			843	10	0.8	0.60					19,700	1,000
ZG-1[2]																	3,700	1,000
ZG-2[2]			0.054	0.05	1.6	0.50			22.9	10							3,980	1,000
FG-1									18.4	10							3,610	1,000
FG-2					2.38	0.50			28.5	10					8.71	varies	3,990	1,000
FG-4																	3,000	1,000
FG-6																	2,600	1,000
FG-7																	2,150	1,000
FG-8																	2,040	1,000
FG-10																	1,390	1,000
FG-11																	1,250	1,000
3/FG Springs[2]					1.07	0.50	0.481	0.50	44.2	10							3,480	1,000
4/FG Zonia Gulch Springs[2]					1.95	0.50	1.90	0.50	27.5	10					7.54	Varies	3,650	1,000
QC-1/FG[2]			0.0757	0.05													3,650	1,000

[1]The standards listed on this table are the standards that were used in 1994, when the listing decision was made. Standards based on hardness. Hardness expressed in mg/L $CaCO_3$.
[2]Site cannot be identified. Data not used in modeling.

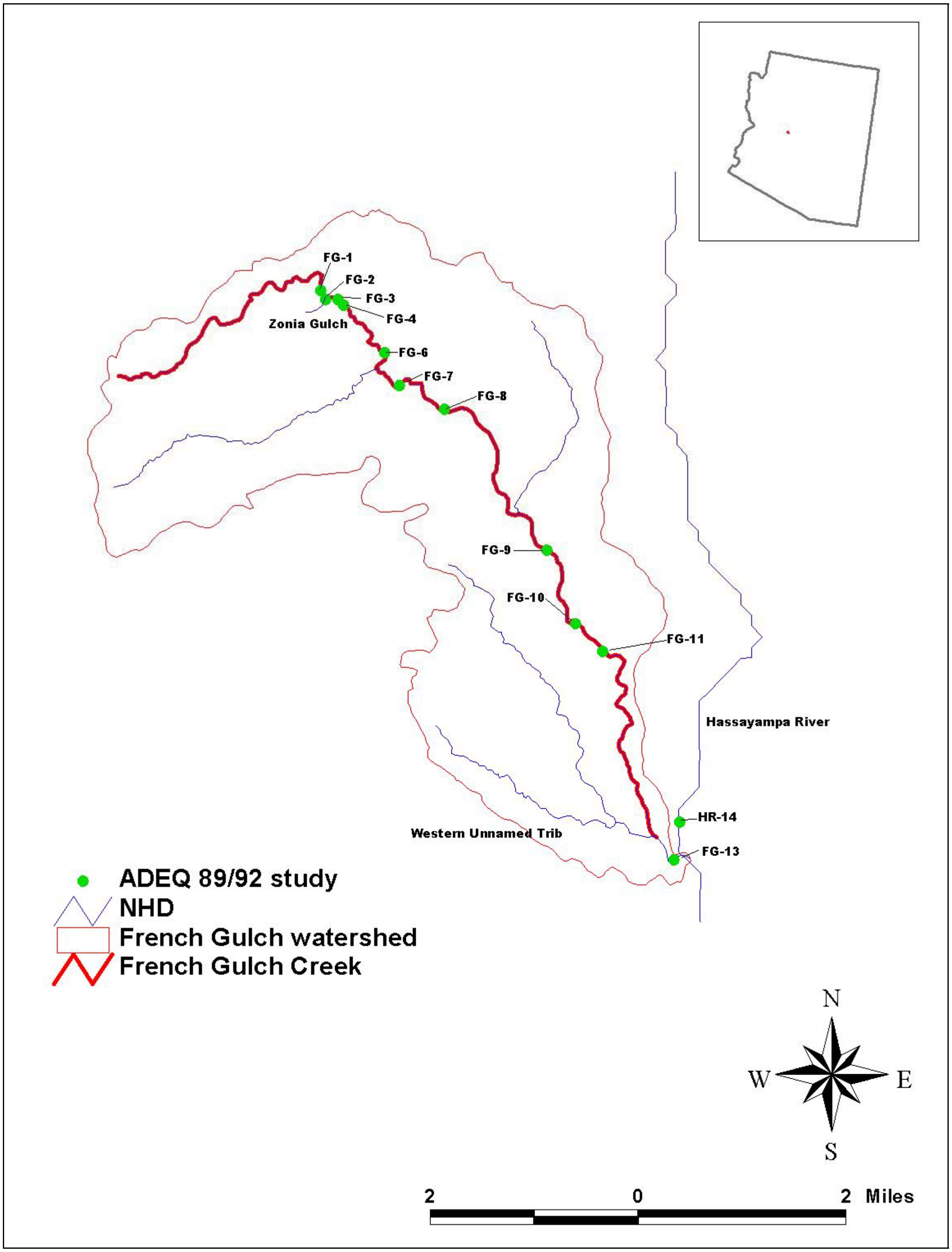


Figure A-1. Data from these water quality stations supported the 1994 listing of French Gulch

APPENDIX B
ADEQ TMDL PROGRAM SAMPLING RESULTS

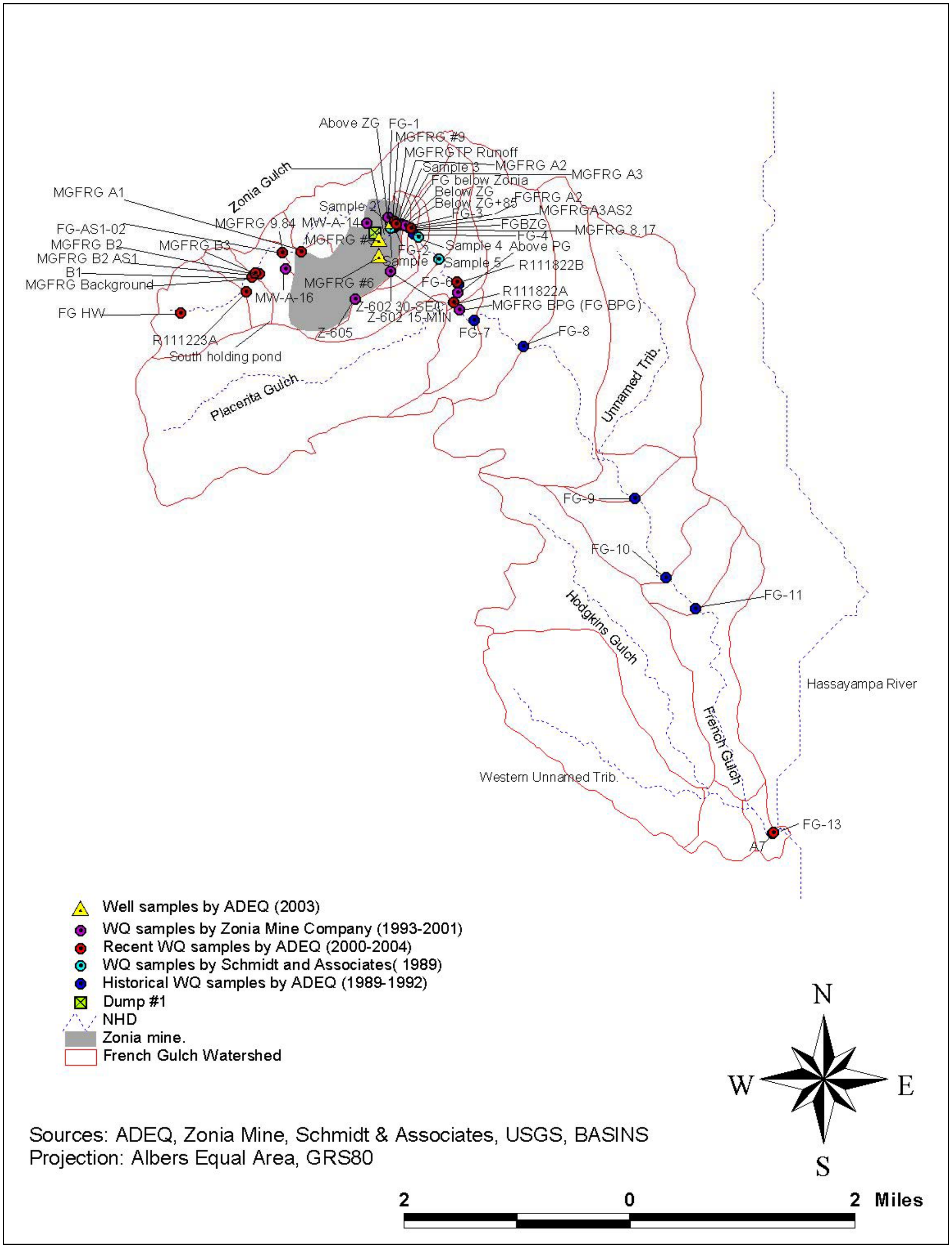


Figure B-1. Sampling Stations in the French Gulch Watershed

Site Descriptor	Sample Date	Cu(d)(mg/L)	Hardness	Hardness[1]	Standard
FG below Zonia	2/23/01	0.019	2573	400	0.0292794
FG below Zonia	1/29/01	0.027	2202	400	0.0292794
FG below Zonia	3/29/01	0.075	2400	400	0.0292794
FG-1	4/30/91	0.26	2480	400	0.0292794
FGAPG	1/2/96	0.007	1562	400	0.0292794
FGAPG	4/1/96	0.008	1504	400	0.0292794
FGAPG	3/20/02	0.01	2037	400	0.0292794
FGAPG	10/2/96	0.011	1697	400	0.0292794
FGAPG	4/10/01	0.014	1600	400	0.0292794
FGAPG	4/3/00	0.018	1700	400	0.0292794
FGAPG	10/4/99	0.019	1900	400	0.0292794
FGAPG	1/9/01	0.02	1800	400	0.0292794
FGAPG	4/7/98	0.03	1800	400	0.0292794
FGAPG	10/30/00	0.033	1000	400	0.0292794
FGAPG	10/5/98	0.13	2200	400	0.0292794
FG-AS2-02	3/4/03	0.064	2000	400	0.0292794
FG-AS2-04	3/4/03	0.064	2000	400	0.0292794
FG-AS2-06	3/4/03	0.065	2000	400	0.0292794
FG-AS2-08	3/4/03	0.064	2000	400	0.0292794
FG-AS2-10	3/5/03	0.06	2000	400	0.0292794
FGAZG	2/13/01	0.012	2400	400	0.0292794
FGAZG	5/15/01	0.014	2400	400	0.0292794
FGAZG	7/17/97	0.014	3300	400	0.0292794
FGAZG	9/4/97	0.017	2300	400	0.0292794
FGAZG	9/26/00	0.019	2400	400	0.0292794
FGAZG	12/18/97	0.021	2310	400	0.0292794
FGAZG	1/6/97	0.023	2600	400	0.0292794
FGAZG	11/1/99	0.024	2200	400	0.0292794
FGAZG	12/11/00	0.025	2300	400	0.0292794
FGAZG	1/9/01	0.025	2300	400	0.0292794
FGAZG	7/17/00	0.028	13000	400	0.0292794
FGAZG	6/26/01	0.03	2600	400	0.0292794
FGAZG	5/6/97	0.03	2390	400	0.0292794
FGAZG	12/6/96	0.03	3000	400	0.0292794
FGAZG	11/20/00	0.031	1340	400	0.0292794
FGAZG	11/20/00	0.031	1340	400	0.0292794
FGAZG	8/7/00	0.035	2400	400	0.0292794
FGAZG	10/23/97	0.035	2483	400	0.0292794
FGAZG	8/14/97	0.036	2466	400	0.0292794
FGAZG	2/3/97	0.048	2400	400	0.0292794
FGAZG	8/12/96	0.05	2884	400	0.0292794
FGAZG	4/10/01	0.054	2000	400	0.0292794
FGAZG	6/5/00	0.055	12000	400	0.0292794
FGAZG	3/2/97	0.055	1260	400	0.0292794
FGAZG	3/13/00	0.057	2400	400	0.0292794
FGAZG	3/25/96	0.06	2549	400	0.0292794

Site Descriptor	Sample Date	Cu(d)(mg/L)	Hardness	Hardness[1]	Standard
FGAZG	10/5/98	0.06	2800	400	0.0292794
FGAZG	11/13/97	0.062	2096	400	0.0292794
FGAZG	2/7/00	0.065	2400	400	0.0292794
FGAZG	1/3/00	0.067	2400	400	0.0292794
FGAZG	1/15/96	0.07	2622	400	0.0292794
FGAZG	3/19/01	0.07	2200	400	0.0292794
FGAZG	10/30/00	0.08	1200	400	0.0292794
FGAZG	3/11/96	0.08	2565	400	0.0292794
FGAZG	10/2/96	0.08	691.6	400	0.0292794
FGAZG	7/11/95	0.09	1896	400	0.0292794
FGAZG	7/15/96	0.09	2549	400	0.0292794
FGAZG	1/4/99	0.094	2300	400	0.0292794
FGAZG	1/2/96	0.1	2320	400	0.0292794
FGAZG	7/1/96	0.1	2426	400	0.0292794
FGAZG	5/1/00	0.11	2300	400	0.0292794
FGAZG	10/4/99	0.11	2400	400	0.0292794
FGAZG	4/8/96	0.11	2235	400	0.0292794
FGAZG	4/3/00	0.12	2200	400	0.0292794
FGAZG	2/9/99	0.12	2200	400	0.0292794
FGAZG	3/1/99	0.12	2500	400	0.0292794
FGAZG	6/3/96	0.12	2485	400	0.0292794
FGAZG	1/29/96	0.14	2664	400	0.0292794
FGAZG	12/8/98	0.17	6849	400	0.0292794
FGAZG	11/3/98	0.18	2340	400	0.0292794
FGAZG	6/4/98	0.19	1900	400	0.0292794
FGAZG	3/25/98	0.19	2400	400	0.0292794
FGAZG	4/7/98	0.24	2400	400	0.0292794
FGAZG	2/26/96	0.26	2715	400	0.0292794
FGAZG	2/23/98	0.26	990	400	0.0292794
FGAZG	5/9/96	0.26	2680	400	0.0292794
FGAZG	5/6/98	0.3	2500	400	0.0292794
FGBPG	10/2/96	0.008	1570	400	0.0292794
FGBPG	4/10/01	0.011	1600	400	0.0292794
FGBPG	4/3/00	0.012	1800	400	0.0292794
FGBPG	10/4/99	0.013	1900	400	0.0292794
FGBPG	1/9/01	0.017	1800	400	0.0292794
FGBPG	4/7/98	0.02	1300	400	0.0292794
FGBPG	10/30/00	0.026	890	400	0.0292794
FGBZG	2/13/01	0.011	2400	400	0.0292794
FGBZG	11/20/00	0.013	1340	400	0.0292794
FGBZG	11/20/00	0.013	1340	400	0.0292794
FGBZG	1/9/01	0.016	2100	400	0.0292794
FGBZG	12/11/00	0.016	2200	400	0.0292794
FGBZG	7/19/01	0.017	2400	400	0.0292794
FGBZG	10/11/01	0.02	2400	400	0.0292794
FGBZG	10/30/00	0.02	920	400	0.0292794

Site Descriptor	Sample Date	Cu(d)(mg/L)	Hardness	Hardness[1]	Standard
FGBZG	3/19/01	0.044	2200	400	0.0292794
FGBZG	4/10/01	0.047	2000	400	0.0292794
FGBZG	9/19/01	0.048	2500	400	0.0292794
FGBZG	12/18/01	0.054	2400	400	0.0292794
FGBZG	7/17/00	0.069	12000	400	0.0292794
FGBZG	7/11/95	0.08	1044	400	0.0292794
FGBZG	9/13/96	0.09	303.1	303.1	0.0231003
FGBZG	12/6/96	0.111	3100	400	0.0292794
FGBZG	8/12/96	0.12	2970	400	0.0292794
FGBZG	11/4/97	0.173	2316	400	0.0292794
FGBZG	7/1/96	0.21	2547	400	0.0292794
FGBZG	3/11/96	0.22	2698	400	0.0292794
FGBZG	6/3/96	0.24	2706	400	0.0292794
FGBZG	5/6/97	0.246	2320	400	0.0292794
FGBZG	1/2/96	0.25	2766	400	0.0292794
FGBZG	3/2/97	0.251	1380	400	0.0292794
FGBZG	10/5/98	0.27	2600	400	0.0292794
FGBZG	2/26/96	0.28	2798	400	0.0292794
FGBZG	5/9/96	0.28	2660	400	0.0292794
FGBZG	10/2/96	0.3	1453.3	400	0.0292794
FGBZG	9/4/97	0.303	1850	400	0.0292794
FGBZG	7/17/97	0.306	3100	400	0.0292794
FGBZG	4/8/96	0.32	2319	400	0.0292794
FGBZG	3/25/96	0.32	2770	400	0.0292794
FGBZG	6/12/97	0.35	2245	400	0.0292794
FGBZG	7/15/96	0.36	2388	400	0.0292794
FGBZG	8/14/97	0.39	2460	400	0.0292794
FGBZG	1/29/96	0.41	2701	400	0.0292794
FGBZG	1/15/96	0.41	2455	400	0.0292794
FGBZG	1/6/97	0.443	2400	400	0.0292794
FGBZG	12/18/97	0.479	2240	400	0.0292794
FGBZG	6/4/98	0.5	1900	400	0.0292794
FGBZG	2/9/99	0.51	2000	400	0.0292794
FGBZG	2/3/97	0.544	2300	400	0.0292794
FGBZG	5/6/98	0.55	2400	400	0.0292794
FGBZG	3/25/98	0.56	2300	400	0.0292794
FGBZG	10/23/97	0.562	2040	400	0.0292794
FGBZG	1/4/99	0.57	2200	400	0.0292794
FGBZG	3/1/99	0.59	2400	400	0.0292794
FGBZG	4/3/00	0.61	2200	400	0.0292794
FGBZG	6/5/00	0.63	12000	400	0.0292794
FGBZG	11/13/97	0.677	2109	400	0.0292794
FGBZG	3/13/00	0.71	2300	400	0.0292794
FGBZG	2/23/98	0.72	1160	400	0.0292794
FGBZG	10/4/99	0.72	2300	400	0.0292794
FGBZG	11/3/98	0.73	2360	400	0.0292794

Site Descriptor	Sample Date	Cu(d)(mg/L)	Hardness	Hardness[1]	Standard
FGBZG	12/8/98	0.78	6602	400	0.0292794
FGBZG	11/1/99	0.78	2200	400	0.0292794
FGBZG	5/1/00	0.79	2300	400	0.0292794
FGBZG	4/7/98	0.82	2100	400	0.0292794
FGBZG	1/5/98	0.9	2400	400	0.0292794
FGBZG	2/7/00	0.94	2300	400	0.0292794
FGBZG	1/3/00	1.2	2300	400	0.0292794
FGBZG+85	3/20/02	0.02	2344	400	0.0292794
FGBZG+85	3/20/02	0.024	2300	400	0.0292794
FGBZG+85	2/20/02	0.031	2300	400	0.0292794
FGBZG+85	8/23/01	0.036	2500	400	0.0292794
FGBZG+85	10/18/01	0.036	2600	400	0.0292794
FGBZG+85	1/15/02	0.045	2600	400	0.0292794
MGFRG 008.17	4/15/03	0.016	2100	400	0.0292794
MGFRG 008.17	3/17/03	0.023	2000	400	0.0292794
MGFRG 008.17	2/26/03	0.097	69	69	0.0065223
MGFRG 008.17	2/26/03	0.12	71	71	0.0066835
MGFRG 008.17	2/27/03	0.15	190	190	0.0154988
MGFRG 008.17-QAQC-Total	2/26/03	0.098	61	61	0.0058704
MGFRG 008.17-Split	2/26/03	0.097	63	63	0.0060345
MGFRG 009.84	2/26/03	0.01	35	35	0.0036518
MGFRG A1	8/27/03	0.032	39	39	0.0040056
MGFRG A2	11/12/03	0.19	140	140	0.0119390
MGFRG A3	8/27/03	0.014	2100	400	0.0292794
MGFRG A3	8/28/03	0.034	750	400	0.0292794
MGFRG A3 AS2 1-2	2/23/04	0.0076	1600	400	0.0292794
MGFRG A4	12/30/03	0.006	2200	400	0.0292794
MGFRG A4 AS 11-12	12/31/03	0.014	2200	400	0.0292794
MGFRG A4 AS 13-14	12/31/03	0.0057	2100	400	0.0292794
MGFRG A4 AS 15-16	12/31/03	0.0056	2100	400	0.0292794
MGFRG A4 AS 3-4	12/30/03	0.0054	2200	400	0.0292794
MGFRG A7 AS3 1-2	11/12/03	0.0094	120	120	0.0104656
MGFRG A7 AS3 3-4	11/12/03	0.0079	360	360	0.0267585
MGFRG A7 AS3 5-6	11/12/03	0.0098	190	190	0.0154988
MGFRG ASBPG 1-2	2/23/04	0.013	1900	400	0.0292794
MGFRG B1	2/23/04	0.01	22	25	0.0027393
MGFRG B1	11/12/03	0.017	18	25	0.0027393
MGFRG B2	2/23/04	0.006	27	27	0.0029255
MGFRG B2	11/12/03	0.0072	14	25	0.0027393
MGFRG B2	8/27/03	0.017	347	347	0.0259307
MGFRG B2 AS1 11-12	11/12/03	0.0075	27	27	0.0029255
MGFRG B2 AS1 11-12	2/23/04	0.0078	28	28	0.0030179
MGFRG B2 AS1 1-2	11/12/03	0.0083	18	25	0.0027393
MGFRG B2 AS1 1-2	2/23/04	0.0096	23	25	0.0027393
MGFRG B2 AS1 1-2	12/26/03	0.014	15	25	0.0027393
MGFRG B2 AS1 13-14	11/12/03	0.0067	25	25	0.0027393

Site Descriptor	Sample Date	Cu(d)(mg/L)	Hardness	Hardness[1]	Standard
MGFRG B2 AS1 13-14	2/23/04	0.0097	29	29	0.0031097
MGFRG B2 AS1 15-16	2/23/04	0.0085	30	30	0.0032011
MGFRG B2 AS1 15-16	11/12/03	0.009	25	25	0.0027393
MGFRG B2 AS1 17-18	11/12/03	0.0072	25	25	0.0027393
MGFRG B2 AS1 17-18	2/23/04	0.0084	31	31	0.0032921
MGFRG B2 AS1 19-20	2/23/04	0.0062	31	31	0.0032921
MGFRG B2 AS1 19-20	11/13/03	0.0077	26	26	0.0028327
MGFRG B2 AS1 21-22	11/13/03	0.0068	26	26	0.0028327
MGFRG B2 AS1 21-22	2/23/04	0.01	33	33	0.0034727
MGFRG B2 AS1 23-24	2/24/04	0.0072	31	31	0.0032921
MGFRG B2 AS1 23-24	11/13/03	0.01	26	26	0.0028327
MGFRG B2 AS1 3-4	11/12/03	0.0072	48	48	0.0047832
MGFRG B2 AS1 3-4	12/26/03	0.0094	20	25	0.0027393
MGFRG B2 AS1 3-4	2/23/04	0.01	26	26	0.0028327
MGFRG B2 AS1 7-8	11/12/03	0.0089	67	67	0.0063604
MGFRG B2 AS1 7-8	2/23/04	0.0094	26	26	0.0028327
MGFRG B2 AS1 7-8	12/26/03	0.031	23	25	0.0027393
MGFRG B2 AS1 9-10	11/12/03	0.0073	38	38	0.0039177
MGFRG B2 AS1 9-10	2/23/04	0.0075	26	26	0.0028327
MGFRG Bckgnd B1	8/27/03	0.062	25	25	0.0027393
MGFRG Below #9	8/28/03	0.1	540	400	0.0292794
MGFRG Below #9	8/28/03	0.1	250	250	0.0195948
MGFRG Below #9	8/28/03	0.12	250	250	0.0195948
MGFRG Below #9	8/28/03	0.12	540	400	0.0292794
MGFRG BPG	2/23/04	0.011	1800	400	0.0292794
MGFRG HW	11/12/03	0.0068	71	71	0.0066835
MGFRG HW	2/23/04	0.011	31	31	0.0032921
MGFRG HW	8/27/03	0.016	36	36	0.0037408
MGFRGA3AS2	8/25/03	0.074	310	310	0.0235489
R111223A	11/12/03	0.0088	26	26	0.0028327
R111822A	11/12/03	0.044	1600	400	0.0292794
R111822B	11/18/03	0.019	2200	400	0.0292794

[1]Calculated hardness used in modeling.

Site Dscriptor	Sample Date	Cd(d)(mg/L)	Hardness	Hardness[1]	Standard
FG below Zonia	3/29/01	0.009	2400	400	0.006222403
FG-1	4/30/91	0.0058	2480	400	0.006222403
FG-2	4/30/91	0.085	2540	400	0.006222403
FG-AS2-02	3/4/03	0.0024	2000	400	0.006222403
FG-AS2-04	3/4/03	0.0023	2000	400	0.006222403
FG-AS2-06	3/4/03	0.0022	2000	400	0.006222403
FG-AS2-08	3/4/03	0.0022	2000	400	0.006222403
FG-AS2-10	3/5/03	0.0022	2000	400	0.006222403
FGAZG	9/26/00	0.0081	2400	400	0.006222403
FGAZG	4/3/00	0.0091	2200	400	0.006222403
FGAZG	5/1/00	0.011	2300	400	0.006222403
FGAZG	6/5/00	0.0068	12000	400	0.006222403
FGAZG	3/13/00	0.009	2400	400	0.006222403
FGAZG	8/7/00	0.0054	2400	400	0.006222403
FGAZG	10/30/00	0.0034	1200	400	0.006222403
FGAZG	11/20/00	0.004	1340	400	0.006222403
FGAZG	11/20/00	0.004	1340	400	0.006222403
FGAZG	5/6/97	0.006	2390	400	0.006222403
FGAZG	7/17/97	0.005	3300	400	0.006222403
FGAZG	1/9/01	0.0039	2300	400	0.006222403
FGAZG	2/13/01	0.001	2400	400	0.006222403
FGAZG	5/15/01	0.0012	2400	400	0.006222403
FGAZG	1/3/00	0.005	2400	400	0.006222403
FGAZG	2/7/00	0.0097	2400	400	0.006222403
FGAZG	2/9/99	0.0098	2200	400	0.006222403
FGAZG	6/12/97	0.004	2517	400	0.006222403
FGAZG	10/5/98	0.012	2800	400	0.006222403
FGAZG	11/3/98	0.007	2340	400	0.006222403
FGAZG	12/8/98	0.0057	6849	400	0.006222403
FGAZG	6/4/98	0.012	1900	400	0.006222403
FGAZG	3/1/99	0.013	2500	400	0.006222403
FGAZG	10/4/99	0.0038	2400	400	0.006222403
FGAZG	11/1/99	0.0022	2200	400	0.006222403
FGAZG	1/4/99	0.0048	2300	400	0.006222403
FGAZG	8/14/97	0.004	2466	400	0.006222403
FGAZG	9/4/97	0.006	2300	400	0.006222403
FGAZG	10/23/97	0.001	2483	400	0.006222403
FGAZG	2/23/98	0.005	990	400	0.006222403
FGAZG	3/25/98	0.009	2400	400	0.006222403
FGAZG	4/7/98	0.004	2400	400	0.006222403
FGAZG	11/13/97	0.004	2096	400	0.006222403
FGBPG	10/23/97	0.004	2040	400	0.006222403
FGBZG	5/15/03	0.0016	1500	400	0.006222403
FGBZG	6/12/97	0.011	2245	400	0.006222403
FGBZG	4/3/00	0.017	2200	400	0.006222403
FGBZG	5/1/00	0.019	2300	400	0.006222403

Site Dscriptor	Sample Date	Cd(d)(mg/L)	Hardness	Hardness[1]	Standard
FGBZG	2/7/00	0.02	2300	400	0.006222403
FGBZG	5/6/97	0.015	2320	400	0.006222403
FGBZG	6/5/00	0.011	12000	400	0.006222403
FGBZG	3/13/00	0.02	2300	400	0.006222403
FGBZG	1/3/00	0.018	2300	400	0.006222403
FGBZG	10/5/98	0.013	2600	400	0.006222403
FGBZG	11/3/98	0.011	2360	400	0.006222403
FGBZG	1/4/99	0.011	2200	400	0.006222403
FGBZG	4/7/98	0.014	2100	400	0.006222403
FGBZG	2/9/99	0.015	2000	400	0.006222403
FGBZG	3/1/99	0.019	2400	400	0.006222403
FGBZG	10/4/99	0.012	2300	400	0.006222403
FGBZG	12/18/97	0.011	2240	400	0.006222403
FGBZG	7/17/97	0.014	3100	400	0.006222403
FGBZG	8/14/97	0.017	2460	400	0.006222403
FGBZG	6/4/98	0.016	1900	400	0.006222403
FGBZG	11/13/97	0.017	2109	400	0.006222403
FGBZG	11/1/99	0.014	2200	400	0.006222403
FGBZG	1/5/98	0.02	2400	400	0.006222403
FGBZG	2/23/98	0.01	1160	400	0.006222403
FGBZG	3/25/98	0.015	2300	400	0.006222403
FGBZG+85	3/20/02	0.0023	2344	400	0.006222403
MGFRG 008.17	3/17/03	0.001	2000	400	0.006222403
MGFRG A2	11/12/03	0.0022	140	140	0.002869566
MGFRG A3	8/27/03	0.0012	2100	400	0.006222403
MGFRG Below #9	8/28/03	0.0036	250	250	0.004401535
MGFRG Below #9	8/28/03	0.0036	540	400	0.006222403

[1]Calculated hardness used in modeling.

Site Descriptor	Sample Date	Zn(d)(mg/L)	Hardness	Hardness[1]	Standard
FG below Zonia	1/29/01	0.14	2202	400	0.379298048
FG below Zonia	2/23/01	0.24	2573	400	0.379298048
FG below Zonia	3/29/01	0.36	2400	400	0.379298048
FG-1	4/30/91	0.46	2480	400	0.379298048
FG-10	5/1/91	0.06	842	400	0.379298048
FG-13	5/2/91	0.06	332	332	0.323903376
FG-2	4/30/91	8.71	2540	400	0.379298048
FG-4	4/30/91	0.015	1960	400	0.379298048
FG-6	5/1/91	0.09	1650	400	0.379298048
FG-8	5/1/91	0.05	1370	400	0.379298048
FGAPG	10/4/99	0.019	1900	400	0.379298048
FGAPG	3/20/02	0.05	1900	400	0.379298048
FGAPG	10/2/96	0.07	1697	400	0.379298048
FGAPG	3/20/02	0.08	2037	400	0.379298048
FGAPG	4/7/98	0.09	1800	400	0.379298048
FGAPG	10/30/00	0.13	1000	400	0.379298048
FG-AS2-02	3/4/03	0.34	2000	400	0.379298048
FG-AS2-04	3/4/03	0.34	2000	400	0.379298048
FG-AS2-06	3/4/03	0.32	2000	400	0.379298048
FG-AS2-08	3/4/03	0.35	2000	400	0.379298048
FG-AS2-10	3/5/03	0.34	2000	400	0.379298048
FGAZG	6/5/00	0.075	12000	400	0.379298048
FGAZG	9/13/96	0.08	320.8	320.8	0.314620886
FGAZG	3/1/99	0.12	2500	400	0.379298048
FGAZG	2/9/99	0.12	2200	400	0.379298048
FGAZG	1/5/98	0.15	2440	400	0.379298048
FGAZG	7/15/96	0.15	2549	400	0.379298048
FGAZG	8/26/96	0.15	3030	400	0.379298048
FGAZG	3/11/96	0.15	2565	400	0.379298048
FGAZG	7/1/96	0.16	2426	400	0.379298048
FGAZG	10/23/97	0.168	2483	400	0.379298048
FGAZG	3/25/96	0.17	2549	400	0.379298048
FGAZG	12/18/97	0.179	2310	400	0.379298048
FGAZG	6/3/96	0.18	2485	400	0.379298048
FGAZG	7/17/97	0.189	3300	400	0.379298048
FGAZG	2/23/98	0.19	990	400	0.379298048
FGAZG	9/4/97	0.191	2300	400	0.379298048
FGAZG	5/6/97	0.192	2390	400	0.379298048
FGAZG	3/2/97	0.197	1260	400	0.379298048
FGAZG	8/12/96	0.2	2884	400	0.379298048
FGAZG	7/17/00	0.21	13000	400	0.379298048
FGAZG	4/8/96	0.21	2235	400	0.379298048
FGAZG	2/3/97	0.22	2400	400	0.379298048
FGAZG	8/14/97	0.228	2466	400	0.379298048
FGAZG	11/13/97	0.229	2096	400	0.379298048

Site Descriptor	Sample Date	Zn(d)(mg/L)	Hardness	Hardness[1]	Standard
FGAZG	10/30/00	0.24	1200	400	0.379298048
FGAZG	11/4/97	0.248	2408	400	0.379298048
FGAZG	1/6/97	0.25	2600	400	0.379298048
FGAZG	2/26/96	0.27	2715	400	0.379298048
FGAZG	9/26/00	0.27	2400	400	0.379298048
FGAZG	8/7/00	0.27	2400	400	0.379298048
FGAZG	5/9/96	0.27	2680	400	0.379298048
FGAZG	12/6/96	0.285	3000	400	0.379298048
FGAZG	5/15/01	0.29	2400	400	0.379298048
FGAZG	6/26/01	0.3	2600	400	0.379298048
FGAZG	3/19/01	0.3	2200	400	0.379298048
FGAZG	5/6/98	0.3	2500	400	0.379298048
FGAZG	10/2/96	0.3	691.6	400	0.379298048
FGAZG	2/13/01	0.31	2400	400	0.379298048
FGAZG	1/29/96	0.34	2664	400	0.379298048
FGAZG	11/20/00	0.34	1340	400	0.379298048
FGAZG	11/20/00	0.34	1340	400	0.379298048
FGAZG	1/9/01	0.34	2300	400	0.379298048
FGAZG	1/2/96	0.36	2320	400	0.379298048
FGAZG	1/15/96	0.37	2622	400	0.379298048
FGAZG	12/11/00	0.37	2300	400	0.379298048
FGAZG	3/13/00	0.38	2400	400	0.379298048
FGAZG	4/10/01	0.38	2000	400	0.379298048
FGAZG	11/1/99	0.38	2200	400	0.379298048
FGAZG	10/4/99	0.38	2400	400	0.379298048
FGAZG	2/7/00	0.43	2400	400	0.379298048
FGAZG	5/1/00	0.44	2300	400	0.379298048
FGAZG	4/3/00	0.44	2200	400	0.379298048
FGAZG	1/3/00	0.45	2400	400	0.379298048
FGAZG	3/25/98	0.45	2400	400	0.379298048
FGAZG	1/4/99	0.59	2300	400	0.379298048
FGAZG	10/5/98	0.62	2800	400	0.379298048
FGAZG	4/7/98	0.68	2400	400	0.379298048
FGAZG	12/8/98	0.74	6849	400	0.379298048
FGAZG	11/3/98	0.77	2340	400	0.379298048
FGAZG	6/4/98	0.95	1900	400	0.379298048
FGBPG	10/2/96	0.06	1570	400	0.379298048
FGBPG	10/30/00	0.078	890	400	0.379298048
FGBZG	5/15/01	0.0092	2400	400	0.379298048
FGBZG	9/13/96	0.04	303.1	303.1	0.299849232
FGBZG	7/11/95	0.08	1044	400	0.379298048
FGBZG	10/30/00	0.094	920	400	0.379298048
FGBZG	2/13/01	0.1	2400	400	0.379298048
FGBZG	7/17/00	0.12	12000	400	0.379298048
FGBZG	8/7/00	0.13	2400	400	0.379298048
FGBZG	6/26/01	0.13	2800	400	0.379298048

Site Descriptor	Sample Date	Zn(d)(mg/L)	Hardness	Hardness[1]	Standard
FGBZG	11/20/00	0.2	1340	400	0.379298048
FGBZG	11/20/00	0.2	1340	400	0.379298048
FGBZG	12/11/00	0.2	2200	400	0.379298048
FGBZG	3/19/01	0.22	2200	400	0.379298048
FGBZG	10/11/01	0.25	2400	400	0.379298048
FGBZG	1/9/01	0.26	2100	400	0.379298048
FGBZG	4/10/01	0.28	2000	400	0.379298048
FGBZG	8/26/96	0.35	3894	400	0.379298048
FGBZG	9/19/01	0.36	2500	400	0.379298048
FGBZG	7/19/01	0.39	2400	400	0.379298048
FGBZG	7/15/96	0.42	2388	400	0.379298048
FGBZG	3/11/96	0.43	2698	400	0.379298048
FGBZG	7/1/96	0.44	2547	400	0.379298048
FGBZG	2/26/96	0.48	2798	400	0.379298048
FGBZG	6/3/96	0.48	2706	400	0.379298048
FGBZG	5/9/96	0.48	2660	400	0.379298048
FGBZG	3/25/96	0.53	2770	400	0.379298048
FGBZG	5/6/98	0.55	2400	400	0.379298048
FGBZG	8/12/96	0.58	2970	400	0.379298048
FGBZG	3/1/99	0.59	2400	400	0.379298048
FGBZG	12/18/01	0.6	2400	400	0.379298048
FGBZG	1/29/96	0.6	2701	400	0.379298048
FGBZG	1/2/96	0.7	2766	400	0.379298048
FGBZG	5/6/97	0.71	2320	400	0.379298048
FGBZG	1/15/96	0.72	2455	400	0.379298048
FGBZG	3/2/97	0.955	1380	400	0.379298048
FGBZG	2/23/98	0.96	1160	400	0.379298048
FGBZG	10/5/98	1	2600	400	0.379298048
FGBZG	6/5/00	1	12000	400	0.379298048
FGBZG	4/8/96	1	2319	400	0.379298048
FGBZG	6/4/98	1.02	1900	400	0.379298048
FGBZG	3/25/98	1.13	2300	400	0.379298048
FGBZG	10/2/96	1.15	1453.3	400	0.379298048
FGBZG	6/12/97	1.2	2245	400	0.379298048
FGBZG	7/17/97	1.29	3100	400	0.379298048
FGBZG	9/4/97	1.3	1850	400	0.379298048
FGBZG	2/3/97	1.3	2300	400	0.379298048
FGBZG	10/23/97	1.33	2040	400	0.379298048
FGBZG	12/6/96	1.34	3100	400	0.379298048
FGBZG	2/9/99	1.4	2000	400	0.379298048
FGBZG	1/6/97	1.4	2400	400	0.379298048
FGBZG	11/4/97	1.42	2316	400	0.379298048
FGBZG	11/13/97	1.43	2109	400	0.379298048
FGBZG	4/7/98	1.49	2100	400	0.379298048
FGBZG	5/1/00	1.5	2300	400	0.379298048
FGBZG	4/3/00	1.5	2200	400	0.379298048

Site Descriptor	Sample Date	Zn(d)(mg/L)	Hardness	Hardness[1]	Standard
FGBZG	1/4/99	1.6	2200	400	0.379298048
FGBZG	11/3/98	1.6	2360	400	0.379298048
FGBZG	12/18/97	1.66	2240	400	0.379298048
FGBZG	3/13/00	1.7	2300	400	0.379298048
FGBZG	10/4/99	1.7	2300	400	0.379298048
FGBZG	8/14/97	1.75	2460	400	0.379298048
FGBZG	12/8/98	1.8	6602	400	0.379298048
FGBZG	11/1/99	1.9	2200	400	0.379298048
FGBZG	2/7/00	2	2300	400	0.379298048
FGBZG	1/3/00	2.2	2300	400	0.379298048
FGBZG	1/5/98	2.26	2400	400	0.379298048
FGBZG+85	3/20/02	0.29	2344	400	0.379298048
FGBZG+85	3/20/02	0.29	2300	400	0.379298048
FGBZG+85	2/20/02	0.36	2300	400	0.379298048
FGBZG+85	8/23/01	0.36	2500	400	0.379298048
FGBZG+85	10/18/01	0.4	2600	400	0.379298048
FGBZG+85	1/15/02	0.45	2600	400	0.379298048
MGFRG 008.17	2/27/03	0.052	190	190	0.201856669
MGFRG 008.17	2/26/03	0.059	69	69	0.085568124
MGFRG 008.17	2/26/03	0.059	71	71	0.087665028
MGFRG 008.17	4/15/03	0.089	2100	400	0.379298048
MGFRG 008.17	3/17/03	0.12	2000	400	0.379298048
MGFRG 008.17	2/26/03	0.13	69	69	0.085568124
MGFRG 008.17-Split	2/26/03	0.1	63	63	0.079220289
MGFRG A1	8/27/03	0.056	39	39	0.05276722
MGFRG A2	11/12/03	0.028	140	140	0.155836599
MGFRG A3	8/27/03	0.056	2100	400	0.379298048
MGFRG A3	8/28/03	0.25	750	400	0.379298048
MGFRG A3 AS2 1-2	2/23/04	0.029	1600	400	0.379298048
MGFRG A4	12/30/03	0.035	2200	400	0.379298048
MGFRG B1	2/23/04	0.025	22	25	0.036201765
MGFRG B2	2/23/04	0.033	27	27	0.038641119
MGFRG B2	8/27/03	0.054	347	347	0.336260877
MGFRG Below #9	8/28/03	0.12	540	400	0.379298048
MGFRG Below #9	8/28/03	0.12	250	250	0.25470047
MGFRG HW	11/12/03	0.099	71	71	0.087665028
R111822A	11/12/03	0.067	1600	400	0.379298048
R111822B	11/18/03	0.026	2200	400	0.379298048

[1]Calculated hardness used in modeling.

Site Descriptor	Sample Date	Mn(t)(mg/L)
FG below Zonia	3/29/01	35
FG below Zonia	1/29/01	8.52
FG below Zonia	4/24/01	29.88
FG-1	4/30/91	18.4
FG-10	5/1/91	0.13
FG-13	5/2/91	0.19
FG-2	4/30/91	28.5
FG-4	4/30/91	0.06
FG-6	5/1/91	0.14
FGAPG	10/30/00	0.99
FGAPG	4/3/00	0.029
FGAPG	4/10/01	0.094
FGAPG	1/9/01	0.058
FGAPG	10/4/99	0.024
FGAPG	1/4/99	0.017
FGAPG	10/5/98	0.02
FGAPG	4/7/98	1.22
FGAPG	1/2/96	0.85
FGAPG	10/2/96	18.6
FGAPG	4/1/96	0.11
FG-AS2-02	3/4/03	0.28
FG-AS2-04	3/4/03	0.26
FG-AS2-06	3/4/03	0.28
FG-AS2-08	3/4/03	0.27
FG-AS2-10	3/5/03	0.27
FGAZG	1/3/00	46
FGAZG	11/20/00	30.4
FGAZG	11/20/00	30.4
FGAZG	10/30/00	27
FGAZG	9/26/00	37
FGAZG	8/7/00	57
FGAZG	7/17/00	38
FGAZG	6/5/00	45
FGAZG	5/1/00	48
FGAZG	4/3/00	40
FGAZG	3/13/00	37
FGAZG	2/7/00	40
FGAZG	6/26/01	44
FGAZG	5/15/01	35
FGAZG	12/11/00	26
FGAZG	4/10/01	33
FGAZG	2/13/01	9.9
FGAZG	3/19/01	31
FGAZG	1/9/01	25
FGAZG	9/4/97	35

Site Descriptor	Sample Date	Mn(t)(mg/L)
FGAZG	1/6/97	20.6
FGAZG	2/23/98	13.3
FGAZG	1/5/98	0.38
FGAZG	12/18/97	1.88
FGAZG	11/13/97	15.3
FGAZG	11/4/97	35.5
FGAZG	3/25/98	23.3
FGAZG	8/14/97	38.4
FGAZG	7/17/97	26
FGAZG	6/12/97	27
FGAZG	5/6/97	31.2
FGAZG	3/2/97	17.4
FGAZG	2/3/97	27.5
FGAZG	10/23/97	9
FGAZG	11/1/99	38
FGAZG	10/4/99	46
FGAZG	3/1/99	43
FGAZG	2/9/99	39
FGAZG	1/4/99	42
FGAZG	12/8/98	46
FGAZG	11/3/98	38
FGAZG	10/5/98	29
FGAZG	6/4/98	41
FGAZG	5/6/98	40
FGAZG	4/7/98	23.5
FGAZG	2/26/96	35
FGAZG	1/29/96	49
FGAZG	1/15/96	48
FGAZG	1/2/96	52
FGAZG	8/2/95	59
FGAZG	3/25/96	44
FGAZG	8/2/95	54
FGAZG	7/11/95	26.4
FGAZG	7/1/96	35
FGAZG	12/6/96	29
FGAZG	10/2/96	31.1
FGAZG	9/13/96	4.64
FGAZG	8/26/96	34.8
FGAZG	8/12/96	28.3
FGAZG	3/11/96	40
FGAZG	6/3/96	40
FGAZG	5/9/96	30.5
FGAZG	4/8/96	42.5
FGAZG	7/15/96	39
FGBPG	10/30/00	0.54
FGBPG	4/3/00	0.049

Site Descriptor	Sample Date	Mn(t)(mg/L)
FGBPG	4/10/01	0.035
FGBPG	1/9/01	0.042
FGBPG	1/5/98	0.02
FGBPG	10/23/97	0.01
FGBPG	10/4/99	0.094
FGBPG	10/5/98	0.06
FGBPG	4/7/98	0.61
FGBPG	10/2/96	2.46
FGBZG	9/19/01	7.7
FGBZG	12/18/01	7.3
FGBZG	7/19/01	8.4
FGBZG	5/15/03	1.2
FGBZG	10/11/01	10.8
FGBZG	6/5/00	29
FGBZG	11/20/00	11
FGBZG	11/20/00	11
FGBZG	10/30/00	12
FGBZG	8/7/00	34
FGBZG	12/11/00	7.4
FGBZG	5/1/00	33
FGBZG	4/3/00	28
FGBZG	3/13/00	26
FGBZG	2/7/00	28
FGBZG	1/3/00	32
FGBZG	7/17/00	24
FGBZG	6/26/01	32
FGBZG	5/15/01	25
FGBZG	4/10/01	23
FGBZG	2/13/01	2
FGBZG	3/19/01	20
FGBZG	1/9/01	8
FGBZG	1/5/98	9.14
FGBZG	12/18/97	8.51
FGBZG	11/13/97	13.8
FGBZG	11/4/97	27.1
FGBZG	9/4/97	27
FGBZG	3/25/98	17.1
FGBZG	8/14/97	31.1
FGBZG	7/17/97	11
FGBZG	6/12/97	16
FGBZG	5/6/97	19.5
FGBZG	3/2/97	16.9
FGBZG	2/3/97	20.7
FGBZG	11/3/98	31
FGBZG	10/4/99	23
FGBZG	3/1/99	35

Site Descriptor	Sample Date	Mn(t)(mg/L)
FGBZG	2/9/99	30
FGBZG	1/4/99	34
FGBZG	2/23/98	12.5
FGBZG	12/6/96	18.8
FGBZG	10/5/98	24
FGBZG	6/4/98	30
FGBZG	5/6/98	31
FGBZG	4/7/98	19
FGBZG	12/8/98	38
FGBZG	8/2/95	46
FGBZG	1/6/97	13.2
FGBZG	2/26/96	32
FGBZG	1/29/96	41
FGBZG	1/15/96	42
FGBZG	1/2/96	41
FGBZG	3/11/96	37
FGBZG	7/11/95	22
FGBZG	11/1/99	24
FGBZG	8/2/95	48
FGBZG	10/2/96	20.4
FGBZG	9/13/96	0.19
FGBZG	8/26/96	27.5
FGBZG	8/12/96	11.9
FGBZG	7/15/96	31
FGBZG	7/1/96	33
FGBZG	6/3/96	31
FGBZG	5/9/96	33.5
FGBZG	4/8/96	40
FGBZG	3/25/96	37
FGBZG+85	3/20/02	2.37
FGBZG+85	8/23/01	8.3
FGBZG+85	10/18/01	7.1
FGBZG+85	2/20/02	2.7
FGBZG+85	1/15/02	4.8
FGBZG+85	3/20/02	2.3
MGFRG 008.17	4/15/03	0.58
MGFRG 008.17	2/26/03	0.39
MGFRG 008.17	3/17/03	0.31
MGFRG 008.17	2/26/03	1
MGFRG 008.17	2/27/03	0.22
MGFRG 008.17-QAQC-Total	2/26/03	1.4
MGFRG 008.17-Split	2/26/03	1.3
MGFRG 009.84	2/26/03	0.067
MGFRG 009.84	2/26/03	0.094
MGFRG 009.84	2/26/03	0.088
MGFRG A1	8/27/03	0.12

Site Descriptor	Sample Date	Mn(t)(mg/L)
MGFRG A2	11/12/03	3.8
MGFRG A3	8/27/03	7.2
MGFRG A3	8/28/03	4
MGFRG A3 AS2 1-2	2/23/04	0.34
MGFRG A4	12/30/03	0.16
MGFRG A4 AS 3-4	12/30/03	0.088
MGFRG A7 AS3 1-2	11/12/03	0.55
MGFRG A7 AS3 3-4	11/12/03	2.9
MGFRG A7 AS3 5-6	11/12/03	1.2
MGFRG ASBPG 1-2	2/23/04	0.25
MGFRG B1	11/12/03	0.056
MGFRG B2	8/27/03	0.12
MGFRG B2 AS1 11-12	11/12/03	0.11
MGFRG B2 AS1 11-12	2/23/04	0.052
MGFRG B2 AS1 1-2	12/26/03	0.053
MGFRG B2 AS1 1-2	2/23/04	0.053
MGFRG B2 AS1 13-14	11/12/03	0.06
MGFRG B2 AS1 17-18	2/23/04	0.05
MGFRG B2 AS1 3-4	11/12/03	0.36
MGFRG B2 AS1 3-4	2/23/04	0.053
MGFRG B2 AS1 3-4	12/26/03	0.064
MGFRG B2 AS1 7-8	11/12/03	0.57
MGFRG B2 AS1 7-8	12/26/03	0.074
MGFRG B2 AS1 7-8	2/23/04	0.058
MGFRG B2 AS1 9-10	11/12/03	0.28
MGFRG B2 AS1 9-10	2/23/04	0.054
MGFRG Bckgnd B1	8/27/03	0.071
MGFRG Below #9	8/28/03	3.7
MGFRG HW	11/12/03	0.6
MGFRG HW	2/23/04	0.058
MGFRG HW	8/27/03	0.092
MGFRGA3AS2	8/25/03	8.6
R111822A	11/12/03	0.42

Alkalinity DATA from STORET

Station ID	County	HUC	Activity Start	Characteristic Name	Result Value as Text	Units
100713	YAVAPAI	15070103	05/03/94	Alkalinity, Carbonate as CaCO3	9	mg/l
101197	MARICOPA	15070103	04/15/02	Alkalinity, Carbonate as CaCO3	14	mg/l
100463	YAVAPAI	15070103	05/19/99	Alkalinity, Carbonate as CaCO3	2	mg/l
100713	YAVAPAI	15070103	04/27/93	Alkalinity, Carbonate as CaCO3	14	mg/l
100463	YAVAPAI	15070103	04/15/93	Alkalinity, Carbonate as CaCO3	4	mg/l
100463	YAVAPAI	15070103	05/15/90	Alkalinity, Carbonate as CaCO3	13	mg/l
100586	YAVAPAI	15070103	04/27/93	Alkalinity, Carbonate as CaCO3	6	mg/l
100463	YAVAPAI	15070103	02/14/00	Alkalinity, Carbonate as CaCO3	2	mg/l
100713	YAVAPAI	15070103	05/08/92	Alkalinity, Carbonate as CaCO3	8	mg/l
100713	YAVAPAI	15070103	04/29/98	Alkalinity, Carbonate as CaCO3	16	mg/l
100463	YAVAPAI	15070103	06/13/91	Alkalinity, Carbonate as CaCO3	5	mg/l
100463	YAVAPAI	15070103	03/13/90	Alkalinity, Carbonate as CaCO3	8	mg/l
100566	YAVAPAI	15070103	05/02/94	Alkalinity, Carbonate as CaCO3	5	mg/l
100463	YAVAPAI	15070103	05/15/90	Alkalinity, Carbonate as CaCO3	13	mg/l
100463	YAVAPAI	15070103	01/16/02	Alkalinity, Carbonate as CaCO3	3	mg/l
100463	YAVAPAI	15070103	01/31/90	Alkalinity, Carbonate as CaCO3	10	mg/l
100463	YAVAPAI	15070103	09/18/00	Alkalinity, Carbonate as CaCO3	3	mg/l
100566	YAVAPAI	15070103	04/27/93	Alkalinity, Carbonate as CaCO3	3	mg/l
100463	YAVAPAI	15070103	06/15/93	Alkalinity, Carbonate as CaCO3	3	mg/l
100463	YAVAPAI	15070103	02/21/91	Alkalinity, Carbonate as CaCO3	4	mg/l
100463	YAVAPAI	15070103	06/15/93	Alkalinity, Carbonate as CaCO3	2	mg/l
100464	YAVAPAI	15070103	01/10/91	Alkalinity, Carbonate as CaCO3	2	mg/l
100464	YAVAPAI	15070103	07/14/99	Alkalinity, Carbonate as CaCO3	3	mg/l

APPENDIX C
ZONIA MINE HISTORY

Years	Company/Name	Activities
1877	Copperopolis	200-foot shaft sunk in 1880. (Lindgren, 1926)
1900 -?	Boston & Arizona Copper Company	Sank Copperopolis shaft; built mill, smelter on French Gulch. (ADEQ, 1993)
1910	Shannon Copper Company	Sank six churn drill holes. (ADEQ, 1993)
1916-1920	Zonia Syndicate	Sank Cuprite or McMahan shaft. (874 feet)
1927-1930	Hammon Copper Company	Extensive development of Cuprite or McMahan shaft; built leaching plant.
1942	U.S. Bureau of Mines	Trenching core drilling; mapping and sampling.
1956	Miami Copper Company	Extensive drilling.
1964 - 1975	McAlester Company	Air reconnaissance, extensive drilling.
1966-1972	McAlester Company	Open pit and heap leach.
1972	Halpenny Report "Ground-Water Conditions in the Vicinity of the Zonia Mine, Yavapai County, Arizona"	Conclusion: Rainfall & runoff sink into ground steadily. Rock material has low coefficient of transmissibility, which is a measure of freedom with which groundwater moves down gradient through permeable rocks. Aquifer tests indicated coefficient of transmissibility of aquifer in range of 5000 gpd & coefficient of storage is 51.5%. Water table is 66" below bed of wash where collecting reservoir would be constructed. If reservoir does not become sealed, estimated rate of leakage is about 30 gpm. Monitor for possible leakage, construct well near wash, 50' or 100' downstream from Well No. 5, depth of 200'.
1975-1975	McAlester Company	Three blasts detonated between April 1973 and May 1974 to fragment the ore for in situ leaching. Dilute sulfuric acid was applied and leach solutions collected at the base of the ore body were pumped to the surface through a recovery well. The water table was used as an aid for leach solution collection.
1975	McAlester Company	All production at Zonia ceased.
1979-1980	Bureau of Land Management	Observed & reported to ADHS water pollution in French Gulch below Zonia Mine. Resurrected proposal to convert Zonia Mine into landfill for Yavapai County.

1980	ADEQ & BLM	Transport study conducted. Six sites sampled below Zonia. First 4.8 miles below mine coated with a 1/4" to ½" layer of blue precipiate. Blue precipitate assumed to be copper carbonate..
1980	Zonia Company	Remedial program begins.
January, 1982	Halpenny Report: "Investigation of Water Quality in French Gulch, Yavapai County, Arizona	Prepared at the request of McAlester Fuel Company, of McAlester, Oklahoma. Recommendation: Continue operation of pumps in leach basin (LB) 5 and LB6 through February 28, 1981, or until pumping is no longer feasible. Continue measurements of stream discharge through 1981.
1983	Antioch Resources Ltd. /Queenstake Resources	Conducted exploration activities.
1983	ADEQ	Remedial process ceased and possibly as early as 1981. No records concerning water quality.
1988	Zonia Company	Acquired property from Antioch Resources.
1988	Zonia Company	Investigated possibility of turning open pit mine into landfill (Zonia Landill, Inc.) but was denied the permit.
1989	Kenneth D. Schmidt & Associates	Hired by Zonia to carry out short range transport study in anticipation of APP application. Selected five sites for study. See map. Reveals depletion consistent with 1980 work.
March 1989	Complaint addressed to ADEQ	Written complaint from a rancher, discharge from a broken pipeline.
April 7, 1989	ADEQ	Non-filer Report, violation indicating violation of section 301(a) CWA discharging pollutants not authorized by an NPDES permit.
May 25, 1989	EPA & ADEQ	Inspected breakages in leachate line allowing discharge to enter French Gulch.
1989	Kenneth D. Schmidt & Associates	Description of hydrogeologic conditions at the proposed landfill: overview of Halpenny reports.

April 5, 1990	EPA & ADEQ	Broken manifold leachate line found from leach basin (LB) 7, LB8 & LB9 discharging into French Gulch; copper, zinc and cadmium.
April 7, 1990	Zonia Company	Repairs on manifold made.
July 13, 1990	U.S. E.P.A.	Received a Finding of Violation from U.S. EPA together with an Order for Compliance.
August 15, 1990	ADEQ	Zonia shall submit a detailed and complete correction plan prepared by a professional engineer, Zonia shall submit compliance progress every three months beginning August 1, 1990 until full compliance achieved.
August 1990	Zonia Company	Currently updating collection system for LB's 7, 8 & 9. LB5 and LB 6 pumps. Berming and fencing; berm extended to spill point for concrete holding bays
November 1990	Zonia Company	LB9 pipeline temporarily rerouted to holding bays. Manifold stabilization repairs. Erosion control. Inactive pipelines removed. Core sampling of collection and barren solution ponds completed.
February 1991	Zonia Company	Solution in LB now contained at LB 8 & 9. Leach lines from LB 8 & 9 no longer utilized to tranport and contain solution. Manifold stabilization repair and erosion control completed. BL 5 & 6 pumps provided in final report. Core sampling done. Berm made on collection pond, dam heights raised and compacted.
April 30, 1991	ADEQ	Permission to sample Zonia Mine property obtained from Ray Hill. John Rubel met R. Williams & P. Hyde for sampling.
May 1, 1991	ADEQ	2nd day sampling.
May 2, 1991	ADEQ	3rd day sampling.
1992	Arimetco, Inc. and Zonia Company	Entered lease agreement, delayed until environmental liability issues were resolved. Arimetco to be held harmless in regard to past offenses.
March 12, 1992	ADEQ	Telephone complaint from resident at Kirkland Junction about green water flowing in French Gulch.

March 16 & 23, 1992	ADEQ	Reconnaissance and sample collection.
December 1, 1992	Arimetco, Inc.	Submitted a remediation plan to EPA to prevent pollutant discharges into French Gulch and its tributaries.
March 12, 1993	Arimetco, Inc.	Arimetco proposes to conduct partial remediation program to eliminate discharge of pollution to French Gulch. Two process water collection dams constructed. Both dams lined. Basins behind dams lined. Impounded water behind two dams will not discharge to surface water.
July 1, 2000	Arimetco, Inc.	Flow in Zonia Gulch decreasing: 7/1/00 - 7/10/00 - .5 gpm 7/11/00 - 7/13/00 - .25 gpm 7/14/00 - 7/15/00 - .10 gpm 7/16/00 - 5 ounces per minutes 7/17/00 - 0 gpm
January 29, 2001	ADEQ	TMDL sampling commences.
June 28, 2001	Arimetco, Inc.	Pumping well #9 began to diminish flow in French Gulch. 10/12/01, diverted flow from well #9 to pond known as French Gulch diverted.
April 1, 2002	Arimetco, Inc.	Flow from French Gulch decreasing: 4/1/02 - 4/10/02 - 4.6 gpm 4/11/02 - 3.3 gpm 4/12/02 - 1.25 gpm 4/15/02 - 4.0 gpm 4/16/02 - 4.0 gpm 4/17/02 - 4/19/02 - 4.6 gpm 4/20/02 - 2.4 gpm 4/21/02 - 1.2 gpm 4/22/02 - .66 gpm 4/23/02 - .28 gpm 4/24/02 - 0 gpm
2003	Arimetco, Inc.	Current owner and operator of property.

APPENDIX D
DATA USED FOR REGIONAL LOADING ANALYSIS (unit:mg/L)

Site Descriptor	Sample Date	Cd(d)
FGBZG	5/15/03	0.0016
FG-AS2-04	3/4/03	0.0023
FG-AS2-06	3/4/03	0.0022
FG-AS2-08	3/4/03	0.0022
FG-AS2-10	3/5/03	0.0022
FG-AS2-02	3/4/03	0.0024
MGFRG A2	11/12/03	0.0022
MGFRG A3	8/27/03	0.0012
FGBZG+85	3/20/02	0.0023
MGFRG 008.17	3/17/03	0.001
FGAZG	9/26/00	0.0081
FGBZG	6/12/97	0.011
FGAZG	4/3/00	0.0091
FGBZG	4/3/00	0.017
FGAZG	5/1/00	0.011
FGBZG	5/1/00	0.019
FGAZG	6/5/00	0.0068
FGAZG	3/13/00	0.009
FGAZG	8/7/00	0.0054
FGBZG	2/7/00	0.02
FGAZG	10/30/00	0.0034
FGAZG	11/20/00	0.004
FGAZG	11/20/00	0.004
FGAZG	5/6/97	0.006
FGBZG	5/6/97	0.015
FG below Zonia	3/29/01	0.009
FGBZG	6/5/00	0.011
FG-1	4/30/91	0.0058
FG-2	4/30/91	0.085
FGBZG	3/13/00	0.02
FGAZG	7/17/97	0.005
FGAZG	1/9/01	0.0039
FGAZG	2/13/01	0.001
FGAZG	5/15/01	0.0012
FGAZG	1/3/00	0.005
FGBZG	1/3/00	0.018
FGAZG	2/7/00	0.0097
FGAZG	2/9/99	0.0098
FGAZG	6/12/97	0.004
FGAZG	10/5/98	0.012
FGBZG	10/5/98	0.013
FGAZG	11/3/98	0.007
FGBZG	11/3/98	0.011
FGAZG	12/8/98	0.0057
FGAZG	6/4/98	0.012

Site Descriptor	Sample Date	Cd(d)
FGBZG	1/4/99	0.011
FGBZG	4/7/98	0.014
FGBZG	2/9/99	0.015
FGAZG	3/1/99	0.013
FGBZG	3/1/99	0.019
FGAZG	10/4/99	0.0038
FGBZG	10/4/99	0.012
FGAZG	11/1/99	0.0022
FGAZG	1/4/99	0.0048
FGBZG	12/18/97	0.011
FGBZG	7/17/97	0.014
FGAZG	8/14/97	0.004
FGBZG	8/14/97	0.017
FGAZG	9/4/97	0.006
FGAZG	10/23/97	0.001
FGBPG	10/23/97	0.004
FGBZG	6/4/98	0.016
FGBZG	11/13/97	0.017
FGBZG	11/1/99	0.014
FGBZG	1/5/98	0.02
FGAZG	2/23/98	0.005
FGBZG	2/23/98	0.01
FGAZG	3/25/98	0.009
FGBZG	3/25/98	0.015
FGAZG	4/7/98	0.004
FGAZG	11/13/97	0.004
FG below Zonia	3/29/01	0.009
FG below Zonia	4/24/01	0.008
FG-AS2-02	3/4/03	0.0024
FG-AS2-04	3/4/03	0.0023
FG-AS2-06	3/4/03	0.0022
FG-AS2-08	3/4/03	0.0022
FG-AS2-10	3/5/03	0.0022
FGBZG	5/15/03	0.0016
MGFRG A3	8/27/03	0.0012
MGFRG Below #9	8/28/03	0.0036
FG-1	4/30/91	0.0058
FG-2	4/30/91	0.085

Site Descriptor	Sample Date	Cu(d)
FGBZG	4/7/98	0.82
FGAZG	4/7/98	0.24
FGBZG	3/25/98	0.56
FGAZG	3/25/98	0.19
FGBZG	2/23/98	0.72
FGAZG	3/11/96	0.08
FGBZG	6/4/98	0.5
FGBZG	6/5/00	0.63
FGAZG	10/23/97	0.035
FGAZG	9/4/97	0.017
FGAZG	8/14/97	0.036
FGAZG	7/17/97	0.014
FGAZG	5/6/97	0.03
FGBZG	2/13/01	0.011
FGAZG	2/13/01	0.012
FGBZG	12/11/00	0.016
FGBZG	1/4/99	0.57
FGAZG	7/17/00	0.028
FGBZG	12/18/97	0.479
FGAZG	6/5/00	0.055
FGBZG	11/1/99	0.78
FGAZG	11/1/99	0.024
FGBPG	10/4/99	0.013
FGAPG	10/4/99	0.019
FGBZG	10/4/99	0.72
FGAZG	10/4/99	0.11
FGBZG	3/1/99	0.59
FGAZG	3/1/99	0.12
FGAZG	9/26/00	0.019
FGBZG	5/9/96	0.28
FGAZG	2/23/98	0.26
FGAZG	8/12/96	0.05
FGBZG	8/12/96	0.12
FGBZG	7/15/96	0.36
FGAZG	7/15/96	0.09
FGBZG	7/1/96	0.21
FGAZG	7/1/96	0.1
FGBZG	6/3/96	0.24
FGAZG	10/2/96	0.08
FGAZG	5/9/96	0.26
FGBZG	10/2/96	0.3
FGBZG	4/8/96	0.32
FGAZG	4/8/96	0.11
FGAPG	4/1/96	0.008
FGBZG	3/25/96	0.32
FGAPG	10/5/98	0.13

Site Descriptor	Sample Date	Cu(d)
FGAZG	6/3/96	0.12
FGBZG	3/2/97	0.251
FGAZG	12/18/97	0.021
FGBZG	11/13/97	0.677
FGAZG	11/13/97	0.062
FGBZG	11/4/97	0.173
FGBZG	10/23/97	0.562
FGBZG	9/4/97	0.303
FGBZG	8/14/97	0.39
FGBZG	7/17/97	0.306
FGBZG	9/13/96	0.09
FGBZG	5/6/97	0.246
FGBZG	3/11/96	0.22
FGAZG	3/2/97	0.055
FGBZG	2/3/97	0.544
FGAZG	2/3/97	0.048
FGBZG	1/6/97	0.443
FGAZG	1/6/97	0.023
FGBZG	12/6/96	0.111
FGAZG	12/6/96	0.03
FGBPG	10/2/96	0.008
FGAPG	10/2/96	0.011
FGBZG	6/12/97	0.35
FG below Zonia	1/29/01	0.027
FG below Zonia	2/23/01	0.019
FG below Zonia	3/29/01	0.075
FG below Zonia	4/24/01	0.056
FGAPG	3/20/02	0.01
FG-AS2-02	3/4/03	0.064
FG-AS2-04	3/4/03	0.064
FG-AS2-06	3/4/03	0.065
FG-AS2-08	3/4/03	0.064
FG-AS2-10	3/5/03	0.06
FGBZG	10/11/01	0.02
FGAPG	3/20/02	0.01
FG-AS2-02	3/4/03	0.064
FG-AS2-04	3/4/03	0.064
FG-AS2-06	3/4/03	0.065
FG-AS2-08	3/4/03	0.064
FG-AS2-10	3/5/03	0.06
FGBZG	10/11/01	0.02
FGBZG+85	3/20/02	0.02
MGFRG 008.17	2/26/03	0.097
MGFRG 008.17	2/26/03	0.12
MGFRG 008.17	2/26/03	0.097
MGFRG 008.17	2/26/03	0.12

Site Descriptor	Sample Date	Cu(d)
MGFRG 008.17	2/27/03	0.15
MGFRG 008.17	3/17/03	0.023
MGFRG 008.17	4/15/03	0.016
MGFRG 009.84	2/26/03	0.01
MGFRG 009.84	2/26/03	0.01
MGFRG A1	8/27/03	0.032
MGFRG A2	11/12/03	0.19
MGFRG A3	8/27/03	0.014
MGFRG A3	8/28/03	0.034
MGFRG A3 AS2 1-2	2/23/04	0.0076
MGFRG A4	12/30/03	0.006
MGFRG A4 AS 11-12	12/31/03	0.014
MGFRG A4 AS 13-14	12/31/03	0.0057
MGFRG A4 AS 15-16	12/31/03	0.0056
MGFRG A4 AS 3-4	12/30/03	0.0054
MGFRG A7 AS3 1-2	11/12/03	0.0094
MGFRG A7 AS3 3-4	11/12/03	0.0079
MGFRG A7 AS3 5-6	11/12/03	0.0098
MGFRG ASBPG 1-2	2/23/04	0.013
MGFRG B1	11/12/03	0.017
MGFRG B1	2/23/04	0.01
MGFRG B2	8/27/03	0.017
MGFRG B2	11/12/03	0.0072
MGFRG B2	2/23/04	0.006
MGFRG B2 AS1 11-12	11/12/03	0.0075
MGFRG B2 AS1 11-12	2/23/04	0.0078
MGFRG B2 AS1 1-2	11/12/03	0.0083
MGFRG B2 AS1 1-2	12/26/03	0.014
MGFRG B2 AS1 1-2	2/23/04	0.0096
MGFRG B2 AS1 13-14	11/12/03	0.0067
MGFRG B2 AS1 13-14	2/23/04	0.0097
MGFRG B2 AS1 15-16	11/12/03	0.009
MGFRG B2 AS1 15-16	2/23/04	0.0085
MGFRG B2 AS1 17-18	11/12/03	0.0072
MGFRG B2 AS1 17-18	2/23/04	0.0084
MGFRG B2 AS1 19-20	11/13/03	0.0077
MGFRG B2 AS1 19-20	2/23/04	0.0062
MGFRG B2 AS1 21-22	11/13/03	0.0068
MGFRG B2 AS1 21-22	2/23/04	0.01
MGFRG B2 AS1 23-24	11/13/03	0.01
MGFRG B2 AS1 23-24	2/24/04	0.0072
MGFRG B2 AS1 3-4	11/12/03	0.0072
MGFRG B2 AS1 3-4	12/26/03	0.0094
MGFRG B2 AS1 3-4	2/23/04	0.01
MGFRG B2 AS1 7-8	11/12/03	0.0089
MGFRG B2 AS1 7-8	12/26/03	0.031

Site Descriptor	Sample Date	Cu(d)
MGFRG B2 AS1 7-8	2/23/04	0.0094
MGFRG B2 AS1 9-10	11/12/03	0.0073
MGFRG B2 AS1 9-10	2/23/04	0.0075
MGFRG Bckgnd B1	8/27/03	0.062
MGFRG BPG	2/23/04	0.011
MGFRGA3AS2	8/25/03	0.074
R111223A	11/12/03	0.0088
R111822A	11/12/03	0.044
R111822B	11/18/03	0.019
FGBZG	7/19/01	0.017
FGBZG	9/19/01	0.048
FGBZG	12/18/01	0.054
FGBZG+85	8/23/01	0.036
FGBZG+85	10/18/01	0.036
FGBZG+85	1/15/02	0.045
FGBZG+85	2/20/02	0.031
FGBZG+85	3/20/02	0.024
FGAZG	1/3/00	0.067
FGAZG	1/2/96	0.1
FGBZG	2/26/96	0.28
FGAZG	2/26/96	0.26
FGBZG	1/29/96	0.41
FGAZG	1/29/96	0.14
FGAZG	1/15/96	0.07
FGBZG	1/15/96	0.41
FGBZG	1/2/96	0.25
FGAZG	7/11/95	0.09
FGBZG	7/11/95	0.08
FGAPG	1/2/96	0.007
FGAZG	5/1/00	0.11
FGAZG	11/20/00	0.031
FGBZG	11/20/00	0.013
FGBPG	10/30/00	0.026
FGAPG	10/30/00	0.033
FGBZG	10/30/00	0.02
FGAZG	10/30/00	0.08
FGAZG	8/7/00	0.035
FGAZG	11/20/00	0.031
FGBZG	5/1/00	0.79
FGAZG	12/11/00	0.025
FGBPG	4/3/00	0.012
FGAPG	4/3/00	0.018
FGBZG	4/3/00	0.61
FGAZG	4/3/00	0.12
FGBZG	3/13/00	0.71
FGAZG	3/13/00	0.057

Site Descriptor	Sample Date	Cu(d)
FGBZG	2/7/00	0.94
FGAZG	2/7/00	0.065
FGBZG	1/3/00	1.2
FGBZG	7/17/00	0.069
FG below Zonia	3/29/01	0.075
FGAZG	3/25/96	0.06
FG-1	4/30/91	0.26
FGAZG	6/26/01	0.03
FGAZG	5/15/01	0.014
FGBPG	4/10/01	0.011
FGAPG	4/10/01	0.014
FGBZG	11/20/00	0.013
FGAZG	4/10/01	0.054
FG below Zonia	2/23/01	0.019
FGAZG	3/19/01	0.07
FGBZG	3/19/01	0.044
FG below Zonia	1/29/01	0.027
FGBPG	1/9/01	0.017
FGAPG	1/9/01	0.02
FGBZG	1/9/01	0.016
FGAZG	1/9/01	0.025
FGBZG	4/10/01	0.047
FGBZG	5/6/98	0.55
FGBZG	1/5/98	0.9
FGAZG	1/4/99	0.094
FGBZG	12/8/98	0.78
FGAZG	12/8/98	0.17
FGBZG	11/3/98	0.73
FGAZG	11/3/98	0.18
FGBZG	10/5/98	0.27
FGAZG	10/5/98	0.06
FGAZG	2/9/99	0.12
FGAZG	6/4/98	0.19
FGBZG	2/9/99	0.51
FGAZG	5/6/98	0.3
FGBPG	4/7/98	0.02
FGAPG	4/7/98	0.03
FGBZG+85	3/20/02	0.02
MGFRG 008.17	2/26/03	0.097
MGFRG 008.17	2/26/03	0.12
MGFRG 008.17	3/17/03	0.023
MGFRG 008.17-QAQC-Total	2/26/03	0.098
MGFRG 008.17-Split	2/26/03	0.097
MGFRG 009.84	2/26/03	0.01
MGFRG A1	8/27/03	0.032
MGFRG A2	11/12/03	0.19

Site Descriptor	Sample Date	Cu(d)
MGFRG A3	8/27/03	0.014
MGFRG A3	8/28/03	0.034
MGFRG A3 AS2 1-2	2/23/04	0.0076
MGFRG A4	12/30/03	0.006
MGFRG A4 AS 11-12	12/31/03	0.014
MGFRG A4 AS 13-14	12/31/03	0.0057
MGFRG A4 AS 15-16	12/31/03	0.0056
MGFRG A4 AS 3-4	12/30/03	0.0054
MGFRG A7 AS3 1-2	11/12/03	0.0094
MGFRG A7 AS3 3-4	11/12/03	0.0079
MGFRG A7 AS3 5-6	11/12/03	0.0098
MGFRG ASBPG 1-2	2/23/04	0.013
MGFRG B1	11/12/03	0.017
MGFRG B1	2/23/04	0.01
MGFRG B2	11/12/03	0.0072
MGFRG B2	2/23/04	0.006
MGFRG B2 AS1 11-12	11/12/03	0.0075
MGFRG B2 AS1 11-12	2/23/04	0.0078
MGFRG B2 AS1 1-2	11/12/03	0.0083
MGFRG B2 AS1 1-2	12/26/03	0.014
MGFRG B2 AS1 1-2	2/23/04	0.0096
MGFRG B2 AS1 13-14	11/12/03	0.0067
MGFRG B2 AS1 13-14	2/23/04	0.0097
MGFRG B2 AS1 15-16	11/12/03	0.009
MGFRG B2 AS1 15-16	2/23/04	0.0085
MGFRG B2 AS1 17-18	11/12/03	0.0072
MGFRG B2 AS1 17-18	2/23/04	0.0084
MGFRG B2 AS1 19-20	11/13/03	0.0077
MGFRG B2 AS1 19-20	2/23/04	0.0062
MGFRG B2 AS1 21-22	11/13/03	0.0068
MGFRG B2 AS1 21-22	2/23/04	0.01
MGFRG B2 AS1 23-24	11/13/03	0.01
MGFRG B2 AS1 23-24	2/24/04	0.0072
MGFRG B2 AS1 3-4	11/12/03	0.0072
MGFRG B2 AS1 3-4	12/26/03	0.0094
MGFRG B2 AS1 3-4	2/23/04	0.01
MGFRG B2 AS1 7-8	11/12/03	0.0089
MGFRG B2 AS1 7-8	12/26/03	0.031
MGFRG B2 AS1 7-8	2/23/04	0.0094
MGFRG B2 AS1 9-10	11/12/03	0.0073
MGFRG B2 AS1 9-10	2/23/04	0.0075
MGFRG Bckgnd B1	8/27/03	0.062
MGFRG Below #9	8/28/03	0.1
MGFRG Below #9	8/28/03	0.12
MGFRG BPG	2/23/04	0.011
MGFRG HW	11/12/03	0.0068

Site Descriptor	Sample Date	Cu(d)
MGFRG HW	2/23/04	0.011
MGFRGA3AS2	8/25/03	0.074
R111223A	11/12/03	0.0088
R111822A	11/12/03	0.044
R111822B	11/18/03	0.019
FG-1	4/30/91	0.26
FGAPG	1/2/96	0.007
FGAPG	4/1/96	0.008
FGAPG	10/2/96	0.011
FGAPG	4/7/98	0.03
FGAPG	10/4/99	0.019
FGAPG	4/3/00	0.018
FGAPG	10/30/00	0.033
FGAPG	1/9/01	0.02
FGAPG	4/10/01	0.014
FGAZG	7/11/95	0.09
FGAZG	1/2/96	0.1
FGAZG	1/15/96	0.07
FGAZG	1/29/96	0.14
FGAZG	2/26/96	0.26
FGAZG	3/11/96	0.08
FGAZG	3/25/96	0.06
FGAZG	4/8/96	0.11
FGAZG	5/9/96	0.26
FGAZG	6/3/96	0.12
FGAZG	7/1/96	0.1
FGAZG	7/15/96	0.09
FGAZG	8/12/96	0.05
FGAZG	10/2/96	0.08
FGAZG	12/6/96	0.03
FGAZG	1/6/97	0.023
FGAZG	2/3/97	0.048
FGAZG	3/2/97	0.055
FGAZG	11/13/97	0.062
FGAZG	12/18/97	0.021
FGAZG	2/23/98	0.26
FGAZG	3/25/98	0.19
FGAZG	4/7/98	0.24
FGAZG	5/6/98	0.3
FGAZG	6/4/98	0.19
FGAZG	10/5/98	0.06
FGAZG	11/3/98	0.18
FGAZG	12/8/98	0.17
FGAZG	1/4/99	0.094
FGAZG	2/9/99	0.12
FGAZG	3/1/99	0.12

Site Descriptor	Sample Date	Cu(d)
FGAZG	10/4/99	0.11
FGAZG	11/1/99	0.024
FGAZG	1/3/00	0.067
FGAZG	2/7/00	0.065
FGAZG	3/13/00	0.057
FGAZG	4/3/00	0.12
FGAZG	5/1/00	0.11
FGAZG	8/7/00	0.035
FGAZG	10/30/00	0.08
FGAZG	11/20/00	0.031
FGAZG	12/11/00	0.025
FGAZG	1/9/01	0.025
FGAZG	3/19/01	0.07
FGAZG	4/10/01	0.054
FGAZG	5/15/01	0.014
FGAZG	6/26/01	0.03
FGBPG	10/2/96	0.008
FGBPG	4/7/98	0.02
FGBPG	10/4/99	0.013
FGBPG	4/3/00	0.012
FGBPG	10/30/00	0.026
FGBPG	1/9/01	0.017
FGBPG	4/10/01	0.011
FGBZG	7/11/95	0.08
FGBZG	1/2/96	0.25
FGBZG	1/15/96	0.41
FGBZG	1/29/96	0.41
FGBZG	2/26/96	0.28
FGBZG	3/11/96	0.22
FGBZG	3/25/96	0.32
FGBZG	4/8/96	0.32
FGBZG	5/9/96	0.28
FGBZG	6/3/96	0.24
FGBZG	7/1/96	0.21
FGBZG	7/15/96	0.36
FGBZG	8/12/96	0.12
FGBZG	9/13/96	0.09
FGBZG	10/2/96	0.3
FGBZG	12/6/96	0.111
FGBZG	1/6/97	0.443
FGBZG	2/3/97	0.544
FGBZG	3/2/97	0.251
FGBZG	5/6/97	0.246
FGBZG	6/12/97	0.35
FGBZG	7/17/97	0.306
FGBZG	8/14/97	0.39

Site Descriptor	Sample Date	Cu(d)
FGBZG	9/4/97	0.303
FGBZG	10/23/97	0.562
FGBZG	11/4/97	0.173
FGBZG	11/13/97	0.677
FGBZG	12/18/97	0.479
FGBZG	1/5/98	0.9
FGBZG	2/23/98	0.72
FGBZG	3/25/98	0.56
FGBZG	4/7/98	0.82
FGBZG	5/6/98	0.55
FGBZG	6/4/98	0.5
FGBZG	10/5/98	0.27
FGBZG	11/3/98	0.73
FGBZG	12/8/98	0.78
FGBZG	1/4/99	0.57
FGBZG	2/9/99	0.51
FGBZG	3/1/99	0.59
FGBZG	10/4/99	0.72
FGBZG	11/1/99	0.78
FGBZG	1/3/00	1.2
FGBZG	2/7/00	0.94
FGBZG	3/13/00	0.71
FGBZG	4/3/00	0.61
FGBZG	5/1/00	0.79
FGBZG	7/17/00	0.069
FGBZG	10/30/00	0.02
FGBZG	11/20/00	0.013
FGBZG	1/9/01	0.016
FGBZG	3/19/01	0.044
FGBZG	4/10/01	0.047
FGBZG	7/19/01	0.017
FGBZG	9/19/01	0.048
FGBZG	12/18/01	0.054
FGBZG+85	8/23/01	0.036
FGBZG+85	10/18/01	0.036
FGBZG+85	1/15/02	0.045
FGBZG+85	2/20/02	0.031
FGBZG+85	3/20/02	0.024

Site Descriptor	Sample Date	Mn
FG below Zonia	1/29/01	8.52
FG below Zonia	3/29/01	35
FG below Zonia	4/24/01	29.88
FG-1	4/30/91	18.4
FG-10	5/1/91	0.13
FG-13	5/2/91	0.19
FG-2	4/30/91	28.5
FG-4	4/30/91	0.06
FG-6	5/1/91	0.14
FGAPG	1/2/96	0.85
FGAPG	4/1/96	0.11
FGAPG	10/2/96	18.6
FGAPG	4/7/98	1.22
FGAPG	10/5/98	0.02
FGAPG	1/4/99	0.017
FGAPG	10/4/99	0.024
FGAPG	4/3/00	0.029
FGAPG	10/30/00	0.99
FGAPG	1/9/01	0.058
FGAPG	4/10/01	0.094
FG-AS2-02	3/4/03	0.28
FG-AS2-04	3/4/03	0.26
FG-AS2-06	3/4/03	0.28
FG-AS2-08	3/4/03	0.27
FG-AS2-10	3/5/03	0.27
FGAZG	7/11/95	26.4
FGAZG	8/2/95	54
FGAZG	8/2/95	59
FGAZG	1/2/96	52
FGAZG	1/15/96	48
FGAZG	1/29/96	49
FGAZG	2/26/96	35
FGAZG	3/11/96	40
FGAZG	3/25/96	44
FGAZG	4/8/96	42.5
FGAZG	5/9/96	30.5
FGAZG	6/3/96	40
FGAZG	7/1/96	35
FGAZG	7/15/96	39
FGAZG	8/12/96	28.3
FGAZG	8/26/96	34.8
FGAZG	9/13/96	4.64
FGAZG	10/2/96	31.1
FGAZG	12/6/96	29
FGAZG	1/6/97	20.6
FGAZG	2/3/97	27.5

Site Descriptor	Sample Date	Mn
FGAZG	3/2/97	17.4
FGAZG	5/6/97	31.2
FGAZG	6/12/97	27
FGAZG	7/17/97	26
FGAZG	8/14/97	38.4
FGAZG	9/4/97	35
FGAZG	10/23/97	9
FGAZG	11/4/97	35.5
FGAZG	11/13/97	15.3
FGAZG	12/18/97	1.88
FGAZG	1/5/98	0.38
FGAZG	2/23/98	13.3
FGAZG	3/25/98	23.3
FGAZG	4/7/98	23.5
FGAZG	5/6/98	40
FGAZG	6/4/98	41
FGAZG	10/5/98	29
FGAZG	11/3/98	38
FGAZG	12/8/98	46
FGAZG	1/4/99	42
FGAZG	2/9/99	39
FGAZG	3/1/99	43
FGAZG	10/4/99	46
FGAZG	11/1/99	38
FGAZG	1/3/00	46
FGAZG	2/7/00	40
FGAZG	3/13/00	37
FGAZG	4/3/00	40
FGAZG	5/1/00	48
FGAZG	6/5/00	45
FGAZG	7/17/00	38
FGAZG	8/7/00	57
FGAZG	9/26/00	37
FGAZG	10/30/00	27
FGAZG	11/20/00	30.4
FGAZG	12/11/00	26
FGAZG	1/9/01	25
FGAZG	2/13/01	9.9
FGAZG	3/19/01	31
FGAZG	4/10/01	33
FGAZG	5/15/01	35
FGAZG	6/26/01	44
FGBPG	10/2/96	2.46
FGBPG	10/23/97	0.01
FGBPG	1/5/98	0.02
FGBPG	4/7/98	0.61

Site Descriptor	Sample Date	Mn
FGBPG	10/5/98	0.06
FGBPG	10/4/99	0.094
FGBPG	4/3/00	0.049
FGBPG	10/30/00	0.54
FGBPG	1/9/01	0.042
FGBPG	4/10/01	0.035
FGBZG	7/11/95	22
FGBZG	8/2/95	46
FGBZG	8/2/95	48
FGBZG	1/2/96	41
FGBZG	1/15/96	42
FGBZG	1/29/96	41
FGBZG	2/26/96	32
FGBZG	3/11/96	37
FGBZG	3/25/96	37
FGBZG	4/8/96	40
FGBZG	5/9/96	33.5
FGBZG	6/3/96	31
FGBZG	7/1/96	33
FGBZG	7/15/96	31
FGBZG	8/12/96	11.9
FGBZG	8/26/96	27.5
FGBZG	9/13/96	0.19
FGBZG	10/2/96	20.4
FGBZG	12/6/96	18.8
FGBZG	1/6/97	13.2
FGBZG	2/3/97	20.7
FGBZG	3/2/97	16.9
FGBZG	5/6/97	19.5
FGBZG	6/12/97	16
FGBZG	7/17/97	11
FGBZG	8/14/97	31.1
FGBZG	9/4/97	27
FGBZG	11/4/97	27.1
FGBZG	11/13/97	13.8
FGBZG	12/18/97	8.51
FGBZG	1/5/98	9.14
FGBZG	2/23/98	12.5
FGBZG	3/25/98	17.1
FGBZG	4/7/98	19
FGBZG	5/6/98	31
FGBZG	6/4/98	30
FGBZG	10/5/98	24
FGBZG	11/3/98	31
FGBZG	12/8/98	38
FGBZG	1/4/99	34

Site Descriptor	Sample Date	Mn
FGBZG	2/9/99	30
FGBZG	3/1/99	35
FGBZG	10/4/99	23
FGBZG	11/1/99	24
FGBZG	1/3/00	32
FGBZG	2/7/00	28
FGBZG	3/13/00	26
FGBZG	4/3/00	28
FGBZG	5/1/00	33
FGBZG	6/5/00	29
FGBZG	7/17/00	24
FGBZG	8/7/00	34
FGBZG	10/30/00	12
FGBZG	11/20/00	11
FGBZG	12/11/00	7.4
FGBZG	1/9/01	8
FGBZG	2/13/01	2
FGBZG	3/19/01	20
FGBZG	4/10/01	23
FGBZG	5/15/01	25
FGBZG	6/26/01	32
FGBZG	7/19/01	8.4
FGBZG	9/19/01	7.7
FGBZG	10/11/01	10.8
FGBZG	12/18/01	7.3
FGBZG	5/15/03	1.2
FGBZG+85	8/23/01	8.3
FGBZG+85	10/18/01	7.1
FGBZG+85	1/15/02	4.8
FGBZG+85	2/20/02	2.7
FGBZG+85	3/20/02	2.3
FGBZG+85	3/20/02	2.37
MGFRG 008.17	2/26/03	0.39
MGFRG 008.17	2/26/03	1
MGFRG 008.17	2/27/03	0.22
MGFRG 008.17	3/17/03	0.31
MGFRG 008.17	4/15/03	0.58
MGFRG 008.17-QAQC-Total	2/26/03	1.4
MGFRG 008.17-Split	2/26/03	1.3
MGFRG 009.84	2/26/03	0.067
MGFRG 009.84	2/26/03	0.088
MGFRG 009.84	2/26/03	0.094
MGFRG A1	8/27/03	0.12
MGFRG A2	11/12/03	3.8
MGFRG A3	8/27/03	7.2
MGFRG A3	8/28/03	4

Site Descriptor	Sample Date	Mn
MGFRG A3 AS2 1-2	2/23/04	0.34
MGFRG A4	12/30/03	0.16
MGFRG A4 AS 3-4	12/30/03	0.088
MGFRG A7 AS3 1-2	11/12/03	0.55
MGFRG A7 AS3 3-4	11/12/03	2.9
MGFRG A7 AS3 5-6	11/12/03	1.2
MGFRG ASBPG 1-2	2/23/04	0.25
MGFRG B1	11/12/03	0.056
MGFRG B2	8/27/03	0.12
MGFRG B2 AS1 11-12	11/12/03	0.11
MGFRG B2 AS1 11-12	2/23/04	0.052
MGFRG B2 AS1 1-2	12/26/03	0.053
MGFRG B2 AS1 1-2	2/23/04	0.053
MGFRG B2 AS1 13-14	11/12/03	0.06
MGFRG B2 AS1 17-18	2/23/04	0.05
MGFRG B2 AS1 3-4	11/12/03	0.36
MGFRG B2 AS1 3-4	12/26/03	0.064
MGFRG B2 AS1 3-4	2/23/04	0.053
MGFRG B2 AS1 7-8	11/12/03	0.57
MGFRG B2 AS1 7-8	12/26/03	0.074
MGFRG B2 AS1 7-8	2/23/04	0.058
MGFRG B2 AS1 9-10	11/12/03	0.28
MGFRG B2 AS1 9-10	2/23/04	0.054
MGFRG Bckgnd B1	8/27/03	0.071
MGFRG Below #9	8/28/03	3.7
MGFRG HW	8/27/03	0.092
MGFRG HW	11/12/03	0.6
MGFRG HW	2/23/04	0.058
MGFRGA3AS2	8/25/03	8.6
R111822A	11/12/03	0.42

Site Descriptor	Sample Date	Zn(d)
FGBZG	7/19/01	0.39
FGBZG+85	8/23/01	0.36
FGBZG	9/19/01	0.36
FGBZG	10/11/01	0.25
FGBZG+85	10/18/01	0.4
FGBZG	12/18/01	0.6
FGBZG+85	1/15/02	0.45
FGBZG+85	2/20/02	0.36
FGBZG+85	3/20/02	0.29
FGBZG+85	3/20/02	0.29
FGAPG	3/20/02	0.05
FGAPG	3/20/02	0.08
MGFRG 008.17	2/26/03	0.059
MGFRG 008.17	2/26/03	0.13
MGFRG 008.17	2/26/03	0.059
MGFRG 008.17	2/26/03	0.13
MGFRG 008.17	2/27/03	0.052
FG-AS2-08	3/4/03	0.35
FG-AS2-06	3/4/03	0.32
FG-AS2-04	3/4/03	0.34
FG-AS2-02	3/4/03	0.34
FG-AS2-10	3/5/03	0.34
MGFRG 008.17	3/17/03	0.12
MGFRG 008.17	4/15/03	0.089
MGFRG A3	8/27/03	0.056
MGFRG A1	8/27/03	0.056
MGFRG B2	8/27/03	0.054
MGFRG A3	8/28/03	0.25
R111822A	11/12/03	0.067
MGFRG A2	11/12/03	0.028
R111822B	11/18/03	0.026
MGFRG A4	12/30/03	0.035
MGFRG A3 AS2 1-2	2/23/04	0.029
MGFRG B2	2/23/04	0.033
MGFRG B1	2/23/04	0.025
FGAZG	1/3/00	0.45
FG-13	5/2/91	0.06
FG-10	5/1/91	0.06
FG-8	5/1/91	0.05
FGAZG	2/26/96	0.27
FGBZG	1/29/96	0.6
FGAZG	1/29/96	0.34
FGAZG	1/15/96	0.37
FGBZG	1/15/96	0.72
FGBZG	1/2/96	0.7
FGAZG	1/2/96	0.36

Site Descriptor	Sample Date	Zn(d)
FGBZG	7/11/95	0.08
FG-2	4/30/91	8.71
FGBZG	5/1/00	1.5
FGAZG	11/20/00	0.34
FGBZG	11/20/00	0.2
FGBZG	10/30/00	0.094
FGAZG	10/30/00	0.24
FGAZG	9/26/00	0.27
FGBZG	8/7/00	0.13
FGAZG	8/7/00	0.27
FGBZG	7/17/00	0.12
FG-6	5/1/91	0.09
FGAZG	6/5/00	0.075
FGAZG	12/11/00	0.37
FGAZG	5/1/00	0.44
FGBZG	4/3/00	1.5
FGAZG	4/3/00	0.44
FGBZG	3/13/00	1.7
FGAZG	3/13/00	0.38
FGBZG	2/7/00	2
FGAZG	2/7/00	0.43
FGBZG	1/3/00	2.2
FGAZG	7/17/00	0.21
FGBZG	2/13/01	0.1
FGBZG	3/11/96	0.43
FG-1	4/30/91	0.46
FGBZG	6/26/01	0.13
FGAZG	6/26/01	0.3
FGBZG	5/15/01	0.0092
FGAZG	5/15/01	0.29
FGBZG	4/10/01	0.28
FGAZG	4/10/01	0.38
FGBZG	11/20/00	0.2
FG below Zonia	2/23/01	0.24
FGAZG	11/20/00	0.34
FGAZG	2/13/01	0.31
FGAZG	3/19/01	0.3
FGBZG	3/19/01	0.22
FG below Zonia	1/29/01	0.14
FGBZG	1/9/01	0.26
FGAZG	1/9/01	0.34
FGBZG	12/11/00	0.2
FG-4	4/30/91	0.015
FG below Zonia	3/29/01	0.36
FGBZG	1/5/98	2.26
FGAZG	6/4/98	0.95

Site Descriptor	Sample Date	Zn(d)
FGBZG	5/6/98	0.55
FGAZG	5/6/98	0.3
FGAPG	4/7/98	0.09
FGBZG	4/7/98	1.49
FGAZG	4/7/98	0.68
FGBZG	3/25/98	1.13
FGAZG	3/25/98	0.45
FGAZG	10/23/97	0.168
FGAZG	2/23/98	0.19
FGBZG	10/5/98	1
FGAZG	1/5/98	0.15
FGBZG	12/18/97	1.66
FGAZG	12/18/97	0.179
FGBZG	11/13/97	1.43
FGAZG	11/13/97	0.229
FGBZG	11/4/97	1.42
FGAZG	11/4/97	0.248
FGBZG	2/26/96	0.48
FGBZG	2/23/98	0.96
FGAZG	3/1/99	0.12
FGAZG	8/14/97	0.228
FGBPG	10/30/00	0.078
FGAPG	10/30/00	0.13
FGBZG	6/5/00	1
FGBZG	11/1/99	1.9
FGAZG	11/1/99	0.38
FGAPG	10/4/99	0.019
FGBZG	10/4/99	1.7
FGBZG	6/4/98	1.02
FGBZG	3/1/99	0.59
FGAZG	10/5/98	0.62
FGBZG	2/9/99	1.4
FGAZG	2/9/99	0.12
FGBZG	1/4/99	1.6
FGAZG	1/4/99	0.59
FGBZG	12/8/98	1.8
FGAZG	12/8/98	0.74
FGBZG	11/3/98	1.6
FGAZG	11/3/98	0.77
FGBZG	9/4/97	1.3
FGAZG	10/4/99	0.38
FGBZG	4/8/96	1
FGAZG	8/12/96	0.2
FGBZG	8/12/96	0.58
FGBZG	7/15/96	0.42
FGAZG	7/15/96	0.15

Site Descriptor	Sample Date	Zn(d)
FGBZG	7/1/96	0.44
FGAZG	7/1/96	0.16
FGBZG	6/3/96	0.48
FGAZG	6/3/96	0.18
FGBZG	10/23/97	1.33
FGBZG	5/9/96	0.48
FGAZG	9/13/96	0.08
FGAZG	4/8/96	0.21
FGBZG	3/25/96	0.53
FGAZG	3/25/96	0.17
FGAZG	9/4/97	0.191
FGAZG	5/9/96	0.27
FGBZG	1/6/97	1.4
FGBZG	8/14/97	1.75
FGBZG	7/17/97	1.29
FGAZG	7/17/97	0.189
FGBZG	6/12/97	1.2
FGBZG	5/6/97	0.71
FGAZG	5/6/97	0.192
FGBZG	3/2/97	0.955
FGAZG	3/2/97	0.197
FGBZG	8/26/96	0.35
FGAZG	2/3/97	0.22
FGAZG	8/26/96	0.15
FGAZG	1/6/97	0.25
FGBZG	12/6/96	1.34
FGAZG	12/6/96	0.285
FGBPG	10/2/96	0.06
FGAPG	10/2/96	0.07
FGBZG	10/2/96	1.15
FGAZG	10/2/96	0.3
FGBZG	9/13/96	0.04
FGAZG	3/11/96	0.15
FGBZG	2/3/97	1.3
FG below Zonia	1/29/01	0.14
FG below Zonia	2/23/01	0.24
FG below Zonia	3/29/01	0.36
FG below Zonia	4/24/01	0.33
FGAPG	3/20/02	0.08
FG-AS2-02	3/4/03	0.34
FG-AS2-04	3/4/03	0.34
FG-AS2-06	3/4/03	0.32
FG-AS2-08	3/4/03	0.35
FG-AS2-10	3/5/03	0.34
FGBZG	10/11/01	0.25
FGBZG+85	3/20/02	0.29

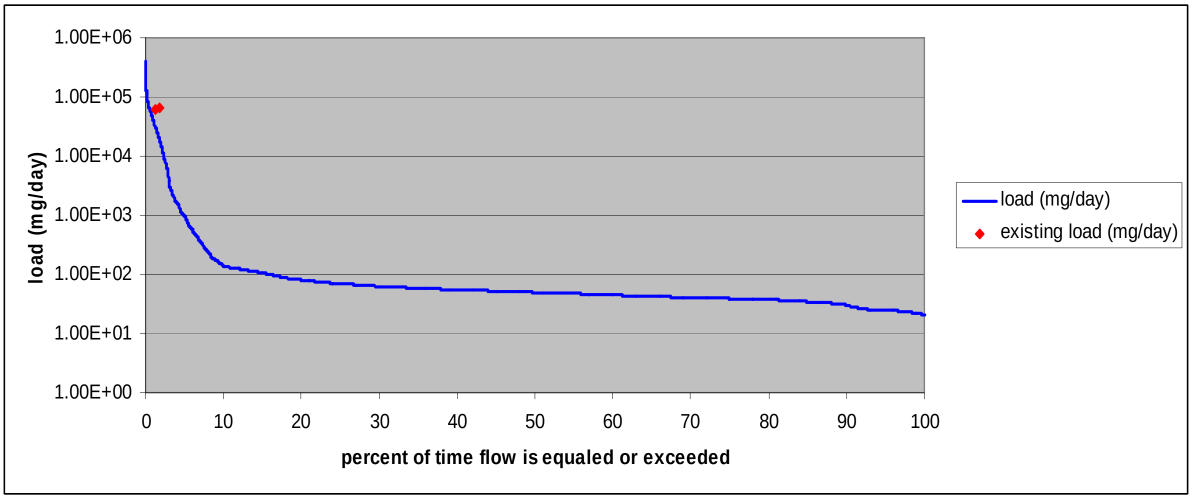
Site Descriptor	Sample Date	Zn(d)
MGFRG 008.17	2/27/03	0.052
MGFRG 008.17	3/17/03	0.12
MGFRG 008.17	4/15/03	0.089
MGFRG A2	11/12/03	0.028
MGFRG A3 AS2 1-2	2/23/04	0.029
MGFRG Below #9	8/28/03	0.12
R111822B	11/18/03	0.026
FG-1	4/30/91	0.46
FG-10	5/1/91	0.06
FG-13	5/2/91	0.06
FG-2	4/30/91	8.71
FG-4	4/30/91	0.015
FG-6	5/1/91	0.09
FG-8	5/1/91	0.05
FGAPG	10/2/96	0.07
FGAPG	4/7/98	0.09
FGAPG	10/4/99	0.019
FGAPG	3/20/02	0.05
FGAZG	1/2/96	0.36
FGAZG	1/15/96	0.37
FGAZG	1/29/96	0.34
FGAZG	2/26/96	0.27
FGAZG	3/11/96	0.15
FGAZG	3/25/96	0.17
FGAZG	4/8/96	0.21
FGAZG	5/9/96	0.27
FGAZG	6/3/96	0.18
FGAZG	7/1/96	0.16
FGAZG	7/15/96	0.15
FGAZG	8/12/96	0.2
FGAZG	8/26/96	0.15
FGAZG	9/13/96	0.08
FGAZG	10/2/96	0.3
FGAZG	12/6/96	0.285
FGAZG	1/6/97	0.25
FGAZG	2/3/97	0.22
FGAZG	3/2/97	0.197
FGAZG	5/6/97	0.192
FGAZG	7/17/97	0.189
FGAZG	10/23/97	0.168
FGAZG	11/4/97	0.248
FGAZG	11/13/97	0.229
FGAZG	12/18/97	0.179
FGAZG	1/5/98	0.15
FGAZG	2/23/98	0.19
FGAZG	3/25/98	0.45

Site Descriptor	Sample Date	Zn(d)
FGAZG	4/7/98	0.68
FGAZG	5/6/98	0.3
FGAZG	6/4/98	0.95
FGAZG	10/5/98	0.62
FGAZG	11/3/98	0.77
FGAZG	12/8/98	0.74
FGAZG	1/4/99	0.59
FGAZG	2/9/99	0.12
FGAZG	3/1/99	0.12
FGAZG	10/4/99	0.38
FGAZG	11/1/99	0.38
FGAZG	1/3/00	0.45
FGAZG	2/7/00	0.43
FGAZG	3/13/00	0.38
FGAZG	4/3/00	0.44
FGAZG	5/1/00	0.44
FGAZG	6/5/00	0.075
FGAZG	7/17/00	0.21
FGAZG	8/7/00	0.27
FGAZG	9/26/00	0.27
FGAZG	10/30/00	0.24
FGAZG	11/20/00	0.34
FGAZG	12/11/00	0.37
FGAZG	1/9/01	0.34
FGAZG	2/13/01	0.31
FGAZG	3/19/01	0.3
FGAZG	4/10/01	0.38
FGAZG	5/15/01	0.29
FGAZG	6/26/01	0.3
FGBPG	10/2/96	0.06
FGBZG	7/11/95	0.08
FGBZG	1/2/96	0.7
FGBZG	1/15/96	0.72
FGBZG	1/29/96	0.6
FGBZG	2/26/96	0.48
FGBZG	3/11/96	0.43
FGBZG	3/25/96	0.53
FGBZG	4/8/96	1
FGBZG	5/9/96	0.48
FGBZG	6/3/96	0.48
FGBZG	7/1/96	0.44
FGBZG	7/15/96	0.42
FGBZG	8/12/96	0.58
FGBZG	8/26/96	0.35
FGBZG	9/13/96	0.04
FGBZG	10/2/96	1.15

Site Descriptor	Sample Date	Zn(d)
FGBZG	12/6/96	1.34
FGBZG	1/6/97	1.4
FGBZG	2/3/97	1.3
FGBZG	3/2/97	0.955
FGBZG	5/6/97	0.71
FGBZG	6/12/97	1.2
FGBZG	7/17/97	1.29
FGBZG	8/14/97	1.75
FGBZG	9/4/97	1.3
FGBZG	10/23/97	1.33
FGBZG	11/4/97	1.42
FGBZG	11/13/97	1.43
FGBZG	12/18/97	1.66
FGBZG	1/5/98	2.26
FGBZG	2/23/98	0.96
FGBZG	3/25/98	1.13
FGBZG	4/7/98	1.49
FGBZG	5/6/98	0.55
FGBZG	6/4/98	1.02
FGBZG	10/5/98	1
FGBZG	11/3/98	1.6
FGBZG	12/8/98	1.8
FGBZG	1/4/99	1.6
FGBZG	2/9/99	1.4
FGBZG	3/1/99	0.59
FGBZG	10/4/99	1.7
FGBZG	11/1/99	1.9
FGBZG	1/3/00	2.2
FGBZG	2/7/00	2
FGBZG	3/13/00	1.7
FGBZG	4/3/00	1.5
FGBZG	5/1/00	1.5
FGBZG	7/17/00	0.12
FGBZG	8/7/00	0.13
FGBZG	10/30/00	0.094
FGBZG	11/20/00	0.2
FGBZG	12/11/00	0.2
FGBZG	1/9/01	0.26
FGBZG	2/13/01	0.1
FGBZG	3/19/01	0.22
FGBZG	4/10/01	0.28
FGBZG	5/15/01	0.0092
FGBZG	6/26/01	0.13
FGBZG	7/19/01	0.39
FGBZG	9/19/01	0.36
FGBZG	12/18/01	0.6

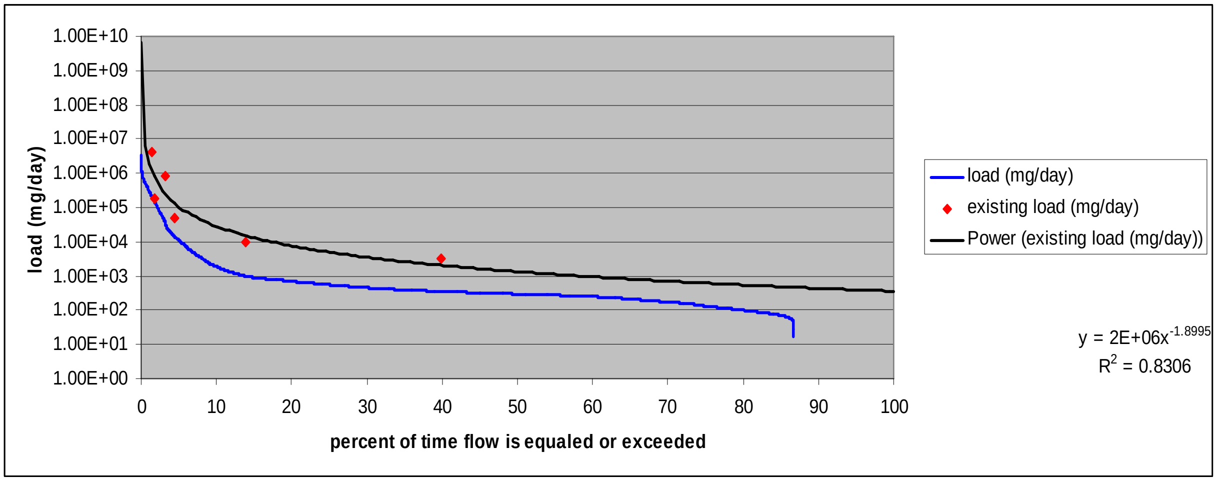
Site Descriptor	Sample Date	Zn(d)
FGBZG+85	8/23/01	0.36
FGBZG+85	10/18/01	0.4
FGBZG+85	1/15/02	0.45
FGBZG+85	2/20/02	0.36
FGBZG+85	3/20/02	0.29

APPENDIX E
REGIONAL LOAD ALLOCATION CHARTS
(Tetra Tech, 2004c)



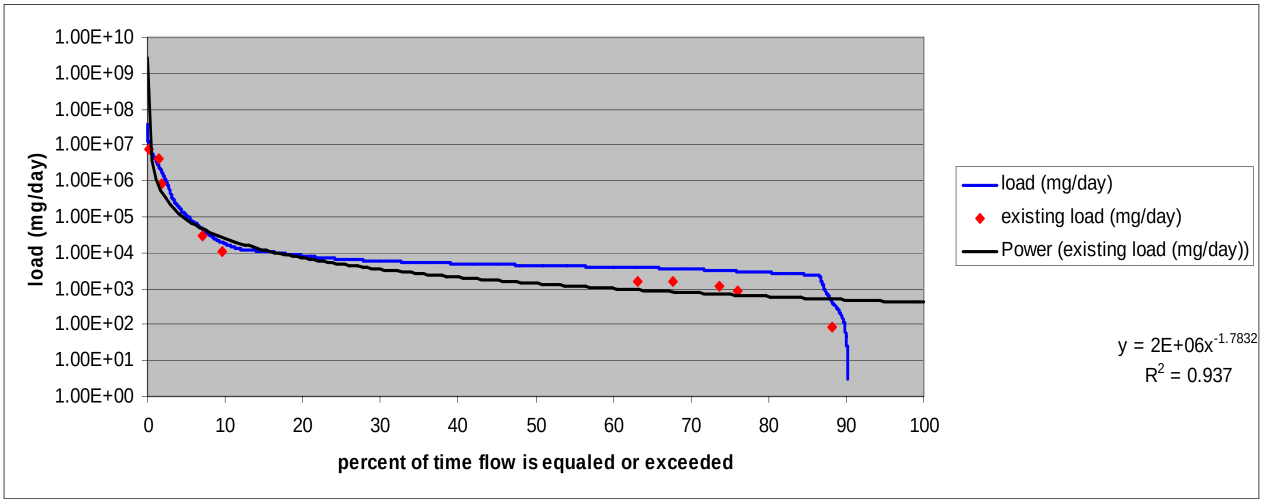
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	4.01E+05	not available	not available	4.01E+05	3.81E+05	2.00E+04
0.120	1.20E+05	not available	not available	1.20E+05	1.14E+05	6.02E+03
10.000	1.37E+02	not available	not available	1.37E+02	1.30E+02	6.87E+00
20.000	8.06E+01	not available	not available	8.06E+01	7.66E+01	4.03E+00
30.000	6.29E+01	not available	not available	6.29E+01	5.97E+01	3.14E+00
40.000	5.52E+01	not available	not available	5.52E+01	5.24E+01	2.76E+00
50.000	4.96E+01	not available	not available	4.96E+01	4.71E+01	2.48E+00
60.000	4.46E+01	not available	not available	4.46E+01	4.24E+01	2.23E+00
70.000	4.08E+01	not available	not available	4.08E+01	3.88E+01	2.04E+00
80.000	3.73E+01	not available	not available	3.73E+01	3.54E+01	1.86E+00
90.000	3.01E+01	not available	not available	3.01E+01	2.86E+01	1.51E+00

Cu Loadings at the Headwaters of French Gulch Creek (Subwatershed26)



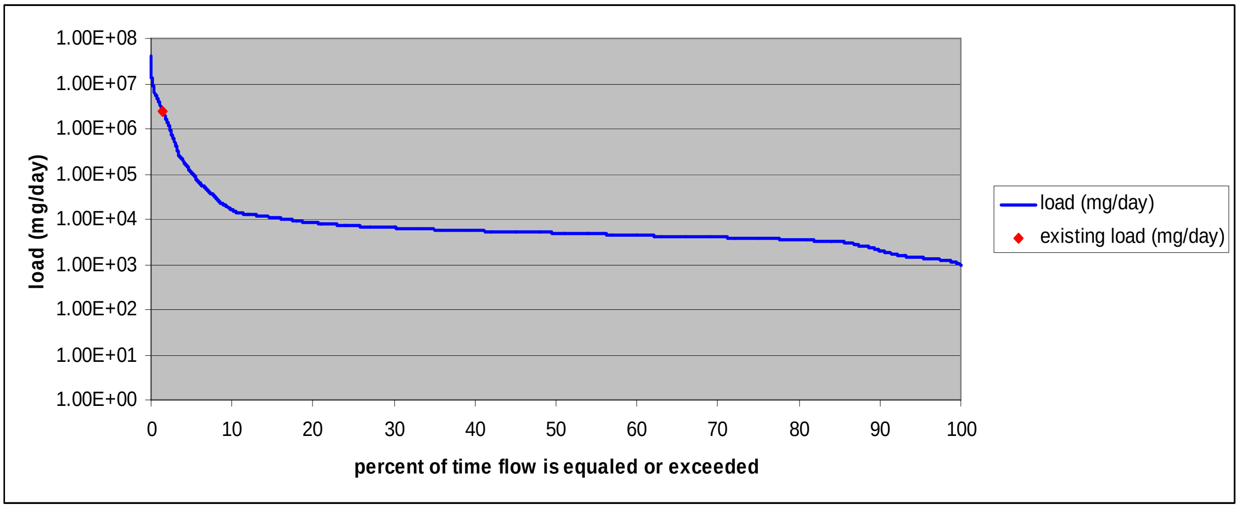
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	3.36E+06	5.83E+09	99.9%	3.36E+06	3.20E+06	1.68E+05
0.150	9.16E+05	7.35E+07	98.8%	9.16E+05	8.71E+05	4.58E+04
10.000	1.89E+03	2.52E+04	92.5%	1.89E+03	1.79E+03	9.44E+01
20.000	7.04E+02	6.76E+03	89.6%	7.04E+02	6.69E+02	3.52E+01
30.000	4.53E+02	3.13E+03	85.5%	4.53E+02	4.30E+02	2.26E+01
40.000	3.52E+02	1.81E+03	80.6%	3.52E+02	3.34E+02	1.76E+01
50.000	2.98E+02	1.19E+03	74.9%	2.98E+02	2.83E+02	1.49E+01
60.000	2.49E+02	8.38E+02	70.3%	2.49E+02	2.37E+02	1.25E+01
70.000	1.74E+02	6.26E+02	72.3%	1.74E+02	1.65E+02	8.68E+00
80.000	1.00E+02	4.85E+02	79.4%	1.00E+02	9.50E+01	5.00E+00
90.000	0.00E+00	3.88E+02	no reduction required	not available	not available	not available

Cu Loadings Below Zonia Gulch (subwatershed 19)



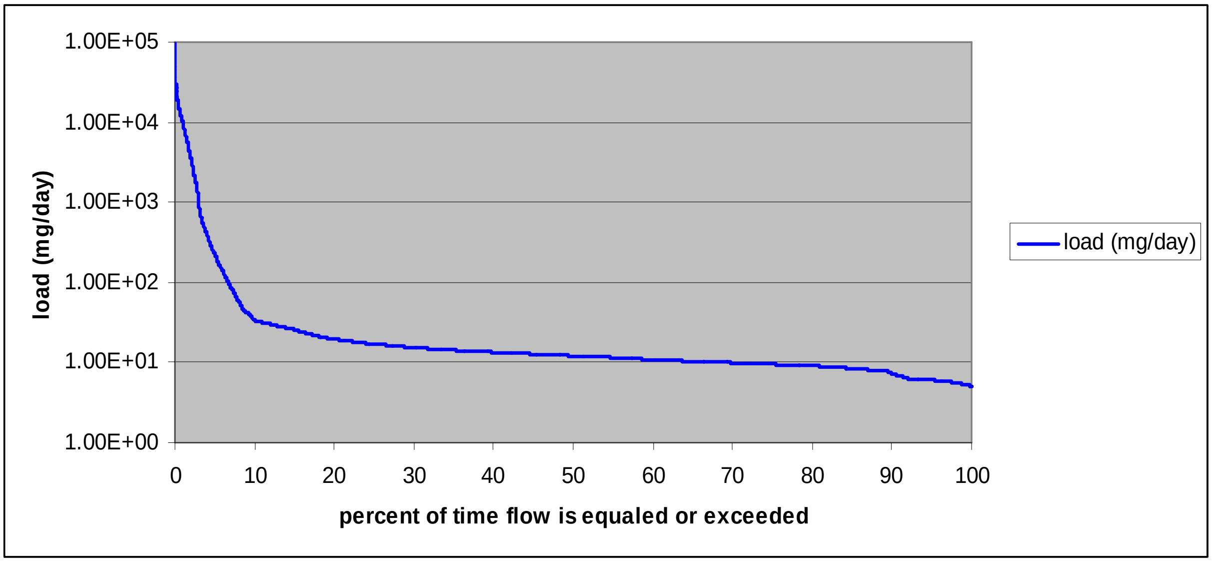
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	4.01E+07	3.58E+09	98.9%	4.01E+07	3.81E+07	2.01E+06
0.135	1.16E+07	7.11E+07	83.7%	1.16E+07	1.10E+07	5.79E+05
10.000	1.79E+04	3.29E+04	45.7%	1.79E+04	1.70E+04	8.95E+02
20.000	8.30E+03	9.57E+03	13.3%	8.30E+03	7.88E+03	4.15E+02
30.000	5.90E+03	4.65E+03	no reduction required	5.90E+03	5.61E+03	2.95E+02
40.000	5.02E+03	2.78E+03	no reduction required	5.02E+03	4.77E+03	2.51E+02
50.000	4.44E+03	1.87E+03	no reduction required	4.44E+03	4.22E+03	2.22E+02
60.000	3.99E+03	1.35E+03	no reduction required	3.99E+03	3.79E+03	2.00E+02
70.000	3.51E+03	1.03E+03	no reduction required	3.51E+03	3.33E+03	1.75E+02
80.000	2.79E+03	8.08E+02	no reduction required	2.79E+03	2.65E+03	1.40E+02
90.000	4.64E+01	6.55E+02	no reduction required	4.64E+01	4.41E+01	2.32E+00

Cu Loadings Below Placerita Gulch (subwatershed 13)



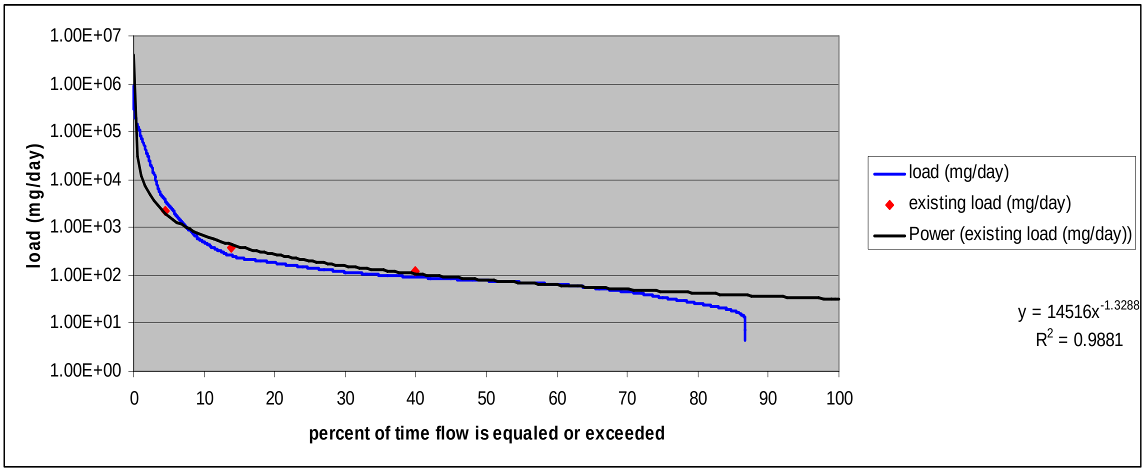
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	4.08E+07	not available	not available	4.08E+07	3.88E+07	2.04E+06
0.150	1.14E+07	not available	not available	1.14E+07	1.08E+07	5.69E+05
10.000	1.60E+04	not available	not available	1.60E+04	1.52E+04	8.01E+02
20.000	8.33E+03	not available	not available	8.33E+03	7.91E+03	4.17E+02
30.000	6.44E+03	not available	not available	6.44E+03	6.12E+03	3.22E+02
40.000	5.53E+03	not available	not available	5.53E+03	5.26E+03	2.77E+02
50.000	4.99E+03	not available	not available	4.99E+03	4.74E+03	2.50E+02
60.000	4.40E+03	not available	not available	4.40E+03	4.18E+03	2.20E+02
70.000	4.00E+03	not available	not available	4.00E+03	3.80E+03	2.00E+02
80.000	3.49E+03	not available	not available	3.49E+03	3.31E+03	1.74E+02
90.000	2.03E+03	not available	not available	2.03E+03	1.92E+03	1.01E+02

Cu Loadings at the Most Downstream Section of French Gulch Creek (subwatershed 1)



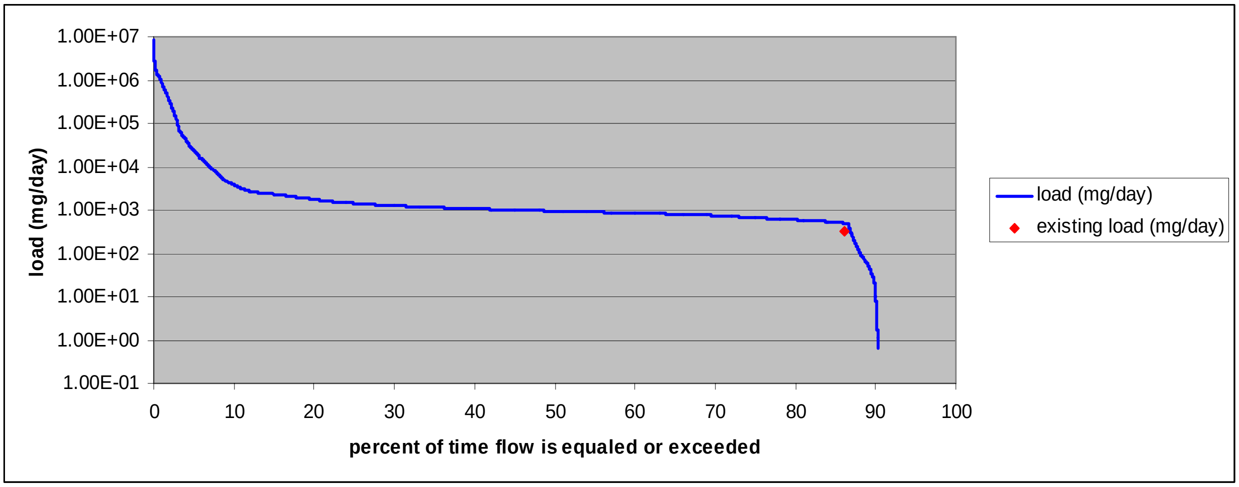
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	9.76E+04	not available	not available	9.76E+04	9.27E+04	4.88E+03
0.120	2.93E+04	not available	not available	2.93E+04	2.79E+04	1.47E+03
10.000	3.34E+01	not available	not available	3.34E+01	3.17E+01	1.67E+00
20.000	1.96E+01	not available	not available	1.96E+01	1.86E+01	9.81E-01
30.000	1.53E+01	not available	not available	1.53E+01	1.45E+01	7.66E-01
40.000	1.34E+01	not available	not available	1.34E+01	1.28E+01	6.72E-01
50.000	1.21E+01	not available	not available	1.21E+01	1.15E+01	6.04E-01
60.000	1.09E+01	not available	not available	1.09E+01	1.03E+01	5.43E-01
70.000	9.93E+00	not available	not available	9.93E+00	9.44E+00	4.97E-01
80.000	9.08E+00	not available	not available	9.08E+00	8.62E+00	4.54E-01
90.000	7.33E+00	not available	not available	7.33E+00	6.96E+00	3.67E-01

Cd Loadings at the Headwaters of French Gulch Creek (Subwatershed26)



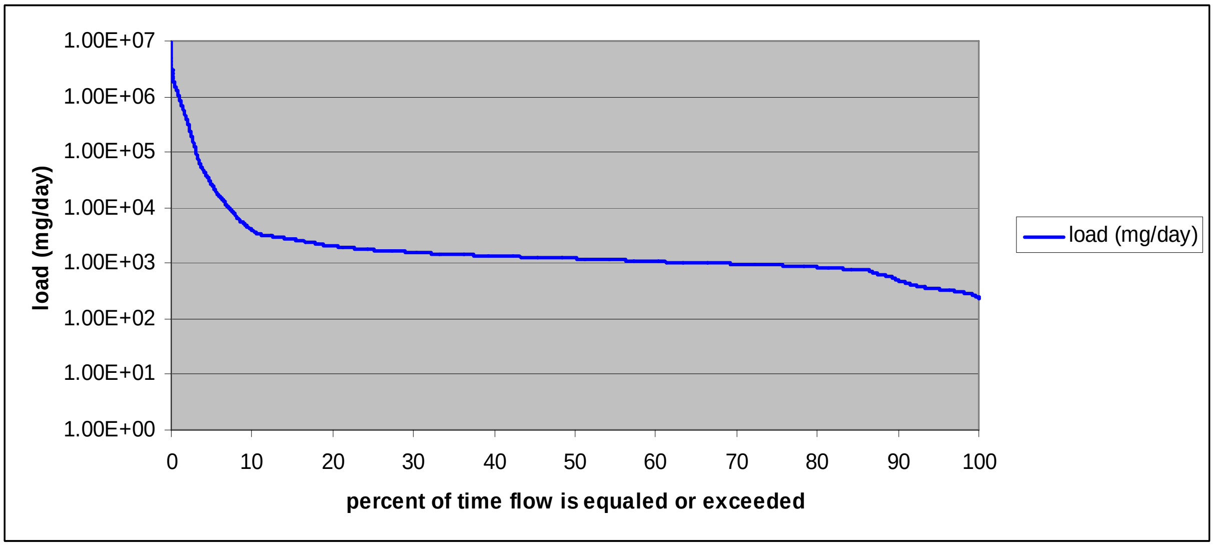
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	8.77E+05	3.85E+06	77.2%	8.77E+05	8.34E+05	4.39E+04
0.150	2.39E+05	1.81E+05	no reduction required	not applicable	not applicable	not applicable
10.000	4.92E+02	6.81E+02	27.7%	4.92E+02	4.68E+02	2.46E+01
20.000	1.84E+02	2.71E+02	32.3%	1.84E+02	1.74E+02	9.18E+00
30.000	1.18E+02	1.58E+02	25.4%	1.18E+02	1.12E+02	5.90E+00
40.000	9.17E+01	1.08E+02	15.0%	9.17E+01	8.71E+01	4.58E+00
50.000	7.77E+01	8.02E+01	3.2%	7.77E+01	7.38E+01	3.88E+00
60.000	6.50E+01	6.30E+01	-3.2%	6.50E+01	6.18E+01	3.25E+00
70.000	4.53E+01	5.13E+01	11.8%	4.53E+01	4.30E+01	2.26E+00
80.000	2.61E+01	4.30E+01	39.3%	2.61E+01	2.48E+01	1.30E+00
90.000	0.00E+00	3.67E+01	no reduction required	not applicable	not applicable	not applicable

Cd Loadings below Zonia Gulch (subwatershed 19)



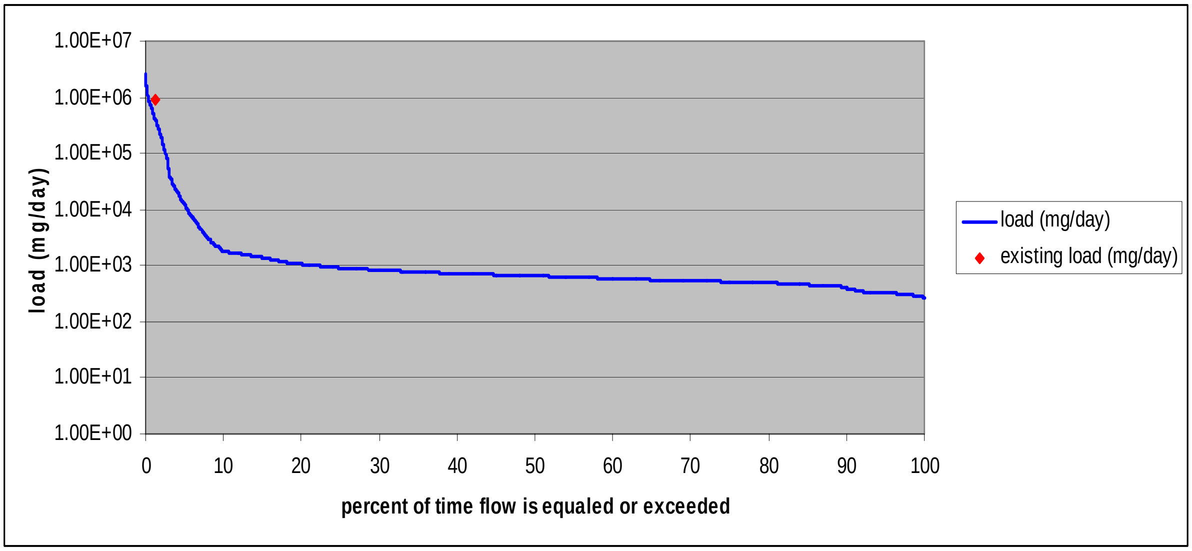
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	8.52E+06	not available	not available	8.52E+06	8.10E+06	4.26E+05
0.1350	2.46E+06	not available	not available	2.46E+06	2.34E+06	1.23E+05
10.000	3.80E+03	not available	not available	3.80E+03	3.61E+03	1.90E+02
20.000	1.76E+03	not available	not available	1.76E+03	1.67E+03	8.82E+01
30.000	1.25E+03	not available	not available	1.25E+03	1.19E+03	6.27E+01
40.000	1.07E+03	not available	not available	1.07E+03	1.01E+03	5.33E+01
50.000	9.44E+02	not available	not available	9.44E+02	8.97E+02	4.72E+01
60.000	8.49E+02	not available	not available	8.49E+02	8.06E+02	4.24E+01
70.000	7.45E+02	not available	not available	7.45E+02	7.08E+02	3.73E+01
80.000	5.93E+02	not available	not available	5.93E+02	5.64E+02	2.97E+01
90.000	9.86E+00	not available	not available	9.86E+00	9.37E+00	4.93E-01

Cd Loadings Below Placerita Gulch (subwatershed 13)



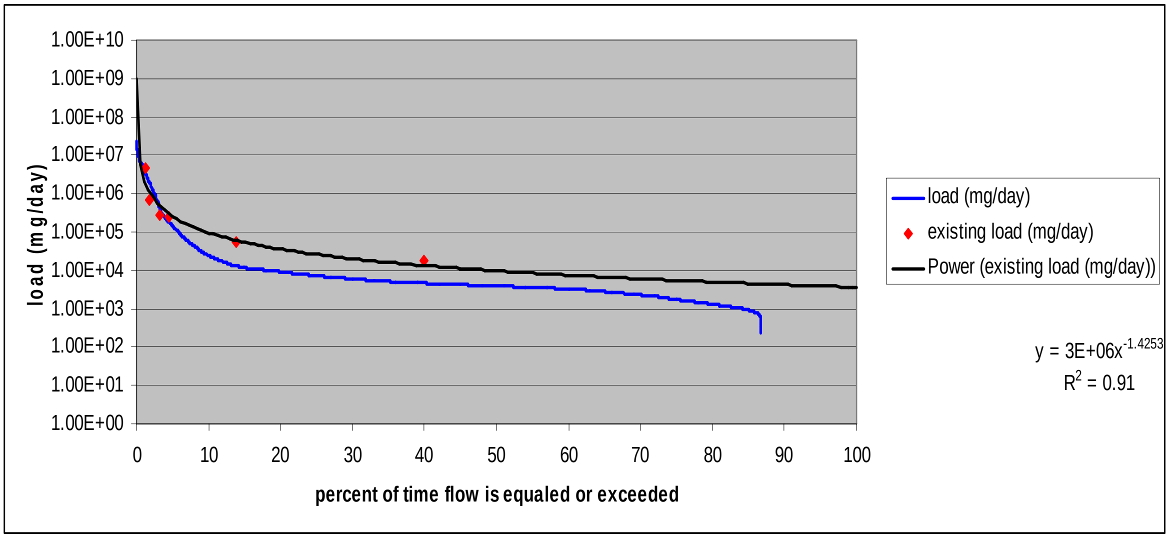
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	9.98E+06	not available	not available	9.98E+06	9.48E+06	4.99E+05
0.150	2.78E+06	not available	not available	2.78E+06	2.64E+06	1.39E+05
10.000	3.92E+03	not available	not available	3.92E+03	3.72E+03	1.96E+02
20.000	2.04E+03	not available	not available	2.04E+03	1.94E+03	1.02E+02
30.000	1.58E+03	not available	not available	1.58E+03	1.50E+03	7.88E+01
40.000	1.35E+03	not available	not available	1.35E+03	1.29E+03	6.77E+01
50.000	1.22E+03	not available	not available	1.22E+03	1.16E+03	6.11E+01
60.000	1.08E+03	not available	not available	1.08E+03	1.02E+03	5.38E+01
70.000	9.78E+02	not available	not available	9.78E+02	9.29E+02	4.89E+01
80.000	8.53E+02	not available	not available	8.53E+02	8.10E+02	4.27E+01
90.000	4.96E+02	not available	not available	4.96E+02	4.71E+02	2.48E+01

Cd Loadings at the Most Downstream Section of French Gulch Creek (subwatershed 1)



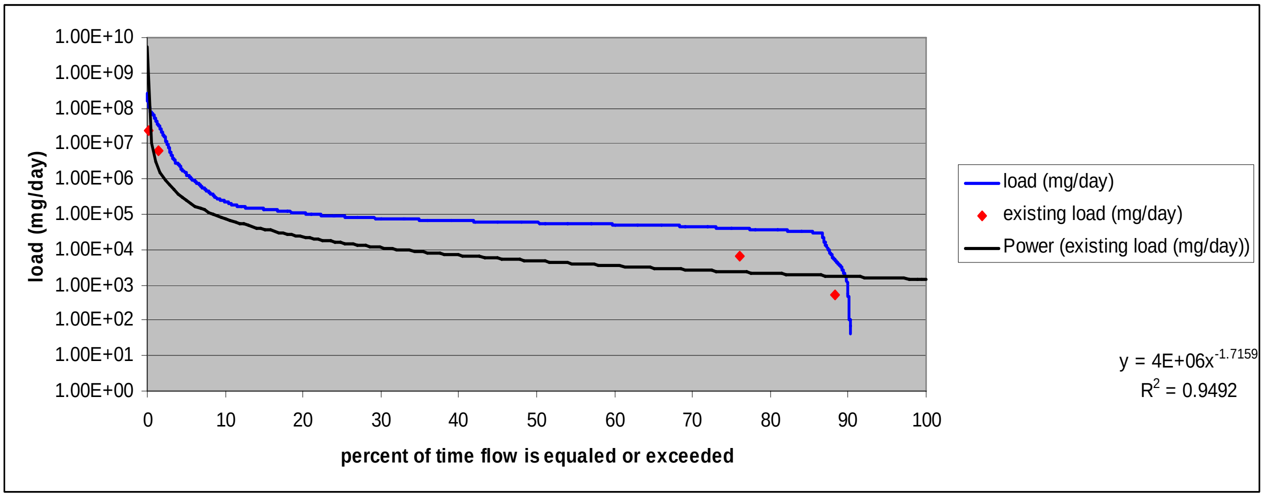
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	9.98E+06	not available	not available	9.98E+06	9.48E+06	4.99E+05
0.150	2.78E+06	not available	not available	2.78E+06	2.64E+06	1.39E+05
10.000	3.92E+03	not available	not available	3.92E+03	3.72E+03	1.96E+02
20.000	2.04E+03	not available	not available	2.04E+03	1.94E+03	1.02E+02
30.000	1.58E+03	not available	not available	1.58E+03	1.50E+03	7.88E+01
40.000	1.35E+03	not available	not available	1.35E+03	1.29E+03	6.77E+01
50.000	1.22E+03	not available	not available	1.22E+03	1.16E+03	6.11E+01
60.000	1.08E+03	not available	not available	1.08E+03	1.02E+03	5.38E+01
70.000	9.78E+02	not available	not available	9.78E+02	9.29E+02	4.89E+01
80.000	8.53E+02	not available	not available	8.53E+02	8.10E+02	4.27E+01
90.000	4.96E+02	not available	not available	4.96E+02	4.71E+02	2.48E+01

Zn loadings at the Headwaters of French Gulch Creek (Subwatershed26)



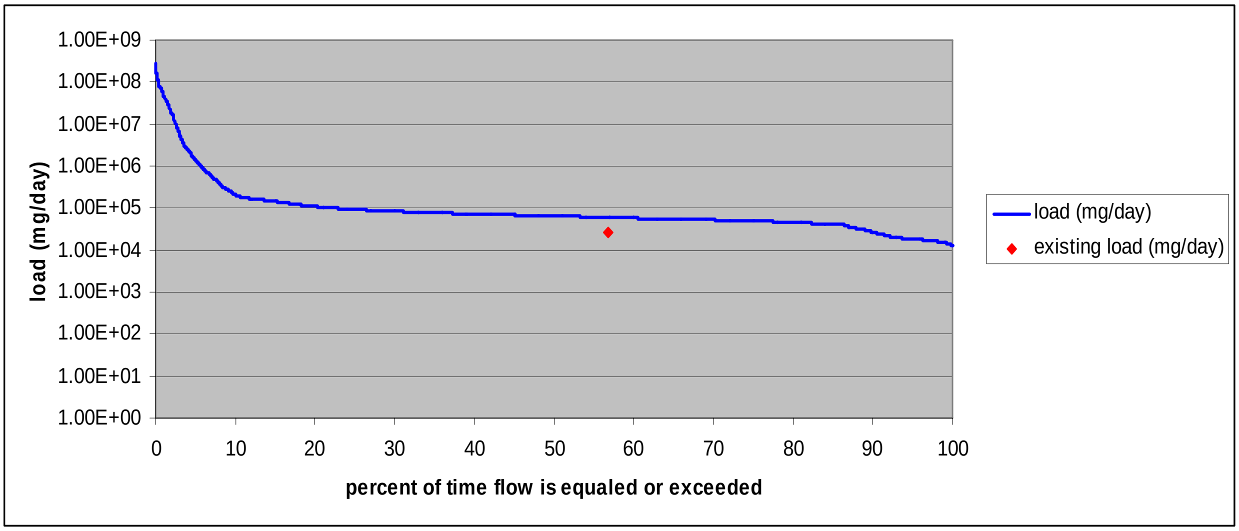
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	2.36E+07	1.19E+09	98.0%	2.36E+07	2.24E+07	1.18E+06
0.150	1.20E+07	4.48E+07	73.3%	1.20E+07	1.14E+07	5.98E+05
10.000	2.47E+04	1.13E+05	78.1%	2.47E+04	2.35E+04	1.23E+03
20.000	9.22E+03	4.20E+04	78.0%	9.22E+03	8.76E+03	4.61E+02
30.000	5.94E+03	2.35E+04	74.8%	5.94E+03	5.64E+03	2.97E+02
40.000	4.61E+03	1.56E+04	70.5%	4.61E+03	4.38E+03	2.31E+02
50.000	3.91E+03	1.14E+04	65.6%	3.91E+03	3.71E+03	1.95E+02
60.000	3.27E+03	8.76E+03	62.7%	3.27E+03	3.11E+03	1.64E+02
70.000	2.27E+03	7.04E+03	67.7%	2.27E+03	2.16E+03	1.14E+02
80.000	1.31E+03	5.82E+03	77.5%	1.31E+03	1.24E+03	6.55E+01
90.000	0.00E+00	4.92E+03	no reduction required	not applicable	not applicable	not applicable

Zn Loadings below Zonia Gulch (subwatershed 19)



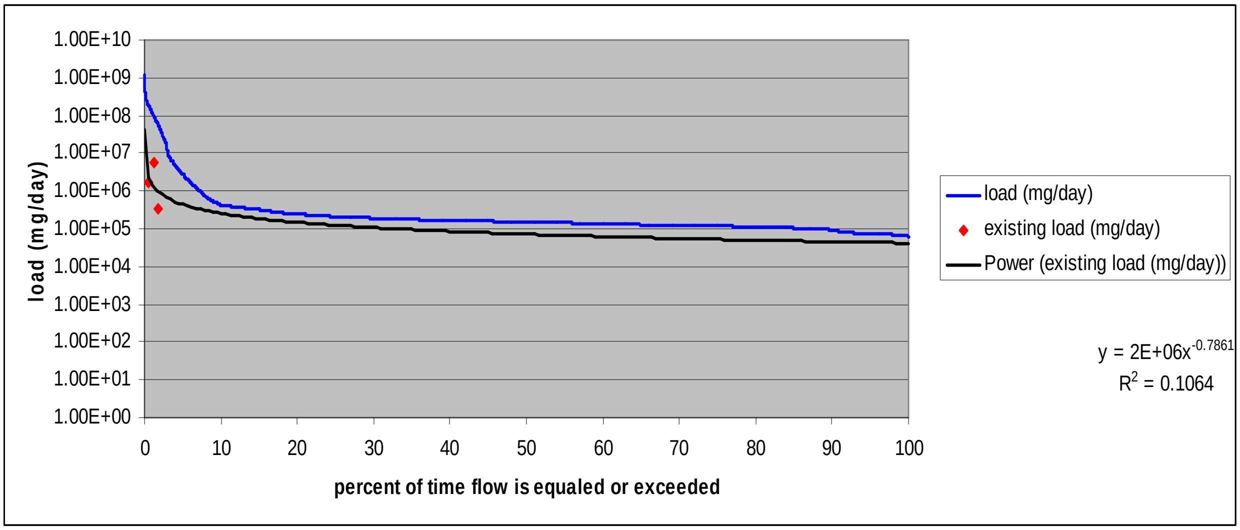
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	2.64E+08	5.39E+09	95.1%	2.64E+08	2.51E+08	1.32E+07
0.135	1.46E+08	1.24E+08	no reduction required	1.46E+08	1.39E+08	7.30E+06
10.000	2.32E+05	7.69E+04	no reduction required	2.32E+05	2.20E+05	1.16E+04
20.000	1.08E+05	2.34E+04	no reduction required	1.08E+05	1.02E+05	5.38E+03
30.000	7.64E+04	1.17E+04	no reduction required	7.64E+04	7.26E+04	3.82E+03
40.000	6.50E+04	7.13E+03	no reduction required	6.50E+04	6.17E+04	3.25E+03
50.000	5.75E+04	4.86E+03	no reduction required	5.75E+04	5.47E+04	2.88E+03
60.000	5.17E+04	3.56E+03	no reduction required	5.17E+04	4.91E+04	2.59E+03
70.000	4.54E+04	2.73E+03	no reduction required	4.54E+04	4.31E+04	2.27E+03
80.000	3.62E+04	2.17E+03	no reduction required	3.62E+04	3.44E+04	1.81E+03
90.000	5.06E+02	1.77E+03	71.5%	5.06E+02	4.80E+02	2.53E+01

Zn Loadings Below Placerita Gulch (subwatershed 13)



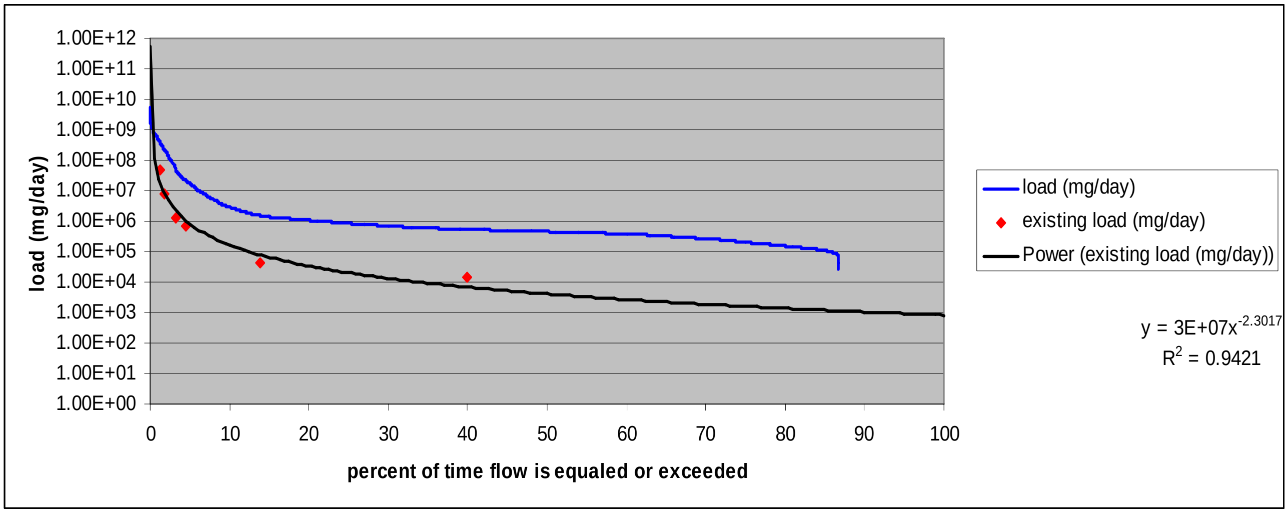
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	2.70E+08	not available	not available	2.70E+08	2.57E+08	1.35E+07
0.150	1.41E+08	not available	not available	1.41E+08	1.34E+08	7.03E+06
10.000	2.09E+05	not available	not available	2.09E+05	1.99E+05	1.05E+04
20.000	1.09E+05	not available	not available	1.09E+05	1.03E+05	5.44E+03
30.000	8.41E+04	not available	not available	8.41E+04	7.99E+04	4.21E+03
40.000	7.23E+04	not available	not available	7.23E+04	6.87E+04	3.61E+03
50.000	6.52E+04	not available	not available	6.52E+04	6.19E+04	3.26E+03
60.000	5.75E+04	not available	not available	5.75E+04	5.46E+04	2.87E+03
70.000	5.22E+04	not available	not available	5.22E+04	4.96E+04	2.61E+03
80.000	4.56E+04	not available	not available	4.56E+04	4.33E+04	2.28E+03
90.000	2.64E+04	not available	not available	2.64E+04	2.51E+04	1.32E+03

Zn Loadings at the Most Downstream Section of French Gulch Creek (subwatershed 1)



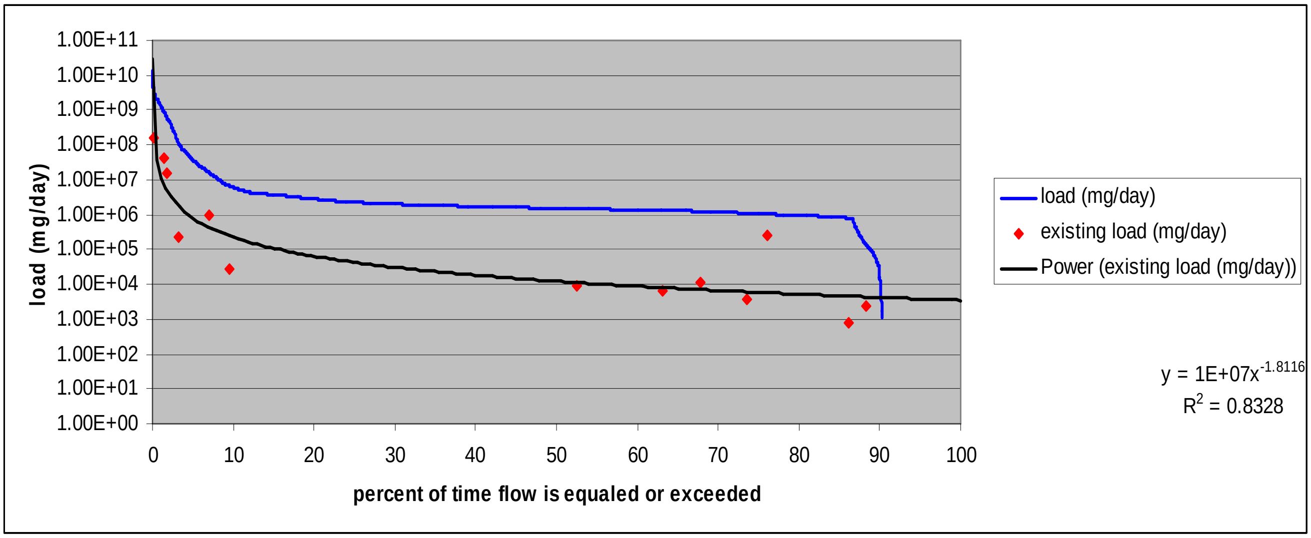
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	1.22E+09	5.43E+07	no reduction required	1.22E+09	1.16E+09	6.09E+07
0.120	3.66E+08	8.89E+06	no reduction required	3.66E+08	3.48E+08	1.83E+07
10.000	4.17E+05	3.27E+05	no reduction required	4.17E+05	3.96E+05	2.08E+04
20.000	2.45E+05	1.90E+05	no reduction required	2.45E+05	2.33E+05	1.22E+04
30.000	1.91E+05	1.38E+05	no reduction required	1.91E+05	1.81E+05	9.55E+03
40.000	1.68E+05	1.10E+05	no reduction required	1.68E+05	1.59E+05	8.38E+03
50.000	1.51E+05	9.24E+04	no reduction required	1.51E+05	1.43E+05	7.54E+03
60.000	1.36E+05	8.00E+04	no reduction required	1.36E+05	1.29E+05	6.78E+03
70.000	1.24E+05	7.09E+04	no reduction required	1.24E+05	1.18E+05	6.20E+03
80.000	1.13E+05	6.38E+04	no reduction required	1.13E+05	1.08E+05	5.66E+03
90.000	9.14E+04	5.82E+04	no reduction required	9.14E+04	8.69E+04	4.57E+03

Mn Loadings at the headwaters of French Gulch Creek (Subwatershed26)



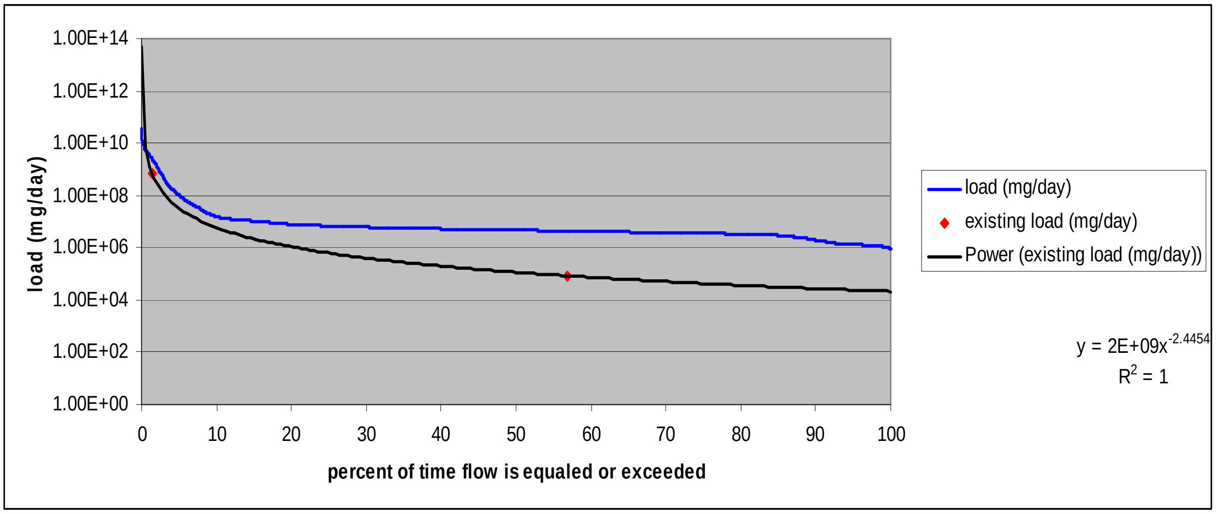
interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	5.16E+09	4.73E+11	98.9%	5.16E+09	4.90E+09	2.58E+08
0.150	1.41E+09	2.36E+09	40.5%	1.41E+09	1.33E+09	7.03E+07
10.000	2.89E+06	1.50E+05	no reduction required	1.50E+05	2.75E+06	1.45E+05
20.000	1.08E+06	3.04E+04	no reduction required	3.04E+04	1.03E+06	5.40E+04
30.000	6.94E+05	1.19E+04	no reduction required	1.19E+04	6.59E+05	3.47E+04
40.000	5.39E+05	6.16E+03	no reduction required	6.16E+03	5.12E+05	2.69E+04
50.000	4.57E+05	3.69E+03	no reduction required	3.69E+03	4.34E+05	2.28E+04
60.000	3.82E+05	2.42E+03	no reduction required	2.42E+03	3.63E+05	1.91E+04
70.000	2.66E+05	1.70E+03	no reduction required	1.70E+03	2.53E+05	1.33E+04
80.000	1.53E+05	1.25E+03	no reduction required	1.25E+03	1.46E+05	7.67E+03
90.000	0.00E+00	9.53E+02	no reduction required	not applicable	not applicable	not applicable

Mn Loadings Below Zonia Gulch (subwatershed 19)



interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	1.37E+10	2.01E+10	32.0%	1.37E+10	1.30E+10	6.85E+08
0.1350	3.95E+09	3.11E+08	no reduction required	3.95E+09	3.76E+09	1.98E+08
10.000	6.11E+06	1.54E+05	no reduction required	6.11E+06	5.80E+06	3.06E+05
20.000	2.83E+06	4.40E+04	no reduction required	2.83E+06	2.69E+06	1.42E+05
30.000	2.02E+06	2.11E+04	no reduction required	2.02E+06	1.92E+06	1.01E+05
40.000	1.71E+06	1.25E+04	no reduction required	1.71E+06	1.63E+06	8.57E+04
50.000	1.52E+06	8.36E+03	no reduction required	1.52E+06	1.44E+06	7.59E+04
60.000	1.36E+06	6.01E+03	no reduction required	1.36E+06	1.30E+06	6.82E+04
70.000	1.20E+06	4.54E+03	no reduction required	1.20E+06	1.14E+06	5.99E+04
80.000	9.54E+05	3.57E+03	no reduction required	9.54E+05	9.06E+05	4.77E+04
90.000	1.59E+04	2.88E+03	no reduction required	1.59E+04	1.51E+04	7.93E+02

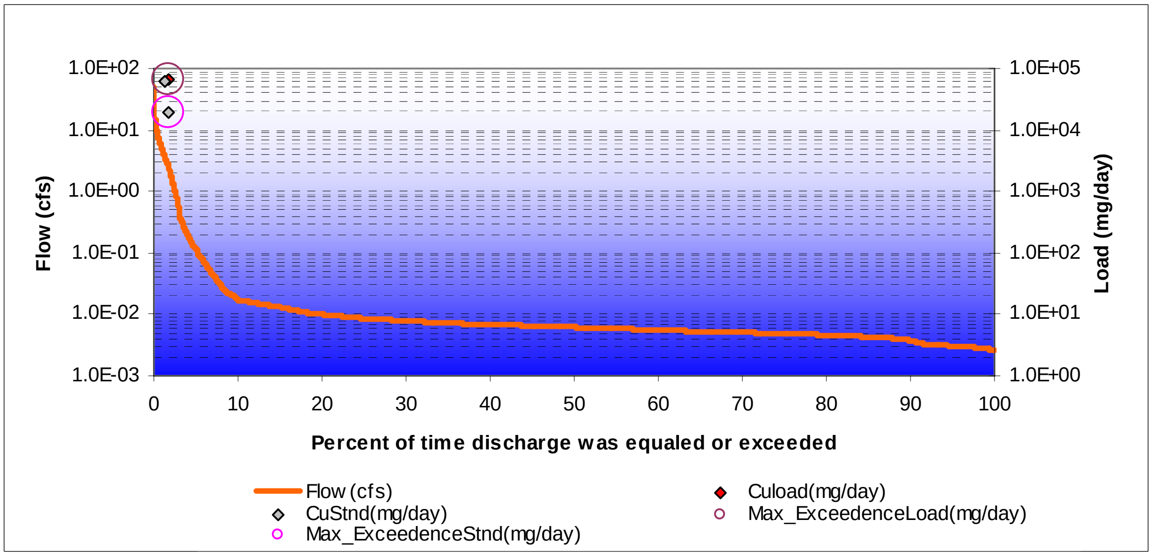
Mn Loadings below Placerita Gulch (subwatershed 13)



interval (percentile)	allowable (mg/day)	existing (mg/day)	% reduction	TMDL (mg/day)	LA (mg/day)	MOS (mg/day)
0.015	3.90E+10	5.77E+13	99.9%	3.90E+10	3.70E+10	1.95E+09
0.150	1.09E+10	2.07E+11	94.7%	1.09E+10	1.03E+10	5.44E+08
10.000	1.53E+07	7.17E+06	no reduction required	1.53E+07	1.45E+07	7.65E+05
20.000	7.96E+06	1.32E+06	no reduction required	7.96E+06	7.56E+06	3.98E+05
30.000	6.15E+06	4.89E+05	no reduction required	6.15E+06	5.85E+06	3.08E+05
40.000	5.29E+06	2.42E+05	no reduction required	5.29E+06	5.02E+06	2.64E+05
50.000	4.77E+06	1.40E+05	no reduction required	4.77E+06	4.53E+06	2.38E+05
60.000	4.20E+06	8.97E+04	no reduction required	4.20E+06	3.99E+06	2.10E+05
70.000	3.82E+06	6.15E+04	no reduction required	3.82E+06	3.63E+06	1.91E+05
80.000	3.33E+06	4.44E+04	no reduction required	3.33E+06	3.17E+06	1.67E+05
90.000	1.94E+06	3.33E+04	no reduction required	1.94E+06	1.84E+06	9.68E+04

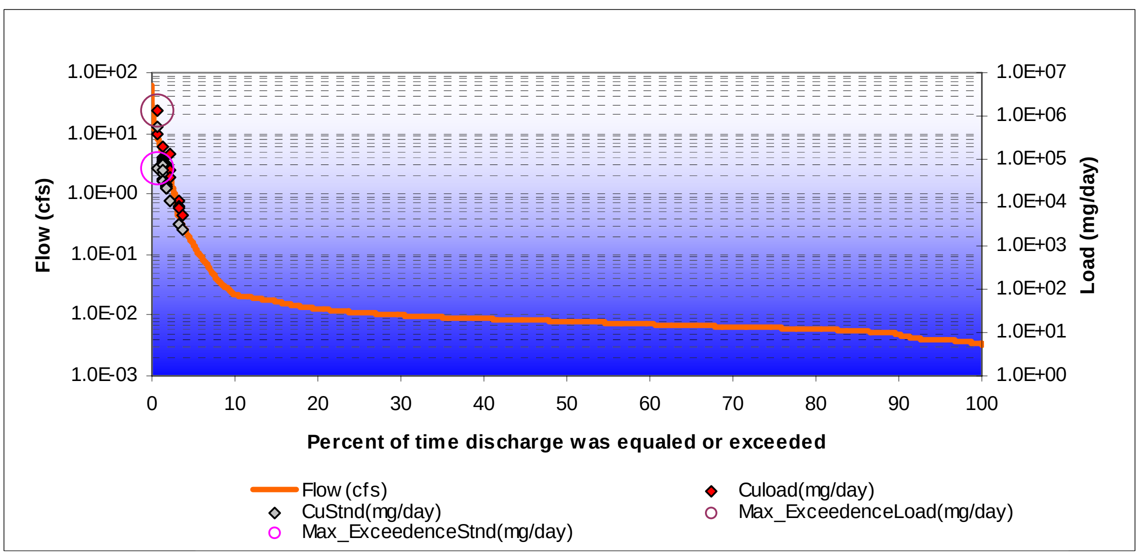
Mn Loadings at the Most Downstream Section of French Gulch Creek (subwatershed 1)

APPENDIX F
SUBWATERSHED LOAD ALLOCATION CHARTS
(Tetra Tech, 2004c)



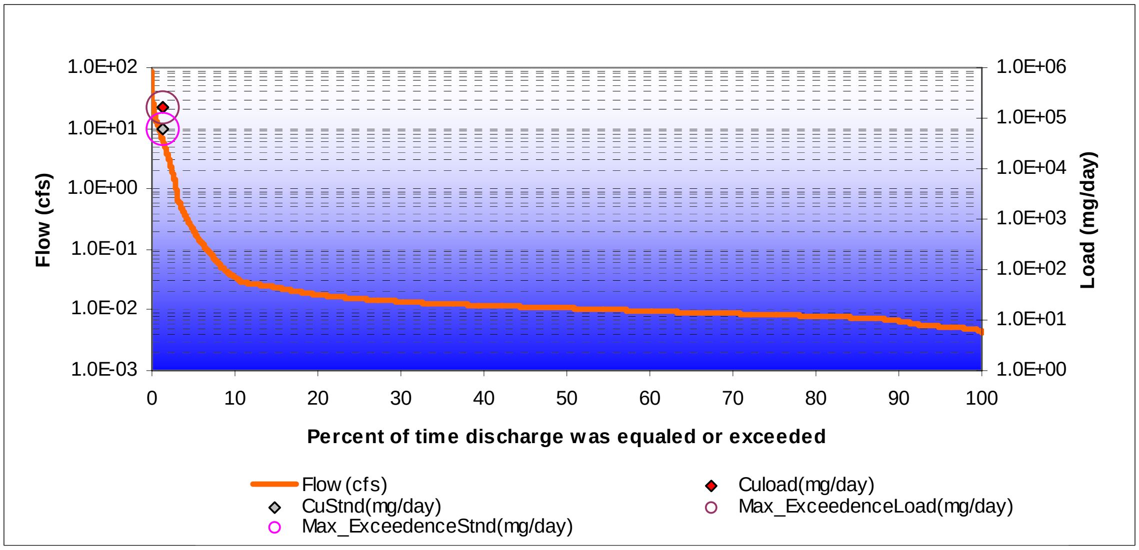
Reduction Percentage	Existing	TMDL	LA	MOS
70%	6.49E+04	1.94E+04	1.85E+04	9.71E+02

Cu loadings at subwatershed 26 (headwaters)



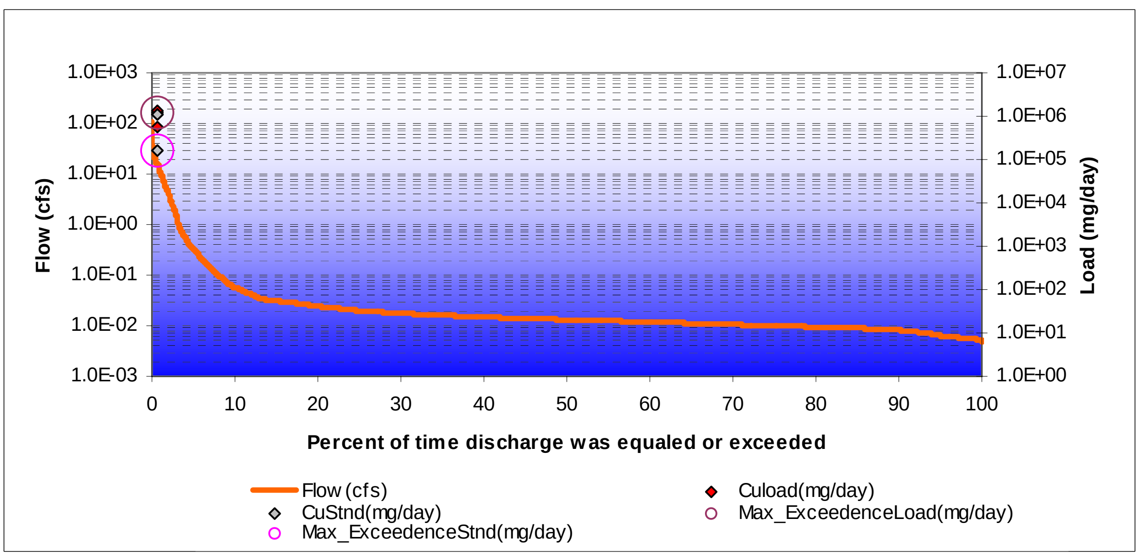
Reduction Percentage	Existing	TMDL	LA	MOS
96%	1.39E+06	6.16E+04	5.85E+04	3.08E+03

Cu loadings at subwatershed 25



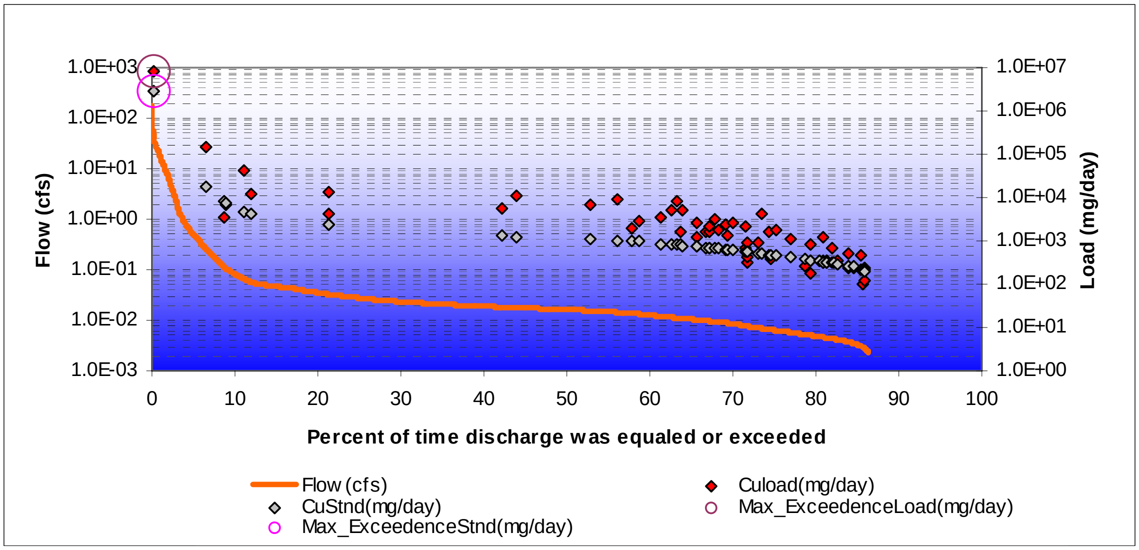
Reduction Percentage	Existing	TMDL	LA	MOS
63%	1.62E+05	5.91E+04	5.61E+04	2.95E+03

Cu loadings at subwatershed 24



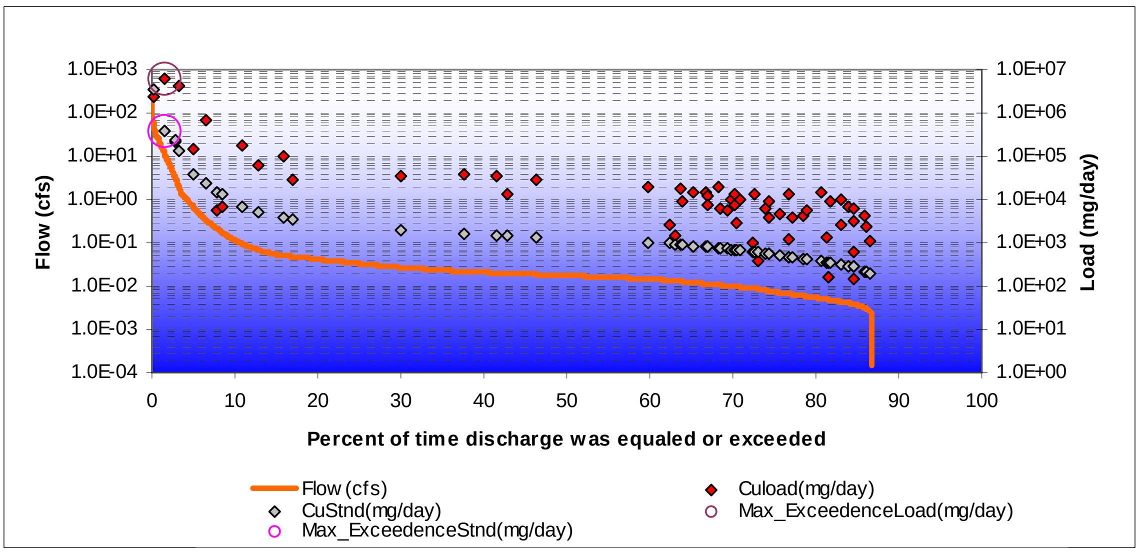
Reduction Percentage	Existing	TMDL	LA	MOS
87%	1.24E+06	1.56E+05	1.48E+05	7.78E+03

Cu loadings at subwatershed 23



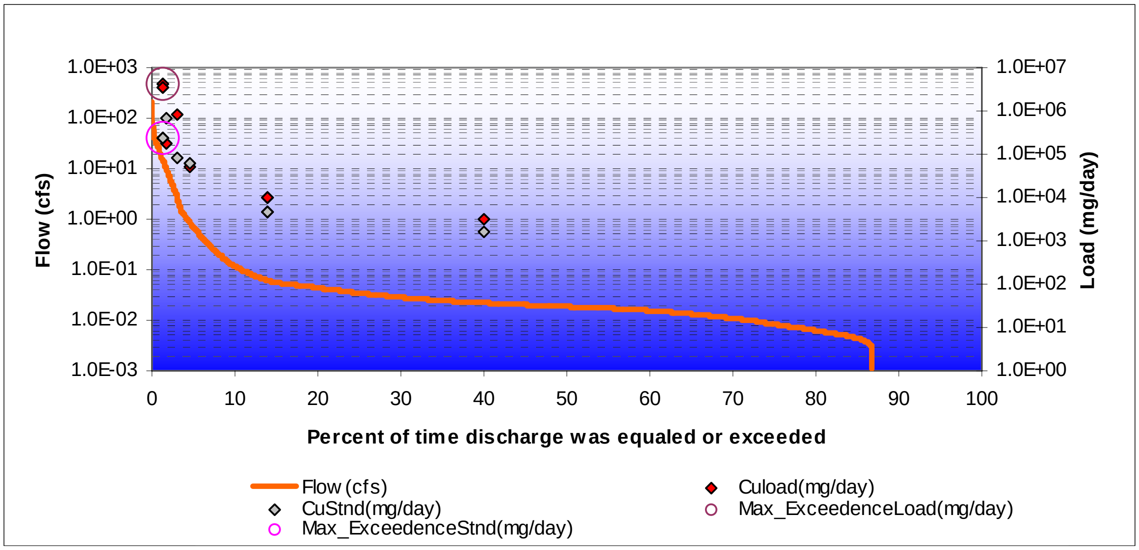
Reduction Percentage	Existing	TMDL	LA	MOS
63%	7.92E+06	2.90E+06	2.76E+06	1.45E+05

Cu loadings at subwatershed 22



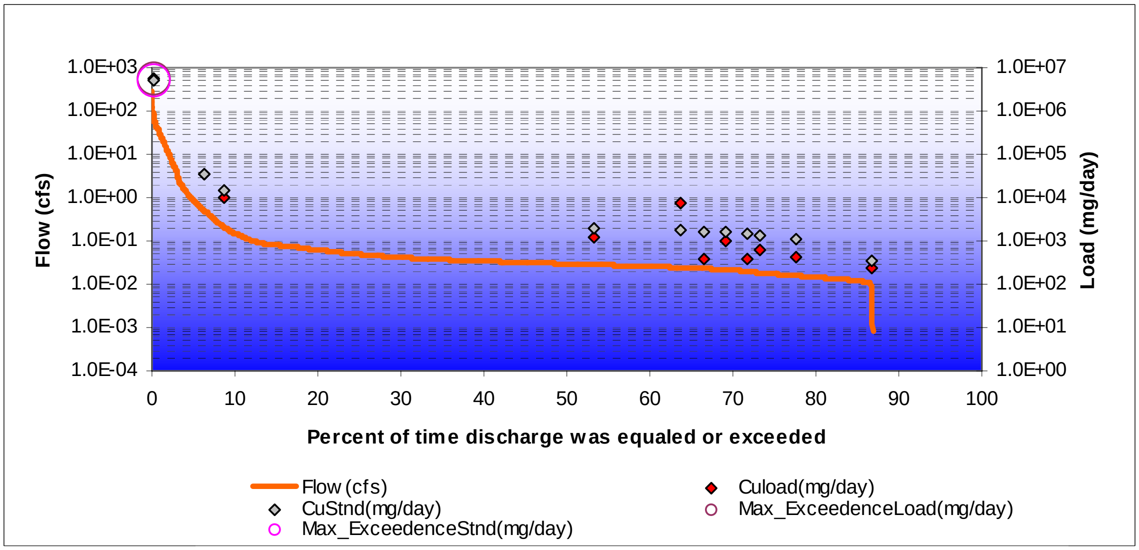
Reduction Percentage	Existing	TMDL	LA	MOS
94%	5.96E+06	3.74E+05	3.56E+05	1.87E+04

Cu loadings at subwatershed 20



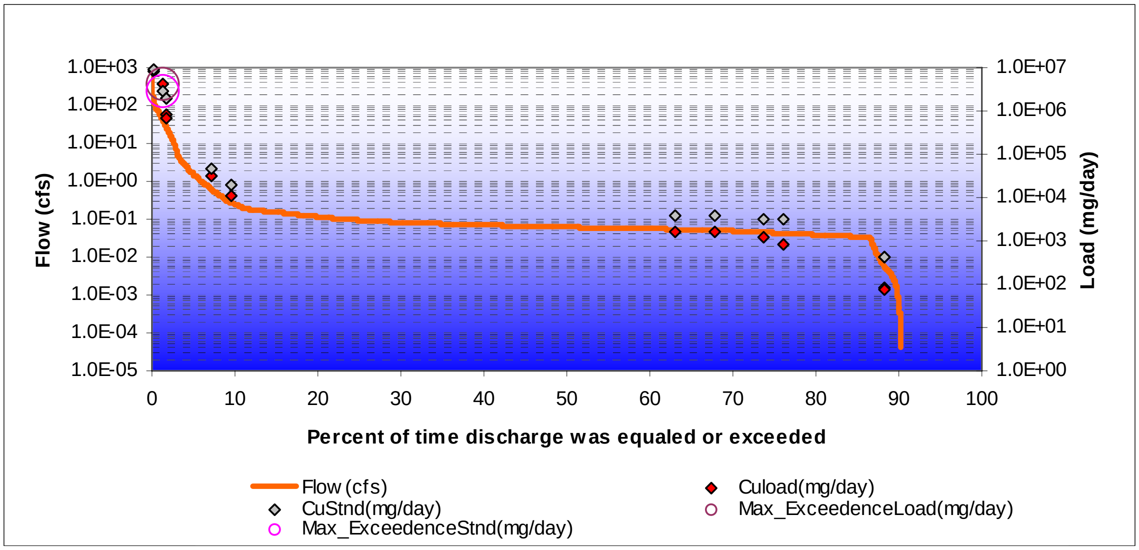
Reduction Percentage	Existing	TMDL	LA	MOS
95%	4.25E+06	2.31E+05	2.20E+05	1.16E+04

Cu loadings at subwatershed 19



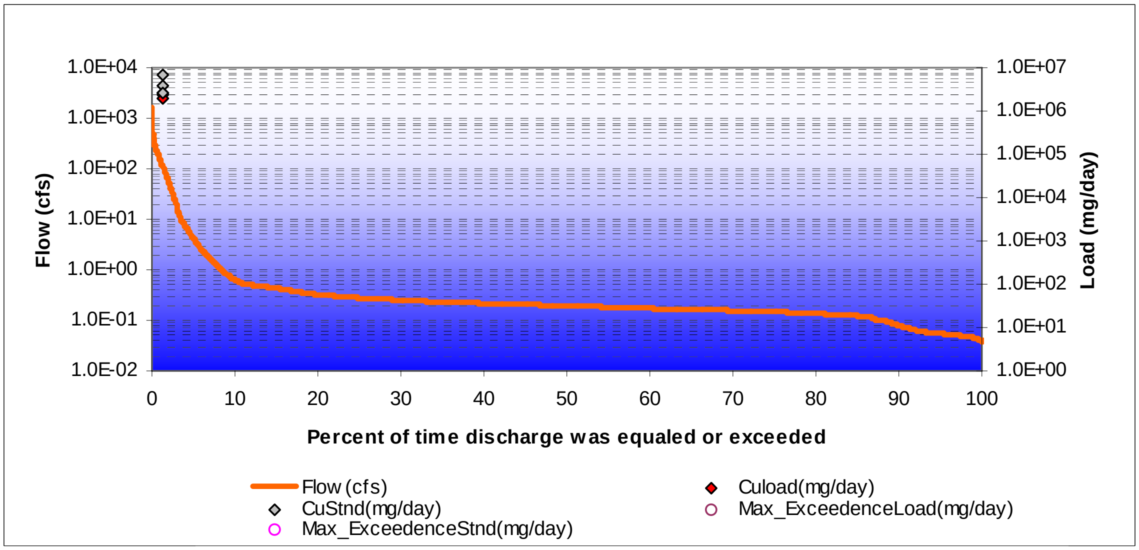
Reduction Percentage	Existing	TMDL	LA	MOS
11%	5.56E+06	4.93E+06	4.68E+06	2.47E+05

Cu loadings at subwatershed 15

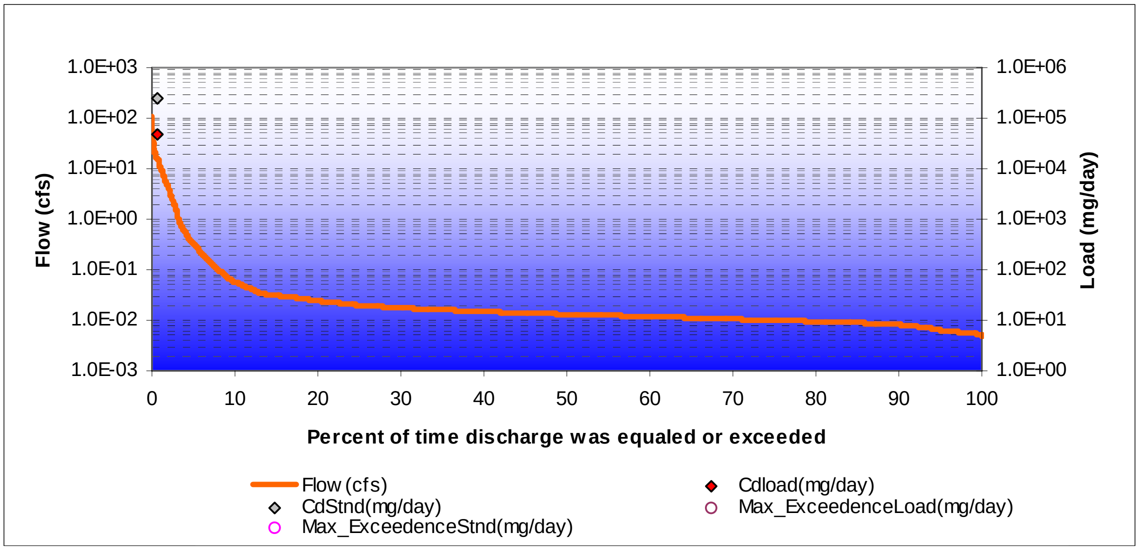


Reduction Percentage	Existing	TMDL	LA	MOS
33%	4.22E+06	2.81E+06	2.67E+06	1.40E+05

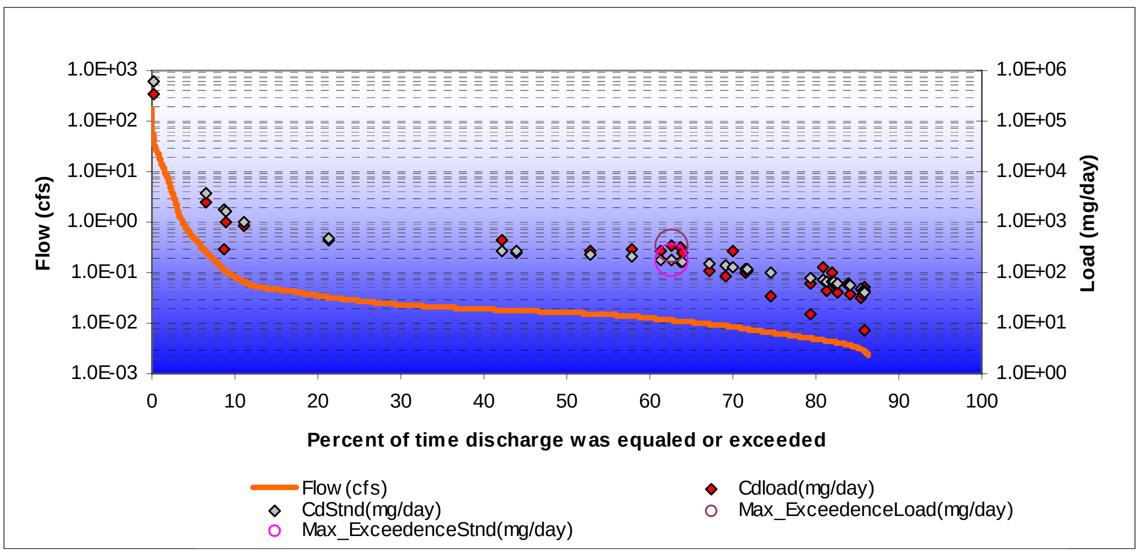
Cu loadings at subwatershed 13



Cu loadings at subwatershed 1

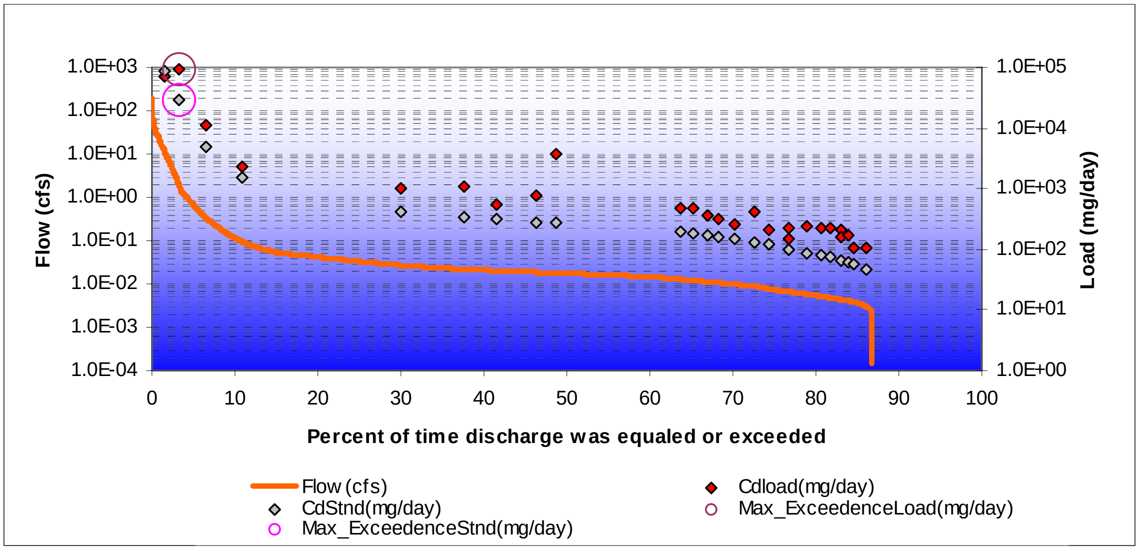


Cd loadings at subwatershed 23



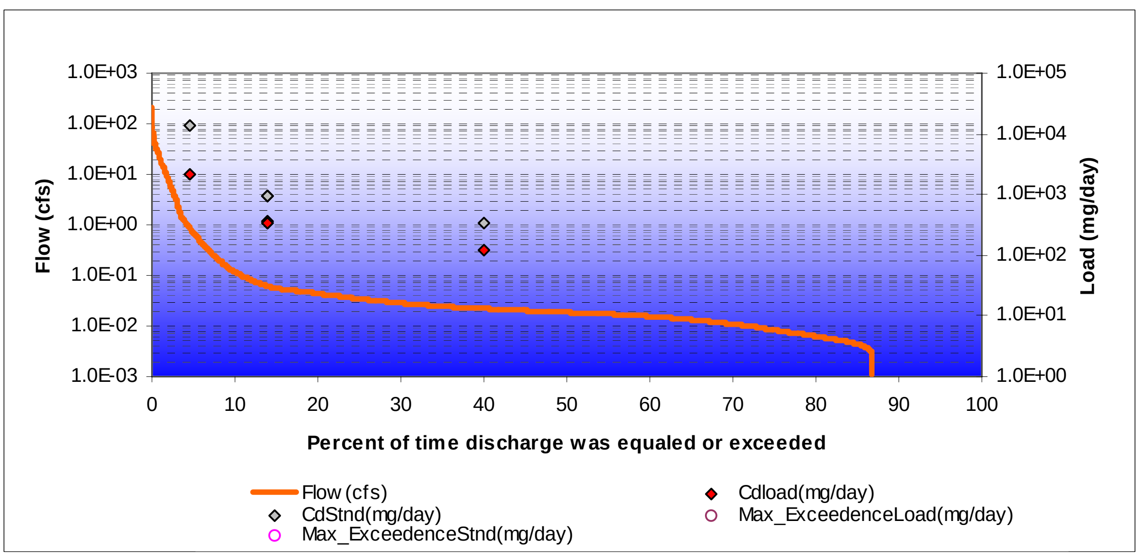
Reduction Percentage	Existing	TMDL	LA	MOS
48%	3.35E+02	1.74E+02	1.65E+02	8.69E+00

Cd loadings at subwatershed 22

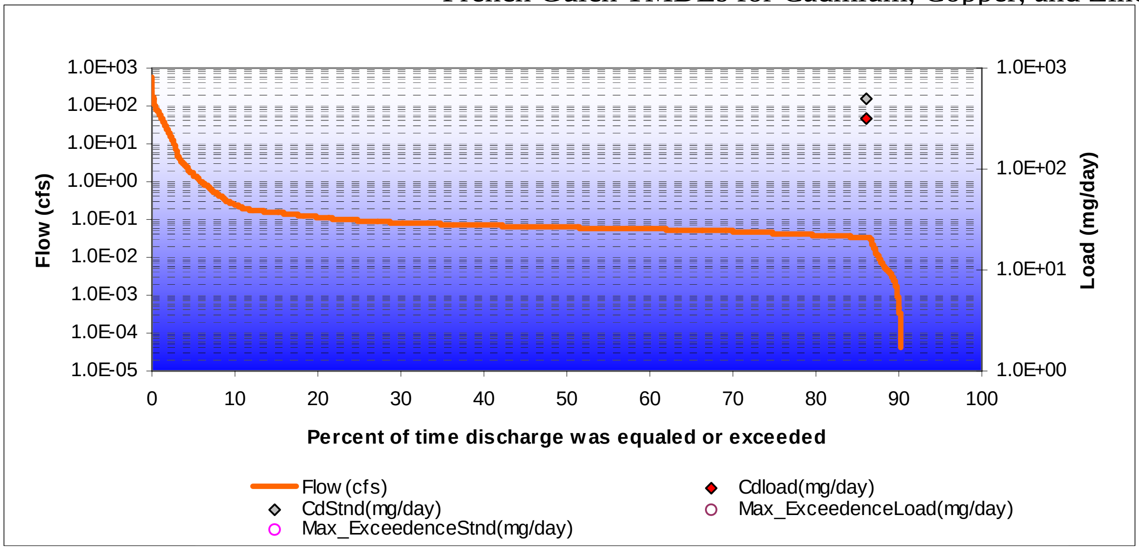


Reduction Percentage	Existing	TMDL	LA	MOS
69%	9.51E+04	2.96E+04	2.81E+04	1.48E+03

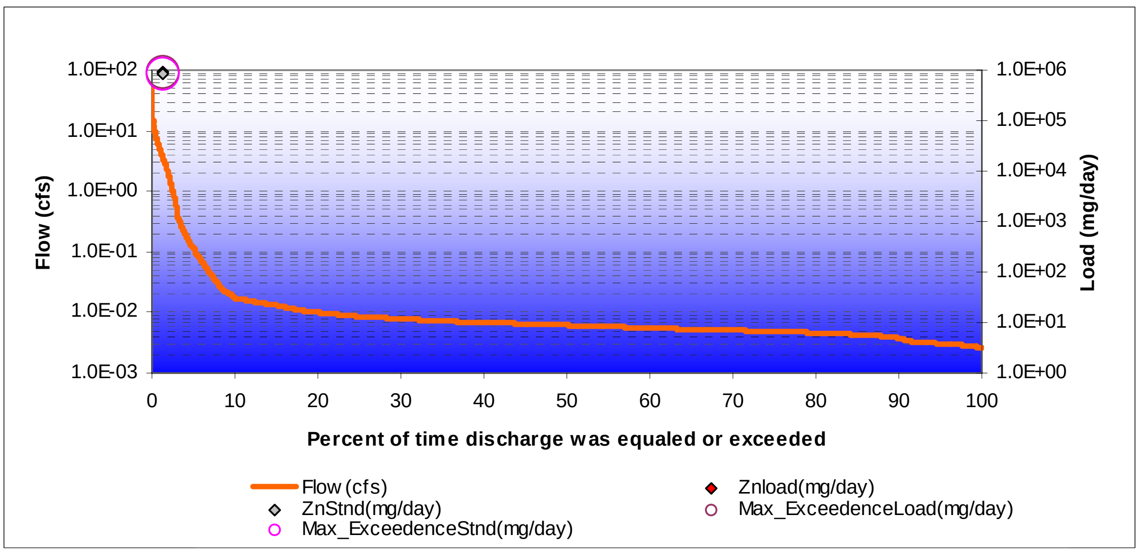
Cd loadings at subwatershed 20



Cd loadings at subwatershed 19

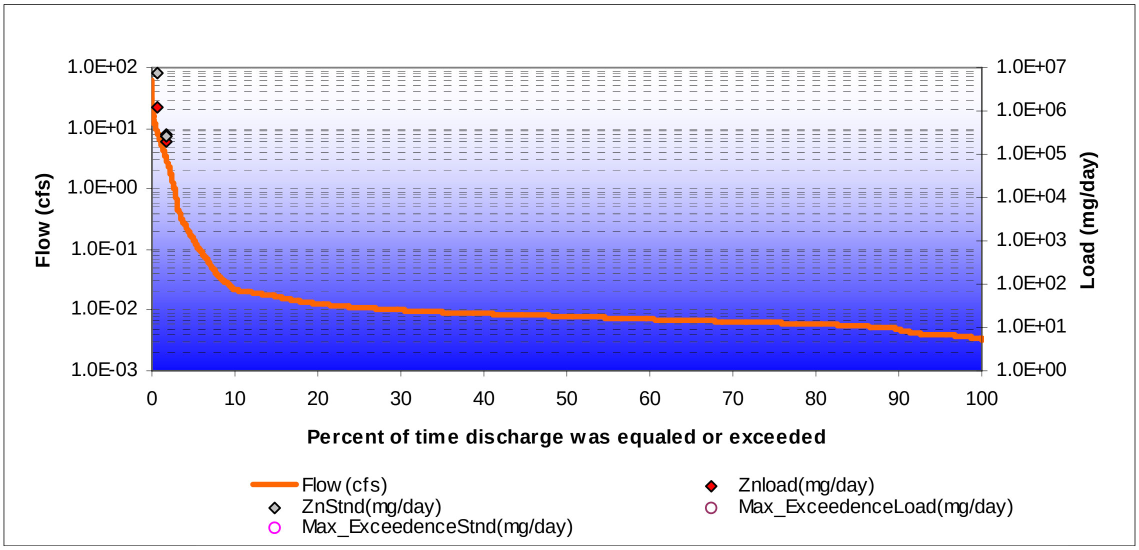


Cd loadings at subwatershed 13

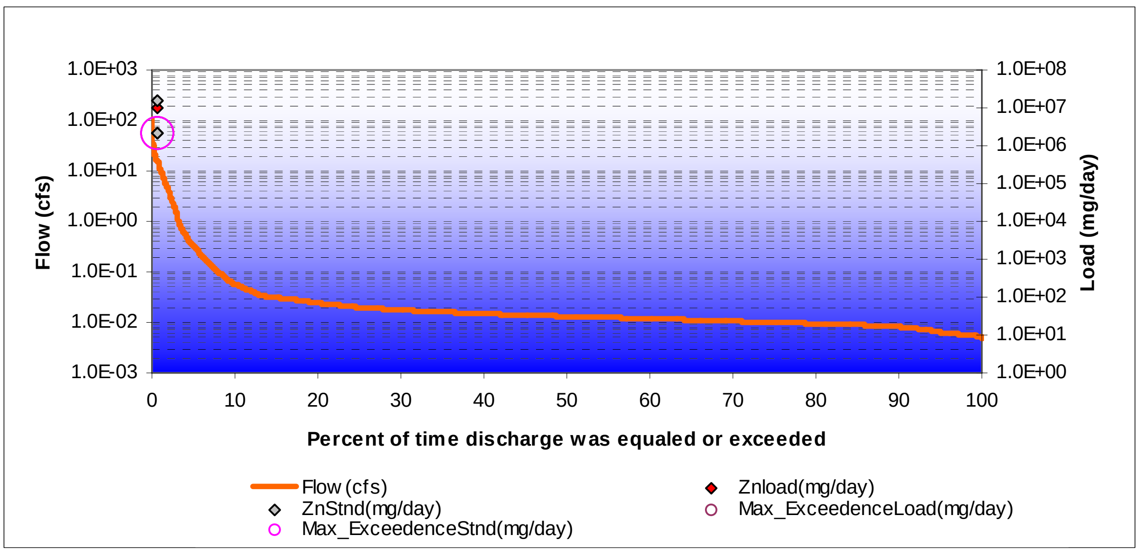


Reduction Percentage	Existing	TMDL	LA	MOS
11%	9.22E+05	8.16E+05	7.75E+05	4.08E+04

Zn loadings at subwatershed 26

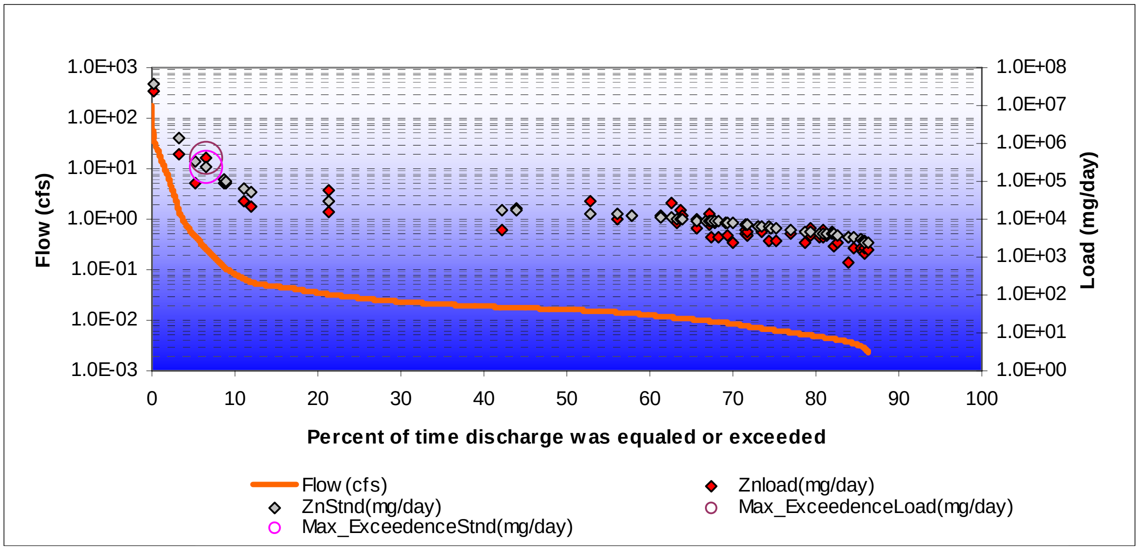


Zn loadings at subwatershed 25



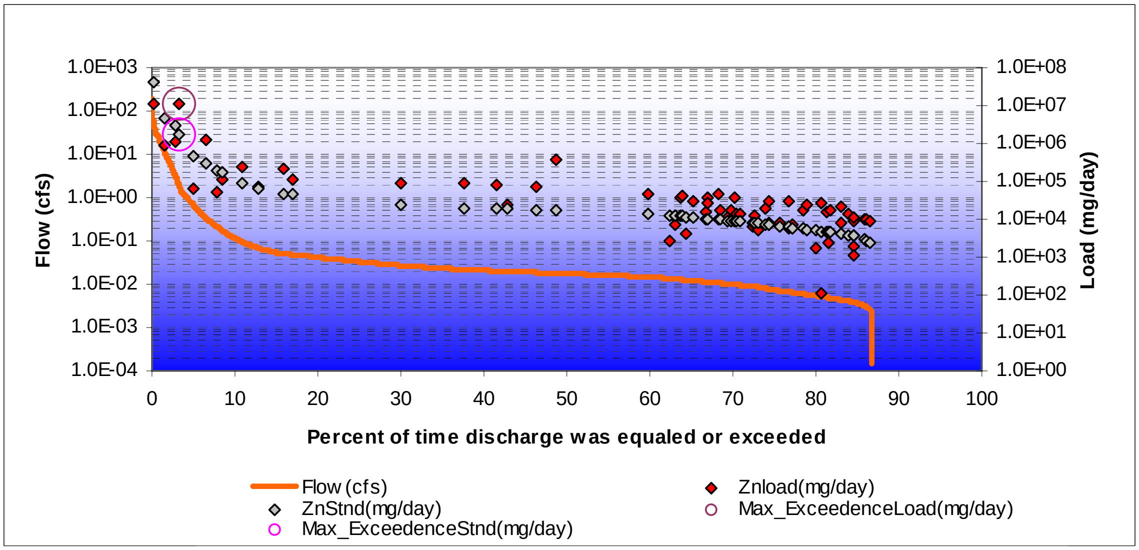
Reduction Percentage	Existing	TMDL	LA	MOS
6%	2.17E+06	2.05E+06	1.95E+06	1.02E+05

Zn loadings at subwatershed 23



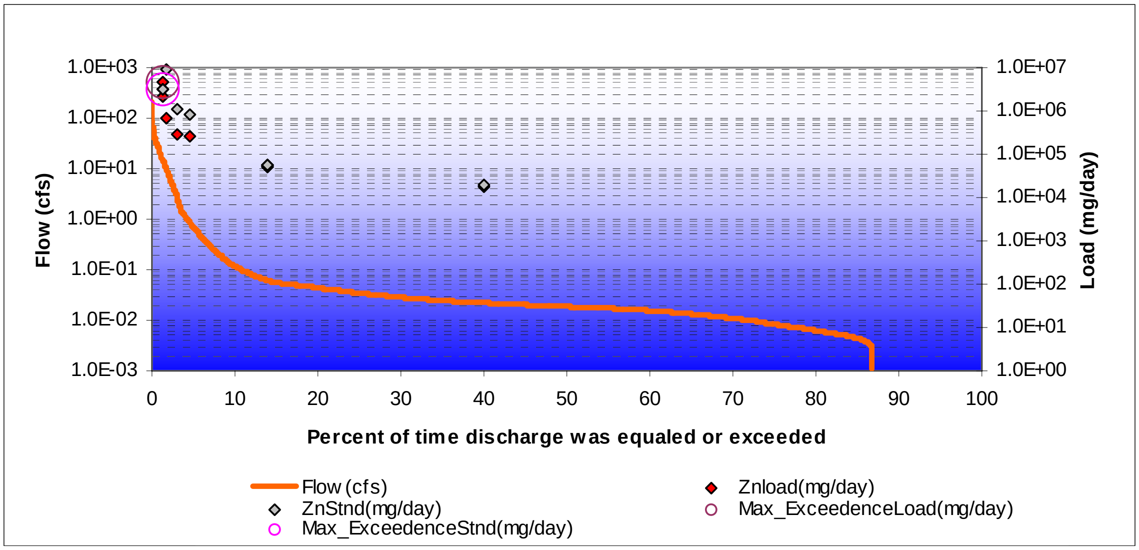
Reduction Percentage	Existing	TMDL	LA	MOS
44%	4.21E+05	2.35E+05	2.23E+05	1.17E+04

Zn loadings at subwatershed 22



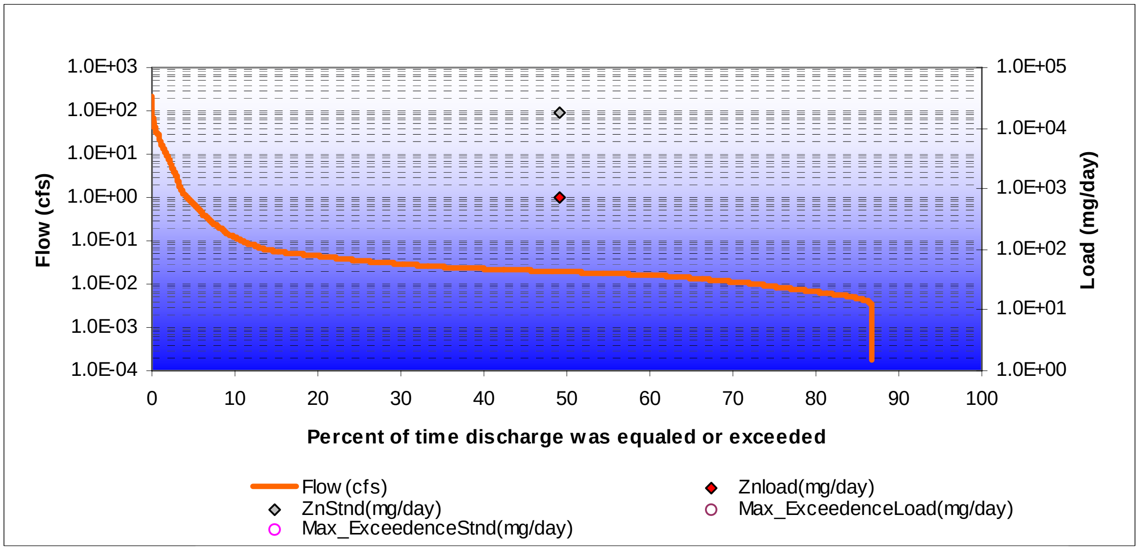
Reduction Percentage	Existing	TMDL	LA	MOS
83%	1.07E+07	1.80E+06	1.71E+06	9.02E+04

Zn loadings at subwatershed 20

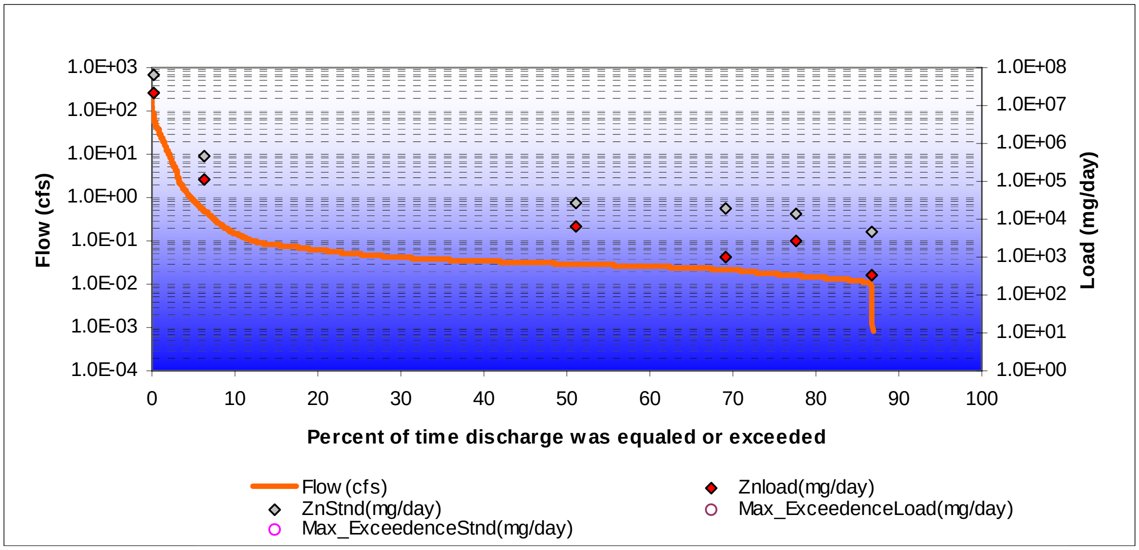


Reduction Percentage	Existing	TMDL	LA	MOS
34%	4.61E+06	3.03E+06	2.88E+06	1.52E+05

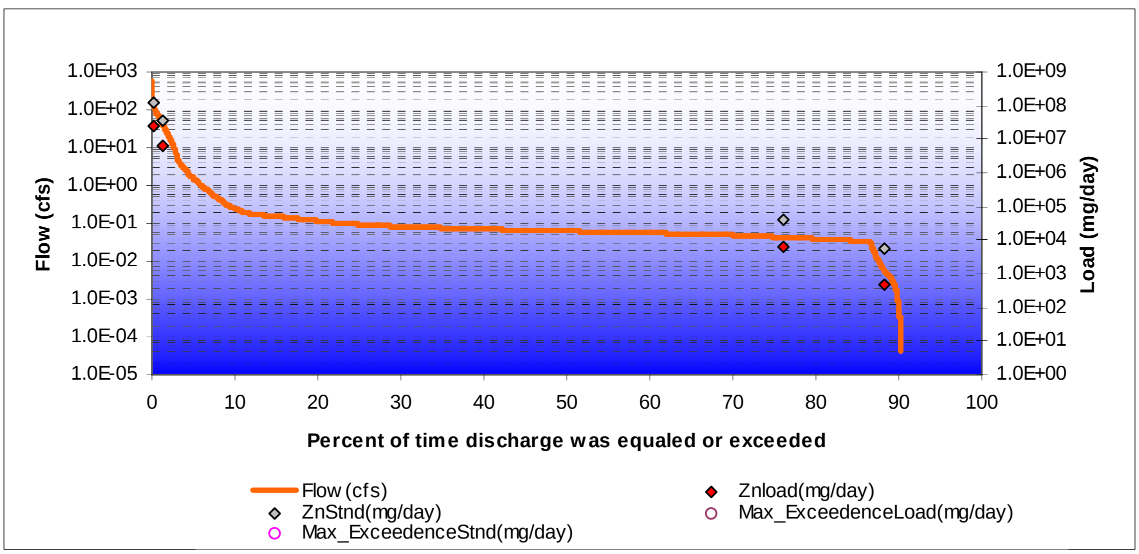
Zn loadings at subwatershed 19



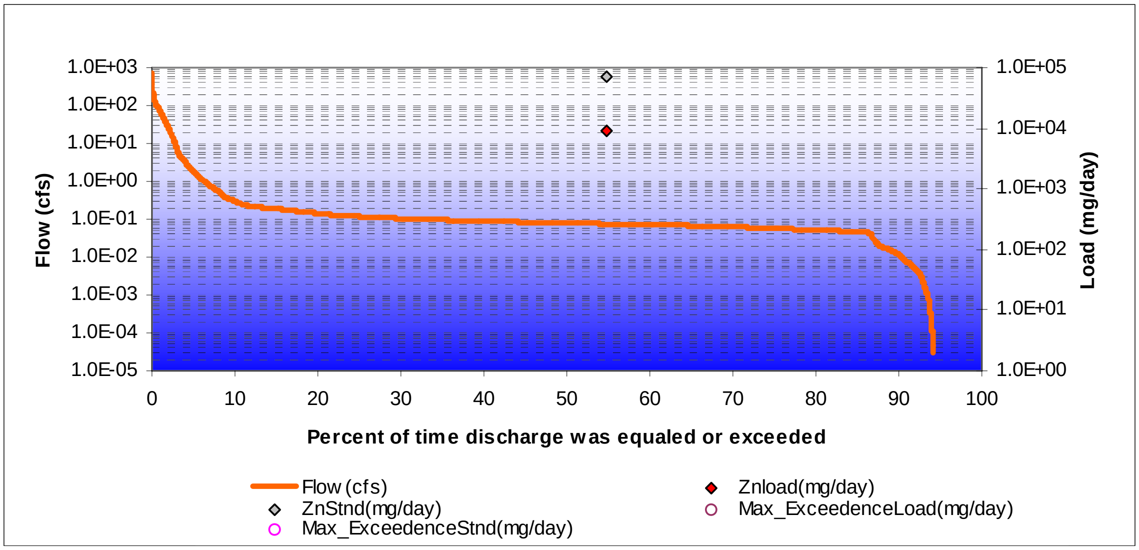
Zn loadings at subwatershed 18



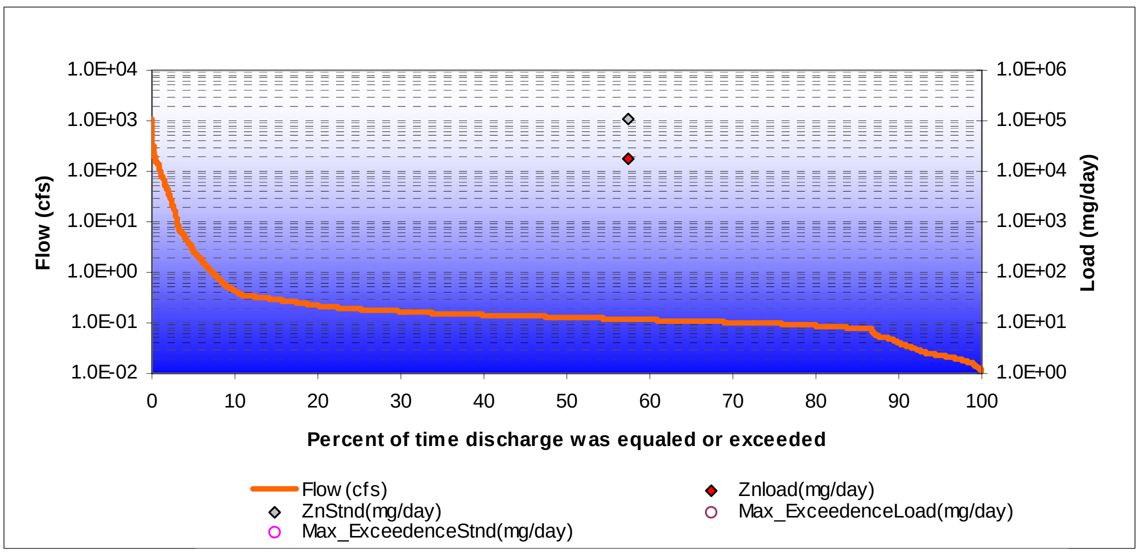
Zn loadings at subwatershed 15



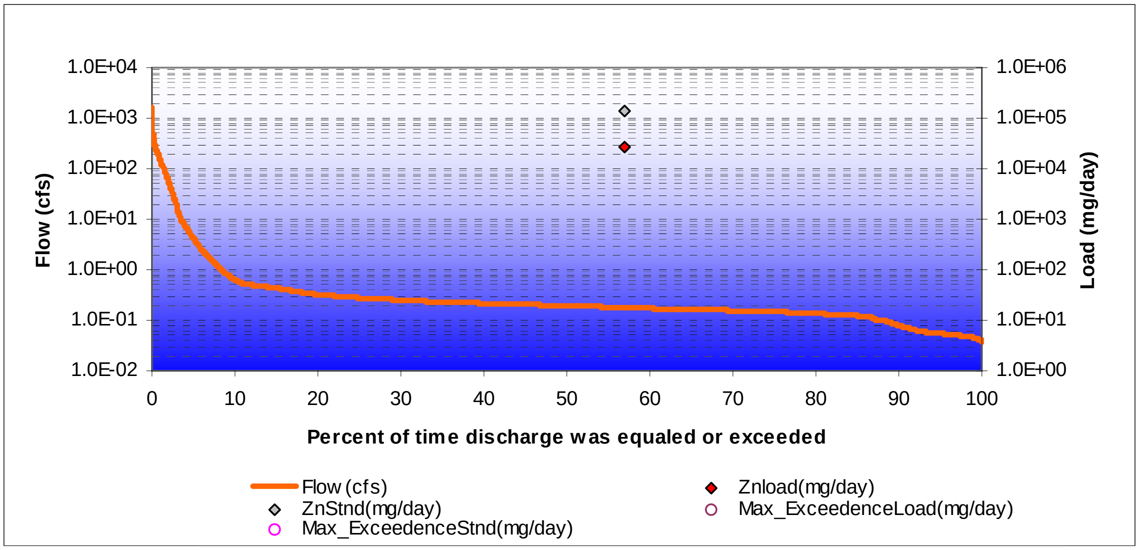
Zn loadings at subwatershed 13



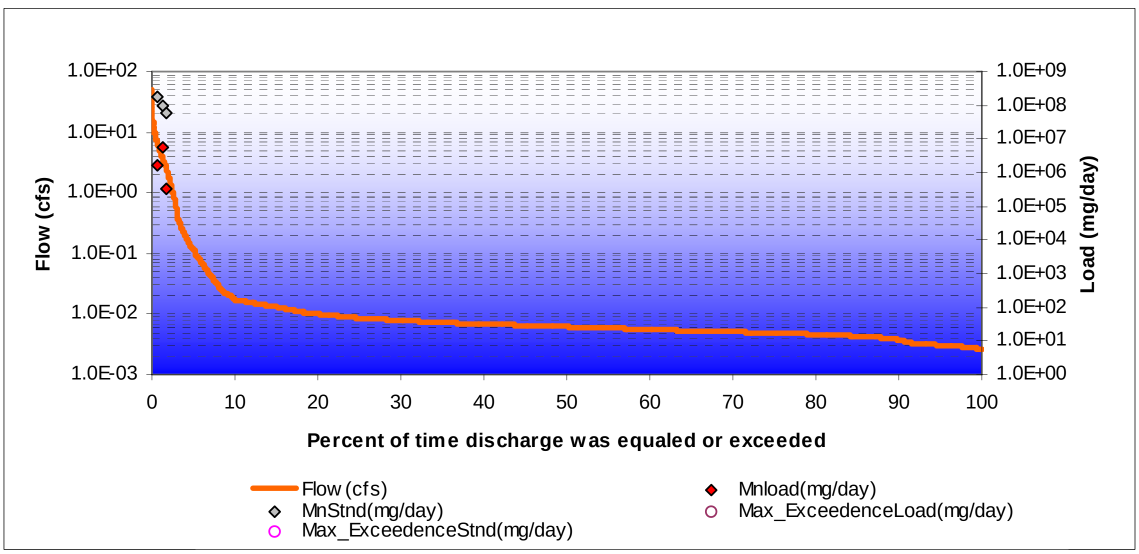
Zn loadings at subwatershed 11



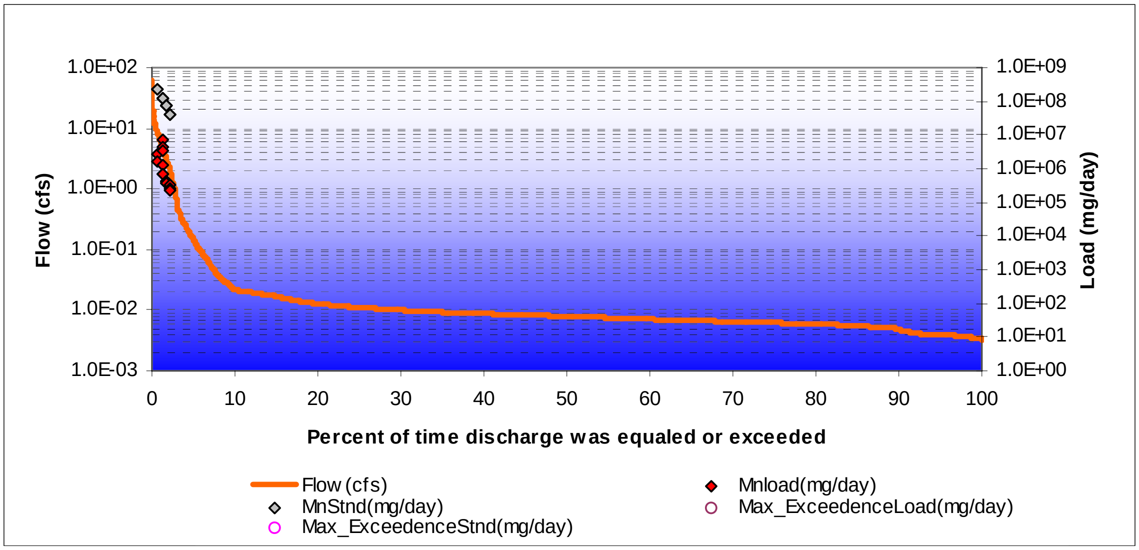
Zn loadings at subwatershed 7



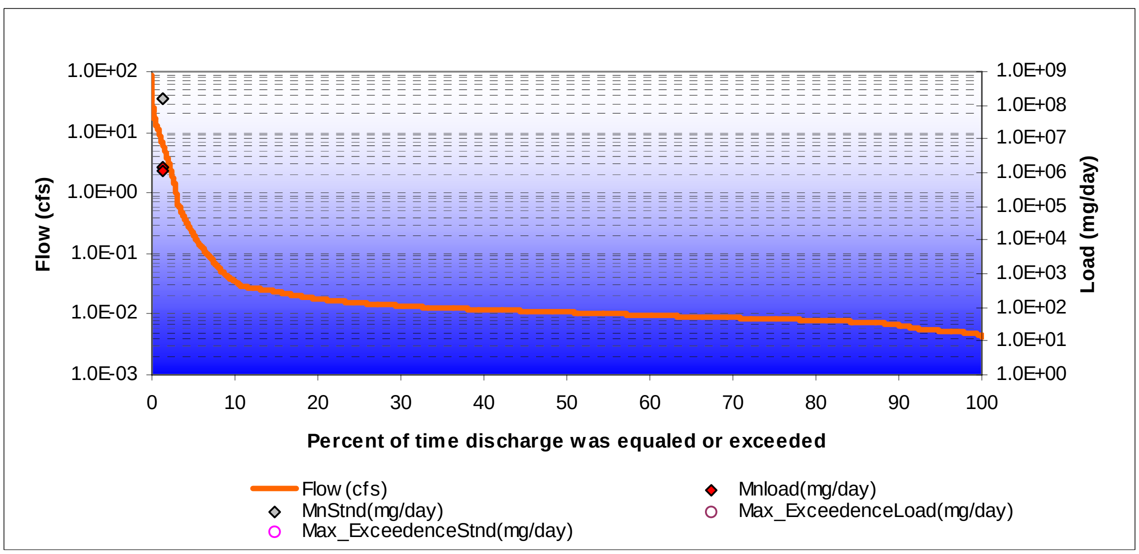
Zn loadings at subwatershed 1



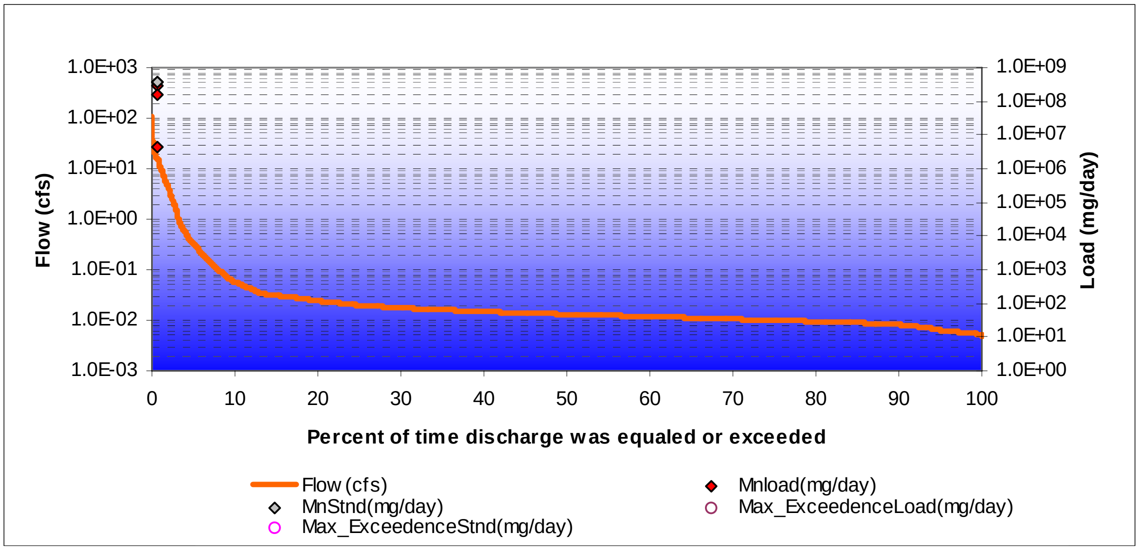
Mn loadings at subwatershed 26



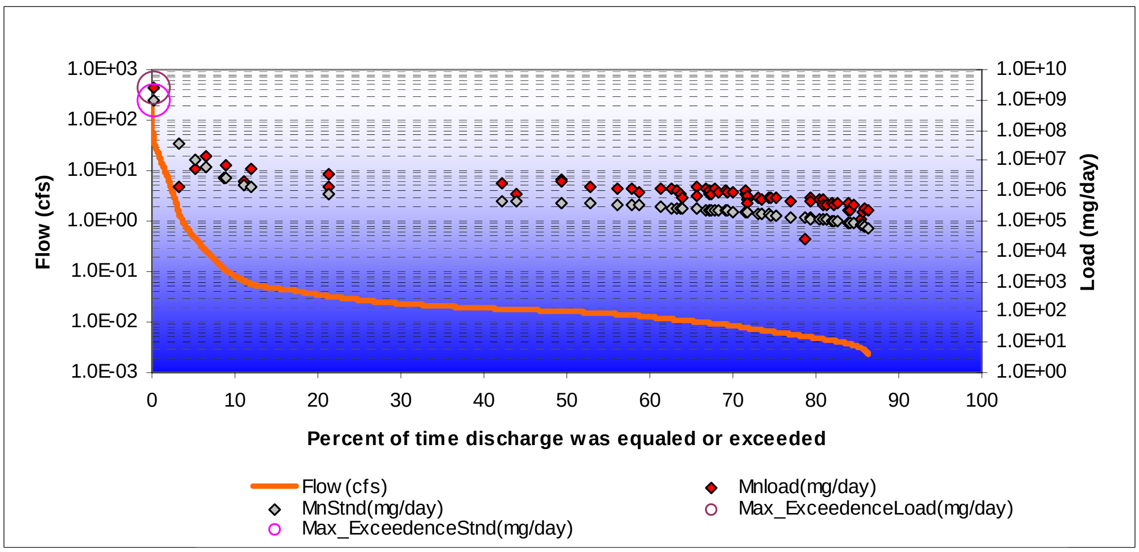
Mn loadings at subwatershed 25



Mn loadings at subwatershed 24

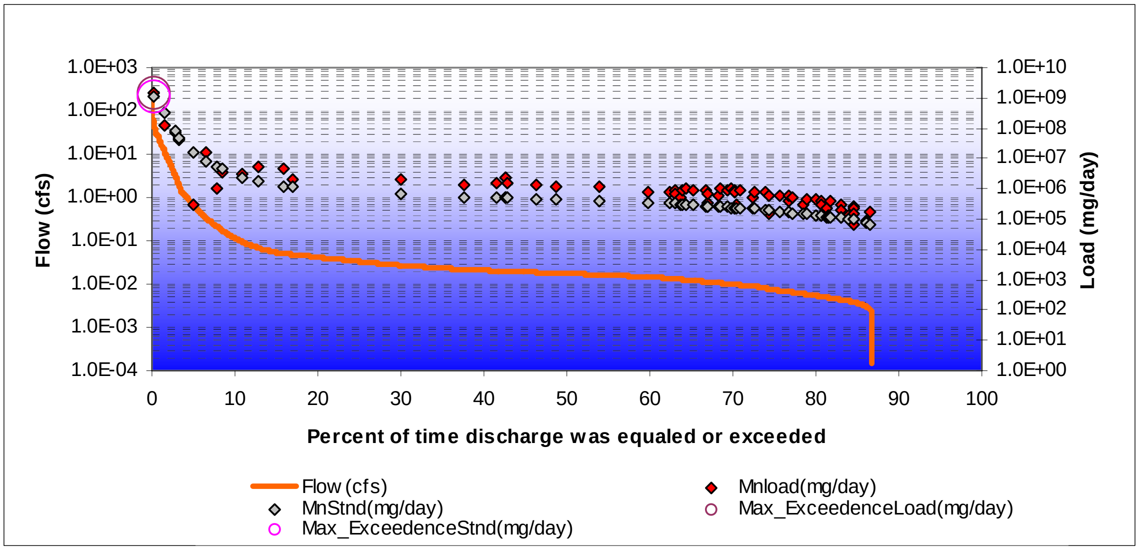


Mn loadings at subwatershed 23



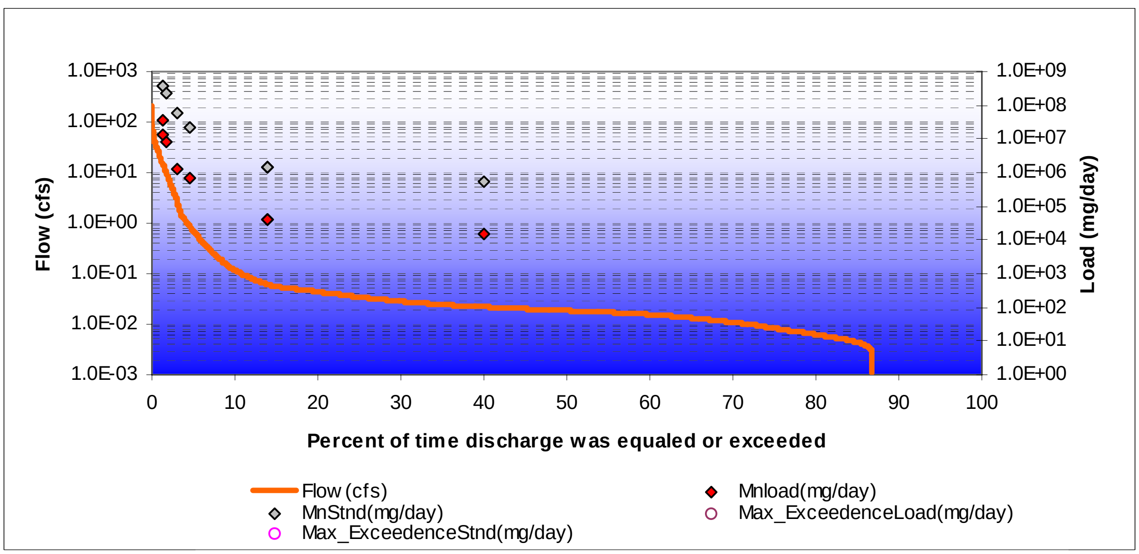
Reduction Percentage	Existing	TMDL	LA	MOS
63%	2.67E+09	9.91E+08	9.41E+08	4.95E+07

Mn loadings at subwatershed 22

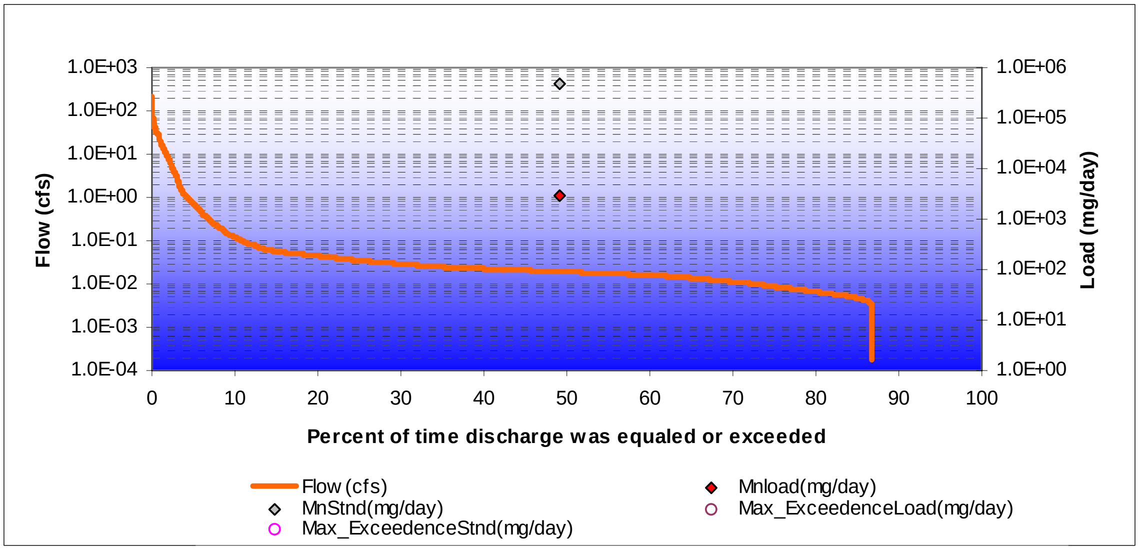


Reduction Percentage	Existing	TMDL	LA	MOS
17%	1.39E+09	1.16E+09	1.10E+09	5.78E+07

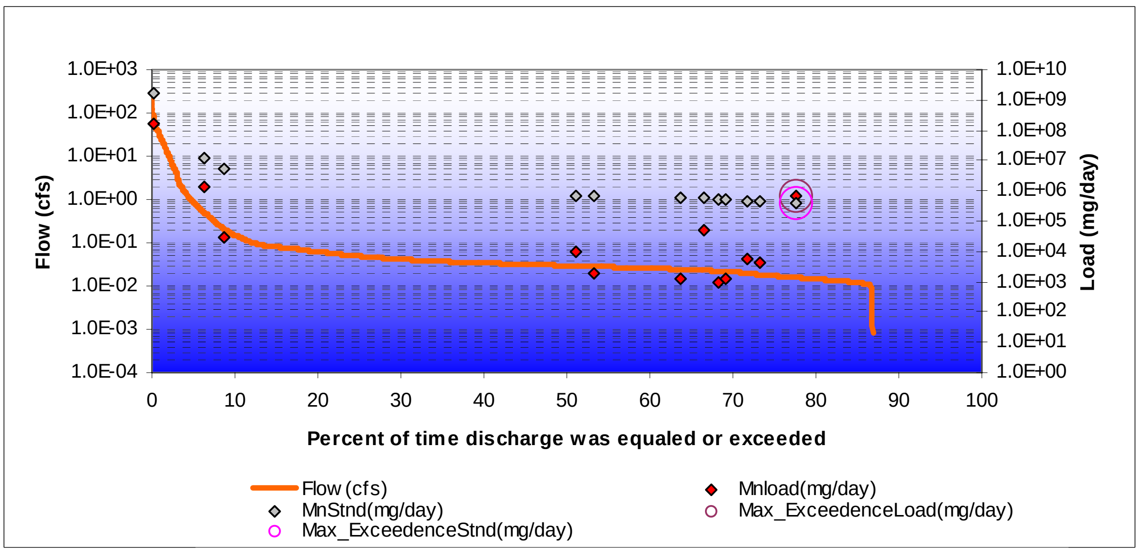
Mn loadings at subwatershed 20



Mn loadings at subwatershed 19

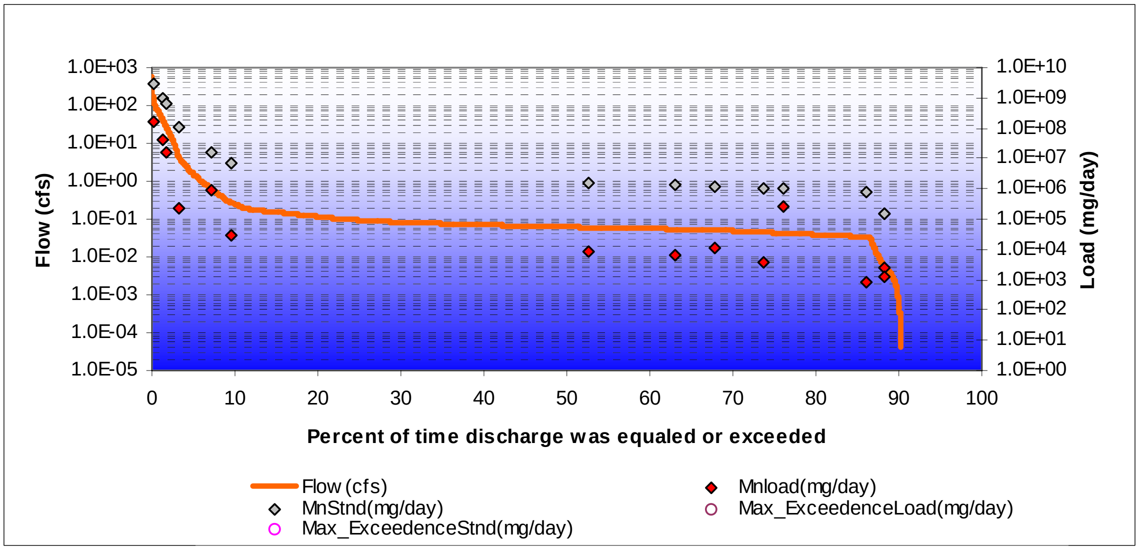


Mn loadings at subwatershed 18

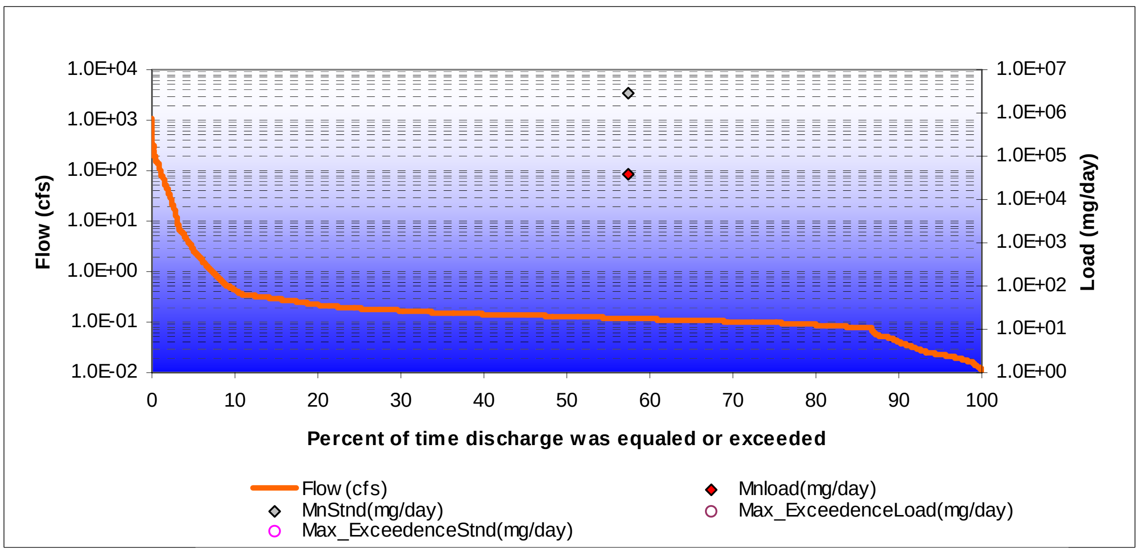


Reduction Percentage	Existing	TMDL	LA	MOS
46%	7.18E+05	3.86E+05	3.67E+05	1.93E+04

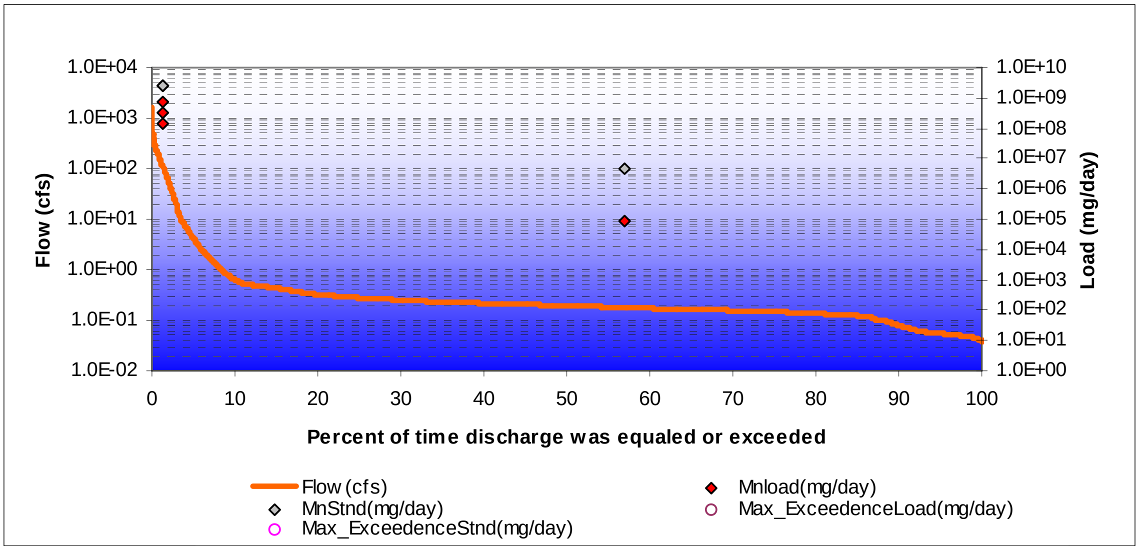
Mn loadings at subwatershed 15



Mn loadings at subwatershed 13



Mn loadings at subwatershed 7



Mn loadings at subwatershed 1

APPENDIX G
LOADS, TMDLS, AND ALLOCATIONS
USING A 20% MOS and a Re-Calculated %-Reduction

Table G-1. Region 2 - Cadmium below Zonia Mine

Flow (cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
2.11E+02	0.015	3.85E+06	7.02E+05	1.75E+05	8.77E+05	81.77%
5.74E+01	0.15	1.81E+05	1.91E+05	4.78E+04	2.39E+05	no reduction required
1.18E-01	10	6.81E+02	3.94E+02	9.84E+01	4.92E+02	42.14%
4.41E-02	20	2.71E+02	1.47E+02	3.67E+01	1.84E+02	45.76%
2.84E-02	30	1.58E+02	9.44E+01	2.36E+01	1.18E+02	40.25%
2.20E-02	40	1.08E+02	7.33E+01	1.83E+01	9.17E+01	32.13%
1.87E-02	50	8.02E+01	6.21E+01	1.55E+01	7.77E+01	22.57%
1.56E-02	60	6.30E+01	5.20E+01	1.30E+01	6.50E+01	17.46%
1.09E-02	70	5.13E+01	3.62E+01	9.05E+00	4.53E+01	29.43%
6.27E-03	80	4.30E+01	2.09E+01	5.21E+00	2.61E+01	51.40%
0.00E+00	90	3.67E+01	0.00E+00	0.00E+00	0.00E+00	no reduction required

Table G-2. Region 2 - Copper below Zonia Mine

Flow (cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
2.11E+02	0.015	5.83E+09	2.69E+06	6.73E+05	3.36E+06	99.95%
5.74E+01	0.15	7.35E+07	7.33E+05	1.83E+05	9.16E+05	99.00%
1.18E-01	10	2.52E+04	1.51E+03	3.77E+02	1.89E+03	94.01%
4.41E-02	20	6.76E+03	5.63E+02	1.41E+02	7.04E+02	91.67%
2.84E-02	30	3.13E+03	3.62E+02	9.05E+01	4.53E+02	88.43%
2.20E-02	40	1.81E+03	2.81E+02	7.03E+01	3.52E+02	84.48%
1.87E-02	50	1.19E+03	2.38E+02	5.96E+01	2.98E+02	80.00%
1.56E-02	60	8.38E+02	1.99E+02	4.99E+01	2.49E+02	76.25%
1.09E-02	70	6.26E+02	1.39E+02	3.47E+01	1.74E+02	77.80%
6.27E-03	80	4.85E+02	8.00E+01	2.00E+01	1.00E+02	83.51%
0.00E+00	90	3.88E+02	0.00E+00	0.00E+00	0.00E+00	no reduction required

Table G-3. Region 2 - Zinc below Zonia Mine

Flow (cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
2.11E+02	0.015	1.19E+09	1.88E+07	4.71E+06	2.36E+07	98.42%
5.74E+01	0.15	4.48E+07	9.57E+06	2.39E+06	1.20E+07	78.64%
1.18E-01	10	1.13E+05	1.98E+04	4.94E+03	2.47E+04	82.48%
4.41E-02	20	4.20E+04	7.37E+03	1.84E+03	9.22E+03	82.45%
2.84E-02	30	2.35E+04	4.75E+03	1.19E+03	5.94E+03	79.79%
2.20E-02	40	1.56E+04	3.69E+03	9.22E+02	4.61E+03	76.35%
1.87E-02	50	1.14E+04	3.12E+03	7.81E+02	3.91E+03	72.63%
1.56E-02	60	8.76E+03	2.62E+03	6.54E+02	3.27E+03	70.09%
1.09E-02	70	7.04E+03	1.82E+03	4.55E+02	2.27E+03	74.15%
6.27E-03	80	5.82E+03	1.05E+03	2.62E+02	1.31E+03	81.96%
0.00E+00	90	4.92E+03	0.00E+00	0.00E+00	0.00E+00	no reduction required

Table G-4. Region 3 - Copper below Placerita Gulch

Flow(cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
5.60E+02	0.015	3.58E+09	3.21E+07	8.02E+06	4.01E+07	99.10%
1.62E+02	0.135	7.11E+07	9.26E+06	2.31E+06	1.16E+07	86.98%
2.50E-01	10	3.29E+04	1.43E+04	3.58E+03	1.79E+04	56.53%
1.16E-01	20	9.57E+03	6.64E+03	1.66E+03	8.30E+03	30.62%
8.24E-02	30	4.65E+03	4.72E+03	1.18E+03	5.90E+03	no reduction required
7.00E-02	40	2.78E+03	4.01E+03	1.00E+03	5.02E+03	no reduction required
6.20E-02	50	1.87E+03	3.55E+03	8.88E+02	4.44E+03	no reduction required
5.58E-02	60	1.35E+03	3.20E+03	7.99E+02	3.99E+03	no reduction required
4.90E-02	70	1.03E+03	2.81E+03	7.01E+02	3.51E+03	no reduction required
3.90E-02	80	8.08E+02	2.23E+03	5.58E+02	2.79E+03	no reduction required
6.48E-04	90	6.55E+02	3.71E+01	9.28E+00	4.64E+01	no reduction required

Table G-5. Region 3 - Zinc below Placerita Gulch

Flow (cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
5.60E+02	0.015	5.39E+09	2.11E+08	5.27E+07	2.64E+08	96.09%
1.62E+02	0.135	1.24E+08	1.17E+08	2.92E+07	1.46E+08	no reduction required
2.50E-01	10	7.69E+04	1.85E+05	4.63E+04	2.32E+05	no reduction required
1.16E-01	20	2.34E+04	8.60E+04	2.15E+04	1.08E+05	no reduction required
8.24E-02	30	1.17E+04	6.12E+04	1.53E+04	7.64E+04	no reduction required
7.00E-02	40	7.13E+03	5.20E+04	1.30E+04	6.50E+04	no reduction required
6.20E-02	50	4.86E+03	4.60E+04	1.15E+04	5.75E+04	no reduction required
5.58E-02	60	3.56E+03	4.14E+04	1.03E+04	5.17E+04	no reduction required
4.90E-02	70	2.73E+03	3.63E+04	9.08E+03	4.54E+04	no reduction required
3.90E-02	80	2.17E+03	2.89E+04	7.23E+03	3.62E+04	no reduction required
6.48E-04	90	1.77E+03	4.04E+02	1.01E+02	5.06E+02	77.18%

Table G-6 Copper - Subwatershed 26

Flow (cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
1.50E+01	0.12	6.49E+04	1.55E+04	3.88E+03	1.94E+04	76.09%

Table G-7 Zinc - Subwatershed 26

Flow (cfs)	Interval (percentile)	Existing (mg/day)	LA (mg/day)	MOS (mg/day)	TMDL (mg/day)	% reduction
1.50E+01	0.12	9.22E+05	6.53E+05	1.63E+05	8.16E+05	29.18%