Bryant Creek:
Total Maximum Daily Loads – Arsenic (total), Iron (total), Nickel (total), Turbidity, and Total Suspended Solids

Submitted to EPA Region IX, October 8, 2003
Approved by EPA Region IX, November 28, 2003

Bureau of Water Quality Planning
Nevada Division of Environmental Protection
Department of Conservation and Natural Resource

Table of Contents

Table of Contents (continued)

List of Tables

List of Figures

List of Figures(continued)

Bryant Creek: Total Maximum Daily Loads –
Arsenic, Iron, Nickel, Turbidity, and Total Suspended Solids

Executive Summary

Section 303(d) of the Clean Water Act requires each state to develop a list of water bodies that need additional work beyond existing controls to achieve or maintain water quality standards, and submit an updated list to the Environmental Protection Agency (EPA) every two years. The Section 303(d) List provides a comprehensive inventory of water bodies impaired by all sources. CFR (Code of Federal Regulations) 40 Part 130.7 require states to develop TMDLs (Total Maximum Daily Loads) for the waterbody/pollutant combinations appearing in the 303(d) List.

Bryant Creek was initially included on Nevada's 1998 303(d) List due to water quality concerns related to copper, iron (total) and nickel (total). With the 2002 303(d) List, the Bryant Creek listing was expanded to include arsenic (total), turbidity, total suspended solids and temperature. This document presents TMDLs for some of these parameters (arsenic (total), iron (total), nickel (total), total suspended solids, turbidity) and justification for delisting other parameters (copper, temperature). All of these 303(d) Listings were based upon Nevada Division of Environmental Protection water quality monitoring at Station BCU (Bryant Creek above Doud Springs).

For each of these pollutants of concern, this report includes a discussion for the following categories:

- Problem Statement
- Source Analysis
- Target Analysis
- Pollutant Load Capacity and Allocation
- Future Needs

While a variety of known and potential pollutant sources exist in the watershed, the highest pollutant levels have mostly occurred during higher flow periods. Impoundment pond overflow, acid mine drainage and natural seepage from waste rock at the Leviathan Mine have all contributed pollutant loads to Bryant Creek. Another potentially significant source is the waste rock and overburden materials that were historically disposed of in Leviathan and Aspen Creeks and eventually transported downstream. These materials may remain in the creek channels and floodplains of Leviathan, Aspen and Bryant creeks (within California and Nevada), and continue to contribute to loading in the system. Additionally, arsenic-, iron- and nickel-rich seeps or springs may be present within Nevada and California. Other potential sources for iron, turbidity and total suspended solids include natural erosion in the watershed and stream channels, and erosion associated with dirt road, trails, mining activities, etc.

In 1999, the Lahontan Regional Water Quality Control Board began treating and disposing of water stored in impoundments at Leviathan Mine thereby creating additional storage volume for capturing spring runoff. Since that time, no impoundment overflows have occurred resulting in improved water quality conditions downstream. However, it must be noted that the area has been experiencing below normal flow conditions (less than 50% of the long-term average) which has likely contributed to the lack of pond overflows.

The TMDLs and load allocations presented in this report are in a form unique for Nevada. Through the use of equations and load duration curves, the defined TMDLs and load allocations vary with flow thereby addressing the EPA requirement to consider seasonal variations and critical flow conditions in the TMDL process.

This document presents a "phased" approach to the Bryant Creek TMDLs. A phased approach is used in situations where data and information needed to determine the TMDL and associated load allocations are limited. The phased or adaptive management approach enables states to use available information to establish interim targets, begin to implement needed controls and restoration actions, monitor waterbody response to these actions, and plan for future TMDL review and revision. As part of the phased approach, a number of future needs are identified for Bryant Creek:

- A detailed source assessment including quantity, location, timing may be necessary for some of the identified pollutants of concern. An initial step could include monitoring at the stateline to begin differentiating between loading within Nevada and within California.
- An evaluation of the appropriateness of "municipal or domestic supply" as a beneficial use may be appropriate.
- Some of the water quality standards need to be reviewed and possibly revised to appropriate levels.
- The addition of nickel analysis for Monitoring Site BCU is needed to characterize nickel levels in Bryant Creek.
- As additional data are collected, update the linear regression relationship between total suspended solids and turbidity.

As time and resources allow, the Nevada Division of Environmental Protection will address these needs and update the TMDLs as appropriate.

Bryant Creek: Total Maximum Daily Loads – Arsenic, Iron, Nickel, Turbidity, and Total Suspended Solids

1.0 Introduction

Section 303(d) of the Clean Water Act requires each state to develop a list of water bodies that need additional work beyond existing controls to achieve or maintain water quality standards, and submit an updated list to the Environmental Protection Agency (EPA) every two years. The Section 303(d) List provides a comprehensive inventory of water bodies impaired by all sources. This inventory is the basis for targeting water bodies for watershed-based solutions, and the TMDL (Total Maximum Daily Load) process provides an organized framework to develop these solutions. CFR (Code of Federal Regulations) 40 Part 130.7 require states to develop TMDLs for the waterbody/pollutant combinations appearing in the 303(d) List.

Bryant Creek was initially included on Nevada's 1998 303(d) List due to water quality concerns related to copper, iron (total) and nickel (total). With the 2002 303(d) List, the Bryant Creek listing was expanded to include arsenic (total), turbidity, total suspended solids and temperature. This document presents TMDLs for some of these parameters (arsenic (total), iron (total), nickel (total), total suspended solids, turbidity) and justification for delisting other parameters (copper, temperature).

1.1 Total Maximum Daily Load (TMDL) Defined

TMDLs are an assessment of the amount of pollutant a water body can receive and not violate water quality standards. Also, TMDLs provide a means to integrate the management of both point and nonpoint sources of pollution through the establishment of waste load allocations for point source discharges and load allocations for nonpoint sources. For pollutants other than heat, TMDLs are to be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standards with consideration given to seasonal variations and a margin of safety.

Once approved by the U.S. Environmental Protection Agency, TMDLs are implemented through existing National Pollutant Discharge Elimination System (NPDES) permits for point source discharges to achieve the necessary pollutant reductions. Nonpoint source TMDLs can be implemented through voluntary or regulatory nonpoint source control programs, depending on the state. In Nevada, the nonpoint source program is voluntary.

While each TMDL report is unique, many contain similar elements. Following is a discussion of the typical components that appear in TMDLs based upon EPA guidance (EPA, October 1999).

1.1.1 Problem Statement: The objective of the problem statement is to describe the key factors and background information that describes the nature of the impairment, such as chemical water quality, biological integrity, physical condition, etc.

1.1.2 Source Analysis: As part of a source analysis, the known loading sources (both point and nonpoint sources) are characterized by location, type, frequency, and magnitude to the extent possible. In the case of nonpoint sources, characterization activities can require significant financial resources.

1.1.3 Target Analysis: Section 303(d) (1) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality standards." A purpose of the target analysis is to identify those future conditions needed for compliance with the water quality standards and for support of the beneficial use. According to the U.S. EPA (1999), one of the primary goals of target analyses are to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use.

1.1.4 Pollutant Load Capacity and Allocation: Another component is the identification of the waterbody loading capacity. The loading capacity is the maximum amount of pollutant loading a waterbody can assimilate without violating TMDL target. The allowable loadings are then distributed or "allocated" among the significant sources of the pollutant.

If appropriate, a margin of safety is included in the analysis to account for uncertainty in the relationship between pollutant loads and the water quality of the receiving water. It can also be stated that the margin of safety is to account for uncertainties in meeting the water quality standards when the target and TMDL are met. Additionally, consideration needs to be given to seasonal variations and critical conditions. The general equation describing the TMDL with the allocation and margin of safety components is given below:

TMDL = Sum of WLA + Sum LA + Margin of Safety (Eq. 1)

Where:

Sum of WLA = sum of wasteload allocations given to point sources
Sum of LA = sum of load allocations given to nonpoint sources

According to CFR 130.2(i), TMDLs need not be expressed in pounds per day when alternative means are better suited for the waterbody problem.

1.1.5 Other Components: TMDL submittals often include a plan for TMDL implementation and for monitoring TMDL effectiveness. In Nevada, the TMDL is implemented through NPDES permits for point sources and through Nevada 319 Nonpoint Source Program for nonpoint sources of impairment.

1.2 A Phased Approach to TMDL Adoption and Implementation

This document presents a "phased" approach to the Bryant Creek TMDLs. A phased approach is used in situations where data and information needed to determine the TMDL and associated load allocations are limited. The phased or adaptive management approach enables states to use available information to establish interim targets, begin to implement needed controls and restoration actions, monitor waterbody response to these actions, and plan for future TMDL review and revision. Adaptive management or phased approach TMDLs are particularly appropriate to address nonpoint source issues. A phased approach enables the adoption and implementation of a TMDL while collecting additional information ("*Guidance for Water Quality Based Decisions—The TMDL Process*" (#EPA 440/4-91-001, April 1991)).

2.0 Background

2.1 Study Area

Bryant Creek is a tributary of the East Fork Carson River. The creek originates in California on the eastern slopes of the Sierra Nevada Mountains in northeast Alpine County. As shown in Figure 1, Mountaineer Creek and Leviathan Creek combine to form Bryant Creek. The approximate 35 square mile watershed contains lands ranging in elevation from 5100 to 9000 feet (Calif. Regional Water Quality Control Board, 1975). For over 50 years, acid mine drainage from the Leviathan Mine has impacted the waters of Leviathan and Bryant creeks, creating significant water quality concerns. This drainage is primarily the result of acid seeps from waste rock, underground workings, and impoundment overflow.

A majority of the land within the Bryant Creek and tributary watershed is owned by the U.S. Forest Service and consists of evergreen and mixed forest, and shrub and brush rangeland. The Bryant Creek drainage also contains over 10,000 acres of Public Domain Indian Trust Allotments, commonly known as the Pine Nut Allotments, with Bryant Creek flowing through at least 12 allotments (The Leviathan Mine Council Natural Resource Trustees, 2002).

2.1.1 Leviathan Mine and its Impact on Water Quality: The Leviathan Mine is located approximately eight miles east of Markleeville, California and ten miles west of Holbrook Junction, Nevada, off California SR-89. Underground development of the mine site began in 1863 in an effort to exploit the large deposits of copper sulfate minerals present. The Leviathan Mine operated intermittently until 1872, never becoming the huge bonanza as envisioned by its investors. The copper sulfate minerals were often intermixed with complex sulfide minerals, making any economical separation and recovery difficult. Furthermore, the mine site was plagued by poor structural geology and extensive ground water infiltration, which resulted in repeated underground wall failures and considerable sub-level flooding.

From 1872 to 1935 the mine remained inactive, only to be reopened by the Calpine Corporation for development of the sulfur body. The mine closed again in 1941, however in 1951, the Anaconda Copper Mining Company purchased the property from Calpine, with the intent of transforming the underground workings into an open pit mine (U.S. EPA, November 1999).

Approximately 22 million tons of overburden and waste rock were removed in the process, spreading over 200 acres, some of which was disposed of in the canyon bottoms of Leviathan and Aspen creek, resulting in the diversion of streamflows from their natural courses. (U.S. EPA, May 2000). Flow diversions, waste rock seeps, and impoundment structure failure at the mine site have contributed to the amount of acidic mine drainage (AMD) and dissolved metals entering Leviathan and Bryant Creek (U.S. EPA, October 1999). As shown on Figure 1, contaminants in Leviathan Creek can enter Bryant Creek as well as the East Fork of the Carson River.

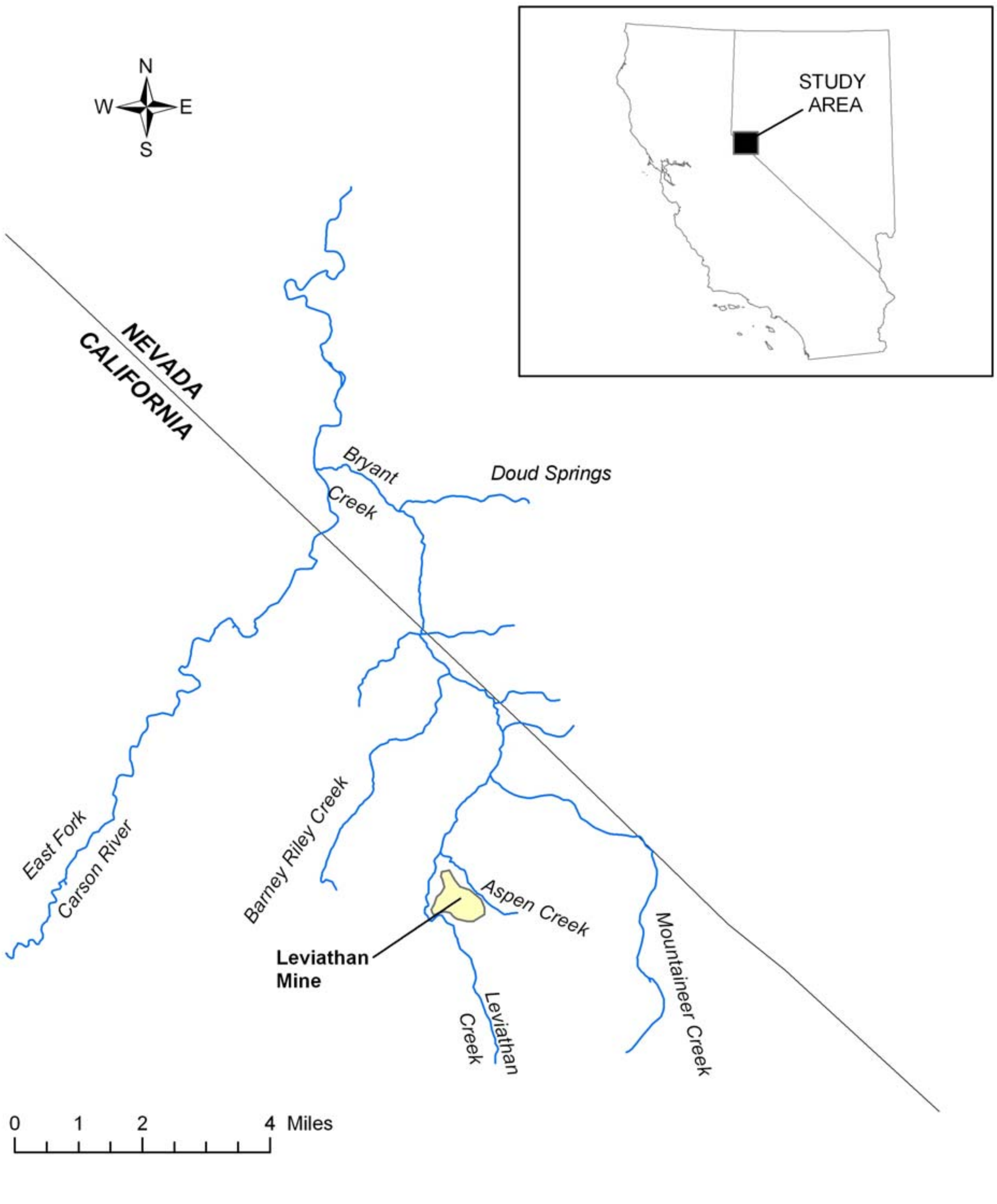


Figure 1. Bryant Creek Location Map

In 1962, Anaconda ceased mining activity at the Leviathan site, and sold the property in 1963 to Alpine Mining Enterprises (Alpine). In 1980, in response to ongoing discharges of AMD from the mine site, the Lahontan Regional Water Quality Control Board (LRWQCB), obtained $3.76 million in State of California bond money to identify and implement a project to abate the discharge of AMD at Leviathan Mine. However, this money was not sufficient to cover the costs of the remedial project and the LRWQCB began to pursue other funding sources (California Department of Health and Human Services, April 2002).

The LRWQCB, took action against Alpine in 1983 to cover site remediation costs. When it became apparent that Alpine did not have the financial means to remediate the site, LRWQCB then took action against the Anaconda Minerals Company (formerly Anaconda Copper Mining Company), which was responsible for the creation of pollution problems at Leviathan Mine. LRWQCB requested the California Attorney General to initiate legal actions against Anaconda to recover funds for the cleanup and abatement of water pollution generated at Leviathan Mine. The decision to pursue legal action against Anaconda culminated in a settlement whereby the LRWQCB obtained $2.337 million from ARCO (which acquired Anaconda Minerals in 1977) for specified remediation work at Leviathan. This money was combined with State funds to pay for the Leviathan Mine Pollution Abatement Project (with an initial total estimated construction cost of $4.227 million). In order to obtain additional funding through the Federal Demonstration Grant program, grantees are required to have title to the project site. In addition, in order to assure unrestricted access for construction, operation, and preservation of State funded improvements, it was deemed necessary for the State to acquire ownership of Leviathan Mine. The State of California acquired the site in 1984 with jurisdiction over the site resting with the California Regional Water Quality Control Board (CRWQCB), which was delegated to LRWQCB (California Department of Health and Human Services, April 2002).

The Leviathan Mine Pollution Abatement Project included the following remediation measures: 1) channelization of Leviathan Creek to prevent its contact with mining wastes, 2) re-grading and compacting the mine pit to reduce AMD production, and 3) construction of five lined evaporation ponds to collect AMD from underground mine workings. The purpose of the evaporation ponds was to reduce the volume of AMD discharged to Leviathan Creek, and prevent the discharge of AMD until the flow in Leviathan Creek could provide the greatest attenuation. In addition, LRWQCB began pursuing other projects to address remaining problems at the site, including pond overflows (California Department of Health and Human Services, April 2002).

The abatement project was completed in 1985. Although the project reduced the volume of AMD generated and discharged from the site and the sediment load to receiving waters, the project did not completely eliminate the discharge of AMD from the site (California Department of Health and Human Services, April 2002). The Channel underdrain, which was constructed as part of the abatement project, pond overflows and natural seeps continued to release AMD into Leviathan Creek (The Leviathan Mine Council Natural Resources Trustees, May 2002).

EPA Region IX first attempted remediation actions at the site in the fall of 1997, when EPA's Office of Emergency Response made an unsuccessful attempt to install a lime neutralization treatment unit to reduce the toxicity of the AMD evaporation ponds. In 1998, the Environmental Protection Agency had issued an Administrative Order on Consent (AOC) to ARCO (successor in interest to it subsidiary, Anaconda Minerals Company) through its subsidiary, ARCO Environmental Remediation, LLC. According to the AOC, ARCO was required to provide at least 8.5 million gallons of storage capacity in the evaporation ponds at Leviathan Mine by October 1, 1998. However, capacity for only 3 million gallons was achieved by that date. The result was that the ponds had filled and by July 1999, untreated AMD overflowed in Leviathan Creek (The Leviathan Mine Council Natural Resources Trustees, May 2002).

In 1999, the LRWQCB implemented its own treatability study to evaluate the neutralization of AMD, utilizing biphasic neutralization (essentially a two-step lime neutralization method). The treatability study was successful in that it: (1) demonstrated that biphasic neutralization could be used to treat pond water (AMD), and (2) resulted in the removal and treatment of approximately 4.5 million gallons of AMD, preventing pond overflow. No pond overflows occurred in 2000. EPA issued an Administrative Abatement Action to the LRWQCB on July 19, 2000, under which the LRWQCB would continue to operate the biphasic treatment plant as well as other activities at the site, including water quality monitoring (The Leviathan Mine Council Natural Resources Trustees, May 2002).

On May 11, 2000, Leviathan Mine was officially designated as a Superfund site, pursuant to section 105 of CERCLA. This designation will bring a long-term plan and Federal attention to the problem (The Leviathan Mine Council Natural Resources Trustees, May 2002).

2.2 Water Quality Standards

Nevada's water quality standards, contained in the Nevada Administrative Code 445A.119 – 445A.225, define the water quality goals for a water body by: 1) assigning beneficial uses of the water; and 2) setting criteria necessary to protect the beneficial uses. The assigned beneficial uses for Bryant Creek include:

- Irrigation
- Watering of livestock
- Recreation involving contact with the water
- Recreation not involving contact with water
- Industrial supply
- Municipal or domestic supply or both
- Propagation of wildlife
- Propagation of aquatic life (specifically rainbow trout and brown trout)

Numeric standards for Bryant Creek can be found in NAC 445A.144 *"Standards for Toxic Materials Applicable to Designated Waters"* and 445A.148, *"Carson River: Bryant Creek Near the State Line"*. The numeric standards for the toxics of concern (arsenic (total), iron (total) and nickel (total)) are summarized in Table 1. Numeric standards for the other pollutants of concern (total suspended solids and turbidity) are summarized in Table 2.

Table 1. Total Arsenic, Total Iron and Total Nickel Standards

Parameter	Beneficial Use	Numeric Standard (µg/l)
Arsenic (total)	Municipal or Domestic Supply	50
	Irrigation	100
	Watering of Livestock	200
Iron (total)	Aquatic Life	1,000
	Irrigation	5,000
Nickel (total)	Municipal or Domestic Supply	13.4
	Irrigation	200

Source: NAC 445A.144

Table 2. Turbidity and Total Suspended Solids Standards

Parameter	Beneficial Use	Numeric Standard (^{o}C, µg/l or NTU)
Turbidity	Aquatic Life	≤ 10 NTU
Total Suspended Solids	Aquatic Life	≤ 25 µg/l

Source: NAC 445A.148.

2.3 303(d) Listing

Bryant Creek first appeared on Nevada's 303(d) list in 1998 due to exceedences of the total dissolved copper, total recoverable iron and total recoverable nickel beneficial use standards. As additional data were collected, the 303(d) List was reevaluated in 2002 and expanded to include arsenic, turbidity, total suspended solids and temperature.

During the development of the Draft Bryant Creek TMDL document, several parties questioned Nevada's decisions to include dissolved copper and temperature in the 303(d) List and TMDL for Bryant Creek. A closer examination of the criteria and data used to support listing revealed that Nevada Division of Environmental Protection (NDEP) had erred in its earlier judgment. As a result, copper and temperature TMDLs have been removed from this report.

Bryant Creek was first listed for copper in the 1998 303(d) List. NDEP data collected since then were insufficient to confirm the listing or to support delisting in 2002. Therefore, copper remained on the 2002 303(d) List. Upon further examination, the original listing in 1998 was found to have been in error. At that time, NDEP samples were analyzed only for total recoverable concentrations. However, it appears that the total copper concentration data were inappropriately compared to dissolved copper water quality standards. When the total concentrations were compared to the total copper standard, no exceedances were found. Therefore, NDEP believes a copper TMDL is not warranted at this time and will seek removal of copper from the Bryant Creek 303(d) listings.

During the 1997 – 2001 monitoring period, a total of 24 field temperature measurements were taken and recorded by NDEP, with only three exceedences of the seasonal temperature standard observed. A closer examination of the Bryant Creek flow data has indicated that two of these exceedences occurred during periods of extreme low flows in May. NAC 445A.121(8) states:

> *"The specified standards are not considered violated when the natural conditions of the receiving water are outside the established limits, including periods of extreme high or low flow. Where effluents are discharged to such waters, the discharges are not considered a contributor to substandard conditions provided maximum treatment in compliance with permit requirements is maintained."*

Because of these two May exceedences occurred during periods of extreme low flow, NDEP has concluded that the two events should not be utilized for 303(d) listing purposes. The elimination of these data from the analyses results in a temperature standard exceedence frequency of approximately 4% of the time. Based on the 303(d) listing rationale, NDEP has concluded that Bryant Creek is not impaired for temperature at this time, and needs to be removed from the 2002 303(d) List.

2.4 Water Quantity and Quality

2.4.1 Primary Monitoring Stations: Locations of selected water quantity and water quality monitoring stations for the Bryant Creek basin are listed in Table 3 and shown in Figure 2. Data collected at these stations were the primary source of water quantity and water quality information utilized in the development of the TMDL. Detailed water data is presented in Appendix A.

Table 3. List of Selected Water Quantity and Water Quality Monitoring Stations

ID	Description	Agency	Period of Record	Pertinent Data Available
Stream flow Gauging Stations				
10308794	Bryant Creek below Confluence, near Markleeville, CA	USGS	1999-Present	Streamflow
10308800	Bryant Creek near Gardnerville, NV	USGS	1961-69, 1977-80, 1994-Present	Stream flow
Water Quality Monitoring Stations				
BCU	Bryant Creek above Doud Springs	Nevada	1997-Present	Dissolved and Total Arsenic, Dissolved and Total Iron, Temperature, Turbidity and Total Suspended Solids
Station 25	Bryant Creek below Confluence with Mountaineer Creek	California	1984- Present	Dissolved and Total Arsenic, Dissolved and Total Iron, Dissolved and Total Nickel and Stream flow

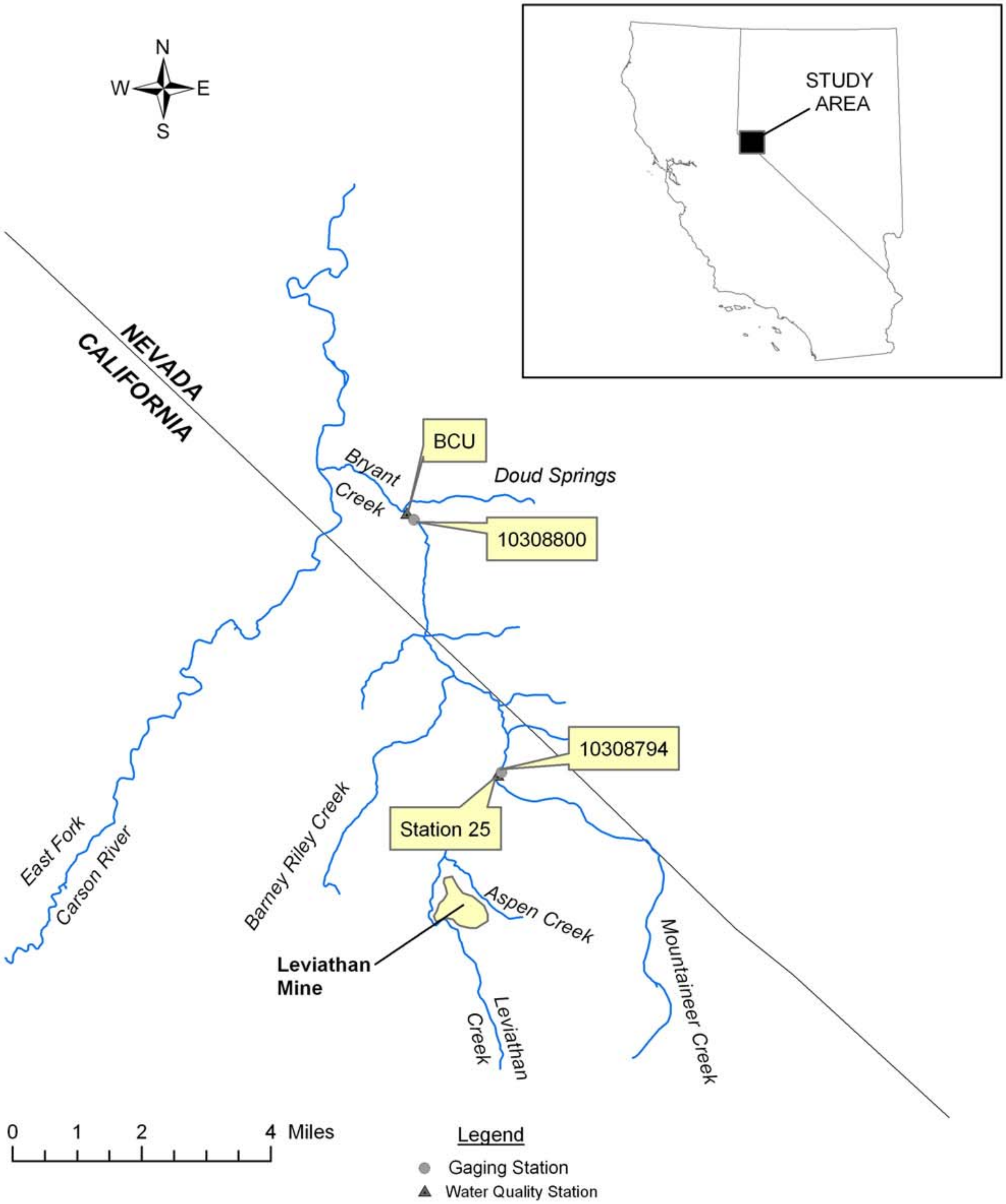
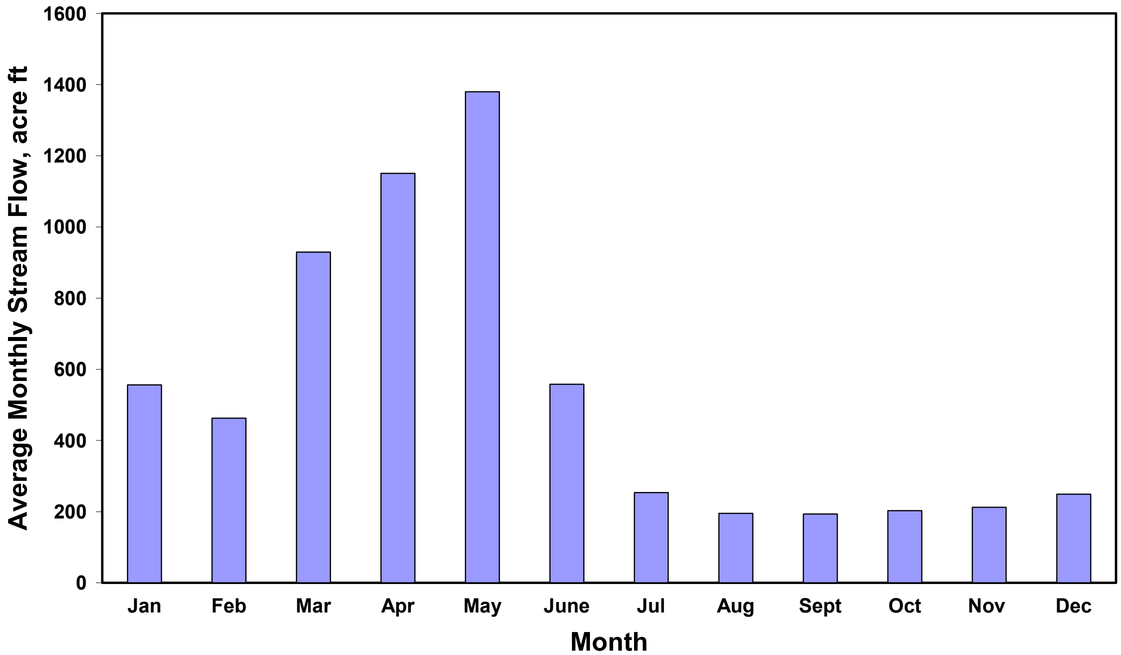


Figure 2. Selected Water Quantity and Quality Monitoring Stations

2.4.2 Water Quantity: Surface water in Bryant Creek is comprised primarily of direct runoff from rainfall and snowmelt with the highest flows typically occurring in March through May as shown in Figure 3. Bryant Creek drains a relatively small watershed with a total area of 35 square miles with about 30% of the watershed within Nevada (Calif. Regional Water Quality Control Board, 1975). USGS Gage 10308800 is located about 1.7 miles upstream from the confluence with the East Fork Carson River, and is above the Doud Springs inflow. At this point, the upstream watershed covers approximately 31.5 square miles with about 20% within Nevada (U.S. Geological Survey, 2002).

Figure 3. Average Monthly Stream Flow (1961-2001)--Bryant Creek Near Gardnerville, NV (USGS #10308800)

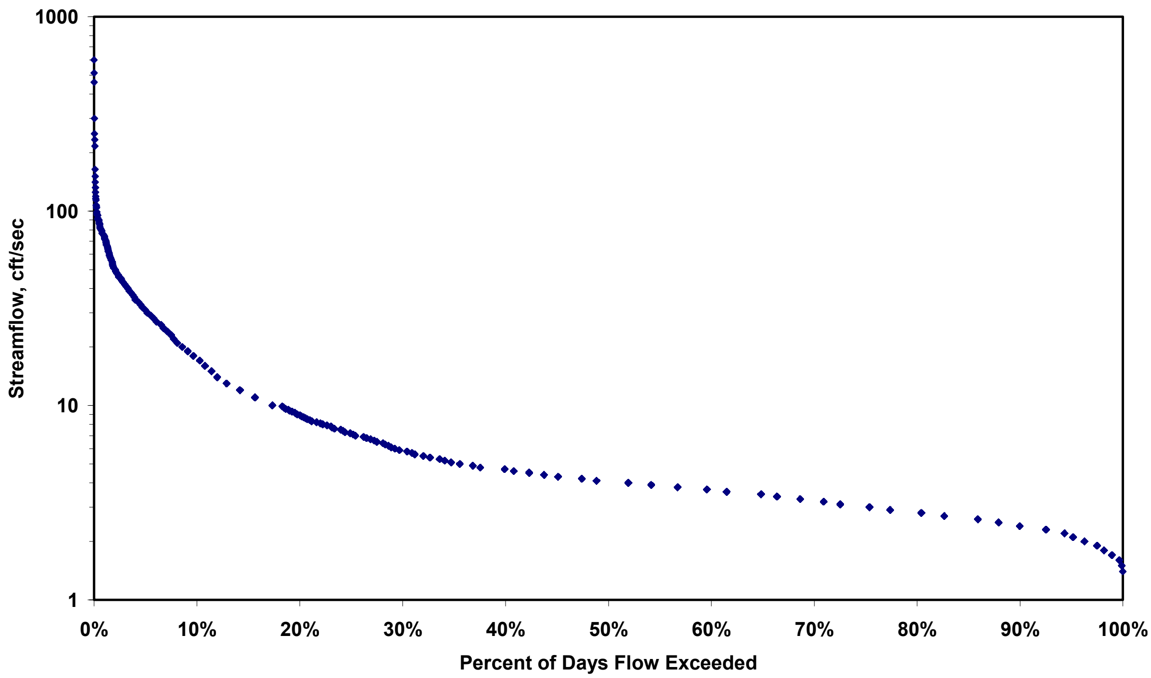


During the agricultural growing season, water from Bryant Creek is regularly diverted (just below the Doud Springs confluence) for irrigation purposes to the River Ranch. Frequently, the entire flow of Bryant Creek is diverted during the growing season (Calif. Regional Water Quality Control Board, 1975). Another River Ranch diversion is located about ¼ mile above the mouth of Bryant Creek (Calif. Dept. of Health Services).

On the average, Bryant Creek discharges about 7,000 acre-feet per year into the East Fork Carson River. Bryant Creek flows account for about 2 percent of the flow in the East Fork Carson River at this point.

The flow duration curve presented in Figure 4, is based on a percentage of the ranking of the Bryant Creek average daily stream flow rates between years 1961 and 2001, almost 7000 daily events. The plot demonstrates the frequency (or likelihood) of a particular stream flow rate occurring. The curve in Figure 4 was developed from data collected at USGS flow gauge #10308800, located above Doud Springs near Gardnerville, NV. During this period, Daily stream flow rates ranged from a low of 1.4 cu ft/sec to a high of 600 cu ft/sec with an average stream flow rate of 8.63 cu ft/sec.

Figure 4. Flow Duration Curve for Bryant Creek at USGS #10308800, 1961 - 2001



2.4.3 Water Quality: For over 50 years, acid mine drainage exiting the Leviathan Mine site has directly impacted Leviathan Creek and Aspen Creek water quality and subsequently the water quality of Bryant Creek. As discussed earlier, Bryant Creek first appeared on 303(d) lists in 1998 for copper, iron and nickel. The decision to include Bryant Creek on the 1998 List was based upon data and information collected by NDEP. As additional data were collected and evaluated, the 2002 Bryant Creek 303(d) Listing was expanded to include arsenic, turbidity, total suspended solids and temperature. Upon further examination, the listings of copper and temperature were found to be inappropriate and removal will be sought during the next 303(d) List cycle. Existing water quality is discussed in greater detail in ***Section 3.0 Total Maximum Daily Loads (TMDL).***

3.0 Total Maximum Daily Loads (TMDL)

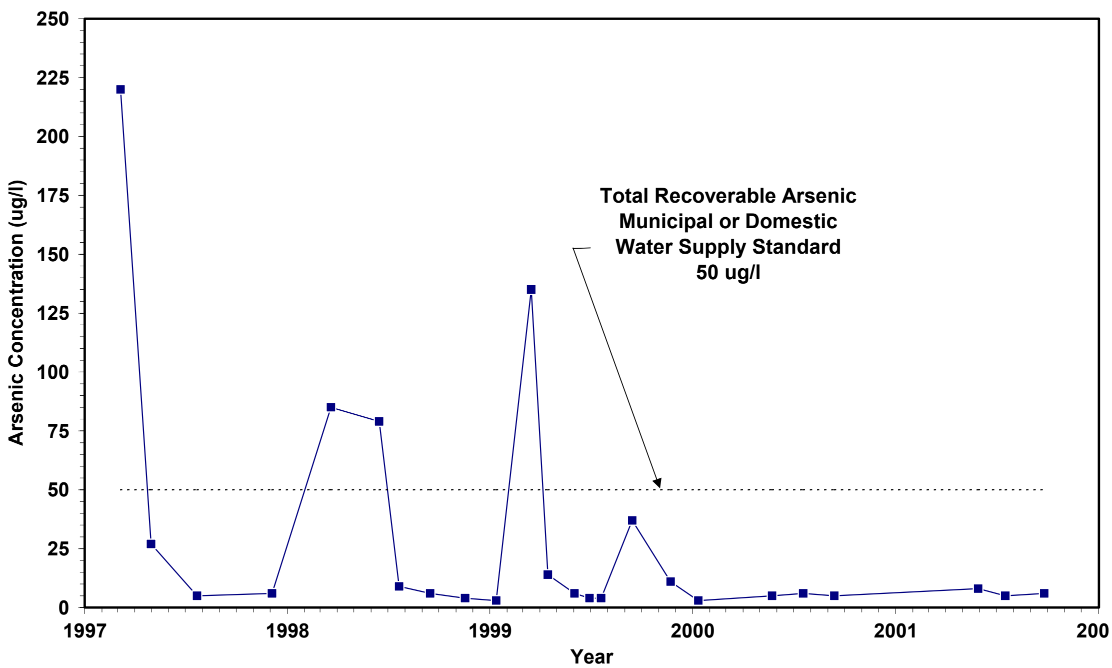
3.1 Total Arsenic TMDL

3.1.1 Problem Statement: Table 4 and Figure 5 summarize total recoverable arsenic data as collected by NDEP (Bryant Creek above Doud Springs) since 1997. An evaluation of NDEP data collected during the 1997-2001 period shows that exceedences of the total recoverable arsenic standard (50 µg/l) occurred about 17 percent of the time for the five-year period. Based upon these data and the associated exceedances, Bryant Creek was placed on the 2002 303(d) List for arsenic (total).

Table 4. Summary of Total Arsenic Water Quality Standards and Historic Data (µg/l)

Parameter	Bryant Creek above Doud Springs (NDEP Station BCU)	Bryant Creek below confluence of Mountaineer Creek (LRWQCB Station 25)
Most restrictive beneficial use	Municipal or Domestic Water Supply	Not applicable
Standard *(NAC 445A.144)*	50 µg/l	
Period of Record	1997-2001	1984-2001
No. of Samples	24	65
% Exceeding Standard	17%	Not applicable
Average	28.88	58.92
Median	6.0	7.8
Minimum	3.0	1.5
Maximum	220	1500

Figure 5. Total Recoverable Arsenic Concentrations - Bryant Creek above Doud Springs (BCU)



These arsenic standard exceedances have typically occurred during higher flow periods. At these times, the dissolved fraction of the total arsenic in the water is small. During low flow periods, a majority of the total arsenic appears in the dissolved form.

For comparison, LRWQCB data at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984 is also provided in Table 4. Approximately four miles separate the two monitoring sites with various inflows entering the Creek between Station 25 and BCU[1]. These inflows have likely resulted in lower arsenic concentrations in Bryant Creek at Station BCU.

3.1.2 Source Analysis: Impoundment pond overflow, acid mine drainage and natural seepage from arsenic-bearing waste rock at the Leviathan Mine have all contributed to Bryant Creek's arsenic impairment. Another potentially significant arsenic source is the arsenic-rich waste rock and overburden materials that were historically disposed of in Leviathan and Aspen Creeks and eventually transported downstream. These materials may remain in the creek channels and floodplains of Leviathan, Aspen and Bryant creeks (within California and Nevada), and continue to contribute to arsenic loading in the system. Additionally, arsenic-rich seeps or springs may be present within the Nevada portion of the watershed (CRWQCB, 2003) which accounts for about 20% of the drainage area above Bryant Creek at Monitoring Site BCU.

As shown in Figure 5, there have been no exceedances of the arsenic standard since 1999. This coincides with Lahontan Regional Water Quality Control Board's implementation of AMD treatment which freed up storage space in the existing evaporation ponds (See Section 2.1.1). Since that time, no evaporation pond overflows have occurred (CRWQCB). It must be noted that the area has been experiencing dry conditions[2] which has possibly contributed to the lack of pond overflows.

3.1.3 Target Analysis:As discussed earlier, NAC 445A.144 sets 50 µg/l as the allowable total recoverable arsenic concentrations in Bryant Creek. This standard has been set at a certain level as needed to ensure continued support of the associated beneficial use, being municipal or domestic water supply. While Bryant Creek is not currently used as a drinking water source, "municipal or domestic water supply" has been identified as one of its designated or potential beneficial uses. As such, NAC 445A.144 criteria still apply.

The arsenic standard of 50 µg/l coincides with the arsenic MCL (Maximum Contaminant Level) that had been previously set by Public Health Service in 1942 and then by EPA in 1975 under the Safe Drinking Water Act. Recent studies have linked arsenic ingestion to a number of health effects including cancer effects (skin, bladder, lung, etc.) and non-cancerous effects (cardiovascular, pulmonary, immunological, etc.). In a recent action to protect the public from these potential impacts, EPA revised the arsenic MCL to 10 µg/l with drinking water systems given until January 23, 2006 to comply (EPA, 2001). NDEP is currently evaluating options for incorporating this new MCL into NAC 445A.144. For the purposes of this TMDL, the total arsenic target has been set at 50 µg/l.

[1] The drainage area increases from 12.4 square miles at Station 25 to 31.5 square miles at BCU. During the period 2000-2002, flows at BCU were approximately 55% higher than flows at Station 25.
[2]Bryant Creek flows during 2000 and 2001 were at levels less than 50% of the long-term average.

3.1.4 Pollutant Load Capacity and Allocation: The total arsenic Load Capacity or TMDL for Bryant Creek above Doud Springs (for any given flow) is represented by the following equation:

TMDL (lbs/day) = Water Quality Target x Flow x 5.39 (Eq. 1)

Where:

Water quality target = 0.050 mg/l
Flow = streamflow at USGS Gage 1030880
5.39 = conversion factor

This TMDL is established at the "Above Doud Springs" site to correspond to NDEP's water quality data collection site and the nearby USGS gaging station. It is recognized that arsenic loading is coming from sources upstream of this site within both Nevada and California. However, additional investigations are needed to characterize the sources and their contributions. Therefore, a gross load allocation that accounts for all these sources has been set and is represented by the following equation:

Load Allocation (lbs/day) = TMDL (lbs/day) (Eq. 2)

No explicit margin of safety is needed in this equation. As previously discussed, TMDLs are to include a margin of safety to account for uncertainties in meeting the water quality standards when the target and TMDL are met. Through Equation 1, the TMDL is directly related to the water quality standard with no uncertainty in this relationship. While there is uncertainty in the gaging station flow data, this uncertainty impacts both sides of Equation 1 equally.

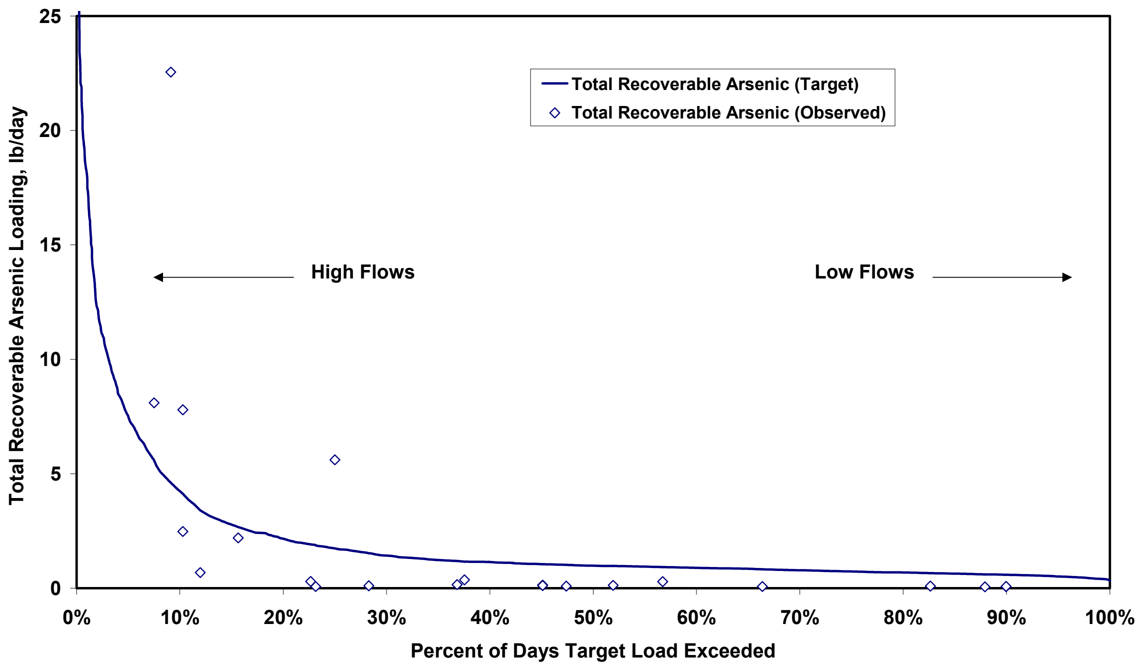
The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This has been accomplished through the use of the above equations whereby seasonal affects and critical conditions can be considered.

In some instances, TMDL reports present estimates of load reductions needed for compliance with the load allocations. However, this is not plausible for the Bryant Creek TMDL. There are insufficient data to accurately calculate historic loads and associated load reductions. However it can be stated that for TMDL compliance, load reductions are needed such that actual loads are at or below the Load Allocation (from Equation 2) at least 90% of the time[3].

Another tool for representing the flow-variable TMDL is the load duration curve as described in "Load Duration Curve Methodology for Assessment and TMDL Development" (NDEP, 2003). Using the load duration curve method, water quality data (as a load) are compared to allowable loads (calculated using Equation 1 and the flows for the period of record for USGS Station 1030880) (see Figure 6). Compliance with the TMDL occurs when 90% of the observed loads fall below the load duration curve. As already discussed and as shown in Figure 6, reductions are currently needed for the high flow loads.

[3] As described in Nevada's 2002 303(d) List, waters are identified as impaired when the water quality standards are exceeded in more than 10% of the samples.

Figure 6. Total Recoverable Arsenic Loading for Bryant Creek above Doud Springs, Nevada (BCU)



3.1.5 Future Needs: Following are future needs that have been identified for the phased total arsenic TMDL and related activities:

- As stated earlier, Bryant Creek's arsenic impairment can be attributed to a number of human-caused source and potential natural sources within Nevada and California. It has been suggested that additional work is needed to better identify and quantify these various arsenic sources. An initial step could include the addition of monitoring above Station BCU at the stateline to begin differentiating between loading within Nevada and within California.

  It may be that a detailed source analysis may not be necessary. Current remediation activities appear to have eliminated evaporation pond overflows, at least during the drier water years, resulting in compliance with Nevada's water quality standards. These results suggest that additional load reduction activities focused on other arsenic sources may not be needed. If this is the case, there is no need to further characterize these other sources. NDEP will continue to monitor Bryant Creek for compliance with the arsenic standard. If appropriate, Bryant Creek will be removed from the 303(d) List for arsenic.

- NDEP is currently evaluating options for incorporating the new arsenic MCL of 10 µg/l into NAC 445A.144. If this lower value is adopted, NDEP will need to revisit the arsenic TMDL. It is anticipated that proposed regulation changes related to arsenic and other toxics will be presented to the State Environmental Commission for their consideration during Fiscal Year 2004.

- The appropriateness of "municipal or domestic supply" as a beneficial use for Bryant Creek is questionable. Bryant Creek is not currently used as a municipal or domestic drinking water source and its potential for that use is limited given the impacts of Leviathan Mine and other sources. BWQP may need to consider undertaking a Use Attainability Analysis for this use on Bryant Creek.

3.2 Total Iron TMDL

3.2.1 Problem Statement: Table 5 and Figure 7 summarize total recoverable iron data as collected by NDEP (Bryant Creek above Doud Springs) since 1997. An evaluation of NDEP data collected during the 1997-2001 period shows that exceedences of the total recoverable iron standard occurred about 57 percent of the time during this period. Based upon these data and the associated exceedances, Bryant Creek was placed on the 2002 303(d) List for iron (total).

Table 5. Summary of Total Iron Water Quality Standards and Historical Data (µg/l)

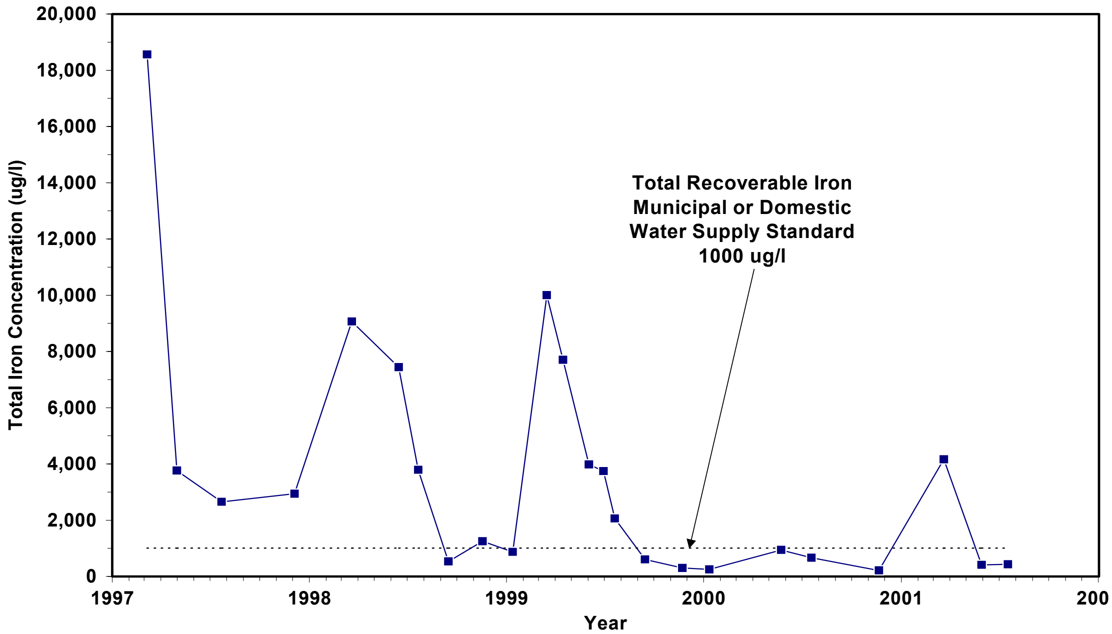
Parameter	Bryant Creek above Doud Springs (NDEP Station BCU)	Bryant Creek below confluence of Mountaineer Creek (LRWQCB Station 25)
Most restrictive beneficial use	Aquatic life	Not applicable
Standard *(NAC 445A.144)*	1000 µg/l	Not applicable
Period of Record	1997-2001	1984-2001
No. of Samples	23	42
% Exceeding Standard	57%	Not applicable
Average	3,596	16,300
Median	2,355	5,100
Minimum	210	120
Maximum	18,650	210,000

These iron standard exceedances have typically occurred during higher flow periods. During all flow conditions, the dissolved fraction of the total iron in the water is typically minor compared to the particulate fraction.

For comparison, LRWQCB data at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984 is also provided in Table 5. Approximately four miles separate the two monitoring sites with various inflows entering the Creek between Station 25 and BCU[4]. These inflows have likely resulted in lower iron concentrations in Bryant Creek at the Doud Springs monitoring site.

[4] The drainage area increases from 12.4 square miles at Station 25 to 31.5 square miles at BCU. During the period 2000-2002, flows at BCU were approximately 55% higher than flows at Station 25.

Figure 7. Total Recoverable Iron Concentrations - Bryant Creek above Doud Springs (BCU)



3.2.2 Source Analysis: Impoundment pond overflow, acid mine drainage and natural seepage from iron-bearing waste rock at the Leviathan Mine have all contributed to Bryant Creek's arsenic impairment. Another potentially significant arsenic source is the iron-rich waste rock and overburden materials that were historically disposed of in Leviathan and Aspen Creeks and eventually transported downstream. These materials may remain in the creek channels and floodplains of Leviathan, Aspen and Bryant creeks (within California and Nevada), and continue to contribute to iron loading in the system (CRWQCB, 2003). Additionally, other natural iron sources are possible within both states. Iron is a common rock and soil constituent found throughout the region and natural runoff and erosion processes are likely to be contributing iron to the Bryant Creek system.

As shown in Figure 7, there have been no exceedances of the total iron standard since 1999, with the exception of 2001. In 1999, Lahontan Regional Water Quality Control Board's implementation of AMD treatment freed up storage space in the existing evaporation ponds (See Section 2.1.1) and no further evaporation pond overflows have occurred (CRWQCB, 2003). It must be noted that the area has been experiencing dry conditions[5] which has possibly contributed to the lack of pond overflows. The one high iron concentration sample collected in 2001 suggests that sources other than impoundment overflows are significant contributors.

3.2.3 Target Analysis: As discussed earlier, NAC 445A.144 sets 1,000 µg/l as the allowable total recoverable iron concentrations in Bryant Creek. This standard has been set at a certain level as needed to ensure continued support of the associated beneficial use, being aquatic life.

[5]Bryant Creek flows during 2000 and 2001 have been at levels less than 50% of the long-term average.

Nevada's iron standard was taken from EPA's 1976 publication – "Quality Criteria for Water", also referred to as the Red Book. According to the Red Book, the main problems associated with elevated iron levels include toxicity to fish and macroinvertebrates; and iron precipitates covering stream bottoms thereby destroying bottom-dwelling invertebrates, plants or incubating fish eggs. For the purposes of this TMDL, the total iron target has been set at the iron water quality standard of 1,000 µg/l.

3.2.4 Pollutant Load Capacity and Allocation: The total iron Load Capacity or TMDL for Bryant Creek above Doud Springs (for any given flow) is represented by the following equation:

TMDL (lbs/day) = Water Quality Target x Flow x 5.39 *(Eq. 3)*

Where:

Water quality target = 1.0 mg/l
Flow = streamflow at USGS Gage 1030880
5.39 = conversion factor

This TMDL is established at the "Above Doud Springs" site to correspond to NDEP's water quality data collection site and the nearby USGS gaging station. It is recognized that iron loading is coming from sources upstream of this site within both Nevada and California. However, additional investigations are needed to characterize the sources and their contribution. Therefore, a gross load allocation that accounts for all these sources has been set and is represented by the following equation:

Load Allocation (lbs/day) = TMDL (lbs/day) *(Eq. 4)*

No explicit margin of safety is needed in this equation. As previously discussed, TMDLs are to include a margin of safety to account for uncertainties in meeting the water quality standards when the target and TMDL are met. Through Equation 3, the TMDL is directly related to the water quality standard with no uncertainty in this relationship. While there is uncertainty in the gaging station flow data, this uncertainty impacts both sides of Equation 3 equally.

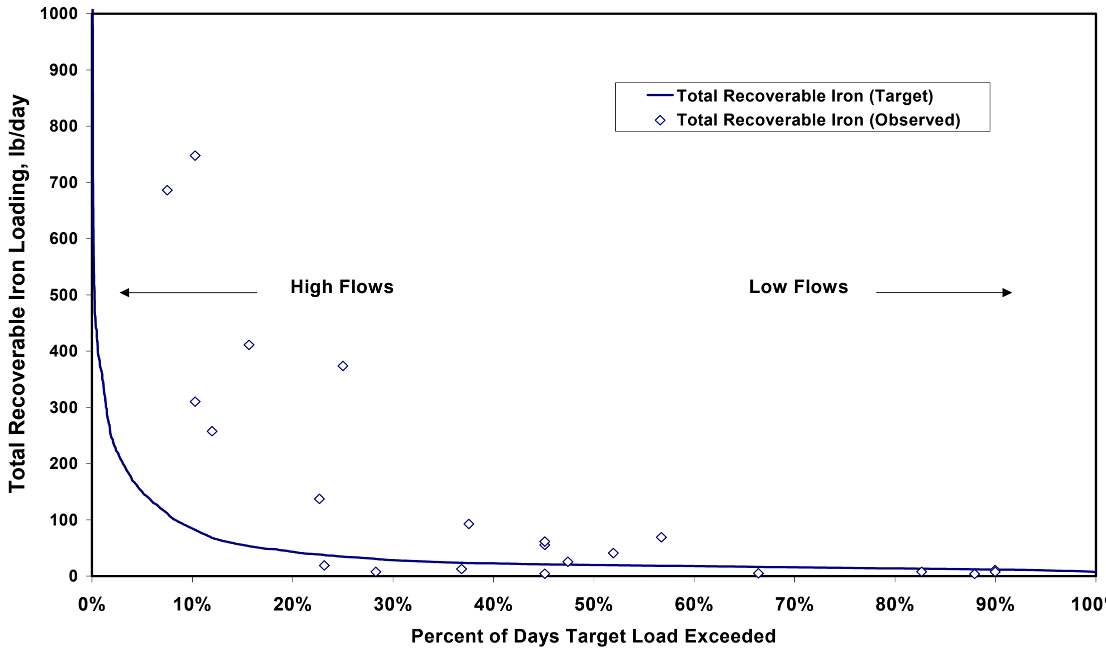
The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This has been accomplished through the use of the above equations whereby seasonal effects and critical conditions can be considered.

In some instances, TMDL reports present estimates of load reductions needed for compliance with the load allocations. However, this is not plausible for the Bryant Creek TMDL. There are insufficient data to accurately calculate historic loads and associated load reductions. However it can be stated that for TMDL compliance, load reductions are needed such that actual loads are at or below the Load Allocation (from Equation 4) at least 90% of the time[6].

[6] As described in Nevada's 2002 303(d) List, waters are identified as impaired when the water quality standards are exceeded in more than 10% of the samples.

Another tool for representing the flow-variable TMDL is the load duration curve as described in "Load Duration Curve Methodology for Assessment and TMDL Development" (NDEP, 2003). Using the load duration curve method, water quality data (in load) is compared to allowable loads (calculated using Equation 3 and the flows for the period of record for USGS Station 1030880) (see Figure 8). Compliance with the TMDL occurs when the observed loads fall below the load duration curve for 90% or more of the samples. As already discussed and as shown in Figure 8, reductions are needed for the higher flow loads.

Figure 8. Total Recoverable Iron Loading for Bryant Creek above Doud Springs, Nevada (BCU)



3.2.5 Future Needs: Following are future needs identified for the phased iron TMDL and related activities

- As stated earlier, Bryant Creek's iron loadings can be attributed to a number of human-caused sources and potential natural sources within Nevada and California. It has been suggested that additional work is needed to better identify and quantify these various iron sources. While CRWQCB's remediation efforts at Leviathan Mine have reduced iron levels in Bryant Creek, reductions in other sources may be necessary to meet the iron criteria as suggested by the elevated iron level in 2001 during a period of no impoundment overflow. Before these other sources can be targeted for reduction, a detailed characterization (source, timing, quantity) is needed. An initial step could include the addition of monitoring above Station BCU at the stateline to begin differentiating between loading within Nevada and within. California.

- Before significant resources are spent on better characterizing iron sources, the iron standard should be revised pending new guidance from EPA. As discussed above, Nevada's total iron water quality criteria was taken from EPA's Red Book. Upon closer examination, it becomes obvious that the Red Book criteria of 1.0 mg/l was based upon minimal information and its appropriateness needs to be questioned. In more recent years, EPA has been following a rather rigorous analysis in setting criteria for toxics. This same approach needs to be taken in revising the iron criteria. EPA recognizes this need and their website reports that they are currently working on revising the current aquatic life criteria for iron (EPA, 2003). NDEP will consider updating the iron standards following an iron criteria update from EPA. Other states are also recognizing the need for more appropriate iron criteria. In fact, Ohio EPA recently deleted their iron aquatic life standard of 1 mg/l. Based upon the presence of healthy aquatic populations in waters exceeding the 1 mg/l level, Ohio EPA concluded that this standard was not appropriate (Vorys, Sater, Seymour and Pease LLP, 2003).

3.3 Total Nickel TMDL

3.3.1 Problem Statement: Table 6 summarizes the total recoverable nickel data collected by NDEP above Doud Springs during 1997 as part of a special study. Other samples collected as part of NDEP's routine monitoring were not analyzed for nickel. While only three samples were collected as part of that special study, all contained total nickel levels in exceedance of the standard for the protection of municipal or domestic water supply. Based on the listing criteria used in 1998 303(d) List, these three exceedances were of sufficient quantity and magnitude to justify the inclusion of nickel in Bryant Creek's 1998 303(d) List. With no additional nickel data collected, there were no data to support delisting and nickel remained on the 2002 303(d) List for Bryant Creek.

Table 6. Summary of Water Quality Standards and Historical Total Nickel Data (µg/l)

Parameter	Bryant Creek above Doud Springs (NDEP Station BCU)	Bryant Creek below confluence of Mountaineer Creek (LRWQCB Station 25)
Most Restrictive Beneficial Use	Municipal or Domestic Water Supply	NA
Standard *(NAC 445A.144)*	13.4	NA
Period of Record	1997	1984-2001
No. of Samples Analyzed for Nickel	3	76
% Exceeding Standard	100%	NA
Average	96.18	111.60
Median	64.85	56.50
Minimum	35	1.00
Maximum	220	1,500

For comparison, LRWQCB data at Station 25 (Bryant Creek below the confluence with Mountaineer Creek) since 1984 is also provided in Table 6. Approximately four miles separate the two monitoring sites with various inflows entering the Creek between Station 25 and BCU[7].

[7] The drainage area increases from 12.4 square miles at Station 25 to 31.5 square miles at BCU. During the period 2000-2002, flows at BCU were approximately 55% higher than flows at Station 25.

These inflows have likely resulted in lower nickel concentrations in Bryant Creek at the Doud Springs monitoring site.

3.3.2 Source Analysis: Impoundment pond overflow, acid mine drainage and natural seepage from nickel-bearing waste rock at the Leviathan Mine have all contributed to Bryant Creek's nickel impairment. Another potentially significant source is the nickel-rich waste rock and overburden materials that were historically disposed of in Leviathan and Aspen Creeks and eventually transported downstream. These materials may remain in the creek channels and floodplains of Leviathan, Aspen and Bryant creeks (within California and Nevada), and continue to contribute to nickel loading in the system. Additionally, nickel-rich seeps or springs may be present within the Nevada portion of the watershed (CRWQCB, 2003).

3.3.3 Target Analysis: As discussed earlier, NAC 445A.144 sets 13.4 µg/l as the allowable total recoverable nickel concentrations in Bryant Creek. This standard has been set at a certain level as needed to ensure continued support of the associated beneficial use, being municipal or domestic water supply. While Bryant Creek is not currently used as a drinking water source, "municipal or domestic water supply" has been identified as one of its designated or potential beneficial uses. As such, NAC 445A.144 criteria still apply.

The nickel standard of 13.4 µg/l is based upon an earlier EPA's recommendation for the protection of human health resulting from the ingestion of nickel through water and aquatic organism consumption. For the purposes of this TMDL, the total nickel target has been set at 13.4 µg/l.

3.3.4 Pollutant Load Capacity and Allocation: The total nickel Load Capacity or TMDL for Bryant Creek above Doud Springs (for any given flow) is represented by the following equation:

TMDL (lbs/day) = Water Quality Target x Flow x 5.39 (Eq. 5)

Where:

Water quality target = 0.0134 mg/l
Flow = streamflow at USGS Gage 1030880
5.39 = conversion factor

This TMDL is established at the "Above Doud Springs" site to correspond to NDEP's water quality data collection site and the nearby USGS gaging station. It is recognized that nickel loading is coming from sources upstream of this site within both Nevada and California. However, additional investigations are needed to characterize the sources and their contributions. Therefore, a gross load allocation that accounts for all these sources has been set and is represented by the following equation:

Load Allocation (lbs/day) = TMDL (lbs/day) (Eq. 6)

No explicit margin of safety is needed in this equation. As previously discussed, TMDLs are to include a margin of safety to account for uncertainties in meeting the water quality standards when the target and TMDL are met. Through Equation 5, the TMDL is directly related to the water quality standard with no uncertainty in this relationship. While there is uncertainty in the gaging station flow data, this uncertainty impacts both sides of Equation 5 equally.

The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This has been accomplished through the use of the above equations whereby seasonal effects and critical conditions can be considered.

In some instances, TMDL reports present estimates of load reductions needed for compliance with the load allocations. However, this is not plausible for the Bryant Creek TMDL. There are insufficient data to accurately calculate historic loads and associated load reductions. However it can be stated that for TMDL compliance, load reductions are needed such that actual loads are at or below the Load Allocation (from Equation 6) at least 90% of the time[8].

3.3.5 Future Needs: Following are future needs identified for the phased nickel TMDL and related activities

- As stated earlier, Bryant Creek's nickel loadings can be attributed to a number of human-caused source and potential natural sources within Nevada and California. It has been suggested that additional work is needed to better identify and quantify these various nickel sources. While CRWQCB's remediation efforts at Leviathan Mine have reduced nickel levels in Bryant Creek, reductions in other sources may be necessary to meet the nickel criteria. Before these other sources can be targeted, a detailed characterization (source, timing, quantity) is needed. An initial step could include the addition of monitoring above Station BCU at the stateline to begin differentiating between loading within Nevada and within California. However, it is recommended that the following issues be resolved prior to any detailed source evaluation.

- The nickel 303(d) listing is based upon limited data. NDEP needs to institute nickel analyses for the Bryant Creek water samples to confirm the listing. Currently, NDEP is working with the Nevada State Health Laboratory to incorporate nickel analyses into our program. Once the Health Laboratory has provided cost estimates, NDEP will evaluate its specific needs related to nickel and other constituents.

- The nickel standard of 13.4 µg/l is based upon an outdated EPA recommendation for the protection of human health resulting from the ingestion of nickel through both water and aquatic organism consumption. Based upon current guidance (EPA, 2002), EPA's human health criteria (water and organism consumption) has been raised to 610 µg/l. However, neither of these values are deemed to be appropriate for the protection of "municipal or domestic supply use" as they do not focus solely on the consumption of water.

  NDEP is currently evaluating the standards for nickel and other metals for possible revision. Typically, NDEP has used Safe Drinking Water Act MCLs (maximum contaminant levels) for the protection of "municipal or domestic supply" beneficial uses. Currently, there is no nickel MCL for drinking water systems under the Safe Drinking

[8] As described in Nevada's 2002 303(d) List, waters are identified as impaired when the water quality standards are exceeded in more than 10% of the samples.

Water Act. In 1992, EPA established a nickel MCL of 100 µg/l but the standard was later removed in response to a lawsuit (EPA Ground Water and Drinking Water website, 2003). Currently, EPA uses a health advisory level of 100 µg/l for nickel concerns. According to their website, EPA intends to complete re-establish a nickel MCL, but the time-frame is unknown. It is recommended that Nevada's nickel water quality standard be revised once the MCL is re-established.

- The appropriateness of "municipal or domestic supply" as a beneficial use for Bryant Creek is questionable. Bryant Creek is not currently used as a municipal or domestic drinking water source and its potential for that use is limited given the impacts of Leviathan Mine and other sources. BWQP may need to consider undertaking a Use Attainability Analysis for this use on Bryant Creek.

3.4 Turbidity and Total Suspended Solids TMDL

3.4.1 Problem Statement: NDEP has monitored and collected data from Bryant Creek at the Doud Springs site since 1997 (Table 13). From Table 7 and Figures 9 and 10, exceedence of the turbidity and total suspended solids (TSS) standards occurred 46% and 29% of the time, respectively, during the 1997 through 2001 monitoring period. As would be expected, the highest observed exceedences typically occurred during the spring months when run-off is higher. Based upon these data and the associated exceedances, Bryant Creek was placed on the 2002 303(d) List for turbidity and TSS.

Table 7. Summary of Turbidity and Total Suspended Solids Water Quality Standards and Historical Data (mg/l)

Parameter	Bryant Creek above Doud Springs (BCU)	
Pollutant	Turbidity	Total Suspended Solids
Most restrictive beneficial use	Aquatic Life	Aquatic Life
Standard (NAC 445A.148)	10 NTU	25 mg/l
Period of Record	1997-2001	1997-2001
No. of Samples	24	24
% Exceeding Standard	46%	29%
Average	23.87	25.75
Median	11.4	16
Minimum	2.8	0
Maximum	108.1	96

Both Figures 9 and 10 show that since July 1999, both standards have only been exceeded once each. Both occurred simultaneously in March 2001. No exceedance was identified during 2000, however, it is likely that NDEP sampling was not frequent enough to capture the spring runoff. In 2000, samples were only collected in January and May with higher flows occurring March and April.

Figure 9. Turbidity - Bryant Creek above Doud Springs, Nevada (BCU)

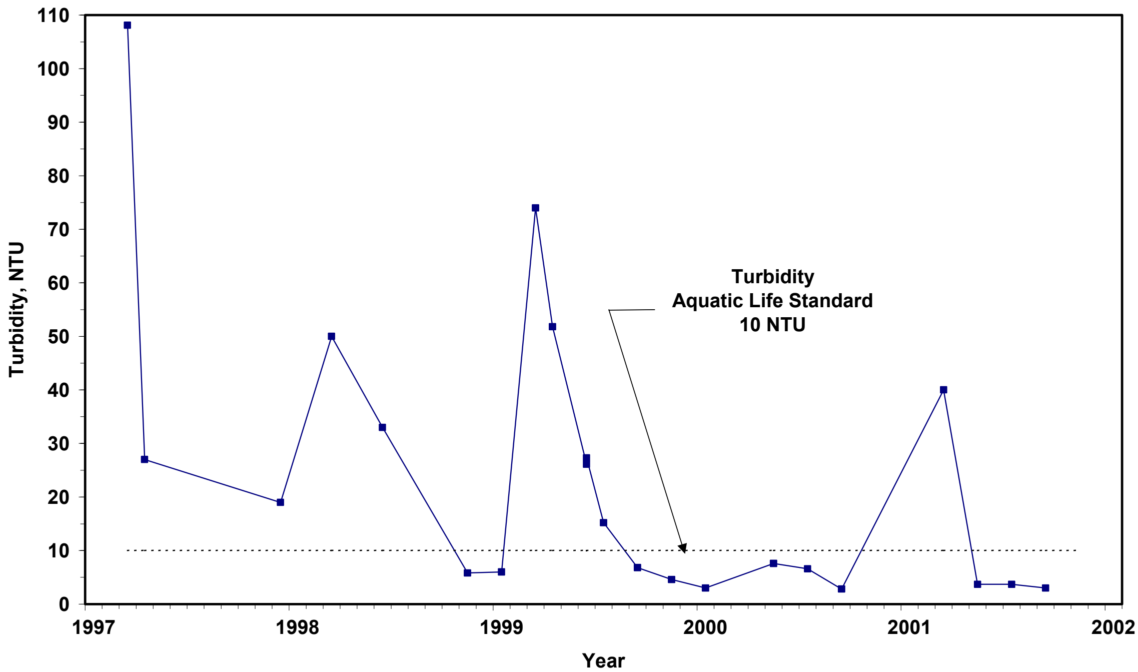
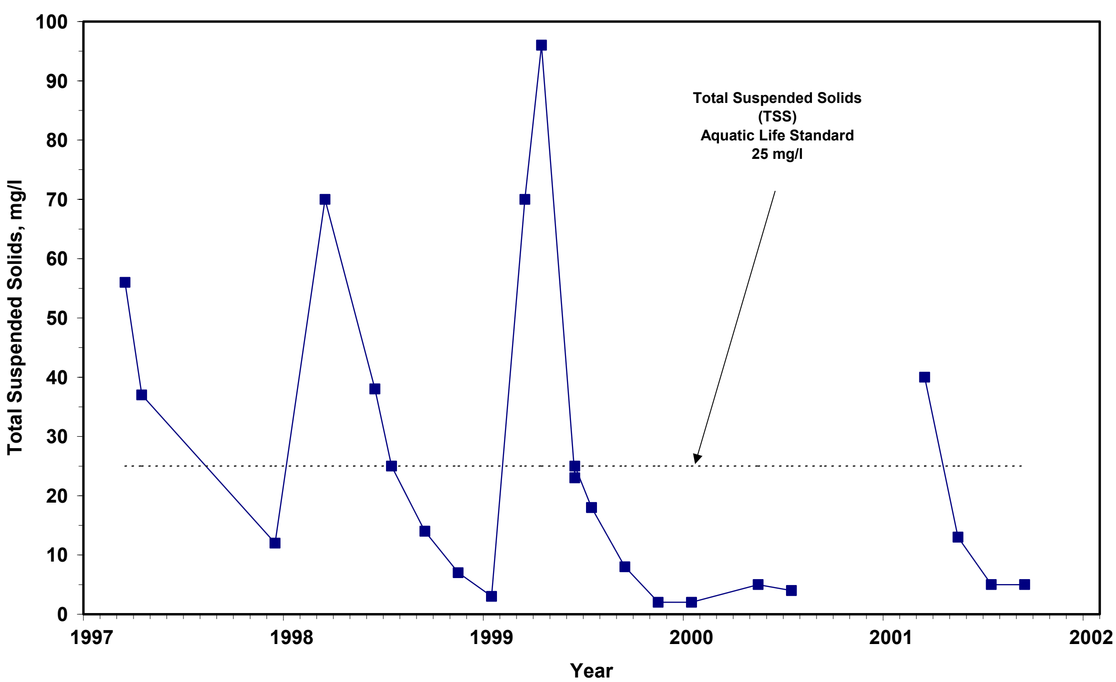


Figure 10. Total Suspended Solids - Bryant Creek above Doud Springs, Nevada (BCU)



3.4.2 Source Analysis: Numerous potential sediment sources exist in the Nevada and California portions of the Bryant Creek watershed. These sources include natural erosion in the watershed and the stream channel, and erosion from dirt roads, trails, mining activities, grazing, etc. With no water quality monitoring at the state line, sediment levels entering Nevada are not quantifiable at this time.

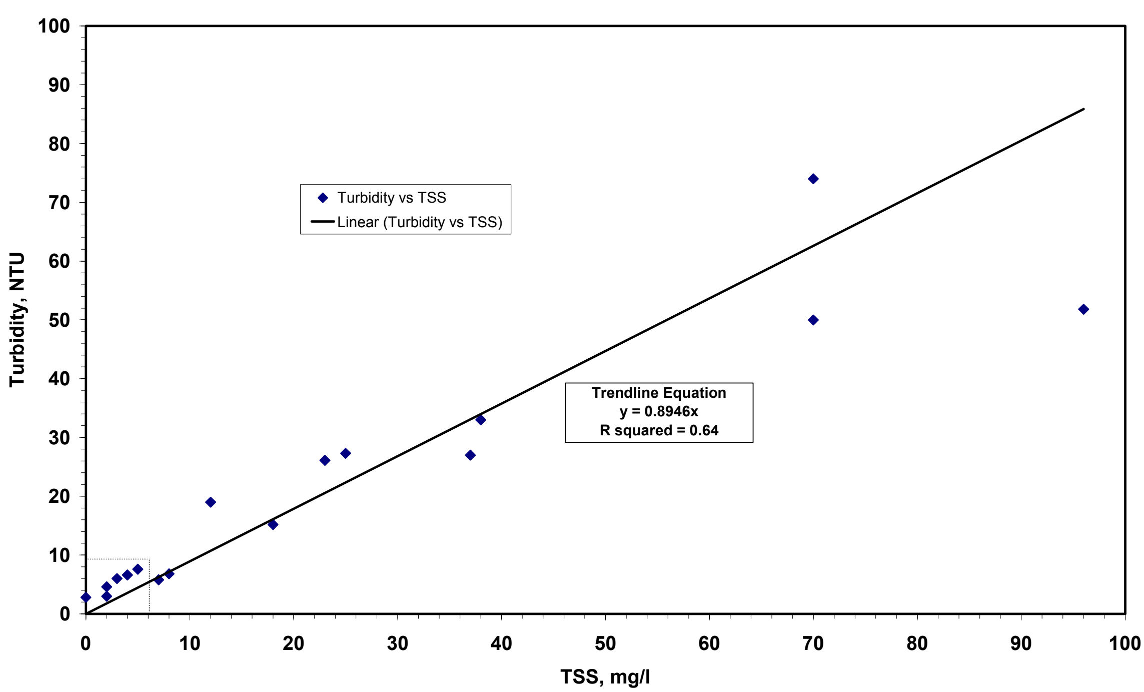
The impact of the Leviathan remediation efforts on sediment loading is unknown. While remediation activities prevented impoundment overflows in 2000 and 2001, standard exceedances were still identified in 2001 suggesting that other sources are a significant factor.

3.4.3 Target Analysis: As discussed earlier, NAC 445A.148 sets 10 NTU and 25 mg/l as the water quality standards for turbidity and total suspended solids, respectively. Nevada's turbidity and TSS standards were taken from past water quality criteria publication (National Technical Advisory Committee, 1968; National Academy of Sciences, 1972). These standards have been set at a certain level as needed to ensure continued support of the associated beneficial use, being aquatic life. Turbidity and TSS can impact aquatic life in several ways: 1) settleable solids block stream bottoms gravels affecting macroinvertebrate and fish egg survival; 2) sediment can clog gills interfering with respiration; 3) sediment can be abrasive to gills; and 4) sediment can impair the ability of sight-feeding species (such as trout) to feed.

The turbidity standard of measurement (NTU) is unique in the fact that it is not directly amenable to any loading equation. Therefore, the use of TSS as a surrogate for turbidity was evaluated. A linear regression (Figure 11) of the water quality data yielded the following equation:

Turbidity (NTU) = TSS (mg/l) x 0.8946 (Equation 7)

Figure 11. Turbidity vs. TSS - Bryant Creek at Doud Springs, Nevada (at BCU)



Based upon this equation, the turbidity standard of 10 NTU equates to a TSS level of 11 mg/l, which is considerably lower than the TSS water quality standard (25 mg/l). This relationship demonstrates that both the turbidity standard and the TSS standards are met when TSS levels are at or below 11 mg/l. Therefore, a TSS level of 11 mg/l was selected as the TMDL target.

3.4.4 Pollutant Load Capacity and Allocation: The TSS Load Capacity or TMDL for Bryant Creek above Doud Springs (for any given flow) is represented by the following equation:

TMDL (lbs/day) = Water Quality Target x Flow x 5.39 (Eq. 8)

Where:
Water quality target = 11 mg/l
Flow = streamflow at USGS Gage 1030880
5.39 = conversion factor

This TMDL is established at the "Above Doud Springs" site to correspond to NDEP's water quality data collection site and the nearby USGS gaging station. It is recognized that TSS loading is coming from sources upstream of this site within both Nevada and California. However, additional investigations are needed to characterize the sources and their contributions. Therefore, a gross load allocation that accounts for all these sources and includes a margin of safety is represented by the following equation:

Load Allocation (lbs/day) = TMDL (lbs/day) x 0.90 (Eq. 9)

Where:
0.90 = margin of safety

As previously discussed, TMDLs are to include a margin of safety to account for uncertainties in meeting the water quality standards when the target and TMDL are met. A factor of 0.90 has been selected to account for uncertainty in the relationship between TSS and turbidity.

The TMDL is intended to reflect adequate water quality needs across the entire range of flows rather than at a single flow, i.e. average flow. This has been accomplished through the use of the above equations whereby seasonal effects and critical conditions can be considered.

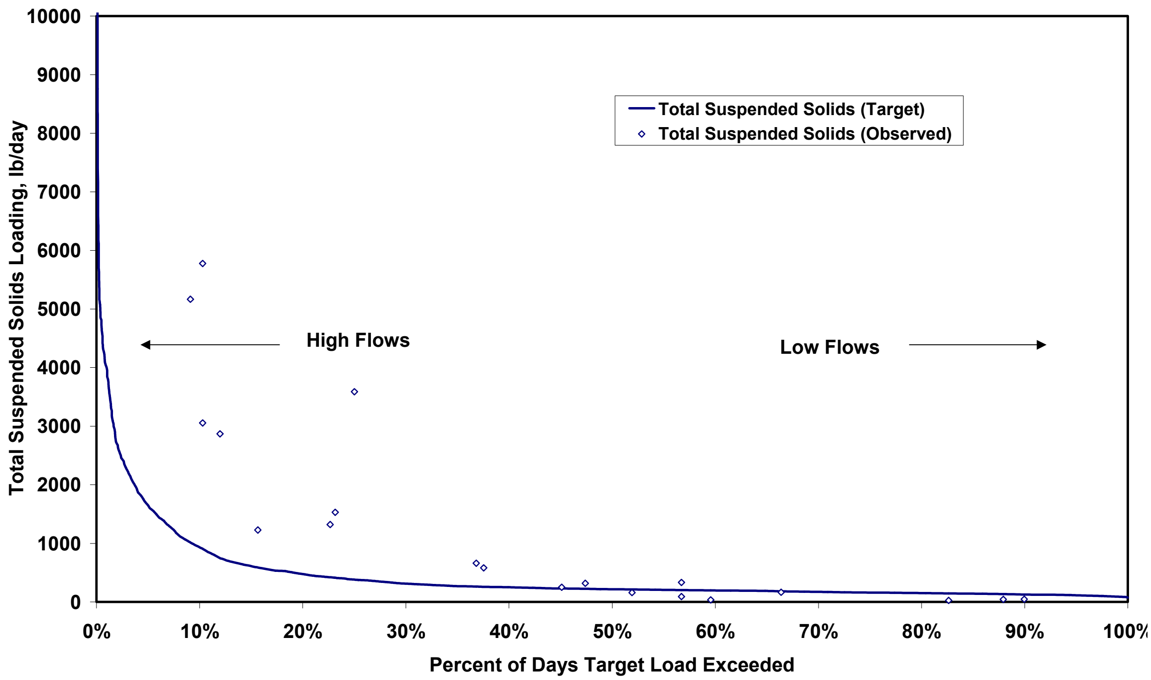
In some instances, TMDL reports present estimates of load reductions needed for compliance with the load allocations. However, this is not plausible for the Bryant Creek TMDL. There are insufficient data to accurately calculate historic loads and associated load reductions. However it can be stated that for TMDL compliance, load reductions are needed such that actual loads are at or below the Load Allocation (from Equation 9) at least 90% of the time[9].

Another tool for representing the flow-variable TMDL is the load duration curve as described in "Load Duration Curve Methodology for Assessment and TMDL Development" (NDEP, 2003). Using the load duration curve method, water quality data (in load) are compared to allowable

[9] As described in Nevada's 2002 303(d) List, waters are identified as impaired when the water quality standards are exceeded in more than 10% of the samples.

loads (calculated using Equation 1 and the flows for the period of record for USGS Station 1030880) (see Figure 12). Compliance with the TMDL occurs when the observed loads fall below the load duration curve for 90% or more of the samples. As already discussed and as shown in Figure 8, reductions are needed for the higher flow loads.

Figure 12. Total Suspended Solids Loading for Bryant Creek above Doud Springs, Nevada (BCU)



3.4.5 Future Needs: Following are future needs identified for the phased TSS/turbidity TMDL and related activities:

- Little is known about the specific TSS and turbidity sources within the watershed. As stated earlier, potential sediment sources in the Bryant Creek watershed include natural erosion in the watershed and the stream channel, and erosion from dirt roads, trails, mining activities, grazing, etc. With no water quality monitoring at the state line, sediment levels entering Nevada are not quantifiable at this time. A source assessment is needed to characterize (location, amount, timing) the various sources within the watershed. An initial step could include the addition of monitoring above Station BCU at the stateline to begin differentiating between loading within Nevada and within California.

- As additional data are collected, the linear regression relationship between TSS and turbidity can be revisited for subsequent TMDL revisions.

References

California Department of Health and Human Services. Public Health Assessment, Evaluation of Leviathan Mine Site, CAD980673685. May 7, 2003.

California Regional Water Quality Control Board (CRWQCB) – Lahontan Region. Report on Pollution of Leviathan Creek, Bryant Creek and the East Fork Carson River caused by the Leviathan Sulphur Mine. January 1975.

California Regional Water Quality Control Board (CRWQCB) – Lahontan Region. Comments on *Draft Bryant Creek: Total Maximum Daily Loads – Arsenic, Copper, Iron, Nickel, Turbidity, Total Suspended Solids and Temperature (March 2003).* June 4, 2003.

The Leviathan Mine Council Natural Resources Trustees. "Leviathan Mine Natural Resource Damage Assessment Plan, Public Release Draft. May 6, 2002.

National Academy of Sciences. Water Quality Criteria (Blue Book). 1972.

National Technical Advisory Committee. Water Quality Criteria (Green Book). 1968

Nevada Division of Environmental Protection. "Load Duration Methodology for Assessment and TMDL Development". April 2003.

U.S. Environmental Protection Agency. Quality Criteria for Water (Red Book). 1976.

U.S. Environmental Protection Agency. *Guidance for Water Quality Based Decisions—The TMDL Process.* EPA 440/4-91-001. April 1991

U.S. Environmental Protection Agency. Protocol for Developing Sediment TMDLs. EPA 841-B-99-004. October 1999.

U.S. Environmental Protection Agency. "EPA Proposes Leviathan Mine for Superfund List." Fact Sheet. November 1999.

U.S. Environmental Protection Agency. "NPL Site Narrative at Listing." Federal Register Notice, EPA Superfund Website. May 11, 2000.

U.S. Environmental Protection Agency. Technical Fact Sheet: Final Rule for Arsenic in Drinking Water, EPA 815-F-00-016. January 2001.

U.S. Environmental Protection Agency. National Recommended Water Quality Criteria: 2002. EPA-822-R-02-047. November 2002.

U.S. Environmental Protection Agency. Aquatic Life Water Quality Criteria - http://www.epa.gov/waterscience/criteria/aqlife.html. September 19, 2003.

U.S. Environmental Protection Agency. Ground Water and Drinking Water website - http://www.epa.gov/safewater/ccl/ccl_fr.html. September 22, 2003.

U.S. Geological Survey. Water Resources Data – Nevada: Water Year 2002. 2003.

Vory, Sater, Seymour and Pease LLP. Environmental Alerts - http://www.vssp.com/CM/Environmental%20Alerts/environmental%20alerts89.asp. September 19, 2003.

Appendix A

Water Quality and Quantity Data at Selected Monitoring Stations

Table A-1. Historical Data Bryant Creek above Doud Springs (NDEP Station BCU)

Date	Total Arsenic (µg/l)	Total Iron (µg/l)	Total Nickel (ug/l)	Total Suspended Solids (mg/l)	Turbidity (NTU)	Stream flow (cfs)
3/6/97	220	18,560	220	56	108.1	19.0
4/30/97	27	3,760	35	37	27.0	17.0
7/22/97	5	2,650	67			4.8
12/4/97	6	2,940		12	19.0	4.3
3/20/98	85	9,060		70	50.0	17.0
6/15/98	79	7,440		38	33.0	14.0
7/21/98	9	3,790		25		4.9
9/15/98	6	533		14		4.2
11/17/98	4	1,250		7*	5.8	4.8
1/12/99	<3	870		3*	6.0	4.5
3/16/99	135	10,000		70	74.0	7.7
4/15/99	37	7,700		96	51.8	25.0
6/2/99	14	3,980		23	26.1	11.0
6/29/99	11	3,740		25	27.3	4.8
7/20/99	6	2,060		18	15.2	3.8
9/14/99	4	600		8*	8.0	4.1
11/22/99	4	300		2*	4.8	2.7
1/11/00	<3	250		2*	3.0	3.7
5/23/00	5	940		5*	7.6	3.8
7/18/00	6	660		4*	6.6	2.4
9/12/00	5	210		0*	2.8	2.4
3/20/01	8.0	4,160		40	40.0	6.8
5/29/01	5.0	410		13	3.7	2.6
7/17/01	6.0	430		5*	3.7	1.8
9/25/01	5.0	230		5*	3.0	1.9

* Laboratory reported levels less than detection limit (10 mg/l) and identified results as estimates.

Table A-2. Historical Data Bryant Creek Below Confluence with Mountaineer Creek (CRWQCB STATION 25)

Date	Total As, ug/l	Total Cu, ug/l	Total Fe, ug/l	Total Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)	*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
8/1/1984	150.00		21000		
10/2/1984	100.00		33000	320.00	
11/16/1984	20.00		20000	160.00	
7/1/1985	10.00		14000	200.00	
9/3/1985	20.00		11000	200.00	
11/1/1985	10.00		7400	100.00	
5/28/1986	83.00		18000	100.00	
7/14/1986	24.00		6600	100.00	
8/15/1986	7.00		5300	100.00	
9/18/1986	5.00		7800	200.00	
10/20/1986	4.00		3600	100.00	
6/10/1987	7.00		4200	100.00	
8/21/1987	3.00		2500	100.00	
10/6/1987	4.00		2200	100.00	
3/30/1988	20.00		7800	70.00	
6/2/1988	4.00		3200	50.00	
8/1/1988	4.00		1500	50.00	
10/21/1988	14.00		4900	140.00	
5/18/1989	170.00		12000	150.00	
7/7/1989	4.00		3400	60.00	
8/14/1989	4.00		1000	50.00	
9/6/1990	5.00		690	20.00	
8/23/1991	5.00		1300	20.00	
10/31/1991	4.00		2700	5.00	
4/7/1993	69.00		210000	110.00	19.06
5/18/1993	35.00		7700	20.00	8.16
6/28/1993	16.00		10000	130.00	1.87
9/8/1993	4.0		2900	73.0	1.40

Table A-2. Historical Data Bryant Creek Below Confluence with Mountaineer Creek (CRWQCB STATION 25)--continued

Date	Total As, ug/l	Total Cu, ug/l	Total Fe, ug/l	Total Ni, ug/l	Flow, cu ft/sec
Minimum Detection Limit (MDL)	*5.0* ***µg/l***	*2.5* ***µg/l***	*100.0* ***µg/l***	*2.5* ***µg/l***	
1/15/1994	1500.0		110000	1500.0	
1/18/1994	700.0		74000	910.0	3.6
3/11/1994	44.0	100.0	6200	180.0	2.24
4/1/1994	110.0		14000	190.0	
4/18/1994	24.0	27.0	7500	74.0	3.56
12/29/1994				68.0	
3/18/1998	190.0	91.0	11000	150.0	
4/20/1998	67.0	67.0	14000	51.0	
2/3/1999	160.0	110.0	18000	340.0	
3/16/2000	17.0	27.0	4700	5.0	
3/23/2000	12.0		5100	62.0	
3/31/2000	13.00	14.0	5400	47.0	
4/6/2000	6.7	8.5	3400	37.0	
4/14/2000	9.3	9.5	3900	40.0	
4/17/2000	8.3	6.8	3700	44.0	
4/28/2000	7.8	6.4	3800	30.0	
4/28/2000	10.0	<2.5	3800	34.0	
5/5/2000	8.6	5.0	3100	56.0	
5/12/2000	<5.0	7.3	3700	57.0	
5/30/2000	5.0	5.5	1900	53.0	
6/15/2000	<5.0		2100	48.0	
7/31/2000	5.0		310	41.0	
8/29/2000	<5.0		680	45.0	
9/27/2000	5.0	5.0	1100	<2.5	
10/30/2000	5.0	5.0	1800	36.0	
11/28/2000	5.0	5.0	840	29.0	
12/28/2000	5.0	5.0	1400	41.0	
1/26/2001	5.0	5.0	1300	38.0	
3/1/2001	5.0	5.0	1100	33.0	
3/27/2001	22.0	12.0	3200	42.0	
3/27/2001	5.0	13.0	2800	50.0	
4/24/2001	26.0	29.0	4600	38.0	
4/24/2001	8.1	12.0	17000	43.0	
4/25/2001	5.0	30.0	6200	34.0	
5/29/2001	5.0	5.0	1900	33.0	
6/27/2001	5.0	5.0	<100	5.4	
6/27/2001	5.0	5.0	1800	20.0	
7/26/2001	5.0	5.0	330	9.3	
7/26/2001	5.0	5.0	<100	5.0	
8/25/2001	<5.0	5.9	440	11.0	