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FIVE YEAR REVIEW OF THE WHITEWOOD CREEK SUPERFUND SITE LEAD, SOUTH DAKOTA

July 2002

Prepared by:

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Region VIII
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With technical assistance from:

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USEPA FIVE-YEAR REVIEW SIGNATURE COVER

Key Review Information

SITE IDENTIFICATION		
Site Name: WHITEWOOD CREEK		**EPA ID:** SDD980717136
Region: 8	**State:** SD	**City/County:** Whitewood/ Lawrence County
SITE STATUS		
NPL Status: DELETED		
Remediation Status: COMPLETE		
Multiple OUs: N		**Number of OUs:** 1
Construction Completion Date: December 21, 1992		
Fund/PRP/Federal Facility lead: PRP		**Lead agency:** USEPA Region VIII
Has site been put into reuse? N		
REVIEW STATUS		
Who Conducted the review (USEPA Region, State, Federal agency): USEPA Region		
Author name: Rebecca Thomas		**Author title:** Remedial Project Manager
Author Affiliation: USEPA Region VIII		
Review Period: 7/1996 to 12/2001		**Date of site inspection:** July 16 & 17, 1996
Review Type: STATUTORY		**Review Number:** 1
Triggering Action Event: Start date of Remedial Action		
Trigger Action Date: September 25, 1991		**Due Date:** January 31, 1997

DEFICIENCIES:

The following five deficiencies were identified during the review:

- Two instances of development in the tailings impacted area of the site without the prior application or soil sampling required by the county ordinance development guidelines.
- Reference information on development guidelines within the site and maps of the tailings impacted area were reported to be missing from Butte County.
- Unauthorized development activities within the tailings impacted area of the Site, and suspected pathways potentially contributing to the recontamination at the Holsclaw property suggest that this information needs to be reiterated or better communicated to residents through the education program.

None of these were determined to be sufficient to warrant a finding of not protective, as long as corrective actions are taken.

RECOMMENDATIONS AND REQUIRED ACTIONS:

The following recommendations are required to ensure the protection of human health and the environment at the Site:

- Prepare updated maps of each residential property affected by the County Ordinances that restrict development activities within the Site. These maps will detail property use, tailings deposits and tailings impacted (100 ppm arsenic) areas within each residence.
- Notification of County Agencies of development activities within the tailings-impacted areas, as Homestake becomes aware of these activities. Include description of development activities and county notification to USEPA in quarterly monitoring reports.
- Supply Butte County with the appropriate map and county development guideline reference materials.
- Modify annual educational materials to address the following:
    - Include a point of contact at the appropriate county offices for development activities.
    - Include an awareness of county ordinances governing development as a "Site Resident's Role"

PROTECTIVENESS STATEMENT(S):

The remedial actions and the institutional controls (as long as corrective actions are taken) are considered protective. The remedy for the Whitewood Creek Superfund Site is considered to remain protective of human health and the environment.

SIGNATURE OF USEPA REGIONAL ADMINISTRATOR or DIVISION DIRECTOR

Signature

7/17/02
Date

Name and Title

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LIST OF ACRONYMS

ARARs	Applicable or Relevant & Appropriate Requirements
ARSD	Administrative Rules of South Dakota
AWQC	Ambient Water Quality Criteria
BOR	Bureau of Reclamation
CERCLA	Comprehensive, Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive, Environmental Response, Compensation and Liability Information System
CFR	Code of Federal Regulations
COPC	Constituent of Potential Concern
DGFP	Department of Game, Fish and Parks
DWNR	Department of Water and Natural Resources
EA	Endangerment Assessment
ERA	Ecological Risk Assessment
ESD	Explanation of Significant Difference
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FS	Feasibility Study
GS	Geological Survey
HQ	Hazard Quotient
MCL	Maximum Contaminant Level
NCP	National Contingency Plan
NPL	National Priorities List
O&M	Operation and Maintenance
PM10	Particulate Matter with a diameter of 10 micrometers or less
PNL	Pacific Northwest Laboratory
PRP	Primary Responsible Party
QAPP	Quality Assurance Project Plan
ROD	Record of Decision
SC	Specific Conductance
SD	South Dakota
TSS	Total Suspended Solids
SRC	Syracuse Research Corporation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WAD	Weak Acid Dissociable (cyanide)

1.0 INTRODUCTION

The United States Environmental Protection Agency (USEPA) Region VIII has conducted a five-year review of the remedial actions implemented at the Whitewood Creek site in Lead, South Dakota. This review was conducted from July 1996 through December 2001. The report was completed by USEPA Region VIII with technical assistance from Syracuse Research Corporation (SRC). This report documents the results of the five-year review.

1.1 Purpose of Review

As specified in the Record of Decision (ROD) for the Whitewood Creek site, a review of the remedial action will be conducted no less than each five years after initiation of the remedial action to ensure that human health and the environment are being protected (USEPA, 1990).

Therefore, the purpose of this five-year review is to determine whether the remedy at the Whitewood Creek site is protective of human health and the environment. The methods, findings and conclusions of the review are documented in this five-year review report. In addition, the five-year review report identifies deficiencies found during the review, if any, and provides recommendations to address them.

1.2 Statute Requirements

USEPA must implement five-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA section 121(c), as amended, states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.*

The NCP part 300.430(f)(ii) of the Code of Federal Regulations (CFR) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and*

unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

1.3 First Review

This is the first five-year review for the Whitewood Creek Site. On behalf of Homestake, Chadwick Ecological Consultants, Inc. (Chadwick) initiated the five-year review of the Whitewood Creek site and submitted their findings in a report dated January 1997 (Chadwick et al., 1997). Among the comments on this five-year review report, USEPA identified the need for additional studies to be conducted at the Site, including an ecological risk assessment (USEPA, 1997a).

In a letter responding to USEPA, dated November 7, 1997 (George, 1997), Homestake refused to conduct any additional studies at the Site, and invoked the dispute resolution provision of the Consent Decree. Homestake argued that the terminated 1990 Consent Decree was no longer a valid tool for USEPA to use to seek additional studies related to the Site.

USEPA invoked Section VII of the Consent Decree, directing Homestake to perform additional work in connection with the Five-Year Review of the Site. This request was later withdrawn, and USEPA proceeded with the additional studies of the Whitewood Creek site on a cost-recovery basis.

This five-year review report includes the findings from the 1997 report submitted by Homestake (Chadwick et al., 1997) and the additional studies of Whitewood Creek to complete the first five-year review of the Site.

1.4 Triggering Action for Review

In keeping with the requirements of CERCLA 121(c) and the NCP, statutory reviews are triggered by the initiation of a remedial action that will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure after the remedial action is complete. The earliest remedial action associated with a remedy that will leave hazardous substances, pollutants, or contaminants at the site triggers a statutory five-year review (USEPA, 1999a).

The remedy implemented at the Whitewood Creek site resulted in mine tailings remaining at the site above levels that allow unlimited use and unrestricted exposure (USEPA, 1990). Thus, a statutory five-year review is required to be conducted to ensure that human health and the environment are being protected. The trigger date for the statutory review is September 25, 1991, which is the start date for remedial action activities reported in USEPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database.

The Consent Decree (United States v. Homestake, 1991) requires that USEPA review the Site no less often than every five years after initiation of the Remedial Action to assure that human health and welfare and the environment are being protected by the work implemented in the Consent Decree.

The five-year review completion date was modified by the Site Operations and Maintenance (O&M) Plan (WDC, 1994b). The O&M plan requires five-year data review collection activities to be completed within five years of the remedial action start date, by September 25, 1996, and the Five-Year review report to be completed by January 31, 1997. This modification was made to allow a reasonable amount of time to transpire before embarking on the significant data collection and soil sampling activities associated with the five-year review for this Site (USEPA, 1996). A schedule based on the Five-Year Review Report being completed within five years of the start date of the remedial action (September, 1996), would have required five-year review soil sampling activities to occur within three years following completion of remediation (USEPA, 1996). The modified schedule requires sampling activities to be completed by September 25, 1996 and the five-year review report to be completed by January 31, 1997, and on the five year anniversaries of these dates.

1.5 Structure of the Five-Year Review Report

The five-year review is completed according to the Comprehensive Five-Year Review Guidance (USEPA, 1999a). The document is organized into eleven sections, as recommended by the guidance:

> Introduction. Chapter 1 provides the introduction of the five-year review. This is a synopsis of the five-year review process including who performed the review, the purpose of the review, the statutory requirements for the review, the trigger for the review and the structure of the report.

Site Chronology. Chapter 2 provides the chronology of the Whitewood Creek site. This includes major events, documents, and remedial actions.

Background. Chapter 3 provides a description of the Site including physical setting, land and resource use, contaminants and initial response.

Remedial Actions. Chapter 4 provides a description of the remedial action objectives, the remedy, remedy implementation, O&M requirements and O&M activities to date.

Five-Year Review Findings. Chapter 5 describes the findings of the five-year review including the results of interviews, site inspection, ARAR review, risk recalculations, ecological risk assessment results and data review.

Assessment. Chapter 6 provides a discussion of the conclusions reached in the five-year review.

Deficiencies. Chapter 7 discusses any deficiencies identified in the remedial action.

Recommendations and Required Actions. Chapter 8 provides any recommendations and actions required to achieve protectiveness. The recommendations include the responsible parties, agencies with oversight authority and the recommended schedule for completion.

Protectiveness Statement(s). Chapter 9 provides the protectiveness statement(s) for the Whitewood Creek site.

Next Review. Chapter 10 provides a statement on when the next review is required, the trigger for the next review and the tasks to be performed as part of the review.

References. Chapter 11 provides the references for the five-year review document.

2.0 SITE CHRONOLOGY

Table 2-1 summarizes the chronology of events at the Whitewood Creek Site.

2.1 Initial Discovery of Contamination

From 1877 to 1977, operations at the Homestake Mine involved the direct discharge of tailings into Whitewood Creek. Since 1977, process materials and water have been treated prior to discharge. In 1960, the South Dakota (SD) Department of Health quantified solids and cyanide loading to Whitewood Creek. In 1965, the SD Department of Game, Fish and Parks (DGFP) concluded that aquatic bottom organisms were absent in Whitewood Creek downstream from the waste discharges. From 1970 to 1971, a series of studies by USEPA, the US Food and Drug Administration (FDA) and the University of SD were conducted to document the magnitude and extent of the tailings. The studies focused on the environmental hazards associated with mercury and their results led to the discontinuation of mercury amalgamation process by Homestake. In December 1970, results of these studies led to the discontinuance of mercury in gold recovery operations (USEPA, 1990).

In the winter of 1974-75, about 50 Holstein cattle that were part of a dairy operation located adjacent to Whitewood Creek died of unknown causes. Later, a study by the SD University Department of Veterinary Science concluded that the cattle had died of arsenic toxicosis due to consumption of corn silage that had been contaminated by the accidental incorporation of mining wastes with fodder during silo-filling operations. A joint study, conducted by the SD Geological Survey (GS) and the SD Water Resources Division between May 1975 and July 1978, investigated the presence of arsenic in surface and groundwater along Whitewood Creek, the Belle Fourche River and portions of the Cheyenne River. This study, published in 1978, found arsenic concentrations ranging from 2.5 to 1,530 ug/L in groundwater from areas with large tailings deposits (USEPA, 1990).

One common conclusion of these investigations was that Whitewood Creek would remain highly contaminated until the discharge of tailings was discontinued. To comply with new environmental laws, including the Ore Mining and Dressing Effluent Guidelines, Homestake implemented the Grizzly Gulch Tailings Disposal project, an impoundment area for tailings storage. The tailings disposal system became operational on December 1, 1977. Since 1977, no tailings have been discharged into Whitewood Creek (USEPA, 1990).

2.2 National Priorities List (NPL) Listing

The Whitewood Creek site was placed on the interim National Priorities List (NPL) at the request of the governor of South Dakota in September 1981. At this time, USEPA sent a notice letter to Homestake regarding potential liability. On September 8, 1983, the Whitewood Creek site was placed on the NPL. Homestake submitted a petition to USEPA to delete Whitewood Creek from the NPL. A report entitled Assessment of Exposure and Possible Effects on Human Health of Gold Mine Tailings in the Whitewood Creek Area of South Dakota was completed in April of 1985 by Environ Corp. to support Homestake's petition for delisting. Homestake also submitted a second petition for delisting the Site in 1985, which was rejected by USEPA as being premature. In 1996, the Whitewood Creek site was deleted from the NPL (USEPA, 1990).

2.3 Decision and Enforcement Document

In December of 1988, an Administrative Order on Consent was signed by USEPA and Homestake. This order concluded that the studies completed by Fox Consultants, Inc., (1984a and 1984b) constituted the functional equivalent of a remedial investigation, as prescribed by the National Contingency Plan (NCP). The order required that Homestake conduct a Feasibility Study (FS) to identify and evaluate alternatives for remedial action (USEPA, 1990). In July of 1989, the Final Environmental Assessment (EA) was completed by USEPA with the assistance of Jacobs Engineering (Jacobs, 1989). In December of 1989, the FS was completed by ICF technology on behalf of Homestake (ICF, 1989a and 1989b). In January of 1990, the Administrative record was established and in March of 1990 the ROD was issued (USEPA, 1990). In August 1990, USEPA and Homestake signed a Consent Decree for Homestake to implement the ROD through Remedial Design and Remedial Action at the Site. This agreement was lodged in the U.S. District Court for South Dakota on October 10, 1990, (Case Number 90-5101), and entered by the Court on April 4, 1991.

2.4 Start and Completion of Remedial Actions

The selected remedial action for the Whitewood Creek site includes:

- Removal and/or covering frequently used areas of residential sites with arsenic levels above 100 mg/kg with clean surface soil (arsenic <20 mg/kg);

- Disposal of the arsenic-contaminated soil;

- Revegetation of the remediated area;
- Soil sampling at all remediated areas to confirm that arsenic levels are below 100 mg/kg;
- Implementing institutional controls including land and access restrictions;
- Conducting an annual education program to inform site residents of the potential health hazards associated with exposure to tailings, soil, and alluvial groundwater contaminated with arsenic;
- Refining knowledge of the extent of contamination and delineating the 100-year floodplain of Whitewood Creek; and
- Surface water monitoring.

USEPA invoked Applicable or Relevant and Appropriate Requirement (ARAR) waivers based on the technical impracticability of remediating contaminated ground and surface waters. The estimated cost of the remedial action at the time of the ROD was $882,813, which includes an annual Operation and Maintenance (O&M) cost of $12,000 for years 1 to 5 and $6,000 for years 6 to 30 (USEPA, 1990).

2.4.1 Remediation of Soils at Residences

In 1992, remediation was completed at 16 residences. Approximately 4,500 cubic yards of materials were removed from the individual residences/sites and placed at the on-site disposal facility (USEPA, 1993).

On July 16 and 17th 1996, inspections and interviews were conducted at all remediated sites as part of the five-year inspection and interview program. The residential five-year verification sampling program was conducted on July 18 and 19, 1996 by Homestake at 6 of the residential properties located within the boundaries of the Superfund site. One property contained arsenic concentrations above the site action level of 100 mg/kg. This property (the Holsclaw residence) was remediated in accordance with the Site Operation and Maintenance (O&M) Plan (WDC, 1994b)

2.4.2 Land Use Institutional Controls

Land Use Restrictions

The institutional control portion of the remedy was implemented during 1993 and 1994. In accordance with the requirements of the ROD, Butte, Meade and Lawrence Counties adopted ordinances in late 1993 and early 1994 that prohibited construction of new residential or commercial structures on the tailings deposits, restricted future development in tailings-impacted areas of the Site, and prohibited removal and use of tailings from outside the tailings areas. A county building permit handbook was developed to aid in the future implementation of the proposed ordinances, and approved by USEPA on November 29, 1993. The handbook defines the steps necessary for residential development of the tailings impacted areas (WDC, 1994b).

State Well Ban Regulation

A State well ban regulation prohibiting wells in the 100 year floodplain of Whitewood Creek remains in effect to limit exposure to groundwater from the downgradient alluvial aquifer.

2.4.3 Annual Education Program

In 1993, Homestake began distributing an annual fact sheet to educate the public on Site hazards and ways to minimize the risk posed by residual contamination (USEPA, 1994). Educational materials were distributed annually to residents during the first quarter of each year from 1993 through 2001.

2.4.4 Extent of Contamination and Delineation of 100 Year Floodplain

The boundaries of the tailings deposits, tailings impacted soils and the 100-year floodplain boundary of Whitewood Creek were delineated during extensive field programs that began the summer of 1991 and ended in the fall of 1992. The detailed maps for these boundaries were approved by USEPA on April 15, 1993 (WDC, 1994a).

2.4.5 Surface Water Monitoring Program

The surface water monitoring program was implemented in May of 1993 to evaluate the unknown rates of release of arsenic from the tailings deposits in Whitewood Creek. Homestake collected

water samples four times annually from two United States Geological Survey (USGS) gauging stations from May 1993 to present. The first USGS station is 06436180 (Whitewood Creek above Whitewood) and is located at the upper end of the NPL site boundary, downstream of the Crook City Bridge. The station located downstream of the confluence with Gold Run and downstream of the tailings discharge point on Gold Run. The second USGS sampling station is 06436198 (Whitewood Creek Above Vale) is located at the downstream end of the NPL site boundary, above the confluence with the Belle Fourche River. Sampling times occurred (1) in late winter before major snow-melt runoff; (2) during peak runoff in the spring; (3) during the low flow period in late summer; and (4) once immediately following a major precipitation event (Addendum B to WDC, 1994b).

Arrangements were made between the USGS Water Resources Division, South Dakota District Office in Rapid City and Homestake for collection and analyses of the surface water samples (Addendum B to WDC, 1994b). Homestake submitted quarterly reports providing the results of the sampling and analyses.

2.5 Construction Completion

Remediation activities at the residences began on September 30, 1991 with a pilot remediation project, and were completed during the fall of 1992. Construction of the Disposal Site began on September 30, 1991 and was completed on September 30, 1992. Construction activities at the Topsoil and Topsoil Subgrade Borrow Site were conducted during the period of September 26, 1991 through September 18, 1992. The Temporary Stream Crossing construction began on July 29, 1992 and removal work was completed by September 7, 1992.

The re-remediation of the Holsclaw property, required as a result of the five year review verification sampling, began in November of 1997 and was completed by late June, 1998 (WDC, 1998).

2.6 Prior Five Year Reviews

This is the first five-year review for the Whitewood Creek site. The five-year review process was initiated by Homestake in 1996 and their findings are reported in Chadwick et al. (1997). Among other comments and issues raised on the report, USEPA identified the need for additional studies to be conducted at the Site to evaluate protectiveness, including an Ecological Risk Assessment (ERA).

This five-year review report includes the findings from the review initiated by Homestake (Chadwick et al., 1997), the findings from the additional studies and ERA (Attachment 5-3), and data and activities conducted as part of Site O&M. This report completes the first five-year review of the Whitewood Creek site.

3.0 BACKGROUND

3.1 Physical Characteristics

The former Whitewood Creek Superfund site is located in Lawrence, Meade and Butte Counties in South Dakota (Figure 3-1). The Site is situated in west central South Dakota on the northern perimeter of the Black Hills, 40 miles northwest of Rapid City on Interstate 90. The town of Whitewood is located about one mile west of the Site (ISSI, 1998; Chadwick et al., 1997).

The Whitewood Creek Site encompasses the 100 year floodplain along an 18 mile stretch of Whitewood Creek from stream mile 18 near the town of Whitewood to stream mile 0 where the Creek flows into the Belle Fourche River. The Site includes the floodplain and surrounding areas that have become contaminated with Site wastes.

3.2 Site Environmental Setting

Whitewood Creek is a tributary of the Belle Fourche River flowing northeast from its source in the Black Hills of South Dakota past the Homestake Mine and the towns of Lead, Deadwood and Whitewood before emerging onto the floodplain of the Belle Fourche on the Missouri Plateau. It is fed by several small headwater streams that enter upstream of the 18 mile segment, and flows into the Belle Fourche River at the downstream end of the 18 mile segment. The Belle Fourche River joins the Cheyenne River approximately 130 miles further downstream (Fox Consultants, Inc., 1984a).

Prior to the initiation of tailings discharge, Whitewood Creek was a small stream with insufficient capacity to move large quantities of sediment. In adjustment to the entry of vast tonnages of tailings sediments into the stream, the length of the stream channel diminished, primarily through meander abandonment, thereby increasing the stream gradient and thus the stream sediment carrying capacity. Abandoned meanders were filled with tailings and natural alluvium. Successive layers of these sediments were deposited in overbank areas, particularly during periods of ice jamming. As the meanders were being abandoned, the stream began a period of down cutting along the course of the present channel. Downcutting was limited by resistant coarse alluvial deposits and by shale outcrops that form the streambed in many places (Fox Consultants, Inc., 1984a).

The present course of Whitewood Creek in the 18-mile study area is a 4-braided pattern with occasional bends or meanders within the broader bottomland. In the upper reaches of the study area, the channel is comparatively straight with few meanders and few bends. Although the present channel is not entirely stable, many of the overbank terraces and abandoned meanders have tailings deposits that have been stable for many decades. A dense cover of leaf mulch, grass, and mature trees, some of which are 2 feet in diameter, exist on many of these stable areas (Fox Consultants, Inc., 1984a).

For Whitewood Creek within the study area, the width of the stream channel is between 40 and 80 feet and the depths from the floodplain to lowest bottomland are about 5 to 8 feet. Under base flow conditions, the flow is approximately 20 to 50 cubic feet per second. About 10 to 25 percent of this flow is effluent discharge from the Homestake wastewater treatment plant at Lead (Cherry et al., 1985; Fox Consultants, Inc., 1984a).

3.2.1 Vegetative Cover

Native vegetation comprises approximately 75 percent of the study area. The remaining area consists of irrigated and nonirrigated croplands (approximately 18 percent) and rangeland/developed areas (7 percent) (Fox Consultants, Inc., 1984a). Riparian woodlands are the most abundant and widespread native vegetative community type. They are concentrated along both the Whitewood Creek and the Belle Fourche River floodplains. Crops in the study area include corn, oats, alfalfa, and hay from range grasses (primarily smooth brome) (USEPA, 1989a). In 1983, Fox Consultants Inc. as part of the Whitewood Creek Study Phase I (Fox Consultants, Inc., 1984a) characterized the vegetative community using visual reconnaissance (four occasions and three seasons) and field sampling.

Native floodplain or riparian woodland vegetation communities are dominated by plains cottonwood (*Populus sargentii*), eastern cottonwood (*P. deltoides*), narrow-leaf cottonwood (*P. angus tifolia*), Amercian elm (*Ulmus americana*), green ash (*Fraxinus pennsylvanica*), willow (*Salix spp.*), box elder (*Acer negundo*), Russian olive (*Elaeagnus angus-tifolia*), and bur oak (*Quercus macrocarpa*). Seedlings and saplings of the overstory species typically dominate understory vegetation. Snowberry (*Symphoricarpos albus*) is a common shrub and perennial grasses are the prevalent ground cover. Dominant grasses included several species of blue grass (*Poa spp.*), wheatgrass (*Agropyron spp.*) as well as smooth brome (*Bromus inermis*) and prairie cordgrass (*Spartina pectinata*) (Fox Consultants, Inc., 1984a). Streamside vegetation includes willow and perennial grasses.

General trends in the abundance and species composition of the native vegetation were reported by Fox Consultants Inc. (1984a) between the upper and lower portions of the study area and between the two stream floodplains. The vegetative communities are described as two zones with plant communities exhibiting relatively constant species composition within each of the two zones.

The first zone is bounded by the confluence of Crow Creek and Whitewood Creek continuing south (upstream) to Crook City and Whitewood. In this zone the topography is steeper and more broken with floodplain width being more restricted. Woodland composition is dominated by bur oak with the plains cottonwood and narrow leaf cottonwood occurring in relatively small quantities. Some ponderosa pine occurs on the edge of the floodplain, near Crook City (Fox Consultants, Inc., 1984a).

The second zone begins, generally, at the confluence of Whitewood Creek and Crow Creek continuing along Whitewood Creek and then eastward along the Belle Fourche River. Basic vegetation characteristics change in response to elevation and topography. The reduced gradients and lower elevations downstream of the Whitewood Creek-Crow Creek confluence encourage an increase in the occurrence of American elm, box elder, green ash, and a decrease in importance of bur oak. Cottonwoods and willow attain greater frequency as the transition occurs from the broken terrain of the foothills to the relatively level terrain of the plains. Plains cottonwood and willow dominate the riparian woodlands with the comparative abundance of willow and cottonwood changing on a site-specific basis depending on local hydrology. Russian olive appears as a minor species upstream becoming increasingly more prevalent downstream (Fox Consultants, Inc., 1984a).

The riparian corridor along Whitewood Creek generally increases in width and tree height with increasing distance downstream. The boundaries of the woodlands closely coincide with floodplain boundaries. Adjacent plant associations in the valley floor include fields of alfalfa, corn and hay and rangeland used for livestock grazing. Over-grazing by livestock (cattle and sheep) was apparent along some stream stretches (Fox Consultants, Inc., 1984a).

The riparian corridor along the Belle Fourche River is more fragmented than Whitewood Creek due to more intense agricultural activities and as such contains a less developed riparian woodland. The understory is less well developed, tree size is greater, fewer species were present and the overhead tree canopy is more open. Cottonwood, willow, Russian olive, green ash, and box elder are the primary overstory and understory species (Fox Consultants, Inc., 1984a).

Mine tailings are reported to be confined to the floodplain (USEPA, 1989a). Although some tailings deposits remain barren, it is reported that a plant community with limited diversity has gradually colonized the tailings (USEPA, 1990). The barren areas have been invaded by rhizomatous grasses, forbs and small shrubs (USEPA, 1989a). Succession appears to begin when grasses take root in leaf litter trapped in depressions in the surface of the tailings. Some trees in the tailings deposits have been dated at over 100 years old (USEPA, 1990). The available study does not report plant stress in or around the tailings areas (USEPA, 1989a).

3.2.2 Aquatic Ecology

Whitewood Creek and the Belle Fourche River are the surface waters located within and adjacent to the Site, respectively. These waters are located in the north high plains of the Black Hills region of western South Dakota and are classified as transitional streams located between the eco-regions of Rocky Mountain Forest and Great Plains Shortgrass Prairie (Bailey, 1982). Whitewood Creek originates in the northern Black Hills, while the Belle Fourche River originates in northeastern Wyoming, south of the town of Gillette. Whitewood Creek in the study area is a moderate gradient stream with well-developed riparian areas. Influence of livestock grazing and agricultural use is visible at many locations, and evidence of historic mining activities occurs in the form of tailings deposits (Chadwick et al., 1997).

Whitewood Creek is classified by the State of South Dakota as warm water permanent fish life propagation waters in the lower portion (from the Belle Fouche River to Interstate 90) and coldwater marginal fish life propagation waters from Interstate 90 to the confluence with Gold Run (South Dakota SL 74:51:03:03). A semipermanent warm water fishery does exist in the creek (ICF, 1989a) The State of South Dakota has reportedly stocked trout in the upper reaches of Whitewood Creek. This cold water fishery cannot be established on a permanent basis due to habitat restrictions (high temperature and low flow) (ICF, 1989a).

It is postulated that the aquatic flora and fauna of Whitewood Creek changed in response to improvements in the Homestake mine discharge and municipal water treatment in 1984. Some improvements were effected after completion of biological studies by Herricks (1982), Fox Consultants, Inc. (1984a), and Goddard (1989). The Herricks (1982) study described a creek flowing through three ecological zones. The upper third of the creek as a cold, fast-flowing water with the fish community dominated by cold-water species. The middle third of the creek (corresponding to the upper half of the 18-mile site reach) was described as a transitional area where the water becomes warmer, has more pools and riffles providing a transition to more

warm-water species. The lower third of the creek (corresponding to the lower half of the 18 mile site reach) runs onto a low-gradient landscape before emptying into the Belle Fourche River and is dominated by warm-water fish species (Herricks, 1982).

The Belle Fourche River in the study area is relatively wide, low gradient stream, with somewhat less riparian development. Much of the stream is bordered by farmland and is used as an irrigation source during summer months.

3.3 Land and Resource Use

3.3.1 Former, Current, and Projected Land Use

The dominant land use within the 100-year floodplain of Whitewood Creek at the time of the ROD was native woodlands. These woodlands were estimated to occupy about 83% of the total land area (2,018 acres) within the Whitewood Creek Site (Fox Consultants, 1984a; 1984b). The remaining land within the Site was used for agriculture and residences. These land use patterns had remained unchanged for more than 100 years and were not anticipated to change in the foreseeable future (ICF, 1989a; 1989b). Based on the information obtained during the Site interviews and inspections, the current and projected land use within the Site have not changed.

3.3.2 Human Use of Resources

At the time of the ROD, residences were scattered along both sides of Whitewood Creek. Based on 1988 data, 22 households and 5 vacant residential properties were situated within or in close proximity to the Site with a total population of 85. The population was primarily rural, and dominated by families who have lived on the Site for 40 years or longer. The land was used for raising animals and raising crops for animal feed. The water supply sources for these households and vacant properties varied from shallow and deep wells, County Water Supply District deep well water and imported water (ICF, 1989a).

Ranches located on or near the Site used groundwater and surface water for stock and irrigation water supplies with shallow wells serving as the primary source of stock water for 24 ranches. Deep wells, County Water Supply Districts, ponds, and springs were other sources of stock water to these ranches.

The Belle Fourche River (upstream from the Whitewood Creek confluence) is the primary water source for irrigation of 11 ranches located on or near the Site. Other water sources for irrigation include the surface waters of Whitewood Creek and shallow or deep well water.

The current and previous use of human resources at the Site are summarized in the following table. Details on the current residences and water resource use at the Site were not available for inclusion in the following table. However, these uses are not anticipated to be significantly different from those reported for 1989.

Resource Use at the Whitewood Creek Site		
	Time of ROD (1989)	**Current (2001)**
Land Use	Woodland Rural (animal and crop production)	Woodland Rural (animal and crop production)
Residences	22	NA
Vacant Residential Properties	5	NA
Household Water Supply Sources		NA
Shallow Wells	10	
Deep Wells	7	
Butte/Meade Water Supply District	2	
Imported Water	3	
Stock Water Supply Sources		NA
Shallow Wells	17	
Deep Wells	4	
Butte/Meade Water Supply District	1	
Pond or Spring	2	
Irrigation Water Supply Sources		NA
Belle Fourche Irrigation District	5	
Whitewood Creek	3	
Shallow Wells	2	
Deep Wells	1	

Source: ICF (1989) NA= Not Available.

3.4 History of Contamination

3.4.1 Historical Activities that Caused Contamination

Gold Mine Operation

A large gold mine operated by Homestake Mining Company (Homestake) is located in Lead, South Dakota near the headwaters of Whitewood Creek. During the period between 1870 and 1977, tailings generated during the operation of the mine were released directly into Gold Run Creek, which flows into Whitewood Creek. Mining operations over the last century produced about 1,000,000,000 tons of ore from both open pit and subsurface (Fox Consultants, Inc., 1984a).

The first milling methods at Homestake were primitive and non-mechanized. Gold was recovered by using crude methods of crushing with recovery by gravity or mercury amalgamation. By 1880, the early non-mechanical methods were replaced with more than 1,000 stamp mills (large blocks of cast iron or steel dropped onto replaceable anvils) that crushed the ore to a coarse sand size. The tailings were then discharged to Whitewood Creek or its tributaries. Prior to the turn of the century, much of the ore consisted of near surface, red-colored minerals that were residual oxidation products of the arsenopyrite, pyrrhotite and pyrite mineralization of the original unoxidized ore bodies (Fox Consultants, Inc., 1984a; Chadwick et al., 1997). After the turn of the century, the black and green-colored reduced ores from deeper in the mine (below the zone of oxidation) were the focus of the mining activity. These ores contained large percentages of reduced oxidation-state minerals, including arsenopyrite and pyrrhotite.

Until 1977 (with the exception of five years of closure during World War II), the "slimes" and some coarse-grained sands, continued to be discharged directly into Whitewood Creek. Discharge from a number of sources ceased in approximately 1920, when Homestake became the only remaining source of tailings discharge. In 1977, Homestake constructed a tailings impoundment in the upper reaches of the watershed and tailings discharges to the creek ceased (Chadwick et al., 1997).

Mercury amalgamation of the ores was used over the greater period of the mining operation and was discontinued in January of 1971. Quotes on the volumes of mercury used and lost to the waste stream in this process vary from an eighth of an ounce to almost half an ounce per ton of ore crushed with almost 50 percent of this volume lost to the entire waste stream. Cyanide has

also been used in the gold recovery process since the early 1900's to process the lower grades of ore and increase gold and silver recoveries. Since the cessation of mercury use in 1971, cyanide has been used exclusively for gold recovery, until 1987, when a gravity circuit was added. Since 1987, both cyanide and gravity have been used for recovery. The tailings also contained considerable quantities of arsenic that is derived from minerals in the ore (Fox Consultants, Inc., 1984a).

Presently, ore is milled in crushers and rod and ball mills. The material from the milling process is separated into two size fractions, sand and slimes. These fractions are treated separately by cyanide leach and carbon filter methods. Residual sand material is used to backfill within the mine. Residual slimes and process waters are piped to the Grizzly Gulch tailings impoundment in the upper reaches of the Whitewood Creek watershed. The tailings disposal system became operational in 1977 resulting in cessation of direct discharge of tailings to Whitewood Creek (Chadwick et al., 1997).

In 1984 a wastewater treatment plant began treating water from the tailings impoundment and mine. The plant uses rotating biological contactors to remove cyanide and ammonia; iron precipitation and sorption to remove metals; and sand filtration to remove suspended solids. Solids are returned to the tailings pond. Water enters Gold Run Creek that discharges into Whitewood Creek between the towns of Lead and Deadwood. This discharge is monitored to meet requirements of the Clean Water Act (Chadwick et al., 1997).

Release and Deposition of Tailings

Tailings, consisting of finely ground rock; residual metallic and nonmetallic compounds not extracted from the ore and trace compounds used in the extractive processes were transported away from the mine by the water of Whitewood Creek. The tailings were deposited downstream from the mine with subsequent deposition along the banks of Whitewood Creek between the Crook City Bridge and the confluence with the Belle Fourche River (Figure 3-2). The tailings remain along much of this reach of Whitewood Creek (Chadwick et al., 1997). Reports indicate that in 1963 as much as 3,000 tons per day of tailings, together with 12,500 tons per day of water were being discharged to Whitewood Creek (ISSI, 1998; Fox Consultants, Inc., 1984a). Tailings in Whitewood Creek were also transported downstream into the Belle Fourche and Cheyenne Rivers (Goddard et al., 1988, USEPA, 1990). Some limited tailings deposits also exist upstream of the Crook City Bridge (USEPA, 1990).

Deposition of tailings altered the morphology of Whitewood Creek. Before tailings were deposited, Whitewood Creek was reportedly a typical Black Hills ephemeral stream with a thin layer of alluvium deposited over bedrock (ISSI, 1998; USEPA, 1989a). It is estimated that approximately 25 to 37 million tons of tailings were deposited in the floodplain (ISSI, 1998; ICF, 1989a). The large mass of tailings transported in the Whitewood Creek basin resulted in a series of depositional and erosional events that distributed tailings throughout the flood plain. In their upper reaches, Gold Run Creek and Whitewood Creek are rather steep, and most of the tailings were carried downstream by the flow of the water. Near Crook City, the gradient of Whitewood Creek becomes less steep, allowing the tailings to become deposited along the banks and in the creek sediment.

Currently, Whitewood Creek has eroded through the tailings to or near shale bedrock and the stream is braided over much of the Site area (USEPA, 1989a; ICF, 1989a). When aggradation of the streambed lessened in the early 1900's, overbank deposits were stabilized in places with vegetation (USEPA, 1989a).

The Feasibility Study (FS) (ICF, 1989a and 1989b) describes the stratigraphy of the tailings deposit areas as: 1) an upper deposit of tailings ranging from approximately one to fifteen feet thick and 50 to several hundred feet wide on each side of the creek along its full 18 mile length within the site, 2) an underlying strata of natural alluvium consisting of sandy to sandy silt materials with variable amounts of intermixed tailings, and 3) the thick shale strata that forms the floor of the valley.

3.4.2 Site Contaminants and Risks

This section discusses the contaminants of concern for the NPL listing, the Remedial Investigations the results of the risk assessments completed prior to the ROD and the determination of the primary health threat at the Site.

Elements of NPL Listing

The hazardous substances of concern considered in the Hazard Ranking Score (HRS) for the Whitewood Creek site were arsenic, copper, zinc, selenium and mercury. Groundwater and surface water were the two release pathways of concern (USEPA, 1994).

Contaminated Media

The contaminated media at the Site include tailings deposits, alluvial materials underlying tailings deposits, surface soil, groundwater in the downgradient alluvial aquifer, surface water and vegetation (USEPA, 1990).

The tailings are the major source of the contamination found in other affected media at the Site (USEPA, 1990). Tailings are slowly released into the alluvial aquifers at the Site and transported into the alluvium underneath the tailings deposits. Some of the tailings and their contaminants are released into the surface waters of Whitewood Creek through seepage from tailings and alluvium, erosion of tailings along the creek bank, and heavy rains or periodic flooding. Vegetation growing on tailings deposits contain concentrations of chemicals associated with tailings. Contaminants are transferred into the downgradient alluvial aquifer during the wet periods of the year when the water table rises to be in contact with the tailings and the slow dissolution and infiltration of chemicals downward through the tailings into the groundwater. Portions of the surface soils of croplands irrigated with waters from Whitewood Creek are impacted by chemicals associated with tailings. Surface soils at residences are impacted by windblown tailings, transport of tailings during flooding or the import of tailings materials for use as a soil conditioner or driveway base (USEPA, 1990).

Results of Risk Assessments Prior to the ROD

Several studies (Fox Consultants Inc., 1984a and 1984b; Environ Corp, 1985; ICF, 1989c; USEPA 1989a; Jacobs 1989) have been conducted that evaluate potential human health and environmental impacts at the Site. The Fox study (Fox Consultants, Inc., 1984a and 1984b) was concluded by USEPA to constitute the functional equivalent of a remedial investigation for the Site (USEPA, 1990). The USEPA (1989a) and Jacobs (1989) studies were used as the basis for the remedial action objectives for the Feasibility Study (USEPA, 1990). The findings of each study are briefly summarized below.

Fox Consultants, Inc. (1984b)

As part of the Phase II Study, Fox Consultants, Inc. (1984b) examined the data collected in the Phase I Study (Fox Consultants, Inc., 1984a) and evaluated the impacts of fourteen target substances including arsenic, cadmium, iron, lead, chromium, manganese, mercury, zinc, sulfate, selenium, copper, cyanide, silver and nickel in environmental media. The environmental media

examined included vadose zone water, groundwater, surface water, soil, irrigated crops, natural vegetation, fish and aquatic invertebrates.

The study reported that arsenic, sulfate, selenium, cadmium, copper, cyanide and pH posed an environmental concern to one or more of the environmental media examined. Specifically, arsenic, selenium and sulfate were of concern in groundwater. Arsenic, cadmium, copper and cyanide were of environmental concern in surface water. Arsenic was additionally of concern in both soil and native vegetation.

The report concluded that of the substances considered to be of environmental concern, arsenic was the most significant throughout the environmental media evaluated.

Environ Corp (1985)

Environ Corp (1985) evaluated potential impacts to human health from gold mine tailings in the 18-mile area of Whitewood Creek. Exposures to eight chemicals associated with mine tailings (arsenic, cadmium, copper, cyanide, iron, manganese, mercury and silver) were evaluated for adult and child residents living within the Whitewood Creek floodplain. Adults were evaluated for exposure by ingesting contaminated groundwater and fish. In addition to the pathways evaluated for an adult resident, child residents were also evaluated for exposure through ingestion of tailings impacted soil. Estimated daily intakes of arsenic, cadmium, copper, cyanide and mercury were below the Acceptable Daily Intakes (ADIs), and concluded to not pose a risk to human health. Although the estimated daily intakes of iron for both adults and children and manganese and silver in children exceeded the ADIs for the respective chemicals, they were concluded unlikely to pose adverse health risks. The study concluded that exposures to chemicals associated with the mine tailings were very unlikely to pose significant adverse risks to human health.

ICF (1989c)

ICF (1989c) summarizes the baseline assessment of potential health impacts used for the Feasibility Study (FS). The study evaluated potential human health threats to persons living within the Site from consumption of elevated levels of chemicals in shallow groundwater used for drinking water , incidental ingestion of surface soils and consumption of food items (milk, vegetables, meat, eggs, fish) produced within the Site. Potential cancer risks from arsenic and potential non-cancer risk from arsenic, cadmium, chromium, copper, lead, manganese, mercury,

nickel and selenium were evaluated. Potential risks were calculated for both "typical-case" and "potential worst-case" exposure scenarios. The study found that arsenic in surface soils and irrigated croplands may present potential cancer risks to human health and that arsenic in shallow groundwaters within the Site appeared to produce potential carcinogenic risks that are higher than those normally deemed acceptable under CERCLA. However, the study noted that potential cancer risks from arsenic may have been overstated due to uncertainties associated with arsenic availability in soils and the reduced soil ingestion during winter months when the ground is frozen. Other chemicals associated with the tailings were concluded to not pose any unacceptable threats to human health from tailings, agricultural soils, shallow groundwater and surface water within the Site.

USEPA (1989a)

A preliminary Endangerment Assessment (EA) of the Whitewood Creek site was completed by Battelle Pacific Northwest Laboratory (PNL) for the USEPA Office of Health and Environmental Assessment. The study evaluated potential impacts to public health, aquatic species and terrestrial species from hazardous substances associated with the Site. Human health risks from exposure to arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel and selenium were evaluated at six ranches along Whitewood Creek. Risks to an adult resident exposed by inhalation of suspended tailings, incidental ingestion of soil, ingestion of groundwater, and ingestion of locally grown food items were evaluated. Risks to children were evaluated from the incidental ingestion of soil. Both typical (average) intakes and worst-case (high end) exposure assumptions were used in the risk evaluations. Adult resident cancer risks from arsenic were greater than 1E-04 for both typical and worst-case exposure scenarios. Cancer risks to a child resident from the incidental ingestion of arsenic in soil were greater than 1E-04 at 3 of the 6 residential sites evaluated under the typical exposure scenario, and greater than 1E-04 at all 6 residential sites based on worst-case exposure assumptions. The total Hazard Index (HI) for non-cancer risks to adult residents from all chemicals were greater than 1 under both typical and worst-case exposure scenarios.

Although the EA primarily focused on evaluation of human health risks, ecological impacts to terrestrial and aquatic receptors were also evaluated. The EA evaluates potential ecological impacts from ten metals, including arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, selenium and silver.

Impacts to Terrestrial Receptors

A limited assessment of impacts to terrestrial receptors was conducted based on historical studies and metal concentrations in vegetation and soil. Historical studies (Bergeland et al. 1976; Hesse et al. 1975; Tveidt, 1981) have documented potential impacts of Site related chemicals on terrestrial animals within Whitewood Creek. Hesse et al. (1975) reported mercury levels in double-breasted cormorants in fish-eating birds in the Cheyenne River, downstream of Whitewood Creek and the Belle Fourche River, that were significantly greater than concentrations observed in a control population from the Missouri River System. Cattle deaths and sickness attributed to arsenic toxicosis have been documented within the Whitewood Creek floodplain (Bergeland et al. 1976) and downstream of Whitewood Creek along the Belle Fourche River (Tveidt, 1981).

Potential impacts to terrestrial wildlife from the consumption of vegetation were hypothesized based on native vegetation and irrigated crop samples collected during the Phase I Investigation (Fox Consultants, Inc. 1984a). Samples were compared with levels known to impact both plants and animals. Cadmium concentrations in irrigated crops were at a level reported to cause adverse effects in some animals. Mercury and arsenic concentrations were at levels that may affect livestock and arsenic-sensitive animals.

Although chemical concentrations in soils or vegetation indicated possible impacts to terrestrial wildlife along Whitewood Creek, data on metal concentrations in animal tissues correlated with plant and soil concentrations were not available. Therefore exposures were difficult to quantify and impacts difficult to rigorously address.

Impacts to Aquatic Receptors

Both a screening analysis and quantitative assessment of potential impacts to aquatic ecosystems were conducted. Total recoverable concentrations measured by USGS (1985) were compared to USEPA acute and chronic ambient water quality criteria (AWQC) for the protection of aquatic life. The results of this screening analysis showed six constituents (arsenic, cadmium, copper, lead, mercury and silver) had geometric mean concentrations higher than respective chronic AWQC values. These same six constituents plus zinc had maximum detected concentrations exceeding respective acute AWQC values. Based on the screening results, a more quantitative assessment was performed that examined the relationships between location, aquatic species, constituent speciation and phase, water quality characteristics, duration of exposure and

toxicological criteria. The results of these analyses indicated the potential for unacceptable adverse effects to aquatic species. Elements of most concern were copper, and cyanide. Elements of moderate concern were cadmium, iron, mercury and silver. Lead and nickel were of minor concern. Arsenic, chromium, selenium and zinc were of no concern.

Jacobs (1989)

The EA for the Whitewood Creek site was finalized by Jacobs Engineering Group Inc. for USEPA Region VIII in July 1989 (Jacobs, 1989). The final EA was based on information in USEPA (1989a) and Subsection 1.7 of the Preliminary Draft of the FS prepared by ICF Technology in April of 1989 (ICF, 1989c). Jacobs (1989) examined the potential human health threats to Site residents from elevated levels of chemicals associated with the mine tailings. Potential cancer risks from arsenic and potential non-cancer risk from arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel and selenium were evaluated in groundwater and surface soils. Cancer and non-cancer risks were calculated for an adult resident exposed to chemicals in surface soils (residential soil, irrigated cropland, tailings areas) and groundwater from the upgradient alluvial aquifer. Risks to a child resident were evaluated for exposure from residential soils and groundwater from the upgradient alluvial aquifer. Risks to a recreational visitor were evaluated from exposure to surface soil. The study concluded that ingestion of contaminated groundwater and surface soils are significant pathways that contribute to health risks at the Site. Cancer risks to adult residents from arsenic were one order of magnitude greater than the cancer risks at a reference site. No potential adverse non-cancer effects were predicted for adult residents. Potential adverse non-cancer health effects were predicted for children from incidental ingestion of Site soils. No adverse cancer or non-cancer risks were predicted for a recreational site visitor.

Primary Health Threat Identified in ROD

The primary health threat identified in the ROD for potential harm to human health and the environment was exposure to arsenic-rich tailings deposits, alluvial soil, residential soil and alluvial groundwater contaminated with arsenic (USEPA, 1990).

Human Health

Concentrations of arsenic exceeded background levels and resulted in an unacceptable risks to current and future Site residents (USEPA, 1990).

Ecological Risk

Dissolved arsenic concentrations in Whitewood Creek approached the ambient water quality criteria established by USEPA for the protection of aquatic life. Since arsenic levels in surface water were not exceeded, the ROD assumed that the aquatic habitat was not threatened or endangered. Some native plants were found to have arsenic concentrations greater than the reference area. However, arsenic was determined to be one of many factors, such as other minerals, clay content, soil pH and permeability) limiting the establishment of a normal plant community (USEPA, 1990).

4.0 REMEDIAL ACTIONS

4.1 Remedy Selection

The only ROD for the Whitewood Creek Superfund Site was signed on March 30, 1990 and addressed arsenic contaminated soil in residential areas (USEPA, 1990). The remedial action objectives identified and outlined in the ROD are:

- Prevent ingestion by Site residents of surface soils from the tailings deposit areas and from other areas within the Site that when combined would pose a potential excess lifetime cancer risk from intake of arsenic that would exceed 1E-04.

- Prevent ingestion, by site residents, of residential surface soils having an average arsenic concentration that exceeds 100 mg/kg.

- Prevent ingestion, by site residents, of drinking water drawn from the downgradient alluvial groundwater having an average concentration of any inorganic constituent other than selenium that exceeds the Maximum Contaminant Level (MCL) for that constituent specified in the National Primary Drinking Water Regulations.

- Continue monitoring the water quality and flow of Whitewood Creek at the sampling stations near Whitewood and Vale.

The site is managed as a single operable unit. However, the remedy has been implemented in two phases: remediation of contaminated soils in existing residential areas (Phase I) and the implementation of institutional controls to limit access to tailings and groundwater (Phase II). The remedial actions at the Whitewood Creek Site include:

- Cover and/or remove soils in the existing residential areas containing arsenic levels of 100 mg/kg or greater. Dispose of contaminated materials removed during this activity in an off-site disposal facility.

- Restrict future development in the 100-year floodplain and tailings deposits as provided through county ordinances regulating land use.

- Prohibit excavation of tailings deposits for other uses and prohibit excavation of remediated areas through county ordinance, however, mining would be allowed subject to the regulations of the State of South Dakota.

- Refine knowledge of the extent of contamination and delineate the 100-year floodplain. Provide detailed maps to define Site boundaries and specify activities to support county ordinances.

- Set up an educational program to inform people about hazards presented at the Site and ways to decrease their personal exposure.

- Continue enforcement of the ban on installation of water supply wells within the 100-year floodplain (this is already prohibited by a state regulation).

- Continue monitoring the surface waters of Whitewood Creek for significant releases of hazardous substances.

- Resample remediated residential areas after major flood events.

As a result of information obtained during remedial design activities, an Explanation of Significant Differences (ESD) to the remedy outlined in the ROD was issued on June 11, 1991. The ESD identified one change and one clarification to the original remedy:

- Contaminated materials removed from residential areas during remediation would be disposed of in an on-site facility instead of an off-site facility.

- The term "existing residential areas" was defined to refer to areas within the Site where residential land use is occurring as of the effective date of county land use ordinances. This term was not explicitly defined previously and was used in the ROD to describe those areas of the Site which would undergo soil cleanup as part of the Remedial Action.

New information on the quantities of contaminated materials to be disposed of during the remedial action were identified during remedial design activities. Based on discussions with Site residents regarding their land use habits, smaller areas around each home (i.e., high use areas)

were identified for remediation. The quantity of material to be disposed of was less than 10,000 cubic yards, less than one-third of the material estimated for disposal during the development of the ROD (30,000 cubic yards).

4.2 Remedy Implementation

The remedy was implemented in two phases: remediation of contaminated soils in existing residential areas (Phase I) and the implementation of institutional controls to control access to tailings and groundwater (Phase II).

4.2.1 Residential Remediation

The remedial design for the site was started August 1990 by FMG, Inc.. Homestake, with USEPA oversight, conducted sampling to identify and characterize soil contamination at 31 residences. Twenty-seven residences were identified with soil arsenic concentrations above the 100 mg/kg action level, and thus required remediation. Eleven of the 27 sites with arsenic concentrations above the action level were removed from the scope of the remediation program. The homes were rendered "uninhabitable through voluntary demolition or removal of the housing" (USEPA, 1993). Thus, remedial activities occurred at 16 residences or individual sites.

Residential remediation activities included removing and/or covering the soils from gardens, yards and driveways that were above the 100 mg/kg action level for arsenic. The objective of the remedial activities was to have 24 inches of clean topsoil in garden areas, 12 inches of clean topsoil in yards, and 6 inches of clean gravel in road and driveway/parking areas. Fill materials imported into the individual residential sites consisted of topsoil, gravel, trees, shrubs, sod, fencing and other miscellaneous debris, many of which were obtained from residential properties within the Site. The majority of the clean topsoil fill materials were obtained from the Keith Silt Loam soils located on the Phillip Bestgen property. Clean gravel fill materials were primarily obtained from the Bestgen property. Clean fill material was stockpiled at the Topsoil and Topsoil Subgrade Borrow Site (FMG, Inc., 1992).

A pilot scale remediation project at the Marrs Residence began in September 1991 and was completed by October 1991. Construction was temporarily halted for the winter. Remediation of the remaining 15 residences/sites was completed during the period of May 6, 1992 through September 15, 1992. Table 4-1 summarizes the construction dates and the type and quantities of materials removed from individual properties during residential remediation activities at the Site.

A Temporary Stream Crossing was constructed across Whitewood Creek to limit traffic across the existing low load capacity bridge (FMG, Inc., 1992). Two 48-inch diameter corrugated metal pipe culverts were installed into the creek during the late summer, low flow periods. Pipes were backfilled with 2 to 6 inch diameter gravel which was used as a road base.

Construction of the on-site disposal facility began on September 30, 1991. The Disposal Site was built on property owned by the Whitewood Venture encompassing approximately 32 acres. About 7.0 acres of this property would be used for disposal of materials. The disposal area was located on an overbank deposit of mine tailings with surface arsenic concentrations ranging from 850 mg/kg to 10,000 mg/kg. No sub-grade preparation of the area was performed, in order to minimize disturbance of the tailings.

Materials removed from the residential sites (contaminated gravel, topsoil, trees, shrubs, sod, and other miscellaneous debris) were transported to the disposal site and placed at the locations specified in the Transportation and Disposal Plan. Wastes were segregated into separate areas of the Disposal Site during materials placement activities. Fences, trees and other debris from the residential areas removed during construction and remediation would be disposed of adjacent to the fill area of contaminated materials. During residential remedial activities, approximately 4,430 cubic yards of waste materials were placed at the on-site disposal facility. Additional work at the disposal site included constructing an access road, placement of Rip-Rap, constructing a fence around the site, and hydroseeding the surface of the disposed soils.

Disposal Site construction was completed on September 30, 1992. Figure 4-1 is an "as constructed" diagram of the disposal site detailing the top soil and tree disposal areas. Figure 4-2 is a post-construction photo of a soil disposal cell within the disposal site. Whitewood Creek is visible in the upper left portion of the photo.

Pre-final inspections of the overall site were conducted by the USEPA and State of South Dakota on September 22, 1992. Punch list items from the inspection included disposal site revegetation, erosion control measures and minor landscaping at an individual site. The final inspection of the overall Whitewood Creek Site was conducted on November 12, 1992. All punch items were satisfactorily completed (USEPA, 1993).

On December 21, 1992, USEPA approved the Construction Completion Report for Remedial Action Activities at the Site. This report was submitted by Homestake and certified by a registered professional engineer that the remedy was operational and functional (USEPA, 1993).

The Preliminary Close-Out Report was signed on September 25, 1992. The completion of the residential remedial action at Whitewood Creek Superfund Site was certified by USEPA Region VIII on March 31, 1993.

Modifications to the Specifications of the ROD for Residential Remediation

During the Remedial Design and Remedial Action, modifications or changes to the specifications in the ROD were made in addition to those previously described in the ESD. The changes were made with USEPA approval and are described below (USEPA, 1993):

Design Sampling Approach. The ROD specified that any 900-square-foot area sampled and determined to exceed the 100 mg/kg arsenic level would be subject to remediation. This approach was applied to 27 of the sampled properties. Homestake developed a statistical approach for evaluating the sampling results of the final four properties and for future verification sampling. This approach established a representative population within the grid. Determination of the need for remediation was based on statistical evaluation of the sample results of the representative population as outlined in the Final Sampling and Analysis Plan. The USEPA guidance document "Methods of Attainment of Cleanup Standards" was referenced in development of the approach.

Maximum Allowable Arsenic Concentration in Replacement Fill. The ROD specified that clean imported soil or gravel contain less than 20 mg/kg arsenic. This criteria was changed during the remedial design to 20 mg/kg +/- 10 mg/kg following evaluation of actual background concentrations of arsenic in the native soils. Soil samples collected during Remedial Design activities indicated that background arsenic concentrations were potentially higher than 20 mg/kg.

Final Confirmation Sampling Elimination. Confirmation soil samples were required by the ROD to be collected following remediation of residential properties to verify that arsenic levels were below 100 mg/kg. However, USEPA determined that this sampling would be a redundant check to ensure action levels had been achieved and eliminated this requirement. This change was justified because extensive pre-construction arsenic sampling was conducted on soil materials to be used as replacement fill during remediation. This sampling effort was conducted in accordance with the Final Sampling and Analysis Plan. Independent construction observers, representing both USEPA and Homestake, were on-site throughout Remedial Action to ensure that previously sampled

materials were used as replacement fill. Homestake conducted additional sampling, beyond that required by the design plans. One sample was collected for every 15 truckloads of fill material.

Difficulties and Unexpected Site Conditions for Residential Remediation

The following difficulties and unexpected Site conditions were encountered for each of the Phases of the remediation.

Residential Remediation. During Residential Remediation Activities, some observations were made that would improve remediation and several situations were encountered that required changes to the individual residential remedial plans . These changes included:

- Additional testing for total arsenic was performed on the fill materials imported to all Individual Sites to provide additional assurance of the imported material quality. The Field Construction Observer sampled fill materials at a frequency of approximately every 15 truckloads (FMG, Inc., 1993).

- Requests for additional work by residents at their property associated with remedy implementation. (For example, rocks were hand picked out of the top soil material being replaced at the Holsclaw property, at the request of the owner).

One ongoing problem was identified during remediation activities at the Nelson Residence:

- Removal of construction staking by cattle in the area. FMG, Inc. replaced the staking on June 16, 1992, however this problem plagued the construction operations during the entire period (FMG, Inc., 1993).

Construction of Disposal Site. No problems or issues were identified during the construction activities of the Disposal Site, fill material placement area or temporary stream crossing (FMG, Inc., 1993). Several changes to the plans and specifications for the Disposal Site and Temporary Stream Crossing were approved by USEPA and implemented during the construction phase of the project, including:

- Elimination of rip-rap by the creeks' edge at the Disposal Site.

- Addition of rip-rap at the downstream end of the fill materials placed in the canal.

- Approval not to abandon the wells at the Disposal Site.

- Changing the location of the fence line surrounding the Disposal Site.

Construction of Topsoil and Topsoil Subgrade Borrow Site. No problems or issues were identified during the construction activities of the Topsoil and Topsoil Subgrade Borrow Site (FMG, Inc., 1993). USEPA approved one change to the plans and specifications for the Topsoil Borrow Site:

- Reseeding the Topsoil and Topsoil Subgrade Borrow Site at the request of the property owner.

Construction of Temporary Stream Crossing. No problems or issues were identified during the construction activities of the Temporary Stream Crossing (FMG, Inc., 1993). Several changes to the plans and specifications for the Temporary Stream Crossing were approved by USEPA and implemented during the construction phase of the project, including:

- Substitution of 2 to 6 inch diameter rock as fill materials for the channel portion of the temporary stream crossing and as the road surfacing for the crossing (in lieu of a geotextile and 6 inch thick layer for gravel surface coarse material).

- Removal of taller trees and shrubs from the overbank areas of the temporary stream crossing.

- Using existing soils and low vegetation as the road surface.

- Elimination of installing 1 to 2 foot diameter rip-rap materials at the Temporary Stream Crossing for erosion control.

- Limited operation of equipment into the water for installation and removal operations at the Temporary Stream Crossing.

- Straw bale installation at the Temporary Stream Crossing to limit silt and sediments entering the creek from construction activities.

- Eliminating the requirement of revegetating the Temporary Stream Crossing (at the request of the property owner) past hydroseeding the site.

4.2.2 Institutional Controls

The institutional control phase of the remedy includes the implementation of both traditional, legal, land use restriction controls as well as other institutional control items, such as an annual educational program. These components of the remedy are designed to control ingestion of surface soils/tailings and prevent ingestion of downgradient alluvial groundwater. The Institutional Controls for the Site include the following:

- Identification and mapping of the tailings deposits, tailings impacted soils, and the 100 year flood plain.

- Enacting land use ordinances restricting future development in Butte, Meade and Lawrence Counties that:

- Prohibit commercial and residential buildings on the tailings deposits and limit residential development to areas that have less than 100 ppm arsenic in the surrounding soil.

- Prohibit excavation of the tailings deposits except for mining projects permitted by the State of South Dakota and restrict excavation below remediated areas where covered soils have greater than 100 ppm arsenic.

- Continue enforcement of the South Dakota shallow well ban in the Whitewood Creek100 year floodplain.

- Conduct an annual educational program to inform people of the hazards associated with the Site and ways to decrease personal exposure.

- Resample remediated residential areas impacted by flooding of Whitewood Creek, if soil arsenic levels are above 100 mg/kg.

- Monitor the surface waters of Whitewood Creek.

Several of these institutional controls will be ongoing operation and maintenance activities, such as long-term surface water monitoring, distribution of educational materials to Site residents, and resampling of flooded areas. Homestake will conduct these activities for a period of at least 30 years following completion of Site remedial activities.

On February 13, 1995, USEPA certified that Homestake had performed in accordance with the consent decree the remedial action at the site, except for continuing obligations (i.e., operation and maintenance activities), enumerated in paragraph 99 of the decree and accepted the Institutional Controls Completion Report for the Site (USEPA, 1995).

Extent of Contamination and Delineation of 100 Year Floodplain

The tailings deposit boundary, tailings impacted soils boundary and the 100-year floodplain boundary were determined by extensive field programs beginning the summer of 1991 and ending the fall of 1992. The detailed maps (Figure 4-3) for these boundaries were approved by USEPA April 15, 1993 (WDC, 1994a). These boundary determinations were the first step towards enacting county land use ordinances.

Future Development Restrictions

Butte, Meade and Lawrence County Land Use Ordinance Enactment

During 1993 and 1994, Butte, Meade and Lawrence Counties adopted ordinances prohibiting construction of new residential or commercial structures on the tailings deposits, restricting future development in tailings-impacted areas of the Site, and prohibited removal and use of tailings from outside the tailings areas. A county building permit handbook (Attachment 4-1) was developed to aid in the future implementation of the proposed ordinances, and approved by USEPA on November 29, 1993. The handbook defines the steps necessary for residential development of the tailings impacted areas (Figure 4-4) (WDC, 1994b). The following table lists the dates of the county meetings where discussions of and the formal adoption of these ordinances occurred.

County Meetings for Formal Adoption of Ordinances		
	First Reading	**2nd Reading and Adoption**
Butte County	December 15, 1993	January 12, 1994
Lawrence County	December 8, 1993	January 4, 1994
Meade County	January 4, 1994	February 1, 1994

State Well Ban Regulation

A state regulation restricting the construction of wells within the 100 year floodplain of Whitewood Creek (ARSD 74:02:04:26), remains in place. The regulation has a provision that allows variances to be granted by the State's Chief Engineer for the construction of wells within the floodplain, if wells are constructed to prevent contamination from the tailings deposits and will not cause groundwater pollution. The state well ban regulation is included as part of the county building permit handbook (Attachment 4-1) for development activities within the Site.

Annual Education Program

In 1993, Homestake began distributing an annual fact sheet to educate the public on Site hazards and ways to minimize risks from residual contamination (USEPA, 1994). Educational materials were distributed annually to residents during the first quarter of each year from 1993 through 2001. Some of these materials are provided as Attachment 4-2.

Surface Water Monitoring Program

The surface water monitoring program was implemented in May of 1993 to evaluate the effect of unknown rates of release of arsenic from the tailings. Surface water samples have been collected four times annually from two United States Geological Survey (USGS) gauging stations from May 1993 to present. The first USGS station (06436180,Whitewood Creek above Whitewood) is located downstream of the confluence of Whitewood Creek with Gold Run. The second USGS sampling station is 06436198 (Whitewood Creek Above Vale). Sampling times occurred (1) in late winter before major snow-melt runoff; (2) during peak runoff in the spring; (3) during the low flow period in late summer; and (4) once immediately following a major precipitation event (Addendum B to WDC, 1994b).

Arrangements were made between Homestake and the USGS, Water Resources Division, South Dakota District Office, Rapid City, South Dakota for the USGS to collect the surface water samples. USGS provided the services for collection of the surface water samples and the analyses of these samples in USGS laboratories (WDC, 1994b).

Residential Flood Monitoring

A program was established for the monitoring of the residential areas along the creek that have the potential to be re-contaminated by the redistribution of contaminants during flooding events. Monitoring and procedures for sampling and remediating re-contaminated areas under this plan are specified in the O&M Plan (WDC, 1994b).

Modifications to the Specifications of the ROD for Institutional Controls

Changes and modifications to specifications in the ROD were made during implementation of the institutional control phase of the remedy. These changes were approved by USEPA and are described below (USEPA, 1993):

Ordinance restrictions on future digging in remediated areas. The remedy outlined in the ROD required counties to adopt ordinances that restrict future digging in areas that have been previously remediated. Information from sampling programs and a negative community response to this restriction prompted the deletion of this requirement. This modification to the ordinances was approved by USEPA in a letter dated November 29, 1993.

Removal of construction of public works projects on tailings provision from ordinances. To meet a need expressed by the City of Whitewood during ROD development, the ROD provides for the construction of public works projects on the tailings after remediation to be included in the county ordinances. In a letter dated November 8, 1993, the City of Whitewood stated that they no longer had a need for this provision. USEPA approved the deletion of this provision in a letter dated November 29, 1993.

Change in reviewing agency for future house sites. The South Dakota Department of Natural Resources was identified to be the reviewing agency for sampling and remediation plans for future house sites in tailings impacted areas. The USEPA, State and local community determined that this program would be more effectively administered at the

county level, and to rely on the State DENR for technical support as requested by the county. USEPA approved this modification in a letter dated November 29, 1993.

Difficulties and Unexpected Site Conditions for Institutional Controls

No difficulties were identified in the Institutional Controls Completion Report (WDC, 1994a) with the implementation of this portion of the remedy at the Site.

4.3 Operation and Maintenance

The Operation and Maintenance (O&M) activities outlined in the Post Closure Operations, Maintenance, and Reporting Plan (WDC, 1994b) for the Whitewood Creek Site include:

- Surface Water Monitoring at two USGS stations on Whitewood Creek
- Annual Site Resident Education Program
- Future Development Restrictions - Annual Review of Building Activity
- Post-closure Residential Site Soil Sampling Activities and Remediation
- Flood Impact Soil Sampling at Remediated Residences
- Five-Year Review Remedial Action Verification Soil Sampling
- Residential Soil Remediation (as necessary)
- Disposal Site Monitoring
- Reporting

4.3.1 Surface Water Monitoring

The ROD requires continued monitoring of Whitewood Creek surface water quality to evaluate the effect of unknown rates of release of arsenic from the tailings deposits. Samples are to be collected four times a year at the two USGS sampling stations on Whitewood Creek near the towns of Whitewood and Vale.

System O&M Requirements

The surface water sampling plan is provided as Addendum B to the O&M Plan (WDC, 1994b). The plan specified that surface water samples were to be collected four times a year at two USGS sampling stations on Whitewood Creek. Water samples were to be analyzed for dissolved and total recoverable arsenic as well as pH (hydrogen ion content), specific conductance (SC) and

total suspended solids (TSS) for the purpose of assessing additional information that may impact the mechanics of arsenic occurrence in Whitewood Creek. Flow measurements were are also to be recorded (Addendum B to WDC, 1994b).

The ROD specified that surface water samples were to be collected during four time periods throughout the year, representing:

(1) late winter before major snow-melt runoff
(2) peak runoff in the spring
(3) the low flow period in late summer
(4) once immediately following a major precipitation event

Based on historical flow data from the two USGS Gauging Stations within the Site, the most appropriate months and/or conditions for sampling are expected to be (Addendum B to WDC, 1994b) :

(1) December - for late winter flow prior to major snow-melt runoff
(2) May - for peak run-off flow in the spring
(3) September - for late summer low flow
(4) Major precipitation event - 0.23 inches of rain or more during a 24-hour period.

USEPA Region VIII provided the criteria for determining a major precipitation event as an event that equals or exceeds 0.23 inches of rain in a 24 hour period. The Water Quality Sampling Plan (Addendum B to WDC, 1994b) states that local landowners in the Site area will be contracted to notify sampling personnel of a local rain event that equals or exceeds the criteria (0.23 inches during a 24 hour period). The major precipitation event water sample will be collected within 36 hours of the initial notification.

The Water Quality Sampling and Analysis Plan (Addendum B to WDC, 1994b) recommends, to the degree that weather and sampling conditions allow, that the surface water samples be collected during any given month in an upstream-to-downstream sequence. The sampling data are included in quarterly O&M reports to USEPA, as the data are available.

System Activities to Date

Surface water quality monitoring commenced in May of 1993. The following table summarizes the water quality monitoring data submitted by Homestake in its Quarterly Reports to USEPA. Surface water samples were collected on the following dates:

Summary of Surface Water Monitoring Samples Collected at Two USGS				
1993	12/27/1993	--	9/9/1993	5/6/1993
1994	12/20/1994	4/21/1994	9/1/1994	4/21/1994
1995	--	5/24/1995	8/30/1995	5/8/1995
1996	1/8/1996	5/8/1996	8/20/1996	5/25/1996
1997	1/7/1997	5/7/1997	8/26/1997	--
1998	12/16/1998	4/28/1998	9/2/1998	6/9/1998
1999	12/29/1999	5/5/1999	9/13/1999	6/3/1999
2000	--	--	6/16/2000	4/26/2000
2001	1/24/2001	5/2/2001	9/13/2001	6/6/2001

Problems Encountered

No major problems were encountered in the implementation of the surface water monitoring program. Seasonal variations and outside circumstances resulted in only three of the four types of samples being collected during 1993, 1994, and 1995:

- Three of the four sample types were collected during 1993. Snowmelt and high flow had already occurred when the monitoring program began in May of 1993. Thus, a high flow sample was not collected during this sampling year. Total suspended solids were not collected during the major precipitation event of 1993. The routine sampler was on vacation and the replacement personnel did not collect the TSS sample.

- A sample was not collected during a major precipitation event in the summer of 1994. Thus, the high flow sample collected on 4/21/94 was used to represent both high flow conditions and a major precipitation event.

- Only three samples were collected during 1995. The winter low flow sample for 1995 was not collected in December, due to the partial government shutdown. The sampling personnel were considered non-essential federal government employees and were unable able to work during the partial shut down.

- A flow measurement was not reported at USGS Station 06436180 during the 1995 major precipitation event. However, this information is available for download from the USGS website.

- A major precipitation event sample was not collected during 1997. However, two late winter samples were collected. Explanations for theses deviations from the Surface Water Monitoring Plan were not available from the Monthly or Quarterly reports reviewed.

- Late winter and high flow samples were not reported during 2000. However, two low flow samples were collected. Explanations for theses deviations from the Surface Water Monitoring Plan were not available from the Monthly or Quarterly reports reviewed.

4.3.2 Annual Site Resident Education Program

The ROD requires an annual site resident education program to acquaint Site residents with the potential health hazards associated with exposure to the tailings soils and downgradient alluvial groundwaters within the Site, and methods for minimizing incidental ingestion of contaminated materials. The education program is additionally prescribed to inform potential property owners of potential health hazards.

Homestake is to annually distribute educational materials to Site residents.

System O&M Requirements

An informational package must be distributed to landowners within the Site on an annual basis. The package shall include a discussion of the EPA's established risks associated with the tailings and tailings impacted soils. The scope of the remedial action program will be outlined and a compilation of the land-use restrictions and discussion of the intent of these ordinances will also be discussed. A list of personal precautions to limit exposure must also be drafted. Individual maps will be provided to each landowner to aid in their understanding of the areas affected by the EPA's risk calculations.

System Activities to Date

The educational mailing program was initiated in 1993, and generally takes place during the first quarter of each year. The following table documents the dates that the annual educational mailings were sent to Site residents, as recorded in Homestake's Quarterly and Monthly Reports. Copies of these materials are included in this report as Attachment 4-2.

Annual Site Resident Educational Program Mailings		
Year	**Date of Mailing**	**Source**
1993	4/8/93	HMC, 1993i
1994	2/28/94	HMC, 1994l
1995	2/14/95	HMC, 1995g
1996	2/21/96	HMC, 1996c
1997	4/97	HMC, 1997c
1998	first quarter 1998	HMC, 1998a
1999	February 18, 1999	HMC, 1999c
2000	date not available	Ted Fellman, USEPA
2001	5/30/01	HMC, 2001d

NA= Information not available in the quarterly reports reviewed

As demonstrated in Attachment 4-2, the content of these annual educational mailings does appear to vary from year-to-year.

Problems Encountered

Based on a review of Site Monthly and Quarterly Progress Reports, no problems relating to the implementation of the Annual Educational Program were identified.

4.3.3 Future Development Restrictions-Annual Review of Residential Building Activity

One institutional control implemented as part of the remedy was to limit exposure to tailings by restricting development within the Site. Development on the tailings deposits is prohibited by county ordinances. Residential development within the tailings impacted area is allowed on locations that have arsenic concentrations of 100 ppm or less. A state regulation prohibits the construction of wells within the 100 year floodplain of Whitewood Creek, unless a variance is granted. (WDC, 1994b).

System O&M Requirements

System O&M activities include an annual review of residential building activity within the Site (WDC, 1994b). Findings from the review are summarized in the Monthly or Quarterly Reports.

System Activities to Date

Table 4-2 summarizes the residential building activities within the Site, reported by Homestake to date.

Some variances have been granted for the construction of wells within the 100 year floodplain of Whitewood Creek since the implementation of the remedy. The following table summarizes the variances granted for well construction within the 100 year floodplain of Whitewood Creek available from the South Dakota Water Rights Program.

Well Variances Granted within the 100 Year Floodplain of Whitewood Creek			
Property	**County**	**Variance Request**	**Variance Date**
Westburg	Lawrence	Construction of a domestic water supply well on the Westberg Property along Whitewood Creek. To protect against contamination from tailings deposits, well construction includes setting a protective surface casing through the alluvium that penetrates at least 20 feet into the bedrock.	March 7, 1989
Holsclaw	Meade	Construction of a domestic water supply well on the Holsclaw Property along Whitewood Creek. To protect against contamination from tailings deposits, well construction includes setting a protective surface casing through the alluvium that penetrates at least 20 feet into the bedrock.	April 18, 1990
Willson	Lawrence	Construction of a domestic well on the Willson Property along Whitewood Creek. To protect against contamination from tailings deposits, well construction includes pressure grouting the well from the top of the aquifer to the land surface.	January 7, 1992 January 14, 1992
Wehner	Butte	Construction of a domestic well on the Wehner Property along Whitewood Creek. To protect against contamination from tailings deposits, well construction includes a surface casing grouted in through the potentially contaminated alluvium prior to drilling.	February 10, 1999

Problems Encountered

Based on the review of the information Quarterly Reports, there do not appear to be any problems associated with residential building activities within the Site. For the two reported instances of development/potential development activities within the Site, landowners were aware of the ordinance requirements or were coordinating their respective development activities with the County to ensure compliance with county ordinances.

Sampling activities indicated that the Crowser Property was located on tailings impacted soil, and the landowner agreed to complete remediation as outlined in the county development handbook, in accordance with Site project plans. Information is not available to confirm that remedial activities were completed at this property.

Based on a review of the available variances from the SD DENR Water Rights Program, there do not appear to be any problems associated with the state well ban regulation. Four wells were installed within the 100 year floodplain. Information on wells installed within the 100 year floodplain without prior application or variances were not uncovered during this five-year review.

4.3.4 Post-Closure Residential Soil Sampling and Remediation

The remedy outlined in the ROD requires the following activities associated with Post-Closure Residential Soil Sampling and Remediation Operations and Maintenance:

- Flood Impact Soil Sampling at Remediated Residences
- Five-Year Review Remedial Action Verification Soil Sampling
- Residential Soil Remediation

Flood Impact Soil Sampling

Surface soil sampling will be conducted, if flooding of Whitewood Creek impacts surface soils within the high use areas of residences that were remediated. Residents are to notify Homestake if flood waters reach residential yards within the Site.

System O&M Requirements

The remedy outlined in the ROD requires the surface soils at remediated residences to be re-sampled after flooding. This is to ensure that residential soil concentrations remain below the 100 ppm residential soil action level, in the event that contaminated materials may potentially be redistributed during flooding.

If during sampling, soil concentrations are determined to statistically exceed remediation standards, those specific areas will be remediated per the project selected remedy. Properties will be remediated within one year of the determination that remediation is necessary (WDC, 1994b).

System Activities to Date

During May 8-9th of 1995, a 20 to 25-year flood event occurred within the Whitewood Creek floodplain. Flooding did not impact any remediated residences, thus, flood impact soil sampling was not conducted (HMC, 1995c).

Problems Encountered

No problems were identified with this operation and maintenance requirement.

Five-Year Review Remedial Action Verification Soil Sampling

As part of the five-year review, site inspections and surface soil sampling will be conducted at remediated residences to ensure arsenic concentrations remain below the soil action level of 100 ppm.

System O&M Requirements

The remedy outlined in the ROD requires an inspection and soil sampling to be conducted at remediated residences. As part of the Five-Year Review Process, remediated properties within and outside of the Whitewood Creek Superfund Site boundaries will be inspected to examine property use and the condition of the remedial cover materials. In addition to the site inspection, verification soil sampling will be conducted at properties within the Superfund Site boundary to ensure that soil concentrations remain below the Site soil action level for arsenic of 100 ppm. These properties may be subject to possible recontamination by wind deposition of arsenic rich materials, importation of contaminated materials, or re-exposure of materials covered during remediation activities.

If during verification sampling, soil concentrations are determined to statistically exceed remediation standards, those specific areas will be remediated per the project selected remedy. Properties will be remediated within one year of the determination that remediation is necessary (WDC, 1994b).

System Activities to Date

In 1996, thirteen residential properties were inspected (see Section 5.3) and six residential properties (remediated in 1992) were sampled. One of the six properties had arsenic concentrations that exceeded the 100 ppm soil action level. This property was remediated within one year of its discovery (WDC, 1998), in accordance with the Site Remedial Action Plan.

Problems Encountered

No problems were identified with this operation and maintenance requirement.

Residential Soil Remediation (as necessary)

Remediation of residential soils is required for properties exceeding remediation standards that are identified during flood impact monitoring or five-year verification sampling.

System O&M Requirements

If as a result of sampling activities, soil concentrations are determined to statistically exceed remediation standards, those specific areas will be remediated per the project selected remedy. Properties will be remediated within one year of the determination that remediation is necessary (WDC, 1994b).

System Activities to Date

During verification sampling activities in 1996, one property was identified with concentrations exceeding the remediation standard of 100 ppm. This property was remediated within one year of its discovery (WDC, 1998), in accordance with the Site Remedial Action Plan.

Problems Encountered

No problems were identified with this operation and maintenance requirement in the Quarterly and Monthly Reports reviewed.

4.3.5 Disposal Site Monitoring

An annual review of the disposal site conditions is required to ensure that site conditions are consistent with the Transportation and Disposal Plan for the Whitewood Creek Superfund Site.

System O&M Requirements

The integrity of the site fencing, vegetative cover, surface slopes, and rip-rap will be reviewed during the annual inspection of the Disposal Site. Site conditions that are not consistent with the Transportation and Disposal Plan will be corrected according to a timetable agreed upon by USEPA and WDC. If the repair or correction of such conditions is not feasible, the disposal site design will be re-evaluated (WDC, 1994b).

In the event the Disposal Site is reopened to accommodate disposal of contaminated soils identified during sampling following flooding or as part of the five year review, Site activities will be conducted in accordance with the Transportation and Disposal Plan (WDC, 1994b).

System Activities to Date

Table 4-3 summarizes the dates, observations and remedial actions taken during the annual inspections of the Disposal Site.

Figure 4-5 contains photos taken during O&M activities at the disposal site during October 2000 and May 2001.

Problems Encountered

One minor problem was encountered during disposal site monitoring activities. In 1998, unauthorized rubble (Figure 4-6) was observed outside of the disposal site. WDC coordinated with the SD DENR and the rubble was placed in the disposal facility (HMC, 1998b).

4.3.6 Reporting

Quarterly reports of O&M activities and a five year review report assessing Site conditions are required as a part of O&M reporting requirements for the Site.

System O&M Requirements

WDC will submit quarterly reports to USEPA describing all O&M activities that have occurred during the previous quarter and which are planned for the upcoming quarter. The quarterly report will include a description of activities that have occurred at the Site including surface water monitoring, residential soil sampling, residential remediation, disposal site inspection and maintenance, flood impact monitoring, residential building activity within the site and the education program. The Quarterly Reports will be prepared and submitted 30 days after each calendar quarter.

A five-year review is required to assess Site conditions and the adequacy of remedial actions that have been taken at the Site. The review will evaluate the protectiveness of the remedy by examining changes in Site conditions, changes in Site risks and evaluating if the remedy has been implemented in accordance with decision documents.

System Activities to Date

Table 4-4 summarizes all quarterly reports submitted to USEPA by Homestake to USEPA available from the Superfund Records Center.

Homestake initiated the five year review report activities for the Site in 1997 with the Five Year Status and Technical Review Report (Chadwick et al., 1997).

Problems Encountered

No problems pertaining to the preparation or submittal of the quarterly reports or five-year review report were identified.

5.0 FIVE YEAR REVIEW FINDINGS

5.1 Five-Year Review Process

5.1.1 Interview Team Members

The Whitewood Creek five-year review team was lead by Gwen Hooten and Rebecca Thomas, the USEPA Remedial Project Managers (RPMs) for the Site. The following team members assisted in the review:

- Ted Fellman, USEPA Region VIII, Community Information Coordinator
- Dale Hoff, USEPA Region VIII, Ecotoxicologist
- Mark Sprenger, USEPA, Environmental Response Team (ERT)
- Karen Kellen, USEPA Region VIII, Site Attorney
- Mia Wood, USEPA Region VIII, Site Attorney
- Mike McCeney, USEPA Region VIII, RPM
- Chris Weis, USEPA Region VIII, Toxicologist
- Joane Lineburg, South Dakota Department of Environment and Natural Resources
- Mark Lawrensen, South Dakota Department of Environment and Natural Resources
- ISSI Consulting Group, Contractor
- Roy F. Weston, Contractor
- Syracuse Research Corporation (SRC), Contractor

5.1.2 Community Notification

Notice of the upcoming five year review was placed in USEPA Fact Sheets during June of 1996 and 1998 (Attachment 5-1), and in Homestake's annual resident information sheet for 2000 (Attachment 5-1). Additionally, the community was notified about the review during interviews with site residents and government officials completed by Homestake in 1996 and by USEPA in 2000 (Section 5.2).

This completed Five-Year Review Report for Whitewood Creek is available in the information repository. Notice of its completion was placed in the local newspaper during July 2002.

5.1.3 Five-Year Review Tasks

The Five-Year Review for Whitewood Creek consists of nine tasks:

Review of relevant documents. A review of documents for the Whitewood Creek Site was completed for the purpose of determining the scope of the remedy, the goals fo the remedy and its current status. The list of documents reviewed for completion of the Five-Year Review is included as Attachment 5-2. Documents pertaining to the Whitewood Creek Site were reviewed to determine the following:

- The remedial action objectives and cleanup levels specified in the ROD and other decision documents;
- The remedial actions and their design;
- Any changes to the assumptions underlying cleanup levels;
- The status of the implementation of the remedy and O&M;
- The status of the implementation and enforcement of institutional controls; and
- The effectiveness of the remedy in meeting remedial action objectives.

Interviews. Interviews were conducted by USEPA staff, SD DENR and HMC with local regulatory officials, response agencies, and residents to identify any problems with the implementation and to evaluate the effectiveness of the remedy. The results of the interviews completed for the Whitewood Creek Five Year Review are provided in Section 5.2.

Site Inspection. A Site Inspection was completed by USEPA, SD DENR and HMC to visually confirm and document the conditions of the Site, remedy and surrounding area. The results of the Site Inspection are reported in Section 5.3.

Risk Information Review. The Risk Information Review includes a review of the Site ARARs and the site-specific, risk based cleanup level. An evaluation is completed to identify if changes in ARARs, toxicity or other characteristics affect the protectiveness of the remedy. The Risk Information Review is provided in Section 5.4.

Risk Recalculation/Assessment. A recalculation of potential site risks and an ecological risk assessment were completed for the Whitewood Creek Site during the five-year

review. The results are summarized in Section 5.5. The entire ecological risk assessment is provided in Attachment 5-3.

Data Review. A review of surface water monitoring data, and five-year verification sampling results from remediated residential properties was completed for the Whitewood Creek Site. This information is provided in Section 5.6.

The results of these tasks are used as the basis of the assessment of the effectiveness of the selected remedy in Section 6.0, to identify any deficiencies in Section 7.0, and to provide any recommendations and required actions in Section 8.0 to ensure the protectiveness of the remedy to human health and the environment.

5.2 Interviews

Interviews were conducted by USEPA, SD DENR and HMC staff with local regulatory officials, response agencies, and residents to review the effectiveness of the remedy. The interview findings are summarized in the following sections.

5.2.1 Interviews with Residents

All remediated properties were inspected and interviews were completed at occupied sites if residents were available. J. Steve Peters of Homestake Mining Company, Joane Lineburg of the SD DENR and Mike McCeney of USEPA Region VIII met with available residents on July 16 and 17, 1996. The results of these interviews were reported in Chadwick et al. (1997) and are summarized below. The following questions were addressed for each property:

1. Have any tailings materials been imported?

2. Has Whitewood Creek flooding impacted any high-use area?

3. Have any new water wells been constructed within tailings impacted areas?

4. Has property use changed, impacting the previously delineated high-use areas?

5. Have there been any excavating activities since remediation?

6. Is the remedial cover intact?

7. Is any geofabric (used beneath remedial cover materials in select areas) visible?

8. Are there any special problems related to previously completed remedial activities?

Inspection and interview findings as summarized by Chadwick et al. (1997) are as follows:

Ala Property. Cover materials were observed to be in good condition. The grass cover in the yard was not in good condition apparently from neglect. There were no apparent changes in site use conditions. It should be noted that Alvin Ala was informally interviewed by J. Steve Peters of Homestake Mining Company at an earlier date and his interview was supported by inspection findings.

Balo Property. Both "upper" and "lower" properties were inspected and Kyla Balo was interviewed. Kyla Balo reports that the modular home is being moved and there will be only one residence at the upper property. The gravel and soil cover was observed to be in good condition at both sites.

Berger Property. Ron and Mary Berger were interviewed. They reported that following remediation, their root cellar tends to collect water. They believe that the imported material restricts drainage and allows water to collect in the cellar following precipitation events. The soil and gravel cover as well as the garden area were observed to be in good condition. There were not apparent changes to the high use area.

Kymala Property. Larry Kymala was interviewed. There were not apparent on-site changes, and the gravel cover was observed to be in good condition. It should be noted that only gravel cover was applied at this residence during remediation.

Marrs Property. The gravel and soil cover were observed to be in good condition. There were no apparent changes at the site. It should be noted that Dan Marrs was informally interviewed by J. Steve Peters of Homestake Mining Company at an earlier date, and his interview was supported by inspection findings.

Tippey Property. Lyle Tippey was interviewed. He reports that there has been some minor movement of gravel during extreme precipitation run-off events. He has reportedly

moved displaced gravel to restore the driveway to a smooth surface. The driveway was observed to be in good condition with no geotextile fabric evident. Also, no site changes were observed except the original home is now unoccupied and has been replaced by a new modular home located further from the tailings area.

Wennberg Property. Charles Wennberg was interviewed. He reports that the buffalo grass sod placed during remediation does not "green up" as soon in the spring as native buffalo grass. He also stated that he tries to restrict access to tailings areas located on his property. There were no observable changes in the remedial cover or site use, except the garden area is apparently not being used.

Willson Property. Jim Willson was interviewed. He reports that the gravel cover was initially soft but is now solid. No changes in the remedial cover or site use conditions were observed.

Alan Property. Gilbert Alan was interviewed. He reported that the imported soil material was extremely "hard to work". The cover materials were observed to be in good condition with no apparent changes in site use.

Holsclaw Property. There were no observable changes in the remedial cover or site high use area conditions. A new pasture-to-yard road approach had been built in June 1996 outside the high use area. It should be noted that Stan Holsclaw was informally interviewed by J. Steve Peters of Homestake Mining Company at an earlier date and his interview was supported by inspection findings.

Nelson Property. There were no observable changes in the remedial cover or site high use area conditions. The property is still being used as an occasional family gathering location with no use of the garden area.

Shuck Property. Both the occupied property and the unoccupied "north" property were inspected, and Neil Shuck was interviewed. In regard to the occupied property, he reports that the buffalo grass sod has been extremely difficult to keep weed-free, and it "greens up" very late in the season. He stated that he may replace it with more conventional yard grass in the future. He pointed out that the back yard fence had been moved into a remediated area to better protect the yard from livestock. At the occupied property, there were no observable changes in the remedial cover or site high use area conditions, except

the garden is no longer used. Also, there were no observable changes in the remedial cover or site high use conditions at the Shuck north property. This property is still unoccupied and no evidence of flooding was observed.

Westberg Property. Both residential areas at this property were inspected and Glen Westberg was interviewed. No problems were reported. The north property is now unoccupied and cover materials appeared in good condition. At the main residence (south property), cover materials appeared in good condition. The driveway within the high use areas has been paved. Also, the high use area south of the house is smaller due to relocation of the yard fence closer to the house (away from the creek). Some slumping of the creek bank south of the lower yard was observed, but it apparently did not impact the high use area.

On March 21, 2000 Stan Holsclaw was interviewed by Mark Lawrensen of the SD DENR and Ted Fellman and Gwen Hooten of USEPA Region VIII. Stan was asked the same 8 questions given during the 1996 interviews with two additional questions:

9. What is your general impression of the project?

10. What is your impression of the risk?

Mr. Holsclaw reported that no tailings material had been imported, flooding had not impacted any high-use area, there were no new additional wells or changes to existing wells, there were no excavation activities within the high-use area, property use has remained the same, and the remedial cover is intact. In general Mr. Holsclaw reported that the asphalt worked well and washed clean. His overall impression of the risk was that the remediation did not clean up enough of the Creek. He believes that it is safe on the asphalt but not elsewhere. The yards may be clean but the Creek still has tailings. After nine or ten years nothing has really changed. As far as he is concerned nothing was done to clean the Creek itself. He has further concerns that new channelizing of the Creek threatens the loss of his barn and he cannot do anything to stop it as he cannot change the Creek channel.

5.2.2 Interviews with Government Officials

To review the implementation and effectiveness of the county ordinance institutional controls specified by the ROD (USEPA, 1990), interviews with government officials responsible for

administering the controls were conducted. An interview with the government agency responsible for managing an irrigation siphon within the Site was also conducted to review any changes in resource use and Site conditions. On July 16, 1996, Mike McCeney of USEPA Region VIII, Steve Peters of Homestake Mining Company and Joane Lineburg of the SDDENR met with officials from each of the three counties (Lawrence, Butte, and Meade) responsible for implementing the institutional controls. Mark Lawrensen of the SD DENR, and Gwen Hooten and Ted Fellman of USEPA Region VIII met with the county officials again and with the Manager of the Belle Fourche Irrigation District on March 21, 2000. The meetings were intended to help USEPA determine if the institutional controls at the Site remain in place and are effective and if there have been any changes in site conditions or resource use. The following basic questions were asked of each government official:

1. What is your impression of the project?

2. What is your impression of the risk?

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.

5. Do you feel well informed about the site's activities and progress?

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?

The parties interviewed and findings are as follows:

Belle Fourche Irrigation District Manager. Renel Hall-Beck, the manager of the Belle Fourche Irrigation District was interviewed by Ted Fellman and Gwen Hooten of USEPA Region VIII on March 20, 2000. The following specific questions in addition to the basic ones were asked of the District with the following responses:

1. Have you in the past, or will you in the future use the surface water in Whitewood Creek? Why?
   There was no use of surface water in the past and no plans for doing so in the future. They are not set up to pull water from Whitewood Creek.

2. Have any tailings material been imported?
   Not applicable

3. Have any new water wells or other irrigation structures been constructed within tailings impacted areas? If so, describe the wells or structures.
   No. All new irrigation structures are on hold for over 5 years. The ditches do not appear to be in the flood plain. The Bureau of Reclamation (BOR) held off on new structures as part of Environmental Assessment (EA).

4. Has surface water usage changed, and what impact does the change have on the impacted surface water and surrounding area?
   Surface water usage has not changed.

5. Have there been any excavating, stabilizing or other activities conducted by the irrigation district since the remediation? What was the purpose of the activity? How effective was the activity in meeting the purpose?
   Rip rap was placed in the summer of 1999 for bank stabilization. It worked, but is a temporary solution. Some material has already flown downstream. Rip rap is designed to hold for about a year, subject to flood events.

In response to the general questions the following responses were provided:

1. What is your impression of the project?
   Project is to minimize negative impacts to the environment.

2. What is your impression of the risk?
   The impacts are regionalized, so the potential for risk is also. The risks are to surface water and not groundwater. Risks are associated with mercury from mining.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
Some informal activities. (BOR? District?) Placed rip rap on the Creek banks near the irrigation siphon once since July. It was the second or third time that rip rap was used for erosion control at this location. The Irrigation District has given some tours of this site, including a group last fall (BOR, EPA). The District is also involved in the EA process pertaining to the siphon.

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
Not aware of any.

5. Do you feel well informed about the site's activities and progress?
Have EA and designs (for siphon). Attended BOR briefings with respect to the siphon. Have not received as much information from EPA or the State, but new to position (July 1999). Do not have water quality tests or sampling results from EPA activities. Mostly concerned with any potential hazards to employees. Want some limited information to understand current water quality concerns. Want to be included in the information loop in terms of receiving initial reports, but not all quarterlies, just before and after construction at siphon is sufficient.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
Answered with a question? Will EPA have environmental oversight during construction at the siphon? EPA answers no that the Bureau of Reclamation (BOR) will have oversight.

Lawrence County Zoning. Erik Birk, the Lawrence County Zoning Administrator was interviewed by Mark Lawrensen of the SD DENR and Ted Fellman and Gwen Hooten of USEPA Region VIII on March 21, 2000. The following responses were provided to the list of six general questions.

1. What is your impression of the project?
Homestake did an excellent job. They spent a lot of money, were open and honest

with land purchases and leasing back to previous owners. Did well with the Red X project which is now a gorgeous park. Homestake planted thousands of trees and turned a terrible looking pit into a beautiful park.

2. What is your impression of the risk?
Property owners will say water has not killed them yet. The risk is low. Few people live along the Creek and the land is used mostly for production of hay or wheat or grazing.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
Routine communications include permits and papers.

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
There was one violation for building without a permit by Tommy Thompson.

5. Do you feel well informed about the site's activities and progress?
Do not feel well informed prior to 1994. It was necessary to read about activities in the paper. After 1994, the county gained control through plats and permits. We don't envision large developments.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
The building permittees ask us why doesn't Homestake pay for soil samples when new people come to build? The county takes the residents' word for where and how they took their soil samples.

The following specific questions in addition to the basic ones were asked of the Lawrence County with the following responses:

1. Have any tailings materials been imported?
No tailings have been imported.

2. Has Whitewood Creek flooding impacted any high-use area?
There was a 50 year flood in 1997 that caused some sediment to move.

3. Have any new water wells been constructed within tailings impacted areas? If so, what is the depth of the wells? Any changes in the existing wells?
No. Thompson built a well in the 100 ppm area, but not in the tailings area.

4. Has property use changed, impacting the previously delineated high-use areas?
Property is still residential use. There is a new bed and breakfast, but it is outside of the high impact area.

5. Have there been any excavating activities since remediation?
Some bridge repair done by the Lawrence County Highway Department. They placed new materials from Centennial Quarry during the work. Placed rock to stabilize banks. There was no excavation.

6. Is the remedial cover intact?
Question not applicable.

7. Is any geofabric (used beneath remedial cover materials in select areas) visible?
Question not applicable.

8. Are there any special problems related to previously completed remedial activities?
Question not applicable.

9. What programs do you have to restrict building, well drilling and other activities in the contaminated floodplain? How is the program executed? Give examples.
Ordinances and FEMA FIRM (Flood Insurance Rate Maps). The FEMA maps must be adhered to. To build in the flood plain, the builder must acquire flood insurance or engineer the facility above flood level. A licensed professional engineer must conduct the survey.

Meade County Assessor's Office. Merlin Ehlers and Kirk Nupen, the Meade County Commissioners were interviewed by Mark Lawrensen of the SD DENR and Ted Fellman and Gwen Hooten of USEPA Region VIII on March 21, 2000. The following responses were provided to the list of six general questions.

1. What is your impression of the project?
   The project was well handled and addressed the problem in the least intrusive way, by stopping exposures. Re-mining seemed dangerous since it would expose hazards.

2. What is your impression of the risk?
   Have the residents had wells tested? Assume all residents are contacted so that they can ensure that their activities are safe.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
   There have not been routine communications. We were supplied with a map which was incorporated into the assessment file. They try to not automatically issue permits. This is a function of the planning board. Try to track properties within the floodplain. No transactions have taken place in the floodplain since the ordinance passed.

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
   No complaints, violations or other incidents are known. Some land transfers have occurred (see paperwork showing land exchanges).

5. Do you feel well informed about the site's activities and progress?
   They do not need much information and assume government and Homestake are doing their job. Given plat built in area, need to step up efforts to identify areas affected by ordinance. Also need to increase enforcement of building and septic permits.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
   There is a big study on the Belle Fourche being conducted, taking water samples. Also, Homestake is trading land (in Haakon or Perkins counties?) for lands along the Belle Fourche. Jim Wainright is contact. The Balo's are a good contact for information as well.

The following specific questions in addition to the basic ones were asked of Meade County with the following responses:

1. Have any tailings materials been imported?
   There are no known imported tailings materials. A new home (across Creek from Holsclaw's) is likely a single family residence. A trench was dug to install the septic system and was not surveyed.

2. Has Whitewood Creek flooding impacted any high-use area?
   Not aware of any floods impacting high-use areas.

3. Have any new water wells been constructed within tailings impacted areas? If so, what is the depth of the wells? Any changes in the existing wells?
   Should ask the State. A new residence tapped into an existing permitted well.

4. Has property use changed, impacting the previously delineated high-use areas?
   Yes, the Berger residence. Don't know whether or not the property is in high use area.

5. Have there been any excavating activities since remediation?
   Only new residence.

6. Is the remedial cover intact?
   Question not applicable.

7. Is any geofabric (used beneath remedial cover materials in select areas) visible?
   Question not applicable.

8. Are there any special problems related to previously completed remedial activities?
   Question not applicable.

9. What programs do you have to restrict building, well drilling and other activities in the contaminated floodplain? How is the program executed? Give examples.
   Subdivision ordinance and plat, building permit issuance, septic permits, ordinance and Flood plain ordinance.

Butte County Planning and Zoning Commission. Bob Morris Chairman of the Butte County Zoning Commission and Dave Anderson, the Commissioner, were interviewed by Mark Lawrensen of the SD DENR, and Ted Fellman and Gwen Hooten of USEPA Region VIII on March 20, 2000. The following responses were provided to the list of six general questions.

1. What is your impression of the project?
The project was well within the scope of work and no negative comments have been recently heard. Nobody is seeing dead fish anymore (Dave). Zoning in place for over two years. No need to raise the issue during that time–no building requests or subdivisions near the Creek. No affect to zoning. "For all intents and purposes, there are no permanent institutional controls as regards land within the Site." No controls in place. The whole county is under a Temporary Emergency Zoning Controls (March 1, 1999) for one year to look at comprehensive land use. Which can be renewed for another year. Whitewood Creek falls under the Temporary Emergency Zoning Controls. If agricultural, then the land use of agricultural is grandfathered in as A-1. If owner of A-1 wants to sub-divide, then land owner has to request for rezoning through the planning commission.

There has not been a need to address the lack of controls because it has not been an issue (there have not been zoning requests on the land within the Site).

In a follow up letter to USEPA (Morris, 2000), Bob Morris clarified the information previously given in the site interviews regarding permanent institutional controls for land within the site. Butte County has two local ordinances in affect that regulate building activities within the Whitewood Creek Site. Ordinance number 94-1 addresses building in the tailings area of Whitewood Creek Site and ordinance number 98-1 addresses building in floodplain areas. This letter also reiterated that building within these areas has not been an issue. The Butte County Planning and Zoning Commission has not received any requests to subdivide or seek building permits under their temporary zoning controls within the affected area.

2. What is your impression of the risk?
This impression depends on information available. The intent is to keep disturbances down but if there are disturbances of the Creek, then they will affect

water quality. There are no reports of health effects since remediation. Out of sight, out of mind. The concerns have decreased over time and no one comes forward with any problems. As long as the area remains primarily agricultural, there will not be a problem. However, if urban sprawl pushes onto this land, there could be a problem. The magnitude of this problem is greater than most realize. Also, the well ban could be a question in the future (Bob). No valid health concerns after remediation. Those informed about the Site are satisfied. General attitude is "just get it fixed". No water quality problems (Dave).

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.
Not particular to the Site.

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
There have been no complaints for planning and zoning commission. The affected residents are fully informed. Over time there could be problems as the land transfers with new generations (Bob). The county commissioner hasn't heard of any complaints, and nothing from the state (Dave).

5. Do you feel well informed about the site's activities and progress?
No. Could use bullet point information for planning and zoning to raise awareness for people coming into the office looking to build or buy in the affected area. No packet of information available for people. The problem is future expansion. If someone comes in they need to know the situation with the Site. The issue has not come up in the last two years. EPA supplied a copy of Lawrence County's "Building Permit Handbook" for the Whitewood Creek Tailings Area (Bob). No good reference material available. The County should have a map of the impacted area. EPA action item. (Dave).

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
Get appropriate information to appropriate people–might be zoning chairman or commissioners. If issues arise, they will need the information (Dave). The information is good. Action is met with "if it ain't broke don't fix it" (Bob).

The following specific questions in addition to the basic ones were asked of the Commission with the following responses:

1. Have any tailings materials been imported?
   Not that aware of.

2. Has Whitewood Creek flooding impacted any high-use area?
   This is unknown as there is not real flooding there.

3. Have any new water wells been constructed within tailings impacted areas? If so, what is the depth of the wells? Any changes in the existing wells?
   Only the State can allow wells to be drilled.

4. Has property use changed, impacting the previously delineated high-use areas?
   No.

5. Have there been any excavating activities since remediation?
   No.

6. Is the remedial cover intact?
   Not sure if any cleanups performed in Butte county. Private controls (i.e. Homestake contracts should be accounted for in review of local controls.

7. What programs do you have to restrict building, well drilling and other activities in the contaminated floodplain? How is the program executed? Give examples.
   Cannot build residential structure in Butte County in a floodplain. Wells are covered by State authority.

5.2.3 Interviews with Remediation Contractors and O&M Contractors

Remediation O&M Contractors were interviewed to understand any problems, successes or changes with regard to the implementation and effectiveness of the remedy. The following questions were asked of each contractor:

1. What is your impression of the project?

2. What documents did you rely upon to execute the project?

3. What did you do?

4. What problems did you encounter?

5. What changes were executed?

6. Do you have any comments, suggestions, or recommendations regarding the project (i.e., design, construction documents, constructability, management, regulatory agencies, etc.)?

The parties interviewed and findings are as follows:

FMG, Inc. Walter Slack of FMG, Inc. was interviewed by Ted Fellman and Gwen Hooten of USEPA Region VIII on March 21, 2000. The following responses were provided to the list of six general questions.

1. What is your impression of the project?
This was a good project for the firm. Solutions were viable given criteria and it went well. Homestake coordinated well with owners. There were a few problem sites where the best option would have been to buy out, but not all owners were willing. Enjoyed working on it. Overall real good project.

2. What documents did you rely upon to execute the project?
All documents, especially consent decree, were relied on to complete project. They followed all that EPA wanted done.

3. What did you do?
Completed observation and oversight of plans and specifications for the remedial sites. Plans and specifications were presented to EPA for confirmation and changed if needed. Plans and specification were provided to Homestake for approval. Homestake hired a contractor for the remediation. Verified that plans and specifications were followed in accordance with EPA.

4. What problems did you encounter?
   There are always problems, but they worked through them.

5. What changes were executed?
   Changes are part of the process and were worked out with the owner and EPA. The changes made it fun.

6. Do you have any comments, suggestions, or recommendations regarding the project (i.e., design, construction documents, constructability, management, regulatory agencies, etc.)?
   A lot of money was spent and could have been more wisely spent. The project was very expensive given all the changes and modifications.

The following additional question were asked of the contractor:

1. Is there a continuous onsite O&M presence? If so, please describe staff and activities. If there is not a continuous onsite presence, describe staff and frequency of site inspections and activities.
   No, but willing if Homestake wants.

2. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.
   Question Not Applicable

3. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.
   Question Not Applicable

4. Have there been opportunities to optimize the operation, maintenance, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.
   Question Not Applicable

Ellis Engineering. Brad Ellis of Ellis Engineering was interviewed by Ted Fellman and Gwen Hooten of USEPA Region VIII on March 21, 2000. The following responses were provided to the list of six general questions.

1. What is your impression of the project?
   Went off well. There were some glitches that were included in the construction completion report. He has not visited the site in a year. Use of the asphalt and gravel helped in high use areas. This material minimized use and looks nice.

2. What documents did you rely upon to execute the project?
   He relied on all documents but cannot remember all names. Of particular use was the design report included in the remediation plan produced by Greg Knell of KRW Consulting.

3. What did you do?
   Construction oversight.

4. What problems did you encounter?
   A garage floor cracked when raised. Topsoil was difficult to find and owner was not fond of the soil used as it was too clayey.

5. What changes were executed?
   None of the problems encountered really constituted a change. There was a border change for the high use area, which was mutually agreed upon.

3. Do you have any comments, suggestions, or recommendations regarding the project (i.e., design, construction documents, constructability, management, regulatory agencies, etc.)
   He did not have any particular recommendations but suggests that the project was perhaps overkill and was very expensive. They followed good construction practices, kept clean and removed soil to on-site repository.

The following additional question were asked of the contractor:

1. Is there a continuous onsite O&M presence? If so, please describe staff and activities. If there is not a continuous onsite presence, describe staff and frequency

of site inspections and activities.
There is not a continuous onsite presence. The activities are complete.

2. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.
Question not applicable.

3. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.
Question not applicable.

4. Have there been opportunities to optimize the operation, maintenance, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency. What could be done better?
Optimized as much as possible within requirements.

5.2.4 Interviews with Homestake Mining Corporation

Al Cox of Homestake Mining Company was interviewed to understand any problems, successes or changes in implementing the remedy in order to access its effectiveness. The interview was conducted on May 15, 2001 by Gwen Hooten of USEPA. The questions asked and responses given are summarized below:

1. What is your impression of the project?
Based on Homestake Mining Corporation's work, there doesn't seem to be a problem. Nothing was identified to indicate the remedial action is not protective.

2. What is your impression of the risk?
The remedial action remains protective.

3. Have there been routine communications or activities (site visits, inspections, reporting activities, etc.) conducted by your office regarding the site? If so, please give purpose and results.

Quarterly O&M reporting, periodic inspections (of soil disposal site annually), annual public information fact sheet for site residents. Don't necessarily visit quarterly.

4. Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.
There was an issue with the root cellar at the Berger property (remediated in 1992) a year or two ago. The property had humidity problems in their root cellar. Remediation solved the problem.

5. Do you feel well informed about the site's activities and progress?
Mostly yes, especially on significant issues. An office in Spearfish and Whitewood would allow us to be in contact with the local feel of the project.

6. Do you have any comments, suggestions, or recommendations regarding the site's management or operation?
No specific recommendations. No more 5-Year reviews would be nice, as this review has evolved beyond a regular five year review.

7. Have you in the past, or will you in the future use the surface water in Whitewood Creek? Why?
Not familiar with water rights on Whitewood Creek. Homestake does not have specific items/activities involving creek flows.

8. Have any tailings materials been imported? Have any tailings been removed from the Creek?
We are only aware of a small amount of tailings that were removed from the Creek and placed in the soil disposal area. We need to check to see how vegetative cover is doing.

9. Have any new water wells or other irrigation structures been constructed within tailings impacted areas? If so, describe the wells or structures.
We are not aware of any new structures or water wells. The shallow well ban is well known by residents. They are notified of the ban in the annual educational fact sheet. There are no regular site visits to check for new wells.

10. Has surface water usage changed, and what impact does the change have on the impacted surface water and surrounding area?
Not aware of any significant changes.

11. Has Whitewood Creek flooding impacted any high-use areas?
Don't believe so, at least not since remediation.

12. Has property use changed, impacting the previously delineated high-use areas?
There have been land purchases and rental to former owners in the Site.
Homestake owns some property on the Belle Fourche, but not recently acquired.
Talk with Harold Barn.

13. Have there been any excavation activities since remediaton?
There has been rip rap and stabilization work by the siphon.

14. Is the remedial cover intact?
Yes. Additional work at Holsclaw property resolved an issue with remedial cover.

15. Is any geofabric (used beneath remedial cover materials in select areas) visible?
Not aware of, but contact Greg Canel at FRK.

16. Are there any special problems related to previously completed remedial activities?
Just at the Berger and Holsclaw properties.

17. What programs do you have to restrict building, well drilling and other activities in the contaminated floodplain? How is the program executed? Give examples.
We rely on the local ordinance program to restrict activities.

18. Can you discuss Homestake's land agreements along Whitewood Creek? How does this relate to efforts to maintain institutional controls?
See question 12.

19. Were each of these properties filed?
See question 12.

20. Do you have 1995 soil sampling results from Ray and Becky Crowser's property (associated with building permit 3788)? Crowser states that Homestake already took samples, and they are outside 100 mg/kg limit for arsenic.
Will check.

21. What documents did you rely upon to execute the project? What did you do? What problems did you encounter? What changes were executed?
The Sampling and Analysis Plan outlined the criteria to determine which sites would be remediated. We sampled along the Creek to determine Arsenic concentrations. Homestake provided this information in a database submitted to EPA. The ROD is the driver.

22. Do you have any comments, suggestions, or recommendations regarding the project (i.e., design, construction documents, constructability, management, regulatory agencies, etc.)
No. Lot of effort in Construction Completion Report. Consent Decree has created some problems, like what are the obligations or responsibilities of Homestake? Need some clarity.

23. Is there a continuous onsite O&M presence? If so, please describe staff and activities. If there is not a continuous onsite presence, describe staff and frequency of site inspections and activities.
Continuous activities include: continue quarterly reporting, fact sheet mail outs, surveillance at the disposal site and water quality monitoring.

24. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since start-up or in the last five years? If so, do they affect the protectiveness or effectiveness of the remedy? Please describe changes and impacts.
No, not that I am aware of. We tried to maintain consistency.

25. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? If so, please give details.
No big ticket items, just money spent on developing the Five-Year Review. Water quality monitoring has become more expensive.

26. Have there been opportunities to optimize the operation, maintenance, or sampling efforts? Please describe changes and resultant or desired cost savings or improved efficiency.
Have not identified any significant changes regarding cost.

5.2.5 Summary of Interview Results

No significant changes in Site conditions were reported during the 1996 or 2000 interviews, except for building activities occurring at some residential properties. Tailings materials were not reported to be imported into the Site, no known excavation activities impacting tailings deposit areas were reported, and flooding is not known to have impacted any residential areas of the Site. The Belle Fourche Irrigation District reported conducting bank stabilization activities on several occasions to prevent erosion of the bank near the irrigation siphon. Homestake reported purchasing land and renting it back to the former owners within the Site boundaries.

Development was reported at several residential properties in both Lawrence and Meade Counties since remediation. Some of these development activities occurred within and outside of the 100 ppm arsenic tailings impacted areas. Butte County did not report any requests for development within the tailings impacted areas since the implementation of its county ordinance.

Successes and Problems in the Implementation of Institutional and Access Controls

The site interviews revealed several instances of development at residential properties within the Whitewood Creek Site, some of which occurred in the 100 ppm arsenic tailings impacted area. The available information on the residential construction activities are summarized below:

Summary of Development Activities within the Whitewood Creek Superfund Site			
Property	**Development Activity**	**Located in 100 ppm Arsenic Tailings Impacted Area?**	**Soil Sampling Conducted and Results**
Johnson	Bed and Breakfast	No	No, sampling not required for areas outside 100 ppm Tailings Impacted Area.

Summary of Development Activities within the Whitewood Creek Superfund Site			
Property	**Development Activity**	**Located in 100 ppm Arsenic Tailings Impacted Area?**	**Soil Sampling Conducted and Results**
Crowser	Placed mobile home on property.	Yes (in an area"barely above 100 ppm arsenic")	Owner agreed to conduct sampling, however information not available from interview on results.
Thompson	Placed mobile home on property and built a well.	Yes	Information not available.
Berger	Built new residence and installed piping to tap into a neighbor's existing well.	Information not available.	Information not available.
Unknown Property ("across the Creek from the Holsclaw residence")	Built new home and installed a septic system.	Information not available.	Information not available.

As shown in the table, there were two instances of development (Crowser and Thompson properties) within the tailings impacted areas without the prior required application or sampling specified by the county ordinances. Information on some of the other reported development activities were not available to determine if the county ordinance development guidelines were followed.

From the available information gathered during the site interviews, it seems that the county ordinance development guidelines for residential building within the Whitewood Creek Site are not consistently followed or reported. Thus, this institutional control may not be functioning effectively to limit residential exposures to arsenic impacted soils.

Successes and Problems with System Operations and Maintenance (O&M)

Homestake Mining Company did not report any unexpected difficulties with Operations and Maintenance (O&M) activities or costs at the Whitewood Creek Site since startup. No other problems were reported during the site interviews.

Unusual Situations or Problems

No unusual situations or problems are reported during the site interviews.

5.3 Site Inspection

A Whitewood Creek Site Inspection was completed by USEPA to visually confirm and document the conditions of the Site, remedy and surrounding area.

5.3.1 Date and Conduct of Site Inspection

J. Steve Peters of Homestake, Joane Lineburg of SD DENR and Mike McCeney of USEPA Region VIII inspected all remediated residential properties on July 16 and 17th, 1996.

5.3.2 Activities

Residential properties that were remediated during the remedy were inspected. The properties were examined for any degradation in or changes to remedial cover and for changes in land use that may have occurred since remediation. The findings from the property inspections are summarized below:

Summary of 1996 Residential Site Inspection Findings		
Residence	Observed Changes in	
	Land Use	Remedial Cover
ALA	No apparent changes in site use.	Observed to be in good condition.
BALO (upper and lower)	Modular home being moved, so that only one residence at upper property.	Observed to be in good condition.
BERGER	No apparent changes in high use area.	Appears to be in good condition.
KYMALA	No apparent onsite changes.	Cover observed to be in good condition.
MARRS	No apparent changes at the site.	Gravel and soil appeared in good condition.
TIPPEY	Original home now unoccupied. New modular home located further from tailings area.	Driveway observed to be in good condition, no geotextile fabric evident; minor movement of gravel during extreme precipitation.
WENNBERG	No observed changes in site sue. Garden area apparently not in use.	No observable changes in remedial cover.

Summary of 1996 Residential Site Inspection Findings			
Residence		Observed Changes in	
		Land Use	Remedial Cover
WILLSON		No changes in site use.	No changes in remedial cover.
ALAN		No apparent changes in site use.	Cover materials observed in good condition.
HOLSCLAW		No observed changes in site high use area conditions. Built pasture to yard road approach in 1996.	No observed changes in cover.
NELSON		No observable changes in high use conditions. Garden area not in use.	No observed changes in cover.
SHUCK	Unoccupied (north)	No observed changes in high use conditions or flooding.	No observed changes in remedial cover.
	Occupied	No observed changes in high use conditions. Garden is no longer used.	No observed changes in remedial cover.
WESTBERG	North	Property now occupied.	Cover materials appeared in good condition.
	South (main residence)	Driveway within high use area was paved. Yard fence moved closer to house making high use area south of home smaller. Some slumping of creek bank south of lower yard.	Cover materials observed in good condition

Source: Chadwick et al., 1997.

5.3.3 Summary of Site Conditions

No significant degradation of remedial cover or any significant changes in land use at remediated properties were discovered as part of the five-year review residential site inspection activities (Chadwick et al., 1997). The remedial cover at residences remains intact.

5.4 Risk Information Review

5.4.1 ARARs Reviewed

Remedial actions under CERCLA are required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and EPA guidance and policy to comply with applicable or relevant and appropriate standards, requirements, criteria, or limitations during and at the completion of the action. These Applicable or Relevant and Appropriate Requirements (ARARs) include both state and federal environmental laws and state facility siting laws. These requirements are threshold standards that any selected remedy must meet, unless an ARAR waiver is invoked.

ARARs are either contaminant, location, or action specific. Contaminant specific ARARs establish acceptable amounts or concentrations of chemicals which may be found in or discharged to the ambient environment. Location specific ARARs relate to the geographical or physical positions of sites, and place restrictions on the conduct of cleanup activities or concentrations of hazardous substances. Action specific ARARs are usually technology based or activity based requirements or limitations on actions taken with respect to hazardous substances, pollutants or contaminants.

As part of the five-year review, the ARAR requirements identified in the ROD for the remedy are examined to assess, as part of the remedy, whether they are still protective of human health and the environment. ARARs are examined for new or revised requirements (such as drinking water Maximum Contaminant Levels (MCLs)) that have occurred since the signature of the ROD. Only those ARARs that address risks posed to human health or the environment are reviewed (USEPA, 1999).

Table 5-1 lists the ARARs for the Whitewood Creek Superfund Site specified by the ROD (USEPA, 1990) and by the 1991 Explanation of Significant Differences (ESD). According to the ROD for this Site, a waiver was invoked for complying with maximum contaminant levels for arsenic under the Safe Drinking Water Act and the arsenic ambient water quality criteria for the protection of human health by consumption of fish because of the technical impracticability of meeting these requirements (USEPA, 1990).

The following ARARs were reviewed for changes that could affect the protectiveness of the remedy to human health and/or the environment:

- Safe Drinking Water Act, National Primary Drinking Water Standards (40 CFR Part 141)
- Clean Water Act, National Ambient Water Quality Criteria (40 CFR Part 131)
- Resource Conservation and Recovery Act (40 CFR Parts 241, 257 and 264)
- Clean Air Act, National Ambient Air Quality Standards (40 CFR Part 50)
- South Dakota Drinking Water Standards (ARSD 74:04:05)

- South Dakota Groundwater Quality Standards, Maximum Contaminant Levels (ARSD 74:54:01)
- South Dakota Surface Water Quality Standards (ARSD 74:51:01)
- South Dakota Water Right Rules (ARSD 74:02)
- South Dakota Solid Waste Disposal Act (ARSD 74:27)
- South Dakota Clean Air Act, Ambient Air Quality Standards (ARSD 74:36:02)

Chemical Specific ARARs

ARARs for the contaminants of concern identified in the 1990 ROD (USEPA, 1990) and the 1997 Screening Level Ecological Risk Assessment for Whitewood Creek (ISSI, 1998) were reviewed for changes that may affect the protectiveness of the remedy to human health and the environment. Table 5-2 summarizes the changes in the chemical-specific ARARs by comparing the current regulations with the regulations in effect at the signing of the ROD in 1990. These standards are relevant to Site groundwater as a potential future drinking water source, the surface waters of Whitewood Creek for the protection of human health from fish consumption and for the protection of aquatic life and ambient air. Some federal and state regulations for various chemicals have been revised since the signing of the ROD in 1990 to be either more or less stringent. The result of these changes is to increase (a less stringent regulation) or decrease (a more stringent regulation) the allowed concentrations of chemicals in groundwater, surface water or air. Table 5-3 summarizes the changes in stringency for chemicals in groundwater, surface water and ambient air that have occurred since the ROD.

Table 5-2 presents both the total recoverable and dissolved ambient water quality criteria for the protection of aquatic life. However, the federal and state surface water quality criteria in effect at the time the ROD were based on total recoverable metals. Since the signing of the ROD, the federal and state regulations have changed to add criteria specific to dissolved metals concentrations. Thus, the total recoverable and dissolved concentrations of metals provided in Table 5-2 are for comparison purposes only.

According to the ROD, a waiver was invoked for complying with maximum contaminant levels (MCLs) for arsenic in groundwater under the Safe Drinking Water Act and the water quality

criteria for the protection of human health by consumption of fish because of the technical impracticability of meeting these requirements (USEPA, 1990). Thus, the changes in the federal and state arsenic surface water quality criteria, drinking water standards, and state groundwater quality standards do not affect the protectiveness of the remedy because, under the waiver, these standards are not required to be attained.

Site-specific water quality criteria for 10 metals are specified for the upper reach of Whitewood Creek, from Interstate 90 to its confluence with Gold Run Creek. With the exception of copper, all ambient water quality criteria for the metals of concern have changed since the 1990 ROD as summarized in the following table:

Site-Specific Water Quality Criteria for Whitewood Creek from Interstate 90 to Confluence with Gold Run Creek

Chemical	30-day average (ug/L)	
	1990 Standards [a]	2001 Standards [b]
Cyanide	209.3	80*
Copper	80	80
Cadmium	4.2	10
Silver	3.9	20
Arsenic	67.4	NA
Chromium	4	NA
Mercury	0.24	0.8
Zinc	45.8	NA
Lead	32.4	70
Nickel	37.3	NA

Standards are expressed as total concentrations, unless otherwise noted.
*weak acid dissociable (WAD) Cyanide
NA - Not applicable, no stream specific criteria for this chemical.

Sources:
[a] Administrative Record of South Dakota (ARSD) 74:03:02:48, 1990
[b] Administrative Record of South Dakota (ARSD) 74:51:01:56, 2001

The changes in criteria for total recoverable cadmium, silver, mercury and lead increase the allowable concentrations of these substances in the surface water of the upper reach of Whitewood Creek. The chemicals arsenic, chromium, zinc, and nickel no longer have stream-specific numeric criteria. Thus the water quality criteria for these metals are the same as the South Dakota water quality standards.

Since the signing of the ROD in 1990, the state designated beneficial uses for the lower reach of Whitewood Creek, from I-90 to the Belle Fourche River, have been upgraded from warm water semi-permanent fish life propagation waters to warm water permanent fish life propagation waters. The change in beneficial use status results in a change in the suspended solids water criteria (adding a daily maximum criteria of 158 mg/L) lowers the maximum allowable temperature from 90°F to 80°F.

One change in ambient air quality standards occurred since the ROD. The state ambient air quality standard lowered the maximum allowable concentration of particulates with a diameter of 10 micrometers or less (PM10) from from 60 ug/m^3 to 50 ug/m^3 over 24 hours. This change does not affect the protectiveness of the remedy. The standards are applicable to the Site, especially during remediation, so that fugitive dust from construction does not cause the area to exceed ambient standards.

Action-Specific ARARs

Table 5-4 summarizes the changes to action-specific ARARs that have occurred since the ROD. The majority of these changes modify design requirements for disposal facilities. Two of these regulations (40 CFR 264.301 and 40 CFR 264.251) require that waste pile and landfill units that are new, lateral expansions of existing units or units that are being reused after July 29, 1992 to have two or more liners and leachate collection, removal and detection systems. These changes are currently not applicable to the disposal unit at the Whitewood Creek Site. Currently, the disposal unit is inactive and is not undergoing new construction/expansion or replacement (triggers for the new design requirements). However, these regulations may be applicable in the future if the use of the disposal facility resumes, and/or the unit undergoes new construction or expansion to accommodate acceptance of additional wastes from any residential remedial activities. These changes currently do not affect the protectiveness of the remedy. Future activity at the disposal facility may trigger the applicability of these changes to the regulations and would affect the protectiveness of the remedy.

One modification to a state solid waste regulation may be applicable to the Site and its protectiveness. A state design regulation was modified to require discharges of retained surface waters from the facility to meet the storm water discharge requirements of 40 CFR 122. This modification may be applicable to the disposal facility if it is not exempted as either a mining waste or inactive mining facility from the regulation.

Both a federal and a state regulation, 40 CFR 241.200-211 and ARSD 74:27:03:08, have been repealed since the ROD and ESD were signed in 1990 and 1991. Repealing these regulations does not make the remedy more or less protective. The regulations were removed because they were "obsolete" and addressed by other regulations.

5.4.2 Review of Site-Specific Cleanup Level

In addition to federal and state regulations, a site-specific risk-based cleanup level for arsenic was established for residential soils. This action level assumed that remedial action efforts aimed at groundwater, the tailings area and the irrigated cropland area were in place, and thus only addressed exposure to residential soils (Jacobs, 1989). A soil action level of 100 mg/kg arsenic for residential soils was derived in the Endangerment Assessment (Jacobs, 1989) based on a 1E-04 target cancer risk protectiveness level selected by USEPA. This soil action level was also determined to reduce non-cancer risks to an acceptable level (USEPA, 1990).

The soil action level for arsenic was reviewed as part of this five-year review process. Although there have been some changes in the toxicity factors and exposure parameters recommended by USEPA for evaluating cancer and noncancer risks from arsenic (SRC, 2001a), USEPA still considers the soil action level of 100 mg/kg to be adequately protective of human health.

5.5 Risk Recalculation and Assessment

This section presents the results of any assessment and/or re-calculation of human health and environmental risks at the Site conducted as part of this five-year review.

5.5.1 Human Health Risk Assessment

Residential Soil Action Level

As discussed in Section 5.4.2, the residential soil action level for arsenic was reviewed (SRC, 2001a) and is considered by USEPA to still be adequately protective of human health.

Acute Arsenic Exposure

In a memo to Homestake (USEPA, 1997a), USEPA Region VIII identified the potential need to evaluate possible acute human health risks from acute arsenic exposure. As discussed in SRC

(2001a), there is still substantial uncertainty associated with short-term arsenic exposure. Until sufficient methods and data become available to permit the quantification of these risks, USEPA considers the current soil action level to be sufficient to reduce or minimize risks from acute arsenic exposure.

Arsenic Exposure From Fish Consumption

Potential risks to recreational fisherman consuming fish from Whitewood Creek were evaluated (SRC, 2002) as part of the five-year review. Based on the review, cancer and non-cancer risks from arsenic in fish tissue are below a risk level identified by USEPA (1991) as typically requiring action at Superfund Sites. Thus, the current remedy is judged by USEPA to remain protective of human health.

5.5.2 Ecological Risk Assessment

At the outset of the Five Year Review, EPA sought to evaluate the adequacy of the ROD not only for the protection of human health, but also the protection of ecological receptors and the environment. After a review of available documents that provide information on potential ecological risks at the site (Fox Consultants, Inc., 1984a and 1984b, Environ Group, 1985; ICF, 1989c, Jacobs Engineering, 1989, USEPA 1989a), EPA determined that the existing evaluations were not adequate to reliably assess whether existing site conditions do or do not pose unacceptable risks to ecological receptors. For this reason, EPA performed an ecological risk assessment for the site, using the most relevant and appropriate ecological risk assessment guidance (USEPA, 1989b, 1992, and 1997b).

Screening Level Assessment

In accordance with EPA guidance, the ecological risk assessment process began by performing a screening level ecological risk assessment (SERA) (ISSI, 1998). The primary sources of contamination that were evaluated in the SERA were the tailings that exist along the banks of Whitewood Creek, as well as chemicals that exist in the water and sediment of the Creek. The main chemicals of potential concern at mining sites are inorganics, including metals in the ore that is mined and processed, as well as chemicals that are used to extract metals from the ore. This included arsenic, cadmium, chromium, copper, cyanide, lead, mercury, nickel, selenium, and zinc. Ecological receptors evaluated in the SERA included aquatic species (fish and benthic macroinvertebrates) residing in Whitewood Creek, and terrestrial receptors (plants, soil

invertebrates, birds, wildlife) that reside in the riparian zone adjacent to Whitewood Creek. Exposure pathways that were quantitatively evaluated in the SERA included:

- Direct contact of aquatic receptors (fish, BMI, periphyton) with surface water
- Direct contact of BMI with sediment
- Direct contact of terrestrial plants with soil
- Direct contact of soil invertebrates with soil
- Ingestion of surface water, sediment, soil by avian and mammalian wildlife
- Ingestion of food items (fish, BMI, terrestrial plants, soil invertebrates) by avian and mammalian wildlife

A summary of the screening level risk findings presented in the SERA is provided in Table 5-5. Based on the preliminary risk characterization in the SERA, none of the exposure pathways considered in the SERA could be excluded, and further evaluation was recommended for all exposure pathways.

Collection of Data to Fill Key Data Gaps

The SERA identified a number of data areas where additional information was needed to help improve the reliability and accuracy of the risk assessment. A summary of these data gaps and recommendations for data collection activities is provided in Table 5-6. These data gaps were used to help development of a field sampling Quality Assurance Work Plan (QAWP) (ERT, 1999a) and Data Quality Objectives (DQOs) (ERT, 1999b). Extensive new data were collected under this QAWP in 1998 and 1999, and these data were then used to help support the baseline ecological risk assessment.

Baseline Risk Assessment

EPA issued a draft baseline ecological risk assessment (BERA) in August 2001 (SRC 2001b). EPA received written comments on the draft BERA from HMC and SD DENR. Based on these comments, EPA revised and finalized the ERA. The findings of the final ERA are summarized below.

Stream Viability and Function

- Risks to aquatic receptors from most COPCs in surface water are generally below a level of concern, although some low level and intermittent stress may occur. Cyanide is not likely to be of concern to stockable size fish, but available data are not sufficient to determine if sensitive life stages of fish or BMI may be at risk from cyanide.

- Risks to aquatic receptors from COPCs in sediment and pore water do not appear to be above a level of concern at most stations, although risks from arsenic and cadmium might be of concern in some locations.

- Seep water is a source of increased COPC concentrations in Whitewood Creek. However, the seep water has little apparent toxicity, and any exposures of aquatic receptors to seep water are minimized by dilution of the seep water is in the creek.

- Exposures of aquatic receptors by ingestion of aquatic prey items and/or sediment do not appear to be of concern.

- Population surveys of fish and benthic invertebrates indicate the communities are generally abundant and diverse, although the possibility of an impact cannot be excluded from these data.

Based on these findings, EPA concluded that COPCs in the aquatic ecosystem may result in some stress to aquatic receptors, but that the level and severity of any effects are probably not substantial.

Riparian Floodplain Function and Viability

- Site soils are not generally toxic to plants or soil invertebrates

- If plant roots are exposed to seep water, phytotoxicity from root exposure to arsenic could be occurring, but confidence in this conclusion is low.

- Terrestrial plant and microinvertebrate population data are insufficient to support a quantitative conclusion

Based on these findings, EPA concluded that the viability and function of the riparian floodplain is probably not substantially impacted by mining-related releases.

Viability of Terrestrial Wildlife

- Risks to wildlife do not appear to be of significant concern for exposures that occur from ingestion of surface water, seep water, or food items.

- Many terrestrial receptors are predicted to have elevated risk of adverse effects from ingestion of arsenic in soil or sediment.

- Site data confirm that small mammals have increased exposure to arsenic, but there are no independent data from site-specific toxicity testing or quantitative population surveys that can confirm or refute the predicted risk from arsenic.

Based on this, EPA concluded that arsenic in soil or sediment may pose a risk to some wildlife receptors, but that this conclusion should be considered tentative unless additional lines of evidence can be added to the evaluation.

Viability of the Amphibian Community

- Some species of amphibians (but not all) may be at risk from dissolved COPCs in surface water.

- Risks from sediment or diet cannot be evaluated quantitatively, but are expected to be minor.

Based on this, EPA concluded that risks to some amphibians are possible, but that this conclusion should be considered tentative unless additional lines of evidence can be added to the evaluation.

Summary

Substantial data are available to evaluate the potential risks to aquatic and terrestrial ecological receptors at the Whitewood Creek site. Based on an evaluation of the weight of evidence across all available lines of evidence, EPA has concluded that mining-related chemicals probably are causing some effects on both the aquatic and the terrestrial ecosystems, but that these effects are

low level and are generally not sufficient to result in substantial disruption of ecosystem function or viability. Based on this, the current remedy is considered to be adequate for protection of ecological receptors and the environment.

5.6 Data Review

5.6.1 Residential Verification Sampling

The Operation and Maintenance Plan for the Site (WDC, 1994b), requires verification soil sampling at remediated residences within the Site boundaries as part of the five-year review process. These properties may be subject to possible recontamination by wind deposition of arsenic rich materials, importation of contaminated materials, or re-exposure of materials covered during remediated activities. Verification sampling at these properties ensures that the remedy is protective of human health by confirming that arsenic concentrations are below the 100 mg/kg action level for residential soils. If during verification sampling activities, arsenic concentrations are discovered that statistically exceed the 100 mg/kg soil action level, those specific areas will be remediated per the project selected remedy within one year of the determination that remediation is necessary.

Soil sampling was conducted at 6 residential properties within the Site boundaries on July 18 and 19, 1996. Samples were collected and analyzed per Addendum E of the O&M Plan (WDC, 1994b), with one exception. Soil samples were collected from a depth interval of 0 to 1 inch, rather than the depth interval of 0 to one-half the remedial fill material (as specified in the O&M Plan). This modification to the sampling plan was implemented per correspondence from Michael McCeney of USEPA dated July 17, 1996 (Chadwick et al. et al., 1997).

Table 5-7 summarizes the results for the five year review residential verification sampling program.
Arsenic concentrations above the site action level of 100 mg/kg were detected at one of the six residences sampled, in two driveway samples collected at the Holsclaw property (Chadwick et al., 1997). The average arsenic concentrations measured at the properties during verification sampling are summarized below:

Property	Number of Samples	1996 Average Arsenic Concentrations (mg/kg)
Alan	5	34
Nelson	5	13
Shuck	4	28
Shuck North	3	16
Westberg	2	12
Holsclaw	33	87

Source: Chadwick et al., 1997

Additional intensive soil sampling was conducted at the Holsclaw property in accordance with Section 4.5.3 of the Whitewood Creek Superfund Site Sampling and Analysis Plan for Residential Remediation and Surface Water Monitoring SAP (WDC, 1991). Sampling activities indicated that the property high use area had been impacted by arsenic containing materials. The driveway area was speculated to have been impacted by deposition of tailings from vehicle tires. Higher arsenic concentrations were detected in the driveway area and apparent tailings materials were observed in samples collected from the north side of the driveway. A garden area with arsenic concentrations greater than 100 mg/kg appeared to contain imported materials, probably derived from a tailings impacted area (Chadwick et al., 1997).

As required by the O&M Plan (WDC, 1994b), remedial activities were conducted at the Holsclaw property. The remedial action at this individual property began in the November 1997 and was completed late June 1998. A post-construction inspection of the residence on July 13, 1998 did not identify any items of significant concern. The construction completion report was submitted in August of 1998 (WDC, 1998).

Verification sampling was also conducted in October 2001 (HMC, 2001a). However, the results from this sampling event were not available for inclusion in the current five-year review report. The next five-year review of the Site will present the results from the October 2001 sampling event.

5.6.2 Surface Water Quality

The Site remedy requires long term monitoring of surface water quality to evaluate the effects of uncertain rates of release of arsenic into the surface waters of Whitewood Creek. Therefore, as

part of the five-year review, these data were reviewed to determine if any significant time trends were apparent and to determine if surface water concenteration values are protective of human health and aquatic life (USEPA, 1990).

Surface Water Data

Surface water data were collected from two USGS sampling stations on Whitewood Creek within the Superfund site boundaries. The upper USGS Station (06436180) is located along Whitewood Creek near the Crook City bridge, about 1.1 miles south of the city of Whitewood, South Dakota. The lower Whitewood Creek USGS Station (06436198) is located about 3.2 miles above the confluence with the Belle Fourche River, about 3.7 miles west of Vale, South Dakota (Figure 5-1). Surface water quality data for arsenic, antimony, cadmium, copper, cyanide, lead, mercury, nickel, selenium and zinc collected during the period of January 1990 through September 1999 (available electronically from USGS) were reviewed.

Time Trends

Surface water data were plotted for each USGS sampling station by sampling date to examine trends in concentrations (dissolved and total recoverable) over time. For each case (dissolved or total at a station), the best fit linear regression line was determined. The results are provided in Figure 5-2, and summary statistics for the regression are presented in Table 5-8. No cases were observed of a statistically significant increase in concentration over time. In 23 out of 36 cases, the slope of the line was not significantly different from zero, indicating no apparent trend of increasing or decreasing concentrations. In 13 out of 36 cases, a small (0.1 to 1 ug/L per year) but statistically significant negative trend was observed, indicating a slow trend toward lower concentrations of these chemicals over time.

Protectiveness of Human Health

Figure 5-3 compares surface water concentrations at both the upper and lower USGS sampling stations during this period to the federal ambient water quality criteria (AWQC) for human health from fish consumption.

Arsenic was the only chemical to exceed federal AWQC for the protection of human health from the consumption of fish. This criteria was exceeded at both the upstream and downstream sampling locations within the Site. However, this AWQC does not take into account the finding

that much of arsenic in fish is non-toxic, and this ARAR has been waived at this Site. In order to evaluate the potential risks to humans from arsenic in fish, an evaluation based on measured concentrations of arsenic in fish tissue was performed (SRC, 2002). As mentioned above (see Section 5.5.1), the potential risks from arsenic to recreational fishermen consuming fish from Whitewood Creek are below the level identified by USEPA (1991) as typically requiring action at Superfund sites. Thus, the current remedy is judged to remain protective of human health.

Protectiveness of Aquatic Life

A detailed evaluation of potential risks to aquatic receptors from chemicals in surface water was conducted as part of the ecological risk assessment conducted at the Site (Attachment 5-3, Section 6.2.1) to evaluate the protectiveness of the remedy to the environment. This evaluation included the selection of COPCs for surface water and a comparison of COPC concentrations to the federal AWQC for COPCs in surface water (Attachment 5-3, Figure 6-1) both within and outside of the NPL site boundaries. Some copper, lead, and selenium concentrations in surface water within the NPL site exceeded the chronic AWQC, suggesting some low level and intermittent stress may occur from these chemicals. The ERA concluded that although mining-related chemicals probably are causing some effects on both the aquatic ecosystems, these effects are low level and are generally not sufficient to result in substantial disruption of ecosystem function or viability. The current remedy is considered to be adequate for protection of ecological receptors and the environment.

6.0 ASSESSMENT

This section summarizes the conclusions of this five-year review report, based on the information presented in previous sections. In assessing the protectiveness of the remedy, the following questions are examined:

- Have conditions external to the remedy changed since the selection of the remedy?
- Has the remedy been implemented in accordance with decision documents?
- Has any risk information changed since the remedy was selected?

6.1 Have External Conditions Changed Since the Remedy?

This section evaluates if conditions external to the remedy have changed at the Whitewood Creek Superfund site since the selection of the remedy. Changes in land use, known contaminants, sources of contaminants, exposure pathways, hydrologic or hydrogeological conditions at the site are evaluated in the following subsections.

6.1.1 Changes in Land Use

Based on the site inspections and site interviews no changes were identified in land use at the Whitewood Creek site. Additionally, no planned changes in the future use of the Site were identified..

6.1.2 Changes in Known Contaminants, Sources and Pathways

Changes in Known Contaminants

No known changes in exposure pathways were identified as part of the five-year review.

Changes in Known Sources

No changes in known sources of contaminants were identified during the five-year review. Erosion of tailings in the stream banks and floodplain continues to be a source of contaminants for Whitewood Creek.

Changes in Known Pathways

No known changes in exposure pathways were identified as part of the five-year review.

6.1.3 Changes in Known Hydrologic or Hydrogeologic Conditions

No known changes in hydrologic or hydrogeologic conditions were identified as part of the five-year review.

6.2 Has the Remedy Been Implemented in Accordance with Decision Documents?

This section evaluates if the remedy, including institutional controls, and its subsequent operation and maintenance are implemented in accordance with project plans and are effective. Access and institutional controls, remedy performance, adequacy of system operations/O&M requirements, optimization, and early indications of potential remedy failure are evaluated in the following subsections.

6.2.1 Health and Safety Plan (HASP) and Contingency Plan

A HASP and Contingency Plan were developed and were in place during remedial activities at the Site. These plans were sufficient to control risks that may have occurred during remedial activities.

6.2.2 Access and Institutional Controls

All institutional controls at the Site, including contamination and floodplain boundary determination, county land use ordinances and state well ban regulations, annual educational program, surface water monitoring, residential flood monitoring and five-year review verification sampling program, are all currently in place. They have been implemented as part of the remedy selected in the ROD and in accordance with the Site Institutional Control Plan.

Contamination and Floodplain Boundary Determination

The tailings deposit areas, tailings impacted soils and 100 year floodplain boundaries were delineated during 1991 to 1992 and approved by USEPA in 1993. These boundaries were used in the enactment of the county land use ordinances institutional control.

Future Development Restrictions

County Land Use Ordinances

Land use ordinances restricting development on tailings deposits and in tailings impacted areas within the Site were adopted by Butte, Meade and Lawrence Counties in 1993 and 1994. These institutional controls remain in place in each of the counties.

Instances of unauthorized development within the Tailings Impacted Areas of the Site reported during Site interviews (Sections 5.2.2 and 5.2.5) suggest that this institutional control is not functioning effectively. By county ordinance, residential developments within the Tailings Impacted Areas of the Site are allowed only in locations where soil concentrations are below the 100 ppm arsenic soil action level. Developers are required to demonstrate that their building sites have arsenic levels below 100 ppm by soil sampling. When arsenic concentrations are determined to be greater than 100 ppm in soil at a building site, they must be reduced by soil tillage or soil covering before development can occur (WDC, 1994b).

Development was reported to occur within the 100 ppm tailings impacted areas at two residential properties (Crowser and Thompson) without the prior application or soil sampling required by the county ordinances. Sampling results were not available for either of these properties during the site interviews. Therefore, it is unknown if the arsenic concentration in the soils at these properties is below or above the residential soil action level.

Two additional properties (Berger and an Unknown Property "across the Creek from the Holsclaw property") are reported to have been developed during this review. Information on the location of these activities is not available to determine if they occurred in the tailings impacted areas of the Site. Thus, these properties may or may not be in compliance with applicable county development guidelines and the residential soil action level.

Based on the information available during this review summarized above, this institutional control is not consistently functioning effectively to limit residents' exposures to arsenic impacted soils.

State Well Ban Regulation

The state well ban regulation prohibiting the construction of wells for residential or agricultural uses in the 100 year floodplain, unless a variance has been granted by the State Chief Engineer,

remains in place. Several variances have been granted for construction of wells within the 100 year floodplain (Section 4.3.3) since the implementation of the remedy. For each variance, the wells were constructed to prevent contamination of groundwater from the tailings deposits, consistent with the well ban regulation. Although a well was reported to have been installed at the Thompson property (Section 5.2.2), based on the information available from the SD DENR Water Rights Program (SD DENR, 2002), the well does not appear to be located within the 100 year floodplain of Whitewood Creek. Information on wells installed within the 100 year floodplain without a variance from SD DENR were not uncovered during this five-year review. Thus, based on the available information, the State well ban regulation appears to be functioning effectively.

Educational Program

Educational materials were distributed on an annual basis during the period 1993 through 2001 as required by the ROD and in accordance with the Institutional Controls Plan. This institutional control remains in place.

The potential pathways hypothesized as the sources of recontamination of the Holsclaw property suggest that this institutional control is not entirely effective. One of the objectives of the annual educational program is to inform residents about ways to minimize personal exposures. Recontamination of garden and driveway materials discovered during five-year review verification sampling are speculated to be the result of the importation of contaminated materials into the garden, and by tracking tailings materials onto the property from driving through tailings impacted areas (Chadwick et al., 1997). An effective education program may have eliminated these pathways as potential sources of re-contamination.

Further, the educational materials remind residents of the development restrictions that are applicable for building within Tailings Impacted Areas of the Site. As previously mentioned, there are instances of development in the Tailings Impacted Areas without the prior applications or soil sampling required by county ordinances. An effective education program addressing the building requirements within the Site may have worked to prevent or reduce the number of these developments that occurred without following county ordinance requirements.

Additionally, the content and type of educational materials distributed annually do not seem to vary significantly from year-to-year (Attachment 4-2). A more effective implementation method

may be to vary the content and type of education materials on a yearly basis to ensure that the information is effectively communicated and not ignored because it is the same material over and over.

Surface Water Monitoring

Surface water monitoring activities have been ongoing at the Site since the program's implementation in 1993. This institutional control remains in place.

The program is effective in collecting data to monitor trends of arsenic concentrations in surface water over time and during various flow conditions.

Residential Flood Monitoring

Plans for resampling remediated properties after flood events and as part of the five-year review are in place as part of the institutional control plan.

No residential properties are reported to be impacted by the flooding events since the implementation of the remedy. Therefore soil sampling has not been required. Thus, the effectiveness of the flood monitoring program cannot be evaluated.

6.2.3 Remedy Performance

As discussed in Sections 4.3.4 (Post-Closure Residential Soil Sampling and Remediation) and in Section 5.6.1 (Residential Verification Sampling) the residential remediation portion of the remedy is in place and remains effective. Verification sampling activities at remediated residences within the Site confirmed concentrations of arsenic in residential soils remained below the Site action level of 100 ppm, and properly identified properties with concentrations above the action level for remediation.

Instances of unauthorized development within the 100 ppm Tailings Impacted Area suggest that the county land use ordinances and the annual education program institutional controls are not functioning effectively. Based on the available information, the state well ban regulation is functioning effectively.

6.2.4 Adequacy of System Operations/O&M

System O&M activities include the long-term maintenance of several of the Site institutional control items. The adequacy of the institutional controls are evaluated in Sections 6.2.2 and 6.2.3. Brief summaries of the institutional control items evaluated in previous sections are included below with the evaluation of other O&M activities.

Surface Water Monitoring

As summarized in Section 4.3.1, surface water samples have been collected during various flow conditions throughout the period of 1993 to 2001 as outlined in Addendum B of the O&M Plan (WDC, 1994b). Although in some years, samples were collected representing only three of the four required flow conditions, the maintenance of this institutional control is generally adequate for the long-term monitoring of arsenic concentrations during varying flow conditions in the surface water of Whitewood Creek

Annual Education Program

As discussed in Section 4.3.1 educational materials have been distributed annually, during the period of 1993 to 2001, in accordance with the Site O&M Plan (WDC, 1994b). The annual maintenance of this institutional control is adequate.

Future Development Restrictions-Annual Review of Residential Building Activity

As reported in Section 4.3.3, the findings from the review of residential development activities within the Site have been reported in the Monthly/Quarterly Reports in accordance with the O&M Plan (WDC, 1994b). Sections 5.2.2 and 5.2.5 reported development activities that have occurred within the Site since the implementation of the remedy. Development occurred on five different properties, two of which (Crowser and Thompson properties) were located within the tailings impacted areas without prior application or sampling.

Of these five instances of development, only two were identified by the available Quarterly Reports (the Crowser and Berger properties). This O&M activity appears to be adequate in identifying some, but not all, of the residential building activities within the Site.

Based on a review of the variance information from the South Dakota Water Rights Program, the state well ban regulation appears to be functioning effectively. Wells installed within the 100 year floodplain were constructed to prevent contamination from tailings materials and to prevent groundwater pollution.

Post-closure Residential Site Soil Sampling Activities and Remediation

Flood Impact Soil Sampling

A plan for resampling residential properties following flood events is in place. No residential properties are reported to be impacted by flooding events since the implementation of the remedy. Thus, the adequacy of the maintenance of this institutional control item cannot be evaluated.

Five-Year Review Verification Sampling

Plans for resampling remediated properties as part of the five-year review are in place as part of the institutional control plan.

The five-year review verification sampling conducted in 1996 was effective in confirming that concentrations of arsenic in residential soils remained below the site action level. It appropriately identified one property with concentrations above the action level for re-remediation. This O&M activity is adequate in ensuring that residential soil concentrations of arsenic remain below the Site soil action level.

Verification sampling was also conducted in October 2001 (HMC, 2001a). However, the results from this sampling event were not available for inclusion in this five-year review report. The next five-year review of the Site will present the results from the October 2001 sampling event.

Residential Soil Remediation (as necessary)

One property was identified during five-year review verification sampling, that required remediation. This property was remediated in accordance with Site project plans so arsenic concentrations were below the soil action level of 100 ppm arsenic. The maintenance of this institutional control is adequate in limiting residents' exposure to arsenic in soil.

Disposal Site Monitoring

Annual inspections of the disposal site have been adequate in identifying conditions needing repair. Maintenance of vegetative cover and rip-rap at the disposal site have been conducted as needed in order to maintain the conditions specified in the Transportation and Disposal Plan (see Section 4.3.5).

Reporting

Quarterly Reports

Quarterly reports of Site O&M activities and the Five-Year Review report of the Site remedy have been submitted in accordance with the Site O&M Plan (WDC, 1994b). This O&M activity is adequate in reporting the respective activities at the Site.

Five-Year Review

Homestake initiated the current five-year review in accordance with the Site O&M Plan (WDC, 1994b).

6.2.5 Need for Optimization

Based on a review of the remedy, the following institutional controls require optimization:

- Follow up with property owners where development has occurred to ensure that these activities are in compliance with county development guidelines and state well regulations, where applicable.

- Information on/review of the county ordinance development requirements with both residents and county officials, and the affected areas of the Site were these guidelines are applicable.

6.2.6 Early Indicators of Potential Remedy Failure

O&M costs can be an indicator of potential remedy failure. Large variances in O&M costs may indicate frequent equipment breakdowns and repairs, suggesting that contaminants are not being

contained and/or treated as required. Costs that are unusually high or inconsistent with original cost estimates may indicate a potential problem for maintaining long-term O&M activities.

Cost information was not available for consideration or evaluation as an indicator of potential remedy failure. Thus, conclusions regarding potential remedy failure based on operations and maintenance costs could not be reached during this review.

6.3 Has Any Risk Information Changed Since the Remedy was Selected?

This section evaluates changes in regulations or other risk information that have changed since the implementation of the remedy. Changes in ARARs, human health and ecological risk information are evaluated in the following subsections.

6.3.1 Changes in ARARs

This five-year review identified changes in both state and federal drinking water, surface water quality criteria, state groundwater quality criteria, ambient air quality standards and in solid waste management regulations that occurred since the signing of the ROD.

Changes to both federal and/or state drinking water standards, surface water quality criteria, groundwater quality standards and ambient air quality standards have occurred, some increasing and some decreasing the stringency of these regulations for various chemicals. An ARAR waiver was invoked for the arsenic MCL in groundwater and the arsenic surface water AWQC based on the technical impracticability of meeting these standards. Thus, the changes in the arsenic regulations do not affect the protectiveness of the remedy. Based on the findings of the risk recalculation and assessment (see Attachment 5-3) and the review of surface water data (Section 5.6), concentrations of chemicals in surface water are considered by EPA to be protective of human health and the environment. Groundwater and ambient air data were not available to review compliance with applicable state and federal standards to ensure protectiveness. However, the contaminated downgradient alluvial aquifer is not a current source of drinking water (USEPA, 1990) and potential ambient air exceedences from Site operations were likely greatest during the remedial action. Based on this, the changes in chemical-specific ARARs that have occurred since the ROD do not affect the protectiveness of the remedy.

Modifications to existing solid waste management regulations that pertain to the disposal facility currently do not affect the protectiveness of the remedy. However, should the disposal facility

become active in the future, these changes in solid waste management regulations may be relevant and appropriate and may affect the protectiveness of the remedy.

6.3.2. Changes in Risk Information

Human Health

Although there have been some changes in the toxicity factors and exposure parameters recommended by USEPA for evaluating cancer and noncancer risks from arsenic (SRC, 2001a), USEPA considers the soil action level of 100 mg/kg to still be adequately protective of human health.

Risks to recreational fishermen from ingestion of arsenic in fish from Whitewood Creek were evaluated (SRC, 2002), and were below USEPA's usual target risk range for cancer and non-cancer effects at Superfund sites (USEPA, 1991).

Ecological

An ecological risk assessment was conducted for the Site to assess whether existing site conditions do or do not pose unacceptable risks to ecological receptors. Based on an evaluation of the weight of evidence across all available lines of evidence, EPA has concluded that mining-related chemicals probably are causing some toxicological effects on both the aquatic and the terrestrial ecosystems, but that these effects are generally low level and are probably not sufficient to cause substantial disruption of aquatic or terrestrial ecosystem function or viability. Based on this, the current remedy is considered to be adequate for protection of ecological receptors and the environment.

7.0 DEFICIENCIES

This section identifies shortcomings, if any, in the current site operations that prevent the remedy from being protective of human health and the environment. The deficiencies discovered during this five-year review are noted in the table below. None of these are sufficient to warrant a finding of not protective, as long as corrective actions are taken.

Deficiencies Identified as Part of the Five-Year Review	
Deficiencies	**Currently Affects Protectiveness (Y/N)**
Future Development Restrictions	
Two instances of unauthorized building in Tailings Impacted Areas	N
Butte County missing site reference map of tailings impacted areas	N
Annual Resident Educational Program	
Two instances of unauthorized building in Tailings Impacted Areas	N
Information addresses the potential pathways suspected to contribute to the recontamination of Holsclaw property	N

7.1 Deficiencies in the Future Development Restrictions

The two instances of unauthorized development in the Tailings Impacted Area of the Site suggests that the county land use ordinances are not consistently effective in controlling arsenic exposure through restricting development activities. Additionally, only one of the two unauthorized development instances was reported during the quarterly review of residential building activities within the Site, suggesting that this O&M activity is not consistently effective at identifying building activities at the Site to ensure compliance with county ordinances.

One minor deficiency associated with county land use ordinances was identified during Site interviews. Butte County was missing a reference map of the delineated boundaries of the tailings deposits, tailings impacted areas, and 100 year floodplain.

7.2 Deficiencies in the Annual Resident Education Program

The two instances of unauthorized development in the tailings impacted areas suggests that this institutional control is not functioning effectively to inform residents of the procedures for development within the Site.

Additionally, the potential sources and pathways that were hypothesized to contribute to the recontamination of the Holsclaw property are addressed in the educational materials distributed to residents. Thus, this information may not be effective in informing residents of how to reduce exposure and prevent contamination of their properties.

8.0 RECOMMENDATIONS AND REQUIRED ACTIONS

This section specifies the required and suggested improvements to current site operations to address the deficiencies that currently affect protectiveness. These recommendations are summarized in the following table along with the parties responsible for actions, milestone dates, and agencies with oversight authority.

Recommendations and Required Actions Identified During the Five-Year Review				
Recommendations/ Required Actions	**Party Responsible**	**Oversight Agency**	**Milestone Date**	**Required Actions: Currently Affects Protectiveness (Y/N)**
County Land Use Ordinances				
Prepare updated maps of each property affected by County Ordinances showing property use, tailings deposits, and tailings impacted (100 ppm arsenic areas). Distribute to property owners, county officials, and USEPA.	Homestake	USEPA	June 30, 2003	N
Notify County of any development activities in the tailings-impacted areas.	Homestake	USEPA	Ongoing	N
Follow up with property owners where development was reported to have occurred to ensure that they are in compliance with county ordinance guidelines and state well ban regulations.	Butte, Meade and Lawrence Counties	USEPA	June 30, 2003	N
Supply Butte County with proper maps and reference materials	Homestake	USEPA	June 30, 2003	N

Recommendations and Required Actions Identified During the Five-Year Review				
Recommendations/ Required Actions	**Party Responsible**	**Oversight Agency**	**Milestone Date**	**Required Actions: Currently Affects Protectiveness (Y/N)**
Annual Resident Education Program				
Modify annual information packet to include a point of contact at the appropriate County Offices and also an awareness of county development ordinances as a "Site Resident's Role"	Homestake	USEPA	June 30, 2003	N

8.1 Recommendations for Future Development Restrictions

8.1.1 Updated Maps

The site interview portion of this five-year review identified residential development activities within the Site. Some of these occurred within the 100 ppm tailings impacted area without prior application or compliance with county development guidelines and information was not available for some of the other development activities to determine if they were in compliance with county guidelines. It is recommended that updated maps of the individual residential properties affected by the county ordinances be prepared and distributed to the residents, county officials and USEPA. These maps will detail the current property use and high-use areas, tailings deposit areas and Tailings Impacted (100 ppm arsenic) Areas, as applicable to each residence. The maps will serve as informational tools to residents and county officials on areas within a property that are governed by the county land use ordinances and development guidelines. These maps can then be submitted to the counties, as necessary, by the residents as part of any building permit applications for development activities on their properties. The maps will also inform residents of areas where arsenic concentrations are above the soil action level and the location of tailings deposits in order to limit exposure and activities in these areas. This may help to limit the possibility of recontamination of residential properties by the tracking or incidental importation of contaminated materials or tailings; speculated as a potential source of recontamination at the Holsclaw property (Chadwick et al., 1997) during the five-year review.

8.1.2 Notification of Development Activities

Homestake periodically has personnel in the area of the Site impacted by fluvial tailings and covered by the county ordinances governing development in these areas. In the event that Homestake becomes aware of development in the tailings-impacted areas, the appropriate County agency should be notified to ensure compliance with applicable ordinances. A brief narrative description of these periodic visits and contact with the respective county agency shall be included in the quarterly monitoring report submitted to USEPA. This narrative description of development activities within the Site is currently required as part of Site O&M activities (WDC, 1994b).

8.1.3 Follow-up Visits With Properties Identified During the Five-Year Review

The site interview portion of this five-year review identified several properties where development activities had occurred. Limited information on the details of these activities were available in this review. To ensure that these building activities are in compliance with applicable county ordinance development guidelines and state well ban regulations, it is recommended that representatives from the appropriate county agencies visit these four properties (Crowser, Thompson, Berger and the Unknown Property located "across the Creek from the Holsclaw property") to follow up with and gain additional information from the residents on their development activities. It is recommended that the results from these follow-up visits (including soil sampling results) be submitted to SD DENR and USEPA.

8.1.4 Provide Maps and Reference Materials to Counties

At the time of the interviews with government officials, USEPA identified the need to supply Butte County officials with the proper maps and reference materials in order to provide information to individuals considering development within the Site. Follow-up with Lawrence and Meade County officials may also be suggested to ensure that they have sufficient copies of maps and reference materials.

8.2 Recommendations for the Annual Resident Education Program

The annual information sheet sent to area residents shall be modified to include a point of contact for the appropriate County offices in the section titled "County Ordinances". Additionally, the "Site Resident's Role" section shall be modified to include an awareness of the county ordinances governing development in tailings-impacted areas.

9.0 PROTECTIVENESS STATEMENT(S)

The protectiveness of the remedy to humans is discussed in two sections: residential remediation and institutional control implementation. The protectiveness of the remedy to the environment is discussed in a third section.

9.1 Residential Remediation

Residential remediation activities are considered to remain protective of human health. The current residential soil action level for arsenic is considered to still be adequately protective of human health. Verification sampling results indicate that the residential remediation portion of the remedy remains effective. Arsenic concentrations within the high use areas of residential properties within the Site remain below the soil action level of 100 mg/kg. In the instance where arsenic concentrations were found to exceed the soil action level, the soils were remediated in accordance with project plans.

9.2 Institutional Control Implementation

The institutional controls implemented at the Site (including land-use restrictions and other controls such as the annual educational program and surface water monitoring) are considered to remain protective of human health and the environment, provided that the corrective actions outlined in Section 8.0 (Recommendations and Required Actions) are taken. Contamination and floodplain boundaries have been determined and are incorporated into county ordinances to restrict development in certain areas of the Site. The state well ban regulation remains in place and is functioning effectively. The surface water monitoring program, annual resident educational program, flood monitoring and five-year verification sampling programs, remain in place and are functioning effectively. Annual inspections of the disposal site have effectively identified and addressed conditions that have needed repair. Incorporating the recommendations identified in Section 8.0 into the annual resident education program and in increasing the implementation and enforcement of the county land use ordinance requirements will ensure that these institutional controls are consistently functioning effectively and are protective of human health.

9.3 Protection of the Environment

The current remedy is considered to be adequate for protection of ecological receptors and the environment. Based on an evaluation of the weight of evidence across all available lines of

evidence, mining-related chemicals probably are probably causing some effects on both the aquatic and the terrestrial ecosystems, but these effects are generally low level and are not likely to be sufficient to cause substantial disruption of aquatic or terrestrial ecosystem function or viability.

9.4 Protectiveness Statement

The remedy for the Site, as long as corrective actions are taken, is considered to remain protective of human health and the environment.

10.0 NEXT REVIEW

The Whitewood Creek Superfund Site requires ongoing five-year reviews. These reviews will be required, as stated by the NCP, as long as hazardous substances, pollutants or contaminants remain at this Site above levels allowing for unlimited use and unrestricted exposure.

The next review will be conducted within five years of the completion of this five-year review report, which is five years from the date listed on this report's signature cover page. This is a slight modification from the date outlined in the O&M Plan of January 31, 2007. The schedule for the Five-Year Review data collection activities remains as outlined in the O&M Plan, to be completed by September 25, 2006, the fifteen year anniversary of the remedial action start date.

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TABLES

Table 2-1
Chronology of Events at the Whitewood Creek Superfund Site

EVENT	DATE	ACTIVITY
Initial Discovery of Problem or Contamination	1960	Quantified solids and cyanide loading to Whitewood Creek.
	1965	South Dakota (SD) Dept of Game, Fish and Parks determined aquatic bottom organisms not present in Whitewood Creek.
	1970-1971	The USEPA and the US Food and Drug Administration characterized tailing discharge to Whitewood Creek and the extent of resultant pollution. A University of SD study focused on the environmental hazard of mercury contamination.
	May 1975 - July 1978	SD Geological Survey and Water Resources Division investigated the presence of arsenic in surface water and groundwater along Whitewood Creek, the Belle Fourche River and portions of the Cheyenne River. Arsenic concentrations were found ranging from 2.5 to 1,530 ug/L in groundwater.
NPL listing	September 1981 September 1983	Interim listing. Official listing.
Remedial Investigation and Feasibility Study	July 1989	*Endangerment Assessment* (EA) released by USEPA and Jacobs Engineering).
	December 1989	*Feasibility Study* (FS) completed by ICF Technology Inc.
ROD Signature	March 30, 1990	*Record of Decision* (ROD) completed.
ROD Amendments or ESDs	June 1991	*Explanation of Significant Difference* (ESD) signed modifying the remedy to dispose of contaminated soils on-site.
Enforcement Documents	December 1988	Administrative Order on Consent signed by USEPA and Homestake requiring Homestake to conduct an FS for the site.
	August 1990	Consent Decree signed by USEPA and Homestake to implement the ROD through remedial design and remedial action at the site. Case No. 90-5101 was lodged in U.S. District Court of South Dakota on October 10, 1990 and entered by the Court on April 4, 1991).

Table 2-1
Chronology of Events at the Whitewood Creek Superfund Site

EVENT	DATE	ACTIVITY
Enforcement Action	1981	USEPA sent notice letter to Homestake notifying them of potential liability at Whitewood Creek and requesting information about their activities.
	1982	USEPA, State of SD and Homestake began negotiations for Homestake to perform necessary studies.
	August 11, 1982	USEPA, the State of SD and Homestake completed negotiations and signed a memorandum of understanding among the three parties to conduct a study of the Whitewood Creek area.
	September 1988	Special Notice Letter sent to Homestake and Goldstake Explorations, Inc. informing them that both companies were Primary Responsible Parties (PRPs) for cleanup of the site. Notice gave both parties the opportunity to conduct the feasibility study. Goldstake elected not to participate in the FS studies.
Remedial Design Start	August 1990	Homestake conducted sampling to identify and characterize soil contamination at 32 residences, 27 of which were identified for remediation.
	June 14, 1991	USEPA approval to proceed with the Institutional Controls Component to the remedy.
Actual Remedial Action Start	September 1991	Began a pilot remediation project of one residence/site.
	May 1992	Began remediation of 15 remaining residences/sites.
Construction Dates (start to finish)	September-October 1991	Pilot remediation project.
	September 30, 1991-September 30, 1992	Disposal Site construction and completion.
	May-September 1992	Remediation of remaining 15 residences/sites.
	July-September 1992	Construction and removal of the Temporary Stream Crossing.
	1993 - 1994	Institutional Controls implemented at the site.
	November 18, 1993	Quarterly Operations and Maintenance (O&M) Reports Commenced.
	May 1993	Surface Water Monitoring Program initiated.

Table 2-1
Chronology of Events at the Whitewood Creek Superfund Site

EVENT	DATE	ACTIVITY
Construction Completion Date	December 21, 1992	Construction completion date for residential remediation.
	July 1994	Institutional Controls Completion Report.
	July 1998	Construction completion of Holsclaw property re-remediation.
Final Close Out Report	September 26, 1994	Documents that ROD was fully implemented at the Whitewood Creek Site.
NPL Delisting	August 1996	Whitewood Creek Site delisted from NPL.

Table 4-1
Summary of Residential Remediation Activities

Residence	General Construction Start Date	Construction Completion Date	Type and Quantity of Materials Removed	
ALA	August 26, 1992	September 2, 1992	Sod and Soil	120 Cubic Yards
ALAN	May 26, 1992	June 19, 1992	Sod and Soil	786 Cubic Yards
BALO-LOWER	June 29, 1992	July 10, 1992	Sod and Soil	0 Cubic Yards
BALO-UPPER	June 9, 1992	June 11, 1992	Sod and Soil	130 Cubic Yards
BERGER	August 11, 1992	September 3, 1992	Sod and Soil	540 Cubic Yards
HOLSCLAW	July 28, 1992	August 27, 1992	Sod and Soil	290 Cubic Yards
KYMALA	September 14, 1992	September 16, 1992	Soil and Gravel	0 Cubic Yards
MARRS	September 30, 1991	October 15, 1991	Sod, Soil, and Gravel Tree Stumps	368 Cubic Yards
NELSON	June 11, 1992	June 26, 1992	Sod and Soil	372 Cubic Yards
SHUCK	July 8, 1992	September 1, 1992	Sod and Soil	260 Cubic Yards
SHUCK NORTH	December 22, 1992	July 1, 1992	Sod and Soil	420 Cubic Yards
TIPPEY	June 29, 1992	June 29, 1992	Gravel and Soil	50 Cubic Yards
WENNEBERG	June 24, 1992	July 10, 1992	Sod and Soil	350 Cubic Yards
WESTBERG	May 11, 1992	May 21, 1992	Sod and Soil	750 Cubic Yards
			Irrigation Pipe	1,287 Lineal Feet
			Trees	4 trees
WESTBERG	May 11, 1992	May 21, 1992	Sod and Soil	82 Cubic Yards
WILLSON	June 26, 1992	June 26, 1992	Gravel and Soil	50 Cubic Yards

Source: FMG (1992)

Table 4-2
Review of Residential Building Activities Within the Whitewood Creek Superfund Site

Quarter	Review Date	Summary of Findings
3rd Quarter 1993	Summer/Fall 1993	Crowsers recently purchased property and established a seasonally occupied mobile home. The purchase occurred between the time of residential remediation and passage of land use control ordinances. The owners were aware of the Site at the time of purchase. While the mobile home is currently unoccupied, a family member occupies the home during the summer months. Soil samples were taken and samples show that a portion of the yard area is on tailings impacted soils. The landowner agreed to complete the remediation in accordance with the sampling and arsenic reducing activities outlined in the county handbook.
4th Quarter 1993	October to December 1993	No new residential building activity occurred.
1st Quarter 1994	January to March 1994	No new residential building activity occurred.
2nd Quarter1994	April to June 1994	No new residential building activity occurred.
3rd Quarter 1994	July to September 1994	No new residential building activity observed.
4th Quarter 1994	October to December 1994	No new residential building activity observed**.**
1st Quarter 1995	January to March 1995	No new residential building activity observed.
2nd Quarter 1995	April to June 1995	No new residential building activity observed.
3rd Quarter 1995	July to September 1995	No new residential building activity occurred.
4th Quarter 1995	October to December 1995	No new residential building activity occurred.
1st Quarter 1996	January to March 1996	No new residential building activity occurred.
2nd Quarter 1996	April to June 1996	No new residential building activity occurred.
3rd Quarter 1996	July to September 1996	No new residential building activity identified or observed.
4th Quarter 1996	October to December 1996	No new residential building activity identified or observed.
1st Quarter 1997	January to March 1997	No new residential building activity was identified or observed. The landowner of the Berger property is contemplating building a new residence. The landowner is coordinating activity with the local planning authorities in Meade County.
2nd Quarter 1997	April to June 1997	No new residential building activity was identified or observed, other than at the Berger property.
3rd Quarter 1997	July to September 1997	No known residential building activities occurred within the Site during the reporting period.
4th Quarter 1997	October to December 1997	No known residential building activities occurred within the Site during the reporting period.
1st Quarter 1998	January to March 1998	No known residential building activities occurred within the Site during the reporting period.

Table 4-2
Review of Residential Building Activities Within the Whitewood Creek Superfund Site

Quarter	Review Date	Summary of Findings
2nd Quarter 1998	April to June 1998	No known residential building activities occurred within the Site during the reporting period.
3rd Quarter 1998	July to September 1998	No known residential building activities occurred within the Site during the reporting period.
4th Quarter 1998	October to December 1998	No known residential building activities occurred within the Site during the reporting period.
1st Quarter 1999	January to March 1999	No known residential building activities occurred within the Site during the reporting period.
2nd Quarter 1999	April to June 1999	NA
3rd Quarter 1999	July to September 1999	--No known residential building activities occurred within the Site during the reporting period.
4th Quarter 1999	October to December 1999	No known residential building activities occurred within the Site during the reporting period.
1st Quarter 2000	January to March 2000	No known residential building activities occurred within the Site during the reporting period.
2nd Quarter 2000	April to June 2000	NA
3rd Quarter 2000	July to September 2000	No known residential building activities occurred within the Site during the reporting period.
4th Quarter 2000	October to December 2000	No known residential building activities occurred within the Site during the reporting period.
1st Quarter 2001	January to March 2001	No known residential building activities occurred within the Site during the reporting period.
2nd Quarter 2001	April to June 2001	No known residential building activities occurred within the Site during the reporting period.
3rd Quarter 2001	July to September 2001	No known residential building activities occurred within the Site during the reporting period.
4th Quarter 2001	October to December 2001	No known residential building activities occurred within the Site during the reporting period.

Source: HMC (1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002)

Table 4-3
Summary of Observations and Remedial Actions Taken During Annual Inspections of the Disposal Site

Inspection Date	Comments	Remedial Actions Taken
December 3, 1993	All areas of site appeared stable, no work necessary.	None.
June 3, 1994	All areas of site appeared stable, no work necessary.	None.
May 12, 1995	All areas of site appeared stable; no work deemed necessary.	None.
May 13, 1996	All areas of the site appeared stable.	Minor fence repairs were completed
July 15, 1996	No items of concern requiring immediate response noted. Good vegetative establishment observed on disposal site-no problems noted.	Future inspection will need to observe whether any new creek bank cutting occurs next to the monitoring well site.
September 1, 1997	No problems identified during visit to the disposal site.	None.
July-September 1998	Inspected only to evaluate unauthorized rubble piles placed on the site to develop a appropriate disposal or removal plan.	Removal of the unauthorized rubble anticipated to be addressed during the 4th quarter of 1998.
October-December 1998	None.	Unauthorized rubble was placed in the disposal facility. Rip-rap was replaced and the disturbance seeded. Some scrap materials were removed from the Site and disposed of at a local landfill.
April-June 1999	Visual inspection conducted; incidental to field review and assessment of the Whitewood Creek channel adjacent to the disposal site area; no problems or issues related to the disposal cell were noted.	None.
October-December 1999	No formal inspection conducted. However, a small bank stabilization project on a short section of Whitewood Creek near the disposal site during the report period was conducted. Observations of the disposal site at that time indicated no issues or concerns related to the disposal cell.	None.
June 1, 2000	No issues identified. Vegetative cover on cell is stable, no erosion is evident; rip-rap protective material on cell face and up gradient along creek bank show no need of maintenance or repair. Vegetative cover on a portion of the ground inside the fence enclosure	Additional organic material, hay will be tilled into soils near the bank stabilization project to increase opportunity for vegetative establishment.

Table 4-3
Summary of Observations and Remedial Actions Taken During Annual Inspections of the Disposal Site

Inspection Date	Comments	Remedial Actions Taken
	surrounding soil disposal cell requires additional work.	
October 4, 2000	Disposal cell and upgradient/downgradient protective rip-rap areas inspected. Cell and rip-rap observed to be in stable condition. No erosional or vegetative stability issues were noted. No other issues identified requiring further investigation or follow up.	None.
May 2001	Site inspection was not conducted during the 2nd quarter. Reopening and subsequent reclosure, topsoiling, seeding and rip-rap armoring of the disposal cell face was completed during the period in relation to disposal of soil samples previously collected at various locations within the site.	None.

Source: HMC (1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001)

Table 4-4
Summary of Quarterly Reports Submitted During Site Operation and Maintenance Activities

Quarter	Report Number	Report Date
1	3rd-1993	November 18, 1993
2	4th-1994	January 31, 1994
3	1st-1994	April 29, 1994
4	2nd-1994	July 31, 1994
5	3rd-1994	October 31, 1994
6	4th-1994	January 31, 1995
7	1st-1995	April 30, 1995
8	2nd-1995	July 31, 1995
9	3rd-1995	October 31, 1995
10	4th-1995	January 31, 1996
11	1st-1996	April 30, 1996
12	2nd-1996	July 31, 1996
13	3rd-1996	October 31, 1996
14	4th-1996	January 31, 1997
15	1st-1997	April 30, 1997
16	2nd-1997	July 29, 1997
17	3rd-1997	October 30, 1997
18	4th-1997	January 20, 1998
19	1st-1998	April 30, 1998
20	2nd-1998	July 30, 1998
21	3rd-1998	October 27, 1998
22	4th-1998	January 13, 1999
23	1st-1999	April 28, 1999
24	2nd-1999	July 28, 1999
25	3rd-1999	October 19, 1999
26	4th-1999	January 25, 2000
27	1st-2000	April 21, 2000
28	2nd-2000	July 25, 2000

Table 4-4
Summary of Quarterly Reports Submitted During Site Operation and Maintenance Activities

Quarter	Report Number	Report Date
29	3rd-2000	October 30, 2000
30	4th-2000	January 31, 2001
31	1st-2001	April 24, 2001
32	2nd-2001	July 30, 2001
33	3rd-2001	October 29, 2001
34	4th-2001	January 31, 2002

Source: HMC (1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002)

Table 5-1
Applicable or Relevant and Appropriate Requirements (ARARs) for Whitewood Creek Superfund Site

ARAR	Citation	Description
CHEMICAL-SPECIFIC		
National Primary Drinking Water Standards*	40 CFR 141	Maximum Contaminant Levels (MCLs) for community water systems, relevant and appropriate to downgradient alluvial groundwaters of Whitewood Creek as a potential future water supply source.
National Water Quality Criteria**	40 CFR 131	Establishes criteria for the protection of aquatic life and the protection of human health through consumption of fish and water. Not applicable because they are not enforceable standards, however relevant and appropriate for protection of human health from fish consumption.
National Ambient Air Quality Standards	40 CFR 50	Standards for ambient air quality to protect human health and welfare. Applicable, as standards may not be attained during brief times during remedy implementation.
RCRA MCLs*	40 CFR 264.94	Relevant and appropriate; but waived for same reason as MCLs above
South Dakota Groundwater Quality Standards*	ARSD 74:03:15	Establishes maximum concentrations for groundwater to protect all ground waters of the state. Standards applicable to downgradient alluvial ground water as a potential future drinking water source.
South Dakota Drinking Water Standards*	ARSD 74:04:05	Establishes MCLs for community drinking water supplies, relevant and appropriate to downgradient alluvial groundwaters of Whitewood Creek as a potential future drinking water source.
Surface Water Quality Standards**	ARSD 74:03:02	Establishes water quality standards for Whitewood Creek for protection of human health from fish consumption and for the protection of aquatic life
Ambient Air Quality Standards	ARSD 74:26:02:04 ARSD 74:26:02:35	Establishes ambient air quality standards for particulate matter. These standards are applicable, as they may not be attained during brief periods during the implementation of the remedy.
LOCATION-SPECIFIC		
Archaeological and Historic Preservation Act	40 CFR 6.301(c)	Establishes procedures to preserve historical and archaeological data which might be destroyed through alteration of terrain that might be applicable to remedial actions (removal of tailings). Determined during remedial design to be not applicable or relevant and appropriate based upon field investigations that did not identify sites of archeological or historical significance that would be affected by the remedial actions.
Historic Sites, Buildings and Antiquities Act	40 CFR 6.301(a) 36 CFR 62.6(d)	Requires considering the existence and location of landmarks on the national registry of natural landmarks to avoid undesirable impacts on landmarks. Applicability of this requirement was believed to not be applicable or relevant and appropriate in that no eligible properties were identified during the survey.
National Historic Preservation Act	40 CFR 6.301(b) 36 CFR 800 36 CFR 63	Coordination with other environmental review and consultation requirements. Requires effects on any district, site, building, structure or object that is included or eligible for inclusion in the national register of historic places. Was determined to be not applicable or relevant and appropriate during the remedial design, in that no eligible properties were identified during a 1991 survey of cultural resources.
Fish and Wildlife Coordination Act	40 CFR 6.302(g)	Requires consultation with Fish and Wildlife Service for the modification of any stream or other water body and adequate provision for protection of fish and wildlife resources. Determined to be applicable to modification of Whitewood Creek.
Endangered Species Act	40 CFR Section 6.302(h)	Requires protection of any threatened or endangered species and their critical habitat. Requirement determined to be not applicable or relevant and appropriate in that no endangered species habitat is believed to be affected by the remedy. No known threatened or endangered species area ffected by the project as determined by the 1990 Baseline Wildlife Survey of Whitewood Creek
Floodplain Management	40 CFR Part 6, Appendix A, Executive Order 11,988	Requires evaluation of potential effects of actions taken in floodplain to avoid adverse impacts associated with direct and indirect development of the floodplain. Determined during remedial design activities to be applicable to disposal of excavated soils and the crossing of Whitewood Creek.
Protection of Wetlands	40 CFR Part 6, Appendix A, Executive Order 11,990	Requires Avoidance of adverse impact associated with the destruction or loss of wetlands. Determined to be applicable because of modifications to Whitewood Creek for the Berger Site crossing. No wetlands were identified in the area in which the residential soils are to be disposed.
Dredge or Fill Requirements	40 CFR Parts 230,231, and 33; 40 CFR Part 323	May be applicable depending upon on-site disposal location, to be determined during remedial design
DOT Hazardous Material Transportation regulation	49 CFR Parts 107, 171, 177	Requirements on the transportation of hazardous materials, potentially relevant and appropriate to the transport of contaminated medial to the on-site disposal location. However, determined not applicable or relevant and appropriate as material to be transported is not considered a DOT hazardous material.

Table 5-1
Applicable or Relevant and Appropriate Requirements (ARARs) for Whitewood Creek Superfund Site

ARAR	Citation	Description
ACTION-SPECIFIC		
Occupational Safety and Health Act	29 U.S.C. Sections 651-678	Regulations protecting the safety and health of workers, may be applicable to remedial action activities that are subject to these regulations. To be determined during remedial design.
Water Right Rules	ARSD 74:02	Regulations governing the use of groundwater, including prohibiting installation of water supply wells within the site.
Solid Waste Disposal Act	40 CFR 241	Regulations regarding the disposal of solid wastes on land. While mining wastes are exempted, the siting and closure criteria are relevant and appropriate to site remedial actions.
Solid Waste Disposal Act	40 CFR 257.3	Criteria for Classification of Solid Waste Disposal Facilities and Practices. Establishes criteria to assess affects of disposal practices on health and environment for purposes of identifying prohibited "open dumps". Applicable to the disposal of excavated soil.
Solid Waste Disposal Act	40 CFR 264.111-112	General Standards for Ownder and Operators of Hazardous Waste Treatment, Storage, and Disposal Areas. Establishes requirement for closure and post-closure plan and standards of performance protective of health and environment. Determined to be relevant and appropriate for disposal activities.
Solid Waste Disposal Act	40 CFR 264 (264.251 and 264.258)	General Standards for Owner and Operators of Hazardous Waste Treatment, Storage and Disposal Areas. Establishes design and operating requirements for waste piles to protect surface-and ground-water quality and for closure and post-closure care. Determined to be relevant and appropriate for disposal activities.
Solid Waste Disposal Act	40 CFR 264 (264.301 and 264.310)	General Standards for Owner and Operators of Hazardous Waste Treatment, Storage and Disposal Areas. Establishes design and operating requirements for landfills to protect surface and ground-water quality and for closure and post-closure care. Determined to be relevant and appropriate for disposal activities.
Surface Mining Control and Reclamation Act	30 CFR 816 (816.111)	Performance standards for surface mining. Establishes general requirements for revegetation in terms of diverse, effective, and permanent. Determined to be relevant and appropriate
Surface Mining Control and Reclamation Act	30 CFR 784 (784.13)	Permit Application Requirements for Underground Mines. Establishes information requirements for surface disturbances of underground mines. Determined to be relevant and appropriate.
Clean Water Act	40 CFR 230 40 CFR 231	Dredge and Fill Requirements (404 requirements). Establishes guidelines for fill projects including provisions to protect suface-water quality, aquatic life, and critical habitat of threatened or endangered species. Determined to be applicable to the crossing of Whitewood Creek. No known threatened or endangered species are affected by the project, nor were any wetlands identified in the area in which the residential soils are to be disposed.
Solid Waste Disposal Act	40 CFR Part 264 264.251 (c), (d), (f)	Regulations for waste piles, may be relevant and appropriate to provision on contouring and dust control at the site.
Solid Waste Regulation	ARSD 74:27:03:08	Requires facilities located in a floodplain to be adequately protected against a 100-year flood
Solid Waste Regulation	ARSD 74:27:09:02	Requires design and construction plans and specifications be prepared and certified by a qualified professional engineer registered in the state of South Dakota.
Solid Waste Regulation	ARSD 74:27:12:09	Establishes requirements for the control of public access. Applicable to the disposal of excavated soils.
Solid Waste Regulation	ARSD 74:27:12:16	Requires surface water to be controlled by diverting drainage around or away from the filled site.
Solid Waste Regulation	ARSD 74:27:13:23	Requires no person excavate, disrupt or remove any deposited material from an active or discontinued landfill. Applicable to excavated soil disposal.
Solid Waste Regulation	ARSD 74:27:15:04	Requires a written closure plan be prepared describing the steps necessary to close a facility. Applicable to disposal of excavated soil.

Sources:
USEPA, 1990. Record of Decision, Whitewood Creek Superfund Site
WDC, 1991. On-site Disposal Plan for Contaminated Soils at Whitewood Creek Superfund Site
WDC, 1992. ARAR Report for Whitewood Creek Superfund Site

Notes
*ARAR waived because of the technical impracticability of meeting the requirements
**ARAR waived due to technical impracticability, as water entering the site does not meet these criteria

Table 5-2
Changes in Chemical-Specific ARARs

Contaminant		GROUND WATER ARARs						SURFACE WATER ARARs										AMBIENT AIR ARARs					
								AWQC (ug/L)						SD WQS (ug/L)						NAAQS			SDAAQS		
		NPDWS (mg/L)	Source	SD DWS (mg/L)	Source	SD WQS (mg/L)	Source	Fish Consumption	Freshwater Acute		Freshwater Chronic		Source	Fish Consumption	Freshwater Acute		Freshwater Chronic		Source	$PM10_{24\ hr}$ (ug/m3)	$PM10_{Annual}$ (ug/m3)	Source	$PM10_{24\ hr}$ (ug/m3)	$PM10_{Annual}$ (ug/m3)	Source
									Total	Dissolved	Total	Dissolved			Total	Dissolved	Total	Dissolved							
Antimony	Previous	NA	40 CFR 141; 1990	NA	ARSD 74:04:05; 1988	NA	ARSD 74:03:15; 1987	45,000	9,000[e]	9,000	1,600[e]	9,000	EPA/440/5-86/001; 1986	45,000	9,000[e]	9,000	1,600[e]	9,000	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.006	40 CFR 141; 2001	0.006	ARSD 74:04:05:03; 2001	NA	ARSD 74:54:01:04; 2001	4,300	NA	NA	NA	NA	EPA 822-Z-99-001; April 1999b	4,300	NA	NA	NA	NA	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Arsenic	Previous	0.05	40 CFR 141; 1990	0.05	ARSD 74:04:05; 1988	0.05	ARSD 74:03:15; 1987	0.0175	360[f]	360	190[f]	190	EPA/440/5-86/001; 1986	0.0175	360[f]	360	190[f]	190	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.01	66 FR 20580; 2001	0.05	ARSD 74:04:05:03; 2001	0.05	ARSD 74:54:01:04; 2001	0.14[b]	340	340	150	150	EPA 822-Z-99-001; April 1999b	0.14[b]	360	360	190	190	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Cadmium	Previous	0.01	40 CFR 141; 1990	0.01	ARSD 74:04:05; 1988	0.01	ARSD 74:03:15; 1987	NA	3.9[c]	3.7[c]	1.1[c]	1.0[c]	EPA/440/5-86/001; 1986	NA	3.9[c]	3.7[c]	1.1[c]	1.0[c]	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.005	40 CFR 141; 2001	0.005	ARSD 74:04:05:03; 2001	0.005	ARSD 74:54:01:04; 2001	NA	2.1[c]	2.0[c]	0.3[c]	0.2[c]	EPA-822-R-01-001; 2001	NA	3.9[c]	3.7[c]	1.1[c]	1.0[c]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Chromium (VI)	Previous	0.05[a]	40 CFR 141; 1990	0.05[a]	ARSD 74:04:05; 1988	0.05[a]	ARSD 74:03:15; 1987	NA	16	15.7	11	10.6	EPA/440/5-86/001; 1986	NA	16	15.7	11	10.6	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.1[a]	40 CFR 141; 2001	0.1[a]	ARSD 74:04:05:03; 2001	0.1[a]	ARSD 74:54:01:04; 2001	NA	16.3	16	11.4	11	EPA 822-Z-99-001; April 1999b	NA	15.3	15	10.4	10	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Chromium (III)	Previous	0.05[a]	40 CFR 141; 1990	0.05[a]	ARSD 74:04:05; 1988	0.05[a]	ARSD 74:03:15; 1987	3,433,000	1700[c]	537[c]	210[c]	180.6[c]	EPA/440/5-86/001; 1986	3,433,000	1700[c]	537[c]	210[c]	180.6[c]	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.1[a]	40 CFR 141; 2001	0.1[a]	ARSD 74:04:05:03; 2001	0.1[a]	ARSD 74:54:01:04; 2001	NA	1803[c]	570[c]	86[c]	74[c]	EPA 822-Z-99-001; April 1999b	NA	1740[c]	550[c]	207[c]	180[c]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Copper	Previous	NA	40 CFR 141; 1990	NA	ARSD 74:04:05; 1988	1.3	ARSD 74:03:15; 1987	NA	18[c]	17.3[c]	12[c]	11.5[c]	EPA/440/5-86/001; 1986	NA	18[c]	17.3[c]	12[c]	11.5[c]	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	1.3*	40 CFR 141; 2001	NA	ARSD 74:04:05:03; 2001	1.3	ARSD 74:54:01:04; 2001	1300	14[c]	13.4[c]	9.3[c]	9.0[c]	EPA 822-Z-99-001; April 1999b	NA	17.7[c]	17[c]	11.5[c]	11[c]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Lead	Previous	0.05	40 CFR 141; 1990	0.05	ARSD 74:04:05; 1988	0.02	ARSD 74:03:15; 1987	NA	82[c]	65[c]	3.2[c]	2.5[c]	EPA/440/5-86/001; 1986	NA	82[c]	65[c]	3.2[c]	2.5[c]	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.015*	40 CFR 141; 2001	NA	ARSD 74:04:05:03; 2001	0.015	ARSD 74:54:01:04; 2001	NA	81.6[c]	65[c]	3.2[c]	2.5[c]	EPA 822-Z-99-001; April 1999b	NA	81.6[c]	65[c]	3.2[c]	2.5[c]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Mercury	Previous	0.002	40 CFR 141; 1990	0.002	ARSD 74:04:05; 1988	0.002	ARSD 74:03:15; 1987	0.146	2.4	2	0.012	0.01	EPA/440/5-86/001; 1986	0.146	2.4	2	0.012	0.01	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.002	40 CFR 141; 2001	0.002	ARSD 74:04:05:03; 2001	0.002	ARSD 74:54:01:04; 2001	1.7	1.7[c]	1.4	0.91	0.77	EPA 822-Z-99-001; April 1999b	0.15	2.5	2.1	0.012	0.01	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Nickel	Previous	NA	40 CFR 141; 1990	NA	ARSD 74:04:05; 1988	NA	ARSD 74:03:15; 1987	100	1400[c]	1397[c]	160[c]	159.5[c]	EPA/440/5-86/001; 1986	100	1400[c]	1397[c]	160[c]	159.5[c]	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	NA	40 CFR 141; 2001	0.1	ARSD 74:04:05:03; 2001	NA	ARSD 74:54:01:04; 2001	4600	469[c]	468[c]	52.2[c]	52[c]	EPA 822-Z-99-001; April 1999b	4600	471[c]	470[c]	52.2[c]	52[c]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Selenium	Previous	0.01	40 CFR 141; 1990	0.01	ARSD 74:04:05; 1988	0.01	ARSD 74:03:15; 1987	NA	260	240	35	32	EPA/440/5-86/001; 1986	NA	260	240	35	32	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.05	40 CFR 141; 2001	0.05	ARSD 74:04:05:03; 2001	0.05	ARSD 74:54:01:04; 2001	11,000e	NA	NA	5	4.6	EPA 822-Z-99-001; April 1999b	NA	22	20	5.4	5	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Silver	Previous	0.05	40 CFR 141; 1990	0.05	ARSD 74:04:05; 1988	0.05	ARSD 74:03:15; 1987	NA	4.1[c]	3.5[c]	0.12	0.12	EPA/440/5-86/001; 1986	NA	4.1[c]	3.5[c]	0.12	0.12	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	NA	40 CFR 141; 2001	NA	ARSD 74:04:05:03; 2001	0.05	ARSD 74:54:01:04; 2001	NA	4.1[c]	3.4[c]	NA	NA	EPA 822-Z-99-001; April 1999b	NA	4.1[c]	3.4[c]	NA	NA	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Zinc	Previous	NA	40 CFR 141; 1990	NA	ARSD 74:04:05; 1988	NA	ARSD 74:03:15; 1987	NA	120[c]	117[c]	110[c]	108[c]	EPA/440/5-86/001; 1986	NA	120[c]	117[c]	110[c]	108[c]	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	NA	40 CFR 141; 2001	NA	ARSD 74:04:05:03; 2001	NA	ARSD 74:54:01:04; 2001	69,000	120[c]	117[c]	120[c]	118[c]	EPA 822-Z-99-001; April 1999b	NA	112[c]	110[c]	101[c]	100[c]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Cyanide	Previous	NA	40 CFR 141; 1990	NA	ARSD 74:04:05; 1988	0.2	ARSD 74:03:15; 1987	NA	22	22	5.2	5.2	EPA/440/5-86/001; 1986	NA	22	22	5.2	5.2	ARSD 74:03:02; 1990	--	--	--	--	--	--
	Current	0.2[d]	40 CFR 141; 2001	0.2	ARSD 74:04:05:03; 2001	0.75	ARSD 74:54:01:04; 2001	220,000	22[d]	22[d]	5.2[d]	5.2[d]	EPA 822-Z-99-001; April 1999b	220,000[d]	22[d]	22[d]	5.2[d]	5.2[d]	ARSD 74:51:01:55; 2001	--	--	--	--	--	--
Particulates (PM10)	Previous	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150 [1]	50 [2]	40 CFR 50; 1990	150 [1]	60 [2]	ARSD 74:26:02:04; 1990
	Current	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150 [1]	50 [2]	40 CFR 50; 2001	150 [1]	50 [2]	ARSD 74:36:02; 2001

Notes
*Action level regulation for treatment techniques; if exceeded in more than 10% of tap water samples water systems are triggered into taking treatment steps
[a] Total chromium
[b] = Human health criteria based on 1E-06 carcingenicity risk
[c]=Hardness dependant, based upon 100 mg/l $CaCO_3$
[d]=Criteria expressed as free cyanide as CN/L
[e]=Insufficient data to develop critieria; value presented is the LOEL
[f]=Trivalent arsenic
[g]=Criteria based on total recoverable fraction
[h]=Weak acid dissociable cyanide
[i] = Max 24 hour concentration
[j] = Annual geometric mean

NPDWS=National Primary Drinking Water Standards
SD DWS= South Dakota Drinking Water Standards
AWQC= National Recommended Ambient Water Quality Criteria
SD WQC= South Dakota Water Quality Criteria
NA=Criteria Not Available
CFR=Code of Federal Regulations
ARSD=Administrative Record of South Dakota
FR=Federal Register
EPA = United States Environmental Protection Agency

Table 5-3
Summary of the Changes in Stringency of Site Chemical-Specific ARARs

Regulation	More Stringent	Less Stringent	Unchanged
GROUND WATER Drinking Water Standards	Antimony (federal and state) Arsenic (federal) Cadmium (federal and state) Cyanide (federal and state) Copper* (federal) Lead* (federal) Nickel (state)	Chromium (federal and state) Lead (state) Selenium (federal and state) Lead (state) Silver (federal and state)	Arsenic (state) Copper (state) Mercury (federal and state) Nickel (federal) Zinc (federal and state)
GROUND WATER South Dakota Groudwater Quality Standards	Cadmium Lead	Chromium Selenium Cyanide	Antimony Arsenic Copper Mercury Nickel Silver Zinc
SURFACE WATER Ambient Water Quality Criteria (fish consumption)	Antimony (federal and state) Copper (federal) Selenium (federal) Zinc (federal) Cyanide (federal and state)	Arsenic (federal and state) Chromium III (federal and state) Mercury (federal and state) Nickel (federal and state)	Cadmium (federal and state) Chromium VI (federal and state) Copper (state) Lead (federal and state) Selenium (state) Silver (federal and state) Zinc (state)
SURFACE WATER Ambient Water Quality Criteria (acute freshwater)	Arsenic (federal) Chromium VI (state) Copper (federal and state) Mercury (federal) Nickel (federal and state) Selenium (state) Zinc (state)	Antimony (federal and state) Cadmium (federal) Chromium III (federal and state) Mercury (state) Selenium (federal)	Arsenic (state) Cadmium (state) Chromium VI (fed) Lead (federal and state) Silver (federal and state) Zinc (federal) Cyanide (federal and state)
SURFACE WATER Ambient Water Quality Criteria (chronic freshwater)	Arsenic (federal) Chromium VI (state) Chromium III (federal and state) Copper (federal and state) Nickel (federal and state) Selenium (federal and state) Zinc (state):	Antimony (federal and state) Cadmium (federal): Mercury (federal) Silver (federal and state) Zinc (federal)	Arsenic (state) Cadmium (state) Chromium VI (fed) Lead (federal and state) Mercury (state) Cyanide (federal and state)
AMBIENT AIR Ambient Air Quality Standards	PM10, annual standard (state)		PM10, annual standard (federal) PM10, 24 hour standard (federal and state)

* Action level.

Table 5-4
Changes in Action-Specific ARARs

Action		Requirement	Source
Solid Waste Disposal			
Land Disposal of Solid Waste	Previous	Establishes levels of performance for solid waste disposal facilities	40 CFR 241.200-211; 1990
	Current	Regulation repealed in 1996: determined to be "obsolete" and "no longer necessary" because it is included and/or addressed by 40 CFR 257 and 40 CFR 258.	61 FR 82 18501; 1996
Design and Operating Requirements for Owners/Operators of hazardous waste treatment, storage or disposal facilities	Previous	Requires waste piles to be designed to prevent migrations of wastes into soil, groundwater or surface water, which includes a liner and leachate collection and removal system for waste piles.	40 CFR 264.251; 1991
	Current	Requires installation of two or more liners and a leachate collection and removal system for new waste pile units, lateral expansion of waste pile units, or replacement or existing waste pile units where construction commences/reuse commences after July 29, 1992.	40 CFR 264.251; 2000
Design and Operating Requirements for Owners/Operators of hazardous waste treatment, storage or disposal facilities	Previous	Design and operating requirements for new and existing landfill units to protect ground water and surface water and for closure/post-closure care, including two liners, leachate collection systems, run-off management and wind dispersion of particulates.	40 CFR 264.301; 1991
	Current	Regulation revised to include design and operating requirements for new landfill units and lateral expansion of landfill units commencing construction after July 29, 1992 and existing landfills beginning reuse after July 29, 1992. Requires a leachate removal system (with a leak detection system) in addition to the leachate collection system and a two part composite bottom liner.	40 CFR 264.301; 2000
Closure and Post-Closure Care	Previous	Outlines post-closure and closure requirements	40 CFR 264.310; 1991
	Current	Requires the leak detection system to be monitored and all other applicable leak detection system requirements be complied with as part of post-closure care (paragraph (b)(3)).	40 CFR 264.310; 2000

Table 5-4
Changes in Action-Specific ARARs

Action		Requirement	Source
Methods of Disposal	Previous		ARSD 74:27:03:08; 1990
	Current	Regulation Repealed	ARSD 74:27:03:08; 2000
Facility Design and Construction: Surface Water Control	Previous	Establishes requirement for control of surface waters, storm runoff, leachate from disposal facility. Required discharges of retained surface waters to meet the requirements of state regulation 74:03:17-74:03:26.	ARSD 74:27:12:16; 1990
	Current	Regulation modified to require discharges of retained surface waters from the facility to meet the requirements of 40 CFR 122, as published in 57 FR 11394-11413.	ARSD 74:27:12:16; 2000

Notes:
CFR=Code of Federal Regulations
ARSD= Administrative Record of South Dakota
FR=Federal Register

Table 5-5
Summary of the Results of the SERA

Medium	Receptor of Interest (ROI)	Exposure Pathway	Constituent	Range of HQ Values	Further Evaluation (Yes/No)
Surface Water	Aquatic Invertebrates and Fish	Direct Contact	Dissolved lead and zinc	2 to 4	Yes
			Total recoverable arsenic, copper, lead, mercury, nickel and zinc	2 to 30	Yes
	Mammals	Ingestion	Lead and arsenic	2 to 3	Yes
Sediment	Benthic Invertebrates	Direct Contact	Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc	2 to 2,000	Yes
	Avian and mammalian piscivores (mink and kingfisher)	Ingestion	Arsenic	2 to 20	Yes
	Avian aquatic insectivores (swallow)	Ingestion	Arsenic, chromium and copper	2 to 30	Yes
Soil	Vegetation	Direct Contact	Arsenic, cadmium, copper, nickel, selenium and zinc	2 to 700	Yes
	Soil Organisms	Direct Contact	Arsenic, cadmium, chromium, copper, mercury, nickel, selenium and zinc	2 to 300	Yes
	Avian and mammalian insectivores (robin and shrew)	Ingestion	Arsenic, cadmium, chromium, and copper	2 to 200	Yes
Food web	Avian insectivores (robin)	Ingestion of soil organisms	Arsenic, cadmium, chromium, lead, mercury, nickel and selenium	2 to 100	Yes
	Mammalian insectivores (shrew)	Ingestion of soil organisms	Arsenic, cadmium, nickel, selenium and zinc	2 to 100	Yes
	Mammalian omnivores (mouse)	Ingestion of soil organisms	Arsenic and cadmium	2 to 6	Yes
	Mammalian herbivores (deer)	Ingestion of vegetation	Arsenic	6 to 9	Yes
	Avian aquatic insectivores (swallow)	Ingestion of benthic invertebrates	Arsenic, cadmium, chromium, copper, lead, mercury, and selenium	2 to 30	Yes

Table 5-6
Summary of Data Gaps Identified in the SERA

Receptor	Exposure Medium	Data Gaps	Potential Data Collection
Benthic Invertebrates	Sediment	• Better definition of extent of sediment exposures	• Additional measurements of COPC concentrations in sediments
		• Bioavailability of metals in sediments	• Measurements of COPCs in interstitial water of sediment at seeps • AVS/SEM measurements
		• Extent of site-specific sediment toxicity	• Sediment toxicity testing • Re-evaluation of current community data • Samples of benthic invertebrate community metrics in comparison to reference
Fish	Surface water, sediment and diet	• COPC concentrations in diet • Bioavailability of mercury • Extent of site-specific effects of metals exposure	• Measurement of COPC concentrations in benthic invertebrates • Tissue measurements of mercury • Re-evaluation of current community data • Fish community structure analyses
Wildlife	Soil, sediment and diet	• Better definition of exposures and bioavailability of metals from soils, sediments and diet • Derivation of site-specific BAFs • Extent of site-specific effects of metals exposure	• Sediment bioaccumulation tests • Constituent concentrations in soil invertebrates • Constituent concentrations in vegetation • Constituent concentrations in small mammals • Evaluation of current wildlife census data • Census studies
Vegetation and Soil Invertebrates	Soil	• Site-specific soil toxicity	• Soil toxicity testing

Table 5-7
Summary of the Five-Year Review Residential Verification Sampling Results

Property	Sample Number	Arsenic Concentration (mg/kg)
Shuck	5OM-01	75.1
Shuck	5OM-02	12.79**
Shuck	5OM-03	13.01**
Shuck	5OM-04*	12.86**
Shuck	5OM-05*	11.78**
Shuck North	5OM-06	24.88
Shuck North	5OM-07	11.79**
Shuck North	5OM-08*	12.2**
Shuck North	5OM-09*	10.76**
Nelson	5OM-10*	23.92
Nelson	5OM-11*	21.42
Nelson	5OM-12	11.16**
Nelson	5OM-13	12.12**
Nelson	5OM-14	10.56**
Nelson	5OM-15	10.29**
Alan	5OM-16*	46.14
Alan	5OM-17*	34.37
Alan	5OM-18	42.77
Alan	5OM-19	61.22
Alan	5OM-20	12.01**
Alan	5OM-21	12.69**
Westberg	5OM-22*	12.18**
Westberg	5OM-23*	12.36**
Westberg	5OM-24	12**
Holsclaw	5OM-25	11.34**
Holsclaw	5OM-26*	10.03**
Holsclaw	5OM-27*	10.19**
Holsclaw	5OM-28	56.29
Holsclaw	5OM-29	54.78
Holsclaw	5OM-30	119.72
Holsclaw	5OM-31	132.16
Holsclaw	5OM-32	72.2
*Duplicate Sample		**Below Detection Limit

Source: Chadwick et al. (1997)

Table 5-8
Summary Statistics for Surface Water Time Trend Plots

Chemical	Form	USES Station 06436180 (Upstream)			USES Station 06436198 (Downstream)		
		Slope (mg/L per year)	p value	R^2	Slope (mg/L per year)	p value	R^2
Antimony	Dissolved	-1E-04	0.221	0.020	-2E-04	0.095	0.038
Arsenic	Dissolved	-1E-03	0.005	0.101	-2E-03	0.001	0.146
	Total	8E-03	0.590	0.004	1E-02	0.460	0.008
Cadmium	Dissolved	1E-06	0.841	0.001	-1E-05	0.164	0.027
	Total	-3E-04	0.000	0.174	-3E-04	0.001	0.141
Copper	Dissolved	-9E-04	0.000	0.268	-2E-04	0.003	0.114
	Total	7E-04	0.856	0.0005	1E-03	0.677	0.002
Cyanide	Total	-1E-03	0.444	0.008	1E-04	0.792	0.001
Lead	Dissolved	-8E-04	0.000	0.309	-2E-04	0.350	0.012
	Total	2E-03	0.560	0.005	1E-03	0.376	0.011
Mercury	Dissolved	-3E-06	0.001	0.133	-1E-06	0.110	0.035
	Total	-3E-06	0.780	0.001	-2E-06	0.707	0.002
Nickel	Dissolved	1E-04	0.275	0.016	-2E-04	0.001	0.148
	Total	-7E-04	0.072	0.111	-4E-03	0.491	0.018
Selenium	Dissolved	-2E-04	0.002	0.118	-2E-06	0.968	0.000
	Total	-3E-04	0.000	0.266	7E-05	0.222	0.022
Zinc	Dissolved	-4E-04	0.002	0.121	-6E-04	0.006	0.102
	Total	4E-03	0.612	0.004	5E-03	0.381	0.011

FIGURES

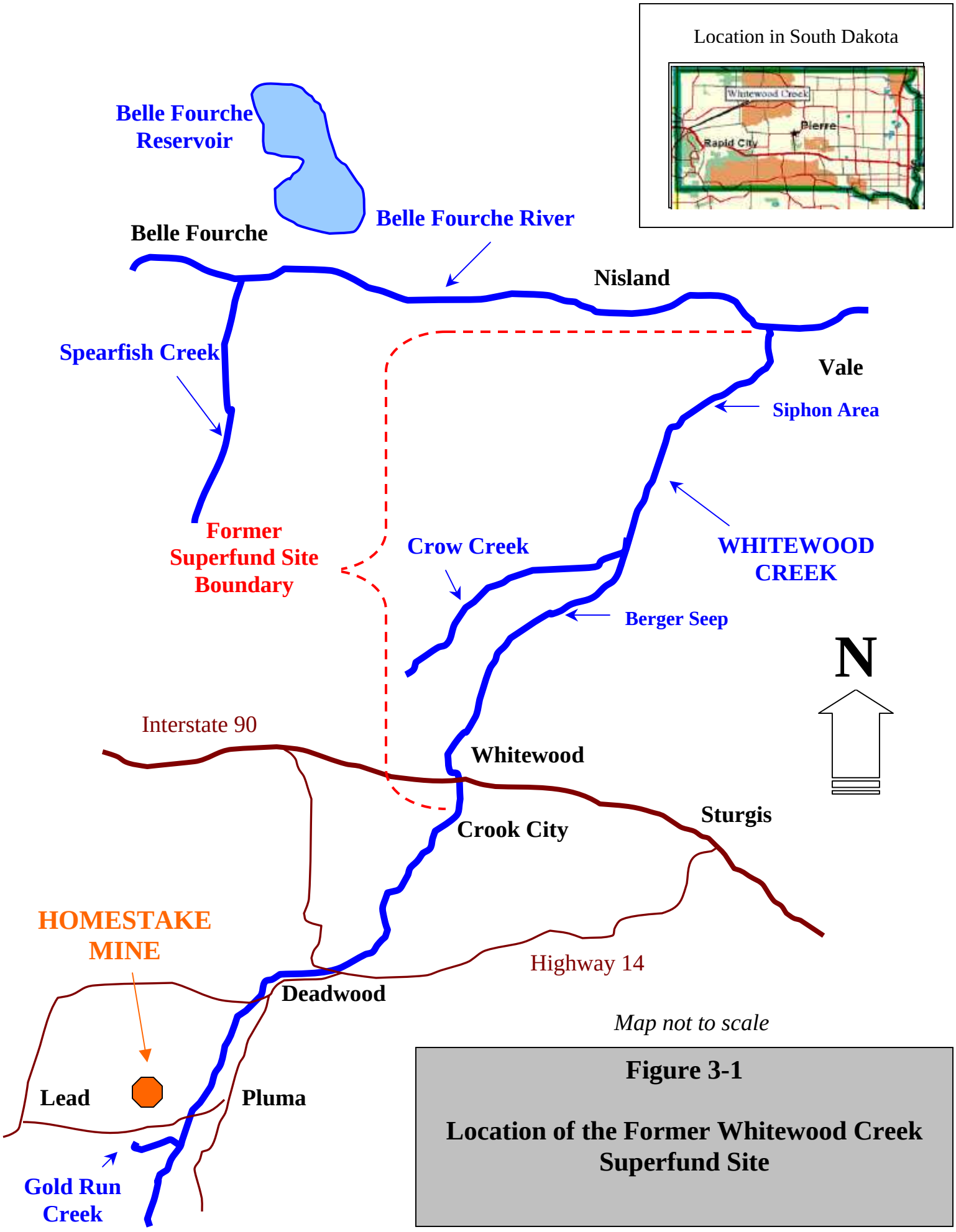
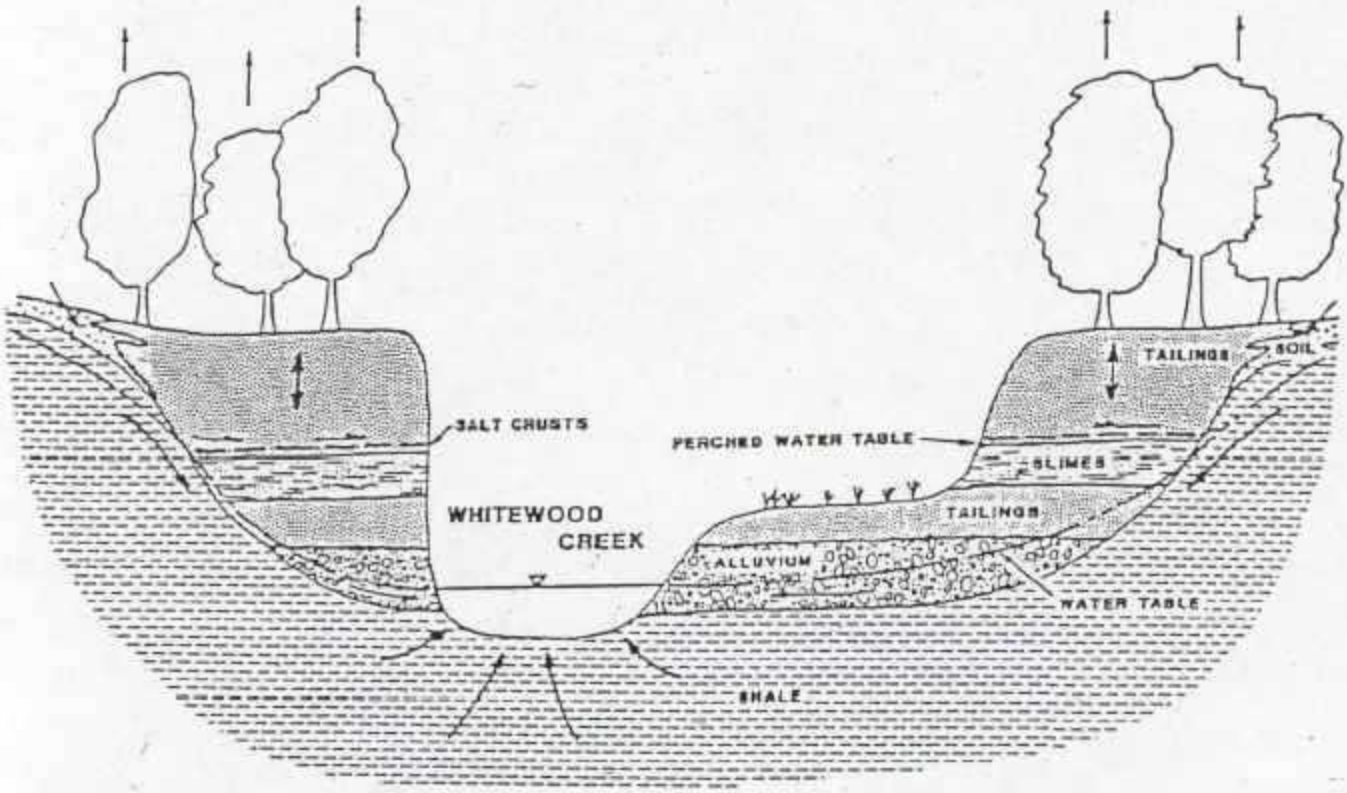


Figure 3-1

Location of the Former Whitewood Creek Superfund Site

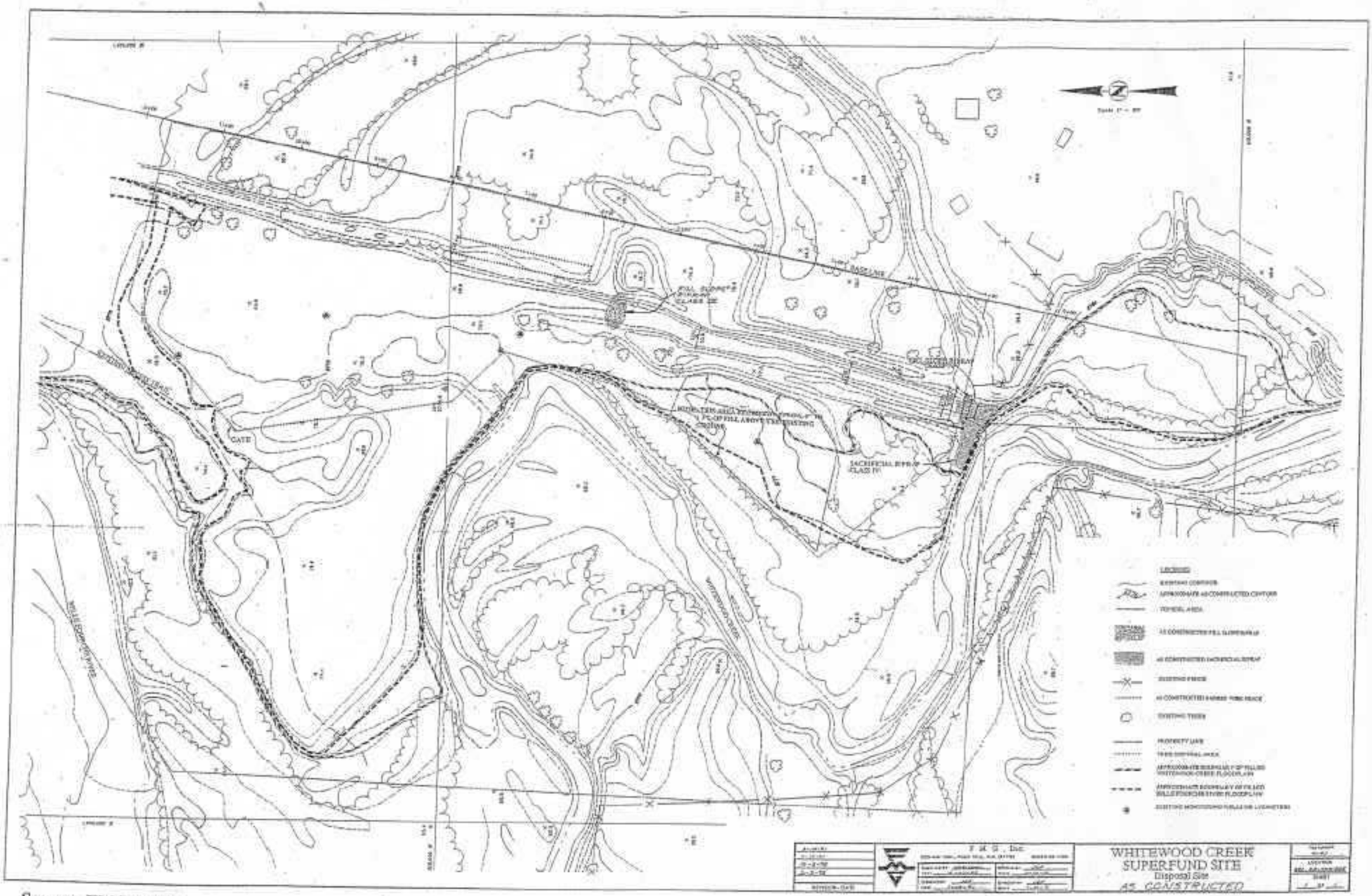
Figure 3-2 Schematic Representation of the Geology and Water-Circulation Pathways in the Whitewood Creek Valley

Whitewood Creek Five-Year Review



Source: Cherry et al., 1986 (Part 2 of 3, Figure 4)

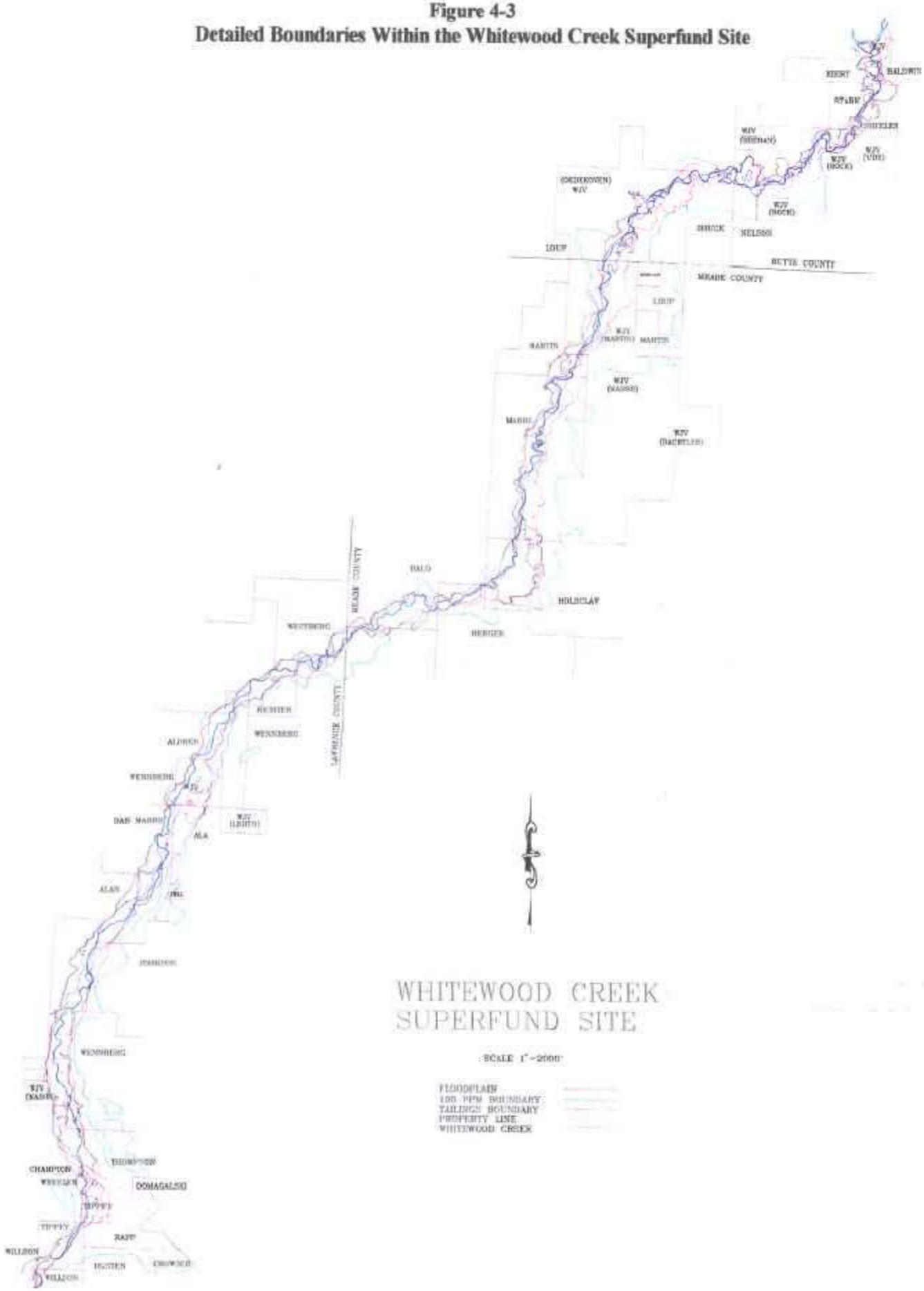
Figure 4-1
As Constructed Diagram of the Whitewood Creek Superfund Site Disposal Site



Source: FMG (1993)

Figure 4-2
Post-construction Photo of a Soil Disposal Cell, Spring 1994

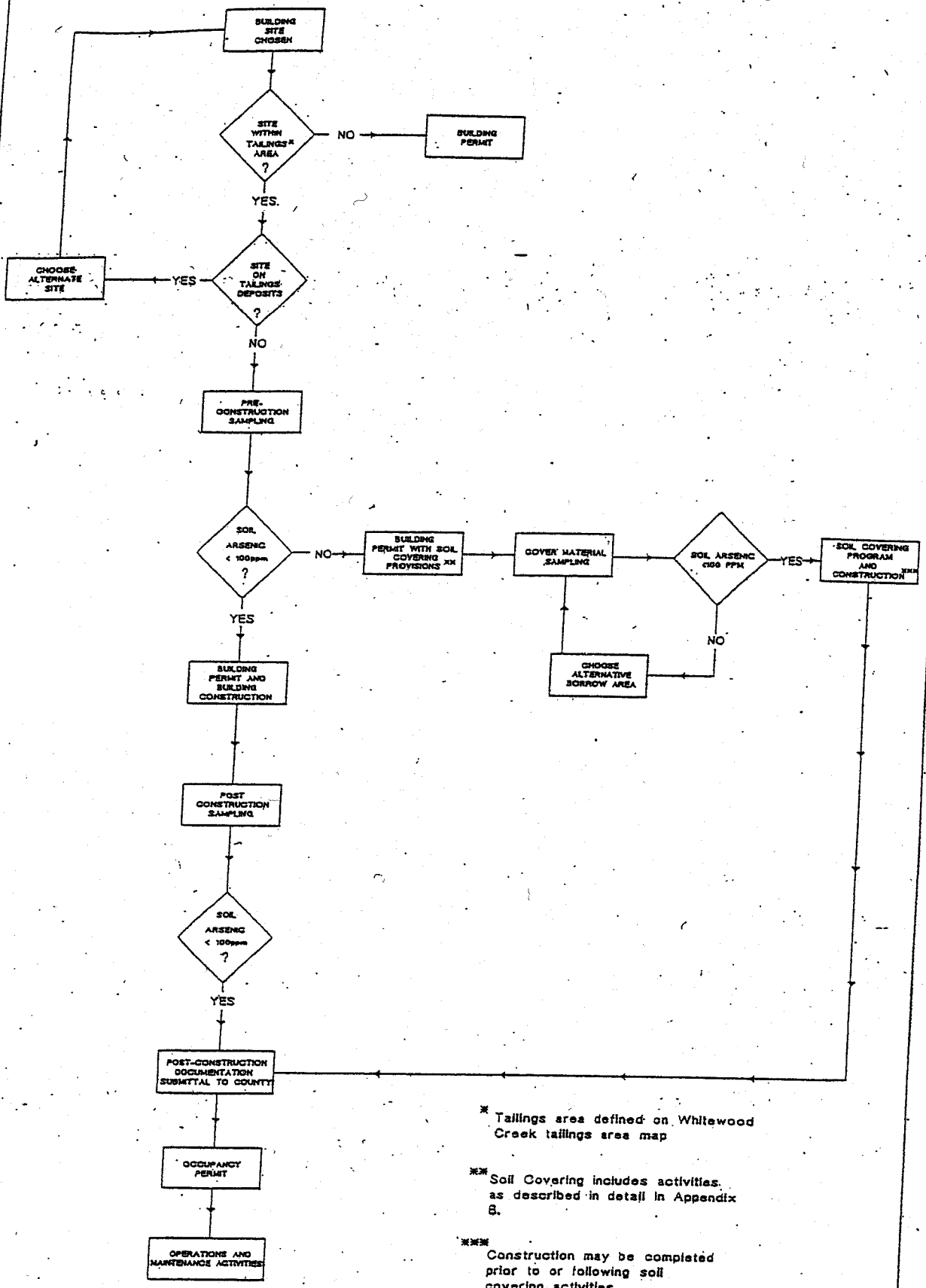
Figure 4-3
Detailed Boundaries Within the Whitewood Creek Superfund Site



Source: WDC (1994a)

Figure 4-4

Homesite Development Flowchart for the Whitewood Creek Tailings Area



* Tailings area defined on Whitewood Creek tailings area map

** Soil Covering includes activities as described in detail in Appendix B.

*** Construction may be completed prior to or following soil covering activities.

PROJECT NO.	PREPARED BY:	FIGURE 1993-B
01944		
DATE		Whitewood Creek Tailings Area Homesite Development Flow Diagram
05/93		
REVISION	STEFFEN ROBERTSON & KIRSTEN (U.S.)	
1	Consulting Engineers & Scientists	

Source: WDC (1994a)

Figure 4-5
Photos Taken During Disposal Site Operation and Maintenance Activities

October 2000. View of rip-rap bank stabilization area and reseeded area. Photo taken looking to the north/northwest.

May 2001. Rip-rap at north end of soil disposal cell after placing Whitewood Creek Soil Samples inside cell. Photo taken looking south/southeast.

Figure 4-6
Unauthorized Rubble Placed Outside of the Disposal Site

Unauthorized rubble, prior to disposal. Looking southwest.

Unauthorized rubble prior to disposal, looking west. Note burned material.

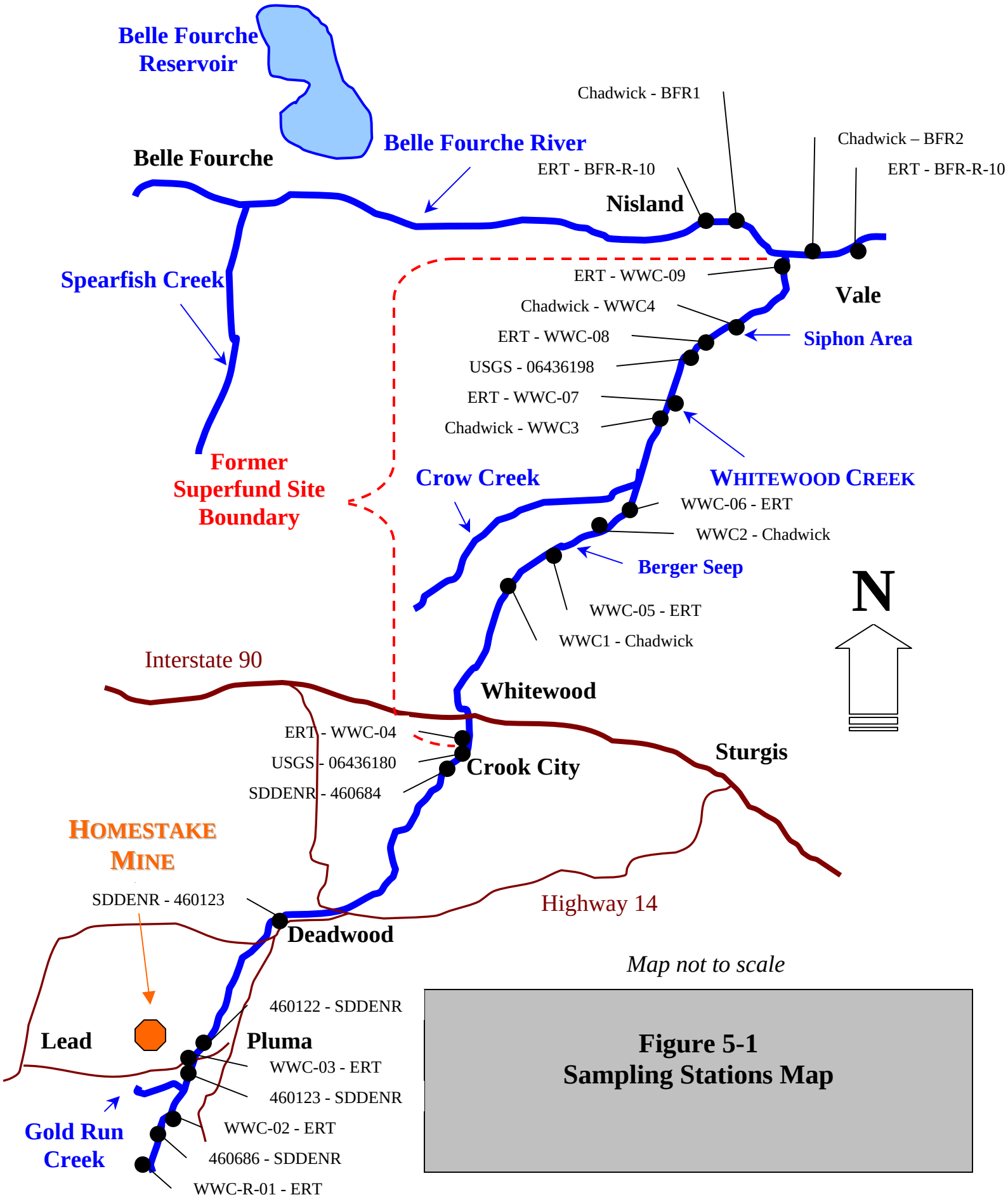
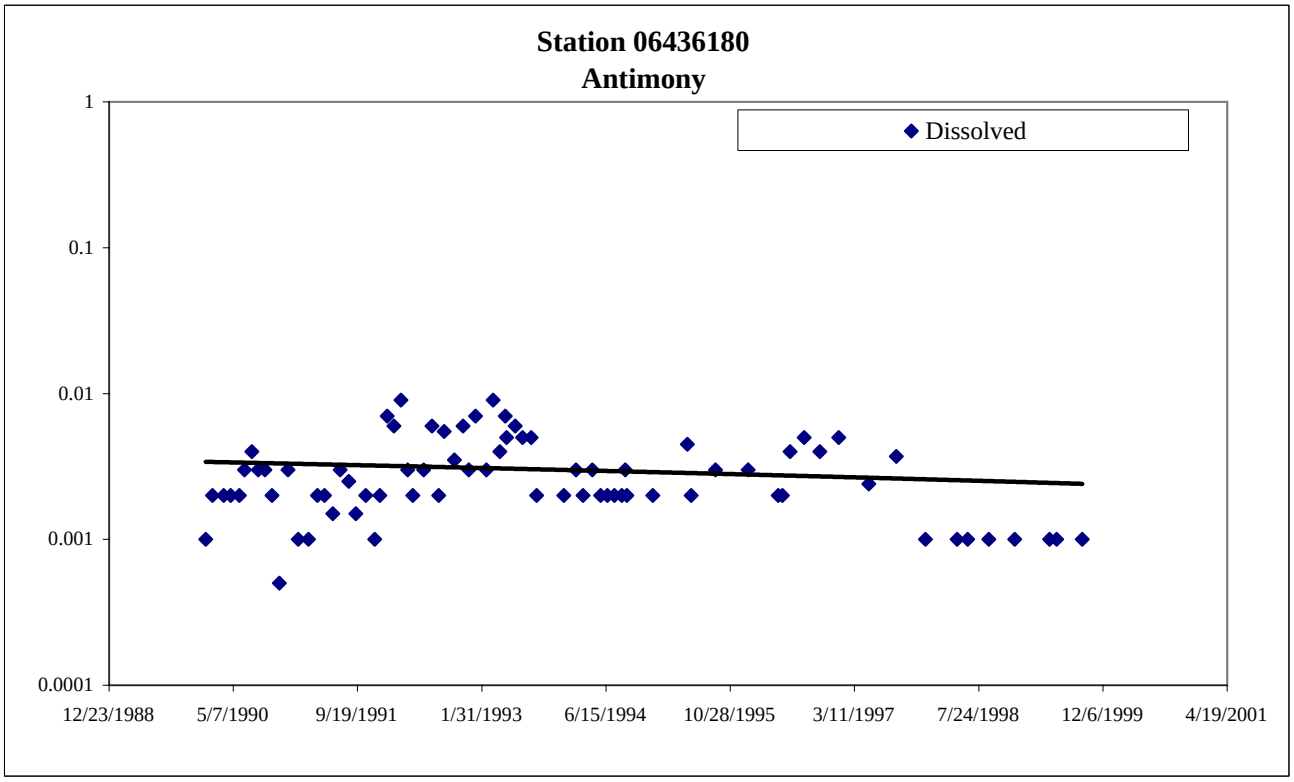


Figure 5-1
Sampling Stations Map

Figure 5-2
Time Trend Analyses for Antimony in Surface Water
Page 1 of 10



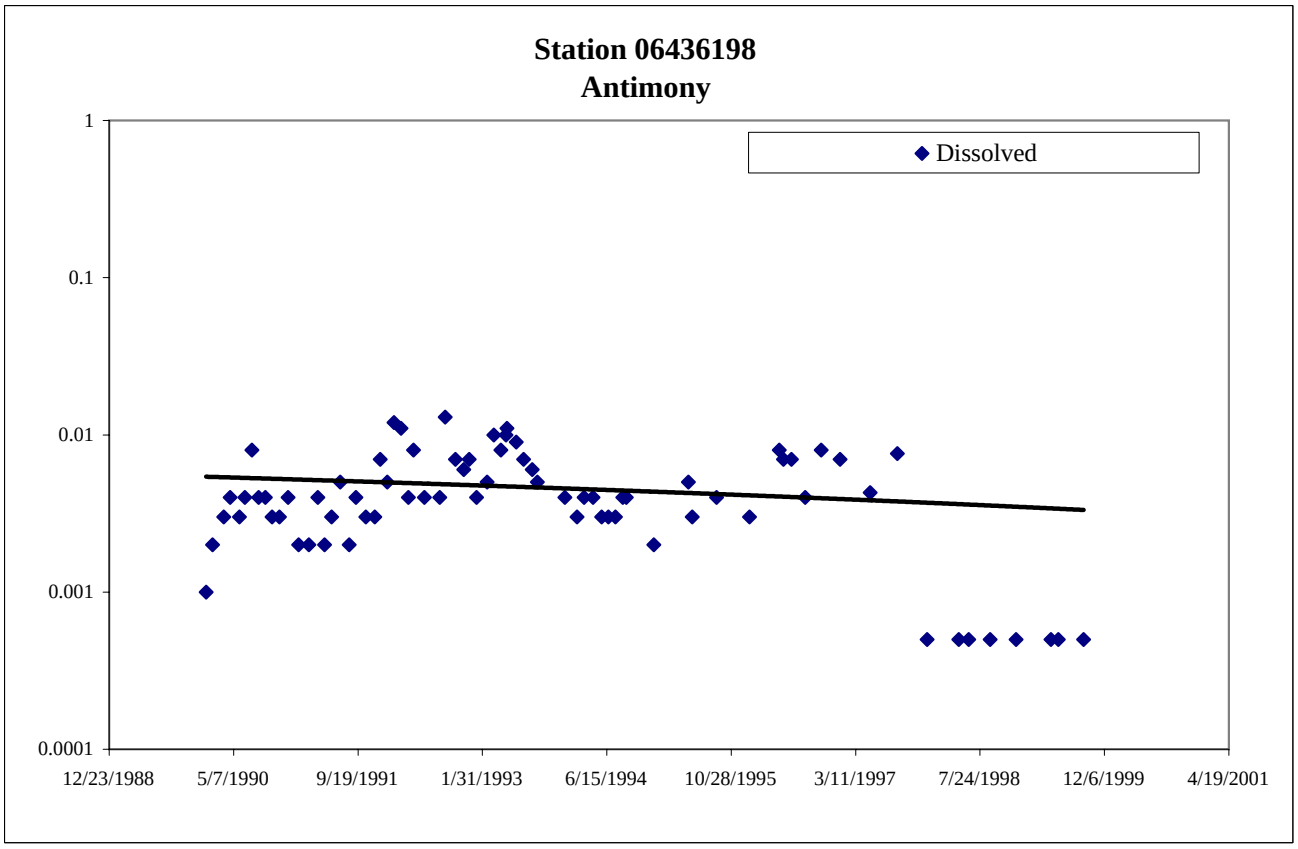
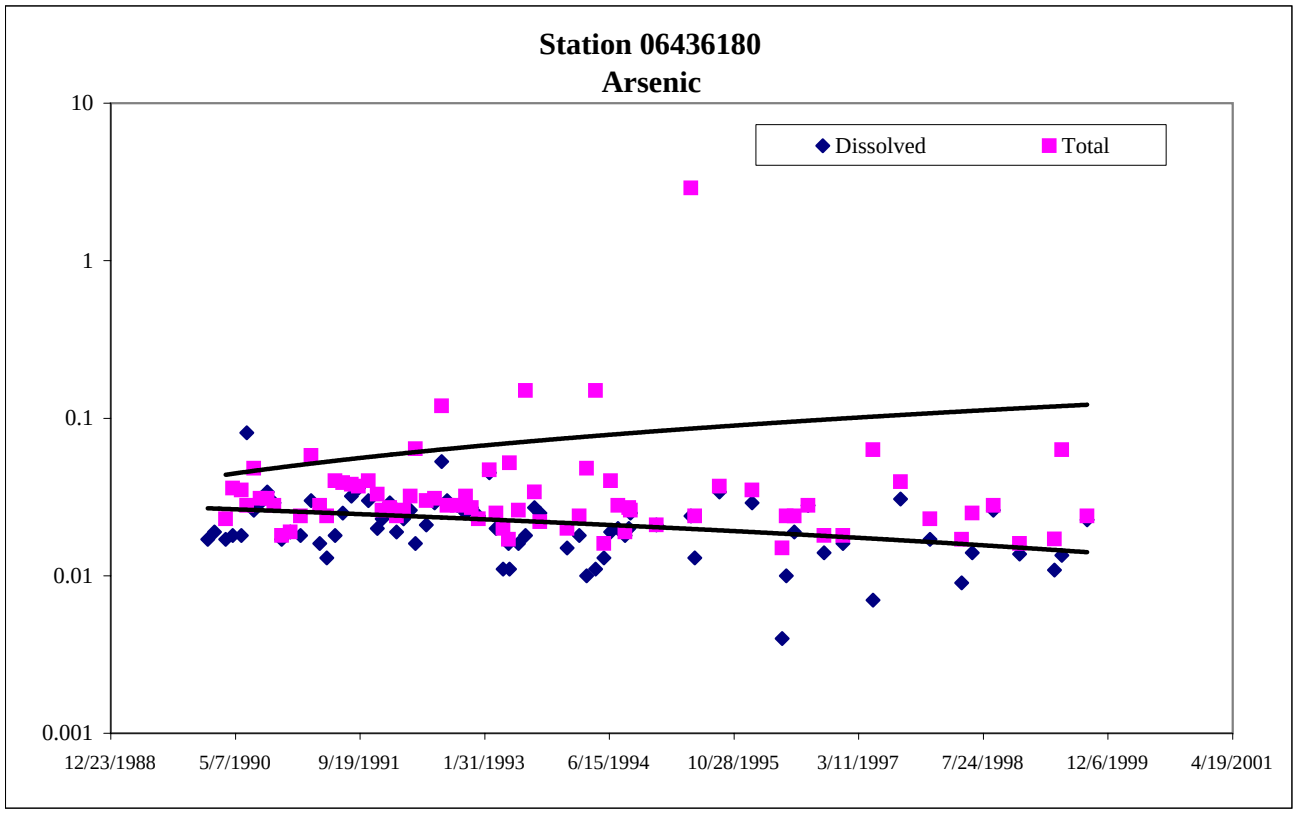
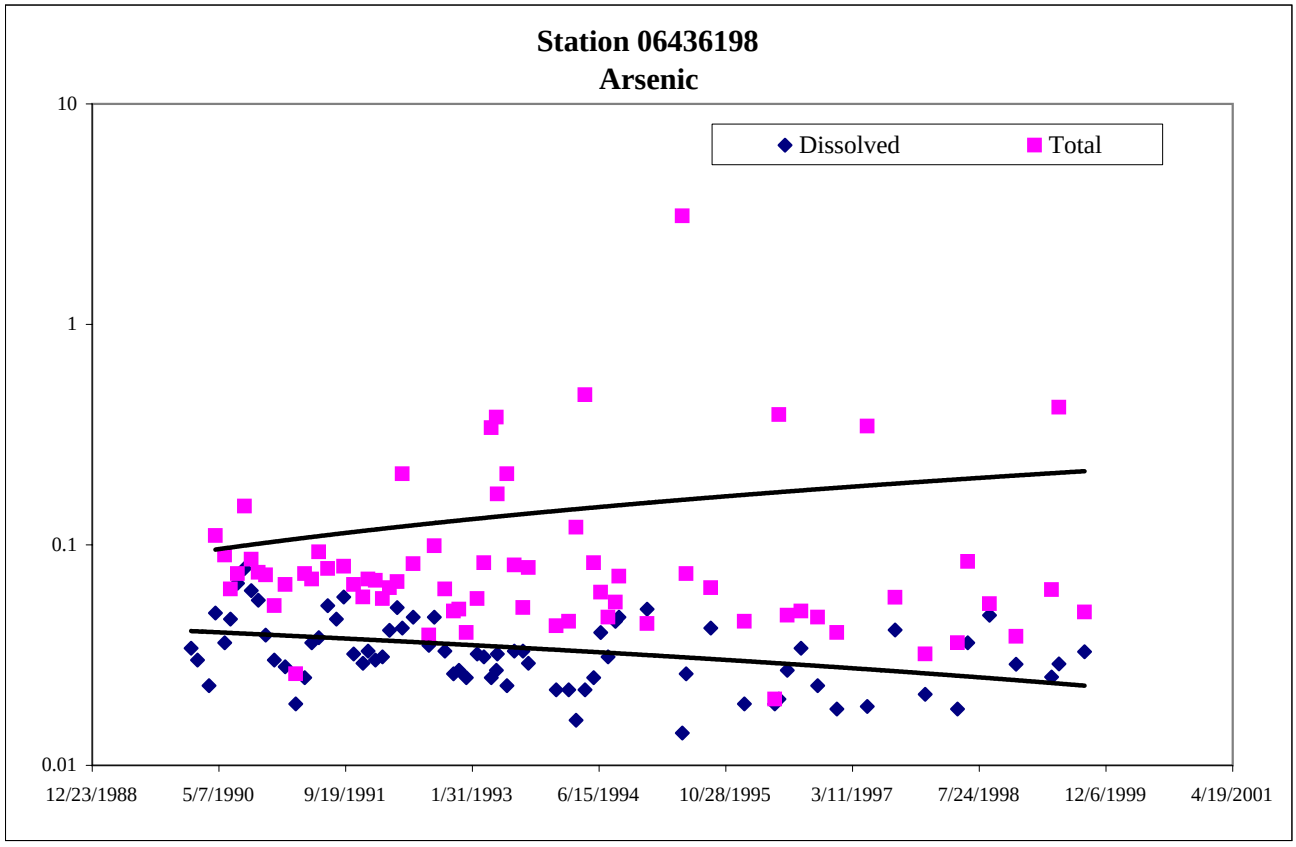


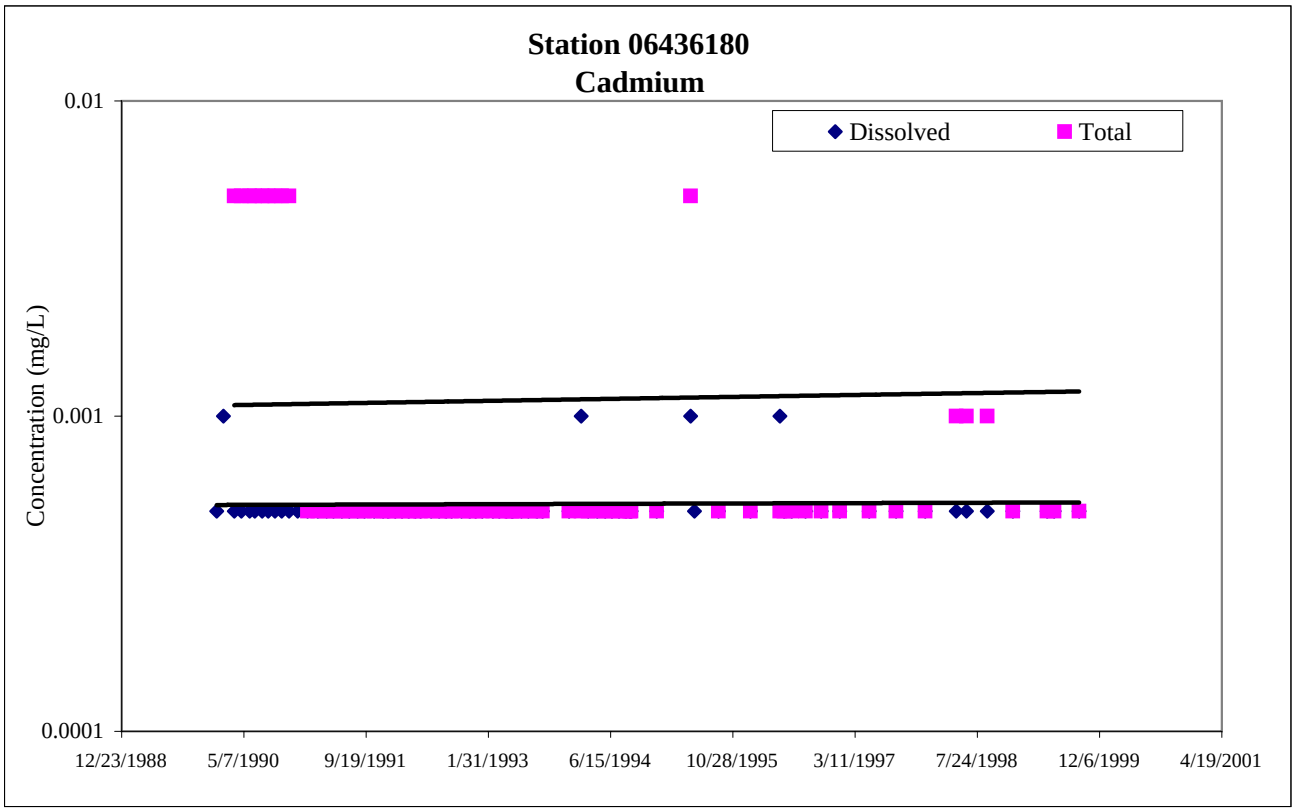
Figure 5-2
Time Trend Analyses for Arsenic in Surface Water
Page 2 of 10





COPC Time Trends.xls:Arsenic
7/10/2002

Figure 5-2
Time Trend Analyses for Cadmium in Surface Water



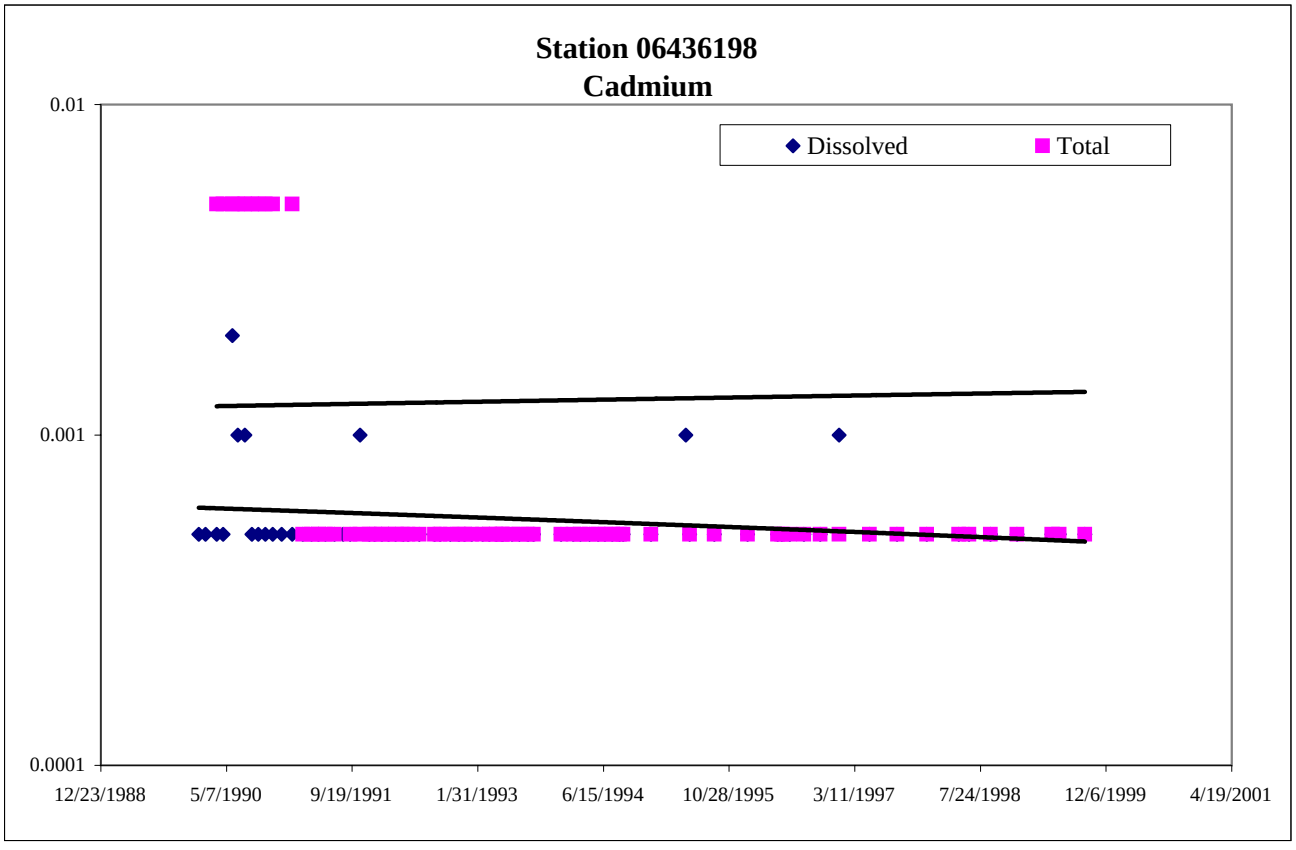
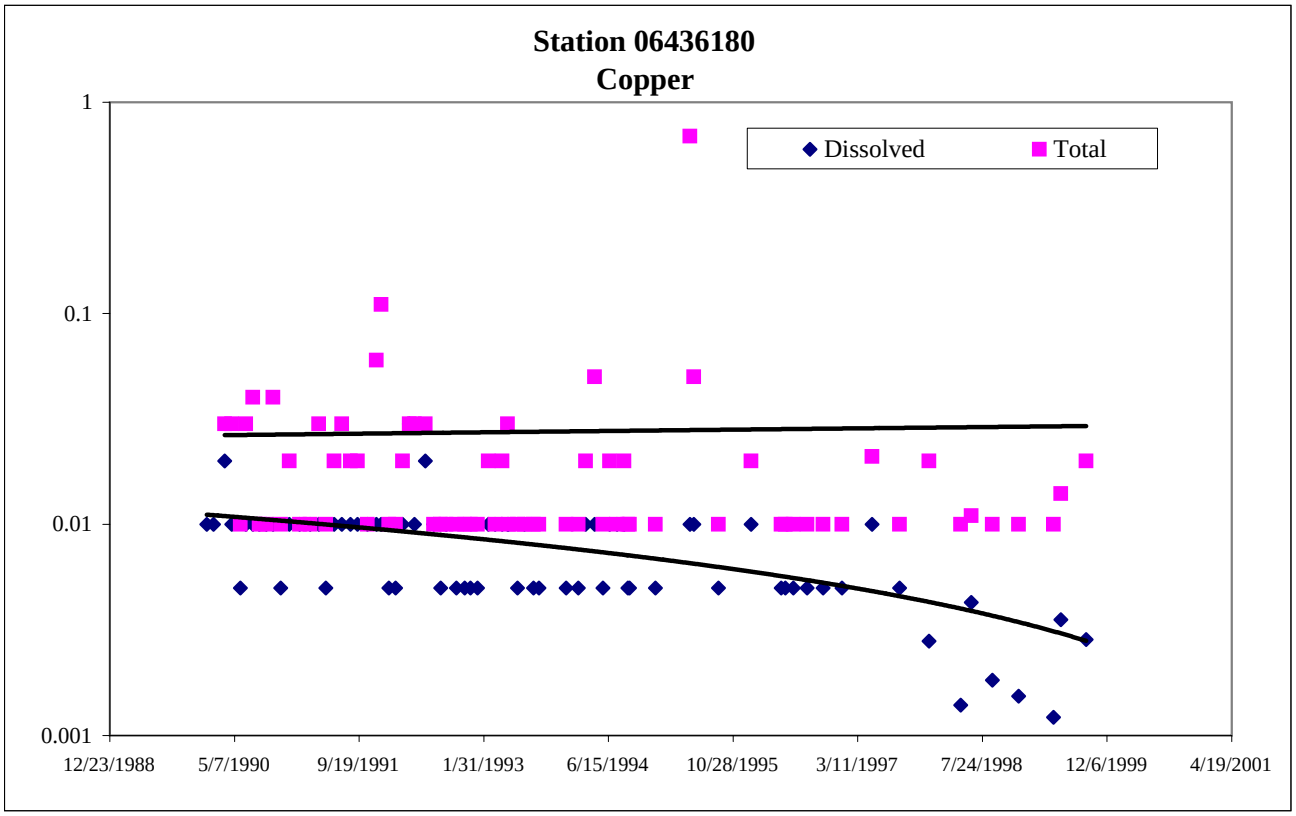


Figure 5-2
Time Trend Analyses for Copper in Surface Water



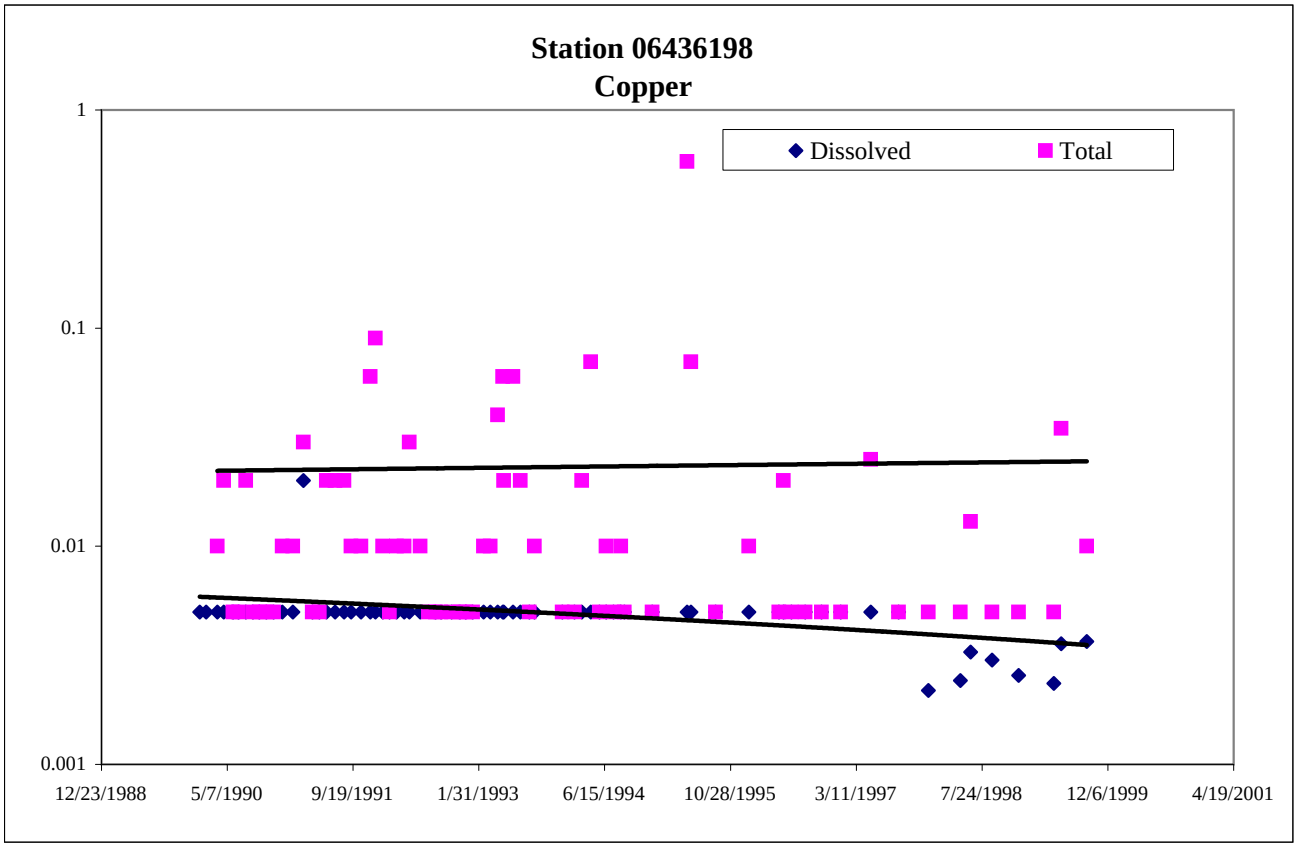
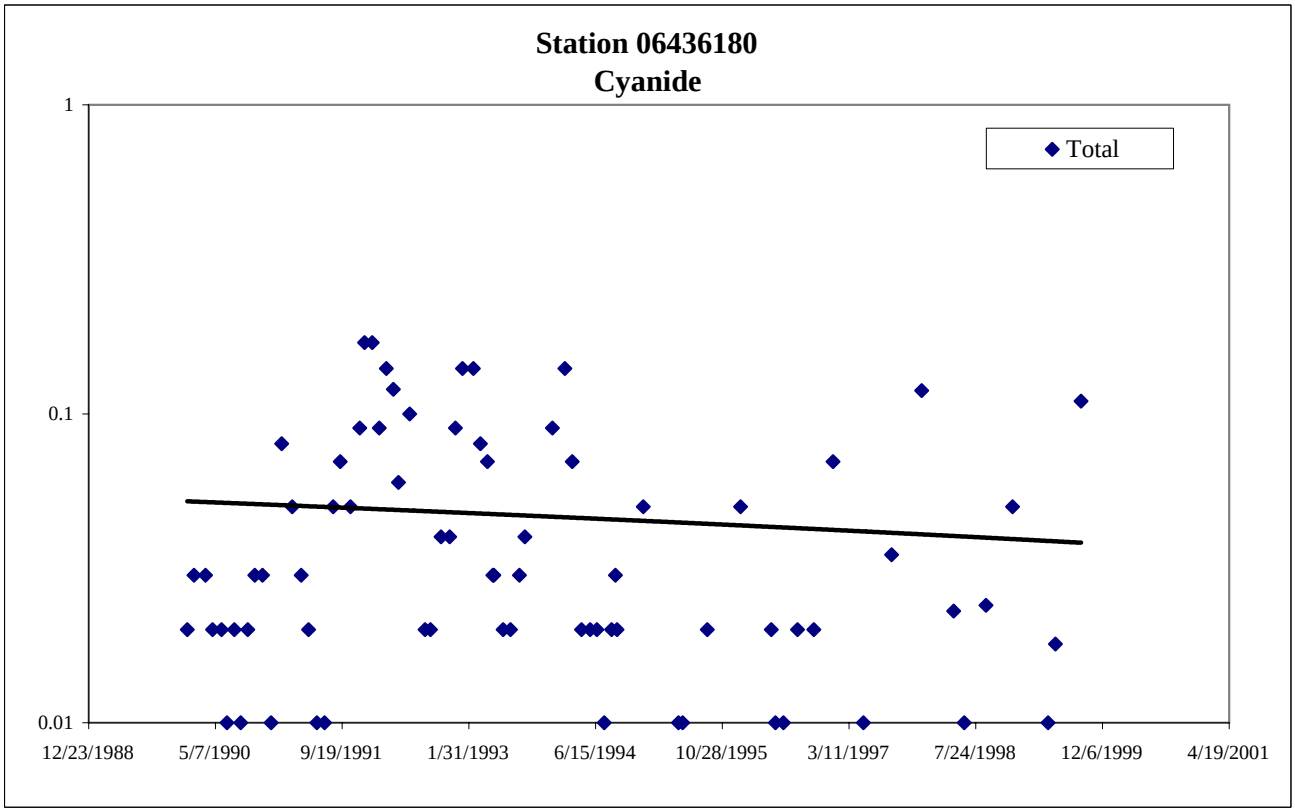


Figure 5-2
Time Trend Analyses for Cyanide in Surface Water



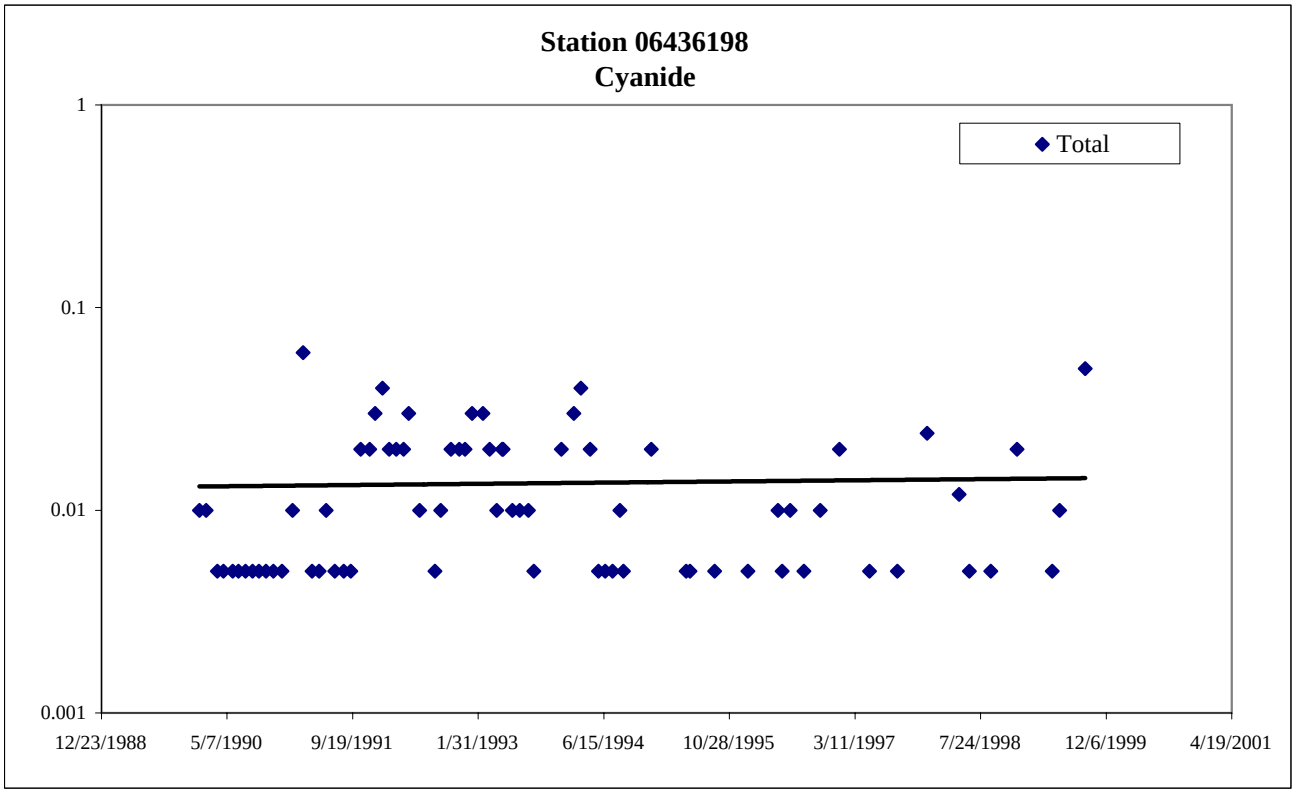
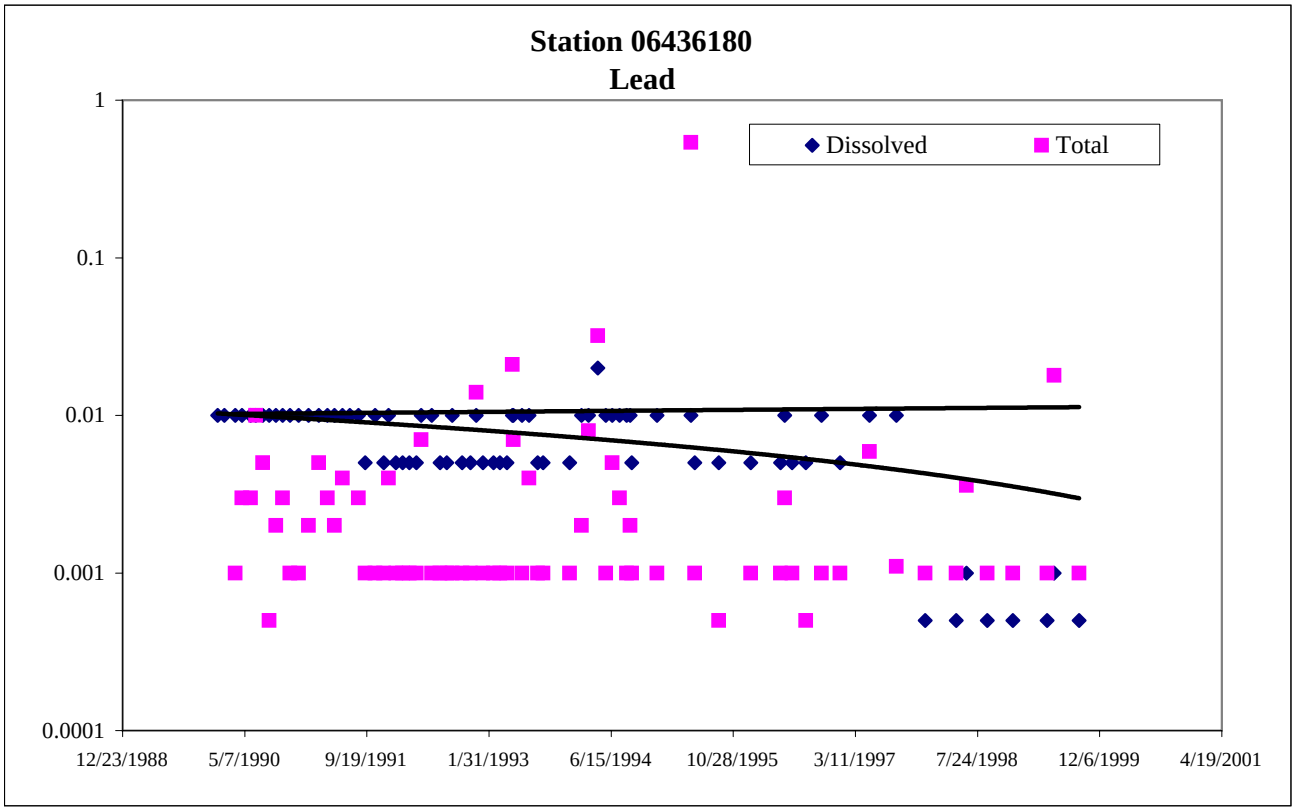


Figure 5-2
Time Trend Analyses for Lead in Surface Water



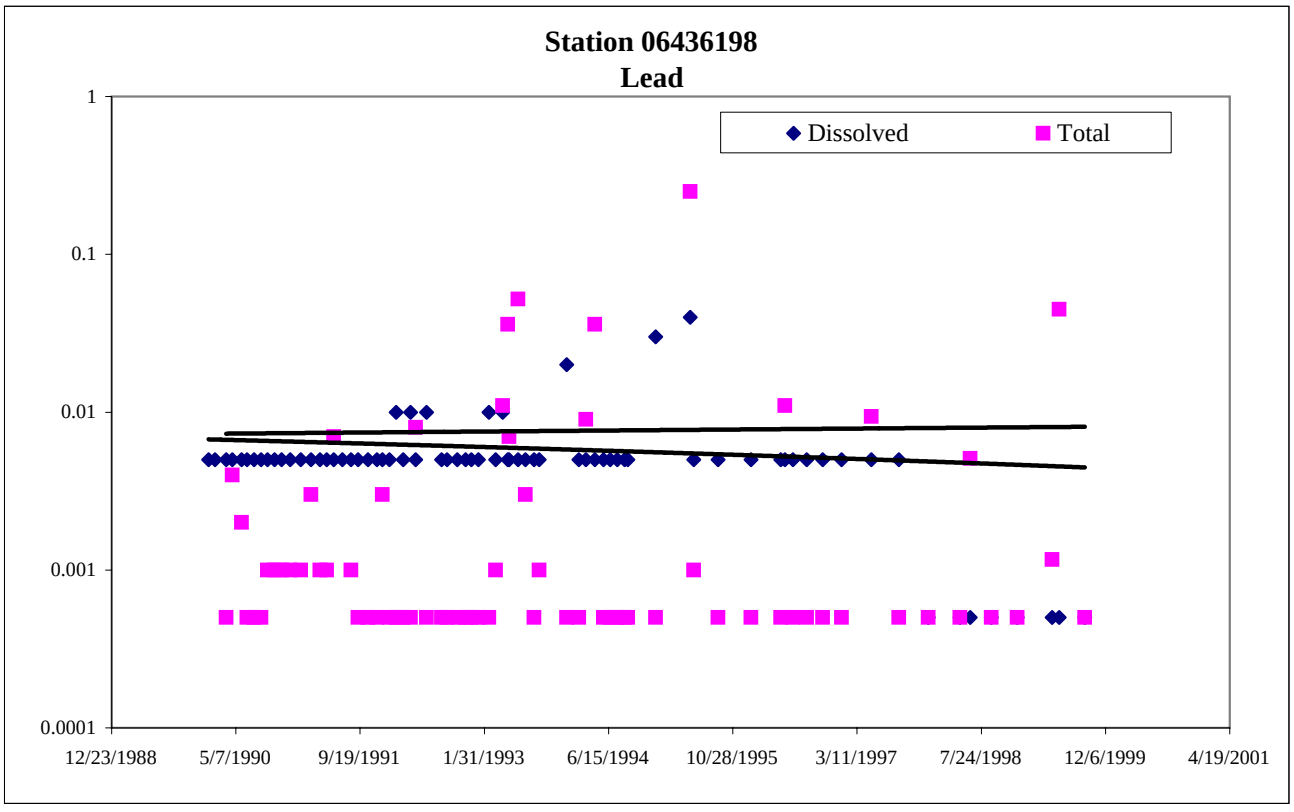
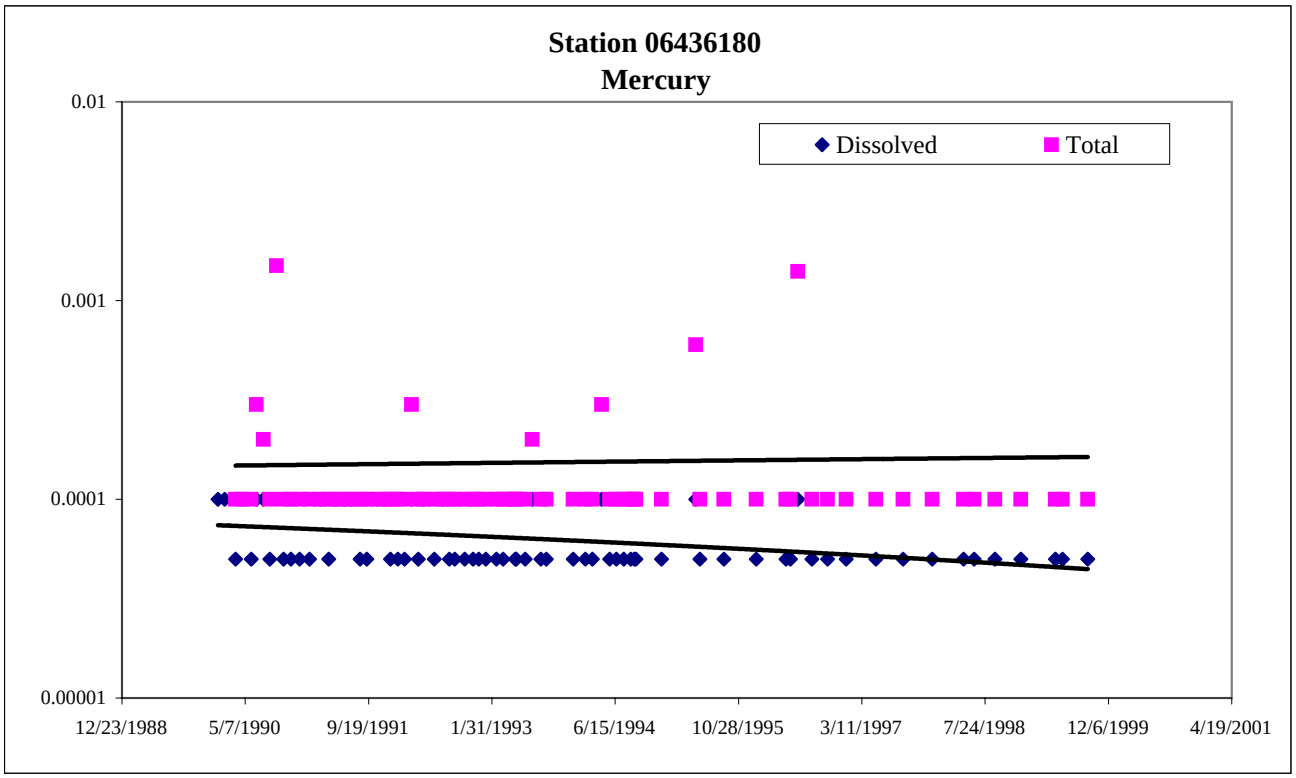


Figure 5-2
Time Trend Analyses for Mercury in Surface Water



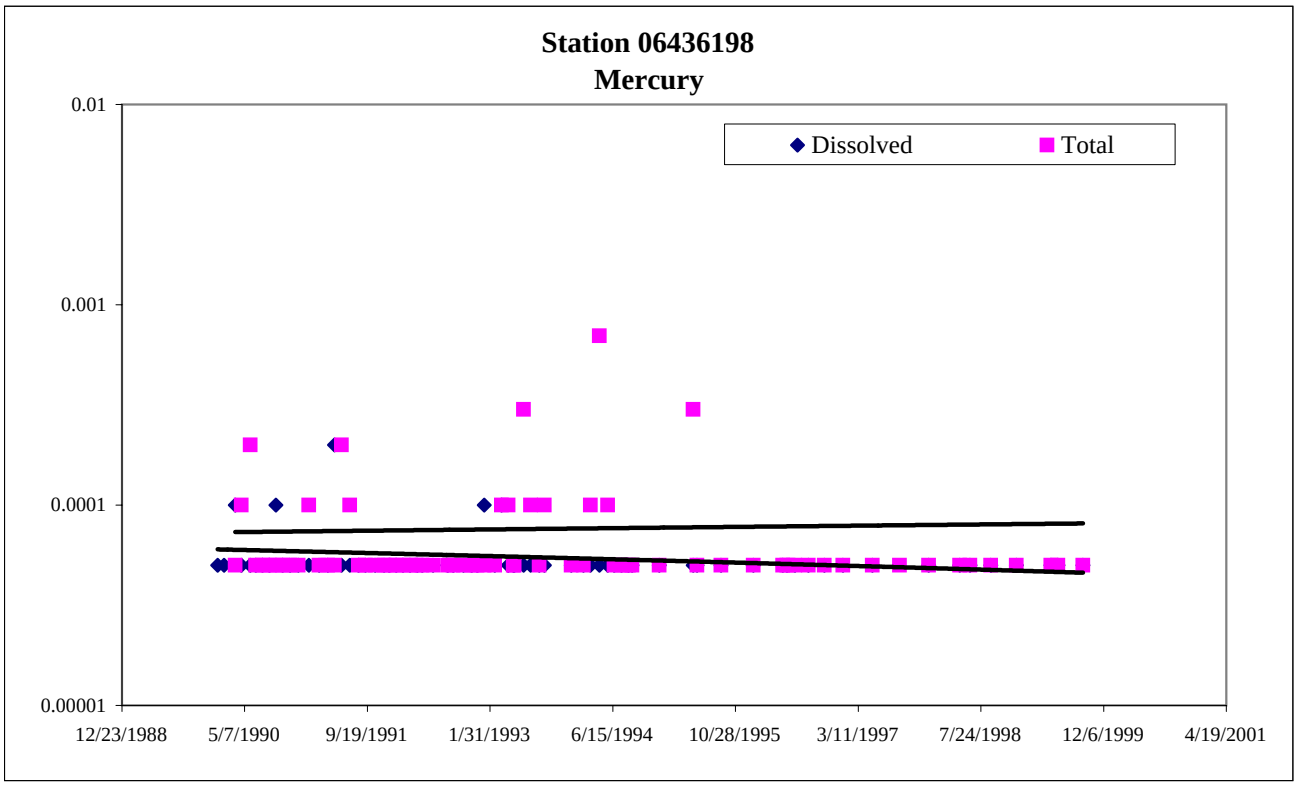
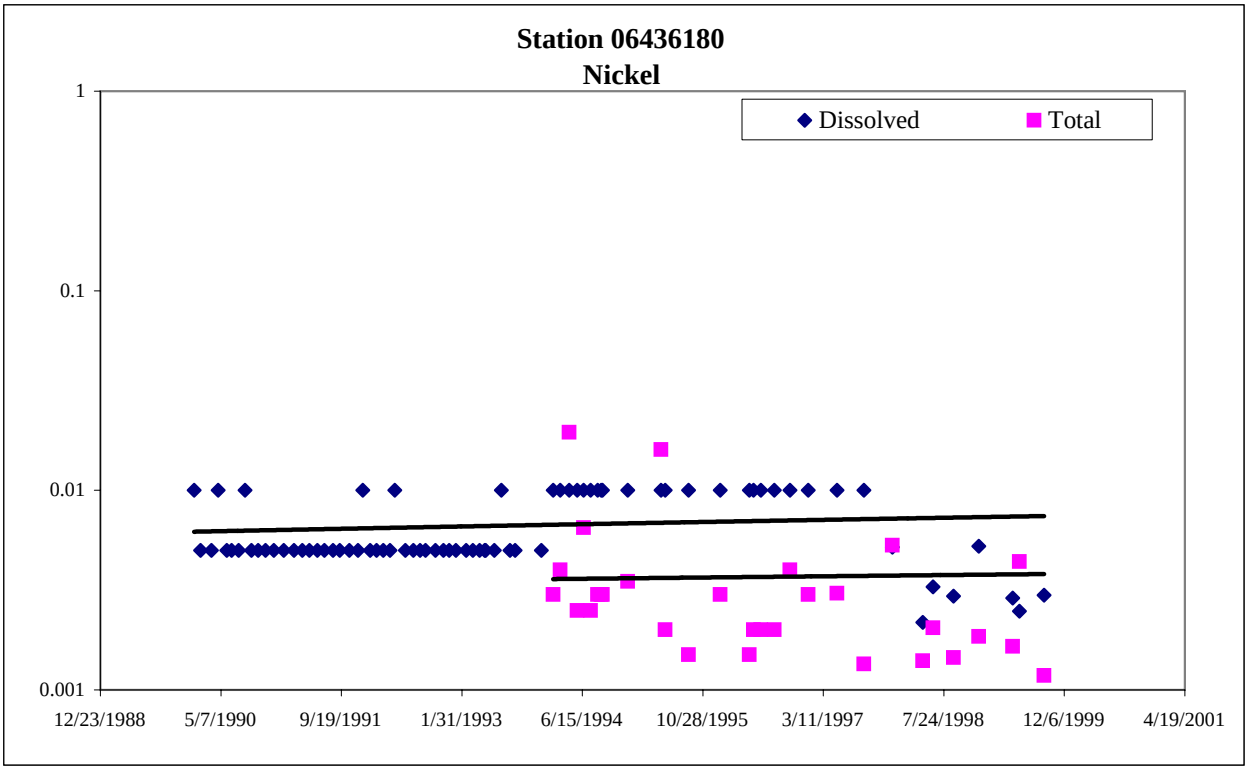


Figure 5-2
Time Trend Analyses for Nickel in Surface Water



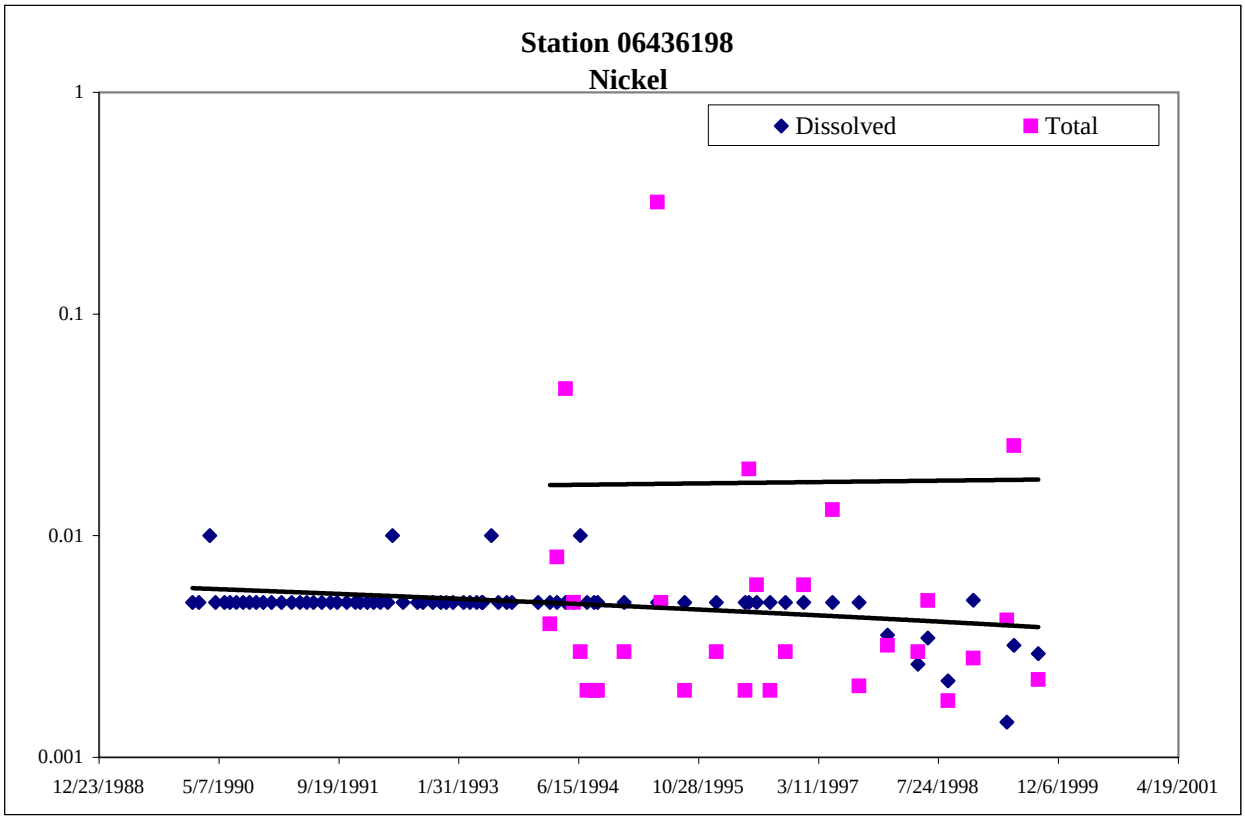
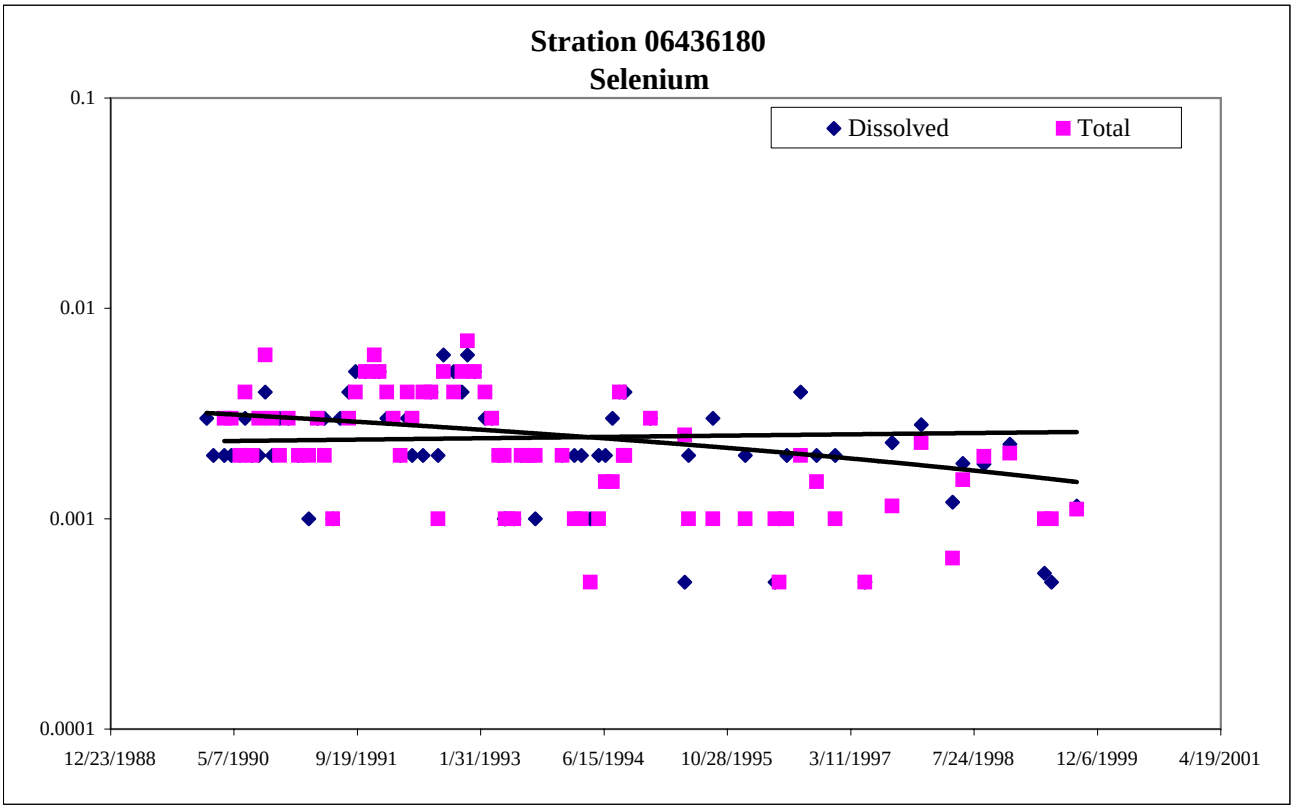


Figure 5-2
Time Trend Analyses for Selenium in Surface Water



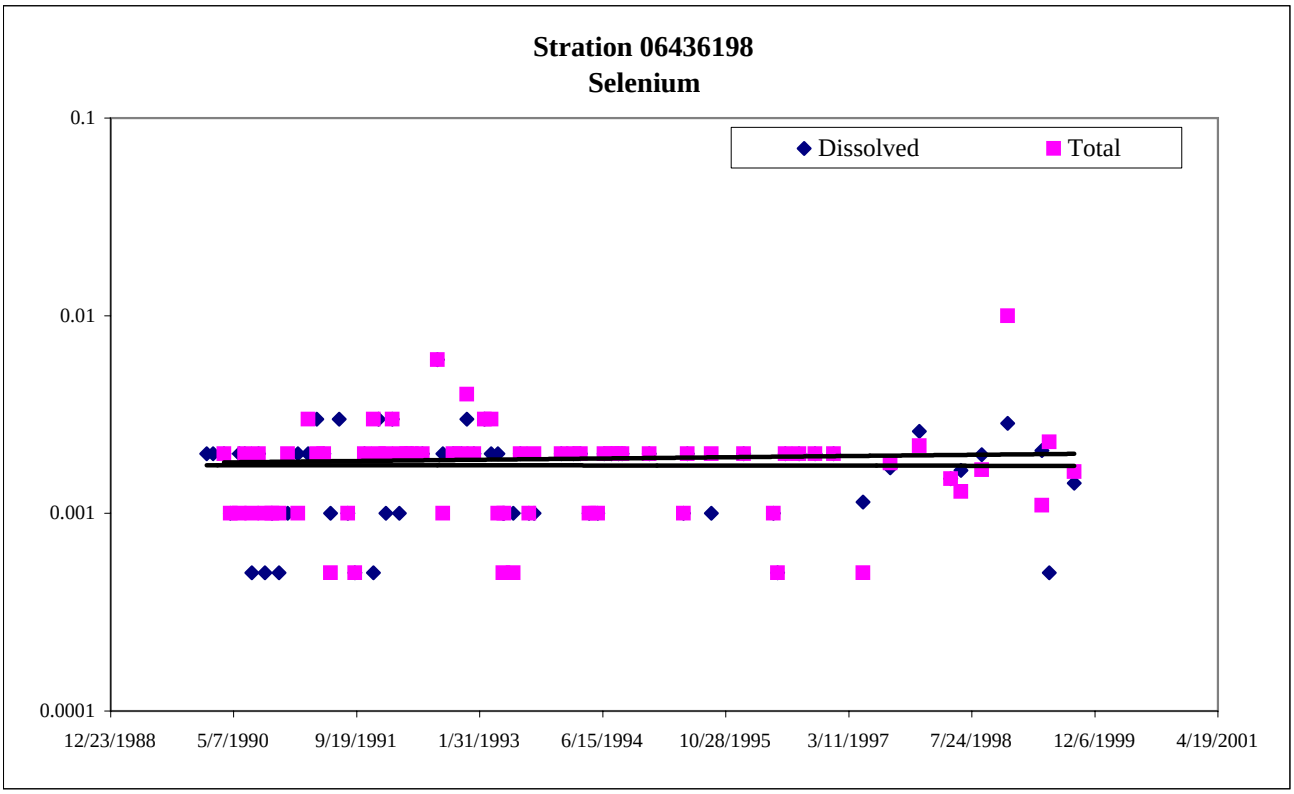
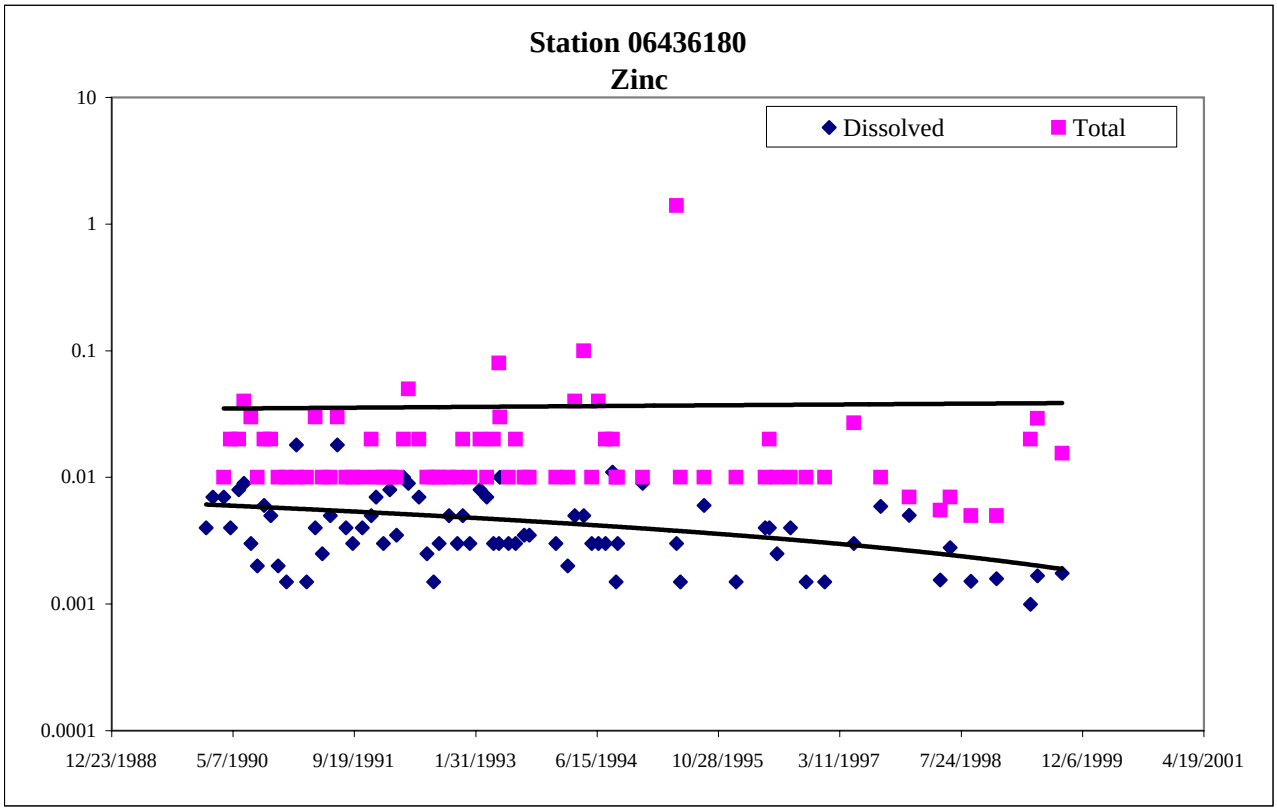


Figure 5-2
Time Trend Analyses of Zinc in Surface Water



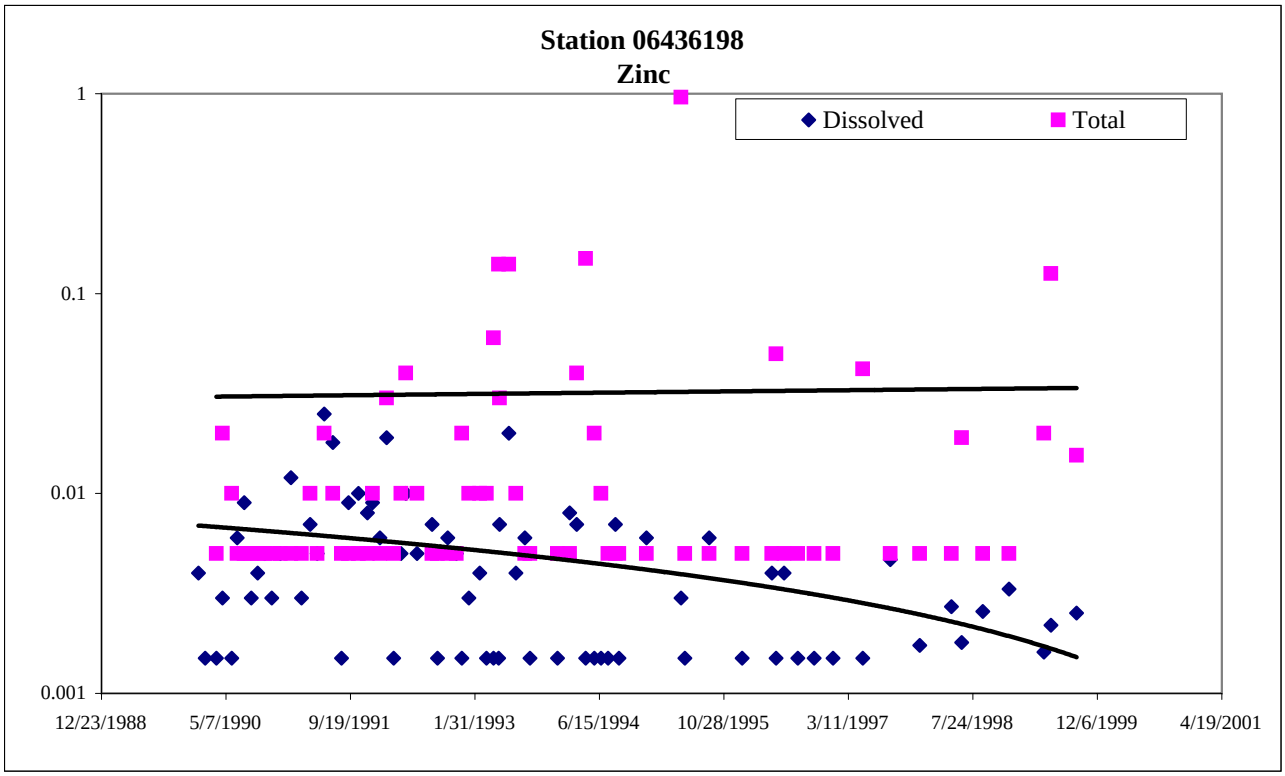
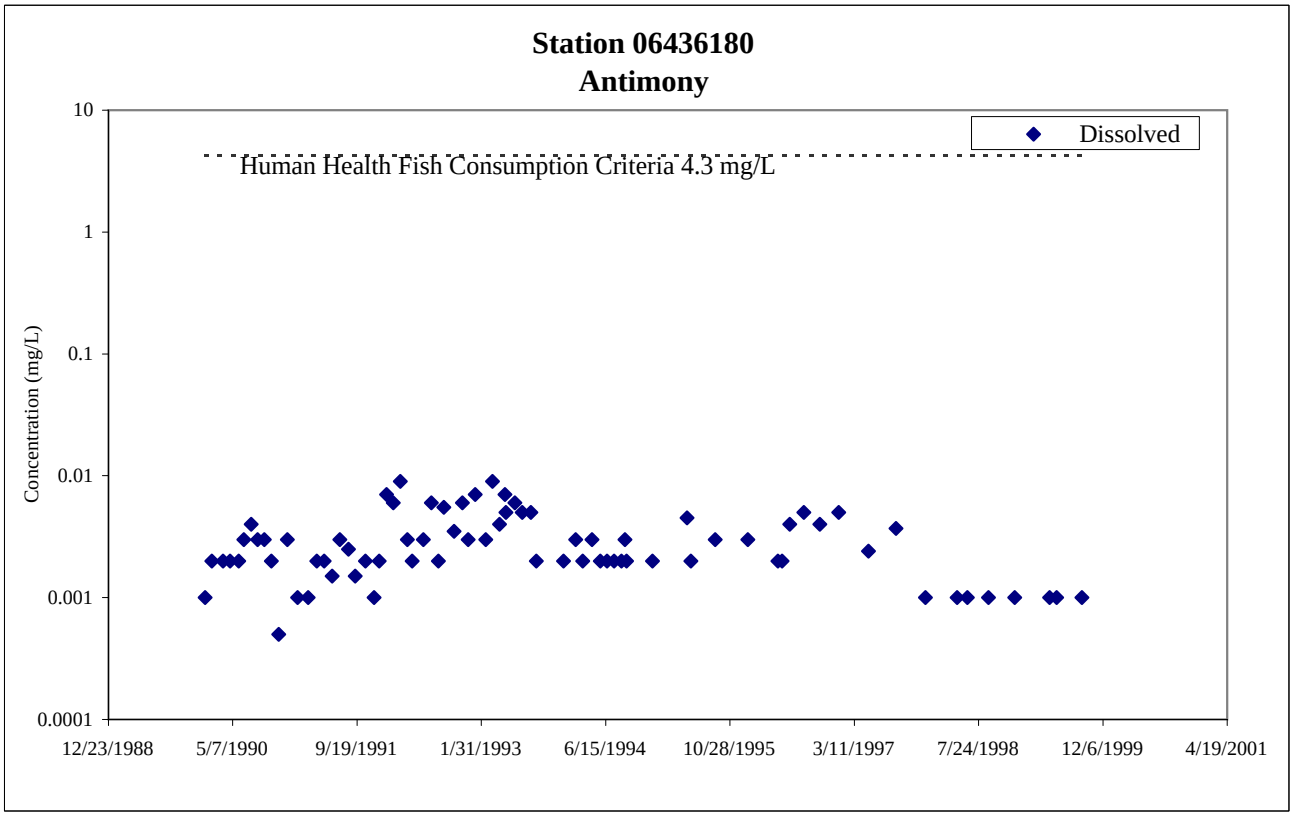


Figure 5-3
Comparison of Time Trend Plots for Antimony in Surface Water with Fish Consumption Criteria



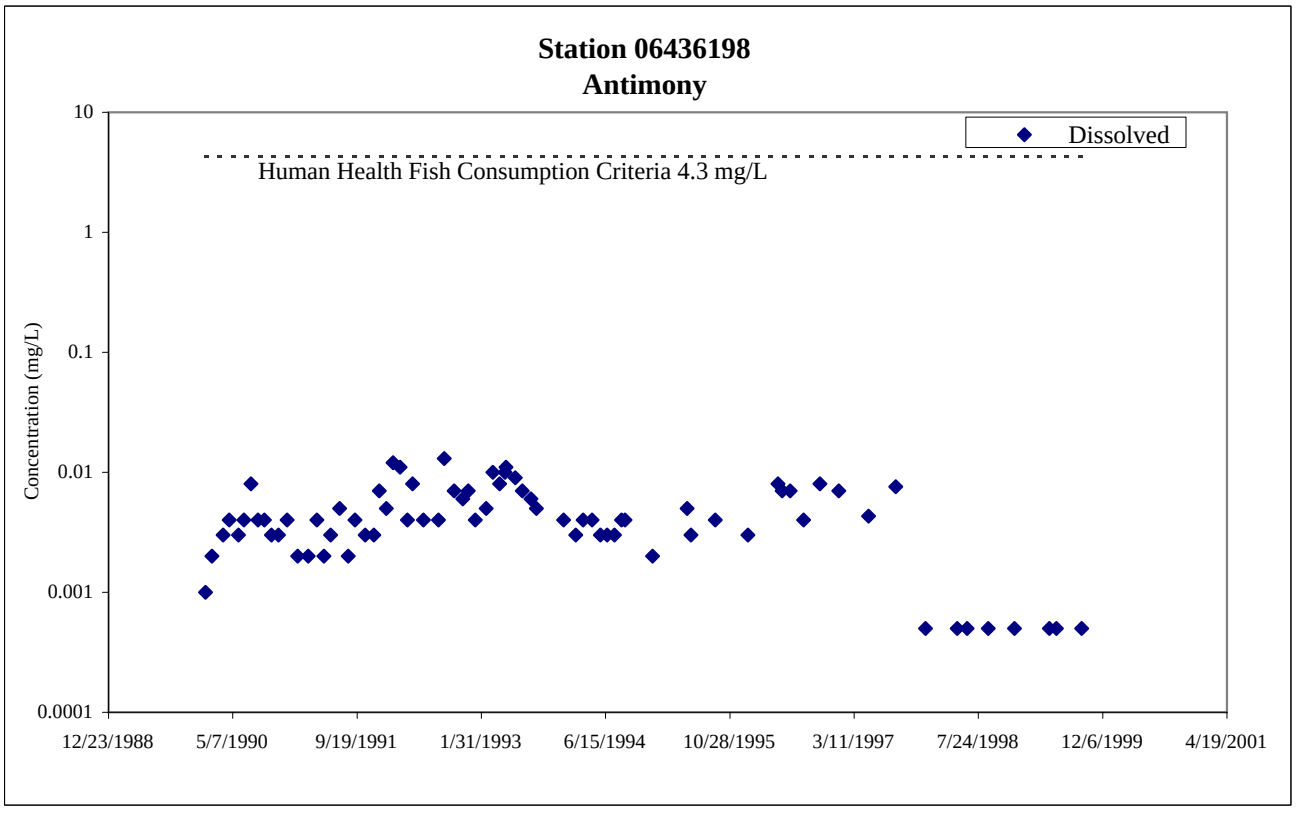
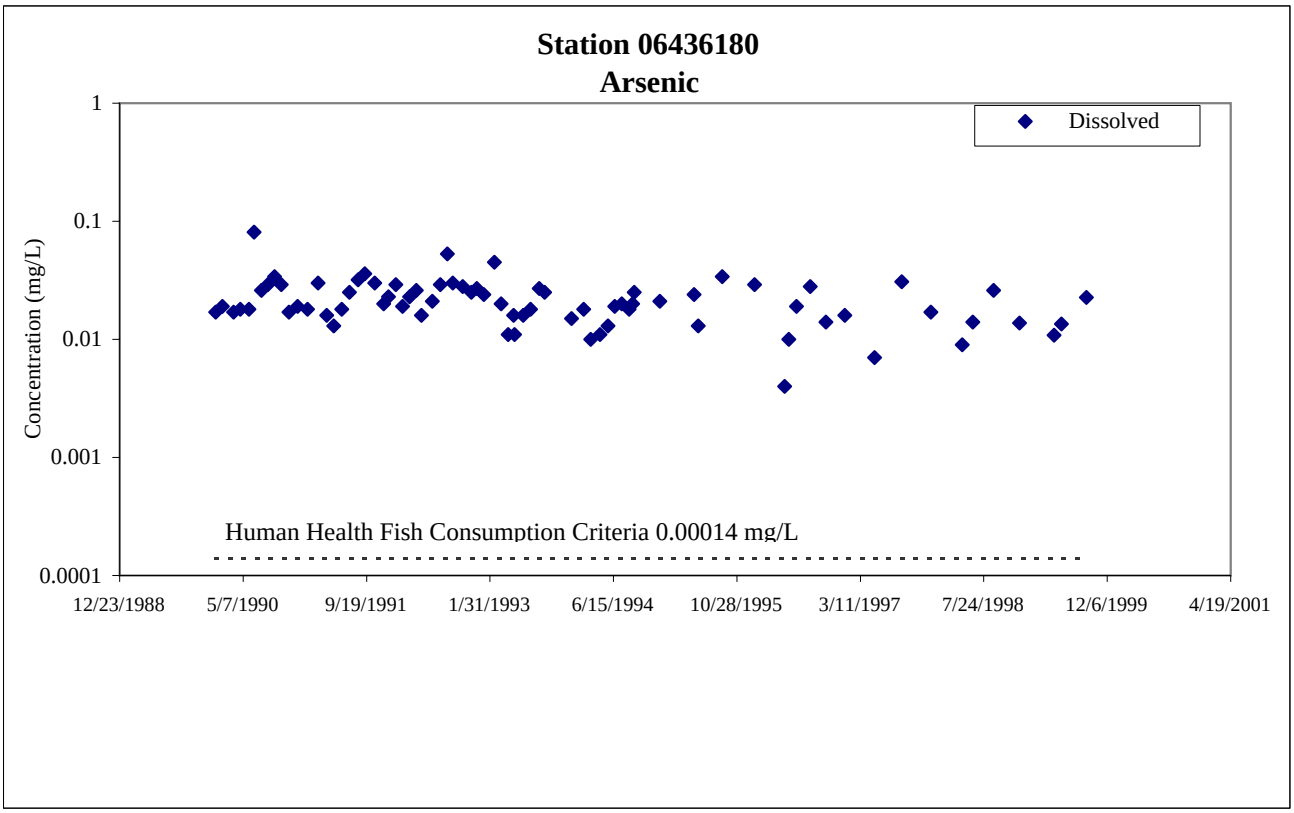


Figure 5-3
Comparison of Time Trend Plots for Arsenic in Surface Water with Fish Consumption Criteria



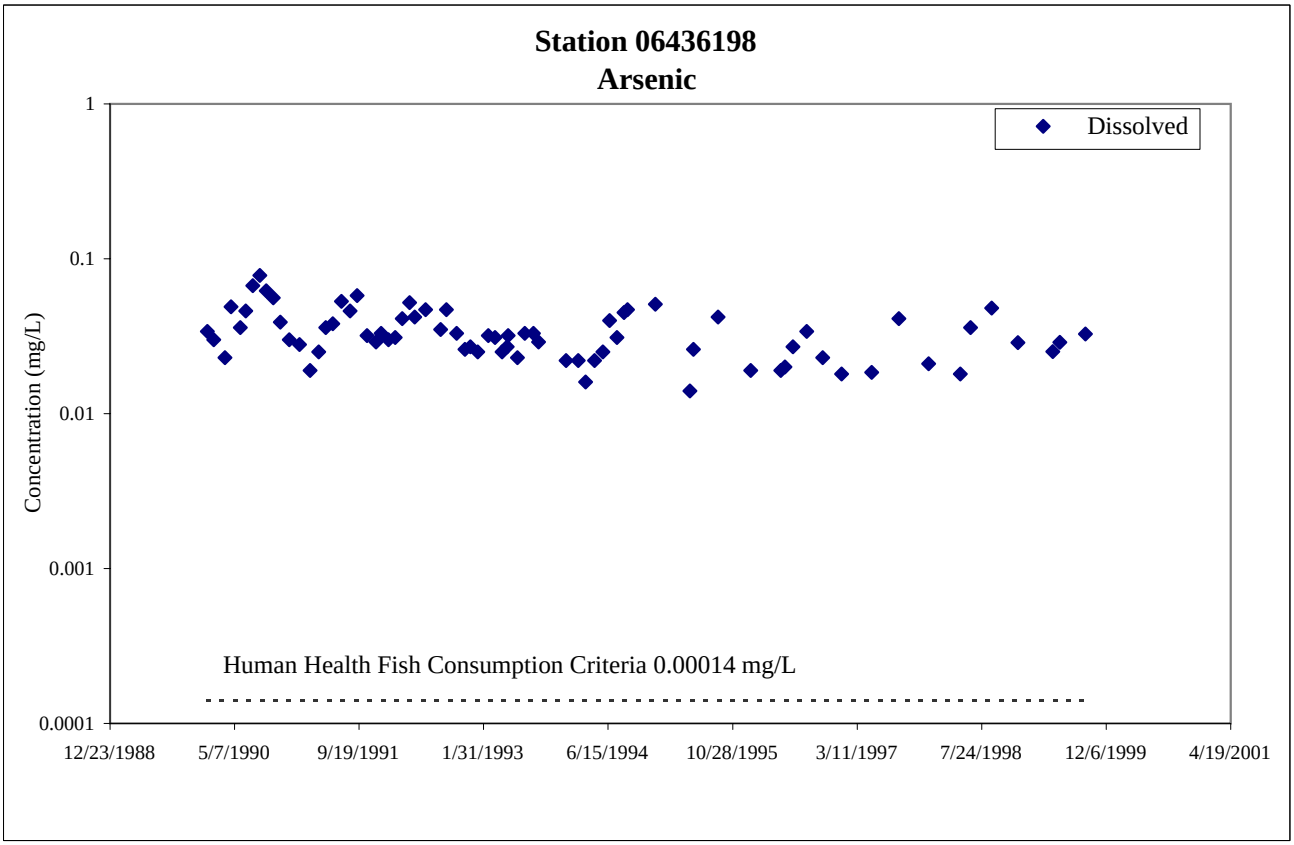
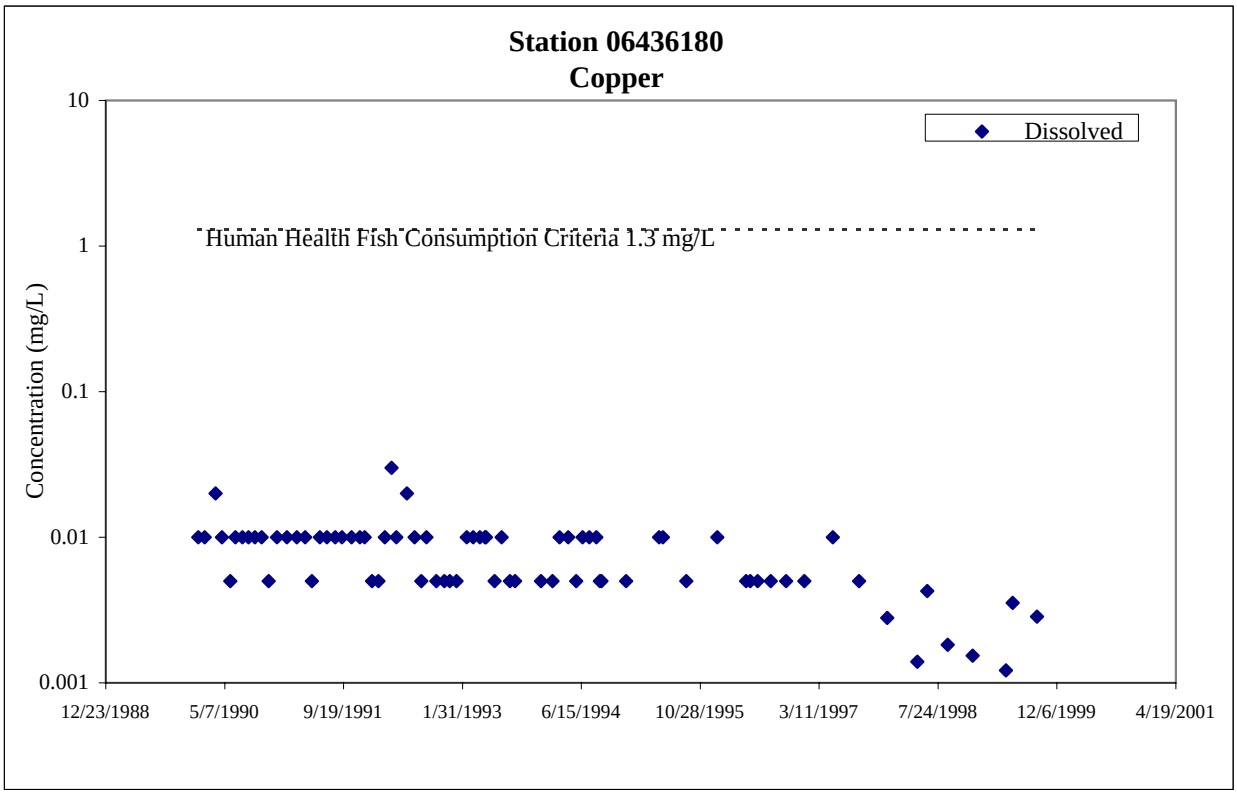


Figure 5-3
Comparison of Time Trend Plots for Copper in Surface Water with Fish Consumption Criteria



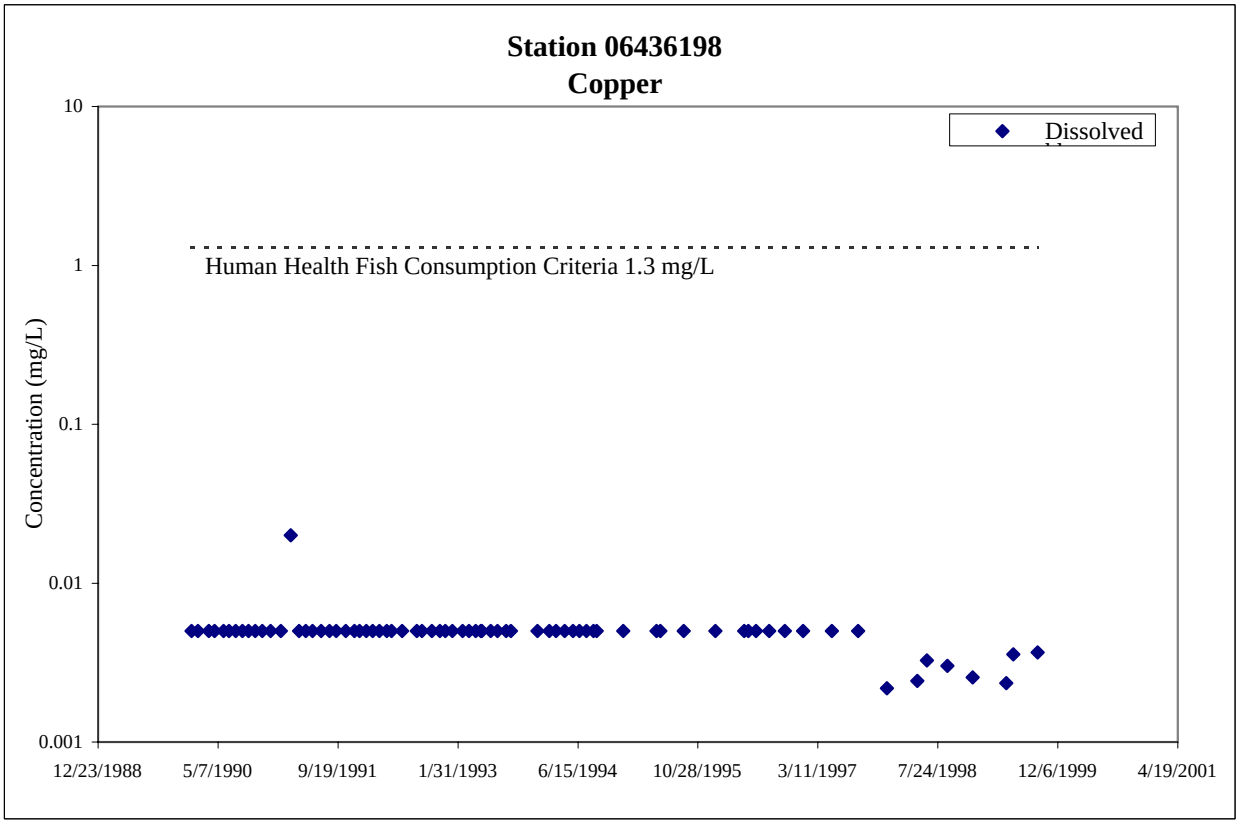
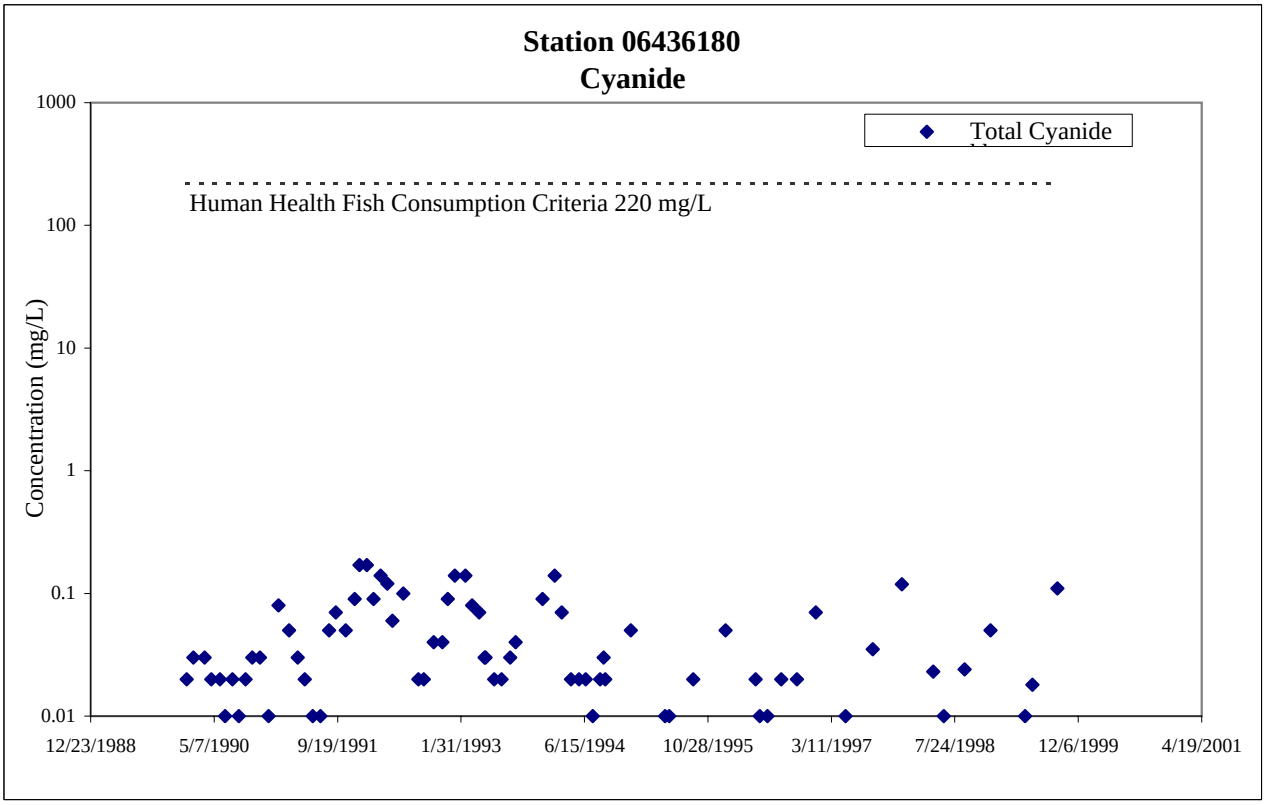


Figure 5-3
Comparison of Time Trend Plots for Cyanide in Surface Water with Fish Consumption Criteria



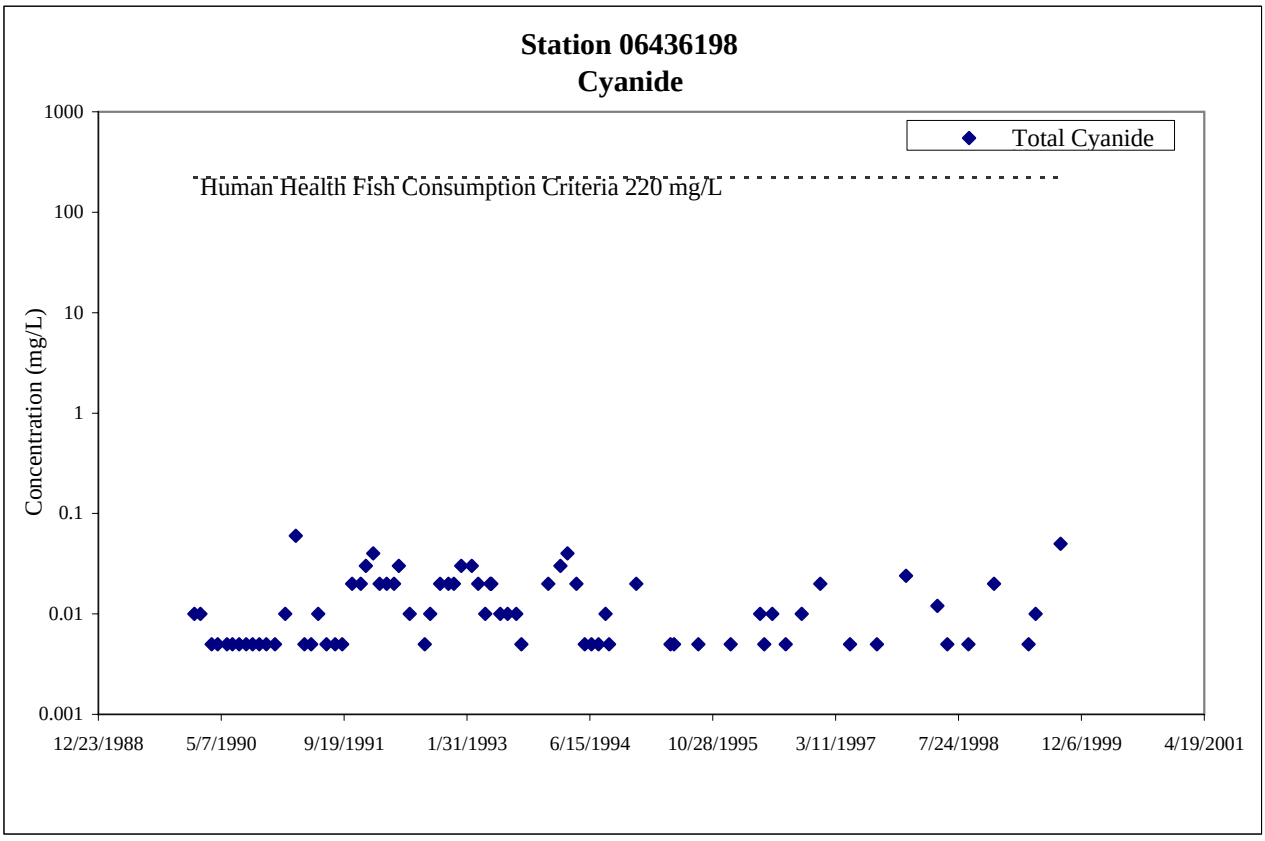
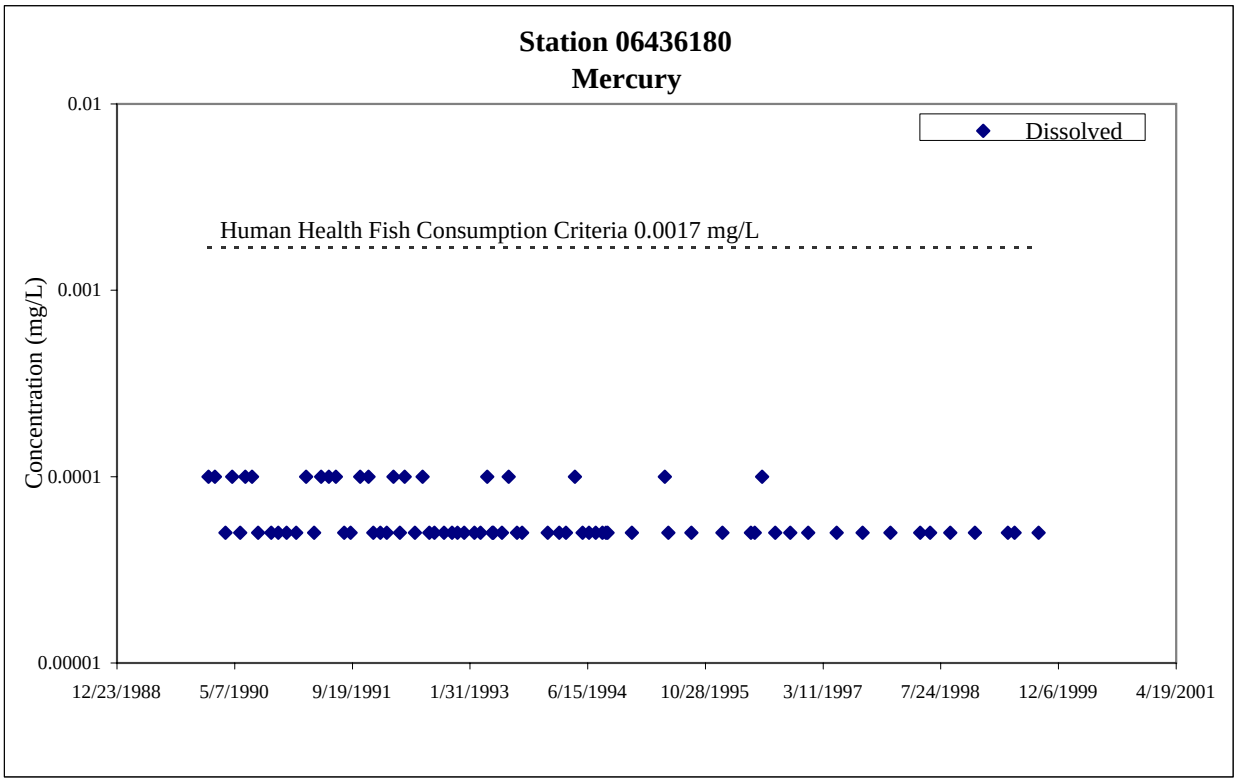


Figure 5-3
Comparison of Time Trend Plots for Mercury in Surface Water with Fish Consumption Criteria



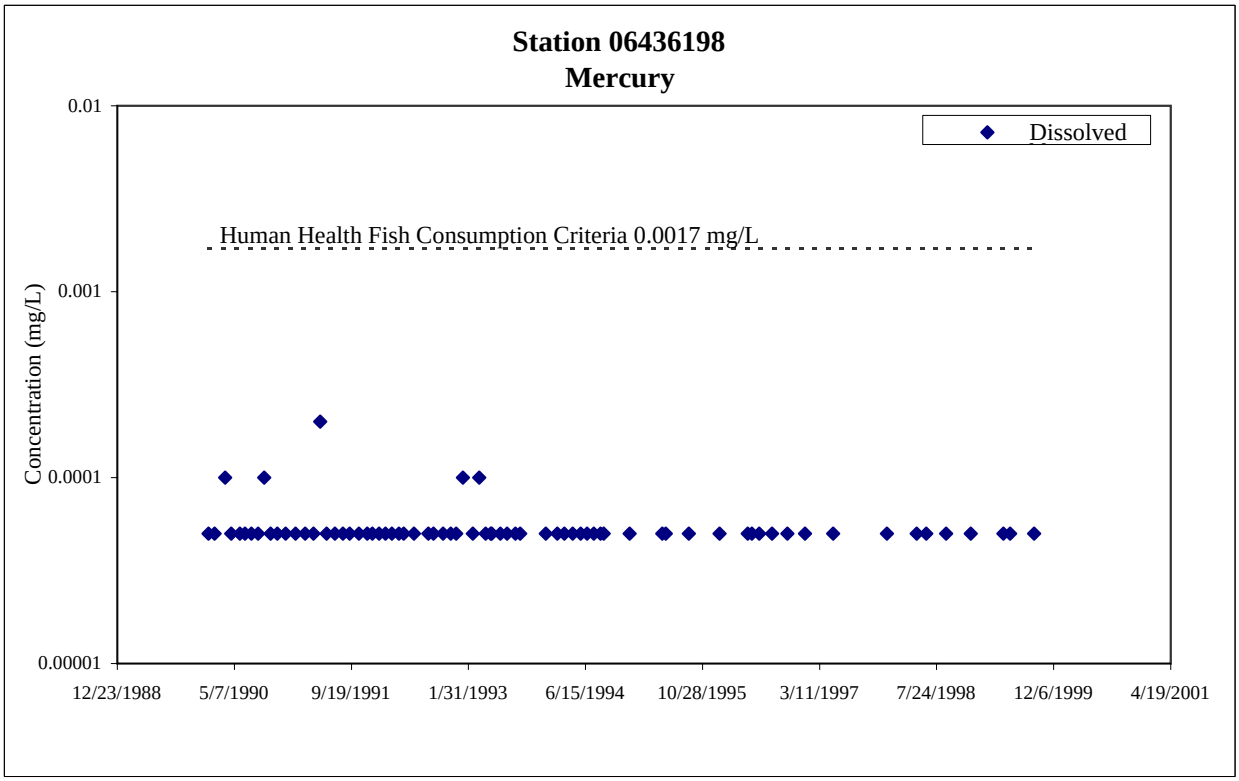
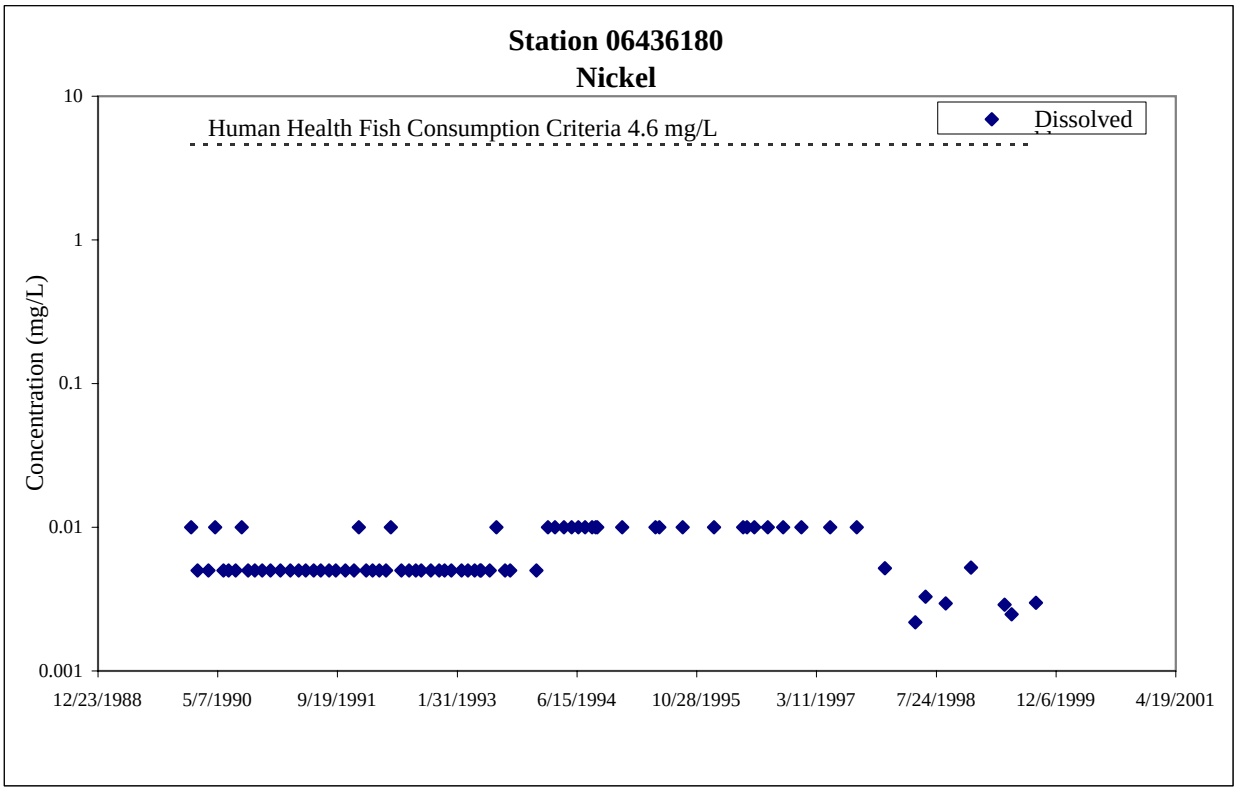


Figure 5-3
Comparison of Time Trend Plots for Nickel in Surface Water with Fish Consumption Criteria



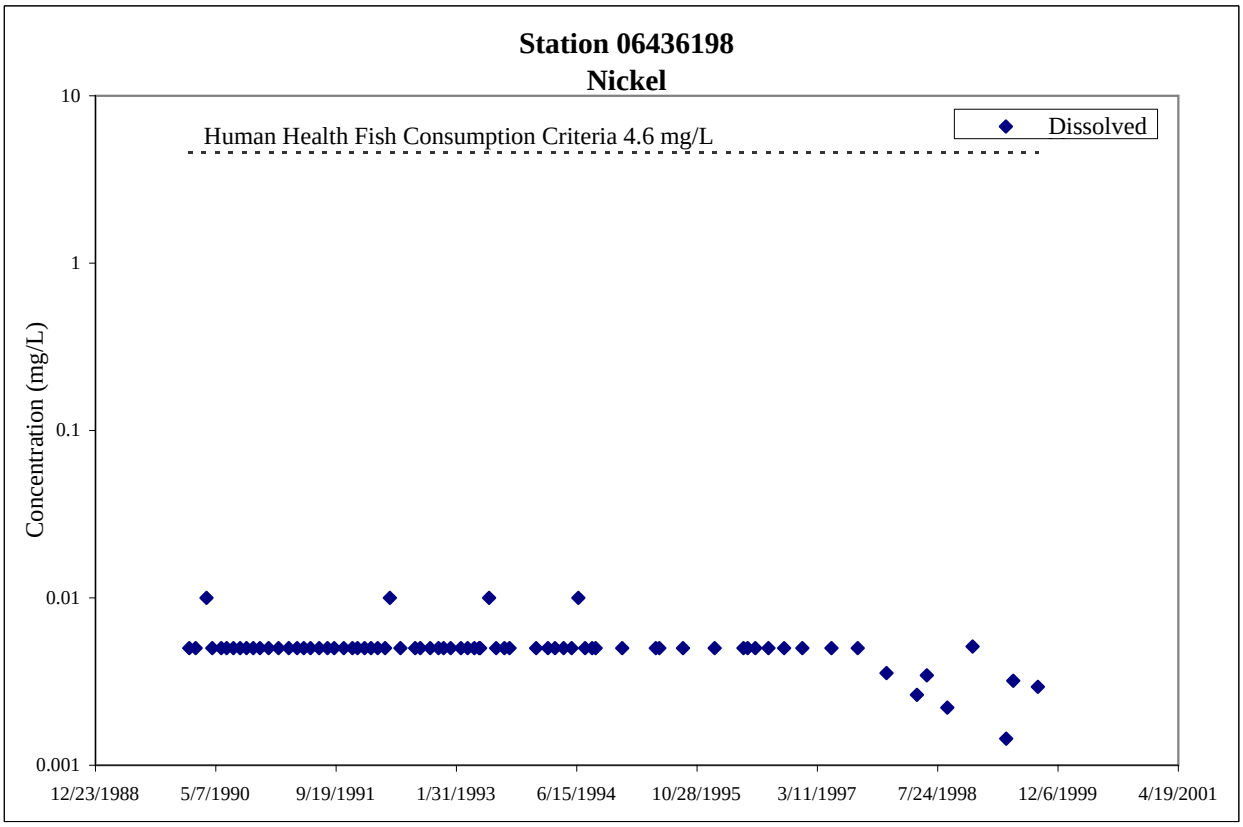
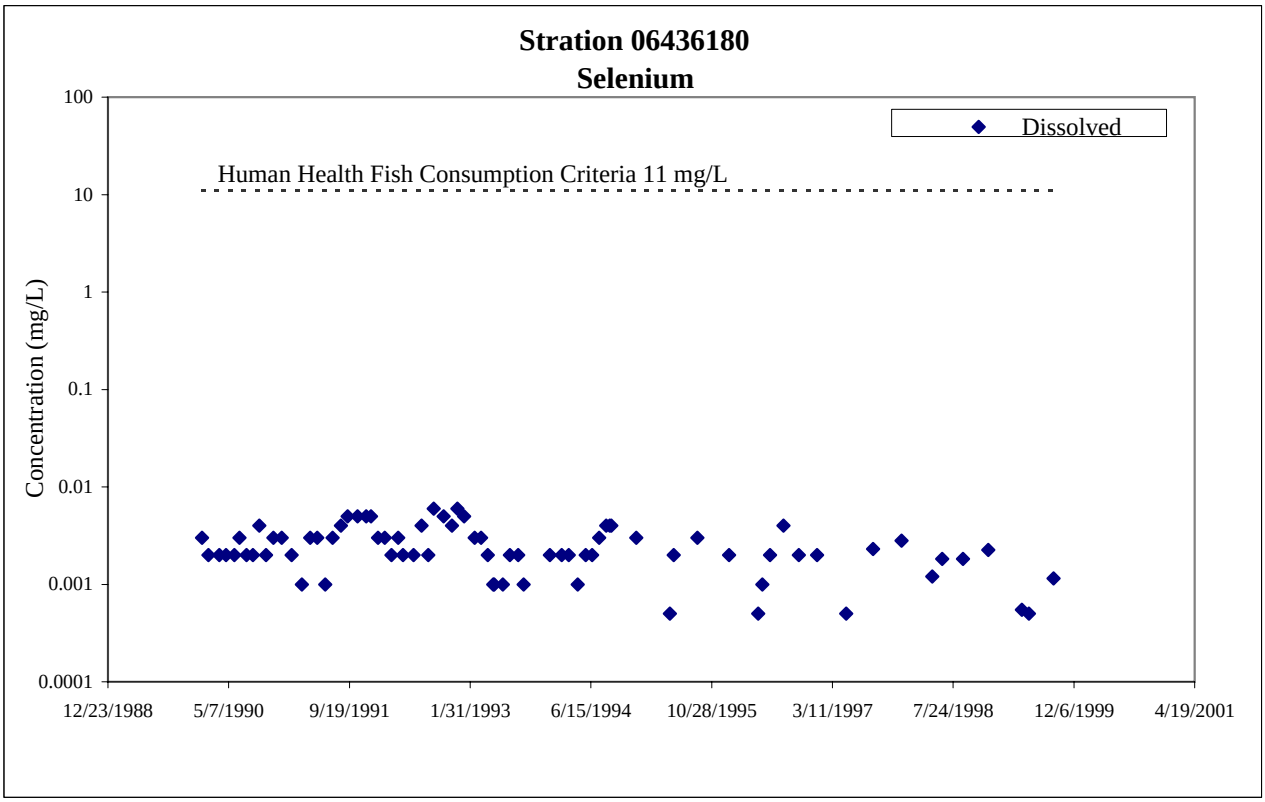


Figure 5-3
Comparison of Time Trend Plots for Selenium in Surface Water with Fish Consumption Criteria



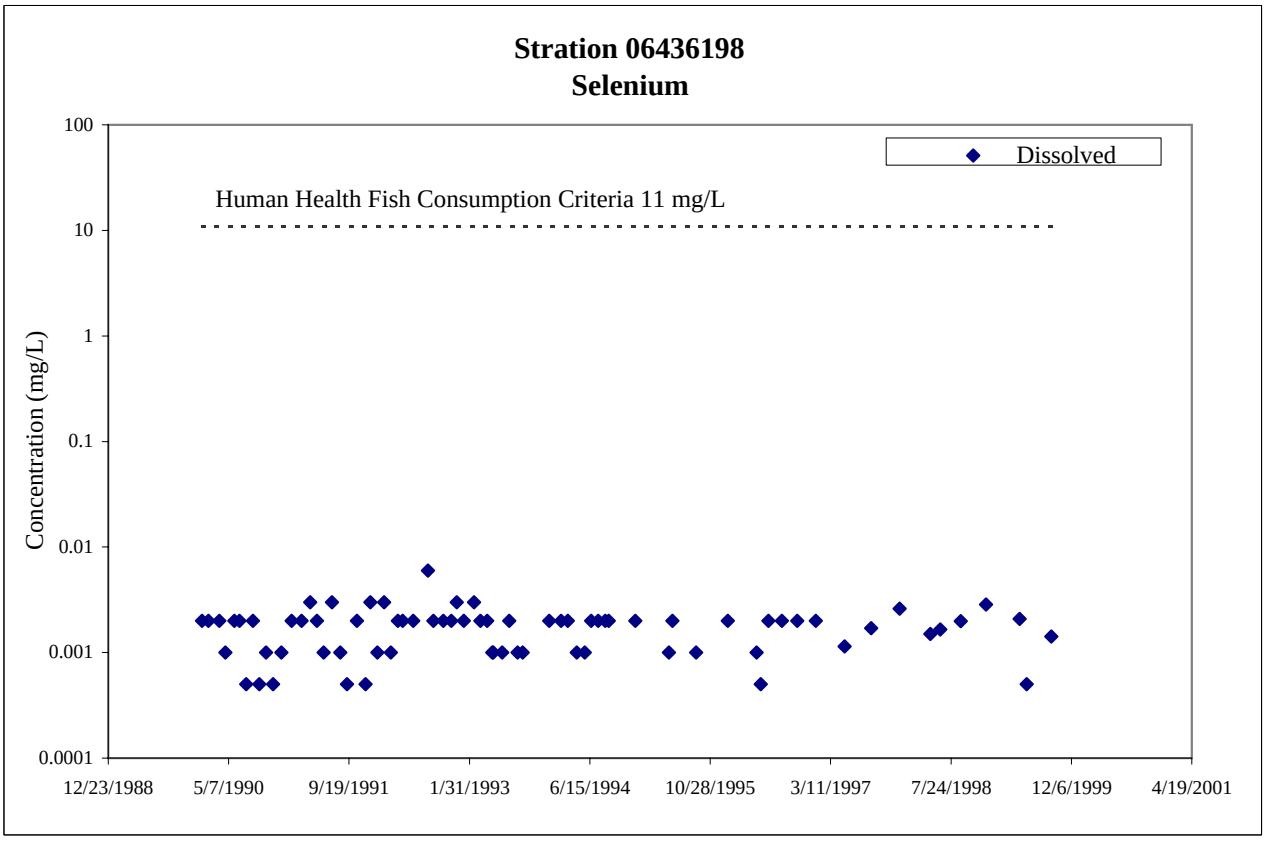


Figure 5-3
Comparison of Time Trend Plots for Zinc in Surface Water with Fish Consumption Criteria