# Third Five-Year Review Report

## Homestake Mining Company Superfund Site
## (EPA ID: NMD007860935)
## Cibola County, New Mexico


**September 2011**

**Region 6**
**United States Environmental Protection Agency**
**Dallas, Texas**

643151

**CONCURRENCES**

**Third Five-Year Review**

**For the**

**Homestake Mining Company Site**

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## List of Abbreviations and Acronyms

| | |
|---|---|
| amsl | above mean sea level |
| ARAR | applicable or relevant and appropriate requirement |
| CAP | Corrective Action Plan |
| CD | Consent Decree |
| CENWK | U.S. Army Corps of Engineers, Kansas City District |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| Cm | Centimeters |
| COC | chemical of concern |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ft | Feet |
| FYR | Five-year Review |
| HMC | Homestake Mining Company |
| IC | Institutional Control |
| IRIS | Integrated Risk Information System |
| MCL | Maximum Contaminant Level |
| mg/L | Milligram Per Liter |
| NCP | National Contingency Plan |
| NMED | New Mexico Environment Department |
| NMEID | New Mexico Environment Improvement Division |
| NPL | National Priorities List |
| NRC | Nuclear Regulatory Commission |
| O&M | Operation and Maintenance |
| OU | Operable Unit |
| pCi/L | Picocurie Per Liter |
| POC | Point-of-Compliance |
| PRG | Preliminary Remediation Goal |
| RAGS | Risk Assessment Guidance for Superfund |
| RAO | Remedial Action Objective |
| RfC | Reference Concentration |
| RfD | Reference Dose |
| RI | Remedial Investigation |
| RO | Reverse Osmosis |
| ROD | Record of Decision |
| RPM | Remedial Project Manager |
| SARA | Superfund Amendments and Reauthorization Act |

| | |
|---|---|
| Site | Homestake Mining Company Superfund Site |
| tpd | Tons Per Day |

## Executive Summary

This is the third five-year review (FYR) for the Homestake Mining Company (HMC) Superfund Site (Site). The Site is located in Cibola County, approximately 5.5 miles north of the Village of Milan in Cibola County, New Mexico. The Site includes the former uranium mill [Operable Unit 2 (OU2) or facility] and those portions of the underlying groundwater aquifers that have been contaminated from waste byproduct materials (tailings) disposed of at the mill site OU1), as well as contamination in the neighboring subdivisions (OU3). The Site location is shown on **Exhibit 1**.

The uranium mill was built in 1958 in a remote ranch-land area. It was operated by HMC through a variety of partnerships and joint venture associations until 1990. Two milling facilities were constructed and operated as two distinct partnerships, with HMC acting as the managing partner of both. The larger of the two mills was organized as Homestake-Sapin Partners, and had a nominal milling capacity of 1,750 tons per day (tpd). The smaller of the two mills was organized as Homestake-New Mexico Partners and had a nominal milling capacity of 1,650 tpd. Both mills used alkaline leach-caustic precipitation processes for concentrating uranium oxide from ores. Tailings from the mill operations, entrained in solutions from the milling process, were placed into lagoons on the top of two disposal piles at the site. These piles were closed and covered by interim covers upon closure of the mill. Windblown materials from the tailings piles were scraped from surrounding areas and placed on the piles before covering. The mill was decommissioned and demolished between 1993 and 1995 and the debris was buried at the former mill site. The mill reclamation work was required under the U.S. Nuclear Regulatory Commission (NRC) Source Materials License No. SUA-1471 (License SUA-1471).

The facility is currently inactive with the exception of ongoing remediation and monitoring activities which were implemented in 1977. Remediation continues with two tailings piles, a groundwater extraction and injection system, a reverse osmosis (RO) water treatment facility, two lined collection ponds, three lined evaporation ponds for disposal of contaminated groundwater, and associated equipment and structures. The large tailings pile covers an area of approximately 170 acres and is 85 to 100 feet high, containing an estimated 21 million tons of tailings. The cover was constructed of natural soils and coarse and fine fraction slurried mill tailings. The small tailings pile cover, constructed entirely of natural soils, encompasses an area of approximately 40 acres and is 25 feet high. It contains approximately 1.2 million tons of tailings. Seepage from the two tailings piles has resulted in contamination of the underlying groundwater aquifers. Groundwater contaminants include both radioactive and non-radioactive constituents, including uranium, thorium-230, radium-226, radium-228, selenium, vanadium, molybdenum, sulfate, chloride, nitrate and total dissolved solids. Soil contaminants include radium-226. Airborne contaminants include radon-222.

The area surrounding the former mill facility is used for residential, agricultural, and commercial purposes. Large areas north and west of the former mill are largely unused except for grazing. In the 1960s and 1970s several residential subdivisions were developed in the vicinity of the mill. Currently, five subdivisions, Broadview Acres, Felice Acres, Murray Acres, Pleasant Valley Estates, and Valle Verde, are located within two miles south and southwest of the facility.

In a mid-1970s study of the uranium industry, the state of New Mexico and EPA detected elevated selenium levels in domestic water in one of the subdivisions. A more comprehensive groundwater sampling program undertaken by HMC did not definitively identify the source of the selenium. However, without regard to the source(s) of the selenium, HMC began supplying bottled drinking water to any of the subdivision residents requesting it.

The Site remediation activities have been divided into three distinct phases or operable units (OUs). The first operable unit (OU1) is the restoration of ground water that is contaminated by tailings seepage. The second operable unit (OU2) consists of the long-term stabilization of the tailings, surface reclamation, and decommissioning and closure of the mill. The third operable unit (OU3) addresses indoor and outdoor radon concentrations in residential areas adjacent to the mill site.

HMC implemented OU1 remedial activities in 1977 by operating a state-approved groundwater collection and injection system at the Site. Using this system, fresh water is injected into three separate aquifers (Middle and Upper Chinle Formation and Alluvial aquifers) at wells located at or within the boundary of the facility to reverse the natural flow of groundwater back toward the groundwater collection wells. The water is injected at a rate of 400 to 600 gallons per minute (gpm) to build a hydraulic barrier between the contaminated zone on the facility and the residential areas. The collected groundwater is then piped either to the RO treatment plant for treatment and subsequent re-injection into the aquifer or to one of three lined evaporation ponds for disposal. This system has undergone several operating adjustments since it was first constructed, including the installation of additional groundwater injection and collection wells and a series of toe drains within the large tailings pile to dewater the tailings. Over three billion gallons of contaminated groundwater have been recovered by the collection wells, tailings wells and the toe drains since 1977 (**Table 4**).

The groundwater restoration program is being implemented under License SUA-1471, a Groundwater Corrective Action Program (CAP), and New Mexico Environment Department (NMED) groundwater discharge plans DP-200 and DP-725. DP-200 includes the requirements for groundwater corrective action, while DP-725 specifically addresses discharge of contaminated groundwater to the evaporation ponds. Groundwater cleanup standards are established by both NRC (License SUA-1471) and NMED (DP-200). HMC is also implementing a secondary groundwater collection and irrigation system to remediate those portions of the contaminant plumes which have migrated beyond the facility's licensed boundary. This secondary system is not currently a required part of the CAP or DP-200. However, it is being incorporated by HMC into a revised CAP to be submitted to NRC for approval. It is also being incorporated into DP-200 as part of a renewal process and is currently under review by NMED. It is estimated that some components of the CAP will be necessary through 2017; however, the actual duration and the components of the CAP that will be necessary will be dependent upon future system performance (MFG, 2006).

In 1981 the U.S. Environmental Protection Agency (EPA) proposed the Site for inclusion on the National Priorities List (NPL). In 1983 the Site was placed on the NPL because of potential radon emissions from the tailings piles. Further investigations at the Site identified groundwater

contamination in on-site monitoring wells and some residential wells. As a result, in 1983 an agreement was signed by EPA and HMC which required HMC to provide for an extension of the Village of Milan municipal water system to the affected residents who were then living in four residential subdivisions located south and southwest of the facility. The agreement also required HMC to pay for those residents' use of the water supply for 10 years. The connection of the subdivisions' residences to the Village of Milan's water supply was completed in 1985. HMC paid for the residents' water use until 1994 and met the terms of the agreement.

In September 2005 NMED and EPA conducted a well survey in the subdivisions located south and southwest of the Site to verify that no residents were consuming contaminated well water. During the survey samples were collected from 34 private drinking water wells. In November 2005 EPA Region 6 contacted the Agency for Toxic Substances and Disease Registry (ATSDR) requesting that they review the results and determine whether a public health hazard exists.

EPA and NMED performed additional sampling in 2006 and 2007. Sampling identified several well owners with selenium and uranium levels above the Maximum Contaminant Level (MCL). Some of these owners were using the Village of Milan water supply while others were still using their private well(s). ATSDR recommended that owners using the wells as a source of potable water and having concentrations above the MCL obtain another source of potable water. They further recommended that owners with connections to the Village of Milan water supply continue to use this source of water to prevent exposure to elevated levels of uranium and selenium in the alluvial and Chinle aquifers. ATSDR calculated exposure doses for the contaminants above MCLs from 2005 through 2007 sample results and determined that contaminant concentrations within those wells being used as a source of potable water were not at levels that would produce known adverse health effects. ATSDR categorized groundwater in the private wells, not connected to the Village of Milan water supply, as "a no apparent public health hazard." They define the "no apparent public health hazard" category as those sites where exposure to site-related chemicals might have occurred in the past or is still occurring, but the exposures are not at levels likely to cause adverse health effects (ATSDR, 2009).

Since the last FYR, HMC financed the hook-up of additional residential properties to the Village of Milan water system and NMED issued a health advisory to minimize the possibility of new wells being installed within the area of contamination. Although the health advisory was issued, residents have the option to use contaminated groundwater for irrigation purposes and for watering livestock.

The state of New Mexico's standard for uranium in groundwater was changed in June 2007 from 5,000 parts per billion (ppb) to 30 ppb. EPA's MCL for uranium is 30 ppb and has remained unchanged since 2000.

OU2 remedial activities involve the stabilization of the tailings piles, surface reclamation, and decommissioning of the mill. The soil contaminated by windblown tailings was excavated and disposed of in the large tailings pile. Beginning in 1993, the mill facility was decontaminated, demolished, and parts were either buried in place or placed in the large tailings pile. A radon barrier and erosion-protection cover were constructed on the sides of the large tailings pile, and

an interim soil cover was constructed on its top and on the small tailings pile. A final radon barrier will be constructed on top of the large pile after the tailings are dewatered. A final radon barrier will also be constructed on the small tailings pile once the groundwater restoration is completed, and the remaining facilities are dismantled and disposed of properly. Following reclamation and closure activities at the Site, NRC will terminate License SUA-1471 and the HMC property will be turned over to the U.S. Department of Energy (DOE) for long-term care in perpetuity. At that time, it is expected that all areas outside the portion of the HMC property that will be deeded to the DOE will be released by NRC for unrestricted use.

OU3 remedial activities addressed indoor and outdoor radon concentrations in subdivisions adjacent to the Site. Although the Record of Decision (ROD) for OU3, signed in September 1989, called for no further action, the NRC license condition requires HMC to monitor outdoor radon and windblown particulate levels south of the disposal area to assure that conditions in the subdivisions do not significantly change prior to final site closure. Therefore, EPA continues to review outdoor radon monitoring and particulates data collected at the facility boundary.

In December 1993 a Memorandum of Understanding (MOU) was signed by NRC and EPA designating NRC as the lead federal agency for all remedial and reclamation activities at OU1 and OU2 (covered by License SUA-1471). Under the MOU, EPA was to monitor remedial and reclamation activities required by NRC in the Corrective Action Plan (CAP) and provide reviews and comments directly to NRC. EPA was also responsible for assuring that the activities conducted under NRC's regulatory authority allow attainment of applicable or relevant and appropriate requirements (ARARs) under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended.

Since remedial activities began in 1977 monitoring results have shown that contaminants have been removed from the various aquifers. The large mass of contaminants removed demonstrate the effectiveness of the groundwater collection/injection system in moving portions of the contaminant plumes back toward the collection wells and, hence, preventing the further migration of contamination.

The remedy, exclusive of OU3 at the Homestake Mining Company Site, is protective of human health and the environment through the combined effects of HMC's ongoing groundwater remedial action with associated groundwater monitoring, and the dissemination of a health advisory through the State's well permitting process, which advises prospective well owners of the potential existence of groundwater exceeding drinking water standards..

Based on current information, the remedy at OU1 is protective of human health and the environment through the use of a groundwater collection and injection system at the Site and the issuance of a health advisory which is designed to limit the primary exposure pathway of ingestion. There is no evidence of current exposure from any media at this time.

Based on current information, the remedy at OU 2 is protective of human health and the environment due to the stabilization of the tailings piles, surface reclamation, and decommissioning of the mill. Soil contaminated by windblown tailings was excavated and

disposed of in the large tailings pile. The mill facility was decontaminated, demolished, and parts were either buried in place or placed in the large tailings pile. A radon barrier and erosion-protection cover were constructed on the sides of the large tailings pile, and an interim soil cover was constructed on its top and on the small tailings pile.

Even though the OU3 ROD called for no further action, the NRC license requires HMC to monitor outdoor radon and windblown particulate levels south of the disposal area to ensure that conditions in the subdivisions remain protective until final site closure. Therefore, EPA continues to review outdoor radon monitoring and particulates data collected at the facility boundary. Based on community concerns, in September 2010, EPA began collecting sample data to support the development of a Human Health Risk Assessment, to include indoor and outdoor radon samples. The sample collection will continue on a quarterly basis until November 2011. A final Human Health Risk Assessment is expected in spring 2012 which will provide information needed to support a determination of the protectiveness of the OU3 remedy. The determination of protectiveness for OU3 is, therefore, deferred until the Human Health Risk Assessment is completed.

Five-Year Review Summary Form

| ***SITE IDENTIFICATION*** | | |
|---|---|---|
| **Site name *(from WasteLAN)*:** Homestake Mining Company Superfund Site | | |
| **EPA ID *(from WasteLAN)*:** NMD0077860935 | | |
| **Region:** 6 | **State:** NM | **City/County:** Grants/Cibola County |
| ***SITE STATUS*** | | |
| **NPL status:** √ Final □ Deleted □ Other (specify) | | |
| **Remediation status** (choose all that apply): □ Under Construction √ Operating □ Complete | | |
| **Multiple OUs?** √ YES □ NO | **Construction completion date:** NA | |
| **Has Site been put into reuse?** □ YES √ NO | | |
| ***REVIEW STATUS*** | | |
| **Lead agency:** √ EPA □ State □ Tribe □ Other Federal Agency _____ | | |
| **Author name:** Sai Appaji/EPA Region 6 supported by the U.S. Army Corps of Engineers, Kansas City District | | |
| **Author title:** Remedial Project Manager | **Author affiliation:** U.S. EPA Region 6 | |
| **Review period:** November 2010 through June 2011 | | |
| **Date(s) of site inspection:** 01/18/2011 | | |
| **Type of review:** □ Statutory<br>√ Policy<br>√ Post-SARA □ Pre-SARA □ NPL-Removal only<br>□ Non-NPL Remedial Action Site □ NPL State/Tribe-lead<br>□ Regional Discretion | | |
| **Review number:** □ 1 (first) □ 2 (second) √ 3 (third) □ Other (specify) _____ | | |
| **Triggering action:**<br>□ Actual RA Onsite Construction at OU #____<br>□ Actual RA Start<br>□ Construction Completion (of first interim response action [installation of two aerators at WDMWW in 11/04])<br>√ Previous Five-Year Review Report<br>□ Other (specify) | | |
| **Triggering action date *(from WasteLAN)*:** 09/26/2006 | | |
| **Due date *(five years after triggering action date)*:** 09/26/2011 | | |

**Issues:** The following issues were identified during the FYR. These issues are identified in Section 8.0 and **Table 1** (Issues) of the FYR Report, as is presented below.

Operable Unit 1

- Extraction of large quantities of water from the San Andres Formation and subsequent injection, primarily into the alluvial aquifer, has created localized areas with an artificial head difference of approximately 100 ft that, combined with the presence of faults and associated fracturing in the bedrock, increases the risk of downward migration of contaminants. In addition, significant geochemical differences between the injected San Andres water and receiving alluvial water may cause reduction of permeability over time as minerals precipitate in the mixing zone.

- The tailings flushing program is expected to continue until 2014 before reaching the uranium cleanup target concentration of 2 mg/l in the leachate. However, the potential for rebound of contaminant concentrations conditions are unknown in the tailings flushing program. The flushing program likely is also decreasing the stability of the large tailings pile due to the increased saturation of the pore spaces. The earthquake stability analysis assumed unsaturated tailings and did not account for the increased percentage of fluid-filled pore space resulting from the tailings flushing program.

Operable Unit 2

- A persistent plume of elevated uranium contamination just south of the former mill site likely a remnant of the large tailings pile may continue to impact groundwater. In addition, an historic irrigation ditch, established in the 1920s, that ran through the future Homestake Mill property (**Exhibit 2**), and presumably was backfilled to original grade during construction of the mill, may be serving as a preferential pathway for leached contaminants to groundwater (Gordon, 1961).

- The east side slope of the small tailings pile/Evaporation Pond 1 had moderate to large furrows and the west side of the westernmost collection pond had moderate furrows, both of which appeared to be the result of rainfall/erosion.

Operable Unit 3

- Annual air monitoring reports in 2006 – 2010 indicate releases of radon outside the area covered by the NRC license, in concentrations exceeding EPA standards.

- The 2006 - 2010 annual air monitoring report indicates that releases of radon exceeded the annual average concentrations allowed under 40 CFR 192.02(b)(2).

- Radon air monitors along the Homestake fenceline have continuously recorded outdoor ambient air radon concentrations associated with cancer risk levels that are greater than EPA's acceptable cancer risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, as published in the National Contingency Plan.

**Recommendations and Follow-up Actions:** The Site Manager should work with EPA to ensure that the issues identified above are addressed in the following manner. These recommendations and follow-up action are also identified in Section 9.0 and **Table 2** (Recommendations and Follow-Up Actions).

Operable Unit 1

- Minimize use of clean water and develop alternate source such as treatment of extracted groundwater for use in injection into the alluvial and Chinle Formation aquifers remedy.

- Conduct a pilot study in a portion of the large tailings pile to quantify possible contaminant concentration rebound effects and demonstrate that rebound will not occur once the flushing program has ended. The earthquake stability analysis should be reevaluated to account for the increased fluid-filled pore space resulting from the relatively recent tailings flushing program. The protectiveness is dependent on a revised earthquake-risk analysis.

Operable Unit 2

- Determine whether a remnant of the large tailings pile contaminant plume is continuing to impact groundwater. Investigate the backfilled irrigation ditch that ran through the HMC property to determine whether it serves as a preferential pathway for the migration of leached contaminants to groundwater.

- Provide some type of native vegetative cover or erosion-protection cover to the east side slope of the small tailings pile/Evaporation Pond 1 and the west side of the westernmost collection pond to prevent erosion.

Operable Unit 3

- EPA is currently in the process of completing a radon survey and a determination of the radon source (if possible), and specific recommendations will be made upon completion of the survey. This information will be incorporated into human health risk assessment in the spring of 2012.

**Protectiveness Statement(s):** The remedy, exclusive of OU3 at the Homestake Mining Company Site, is protective of human health and the environment through the combined effects of HMC's ongoing ground water remedial action with associated ground water monitoring, and the dissemination of a health advisory through the State's well permitting process, which advises prospective well owners of the potential existence of ground water exceeding drinking water standards.

Based on current information, the remedy at OU1 is protective of human health and the environment through the use of a groundwater collection and injection system at the Site and the use of a health advisory. The health advisory informs current and future residents of potential risks of drinking water standard exceedances in the use of water from private wells and minimizes the possibility of new wells being installed within the area of contamination thus limiting the primary exposure pathway of ingestion. There is no evidence of current exposure from any media at this time.

Based on current information, the remedy at OU 2 is protective of human health and the environment due to the stabilization of the tailings piles, surface reclamation, and decommissioning of the mill. Soil contaminated by windblown tailings was excavated and disposed of in the large tailings pile and the mill facility was decontaminated, demolished, and parts were either buried in place or placed in the large tailings pile. A radon barrier and erosion-protection cover were constructed on the sides of the large tailings pile, and an interim soil cover was constructed on its top and on the small tailings pile.***

Even though the OU3 ROD called for no further action, EPA recognized the need to monitor outdoor radon and windblown particulate levels south of the disposal area to ensure that conditions in the subdivisions remain protective until final site closure. Therefore, EPA continues to review outdoor radon monitoring and particulates data collected at the facility boundary. Also, in September 2010, EPA began collecting sample data to support the development of a Human Health Risk Assessment, to include indoor and outdoor radon samples. The sample collection will continue on a quarterly basis until November 2011. A final Human Health Risk Assessment is expected in spring 2012 which will provide information needed to support a determination of the protectiveness of the OU3 remedy. The determination of protectiveness for OU3 is, therefore, deferred until the Human Health Risk Assessment is completed.

**Other Comment(s):** The annual reports present large amounts of information collected from the hundreds of monitoring/injection/extraction wells during the previous year. In a hydrogeologic setting as complicated as that encountered at the Site, cross-sections through the various contaminant plumes and aquifers should be included in these reports, along with an analysis of the data depicted.

The cross-section included in many site documents (see **Exhibit 6**), does not seem geologically plausible since it depicts a very steeply-dipping monocline that is not supported by other geologic information.

Overall the Site appears to be well maintained, and the operators are effectively implementing and maintaining the system as designed and installed. The various parties involved with the site cleanup are NRC, NMED, Homestake, and EPA.

# 1.0 **Introduction**

The purpose of the five-year review (FYR) is to evaluate the implementation and performance of the remedy to determine whether the remedy is protective of human health and the environment, and functions as intended based on the decision documents. Furthermore, the five-year review assesses whether the remedy will continue to be protective in the future. It determines whether the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs), used at the time of the remedy selection are still valid and whether any other information has come to light that could call into question the protectiveness of the remedy.

The U.S. Environmental Protection Agency (EPA) is preparing this FYR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 121(c) and the National Contingency Plan (NCP). CERCLA § 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. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

In the NCP implementing regulations, Code of Federal Regulations (CFR) 40 CFR § 300.430(f)(4)(ii), EPA provided the following interpretation:

> *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.*

EPA Region 6 has conducted a FYR of the remedial actions implemented at the Homestake Mining Company (HMC) Superfund Site (Site) in Cibola County, New Mexico. This review was conducted from November 2010 through June 2011. This report documents the results of that review.

This is the third FYR for the Site. The Site consists of three project areas called operable units (OUs). OU1 is identified as tailings seepage contamination of groundwater aquifers; OU2 is identified as long-term tailings stabilization, surface reclamation, and site closure; and OU3 is identified as radon concentrations in the neighboring subdivisions (EPA, 1989). All remedial actions at the Site are being undertaken by HMC. The triggering action for this policy review is the signature date of the previous FYR Report which was signed on September 26, 2006. The FYR is required because the remedial actions to remove hazardous substances, pollutants, or

contaminants to levels that will allow for unlimited use and unrestricted exposure, will require five or more years to complete.

OU1 remedial activities are being conducted in accordance with a groundwater restoration program under License SUA-1471, a groundwater CAP, and NMED groundwater discharge plans DP-200 and DP-725.

OU2 remedial activities are being addressed by the Nuclear Regulatory Commission (NRC) under mill tailings regulations in 10 Code of Federal Regulations (CFR) 40, Appendix A (*Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material from Ores Processes Primarily for Their Source Material Content*). According to these regulations, NRC will require HMC to submit a final reclamation plan for NRC approval, and upon HMC's decision to terminate its operations, to implement the plan for the tailings disposal area which meets the technical requirements of 10 CFR 40, Appendix A, as amended, which conform with EPA standards in 40 CFR 192.

The OU3 ROD was signed on September 27, 1989. Even though the selected remedial action for OU3 was No Further Action and, therefore, there are no current RAOs under CERCLA, the decision formalized in the ROD did not constitute a finding by EPA that adequate protection had been achieved within the neighboring subdivisions. The ROD recommended radon reduction techniques to residents in the adjacent subdivisions having elevated indoor radon levels. This was based on results from the Remedial Investigation (RI) which found that eight of 66 residences investigated for radon (radon-222) had annual indoor radon concentrations exceeding the 4 picocurie per liter (pCi/L) action level guideline (between 4.1 pCi/L and 6.7 pCi/L). These observations indicated that uranium and radium levels in surface soils collected beneath or adjacent to homes with elevated indoor radon concentrations were indicative of background levels and provided no evidence that tailings were significant in the soil in the vicinity of the residences. In view of these findings, it was concluded that the primary source of indoor radon in homes in the subdivisions is local soil which emits radon gas.

As a result of these findings, EPA continues to review outdoor radon monitoring and particulates data collected at the facility boundary. Under 10 CFR 20 (*Standards for Protection Against Radiation*) the concentration of radon-222 is limited to 3 pCi/L above background at HMC's property boundary. In December 1993 a Memorandum of Understanding (MOU) was signed by NRC and EPA designating NRC as the lead federal agency for all remedial and reclamation activities at the facility (within the NRC Source Materials License SUA 1471 [License SUA-1471] boundary). Under the MOU, EPA is to monitor all remedial and reclamation activities and provide reviews and comments directly to NRC. EPA is also responsible for assuring that the activities conducted under NRC's regulatory authority allow attainment of applicable or relevant and appropriate requirements (ARARs) under CERCLA, as amended.

In September of 2010 EPA began collecting sample data to support the development of a Human Health Risk Assessment, to include indoor and outdoor radon samples. Sample collection will continue on a quarterly basis until November 2011. A final Human Health Risk Assessment is

expected in spring of 2012. A determination of the protectiveness of the OU3 remedy will be deferred until the Human Health Risk Assessment is completed.

## 2.0 Site Chronology

Significant events and/or milestones for the Site are presented in **Table 3**.

# 3.0 **Background**

## 3.1 **Physical Characteristics**

The Site is located approximately six miles north of Grants, New Mexico near the intersection of State Highway 605 and County Road 63 (**Exhibit 1**). Prior to development of the Grants Uranium Mining Belt in the 1950s, the area was sparsely settled, and agriculture (ranching, truck-farming) was the primary industry. A local irrigation district had been established, with one of three distribution ditches running through what would become the Homestake Mill property in 1958 (**Exhibit 2** [Figure 11 from Gordon, 1961]). The original mill property was confined to Section 26, Township 12 North, Range 10 West (Section 26-T12N-R10W), and was the only development within several miles other than the agricultural activities. The Anaconda Corporation had developed a uranium mill approximately five miles west of the Site a couple of years earlier. Within a few years following development of the uranium mills, the booming population led to the creation of a new town, Milan, northwest of Grants, and several residential subdivisions to the south and southwest of the HMC property. HMC has acquired additional property surrounding the original parcel over the years, but little additional development has occurred. The mill facility was decommissioned/demolished in the early 1990s. Currently, the facility includes a small office and maintenance complex, large and small tailings-disposal structures, a groundwater treatment building, and several engineered reservoirs related to the ongoing groundwater remediation project.

The Site lies at an elevation of approximately 6,500 feet above mean sea level within a geologically-complex zone known as the Jemez Lineament. This lineament is a major flaw in the earth's crust along which volcanoes have erupted for the past 16 million years, including flows as recent as a few thousand to several hundred years ago. Although these volcanic features are conspicuous in the region, they are not hydrogeologically important in the area of the Site. Prior to the geologically recent volcanic activity, the region was subject to deposition of thousands of feet of marine and continental sedimentary deposits from the Permian through Cretaceous Periods. At the conclusion of the Cretaceous, the Zuni Uplift to the southwest of the Site began slowly rising, eventually exposing its Precambrian core and resulting in extensive faulting and tilting of the surrounding sedimentary units. Finally, concurrent with the recent volcanic activity, the Ice Age of the past 2 to 3 million years resulted in alternating cycles of erosion and alluvial deposition, with alluvial thicknesses of up to 200+ feet. **Exhibit 3a** is a geologic map showing the Site location within an extensive complex of alluvial deposits, and **Exhibit 3b** contains the index for the various geologic units.

The Site lies above the alluvial aquifer at the confluence of the San Mateo Creek and Lobo Creek drainages (**Exhibit 3a-3b**). Although these watersheds drain over 300 square miles to the north and west of the Site, surface flow rarely occurs with the prevailing arid climate. However, during Pleistocene glacial advances, a wetter climate and much lower sea levels created conditions of perennial streams actively downcutting and eroding the local valleys. These former valleys are now buried, and the current streambeds are poorly defined and typically dry. The alluvial sediments consist of unconsolidated clay, silt, sand, and gravel that can exceed 100 feet in thickness in the area of the Site. Coarse-grained units within the saturated portion of the

alluvium have historically been used for water supplies. Below the alluvial deposits is the Triassic-age Chinle Formation, which is composed primarily of shale and siltstone, with three sandstone units that have been exploited for water supplies. The Chinle beds have been tilted up to ten degrees (generally to the northeast) and been extensively faulted in the Site area due to uplift of the Zuni Mountains southwest of the Site.

The climate of the area is arid to semi-arid, with an average of 10 to 12 inches of total annual precipitation, of which about half occurs during the summer monsoon season, which typically occurs July through September. Potential evapotranspiration exceeds precipitation in this high desert environment even during the monsoon season. The depth to groundwater in the Site area ranges from approximately 40 to 60 feet below ground surface. The natural groundwater flow in the alluvial aquifer is generally to the southwest, while flow direction in the bedrock aquifers is generally eastward (downdip) under natural conditions.

### 3.2 Land and Resource Use

In 1977 when groundwater remedial activities were initiated, the Site consisted of most of Section 26, the northwest part of Section 35, and the southeast part of Section 27-T12N-R10W (**Exhibit 4** [Figure 4 from 2006 MFG CAP]). Since that time, the OU1 Site has expanded to the south and west as the full extent of impact to groundwater in the alluvial aquifer was delineated (**Exhibits 9a-9b**). OU2 included decommissioning of the former mill facilities which were located in the northeast part of Section 26 and associated impacts to soils from operation of the mill. Impacted soils were removed from the mill site and areas to the north and east in the early 1990s (**Exhibit 5** [Figure 3-2 from 1995 soils report]). The impacted areas resulted from windblown dust that accumulated on the tailings piles and leachate from former ore storage areas.

Land use in the OU1/OU2 areas is currently primarily agricultural, with some low-density residential. The region has experienced the "boom and bust" of the Grants Uranium Mining Belt, and the nearby population decline is likely due to the general lack of activity in the industry since the 1990s. The only significant difference in land use since the previous FYR is the addition of Evaporation Pond No. 3 to the northwest of the large tailings pile (**Exhibit 5**). Future land use in the area of the Site is anticipated to be similar to current uses, although there is talk of a rebound in the uranium mining industry, which could create another local boom in the economy.

### 3.3 History of Contamination

Since the tailings piles were not constructed with engineered liners, they likely began leaking soon after milling operations began in 1958. The previous FYR reports state that groundwater contamination was first observed in 1961; however, the source of this information could not be corroborated. In the mid-1970s high levels of selenium were detected in residential wells completed in the alluvial aquifer, which prompted the beginning of groundwater remedial activities. In addition to the tailings pile sources, areas of soil contamination from the uranium ore storage and windblown tailings began occurring from the start of mill operations and

continued until the soil cleanup was completed as a part of the OU2 remedy. It is possible that leaching of soil contaminants left in place continue to impact groundwater, since the soil cleanup standard was based on human-health risk rather than potential for contaminants to leach to groundwater, and may explain the area of persistent groundwater contamination just south of the former mill site.

An important change in the remedial strategy occurred approximately ten years ago when the tailings-flushing program began. As designed, this flushing has resulted in considerable mobilization of contaminant mass that would not otherwise be occurring. Injection of "clean" groundwater into impacted alluvial and Chinle Formation aquifers has been a major part of the OU1 remedial strategy from the very beginning. This has been done to assist in hydraulic control of the contaminant plumes; however, it has also caused dilution of contaminant concentrations in samples from nearby monitoring wells, making it difficult to assess contaminant trends. Periodic movement and/or addition of injection lines over the years has added to the difficulty in assessing such trends.

### 3.4 Initial Response

The OU1 initial response was due to the detection of elevated levels of selenium in residential water-supply wells just southwest of the mill facility in 1976. The original groundwater remedy has been continuously revised and expanded over the years on HMC's initiative, to the current system consisting of hundreds of monitoring, injection, and extraction wells located over thousands of acres.

The initial response for OU2 was triggered by the decision to close the mill facility. Cleanup of the mill facilities and impacted soils was completed in 1995; however, the closure of the tailings piles has not yet occurred due to a change in remedial strategy from that presented in the original tailings piles closure plan. The original strategy was to dewater the large tailings pile as much as possible, assure that at least 90% consolidation had occurred, and then construct the final radon cover. However, in 2000 the tailings flushing program began which entails injection of considerable quantities of water and, therefore, final closure of the large tailings pile has been postponed. NRC is the lead agency. HMC follows the NRC closure process, approved pursuant to the NRC license. There have been no interim response actions.

### 3.5 Basis for Taking Action

The basis for taking action at the Site includes detections of the following constituents in each media:

| Groundwater | Soil | Uranium Mill Tailings |
|---|---|---|
| • Uranium | • radium-226 | • radon-222 emissions |
| • selenium | • thorium-230 | |
| • molybdenum | | |
| • vanadium | | |
| • chromium | | |

| Groundwater | Soil | Uranium Mill Tailings |
|---|---|---|
| • radium-226+radium228 | | |
| • thorium-230 | | |
| • sulfate | | |
| • chloride | | |
| • nitrate | | |
| • total dissolved solids | | |

The initial response at the Site was taken to address exposure to residents in the subdivisions to groundwater contaminated with radiological and non-radiological constituents. Additional response actions at the Site were taken due to concerns associated with exposure to indoor radon levels in nearby homes. Other potential historical exposures at the Site included exposure to the following: uranium by-products; contaminated surface soil; buildings; equipment; and radon emissions to ambient air from the tailings piles.

# 4.0 Remedial Actions

## 4.1 Operable Unit 1 – Groundwater Restoration

### 4.1.1 Remedy Selection (OU1)

Documents that detail the remedial decisions for the Site include the following: License SUA-1471; the NRC-approved Reclamation Plan; the NRC-approved groundwater CAP; 1989 EPA ROD and NMED-approved Discharge Plans DP-200 and DP-725.

Remedial activities are being addressed by NRC under mill tailings regulations in 10 CFR 40, Appendix A, as amended, which conform with EPA standards in 40 CFR 192. RAOs for groundwater restoration are defined in License SUA-1471, the groundwater CAP, NMED DP-200, and the Consent Decree signed in 1983 by EPA and HMC. RAOs for decommissioning the mill, surface reclamation, long-term stabilization of the tailings and closure (OU2) are defined in License SUA-1471. In general, the objectives of the remedial activities are as follows:

- limit radon emissions from the tailings impoundments
- remediate contamination in soil that resulted from windblown tailings
- remediate groundwater to levels stipulated in License SUA-1471 and NMED DP-200
- dewater the large tailings pile to remove this area as a continuing source of groundwater contamination
- prevent the consumption of contaminated groundwater by residents in the subdivisions

Remedy selection at the Site has been based on the procedures specified by NRC, NMED, and the 1983 Consent Decree. The remedy has been primarily driven by the CAP with NRC, NMED, and EPA providing approval and oversight of the remedy. The groundwater CAP describes the remediation plan approved by NRC for contaminated groundwater at the mill site. DP-200 contains the NMED-approved groundwater restoration plan for the Site. Also, License SUA-1471, as amended, defines the plans for mill decommissioning, surface reclamation, long-term stabilization of the tailings impoundments and closure of the mill site.

The major components of the remedy employed at the Site include the following:

- Decontamination of the mill facilities and equipment
- Demolition of the mill facilities and equipment
- Burial of contaminated debris and asbestos-containing materials in the out slope of the large tailings pile
- Burial of uncontaminated debris and equipment in pits on the mill site
- Excavation of surface soils contaminated with windblown tailings and burial in the out slope of the large tailings pile
- Construction of a final radon barrier on the two tailings piles to minimize radon emissions and reduce erosion

- Dewatering the large tailings pile to remove contaminated groundwater and control the source area of the groundwater contamination
- Provisions for an alternate and permanent water supply for residents of the subdivisions and finance the cost of residents' water use for a period of ten years
- Operation of a groundwater collection and injection system to reverse groundwater flow back toward the collection wells adjacent to the tailings piles, with treatment of the collected groundwater by reverse osmosis for re-injection or by evaporation, and tailings flushing and dewatering

### 4.1.2 Remedy Implementation (OU1)

HMC implemented the state-approved groundwater restoration program in 1977. The groundwater restoration program was modified on September 15, 1989, to incorporate the groundwater CAP, approved by NRC, and modified by the RO system described in a January 15, 1998, submittal to NRC. The current program consists of the following: a groundwater collection/injection system for the San Mateo alluvial aquifer and the Upper and Middle Chinle aquifers; a tailings collection/injection system within the large tailings pile; a tailings impoundment toe drain; an RO treatment plant; two collection ponds; and three evaporation ponds. Fresh water is injected into the alluvial aquifer and the Upper and Middle Chinle aquifers to reverse the natural gradients and to flush contaminants from the impacted portions of the aquifer. Fresh water and treated water are injected into the San Mateo alluvial aquifer at wells located along or near the south and southwest boundary of the mill site, between the subdivisions and the tailings piles, to reverse the natural flow direction of the groundwater away from the residences and back toward the tailings piles. Modifications have been made over time, including discontinuing injection in some of the downgradient alluvial wells and expanding injection closer to the collection wells as restoration has progressed. The injection and collection system was expanded to include the Upper and Middle Chinle aquifers. Also, upgradient collection Well P1 was added in 1993 to help maintain the reversal of flow in the alluvial aquifer and to prevent any upgradient contaminant contributions.

Collected groundwater is pumped to either the RO treatment plant for treatment and aquifer re-injection or to the two collection ponds. The water in the collection ponds is then piped to one of three lined evaporation ponds for disposal along with RO treatment brines. Evaporation of water at the ponds is enhanced through spray misters (**Photo 11**). Fresh water for injection is obtained from the San Andres limestone aquifer and from product water that has been treated at the RO treatment plant. Since the last FYR, HMC has performed several operating modifications or adjustments under the oversight of NMED and NRC.

Additional injection wells have been periodically installed closer to the tailings impoundments as the groundwater has been restored downgradient. Additional injection and collection wells in the large tailings pile have been installed. Since the last FYR a third evaporation pond (Evaporation Pond 3) was constructed north of the large tailings pile to increase the evaporative treatment capacity for collected groundwater. In addition to the components of the remedy listed above, HMC has been investigating options to optimize the operations and enhance the rate of groundwater remediation at the Site. HMC is currently conducting a pilot test to evaluate the

efficacy of zeolite treatment of contaminated groundwater, and is reportedly considering in-situ immobilization pilot-testing.

HMC is operating a second groundwater restoration system to remediate those portions of the groundwater contaminant plumes that have migrated off the mill site and are beyond the influence of the primary groundwater collection and injection system. This system includes extraction of affected groundwater and land application treatment using an irrigation system. Initially, the off-site groundwater restoration system was comprised of 13 collection wells and two irrigation systems located south and southwest of the subdivisions. By 2005 the off-site groundwater restoration system had been expanded to four irrigation systems and groundwater collection at 35 wells. The collection wells extract contaminated groundwater by pumping, thereby gradually reducing the contaminant levels within the aquifer, provided that the upgradient source of contamination from the tailings seepage is effectively contained by the groundwater collection/injection system at the mill site.

The four irrigation systems consist of two center pivot spray irrigation systems and two flood irrigation locations. The irrigation systems provide land application treatment of the collected contaminated groundwater. HMC has recently completed a study of the effects of irrigating with contaminated water in an effort to gain approval for the continued use of the system. NMED has prohibited application of water in three of the four irrigation areas. Currently, irrigation is only permitted in the 100-acre center pivot irrigation area.

Pursuant to the 1983 Consent Decree, HMC financed the extension of the Village of Milan's municipal water supply to then-existing residences of the subdivisions and made payments to the Village of Milan for the residents' water usage over a period of ten years. The extension of the water supply was completed in 1985 (EPA 1989). Since the last FYR, HMC financed the hook-up of additional residential properties to the Village of Milan water system (**Exhibit 7b**), and a health advisory was issued to minimize the possibility of new wells being installed within the area of contamination.

### 4.1.3 System Operation/Operation and Maintenance (O&M) (OU1)

Since NRC is the lead federal agency for the Site, there is no O&M Plan typically found under CERCLA. Required O&M activities at the Site are stipulated in License SUA-1471 and the NMED discharge permits DP-200 and DP-725. O&M activities are also specified in a number of internal documents kept at the Site. The O&M activities include:

- Operation, maintenance, and monitoring of the groundwater injection and collection wells and associated piping
- Operation and maintenance of the large tailings pile flushing and dewatering system using collection and injection wells within the tailings pile and toe drains
- Maintenance of interim covers on the large and small tailings piles
- Operation and maintenance of the RO treatment plant, collection ponds, and evaporation ponds
- Groundwater sampling and monitoring

- Air monitoring
- Maintenance of air monitoring stations and groundwater monitoring wells
- Operation and maintenance of the collection wells and the spray irrigation and flood irrigation components of the off-site groundwater restoration system

HMC personnel are at the Site daily during the week performing O&M activities**.** Daily and weekly inspections are conducted to verify the condition of the components of the two groundwater restoration systems, including the RO treatment plant and the collection and evaporation ponds. The groundwater restoration and treatment/disposal systems are also monitored by computer, and the systems are capable of calling HMC personnel at home during non-working hours if a problem occurs. Monitoring of collected water is performed as a part of the operation and maintenance. Total volume of groundwater collected and quantities of constituents removed by the contaminated groundwater collection and tailings dewatering systems from 1978 to 2009 are shown in **Table 4**.

The O&M costs are not provided in any of the reporting or decision documents for the Site. License SUA-1471 contains a condition requiring HMC to provide a financial surety to cover the cost to implement the remaining reclamation and closure activities. During the January 19, 2011, site inspection, the HMC representative stated that it costs approximately $3.5 million to operate the facility annually. Given the fact that operations at the Site have varied from one year to the next and that HMC continues to investigate methods to enhance and accelerate the rate of groundwater restoration, it is likely that annual O&M costs may increase.

The OU1 remedial system's O&M involves periodic monitoring of several hundred groundwater monitoring wells, in addition to continual O&M of dozens of extraction and injection wells, the collection and evaporation ponds, the irrigation system, and the RO treatment facility. It is a complex system requiring considerable human resources to oversee and manage. Using groundwater injection wells and trenches to assist in hydraulic control of contaminant plumes creates the following issues that should be considered:

- Determining groundwater remedial progress by assessing contaminant trends in adjacent monitoring wells is made practically impossible due to the localized dilution of the groundwater, in addition to periodic revisions to the system over the years that have resulted in a hydrogeologic system in a constant transient state.

- The heavy pumpage from the San Andres Formation to supply water for the injection program has resulted in significant hydraulic head differences that may be inducing downward migration of impacted groundwater through secondary permeability features such as faults and fractures associated with faulting, and increasing the amount of water that must be extracted.

The hydrogeology in the project area is complex with regard to the faulted Chinle Formation, with its three separate aquifers (upper, middle, and lower units) tilted to the northeast. A cross-section parallel to the east and west faults is included in several of the documents reviewed for this FYR, and indicates a very steeply-dipping monocline in the area about 1.5 miles south of the

large tailings pile (**Exhibit 6**). It is suggested that this may not be a correct interpretation, and could be an east-west fault downthrown to the north. Since there is some question whether the Chinle aquifers are adequately monitored based on the recommendations in the Addendum to the Remedy System Evaluation (RSE), extra attention should be given to providing evidence to confirm that the Chinle Formation is adequately monitored and understood. An additional complicating factor is that the Chinle Formation is a continental deposit, with deposition of its shales/siltstones/sandstones occurring within a few feet of sea level, and these types of deposits are known to be generally discontinuous and difficult to correlate. HMC should demonstrate that the bedrock aquifers are reasonably correlated in addition to providing evidence of a plausible structural interpretation supported by the development of detailed cross-sections. HMC should also conduct a thorough geochemical assessment of the various aquifers.

The San Andres Formation should also be given special attention given the recent detections of uranium in some San Andres monitoring wells. The top of this aquifer is as shallow as approximately 500 feet below ground surface in the vicinity of the west fault, and may be receiving recharge from the alluvial and/or Chinle aquifers due to potentiometric head differences induced by pumpage in the San Andres and subsequent injection mostly in the alluvial aquifer.

## 4.2 Operable Unit 2 – Mill Decommissioning, Surface Soils and Tailings Reclamation

### 4.2.1 Remedy Selection (OU2)

The OU2 remedy selection was addressed through a closure plan finalized in 1995 between HMC and NRC. The strategy for closure of the tailings piles was documented in this plan. RAOs for decommissioning the mill, surface reclamation, long-term stabilization of the tailings and closure are defined in License SUA-1471. In general, the objectives of the remedial activities are as follows:

- limit radon emissions from the tailings impoundments
- remediate contamination in soil that resulted from windblown tailings
- remediate groundwater to levels stipulated in License SUA-1471 and NMED DP-200
- dewater the large tailings pile to remove this area as a continuing source of groundwater contamination
- prevent the consumption of contaminated groundwater by residents in the subdivisions

Remedy selection at the Site has been based on the procedures specified by NRC, NMED, and the 1983 agreement between the EPA and HMC. The groundwater CAP describes the remediation plan approved by NRC for contaminated groundwater at the mill site. DP-200 contains the NMED-approved groundwater restoration plan for the Site. Also, License SUA-1471, as amended, defines the plans for mill decommissioning, surface reclamation, long-term stabilization of the tailings impoundments and closure of the mill site. Remedial activities are being addressed by NRC under mill tailings regulations in 10 CFR 40, Appendix A, as amended, which conform with EPA standards in 40 CFR 192.

The major components of the remedy employed at the Site include the following:

- Decontamination of the mill facilities and equipment
- Demolition of the mill facilities and equipment
- Burial of contaminated debris and asbestos-containing materials in the out slope of the large tailings pile
- Burial of uncontaminated debris and equipment in pits on the mill site
- Excavation of surface soils contaminated with windblown tailings and burial in the out slope of the large tailings pile
- Construction of a final radon barrier on the two tailings piles to minimize radon emissions and reduce erosion
- Dewatering the large tailings pile to remove contaminated groundwater and control the source area of the groundwater contamination
- Provisions for an alternate and permanent water supply for residents of the subdivisions and finance the cost of residents' water use for a period of ten years
- Operation of a groundwater collection and injection system to reverse groundwater flow back toward the collection wells adjacent to the tailings piles, with treatment of the collected groundwater by reverse osmosis for re-injection or by evaporation, and tailings flushing and dewatering

### 4.2.2 Remedy Implementation (OU2)

The mill was decommissioned and dismantled in the early 1990s, with some of the waste materials deposited in the large tailings pile or buried adjacent to the south side of the large tailings pile. Soil that had been impacted by windblown tailings and/or storage/processing of uranium ore was removed following demolition of the mill facility. The large tailings pile was also re-contoured to provide for better long-term stability and as preparation for final closure. All of these activities were approved by NRC, in addition to the 1995 plan for reclamation and closure of the tailings piles.

Soil remediation was based on human-health risk rather than the potential to leach contaminants to the groundwater. This approach was probably sufficient to prevent leaching of contaminants in the areas of windblown impact, but may have left sufficient source mass in place in the former ore storage/processing areas that continued impacts to groundwater are occurring. This may explain the persistent plume of elevated uranium contamination just south of the former mill site. The closure plan identified the location of a "north ore storage" pad, but it is believed that another ore storage pad had been located south of the mill site. It is recommended that this issue be addressed by HMC to determine whether these ore storage areas are continuing to impact groundwater. It is also recommended that the backfilled former irrigation ditch that ran through the area of the mill site be investigated, since this feature could serve as a preferential pathway for migration of leached contaminants to groundwater.

The 1995 reclamation plan stated that the large tailings pile was in the final phase of dewatering, and upon sufficient additional dewatering it was to begin undergoing final closure. However, in 2000, HMC began a program of tailings flushing. This program involved the installation of

injection wells, starting with a relatively small number of wells with additional wells added each year, until reaching the current configuration. This deviation from the plan has resulted in delaying indefinitely the closure of the large tailings pile. In addition to the delay in closure, the increased saturation of the tailings reduces the stability of the large tailings pile. Although re-contouring of the large tailings pile was done primarily for purposes of geotechnical stability, safety factors were calculated assuming that the tailings were dewatered, which is currently not the case. The stability analysis may also have determined that the tailings pile would not fail in an earthquake event in this seismically-active area; however it is not known whether this assessment assumed dewatered tailings.

### 4.2.3 System Operation/Operation and Maintenance (OU2)

Currently, O&M for OU2 is restricted to the tailings flushing program. This program was not anticipated in the closure plan, but HMC has been continually expanding it over the past ten years. Neither the OU1 nor OU2 remedies can be expected to be completed by 2017 with continued operation of the tailings flushing program, therefore, this strategy should be re-evaluated. HMC is currently conducting a pilot study in a portion of the large tailings pile to demonstrate that rebound will not occur once the flushing program has ended. Any decision to discontinue flushing will depend on the findings of this study.

## 5.0 **Progress Since Last Review**

The previous FYR contained the following Protectiveness Statement:

> "The remedy involving the decommissioning and reclamation of the mill site, including the decommissioning and dismantling of the mill, soil remediation, long-term stabilization of the tailings, and closure, is considered protective of human health and the environment in the short-term because the tailings (uranium mill byproduct) have been contained under the temporary radon barrier that limits emissions of radiological constituents into ambient air and protects against erosion. Tailings dewatering and use of evaporation ponds for treatment of collected water during the ongoing groundwater restoration activities is necessary. The second and final phase of reclamation of the tailing impoundments and evaporation ponds will be implemented following completion of the groundwater restoration program. The remedy involving groundwater is also considered protective of human health and the environment in the short-term because a groundwater collection and injection system is in place. The system appears to have already been effective in preventing further migration of contaminants and in partially restoring portions of the affected aquifers, and because an alternate water supply has been provided to residents within the affected area.
>
> Currently, 15 residences within and near the subdivisions use groundwater as a domestic water supply, and EPA, NMED, NRC, and HMC are working to eliminate use of groundwater by these residences as a primary source of drinking water. Three of these wells have been sampled, and uranium concentrations in two of the private wells are slightly above EPA's drinking water MCL, but below the Site proposed background concentrations, supported by EPA and NMED. The uranium concentrations in these two private alluvial wells are not definitively impacted by the Site, and may be from other sources or from variations in the natural background concentrations. Short-term exposure to a drinking water supply with uranium at concentrations observed in these wells would be considered protective under EPA's $10^{-4}$ to $10^{-6}$ risk range. Therefore, the remedy is still considered protective in the short-term. However, to assure long-term protectiveness, on-going efforts to monitor and evaluate the potential risk of groundwater use by local residents should continue. HMC should explore options to eliminate the potential for local residents and landowners to use groundwater when concentrations exceed MCLs, regardless of whether the source of contamination is site related or due to background conditions. Also, efforts to connect all residences within the affected area to the Village of Milan municipal water system should continue."

Following are issues identified during the previous FYR along with their current status:

1. In 1985 an alternate drinking water supply was provided for the community, however, based on recent surveys additional residents whose wells are in the affected area are targeted for alternate water supply.

Current status: Since the last FYR, HMC financed the hook-up of additional residential properties to the Village of Milan water system under an agreement with NMED.

2. There is a need to establish legally enforceable, effective institutional controls (ICs) restricting the potential use of contaminated groundwater by local residents and ensuring that they are connected to the alternate drinking water supply previously implemented.

   Current status: In 2009 a health advisory was issued to minimize the possibility of new wells being installed within the area of contamination. Although a health advisory was issued, it does not prevent residents from drinking contaminated groundwater or using it for irrigation purposes or for watering livestock. Also, NMED requires the New Mexico Office of State Engineer to issue a health advisory to every person who applies for a well permit within the area referenced in the drinking water advisory (**Exhibit 7b**). The advisory was published in two newspapers of general circulation in Cibola and McKinley Counties (HMC, 2009).

3. Specific objectives/monitoring requirements need to be established for the groundwater restoration that is ongoing downgradient of the mill site.

   Current status: Off-site groundwater restoration is addressed under DP-200, however, no specific objectives or monitoring requirements have been established.

4. When the revised groundwater clean-up levels, based on the proposed background concentrations supported by EPA and NMED, are approved by NRC, new Point of Compliance (POC)s for the upper and middle Chinle aquifers and the mixing zone should be established. With these changes, some form of groundwater CAP would need to be implemented until the groundwater clean-up levels are attained at the specified POCs in all of the regulated aquifer units. However, it is likely that when these cleanup levels are met, some constituents could be at concentrations above the applicable MCL in various aquifer units, since the cleanup levels based on the background concentrations are above the MCLs.

   Current status: Although revised background cleanup levels were approved by NRC, no new POCs were established for the upper and middle Chinle aquifers and mixing zone. However, New Mexico Water Quality Control Commission regulations require the entire aquifer that has been impacted to be restored. It is acknowledged by all stakeholders that once HMC meets the NRC-approved groundwater cleanup goals, concentrations in the aquifers will not meet the MCLs. The regulatory agencies will still be responsible for protecting human health and the environment.

# 6.0 Five-Year Review Process

## 6.1 Administrative Components

The Homestake Mining Company Superfund Site FYR included the following team members: Sai Appaji, Remedial Project Manager (RPM), EPA Region 6; and David Daniel, Risk Assessor, Chuck Williams, Geologist, and Fred Molloy, Project Manager, U.S. Army Corps of Engineers, Kansas City District (CENWK). Angelo Ortelli, NMED; George Hoffman, Hydro-Engineering L.L.C.; Alan Cox, Patrick Malone, and Dan Kump, HMC; and John Buckley, NRC, were notified of the FYR and FYR site inspection on January 19 and 20, 2011. The community was also notified through a newspaper notification and in a public meeting.

## 6.2 Community Involvement

A public notice was placed in a local newspaper by EPA Region 6 announcing the initiation of the FYR. At the end of the five-year review, a second newspaper notice will indicate the availability of the FYR report for viewing by the public. The completed FYR report will be available in the Site information repository, the New Mexico State University, Grants Campus Library, 1500 North Third Street, Grants, New Mexico 87020; the EPA Superfund Division Records Center, 1445 Ross Avenue, Dallas, Texas 75202-2733; and the NMED Ground Water Quality Bureau, 1190 St. Francis Drive, Santa Fe, New Mexico 87502. The FYR report will also be available on the NMED Ground Water Quality Bureau website at http://www.nmenv.state.nm.us/gwb/NMED-GWQB-SOS-HomestakeMine.htm.

## 6.3 Document Review

This FYR included a review of relevant information contained in a variety of site-related documents, with emphasis on those published during the past five years. However, a review of a considerable number of historic documents was also necessary to gain an adequate understanding of the project. An attempt was made to conduct an assessment of the condition of the Administrative Record located at the New Mexico State University, Grants Campus Library, but the library was closed for remodeling at the time of the site visit. A list of site-related documents, reviewed in total or in part during preparation of this FYR, is presented in **Attachment 3**.

## 6.4 Data Review

### 6.4.1 Operable Unit 1

The data review for OU1 was conducted primarily through annual reports prepared by a contractor that has been involved with the Site since the 1970s. The format of these reports has evolved over the years but has remained relatively consistent over the past ten years or so. These reports contain operational and monitoring data for each individual calendar year for the hundreds of monitoring, injection, and extraction wells that make up the groundwater remedial system. In addition, much of the monitoring data is presented over the most recent ten-year

period in an effort to illustrate trending of data sets. The information is presented both textually and through liberal use of figures and tables.

The current monitoring program consists of several hundred groundwater monitoring wells, most of which are completed in the alluvial aquifer but with a significant number within the Chinle Formation divided between its three separate aquifers, and several that monitor the San Andres aquifer. These wells are sampled at least annually, with some sampled semi-annually or even more frequently. Water levels are measured prior to sampling; however, the time necessary to sample so many wells results in water-level data sets that cannot be considered representative of the water level for the Site.

In addition to the groundwater monitoring wells, a large network of injection and extraction wells is in place which operates in tandem to control/remediate the various plumes of impacted groundwater. Operation of this system, which has been modified over the years, results in a groundwater hydrologic regime that is in a constant state of flux. Evaluating the adequacy of capture of the site contaminants is difficult, if not impossible, under the current remedial strategy.

### 6.4.2 Operable Unit 2

Data review for OU2 consisted of analysis of the tailings flushing program for the large tailings pile. Flushing of the tailings via injection wells was started approximately ten years ago, and new injection wells are added every year in an effort to reduce contaminant mass remaining, primarily in the fine-grained fraction of the waste tailings. The efficacy of this program is questionable, as it postpones indefinitely the closure of the tailings piles due to mobilization of contaminants that could otherwise be left relatively immobile, while only transferring the contaminants from the large tailings pile to the evaporation ponds. This affects not only the closure of the tailings piles, but also extends indefinitely the OU1 remedy due to the rejuvenation of this source. The flushing program is believed to have resulted in significantly changed geochemical conditions that further complicate this issue. HMC is currently conducting a pilot study in a portion of the large tailings pile to demonstrate that rebound will not occur once the flushing program has ended. Though the regulatory agencies agree that the flushing program should continue to completion, the decision to discontinue the program will depend on the findings of the pilot study.

## 6.5 Evaluation of Historical COC Concentration Trends

### 6.5.1 OU 1 Concentration Trends

Due to the complex and evolving nature of the groundwater remedial system, a trend analysis is difficult, if not impossible to conduct. Injection wells/trenches cause dilution of contaminants in their vicinity and downgradient, and the location of injection has been modified periodically throughout the life of the project. Further complicating the validity of concentration trends is the re-mobilization of contaminants within the large tailings pile, particularly for wells located in the vicinity of the large tailings pile. As examples of this difficulty, the three designated POC wells,

Wells X, D1, and S4 were analyzed with respect to water-level and contaminant concentration graphs over the past ten years of operation (**Exhibits 8a-8f**). Trend analyses were also conducted as part of the 2010 Addendum to the RSE, and the data interpretation is similar to that discussed below for the POC wells.

Beginning in early 2000, Well S4 had a water level of approximately 6,524 feet (ft) above mean sea level (amsl) and a uranium concentration of over 10 milligrams per liter (mg/L). During 2000, the WR-series injection wells was installed to the west, which seems to have had little effect on the water level in S4, but slowly caused the uranium concentration to decrease to below 2 mg/L by mid-2003. In 2003, the S-series injection wells were installed just north of S4 which has caused a slow rise in water levels that had reached 6,534 ft. amsl by 2009. However, unlike the WR-series injection wells, operation of the S-series wells resulted in an initial rise in uranium concentrations to nearly 6 mg/L, followed by a gradual decrease to approximately 0.2 mg/L by 2009. Well S4 is not believed to be affected by the tailings flushing program begun in 2000 due to its location west of the extraction wells at the southwest corner of the large tailings pile.

Well D1 is approximately the same distance from the large tailings pile as Well S4, but to the south rather than west, and its water level elevation trend is similar, showing no discernible effect from the WR-series injection wells and an eventual six-foot rise after startup of the S-series injection wells. Uranium concentrations from Well D1 started at just below 2 mg/L in early 2000 and slowly decreased to just over 1 mg/L by the end of 2003. Concentrations then slightly increased but remained stable through 2007, at which point a concentration spike of approximately 5 mg/L was measured in 2008. The most recent three samples have contained approximately 2 mg/L of uranium, essentially what was being measured in 2000.

Well X is located at the toe of the small tailings pile on the south side, in an area that has not been subject to remedial system modification since 1995. Although new injection/extraction wells have not been installed since 1995, it is evident from the hydrograph for Well X that injection rates increased considerably between 2000 and 2003, based on a water-level increase of approximately 20 feet. Since 2003, water levels have been gradually decreasing so that the level in 2009 was only ten feet higher than in 2000, and this decline is probably due to a decreased injection rate in late 2003. During this same time period, the uranium concentration measured in samples from Well X decreased from 0.7 mg/L in 2003 to nearly undetectable in early 2003, and has fluctuated since that time both above and below 0.1 mg/L.

These examples demonstrate the continual flux of the groundwater hydrologic regime over the past ten years, and it is expected that the situation was similar during the first 20+ years of the remediation project. Based on the review of the three POC wells and other trend analyses from the RSE, there is uncertainty that the remediation will be complete by 2017 as HMC has stated. Because the project has been operating approximately 35 years with still years away from the end goal the CAP should reevaluate the overall remedial strategy. This re-evaluation should include developing a monitoring strategy and associated metrics to provide an unbiased indication of remedial progress.

### 6.5.2 OU2 Concentration Trends

Closure of OU2 involves the cleanup and disposal of any soils contaminated by irrigation or evaporative spraying to levels above 10 CFR, Appendix 40, Criterion 6 (6) levels, consolidation, disposal of, and covering of the evaporation and collection ponds, and the final cover for the large tailings pile. The tailings flushing program that was begun in 2000 has postponed closure of the large tailings pile indefinitely. It is assumed that concentration trends for monitoring wells installed in the alluvium below the large tailings pile showed a decreasing trend in contaminant concentrations prior to initiation of tailings flushing. Flushing of the tailings has resulted in increased flux through the bottom of the large tailings pile for uranium and other COCs, but a reduction in selenium flux may indicate that significant geochemical changes have resulted from the flushing program. OU2 closure is not possible until tailings flushing ends, the tailings are allowed to drain and settle, and the final cover is constructed.

## 6.6 Site Inspection

A site inspection was conducted at the Site on January 19 and 20, 2011. Participants on January 19, 2011, included Sai Appaji, EPA; Angelo Ortelli, NMED; George Hoffman, Hydro-Engineering L.L.C.; Alan Cox, Patrick Malone, and Dan Kump, HMC; and Chuck Williams and Fred Molloy, CENWK. Angelo Ortelli, NMED, and Patrick Malone, HMC, were not present on January 20, 2011.

The purpose of the site inspection was to assess the condition of the remedy and identify any issues that could negatively affect its protectiveness. The site inspection assessed the small and large tailings piles, two lined collection ponds, three lined evaporation ponds, the RO water treatment facility, various monitoring wells, the groundwater extraction and injection system (and associated equipment and structures), and the overall maintenance of the site.

Prior to the site inspection, the inspection team met for introductions, and to discuss current and historic remedial activities. The meeting was conducted in the office of Alan Cox at the HMC facility at Highway 605, Cibola County, New Mexico. Interviews were also conducted during the meeting and are discussed in Section 6.7 below.

The site inspection began by driving up the south side slope of the large tailings pile to get an overall perspective of the site. Evaporation Pond 1 on top of the small tailings pile, Evaporation Pond 2, the collection ponds, and the RO water treatment plant were viewed from the top of the large tailings pile (**Photos 1**through **4**). The inspection team was led by Dan Kump, HMC Senior Project Engineer.

The team then drove to various locations on top of the large tailings pile, observing piping used to convey collected groundwater to the RO treatment plant or to one of the evaporation ponds for disposal (**Photo 5**). Various injection and extraction wells and associated piping were also observed (**Photo 6**). Still on top of the large tailings pile, the team drove to a location on the south side where a zeolite pilot test was underway (**Photos 7** and **8**). The zeolite was set in a pit with a 60 millimeter thick high density polyethylene (HPDE) liner. The zeolite is used to extract

uranium from Upper Chinle groundwater. After a one-hour retention time with the zeolite, the water is re-injected.

The team then drove on top of the large tailings pile to the west end where they observed two concrete discharge structures used to convey surface water off of the top of the large tailings pile (**Photo 9**). A total of 14 such discharge structures are situated on top of the large tailings pile. Areas of ponded water resulting from snow melt were noted on top of the large tailings pile, however, this does not affect the protectiveness of the remedy. The team concluded the first day of the site inspection by returning to the HMC office.

The site inspection on January 20, 2011, began by driving around the base of the evaporation ponds and the toe of the small tailings pile. The side slopes of the evaporation ponds and collection ponds had recently been graded, however, the east side slope of the small tailings pile/Evaporation Pond 1 had moderate to large furrows and the west side of the westernmost collection pond had moderate furrows, both of which appeared to be the result of rainfall/erosion. The permitted freeboard for the evaporation ponds was 2 ft and at the time of the inspection, the freeboard provided was as follows: approximately 4 ft (Evaporation Pond 1); 3.5 ft (Evaporation Pond 2); and 7-8 ft (Evaporation Pond 3). The team proceeded to the top of the southern berm of Evaporation Pond 1. While on top the team observed the pump, pump house, and piping used to convey extracted groundwater from the large tailings pile to the pond. Evaporation Pond 1 has an asphalt-emulsion liner, constructed in 1990, and no leak detection system (**Photos 10** through **12**).

The team observed POC Well X at the toe of the small tailings pile (**Photo 13**) and POC Well D1 near the RO treatment plant (**Photo 14**). The team then proceeded to the RO treatment plant (**Photo 15**). The plant was undergoing renovation at the time of the inspection but the team was able to view the computers and ancillary equipment that control the flow of water into and out of the system, and the membrane filtration system (**Photo 16**).

The team drove to POC Well S4 on the west side of the large tailings pile (**Photo 17**). Two corners of the concrete well pad for Well S4 were broken off; however, the integrity of the well was not compromised. The team concluded the second day of the site inspection by returning to the HMC office.

### 6.7 Interviews

The following individuals were interviewed as a part of this FYR: Alan Cox (HMC) and George Hoffman (Hydro-Engineering, L.L.C.) were interviewed in the office of Alan Cox at the HMC facility at Highway 605, Grants, New Mexico on January 19, 2011; John Boomer (homeowner) was interviewed at his residence at 3021 Highway 605, Cibola County, New Mexico on January 20, 2011; Art Gebeau (homeowner) was interviewed at his residence at 1986 Ralph Card Road, Grants, New Mexico on January 21, 2011; David Mayerson, Jerry Schoeppner, and Angelo Ortelli (NMED) were interviewed by telephone on February 8, 2011; and Paul Robinson (Southwest Research and Information Center) was interviewed by telephone on April 15, 2011. The interviews are documented in the Interview Records provided in **Attachment 4**.

# 7.0 Technical Assessment

As identified in Section 1.0, the type of review performed is considered to be a policy review. According to EPA's Comprehensive Five-Year Review Guidance, a policy review is conducted for post-SARA (Superfund Amendments and Reauthorization Act) remedial actions that leave hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure, but requires five or more years to complete. The remedial action for the Homestake Mining Company Superfund Site meets this criterion. EPA guidance also identifies the trigger for subsequent policy reviews as the signature date of the previous FYR. The previous FYR Report for this Site was signed on September 26, 2006. This document constitutes the FYR for the entire site.

This section presents a technical assessment and is formulated based on the answers to Questions A, B, and C, presented below. As answers were formulated, consideration was given to the status of the remedial action. For consistency with FYR guidance, each question is summarily answered yes or no. Supporting information is provided in the previous sections and referenced documents with additional analysis provided, as needed. Section 7.4 presents a summary of the technical assessment.

***Question A***: Is the remedy functioning as intended by the decision documents?

***Question B***: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

***Question C***: Has any other information come to light that could call into question the protectiveness of the remedy?

## 7.1 Question A: Is the remedy functioning as intended by the decision documents?

### 7.1.1 OPERABLE UNIT 1

Yes.

#### 7.1.1.1 Remedial Action Performance (OU1)

The 1989 ROD did not address the groundwater issues and stated that it was being addressed by NRC licensing activities. Modern RODs generally contain a summary of the CERCLA process and the approved remedy, but this project began before CERCLA was enacted and, therefore, the Preliminary Assessment/Site Inspection, RI/Feasibility Study, and Remedial Design/Remedial Action process was not done. HMC has been proactive in their response to groundwater contamination and has cooperated with site regulators throughout the history of the project. From a protectiveness standpoint, it would appear that potential receptors of impacted groundwater have been prevented from becoming actual receptors through HMC's actions. However, there are other potential protectiveness issues that have emerged during this FYR, including the following:

- While the contaminant plumes in the alluvial aquifer appear to be sufficiently characterized and contained based on planimetric potentiometric data (see Exhibit 10), the complexity of the system requires additional cross-sections to present a complete picture. For example, screened intervals of the various remediation-system wells (injection/extraction/monitoring) within the alluvial sequence are crucial in interpreting the data.

- The bedrock aquifers do not appear to have been adequately characterized, especially with respect to structural geology but also possibly with respect to correlation of Chinle aquifers, and planimetric maps by themselves cannot provide the reviewer with sufficient information to assess capture of site-related contaminants.

- Considerable quantities of water have been pumped from wells in the San Andres aquifer, which unconformably underlies the Chinle Formation, and reinjected into the alluvial aquifer for 30+ years for hydraulic control purposes. The natural vertical hydraulic gradient in the vicinity of the Site was probably upward, or possibly neutral, as is usually the case in valleys. However, an artificial downward hydraulic gradient has developed due to the remediation, and coupled with the faulted/fractured nature of the bedrock units may be causing contaminants to escape vertical containment. In addition, geochemical differences of waters in the various aquifers may cause precipitation of dissolved minerals within the injection zones, changing the ground water flow regime.

- The evaporation ponds are the ultimate destination for the onsite COCs, and eventually Evaporation Pond 1 (EP-1) will be used to consolidate the wastes from all of the evaporation ponds and collection ponds. This pond has a single liner that is 20 years old with no leak detection system other than the nearby monitoring wells.

#### 7.1.1.2 System Operations and Maintenance (OU1)

The ROD does not specify the methodology for groundwater remediation, and the remedial system has evolved over the years on HMC's initiative. HMC recently constructed a third evaporation pond (see **Exhibit 5**), and has been making substantial upgrades to the RO treatment facility. The complexity of the remedial system requires daily O&M and HMC has full-time staff engaged for that purpose. This level of O&M appears to be adequate to maintain the groundwater remedial system.

#### 7.1.1.3 Opportunities for Optimization (OU1)

An RSE was conducted under EPA contract in 2009, and was followed up with an Addendum to the RSE, prepared by the USACE Environmental and Munitions Center of Expertise in 2010. The Addendum focused on several specific issues raised by the original RSE. Both documents recommended changes to the remedial strategy for optimization purposes. Some of the RSE recommendations may be implemented in the overall context of the remedial process and will be incorporated into the CAP. HMC is currently implementing several projects that mirror the RSE recommendations, including pilot testing the rebounding effects of the large tailings pile flushing

program, and several groundwater treatment technologies including zeolite, bioremediation, and zero-valent iron.

#### 7.1.1.4 Early Indicators of Potential Issues (OU1)

There have been intermittent elevated concentrations of site-related contaminants in at least one of the San Andres wells, possibly signaling the downward migration of impacted groundwater. Under natural conditions, the vertical gradient would be expected to be generally upward or neutral, owing to the site being in the San Mateo Valley. However, after decades of pumping water from the San Andres and subsequently injecting it mostly in the alluvial aquifer, a downward head differential of approximately 100 feet exists in the site area. This artificially high head differential, coupled with the presence of considerable faulting/fracturing of the Chinle Formation, could be causing alluvial water to migrate to the San Andres. In addition, mixing of groundwaters of significantly different geochemical composition may be resulting in precipitation of minerals, progressively decreasing aquifer permeability in the injection zone.

#### 7.1.1.5 Implementation of Institutional Controls (ICs) and Other Measures (OU1)

The lack of a formal IC process has been an issue in the past. HMC paid for the extension of the Village of Milan water system to residents of the nearby subdivisions in the 1980s, and paid the water bills for those users for ten years following hookup. However, approximately 20 years later it was discovered that new domestic-use wells had been drilled in the area. The second FYR discusses this situation and its resolution, and in 2009 an agreement between NMED and HMC took steps to minimize exposure within the area of contamination and minimize the possibility of new wells being installed. NMED requires that the New Mexico Office of State Engineer issue a health advisory to every person who applies for a well permit within the area referenced in the drinking water advisory (**Exhibit 7a**); and that the advisory be published in two newspapers of general circulation in Cibola and McKinley Counties (HMC, 2009). Also, HMC is required to determine if any new wells have been installed within the area of contamination and report their findings in the annual report.

### 7.1.2 OPERABLE UNIT 2

#### 7.1.2.1 Remedial Action Performance (OU2)

In 1995, HMC completed the decommissioning of the former mill facility and remediation of soils impacted by operation of the mill and/or windblown tailings. In addition, the large tailings pile was re-contoured for stability and an interim radon cover was provided. It was also in the process of being dewatered to provide the final measure of geotechnical stability needed for closure of the waste facility. At that time, it was estimated that a few more years of dewatering would be conducted before constructing the final radon barrier. However, in 2000, HMC began the tailings flushing program which has postponed OU2 closure indefinitely.

Soil remediation was conducted by using human-health risk criteria. However, it is possible that sufficient residual contaminant concentrations were left in place that continue to act as a source

to groundwater through leaching, especially in the areas of the mill site where the uranium ore was stored. If this leaching is occurring, the OU1 remedy may be prolonged and, therefore, it is recommended that an assessment of the subject area be conducted with respect to leaching potential of residual contamination.

#### 7.1.2.2 System Operations and Maintenance (OU2)

The tailings flushing program began in 2000 with a couple of dozen injection wells. More injection wells have periodically been added over the past ten years. HMC plans to continue installation of new injection wells in an effort to close gaps in the coverage of flushing water until the mass-flux of contaminants drops substantially. The flushing program is believed to have resulted in geochemical changes within the large tailings pile, and the cessation of flushing may cause a slow return to the original geochemical situation. HMC should include geochemical parameters in its analytical suite for large tailings-pile wells to assess the geochemical regime, its affect on the COCs, and to evaluate the potential for long-term reducing conditions and rebound.

#### 7.1.2.3 Opportunities for Optimization (OU2)

HMC considers the tailings flushing program to be a continual optimization of the OU2 remedy, by mobilizing additional contaminant mass and subsequently capturing the aqueous-phase contamination. The RSE and Addendum to the RSE recommended that the tailings flushing program be reconsidered. HMC is considering the RSE recommendation concerning tailings flushing and is currently conducting a pilot test to study the rebound in discontinuing the large tailings pile flushing program. Though not a protectiveness issue, extraction of all flushed contaminants within the alluvial aquifer prolongs closure of the large tailings pile directly.

#### 7.1.2.4 Early Indicators of Potential Issues (OU2)

No early indicators of potential issues were identified that could place the protectiveness of the remedy at risk. However, the timeliness for remedy completion is a concern.

#### 7.1.2.5 Implementation of Institutional Controls and Other Measures (OU2)

Following approved closure of the large tailings pile, NRC will implement ICs for the former mill facility in perpetuity through periodic inspections. Following HMC's specific license termination a custodial agency (U.S. Department of Energy) will ensure continued long-term care, including monitoring and maintenance to protect the public health and safety, as required by 10 CFR 40.28. At that point, HMC would still be responsible for completing remedial actions for OU1 by meeting groundwater cleanup standards.

## 7.2 Question B: Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection still valid?

Yes. However, it should be noted that the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of the remedy selection were all drawn from NRC closure requirements, NMED requirements, and 40 CFR, Part 192. Additional CERCLA ARARs or risk-based protectiveness standards have not been comprehensively identified to date.

### 7.2.1 OPERABLE UNIT 1

#### 7.2.1.1 Changes in Standards and To-Be-Considered Criteria (OU1)

- *Have there been changes to risk-based cleanup levels or standards identified as ARARs in the ROD that call into question the protectiveness of the remedy?*

Radiological and some non-radiological contaminants in groundwater are regulated under NRC's Corrective Action Program (License SUA-1471) and under the New Mexico Water Quality Control Commission's (NMWQCC) groundwater restoration requirements (NMED Discharge Permit DP-200). The groundwater standards in place at the beginning of the review period are presented in **Table 6**.

In 2000, HMC requested updated groundwater standards based on a more detailed evaluation of background concentrations. The requested standards were based on 95% Upper Tolerance Limits of background concentrations, which are higher than health risk-based levels and promulgated legal standards. After coordinating with EPA and NMED, NRC published an Environmental Assessment in May 2006 and a Finding of No Significant Impact in June 2006. License Amendment 39 to NRC License SUA-1471 was issued in July 2006 with a more detailed revised list of groundwater standards, which is presented in **Table 7**. These groundwater protection standards have also been incorporated into the NMED discharge permit.

**Table 7** shows that uranium is regulated based on site-specific background levels for all zones except the Lower Chinle Non-Mixing Zone. The NMWQCC groundwater protection standard for uranium has decreased from 5.0 mg/L to 0.03 mg/L while the molybdenum standard has decreased from 1.0 mg/L to 0.1 mg/L. The radium-226 and -228, thorium-230, and chloride groundwater protection standards have remained constant.

#### 7.2.1.2 Changes in Exposure Pathways (OU1)

- *Has land use or expected land use on or near the site changed (e.g., industrial to residential, commercial to residential)?*

Land use in OU1 has been primarily agricultural with some low density residential use. The region has experienced the "boom and bust" cycle of the Grants Uranium Mining Belt with the trend being toward declining populations since 1992. Future land use in the area of the Site is anticipated to be similar to current uses, although there is talk of a rebound in the uranium

mining industry that might create another "boom" in the local economy and draw in more people. The city of Milan has annexed property southwest of the Site for creation of a subdivision.

- *Have any human health or ecological routes of exposure or receptors changed or been newly identified (e.g., dermal contact where none previously existed, new populations or species identified on site or near the site) that could affect the protectiveness of the remedy?*

No human health or ecological routes of exposure or receptors have changed or been newly identified that could affect the protectiveness of the remedy at OU1.

- *Are there newly identified contaminants or contaminant sources?*

No new contaminants or contaminant sources were identified at OU1 during the FYR. However, recently-constructed EP-3 should be considered a potential source. EP-3 was constructed with a double-lined synthetic liner, a leak detection system, and pipes to carry the reclamation water to the pond for evaporation. A monitoring well proposed near the southeast side of the EP-3 location will monitor the alluvial aquifer downgradient of EP-3.

- *Are there unanticipated toxic byproducts of the remedy not previously addressed by the decision documents (e.g., byproducts not evaluated at the time of remedy selection)?*

No unanticipated toxic byproducts of the remedy have been identified at OU1.

- *Have physical site conditions (e.g., changes in anticipated direction or rate of groundwater flow) or the understanding of these conditions (e.g., changes in anticipated direction or rate of groundwater flow) changed in a way that could affect the protectiveness of the remedy?*

No changes in site conditions were identified at OU1 during this FYR that would affect exposure pathways. There have been no land-use changes, although it is possible that a rebound in uranium mining might fuel a "boom" in the area. No new contaminants, sources, or routes of exposure were identified. The aquifers have been better characterized than when the original groundwater protection standards were determined. The groundwater protection standards have been adjusted to incorporate new knowledge concerning background values and the presence or absence of specific contaminants in different zones.

#### 7.2.1.3 Changes in Toxicity and Other Contaminant Characteristics (OU1)

- *Have toxicity factors for contaminants of concern at the site changed in a way that could affect the protectiveness of the remedy?*

Toxicity values for COCs that have changed since the last FYR are summarized in **Table 9**. Using the 2004 Region 9 Preliminary Remediation Goals (PRGs) Table for the toxicity values that would most likely have been in place in 2006, toxicity values for three chemicals of concern have changed. A Reference Dose has been put into place in the Integrated Risk Information

System (IRIS) for nitrate. Selenium has a Reference Concentration that has been added to IRIS; however, the inhalation pathway is not significant for selenium exposures from drinking water. The Reference Dose for uranium has increased by 15-fold, indicating that the estimate of oral toxicity of uranium decreased by 15-fold. A Reference Concentration for uranium has also been posted to IRIS, but is not relevant to exposures to uranium in drinking water.

- *Have other contaminant characteristics changed in a way that could affect protectiveness of the remedy?*

Other contaminant characteristics have not changed in a way that would affect the protectiveness of the remedy.

#### 7.2.1.4 Changes in Risk Assessment Methods (OU1)

- *Have standardized risk assessment methodologies changed in a way that could affect the protectiveness of the remedy?*

Risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy.

#### 7.2.1.5 Expected Progress Towards Meeting RAOs (OU1)

The RAOs for groundwater restoration are defined in License SUA-1471, the groundwater CAP, NMED DP-200, and the 1983 agreement between EPA and HMC. Progress toward meeting each of the OU1 RAOs is described below:

- Limit radon emissions from the tailings impoundments
  - A radon barrier and an erosion-protection cover were constructed on the sides of the large tailings pile, and an interim soil cover was constructed on the top and on the sides of the small tailings pile

- Remediate contamination in soil that resulted from windblown tailings
  - Excavation of surface soil contaminated with windblown tailings and disposal occurred between 1988 and 1995

- Remediate groundwater to levels stipulated in License SUA-1471 and NMED DP-200
  - Although significant efforts have taken place since 1977 toward the remediation of groundwater, cleanup standards have not been achieved at the POC wells

- Dewater the large tailings pile to remove this area as a continuing source of groundwater contamination
  - The tailings pile flushing program has delayed dewatering of the large tailings pile and, therefore, this area continues to serve as a source of groundwater contamination

- Prevent the consumption of contaminated groundwater by residents in the subdivisions

- Between 1983 and 1985 HMC provided for an extension of the Village of Milan municipal water system to the affected residents in four residential subdivisions located south and southwest of the Site, and paid for the residents' use of the water supply until 1994. Since the last FYR, HMC financed the hook-up of additional residential properties to the Village of Milan water system. A health advisory was also issued to minimize the possibility of new wells being installed within the area of contamination. This health advisory, however, does not prevent the residents from drinking contaminated groundwater or using it for irrigation purposes or for watering livestock.

### 7.2.2 OPERABLE UNIT 2

#### 7.2.2.1 Changes in Standards and To-Be-Considered Criteria (OU2)

- *Have there been changes to risk-based cleanup levels or standards identified as ARARs in the ROD that call into question the protectiveness of the remedy?*

The cleanup criteria for OU2 were based on the NRC requirements in 10 CFR 40, Appendix A, Criterion 6, which are repeated in the EPA requirements specified in 40 CFR 192. These regulations include a cleanup standard for radium-226 in the top 15 centimeters (cm) of soil of 5 picocuries/gram (pCi/g) above background and 15 pCi/g above background for each 15-cm depth increment below the top 15 cm. The background level for radium-226 at the mill site was established as 5.5 pCi/g. Therefore, the cleanup standards were 10.5 pCi/g for the top 15 cm of soil, 20.5 pCi/g for the next, 15-cm depth increment, increasing by 15 pCi/g for each successive 15 cm of depth. This standard has not changed. There are, therefore, no changes in these standards that would call into question the protectiveness of the remedy.

The requirements in 10 CFR 40, Appendix A, Criterion 6 (6) were revised to include a benchmark dose criterion to address residual uranium and thorium during mill cleanups. Though the requirement does not apply to sites with a previously-approved decommissioning plan, NRC has indicated that it would be applied to new areas contaminated by spraying or future cleanup actions that the Site.

#### 7.2.2.2 Changes in Exposure Pathways (OU2)

- *Has land use or expected land use on or near the site changed (e.g., industrial to residential, commercial to residential)?*

OU2 is still a licensed uranium mill tailings disposal site. Land use near OU2 has been primarily agricultural with some low density residential use. The region has experienced the "boom and bust" cycle of the Grants Uranium Mining Belt with the trend being toward declining populations since the 1990s. Future land use in the area of the Site is anticipated to be similar to current uses, although there is talk of a rebound in the uranium mining industry that might create another "boom" in the local economy and draw in more people.

- *Have any human health or ecological routes of exposure or receptors changed or been newly identified (e.g., dermal contact where none previously existed, new populations or species identified on site or near the site) that could affect the protectiveness of the remedy?*

No human health or ecological routes of exposure or receptors have changed or been newly identified that could affect the protectiveness of the remedy at OU2.

- *Are there newly identified contaminants or contaminant sources?*

No new contaminants or contaminant sources were identified at OU2 during the FYR.

- *Are there unanticipated toxic byproducts of the remedy not previously addressed by the decision documents (e.g., byproducts not evaluated at the time of remedy selection)?*

No unanticipated toxic byproducts of the remedy have been identified at OU2.

- *Have physical site conditions (e.g., changes in anticipated direction or rate of groundwater flow) or the understanding of these conditions (e.g., changes in anticipated direction or rate of groundwater flow) changed in a way that could affect the protectiveness of the remedy?*

No changes in site conditions were identified at OU2 during this FYR that would affect exposure pathways. There have been no land-use changes nor are any land-use changes anticipated. No new contaminants, sources, or routes of exposure were identified.

#### 7.2.2.3 Changes in Toxicity and Other Contaminant Characteristics (OU2)

Toxicity values for radium-226, radium-228, and thorium -230 have not changed since the last FYR.

- *Have other contaminant characteristics changed in a way that could affect protectiveness of the remedy?*

Other contaminant characteristics have not changed in a way that would affect the protectiveness of the remedy.

#### 7.2.2.4 Changes in Risk Assessment Methods (OU2)

Risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy. The method of calculating cancer and non-cancer risks by the inhalation exposure route were changed in the Risk Assessment Guidance for Superfund (RAGS) Part F (EPA, 2009), but this change should not result in risk estimate changes sufficient to affect the protectiveness of the remedy.

#### 7.2.2.5 Expected Progress Towards Meeting RAOs (OU2)

The RAOs for decommissioning the mill, surface reclamation, long-term stabilization of the tailings and closure are defined in License SUA-1471. To date, HMC has completed the following OU2 remedial activities at the Site:

- Decontamination of the mill facilities and equipment
- Demolition of the mill facilities and equipment
- Burial of contaminated debris and asbestos-containing materials in the out slope of the large tailings pile
- Burial of uncontaminated debris and equipment in pits on the mill site
- Excavation of surface soils contaminated with windblown tailings and burial in the out slope of the large tailings pile
- Construction of a temporary radon barrier on the two tailings piles to minimize radon emissions and reduce erosion

Closure of the tailings piles has been delayed as a result of the tailings flushing program and soils remediation conducted as part of the mill decommissioning may have left contaminants in place that continue to leach contaminants to the groundwater.

### 7.2.3 OPERABLE UNIT 3

#### 7.2.3.1 Changes in Standards and To-Be-Considered Criteria (OU3)

- *Have there been changes to risk-based cleanup levels or standards identified as ARARs in the ROD that call into question the protectiveness of the remedy?*

There is no identified cleanup standard for OU3. The EPA action level for radon in homes of 4.0 pCi/L was used to make house-specific radon reduction recommendations to residents and has not changed. This is the only standard relevant to OU3.

#### 7.2.3.2 Changes in Exposure Pathways (OU3)

- *Has land use or expected land use on or near the site changed (e.g., industrial to residential, commercial to residential)?*

The only recent land-use change on Site has been the recent construction of EP-3. Land use near the Site is primarily agricultural with low-density residential. The population trend since the 1990s has been on the decline, although a rebound in uranium mining might result in a regional "boom." Land use is not expected to change significantly in the area.

- *Have any human health or ecological routes of exposure or receptors changed or been newly identified (e.g., dermal contact where none previously existed, new populations or species identified on site or near the site) that could affect the protectiveness of the remedy?*

The human health route of exposure and receptors have not changed nor have additional routes of exposure or receptors been newly identified that could affect the protectiveness of the remedy at OU3. Ecological receptors are not considered for OU3. In September 2010 EPA began collecting sample data to support the development of a Human Health Risk Assessment, to include indoor and outdoor radon samples. The sample collection will continue on a quarterly basis until November 2011. A final Human Health Risk Assessment is expected in spring 2012 which will provide information needed to support a protectiveness determination of the OU3 remedy.

- *Are there newly identified contaminants or contaminant sources?*

No new contaminants or contaminant sources were identified at OU3 during the FYR.

- *Are there unanticipated toxic byproducts of the remedy not previously addressed by the decision documents (e.g., byproducts not evaluated at the time of remedy selection)?*

No unanticipated toxic byproducts of the remedy have been identified at OU3.

- *Have physical site conditions (e.g., changes in anticipated direction or rate of groundwater flow) or the understanding of these conditions (e.g., changes in anticipated direction or rate of groundwater flow) changed in a way that could affect the protectiveness of the remedy?*

No changes in site conditions were identified at OU3 during this FYR that would affect exposure pathways. There have been no land-use changes nor are any land-use change anticipated. No new contaminants, sources, or routes of exposure were identified. There is no indication that hydrologic or geologic conditions were inadequately characterized. The contaminant levels in the groundwater are consistent with expectations at the time of the ROD.

#### 7.2.3.3 Changes in Toxicity and Other Contaminant Characteristics (OU3)

There has been no change in the toxicity factors for radon.

- *Have other contaminant characteristics changed in a way that could affect protectiveness of the remedy?*

Other contaminant characteristics have not changed in a way that would affect the protectiveness of the remedy.

#### 7.2.3.4 Changes in Risk Assessment Methods (OU3)

Risk assessment methodologies have not changed in a way that could affect the protectiveness of the remedy. The method of calculating cancer and non-cancer risks by the inhalation exposure route were changed in RAGS Part F (EPA, 2009), but this change should not result in risk estimate changes sufficient to affect the protectiveness of the remedy.

#### 7.2.3.5 Expected Progress Towards Meeting RAOs (OU3)

Because the ROD for OU3 identified No Further Action, there are no current RAOs.

### 7.3 Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

Yes. The annual air monitoring reports 2006 – 2010 indicate releases of radon gas outside the area covered by NRC license in concentrations exceeding EPA standards and potential ARARs. Over the last few years, the radon air monitors at the Homestake fenceline (especially air monitors HMC#4 and HMC#5, the closest monitors to the residential community) have been continuously recording outdoor ambient air radon concentrations associated with $1 \times 10^{-3}$ and higher cancer risk levels. The cancer risks are greater than the EPA's acceptable cancer risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$ as published in the NCP. Therefore the EPA is currently conducting a risk assessment to determine the protectiveness of human health.

#### 7.3.1 Ecological Risks

With respect to OU1, contaminants occur in groundwater with no identified releases to surface water. They are, therefore, not expected to adversely affect environmental receptors at the Site.

With respect to OU2, nothing has changed that would affect the protectiveness of the remedy.

With respect to OU3, radon entering houses and buildings is not expected to affect ecological receptors.

Overall, no information has been found with respect to ecological receptors that would call into question the protectiveness of the remedy.

#### 7.3.2 Natural Disaster Impacts

The large tailings pile has been engineered to withstand the probable maximum flood event occurring within the San Mateo Creek watershed, and the probable maximum earthquake event, although it is unclear whether the earthquake stability analysis assumed unsaturated tailings. In light of the relatively recent tailings flushing program, which has increased the percentage of fluid-filled pore-space, this issue should be revisited. Although this part of New Mexico is not as seismically active as the Rio Grande Valley to the east-southeast, earthquakes do occur in the Grants area, and the large tailings pile sits above a fault.

With respect to the continued competence of the tailings piles and other engineered structures, volcanism may pose the highest potential risk from a natural disaster standpoint. The Site is within the Jemez Lineament, a zone of crustal weakness that has experienced periodic eruptions

over the past 16 million years. The Bluewater basalt flow that originated from the El Tintero cinder cone approximately eight miles northwest of the site came to within a mile of the west side of the large tailings pile, and is dated at approximately 50,000 years before present. The McCarty's basalt flow southeast of Grants may be as young as a few hundred years. Obviously it is not practical to engineer for a potential basalt flow in the area, and there would likely be bigger concerns should renewed volcanism occur, but it should be understood that it is a possibility that could compromise the integrity of engineered structures at the Site. Also, the waste disposal area design should provide a reasonable assurance that it will effectively control radiological hazards for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years (10 CFR 40, Appendix A, Criterion 6 (1)).

### 7.3.3 Any Other Information That Could Call Into Question the Protectiveness of the Remedy

Although the OU3 ROD called for no further action, EPA recognized the need to monitor outdoor radon and windblown particulate levels south of the disposal area to ensure that conditions in the subdivisions remain protective until final site closure. Therefore, in September 2010, EPA began collecting sample data to support the development of a Human Health Risk Assessment, to include indoor and outdoor radon samples. The sample collection will continue on a quarterly basis until September 2011. A final Human Health Risk Assessment is expected in March 2012. A determination of the protectiveness of the remedy for OU3 is deferred until the HHRA is completed.

## 7.4 Technical Assessment Summary

The relatively small groundwater remediation system that started in 1977 has become a large, complex system costing in excess of $3 million per year to operate and maintain. HMC has been proactive and creative throughout the process in its efforts to maintain an appropriate level of protectiveness to the nearby residents. However, after 34 years of aggressively working to remediate groundwater, contamination levels remain that are up to three orders of magnitude greater than the action levels.

The groundwater remediation can actually be broken down into three phases when considering contaminant flux. From 1977 to approximately 1990 the milling operation was active and, during that time, contaminant flux was kept steady due to continued processing of ore. From approximately 1990 to 2000, contaminant flux presumably declined because no new mass was added into the system. From 2000 to the present, the tailings flushing program has increased the contaminant flux due to the enhanced mobilization of contaminants from the fines portion of the tailings.

Due to the age of the project and the large volume of documents generated over the 30+ years since project inception, this FYR focused on those documents thought to be relevant to an overall understanding of the site rather than detailed analyses of the various components of the complex remedial system. This general technical assessment includes the following observations:

- The remedial system is somewhat unconventional with its considerable use of injection wells as part of the system; however, the injection of "clean" water into the alluvium continues to be an important component of the remedy to maintain hydraulic control and prevent potential breakthrough of the contaminant plume downgradient.

- The remedial system began operating 34 years ago, and although system operation has removed contaminants from the impacted aquifers, clean-up contaminant concentrations have not been achieved.

- Injection of "clean" water into the alluvial aquifer and continual modification of the system results in an inability to determine meaningful concentration trends. This has also increased the downward hydraulic-head differential which puts vertical containment at risk. Progressive reduction of permeability may occur due to mineral precipitation in injection zones due to significant geochemical differences of the various aquifers.

- The documents reviewed generally do not include sufficient information on the hydrogeologic conceptual model in which the engineered system operates, including geochemical considerations.

- The persistence of some portions of the contaminant plumes may be indicative of residual soil source(s) left in place during the mill decommissioning process.

Since a health advisory has been issued to minimize the possibility of new water-supply wells being installed in the project area, the primary concern with the protectiveness of the OU1 and OU2 remedies are timeliness and vertical containment.

HMC has continued to remove contaminant mass from the groundwater, and has continually adjusted the unconventional remedial system in efforts to remediate the Site. However, there may be significant residual soil sources beneath the former ore storage areas that continue to leach contaminants to groundwater, and the tailings flushing program has mobilized contaminants that may be better left in place in the large tailings pile. The current remedial strategy may result in delaying closure of OU1 and OU2 indefinitely. In addition, injection of clean water for hydraulic control purposes has created a situation where it is nearly impossible to determine how much progress has been made by diluting some parts of the aquifers and pushing contaminants into other areas. The system is modified so frequently that the hydrologic regime is in a constant state of flux. An unintended consequence of the injection programs may be loss of containment below the alluvium due to the faulted/fractured bedrock and persistence of significant downward vertical hydraulic gradients that have been artificially created.

The system is complicated and the results of the current pilot study should be evaluated to determine whether rebounding will occur once the flushing program has ended. Construction of a final engineered radon/recharge reduction cover on the large tailings pile will result in drastically lower contaminant flux in this semi-arid climate. Current plans call for all solid wastes from the collection and evaporation ponds to be placed in EP-1. EP-1 is the oldest of the

evaporation ponds, has only a single liner near the end of its design life, and no dedicated leak-detection system.

## 8.0 Issues

Issues that affect either the protectiveness of the remedy, the timeliness of the remedy, or both are presented in **Table 1**.

## 9.0 Recommendations and Follow-up Actions

**Table 2** presents a recommended action to address the potential issues identified in Section 8.0. While not all of the issues relate to protectiveness, some relate more to timeliness of the remedy. While timeliness is not a protectiveness issue, there is an indirect correlation since Site workers are subject to more cumulative exposure the longer remediation continues.

## 10.0 Protectiveness Statement

The remedy, exclusive of OU3 at the Homestake Mining Company Site, is protective of human health and the environment through the combined effects of HMC's ongoing ground water remedial action with associated ground water monitoring, and the dissemination of a health advisory through the State's well permitting process, which advises prospective wellowners of the potential existence of ground water exceeding drinking water standards. Potential exposure to onsite contamination has been minimized through stabilization of the tailings piles, surface reclamation, and decommissioning of the former mill. Radon barrier and erosion protection covers were constructed on the sides of the large tailings pile, and an interim soil cover was constructed on its top and on the small tailings pile. Groundwater contamination is controlled through the use of a groundwater collection and injection system and issuance of a health advisory to limit the primary exposure pathway of ingestion.

Based on current information, the remedy at OU1 is protective of human health and the environment through the use of a groundwater collection and injection system at the Site and the use of a health advisory which limits the primary exposure pathway of ingestion. There is no evidence of current exposure from any media at this time.

Based on current information, the remedy at OU 2 is protective of human health and the environment due to the stabilization of the tailings piles, surface reclamation, and decommissioning of the mill. Soil contaminated by windblown tailings was excavated and disposed of in the large tailings pile and the mill facility was decontaminated, demolished, and parts were either buried in place or placed in the large tailings pile. A radon barrier and erosion-protection cover were constructed on the sides of the large tailings pile, and an interim soil cover was constructed on its top and on the small tailings pile.

Even though the OU3 ROD called for no further action, EPA recognized the need to monitor outdoor radon and windblown particulate levels south of the disposal area to ensure that conditions in the subdivisions remain protective until final site closure. Therefore, EPA continues to review outdoor radon monitoring and particulates data collected at the facility boundary. Also, in September 2010, EPA began collecting sample data to support the development of a Human Health Risk Assessment, to include indoor and outdoor radon samples. The sample collection will continue on a quarterly basis until September 2011. A final Human Health Risk Assessment is expected in March 2012 which will provide information needed to support a determination of the protectiveness of the OU3 remedy. The determination of protectiveness for OU3 is, therefore, deferred until the Human Health Risk Assessment is completed.

## 11.0 Next Review

The next FYR will be conducted within five years of the signature date of this review by EPA.

# TABLES

**Table 1**
**Issues**
**Homestake Mining Company Superfund Site**
**Cibola County, New Mexico**

| Issue No. | Issue | Affects Protectiveness (Y/N) | |
|---|---|---|---|
| | | Current | Future |
| | **Operable Unit 1** | | |
| 1 | Extraction of large quantities of water from the San Andres Formation and subsequent injection, primarily into the alluvial aquifer, has created localized areas with an artificial head difference of approximately 100 ft that, combined with the presence of faults and associated fracturing in the bedrock, increases the risk of downward migration of contaminants. | No | Yes |
| 2 | Rebound conditions are unknown in the tailings flushing program. The flushing program is also likely decreasing the stability of the large tailings pile due to the increased saturation of the pore spaces. The earthquake stability analysis assumed unsaturated tailings and did not account for the increased percentage of fluid-filled pore space resulting from the relatively recent tailings flushing program. | No | Yes |
| | **Operable Unit 2** | | |
| 1 | A persistent plume of elevated uranium contamination just south of the former mill site may be a remnant of the large tailings pile contaminant plume and may continue to impact groundwater. In addition, an historic irrigation ditch established in the 1920s that ran through the future Homestake Mill property, and presumably was backfilled to original grade during construction of the mill, may be serving as a preferential pathway for leached contaminants to groundwater. | No | Yes |
| 2 | The east side slope of the small tailings pile/Evaporation Pond 1 had moderate to large furrows and the west side of the westernmost collection pond had moderate furrows, both of which appeared to be the result of rainfall/erosion. | No | No |
| | **Operable Unit 3** | | |
| 1 | Annual air monitoring reports in 2006 – 2010 indicate releases of radon outside the area covered by the NRC license, in concentrations exceeding EPA standards. | Yes | Yes |

| Issue No. | Issue | Affects Protectiveness (Y/N) | |
|---|---|---|---|
| | | Current | Future |
| | **Operable Unit 3** | | |
| 2 | The 2006- 2010 annual air monitoring report indicates that releases of radon exceeded the annual average concentrations allowed under 40 CFR 192.02(b)(2). | Yes | Yes |
| 3 | Radon air monitors along the Homestake fenceline have continuously recorded outdoor ambient air radon concentrations associated with cancer risk levels that are greater than EPA's acceptable cancer risk range of $1 \times 10^{-4}$ to $1 \times 10^{-6}$, as published in the National Contingency Plan. | Yes | Yes |

**Table 2**
**Recommendations and Follow-Up Actions**
**Homestake Mining Company Superfund Site**
**Cibola County, New Mexico**

| Issue No. | Recommendations/Follow-up Actions | Party Responsible | Oversight Agency | Milestone Date |
|---|---|---|---|---|
| | **Operable Unit 1** | | | |
| 1 | Minimize use of clean water and develop alternate source such as treatment of extracted groundwater for use in injection into the alluvial and Chinle Formation aquifers remedy. | HMC | NRC NMED EPA | September 2014 |
| 2 | Conduct a pilot study in a portion of the large tailings pile to demonstrate that rebound will not occur once the flushing program has ended. The earthquake stability analysis should be reevaluated to account for the increased fluid-filled pore space resulting from the tailings flushing program. The protectiveness is dependent on a revised earthquake-risk analysis. | HMC | NRC NMED EPA | September 2012 |
| | **Operable Unit 2** | | | |
| 1 | Determine whether a remnant of the large tailings pile contaminant plume is continuing to impact groundwater. Investigate the backfilled irrigation ditch that ran through the HMC property to determine whether it serves as a preferential pathway for the migration of leached contaminants to groundwater. | HMC | NRC NMED EPA | September 2012 |
| 2 | Provide some type of native vegetative cover or erosion-protection cover to the east side slope of the small tailings pile/Evaporation Pond 1 and the west side of the westernmost collection pond to prevent erosion. | HMC | NRC NMED EPA | September 2012 |
| | **Operable Unit 3** | | | |
| 1 -3 | EPA is currently in the process of completing a radon survey and a determination of the radon source (if possible). Specific recommendations will be made upon completion of the survey. | EPA | - | September 2012 |

**Notes**:

| | |
|---|---|
| HMC | Homestake Mining Company |
| NMED | New Mexico Environment Department |
| NRC | Nuclear Regulatory Commission |

**Table 3**
**Chronology of Site Events**
**Homestake Mining Company Superfund Site**
**Cibola County, New Mexico**

| Operable Unit | Event | Date |
|---|---|---|
| NA | Uranium mining mill operations began at the Homestake Mining Company (HMC) site | 1958 |
| NA | Groundwater contamination first detected at the site | 1961 |
| NA | The state of New Mexico signed an agreement with the Nuclear Regulatory Commission (NRC) authorizing the state to regulate uranium milling activities under the Atomic Energy Act | 1974 |
| NA | The New Mexico Environment Improvement Division (NMEID) and EPA conducted a study of the impacts of mining activities in the Grants Mineral Belt on area groundwater and surface water | 1974-1975 |
| Site wide | Agreement between the New Mexico Environmental Department (NMED) and HMC on a Corrective Action Program (CAP) | 1976 |
| OU1 | Implemented comprehensive groundwater CAP – groundwater remediation began | 1977 |
| OU1 | Initiated fresh-water injection into six alluvial wells on the north side of Broadview Acres (G line) | 1977 |
| OU1 | Installed S and D line collection wells | 1978 |
| OU1 | Began Murray Acres collection program by pumping two alluvial wells | 1980 |
| Site wide | HMC site proposed for inclusion on the National Priorities List (NPL). Added two additional Murray Acres collection wells. | 1981 |
| OU1 | Added additional collection wells on the D collection line. Added 11 injection wells on the north side of Broadview Acres, extending the fresh water injection line to the east along the G line injection wells | 1982 |
| Site-wide | HMC site placed on the NPL | 1983 |
| OU1 | Consent Decree (CD) signed by EPA and HMC requiring HMC to pay for an extension of the Village of Milan municipal water system to four residential subdivisions, and to pay for basic water services for the residents of these subdivisions for 10 years. Added M injection line on the north side of Murray Acres | 1983 |
| OU1 | Well CW5 initiated injection into Upper Chinle | 1984 |
| OU1 | Approval of groundwater discharge plan (DP) - 200 | 1984 |
| OU1 | Completed Phase II Feasibility Study (FS) | 1986 |
| OU1 | Milan water supply installed for Broadview Acres, Felice, Acres, Murray Acres, and Pleasant Valley Estates subdivisions | 1986 |
| Site-wide | The state of New Mexico returned regulatory authority for uranium mills to NRC | 1986 |
| OU3 | Administrative Order on Consent issued to HMC to conduct a Remedial Investigation (RI)/FS for the Radon Operable Unit | 1987 |
| OU3 | RI/FS conducted for the Radon Operable Unit | 1987-1989 |
| OU3 | RI/FS reports issued for the Radon Operable Unit | 1989 |
| OU1 | Record of Decision (ROD) – OU1 | 1989 |
| OU1 | NRC Corrective Action Plan developed | 1989 |

| Operable Unit | Event | Date |
|---|---|---|
| OU3 | ROD for the Radon Operable Unit selecting no further action was necessary | 1989 |
| Site-wide | Uranium milling operations at the site ceased | 1990 |
| OU1 | Modified Murray Acres collection system by closing well AW and adding collection wells E, Z, and JC. Added injection well AW (Murray Acres) and wells GW1, GW2, and GW3 (north of Broadview Acres) to the injection system. | 1990 |
| OU1 | Started using Evaporation Pond No. 1 | 1990 |
| OU1 | Installed toe drains around the tailings | 1992 |
| OU2 | Began reclamation activities to clean up soils and decommission the mill. Reclamation plan submitted to NRC. | 1993 |
| Site-wide | Memorandum of Understanding signed by EPA Region 6 and NRC Region 4 detailing each agency's responsibilities and authority at the HMC site | 1993 |
| OU1 | Turned off the last two Murray Acres collection wells. Added three wells in the K line to the collection program. Upgradient P wells began pumping upgradient alluvial water and transferring it to the drainage to the west. | 1993 |
| OU2 | Re-contoured west side of large tailings pile | 1993 |
| OU1 | Ceased operation of GW injection wells | 1993 |
| OU1 | J injection line started | 1993 |
| OU1 | EPA released HMC from 1983 CD | 1994 |
| OU1 | Added additional K line wells | 1994 |
| OU2 | Re-contoured east side of large tailings pile | 1994 |
| OU1 | Drilled additional downgradient wells in the alluvial aquifer and Chinle formations | 1995/1996 |
| OU2 | Completed demolition of the mill and surface reclamation activities | 1995 |
| OU1 | Began collection of lower concentration water for re-injection into the higher concentration areas in the alluvial aquifer | 1995 |
| OU2 | Tested dewatering of the large tailings pile | 1995 |
| OU1 | Began using C collection wells. Ceased injection into Upper Chinle well CW5. | 1995 |
| OU1 | Extended M injection line to the north | 1996 |
| OU1 | Began using Evaporation Pond No. 2 | 1996 |
| OU1 | Initiated fresh-water injection in Upper Chinle well CW13 | 1996 |
| OU1 | Resumed injection into Upper Chinle well CW5. Initiated injection into Middle Chinle well CW14. Installed additional M injection wells. | 1997 |
| OU1 | Ceased injection into Murray Acres well AW. Added additional upgradient collection wells. | 1998 |
| OU2 | Soil cleanup and mill reclamation approved by NRC | 1999 |
| OU1 | Added reverse osmosis (RO) unit to treat water and produce RO product water for injection into the alluvial aquifer | 1999 |
| OU1 | Initiated collection from Upper Chinle well CE2 | 1999 |
| OU1 | Moved M injection line to the WR injection line; initiated irrigation of 270 acres; and initiated injection into Upper Chinle well CW25. | 2000 |
| OU2 | Initiated flushing program for the large tailings pile. | 2000 |

| Operable Unit | Event | Date |
|---|---|---|
| Site-wide | First EPA Five-year Review (FYR) approved | 2001 |
| OU1 | Added 60 acres of irrigation area | 2002 |
| OU1 | Initiated fresh-water injection in Section 28; fresh-water injection into Upper Chinle well 944; fresh-water injection into the alluvial aquifer east of Felice Acres; and fresh-water injection east of Broadview Acres. | 2002 |
| OU2 | Second RO unit added to the treatment plant to increase RO treatment capacity from 300 to 600 gallons per minute | 2002 |
| OU2 | Added fresh-water injection line west of the large tailings pile. Initiated fresh-water injection into Section 3. | 2003 |
| OU2 | Added 24 acres of flood irrigation area in Section 33; injection lines in Section 3; and injection lines east of Broadview Acres and in southern Felice Acres. | 2004 |
| OU1 | Expansion of groundwater collection and irrigation system completed - added 40 acres of irrigation to the Section 28 center pivot; extended the S injection line west of the large tailings pile to the north; added fresh-water injection lines NP1 - NP8 in Sections 27 and 28; initiated injection into NP1 - NP6; added three fresh-water injection lines to the east of the large tailings pile; added freshwater injection lines EBA3 - EBA5 near the L collection line; added injection lines EMA1 - EMA5 to the south and west of the large tailings pile; and initiated fresh-water injection into EMA1 and RO product water into EMA2 - EMA5. | 2005 |
| OU1 | NMED approved revised site groundwater background concentrations for each aquifer unit | 2005 |
| OU1 | NMED performed sampling of residential wells at nearby subdivisions | 2005 |
| OU1 | Implemented Revised CAP | 2006 |
| Site-wide | Second EPA FYR approved | 2006 |
| Site -wide | EPA begins a Remedy System Evaluation | 2008 |
| Site-wide | NMED issues a Health Advisory to limit ground water exposure | 2009 |
| Site-wide | Memorandum of Agreement between NMED and HMC to provide water hook-ups to residents | 2009 |
| Site-wide | ATSDR issues a Health Consultation Report | 2009 |
| OU 1-2 | NMED approves DP-725 and Evaporation Pond 3 | 2009 |
| Site-wide | EPA begins year long multi-media sampling including radon, water and soil to support a risk assessment effort | 2010 |
| Site -wide | EPA - Addendum to Remedy System Evaluation | 2010 |
| OU 1-2 | EPA recommends implementation of Remedy System Evaluation Recommendations | 2011 |
| OU 1-2 | EPA issues a deficiency letter to NRC regarding HMC's non-compliance with radon standards and potential ARARs | 2011 |
| OU 1-2 | NMED - Temporary permission granted for land application of alluvial water in Section 28 | 2011 |
| OU 1-2 | NMED - Temporary permission denied for land application of alluvial water in Section 33 center pivot and Sections 33 and 34 flood irrigation areas | 2011 |

**TABLE 2.1-1. QUANTITIES OF CONSTITUENTS COLLECTED.**

| YEAR | SOURCE | TOTAL VOLUME PUMPED (GAL) | SULFATE (SO4) CONC. AMT. (MG/L) | (LB) | URANIUM (U) CONC. AMT. (MG/L) | (LB) | MOLYBDENUM (MO) CONC. AMT. (MG/L) | (LB) | SELENIUM (SE) CONC. AMT. (MG/L) | (LB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1978 | G.W. | 27670033 | 5200 | 1200620 | 35 | 8081 | 40 | 9236 | 2 | 462 |
| 1979 | G.W. | 46371629 | 5200 | 2012095 | 35 | 13543 | 40 | 15478 | 2 | 774 |
| 1980 | G.W. | 39385860 | 5200 | 1708978 | 35 | 11503 | 40 | 13146 | 2 | 657 |
| 1981 | G.W. | 91613183 | 5200 | 3975155 | 35 | 26756 | 40 | 30578 | 2 | 1529 |
| 1982 | G.W. | 159848025 | 5200 | 6935910 | 35 | 46684 | 40 | 53353 | 2 | 2668 |
| 1983 | G.W. | 167018540 | 5200 | 7247043 | 35 | 48778 | 40 | 55746 | 2 | 2787 |
| 1984 | G.W. | 203258522 | 5200 | 8819519 | 35 | 59362 | 40 | 67842 | 2 | 3392 |
| 1985 | G.W. | 194074421 | 5200 | 8421015 | 35 | 56680 | 40 | 64777 | 2 | 3239 |
| 1986 | G.W. | 199326030 | 5200 | 8648886 | 35 | 58214 | 40 | 66530 | 2 | 3326 |
| 1987 | G.W. | 180881740 | 5200 | 7848576 | 35 | 52827 | 40 | 60374 | 2 | 3019 |
| 1988 | G.W. | 166460826 | 5200 | 7222843 | 35 | 48615 | 40 | 55560 | 2 | 2778 |
| 1989 | G.W. | 175780800 | 5200 | 7627243 | 35 | 51337 | 40 | 58671 | 2 | 2934 |
| 1990 | G.W. | 164378919 | 5200 | 7132508 | 35 | 48007 | 40 | 54865 | 2 | 2743 |
| 1991 | G.W. | 171497720 | 5200 | 7441397 | 35 | 50086 | 40 | 57242 | 2 | 2862 |
| 1992 | G.W. | 128398849 | 4925 | 5276234 | 27.2 | 29134 | 35.9 | 38419 | 1.60 | 1718 |
| 1992 | TOE | 8544670 | 12117 | 864006 | 53.2 | 3793 | 106.5 | 7595 | 1.73 | 123 |
| 1993 | G.W. | 115795020 | 5011 | 4841203 | 28.1 | 27130 | 45.4 | 43885 | 1.47 | 1425 |
| 1993 | TOE | 18357680 | 12117 | 1856262 | 53.2 | 8150 | 106.5 | 16315 | 1.73 | 265 |
| 1994 | G.W. | 98294087 | 4423 | 3624762 | 26.0 | 21146 | 27.3 | 22349 | 1.42 | 1162 |
| 1994 | TOE | 18337680 | 12117 | 1854240 | 53.2 | 8141 | 106.5 | 16299 | 1.73 | 264 |
| 1995 | G.W. | 108306398 | 3256 | 2942827 | 16.1 | 14553 | 19.2 | 17355 | 1.65 | 1491 |
| 1995 | TOE | 17711370 | 11370 | 1680500 | 54.6 | 8069 | 94.4 | 13952 | 2.25 | 332 |
| 1995 | TAILS | 5905740 | 8191 | 403680 | 36.1 | 1778 | 89.7 | 4420 | 0.15 | 7 |
| 1996 | G.W. | 122064160 | 3899 | 3967919 | 20.9 | 21225 | 26.8 | 27259 | 1.92 | 1950 |
| 1996 | TOE | 15431810 | 11537 | 1484295 | 46.4 | 5970 | 105.0 | 13509 | 1.29 | 166 |
| 1996 | TAILS | 9181390 | 9434 | 722129 | 40.2 | 3077 | 108.0 | 8236 | 0.18 | 14 |
| 1997 | G.W. | 94465562 | 4955 | 3836678 | 26.9 | 20892 | 33.4 | 25887 | 3.17 | 2456 |
| 1997 | TOE | 12029390 | 11094 | 1113808 | 41.8 | 419 | 100.0 | 10040 | 0.81 | 81 |
| 1997 | TAILS | 21292900 | 10284 | 1827575 | 45.8 | 8139 | 92.4 | 16420 | 0.14 | 25 |
| 1998 | G.W. | 74459130 | 5088 | 3161866 | 29.6 | 18385 | 34.8 | 21625 | 1.85 | 1151 |
| 1998 | TOE | 10321780 | 9870 | 850257 | 42.5 | 3665 | 95.2 | 8203 | 0.73 | 63 |
| 1999 | G.W. | 117752408 | 3363 | 3305027 | 16.6 | 16314 | 14.8 | 14545 | 2.06 | 2024 |
| 1999 | TOE | 8809890 | 11560 | 849976 | 54.3 | 3993 | 106.0 | 7794 | 0.46 | 34 |
| 1999 | TAILS | 120550 | 9420 | 9478 | 40.9 | 41 | 111.5 | 112 | 0.19 | 0 |
| 2000 | G.W. | 146609842 | 3358 | 4108868 | 18.8 | 23004 | 20.6 | 25206 | 1.94 | 2374 |
| 2000 | TOE | 8032870 | 9734 | 652590 | 58.6 | 3929 | 118.0 | 7911 | 0.34 | 23 |
| 2000 | TAILS | 12446810 | 9710 | 1008685 | 37.8 | 3927 | 127.0 | 13193 | 0.30 | 31 |
| 2001 | G.W. | 144925056 | 2770 | 3350438 | 19.6 | 23707 | 21.4 | 25884 | 1.65 | 1996 |
| 2001 | TOE | 9606280 | 9935 | 796529 | 43.1 | 3455 | 95.7 | 7673 | 0.78 | 63 |
| 2001 | TAILS | 31465370 | 8688 | 2281555 | 34.6 | 9086 | 89.2 | 23425 | 0.19 | 50 |
| 2002 | G.W. | 201357360 | 2748 | 4618092 | 14.9 | 25040 | 16.7 | 28065 | 1.23 | 2067 |
| 2002 | TOE | 17975520 | 9210 | 1381718 | 33.4 | 5011 | 88.7 | 13307 | 0.76 | 114 |
| 2002 | TAILS | 17817840 | 7670 | 1140588 | 23.5 | 3495 | 40.8 | 6067 | 0.12 | 18 |
| 2003 | G.W. | 177727419 | 2417 | 3585168 | 13.8 | 20470 | 15.5 | 22991 | 0.73 | 1083 |
| 2003 | TOE | 28418871 | 9457 | 2243048 | 35.6 | 8444 | 78.9 | 18714 | 4.35 | 1032 |
| 2003 | TAILS | 8890076 | 9800 | 727126 | 28.0 | 2078 | 92.0 | 6826 | 0.30 | 22 |
| 2004 | G.W. | 154422720 | 2272 | 2931913 | 11.3 | 14633 | 16.6 | 21386 | 0.79 | 1017 |
| 2004 | TOE | 26720928 | 8007 | 1787722 | 31.9 | 7115 | 67.6 | 15102 | 2.78 | 622 |
| 2004 | TAILS | 44745696 | 6360 | 2377848 | 23.1 | 8637 | 60.9 | 22769 | 0.20 | 75 |
| 2005 | G.W. | 130810679 | 2478 | 2705346 | 11.8 | 12883 | 15.5 | 16922 | 0.59 | 644 |
| 2005 | TOE | 20704320 | 8228 | 1421784 | 43.5 | 7517 | 87.5 | 15120 | 2.63 | 454 |
| 2005 | TAILS | 45685786 | 4389 | 1673497 | 18.7 | 7130 | 56.3 | 21467 | 0.18 | 69 |
| 2006 | G.W. | 132406109 | 1990 | 2199072 | 9.6 | 10609 | 14.3 | 15802 | 0.73 | 807 |
| 2006 | TOE | 20374782 | 7432 | 1263796 | 38.0 | 6462 | 76.2 | 12958 | 1.09 | 185 |
| 2006 | TAILS | 43707760 | 4278 | 1560550 | 17.6 | 6420 | 51.9 | 18932 | 0.14 | 51 |
| 2007 | G.W. | 137707200 | 2420 | 2781316 | 10.3 | 11838 | 16.7 | 19193 | 0.52 | 598 |
| 2007 | TOE | 25037779 | 6829 | 1427024 | 31.9 | 6666 | 67.3 | 14063 | 1.20 | 251 |
| 2007 | TAILS | 24561680 | 4130 | 846616 | 19.9 | 4079 | 61.1 | 12525 | 0.15 | 31 |
| 2008 | G.W. | 137145174 | 2672 | 3058408 | 11.5 | 13163 | 16.5 | 18886 | 0.61 | 698 |
| 2008 | TOE | 26140850 | 7847 | 1711992 | 31.6 | 6894 | 68.5 | 14945 | 1.58 | 345 |
| 2008 | TAILS | 5950324 | 4671 | 231968 | 16.0 | 795 | 42.8 | 2126 | 0.24 | 12 |
| 2009 | G.W. | 131564160 | 3145 | 3401818 | 15.5 | 16766 | 19.1 | 20660 | 0.85 | 919 |
| 2009 | TOE | 27238830 | 7792 | 1771396 | 35.0 | 7957 | 69.9 | 15891 | 0.81 | 184 |
| 2009 | TAILS | 29403070 | 3850 | 944782 | 13.7 | 3362 | 38.6 | 9472 | 0.24 | 59 |
| SUM G.W. | | 4,341,777,581 | | 149,938,744 | | 921,363 | | 1,089,718 | | 58,750 |
| SUM TOE | | 319,795,300 | | 25,010,943 | | 105,649 | | 229,390 | | 4,600 |
| SUM TAILS | | 301,174,992 | | 15,756,079 | | 62,044 | | 165,990 | | 463 |
| COMBINED SUM | | 4,962,747,873 | | 190,705,766 | | 1,089,056 | | 1,485,098 | | 63,813 |

NOTE: Average concentrations for 1978 to 1991 were used in calculating the quantities of constituents removed.
Concentrations from the collection wells have gradually decreased from 1978 through 1991.
G.W. = Ground water; TOE = Toe drains on edge of tailings; TAILS = Large tailings collection wells

## 4.3 QA Program

A comprehensive field and laboratory quality control program has been used, and will continue to be used, to assure the quality of the monitoring data. The program (which is anticipated for use) is presented in Appendix B.

Table 5

**Table 4-1 Proposed Compliance Monitoring Program**

| Well | Parameters to be Monitored | Frequency of Monitoring |
|---|---|---|
| POINT-OF-COMPLIANCE WELLS | | |
| Point-of-compliance wells D1, X, S4, CE2, CE8 | B, F<br>H | Annually<br>Semi-Annually |
| Background wells P, Q | B, F<br>G | Annually<br>Semi-Annually |
| COMPLIANCE MONITORING WELLS | | |
| ALLUVIAL WELLS | | |
| Broadview Acres wells SUB1, SUB2, SUB3 | B, F<br>G | Annually<br>Semi-Annually |
| Felice Acres wells 490, 491, 496 | G | Semi-Annually |
| Murray Acres wells 802, 844 | G | Semi-Annually |
| Pleasant Valley wells 688, 846 | G | Semi-Annually |
| Regional wells 631, 649, 687, 869, 881, 920, 942 | G | Semi-Annually |
| Site monitoring wells F, FB, GH, GN, MO, MR, MX, R, S2 | G | Semi-Annually |
| Collection system wells | Total volume | Monthly |
| Injection system wells | Total volume | Monthly |
| Reversal wells B, BA, KZ, DZ, SO, SP, S2, S5 | Water level | Weekly |
| CHINLE WELLS | | |
| Broadview Acres well CE9 | G | Semi-Annually |
| Felice Acres wells 493, 494, CW45 | G | Semi-Annually |
| Regional wells CW18, CW29, CW42 | G | Semi-Annually |
| Site monitoring wells CW25, CW50 | G | Semi-Annually |
| SAN ANDRES WELLS | | |
| #1 Deep, #2 Deep, 943, 951 | D<br>G | Annually<br>Semi-Annually |

*Parameters:

B: Water level, pH, TDS, $SO_4$, Cl, $HCO_3$, $CO_3$, Na, Ca, Mg, K, $NO_3$, U, Se, Mo, Ra-226

D: pH, TDS, Ca, Mg, K, Na, $SO_4$, Cl, $HCO_3$, $CO_3$, $NO_3$ as N, Se, Mo, Al, As, Ba, Cd, Cu, CN, F, Fe, Pb, Mn, Hg, Ni, Ag, Zn, U, Ra-226 (filtered)

F: V, Ra-228, Th-230

G: Water level, TDS, $SO_4$, U, Se, Mo

H: Water level, TDS, $SO_4$, U, Se, Mo, Cl

**Table 6**
**Groundwater Protection Standards at Beginning of Review Period**
**Homestake Mining Company Superfund Site**
**Cibola County, New Mexico**

| Constituent | License SUA-1471 GWPS | NMED DP-200 GWCL |
|---|---|---|
| uranium | 0.04 mg/L[1] | 5.0 mg/L |
| selenium | 0.10 mg/L[1] | 0.12 mg/L[1] |
| molybdenum | 0.03 mg/L[1] | 1.0 mg/L (irrigation) |
| vanadium | 0.02 mg/L[1] | - |
| chromium | 0.06 mg/L[1] | 0.05 mg/L |
| radium-226 and -228 | 5.0 pCi/L | 30 pCi/L |
| thorium-230 | 0.30 pCi/L[1] | - |
| sulfate | - | 976 mg/L[1] |
| chloride | - | 250 mg/L |
| total dissolved solids | - | 1770 mg/L[1] |
| nitrate | - | 12.4 mg/L[1] |

**Notes:**
[1] Values based on site-specific groundwater background concentrations
pCi/L – picocurie per liter
mg/L – milligram per liter

**Table 7**
**Revised Groundwater Protection Standards**
**Homestake Mining Company Superfund Site**
**Cibola County, New Mexico**

| Constituent | Alluvial Aquifer | Chinle Mixing Zone | Upper Chinle Non-Mixing Zone | Middle Chinle Non-Mixing Zone | Lower Chinle Non-Mixing Zone |
|---|---|---|---|---|---|
| uranium | 0.16 mg/L[1] | 0.18 mg/L[1] | 0.09 mg/L[1] | 0.07 mg/L[1] | 0.03 mg/L |
| selenium | 0.32 mg/L[1] | 0.14 mg/L[1] | 0.06 mg/L[1] | 0.07 mg/L[1] | 0.32 mg/L[1] |
| molybdenum | 0.1 mg/L | 0.1 mg/L | 0.1 mg/L | 0.1 mg/L | 0.1 mg/L |
| radium-226 and -228 | 5.0 pCi/L | * | * | * | * |
| thorium-230 | 0.3 pCi/L | * | * | * | * |
| sulfate | 1500 mg/L[1] | 1750 mg/L[1] | 914 mg/L[1] | 857 mg/L[1] | 2000 mg/L[1] |
| chloride | 250 mg/L | 250 mg/L | 412 mg/L[1] | 250 mg/L | 634 mg/L[1] |
| total dissolved solids | 2734 mg/L[1] | 3140 mg/L[1] | 2010 mg/L[1] | 1560 mg/L[1] | 4140 mg/L[1] |
| nitrate | 12 mg/L[1] | 15 mg/L[1] | * | * | * |

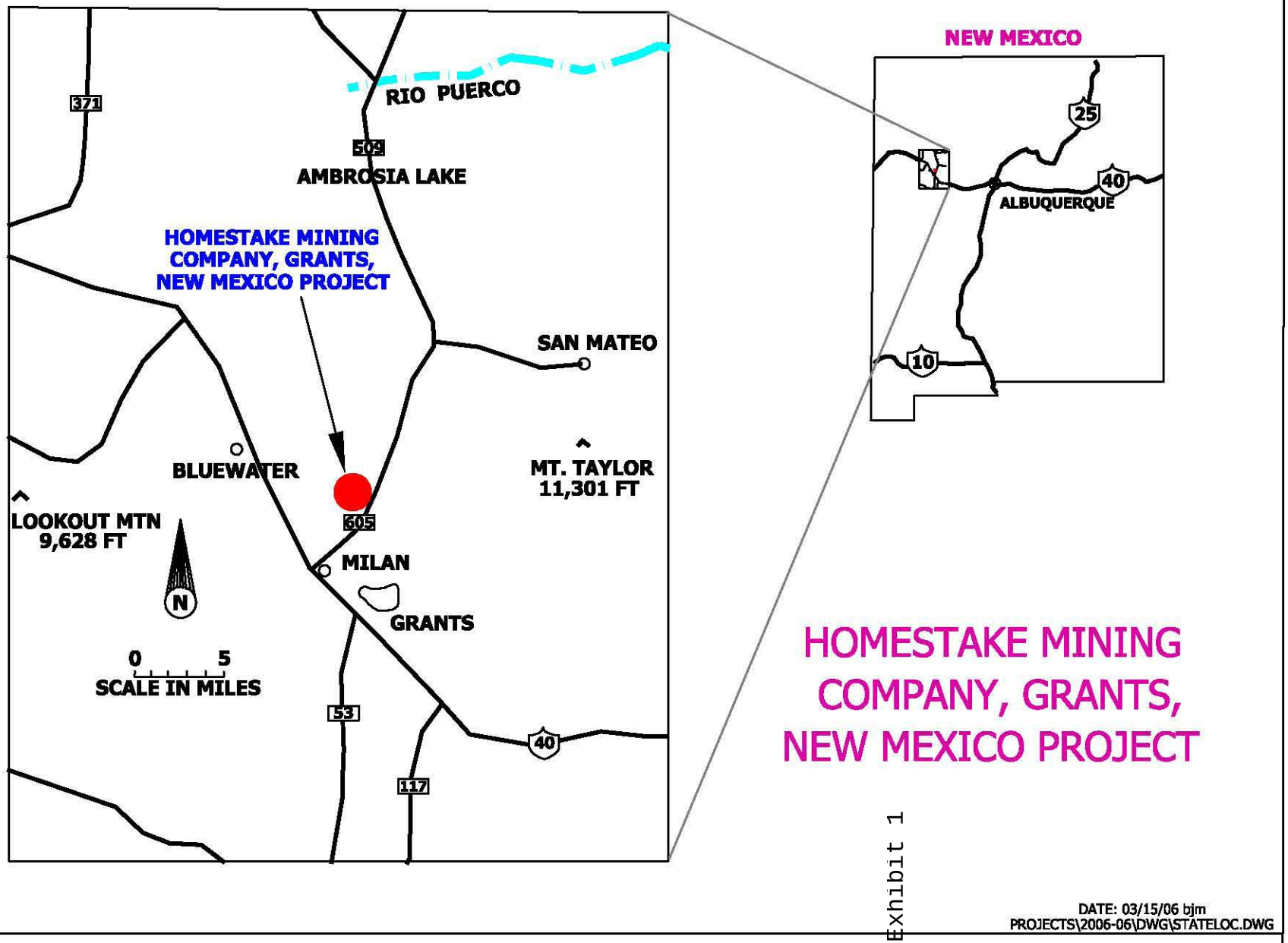
**Notes**:
[1]Values based on site-specific groundwater background concentrations
*Groundwater protection standards not required for constituents in this zone
pC/L – picocurie per liter
mg/L – milligram per liter

**Table 8**
**Changes in Toxicity Values for Chemicals of Concern**
**Homestake Mining Company Superfund Site**
**Cibola County, New Mexico**

| Constituent | Old RfD | Old RfC | Current RfD | Current RfC |
|---|---|---|---|---|
| nitrate | NA | NA | 1.6 mg/kg/day | NA |
| selenium | $5x10^{-3}$ mg/kg/day | NA | $5x10^{-3}$ mg/kg/day | $2.0x10^{-2}$ mg/m$^3$ |
| uranium | $2x10^{-4}$ mg/kg/day | NA | $3x10^{-3}$ mg/kg/day | $3.0x10^{-4}$ mg/m$^3$ |

**Notes:**
NA = not available
RfC – reference concentration
RfD – reference dose
mg/m$^3$ – milligram per cubic millimeter
mg/kg/day – milligram per kilogram per day

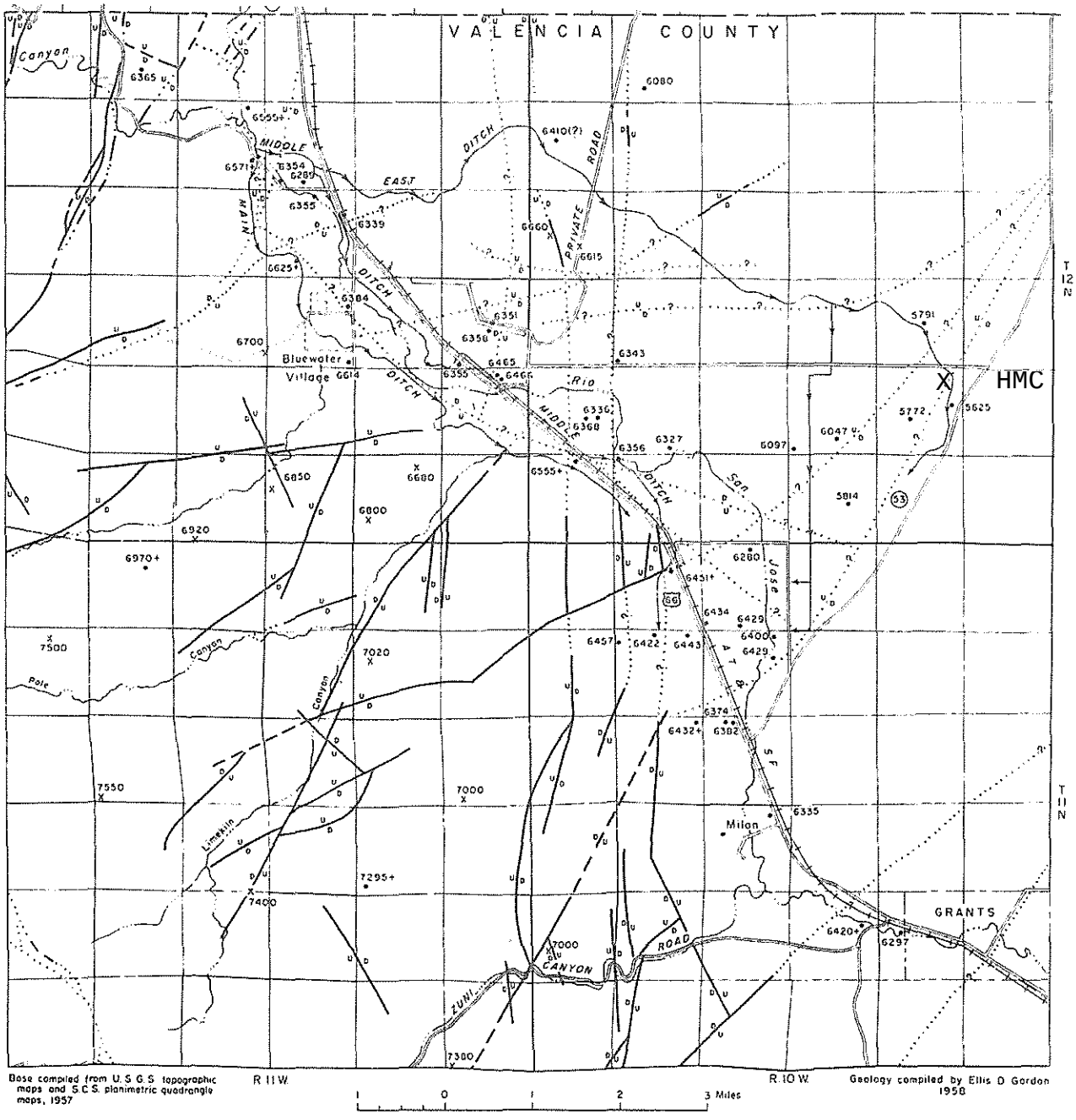
# EXHIBITS




1.2-3

FIGURE 1.2-1. LOCATION OF THE GRANTS PROJECT

Exhibit 2




EXPLANATION

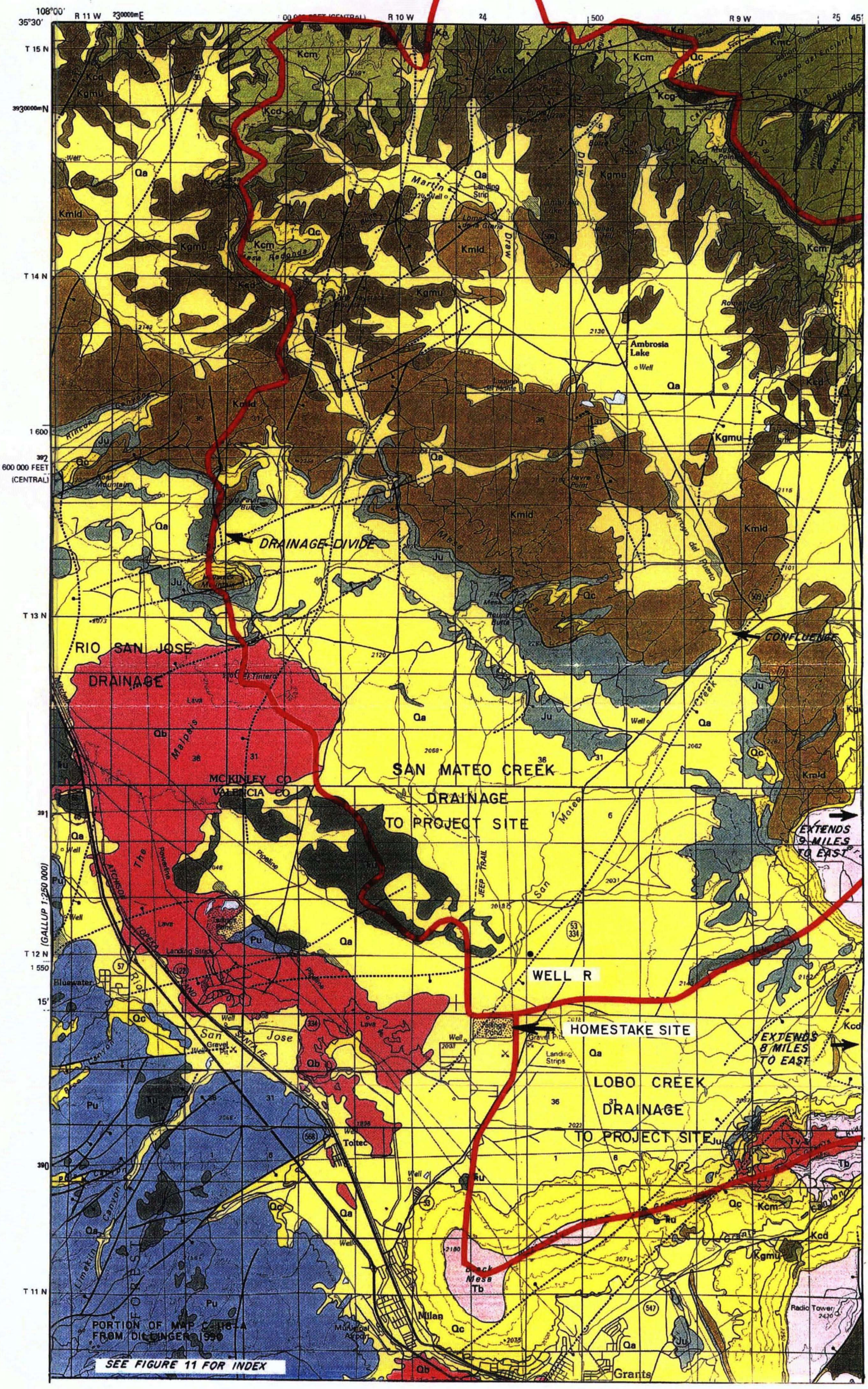
5625
Altitude of top of San Andres limestone in well; + following altitude figure denotes eroded top of formation.

6660
Approximate altitude of top of San Andres limestone at selected points on outcrop.

D
U
Fault; dashed where approximately located or doubtful; dotted where covered by alluvium or basalt (D, downthrown block; U, upthrown block).

FIGURE 11. -- Map of a part of the Grants-Bluewater area showing principal faults and the altitude of the top of the San Andres limestone at selected points in wells and on the outcrop, Valencia County, N. Mex.

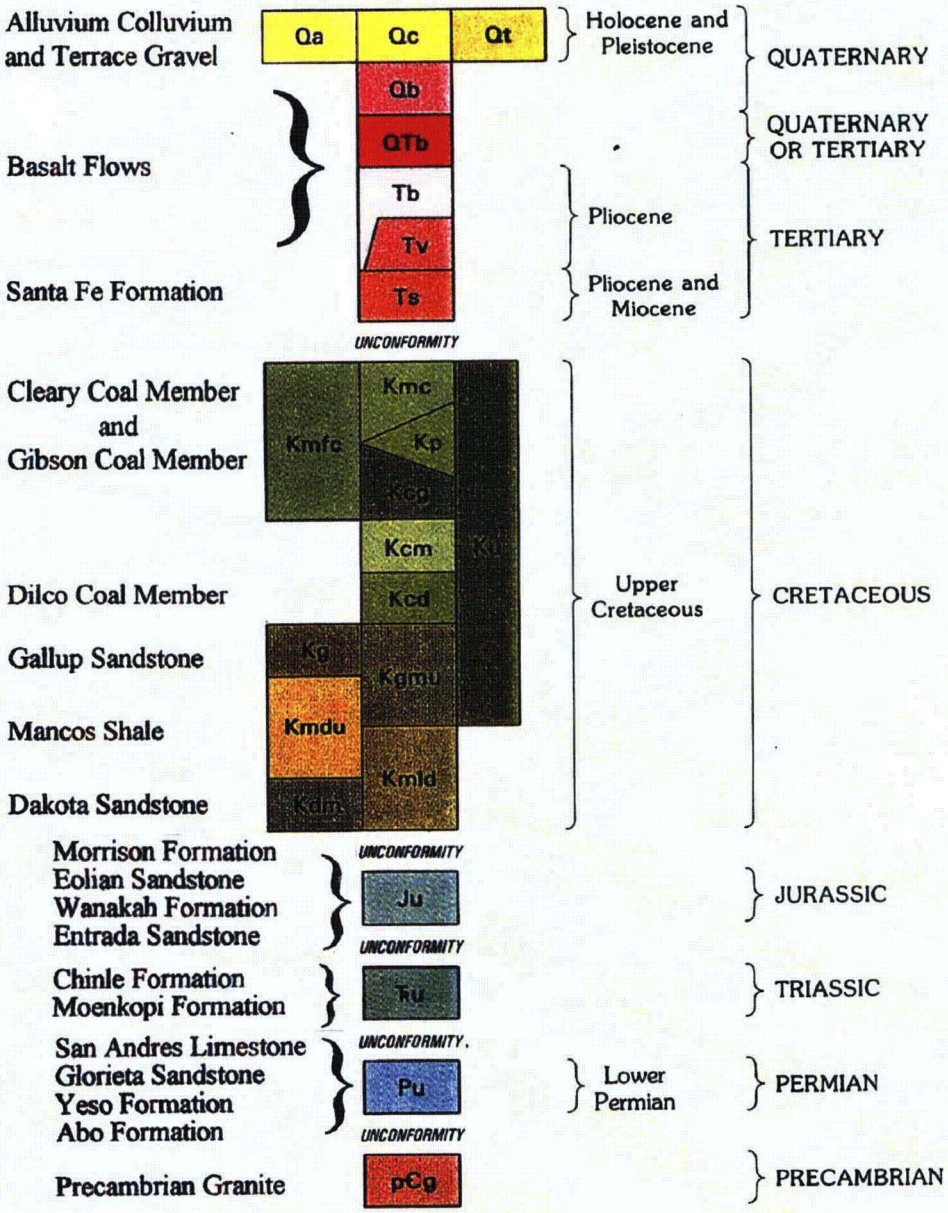
Exhibit 3a




| | |
|---|---|
| HOMESTAKE-MILL-AND-ADJACENT-PROPERTIES<br>GRANTS-NM-TOWNSHIP-11&12-N-RANGE-10-W<br>Date: 10/24/2006 Filename: E:\180899\GEO-figs.dwg | FIGURE 9<br>SAN MATEO AND LOBO CREEK<br>DRAINAGE AND SURFACE GEOLOGY |

Exhibit 3b

CORRELATION OF MAP UNITS




From Map C-113-A Dillinger, 1990

HOMESTAKE-MILL-AND-ADJACENT-PROPERTIES
GRANTS-NM-TOWNSHIP-11&12-N-RANGE-10-W

Date: 10/24/2006 Filename: E:\180899\GEO-figs.dwg

FIGURE 11
GEOLOGIC INDEX FOR FIGURES 9 AND 10

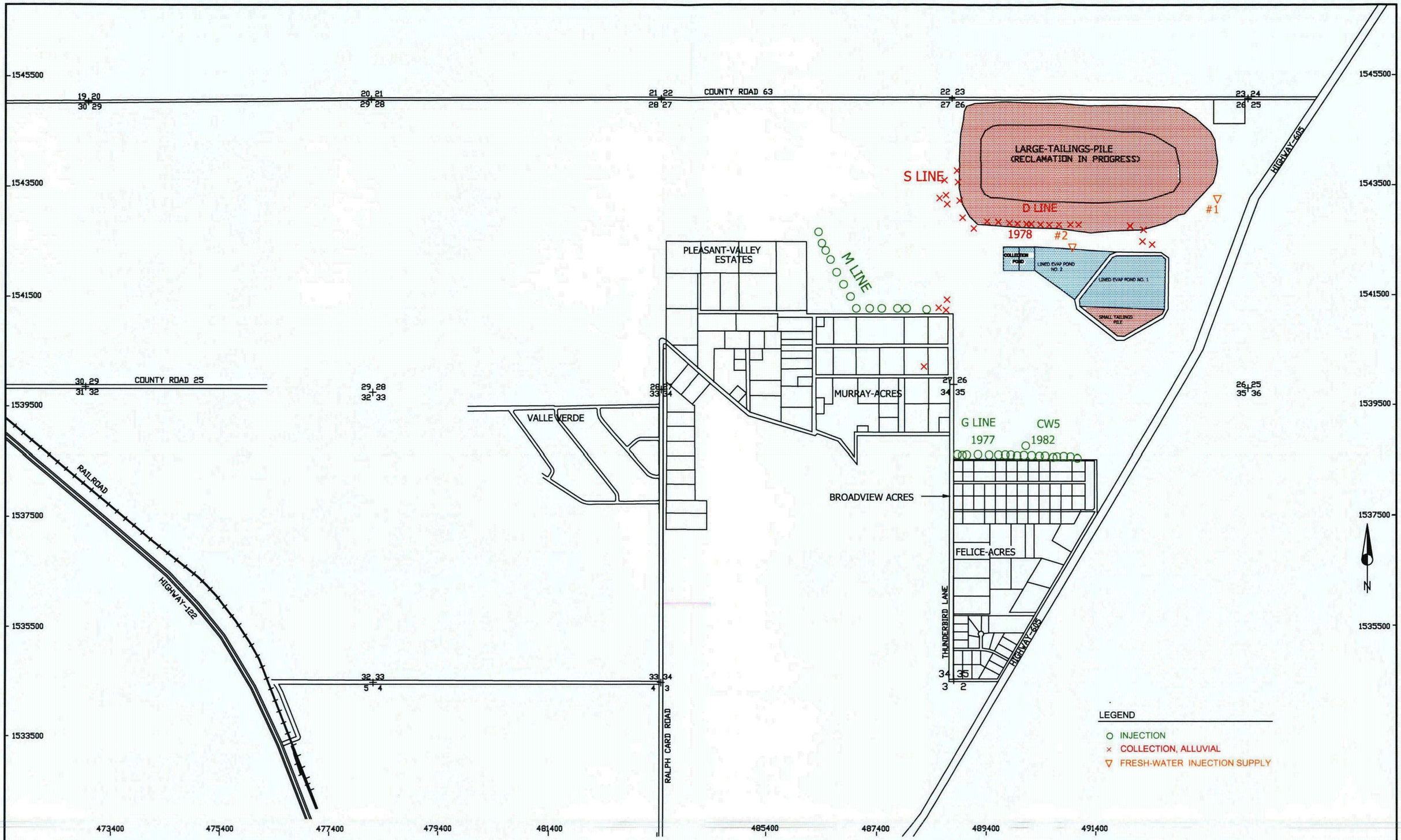



Exhibit 4

Date: 11/16/2004 Filename: E:\180899\CLIENT\2004-AUG\1983.dwg

HOMESTAKE-MILL-AND-ADJACENT-PROPERTIES
GRANTS-NM-TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4
LOCATION OF
COLLECTION/INJECTION WELLS, 1983

Exhibit 5

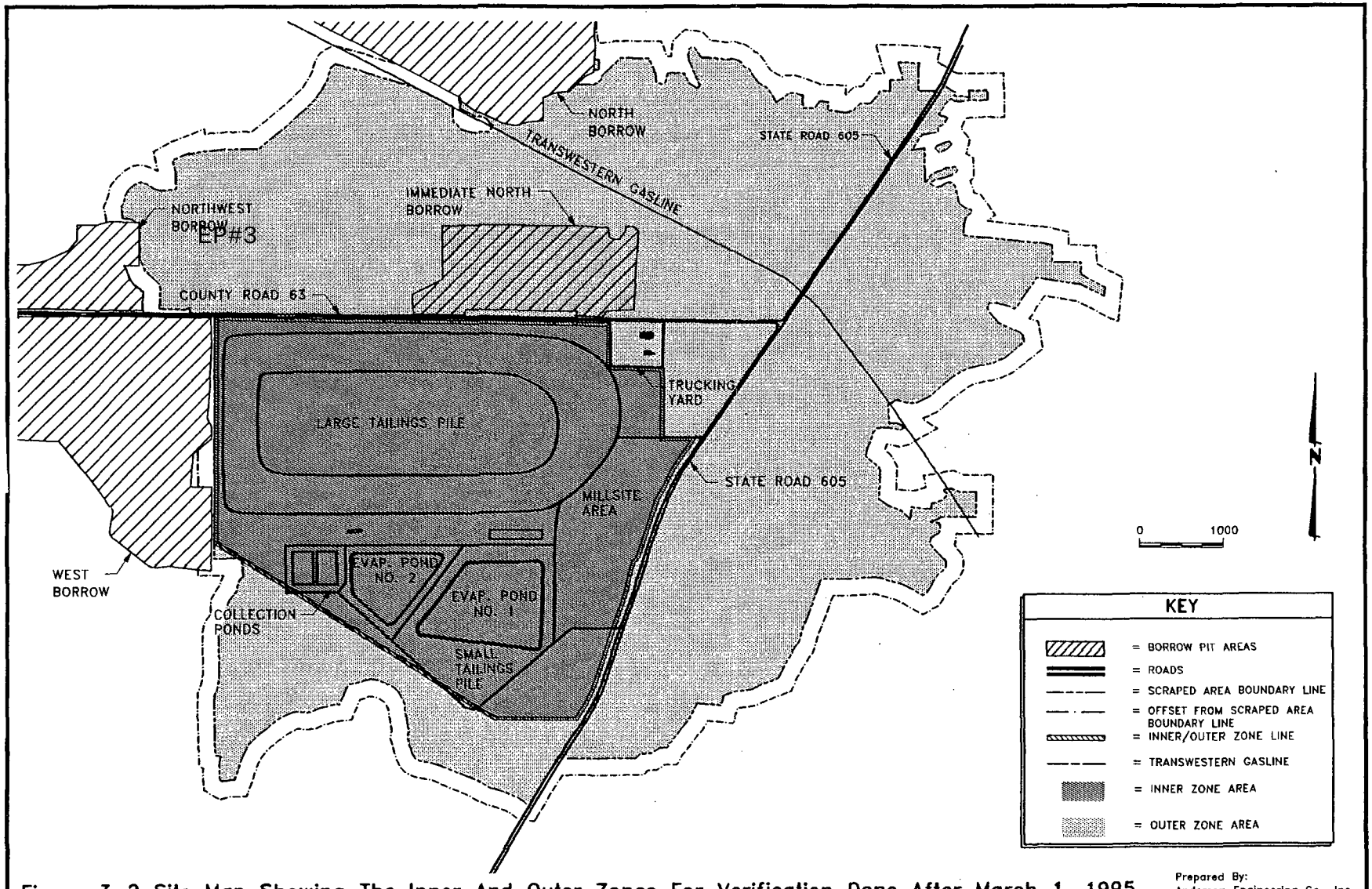
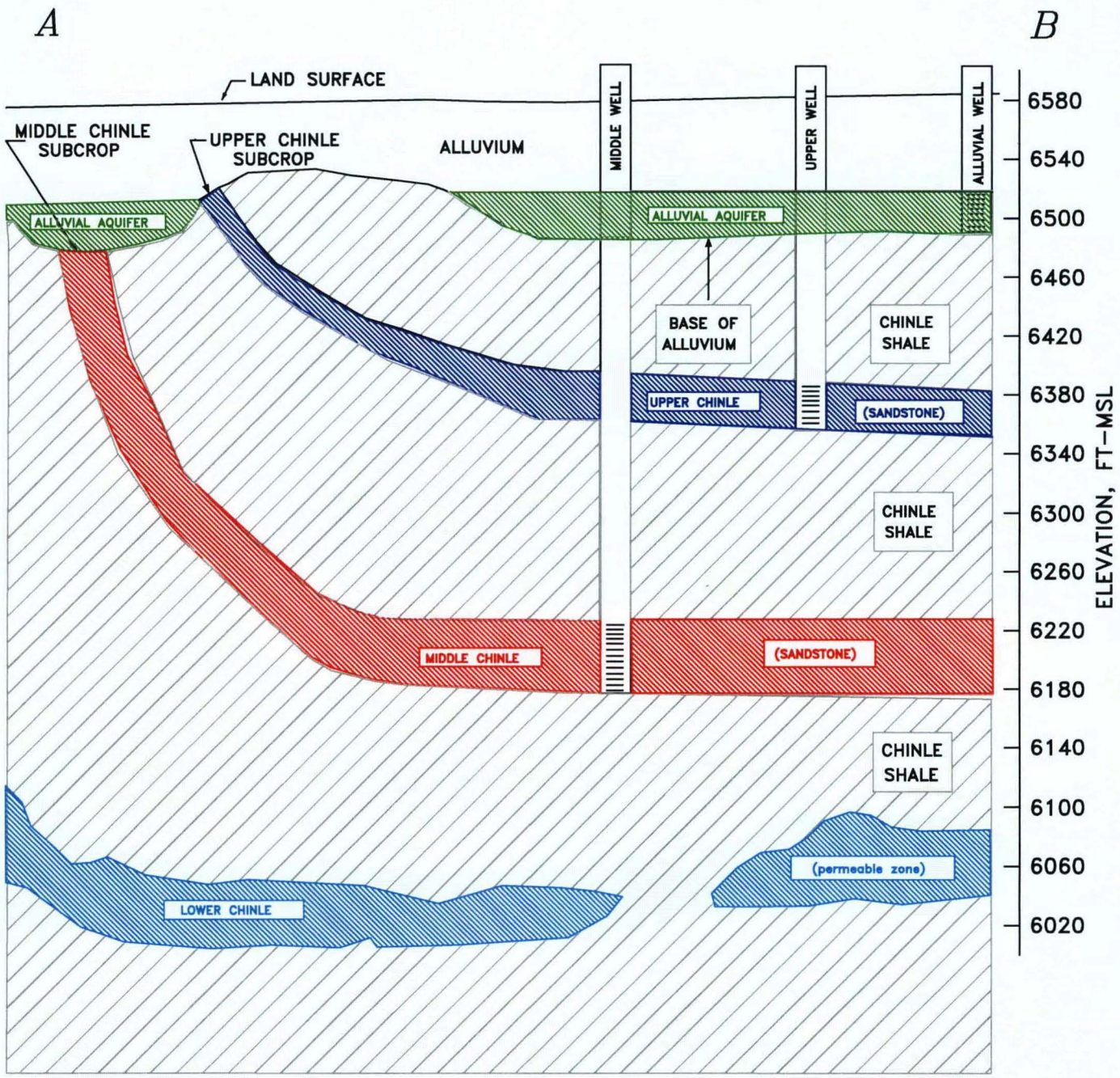



Figure 3-2 Site Map Showing The Inner And Outer Zones For Verification Done After March 1, 1995

Prepared By:
Anderson Engineering Co., Inc.
10-20-95 FIG3-2.DWG

Exhibit 6




HOMESTAKE-MILL-AND-ADJACENT-PROPERTIES
GRANTS-NM-TOWNSHIP-11&12-N-RANGE-10-W

Date: 11/17/2004 Filename: E:\180899\CLIENT\2004-NOV\BCKGXSEC.dwg

FIGURE 12
TYPICAL GEOLOGIC CROSS SECTION

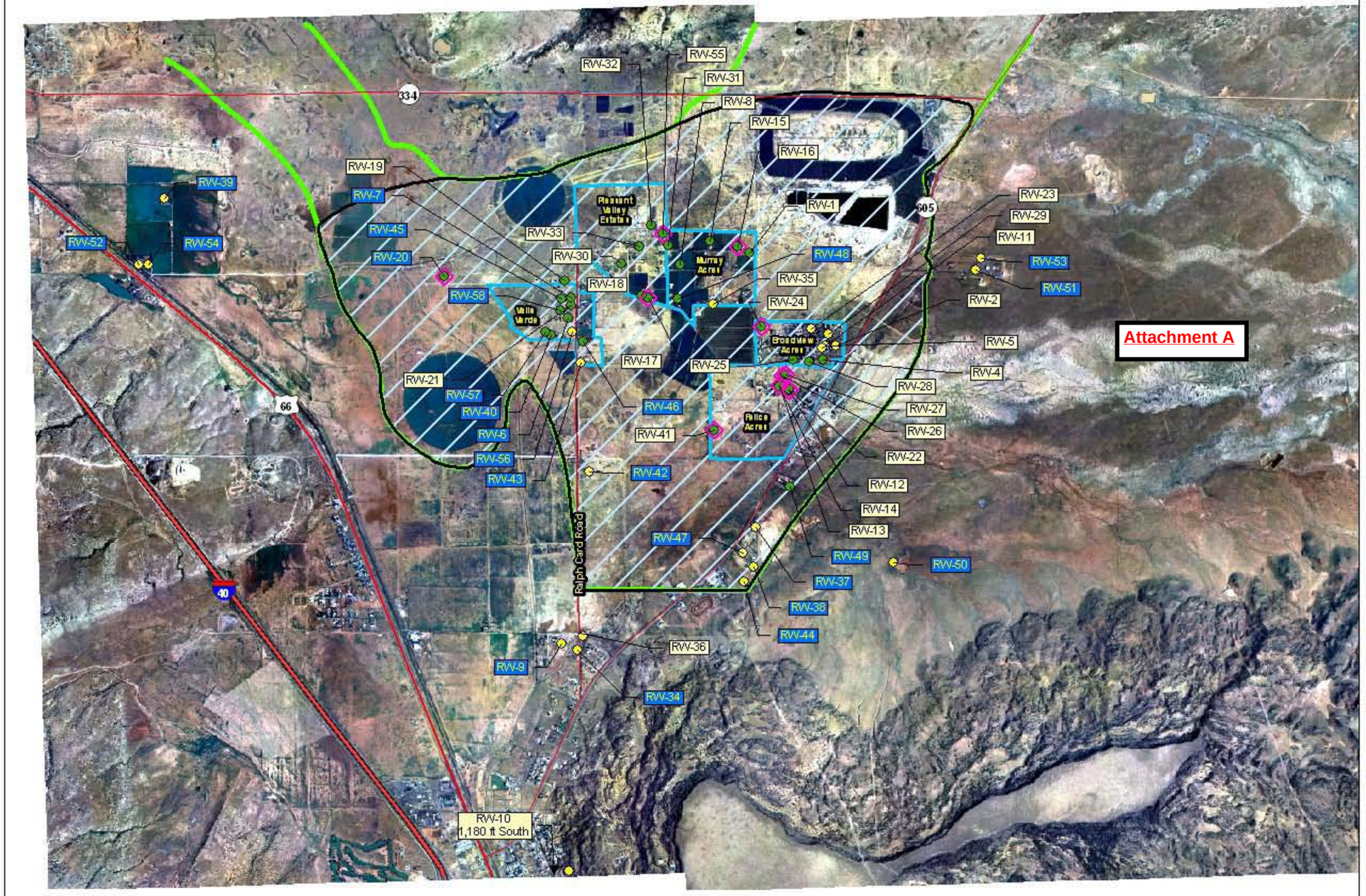



Exhibit 7a

N

DATA SOURCES:
NMED Ground Water Quality Bureau,
Superfund Oversight Section
RGIS
Homestake Mining Company

PROJECTION:
New Mexico State Plane Coordinate System
Western Zone
North American Datum, 1927

Map produced by K. Grancow, April, 2007
NMED DOE Oversight Bureau
134 State Road 4, SUITE A
White Rock, NM 87544

0 0.5 1 2 3 Miles

**Residential wells sampled by NMED 2005-2007 in the vicinity of the Homestake Mining Company Superfund Site, Milan, NM**

RW-6 Residence NOT on Village of Milan water supply
Health-based regulatory exceedances for U, Se, NO3, Pb
Site specific background exceedances for U, Se, NO3, Pb
Sampled residential wells without health-based contaminant regulatory exceedances
NMED Area of Concern
Area of underlying aquifers where one or more health-based contaminant concentrations potentially exceed regulatory standards

**ATTACHMENT B**
Memorandum of Agreement
Property Listing

Exhibit 7b

**Offer to Reimburse for Cost of Hookup to Village of Milan Water System**

| State Well ID Reference No. | Property Description | | | |
|---|---|---|---|---|
| | Subdivision | Block / Lot | Assessor Parcel No. | Assessor Map Code |
| RW-44 | | | TBD | TBD |
| NA | | | 10-08348 | 2-056-067-225-320 |
| RW-42 | | | 21-01596 | 2-057-066-465-492 |
| RW-43 | La Siembra Estates | Block 1, Lot 21 | | |
| RW-46 | La Siembra Estates | Block 2, Lot 1 | | |
| RW-40 | Valle Verde Estates | Block 4, Lot 14 | | |
| RW-6 | Valle Verde Estates | Block 3, Lot 2 | | |
| RW-45 | Valle Verde Estates | Block2, Lot 6 | | |
| RW-57 | Valle Verde Estates | Block 5, Lot 12 | | |
| RW-58 | Valle Verde Estates | Block 3, Lot 3 | | |

**Offer to Reimburse for Past Cost of Current Service Hookup with Village of Milan Water System**

| State Well ID Reference No. | Property Description | | | |
|---|---|---|---|---|
| | Subdivision | Block / Lot | Assessor Parcel No. | Assessor Map Code |
| RW-47 | | | 10-15997 | 2-057-066-055-248 |
| RW-37 | | | 10-00858 | 2-057-066-025-265 |
| RW-38 | | | 10-03406 | 2-057-066-046-202 |
| RW-49 | | | 10-03205 | 2-056-066-260-512 |
| RW-7 | Valle Verde Estates | Block 2, Lot 5 | | |
| RW-56 | Valle Verde Estates | Block 4, Lot11 | | |

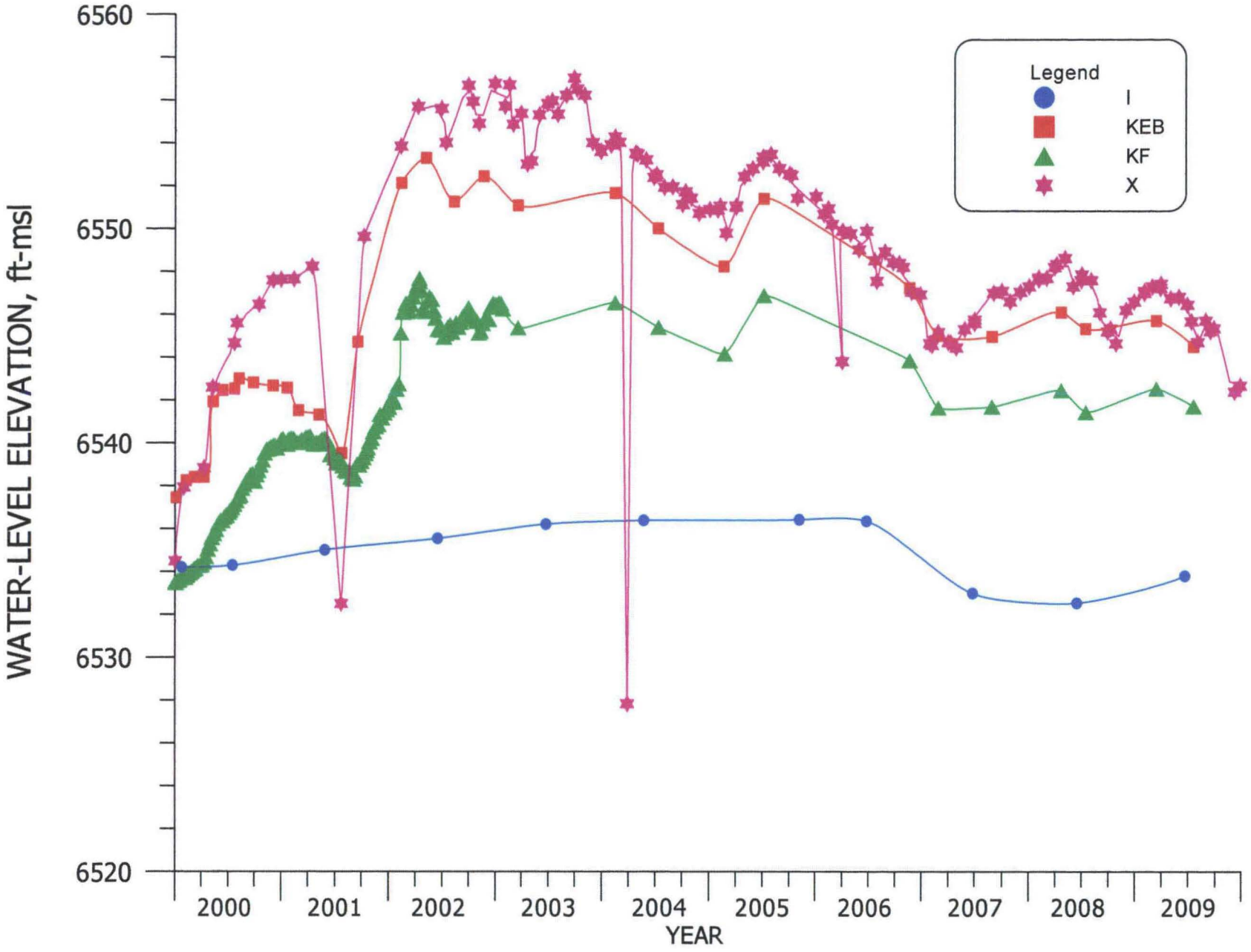



**FIGURE 4.2-12. WATER-LEVEL ELEVATION FOR WELLS I, KEB, KF AND X.**



Exhibit 8a

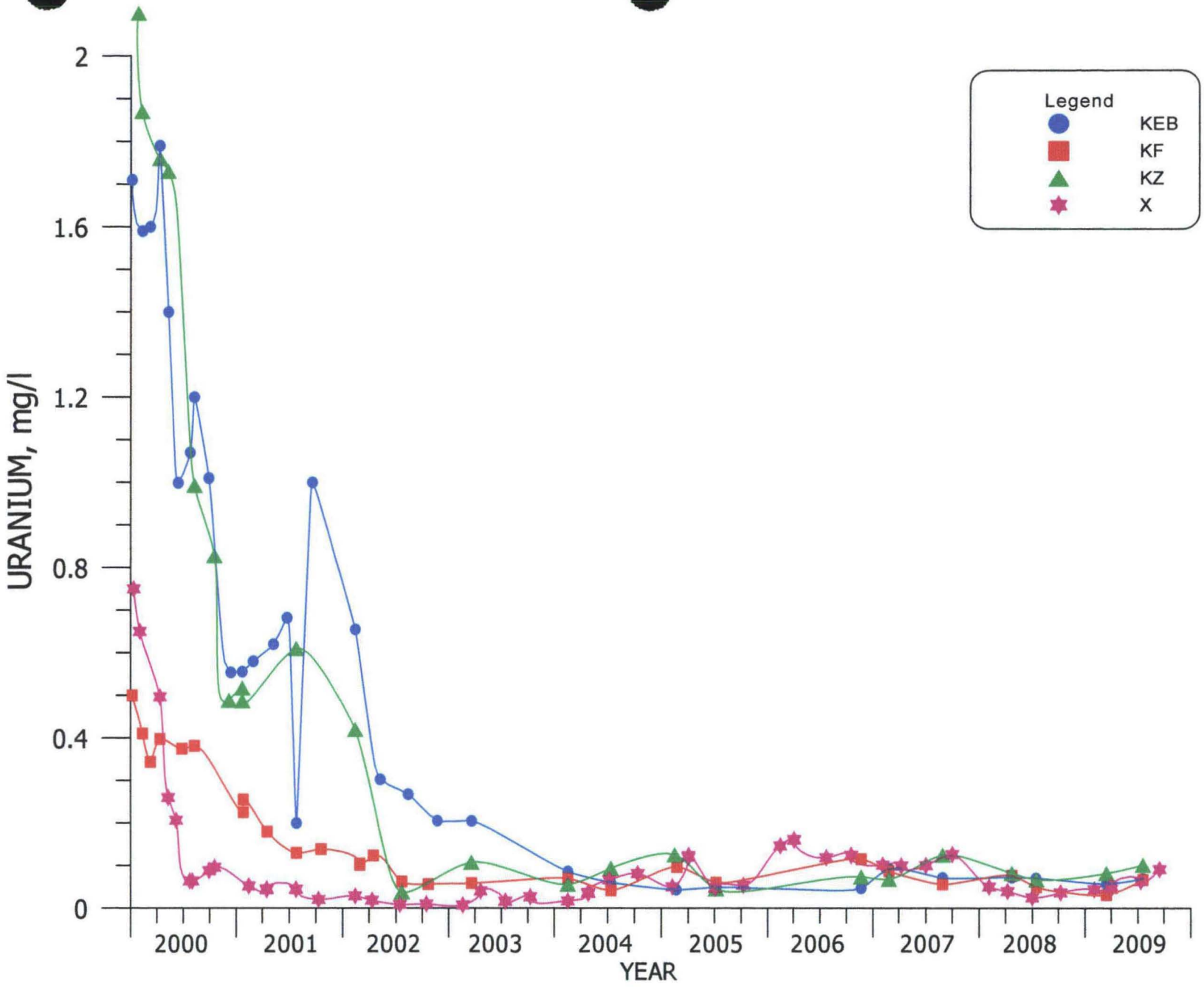



**FIGURE 4.3-60. URANIUM CONCENTRATIONS FOR WELLS KEB, KF, KZ AND X.**

Exhibit 8b

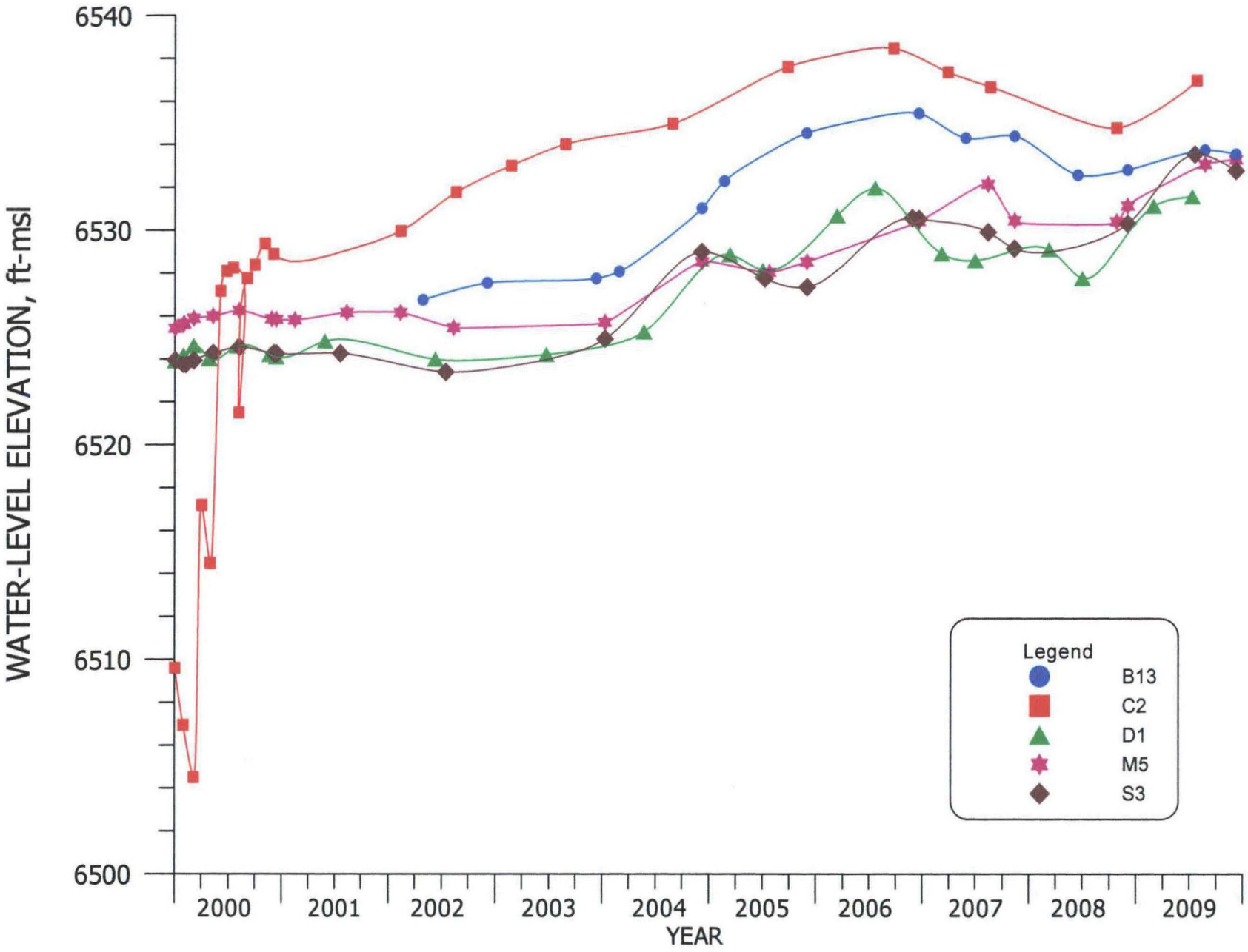



**FIGURE 4.2-9. WATER-LEVEL ELEVATION FOR WELLS B13, C2, D1, M5 AND S3.**



Exhibit 8c

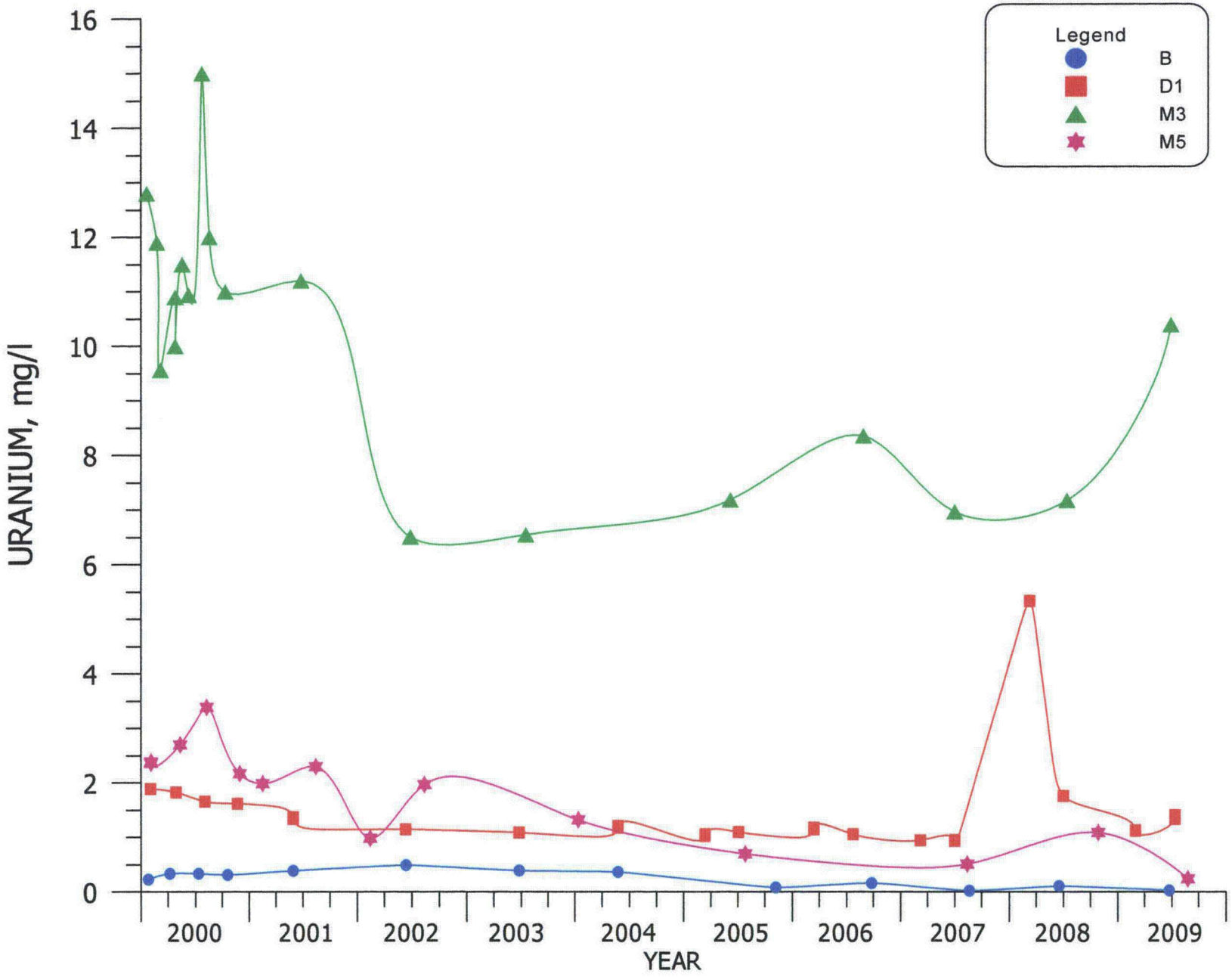



**FIGURE 4.3-57. URANIUM CONCENTRATIONS FOR WELLS B, D1, M3 AND M5.**

Exhibit 8d

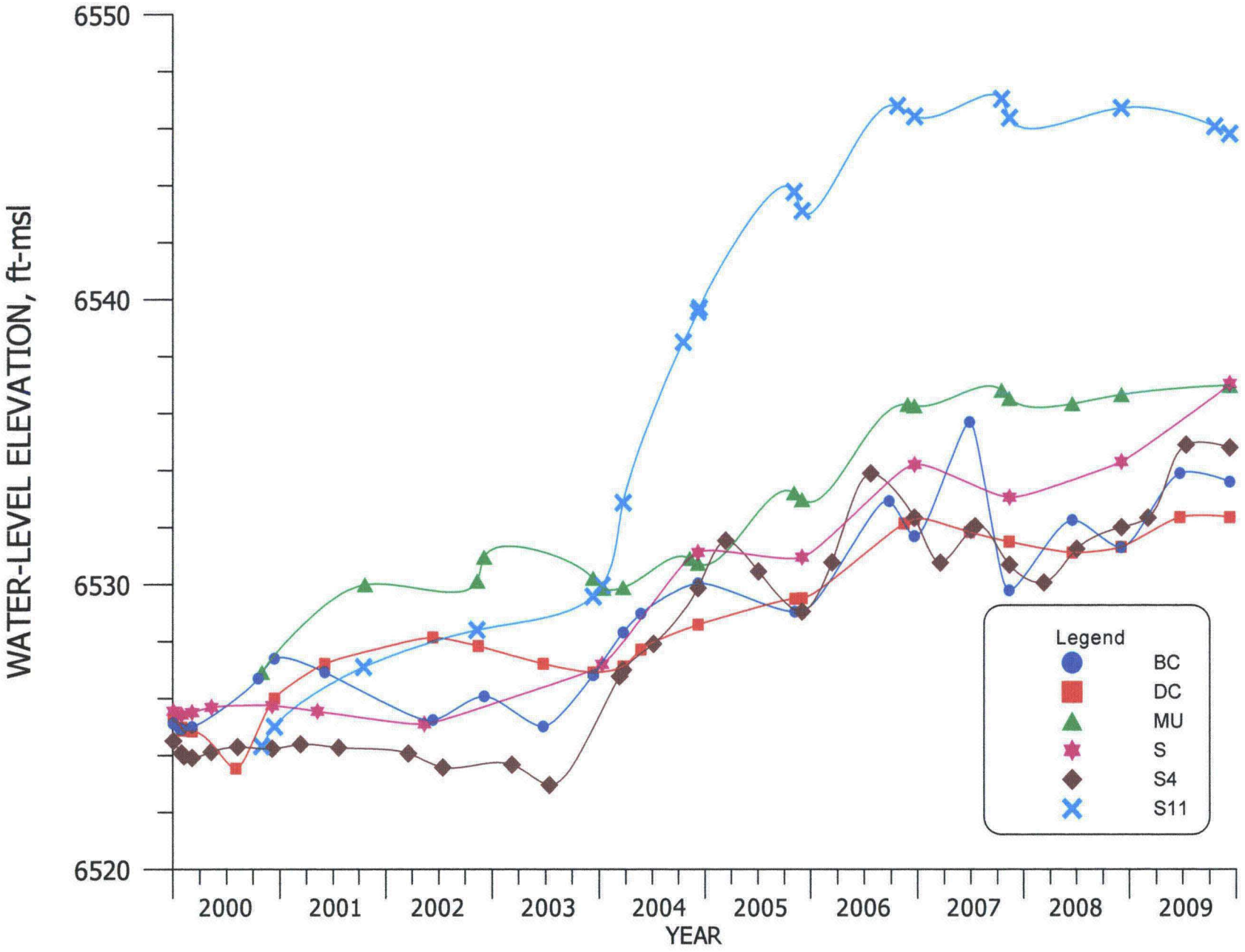



**FIGURE 4.2-6. WATER-LEVEL ELEVATION FOR WELLS BC, DC, MU, S, S4 AND S11.**



Exhibit 8e

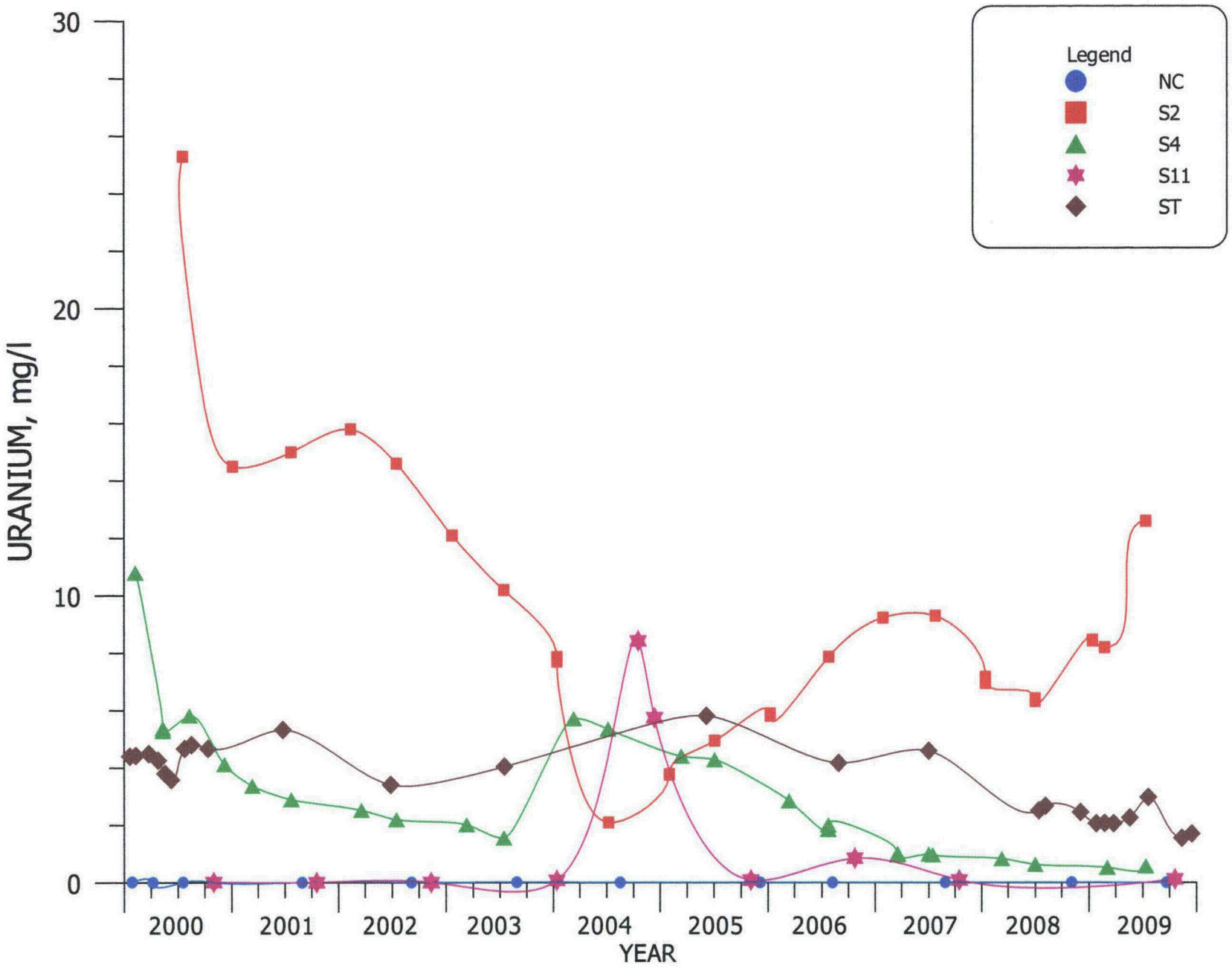
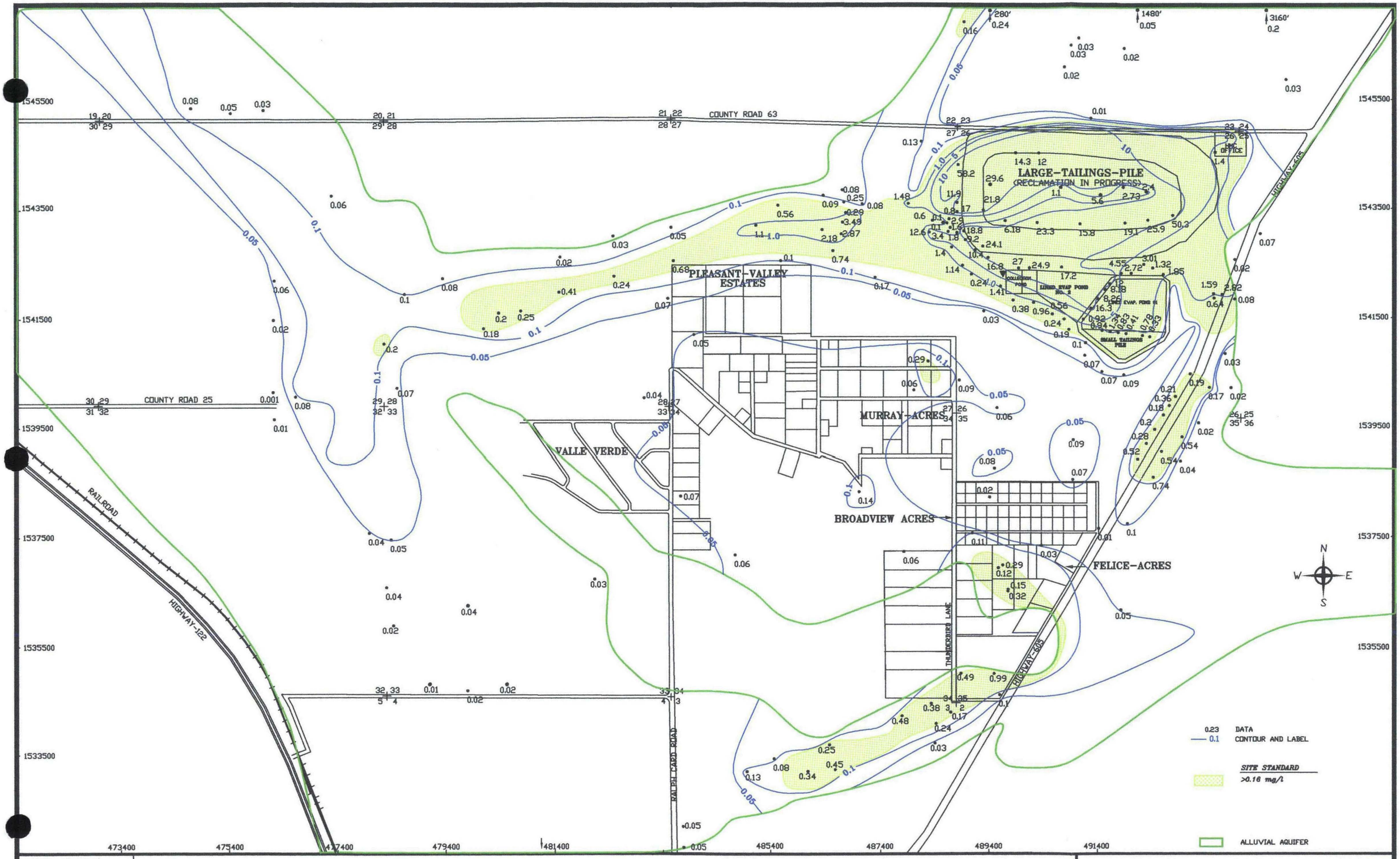



**FIGURE 4.3-55. URANIUM CONCENTRATIONS FOR WELLS NC, S2, S4, S11 AND ST.**

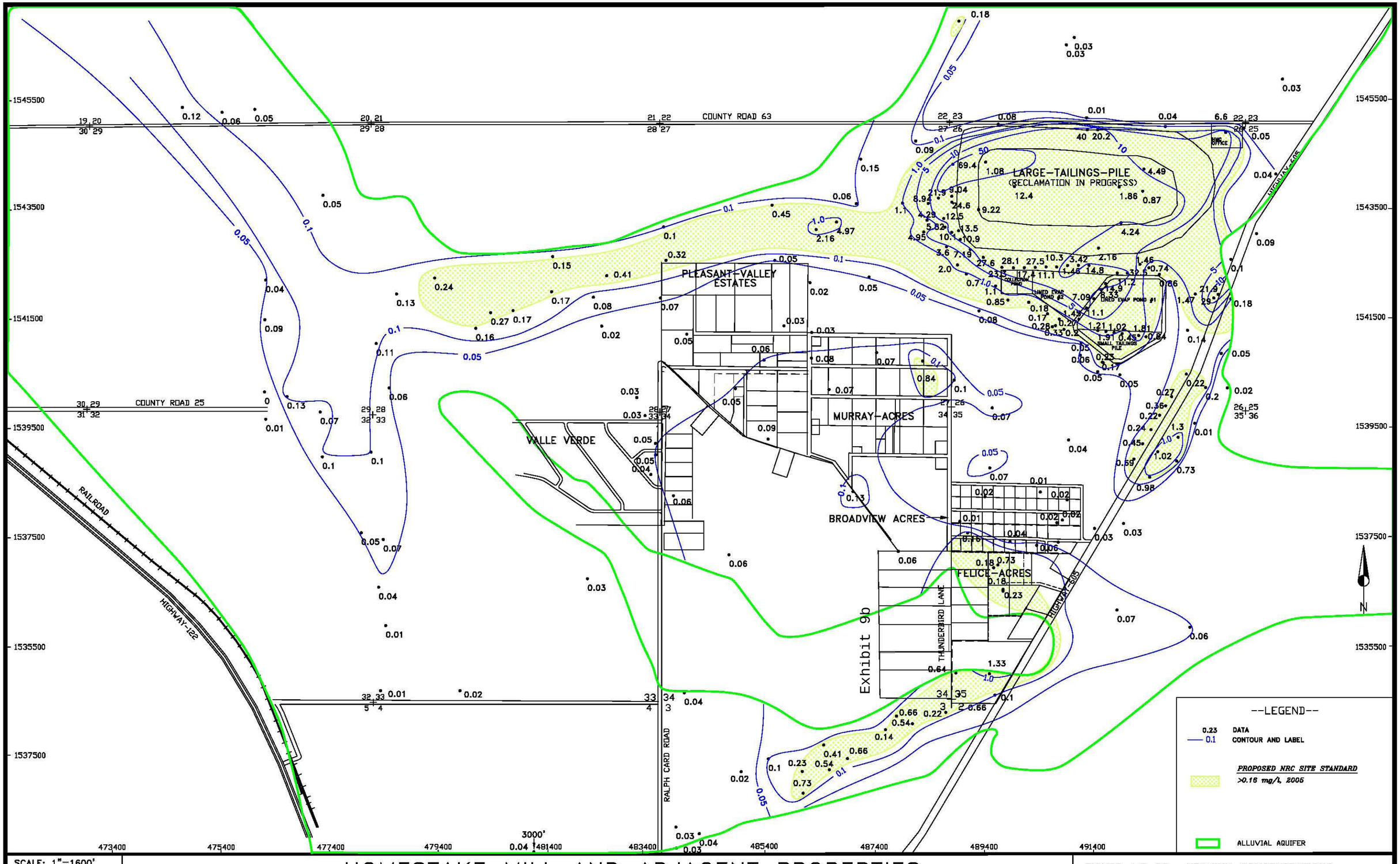
Exhibit 8f




SCALE: 1"=1600'
C:\PROJECTS\2010-06 1600QAL09
DATE: 2/22/2010

Exhibit 9a

FIGURE 4.3-53. URANIUM CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2009 mg/l

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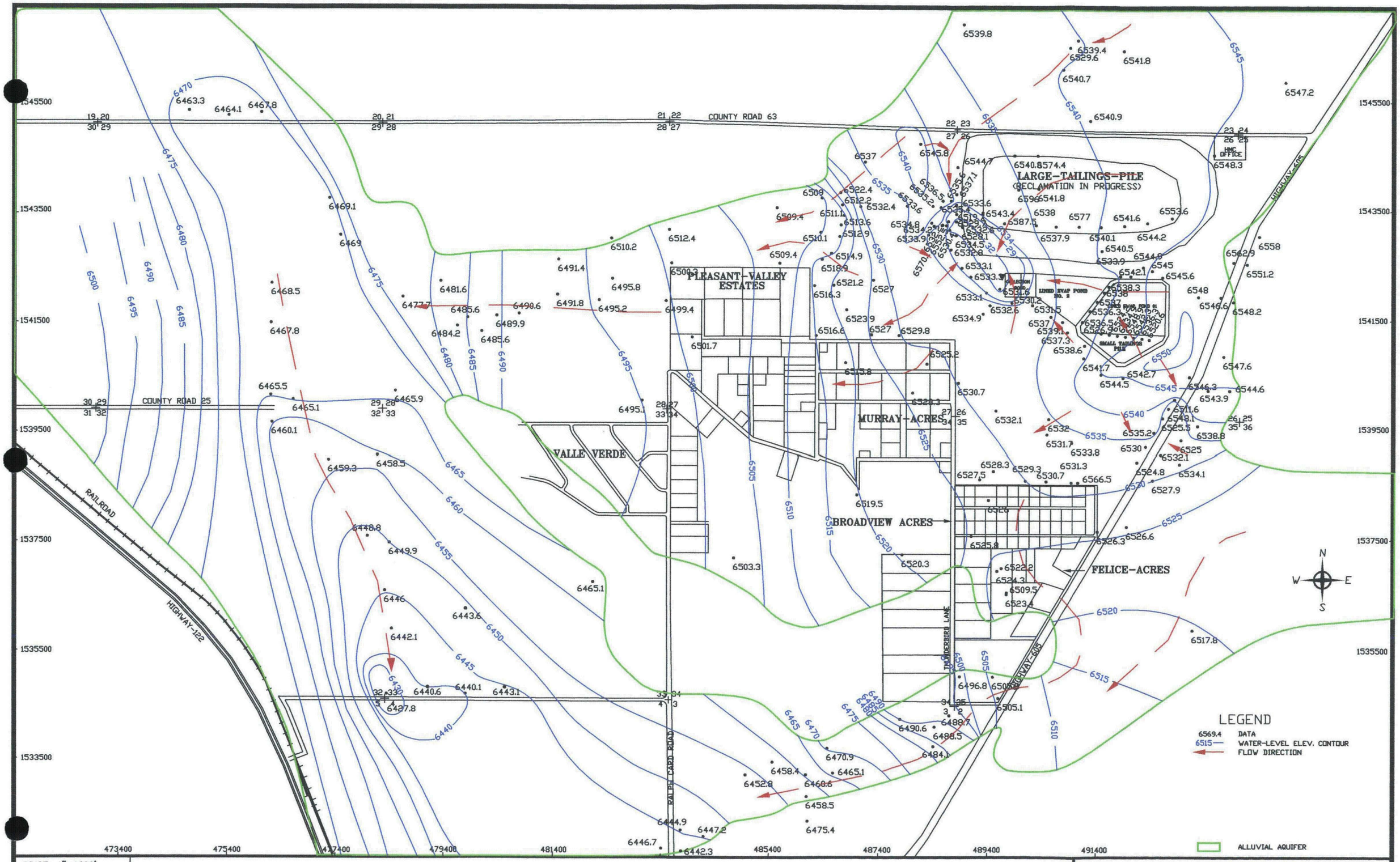
C:\PROJECTS\2005-06\1600QAL
DATE: 03/16/06

# HOMESTAKE MILL AND ADJACENT PROPERTIES

GRANTS, NM TOWNSHIP-11&12-N-RANGE-10-W

FIGURE 4.3-53. URANIUM CONCENTRATIONS OF THE ALLUVIAL AQUIFER, 2005, mg/l




| | |
|---|---|
| SCALE: 1"=1600' | |
| C:\PROJECTS\2010-06 1600QAL09 | |
| DATE: 2/22/2010 | |

Exhibit 10

FIGURE 4.2-1. WATER-LEVEL ELEVATIONS OF THE ALLUVIAL AQUIFER, FALL 2009, FT-MSL

# ATTACHMENTS

# Attachment 1

# Site Inspection Checklist/Inspection Roster

# Site Inspection Checklist

| I. SITE INFORMATION | |
|---|---|
| **Site name:** Homestake Mining Company of California | **Date of inspection:** January 19, 2011 |
| **Location and Region:** Cibola County, New Mexico/Region 6 | **EPA ID:** NMD007860935 |
| **Agency, office, or company leading the five-year review:** U.S. EPA Region 6 | **Weather/temperature:** Sunny / 50°F |

**Remedy Includes**: (Check all that apply)

- ☒ Tailings pile cover[1]/containment
- ☒ Access controls
- ☒ Institutional controls
- ☒ Groundwater pump and treatment
- ☐ Surface water collection and treatment
- ☐ Monitored natural attenuation
- ☒ Groundwater containment
- ☐ Vertical barrier walls
- ☒ Other: Fourteen concrete conduits (letdown channels) drain surface water off the top of the large tailings pile

[1]Radon barrier and erosion protection on small and large tailings pile

**Attachments:** ☐ Inspection team roster attached ☐ Site map attached

**II. INTERVIEWS** (Check all that apply)

1. **O&M site manager – Homestake Mining Company**
   Name: Alan Cox Title: Project Manager Date: January 19, 2011
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☒ Report attached: Mr. Cox stated that, historically, they [Homestake Mining Company (HMC)] had been pretty well supported by the regulatory agencies. However, he cited problems gaining timely permit approvals and frustrations with the appeals and protests related to the regulatory agencies, stating that HMC wanted to move forward (with remediation) but that they had been hamstrung the last couple of years.

2. **O&M consultant – Hydro-Engineering L.L.C.**
   Name: George Hoffman Title: Hydrologist Date: January 19, 2011
   Interviewed ☒ at site ☐ at office ☐ by phone Phone no. _____
   Problems, suggestions; ☒ Report attached: Mr. Hoffman referred to Mr. Cox's responses regarding problems with the permits, approvals, appeals, and protests. He added that help was needed from the regulatory agencies in approving the testing of alternative restoration methods.

3. **Local regulatory authorities and response agencies** (i.e., State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.) Fill in all that apply.

Agency: New Mexico Environment Department

| Name | Title | Date | Phone no. |
|---|---|---|---|
| Angelo Ortelli | Project Manager-Geoscientist | February 8, 2011 | 505-827-2866 |
| David Mayerson | Former Project Manager | February 8, 2011 | 505-476-3787 |
| Jerry Schoeppner | Mining/Environmental Compliance | February 8, 2011 | 505-827-0652 |

Problems; suggestions; ☒ Report attached: Mr. Schoeppner stated that there was some question whether there is capture of the western alluvial plume from the large tailings pile but it is mixing with upgradient contamination from an unidentified source. He also stated that they were losing ground on the western and southern plume footprints. Mr. Schoeppner stated that HMC needs to relay the public relations issues to the state so that they are well informed. He also stated that as the lead agency, the Nuclear Regulatory Commission is continually revising the monitoring system - changes in wells or new wells installed – without notification to NMED. Mr. Mayerson stated that HMC has a lot of data but, because of the way it is organized, the data is hard to relate to specific remediation goals. Mr. Ortelli stated that the data should be related to data quality objectives. Mr. Schoeppner and Mr. Mayerson suggested conference calls every six months so that HMC could update all parties about ongoing site activities and also suggested having public meetings with the regulators and HMC every six months.

4. **Other interviews** (optional) ☒ Reports attached.

| Name | Title | Date | Phone no. |
|---|---|---|---|
| John Boomer | Property owner | January 20, 2011 | 505-979-3917 |

Interviewed ☒ at home

Problems; suggestions; ☒ Report attached: Mr. Boomer cited the following problems/suggestions: would like to be better informed (on activities associated with remediation); would like to hear about innovative technologies being tested; would like to see the [large] tailings pile moved isolated; would like to see additional monitoring system every half mile or so; would like better monitoring out in front of the groundwater plume; wants an independent analysis of the alluvial floodplain to establish a baseline for planned mining further up in the San Mateo Drainage Basin; and wants better community education.

| Name | Title | Date | Phone no. |
|---|---|---|---|
| Art Gebeau | Property owner | January 21, 2011 | 505-287-3613 |

Interviewed ☒ at home

Problems; suggestions; ☒ Report attached: Mr. Gebeau cited the following problems/suggestions: concerned with remediation involving flushing of the large tailings pile; they (HMC) should spend a little more money and do the remediation right; they should move the (large) tailings pile; they did not get out in front of the problem (groundwater plume) early enough and had a poor understanding of the geology of the area; they installed injection wells and pushed the groundwater plume out away from the HMC property; and they should increase the size of the reverse osmosis treatment plant (to handle all of the extracted groundwater).

**III. ON-SITE DOCUMENTS & RECORDS VERIFIED** (Check all that apply)

1. **O&M Documents**
☐ O&M manual ☐ Readily available ☐ Up to date ☒ N/A
☐ As-built drawings ☐ Readily available ☐ Up to date ☒ N/A
☐ Maintenance logs ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Documents related to operation and maintenance (O&M) of the varying ongoing remedial activities are available at the site. However, there is no single, all-encompassing "O&M Manual" for the site.

2. **Site-Specific Health and Safety Plan** ☐ Readily available ☐ Up to date ☒ N/A
☐ Contingency plan/emergency response plan ☐ Readily available ☐ Up to date ☒ N/A
Remarks__ _____

3. **O&M and OSHA Training Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks: Not evaluated

4. **Permits and Service Agreements**
☐ Air discharge permit ☐ Readily available ☐ Up to date ☒ N/A
☐ Effluent discharge ☐ Readily available ☐ Up to date ☒ N/A
☐ Waste disposal, POTW ☐ Readily available ☐ Up to date ☒ N/A
☐ Other permits_____ ☐ Readily available ☐ Up to date ☒ N/A
Remarks_____
_____

5. **Gas Generation Records** ☐ Readily available ☐ Up to date ☒ N/A
Remarks_____
_____

6. **Settlement Monument Records** ☐ Readily available ☒ Up to date ☐ N/A
Remarks: Settlement monuments are surveyed annually by the Nuclear Regulatory Commission (NRC)

7. **Groundwater Monitoring Records** ☐ Readily available ☒ Up to date ☐ N/A
Remarks: None

8. **Leachate Extraction Records** ☐ Readily available ☒ Up to date ☐ N/A
Remarks: None

9. **Discharge Compliance Records**
☐ Air ☐ Readily available ☐ Up to date ☒ N/A
☐ Water (effluent) ☐ Readily available ☐ Up to date ☒ N/A
Remarks_____
_____

10. **Daily Access/Security Logs** ☐ Readily available ☒ Up to date ☐ N/A
Remarks: None

## IV. O&M COSTS

1. **O&M Organization**
☐ State in-house ☐ Contractor for State
☐ PRP in-house ☐ Contractor for PRP
☐ Federal Facility in-house ☐ Contractor for Federal Facility
☒ Other: O&M costs are not captured and reported as with typical Superfund sites. NRC License SUA-1471 requires HMC to periodically submit estimated costs for reclamation milestones as a part of the federal surety requirements. Mr. Cox stated that annual O&M costs were approximately $3.5 million per year but that the costs may increase with improvements in the remedial system.

2. **O&M Cost Records**

☐ Readily available ☐ Up to date

☐ Funding mechanism/agreement in place

Original O&M cost estimate_____ ☐ Breakdown attached

Total annual cost by year for review period if available

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

From_____ To_____ _____ ☐ Breakdown attached
Date Date Total cost

3. **Unanticipated or Unusually High O&M Costs During Review Period**

Describe costs and reasons: _None_____

_____

_____

_____

_____

_____

## V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

### A. Fencing

1. **Fencing damaged** ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: The HMC property includes an office building, maintenance/storage buildings, water towers, tailings piles, evaporation ponds, collection ponds, and a reverse osmosis treatment plant. The office building and maintenance/storage buildings are surrounded by a chain link fence which is unlocked only during business hours. The remainder of the property is surrounded by barbed wire fencing.

### B. Other Access Restrictions

1. **Signs and other security measures** ☐ Location shown on site map ☒ N/A

Remarks_____

### C. Institutional Controls (ICs)

1. **Implementation and enforcement**

Site conditions imply ICs not properly implemented ☐ Yes ☐ No ☒ N/A

Site conditions imply ICs not being fully enforced ☐ Yes ☐ No ☒ N/A

Type of monitoring (*e.g.*, self-reporting, drive by): Under the IC put into place in 2007, NMED requires the New Mexico Office of the State Engineer to issue a health advisory to every person who applies for a well permit with the area referenced in the drinking water advisory (Exhibit 7a); and the advisory is to be published in two newspapers of general circulation in Cibola and McKinley Counties.

Frequency: N/A

Responsible party/agency: New Mexico Office of the State Engineer

Contact _____ _____ _____ (505) 827-6091

Name Title Date Phone no.

Reporting is up-to-date ☐ Yes ☐ No ☒ N/A

Reports are verified by the lead agency ☐ Yes ☐ No ☒ N/A

Specific requirements in deed or decision documents have been met ☐ Yes ☐ No ☒ N/A

Violations have been reported ☐ Yes ☐ No ☒ N/A

Other problems or suggestions: ☐ Report attached

2. **Adequacy** ☒ ICs are adequate ☐ ICs are inadequate ☐ N/A

Remarks_____

**D. General**

1. **Vandalism/trespassing** ☐ Location shown on site map ☒ No vandalism evident

Remarks: No vandalism or trespassing reported during in the last five years.

2. **Land use changes on site** ☒ N/A

Remarks_____

_____

3. **Land use changes off site** ☐ N/A

Remarks: Evaporation Pond 3 was installed in 2010 northwest of the large tailings impoundment. No other land-use changes were documented.

## VI. GENERAL SITE CONDITIONS

**A. Roads** ☐ Applicable ☐ N/A

1. **Roads damaged** ☐ Location shown on site map ☒ Roads adequate ☐ N/A

Remarks: None

**B. Other Site Conditions**

Remarks: None

## VII. LANDFILL COVERS ☐ Applicable ☐ N/A

**A. Temporary Radon Cover**

1. **Settlement** (Low spots) ☐ Location shown on site map ☒ Settlement not evident

Areal extent_____ Depth_____

Remarks: Settlement of the large tailings pile is monitored annually by NRC. Settlement of seven to eight monuments was noted on the north side of the large tailings pile in 1998 – 1999. No current settlement evident, however, soil is stockpiled on the top of the large tailings pile to be used for fill.

2. **Cracks** ☐ Location shown on site map ☒ Cracking not evident
Lengths_____ Widths_____ Depths_____
Remarks: None

3. **Erosion** ☐ Location shown on site map ☒ Erosion not evident
Areal extent_____ Depth_____
Remarks: No erosion was evident on the large tailings pile. Erosion was, however, moderate to pronounced on the southeast and southwest sides of the small tailings pile/Evaporation Pond 1 and on the west side of the west collection pond.

4. **Holes** ☐ Location shown on site map ☐ Holes not evident
Areal extent_____ Dimensions : 10' wide x 15' long x 6' deep)
Remarks: Approximately seven pits and associated mounded dirt observed on the top of the large tailings pile. Pits associated with emplacement of new monitoring wells.

5. **Vegetative Cover** ☐ Grass ☒ Cover properly established ☒ No signs of stress
G Trees/Shrubs (indicate size and locations on a diagram)
Remarks: Vegetative cover consists of native grasses and low-lying bushes. Vegetative cover minimal to lacking on the southeast and southwest sides of the small tailings pile/Evaporation Pond 1 and on the west side of the west collection pond.

6. **Alternative Cover (armored rock, concrete, etc.)** ☐ N/A
Remarks: The cover on top of the temporary radon barrier consists of large rocks

7. **Bulges** ☐ Location shown on site map ☒ Bulges not evident
Areal extent_____ Height_____
Remarks: None

8. **Wet Areas/Water Damage** ☐ Wet areas/water damage not evident
☐ Wet areas ☐ Location shown on site map Areal extent_____
☒ Ponding ☐ Location shown on site map Areal extent_____
☐ Seeps ☐ Location shown on site map Areal extent_____
☐ Soft subgrade ☐ Location shown on site map Areal extent_____
Remarks: Two small areas of ponding (10' x 20') and (3' x 5') observed near the zeolite pilot-test pit on the top of the south side of the large tailings pile. Ponded water due to melting snow.

9. **Slope Instability** ☐ Slides ☐ Location shown on site map ☒ No evidence of slope instability
Areal extent_____
Remarks: None

**B. Benches** ☐ Applicable ☒ N/A
(Horizontally constructed mounds of earth placed across landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. **Flows Bypass Bench** ☐ Location shown on site map ☒ N/A or okay
Remarks_____
_____

2. **Bench Breached** ☐ Location shown on site map ☒ N/A or okay
Remarks_____
_____

3. **Bench Overtopped** ☐ Location shown on site map ☒ N/A or okay
Remarks_____
_____

**C. Letdown Channels** ☒ Applicable ☐ N/A

(Channel lined with erosion control mats, riprap, grout bags, or gabions that descend down the steep side slope of the cover and will allow the runoff water collected by the benches to move off of the landfill cover without creating erosion gullies.)

1. **Settlement** ☐ Location shown on site map ☒ No evidence of settlement
   Areal extent_____ Depth_____
   Remarks: None

2. **Material Degradation** ☐ Location shown on site map ☒ No evidence of degradation
   Material type_____ Areal extent_____
   Remarks: None

3. **Erosion** ☐ Location shown on site map ☒ No evidence of erosion
   Areal extent_____ Depth_____
   Remarks: None

4. **Undercutting** ☐ Location shown on site map ☒ No evidence of undercutting
   Areal extent_____ Depth_____
   Remarks: None

5. **Obstructions** Type_____ ☒ No obstructions
   ☐ Location shown on site map Areal extent_____
   Size_____
   Remarks: None

6. **Excessive Vegetative Growth** Type_____
   ☒ No evidence of excessive growth
   ☐ Vegetation in channels does not obstruct flow
   ☐ Location shown on site map Areal extent_____
   Remarks: None

**D. Cover Penetrations** ☒ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance
   ☐ N/A
   Remarks: None

2. **Gas Monitoring Probes**
   ☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
   Remarks: None

3. **Monitoring Wells** (within surface area of landfill)
   ☐ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☒ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
   Remarks: None

4. **Leachate Extraction Wells**
   ☐ Properly secured/locked ☒ Functioning ☐ Routinely sampled ☒ Good condition
   ☐ Evidence of leakage at penetration ☐ Needs Maintenance ☐ N/A
   Remarks: None

5. **Settlement Monuments** ☒ Located ☒ Routinely surveyed ☐ N/A
   Remarks: Settlement monuments surveyed annually by NRC

**E. Gas Collection and Treatment** ☐ Applicable ☒ N/A

1. **Gas Treatment Facilities**
   ☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
   ☐ Good condition ☐ Needs Maintenance
   Remarks: None

2. **Gas Collection Wells, Manifolds and Piping**
   ☐ Good condition ☐ Needs Maintenance
   Remarks: None

3. **Gas Monitoring Facilities** (*e.g.*, gas monitoring of adjacent homes or buildings)
   ☐ Good condition ☐ Needs Maintenance ☐ N/A
   Remarks: None

**F. Cover Drainage Layer** ☒ Applicable ☐ N/A

1. **Outlet Pipes Inspected** ☒ Functioning ☐ N/A
   Remarks: None

2. **Outlet Rock Inspected** ☐ Functioning ☒ N/A
   Remarks: None

**G. Collection Ponds** ☒ Applicable ☐ N/A

1. **Siltation** Areal extent_____ Depth_____ ☐ N/A
   ☐ Siltation not evident
   Remarks: There is some sediment buildup in the collection and evaporation ponds (Evaporation Ponds 1 and 2) according to HMC

2. **Erosion** Areal extent_____ Depth_____
   ☐ Erosion not evident
   Remarks: Moderate to pronounced erosion observed on the southeast and southwest sides of the small tailings pile/Evaporation Pond 1 and on the west side of the west collection pond

3. **Outlet Works** ☐ Functioning ☒ N/A
   Remarks_____
   _____

4. **Dam** ☐ Functioning ☒ N/A
   Remarks_____
   _____

**H. Retaining Walls** ☐ Applicable ☒ N/A

1. **Deformations** ☐ Location shown on site map ☐ Deformation not evident
   Horizontal displacement_____ Vertical displacement_____
   Rotational displacement_____
   Remarks: None

2. **Degradation** ☐ Location shown on site map ☐ Degradation not evident
   Remarks: None

**I. Perimeter Ditches/Off-Site Discharge** ☐ Applicable ☒ N/A

1. **Siltation** ☐ Location shown on site map ☐ Siltation not evident
   Areal extent_____ Depth_____
   Remarks: None

| | |
|---|---|
| 2. | **Vegetative Growth** ☐ Location shown on site map ☐ N/A<br>☐ Vegetation does not impede flow<br>Areal extent_____ Type_____<br>Remarks: None |
| 3. | **Erosion** ☐ Location shown on site map ☐ Erosion not evident<br>Areal extent_____ Depth_____<br>Remarks: None |
| 4. | **Discharge Structure** ☐ Functioning ☐ N/A<br>Remarks: None |
| | **VIII. VERTICAL BARRIER WALLS** ☐ Applicable ☒ N/A |
| 1. | **Settlement** ☐ Location shown on site map ☐ Settlement not evident<br>Areal extent_____ Depth_____<br>Remarks: None |
| 2. | **Performance Monitoring** Type of monitoring_____<br>☐ Performance not monitored<br>Frequency_____ ☐ Evidence of breaching<br>Head differential_____<br>Remarks: None |
| | **IX. GROUNDWATER/SURFACE WATER REMEDIES** ☒ Applicable ☐ N/A |
| | **A. Groundwater Extraction Wells, Pumps, and Pipelines** ☒ Applicable ☐ N/A |
| 1. | **Pumps, Wellhead Plumbing, and Electrical**<br>☒ Good condition ☒ All required wells properly operating ☐ Needs Maintenance ☐ N/A<br>Remarks: Identified extraction wells observed during the inspection were functioning properly. |
| 2. | **Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances**<br>☒ Good condition ☐ Needs Maintenance<br>Remarks: Pipelines and associated equipment used to convey extracted and treated groundwater observed during the inspection were functioning properly. |
| 3. | **Spare Parts and Equipment**<br>☒ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided<br>Remarks: None |
| | **B. Surface Water Collection Structures, Pumps, and Pipelines** ☐ Applicable ☒ N/A |
| 1. | **Collection Structures, Pumps, and Electrical**<br>☐ Good condition ☐ Needs Maintenance<br>Remarks: None |
| 2. | **Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances**<br>☐ Good condition ☐ Needs Maintenance<br>Remarks: None |
| 3. | **Spare Parts and Equipment**<br>☐ Readily available ☐ Good condition ☐ Requires upgrade ☐ Needs to be provided<br>Remarks: None |
| | **C. Treatment System** ☐ Applicable ☐ N/A |

1. **Treatment Train** (Check components that apply)

☐ Metals removal ☐ Oil/water separation ☐ Bioremediation
☐ Air stripping ☐ Carbon adsorbers
☐ Filters_____
☐ Additive (*e.g.*, chelation agent, flocculent)_____
☒ Others: Extraction wells, evaporation ponds (EP1, EP2, EP3) and associated spray misters, east and west collection ponds, and a Reverse Osmosis (RO) Treatment Plant
☐ Good condition ☐ Needs Maintenance
☐ Sampling ports properly marked and functional
☐ Sampling/maintenance log displayed and up to date
☐ Equipment properly identified
☒ Quantity of groundwater treated annually: 256 gallons per minute (gpm) (RO Treatment Plant and 159 gpm (spray misters for EP1/EP2)
☐ Quantity of surface water treated annually_____
Remarks: EP1, EP2, and EP3 include spray misters to increase their evaporative capacity. Due to the high winds, the spray misters were not operating at EP1 and EP2 during the site inspection. The misters were not yet operational at EPA3. The RO Treatment Plant was undergoing maintenance during the site inspection and was, therefore, not operational.

2. **Electrical Enclosures and Panels** (properly rated and functional)

☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: The computer control panel used to activities within the RO Treatment Plant (influent, effluent, fluid levels, among others) was in working condition but not operational due the maintenance shutdown.

3. **Tanks, Vaults, Storage Vessels**

☒ N/A ☐ Good condition ☐ Proper secondary containment ☐ Needs Maintenance
Remarks_____
_____

4. **Discharge Structure and Appurtenances**

☐ N/A ☒ Good condition ☐ Needs Maintenance
Remarks: Discharge structures observed during the site inspection that are used to convey surface water from the top of the large tailings pile were in good condition. Discharge lines observed during the site inspection, used to convey water to the evaporation ponds and collection ponds, were in good condition.

5. **Treatment Building(s)**

☐ N/A ☒ Good condition (esp. roof and doorways) ☐ Needs repair
☒ Chemicals and equipment properly stored
Remarks: The RO Treatment Plant was shut down for maintenance during the site inspection but observed piping, holding tanks, electrical conveyances, and the physical building, including concrete flooring, were in good condition.

6. **Monitoring Wells** (pump and treatment remedy)

☐ Properly secured/locked ☒ Functioning ☒ Routinely sampled ☒ Good condition
☒ All required wells located ☐ Needs Maintenance ☐ N/A
Remarks: Due to the extremely large number of monitoring wells at this site not all wells were located or inspected. However, the point-of-compliance wells were in good condition and were wired for operation. Monitoring well sampling schedules are dependent upon their status as permitted monitoring wells, non-permitted monitoring wells, wells on the property boundary, key wells (downgradient of irrigation areas for example), and other wells.

**D. Monitoring Data**

| | |
|---|---|
| 1. | Monitoring Data<br>☒ Is routinely submitted on time ☒ Is of acceptable quality |
| 2. | Monitoring data suggests:<br>☒ Groundwater plume is effectively contained in the alluvial aquifer but not in the Chinle Formation aquifers ☐ Contaminant concentrations are declining |
| **E. Monitored Natural Attenuation** | |
| 1. | **Monitoring Wells** (natural attenuation remedy)<br>☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition<br>☐ All required wells located ☐ Needs Maintenance ☒ N/A<br>Remarks_____<br>_____ |

## X. OTHER REMEDIES

The restoration program involves stabilization of the tailings piles, surface reclamation, and the removal of target contaminants from site groundwater and consists of an injection and collection system, using deep-well-supplied fresh water or water produced from the RO Treatment Plant. The established groundwater collection area is hydraulically bounded by a downgradient perimeter of injection and infiltration systems consisting of groundwater wells and infiltration lines. The RO Treatment Plant was designed to augment the groundwater clean-up activities and a series of collection wells is used to collect the contaminated water, which is pumped to the plant for treatment or, alternatively, pumped to a series of evaporation ponds. In addition to treating the groundwater, the RO Treatment Plant also treats water extracted from the large tailings pile. Treatment consists of a clarifier (with the addition of lime), filtration primarily via sand filters, and RO. The RO system includes both high- and low-pressure units.

Brine from the RO system and some water extracted from the large tailings pile are disposed of directly in the evaporation ponds. Solids from the clarifier and filtration system also go into the ponds. The ponds are used to concentrate salts and sprayers installed in the evaporation ponds increase the evaporative loss of contaminated water (forced evaporation).

Evaporation Pond 1 has a single liner and is the easternmost evaporation pond, located on top of and covering the majority of the small tailings pile. Evaporation Pond 2 is double lined and is located adjacent to and west of Evaporation Pond 1. Evaporation Pond 3, installed in 2009, is double lined and is located approximately 1,800 feet north of County Road 63 northwest of the large tailings pile. It has an evaporative surface of approximately 26.5 acres.

The side slopes of the large tailings pile consists of the final radon barrier and rock cover for erosion protection; however, the top consists of only an interim cover. The cover on the small tailings pile is also an interim cover. Installation of the final radon barriers will be implemented following completion of the groundwater restoration program. Also, settlement on the top of the large tailings pile must meet NRC requirements before the final radon barrier/cover can be installed.

During the five-year review period restoration activities involved flushing and dewatering of the large tailings pile using a series of injection/extraction wells, treatment, and use of the collection and evaporation ponds. Selenium- and uranium-contaminated irrigation water was applied to four fields corresponding to approximately 400 acres. The following alternative treatment pilot tests were conducted during this review period on the large tailings pile:

- Water with low concentrations of uranium was being pumped from the Upper Chinle formation into test pits filled with zeolite. The zeolite would act as an absorbent, binding the uranium, and the supernatent would then be re-injected at a rate of 50 – 100 gpm.
- A soluble sodium tripolyphosphate or STPP amendment was injected into groundwater having a pH of 6 and a uranium concentration of less than 2 µg/L. The goal of the pilot test was to study the effects of STPP injections on uranium stabilization.

## XI. OVERALL OBSERVATIONS

### A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

The objective of the Operable Unit 1 (OU1) remedy is long-term remediation of tailings-contaminated groundwater. The objective of the OU2 remedy is long-term stabilization and closure of the tailings disposal area, including a land-cleanup program for wind-blown tailings. In the OU3 Record of Decision EPA stated that they did not have the authority under Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to address radon concentrations identified as elevated in the neighboring subdivisions and would, therefore, take no further action for this OU.

The remedy appears to be functioning as intended by NRC, NMED, and HMC. The groundwater gradients appear to have been reversed away from the subdivisions, and HMC has been actively seeking ways to enhance and speed up the rate of restoration of the contaminated groundwater. Other monitoring data is collected to verify that no airborne emissions are coming from the site. The monitoring program shows that the site is operating within the conditions of its NRC license and NMED permits, and the remedy appears to be effective at protecting human health and the environment.

Describe issues and observations related to the implementation and scope of O&M procedures. In particular, discuss their relationship to the current and long-term protectiveness of the remedy.

The breadth and implementation of O&M procedures has been adequate for the ongoing remedial actions. This includes O&M procedures that have been implemented for new or pilot tested treatment technologies such as RO, zeolite, STPP, and application of uranium-contaminated irrigation water. One are of concern was noted and that was with the erosion on the southeast and southwest sides of the small tailings pile/Evaporation Pond 1 and on the west side of the west collection pond. With correction of this noted concern, the extant O&M procedures should be adequate to ensure the protectiveness of the existing remedy.

### C. Early Indicators of Potential Remedy Problems

Describe issues and observations such as unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs, that suggest that the protectiveness of the remedy may be compromised in the future.

There have been increased consulting costs due to the increased scrutiny on crop irrigation from the public, the state, and EPA. It took three years to get approval for Evaporation Pond 3. There were no other unexpected changes in the cost or scope of O&M or a high frequency of unscheduled repairs that suggest that the protectiveness of the remedy may be compromised in the future.

### D. Opportunities for Optimization

Describe possible opportunities for optimization in monitoring tasks or the operation of the remedy.

HMC continues to evaluate different treatment technologies (RO, zeolite, STPP, and the application of uranium-contaminated irrigation water) to improve upon the remedy and reduce treatment time.

**Five-year Review Site Inspection**
**Homestake Mining Company Site**
**January 19, 2011**
**Sign-in Sheet**

| Personnel | Title | Representing | Phone Number |
|---|---|---|---|
| Sai Appaji | Remedial Project Manager | U.S. EPA Region 6 | 214-665-3126 |
| Fred Molloy | Technical Lead | U.S. Army Corps of Engineers, Kansas City District | 816-389-3499 |
| Chuck Williams | Project Hydrogeologist | U.S. Army Corps of Engineers, Kansas City District | 816-389-3575 |
| Angelo Ortelli | Project Manager - Geoscientist | New Mexico Environment Department Superfund Oversight Section | 505-827-2866 |
| George Hoffman | Hydrologist | Hydro-Engineering L.L.C. | 307-261-6597 |
| Alan Cox | Project Manager | Homestake Mining Company | 505-400-2794 |
| Patrick Malone | Senior Counsel | Homestake Mining Company | 801-990-3846 |
| Dan Kump | Senior Project Engineer | Homestake Mining Company | 505-287-4456 |

# Attachment 2

# Interview Records

**INTERVIEW RECORD**

| | | |
|---|---|---|
| **Site Name:** Homestake Mining Company Superfund Site | | **EPA ID No.:** NMD007860935 |
| **Subject:** Third Five-year Review | | **Time:** 8:30 a.m. **Date:** January 19, 2011 |
| **Type:** ☐ **Telephone** ☒ **Visit** ☐ **Other**<br>**Location of Visit:** Homestake Mining Company<br>Cibola County, New Mexico | | ☐ **Incoming** ☐ **Outgoing** |
| **Contact Made By** | | |
| **Name:** Fred Molloy | **Title:** Project Manager | **Organization:** U.S. Army Corps of Engineers |
| **Individual Contacted** | | |
| **Name:** Alan Cox | **Title:** Project Manager | **Organization:** Homestake Mining Company of California |
| **Telephone No.:** 505-287-4456<br>**E-mail Address:** acox@barrick.com | **Street Address:** Highway 605, P.O. Box 98<br>**City, State, Zip Code:** Grants, New Mexico 87020 | |

**Summary of Conversation**

1. What is your overall impression of the project (since 2006 Five-year Review)?

   - Homestake (HMC) is making progress on groundwater remediation which is not a quick and fast process
   - There has been a problem gaining timely permit approval
   - HMC is making positive progress toward cleanup and closure of the site

2. Is the remedy functioning as expected? How well is the remedy performing?

   - Yes, in general

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? Increasing?

   - Generally it shows that there has been progress in remediating the groundwater even though ups and downs have been observed locally
   - The geographic extent is shrinking
   - Contaminant concentrations are decreasing

4. Is there a continuous on-site O&M presence? *If so*, describe the staff and activities. *If not*, describe staff and frequency of site inspections and activities.

   - Yes, the staff level is constant - five field staff, site foreman, radiation tech, three utility operators, senior project engineer, and a staff accountant
   - Electrical contractors are not on staff but are local
   - Four range lessors for pipeline maintenance are used but are not on staff

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since remedy start up? If so, do they affect the protectiveness or effectiveness of the remedy? Describe changes and impacts.

   - Changes in relation to the compliance reporting to the state. For example, the new evaporation pond [Evaporation Pond 3] required a new discharge plan amendment.
   - There have been no significant license changes – maybe three amendments in the last five years.

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years?

- There have been increased consulting costs due to the increased scrutiny on crop irrigation from the public, the state, and EPA
- The need to add Evaporation Pond 3 was recognized for the last four years and it took three years to gain approval

7. Have there been opportunities to optimize O&M or sampling efforts? Describe changes and resultant or desired cost savings or improve efficiency.

- O&M/sampling efforts undergo a continual review by HMC's consultant [Hydro-Engineering L.L.C.]
- There has been internal optimization to assess progress at the site
- Annually the monitoring program is reviewed to determine which wells need to be sampled, put into a spreadsheet, and placed on the sampling schedule
- There is monthly internal reporting on what has been sampled, what is due to be sampled, and what is overdue for sampling

8. Are there any planned activities that would accelerate and/or enhance the groundwater remediation at the site?

- Yes, research and development work initiated over a number of years has accelerated recently – bench scale and pilot testing. These are all internal not requiring the work plan approval or permit amending processes, although the information is shared with the state and NRC.

9. Are you aware of any events, incidents, or activities that have occurred at the site, such as dumping, vandalism, trespassing, or emergency response from local authorities? If so, please describe.

- Theft of copper wiring – the sheriff's office was notified
- The fence was cut
- Bales of hay were stolen from the south pivot irrigation area
- The thefts were of minor assets and not malicious vandalism

10. Who is responsible for O&M of the 900+ wells associated with the site?

- 250 wells on the large tailings pile
- HMC is responsible for HMC wells only but has access to some wells owned by homeowners – data is shared with property owners

11. Are there any restrictive covenants that prohibit the installation of wells offsite (outside the facility boundaries) for purposes of extracting water for human consumption, bathing or swimming, or for the irrigation of food or feed crops, as well as any construction or intrusive activities offsite?

- Yes, HMC is making a drinking water supply available to remaining residents in the areas of concern – a formal agreement was signed with the state in approximately 2008
- A state-drafted advisory was provided to those parties wanting to drill in this identified area of concern for drinking water purposes
- HMC is hauling water twice each week to a homeowner with high nitrates in a Lower Chinle well located in the area of concern

12. Do you have any comments, suggestions, or recommendations regarding the project?

- Historically, Homestake has been pretty well supported by the agencies, but is frustrated
- HMC wants to meet the objective and requirements for cleaning up the site and turning it over to the Department of Energy for operation and maintenance

**INTERVIEW RECORD**

| | | |
|---|---|---|
| **Site Name:** Homestake Mining Company Superfund Site | | **EPA ID No.:** NMD007860935 |
| **Subject:** Third Five-year Review | | **Time:** 11:00 a.m. **Date:** January 19, 2011 |
| **Type:** ☐ **Telephone** ☒ **Visit** ☐ **Other**<br>**Location of Visit:** Homestake Mining Company<br>Cibola County, New Mexico | | ☐ **Incoming** ☐ **Outgoing** |
| **Contact Made By** | | |
| **Name:** Fred Molloy | **Title:** Project Manager | **Organization:** U.S. Army Corps of Engineers |
| **Individual Contacted** | | |
| **Name:** George Hoffman | **Title:** Hydrologist | **Organization:** Hydro-Engineering L.L.C. |
| **Telephone No.:** 307-266-6597<br>**E-mail Address:** hydro@alluretech.net | **Street Address:** 4685 East Magnolia Street<br>**City, State, Zip Code:** Casper, Wyoming 82604 | |

**Summary of Conversation**

1. What is your overall impression of the project (since 2006 Five-year Review)?

   - Homestake (HMC) is very progressive on this project – more so than other projects – as an example, the Reverse Osmosis Treatment Plant was expensive by important
   - HMC is very progressive in looking at other cleanup options for the site

2. Is the remedy functioning as expected? How well is the remedy performing?

   - Yes, overall it is working well
   - There have been delays in restoration – for example the limited evaporative capacity

3. What does the monitoring data show? Are there any trends that show contaminant levels are decreasing? Increasing?

   - Most trends show gradual decreases over time
   - Some areas have had significant decreases – for example, the southern area has had a decrease in concentration, however, the areal extent is approximately the same as five years ago

4. Is there a continuous on-site O&M presence? *If so*, describe the staff and activities. *If not*, describe staff and frequency of site inspections and activities. Mr. Hoffman answered in the affirmative and deferred to Alan Cox's responses (provided below) for specific staff and activities.

   - Yes, the staff level is constant - five field staff, site foreman, radiation tech, three utility operators, senior project engineer, and a staff accountant
   - Electrical contractors are not on staff but are local
   - Four range lessors for pipeline maintenance are used but are not on staff

5. Have there been any significant changes in the O&M requirements, maintenance schedules, or sampling routines since remedy start up? If so, do they affect the protectiveness or effectiveness of the remedy? Describe changes and impacts.

   - The overall sampling program has been fairly steady
   - There are permit monitoring requirements have been modified over time, but not in the last five years
   - In-house monitoring revisions are discussed with HMC

6. Have there been unexpected O&M difficulties or costs at the site since start-up or in the last five years? Mr. Hoffman deferred to Alan Cox's responses provided below

   - There have been increased consulting costs due to the increased scrutiny on crop irrigation from the public, the state, and EPA
   - The need to add Evaporation Pond 3 was recognized for the last four years and it took three years to gain approval

7. Have there been opportunities to optimize O&M or sampling efforts? Describe changes and resultant or desired cost savings or improve efficiency.

   - There have not been any major opportunities yet – as restoration continues there will be more opportunities

8. Are there any planned activities that would accelerate and/or enhance the groundwater remediation at the site?

   - Alternate restoration should enhance restoration and decrease the time needed to restore low concentrations in the groundwater

9. Are you aware of any events, incidents, or activities that have occurred at the site, such as dumping, vandalism, trespassing, or emergency response from local authorities? If so, please describe. Mr. Hoffman deferred to Alan Cox's responses provided below.

   - Theft of copper wiring – the sheriff's office was notified
   - The fence was cut
   - Bales of hay were stolen from the south pivot irrigation area
   - The thefts were of minor assets and not malicious vandalism

10. Who is responsible for O&M of the 900+ wells associated with the site?

    - HMC is responsible for the majority of the wells
    - Private wells are sampled but the O&M is their responsibility

11. Are there any restrictive covenants that prohibit the installation of wells offsite (outside the facility boundaries) for purposes of extracting water for human consumption, bathing or swimming, or for the irrigation of food or feed crops, as well as any construction or intrusive activities offsite? Mr. Hoffman deferred to Alan Cox's responses provided below.

    - Yes, HMC is making a drinking water supply available to remaining residents in the areas of concern – a formal agreement was signed with the state in approximately 2008
    - A state-drafted advisory was provided to those parties wanting to drill in this identified area of concern for drinking water purposes
    - HMC is hauling water twice each week to a homeowner with high nitrates in a Lower Chinle well located in the area of concern

12. Do you have any comments, suggestions, or recommendations regarding the project? Mr. Hoffman said that he would like to see help from the agencies on their approval on testing alternative restoration methods but deferred to Alan Cox's responses (provided below) for the remainder of the responses.

    - Historically, HMC has been pretty well supported by the agencies, but is frustrated
    - HMC wants to meet the objective and requirements for cleaning up the site and turning it over to the Department of Energy for operation and maintenance

**INTERVIEW RECORD**

| | | |
|---|---|---|
| **Site Name:** Homestake Mining Company Superfund Site | | **EPA ID No.:** NMD007860935 |
| **Subject:** Third Five-year Review | | **Time:** 4:00 p.m. **Date:** January 20, 2011 |
| **Type:** ☐ **Telephone** ☒ **Visit** ☐ **Other**<br>**Location of Visit:** Residence at 3021 Highway 605<br>Cibola County, New Mexico | | ☐ **Incoming** ☐ **Outgoing** |
| **Contact Made By** | | |
| **Name:** Fred Molloy | **Title:** Project Manager | **Organization:** U.S. Army Corps of Engineers |
| **Individual Contacted** | | |
| **Name:** John Boomer | **Title:** Property Owner | **Organization:** Not applicable |
| **Telephone No.:** 505- 979-3917<br>**E-mail Address:** Not available | | **Street Address:** 3021 Highway 605<br>**City, State, Zip Code:** Cibola County, New Mexico |

**Summary of Conversation**

1. What is your overall impression of the project (since 2006 Five-year Review)?

   - Gives Homestake (HMC) a grade of D-
   - Does not think the remediation is effective – it's dilution instead of treating the water
   - Mr. Boomer referenced a breach of one of the evaporation ponds in the 1980s as the reason for elevated uranium levels recently detected in soils in his backyard
   - There are a lot of unanswered questions – for example, regarding irrigation and how clean water is being pumped into contaminated water – it's mixing with a little bit of treatment

2. What effects have site operations had on the surrounding community?

   - Concerned with the affects that contamination from this site will have when combined with discharge from other mining operations proposed for the area
   - Impacts are the spread of the plume, initially going to the edge of the HMC property, and that no one really looked for the plume downgradient
   - Remediation has divided the community – those that speak up against are ostracized

3. Are you aware of any community concerns regarding the site or its operation and administration?

   - Yes, see above responses
   - Have grown to mistrust a lot of HMC's efforts

4. Are you aware of any events, incidents, or activities at the sites such as vandalism or emergency responses from local authorities?

   - Not aware of any since arriving in town in January 2001

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

   - Moderately so – can't keep up with the site's activities
   - Does not receive local newspaper
   - Does not know whether the community has been canvassed regarding their feelings about what is going on and how the cleanup is progressing

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

- Would like to see the large tailings pile moved and isolated – moving the site would show responsibility and provide relief to the community
- Would like to see the source removed and to see a feasibility study on the effort
- If existing remedial system continues, would like to see additional monitoring system established in the community – possibly every one-half mile
- Would like to see better monitoring in front of the plume and would like to see a plan for this monitoring
- Would like independent analysis of the alluvial floodplain to set a baseline for other mining operations proposed for the area (five more mining companies trying to obtain permits to mine for uranium in the Mount Taylor area)
- Gives HMC a grade of D- on community education

**INTERVIEW RECORD**

| | | |
|---|---|---|
| **Site Name:** Homestake Mining Company Superfund Site | | **EPA ID No.:** NMD007860935 |
| **Subject:** Third Five-year Review | | **Time:** 9:30 a.m. **Date:** January 21, 2011 |
| **Type:** ☐ **Telephone** ☒ **Visit** ☐ **Other**<br>**Location of Visit:** Residence at 1986 Ralph Card Road<br>Grants, New Mexico | | ☐ **Incoming** ☐ **Outgoing** |
| **Contact Made By** | | |
| **Name:** Fred Molloy | **Title:** Project Manager | **Organization:** U.S. Army Corps of Engineers |
| **Individual Contacted** | | |
| **Name:** Art Gebeau | **Title:** Property Owner | **Organization:** Bluewater Valley Downstream Alliance* |
| **Telephone No.:** 505- 287-3613<br>**E-mail Address:** Not available | **Street Address:** 1986 Ralph Card Road<br>**City, State, Zip Code:** Grants, New Mexico | |

**Summary of Conversation**

*Note – Mr. Gebeau, while involved with the Bluewater Valley Downstream Alliance (BVDA), was interviewed in his capacity as a property owner.

1. What is your overall impression of the project (since 2006 Five-year Review)?

- Poor – Homestake (HMC) got off to a terrible start and the remediation cannot be handled
- The major problems are water, radon, and blowing dust
- Homeowners have found residue on their cars as much as one-half mile away from the spray irrigation
- The center pivot irrigation has started new areas of contamination
- HMC is trying to dilute as a means of treating the problem
- The reverse osmosis treatment facility should be enlarged

2. What effects have site operations had on the surrounding community?

- The issues with water, radon, and blowing dust have taken away our enjoyment of life, particularly close by
- Taken away the use of our wells and imposed costs on us from water supplied by the city of Milan

3. Are you aware of any community concerns regarding the site or its operation and administration?

- Definitely so – BVDA joined with MASE (Multicultural Alliance for a Safe Environment) and both are represented by the Southwest Research and Information Center

4. Are you aware of any events, incidents, or activities at the sites such as vandalism or emergency responses from local authorities?

- Not aware of any

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

- Not from HMC
- EPA has been good in the last year or so and this interview is a positive step – three or four years ago we wouldn't even be sitting here
- NRC promotes but doesn't regulate the industry
- Any economic relief will have to come from EPA and not the New Mexico Environment Department – EPA seems to be the one chance people have

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

- HMC has not done their job – they ignored their job
- Corporately, HMC is owned by the largest gold mining company in the world – and a little more money should be spent to do the job right – it would be a drop in the bucket to what they [Barrick] are making
- Would like to see the large tailings pile moved to an appropriate place in the area – moving can be accomplished by slurrying or a conveyor belt
- HMC should take the same approach as was used at Durango, Colorado and Moab, Utah and move the tailings pile
- HMC has not gotten out in front of the problem – they have a poor knowledge of the geology of the area – they put in injection wells and pushed the groundwater plume out away from the HMC property

**INTERVIEW RECORD**

| | |
|---|---|
| **Site Name:** Homestake Mining Company Superfund Site | **EPA ID No.:** NMD007860935 |
| **Subject:** Third Five-year Review | **Time:** 2:00 p.m. **Date:** February 8, 2011 |
| **Type:** ☒ **Telephone** ☐ **Visit** ☐ **Other** **Location of Visit:** NA | ☐ **Incoming** ☒ **Outgoing** |

**Contact Made By**

| | | |
|---|---|---|
| **Name:** Fred Molloy | **Title:** Project Manager | **Organization:** U.S. Army Corps of Engineers |

**Individual Contacted**

| | | |
|---|---|---|
| **Name:** Angelo Ortelli<br>David Mayerson<br>Jerry Schoeppner | **Title:** Project Manager (PM)<br>Mining/Environmental Compliance<br>Mining/Environmental Compliance | **Organization:** New Mexico Environment Department |

| | |
|---|---|
| **Telephone No.:** 505-287-2866 (Angelo)<br>505-476-3777 (David)<br>505-827-0652 (Jerry)<br>**E-mail Address:** angelo.ortelli@state.nm.us<br>david.mayerson@state.nm.us<br>jerry.schoeppner@state.nm.us | **Street Address:** Harold Runnels Building<br>11190 St. Francis Drive<br>**City, State, Zip Code:** Santa Fe, New Mexico 87502-5469 |

**Summary of Conversation**

Note: Responses by Angelo Ortelli are preceded by "AO"; responses by David Mayerson are preceded by "DM"; and responses by Jerry Schoeppner are preceded by "JS."

1. What is your overall impression of the project (since 2006 Five-year Review [FYR])?

   - AO – During the previous FYR there was a concern with the residents using water – there is a 2009 settlement in place but hookups are not yet completed due to access issues with the Department of Transportation and boring under the road
   - AO – As issues arise Homestake (HMC) deals with them in a timely manner, they do studies on their own – they are proactive to remediation
   - DM –There was a situation where one residence was intentionally given access to the Village of Milan water system even though the costs were higher than HMC wanted to assume
   - DM – Satisfactory rating - HMC has been very cooperative providing information
   - DM – Overall happy with the performance of HMC and their program

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

   - JS – Yes, because there are a lot of issues there has been communication 1 to 2 times per month, plus annual public meetings
   - JS – Responding to public concerns, plus split sampling, in addition to regular Superfund responsibilities

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

   - JS – There was one violation regarding irrigation at the end of the 2009 irrigation season – the lines were drained but the power was left on and a single extraction well continued to discharge. The New Mexico Environment Department issued a Notice of Violation for illegal discharge and gave HMC one month to find the problem.

4. Have there been any changes in the state's environmental standards since implementing the remdy such ahtat the protectiveness or effectiveness of the remedy would be called into question?

    - JS – The uranium standard changed but that did not affect the protectiveness; however, this standard change affected the land application, through irrigation, from the alluvial aquifer. NRC license (0.44 µg/L), 1.6 µg/L (background), and 0.03 µg/L (NMED/EPA standard) for discharge – but the protectiveness has not been an issue.

5. Is groundwater remediation progressing according to the state's expectations? Does the state have any concerns with the status of groundwater remediation being conducted at the site?

    - JS – There is some question whether the western alluvial plume from the large tailings pile is being captured. It is mixing with contamination from an unidentified source upgradient of the HMC site.
    - JS – We're happy to have hydraulic containment but we're losing ground on the western and southern footprints – held up in regulations as to whether NMED will allow land application in the future.
    - DM – Evaporation Pond 3 is already too small – JS - but it was assumed that land application would continue.

6. From a regulator's perspective, are adequate data being collected to allow for an adequate evaluation of the remedy's performance? If not, what additional data would be useful?

    - DM – They have a lot of data, however, one of the recommendations of the Remediation System Evaluation was the reorganization of monitoring, related to specific remediation goals. Currently is it hard to relate data to remediation goals, although a lot is captured. We want to see how HMC responds to this recommendation.
    - AO – The data needs to be related to data quality objectives.

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

    - JS – Due to regulatory oversight, HMC usually notifies NMED, but sometimes they have not. The community is the watchdog.
    - JS – HMC needs to relay the public relations issues to the state so that the state is well informed.'
    - JS – Because NRC is the lead agency they tweak the system on a continual basis – changing wells to be monitored or installing wells without notification to NMED/
    - DM – EPA ought to have more public meetings describing what has been done and providing a status report.

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

    - JS – No. About one year ago David [Mayerson] took the lead on having more regular conference calls with the regulators on issues. HMC was brought in on some of the calls. It is good to have calls approximately six months so that HMC can update the parties on what has been done. DM – This shows a more unified front to the public as a result of these more frequent calls.
    - DM – I would like to have more public meetings with the regulators and HMC every six months.
    - DM – HMC is the most downgradient of the legacy uranium sites in the basin [San Mateo Creek]. They're near the community and so it is difficult to understand the regulation of the HMC site with the upstream contribution and how it fits into the overall picture.
    - DM – There is a lot of fanfare about investigating the upgradient sites, but not much has been done.

**INTERVIEW RECORD**

| | | |
|---|---|---|
| **Site Name:** Homestake Mining Company Superfund Site | | **EPA ID No.:** NMD007860935 |
| **Subject:** Third Five-year Review | | **Time:** 10:00 a.m. **Date:** April 15, 2011 |
| **Type:** ☒ **Telephone** ☐ **Visit** ☐ **Other** **Location of Visit:** NA | | ☐ **Incoming** ☒ **Outgoing** |
| **Contact Made By** | | |
| **Name:** Fred Molloy | **Title:** Project Manager | **Organization:** U.S. Army Corps of Engineers |
| **Individual Contacted** | | |
| **Name:** Paul Robinson | **Title:** Research Director | **Organization:** Southwest Research and Information Center |
| **Telephone No.:** 505- 262-1862 **E-mail Address:** Not available | **Street Address:** 105 Stanford SE **City, State, Zip Code:** Albuquerque, New Mexico | |

**Summary of Conversation**

1. What is your overall impression of the project?

   - Taking a lot longer than anyone had thought to solve the problem and there is no clear remedy in place for groundwater
   - There is no effective management concept
   - No technology forcing a commitment to get cleanup achieved – Homestake just makes another commitment when one is broken

2. What effects have site operations had on the surrounding community?

   - Site operations should be considered to include the operational phase of operations back to the 1950s, which had large impact on the community.
   - The area used for land application of irrigated runoff has been a concern, as well as runoff from the site into the neighborhoods. A late summer breach of the small tailings pile had water running into the streets.
   - The site is not readily available to cleanup.

3. Are you aware of any community concerns regarding the site or its operation and administration?

   - Alot
   - People in the Bluewater Valley Downstream Alliance have heard promises but have not seen things happen
   - Mr. Larry Carver has seen flooding in San Mateo Creek and has pictures showing water coming down the west side of HMC (1979 flood). A diversion canal on the north side of HMC would allow the alluvium to be re-saturated even if the water is diverted around the site

4. Are you aware of any events, incidents, or activities at the sites such as vandalism or emergency responses from local authorities?

   - No

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

   - I've tried to be – there are alot of data gaps and uncertainties of great concern, i.e., what is the end game – how is the site going to be cleaned up
   - Inability to get accessible public record and to get the Remediation System Evaluation (RSE) onto a public site – it's not accessible
   - Getting to some of the site information is difficult

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

- There is good reason to think that EPA and the Nuclear Regulatory Commission (NRC) do not have a partnership.
- NRC has been a hesitant participant in the RSE process.
- There is no idea what the costs for remediation will be – are the taxpayers getting a good deal?
- There is no good accounting for how much taxpayers have paid.
- There is no effective government oversight over the quality of the remediation – only oversight on the goals.
- A regional solution for all the area mine sites should be considered.

# Attachment 3

# Photographs Documenting Site Conditions

**Photo 1**: View of Evaporation Pond 1 (far left) and Evaporation Pond 2 from on top of the large tailings pile. Note the cobbles in the foreground used as a part of the erosion-protection cover on the large tailings pile. View looking southeast.

**Photo 2**: Pump house and equipment at Evaporation Pond 1. View looking southeast.

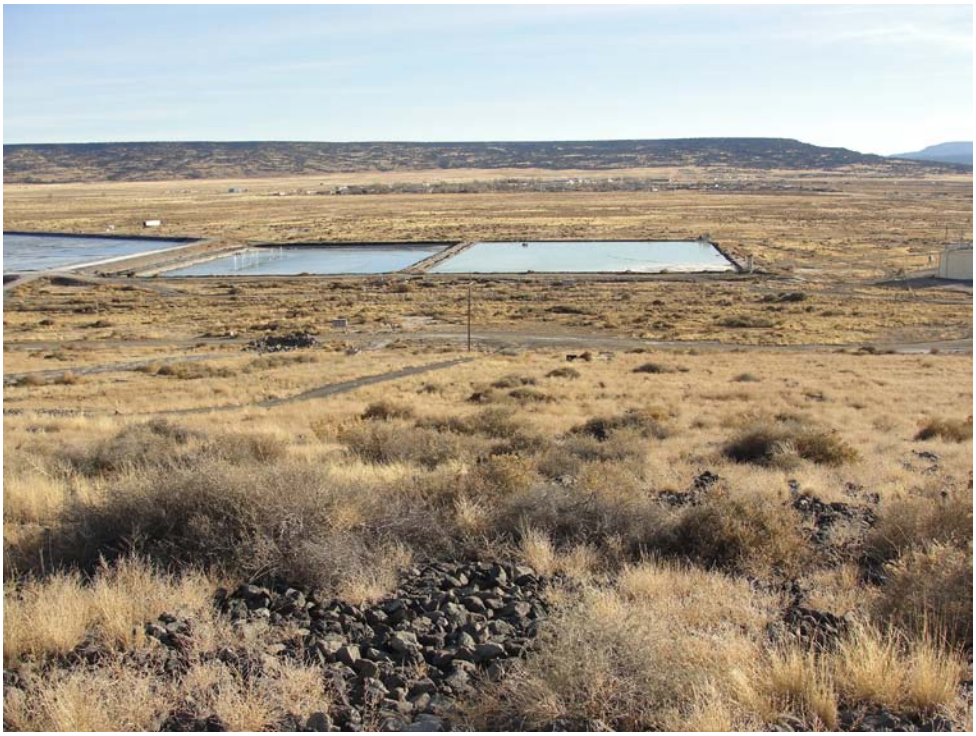


**Photo 3**: Collection ponds (in center of photo) on the south side of the large tailings pile. A portion of Evaporation Pond 2 is visible on the left side of the photo. View looking south.

**Photo 4**: Reverse osmosis (RO) treatment plant on southwest side of the large tailings pile. View looking southwest.

**Photo 5**: Roads leading up to (foreground) and on top of the large tailings pile. Piping on the opposite side of the road is used to convey collected groundwater to the RO treatment plant or to one of the evaporation ponds for disposal. Note the water towers marking the locations of the two former mill sites. View looking east.

**Photo 6**: Extraction wells and piping on top of the large tailings pile. View looking east.

**Photo 7**: Zeolite pilot-test area on the south side of the top of the large tailing pile. Note extraction wells (white) and piping in foreground used to convey collected groundwater to the RO treatment plant or to one of the evaporation ponds for disposal. View looking northeast.

**Photo 8**: Zeolite pilot-test pit on the top of the large tailing pile. The zeolite is used to extract low-concentration uranium before being re-injected at 50 gallons per minute. Pit is lined with a 60 millimeter thick high density polyethylene (HPDE) liner. View looking northeast.


**Photo 9**: Two of 14 discharge structures used to convey surface water off of the top of the large tailings pile. View looking northwest.

**Photo 10**: Pump, pump house, and piping at Evaporation Pond 1. Equipment is used to convey extracted groundwater from the large tailings pile (to the right out of the photo) to the evaporation pond. The black surface is an asphalt-emulsion liner that forms the base for the pond. View looking west.

**Photo 11**: Evaporation Pond 1. Piping used to conve y extracted groundwater from the large tailings pile to the evaporation pond and to the spray misters (structures in the center of the pond). View looking south.

**Photo 12**: South side of the large tailings pile viewed from the south berm of Evaporation Pond 1. Extracted groundwater is pumped from the large tailings pile to the evaporation ponds using the piping in the center of the pictured. View looking north.

**Photo 13**: Point-of-Compliance (POC) Well X at the toe of the small tailings pile. The well was installed in 1975 and monitors the base of the alluvium at approximately 51 feet below ground surface. View looking northeast.


**Photo 14**: POC Well D1 near the RO treatment plant. Well D1 is a replacement well for the original POC Well D.

**Photo 15**: RO treatment plant. View looking west.

**Photo 16**: A portion of the membrane filtration system in the RO treatment plant.


**Photo 17**:  POC Well S4 on the west side of the large tailings pile.

# Attachment 4

# List of Documents Reviewed

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# Attachment 5

# Public Notice