Department of Energy
Office of Legacy Management

AUG 06 2009

Myron Fliegel
U.S. Nuclear Regulatory Commission
Mail Stop T8 F5
Washington, DC 20555-0001

Subject: Draft Long-Term Surveillance Plan for the Gas Hills East, Wyoming, UMTRCA Title II Site

Dear Mr. Fliegel:

Enclosed for NRC review and comment are four copies of the draft *Long-Term Surveillance Plan for the Gas Hills East (UMTRCA Title II) Disposal Site, Fremont and Natrona Counties, Wyoming* (LTSP). This LTSP captures information provided in licensee site documents and demonstrates how the U.S. Department of Energy will fulfill the requirements of Title 10, *Code of Federal Regulations*, Part 40.28, as long-term custodian of the Gas Hills East, Wyoming, site. In accordance with these regulations, this LTSP is being submitted to the NRC as one of the final steps in the license termination process and for transferring the site to DOE for long-term care.

The draft LTSP is complete, except for "placeholders" that were left in Appendix A for the following site real property instruments (that are in process): the Warrantee Deed and the Public Land Order Notice of Permanent Withdrawal as posted in the Federal Register.

DOE understands that NRC cannot give final concurrence to this LTSP until these real property instruments are inserted into the document. However, in order to facilitate NRC's review of the draft LTSP and in an effort to accommodate site transfer from the current licensee (Umetco Minerals Corporation) to DOE, the document is being submitted with these "placeholders" in order that a technical review may be performed. Once these real property actions have been completed and the associated documentation has been obtained and inserted into the draft LTSP, the revised final draft LTSP will be submitted to NRC for concurrence.

Your prompt reply with any comments to this draft LTSP is appreciated. A 90-day review period is anticipated. Please call me at (720) 377-9682 if you have questions.

Sincerely,

Scott R. Surovchak

Digitally signed by Scott R. Surovchak
DN: cn=Scott R. Surovchak, c=us, o=u.s. government, ou=department of energy, public cas, people
Date: 2009.08.03 12:25:46 -06'00'

Scott Surovchak
Site Manager

Enclosures

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Surovchak/GHE final NRC 6-24-09.doc

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Long-Term Surveillance Plan for the Gas Hills East (UMTRCA Title II) Disposal Site Fremont and Natrona Counties, Wyoming

DRAFT

July 2009

U.S. DEPARTMENT OF ENERGY | Legacy Management

LMS/GHE/S01407-0.0

Long-Term Surveillance Plan

for the

Gas Hills East (UMTRCA Title II) Disposal Site
Fremont and Natrona Counties, Wyoming

July 2009

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Abbreviations

ACL	alternate concentration limit
AGTI	Above-Grade Tailings Impoundment
ALARA	as low as reasonably achievable
BLM	U.S. Bureau of Land Management
CAP	Corrective action program
CFR	*Code of Federal Regulations*
COPC	constituent of potential concern
D_{50}	median diameter
DOE	U.S. Department of Energy
EMS	environmental management system
ft	feet, foot
ft/yr	feet per year
GHP	Gas Hills Ponds
HDPE	high-density polyethylene
IX/RO	ion-exchange/reverse osmosis
LM	Office of Legacy Management
LTS&M	long-term surveillance and maintenance
LTSP	Long-Term Surveillance Plan
mg/L	milligram(s) per liter
NRC	U.S. Nuclear Regulatory Commission
pCi/L	picocurie(s) per liter
PMP	probable maximum precipitation
POC	point of compliance
POE	point of exposure
TDS	total dissolved solids
Umetco	Umetco Minerals Corporation
UMTRCA	Uranium Mill Tailings Radiation Control Act
USC	*United States Code*
WDEQ	Wyoming Department of Environmental Quality

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1.0 Introduction

1.1 Purpose

This Long-Term Surveillance Plan (LTSP) explains how the U.S. Department of Energy (DOE) will fulfill general license requirements of Title 10 *Code of Federal Regulations* Part 40.28 (10 CFR 40.28) as the long-term custodian of the Gas Hills East disposal site (formerly known as the Umetco Minerals Corporation [Umetco] Gas Hills, Wyoming, uranium mill tailings disposal site) in Fremont and Natrona Counties, Wyoming. The DOE Office of Legacy Management (LM) is responsible for the preparation, revision, and implementation of this LTSP, which specifies procedures for inspecting the site, monitoring, conducting maintenance, fulfilling annual and other reporting requirements, and maintaining records pertaining to the site.

1.2 Legal and Regulatory Requirements

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978 (Title 42, *United States Code*, Section 7901 [42 USC §7901] as amended, provides for the remediation (or reclamation) and regulation of uranium mill tailings under either Title I or Title II of the act. Title I addresses former uranium millsites that were unlicensed as of January 1, 1978, and essentially abandoned. Title II addresses uranium millsites under specific license as of January 1, 1978. In both cases, the licensing agency is the U.S. Nuclear Regulatory Commission (NRC) or, in the case of certain Title II disposal sites, an Agreement State. The Gas Hills East disposal site is regulated under Title II of UMTRCA. The State of Wyoming is not an Agreement State.

Federal regulations at 10 CFR 40.28 provide for the licensing, custody, and long-term care of uranium and thorium mill tailings sites closed (reclaimed) under Title II of UMTRCA.

A general license is issued by NRC for the custody and long-term care—including monitoring, maintenance, and emergency measures—necessary to ensure that uranium and thorium mill tailings disposal sites will be cared for in such a manner as to protect public health, safety, and the environment after closure (completion of reclamation activities).

The general license becomes effective when NRC or an Agreement State approves the site reclamation and terminates the operating license, and the NRC accepts a site-specific LTSP (this document).

Requirements of the LTSP and general requirements for the long-term custody of the Gas Hills East disposal site specified in 10 CFR 40 are addressed in various sections of the LTSP as shown in Table 1–1.

The plans, procedures, and specifications in this LTSP are based on *Guidance for Implementing the Long-Term Surveillance Program for UMTRCA Title I and Title II Disposal Sites* (DOE 2001). Rationale and procedures in the guidance document are considered part of this LTSP.

Table 1–1. Requirements of the LTSP and for the Long-Term Custodian of the Gas Hills East, Wyoming Disposal Site

	Requirements of the LTSP	
	Requirement	***LTSP Section***
1.	Description of the final site conditions	Section 2.0
2.	Legal description of the site	Appendix A
3.	Description of the long-term surveillance program	Section 3.0
4.	Criteria for follow-up inspections	Section 3.5.1
5.	Criteria for maintenance and emergency measures	Section 3.6.3
	Requirements for the Long-Term Custodian (DOE)	
	Requirement	***LTSP Section***
1.	Notification to NRC of changes to the LTSP	Section 3.1
2.	NRC permanent right-of-entry	Section 3.1
3.	Notification to NRC of significant construction, actions, or repairs at the site	Sections 3.5 and 3.6

1.3 Role of the Department of Energy

In 1988, DOE had designated the Grand Junction facility as the program office for managing long-term surveillance and maintenance (LTS&M) of DOE disposal sites that contain regulated low-level radioactive materials and portions of sites that do not have a DOE mission after cleanup, as well as other sites (including Title II sites) as assigned, and to establish a common office for the security, surveillance, monitoring, and maintenance of those sites.

In December 2003, DOE formally established the LM office. The LM mission includes "implementing LTS&M projects at sites transferred to LM to ensure sustainable protection of human health and the environment." LM is responsible for implementing this LTSP after it is accepted by NRC and the site becomes regulated under the general license.

According to the objectives of DOE Order 450.1A, *Environmental Protection Program*, or current guidance, DOE sites must implement sound stewardship practices protective of the air, water, land and other natural and cultural resources potentially affected by their operations. DOE Order 450.1A requires DOE sites to have an environmental management system (EMS) to implement these practices. The LM EMS incorporates federal mandates specified in Executive Order 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* and DOE Order 430.2B, *Departmental Energy Renewable Energy and Transportation Management.*

2.0 Final Site Conditions

Reclamation of the Gas Hills East disposal site consisted of demolishing site uranium-processing structures and relocating the contaminated structural materials and contaminated mill tailings and soils to three primary on site disposal areas: the Above-Grade Tailings Impoundment (AGTI), the Heap Leach Pile, and the A–9 Repository. All disposed materials are isolated from the environment in engineered disposal structures that were constructed in accordance with NRC-approved reclamation plans and designs.

2.1 Site History

Uranium mining in the Gas Hills region began in the late 1950s and continued until 1984. Pathfinder Mines Corporation, Umetco (formerly Union Carbide Corporation), the Tennessee Valley Authority, and smaller mining companies extracted uranium ore by open pit mining in the vicinity of the site. Several of the open-pit mines have been reclaimed under the Wyoming Abandoned Mine Land reclamation program; however, groundwater has been impacted by mining and reclamation of these pits (Umetco 2001). Currently, Power Resources, Inc. is permitting an *in situ* leach uranium mine south-southwest of the Gas Hills East disposal site.

Between 1956 and 1958, Union Carbide Corporation acquired properties in the Gas Hills Mining District (Umetco 2007). The mill at the Gas Hills East site was constructed in 1959, at which time mining operations were initiated. Conventional milling procedures began at the site in 1960. These procedures included sulfuric acid leaching, solid liquid extraction, resin-in-pulp separation, solvent extraction, and precipitation. Ore that was processed came from nearby open-pit mining operations (Shepherd Miller, Inc. 1998), including several which were located on site. Ore processed on site was also received (to a limited extent) from Union Carbide operations in Maybell, Rifle, and Uravan, Colorado (Umetco 2001). During this period, tailings slurry was placed in the AGTI (Umetco 2001). Soil and rock that was not mineralized was used as backfill in the open-pit mine. Conventional milling at the site ceased in 1984, at which time the mill was put on standby status until 1987, when it was shut down. From 1960 through 1984, approximately 8 million tons of ore was processed at the Gas Hills East mill (Umetco 2001).

In addition to the conventional milling performed at the site, ore that was of marginal grade was used in the heap leach processing operations that began in 1963 (Shepherd Miller, Inc. 1998). A total of three heap leach operations were conducted at the site (Umetco 2007). Heap leach operations were ultimately shut down in January 1988 (NRC 1998a).

In 1979, after NRC approved use of the A–9 open-pit mine as a tailings repository, 3 feet (ft) of compacted clay were placed at the bottom of the A–9 Repository. Through 1984, approximately 1.6 million tons of tailings were placed in the A–9 Repository. In 1988, approximately 1.8 million cubic yards of tailings from the Riverton UMTRCA Title I site were also placed in the A–9 Repository (Umetco 2001). Consistent with the NRC-approved 1987 reclamation design for the A–9 Repository, an interim cover consisting of 1 to 5 ft of compacted clay was placed over the entire A–9 area. Final reclamation of the A–9 Repository was in accordance with the *Design for Enhancement of the Previously Approved Reclamation Plan for the A–9 Repository* (Shepherd Miller, Inc. 1998) as modified by Umetco submittals dated December 10, 1998 and March 29, 1999. Disposal of contaminated materials in the A–9 Repository was completed by the end of 2002. The radon barrier and frost-protection layer of the A–9 Repository reclamation cover were completed in 2003.

Reclamation of the C-18 Pit was also addressed in the reclamation plan for the A-9 Pit (Shepherd Miller, Inc. 1998). Reclamation of the C-18 Pit, used historically as a surface water impoundment (Umetco 2001), involved placement of approximately 56 ft of backfill (excluding the 10 ft of bridge fill soil initially placed) into the pit to bring the fill material to surface level (Umetco 2007). Grading was done to promote drainage away from the pit, in accordance with the site-wide grading plan.

In 1979, the North and South Evaporation Ponds were constructed to store and evaporate tailings liquids pumped from the A–9 Repository and groundwater recovered from the Wind River aquifer. The ponds were constructed on top of a mine spoils pile west of the A–9 Repository and were lined with clay. Decommissioning of the North and South Evaporation Ponds began in 1991. Because residual byproduct material was not detected under the pond liners, an engineered cover was not required for these areas. The North and South Ponds were replaced by the synthetic-lined ponds, Gas Hills Ponds (GHP) No. 1 and No. 2, which were constructed to contain and evaporate groundwater extracted under the groundwater corrective action program (CAP). GHP No. 1 was decommissioned in 2000 (Umetco 2001). GHP No. 2, which was constructed in the former mill area and stockpile area, was reclaimed in place because of the volume of potentially contaminated soils and the difficulty in distinguishing soils containing naturally elevated concentrations of radionuclides from those impacted by mill activities. Reclamation of GHP No. 2 was completed in 2006.

The Gas Hill East mill facility was demolished and disposed of in the Heap Leach Pile in accordance with the Heap Leach reclamation plan modification (Umetco 1996) as supplemented or revised by submittals dated June 6, August 19, and October 15, 1997; January 15 and February 11 and 13, 1998; and December 20, 2000. Portions of the mill facility were disposed in the A–9 Repository in accordance with the plans noted above. A clay cover and erosion-protection layer were placed over the reclaimed Heap Leach area in 2001 (Umetco 2001).

Initial reclamation of the AGTI was in accordance with the December 18, 1980, Reclamation Plan and the April 19, 1979, and May 13, 1982, letters. By 1992, Umetco had completed grading of tailings and construction of the cover, except for 6 inches of topsoil and seed. Several years after construction, erosion of the cover was noted and concerns were expressed for erosion along the east toe of the impoundment, the closure of the north toe drain, and additional contamination found near the north edge of the impoundment. Also during construction, a potential cultural/historical resource area was noted in close proximity to the AGTI. Umetco, working with the Wyoming State Historic Preservation Office, NRC, the U.S. Bureau of Land Management (BLM) Casper Field Office, and the Advisory Council on Historic Preservation, agreed to modify the design to minimize the impact to historic resources in the immediate area. Final reclamation of the AGTI was in accordance with the above-mentioned plans, except as superseded by the *Design for Enhancement of the Previously Approved Reclamation Plan for the Above-Grade Inactive Tailings Design Report* of October 6 and October 28, 1997 (Shepherd Miller, Inc. 1997), as modified by submittals dated May 22, June 26, July 20, July 28, September 8, September 15, and November 23, 1998; April 9 and June 7, 1999; and December 2000.

Enhanced reclamation plans for the AGTI and A–9 Repository were necessary, in part, due to new criteria contained in 10 CFR 40, Appendix A, and in NRC's *Final Position on Previously*

Approved Reclamation Plans (NRC 1995). Generalized components of the enhanced plans included (1) replacement of a vegetative cover with rock riprap erosion protection; (2) extension and/or increased thickness of the radon barrier; and (3) diversion channel modifications, including installation of additional erosion protection and realignment.

In 1983, Umetco initiated groundwater remediation with the installation of extraction wells in the Wind River aquifer downgradient of the A–9 Repository. In 1990, groundwater extraction began downgradient of the AGTI, and Umetco constructed an ion exchange/reverse osmosis (IX/RO) water treatment system. Treated water was injected into wells upgradient and downgradient of the AGTI and A–9 Repository to increase groundwater flux through the aquifer. This treatment and injection system was not effective, and the system was eventually discontinued.

In February 1999, following extensive groundwater corrective action, Umetco prepared an alternate concentration limit (ACL) application based on the premise that the chemical constituents that are derived from the mill process are the same as those related to uranium deposition, mining, and reclamation (Umetco 2001). Umetco provided data showing that differentiation between milling impacts, mining impacts, or dissolution of naturally occurring uranium deposits can not be made. Umetco developed site-specific ACLs that are protective of human health and the environment at the point of exposure (POE) and are as low as reasonably achievable (ALARA) based on the results of the hazard assessment and analytical data from site monitor wells. The hazard assessment indicated that constituent concentrations are attenuated to background levels or below Wyoming Class III standards (i.e., suitable for livestock) before reaching the proposed POE regardless of whether the constituents are derived from mineralization, mining, or milling activities (Umetco 2001). NRC approved ACLs for the Gas Hills East disposal site on March 29, 2002 (NRC 2002). Groundwater extraction downgradient of the AGTI and A–9 Repository was terminated after ACLs were approved. Since that time, Umetco performed annual post-remediation monitoring for all ACL constituents and semiannual monitoring of sulfate, chloride, and uranium until transfer of the site to DOE for LTS&M.

Reclamation of the AGTI, Heap Leach Pile Area, A–9 Repository, and GHP No. 2/Mill Area is complete, and erosion protection is in place. Umetco submitted the Final Status Survey Report to NRC, which was approved with addenda by NRC in September 2005 (NRC 2005).

2.2 General Description of the Disposal Site Vicinity

The Gas Hills East disposal site is located in rural Fremont and Natrona Counties (the county line runs through the site), approximately 50 miles southeast of Riverton and 60 miles west of Casper, Wyoming (Figure 2–1). The site encompasses approximately 1,920 acres (Figure 2–2). Elevation at the site ranges from 6,800 ft to 7,050 ft (Umetco 2001) (Figure 2–3).

The site lies within the Gas Hills Uranium District of the Wind River Basin, in portions of Sections 10, 15, 16, and 22, Township 33 North, Range 89 West (Umetco 2001). The area surrounding the site is sparsely populated. The nearest residence is approximately 5 miles to the northeast of the site (Umetco 1995). Within a 50-mile radius, the 1990 population was 4,407. Within 5 miles of the site, approximately 78 percent of the land is under BLM jurisdiction (NRC 1998b).

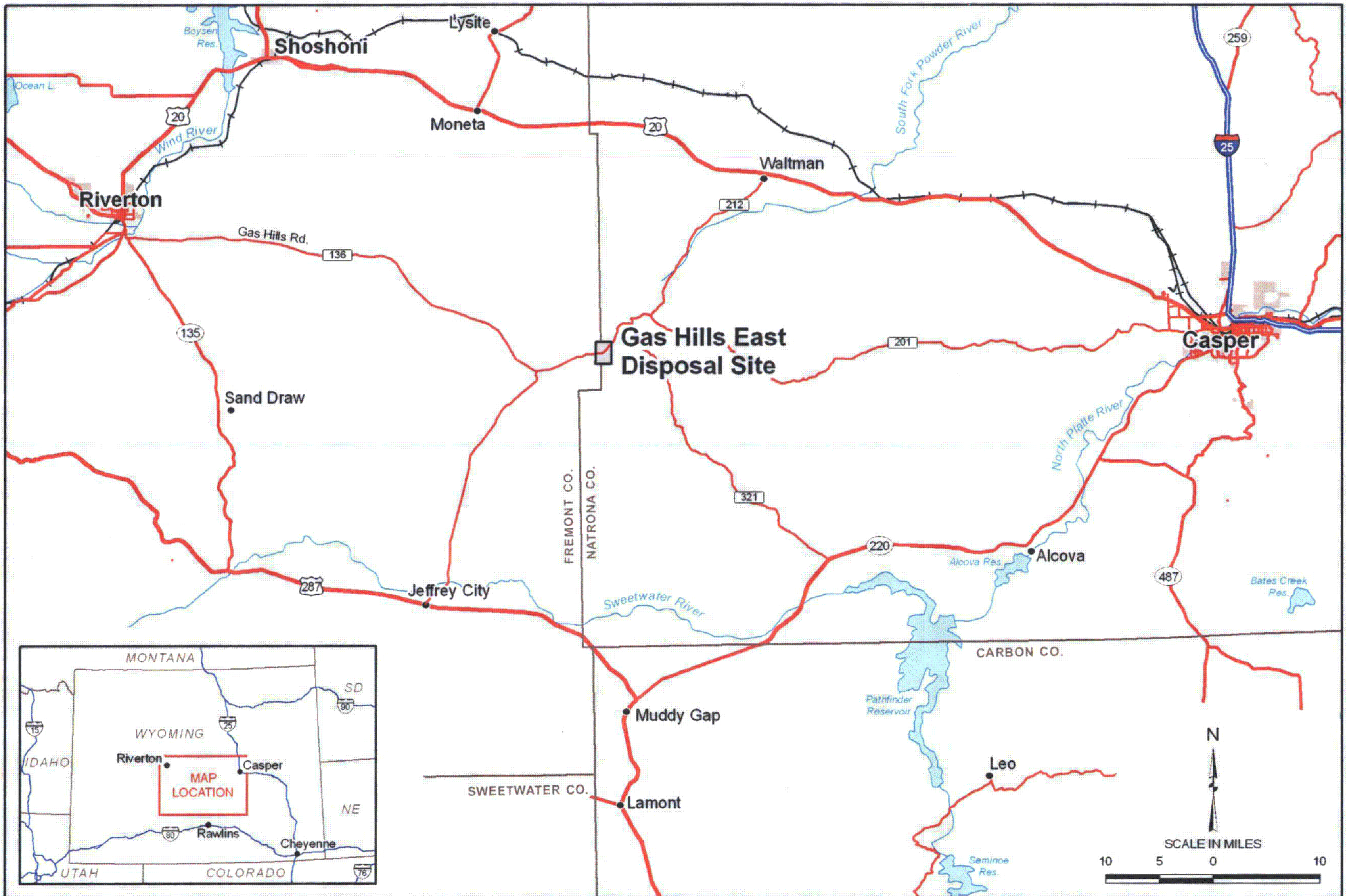

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Figure 2-1. General Location Map of the Gas Hills East, Wyoming, Disposal Site

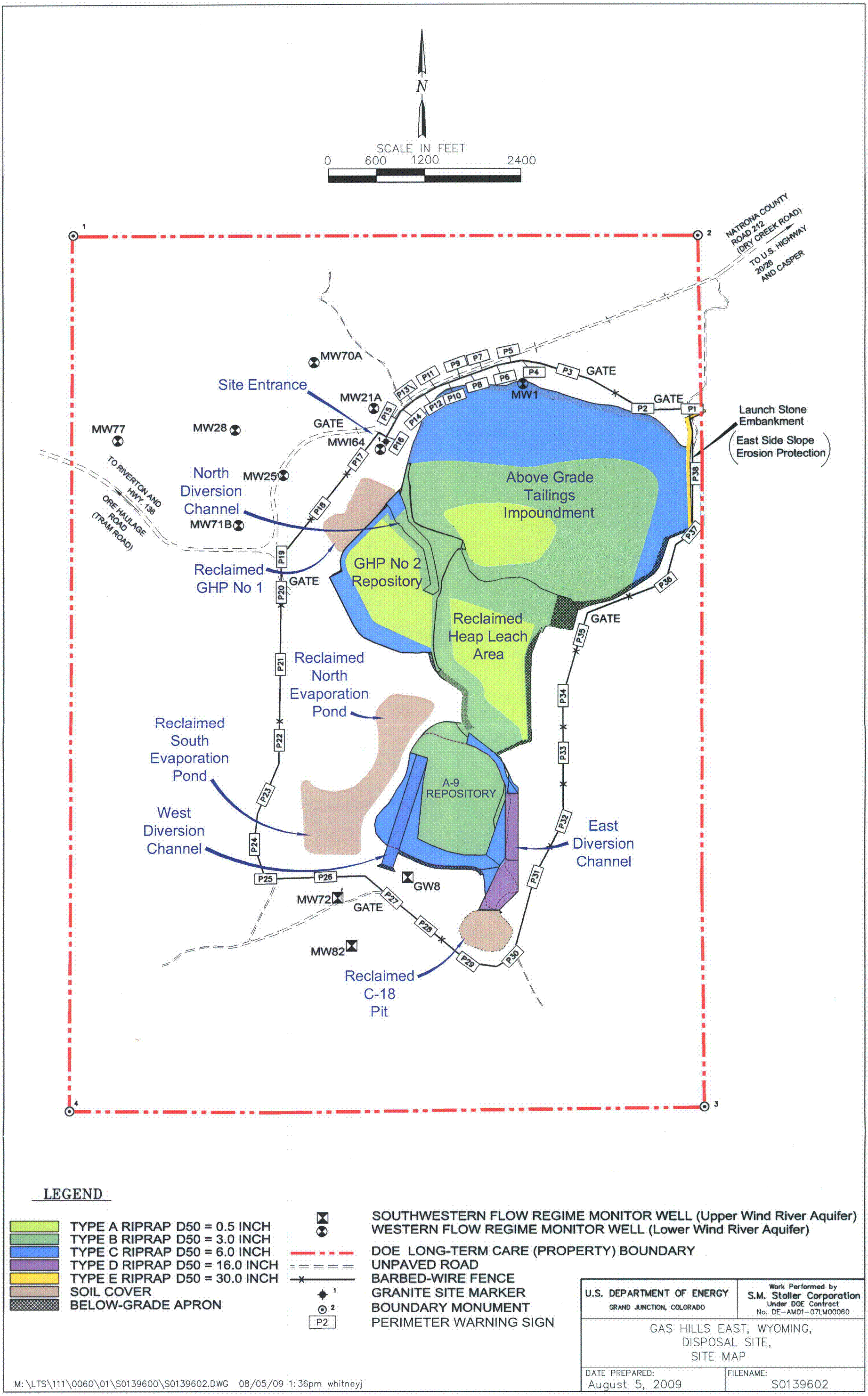

Figure 2–2. Gas Hills East, Wyoming, Disposal Site Map

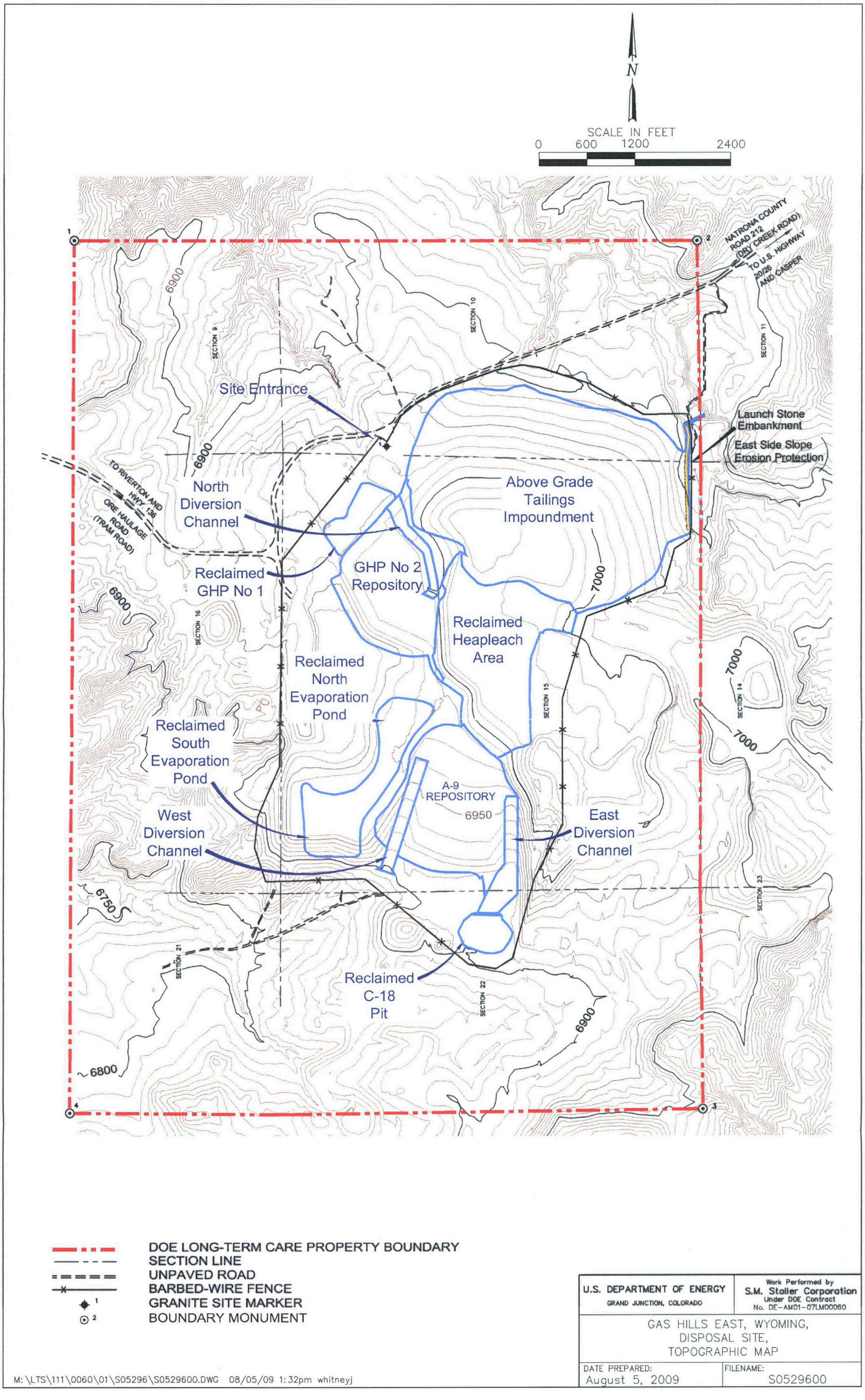

Figure 2–3. Gas Hills East, Wyoming, Disposal Site Topographic Map

The weather and climate of central Wyoming is dominated by low- and high-pressure centers, with attendant frontal systems, that migrate through the area throughout the year. The climate is semiarid with wide seasonal fluctuation in temperature. Average annual precipitation for the site is 9 inches (NRC 1999a). Most of the annual precipitation is received during the months of April, May, and June (Shepherd Miller, Inc. 1998) falling mainly in the spring and summer in the form of wet snow and rain (NRC 1999b). Temperatures vary from highs in the summer near 100 °F to lows in the winter near –40 °F with average temperature of 18 °F in January and 68 °F in July (Umetco 2001). The seasons are distinct, with mild summers and harsh winters. Spring and fall are transition seasons, with warm days and cold nights. The mean annual snowfall is 72 inches; pan evaporation averages 46 inches per year. Wind gusts prevail from the west-southwest and average from 11 to 17 miles per hour (mph); however, gusts average around 60 mph (Shepherd Miller, Inc. 1997).

The rolling terrain of the Gas Hills Uranium District is dissected by dry washes that drain into ephemeral creeks that discharge to the Wind River, approximately 45 miles north-northwest of the site (Umetco 2001). There are no perennial surface water bodies in the area of the Gas Hills East mining district. The mill site is in the surface drainage area of the East Canyon Creek, which is approximately 200 ft east of the AGTI. East Canyon Creek is ephemeral in the site area and drains generally from south to north (Umetco 2001). West Canyon Creek is an intermittent stream west of the former north and south evaporation ponds and the A–9 cell. Vegetation in the area is sparse, consisting mainly of sagebrush and native grasses with some trees (Shepherd Miller, Inc. 1998).

The primary land uses in the vicinity of the site are livestock grazing, wildlife habitat, and mineral exploration. An in-situ leach facility is planned for the property south of the Umetco site. Within 30 miles of the site are three other uranium mill sites and several former uranium mine sites. The Wyoming abandoned mine land-reclamation program has reclaimed uranium mine pits and overburden piles adjacent to the site. Two abandoned mines are located in the southwest corner of the site (Umetco 2001, Figure A.2). A map showing land ownership and use (both surface and subsurface) within and adjacent to the site at the time of transition is provided in Appendix A.

2.3 Disposal Site Description

2.3.1 Site Ownership

Upon completion of reclamation work and acceptance of the site under the NRC general license, the U.S. Government assumed ownership of the approximately 1,920-acre Gas Hills East disposal site property. DOE has jurisdiction of the property, which has been withdrawn from public access. Real estate information is presented in Appendix A and includes a copy of the:

- Warranty deed.
- Public Land Order Notice of Permanent Withdrawal (Transfer of Public Land for the Gas Hills East, Wyoming, Uranium Repository).
- Legal description for the disposal site property.
- Pre-Transition Land Ownership and Use Map.

Access to the disposal site from the east is by way of unpaved county road (i.e., Natrona County Road 212).

2.3.2 Directions to the Disposal Site

From Casper, Wyoming, travel west on State Highway 20/26 approximately 45 miles to Waltman, Wyoming. Exit at Waltman and proceed southwest toward Ervay, approximately 21.5 miles on Natrona County Road 212 past Poison Spider Road. Continue on County Road 212, now also known as Dry Creek Road, to the site (Figure 2–1).

Alternatively, travel south approximately 4 miles on State Highway 135 from Riverton. Exit east on State Highway 136; travel east-southeast approximately 45 miles to a dirt road. Travel north-northeast on this road approximately 4 miles until the road ends. Turn right and proceed approximately 8 miles to the site (Figure 2–1).

2.3.3 Description of Surface Conditions

The Gas Hills East disposal site consists of three primary disposal areas located on the 1,920-acre parcel: the 170-acre AGTI, the 55-acre A–9 Repository, and the 60-acre Heap Leach Area (Figure 2–2). Engineered covers were placed over these disposal areas. Mill tailings were placed in two of these impoundment areas; the AGTI and the A–9 Repository (Umetco 2007). Wastes from heap leach operations are contained primarily in the reclaimed Heap Leach Area; although, the first pilot heap leach operation coincides with the location of GHP No. 2, a lined evaporation pond constructed for use during groundwater remediation and to collect surface water runoff (Umetco 2007). An engineered cover was also placed over GHP No. 2 following its closure; after which time it is referred to as the GHP No 2 Repository. The cover was installed because GHP No. 2 was constructed in the former mill and stockpile area, which contained potentially contaminated soils (i.e., impacted by mill activities) that were often difficult to distinguish from soils containing naturally elevated concentrations of radionuclides (Umetco 2003). Several other reclaimed areas are also indicated on Figure 2–2—the C-18 Pit, GHP No. 1, the North Evaporation Pond, and the South Evaporation Pond—all of which have a soil cover and were not used for the disposal of radioactive waste materials. There are a number of reclaimed former open uranium mine pits located on the disposal site (Umetco 2001, Figure 2–2) that are not shown on Figure 2–2; these former pits were also not used for the disposal of radioactive waste materials.

The final surface conditions at the Gas Hills East disposal site are a combination of rock armoring, contouring, and revegetation to achieve the necessary surface water run-on and runoff control and erosion protection to satisfy the longevity design requirements. The revegetated surfaces have been planted with a mix of native grasses that have proven to be successful in reclaiming nearby surface mine areas and will help provide soil stability.

A site-wide grading plan approved for the site used a combination of drainage swales and diversion channels to convey incident surface water away from the tailings disposal areas. All portions of the disposal areas have been covered with erosion protection. In general, on the gently sloping tops of the cells, riprap consists of Type A rock with a median diameter (D_{50}) of 0.5 inch. Steeper faces are armored with progressively larger riprap. Diversion channels are armored with the largest rock, Type E rock, with a D_{50} of 20.0 inches. The tailings area itself occupies 300 acres of the 1,920-acre disposal site property, and is surrounded by a four-strand barbed-wire fence. Figure 2–2 shows locations of the various types of riprap at the disposal site. The final site topography is shown on Figure 2–3.

There are 11 long-term monitor wells at the Gas Hills East disposal site (Figure 2–2).

2.3.4 Permanent Site Surveillance Features

Boundary monuments, a site marker, and warning signs are the permanent long-term surveillance features at the Gas Hills East disposal site. These features will be inspected and maintained as necessary as part of the passive institutional controls for the site. Figure 2–2 is the inspection map for the site.

Four boundary monuments mark the final site boundary, one at each corner of the 1,920-acre disposal site property. One unpolished granite site marker with an incised message identifying each of the primary disposal areas at the Gas Hills East disposal site is placed at the site entrance where a random visitor would likely discover it. The message on the granite site marker is shown on Figure 2–4. There are 38 warning signs which display the DOE 24-hour telephone number (Figure 2–5) placed along the barbed-wire fence that surrounds the disposal area. The barbed-wire fence serves as a land management tool and is not a permanent site surveillance feature. The positions of the permanent site surveillance features are shown on Figure 2–2.

2.3.5 Site Geology

The Gas Hills East disposal site is located in the Wind River Basin of Central Wyoming (Shepherd Miller, Inc. 1998). The Wind River Basin is a large sediment filled, northwest-trending structural depression that was formed by tectonic activity during the Late Cretaceous and Early Cenozoic periods. During Eocene times, continued uplift and subsequent erosion of the surrounding mountain ranges resulted in deposition of the Wind River Formation that is the bedrock at the site. The Wind River Formation is composed predominately of debris eroded from surrounding highland areas, deposited in alluvial fans, stream channels, flood plains, lakes, and swamps. Underlying the Wind River Formation are the Cody Shale and the Frontier Formation.

The thickness of the Wind River Formation varies from a few feet near the basin margin to several thousand feet in the northern part of the basin. Within a few thousand feet to a few miles from the site, the Wind River Formation pinches out west, east, and south against Cretaceous and older deposits (Umetco 2001). In the vicinity of the Gas Hills East disposal site, the Wind River Formation is approximately 300 ft thick and is characterized as a sequence of alternating and discontinuous layers of sandstone, siltstone, claystone, and conglomerate (Shepherd Miller, Inc. 1998). The formation has been segmented into upper and lower units (Geraghty & Miller, Inc. 1996). A mudstone unit approximately 20 to 40 ft thick separates the upper unit from the lower unit.

Uranium typically occurs as roll-front deposits within the Wind River Formation. Roll-front uranium deposits are discontinuous both vertically and laterally and occur at the interface between oxidized and reduced rock in an arcuate pattern, with the convex side of the arc pointing in the direction of groundwater flow. Uranium produced at the Gas Hills East mill was mined from open-pit mines in the Wind River Formation (Umetco 2001).

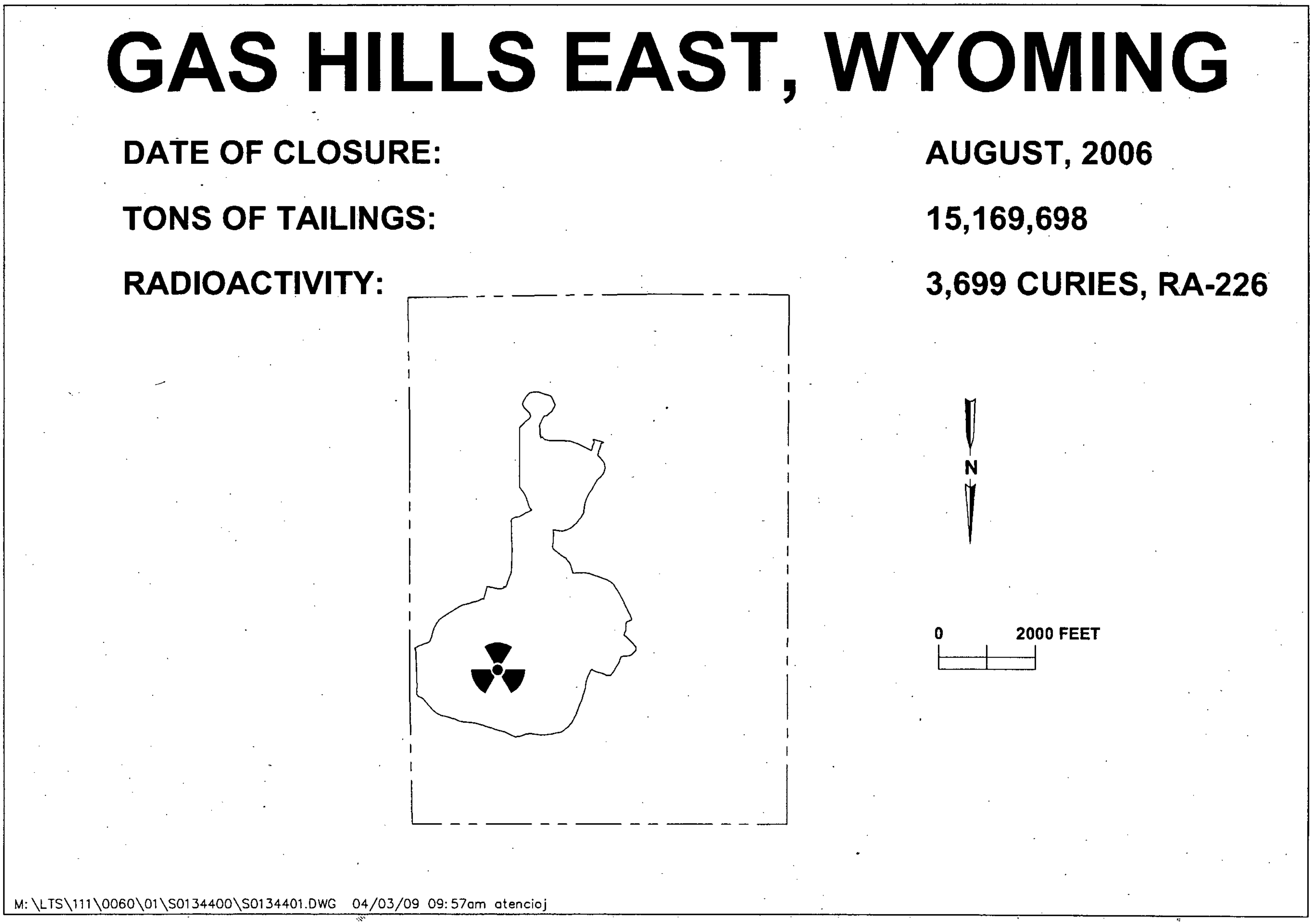

Figure 2–4. Site Marker at the Gas Hills East, Wyoming, Disposal Site

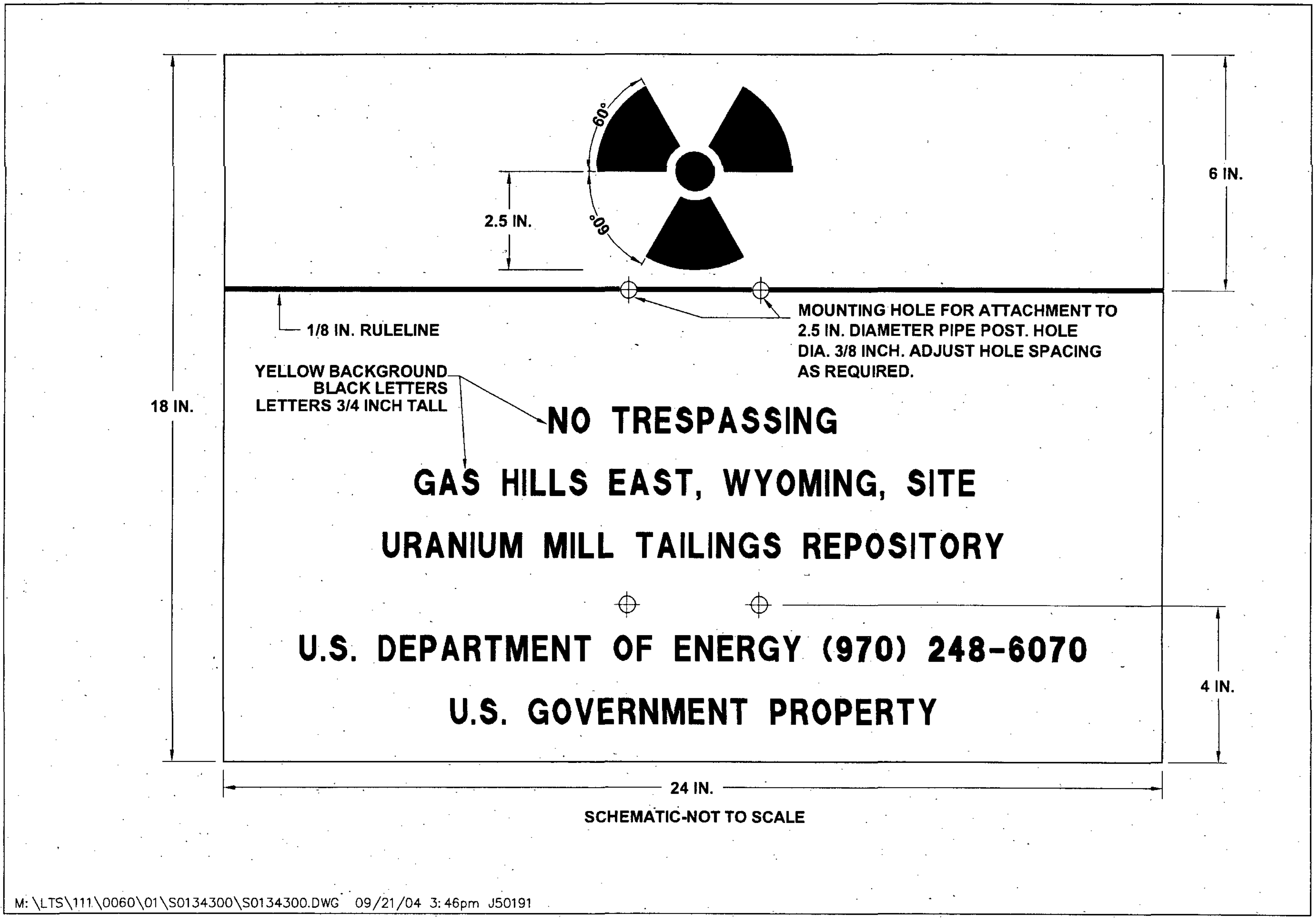

Figure 2–5. Warning Sign at the Gas Hills East, Wyoming, Disposal Site

2.3.6 Hydrology

There are no surface water bodies in the vicinity of the Gas Hills East disposal site, with the exception of man-made impoundments. Boysen Reservoir, the nearest large body of water, is located approximately 50 miles to the northwest. Most of the drainages are dry except during runoff following precipitation and in areas near seeps and springs. East and West Canyon Creeks, on either side of the disposal site, join Canyon Creek 4 miles to the northwest. Canyon Creek then joins Deer Creek which runs into Poison Creek approximately 8 miles further to the north. Poison Creek then discharges into Boysen Reservoir (Umetco 2001). Surface runoff on the site was collected in GHP No. 2 until its closure. Surface runoff now is controlled by the final grade established for the site.

Regionally, groundwater occurs within the Wind River Formation. Although the Wind River Formation contains an extensive regional aquifer system, locally the aquifer is discontinuous and of limited use (Umetco 2001). The regional groundwater flow pattern within the aquifer is toward the Wind River, northwest of the site. In the vicinity of the Gas Hills, the groundwater flow is constrained by pre-Wind River deposits. East of the site, the Wind River Formation pinches out against the Rattlesnake Hills. The Granite Mountains south of the site delineate the southern extent of the Wind River Formation.

Groundwater beneath the site occurs under confined, unconfined, and perched hydrostatic conditions within the Wind River Formation (Figure 2–6). This uppermost occurrence of groundwater, referred to as the Wind River aquifer, is divided into two hydostratigraphic units (or flow regimes) named the Upper and Lower Wind River aquifers. A mudstone unit, between 20 and 40 ft thick is the confining unit between the Upper and Lower Wind River aquifers. This underlying confining layer is believed to exist across the majority of the site, including the impoundment and repository areas. However, it is not conclusive from site information (hydrogeologic cross-sections and well completion logs) whether the mudstone is continuous and extends across the entire site. Because site-related contamination occurs in the Lower Wind River aquifer, this mudstone unit may either pinch out in the northern portion of the site or not be entirely effective as a confining unit.

The Upper Wind River aquifer is found to occur beneath the A–9 Repository, where it exists under unconfined conditions (Umetco 2001), as shown on Figure 2–6. This shallowest occurrence of groundwater is referred to as the southwestern flow regime (Figure 2–7) because groundwater flow is to the south-southwest (Geraghty & Miller, Inc. 1996). In the southwestern flow regime, groundwater exists in oxidizing conditions in the immediate vicinity of the A–9 Repository; however, conditions become more reducing away from the site. The southwestern flow regime is absent below the AGTI and west of the site (Umetco 2001). The maximum and average groundwater velocity for the southwestern flow regime was calculated at 102 and 36 feet per year (ft/yr), respectively (Umetco 2001). Because of variations in hydrologic properties at the site, groundwater modeling predicted for the southwestern flow regime the minimum and average travel times to reach the long-term care boundary from the downgradient edge of the A–9 Repository to be 40 and 139 years, respectively (Umetco 2001).

The Lower Wind River aquifer is present beneath the entire site, changing from an unconfined aquifer in the northern portion of the site to a confined aquifer in the southern portion of the site (Figure 2–6). Groundwater in the Lower Wind River aquifer is referred to as the western flow regime (Figure 2–7) because groundwater flow is primarily to the west (Geraghty & Miller, Inc. 1996). The maximum and average groundwater velocity for the western flow regime was

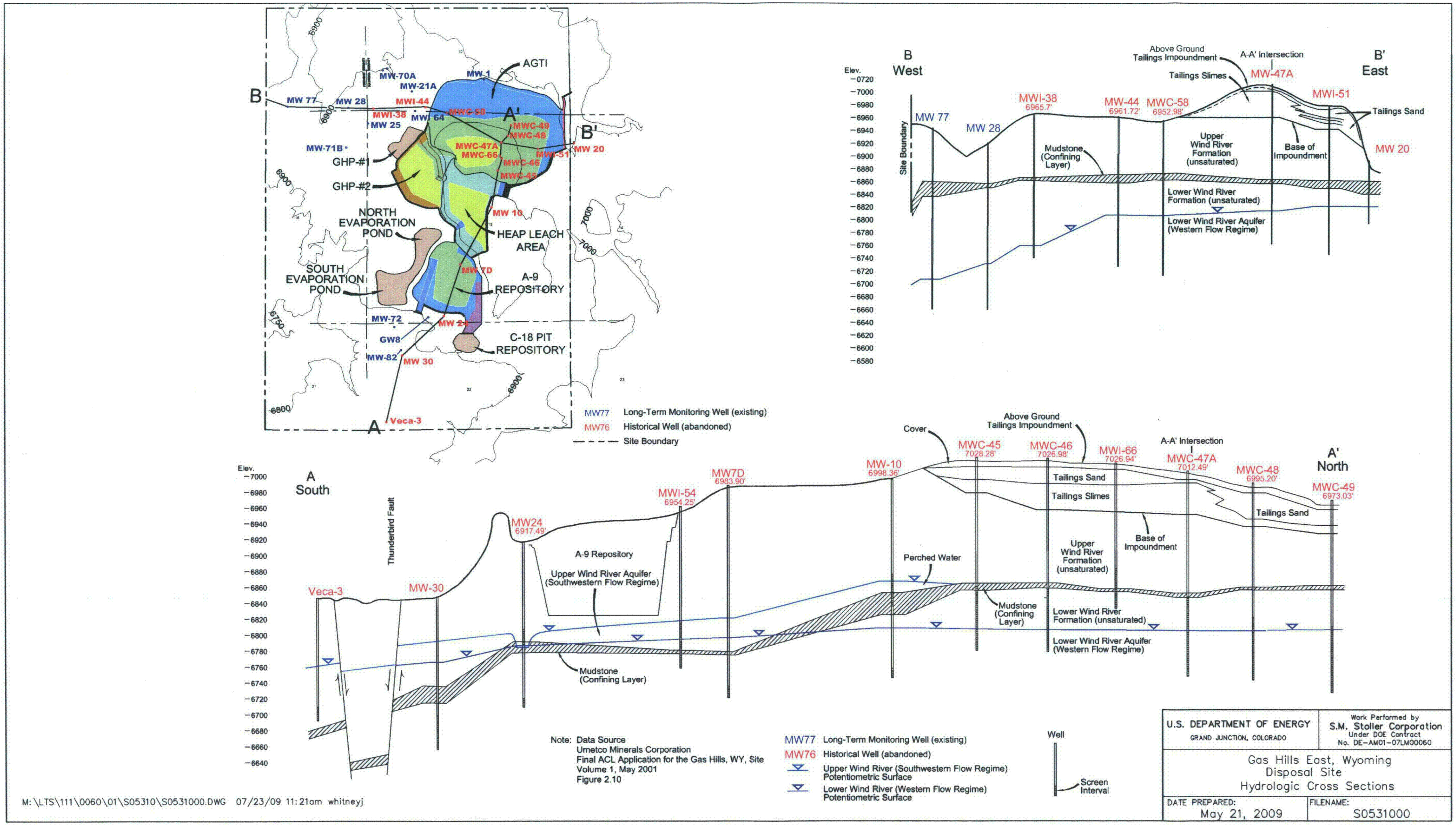

Figure 2–6. Hydrogeologic Cross Sections at the Gas Hills East, Wyoming, Disposal Site

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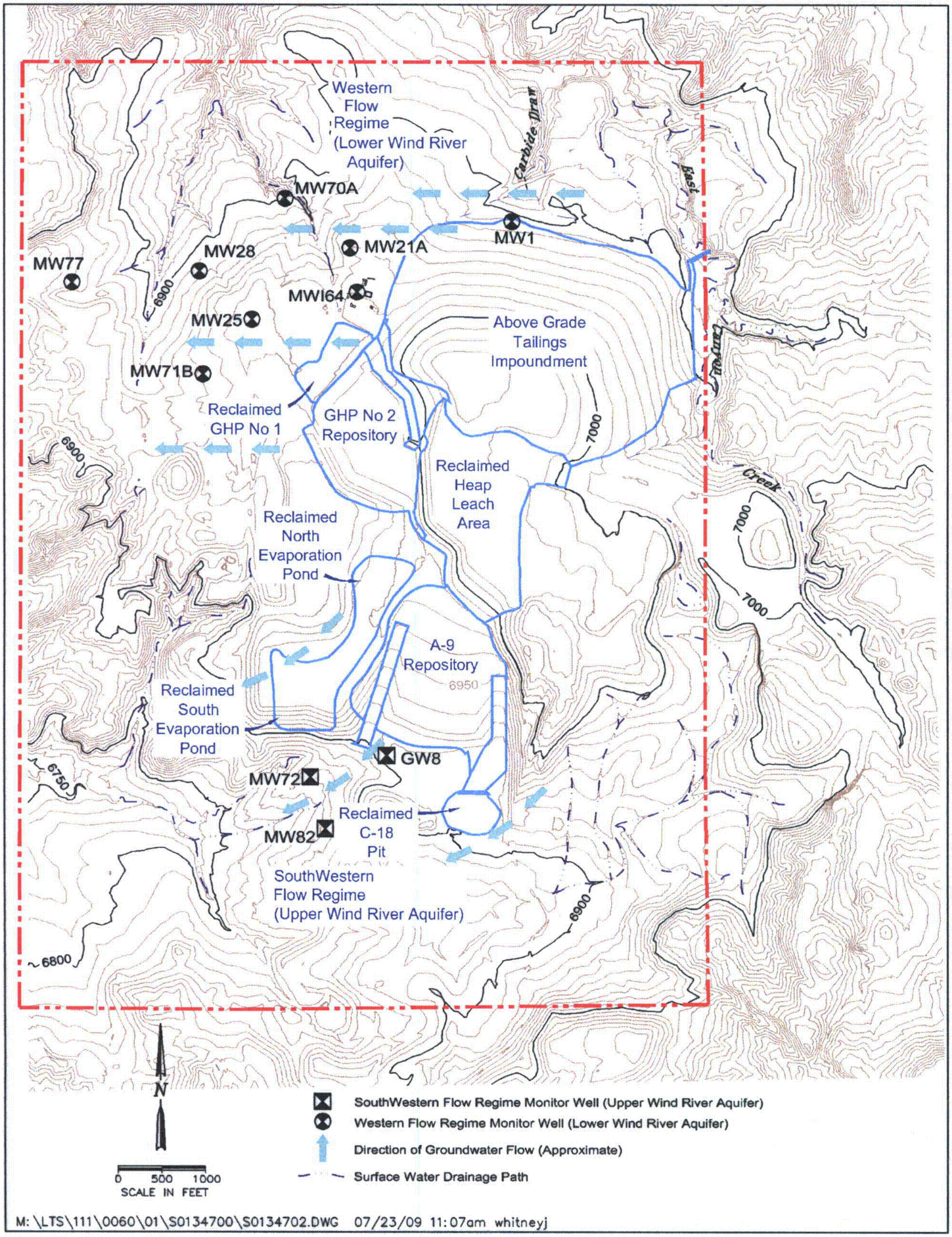

Figure 2–7. Approximate Groundwater Flow Direction in the Western and Southwestern Flow Regimes at the Gas Hills East, Wyoming, Disposal Site

calculated at 120 and 55 ft/yr, respectively (Umetco 2001). Because of variations in hydrologic properties at the site, groundwater modeling predicted for the western flow regime the minimum and average travel times to reach the long-term care boundary from the downgradient edge of the AGTI to be 30 and 101 years, respectively (Umetco 2001).

Locally, in the northern portion of the site, where the groundwater flows toward the west, truncation of the Wind River Formation downgradient of the site results in discharge of groundwater at several springs. Medicine Spring, Lincoln Spring, and Iron Spring are examples of these discharge points that occur along West Canyon Creek (Umetco 2001). In the southern portion of the site, where groundwater flows toward the southwest, discharge eventually occurs at springs north of the former Lucky Mc uranium milling site (i.e., the Gas Hills North Disposal Site), which is located approximately 5 miles from the Gas Hills East site (Umetco 2001).

Recharge to the Wind River aquifer occurs from several sources; direct infiltration, discharge from pre-Wind River deposits, and from streams and surface drainages. Localized recharge has also occurred as a result of infiltration from impoundments associated with mining and reclamation. Before placement of the reclamation cover, infiltration through the AGTI was a source of recharge to the Wind River aquifer. Additionally, a portion of the water treated under the groundwater CAP was injected into the Wind River aquifer (Umetco 2001).

2.3.7 Groundwater Conditions

Umetco initiated groundwater remediation in 1983 to address tailings leachate that was entering the uppermost aquifer. Extraction wells were installed and groundwater was extracted in the vicinity of the A–9 Repository. Extracted groundwater was evaporated in the South Evaporation Pond.

In 1990, groundwater remediation was brought under an NRC-approved groundwater corrective action program (CAP) which included (1) monitoring of surface and groundwater quality, (2) minimization of sources, and (3) extraction and evaporation or treatment of groundwater. Results of characterization and monitoring efforts indicated there were two flow paths associated with leachate from the disposal areas. These flow paths are called the western flow regime and the southwestern flow regime and correspond to contamination in the Lower Wind River aquifer and Upper Wind River aquifer, respectively.

In 2001, at the time the ACL application was submitted, the leading edge of the contaminant plume in the western flow regime was determined to be approximately 2,000 ft hydraulically downgradient of the AGTI. The leading edge of the contaminant plume in the southwestern flow regime was determined to be approximately 1,000 ft hydraulically downgradient of the A–9 Repository (Umetco 2001).

During site reclamation, sources of contamination were minimized by capping the tailings in the AGTI, grading the ground surface to reduce infiltration rates, placing a clay liner and interim cover on the A–9 Repository, and replacing the clay-lined north and south evaporation ponds with the GHP No. 1 and 2 ponds that had synthetic liners and leak detection systems.

Under the CAP, groundwater pumped from the vicinity of the AGTI and A–9 Repository was either evaporated in the GHP No. 1 or 2 or treated using an IX/RO treatment system. Treated groundwater was injected into the Wind River aquifer. The goal of groundwater injection was to enhance remediation by increasing the groundwater flux beneath the A–9 Repository and the AGTI. The IX/RO treatment and injection system was evaluated in 1996 and determined to be ineffective, and treatment was discontinued (Umetco2001).

From 1983 through the first half of 2000, 125 million gallons of contaminated groundwater were extracted from the A–9 Repository extraction wells and approximately 55 million gallons of treated groundwater were re-injected into the aquifer. Through the same time period, approximately 95 million gallons of groundwater were extracted from wells in the vicinity of the AGTI, with approximately 45 million gallons of treated groundwater re-injected into the aquifer. Contaminated groundwater extracted was treated and either discharged to evaporation ponds or re-injected into the aquifer (Umetco 2001). Injection of treated groundwater was performed both upgradient and downgradient of the impoundments. Upgradient injection was done in an effort to increase groundwater flux, thereby increasing the flushing action within the aquifer and enhancing groundwater remediation. Downgradient injection was done in an effort to create a hydraulic barrier (i.e., groundwater mound) that would prevent offsite migration of contaminated groundwater (Umetco 2001).

Evaluation of the effectiveness of the CAP was performed, and it was determined that extraction of groundwater in the vicinity of the A–9 Repository resulted in hydraulic capture of groundwater and that the resultant cone of depression also captured groundwater from reclaimed areas east of the disposal site. In the vicinity of the AGTI, groundwater flow-path models and water-level data indicated that both extraction and extraction/treatment did not result in hydraulic capture. Decreasing concentrations of some constituents were attributed to the cover placement on the repository reducing the groundwater mound below the repository rather than a result of the CAP (Umetco 2001).

In February 1999, following extensive corrective action, Umetco submitted an application for ACLs for certain elevated groundwater constituents; arsenic, beryllium, lead-210, nickel, selenium, thorium-230, uranium, and combined radium-226 and radium-228 (Umetco 2001). Modeling was performed using 95 percent upper confidence level concentrations as ACLs in point-of-compliance (POC) wells. Separate ACLs were used for the western and southwestern flow regimes. The modeling, which incorporated geochemical attenuation from the POC wells to the POE (i.e., site boundary), indicated that concentrations at the POE would be reduced to concentrations within the range of ambient background levels. Based on background levels of constituents in the groundwater, both the western and southwestern flow regimes are considered to be Class III groundwater per Wyoming Department of Environmental Quality (WDEQ) regulations; this class of groundwater is suitable for livestock watering.

Because site-related contamination is not anticipated to result in increases at the POE over background levels (or Class III standards), it was determined that the ACLs are protective of human health and the environment at the POE and are ALARA. The evaluation indicated that constituent concentrations are attenuated before reaching the proposed POE regardless of whether the constituents are derived from mineralization, mining, or milling activities (processes that could not be differentiated). With approval by NRC of the ACLs for the Gas Hills East disposal site on March 29, 2002 (NRC 2002), operation of the CAP was discontinued. The CAP operated for more than 12 years (Umetco 2001).

Not long after the ACL application was submitted, the ACL for lead-210 (46.7 picocuries per liter [pCi/L]) was exceeded at a southwest flow regime POC well. This prompted further evaluation of lead-210 geochemical behavior and resulted in a proposed ACL for lead-210 that corresponded to the all-time observed high (189 pCi/L). This resulted in an amendment of the ACL application to incorporate this higher value (NRC 2006a).

ACLs have been granted for arsenic, beryllium, lead-210, nickel, selenium, thorium-230, uranium, and combined radium-226 and radium-228 (NRC 2006b). The long-term groundwater monitoring plan (described in Section 3.7) adopted these ACLs for the Gas Hills East disposal site.

ACLs, groundwater protection standards, modeled POE values and background concentrations are provided in Table 2–1. Historical groundwater monitoring data for the constituents with ACLs, along with the indicator parameters chloride and sulfate, are summarized in Table 2–2 (time-concentration plots for these analytes are provided in Appendix D). As shown on these trend graphs, historical concentrations of some of these constituents exceeded ACLs, as would be expected when considering that ACLs were based on the 95 percent upper confidence level of historical concentrations found at the POC wells. However, as shown on the trend graphs, since reclamation has been performed, concentrations have remained below the ACLs (Appendix D).

Table 2–1. ACLs, Groundwater Protection Standards, Modeled POE Values and Background Concentrations for the Gas Hills East, Wyoming, Disposal Site

Analyte	ACL[a]		Groundwater Protection Standard[b]	Modeled POE Values[c]		Background Range[c]	
	Western Flow Regime	Southwestern Flow Regime		Western Flow Regime	Southwestern Flow Regime	Western Flow Regime	Southwestern Flow Regime
Arsenic (mg/L)	1.8	1.36	0.2	0.039	0.017	0.001–0.092	0.001–1.26
Beryllium (mg/L)	1.64	1.70	NA	0.005	0.0012	0.01–0.01	--
Lead 210 (pCi/L)	35.4	189	NA	2.45	0.24	–2.8–6.1	-0.8–3.5
Nickel (mg/L)	13.0	9.34	NA	0.065	0.016	0.01–2.1	0.01–0.28
Ra 226+228 (pCi/L)	250	353	5	69.5	16.9	0.6–84	1.7–2,070
Selenium (mg/L)	0.161	0.53	0.05	0.0048	0.043	0.01–0.01	0.001–0.097
Thorium 230 (pCi/L)	57.4	44.8	NA	0.108	0.86	–2.9–0.5	-0.93–8.2
Uranium (mg/L)	11.9	34.1	NA	0.0071	0.15	0.0009–0.26	0.0003–5.9
Chloride[d] (mg/L)	NA		2,000	76	84	1–14	1–138
Sulfate[d] (mg/L)	NA		3,000	1715	730	125–1,920	61–1,675

ACL = alternate concentration limit; POE = point of exposure; mg/L = milligrams per liter; pCi/L = picocuries per liter; Ra = radium; NA = not applicable.
[a]ACLs are applicable at the POC (Umetco 2001).
[b]Wyoming Class III Groundwater Protection Standards for livestock use are applicable at the POE (Umetco 2001).
[c]Modeled POE values and background concentrations obtained from the ACL application, Table 2.10 (Umetco 2001).
[d]Constituent is considered an indicator parameter (Umetco 2001).

Table 2–2. Summary of Historical Groundwater Data for the Gas Hills East, Wyoming, Disposal Site

Constituent	Concentration Range						Detections vs Total Analyses		
	Western Flow Regime[a]				Southwestern Flow Regime[b]		Western Flow Regime[a]		Southwestern Flow Regime[b]
	Wells		Iron Spring				Wells	Iron Spring	
	Min	Max	Min	Max	Min	Max			
Arsenic (mg/L)	<0.001	<0.4	0.001	0.068	<0.001	0.6	190 vs 224	13 vs 23	157 vs 180
Beryllium (mg/L)	0.0003	1.34	0.0001	<0.1	0.0001	0.22	119 vs 205	1 vs 7	99 vs 138
Chloride (mg/L)	<1	810	9.3	29	0.97	480	294 vs 295	32 vs 32	221 vs 221
Lead-210 (pCi/L)	-2.8	45	1.2	2.3	0	94	188 vs 219	2 vs 2	175 vs 181
Nickel (mg/L)	<0.01	8.88	0.0089	0.22	<0.01	3.2	192 vs 210	21 vs 23	135 vs 139
Radium-226+228 (pCi/L)	<1.2	215	2.9	26.9	1.6	418.2	223 vs 224	22 vs 22	182 vs 182
Selenium (mg/L)	0.0001	0.422	<0.001	<0.005	<0.001	0.058	79 vs 226	1 vs 23	22 vs 181
Sulfate (mg/L)	115	5,660	554	912	213	3,020	294 vs 294	32 vs 32	219 vs 219
Thorium-230 (pCi/L)	-2.9	154	0.2	0.2	-1.5	149.3	178 vs 215	2 vs 2	147 vs 174
Uranium (mg/L)	<0.00005	27.45	0.014	0.48	<0.00005	2,028	271 vs 295	32 vs 32	218 vs 221

mg/L = milligrams per liter; pCi/L = picocuries per liter; Ra = radium; < = less than.
[a]Includes data from wells MW1, MW21A, MW25, MW28, MW70A, MW71B, MW77, and MWI64.
[b]Includes data from wells GW7, GW8, MW72, MW82, and PW4.
Note: Historical data obtained from Umetco.

2.4 Tailings Impoundment and Repository Design

At the Gas Hills East disposal site, mill tailings, mill structures and debris, and haul road material were disposed into a former on-site open-pit mine (the A–9 Repository), or in existing on-site impoundments (the AGTI, Heap Leach Area, and GHP No. 2 Repository). Together these disposal areas cover approximately 300 acres of the site.

At both the AGTI and the Heap Leach Area, compacted clay was used to form the base and dams of the impoundments during milling operations—mill tailings slurry was pumped into the AGTI and low-grade ore was leached in the Heap Leach Area. These clay liners were not removed prior to reclamation. At the GHP No. 2 Repository, the original liner consisted of a top liner of high-density polyethylene (HDPE) geomembrane, a leachate collection/leachate detection layer, and a bottom liner of HDPE on top of 18 inches of compacted clay. These liner materials, down to within a few inches of the bottom of the clay, were removed during reclamation so that there would not be a low permeability layer in the bottom of the GHP No. 2 Repository that could provide a "bathtub" effect (Umetco 2003). At the A–9 Repository, prior to tailings disposal, the bottom was lined with 3 ft of compacted clay, and a decant system was installed to dewater the tailings (Shepherd Miller, Inc. 1998).

In designing the impoundments and repositories for permanent disposal of contaminated material, Umetco performed analyses to evaluate slope stability, settlement and cover cracking, liquefaction, and the need for radon attenuation, frost protection, and erosion protection. Radon barriers designed to reduce radon gas emission rates to below the regulatory standard of 20 picocuries per square meter per second were constructed over all disposal areas. Diversion channels and slope grade were designed to hydraulically isolate the disposal areas preventing erosion over the long-term. The hydrologic basis for the design of the embankment slopes and diversion channels was the probable maximum precipitation (PMP) event that was computed for the site (Umetco 2003). NRC accepted a rainfall depth of 9.3 inches in 1 hour to estimate the probable maximum flood event for the small drainage areas associated with the site (NRC 1998a).

2.4.1 Encapsulation Design

The objective of the tailings impoundment cover is to isolate the uranium mill tailings from the surrounding environment. This is accomplished by reducing radon gas emission rates to below the regulatory standard (20 picocuries per square meter per second), minimizing infiltration of meteoric water that could potentially leach contaminants into the subsurface, and physically containing the contaminated materials to prevent dispersion.

Each of the disposal areas is covered by a radon barrier, a filter layer, a frost-protection layer, and a riprap cover. The thickness of these layers varies between disposal areas because disposal cell design was revised during construction activities to reflect current criteria contained in 10 CFR 40, Appendix A and NRC's *Final Position on Previously Approved Reclamation Plans* (NRC 1995). Umetco prepared enhanced designs for the AGTI (Shepherd Miller, Inc. 1997) and the A–9 Repository (Shepherd Miller, Inc. 1998) in response to the new regulations and guidance.

For the Heap Leach Area, Umetco placed a 12-inch-thick radon barrier of compacted soil, 12-inch-thick filter layer, and 30-inch-thick frost-protection layer over the tailings and mill debris according to a design that was not approved by NRC. In response to NRC concerns over the design, Umetco enhanced the cover design by: (1) placing additional frost-protection soil on the existing cover of the top slope; (2) extending the proposed reclamation cover (18-inch-thick radon barrier, 54-inch-thick frost-protection layer and the erosion-protection layer) down the side slopes of the disposal cell; (3) extending the proposed reclamation cover over the gap between the Heap Leach Area and the AGTI and over the GHP No. 2 Repository; and (4) replacing the previously proposed vegetative cover with riprap erosion protection on both the top and side slopes of the Heap Leach Area. As a result of the enhancements, the radon barrier layer is 12 inches thick beneath the top slopes and 18 inches thick on side slopes (NRC 1998a).

Per the approved 1980 reclamation plan, the AGTI cover consists of a clay radon barrier that is a minimum of 1 ft thick, a filter material that is a minimum of 1 ft thick, and a layer of overburden and spoils material that is a minimum of 7.5 ft thick. Several years after construction, erosion of the cover was noted, and concerns were expressed regarding erosion along the east toe of the AGTI impoundment. Also, additional contamination was found near the north edge of the AGTI impoundment. Umetco prepared the *Design for Enhancement of the Previously Approved Reclamation Plan for the Above Grade Tailings Impoundment* (Shepherd Miller, Inc. 1997) and modified the cover to (1) extend the radon barrier to the north and east sides to cover contamination found along the downstream toe, (2) add riprap along a portion of East Canyon Creek to protect the toe of the impoundment, and (3) replace the vegetative cover with riprap rock on top (6 inches thick) and side slopes (1 ft thick). A generalized cross section of the AGTI is shown on Figure 2–8.

In the NRC-approved 1987 reclamation design for the A–9 Repository (i.e., disposal cell), the cover consisted of a 1-ft-thick clay radon barrier, a 1-ft-thick filter layer, a 6.5-ft-thick frost-protection/spoil layer, and a 6-inch-thick topsoil layer. An interim cover from 1 to 5 ft thick was placed over the entire A–9 area in 1988 and 1989. In the enhanced design the frost-protection layer thickness was reduced to 4.5 ft and the radon barrier thickness was increased to 1.5 ft. Riprap replaced the vegetative cover to enhance durability. The slope of the cover varies from about 3 percent at the upstream end to a maximum of about 13 percent at the downstream end. The steeper slopes terminate in a rock apron/toe.

In addition, riprap-protected diversion channels to control surface water drainage were constructed along the east and west margins of the cell to convey flood flows away from the site. These diversion channels have an apron/toe to prevent gully intrusion into the channel. The maximum depth of gullying in the site area was estimated to be about 6.5 ft, and the toe was extended to this depth. In designing the diversion channels, some sediment from the upland drainage areas was expected to enter the channels. However, the amount of sediment entering the diversion channels is expected to be small because most of the drainage area that funnels to the channels is protected by rock covers, and because channel velocities are expected to be high enough to prevent accumulations in the channels (Shepherd Miller, Inc. 1998). A generalized cross section of the A–9 Repository is shown on Figure 2–9.

The GHP No. 2 Repository reclamation cover consists of a 1-ft-thick radon barrier layer, a 4.5-ft-thick frost-protection layer, and an erosion-protection layer. The reclamation cover for the GHP No. 2 Repository was designed with a 1 percent grade on the top slope and 20 percent side slope grades. A diversion channel exists between the AGTI embankment and the GHP No. 2 Repository to prevent surface water runoff flows from impacting the GHP No. 2 Repository cover. A peak channel discharge was computed assuming a 9.3-inch PMP event over the 17.5-acre drainage basin of the AGTI (Umetco 2003).

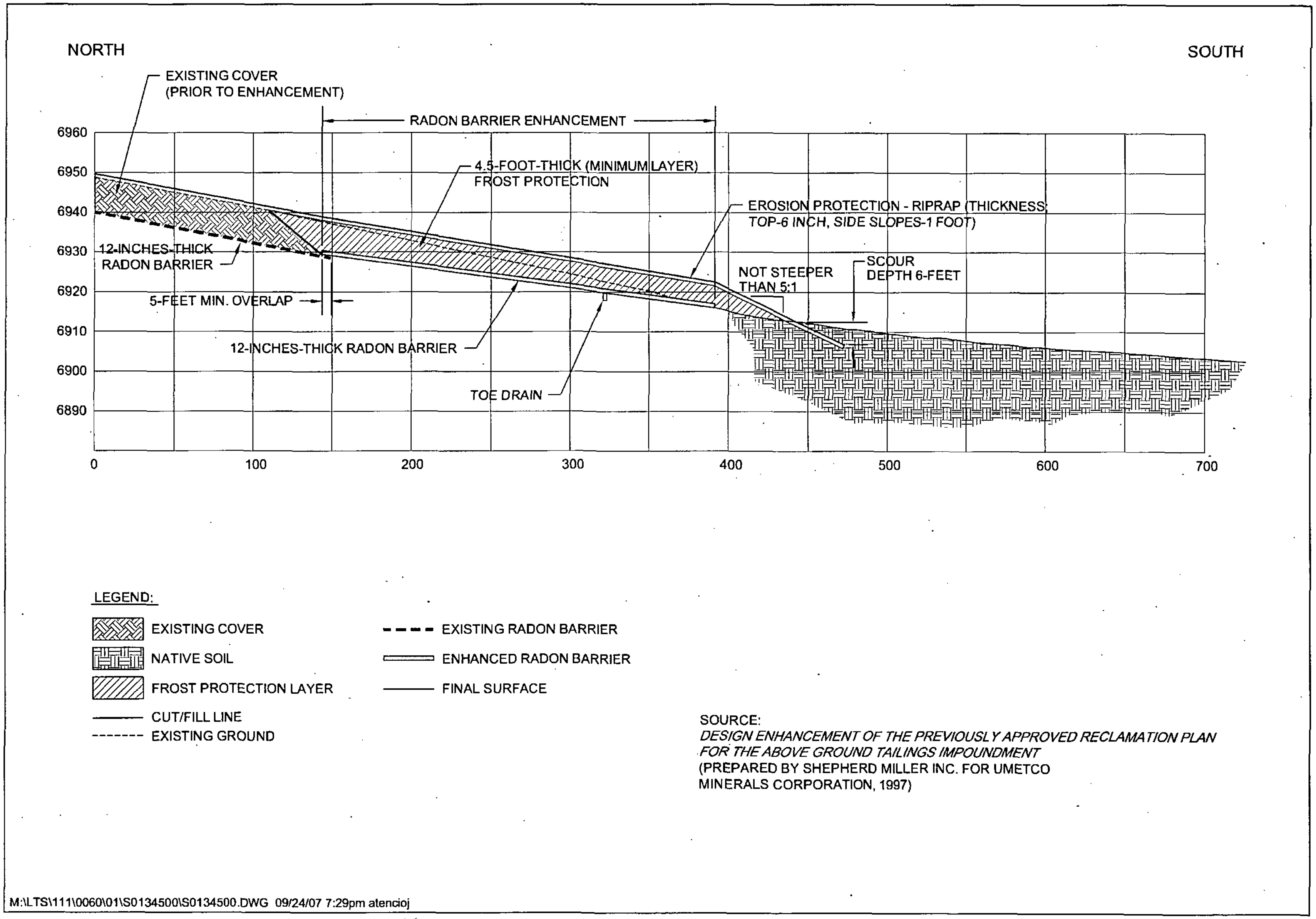

Figure 2–8. Generalized Cross Section of the Above-Grade Tailings Impoundment

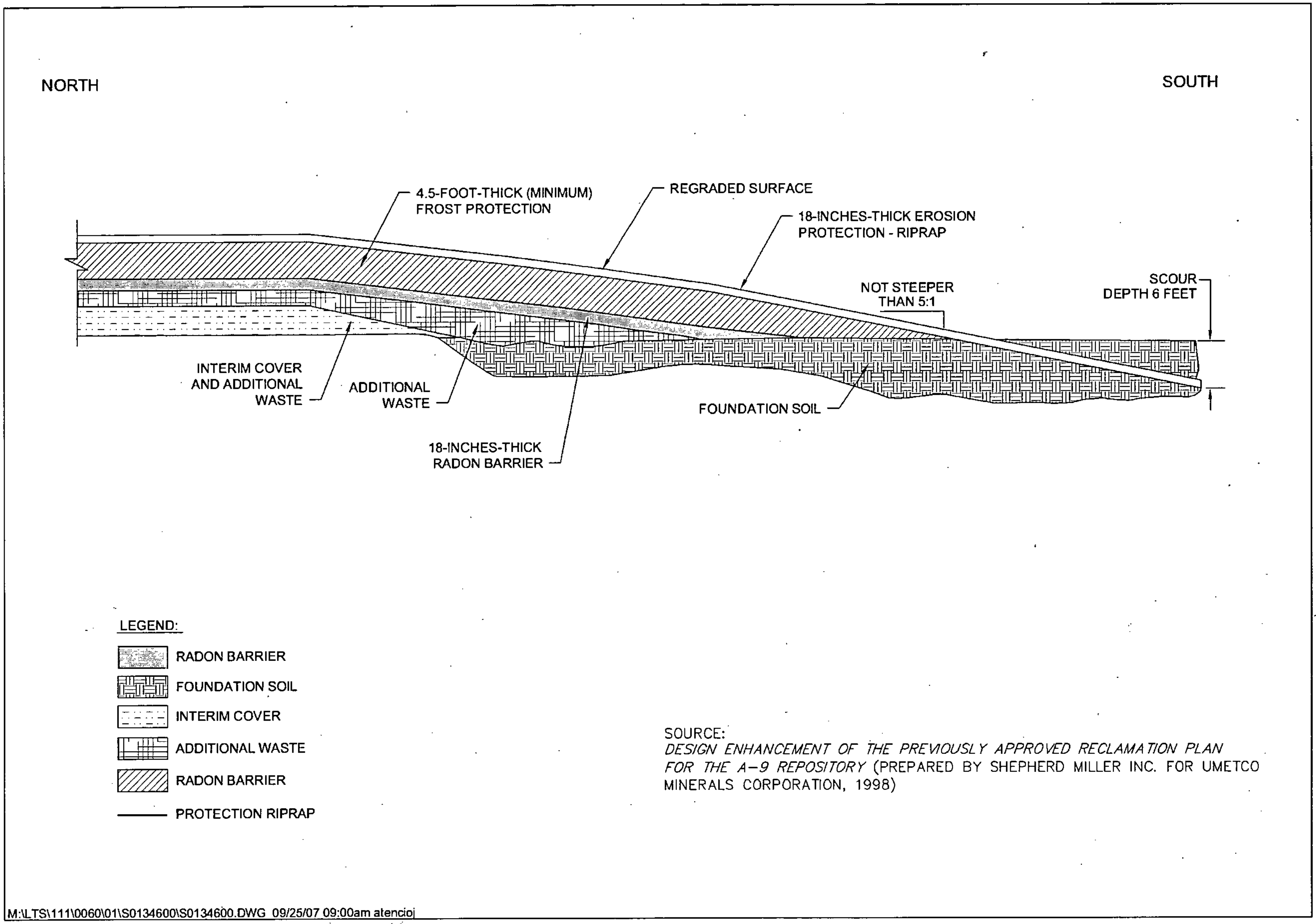

Figure 2–9. Generalized Cross Section of the A–9 Repository

2.4.2 Surface Water Diversion System

A site-wide grading plan was developed to determine the final grades and diversion structures that would be used to control surface water flows from impacting the disposal areas. The final grade established for the site forms the basis of the surface water diversion system. The grading plan (1) uses contours approved with the reclamation plans for the Heap Leach Area, AGTI, and A–9 Repository; (2) provides a diversion channel to minimize potential erosion caused by drainage from the AGTI cover; (3) provides diversion channels on the east and west side of the A–9 Repository to direct runoff away from the cover; and (4) provides positive drainage for other areas of the site. The North, East, and West Diversion Channels are shown on Figure 2–2. Final topography at the disposal site is shown on Figure 2–3.

In addition to the final grade and associated diversion structures that provides for directed flow of surface water, the surfaces of the reclaimed tailings disposal areas are covered with rock riprap to prevent erosion, and the diversion channels were designed based on a PMP event. Figure 2–2 shows the areas covered with different sized rock riprap used for erosion protection on the top and side slopes of the disposal areas and in the diversion channels.

3.0 Long-Term Surveillance Program

3.1 General License for Long-Term Custody

States have right of first refusal for custody and long-term care of Title II disposal sites (UMTRCA, Section 202 [a]). On July 15, 1994, the State of Wyoming exercised its right of first refusal and declined the custody and long-term care of the Gas Hills East disposal site (State of Wyoming 1994). Because the State declined this right, the site was transferred to DOE for custody and long-term care.

Upon NRC acceptance of this LTSP and termination of Umetco's license (Number SUA–648), the site is included under NRC's general license for custody and long-term care (10 CFR 40.28 [b]). Concurrent with this action, a deed and title to the portion of the site owned by Umetco were transferred to DOE (Appendix A). The balance of the site, which is federally owned, was withdrawn by BLM from public use and placed under DOE's jurisdiction for custody and long-term care (Appendix A).

Although sites are designed to last "for up to 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years (10 CFR 40, Appendix A, Criterion 6)," there is no termination of the general license for DOE's custody and long-term care of the site (10 CFR 40.28 [b]).

Should changes to this LTSP become necessary, NRC must be notified of the changes, and the changes may not conflict with the requirements of the general license. Additionally, NRC representatives must be guaranteed permanent right of entry for the purpose of periodic site inspections. Access to the site, as shown on Figures 2–1 and 2–2, is unimpeded from public roads (Section 2.3.2).

3.2 Requirements of the General License

To meet the requirements of NRC's license at 10 CFR 40.28, and Appendix A, Criterion 12, the long-term custodian must, at a minimum, perform the following LTS&M tasks. The section in the LTSP in which each requirement is addressed is given in parentheses.

1. Annual site inspection (Section 3.3).

2. Annual inspection report (Section 3.4).

3. Follow-up inspections and inspection reports, as necessary (Section 3.5).

4. Site maintenance, as necessary (Section 3.6).

5. Emergency measures in the event of catastrophe (Section 3.6).

6. Environmental monitoring (Section 3.7).

3.3 Annual Site Inspections

3.3.1 Frequency of Inspections

At a minimum, sites must be inspected annually to confirm the integrity of visible features at the site and to determine the need, if any, for maintenance, additional inspections, or monitoring (10 CFR 40, Appendix A, Criterion 12).

To meet this requirement, DOE will inspect the Gas Hills East disposal site once each calendar year. The date of the inspection may vary from year to year, but DOE will endeavor to inspect the site approximately once every 12 months unless circumstances warrant variance. Any variance to this inspection frequency will be explained in the inspection report. DOE will notify NRC and the State of Wyoming of the inspection at least 30 days in advance of the scheduled inspection date.

3.3.2 Inspection Procedure

For the purposes of inspection, the Gas Hills East disposal site will be divided into sections called *transects*. Each transect will be inspected individually. Proposed transects for the first inspection of the Gas Hills East disposal site are listed in Table 3–1 and shown on Figure 3–1.

Table 3–1. Transects Used During the First Inspection of the Gas Hills East, Wyoming, Disposal Site

Transect	Description
Cover of tailings impoundments (AGTI, A-9 Repository, Heap Leach Area, and GHP No. 2 Repository)	Check integrity of impoundments—cover, sideslopes, and rock mulch. Check for any visual evidence of seepage from the impoundments.
East, West, and North Diversion Channels (GHP No. 2 Repository/AGTI) and the launch stone embankment (AGTI east side slope erosion protection area)	Check for erosion, riprap placement, integrity, and functionality.
Site Perimeter and Balance of Site	Check integrity of the area between tailings impoundments, the site perimeter and boundary, perimeter fence and gates, site entrance, boundary monuments, entrance sign, and site marker.
Outlying Area	Check 0.25 mile beyond site boundary for changes in land use.

The annual inspection will be a visual walk-through. The primary purpose of the inspection will be to look for evidence such as disposal cell settlement, slumping, or cracking; wind or water erosion; structural discontinuity of the containment dams; vegetation condition (including the presence of noxious weeds); animal or human intrusions that could result in adverse impacts to the site; or other modifying processes that could be detrimental to the performance of the disposal system. Disposal site and disposal cell inspection techniques are described in detail in Attachment 4 of the *Guidance for Implementing the Long-Term Surveillance Program for UMTRCA Title I and Title II Disposal Sites* (DOE 2001).

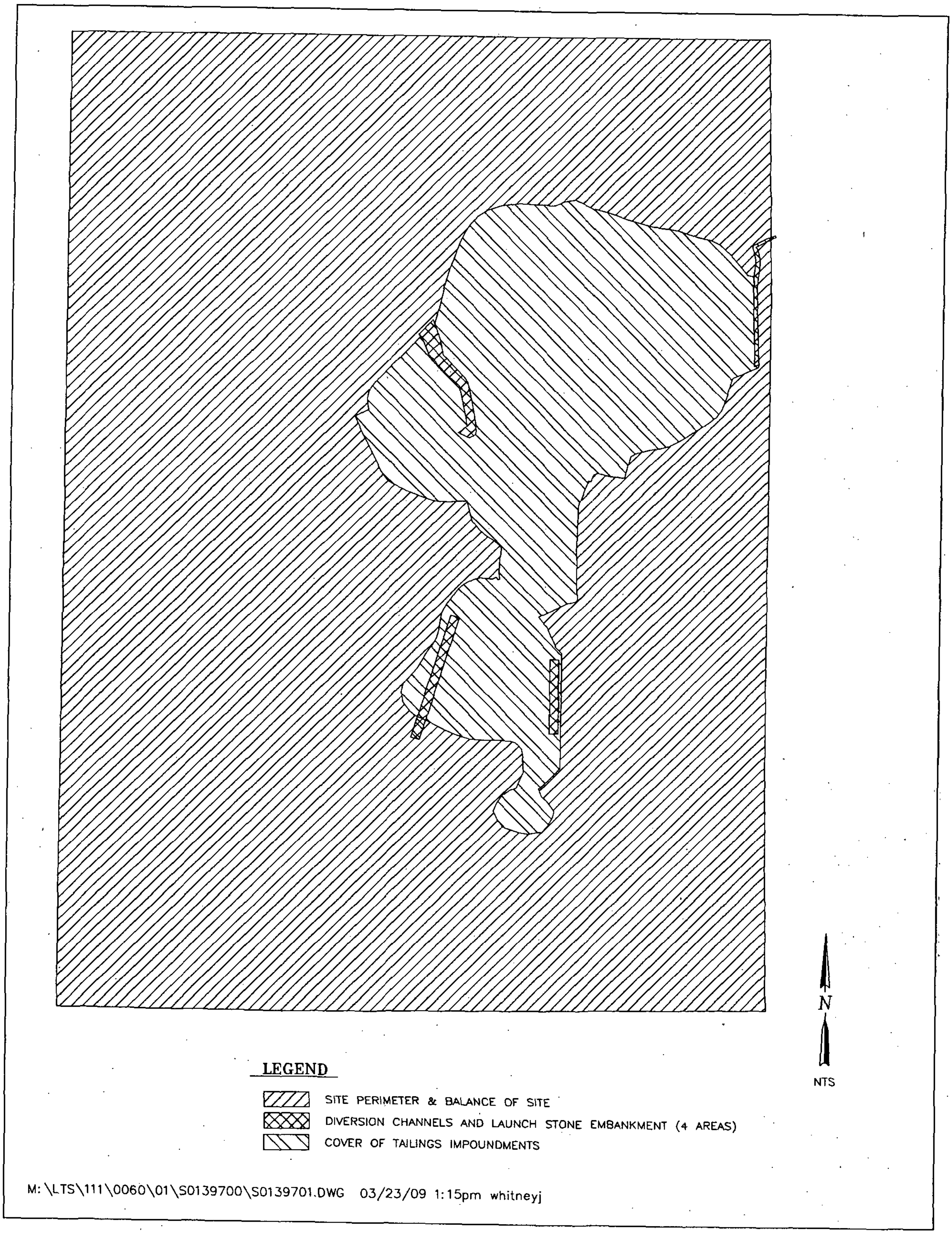

Figure 3–1. Map of Inspection Transects for the Gas Hills East, Wyoming, Disposal Site

Any changes in site vegetation will be noted during routine site inspections. If encroachment of deep-rooted vegetation is observed in the vicinity of the disposal cell, particularly on the cover, an evaluation will be conducted to determine if any action is necessary. Federally, locally, or state-listed noxious weeds present will be controlled.

In addition to inspection of the site itself, inspectors will note changes and developments in the area surrounding the site, especially changes within the surrounding watershed basin. Significant changes within this area could include development or expansion of human habitation, erosion, road building, mining and exploration activities, or other changes in land use. Changes in land (or groundwater) use in the area immediately surrounding the site that could negatively impact the site will be evaluated, as outlined in Section 3.7.

It may be necessary to document certain observations with photographs. Observations warranting photographs include evidence of vandalism or a slow modifying process, such as rill erosion, that should be monitored more closely during general site inspections. Photographs will be documented in a field photograph log (Appendix B).

3.3.3 Inspection Checklist

The field inspection is guided by the inspection checklist. The initial site inspection checklist for the Gas Hills East disposal site is presented in Appendix C.

The checklist is subject to revision. At the conclusion of the annual site inspection, inspectors will make notes regarding revisions to the checklist, if necessary, in anticipation of the next annual site inspection. Revisions to the checklist will include such items as new discoveries or changes in site conditions that must be inspected and evaluated during the next annual inspection.

3.3.4 Personnel

Annual inspections normally will be performed by a minimum of two inspectors. Inspectors will be experienced engineers and scientists who have been specifically trained to conduct site inspections (through participation in previous site inspections).

Engineers will typically be geotechnical, or geological, or civil engineers. Scientists will include geologists, hydrologists, biologists, and environmental scientists representing various fields (e.g., ecology, soils, range management). If serious or unique problems develop at the site, more than two inspectors may be assigned to the inspection. Inspectors trained in specific fields may be assigned to the inspection to evaluate serious or unusual problems and make recommendations.

3.4 Annual Inspection Report

Results of annual site inspections and monitoring will be reported to NRC within 90 days of the last site inspection of that calendar year (10 CFR 40, Appendix A, Criterion 12). In the event that the annual report cannot be submitted within 90 days, DOE will notify NRC of the circumstances. Annual inspection reports will also be made available to the State and any other stakeholders who request a copy. The annual inspection report for the Gas Hills East disposal site is included in a document containing the annual inspection reports for all sites licensed under 10 CFR 40.28.

Results of the groundwater monitoring program will also be included in the annual inspection and monitoring report. DOE will typically provide trends in water quality, in the form of concentration versus time graphs, for all analytes with an ACL (along with the indicator parameters, sulfate and chloride), for all wells in the monitoring program. In addition, DOE will provide a table(s) containing groundwater quality data and water level measurements.

3.5 Follow-up Inspections

Follow-up inspections are unscheduled inspections that are targeted to evaluate specific findings or concerns; and may be required (1) as a result of discoveries made during a previous annual site inspection, or (2) as a result of changed site conditions reported by a citizen or outside agency.

3.5.1 Criteria for Follow-up Inspections

Criteria necessitating follow-up inspections are described in 10 CFR 40.28 (b)(4). Accordingly, DOE will conduct follow-up inspections should any of the following occur:

- A condition is identified during the annual site inspection or other site visit that requires personnel, perhaps with specific expertise, to return to the site to evaluate the condition.
- DOE is notified by a citizen or outside agency that conditions at the site are substantially changed.
- An extreme natural condition, such as a 6.5-Richter-scale earthquake or a rainfall event of 9.3 inches or more in 1 hour (NRC 1998a).

With respect to citizens and outside agencies, DOE will establish and maintain lines of communication with local law enforcement and emergency response agencies to facilitate notification in the event of significant trespass, vandalism, or natural disaster. Due to the remote location of the Gas Hills East disposal site, DOE recognizes that local agencies may not necessarily be aware of current conditions at the site. However, these agencies will be requested to notify DOE or provide information should they become aware of a significant event that might affect the security or integrity of the site.

DOE may request the assistance of local agencies to confirm the seriousness of a condition before conducting a follow-up inspection or emergency response.

The public may use the 24-hour DOE telephone number (970-248-6070) posted prominently on the entrance sign to request information or to report a problem at the site.

Once a condition or concern is identified at the site, DOE will evaluate the information and determine whether a follow-up inspection is warranted. Conditions that may require a routine follow-up inspection include significant erosion, storm damage, changes in vegetation, wildfire, low-impact human intrusion, minor vandalism, or the need to evaluate, define, or perform maintenance tasks.

Conditions that threaten the safety or the integrity of the disposal site may require a more immediate (non-routine) follow-up inspection. Slope failure, disastrous storm, major seismic event, and deliberate human intrusion are among these conditions.

DOE will use a graded approach with respect to follow-up inspections. The urgency of the follow-up inspection will be in proportion to the seriousness of the condition. The timing of the inspection may be governed by seasonal considerations. For example, a follow-up inspection to investigate a vegetation problem may be scheduled for a particular time of year when growing conditions are optimum. A routine follow-up inspection to perform maintenance or to evaluate an erosion problem might be scheduled to avoid significant snow cover.

In the event of "unusual damage or disruption" (10 CFR 40, Appendix A, Criterion 12) that threatens or compromises site safety, security, or integrity, DOE will:

- Notify NRC pursuant to 10 CFR 40, Appendix A, Criterion 12, or 10 CFR 40.60, whichever is determined to apply.
- Begin the DOE Environment, Safety, and Health Reporting process (DOE Order 231.1A, Chg. 1, or most current guidance).
- Respond with an immediate follow-up inspection or mobilization of an emergency response team.
- Implement measures as necessary to contain or prevent dispersion of radioactive materials (Section 3.6).

3.5.2 Personnel

Inspectors assigned to follow-up inspections will be selected on the same basis as for the annual site inspection (Section 3.3.4).

3.5.3 Reports of Follow-up Inspections

Results of routine follow-up inspections will be included in the next annual inspection and monitoring report (Section 3.4). Separate reports will not be prepared unless DOE determines it is advisable to notify NRC or other outside agency of a problem at the site.

If follow-up inspections are required for more serious or emergency reasons, DOE will submit to NRC a preliminary report of the follow-up inspection within the required 60 days (10 CFR 40, Appendix A, Criterion 12).

3.6 Routine Site Maintenance and Emergency Measures

3.6.1 Routine Site Maintenance

UMTRCA disposal sites are designed and constructed so that "ongoing active maintenance is not necessary to preserve isolation" of radioactive material (10 CFR 40, Appendix A, Criterion 12). The Heap Leach Area, GHP No. 2 Repository, A–9 Repository, and AGTI (and associated surface water control systems) have been designed and constructed to minimize the need for routine maintenance.

The top surface of the tailings impoundments were constructed with minimal slope to promote positive drainage while minimizing runoff water velocities that result in erosion. Erosion protection in the form of riprap has been placed over all impoundment covers and is expected to endure for the long-term. Because of the riprap and mild slopes, adverse wind or water erosion impacts that would require maintenance are not anticipated. Areas where runoff water could achieve erosional velocities have been armored with riprap sized to withstand these forces. The tailings impoundment area may be fenced to prevent damage from any livestock grazing in the vicinity and to discourage intentional or unintentional trespassing.

If an inspection of the disposal site does reveal that an as-built feature has failed or degraded in such a way that it compromises site protectiveness, an evaluation will be conducted to determine an appropriate response action that ensures protectiveness of the disposal system is maintained. DOE will perform routine site maintenance, where and when needed, to maintain protectiveness. Results of routine site maintenance will be summarized in the annual site inspection report.

3.6.2 Emergency Measures

Emergency measures are the actions that DOE will take in response to unusual damage or disruption that threaten or compromise site safety, security, or integrity. DOE will contain or prevent the dispersal of radioactive materials in the unlikely event of a breach in impoundment cover materials.

3.6.3 Criteria for Routine Site Maintenance and Emergency Measures

Conceptually, there is a continuum in the progression from minor routine maintenance to the large-scale reconstruction of a tailings impoundment system following a potential disaster. Although required by 10 CFR 40.28 (b)(5), criteria for triggering particular DOE responses for each increasingly serious level of intervention are not easily defined because the nature and scale of all potential problems cannot be foreseen. Nevertheless, with regard to identified potentially threatening situations, DOE will evaluate conditions and determine appropriate actions.

The information in Table 3–2 will serve as a guide for appropriate DOE responses (to specific example scenarios). The table shows that the difference between routine maintenance and emergency response is primarily one of urgency and degree of threat or risk. DOE's priority (urgency) in column 1 of Table 3–2 bears an inverse relationship with DOE's estimate of probability. The highest priority response is also believed to be the least likely to occur.

Table 3–2. DOE Criteria for Maintenance and Emergency Measures

Priority	Description[a]	Example	Response
1	Breach of disposal cells with dispersal of radioactive material.	Seismic event that exceeds design basis and causes massive discontinuity in cover.	Notify NRC. Immediate follow-up inspection by DOE emergency response team. Emergency actions to prevent further dispersal, recover radioactive materials, and repair breach.
2	Breach without dispersal of radioactive material.	Partial or threatened exposure of radioactive materials.	Notify NRC. Immediate follow-up inspection by DOE emergency response team. Emergency actions to repair the breach.
3	Breach of site security.	Human intrusion, vandalism.	Restore security; urgency based on assessment of risk.
4	Maintenance of specific site surveillance features.	Deterioration of signs, markers.	Repair at first opportunity.
5	Minor erosion or undesirable changes in riprap integrity or vegetation.	Erosion not immediately affecting disposal cell, change in riprap protection-layer thickness. Invasion of undesirable plant species.	Evaluate, assess impact, and respond as appropriate to address problem.

[a]Other changes or conditions will be evaluated and treated similarly on the basis of perceived risk.

3.6.4 Reporting Maintenance and Emergency Measures

Routine maintenance completed during the previous 12 months will be summarized in the annual inspection report.

In accordance with 10 CFR 40.60, within 4 hours of discovery of any Priority 1 or 2 events listed in Table 3–2, DOE will notify the following group at NRC:

- Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs

The telephone number for the required 4-hour notification to the NRC Operations Center is (301) 816-5100. The DOE 24-hour telephone number is (970) 248-6070.

3.7 Environmental Monitoring

3.7.1 Groundwater Monitoring

Groundwater monitoring is performed under this LTSP to demonstrate that 1) established ACLs are not exceeded at the POC and remain protective at the POE (i.e., Wyoming Class III standards—livestock only—will not be exceeded); 2) results are trending as expected (i.e., the groundwater model presented in the ACL application is valid and attenuation of contaminants is occurring as predicted); and 3) the engineered disposal system is performing as designed.

Background

In 2002, following extensive groundwater corrective action, NRC granted ACLs for arsenic, beryllium, lead-210, nickel, combined radium-226 and radium-228, selenium, thorium-230, and uranium for both the western and southwestern flow regimes (NRC 2002). The lead-210 ACL for the southwestern flow regime was subsequently amended (NRC 2006b). Groundwater monitoring requirements are contained in Appendix M of the ACL application (Umetco 2001). The monitoring plan described therein identifies three types of wells: POC wells, non-POC wells, and model validation wells. Upon approval, these ACLs and the associated groundwater monitoring requirements were adopted into Umetco's monitoring program as described in their source material license (SUA-648, Condition 35), as amended per submittal dated January 5, 2004 (Umetco 2004).

The long-term groundwater monitoring program for the site, as presented in this LTSP, incorporated these ACLs and many of the monitoring requirements contained in the ACL application. However, the ACL application noted that post-license-termination monitoring might require adjustments as DOE developed its LTSP. In particular, it was noted that results of monitoring prior to license termination should be used by DOE and NRC to establish long-term monitoring requirements in the site's LTSP.

Evaluation of License SUA-648 Monitoring Requirements

An evaluation of the licensee's groundwater monitoring requirements (contained in source material license SUA-648, Condition 35) was conducted to determine if they are suitable for DOE's long-term stewardship responsibilities (Appendix D). The ACL application (Umetco 2001) and historical groundwater data from the licensee, including data provided in the most recent annual report (Umetco 2008), were evaluated. All monitoring constituents were looked at to determine if any trends were discernible or if the system appeared to be relatively stable. This evaluation provided the basis for the long-term monitoring. As a result of this evaluation, the following modifications to the long-term groundwater monitoring program were recommended and incorporated:

- Arsenic, beryllium, selenium, and thorium-230 were eliminated from the analytical suite.
- All wells in the monitoring network will be sampled and analyzed annually for all of the remaining analytes—constituents of potential concern (COPC)—(lead-210, nickel, combined radium-226 and-228, uranium, chloride, and sulfate); water level, pH, and specific conductance will also be measured during sampling.
- Well MWI64 will be considered the POC well for the western flow regime.
- Wells MW1 and MW21A will be considered trend wells for the western flow regime (rather than POCs).
- Well GW8 will be considered the POC well for the southwestern flow regime.
- Wells GW7 and PW4 will be eliminated from the groundwater monitoring network in the southwestern flow regime.
- Iron Spring will be eliminated from the groundwater monitoring network in the western flow regime.

Long-Term Groundwater Monitoring Program

The long-term groundwater monitoring requirements are summarized in Table 3–3. Analytes (i.e., COPC) and their respective groundwater protection standards, including NRC-approved ACLs for the western and southwestern flow regimes, are presented in Table 3–4. Monitoring locations are shown on Figure 2–2.

Table 3–3. LTS&M Groundwater Monitoring Plan for the Gas Hills East, Wyoming, Disposal Site

Well Designation	Comments	Monitoring Frequency	Analytes[a] and Water Quality Parameters
MW1	Western flow regime trend well. Monitors radial flow from the AGTI.	Annually for the first 5 years (through 2014) at all locations. DOE will reevaluate the monitoring requirements every 5 years (beginning in 2015).	All locations: Lead-210, nickel, combined radium-226 and-228, uranium, chloride, and sulfate; also water level, pH, and specific conductance[b].
MW21A	Western flow regime trend well. Downgradient of the AGTI.		
MWI64	Western flow regime POC well. Closest well downgradient of the AGTI. Historically reported highest concentrations of most constituents.		
MW70A	Western flow regime trend well. Screened in upper part of aquifer. Monitors radial flow from AGTI.		
MW25	Western flow regime trend well. Downgradient of the AGTI. Approximate leading edge of the plume. Monitors plume migration/attenuation.		
MW71B	Western flow regime model validation well. Downgradient of the AGTI. Screened in lower portion of aquifer. Monitors vertical plume migration.		
MW28	Western flow regime model validation well. Downgradient of the AGTI. Historically showed no sign of contamination—early indicator of plume migration.		
MW77	Western flow regime. Downgradient of the AGTI. Representative of the POE.		
GW8	Southwestern flow regime trend well. Downgradient of the A–9 Repository.		
MW72	Southwestern flow regime model validation well. Downgradient of the A–9 Repository. Approximate leading edge of plume.		
MW82	Southwestern flow regime model validation well. Downgradient of the A–9 Repository. Outside of contaminant plume. Early indicator of plume migration.		

ACL = alternate concentration limit; AGTI = above ground tailings impoundment; DOE = Department of Energy; POC = point of compliance; POE = point of exposure.
[a]Analytes represent constituents of potential concern.
[b]Specific conductance is an estimator of total dissolved solids and can be used to demonstrate that Wyoming Class III standards are being met at the POE.
Note: Model validation wells designated in accordance with the ACL application (Umetco 2001).

Table 3–4. Analytes, ACLs, and Groundwater Protection Standards for the Gas Hills East, Wyoming, Disposal Site

Analyte (COPC)	ACL[a]		Groundwater Protection Standard[b]
	Western Flow Regime	Southwestern Flow Regime	
Arsenic[c]	1.8 mg/L	1.36 mg/L	0.2 mg/L
Beryllium[c]	1.64 mg/L	1.70 mg/L	NA
Lead-210	35.4 pCi/L	189 pCi/L	NA
Nickel	13.0 mg/l	9.34 mg/L	NA
Combined Radium-226 and -228	250 pCi/L	353 pCi/L	5 pCi/L
Selenium[c]	0.161 mg/L	0.53 mg/L	0.05 mg/L
Thorium-230[c]	57.4 pCi/L	44.8 pCi/L	NA
Uranium	11.9 mg/L	34.1 mg/L	NA
Chloride[d]	NA		2,000 mg/L
Sulfate[d]	NA		3,000 mg/L

COPC = constituent of potential concern; ACL = alternate concentration limit; mg/L = milligrams per liter; pCi/L = picocuries per liter; NA = not applicable.
[a]ACLs are applicable at the POC (Umetco 2001).
[b]Wyoming Class III Groundwater Protection Standards for livestock use are applicable at the POE (Umetco 2001).
[c]Analyte was removed from the LTS&M groundwater monitoring suite because results from the last 5 years indicate that concentrations have been very low and consistent.
[d]Analyte is considered an indicator parameter and will be used for validating the groundwater model (Umetco 2001).

Only one of the wells (MW77) was specifically identified in the ACL application's monitoring plan as representative of water quality at the POE (defined as the site boundary). Additionally, a comparison of POC wells with downgradient trend wells is presumed to confirm that contaminant concentrations are attenuating as groundwater moves toward the site boundary and that plumes are behaving as predicted by the groundwater models. Chloride and sulfate analytical results from wells MW71B, MW28, MW72, and MW82 will be compared to background levels and WDEQ Class III groundwater standards to validate groundwater modeling predictions that these levels and standards will not be exceeded at the POE. These two analytes are conservative tracers (their migration along the groundwater flow path is not significantly attenuated) and early indicators of plume movement.

If sampling results indicate an ACL is exceeded at a POC well, or trends indicate that either a predicted maximum value or a groundwater protection standard may be exceeded at the POE (i.e., that offsite protectiveness may be compromised), DOE will inform NRC and WDEQ of the results and conduct confirmatory sampling. If the confirmatory sampling verifies the exceedance or the threat of an exceedance, DOE will develop an evaluative monitoring work plan and submit that plan to NRC for review prior to initiating the evaluative monitoring program. This plan could involve expanding the analyte list to include all ACL constituents or other relevant constituents, increasing monitoring frequency, or some other approach. Results of the evaluative monitoring program will be used, in consultation with NRC, to determine if it is necessary for DOE to perform additional studies or if implementation of corrective action is warranted.

Following the establishment of a baseline, the long-term groundwater monitoring program will be reevaluated every five years (beginning in 2015) to determine if the ACLs remain protective and that the cell is performing as designed. This approach is consistent with the ACL application which indicated that the post-license-termination groundwater monitoring frequency should be reduced to once every 5 years (Umetco 2001). Modifications to the monitoring program will be made as recommended by these evaluations. For example, the evaluation may recommend that the monitoring frequency and suite of analytical constituents be modified. Modifications to the monitoring program will only occur following NRC concurrence, and will be documented.

Groundwater monitoring will be discontinued entirely once the following criteria have been met: 1) trends have established that ACLs will not be exceeded at the POC (e.g., concentrations of site-related constituents remain in compliance); 2) trends have demonstrated that ACLs will remain protective at the POE—no exceedance of groundwater protection standards (i.e., the site groundwater model has been validated and attenuation of contamination is occurring as predicted); and 3) monitoring has demonstrated that the disposal system is performing as designed (i.e., no evidence that contamination from the cell is being mobilized). Discontinuing of groundwater monitoring will only occur following NRC concurrence.

Once every 10 years, beginning in 2010, DOE will check the records at the Wyoming State Engineer's Office to determine if there have been significant changes in water demands in the vicinity of the site, as suggested by WDEQ (WDEQ 1999). Other nearby activities, such as residential developments, uranium exploration or extraction, that could affect the site groundwater conditions will be noted during annual site inspections and subsequently evaluated.

Results of the groundwater monitoring program will be included in the annual inspection and monitoring report as discussed in Section 3.4.

3.7.2 Land Use Monitoring

During each annual site inspection, DOE will monitor land use in the area surrounding the site to ensure that changes in land do not affect site protectiveness. For example, a resurgence of interest in uranium mining and processing could lead to increased activity in the vicinity of the site and an increased potential for site disturbance. Monitoring of local water use will also be performed periodically as discussed in Section 3.7.1

3.7.3 Vegetation Monitoring

Riprap rock was selected as the cover material over the disposal areas on site; however, some areas of the Gas Hills East disposal site were revegetated as part of the site reclamation. Vegetation at the disposal site is expected to help maintain erosional stability. Annual visual inspections will be conducted to verify the continued health of the on-site vegetation and to ensure that undesirable plant species do not proliferate at the site. Natural plant community succession caused by fire or other natural processes is expected and will not adversely impact the performance of the waste containment system.

3.8 Institutional Controls

The Gas Hills East disposal site is owned by the U.S. Government. Federal ownership serves as the primary institutional control protecting the site by ensuring control of land use. DOE also protects the site through institutional controls such as inspections and appropriate signage. Deed notices may be used if determined appropriate (e.g., unsecured subsurface mineral interests).

Once every 10 years, beginning in 2010, DOE will verify that the property deed remains on file in the Fremont County Courthouse.

3.9 Records

LM receives and maintains selected records to support post-closure site surveillance and maintenance. Inactive records are preserved at a federal records center. Site records contain critical information required to protect human health and the environment, manage land and assets, protect legal interests of DOE and the public, and mitigate community impacts resulting from the cleanup of legacy waste.

The records are managed in accordance with the following requirements:

- 44 USC 29, "Records Management by the Archivist of the United States and by the Administrator of General Services."
- 44 USC 31, "Records Management by Federal Agencies."
- 44 USC 33, "Disposal of Records."
- 36 CFR 12, Subchapter B, "Records Management."
- DOE G 1324.5B, *Implementation Guide.*
- *LM Information and Records Management Transition Guidance.*

3.10 Quality Assurance

All activities related to the surveillance and maintenance of the Gas Hills East disposal site will comply with DOE Order 414.1C, *Quality Assurance*. Quality assurance requirements are routinely fulfilled by use of a work planning process, standard operating procedures, trained personnel, documents and records maintenance, and assessment activities. Requirements will be transmitted through procurement documents to subcontractors if and when appropriate.

3.11 Health and Safety

Health and safety requirements and procedures for LM activities are consistent with DOE orders, federal regulations, and applicable codes and standards. The DOE Integrated Safety Management process serves as the basis for the Contractor's Health and Safety Program.

Specific guidance is contained in the *Office of Legacy Management Project Safety Plan* (DOE 2007) or current guidance. This project safety plan is used to identify specific hazards associated with the anticipated scope of work and provides direction for the control of these hazards. During the pre-inspection briefing, inspectors are required to review this document and the LTSP to ensure that they have an understanding of the site. All personnel accessing the site are briefed prior to entry of the potential hazards and the health and safety requirements associated with the site and any work to be performed.

4.0 References

10 CFR 40. U.S. Nuclear Regulatory Commission, Title 10, Part 40, "Domestic Licensing of Source Material," *Code of Federal Regulations*, January 1, 2008.

36 CFR 12. National Archives and Records Administration, Title 36, Part 12, Subchapter B, "Records Management," *Code of Federal Regulations*, July 1, 2008.

40 CFR 192. U.S. Environmental Protection Agency, Title 40, Part 192, "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations*, July 1, 2008.

42 USC §7901 *et seq*. "The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978," *United States Code*, November 8, 1978.

44 USC 29, "Records Management by the Archivist of the United States and by the Administrator of General Services," *United States Code*.

44 USC 31, "Records Management by Federal Agencies," *United States Code*.

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Umetco (Umetco Minerals Corporation), 2008. Annual Report for Gas Hills, Wyoming, July 2007 through June 2008, License SUA-648, Docket Number 40-0299, September.

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Appendix A

Real Estate Information

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Warranty Deed
(to be inserted)

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Public Land Order
(Federal Register Notice of Permanent Withdrawal)
(to be inserted)

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Site Legal Description

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Legal Description of Site Boundary

The legal description of the approximately 1,920-acre Gas Hills East, Wyoming, disposal site is:

> All of Section 15, the N ½ of Section 22, the NE ¼ of Section 21, the E ½ of Section 16, the SE ¼ of Section 9, and the S ½ of Section 10, Township 33 N, Range 89 W, 6th p.m., Natrona and Fremont Counties, Wyoming.

Contains approximately 1,920 acres.

The real estate correspondence and instruments are maintained and filed by the U.S. Department of Energy, Office of Legacy Management, Grand Junction, Colorado.

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Pre-Transition Land Ownership and Use Map

Draft

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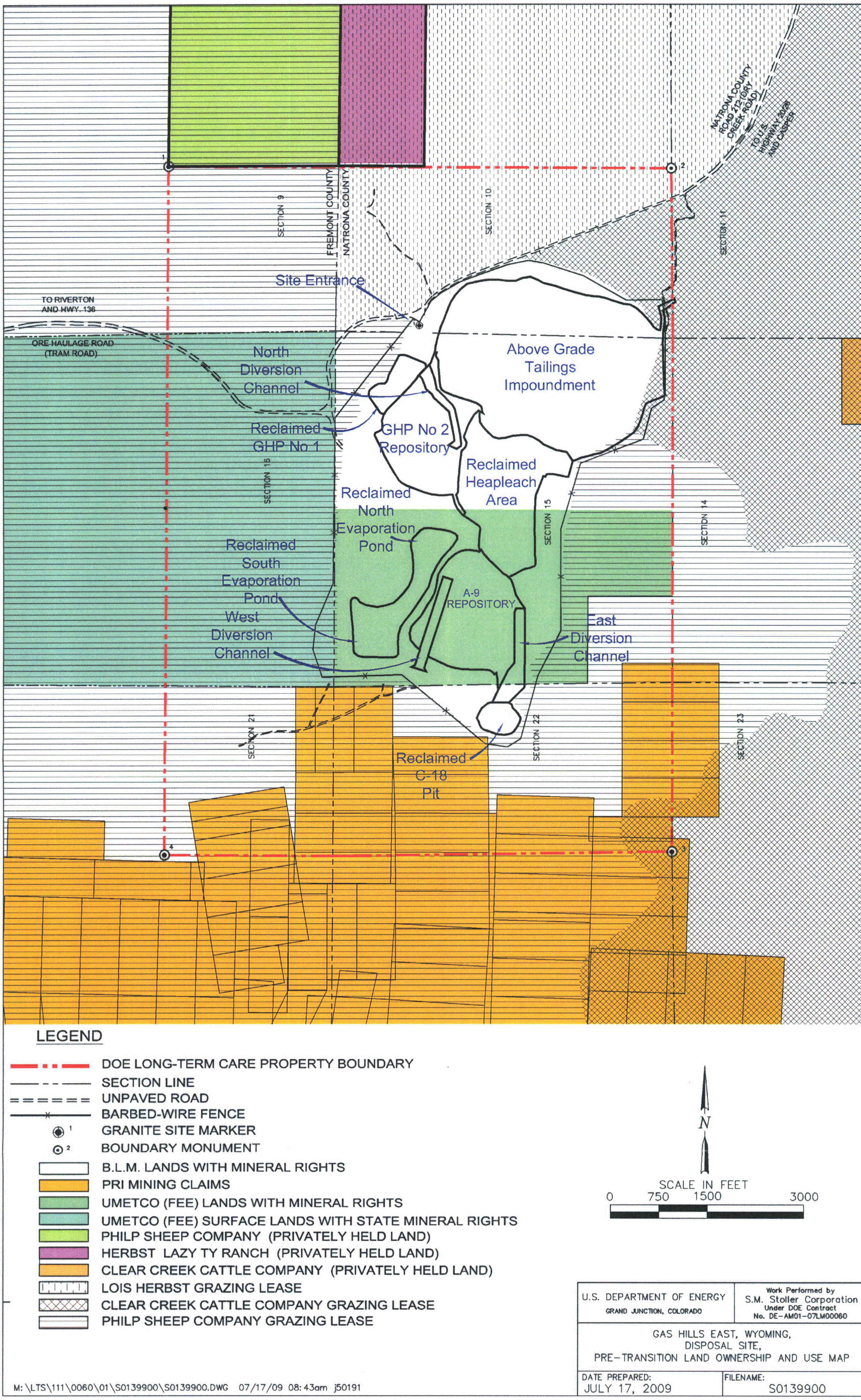

Figure A-1. Pre-Transition Land Ownership and Use Map for the Gas Hills East, Wyoming, Disposal Site

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Appendix B

Field Photograph Log

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Field Photograph Log

Site: Purpose of Visit:

Date of Visit: Photo Type: (film and/or digital)

Photo File Name	Film Frame No.	Azimuth	Field Inspection Photo No.	Trip Report PL No.	Post on Web (Y/N)	Photo Caption

Lead Inspector: Assistant Inspector:
Remarks:
Electronic File Location:

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Appendix C

Initial Site Inspection Checklist

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Inspection Checklist: Gas Hills East

Date of This Revision: ______________
Last Annual Inspection: ______________
Inspectors: ______________ and ______________

Next Annual Inspection (Planned): ______________

No.	Item	Issue	Action
1	Protocols	Contact NRC and WDEQ 30 days before inspection.	
2	Access	Access is from the east on an established county road.	None.
3	Specific site surveillance features	See attached list.	Inspect. Identify maintenance requirements.
4	Monitor wells	There are 13 monitor wells in the monitoring network.	Inspect the 13 monitor wells each year.
5	Riprap	The AGTI, A–9 Repository, GHP No. 2, and Heap Leach areas and diversion channels have been armored with riprap for erosion protection.	Inspect riprap, note evidence of rock displacement or rock degradation—determine if performance is impacted.
6	Diversion Channel and Creek erosion protection area	Protection relies on rock size and channel capacity.	Confirm rock degradation is not impacting performance (visual inspection) and sediment or other obstructions are not accumulating.
7	Vegetation	Haul roads and other areas outside the disposal areas have been revegetated to control wind and water erosion, although vegetation is not integral to the tailings isolation design.	Inspect revegetated areas and note condition of vegetation.

Checklist of Site-Specific Surveillance Features: Gas Hills East

Feature	Comment
Access Road	
Entrance Gate	
Entrance Sign	
Boundary Monuments and Section Corner Monuments	
Site Marker	
Monitor Wells	POC wells: MWI164 (Western Flow Regime) and GW8 (Southwestern Flow Regime) Downgradient wells (trend wells or model validation wells): MW21A, MW70A, MW25, MW71B, MW28, and MW77 (Western Flow Regime) MW72 and MW82 (Southwestern Flow Regime)

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Appendix D

Historical Groundwater Monitoring at the Gas Hills East, WY, Disposal Site: Evaluation and Recommendations for Long-Term Monitoring

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Historical Groundwater Monitoring at the Gas Hills East, WY, Disposal Site: Evaluation and Recommendations for Long-Term Monitoring

D1 Purpose

Extensive groundwater monitoring has been conducted at the Gas Hills East disposal site (formerly known as the Umetco Minerals Corporation [Umetco] Gas Hills, Wyoming, uranium mill tailings disposal site) in Fremont and Natrona Counties, Wyoming. Upon termination of Umetco's operating license (Number SUA–648) and development of a long-term surveillance plan (LTSP), the site is transferred to the U.S. Department of Energy (DOE) for custody and long-term care, and included under the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Part 40.28. In order to develop the groundwater monitoring program presented in the LTSP, DOE performed an evaluation of this historical (pre-license termination) groundwater monitoring.

D2 Background

In February 1999, following extensive groundwater corrective action, Umetco prepared an alternate concentration limit (ACL) application to address certain residual elevated concentrations which remained (Umetco 2001). The ACL application was based on the premise that the chemical constituents that are derived from the mill process are the same as those related to uranium deposition, mining, and reclamation. In 2002, NRC granted ACLs for arsenic, beryllium, lead-210, nickel, combined radium-226 and radium-228, selenium, thorium-230, and uranium (NRC 2002). ACLs were granted for both the western and southwestern flow regimes (NRC 2002). The lead-210 ACL for the southwestern flow regime was subsequently amended (NRC 2006).

The uppermost occurrence of groundwater beneath the site is within the Wind River aquifer. The Wind River aquifer is divided into two hydostratigraphic units referred to as the Upper and Lower Wind River aquifers. These two hydostratigraphic units are separated by a mudstone confining layer (Figure D–1); however, it is not conclusive from site information (hydrogeologic cross-sections and well completion logs) whether the mudstone is continuous and extends across the entire site. Groundwater flow beneath the site occurs in two distinct directions based on these two hydostratigraphic units. The Upper Wind River aquifer is the shallowest occurrence of groundwater and is referred to as the southwestern flow regime because groundwater flow is to the southwest. Groundwater in the Lower Wind River aquifer is referred to as the western flow regime because groundwater flow is primarily to the west.

Site groundwater monitoring requirements are contained in Appendix M of the ACL application. The monitoring plan described therein identifies three types of wells: POC wells, non-POC wells, and model validation wells. Upon approval, these ACLs and the associated groundwater monitoring requirements were adopted into Umetco's monitoring program as described in their source material license (SUA-648, Condition 35), as amended per submittal dated January 5, 2004 (Umetco 2004).

SUA-648 license monitoring requirements are summarized in Table D–1. ACLs, groundwater protection standards, modeled POE values and background concentrations are provided in Table D–2. Historical groundwater monitoring data for the constituents with ACLs, along with the indicator parameters chloride and sulfate, are summarized in Table D–3 (time-concentration plots for these analytes are provided in Attachment D–1). Monitoring locations are shown on Figure D–2. Completion information for wells in the western flow regime and southwestern flow regime are provided in Tables D–4 and D–5, respectively. And, a graphical representation of the screen interval elevations for wells in the western flow regime and southwestern flow regime are provided in Figures D–3 and D–4, respectively.

Table D–1. Historical Groundwater Monitoring Requirements from Umetco License SUA-648 for the Gas Hills East, Wyoming, Disposal Site

Well Type	Western Flow Regime Wells	Southwestern Flow Regime Wells	Monitoring Approach
POC Wells	MW1* MW21A	GW7* GW8	Wells to be sampled annually for ACL constituents. *Wells to be sampled semi-annually for natural uranium (U-nat), sulfate, and chloride.
Non-POC Wells	MWI64 MW70A MW25 MW71B** MW28** MW77 Iron Spring	PW4 MW72** MW82**	Wells to be sampled semi-annually for U-nat, chloride, and sulfate. Except for chloride and sulfate monitoring at the four model validation wells, *this sampling will be conducted for information and tracking purposes only* (i.e., results will not be assess for exceedances). **Results will be used to verify model results.
Model Validation Wells	MW71B MW28	MW72 MW82	Semi-annual sampling for chloride and sulfate as described above. Results will be compared with the target levels derived for the applicable timeframe (see ACL application, Section 3.0 and Attachment M-1, Tables 2 through 5).

ACL = alternate concentration limit; POC = point of compliance.

Table D–2. ACLs, Groundwater Protection Standards, Modeled POE Values and Background Concentrations for the Gas Hills East, Wyoming, Disposal Site

Analyte	ACL[a]		Groundwater Protection Standard[b]	Modeled POE Values[c]		Background Range[c]	
	Western Flow Regime	Southwestern Flow Regime		Western Flow Regime	Southwestern Flow Regime	Western Flow Regime	Southwestern Flow Regime
Arsenic (mg/L)	1.8	1.36	0.2	0.039	0.017	0.001–0.092	0.001–1.26
Beryllium (mg/L)	1.64	1.70	NA	0.005	0.0012	0.01–0.01	--
Lead ^{210} (pCi/L)	35.4	189	NA	2.45	0.24	-2.8–6.1	-0.8–3.5
Nickel (mg/L)	13.0	9.34	NA	0.065	0.016	0.01–2.1	0.01–0.28
Ra $^{226+228}$ (pCi/L)	250	353	5	69.5	16.9	0.6–84	1.7–2,070
Selenium (mg/L)	0.161	0.53	0.05	0.0048	0.043	0.01–0.01	0.001–0.097
Thorium ^{230} (pCi/L)	57.4	44.8	NA	0.108	0.86	-2.9–0.5	-0.93–8.2
Uranium (mg/L)	11.9	34.1	NA	0.0071	0.15	0.0009–0.26	0.0003–5.9
Chloride[d] (mg/L)	NA		2,000	76	84	1–14	1–138
Sulfate[d] (mg/L)	NA		3,000	1715	730	125–1,920	61–1,675

ACL = alternate concentration limit; POE = point of exposure; mg/L = milligrams per liter; pCi/L = picocuries per liter; Ra = radium; NA = not applicable.
[a]ACLs are applicable at the POC (Umetco 2001).
[b]Wyoming Class III Groundwater Protection Standards for livestock use are applicable at the POE (Umetco 2001).
[c]Modeled POE values and background concentrations obtained from the ACL application, Table 2.10 (Umetco 2001).
[d]Constituent is considered an indicator parameter (Umetco 2001).

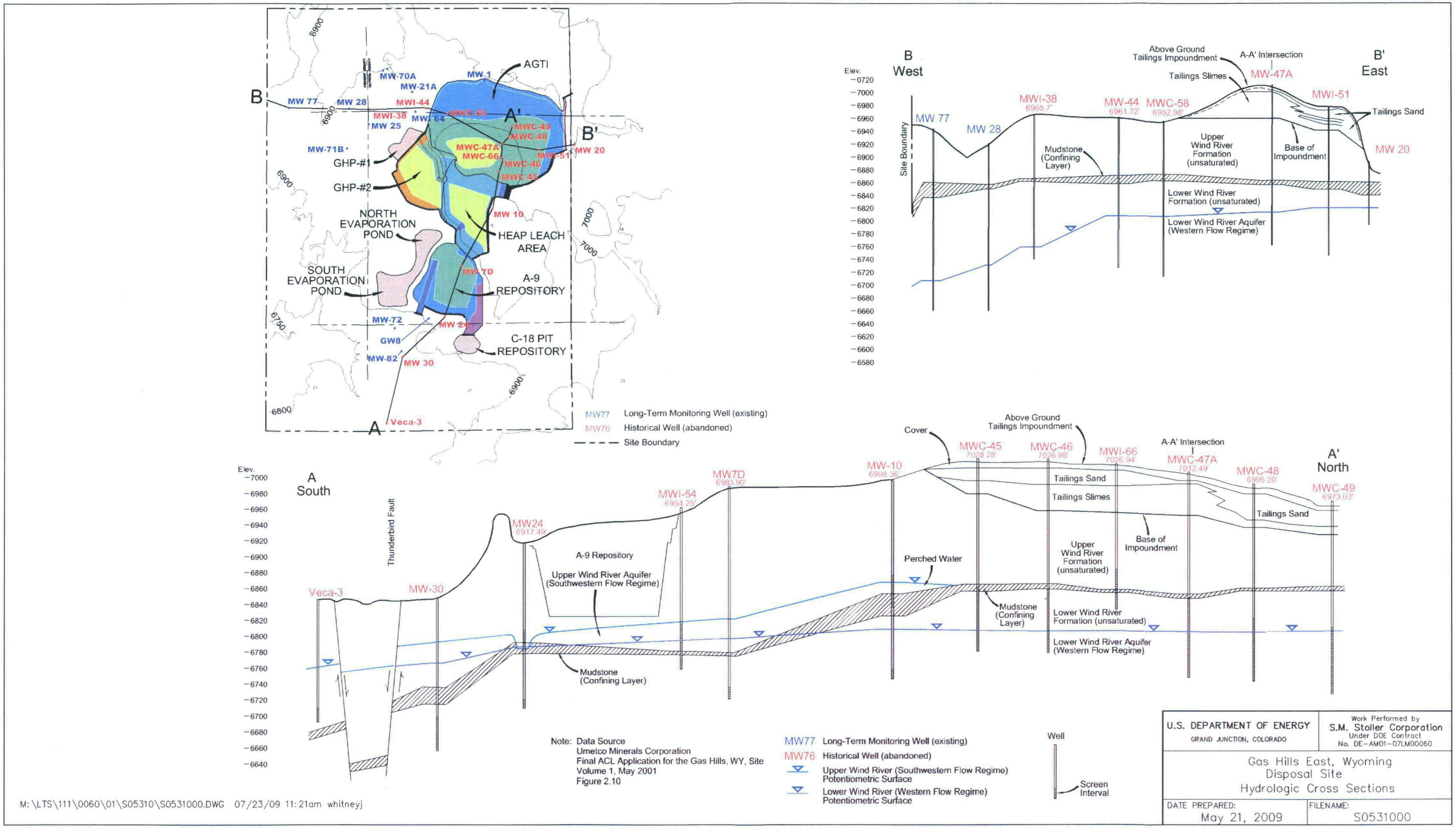

Figure D–1. Hydrogeologic Cross Sections at the Gas Hills East, Wyoming, Disposal Site

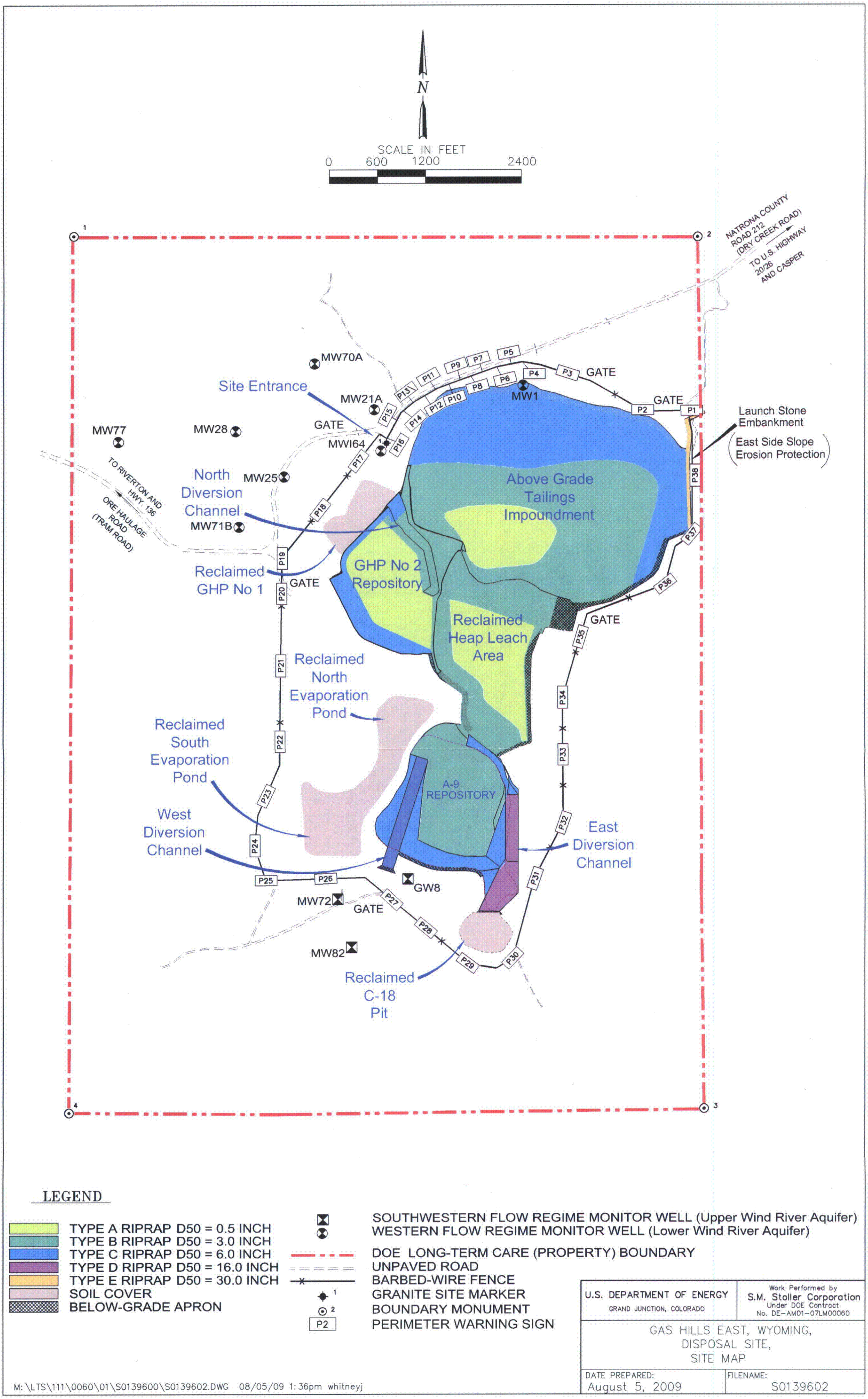

Figure D–2. Gas Hills East, Wyoming, Disposal Site Map

Table D–3. Summary of Historical Groundwater Data for the Gas Hills East, Wyoming, Disposal Site

Constituent	Concentration Range						Detections vs Total Analyses		
	Western Flow Regime[a]				Southwestern Flow Regime[b]		Western Flow Regime[a]		Southwestern Flow Regime[b]
	Wells		Iron Spring				Wells	Iron Spring	
	Min	Max	Min	Max	Min	Max			
Arsenic (mg/L)	<0.001	<0.4	0.001	0.068	<0.001	0.6	190 vs 224	13 vs 23	157 vs 180
Beryllium (mg/L)	0.0003	1.34	0.0001	<0.1	0.0001	0.22	119 vs 205	1 vs 7	99 vs 138
Chloride (mg/L)	<1	810	9.3	29	0.97	480	294 vs 295	32 vs 32	221 vs 221
Lead-210 (pCi/L)	-2.8	45	1.2	2.3	0	94	188 vs 219	2 vs 2	175 vs 181
Nickel (mg/L)	<0.01	8.88	0.0089	0.22	<0.01	3.2	192 vs 210	21 vs 23	135 vs 139
Radium-226+228 (pCi/L)	<1.2	215	2.9	26.9	1.6	418.2	223 vs 224	22 vs 22	182 vs 182
Selenium (mg/L)	0.0001	0.422	<0.001	<0.005	<0.001	0.058	79 vs 226	1 vs 23	22 vs 181
Sulfate (mg/L)	115	5,660	554	912	213	3,020	294 vs 294	32 vs 32	219 vs 219
Thorium-230 (pCi/L)	-2.9	154	0.2	0.2	-1.5	149.3	178 vs 215	2 vs 2	147 vs 174
Uranium (mg/L)	<0.00005	27.45	0.014	0.48	<0.00005	2,028	271 vs 295	32 vs 32	218 vs 221

mg/L = milligrams per liter; pCi/L = picocuries per liter; Ra = radium; < = less than.
[a]Includes data from wells MW1, MW21A, MW25, MW28, MW70A, MW71B, MW77, and MWI64.
[b]Includes data from wells GW7, GW8, MW72, MW82, and PW4.
Note: Historical data obtained from Umetco.

Table D–4. Historical Completion Information for Wells in the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site

Well Designation	Depth (ft)	Screen Interval (ft)	Surface Elev.* (ft)	Screen Interval Elev. (ft)	Completion Zone
MW1	79	39 – 79	6877.81	6838.81 - 6798.81	NA
MW21A	200	140 – 200	6958	6818 - 6758	NA
MW25	260	246 – 256	NA	6731.64 - 6721.64	Lower
MW28	282	242 – 282	6911.2	6669.2 - 6629.2	Lower
MWI64	260	180 – 260	6968.73	6788.73 - 6708.73	Lower
MW70A	151	130 – 150	6903.24	6773.24 - 6753.24	Upper
MW71B	329	303 – 323	6955.21	6652.21 - 6632.21	Lower
MW77	279	269 - 279	6942.71	6673.71 - 6663.71	Lower

Note; Information was obtained from the Statement of Completion and Description of Well (State of Wyoming). It is unclear what "Upper" under the completion zone column for well MW70A refers to as the western flow regime is in the Lower Wind River aquifer (possibly is meant to be the upper portion of this regime).
NA = Not Available: information was not provided for this field on the Statement of Completion and Description of Well (State of Wyoming).
* Surface elevations represent the ground surface elevation at the time of well installation and do not account for changes that occurred as a result of post-installation site construction activities.

Table D–5. Historical Completion Information for Wells in the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site

Well Designation	Depth (ft)	Screen Interval (ft)	Surface Elev.* (ft)	Screen Interval Elev. (ft)	Completion Zone
GW7	190	150 - 190	6951.17	6801.17 - 6761.17	NA
GW8	172	132 – 172	6921.34	6789.34 - 6749.34	NA
PW4	136	96 – 136	6894.51	6798.51 - 6758.51	NA
MW72	85	63 – 83	6856.04	6793.04 - 6773.04	Upper
MW82	115	95 – 110	6840.2	6745.2 - 6730.2	Upper

Note: Information was obtained from the Statement of Completion and Description of Well (State of Wyoming).
NA = Not Available: information was not provided for this field on the Statement of Completion and Description of Well (State of Wyoming).
* Surface elevations represent the ground surface elevation at the time of well installation and do not account for changes that occurred as a result of post-installation site construction activities.

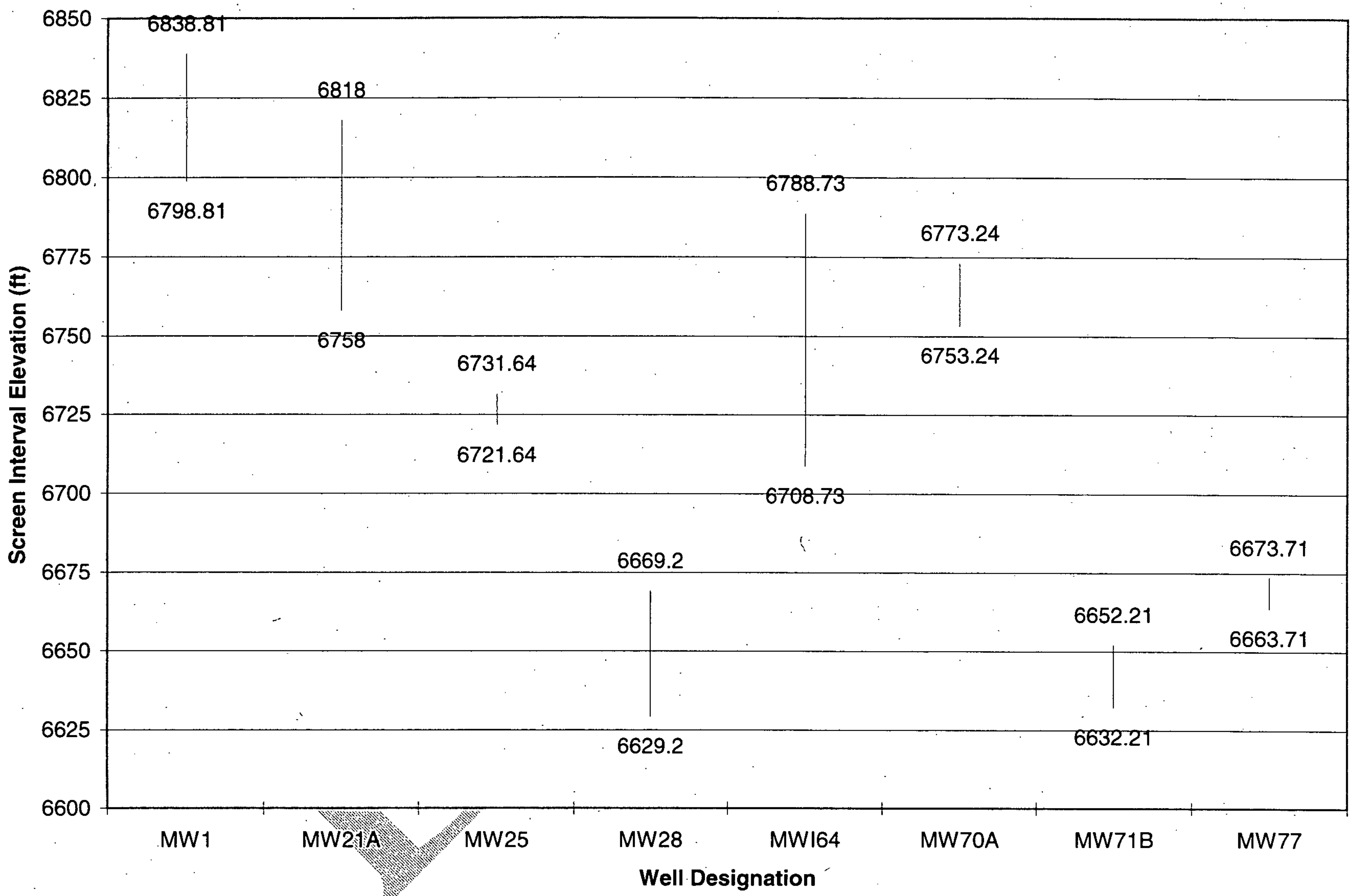

Figure D–3. Graphical Representation of Screen Intervals for Wells in the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site

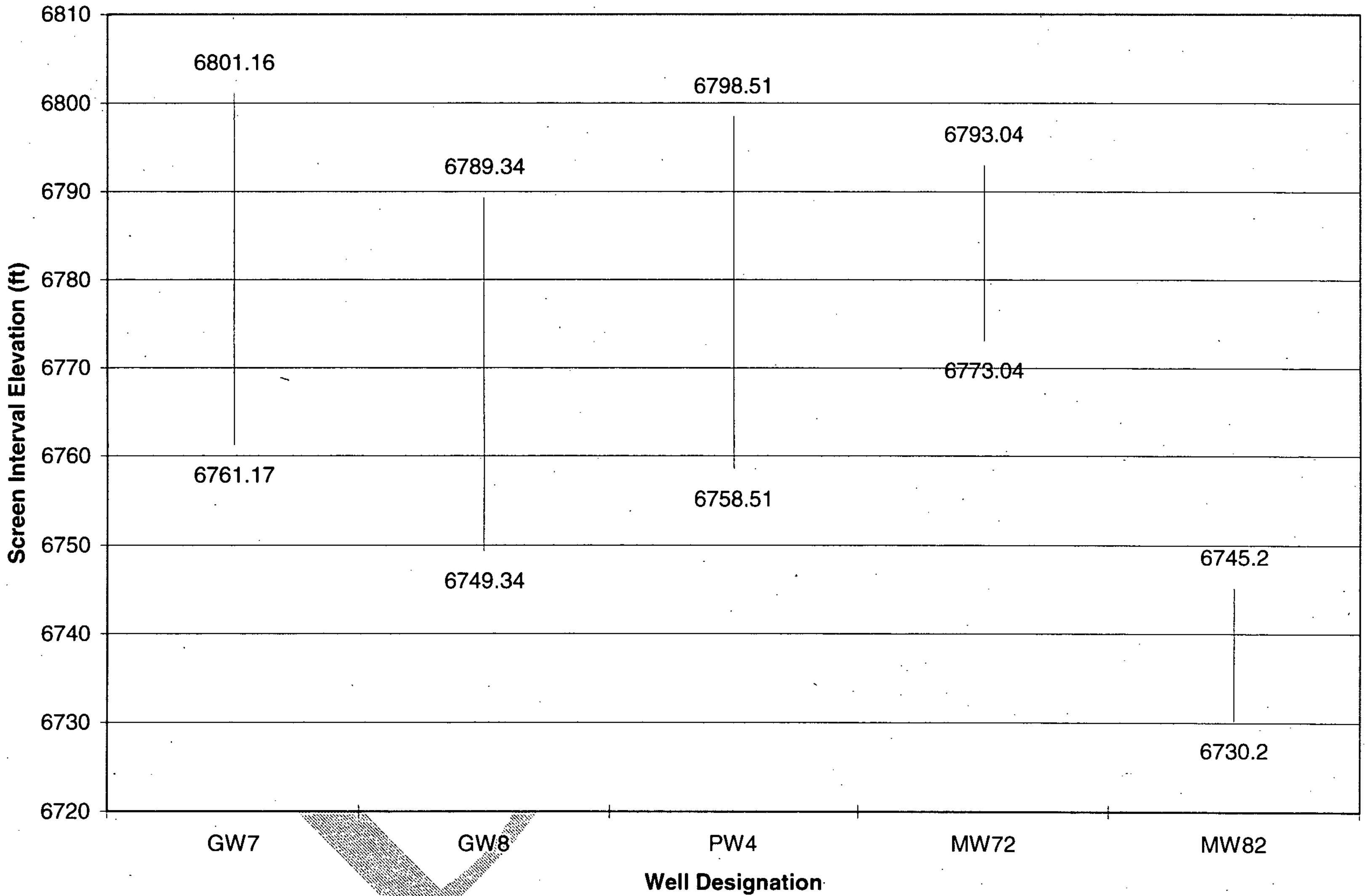

Figure D–4. Graphical Representation of Screen Intervals for Wells in the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site

The long-term groundwater monitoring program for the site, as presented in the LTSP, incorporated these ACLs and many of the monitoring requirements contained in the ACL application and subsequently adopted into Umetco's source material license. However, following a review of the ACL application and an evaluation of the historical groundwater monitoring data, several observations were made that resulted in recommended modifications to the long-term groundwater monitoring program.

D3 Evaluation of License SUA-648 Monitoring Requirements

The groundwater monitoring plan presented in the ACL application (and adopted into License SUA-648) noted that post-license-termination monitoring might require adjustments as DOE developed an LTSP. In particular, it was noted that results of monitoring prior to license termination should be used by DOE and NRC to establish long-term monitoring requirements in the site's LTSP.

An evaluation of the licensee's groundwater monitoring requirements was conducted to determine if they are suitable for DOE's long-term stewardship responsibilities. Site documentation, particularly, the ACL application (Umetco 2001) and historical groundwater data from the licensee, including data provided in the most recent annual report (Umetco 2008), were evaluated for all monitoring constituents to determine if any trends were discernible or if the system appeared to be relatively stable. Well completion records for monitor wells in the licensee's network were also reviewed against hydrogeological cross-sections to determine if screen intervals and well locations were adequate for long-term cell performance monitoring.

This evaluation provided the basis for the monitoring program included in the LTSP. The following observations were made as a result of this evaluation:

- Monitoring results from the last 5 years indicate that concentrations of arsenic, beryllium, selenium, and thorium-230 have been very low and consistent. These constituents are therefore of little use in monitoring changes in the groundwater system. In contrast, lead-210, radium 226+228, nickel, and uranium have been elevated and variable in point of compliance (POC) wells. Therefore, these constituents may be more useful (along with the indicator parameters sulfate and chloride) in monitoring legacy groundwater contamination and the long-term performance of the disposal system.
- The ACL application only required the POC wells to be analyzed for constituents other than chloride, sulfate, and uranium. The groundwater model assumed that if observed concentrations of chloride and sulfate in the model validation wells agreed with predictions, that other constituents would also behave as similarly (as long as they remain below ACLs in POC wells). There is no obvious correlation in time-concentrations plots for sulfate and chloride compared to other monitored constituents.
- The modeling approach for sulfate and chloride (i.e., numerical modeling) was different than the geochemical modeling conducted for all other constituents. Therefore it is questionable if sulfate and chloride trends are sufficient to validate the geochemical model.
- Because observed concentrations of a number of constituents in the POC wells are quite erratic (the model assumed a constant source), it is not possible to interpret how this variability might affect downgradient wells. It would therefore seem prudent, at least in

the near term, to monitor all wells in the monitoring network for all constituents in order to validate the geochemical modeling.

- Only one of the wells (MW77) was specifically identified in the ACL application's monitoring plan as representative of water quality at the POE (defined as the site boundary). However, a comparison of POC wells with downgradient trend wells is presumed to confirm that contaminant concentrations are attenuating as groundwater moves toward the site boundary and that plumes are behaving as predicted by the groundwater models.
- Chloride and sulfate analytical results from wells MW71B, MW28, MW72, and MW82 will be compared to background levels and WDEQ Class III groundwater standards to validate groundwater modeling predictions that these levels and standards will not be exceeded at the POE. These two analytes are conservative tracers (their migration along the groundwater flow path is not significantly attenuated) and early indicators of plume movement.
- Well MW1 seems questionable as a long-term POC for the western flow regime. The ACL application indicates that well MW1 was used historically to monitor radial flow from the above ground tailings impoundment (AGTI). However, upon dissipation of the legacy groundwater mound under the AGTI and stabilization of the effects caused by the groundwater corrective action program, the general groundwater flow direction under natural static conditions is from the east to west. Well MW1 is at the northern edge of the AGTI (Figure D–2) and would be cross-gradient to the direction of groundwater flow long-term and therefore not representative of groundwater concentrations downgradient of the AGTI (i.e., not a true long-term cell performance measure). However, due to recent concentrations of uranium displaying an upward trend, well MW1 should remain in the long-term monitoring program as a trend well.
- Well MWI64 is directly downgradient of the AGTI, and therefore, a more appropriate location for a long-term POC for the western flow regime. Additionally, the ACL application indicated that well MWI64 was used as the starting point for the geochemical model (and as a POC for the western flow regime).
- Well MWI64 in the western flow regime historically displayed the highest concentrations of most constituents (higher than designated POC wells) and was used to establish several of the ACLs. However, the groundwater monitoring plan in the ACL application only required this well to be analyzed for chloride, sulfate, and uranium. Because this well reported the highest concentrations of most constituents, it seems reasonable that well MWI64 should be monitored for all constituents with ACLs (except, as discussed above, arsenic, beryllium, selenium, and thorium-230), along with the indicator parameters sulfate and chloride.
- Variability of some constituent concentrations is observed historically in well MWI64 indicating possible influences from legacy contamination rather than cell performance. Therefore, with regard to cell performance, exceedance of an ACL at well MWI64 would not be immediate cause for concern.
- Because well MWI64 is a more appropriate location for a long-term POC for the western flow regime (for the reasons stated above), well MW21A will be considered a trend well for the western flow regime (rather than a POC).

- The isoconcentration maps in Appendix G of the ACL application indicate the contaminant migration direction for some of the site-related constituents. These maps were used to assist in determining which monitoring locations to include in the long-term network based on these contaminant migration directions. A series of isoconcentration maps for each analyte displays the result for three time periods; April-June 1990, January-March 1995, and January-March 2000. It is recognized that these isoconcentration maps are not current and conditions may have changed in the last 8-9 years.
- Some of these isoconcentration results are conflicting and opposite to the flow direction as indicated in Umetco's 2008 annual monitoring report (which shows water level elevations collected in June 2008). For example, nickel, uranium, and beryllium show migration to the east of the AGTI. This flow direction may be a result of the disruption that was caused to the natural static groundwater flow conditions from nearly twenty years of groundwater corrective action (both extraction and injection of groundwater was performed under the program). A return to natural static groundwater flow conditions (which is what appears to have occurred based on water levels shown in Umetco's 2008 annual monitoring report), is likely to result in a corresponding direction of contaminant migration that will continue over the long-term.
- The series of isoconcentration maps for selenium and lead-210 show migration toward well MW70A, which is in the Upper Wind River aquifer and may be an early indicator of future cell performance. This location also appears to be an area of high concentration for these two analytes. The series of isoconcentration maps for arsenic, beryllium, combined radium-226 + 228, and chloride show some migration toward well MW71B in the Lower Wind River aquifer. In addition to the migration of some contamination toward wells MW70A and MW71B, these locations would also be useful for monitoring long-term radial migration from the AGTI in the northwest and west-southwest direction, respectively.
- The length and depth of screen intervals for wells completed in the western flow regime (Lower Wind River aquifer) vary significantly. For example, when comparing the screen interval depth for well MW21A with the screen interval elevation of well MW70A (Table D–4 and Figure D–3), it appears that well MW70A is targeting a more specific interval within the formation than well MW21A, which has a 60-foot screen interval (as compared to the 20-foot screen interval in well MW70A). Additionally, when comparing the screen interval depth for wells MW70 and MW71B (Table D–4 and Figure D–3), which monitor radial flow from the AGTI, it is noted that well MW70A is screened in the upper portion of the aquifer and well MW71B is screened in the lower portion of the aquifer (apparently to monitor vertical plume migration).
- Historical groundwater data for well GW8 indicated that the high concentration for most analytes occurs at this location for the southwestern flow regime. These include beryllium, chloride, lead-210, nickel, sulfate, and uranium. In addition, the trend is increasing for chloride, lead-210, nickel, combined radium-226 + 228, and sulfate at well GW8. Therefore, well GW8 will be considered the POC for the southwestern flow regime.
- In September 2008, contract workers at the site inadvertently placed bentonite in POC well GW7 (letter report from Umetco to NRC, January 6, 2009). The report indicates that removal of bentonite from well GW7 was successful and accurate formational groundwater samples were being obtained, as demonstrated by subsequent monitoring results. However, while it appears that the effort to remove the bentonite was successful,

in order to ensure that future results are not affected by any residual bentonite that may remain, technically, it would be better to use another nearby location (i.e., well GW8) as the designated POC.

- Well PW4 is located directly downgradient to well GW8 and is screened across much of the same interval. Therefore, well PW4 is somewhat redundant and does not provide significant value for monitoring long-term performance of the disposal system in the southwestern flow regime.
- Similarly, well GW7 is located directly upgradient to well GW8 and is screened across much of the same interval. Therefore, well PW4 is also somewhat redundant and does not provide significant value for monitoring long-term performance of the disposal system in the southwestern flow regime.
- Wells MW72 and MW82 are both validation wells downgradient of the A-9 Repository. In Umetco's 2008 annual monitoring report it is evident from the June 2008 water level elevation map that well MW82 is more closely aligned with the southwest direction of flow that occurs downgradient of the A-9 Repository than is well MW72. As shown on Table D–4, the screen interval elevations for wells MW72 and MW82 are considerably different. Well MW82 is screened across the lower portion of the Upper Wind River aquifer, whereas well MW72 is screened across the upper portion of the Upper Wind River aquifer. However, because these two wells provide the only downgradient monitoring locations from the POC they are recommended to be retained.
- Although Iron Spring is the first true POE for the western flow regime, Appendix M of the ACL application states: "Groundwater modeling indicates no significant impacts to water quality resulting from site-derived constituents" (is expected). Additionally, groundwater modeling presented in the ACL application predicts contaminant concentrations will attenuate and be compliant with standards and/or background concentrations before reaching the site's long-term care boundary—making the monitoring of a point (such as Iron Spring) that is approximately 1 mile downgradient of the site unnecessary. It should also be noted that well MW77 is representative of the POE for the western flow regime.

D4 Recommended Modifications to the Long-Term Monitoring Program

Based on this evaluation, and the resulting observations discussed above, the following modifications to the long-term monitoring program are recommended:

- Arsenic, beryllium, selenium, and thorium-230 were eliminated from the analytical suite.
- All wells in the monitoring network will be sampled and analyzed annually for all of the remaining analytes—constituents of potential concern—(lead-210, nickel, combined radium-226 and-228, uranium, chloride, and sulfate); water level, pH, and specific conductance will also be measured during sampling.
- Well MWI64 will be considered the POC well for the western flow regime.
- Wells MW1 and MW21A will be considered trend wells for the western flow regime (rather than POCs).
- Well GW8 will be considered the POC well for the southwestern flow regime.
- Wells GW7 and PW4 will be eliminated from the groundwater monitoring network in the southwestern flow regime.

- Iron Spring will be eliminated from the groundwater monitoring network in the western flow regime.

D5 Long-Term Groundwater Monitoring Program

The recommended long-term groundwater monitoring requirements are summarized in Table D–6. Analytes (COPC) and their respective groundwater protection standards, including NRC-approved ACLs for the western and southwestern flow regimes, are presented in Table D–7. Monitoring locations are shown on Figure D–2.

If sampling results indicate an ACL is exceeded at a POC well, or trends indicate that either a predicted maximum value or a groundwater protection standard may be exceeded at the POE, DOE will inform NRC and WDEQ of the results and conduct confirmatory sampling. If the confirmatory sampling verifies the exceedance or the threat of an exceedance, DOE will develop an evaluative monitoring work plan and submit that plan to NRC for review prior to initiating the evaluative monitoring program. This plan could involve expanding the analyte list to include all ACL constituents or other relevant constituents, increasing monitoring frequency, or some other approach. Results of the evaluative monitoring program will be used, in consultation with NRC, to determine if it is necessary for DOE to perform additional studies or if implementation of corrective action is warranted.

Following the establishment of a baseline, the long-term groundwater monitoring program will be reevaluated every five years (beginning in 2015) to determine if the ACLs remain protective and that the cell is performing as designed. This approach is consistent with the ACL application which indicated that the post-license-termination groundwater monitoring frequency should be reduced to once every 5 years (Umetco 2001). Modifications to the monitoring program will be made as recommended by these evaluations. For example, the evaluation may recommend that the monitoring frequency and suite of analytical constituents be modified. Modifications to the monitoring program will only occur following NRC concurrence, and will be documented. If the evaluation recommends discontinuation of groundwater monitoring entirely, the LTSP will be revised and submitted to NRC for concurrence.

Groundwater monitoring will be discontinued entirely once the following criteria have been met: 1) trends have established that ACLs will not be exceeded at the POC (e.g., concentrations of site-related constituents have remained in compliance and consistent over an adequate period of time); 2) trends have demonstrated that ACLs will remain protective at the POE—no exceedance of groundwater protection standards (i.e., the site groundwater model has been validated and attenuation of contamination is occurring as predicted); and 3) monitoring has demonstrated that the disposal system is performing as designed (i.e., no evidence that contamination from the cell is being mobilized). Discontinuing of groundwater monitoring will only occur following NRC concurrence.

Results of the groundwater monitoring program will be included in the annual inspection and monitoring report submitted to NRC.

Table D–6. Long-Term Groundwater Monitoring Plan for the Gas Hills East, Wyoming, Disposal Site

Well Designation	Comments	Monitoring Frequency	Analytes[a] and Water Quality Parameters
MW1	Western flow regime trend well. Monitors radial flow from the AGTI.	Annually for the first 5 years (through 2014) at all locations. DOE will reevaluate the monitoring requirements every 5 years (beginning in 2015).	All locations: Lead-210, nickel, combined radium-226 and-228, uranium, chloride, and sulfate; also water level, pH, and specific conductance[b].
MW21A	Western flow regime trend well. Downgradient of the AGTI.		
MWI64	Western flow regime POC well. Closest well downgradient of the AGTI. Historically reported highest concentrations of most constituents.		
MW70A	Western flow regime trend well. Screened in upper part of aquifer. Monitors radial flow from AGTI.		
MW25	Western flow regime trend well. Downgradient of the AGTI. Approximate leading edge of the plume. Monitors plume migration/attenuation.		
MW71B	Western flow regime model validation well. Downgradient of the AGTI. Screened in lower portion of aquifer. Monitors vertical plume migration.		
MW28	Western flow regime model validation well. Downgradient of the AGTI. Historically showed no sign of contamination—early indicator of plume migration.		
MW77	Western flow regime. Downgradient of the AGTI. Representative of the POE.		
GW8	Southwestern flow regime trend well. Downgradient of the A–9 Repository.		
MW72	Southwestern flow regime model validation well. Downgradient of the A–9 Repository. Approximate leading edge of plume.		
MW82	Southwestern flow regime model validation well. Downgradient of the A–9 Repository. Outside of contaminant plume. Early indicator of plume migration.		

ACL = alternate concentration limit; AGTI = above ground tailings impoundment; DOE = Department of Energy; POC = point of compliance; POE = point of exposure.

[a]Analytes represent constituents of potential concern.

[b]Specific conductance is an estimator of total dissolved solids and can be used to demonstrate that Wyoming Class III standards are being met at the POE.

Note: Model validation wells designated in accordance with the ACL application (Umetco 2001).

Table D–7. Analytes, ACLs, and Groundwater Protection Standards for the Gas Hills East, Wyoming, Disposal Site

Analyte (COPC)	ACL[a]		Groundwater Protection Standard[b]
	Western Flow Regime	Southwestern Flow Regime	
Arsenic[c]	1.8 mg/L	1.36 mg/L	0.2 mg/L
Beryllium[c]	1.64 mg/L	1.70 mg/L	NA
Lead-210	35.4 pCi/L	189 pCi/L	NA
Nickel	13.0 mg/l	9.34 mg/L	NA
Combined Radium-226 and -228	250 pCi/L	353 pCi/L	5 pCi/L
Selenium[c]	0.161 mg/L	0.53 mg/L	0.05 mg/L
Thorium-230[c]	57.4 pCi/L	44.8 pCi/L	NA
Uranium	11.9 mg/L	34.1 mg/L	NA
Chloride[d]	NA		2,000 mg/L
Sulfate[d]	NA		3,000 mg/L

COPC = constituent of potential concern; ACL = alternate concentration limit; mg/L = milligrams per liter; pCi/L = picocuries per liter; NA = Not Applicable.
[a]ACLs are applicable at the POC (Umetco 2001).
[b]Wyoming Class III Groundwater Protection Standards for livestock use are applicable at the POE (Umetco 2001).
[c]Analyte was removed from the LTS&M groundwater monitoring suite because results from the last 5 years indicate that concentrations have been very low and consistent.
[d]Analyte is considered an indicator parameter and will be used for validating the groundwater model (Umetco 2001).

D6 References

NRC (U.S. Nuclear Regulatory Commission), 2002. Letter from NRC to Umetco Minerals Corporation, Re: Amendment 48, License SUA-648, Umetco Minerals Corporation, Gas Hills Uranium Mill Site, Alternate Concentration Limits, March 29.

NRC (U.S. Nuclear Regulatory Commission), 2006. Letter from NRC to Umetco Minerals Corporation, Re: Umetco – Gas Hills Material License SU-648 – Environmental Assessment of Alternate Concentration Limit, March 24.

Umetco (Umetco Minerals Corporation), 2001. *Final Application for Alternate Concentration Limits for Gas Hills, Wyoming*, Umetco Minerals Corporation, Grand Junction, Colorado, May.

Umetco (Umetco Minerals Corporation), 2004. Letter from Umetco Minerals Corporation to NRC, Re: License Amendment Request, Material License SUA-648, Docket No. 40-0299, January 5.

Umetco (Umetco Minerals Corporation), 2008. Annual Report for Gas Hills, Wyoming, July 2007 through June 2008, License SUA-648, Docket Number 40-0299, September.

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Attachment D1

Time-Concentration Plots of Historical Groundwater Monitoring Data for Constituents of Potential Concern at the Gas Hills East Disposal Site

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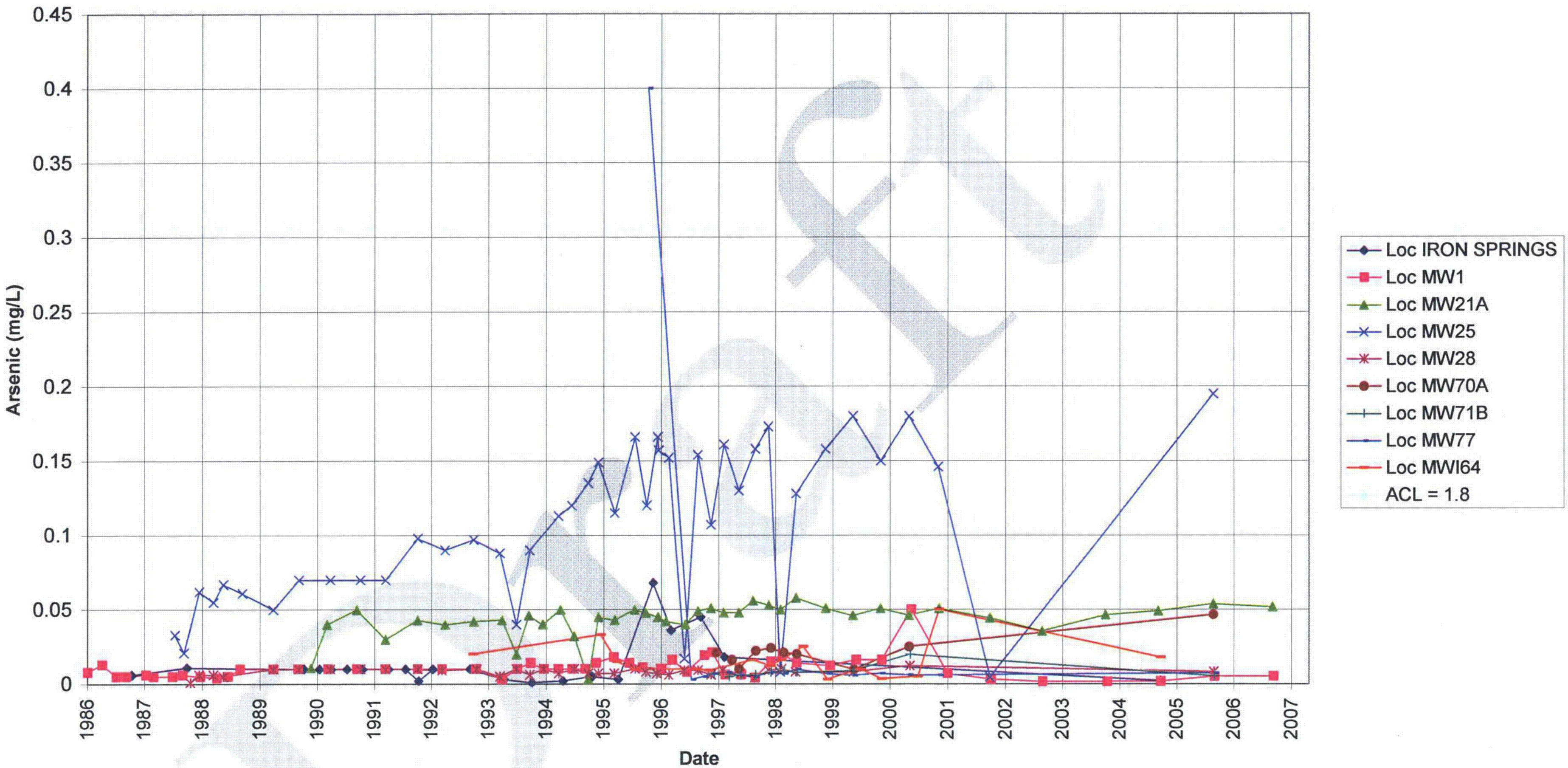
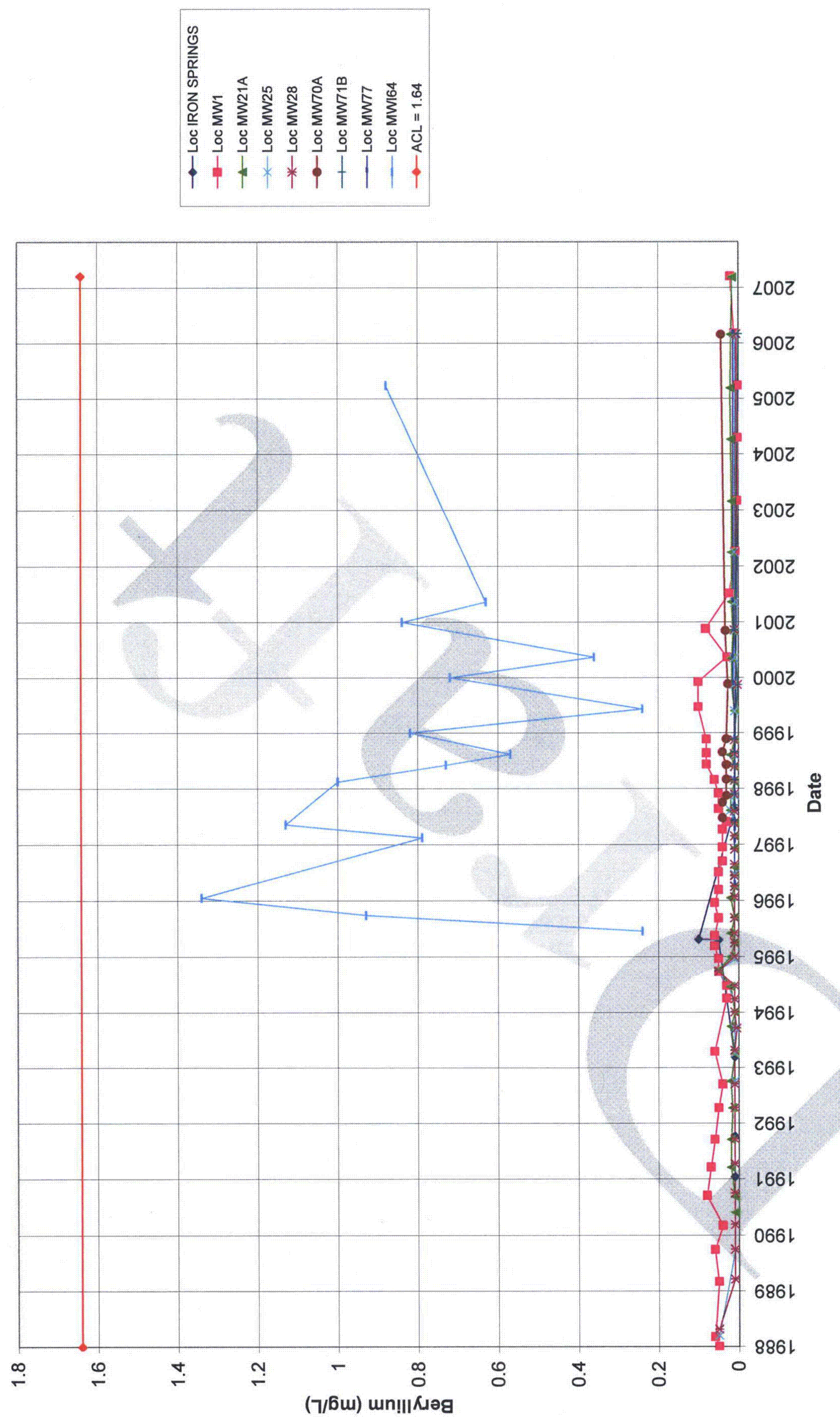
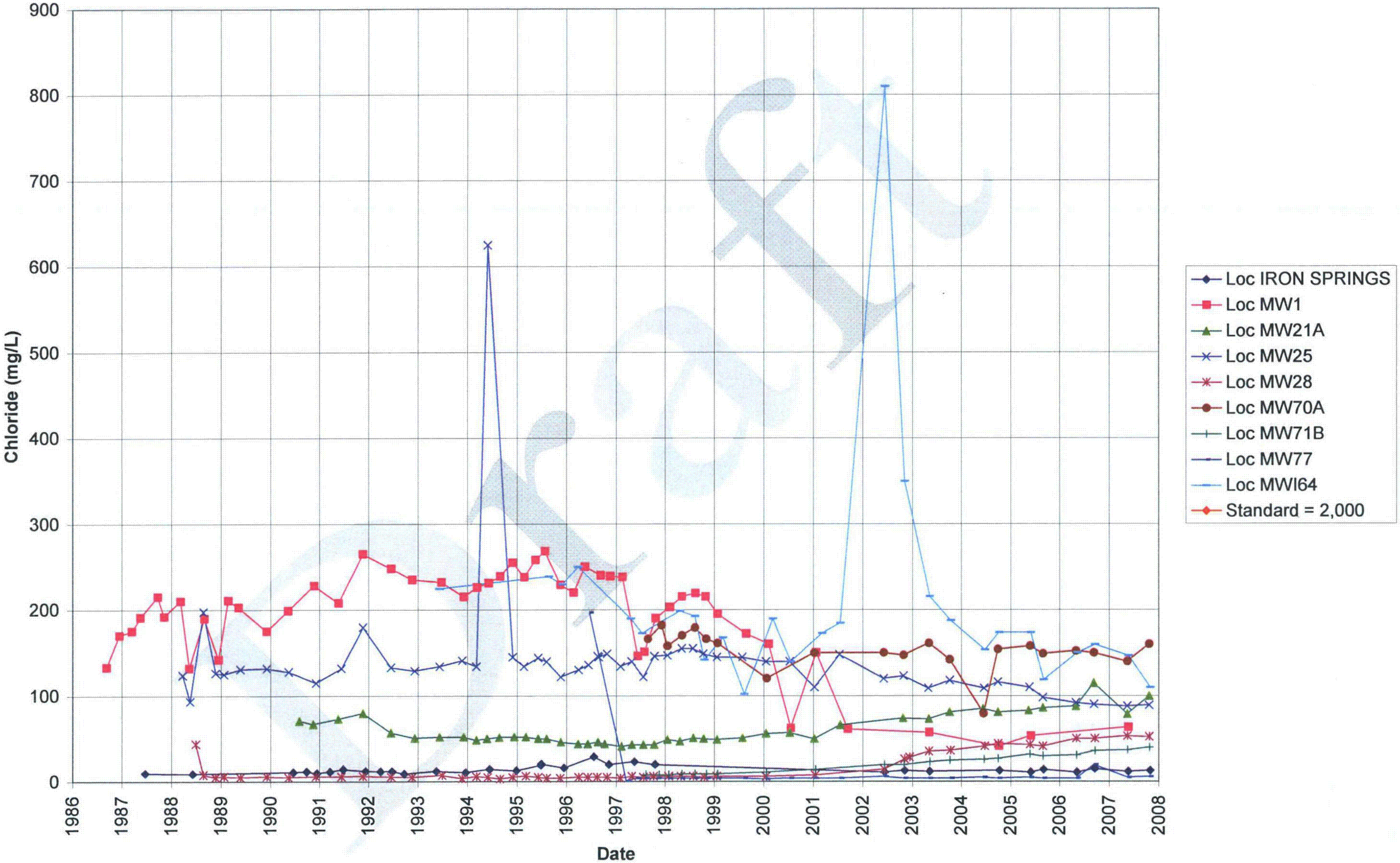


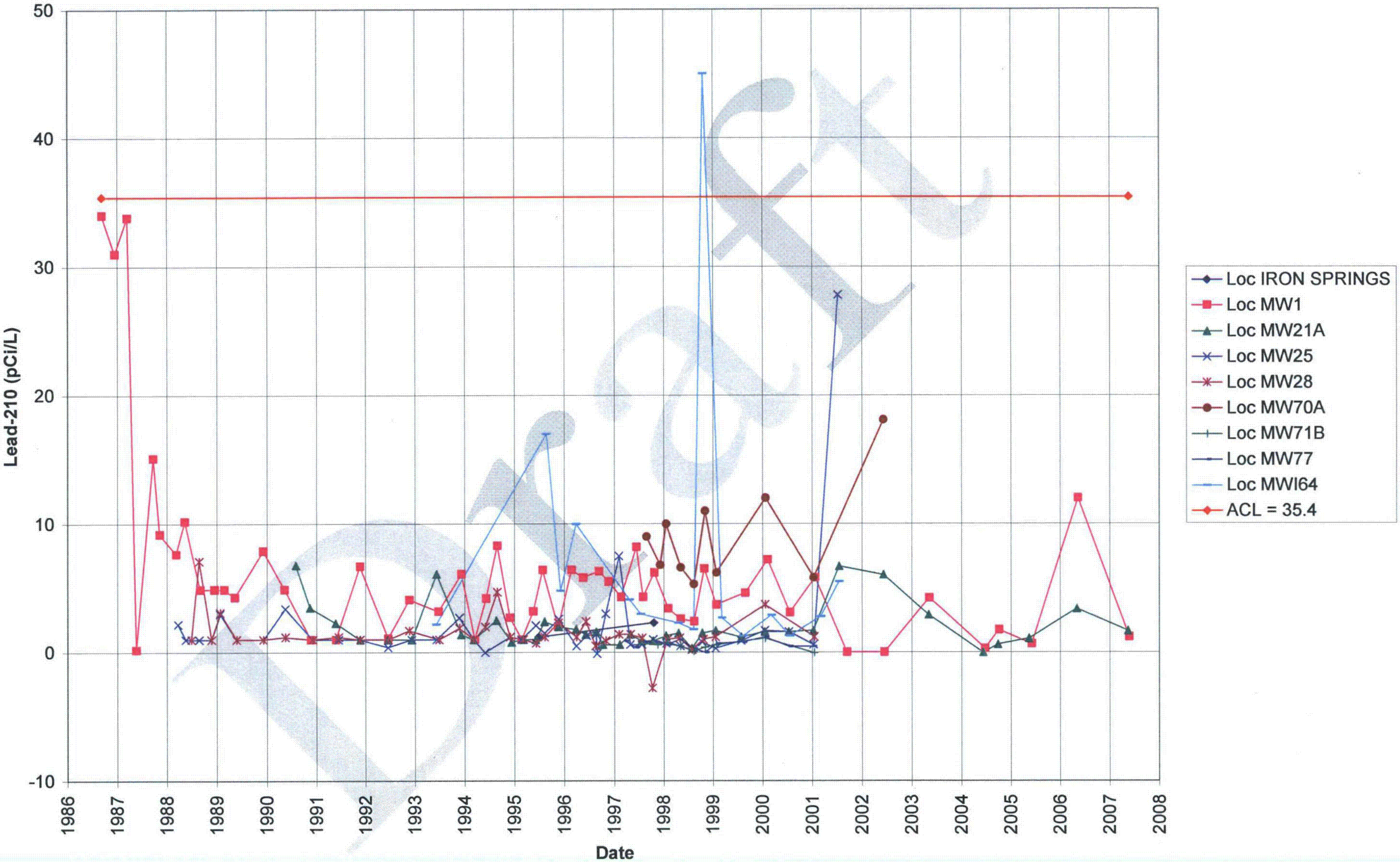
Time-Concentration Plots of Arsenic in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



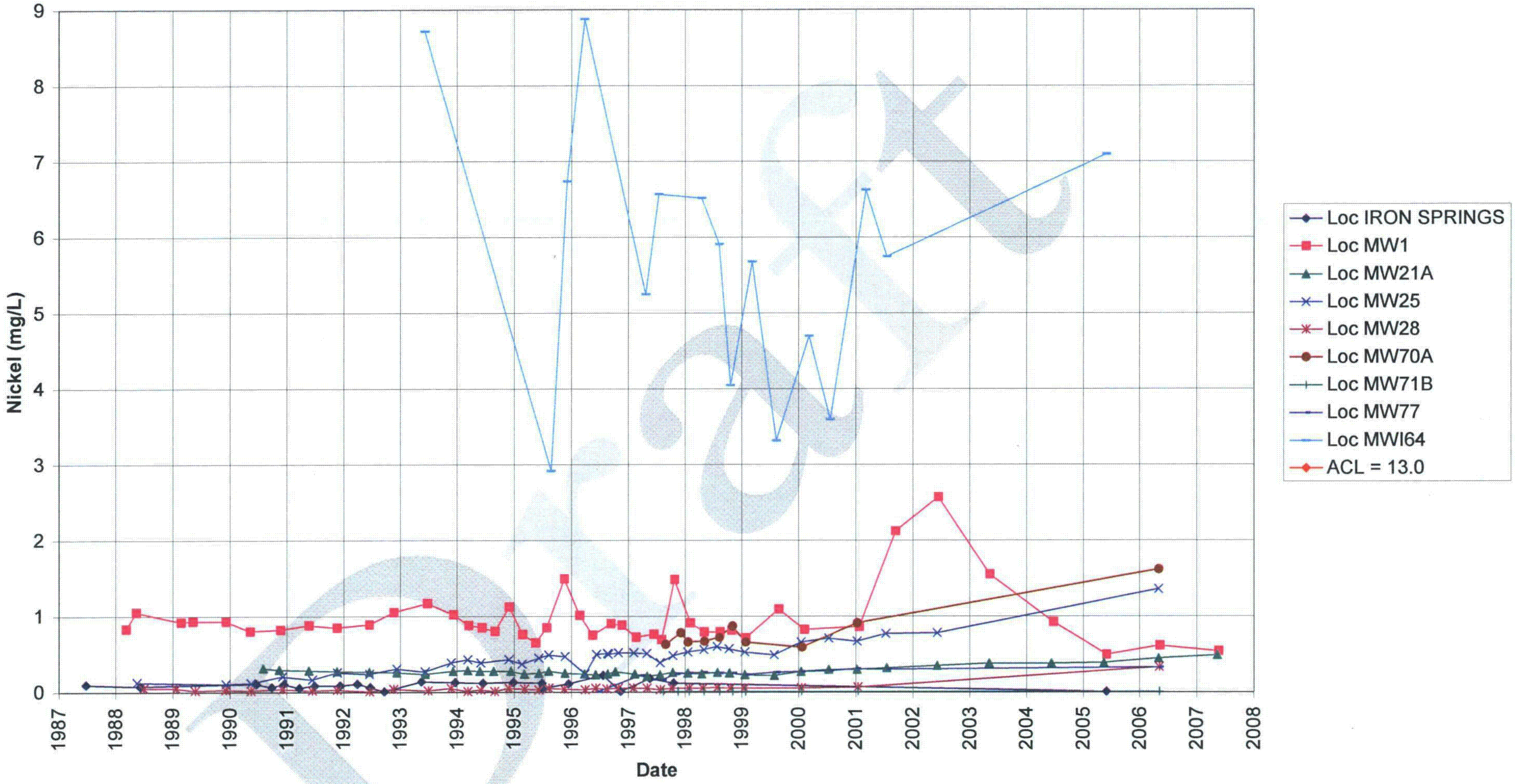
Time-Concentration Plots of Beryllium in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Chloride in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Lead-210 in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



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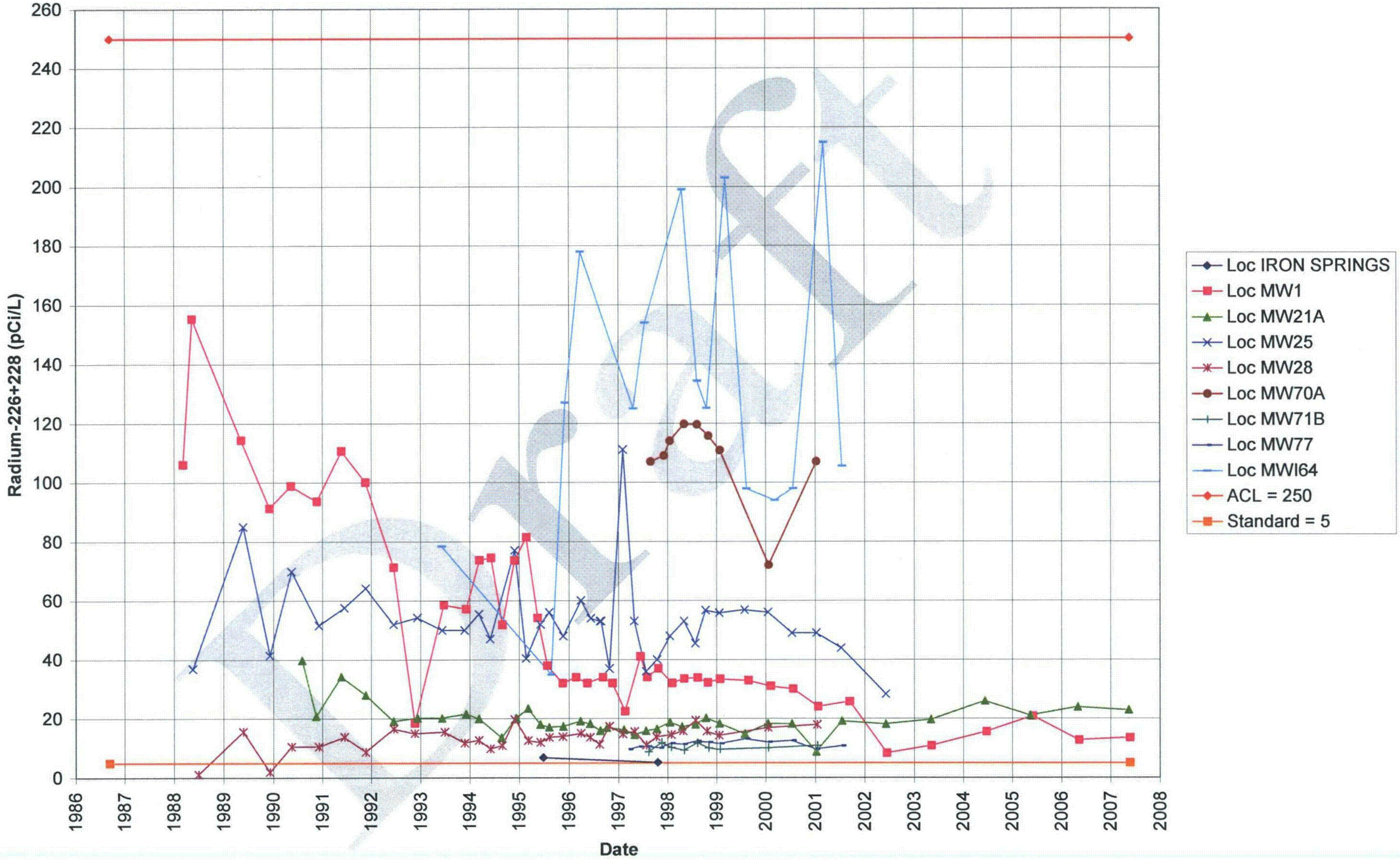

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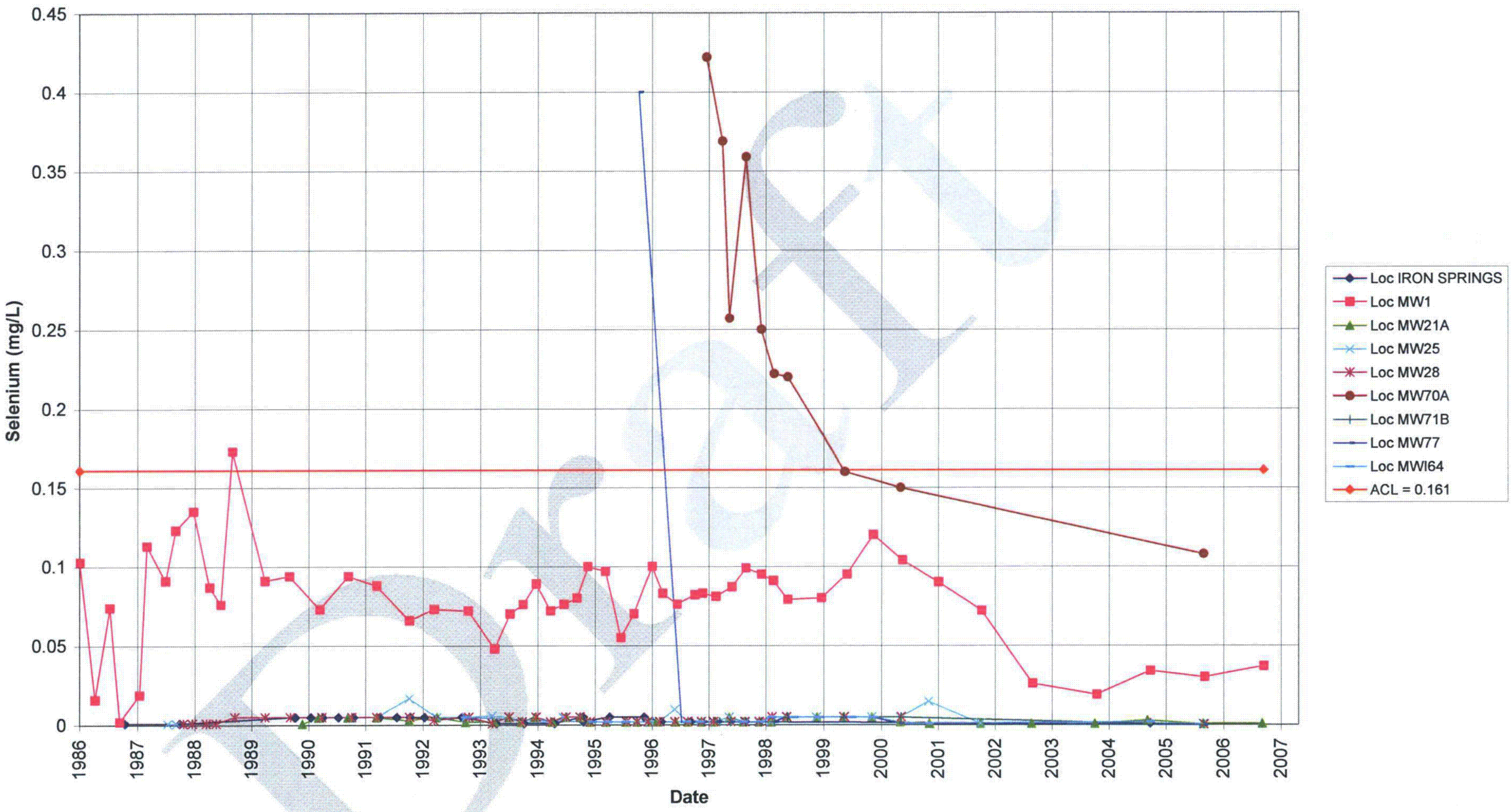
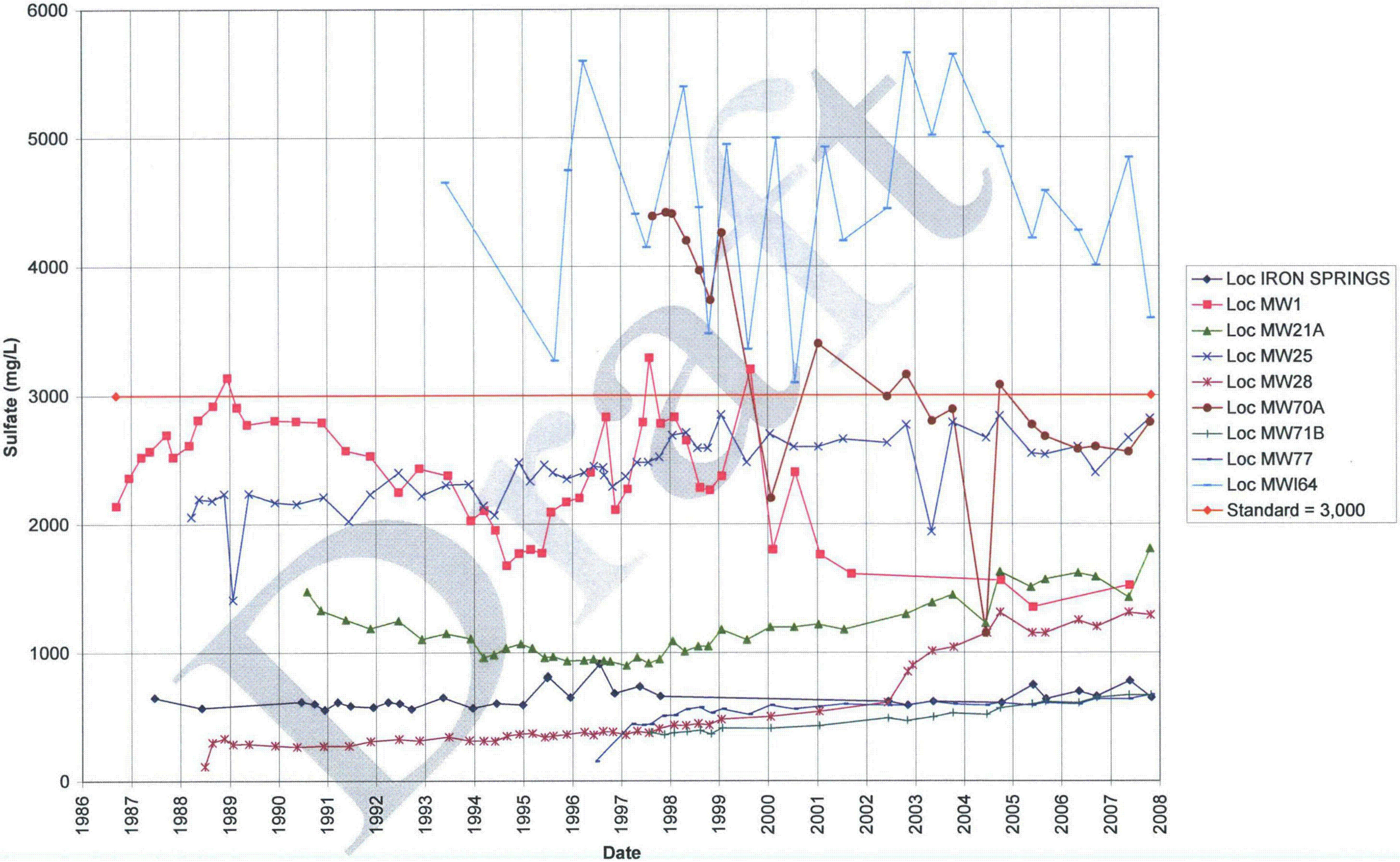
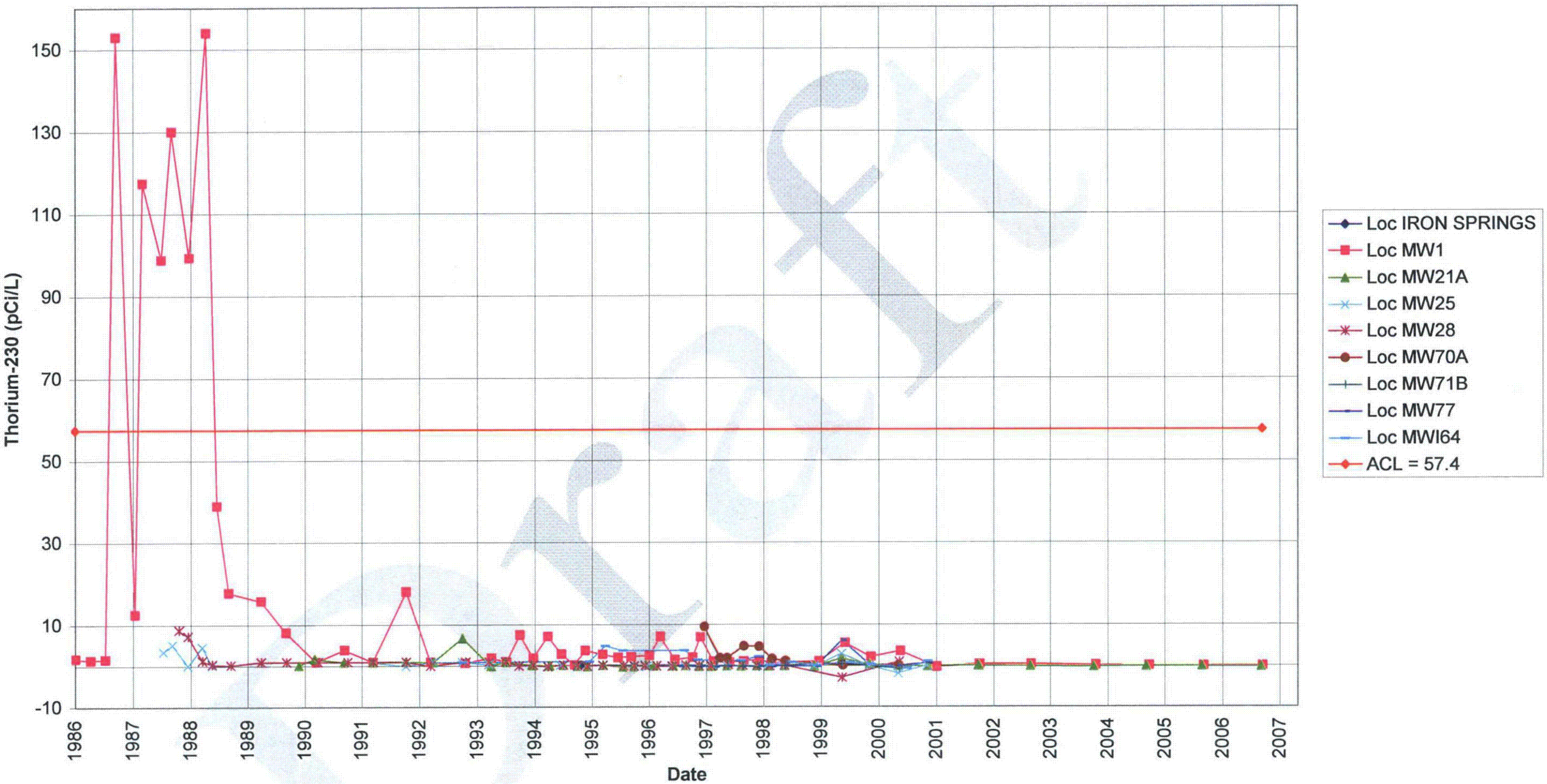


Time-Concentration Plots of Selenium in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Sulfate in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



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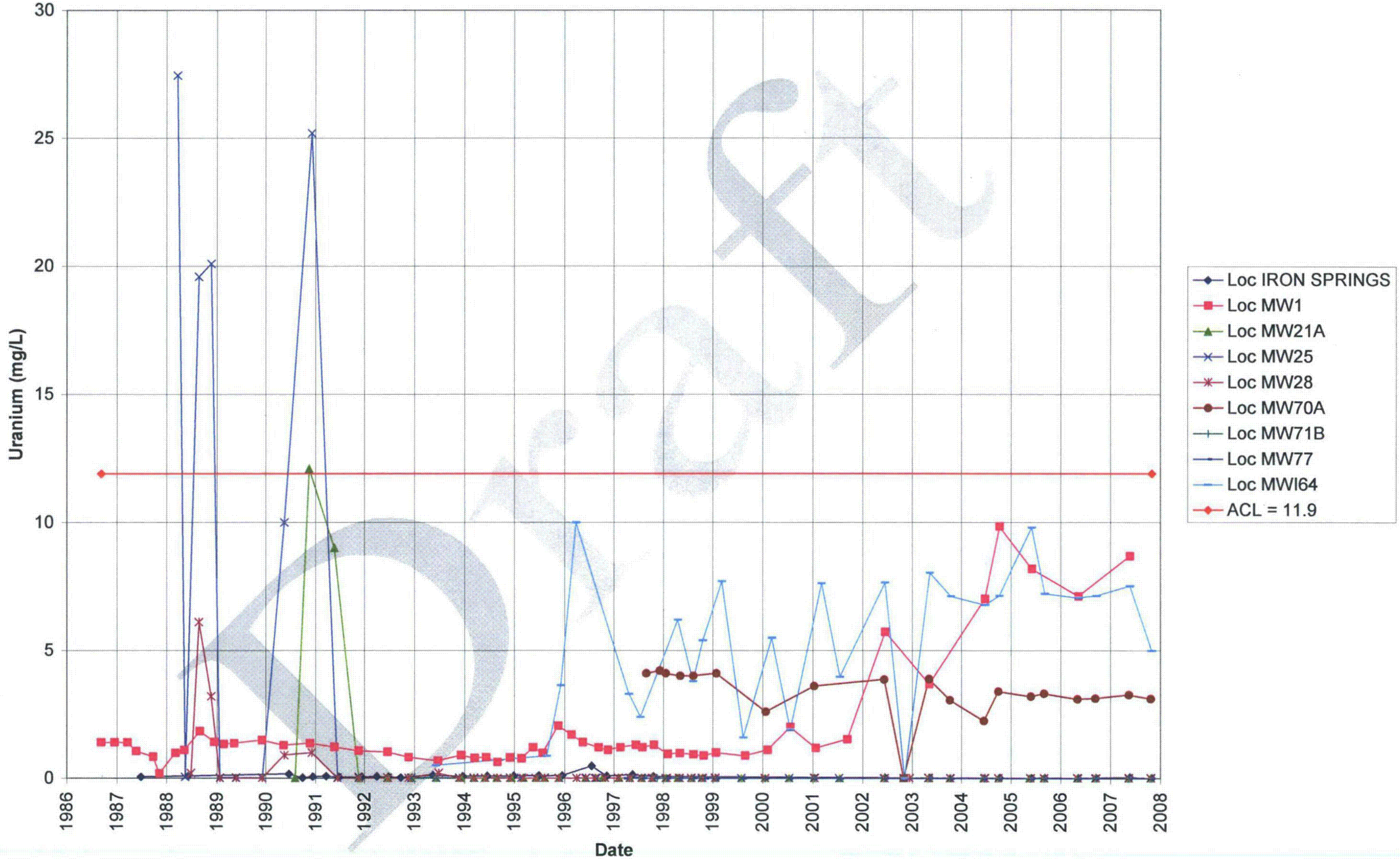

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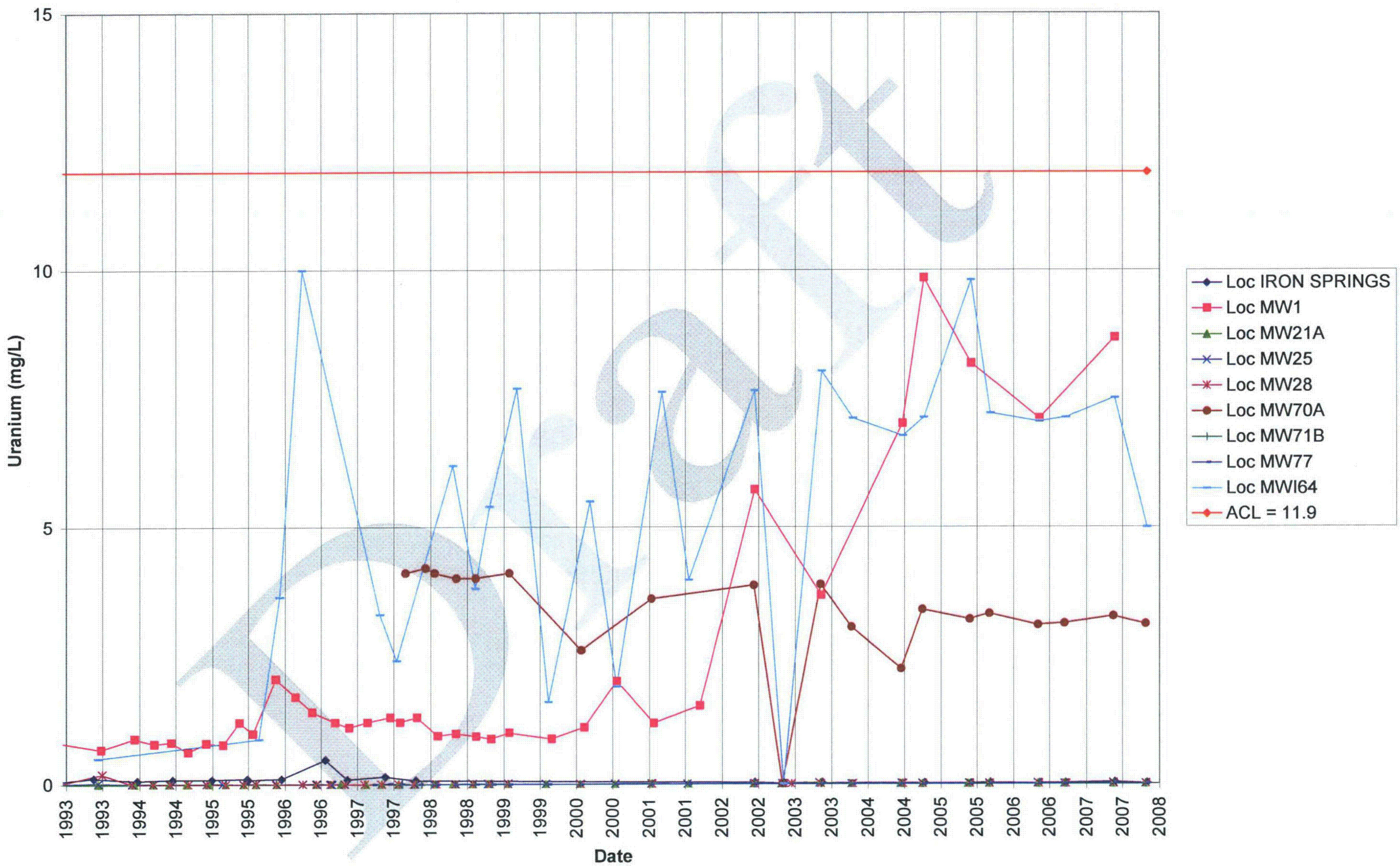
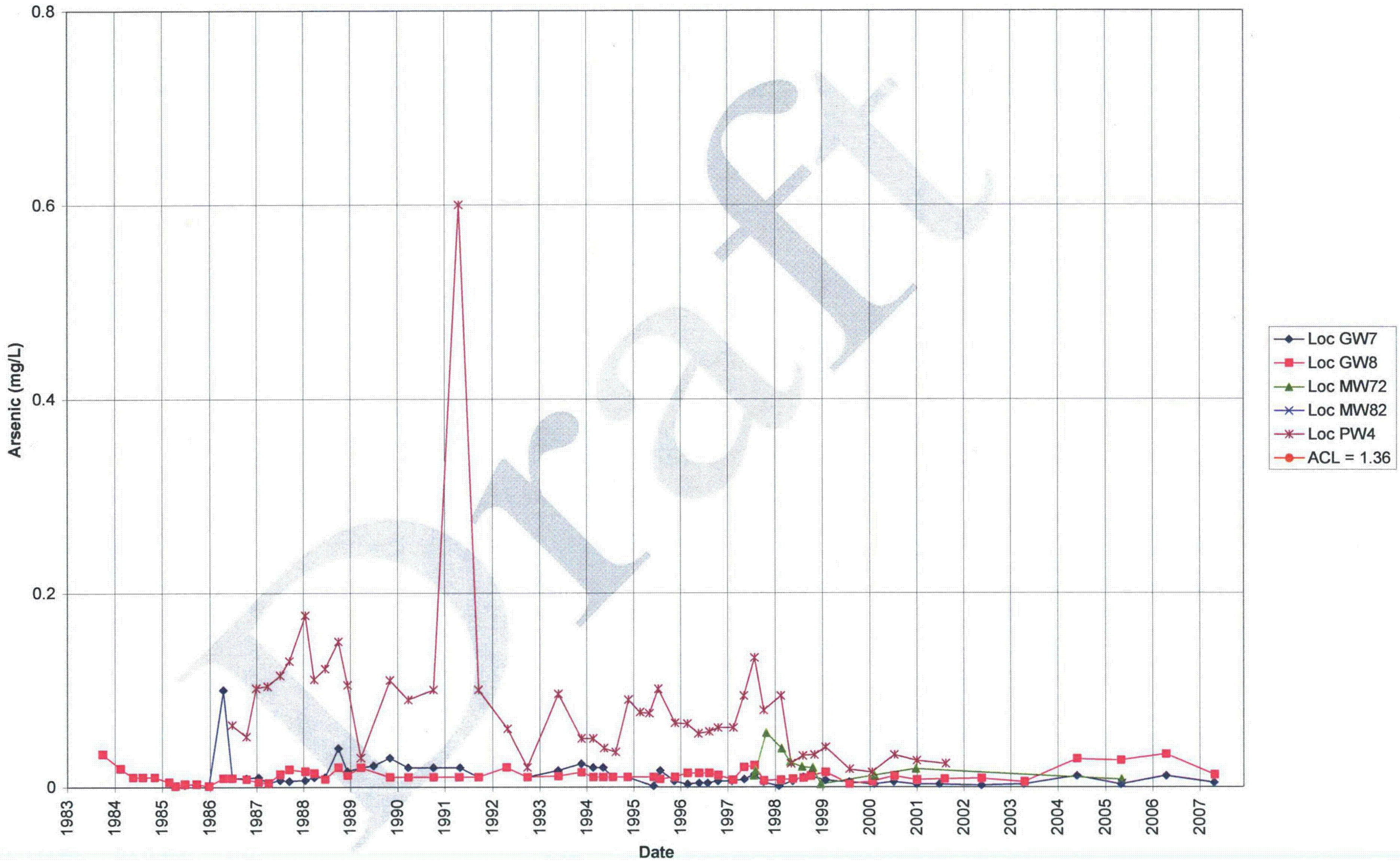
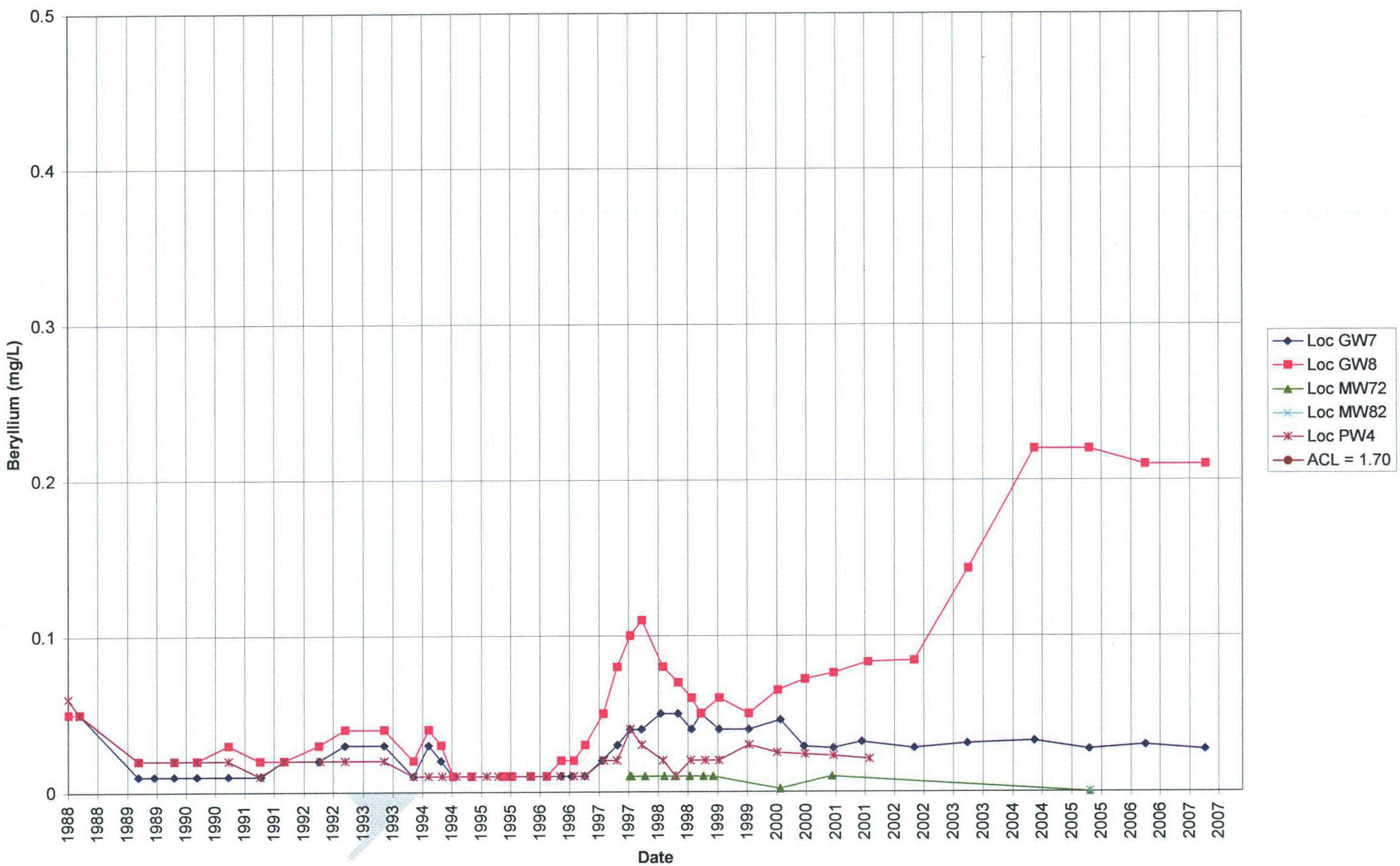


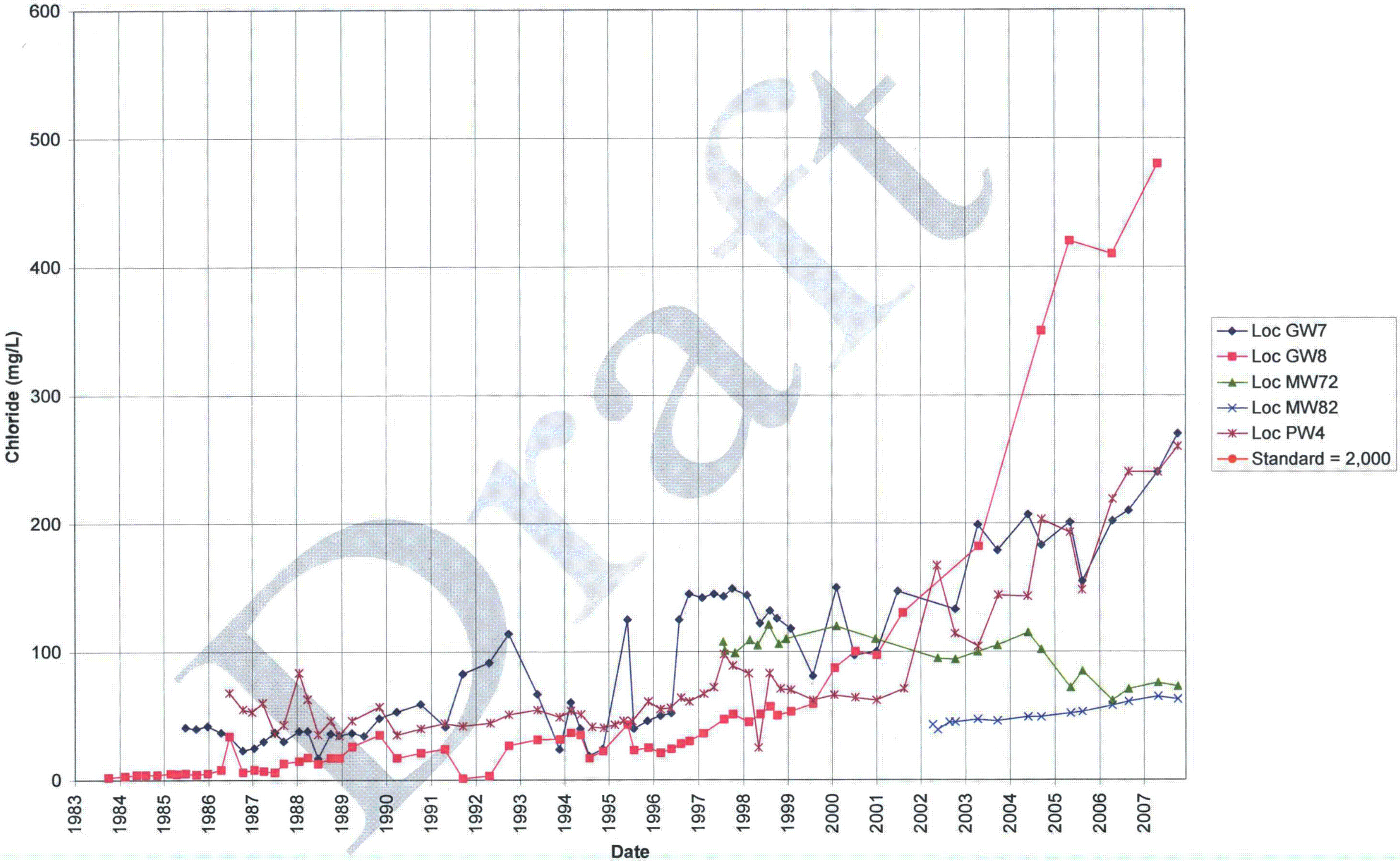
Time-Concentration Plots of Uranium in Groundwater within the Western Flow Regime at the Gas Hills East, Wyoming, Disposal Site



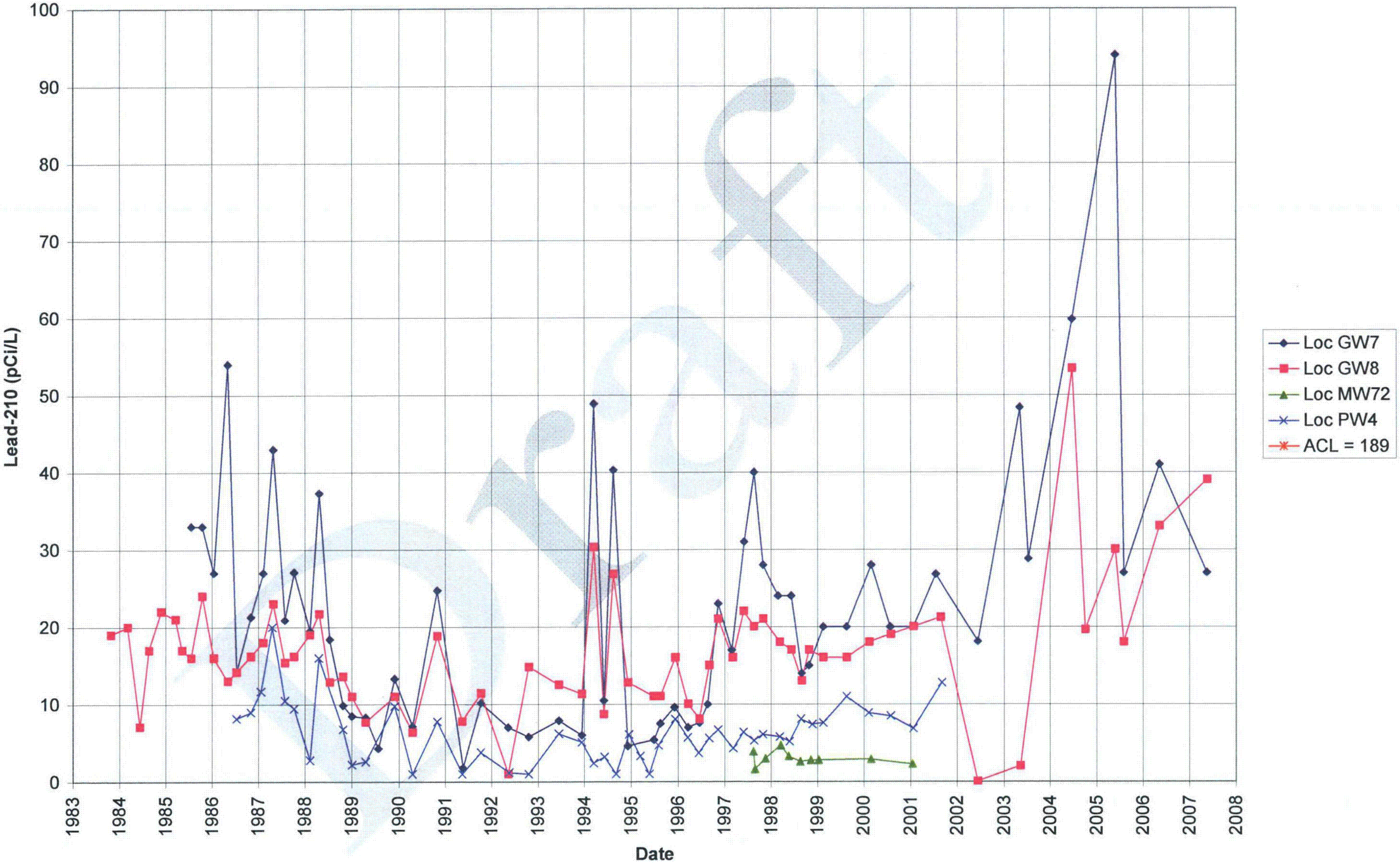
Time-Concentration Plots of Arsenic in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Beryllium in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Chloride in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



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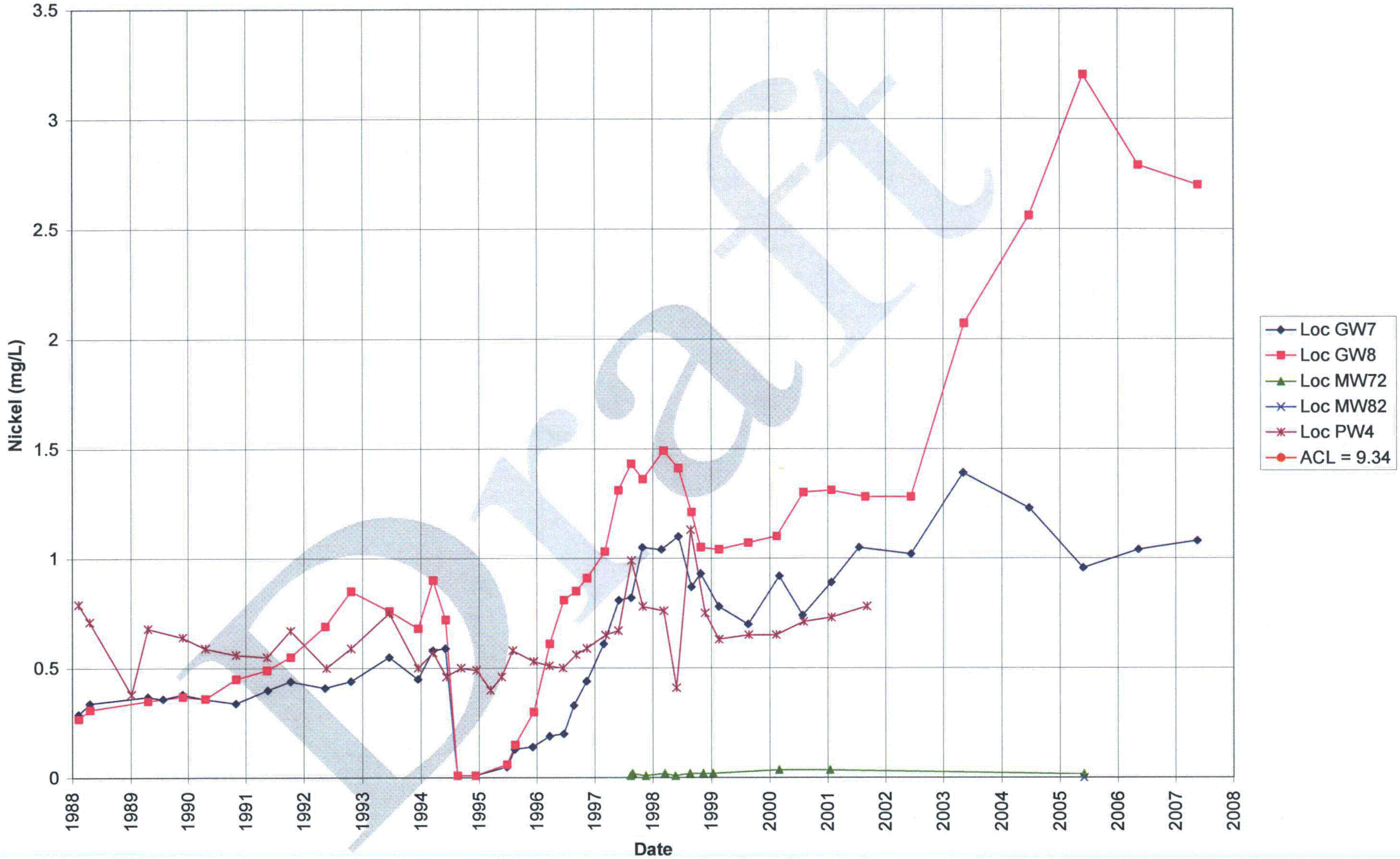
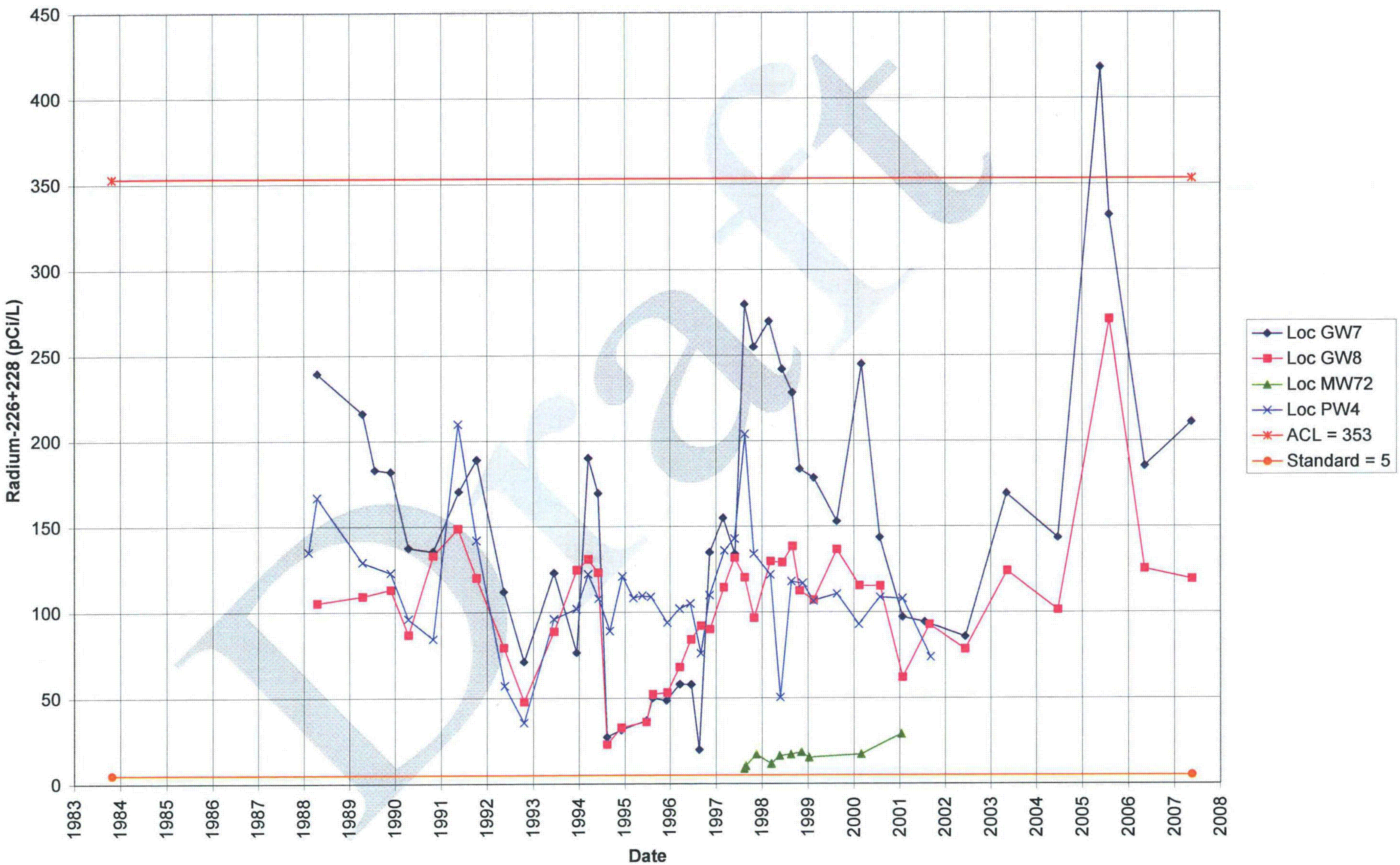
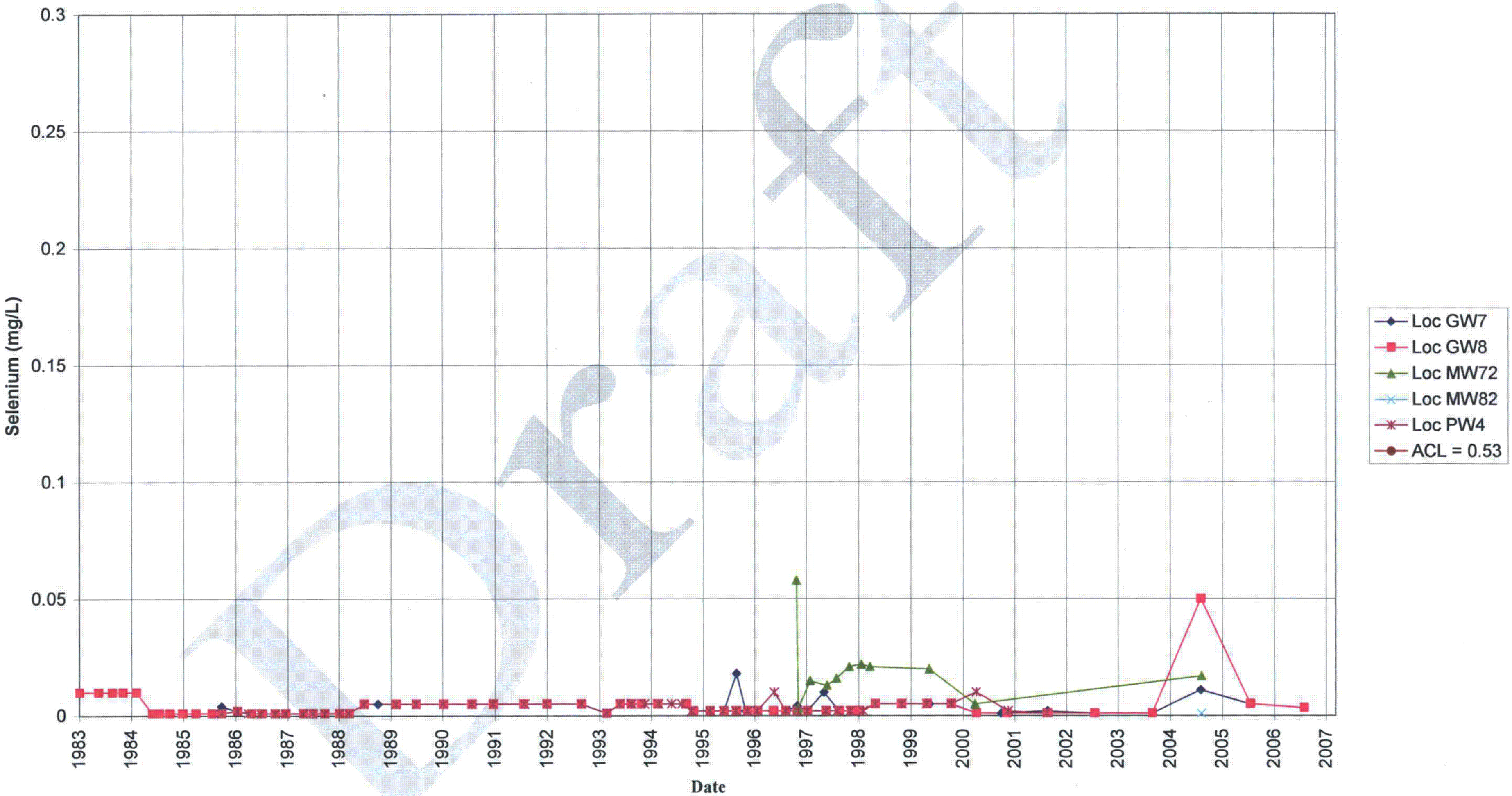


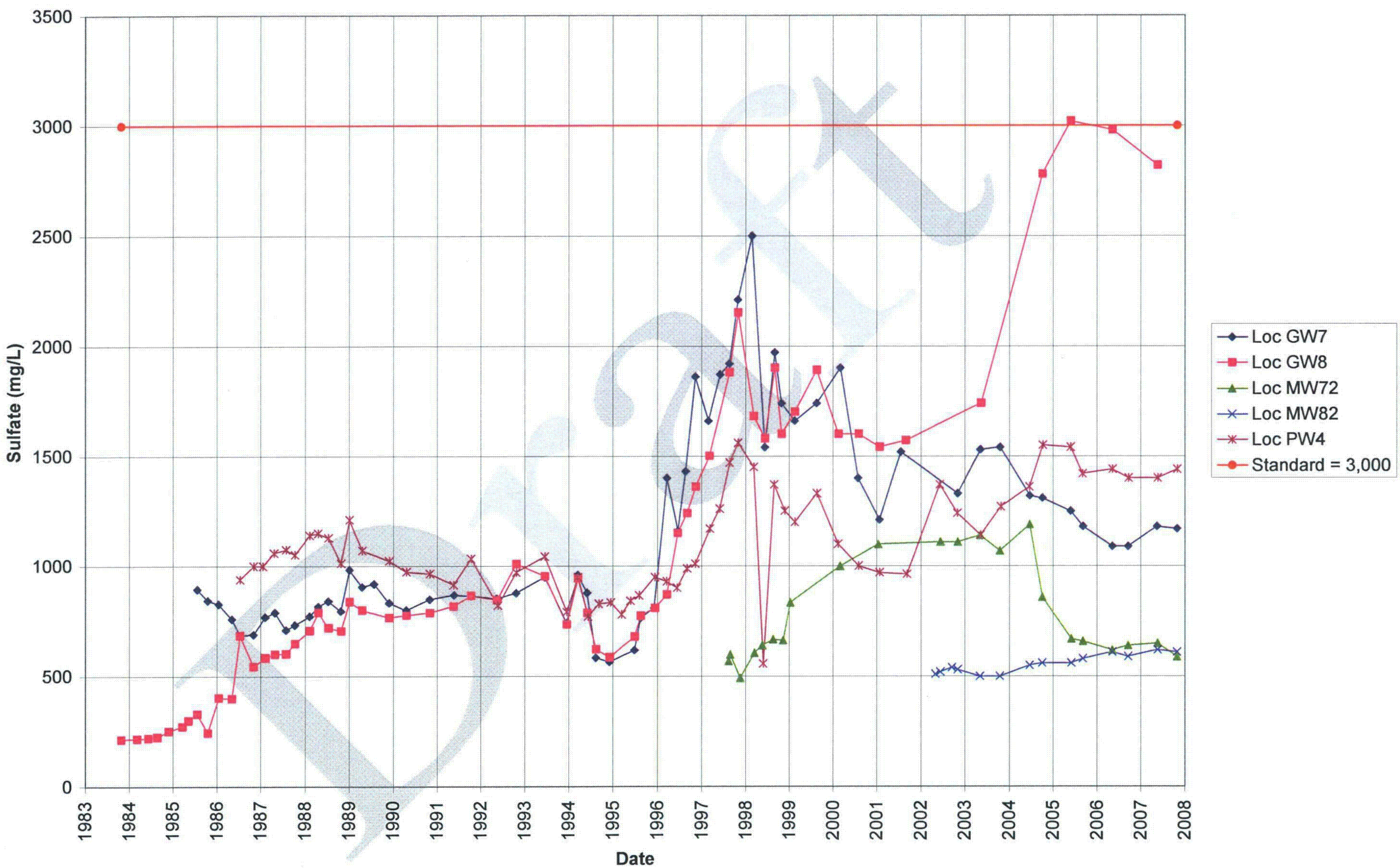
Time-Concentration Plots of Nickel in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



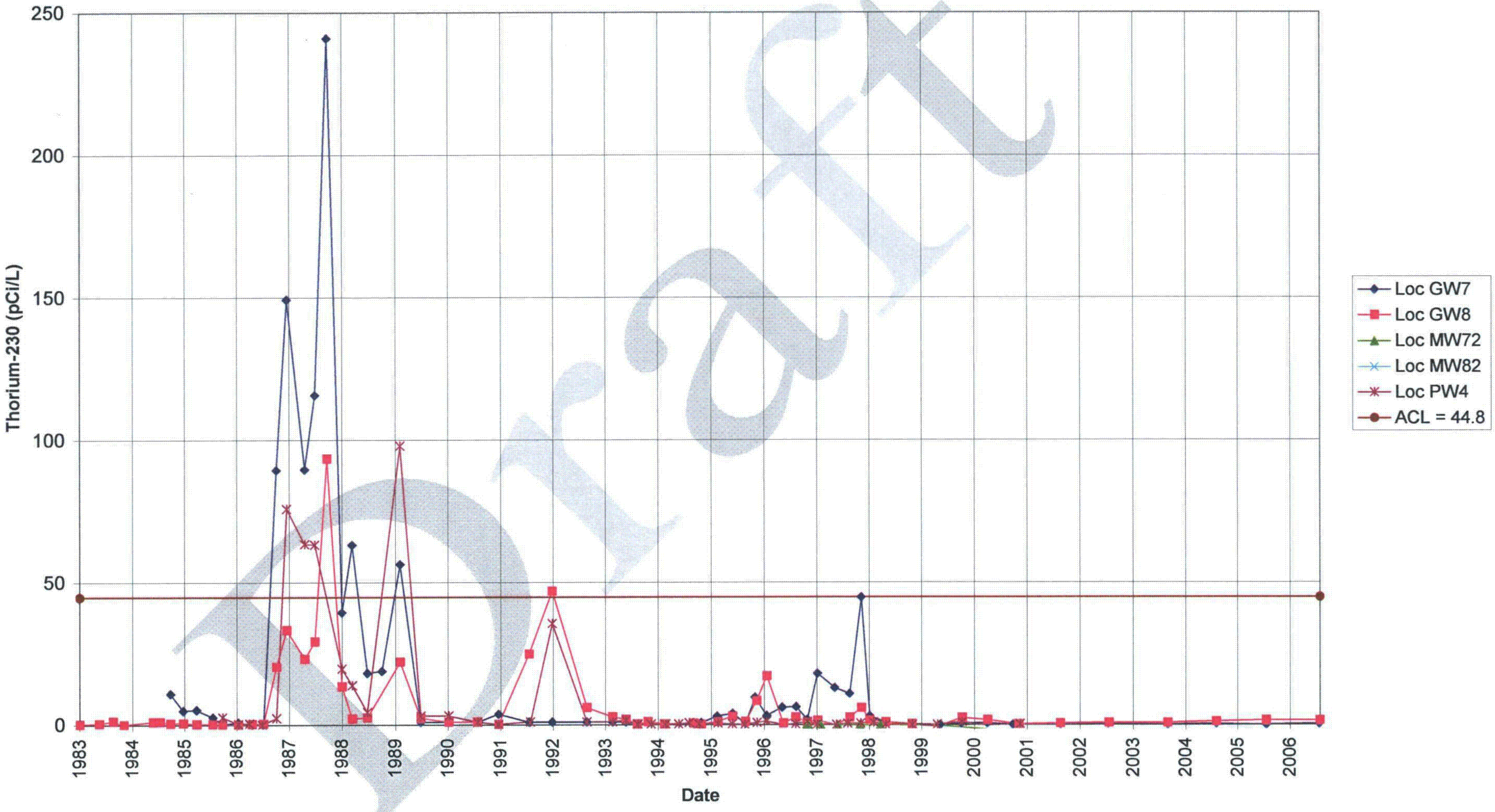
Time-Concentration Plots of Radium-226+228 in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



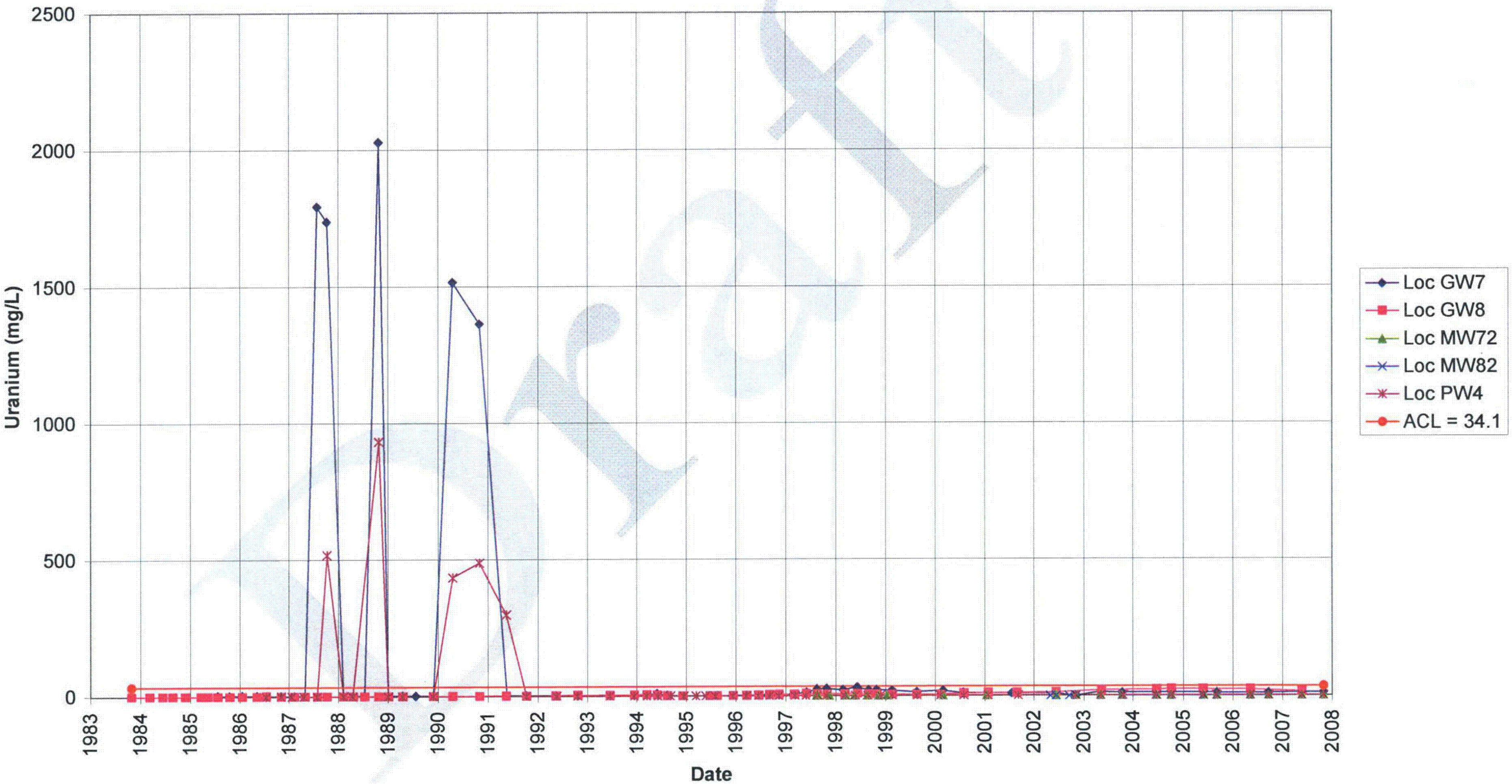
Time-Concentration Plots of Selenium in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Sulfate in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



Time-Concentration Plots of Thorium-230 in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site



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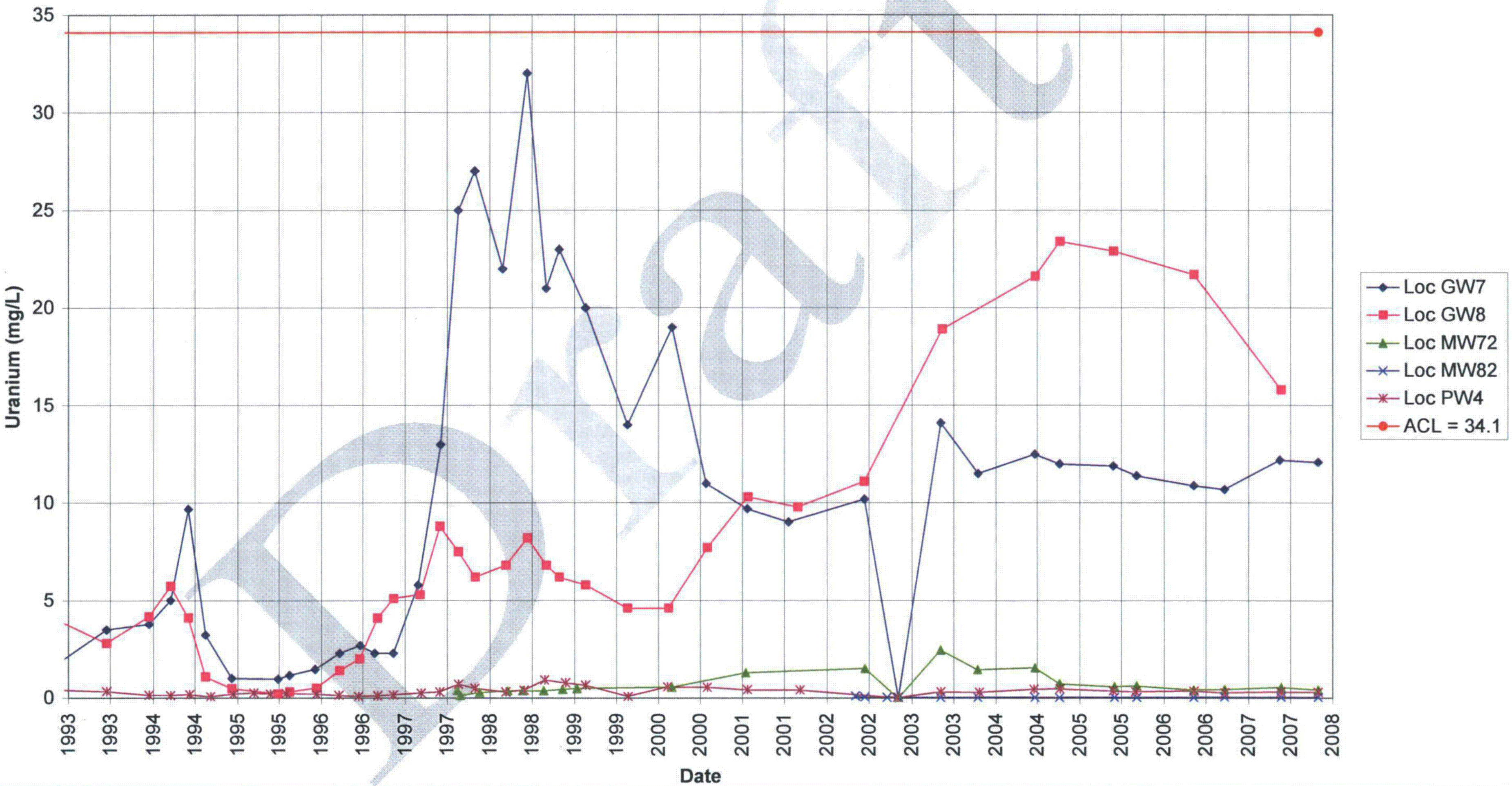

Time-Concentration Plots of Uranium in Groundwater within the Southwestern Flow Regime at the Gas Hills East, Wyoming, Disposal Site

NRC Acceptance Documentation

This documentation was added following acceptance of this Long-Term Surveillance Plan by the U.S. Nuclear Regulatory Commission

(to be inserted upon receipt)

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