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August 21, 2007

VIA FEDERAL EXPRESS

Mr. Dane L. Finerfrock
Executive Secretary
Utah Radiation Control Board
State of Utah Department of Environmental Quality
168 North 1950 West
Salt Lake City, UT 84114-4850

Re: White Mesa Mill-Preliminary Corrective Action Plan
State of Utah Notice of Violation and Groundwater Corrective Action Order
(UDEQ Docket No. UGO-20-01)(the "Order")

Dear Mr. Finerfrock,

Please find enclosed one printed copy and one electronic copy of the Preliminary Corrective Action Plan pertaining to the above-captioned UDEQ Order.

If you should have any questions regarding this matter, please contact me.

Yours very truly,

DENISON MINES (USA) CORP.
Steven D. Landau
Manager, Environmental Affairs

Cc Ron Hochstein
Harold Roberts
Dave Frydenlund
David Turk

PRELIMINARY CORRECTIVE ACTION PLAN
WHITE MESA URANIUM MILL
NEAR BLANDING, UTAH

Prepared for:

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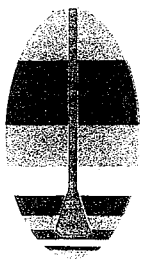
August 20, 2007



HYDRO GEO CHEM, INC.

Environmental Science & Technology

PRELIMINARY CORRECTIVE ACTION PLAN
WHITE MESA URANIUM MILL
NEAR BLANDING, UTAH

Prepared for:

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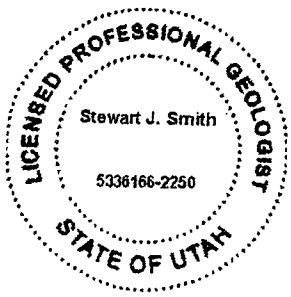

August 20, 2007

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1. INTRODUCTION, OVERVIEW, AND SCOPE

This document presents a Corrective Action Plan (CAP) to address chloroform contamination in a shallow perched groundwater zone beneath the White Mesa Uranium Mill Site (the site), located near Blanding, Utah. Figure 1 is a map of the site showing the locations of perched zone monitoring wells. The area of the perched groundwater zone affected by chloroform concentrations exceeding 70 µg/L is shown in Figure 2. The sources of the chloroform have been identified as two sanitary leach fields, abandoned more than 25 years ago, that accepted sanitary wastes and laboratory wastes containing chloroform. The chloroform was first discovered at perched well MW-4 in 1999. Since that time, 25 temporary perched zone wells have been installed to study and delineate the chloroform. An interim remedial action, consisting of pumping perched water containing high concentrations of chloroform from areas where the perched zone has a relatively high productivity, was initiated in 2003.

The elements of this document include the following items:

- CAP objectives
- A description of the site hydrogeology
- The nature and extent of chloroform in the perched zone and relation to source areas
- Ongoing interim remedial actions
- Proposed corrective remedial actions and concentration limits
- Proposed corrective action contingencies

2. OBJECTIVES

The objectives of the CAP include the following:

1) Minimize or prevent further downgradient migration of the chloroform plume by a combination of pumping and reliance on natural attenuation,

2) Prevent chloroform concentrations exceeding the action level from migrating south or southwest of the tailings cells,

3) Monitor to track changes in concentrations within the plume and to establish whether the plume boundaries are expanding, contracting, or stable,

4) Provide contingency plans to address potential continued expansion of the plume and the need for additional monitoring and/or pumping points, and

5) Ultimately reduce chloroform concentrations at all monitoring locations to the action level or below.

To achieve these objectives, the CAP proposes a phased approach. The first phase consists of a combination of "active" and "passive" strategies. The active strategy consists of removing chloroform mass as rapidly as practical by pumping areas that have (on a relative basis) both high chloroform concentrations, and high productivity. Continued monitoring within and outside the plume is considered part of the active strategy. The passive strategy consists of relying on natural attenuation processes to remove chloroform mass and reduce concentrations. Reductions in concentrations would be achieved by physical processes such as volatilization, hydrodynamic dispersion, and abiotic degradation, and through natural biological degradation of chloroform. These are essentially the same processes that have been relied upon in the interim action.

Natural attenuation is expected to reduce chloroform concentrations within the entire plume. However, within upgradient portions of the plume that occur in higher permeability materials that are amenable to pumping, direct mass removal via pumping will be the primary means to reduce concentrations. In downgradient portions of the plume where permeabilities are low, chloroform migration rates are low, and mass removal by pumping is not practical because achievable pumping rates would be very low, natural attenuation will be the primary means to reduce concentrations.

The second phase relies on natural attenuation (without pumping) to reduce chloroform concentrations at all monitoring locations to action levels once concentrations during Phase 1 are judged to be sufficiently low that Phase 2 will be effective. Corrective action strategies will be discussed in detail in Section 6.

3. BACKGROUND

The White Mesa Uranium Mill (the "Mill" or the "site") is located in southeastern Utah, approximately 5 miles south of the town of Blanding. It is situated on White Mesa, a flat area bounded on the east by Corral Canyon, to the west by Westwater Creek, and to the south by Cottonwood Canyon. The site consists of a uranium processing mill, and four engineered lined tailings disposal cells.

3.1 Site Hydrogeology

Titan, 1994 provides a detailed description of site hydrogeology based on information available at that time. A brief summary of site hydrogeology that is based on Titan, 1994, and that includes the results of more recent site investigations, is provided below.

3.1.1 Geologic Setting

The site is located within the Blanding Basin of the Colorado Plateau physiographic province. Typical of large portions of the Colorado Plateau province, the rocks underlying the site are relatively undeformed. The average elevation of the site is approximately 5,600 feet (ft) above mean sea level (amsl).

The site is underlain by unconsolidated alluvium and indurated sedimentary rocks consisting primarily of sandstone and shale. The indurated rocks are relatively flat lying with

dips generally less than 3°. The alluvial materials consist mostly of aeolian silts and fine-grained aeolian sands with a thickness varying from a few feet to as much as 25 to 30 ft across the site. In places, the alluvium is underlain by fine grained materials that have been interpreted as erosional remnants of the Mancos Shale. The alluvium (and Mancos, where present) is underlain by the Dakota Sandstone and Burro Canyon Formation, which are sandstones having a total thickness ranging from approximately 100 to 140 ft. Beneath the Burro Canyon Formation lies the Morrison Formation, consisting, in descending order, of the Brushy Basin Member, the Westwater Canyon Member, the Recapture Member, and the Salt Wash Member. The Brushy Basin and Recapture Members of the Morrison Formation, classified as shales, are very fine-grained and have a very low permeability. The Brushy Basin Member is primarily composed of bentonitic mudstones, siltstones, and claystones. The Westwater Canyon and Salt Wash Members also have a low average vertical permeability due to the presence of interbedded shales.

Beneath the Morrison Formation lie the Summerville Formation, an argillaceous sandstone with interbedded shales, and the Entrada Sandstone. Beneath the Entrada lies the Navajo Sandstone. The Navajo and Entrada Sandstones constitute the primary aquifer in the area of the site. The Entrada and Navajo Sandstones are separated from the Burro Canyon Formation by approximately 1,000 to 1,100 feet of materials having a low average vertical permeability. Groundwater within this system is under artesian pressure in the vicinity of the site, is of generally good quality, and is used as a secondary source of water at the site.

3.1.2 Hydrogeologic Setting

The site is located within a region that has a dry to arid continental climate, with average annual precipitation of less than 11.8 inches, and average annual evapotranspiration of approximately 61.5 inches. Recharge to aquifers occurs primarily along the mountain fronts (for example, the Henry, Abajo, and La Sal Mountains), and along the flanks of folds such as Comb Ridge Monocline.

Although the water quality and productivity of the Navajo/Entrada aquifer are generally good, the depth of the aquifer (approximately 1,200 feet below land surface [ft bls]) makes access difficult. The Navajo/Entrada aquifer is capable of yielding significant quantities of water to wells (hundreds of gallons per minute [gpm]). Water in wells completed across these units at the site rises approximately 800 feet above the base of the overlying Summerville Formation.

Perched groundwater in the Dakota Sandstone and Burro Canyon Formation is used on a limited basis to the north (upgradient) of the site because it is more easily accessible. Water quality of the Dakota Sandstone and Burro Canyon Formation is generally poor due to high total dissolved solids (TDS) and is used primarily for stock watering and irrigation. The saturated thickness of the perched water zone generally increases to the north of the site, increasing the yield of the perched zone to wells installed north of the site.

3.1.3 Perched Zone Hydrogeology

Perched groundwater beneath the site occurs primarily within the Burro Canyon Formation, but locally rises into the Dakota northeast of the tailings cells where saturated thicknesses are greater. Perched groundwater at the site has a generally low quality due to high total dissolved solids (TDS) in the range of approximately 1,200 to 5,000 milligrams per liter (mg/L), and is used primarily for stock watering and irrigation in the areas upgradient (north) of the site. Perched water is supported within the Burro Canyon Formation by the underlying, fine-grained Brushy Basin Member of the Morrison Formation. Figure 3 is a contour map showing the approximate elevation of the contact of the Burro Canyon Formation with the Brushy Basin Member, which essentially forms the base of the perched water zone at the site. Contact elevations are based on perched monitoring well lithologic logs and surveyed land surface elevations. As indicated, the contact generally dips to the south/southwest beneath the site.

Groundwater within the perched zone generally flows south to southwest beneath the site. Beneath the tailings cells at the site, perched water flow is generally southwest to south-southwest. East of the tailings cells, perched water flow is more southerly.

3.1.3.1 Lithologic and Hydraulic Properties

Although the Dakota Sandstone and Burro Canyon Formations are often described as a single unit due to their similarity, previous investigators at the site have distinguished between them. The Dakota Sandstone is a relatively-hard to hard, generally fine-to-medium grained

sandstone cemented by kaolinite clays. The Dakota Sandstone locally contains discontinuous interbeds of siltstone, shale, and conglomeratic materials. Porosity is primarily intergranular. The underlying Burro Canyon Formation hosts most of the perched groundwater at the site. The Burro Canyon Formation is similar to the Dakota Sandstone but is generally more poorly sorted, contains more conglomeratic materials, and becomes argillaceous near its contact with the underlying Brushy Basin Member. The permeability of the Dakota Sandstone and Burro Canyon Formation at the site is generally low.

No significant joints or fractures within the Dakota Sandstone or Burro Canyon Formation have been documented in any wells or borings installed across the site. This was the conclusion of Knight Piésold, 1998, and HGC, 2001, and is consistent with findings provided in HGC, 2005. Any fractures observed in cores collected from site borings are typically cemented, showing no open space.

3.1.3.1.1 Dakota

Based on samples collected during installation of wells MW-16 (no longer used) and MW-17, located immediately downgradient of the tailings cells at the site, porosities of the Dakota Sandstone range from 13.4% to 26%, averaging 20%, and water saturations range from 3.7% to 27.2%, averaging 13.5%. The average volumetric water content is approximately 3%. The permeability of the Dakota Sandstone based on packer tests in borings installed at the site ranges from 2.71 x 10^{-6} centimeters per second (cm/s) to 9.12 x 10^{-4} cm/s, with a geometric average of 3.89 x 10^{-5} cm/s (Titan, 1994).

3.1.3.1.2 Burro Canyon

The average porosity of the Burro Canyon Formation is similar to that of the Dakota Sandstone. Based on samples collected from the Burro Canyon Formation at MW-16 (no longer used), located immediately downgradient of the tailings cells at the site, Titan, 1994, reported that porosity ranges from 2% to 29.1%, averaging 18.3%, and water saturations of unsaturated materials range from 0.6% to 77.2%, averaging 23.4%. Titan, 1994, reported that the hydraulic conductivity of the Burro Canyon Formation ranges from 1.9×10^{-7} to 1.6×10^{-3} cm/s, with a geometric mean of 1.1×10^{-5} cm/s, based on the results of 12 pumping/recovery tests performed in monitoring wells and 30 packer tests performed in borings prior to 1994.

Hydraulic testing of wells MW-01, MW-03, MW-05, MW-17, MW-18, MW-19, MW-20, and MW-22 during the week of July 8, 2002, and newly installed wells MW-23, MW-25, MW-27, MW-28, MW-29, MW-30, MW-31, MW-32, TW4-20, TW4-21, and TW4-22 during June, 2005, yielded average perched zone permeabilities ranging from approximately 2×10^{-7} cm/s to 5×10^{-4} cm/s, similar to the range reported by previous investigators at the site (Hydro Geo Chem, Inc [HGC], 2002; HGC, 2005). Downgradient (south to southwest) of the tailings cells, average perched zone permeabilities based on tests at MW-3, MW-5, MW-17, MW-20, MW-22, and MW-25 ranged from approximately 4×10^{-7} to 1×10^{-4} cm/s Permeability estimates from these tests were based on pumping/recovery and slug tests analyzed using several different methodologies. Permeability estimates from these tests are summarized in Table 1.

25 temporary perched zone monitoring wells have been installed at the site to investigate elevated concentrations of chloroform initially discovered at well MW-4 in 1999. The

occurrence of chloroform in the perched zone will be discussed in Sections 3.3 and 4. Some of the coarser grained and conglomeratic zones encountered within the perched zone during installation of these wells are believed to be continuous with or at least associated with a relatively thin, relatively continuous zone of higher permeability (International Uranium [USA] Corporation [IUSA] and HGC, 2001).

The higher permeability zone defined by these wells is generally located east to northeast of the tailings cells at the site, and is hydraulically cross-gradient or upgradient of the tailings cells with respect to perched groundwater flow. Based on analyses of pumping tests at MW-4 and drilling logs from nearby temporary wells, the permeability of this relatively thin coarser-grained zone was estimated to be as high as 2.5×10^{-3} cm/s or 7 ft/day. Relatively high average permeabilities estimated at MW-11, located on the southeastern margin of the downgradient edge of tailings cell #3, and at MW-14, located on the downgradient edge of tailings cell #4, of 1.4×10^{-3} cm/s and 7.5×10^{-4} cm/s, respectively (UMETCO, 1993), may indicate that this zone extends beneath the southeastern margin of the cells. However, this zone of higher permeability within the perched water zone does not appear to exist downgradient (south-southwest) of the tailings cells. At depths beneath the perched water table, the zone is not evident in lithologic logs of the southernmost temporary wells TW4-4 and TW4-6 (located east [cross-gradient] of cell #3), nor is it evident in wells MW-3, MW-5, MW-12, MW-15, MW-16 (no longer used), MW-17, MW-20, MW-21, or MW-22, located south to southwest (downgradient) of the tailings cells, based on the lithologic logs or hydraulic testing of the wells. The apparent absence of the zone south of TW4-4 and south-southwest of the tailings cells indicates that it "pinches out" (HGC, 2005).

To test the potential existence and continuity of this higher permeability zone, and to refine hydraulic parameter estimates, long term pumping of MW-4 and TW4-19 began in April 2003. MW-26 (TW4-15) was added to the pumping network in August 2003, and TW4-20 was added in August, 2005. These wells were selected for pumping because they were 1) located in areas of the perched zone having relatively high transmissivity, and could therefore sustain relatively high pumping rates, and 2) because the wells were also located in perched water having relatively high chloroform concentrations, which resulted in significant rates of chloroform mass removal. As such, the pumping has constituted an interim action to mitigate chloroform in the perched zone (HGC, 2004).

Analysis of drawdown data collected from wells that responded measurably to pumping between the start of pumping (April 2003) and November 2003, indicated average permeabilities ranging from 4×10^{-5} to 5×10^{-4} cm/s in the area east to northeast of the tailings cells, assuming the perched zone is unconfined (HGC, 2004). Table 2 summarizes the results of the testing. Figure 4 shows the approximate area where detectable drawdowns were measured during the 7 months of pumping. This area is interpreted to coincide roughly with the zone of higher permeability. Wells located outside this zone that did not respond measurably to pumping are interpreted to be completed in lower permeability materials.

3.1.3.2 Perched Groundwater Flow

Perched groundwater flow at the site has historically been to the south/southwest. Figures 5 through 8 are perched groundwater elevation contour maps for the years 1990, 1994, 2002, and the first quarter of 2007, respectively. The 1990, 1994, and 2002 maps were hand contoured because of sparse data. As groundwater elevations indicate, the perched groundwater gradient changes from generally southwesterly in the western portion of the site, to generally southerly in the eastern portion of the site. The most significant changes between the 2002 and 2007 water levels result from pumping of wells MW-4, TW4-19, TW4-20, and MW-26 (TW4-15). These wells are pumped to reduce chloroform mass in the perched zone east and northeast of the tailings cells. (Chloroform occurrence in the perched zone will be discussed in Sections 3.3 and 4.)

In general, perched groundwater elevations have not changed significantly over most of the site since monitoring began, except in the vicinity of the wildlife ponds and the pumping wells. For example, relatively large increases in water levels occurred between 1994 and 2002 at MW-4 and MW-19, located in the east and northeast portions of the site, as shown by comparing Figures 6 and 7. These water level increases in the northeastern and eastern portions of the site are likely the result of seepage from wildlife ponds located near the piezometers shown in Figures 7 and 8, which were installed in 2001 for the purpose of investigating these changes. Increasing water levels affect many of the chloroform investigation wells as shown in the hydrographs provided in Appendix A (from Denison Mines (USA) Corp [DUSA], 2007).

The increases in water levels in the northeastern portion of the site have resulted in locally steepening groundwater gradients over portions of the site. Conversely, pumping of wells MW-4, TW4-19, TW4-20, and MW-26 (TW4-15) has depressed the perched water table locally and reduced average hydraulic gradients to the south and southwest of these wells. Perched zone hydraulic gradients currently range from a maximum of approximately 0.05 ft/ft east of tailings cell #2 to approximately 0.01 ft/ft downgradient of cell #3, between cell #3 and MW-20.

Perched water discharges in springs and seeps along Westwater Creek Canyon and Cottonwood Canyon to the west-southwest of the site, and along Corral Canyon to the east of the site, where the Burro Canyon Formation outcrops. The discharge point located most directly downgradient of the tailings cells is Ruin Spring. This feature is located approximately 10,000 feet south-southwest of the tailings cells at the site and is depicted on the USGS 7.5-minute quad sheet for Black Mesa (Figure 9).

The average hydraulic gradient between the downgradient edge of tailings cell #3 and Ruin Spring is approximately 0.12 ft/ft assuming the following:

1) The elevation of Ruin Spring, based on the USGS topographic map for Black Mesa, is approximately 5,390 ft amsl.

2) The distance between the downgradient edge of tailings cell #3 and Ruin Spring is approximately 10,000 ft.

3) The average groundwater elevation at the downgradient edge of tailings cell #3 is approximately 5,510 ft amsl.

3.1.3.3 Saturated Thickness

The saturated thickness of the perched zone as of the first quarter of 2007 ranges from approximately 93 ft in the northeastern portion of the site to less than 5 ft in the southwest portion of the site (Figure 10), and depths to water range from approximately 14 ft in the northeastern portion of the site (adjacent to the wildlife ponds) to approximately 114 ft at the southwest margin of tailings cell #3 (Figure 11). The relatively large saturated thicknesses in the northeastern portion of the site are likely related to seepage from wildlife ponds located near the piezometers shown in Figure 10.

Although sustainable yields of as much as 4 gpm have been achieved in wells intercepting the larger saturated thicknesses and higher permeability zones in the northeast portion of the site, perched zone well yields are typically low (<0.5 gpm) due to the generally low permeability of the perched zone. Sufficient productivity can generally be obtained only in areas where the saturated thickness is greater, which is the primary reason that the perched zone has been used on a limited basis as a water supply to the north (upgradient) of the site, but not downgradient of the site.

3.1.3.4 Perched Groundwater Travel Times

Average rates of movement of a conservative solute in perched groundwater (equivalent to interstitial or pore velocity) have been calculated for the area of the perched zone downgradient of the tailings cells, and beneath and immediately upgradient of the tailings cells (HGC, 2005 and HGC, 2007).

The calculated rate of movement downgradient of the tailings cells was based on an effective porosity of 0.18, an average hydraulic gradient of 0.012 ft/ft, and geometric averages of permeabilities estimated from hydraulic tests at wells located south and southwest of the cells. The geometric averages were based on slug tests performed at MW-3, MW-5, MW-17, MW-20, MW-22, and MW-25 (HGC, 2002; HGC, 2005), and pump tests performed by Peel Environmental (UMETCO, 1993) at MW-11, MW-12, MW-14, and MW-15. Two averages were calculated; one using permeabilities estimated from HGC slug test data analyzed using the Bouwer-Rice solution (Bouwer and Rice, 1976) and the other using permeabilities estimated from the same data using the KGS solution (Hyder, 1994). Included in each average were the results of the pump tests reported in UMETCO, 1993, for MW-11, MW-12, MW-14, and MW-15. The geometric averages thus calculated were 2.3×10^{-5} and 4.3×10^{-5} cm/s. Assuming the average permeability ranges from 2.3×10^{-5} to 4.3×10^{-5} cm/s (0.064 ft/day to 0.120 ft/day), the calculated average rate of movement ranges from 0.0043 ft/day to 0.0080 ft/day (or 1.6 ft/year to 2.9 ft/year).

Beneath and immediately upgradient of the tailings cells, using hydraulic gradients in the vicinity of each well, the estimated permeability at each well, and an effective porosity of 0.18, the estimated pore velocities ranged from 49.5 ft/year at TW4-21, to 0.010 ft/year at MW-23 (HGC, 2005), and have a geometric average of approximately 4.5 ft/year. Wells with relatively high calculated pore velocities, such as TW4-21, likely penetrate the relatively thin, coarser-grained, higher permeability zone discussed in Section 3.1.3.1.2, that is interpreted to "pinch

out" to the south and southwest, and does not appear to be present south of TW4-4 or south or southwest of the tailings cells.

3.2 Chloroform Occurrence

Chloroform was detected in monitoring well MW-4 during groundwater split sampling conducted on May 11, 1999. The results of the sampling and analyses indicated chloroform concentrations of 4,520 and 4,700 µg/L. As a result of the chloroform detection, the Utah Department of Environmental Quality (UDEQ) issued a Notice of Violation and groundwater Corrective Action Order (the "Order") dated August 23, 1999.

Subsequent investigation has included the installation of 25 temporary perched zone monitoring wells to delineate and monitor the chloroform (Figure 1). Chloroform concentrations in the perched zone as of the first quarter of 2007 are shown in Figure 12. Chloroform concentrations in the perched zone have ranged from non-detect to a maximum of 61,000 µg/L at well TW4-20 in the second quarter of 2006. The chloroform concentration at TW4-20 has fluctuated, and was 4,400 µg/L as of the first quarter of 2007. Chloroform concentrations at the most downgradient well, TW4-6, were non-detect for approximately 5 years, became detectable in the second quarter of 2005, and have been slowly increasing but have not exceeded 70 µg/L as of the first quarter of 2007.

Compounds associated with the chloroform include methylene chloride (DCM), chloromethane (CM), and nitrate. DCM and CM have been detected sporadically in chloroform

investigation wells at low concentrations (typically a few µg/L). Nitrate concentrations in chloroform investigation wells range from non-detect to the low mg/L range (typically < 10 mg/L, but have exceeded 10 mg/L at some locations near source areas).

3.2.1 Source Areas

Investigation of potential source areas for the chloroform included a soil gas survey conducted in September 1999 (HGC, 1999). Detectable chloroform concentrations were measured in two suspected source areas; 1) the abandoned scale house leach field located approximately 1,100 ft north (upgradient) of MW-4, and 2) the former office leach field, located immediately southeast of the office building and immediately north-east of tailings cell #2 (Figure 13). These leach fields, abandoned more than 25 years ago, were known to have accepted sanitary wastes as well as laboratory wastes containing chloroform at quantities sufficient to have resulted in the measured groundwater concentrations.

Discussions of the results of the soil gas survey and the identification of the abandoned scale house leach field as the most likely source of the chloroform detected at MW-4 are provided in IUSA and HGC, 2000. The former office leach field is considered the most likely source of the chloroform detected immediately northeast and upgradient of tailings cell #2.

In general, the leach-field origin of the chloroform is supported by the following factors:

1) The leach fields are upgradient of the chloroform contamination,

2) Based on records of chloroform used in the laboratory, sufficient chloroform was disposed in the leach fields to result in the measured groundwater concentrations,

3) Elevated nitrate is associated with the chloroform, and

4) The leach fields were designed to infiltrate water rapidly, which would reduce travel times to the perched water through the vadose zone.

An additional conclusion based on the low soil gas chloroform concentrations detected was that a significant residual vadose zone source does not exist in either source area (HGC, 1999). The association of nitrate with the chloroform is discussed in IUSA and HGC, 2001.

3.2.2 Chloroform Concentration Trends

Appendix B contains graphs of chloroform concentrations over time at the chloroform investigation wells (from DUSA, 2007). The chloroform investigation wells include MW-4, MW-26 (TW4-15), MW-32 (TW4-17), and the TW4-series wells. As indicated, within the last few years, chloroform concentrations at most of the wells have been decreasing. Concentrations at some of the wells, for example TW4-20, have fluctuated substantially, even though concentrations at this well have been on a general downward trend during the last few quarters. Historically, the highest chloroform concentrations have been detected near MW-4 and TW4-19. The highest detected concentration was 61,000 µg/L at TW4-20 in the second quarter of 2006. As of the first quarter of 2007, the chloroform concentration at TW4-20 was 4,400 µg/L. TW4-20 is located immediately downgradient of TW4-19 and the former office leach field source area. The highest detected concentration near MW-4 was 6,300 µg/L during the second quarter of 2001. As of the first quarter of 2007, the chloroform concentration at MW4 was 2,900 µg/L. MW-4 is located downgradient of the abandoned scale house leach field source area. MW-4,

MW-26 (TW4-15), TW4-19, and TW4-20 are all pumping chloroform laden water as part of the interim remedial action for the site.

The general reduction in chloroform concentrations within the plume over the last 2 years is illustrated in Tables 3, 4, and 5. Table 3 compares chloroform concentrations from the first quarter, 2007 with concentrations from the second quarter of 2005. Table 4 compares concentrations from the first quarter, 2007 with concentrations from the second quarter, 2006. Table 5 compares average concentrations over the four quarters from second quarter, 2006 to first quarter, 2007 with average concentrations over the four quarters from second quarter, 2005 to first quarter, 2006. Only wells with consistently detectable concentrations are included in these Tables.

Between the second quarter, 2005 and first quarter, 2007 (Table 3), 11 wells decreased in concentration, 4 increased, and 1 remained the same. Between the second quarter, 2006, and the first quarter, 2007, 11 wells decreased in concentration, and 5 increased. Using the averages (Table 5), 10 wells decreased in concentration, and 6 increased. These comparisons indicate that despite short term fluctuations, chloroform concentrations within most of the plume area are decreasing. This decrease is attributed to mass removal by pumping and natural attenuation.

3.2.3 Chloroform Mass Removal Rates

The interim action, which has included pumping of MW-4, MW-26 (TW4-15), TW4-19, and TW4-20, has resulted in substantial removal of chloroform mass from the perched zone.

Chloroform mass removal rates and the cumulative mass removed can be estimated using the cumulative pumped volumes for each well and the average chloroform concentrations over the pumping period. Based on DUSA, 2007, during the first quarter of 2007, the approximate total volumes of water pumped were 81,230 gallons from MW-4; 54,400 gallons from MW-26; 605,400 gallons from TW4-19; and 163,520 gallons from TW4-20. Since the start of pumping, the total approximate volumes of water pumped were 1,307,110 gallons from MW-4; 930,510 gallons from MW-26; 6,768,986 gallons from TW4-19; and 642,290 gallons from TW4-20.

Using first quarter, 2007, chloroform concentrations, and the first quarter pumped volumes, chloroform mass removal rates were approximately 0.15 lbs/day (pounds per day), and the total chloroform removed within the quarter was approximately 13.6 lbs or 1.1 gallons. Since pumping began, using the total pumped volumes and average chloroform concentrations of 3,370 µg/L for MW-4, 1,660 µg/L for MW-26, 2,660 µg/L for TW4-19, and 16,240 µg/L for TW4-20, an estimated 283 lbs, or 23 gallons of chloroform have been removed by pumping from the perched zone. Average chloroform concentrations used in the above calculations are the averages of all chloroform analytical results for each well during each well's pumping period.

The total amount of chloroform estimated to remain in the plume is approximately 650 lbs or 52 gallons. This estimate is based on the first quarter, 2007 saturated thicknesses (Figure 10), and the average chloroform concentrations from the second quarter of 2006 to the first quarter of 2007. Average chloroform concentrations were used because of the large fluctuations in concentrations measured at pumping well TW4-20. The total amount estimated to have been removed by pumping is approximately 44 % of the estimated amount remaining. Assuming that

no natural attenuation of chloroform has occurred, the total amount that entered the perched zone can be approximated as the sum of the estimated amounts pumped and remaining, or approximately 75 gallons. The total removed by pumping would then be approximately 30 % of the initial amount. The actual percentage of the initial amount removed by pumping may be somewhat less than 30 % because natural attenuation of chloroform, in particular biodegradation of chloroform as discussed in Appendix C, has likely been a significant mass removal mechanism. Accounting for natural attenuation would increase the estimate of the initial chloroform mass in the perched zone. Regardless of the mass reduction contributed by natural attenuation, the amount of chloroform removed by pumping has been significant.

4. CHARACTERIZATION OF STUDY AREA

The study area encompasses an area in the northeastern portion of the site where the chloroform plume has been detected and bounded by a series of chloroform investigation wells. These include wells MW-4 and MW-26 (TW4-15), and temporary wells TW4-1 through TW4-25. Characterization of the study area has been based on data collected from MW-4, MW-4A, MW-26 (TW4-15), and TW4-1 through TW4-22. Wells TW4-23, TW4-24, and TW4-25 were installed in May, 2007 to refine the boundaries of the plume and will require recovery time before representative water level and analytical data can be collected. The extent and hydrogeology of the study area is discussed below. Sources of the chloroform plume, and trends in water levels and chloroform concentrations within the study area are discussed in Section 3.2.

4.1 Extent

The study area includes the region of the perched zone containing chloroform concentrations exceeding 70 µg/L, and the immediately surrounding area. The area containing chloroform exceeding 70 µg/L, as of the first quarter of 2007, is shown in Figure 12. This area is located east and northeast (cross- and up-gradient) of the tailings cells. As discussed in section 3, the highest chloroform concentrations have historically been detected near MW-4 and TW4-19, in areas downgradient of the source areas.

The chloroform plume, as defined by the 70 µg/L concentration boundary, is bounded to the south by TW4-6 and MW-32, and to the east by TW4-3, TW4-5, TW4-8, TW4-9, TW4-13,

TW4-14, and TW4-18. The southern half of the plume is bounded to the west by MW-32 and TW4-16. The northern half of the plume is bounded to the south and southwest by MW-31 and is somewhat poorly bounded to the north by MW-27 and to the west by MW-28. Wells TW4-23, TW4-24, and TW4-25 (Figure 1) were installed in May, 2007, to refine the limits of the plume to the south, west, and north, respectively. Some time will be required for recovery of these wells before analytical results can be considered representative.

4.2 Hydrogeology

A description of the hydrogeology of the site in the vicinity of the chloroform plume is provided in Section 3.2. In general, the chloroform plume is associated with a region of relatively high perched zone permeabilities. This region is generally defined by wells that responded measurably to pumping at MW-4, MW-26 (TW4-15), and TW4-19 during the first 7 months of the interim remedial action (long-term pumping test) (Figure 4). Most of the detected chloroform is considered to be within higher permeability materials because most of the detections have been in wells that responded to the long term pumping. To the south, in the downgradient portion of the plume, the chloroform is considered to have migrated into lower permeability materials near TW4-4 and TW4-6. The chloroform detected at TW4-11 is also considered to be located within lower permeability materials. TW4-4, TW4-6, and TW4-11 are all wells that did not respond measurably during the first 7 months of long term pumping.

Perched groundwater flow in the area of the chloroform plume ranges from south westerly in the western portion of the study area to southerly in the eastern portion of the area.

Saturated thicknesses in the study area are generally higher than in areas to the south and southwest. As shown in Figure 10 they range from a maximum of approximately 84 ft at TW4-18 to approximately 22 ft at TW4-6. TW4-6 is the most downgradient temporary chloroform investigation well. At TW4-14 (east of TW4-6), the perched zone apparently pinches out, with saturated thicknesses of only a few feet. In general, saturated thicknesses increase toward the northeast, where the wildlife ponds are located, and are locally affected by pumping at MW-4, MW-26 (TW4-15), TW4-19, and TW4-20.

Average permeabilities within the general area of the chloroform plume based on analysis of drawdowns from wells that responded to the first 7 months of pumping (HGC, 2004) ranged from approximately 4×10^{-5} to 5×10^{-4} cm/s, and have a geometric average of 1×10^{-4} cm/s, assuming unconfined conditions, as discussed in Section 3. Estimated average permeabilities near TW4-19 were approximately five times higher than those near MW-4 (HGC, 2004). Estimated storage coefficients indicated that on average the perched zone in this area is unconfined but approaches conditions intermediate between confined and unconfined, and may be confined locally. The combination of relatively high permeability and relatively large saturated thickness in the northern and central portions of the area make the productivity of the perched zone high in these areas. Sustainable pumping rates of as much as about 4 gpm allow relatively high chloroform mass removal rates at the existing pumping wells.

The range in estimated perched zone permeabilities in the vicinity of the chloroform plume, which are representative of the higher permeability zone, are one to two orders of magnitude greater than estimates for areas downgradient of the chloroform plume and the

tailings cells. This reduction in permeability to the south and southwest is interpreted as a "pinching out" of a coarser-grained, higher permeability zone identified during installation of many of the temporary wells (HGC, 2005). The pinching out of this zone is important in limiting the rate of downgradient migration of chloroform, in stabilizing the plume boundaries, and in allowing natural attenuation to be more effective in limiting plume migration. The combination of relatively high permeability and relatively large saturated thickness in the upgradient portions of the plume that make the productivity of the perched zone high and allow relatively high chloroform mass removal rates, is absent at downgradient wells such as TW4-4 and TW4-6. The combination of relatively low permeability and small saturated thickness near these downgradient wells makes pumping at these wells impractical.

5. CORRECTIVE ACTION CONCENTRATION LIMITS

The corrective action concentration limit for chloroform is 70µg/L. This concentration is considered to bound the outer extent of the plume and is the ultimate target for reducing chloroform concentrations within the plume. As discussed in Section 9, once the chloroform concentrations in all chloroform monitoring wells are 70µg/L or less, concurrence with UDEQ will be sought that the plume is remediated and the corrective action complete.

6. CORRECTIVE ACTION PLAN – CONSTRUCTION AND OPERATION

The corrective action for the site is proposed to occur in two phases. The first phase (Phase 1) will essentially be a continuation of the currently implemented interim action for the site, with specified contingencies. Phase 1 relies on both pumping and natural attenuation to remove chloroform mass, reduce chloroform concentrations within the plume, and minimize or prevent plume migration. Included in Phase 1 are continued monitoring within and outside the plume to verify plume boundaries (as defined by a concentration of 70 µg/L), estimate changes in hydraulic capture, and track changes in chloroform concentrations within the plume.

The second phase (Phase 2) will rely only on natural attenuation to reduce residual chloroform concentrations within the plume to 70µg/L or less, and monitoring to verify plume boundaries and track changes in concentrations within the residual plume. Once residual concentrations have dropped to 70µg/L or less at all monitored locations, concurrence with UDEQ will be sought that the corrective action is complete. Both Phase 1 and Phase 2 have contingencies to be implemented if needed based on monitoring as discussed in Section 7. The termination of Phase 1 and implementation of Phase 2 will be with the concurrence of UDEQ and will be based on data collected as part of the routine monitoring during Phase 1, and quantitative calculations that may include the use of numerical models. These calculations will consider residual chloroform concentrations, natural attenuation rates, and expected chloroform migration rates in the absence of pumping.

An important goal of Phase 2 is to manage Phase 1 and to implement Phase 2 such that chloroform concentrations exceeding the action level will not migrate into the area south or

southwest of the tailings impoundments within 200 years. As discussed in Appendix C, migration of the chloroform plume into this area is not expected to occur. However, the decision to terminate Phase 1 and implement Phase 2 will be based on Phase 1 monitoring data and quantitative calculations that indicate this goal is attainable

6.1 Phase 1

Phase 1 consists of two active components and one passive component. The active components are:

1) Removal of chloroform mass from the perched zone as rapidly as is practical by pumping from wells located in areas having both high chloroform concentrations and high productivities,

2) Perched zone water level and chloroform monitoring to assess changes in chloroform concentrations within the plume, verify the location of the plume boundary over time, and estimate hydraulic capture zones.

Pumped water will be disposed in the tailings cells as 11.e.(2) byproduct.

The passive component consists of relying on natural attenuation to remove chloroform mass and reduce concentrations. Physical mechanisms that will reduce chloroform concentrations include processes that remove chloroform mass such as volatilization from the water table and abiotic reductive dechlorination, and processes such as hydrodynamic dispersion that rely on mixing with recharge and waters outside the plume. In addition to these physical mechanisms, biologically mediated decomposition of chloroform is also expected to reduce chloroform mass and concentrations within the plume. A discussion of expected rates of chloroform degradation by biological and abiotic means is provided in Appendix C.

In addition to these mechanisms which reduce chloroform concentrations within the plume, retardation of the plume by sorption onto natural organic carbon in the subsurface will act to slow the rate of downgradient migration. Sorption onto organic carbon and mass loss by volatilization will act to retard the migration of chloroform with respect to more conservative constituents such as nitrate which does not sorb and is not volatile.

In general, Phase 1 is a continuation of the existing and ongoing interim remedial action at the site. Monitoring of the interim action, which began in 2003, has included estimation of capture zones for pumping wells MW-4, MW-26 (TW4-15), TW4-19, and TW4-20 based on quarterly water level contour maps generated as part of the quarterly chloroform monitoring reports submitted by DUSA to UDEQ. The latest report (DUSA, 2007) covered the first quarter of 2007. Figure 14 is a map showing the plume boundary, the estimated combined capture zones of MW-26 (TW4-15), TW4-19, and TW4-20, and the estimated capture zone for MW-4 for the first quarter, 2007 (from DUSA, 2007). As shown, hydraulic capture of approximately 2/3 to 3/4 of the plume has been achieved. A portion of the southern half of the plume is currently outside the estimated capture zone. Although the extent of the capture zone is expected to increase over time, including expansion to the south, it is unlikely that complete hydraulic capture of the plume is achievable with the current pumping scheme. However, pumping in the southern (downgradient) extremity of the plume is impractical due to low permeability and low saturated thickness (HGC, 2005). Because low permeability conditions to the south, and flattening hydraulic gradients resulting from upgradient pumping will reduce rates of downgradient

migration, natural attenuation will likely be effective in treating that portion of the plume that will remain outside hydraulic capture (Appendix C).

As a result of the above factors (reduction in hydraulic gradients, transition to lower permeability conditions to the south, natural attenuation), and the reduction in chloroform concentrations in upgradient areas resulting from pumping, the plume is expected to stabilize. For example, Figure 15 compares the extents of the chloroform plume in the first quarters of 2006 and 2007. Over this period, the plume seems to be relatively stable, having expanded slightly in some areas and contracted slightly in others. Although the plume appears to have stabilized, continued monitoring is needed to verify this condition. If continued monitoring indicates the plume has not stabilized, then contingencies will be implemented.

Data collected during Phase 1 monitoring will be used to calculate chloroform mass removal rates by pumping, estimate mass removal by natural in-situ degradation, and estimate migration rates once pumping ceases. Numerical and/or analytical models will be used as needed to assist in evaluating the data and estimating natural in-situ degradation.

6.1.1 Groundwater Pumping System

The Phase 1 corrective action groundwater pumping system will be the same as currently used for the interim remedial action. Wells MW-4, MW-26 (TW4-15), TW4-19, and TW4-20 are the current pumping wells. Each well is equipped with a Grundfos submersible pump. To prevent damage to the pumps, each operates on a cycle that allows pumping only when sufficient water

is present in the well. The capacity of each pump is greater than the sustainable pumping rate for each well. Therefore, the average amount of water pumped from each well is, in general, the maximum practical. These wells were selected for pumping because they are located in areas of the perched zone having both high chloroform concentrations and relatively high permeabilities that allow relatively high rates of mass removal that are not possible within low permeability, low yield downgradient areas.

Water pumped from each well is considered 11.e.(2) byproduct and is routed by discharge lines to the tailings cells for disposal. The discharge line near each wellhead is equipped with an in-line flow meter and totalizer. Readings from each totalizer are used to report quarterly pumped volumes and average pumping rates.

Operation of the wellfield will be as described in the *Operations and Maintenance Plan, Chloroform Pumping System, White Mesa Mill, Blanding, Utah*, which includes provisions for daily inspections. The contingencies described in Section 7 will be implemented should chloroform mass removal rates drop significantly due to losses in well productivity.

6.1.2 Water Level Monitoring

Continuation of the monthly water level monitoring for all non-pumping chloroform investigation wells, and weekly monitoring for pumping wells, is proposed for Phase 1. The chloroform investigation wells are MW-4, MW-26 (TW4-15), MW-31, and all TW4-series wells. Depths to water will be measured using an electric water level meter in the same way they

are currently collected. Hydraulic capture zones will be estimated from water level contour maps generated quarterly from the water level data. The contingencies described in Section 7 will be implemented should the proportion of the remaining chloroform plume that is under hydraulic capture shrink significantly.

6.1.3 Water Quality Monitoring

Continuation of the quarterly water quality monitoring for all chloroform investigation wells is proposed for Phase 1. Sampling and analytical procedures will be the same as currently employed for the chloroform monitoring as described in the quarterly chloroform monitoring reports submitted by DUSA to UDEQ. Each well will be sampled for the following constituents:

- Chloroform
- Chloromethane
- Carbon tetrachloride
- Methylene chloride
- Chloride
- Nitrogen, Nitrate + Nitrite as N

Should concentrations within the plume begin to generally increase (disregarding short-term fluctuations), or the plume boundaries begin to expand, the contingencies discussed in Section 7 will be implemented.

6.1.4 Reporting

Corrective action reporting is proposed to occur semi-annually, using a format and content similar to the quarterly chloroform monitoring reports submitted by DUSA to UDEQ

(see DUSA, 2007). The first semi-annual report submitted each year will cover the third and fourth quarters of the previous year, and the second semi-annual report submitted each year will cover the first and second quarters of that year. The semi-annual reports will, in addition to the elements of the current quarterly reports, contain the following:

1) calculation of quarterly chloroform mass removed by pumping

2) comparison of the current areal extent of the chloroform plume from the latest quarter with the latest quarter of the previous reporting period

3) discussion of any contingencies to be implemented

6.2 Phase 2

Phase 2 will consist of 1) reliance on natural attenuation to reduce remaining chloroform within the plume to action levels and 2) continued monitoring. Phase 2 will be implemented with the concurrence of UDEQ once concentrations have been judged to have been reduced sufficiently that pumping can cease, and natural attenuation will be sufficient to remediate the remaining chloroform. At a minimum, factors that will be considered include 1) expected rates of natural in-situ degradation of chloroform, 2) hydrodynamic dispersion, mixing, and volatilization, 3) retardation by sorption and 4) perched zone hydraulic conditions. These factors will all be considered in estimating the rate of migration of the residual plume and the time required for all concentrations to be reduced to the action levels. Numerical and/or analytical models will be used as needed in the evaluation.

6.3 Achievement of Concentration Limits

The CAP, as described in sections 6.1 and 6.2 above, is designed to meet the chloroform concentration limit of 70µg/L. Alternate Standards are not believed to be necessary at this time.

7. ASSESSMENT OF CORRECTIVE ACTION AND PROTECTION OF PUBLIC HEALTH AND THE ENVIRONMENT

The effectiveness of Phase 1 of the corrective action will be assessed based on the following criteria:

1) stability of plume boundaries

2) concentration trends within the plume

3) chloroform mass removal rates resulting from pumping, and

4) stability of capture zones with respect to the proportion of the chloroform plume within hydraulic capture

The effectiveness of Phase 2 of the corrective action will be assessed based only on above criteria 1 and 2. The following sections describe the contingencies to be implemented based on effectiveness assessed using the above criteria.

7.1 Stability of Plume Boundary (Phase 1)

The stability of the plume boundary, based on Phase 1 CAP monitoring activities discussed in Sections 6 and 8, will be used to determine the following:

- Whether additional perched zone monitoring wells will be installed, and
- The need to reevaluate the Phase 1 strategy.

Under conditions where the plume boundaries remain stable or contract, no additional downgradient monitoring wells will be installed, and no reevaluation of Phase 1 will be needed. Under conditions where the plume migrates beyond existing downgradient monitoring wells, and

with the concurrence of UDEQ, one round of additional downgradient wells will be installed. The additional downgradient wells will be installed within one year. If the plume migrates beyond these wells, then Phase 1 will be reevaluated. Analytical or numerical models will be used if needed in the reevaluation to develop a response. The reevaluation process will be completed within one year.

Anticipated responses to this condition would likely include adding existing or new wells to the pumping network to slow the migration rates and/or to bring more of the plume under hydraulic capture, and installation of additional downgradient monitoring wells as needed.

7.2 Concentration Trends within the Plume (Phase 1)

Concentration trends within the plume will be used to determine the need for reevaluation of Phase 1. Concentration trends will be based on analytical data collected through Phase 1 CAP monitoring.

Under conditions where concentrations within the plume continue their current generally downward trend (disregarding short term fluctuations), no reevaluation will be required. Should concentrations within the plume begin to generally increase (disregarding short term fluctuations), then reevaluation of Phase 1 will be required. Analytical or numerical models will be used in the reevaluation if needed to develop a response. The reevaluation process will be completed within one year. Anticipated responses to this condition would likely include adding

existing or new wells to the pumping network, or other measures designed to achieve a more rapid rate of mass reduction.

7.3 Chloroform Mass Removal Rates Resulting from Pumping (Phase 1)

Under conditions where chloroform mass removal rates by pumping drop substantially as a result of reduced concentrations within the plume, no action will be taken. Under conditions where chloroform mass removal rates by pumping drop substantially as a result of lost well productivities, then an evaluation of the lost productivity will be undertaken. If the lost productivity is determined to be a well efficiency problem, the inefficient wells will be re-developed or replaced within one year. Should the lost productivity be determined to be due to a general reduction in saturated thickness, analytical or numerical models will be used to evaluate the potential effectiveness of adding existing or new wells to the pumping network to improve overall productivity. If the analysis indicates that overall productivity will not improve significantly by adding wells, then no action will be taken.

A loss in productivity due to a general decrease in saturated thickness will be offset by the benefits of the reduced saturated thickness. First, this condition would indicate that removal of a substantial amount of chloroform laden water had already taken place. Second, the reduced saturated thickness within the chloroform plume would reduce average hydraulic gradients and reduce the potential for downgradient migration. These factors will be considered in any reevaluation that may be performed.

7.4 Stability of the Proportion of the Chloroform Plume under Hydraulic Capture (Phase 1)

Under conditions where the proportion of the remaining chloroform plume that lies within hydraulic capture shrinks substantially, an evaluation of the factors resulting in this condition will be undertaken. If the condition is determined to result from lost productivity of the pumping wells due to well efficiency problems, the inefficient wells will be re-developed or replaced within one year. Should the loss in capture be determined to result from other conditions, then Phase 1 will be reevaluated. Analytical or numerical models will be used in the reevaluation if needed to develop a response. The reevaluation process will be completed within one year.

Anticipated responses to this condition would likely include adding existing or new wells to the pumping network to bring a larger proportion of the plume within hydraulic capture.

7.5 Phase 2

As part of Phase 2, water levels and chloroform concentrations within the residual plume will be monitored in the same fashion as in Phase 1, except that pumping related monitoring will not occur. Because no pumping will occur, the plume may migrate to some extent depending on the relative rates of natural attenuation and perched groundwater flow, and any additional downgradient monitoring wells needed to define the limits of the plume will be installed. Installation of additional downgradient wells to define the plume boundary would be within one year of concentrations in the existing downgradient wells exceeding the action level and with the

concurrence of UDEQ. Should concentrations within the plume begin to generally increase (disregarding short term fluctuations), or should the plume migrate near the southern edge of the tailings cells, then Phase 2 will be reevaluated. Analytical or numerical models will be used in the reevaluation as needed to develop a response. The reevaluation process will be completed within one year. Anticipated responses to these conditions would likely include a resumption of pumping or other measures taken to slow the rate of chloroform migration and increase the rate of mass reduction within the residual plume.

7.6 Permanent Effect of Corrective Action

Phase 1, Phase 2, and the contingencies outlined above (Sections 7.1 through 7.5) are designed to protect the public health and the environment by containing the chloroform plume within the site property boundary and reducing chloroform concentrations within the plume to the concentration limit of 70μg/L. As concentrations will then continue to be reduced by natural attenuation, the corrective action will have a permanent effect.

7.7 In-Place Contaminant Control

As discussed in Section 6, the corrective action relies on active and passive strategies to meet CAP objectives. The passive strategy includes in-place contaminant control by removing chloroform via in-situ natural biodegradation. A significant portion of the chloroform within the plume is anticipated to be treated in place via natural biodegradation as discussed in Appendix C.

8. IMPACTS OF OFFSITE ACTIVITIES

As discussed in Section 6, chloroform will be treated in place by natural attenuation and removed from the perched zone by pumping. Because all pumped water is considered 11.e.(2) byproduct and will be disposed onsite in the tailings cells, there will be no offsite impacts resulting from CAP implementation.

9. PROPOSED PLUME CORRECTIVE ACTION ACTIVITIES

Phase1 and Phase 2 corrective action activities and contingencies are discussed in detail in Sections 6 and 7. These activities are summarized in Sections 8.1 and 8.2 below.

9.1 Phase 1

Phase 1 corrective action activities include continued pumping of wells MW-4, MW-26 (TW4-15), TW4-19, and TW4-20, monitoring and maintenance of the pumping system, water level monitoring, monitoring for chloroform and other constituents, estimation of hydraulic capture, implementation of contingencies as needed, and reporting.

9.1.1 Groundwater Pumping

Wells MW-4, MW-26 (TW4-15), TW4-19, and TW4-20 will continue to be pumped at the maximum practical rates. Pumped water will be disposed in the tailings cells as 11.e.(2) byproduct. The wellfield will be operated and maintained in accordance with the *Operations and Maintenance Plan, Chloroform Pumping System, White Mesa Mill, Blanding, Utah.* Monitoring will include pumping rates and volumes for each well.

9.1.2 Water Level Monitoring

Water levels will be monitored at all chloroform investigation wells (MW-4, MW-26, MW-32, and TW4-series wells) at the same frequency and using the same methods as currently employed. This includes weekly monitoring of pumping wells and monthly monitoring of non-pumped wells. Water level contour maps of the data will be generated quarterly.

9.1.3 Water Quality Monitoring

All chloroform investigation wells will be sampled quarterly using the same methods as currently employed. Samples will be analyzed for chloroform, chloromethane, methylene chloride, carbon tetrachloride, chloride, and nitrogen, nitrate and nitrite as N (Section 6.1.3).

9.1.4 Estimation of Capture Zones

Hydraulic capture zones will be generated from the quarterly water level contour maps in the same manner as they are currently generated.

9.1.5 Estimation of Pumped Chloroform Mass

Quarterly estimates of chloroform mass removed by pumping will be made based on cumulative pumped volumes at each pumped well and chloroform concentrations at each pumped well.

9.1.6 Reporting

Semi-annual reports will be prepared that contain the elements of the current quarterly chloroform monitoring reports submitted by DUSA to UDEQ (see DUSA, 2007) in addition to the following:

1) quarterly chloroform mass removed by pumping

2) comparison of the areal extent of the chloroform plume from the latest quarter with the latest quarter of the previous reporting period

3) discussion of any contingencies implemented or to be implemented

The first semi-annual report submitted each year will cover the third and fourth quarters of the previous year, and the second semi-annual report submitted each year will cover the first and second quarters of that year.

9.1.7 Additional Measures

Based on Phase 1 monitoring, and the criteria discussed in Section 7, contingencies that include potential installation of additional wells, well rehabilitation or replacement, expansion of the pumping well network, and reevaluation of the Phase 1 strategy will be implemented as needed. Factors that could trigger the implementation of contingencies include 1) expansion of the plume boundaries, 2) generally increasing chloroform concentrations within the plume, 3) reductions in chloroform mass removal rates due to losses in pumping well productivities, and 4) decreases in the proportion of the plume under hydraulic capture.

9.2 Phase 2

Phase 2 corrective action activities include quarterly monitoring for chloroform and the other analytical parameters listed in section 6.1.3, quarterly water level monitoring, and semi-annual reporting. Because the pumping system will be inactive, the semi-annual reports will not contain information related to the pumping system. Other elements of the reporting will be the same as for Phase 1.

Based on Phase 2 monitoring, and the criteria discussed in Section 7, contingencies that include potential installation of additional wells, reestablishment of pumping, and reevaluation of the Phase 2 strategy, will be implemented as needed.

Once chloroform concentrations at all monitoring locations are at or below the action level of 70 µg/L, concurrence with UDEQ will be sought that the corrective action is complete, as discussed in Section 5.

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11. LIMITATIONS STATEMENT

The opinions and recommendations presented in this report are based upon the scope of services and information obtained through the performance of the services, as agreed upon by HGC and the party for whom this report was originally prepared. Results of any investigations, tests, or findings presented in this report apply solely to conditions existing at the time HGC's investigative work was performed and are inherently based on and limited to the available data and the extent of the investigation activities. No representation, warranty, or guarantee, express or implied, is intended or given. HGC makes no representation as to the accuracy or completeness of any information provided by other parties not under contract to HGC to the extent that HGC relied upon that information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and for the particular purpose that it was intended. Reuse of this report, or any portion thereof, for other than its intended purpose, or if modified, or if used by third parties, shall be at the sole risk of the user.

TABLES

TABLE 1
Hydraulic Test Analysis Results
Single Well Tests

Well ID	Interpretation Method	Type	Hydraulic Conductivity (cm/sec)	Storativity	Specific Storage (1/foot)	Saturated Thickness (feet)	Skin
MW-01	WHIP	pump/recovery	7.7×10^{-7}	0.0082	--	20	none
	AQTESOLV (Moench, Leaky)	pump/recovery	7.7×10^{-7}	0.0082	--	20	none
	AQTESOLV (Moench, Unconfined)	pump/recovery	8.9×10^{-7}	0.01	--	40	none
MW-03	WHIP	slug	4.3×10^{-5}	0.01	--	5.2	none
	AQTESOLV (KGS, Unconfined)	slug	4.0×10^{-7}	0.098	1.92×10^{-2}	5.2	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	1.5×10^{-5}	--	--	5.2	--
MW-05	WHIP	slug	1.1×10^{-5}	0.1	--	10	none
	AQTESOLV (KGS, Unconfined)	slug	3.5×10^{-6}	0.044	4.4×10^{-3}	10	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	3.9×10^{-6}	--	--	10	--
	AQTESOLV (Bouwer-Rice, unconfined)	slug	2.4×10^{-5}	--	--	10	--
MW-17	WHIP	slug	2.9×10^{-5}	0.01	--	18	none
	AQTESOLV (KGS, Unconfined)	slug	2.6×10^{-5}	0.0031	1.71×10^{-4}	18	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	2.7×10^{-5}	--	--	18	--
MW-18	WHIP	slug	4.4×10^{-4}	2.2×10^{-5}	--	45	none
	WHIP	slug	5.3×10^{-4}	0.02	--	45	6.54
	AQTESOLV (KGS, Unconfined)	slug	2.9×10^{-4}	2.7×10^{-5}	4.6×10^{-7}	58	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	2.4×10^{-4}	--	--	58	--

TABLE 1
Hydraulic Test Analysis Results
Single Well Tests

Well ID	Interpretation Method	Type	Hydraulic Conductivity (cm/sec)	Storativity	Specific Storage (1/foot)	Saturated Thickness (feet)	Skin
MW-19	WHIP	slug	7.1×10^{-6}	0.032	--	47	none
	WHIP	slug	1.7×10^{-5}	0.027	--	47	2.24
	AQTESOLV (Moench, Leaky)	slug	1.7×10^{-5}	0.027	--	47	2.24
	AQTESOLV (KGS, Unconfined)	slug	1.7×10^{-5}	1.2×10^{-4}	1.44×10^{-6}	80	none
	AQTESOLV (KGS, Confined)	slug	1.6×10^{-5}	1.5×10^{-4}	3.24×10^{-6}	47	none
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	1.3×10^{-5}	--	--	80	--
	AQTESOLV (Bouwer-Rice, Confined)	slug	1.2×10^{-5}	--	--	47	--
MW-20	WHIP	slug	8.2×10^{-6}	0.02	--	12	none
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	9.3×10^{-6}	--	--	12	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	5.9×10^{-6}	--	--	12	--
MW-22	WHIP	slug	4.2×10^{-6}	0.014	--	51	none
	AQTESOLV (KGS, Unconfined)	slug	1.0×10^{-6}	0.10	2.0×10^{-3}	51	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	7.9×10^{-6}	--	--	51	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	4.4×10^{-6}	--	--	51	--
MW-23	AQTESOLV (KGS, Unconfined)	slug	3.2×10^{-8}	--	1×10^{-1}	12	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	1.6×10^{-6}	--	--	12	--
MW-23b[1]	AQTESOLV (KGS, Unconfined)	slug	2.3×10^{-7}	--	2.3×10^{-3}	12	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	2.5×10^{-7}	--	--	12	--
MW-25	AQTESOLV (KGS, Unconfined)	slug	1.1×10^{-4}	--	3.0×10^{-4}	33	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	7.4×10^{-5}	--	--	33	--

TABLE 1
Hydraulic Test Analysis Results
Single Well Tests

Well ID	Interpretation Method	Type	Hydraulic Conductivity (cm/sec)	Storativity	Specific Storage (1/foot)	Saturated Thickness (feet)	Skin
MW-27	AQTESOLV (KGS, Unconfined)	slug	8.2×10^{-5}	--	5.3×10^{-4}	36	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	3.6×10^{-5}	--	--	36	--
MW-28	AQTESOLV (KGS, Unconfined)	slug	1.7×10^{-6}	--	2.0×10^{-2}	23	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	1.7×10^{-6}	--	--	23	--
MW-29	AQTESOLV (KGS, Unconfined)	slug	1.1×10^{-4}	--	1.9×10^{-4}	18	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	9.3×10^{-5}	--	--	18	--
MW-30	AQTESOLV (KGS, Unconfined)	slug	1.0×10^{-4}	--	2.9×10^{-4}	24	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	6.4×10^{-5}	--	--	24	--
MW-31	AQTESOLV (KGS, Unconfined)	slug	7.1×10^{-5}	--	2.5×10^{-5}	53	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	6.9×10^{-5}	--	--	53	--
MW-32	AQTESOLV (KGS, Unconfined)	slug	3.0×10^{-5}	--	8.8×10^{-5}	46	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	2.6×10^{-5}	--	--	46	--
TW4-20	AQTESOLV (KGS, Unconfined)	slug	5.9×10^{-5}	--	1.6×10^{-5}	43	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	4.2×10^{-5}	--	--	43	--
TW4-21	AQTESOLV (KGS, Unconfined)	slug	1.9×10^{-4}	--	1.1×10^{-4}	63	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	3.2×10^{-5}	--	--	63	--
TW4-22	AQTESOLV (KGS, Unconfined)	slug	1.3×10^{-4}	--	6.8×10^{-6}	55	--
	AQTESOLV (Bouwer-Rice, Unconfined)	slug	1.1×10^{-4}	--	--	55	--

Notes:
cm/sec = Centimeters per second
[1] = overnight test

TABLE 2
Estimated Perched Zone Hydraulic Properties Based on Analysis of Observation Wells Near MW-4 and TW4-19

Observation Well	Theis Solution (Confined or Unconfined)	Transmissivity (ft^2/day)	Storage Coefficient	Water Bearing Zone Thickness (feet)	Average Hydraulic Conductivity (ft/day)	Average Hydraulic Conductivity (cm/sec)
TW4-1	Unconfined	8.9	0.023	39	0.23	$8.2x10^{-5}$
	Confined	8.4	0.023	24	0.35	$1.3x10^{-4}$
TW4-2	Unconfined	4.6	0.0065	39	0.12	$4.3x10^{-5}$
	Confined	3.8	0.0063	24	0.16	$5.7x10^{-5}$
TW4-7	Unconfined	4.7	0.011	39	0.12	$4.3x10^{-5}$
	Confined	3.3	0.011	24	0.14	$5.0x10^{-5}$
TW4-8	Unconfined	4.5	0.010	39	0.12	$4.3x10^{-5}$
	Confined	3.9	0.010	24	0.16	$5.7x10^{-5}$
MW-4A	Unconfined	5.8	0.019	39	0.15	$5.4x10^{-5}$
	Confined	3.5	0.019	24	0.15	$5.4x10^{-5}$
MW-4A (early time)	Unconfined	12.4	0.0029	39	0.32	$1.1x10^{-4}$
	Confined	9.1	0.0031	24	0.38	$1.4x10^{-4}$
TW4-5	Unconfined	89	0.0043	67	1.3	$4.6x10^{-4}$
	Confined	87	0.0043	31	2.8	$1.0x10^{-3}$
TW4-9	Unconfined	72	0.0043	67	1.1	$3.9x10^{-4}$
	Confined	71	0.0043	31	2.3	$8.2x10^{-4}$
TW4-10	Unconfined	48	0.0077	67	0.72	$2.6x10^{-4}$
	Confined	46	0.0076	31	1.5	$5.4x10^{-4}$
TW4-15	Unconfined	15	0.0037	67	0.22	$7.9x10^{-5}$
	Confined	12	0.0037	31	0.39	$1.4x10^{-4}$
TW4-16	Unconfined	19	0.0036	67	0.28	$1.0x10^{-4}$
	Confined	18	0.0035	31	0.58	$2.1x10^{-4}$

TABLE 2
Estimated Perched Zone Hydraulic Properties Based on Analysis of Observation Wells Near MW-4 and TW4-19

Observation Well	Theis Solution (Confined or Unconfined)	Transmissivity (ft^2/day)	Storage Coefficient	Water Bearing Zone Thickness (feet)	Average Hydraulic Conductivity (ft/day)	Average Hydraulic Conductivity (cm/sec)
TW4-18	Unconfined	76	0.0046	67	1.1	$3.9x10^{-4}$
	Confined	74	0.0046	31	2.4	$8.6x10^{-4}$
TW4-19	Unconfined	44	0.12	67	0.66	$2.4x10^{-4}$
	Confined	39	0.12	31	1.3	$4.6x10^{-4}$

Notes:
cm/sec = Centimeters per second
ft/day = Feet per day
ft^2/day = Feet squared per day

TABLE 3
Comparison of 2nd Quarter 2005 and 1st Quarter 2007 Chloroform Concentrations

Well	Q2 2005 Chloroform (µg/L)	Q1 2007 Chloroform (µg/L)	Change
MW-4	3170	2300	-870
TW4-1	3080	1900	-1180
TW4-2	3750	2900	-850
TW4-4	2400	2200	-200
TW4-5	113	33	-80
TW4-6	2.5	46	43
TW4-7	2700	1100	-1600
TW4-10	62.4	500	438
TW4-11	3590	3500	-90
TW4-15	442	570	128
TW4-16	212	8.7	-203
TW4-18	29.8	9.2	-21
TW4-19	1200	1200	0
TW4-20	39000	4400	-34600
TW4-21	192	160	-32
TW4-22	340	440	100

TABLE 4
Comparison of 2nd Quarter 2006 and 1st Quarter 2007 Chloroform Concentrations

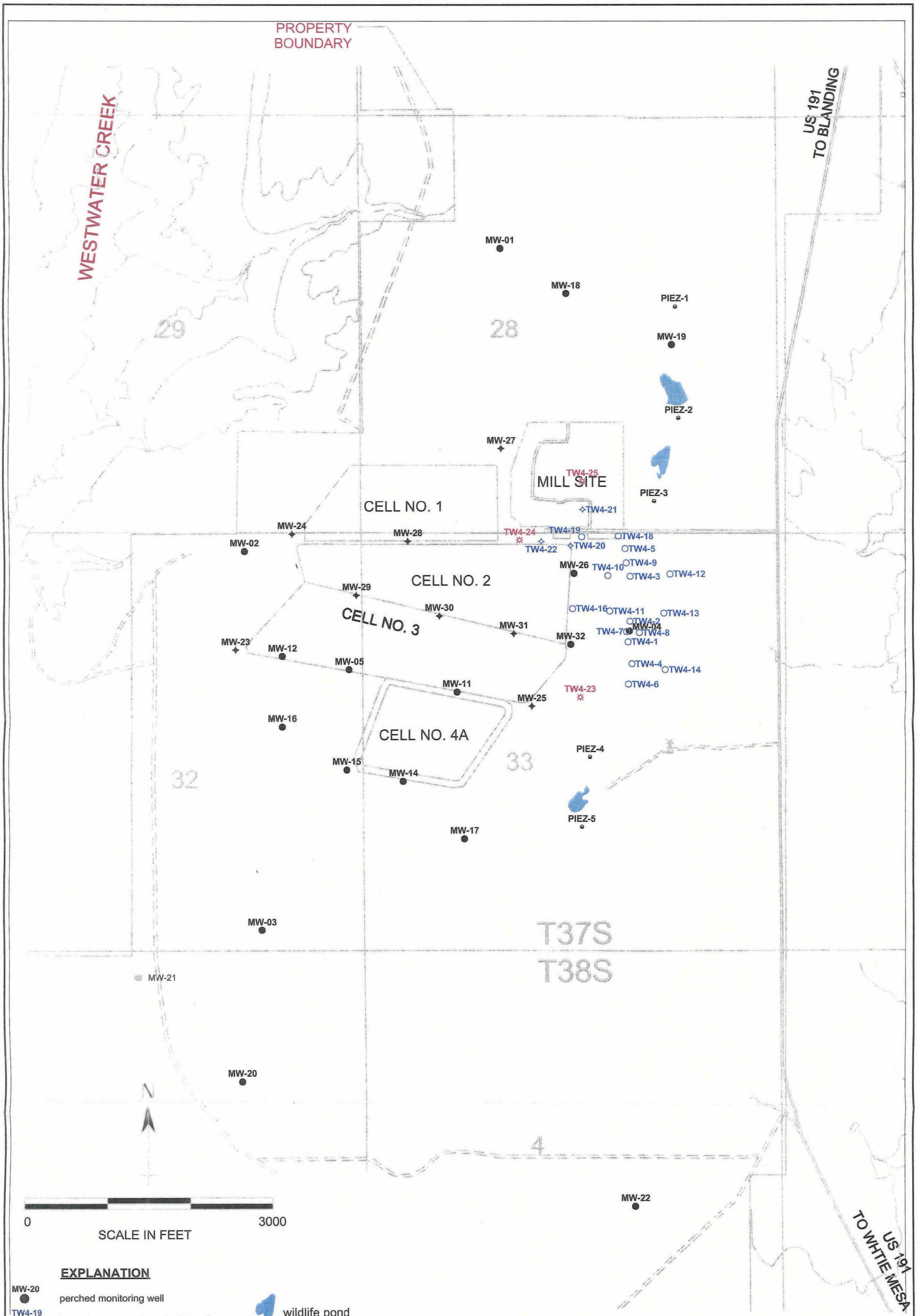
Well	Q2 2006 Chloroform (µg/L)	Q1 2007 Chloroform (µg/L)	Change
MW-4	3000	2300	-700
TW4-1	2200	1900	-300
TW4-2	3200	2900	-300
TW4-4	2600	2200	-400
TW4-5	51	33	-18
TW4-6	19	46	27
TW4-7	2200	1100	-1100
TW4-10	300	500	200
TW4-11	4300	3500	-800
TW4-15	830	570	-260
TW4-16	13	8.7	-4
TW4-18	12	9.2	-3
TW4-19	1100	1200	100
TW4-20	61000	4400	-56600
TW4-21	130	160	30
TW4-22	390*	440	50

Notes:
** Q1 2006 Concentration*

TABLE 5
Comparison of Average Chloroform Concentrations between 1st Quarter 2007 and 2nd Quarter 2006 and Between 1st Quarter 2006 and 2nd Quarter 2005

Well	Average Concentrations Q2, Q3, Q4, 2005 and Q1 2006	Average Concentrations Q2, Q3, Q4, 2006 and Q1 2007	Change
MW-4	3192	2738	-455
TW4-1	2770	2305	-465
TW4-2	3738	3410	-328
TW4-4	2825	2505	-320
TW4-5	81	46	-35
TW4-6	15	30	15
TW4-7	2550	2060	-490
TW4-10	166	439	273
TW4-11	4198	3885	-313
TW4-15	876	963	88
TW4-16	88	10	-77
TW4-18	24	11	-13
TW4-19	1650	1118	-533
TW4-20	17750	20425	2675
TW4-21	119	134	15
TW4-22	335	558	223

FIGURES



EXPLANATION

- MW-20 — perched monitoring well
- TW4-19 — temporary perched monitoring well
- PIEZ-1 — perched piezometer
- MW-31 — perched monitoring well installed April, 2005
- TW4-20 — temporary perched monitoring well installed April,2005
- TW4-23 — new temporary perched monitoring well installed May,2007 (locations approximate)
- wildlife pond

HYDRO GEO CHEM, INC.

SITE PLAN AND PERCHED WELL LOCATIONS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/CorrectiveActionPlan/welloc.srf	1

PROPERTY BOUNDARY

WESTWATER CREEK

US 191 TO BLANDING

MW-01

MW-18

PIEZ-1

MW-19

PIEZ-2

MW-27

TW4-25

MILL SITE

PIEZ-3

CELL NO. 1

TW4-21

MW-24

MW-28

TW4-24

TW4-19

TW4-18

MW-02

TW4-22

TW4-20

TW4-5

MW-26

TW4-10

TW4-9

TW4-3

TW4-12

CELL NO. 2

MW-29

MW-30

TW4-16

TW4-11

TW4-13

CELL NO. 3

MW-31

TW4-2

MW-04

MW-23

MW-12

MW-32

TW4-7

TW4-8

TW4-1

MW-05

TW4-4

TW4-14

MW-11

TW4-6

TW4-23

MW-25

chloroform plume defined by kriged 70 uG/L boundary

MW-16

CELL NO. 4A

PIEZ-4

MW-15

MW-14

29

28

33

32

PIEZ-5

MW-17

MW-03

T37S

T38S

MW-21

MW-20

N

MW-22

4

0

3000

SCALE IN FEET

US 191 TO WHITE MESA

EXPLANATION

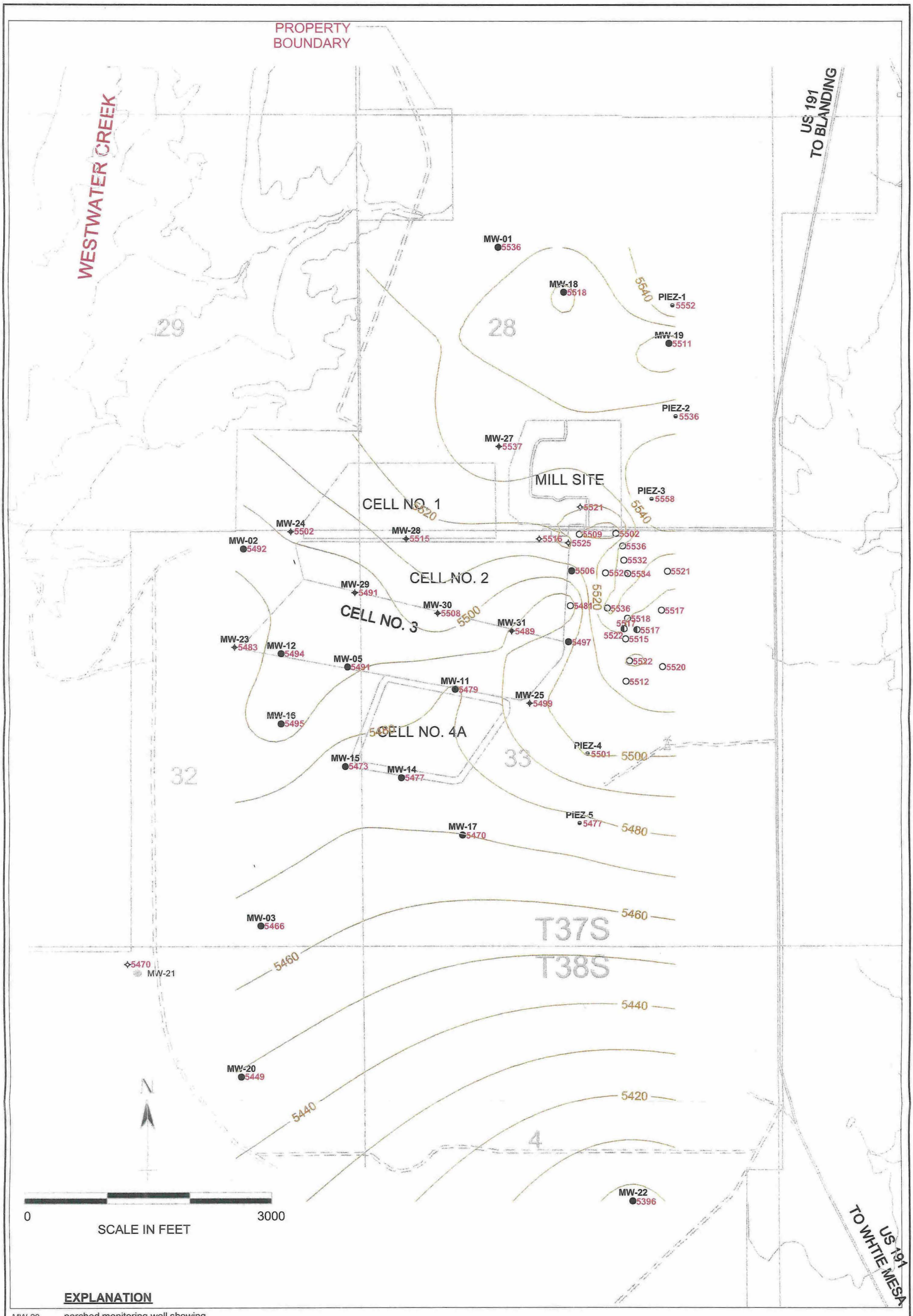
MW-20	perched monitoring well
TW4-19	temporary perched monitoring well
PIEZ-1	perched piezometer
MW-31	perched monitoring well installed April, 2005
TW4-20	temporary perched monitoring well installed April,2005
TW4-23	new temporary perched monitoring well installed May,2007 (locations approximate)

NOTE: New wells TW4-23, TW4-24, and TW4-25 not used in defining plume boundary

HYDRO GEO CHEM, INC.

1st QUARTER 2007 CHLOROFORM PLUME AND PERCHED WELL LOCATIONS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/CorrectiveActionPlan/chlloc.srf	2



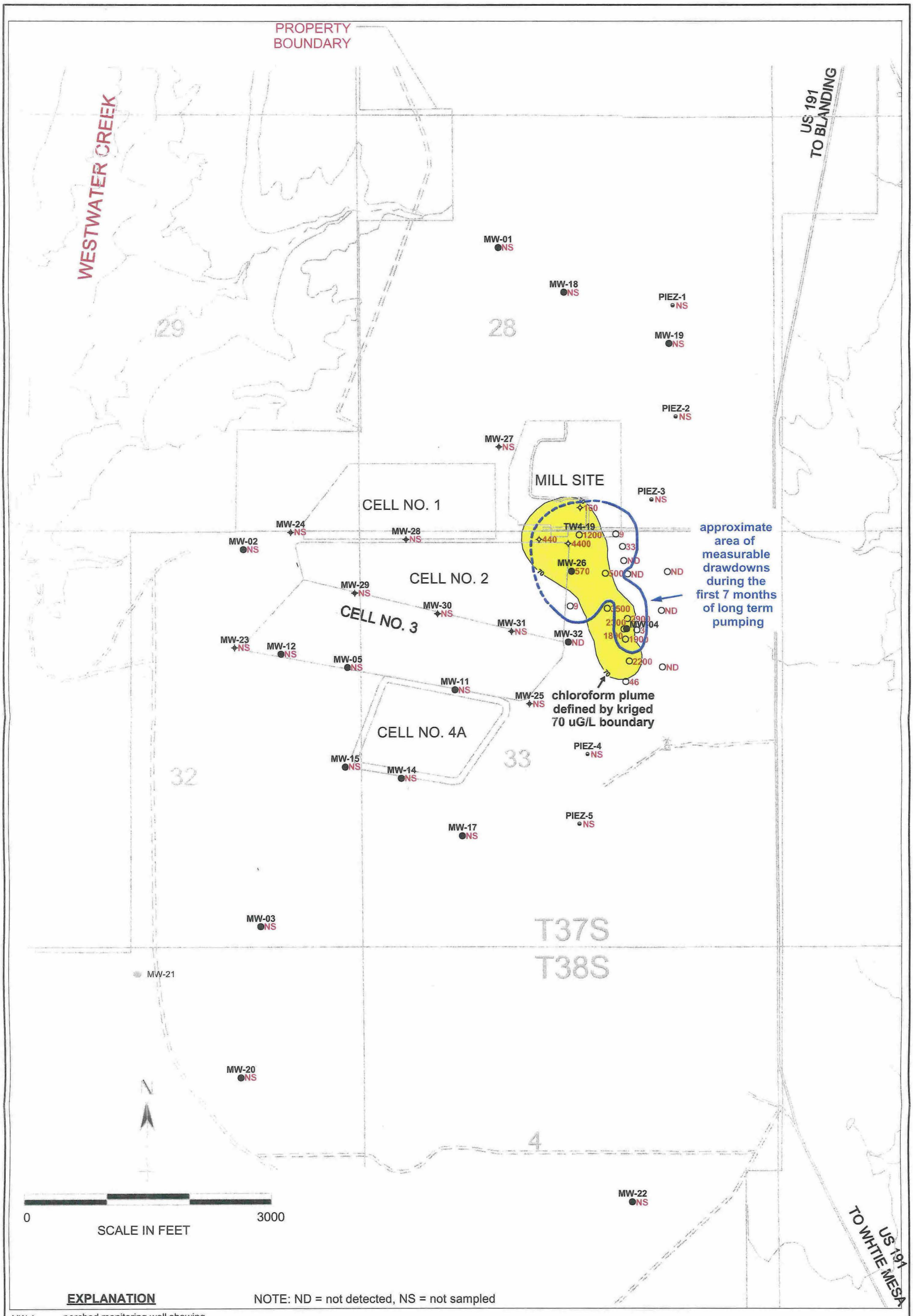
EXPLANATION

MW-20 ● 5449	perched monitoring well showing elevation in feet amsl
○ 5481	temporary perched monitoring well showing elevation in feet amsl
PIEZ-1 ⊖ 5552	perched piezometer showing elevation in feet amsl
MW-31 ✦ 5489	perched monitoring well installed April,2005 showing elevation in feet amsl
✧ 5525	temporary perched monitoring well installed April,2005 showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED BRUSHY BASIN CONTACT ELEVATIONS WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ CorrectiveActionPlan/bbel0705.srf	3



EXPLANATION

NOTE: ND = not detected, NS = not sampled

MW-4 2300	perched monitoring well showing concentration in uG/l
2200	temporary perched monitoring well showing concentration in uG/l
PIEZ-1 NS	perched piezometer (not sampled)
MW-32 ND	perched monitoring well installed April, 2005 showing concentration in uG/l
160	temporary perched monitoring well installed April, 2005 showing concentration in uG/l

HYDRO GEO CHEM, INC.

1st QUARTER 2007 CHLOROFORM PLUME SHOWING AREA RESPONDING TO THE FIRST 7 MONTHS OF LONG TERM PUMPING WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ Corrective Action Plan/chldwn.srf	4

PROPERTY BOUNDARY

WESTWATER CREEK

US 191 TO BLANDING

MW-1 5573

5570

5560

5550

5540

5530

5520

5510

5500

5490

5480

5470

MILL SITE

CELL NO. 1

CELL NO. 2

CELL NO. 3

CELL NO. 4A

MW-2 5503

MW-12 5500

MW-5 5501

MW-11 5508

MW-4 5529

MW-15 5492

MW-14 5493

MW-3 5471

W

US 191 TO WHITE MESA

EXPLANATION

● MW-3 5471	PERCHED MONITORING WELL SHOWING WATER LEVEL IN FEET AMSL
W	WILDLIFE POND
5580 ———	WATER LEVEL CONTOUR LINE, DASHED WHERE UNCERTAIN

N

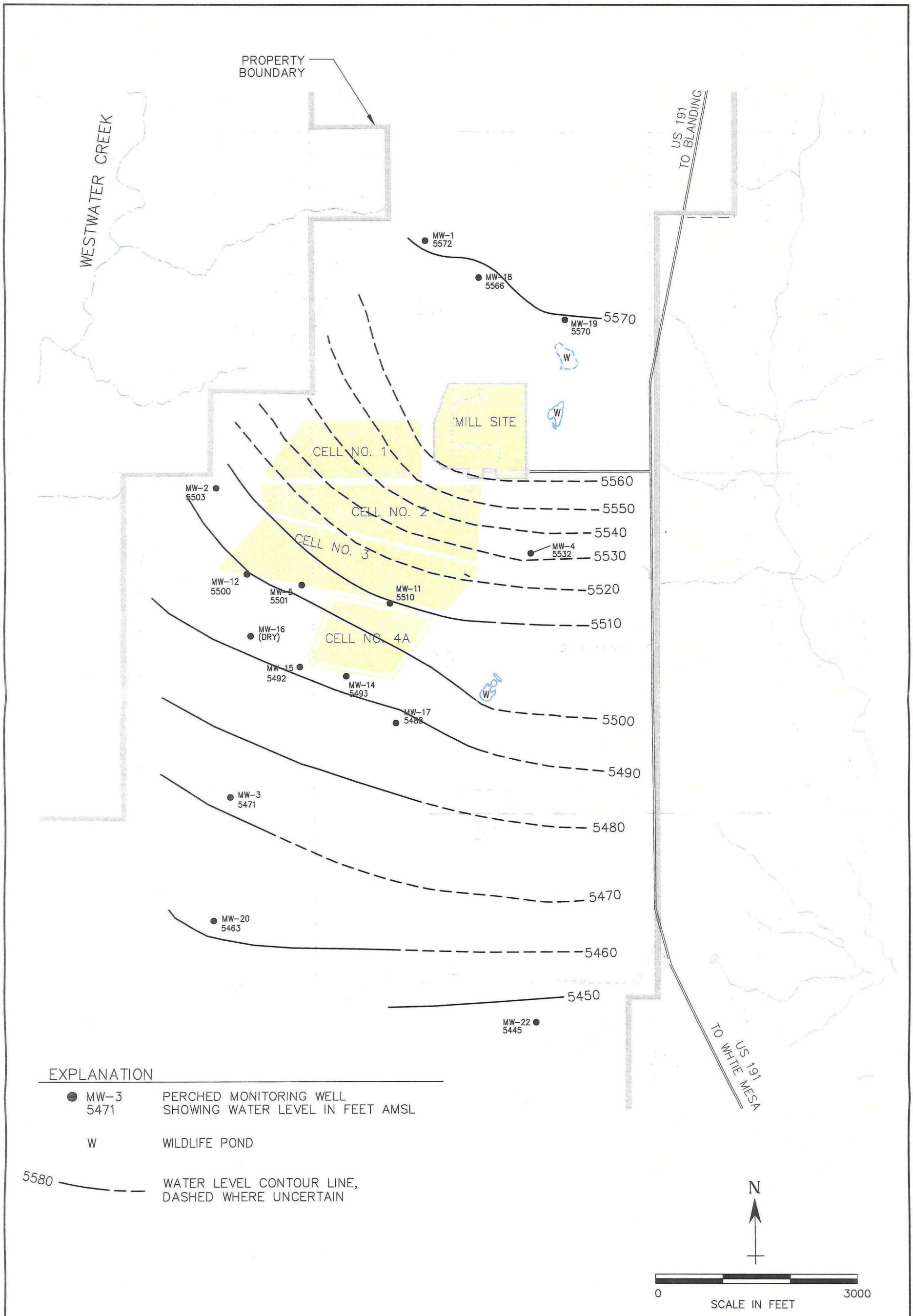
0 3000

SCALE IN FEET

HYDRO GEO CHEM, INC.

PERCHED WATER LEVELS AUGUST 1990

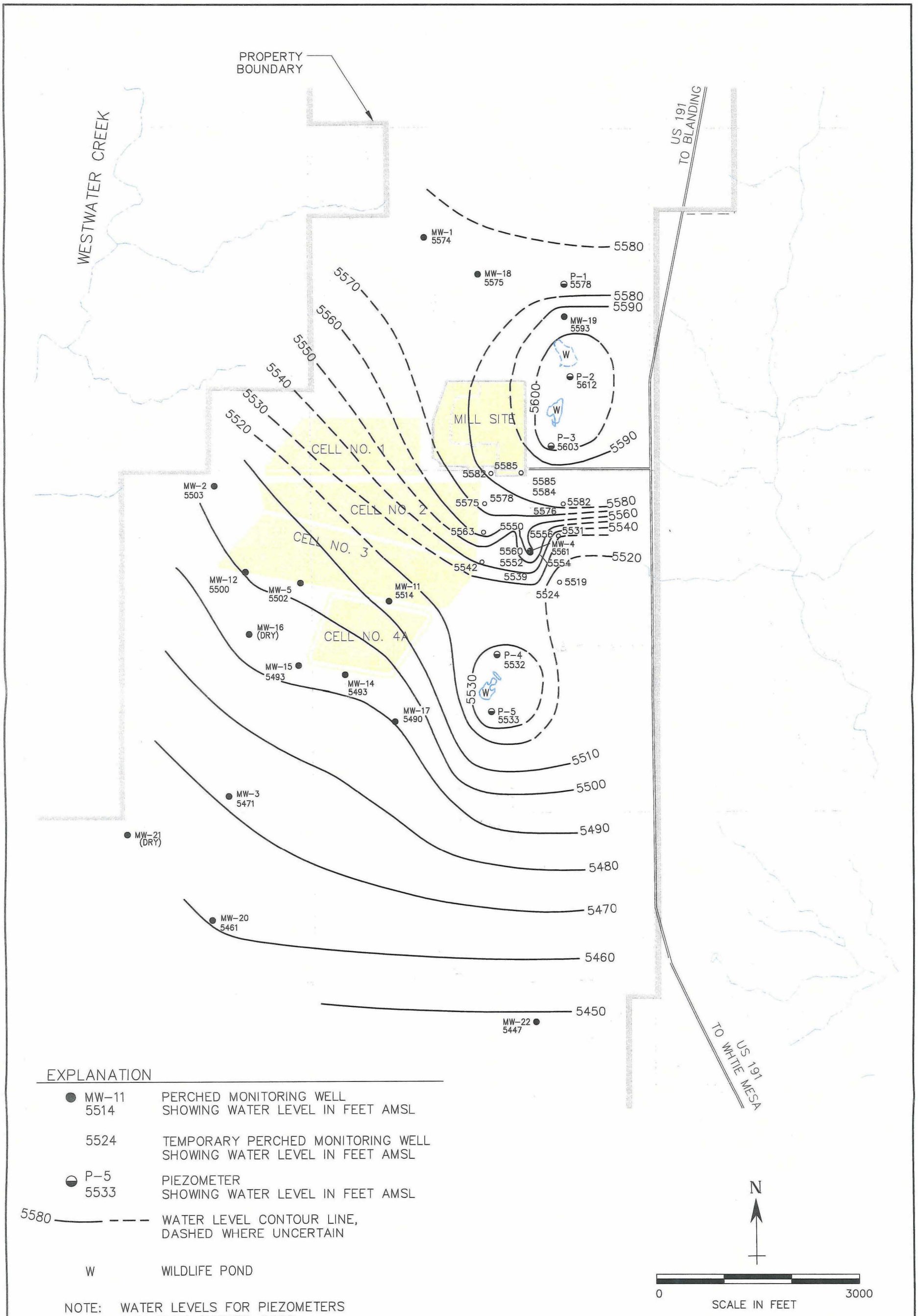
Approved:	Date:	Author:	Date:	File Name:	Figure:
SS	06/22/07			71800086	5



HYDRO GEO CHEM, INC.

PERCHED WATER LEVELS AUGUST 1994

Approved	Date	Revised	Date	Reference:	FIG:
SS	06/2/07			71800070	6



EXPLANATION

● MW-11 5514	PERCHED MONITORING WELL SHOWING WATER LEVEL IN FEET AMSL
5524	TEMPORARY PERCHED MONITORING WELL SHOWING WATER LEVEL IN FEET AMSL
◒ P-5 5533	PIEZOMETER SHOWING WATER LEVEL IN FEET AMSL
5580 —— – – –	WATER LEVEL CONTOUR LINE, DASHED WHERE UNCERTAIN
W	WILDLIFE POND

NOTE: WATER LEVELS FOR PIEZOMETERS ARE FROM AUGUST, 2002

HYDRO GEO CHEM, INC.

PERCHED WATER LEVELS SEPTEMBER 2002

Approved	Date	Revised	Date	Reference:	FIG:
SS	06/22/07			71800088	7

PROPERTY BOUNDARY

WESTWATER CREEK

US 191 TO BLANDING

MW-01 5579

MW-18 5583

PIEZ-1 5590

MW-19 5604

PIEZ-2 5614

MW-27 5576

MILL SITE

PIEZ-3 5606

5580

CELL NO. 1

MW-24 5506

MW-28 5541

MW-02 5503

TW4-19 5544 5586 5571 5549 5586 5585 5589

MW-26 5541 5570 5583

CELL NO. 2

MW-29 5511

MW-30 5535

5557 5568 5571

CELL NO. 3

MW-31 5544

MW-32 5546

5546 MW-04 5551 5550 5554

MW-23 5498

MW-12 5500

MW-05 5502

5547 5522

5534

MW-11 5518

MW-25 5535

CELL NO. 4A

PIEZ-4 5539

MW-15 5493

MW-14 5494

PIEZ-5 5538

MW-17 5496

MW-03 5471

MW-21

MW-20 5461

MW-22 5450

29 28 32 33 4

T37S

T38S

5560 5540 5520 5500 5480 5460 5600 5580

N

0 3000

SCALE IN FEET

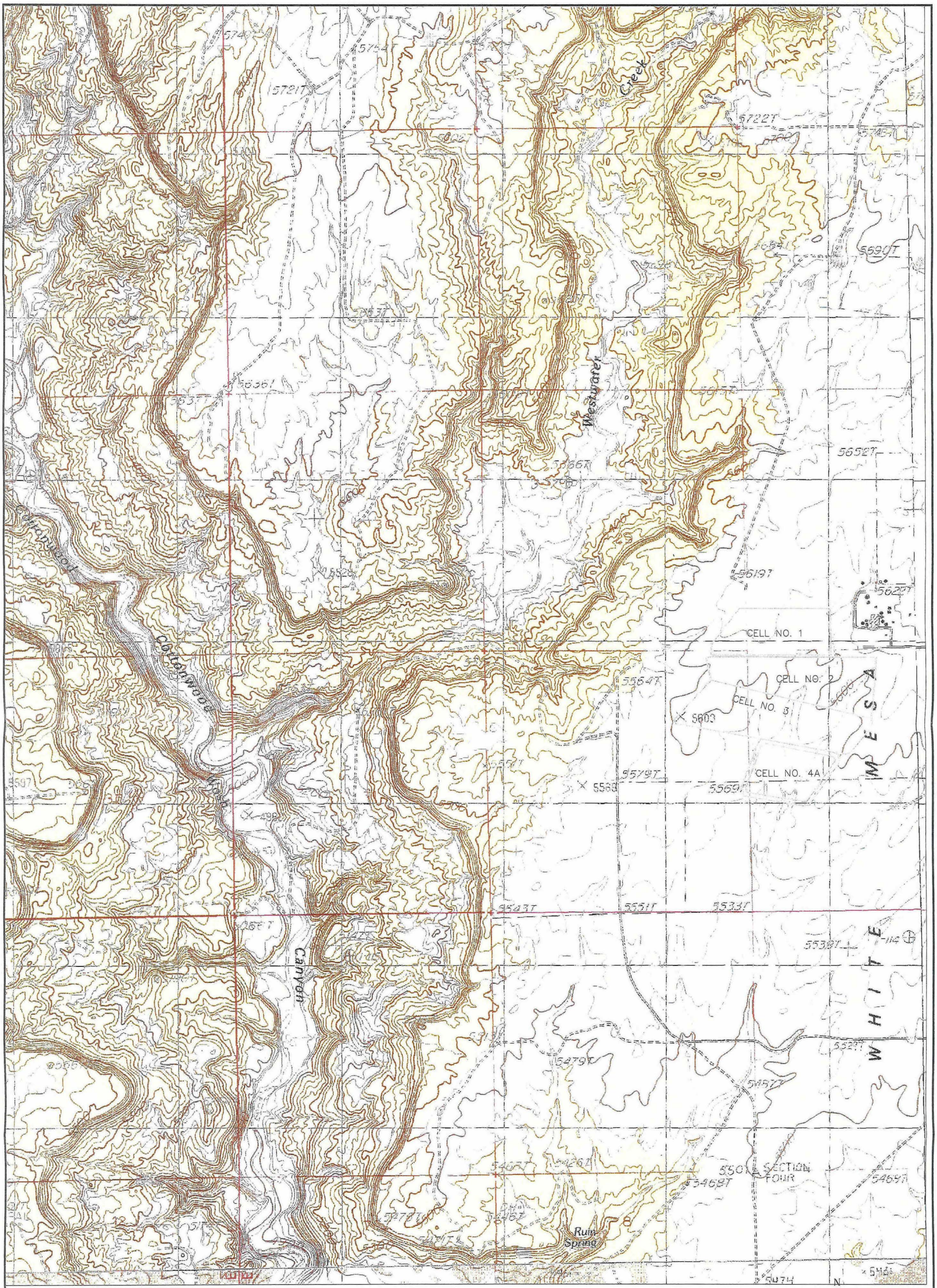
EXPLANATION

MW-20 5461	perched monitoring well showing elevation in feet amsl
5551	temporary perched monitoring well showing elevation in feet amsl
PIEZ-1 5590	perched piezometer showing elevation in feet amsl
MW-31 5544	perched monitoring well installed April, 2005 showing elevation in feet amsl
5571	temporary perched monitoring well installed April, 2005 showing elevation in feet amsl

HYDRO GEO CHEM, INC.

KRIGED 1st QUARTER 2007 WATER LEVELS WHITE MESA SITE

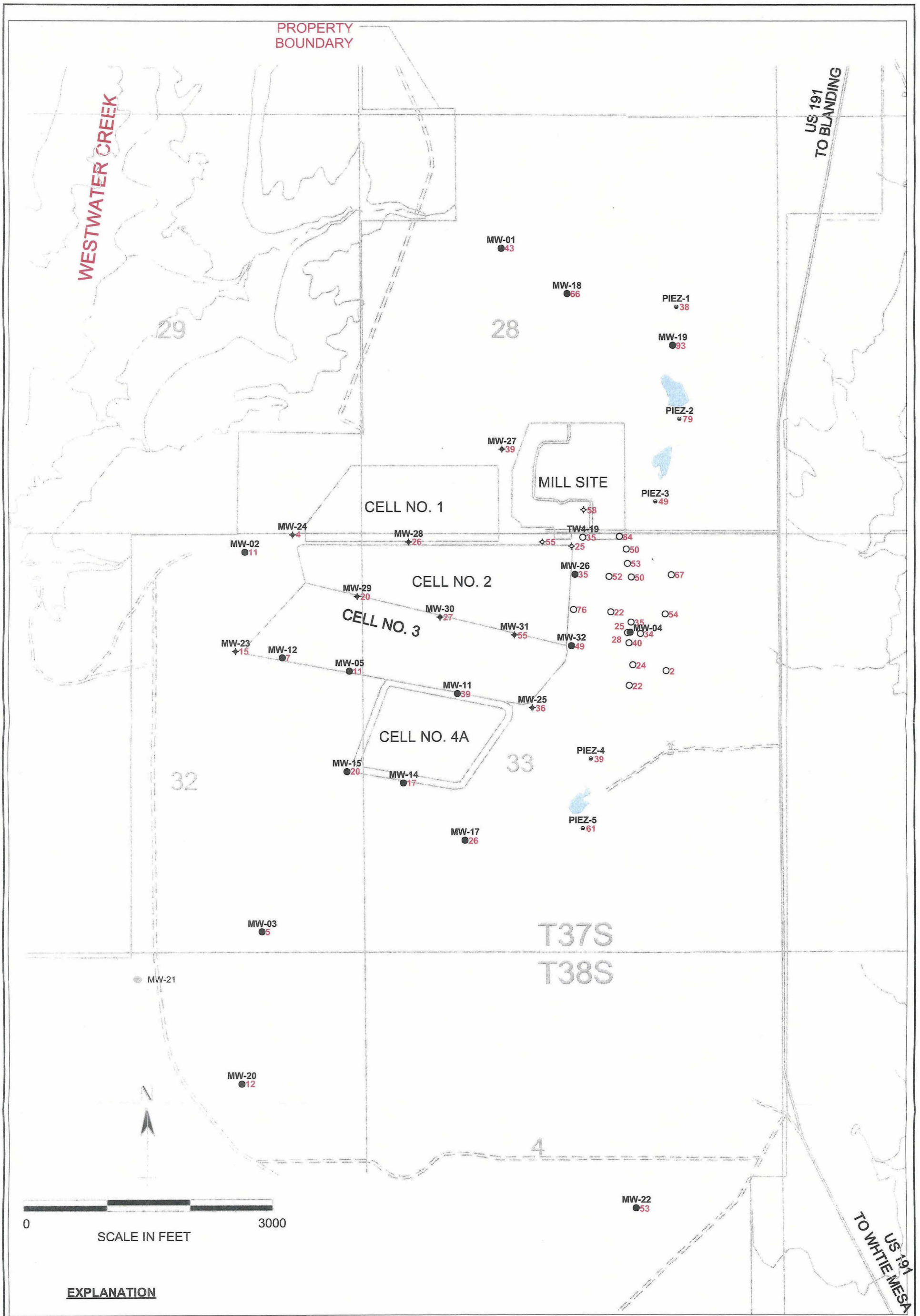
APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ CorrectiveActionPlan/wl0307.srf	8



HYDRO GEO CHEM, INC.

PORTION OF USGS BLACK MESA 7.5' SHEET SHOWING APPROXIMATE LOCATION OF TAILING CELLS IN RELATION TO NEARBY CANYONS AND RUIN SPRING

Approved	Date	Revised	Date	Reference:	Figure:
SS	06/22/07			71800089	9



HYDRO GEO CHEM, INC.

PERCHED ZONE SATURATED THICKNESS 1st QUARTER 2007 WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71802/CorrectiveActionPlan/satthck07.srf	10

PROPERTY BOUNDARY

WESTWATER CREEK

US 191 TO BLANDING

MW-01 69

MW-18 74

PIEZ-1 65

MW-19 51

PIEZ-2 14

MW-27 51

MILL SITE

PIEZ-3 32

60

CELL NO. 1

MW-24 115

MW-28 79

MW-02 110

58 80 88 55 55 53

TW4-19

MW-26 84

56 49 35

CELL NO. 2

MW-29 104

MW-30 79

67 66 49

CELL NO. 3

MW-31 72

76 72 MW-04 70

71 64

MW-32 79

MW-23 114

MW-12 109

MW-05 107

67 91

75

MW-11 93

MW-25 78

CELL NO. 4A

PIEZ-4 52

MW-15 107

MW-14 104

PIEZ-5 46

MW-17 79

MW-03 84

MW-21

T37S

T38S

MW-20 79

MW-22 68

0 3000

SCALE IN FEET

US 191 TO WHITE MESA

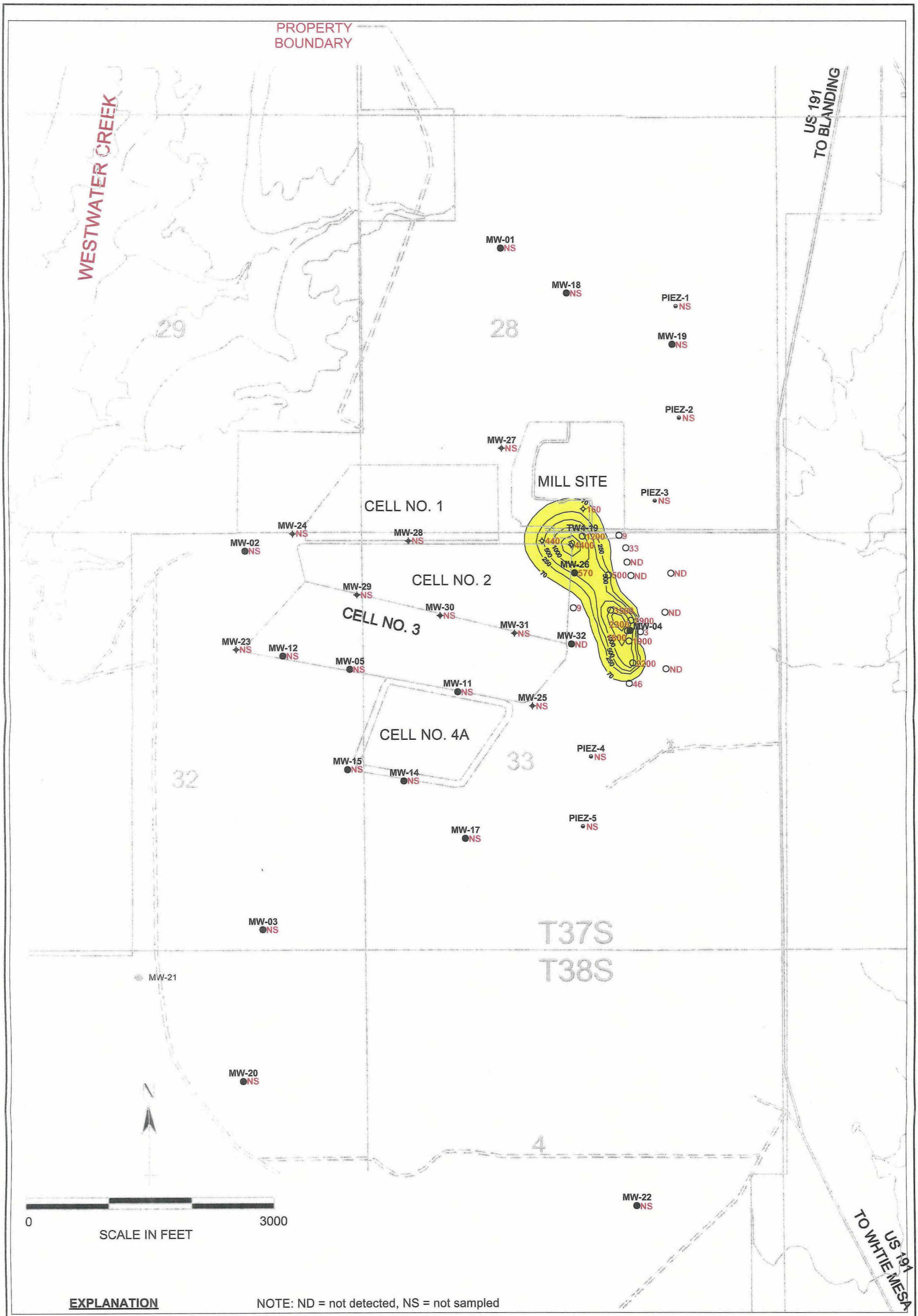
EXPLANATION

MW-20 ● 79	perched monitoring well showing depth to water in feet
○ 75	temporary perched monitoring well showing depth to water in feet
PIEZ-1 ⊖ 65	perched piezometer showing depth to water in feet
MW-31 ✦ 72	perched monitoring well installed April, 2005 showing depth to water in feet
✧ 58	temporary perched monitoring well installed April, 2005 showing depth to water in feet

HYDRO GEO CHEM, INC.

DEPTH TO PERCHED WATER 1st QUARTER 2007 WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ Corrective Action Plan/dtw0307.srf	11



EXPLANATION

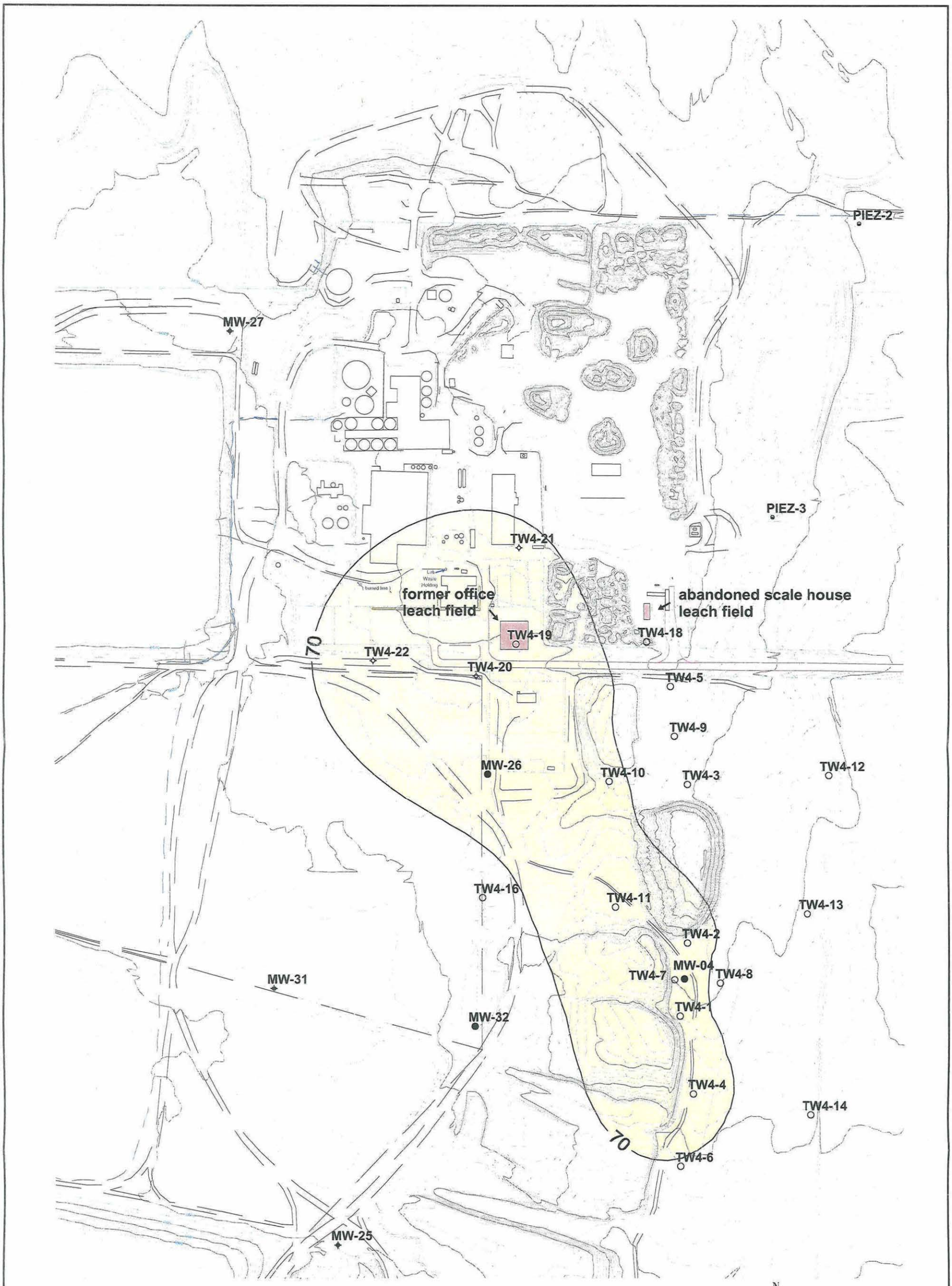
NOTE: ND = not detected, NS = not sampled

MW-4 2300	perched monitoring well showing concentration in uG/l
2200	temporary perched monitoring well showing concentration in uG/l
PIEZ-1 NS	perched piezometer (not sampled)
MW-32 ND	perched monitoring well installed April, 2005 showing concentration in uG/l
160	temporary perched monitoring well installed April, 2005 showing concentration in uG/l

HYDRO GEO CHEM, INC.

KRIGED 1st QUARTER 2007 CHLOROFORM (ug/L) WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ Corrective Action Plan/chl0307.srf	12



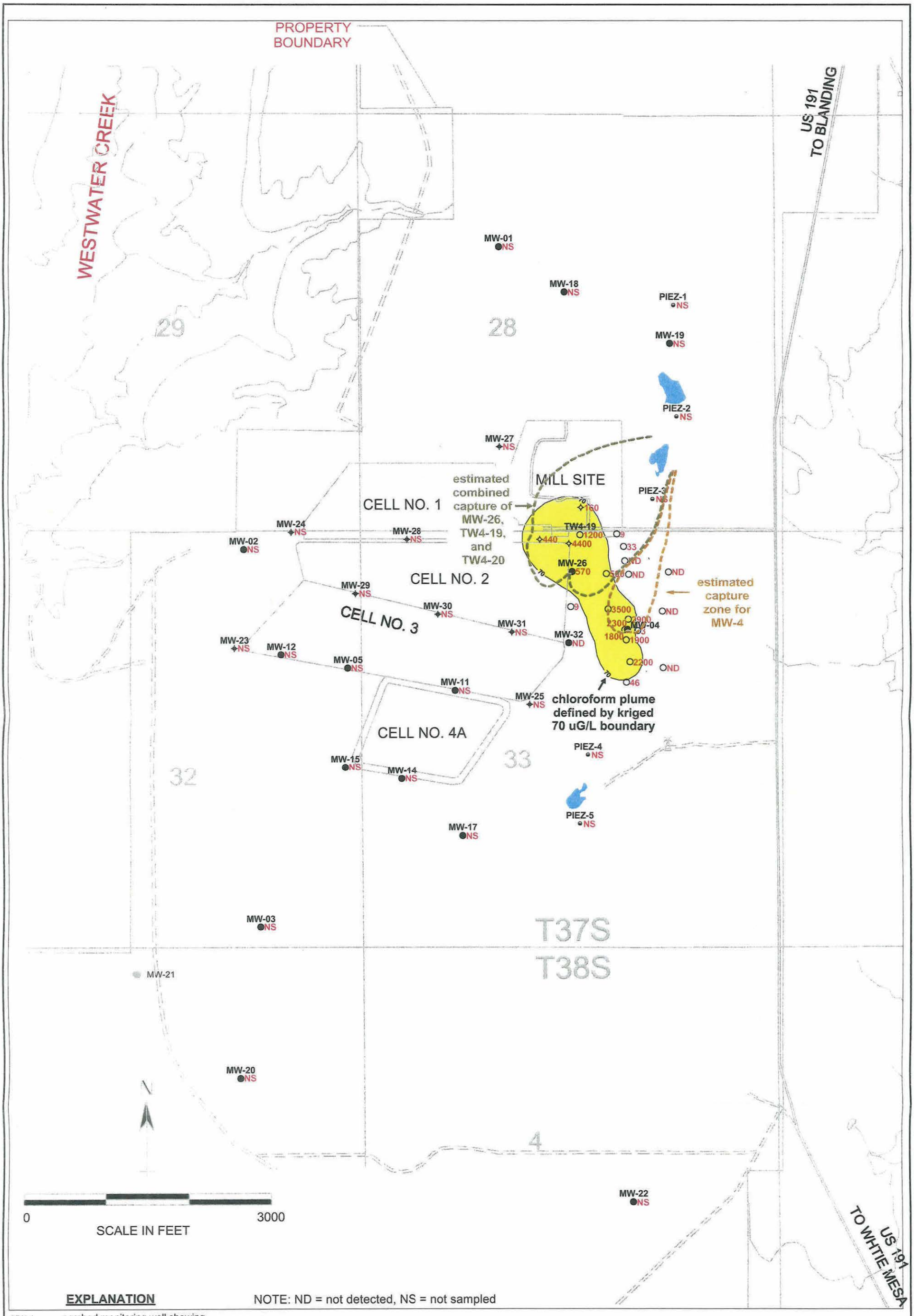
EXPLANATION

- inactive leach fields
- area of chloroform plume defined by kriged 70 uG/L boundary
- TW4-4 temporary perched monitoring well
- MW-32 perched monitoring well

HYDRO GEO CHEM, INC.

LOCATIONS OF ABANDONED SCALE HOUSE AND FORMER OFFICE LEACH FIELDS IN RELATION TO 1st QUARTER 2007 CHLOROFORM PLUME (detail map of northeastern portion of White Mesa Site)

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ Corrective Action Plan/leach.srf	13



EXPLANATION

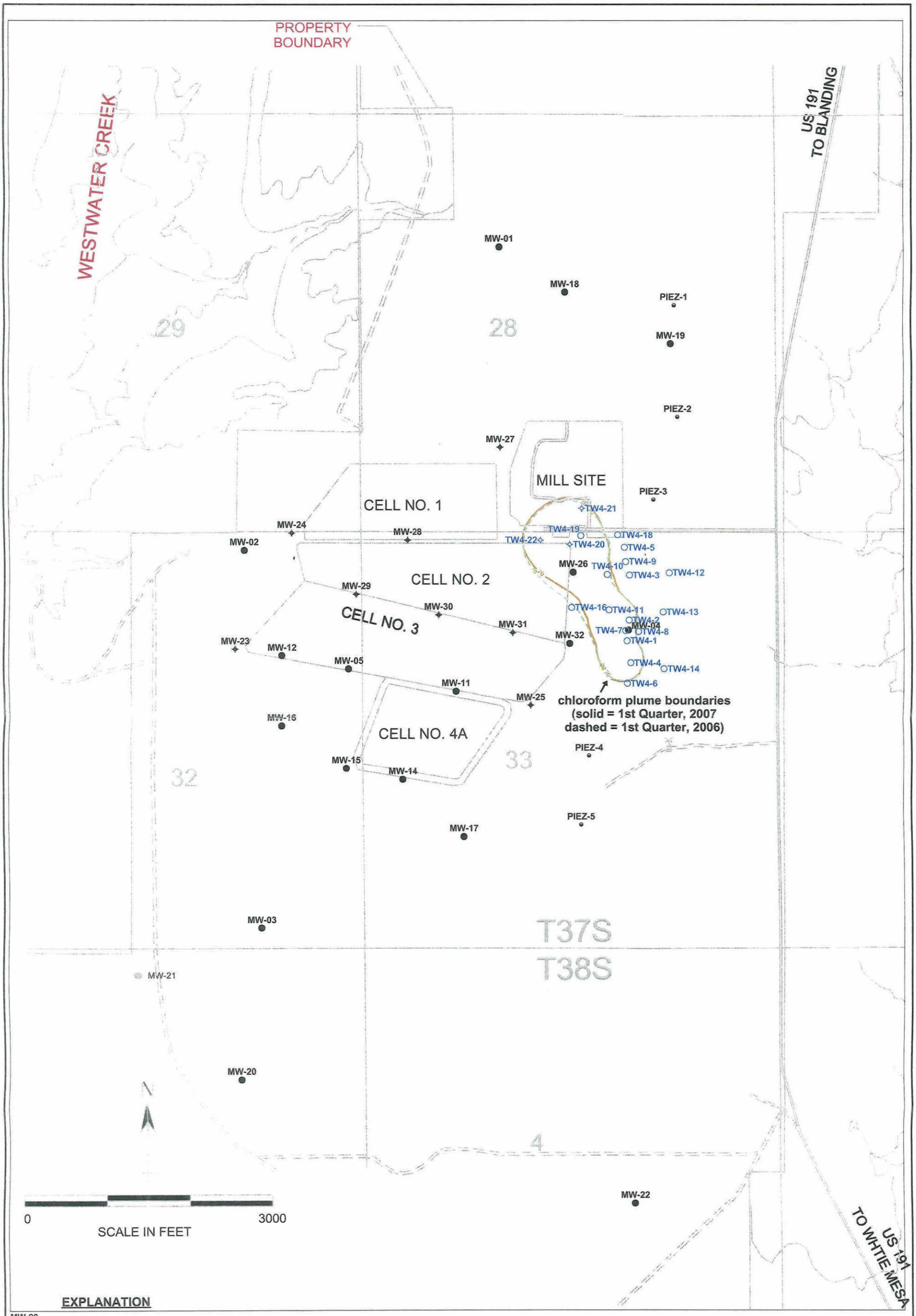
NOTE: ND = not detected, NS = not sampled

- MW-4 2300 — perched monitoring well showing concentration in uG/l
- 2200 — temporary perched monitoring well showing concentration in uG/l
- PIEZ-1 NS — perched piezometer (not sampled)
- MW-32 ND — perched monitoring well installed April, 2005 showing concentration in uG/l
- 160 — temporary perched monitoring well installed April, 2005 showing concentration in uG/l

HYDRO GEO CHEM, INC.

1st QUARTER 2007 CHLOROFORM PLUME SHOWING ESTIMATED CAPTURE ZONES WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/ Corrective Action Plan/chl0307cz.srf	14



EXPLANATION

MW-20	perched monitoring well
TW4-19	temporary perched monitoring well
PIEZ-1	perched piezometer
MW-31	perched monitoring well installed April, 2005
TW4-20	temporary perched monitoring well installed April,2005

HYDRO GEO CHEM, INC.

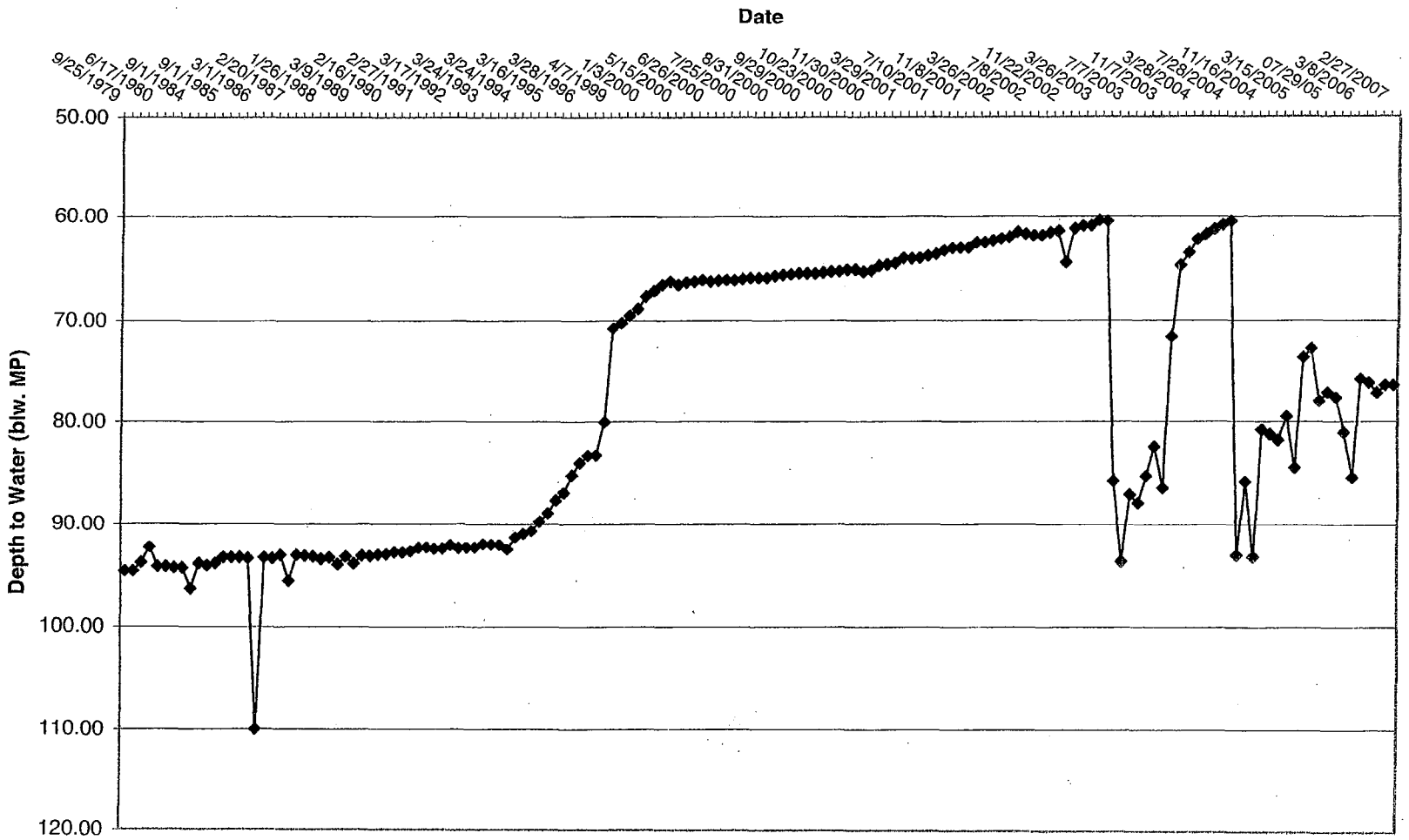
COMPARISON OF KRIGED 1st QUARTER 2007 AND 1st QUARTER 2006 CHLOROFORM PLUMES WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
SJS	8/16/2007	H:/718000/71801/CorrectiveActionPlan/chlcomp.srf	15

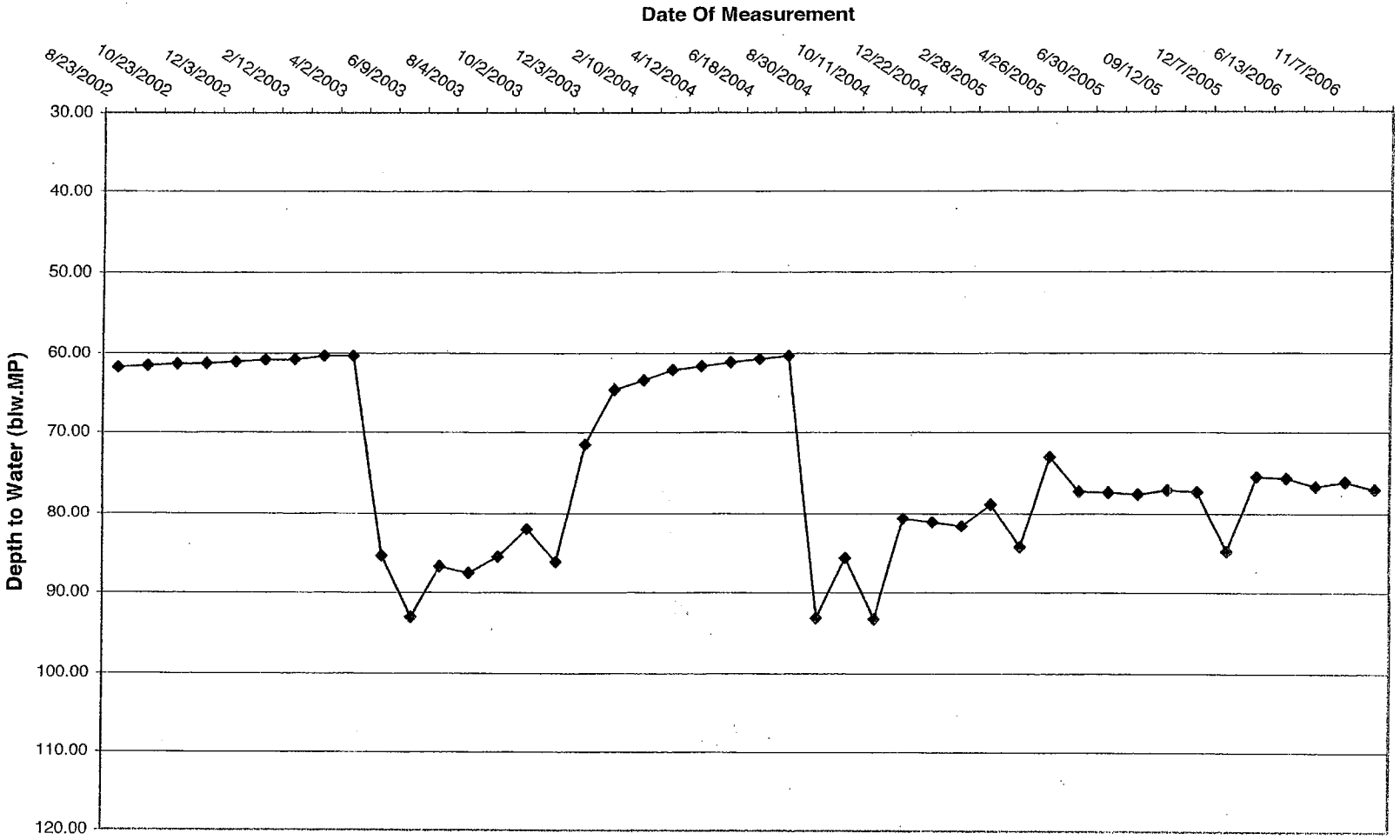
APPENDIX A

PERCHED MONITORING WELL HYDROGRAPHS

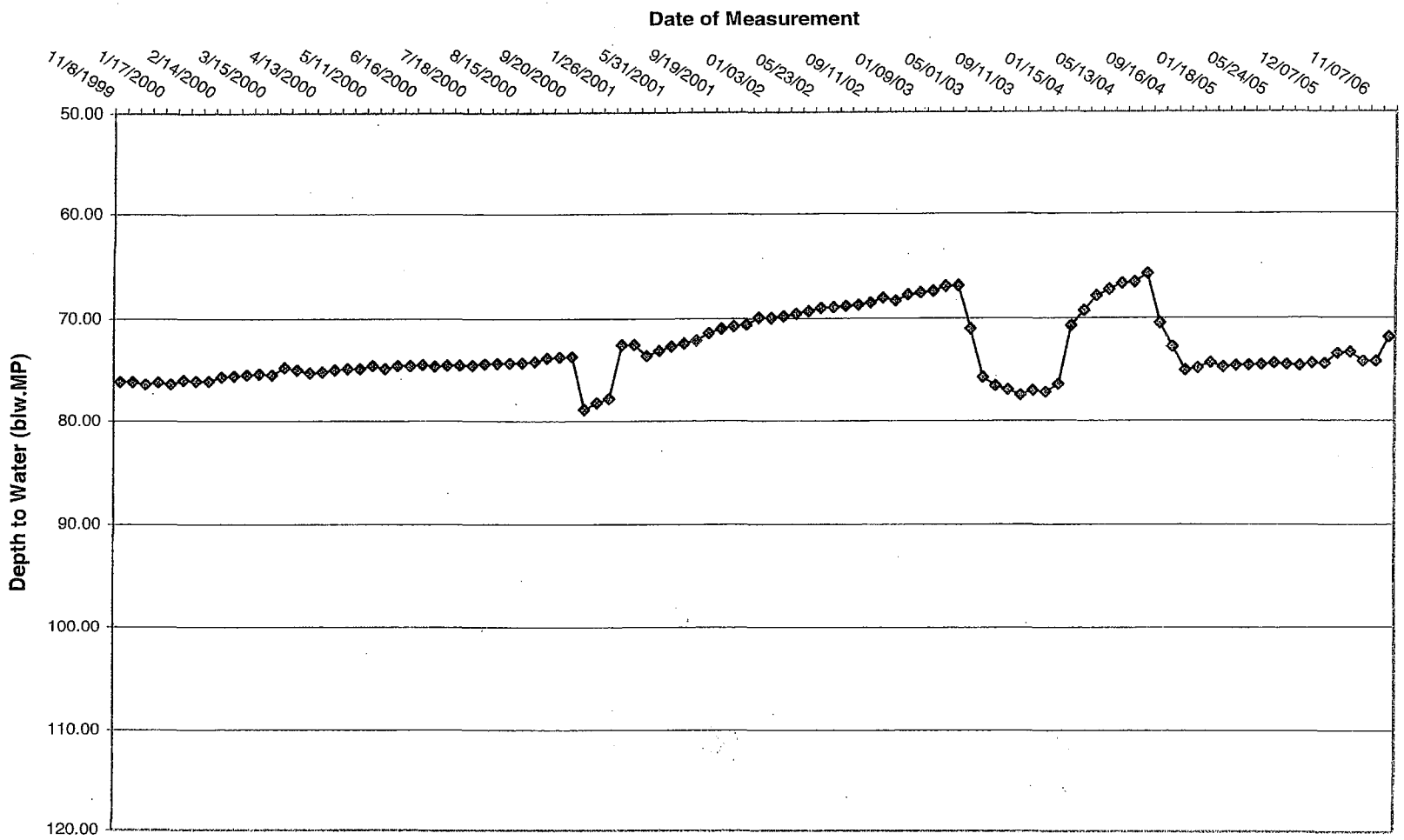
White Mesa Monitor Well 4 Depth Over Time



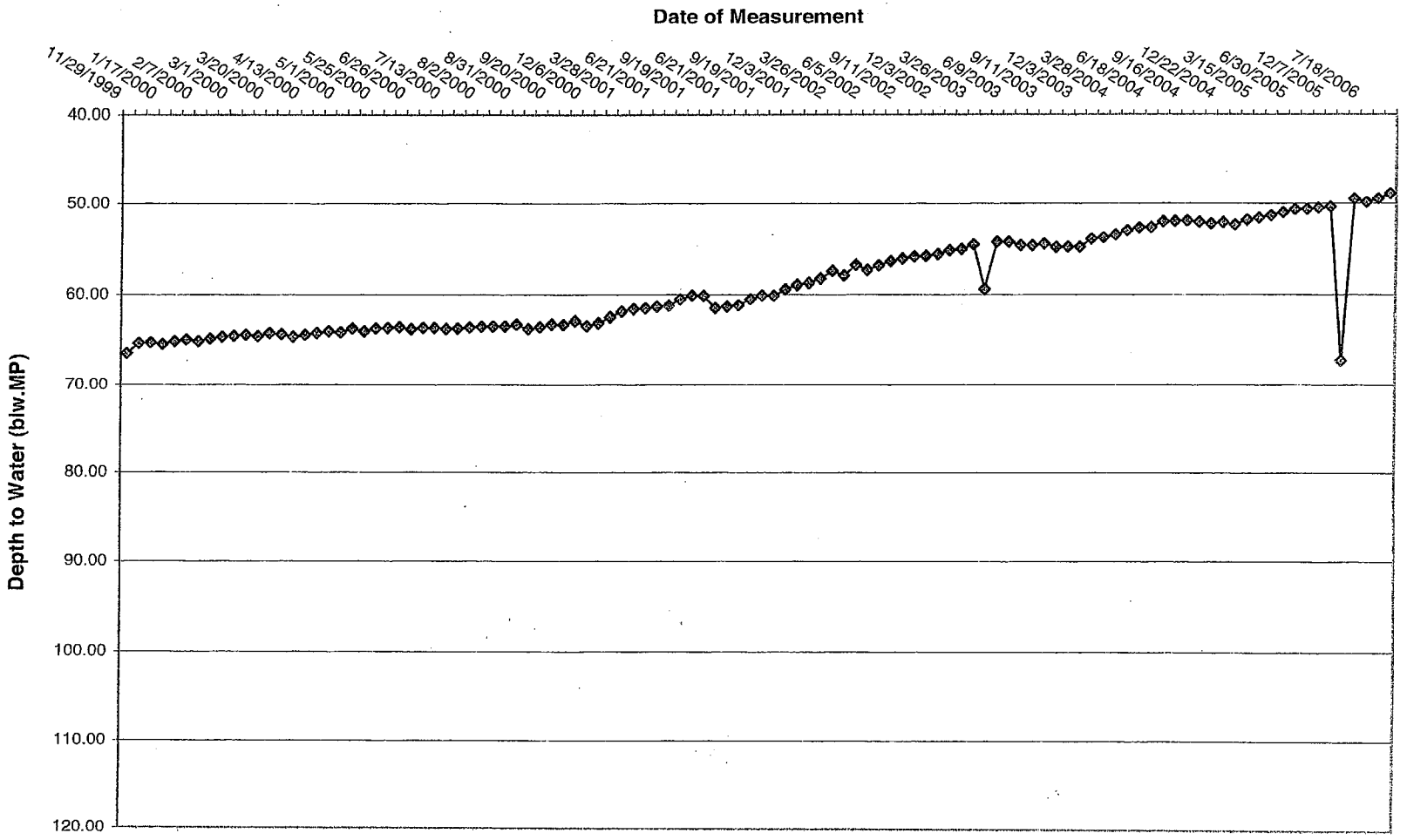
White Mesa Temporary Well (4-A) Over Time



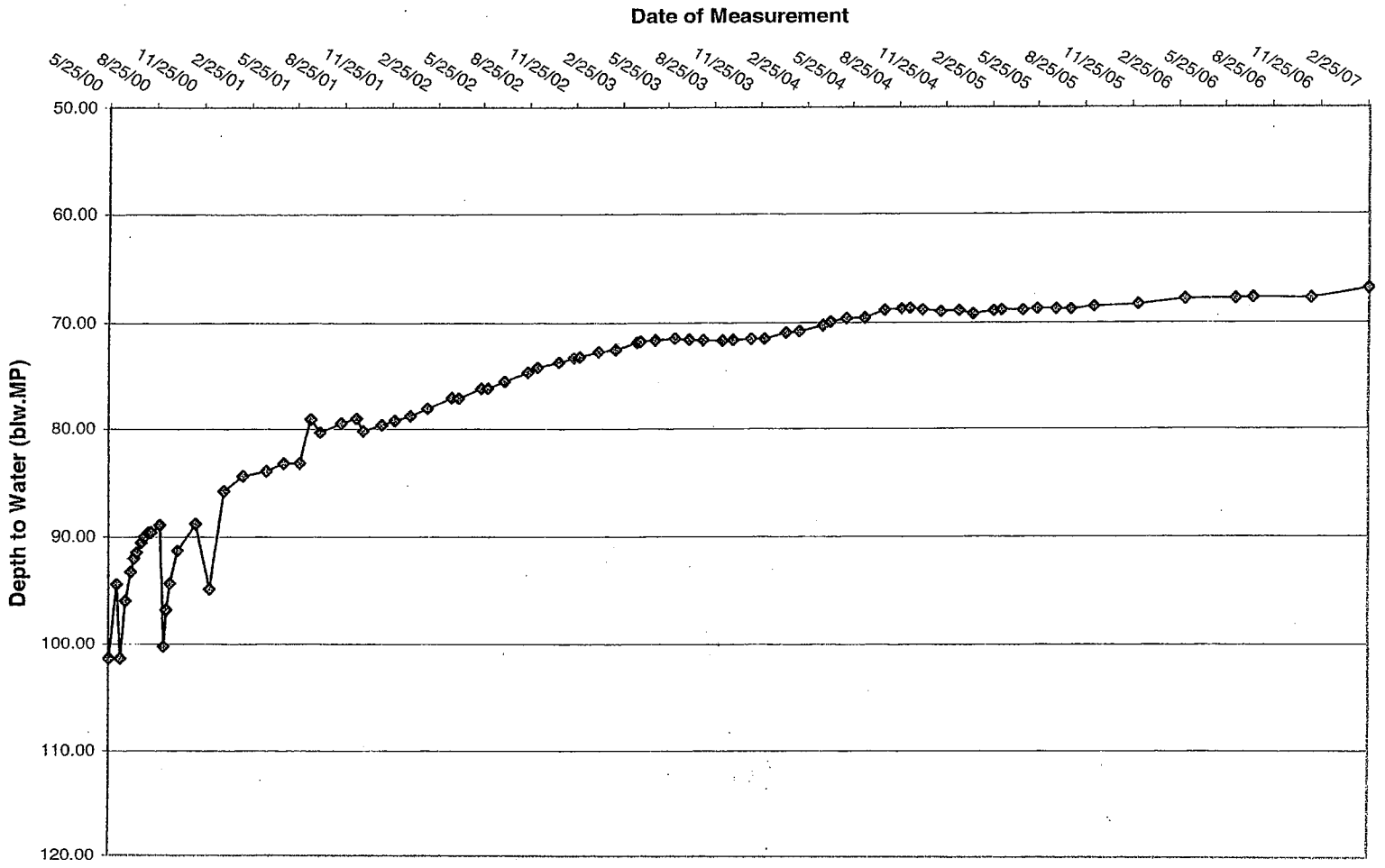
White Mesa Mill Temporary Well (4-2) Water Level Over Time



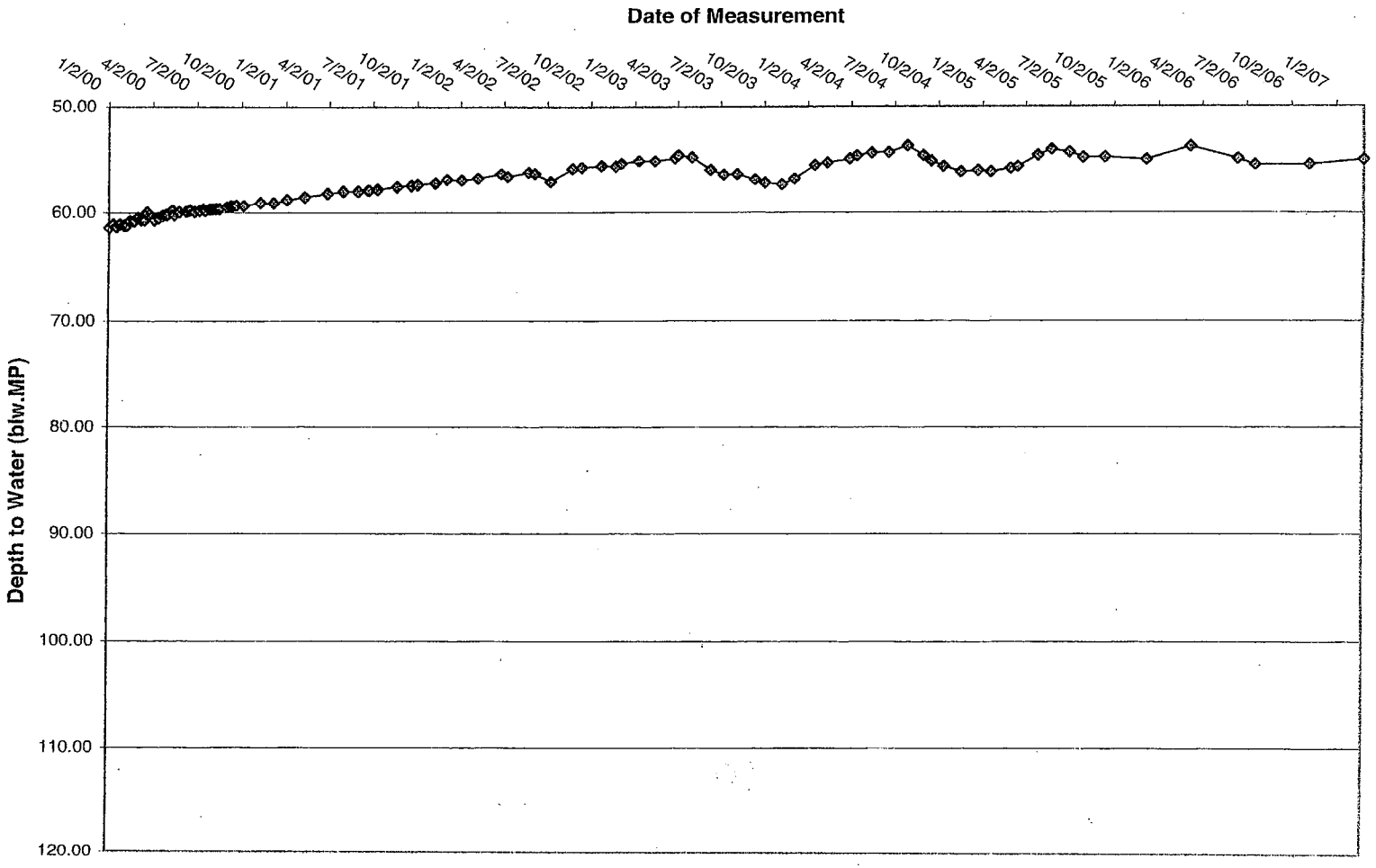
White Mesa Mill Temporary Well (4-3) Water Level Over Time



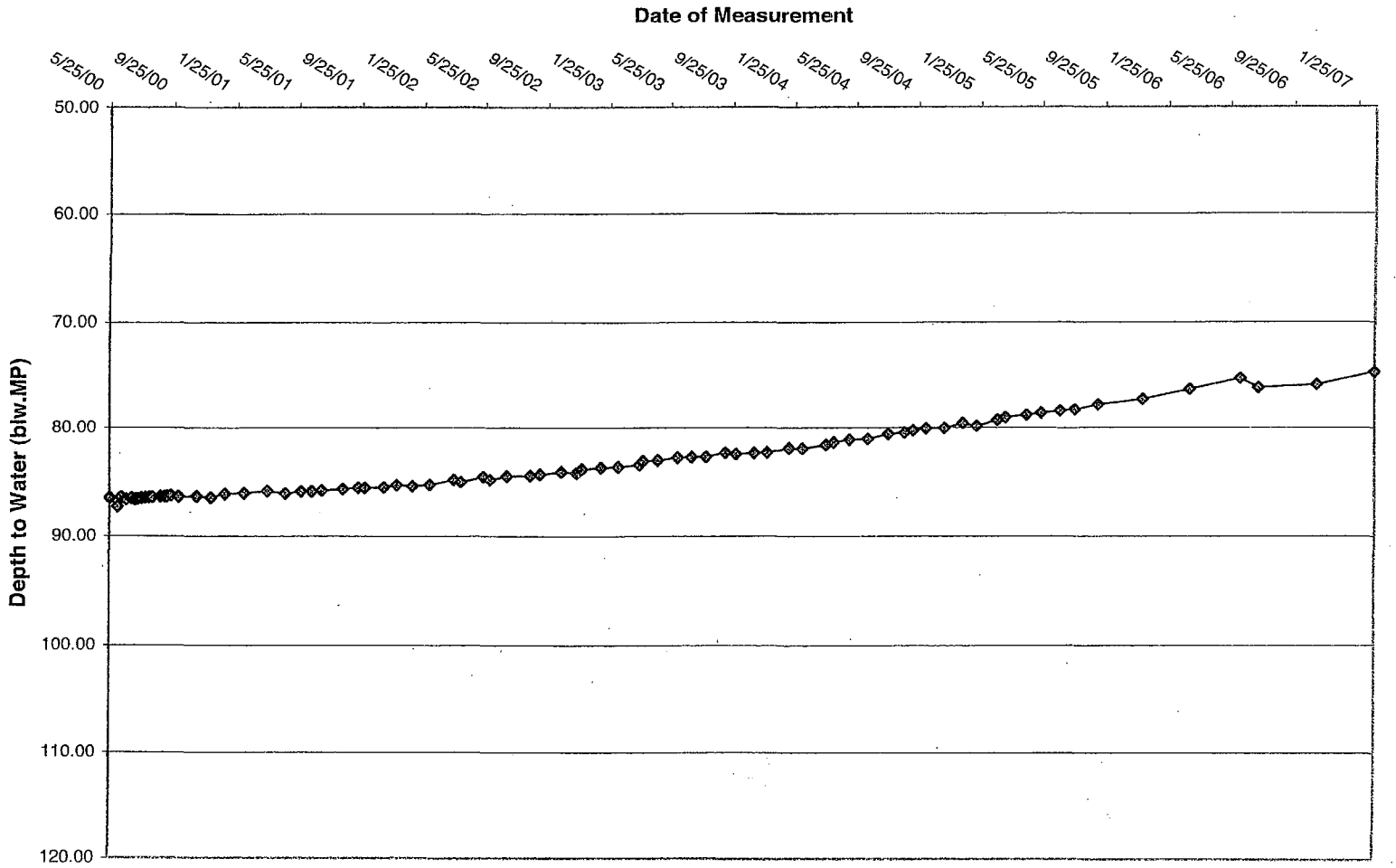
White Mesa Mill Temporary Well (4-4) Water Level Over Time



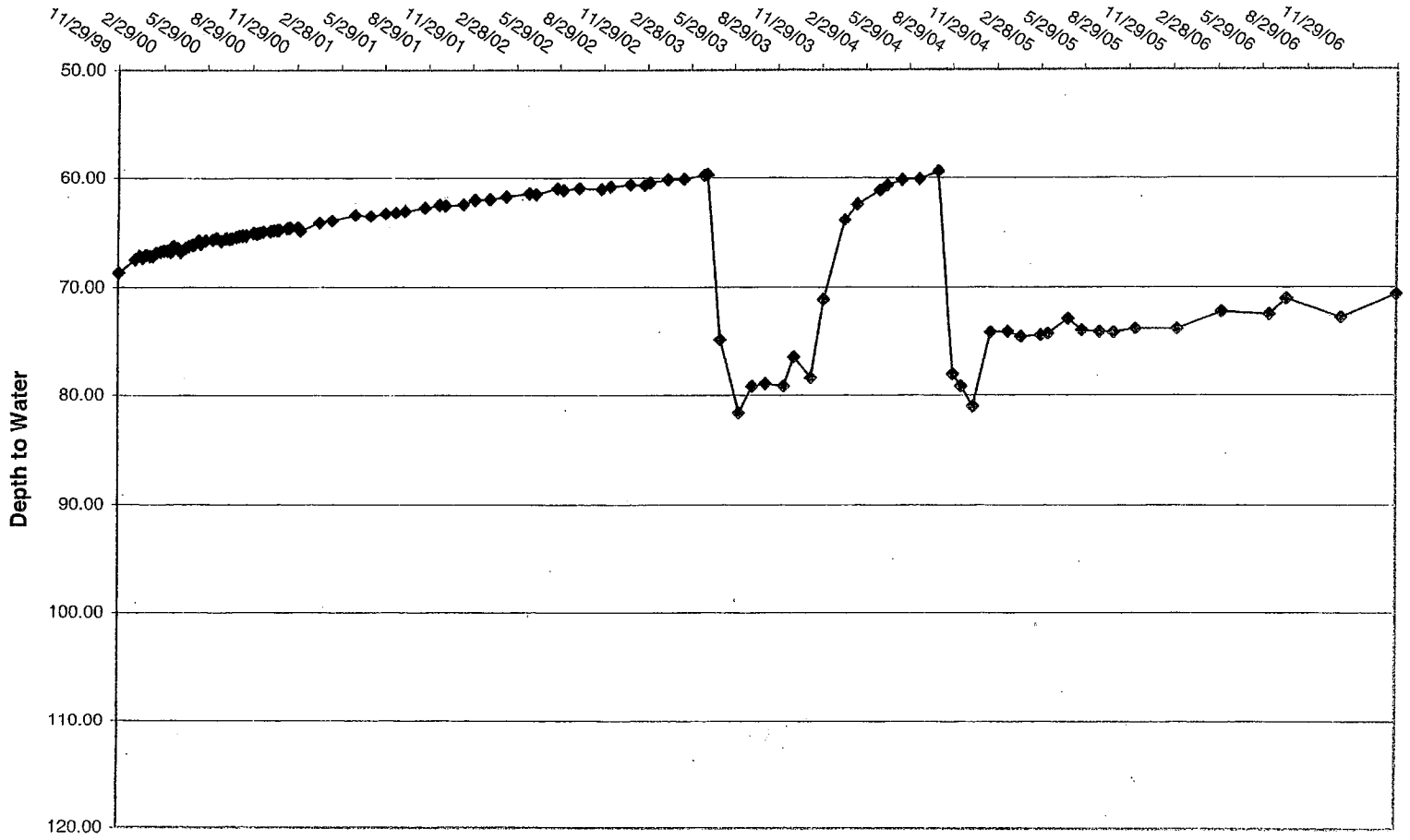
White Mesa Mill Temporary Well (4-5) Water Level Over Time



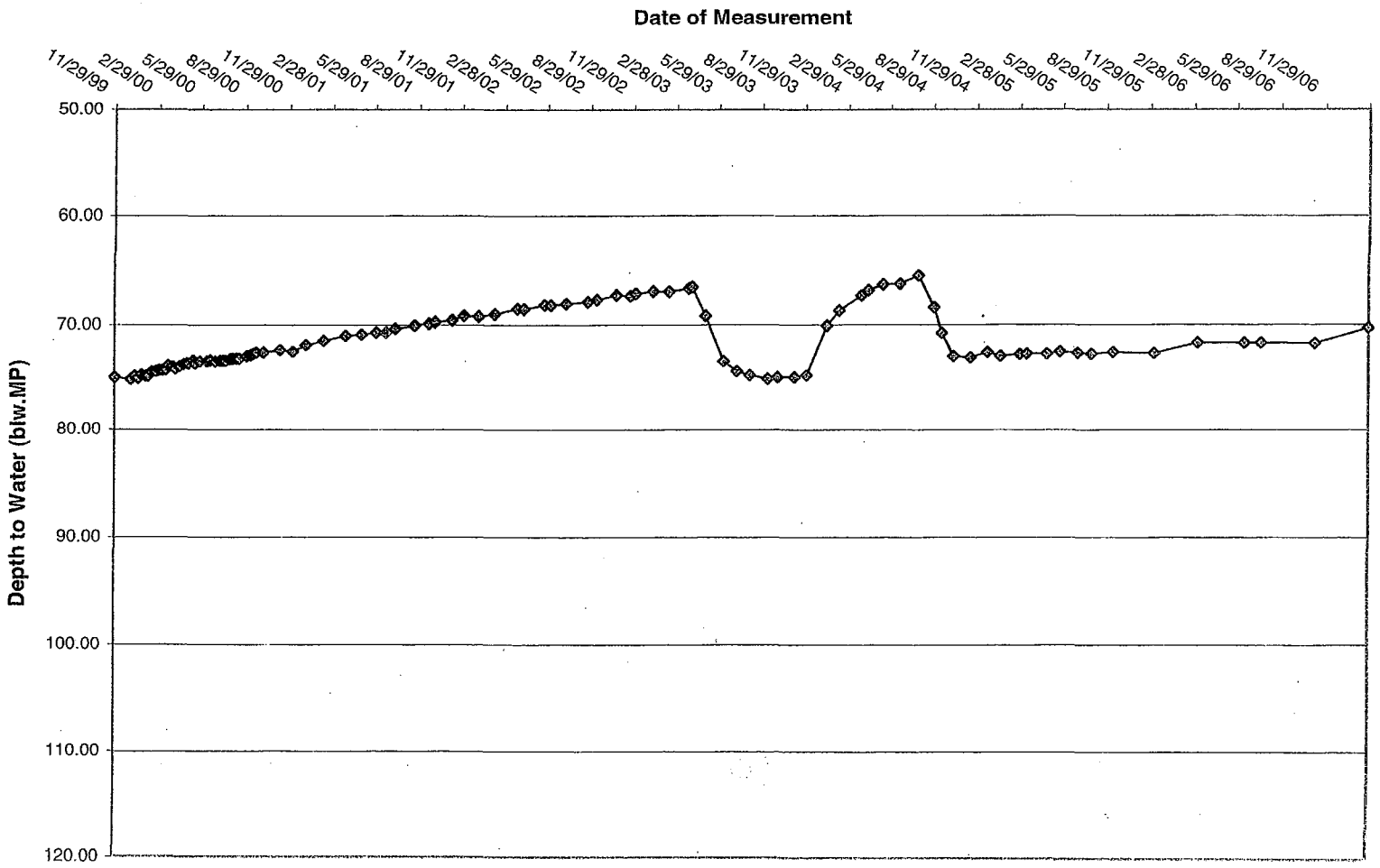
White Mesa Mill Temporary Well (4-6) Water Level Over Time



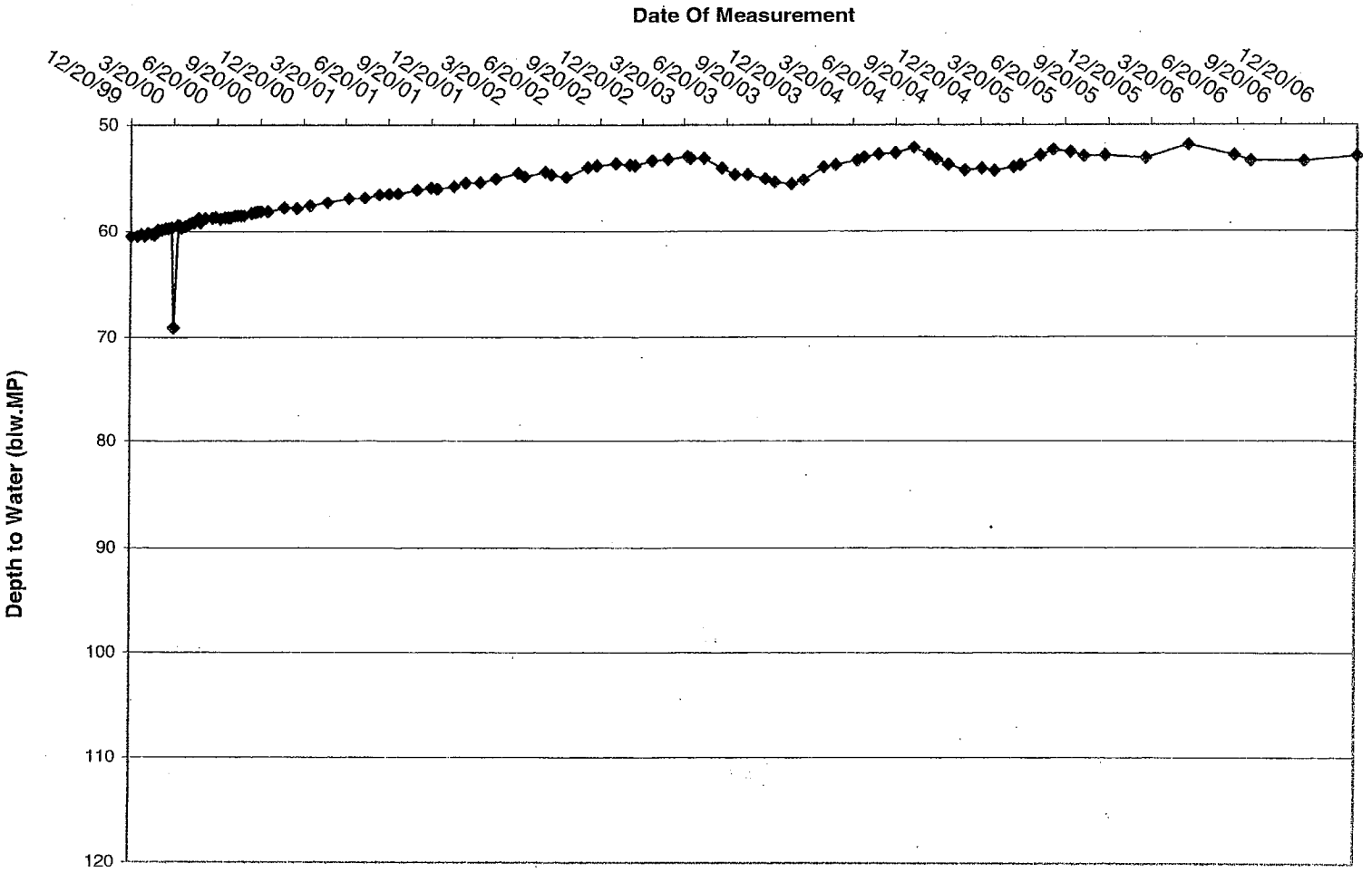
White Mesa Mill Temporary Well (4-7) Water Level Over Time



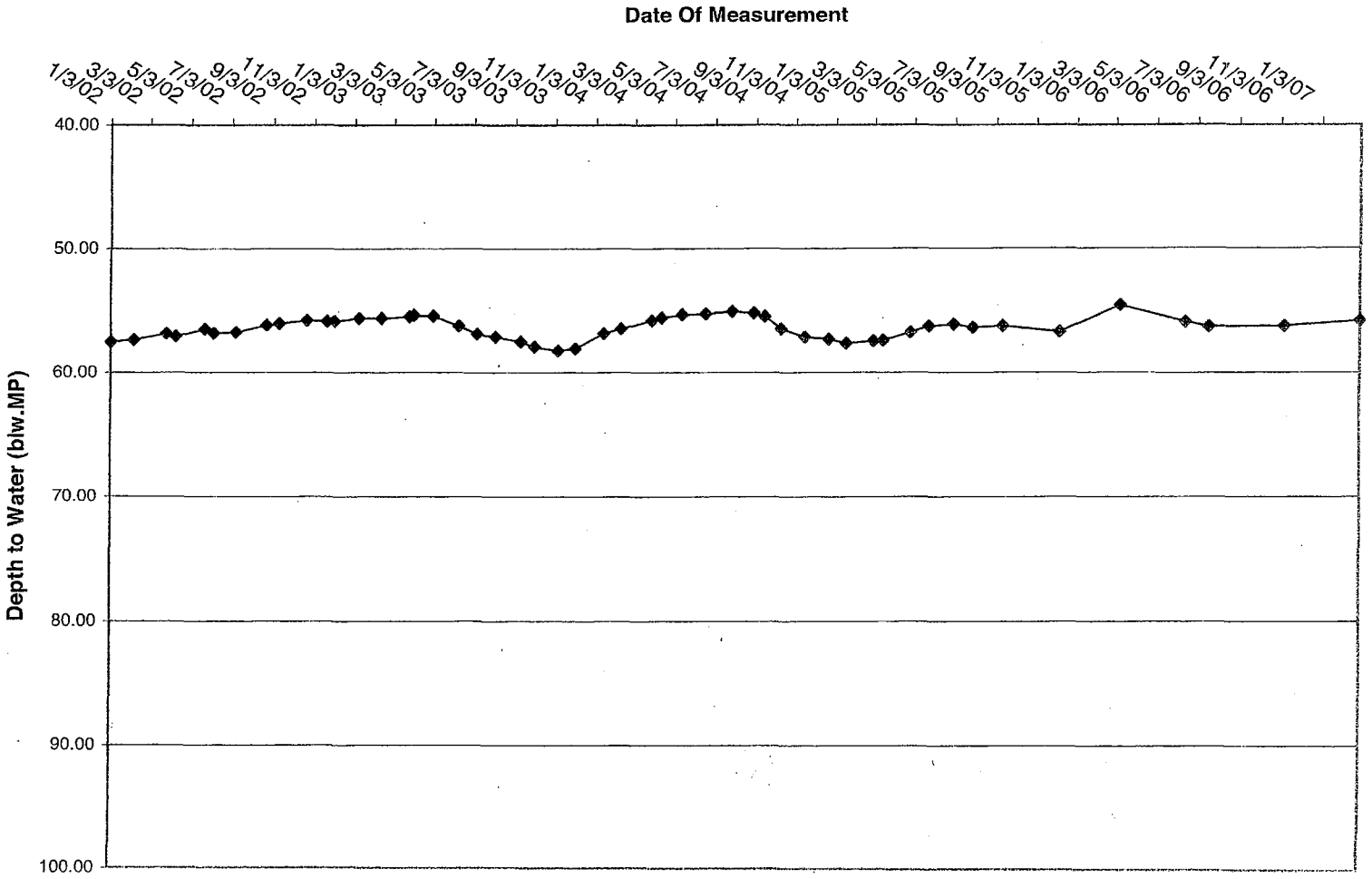
White Mesa Mill Temporary Well (4-8) Water Level Over Time



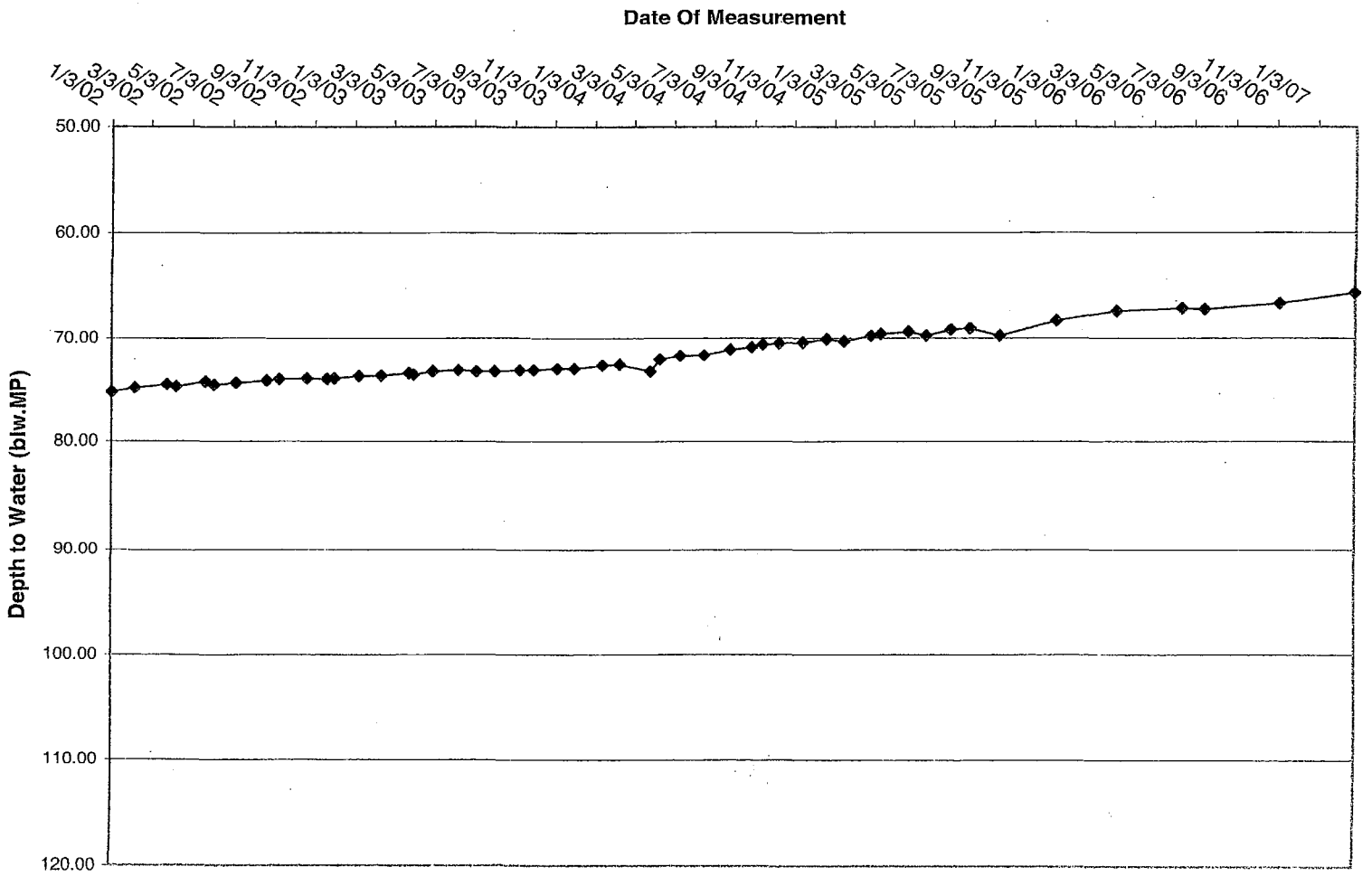
White Mesa Temporary Well (4-9) Over Time



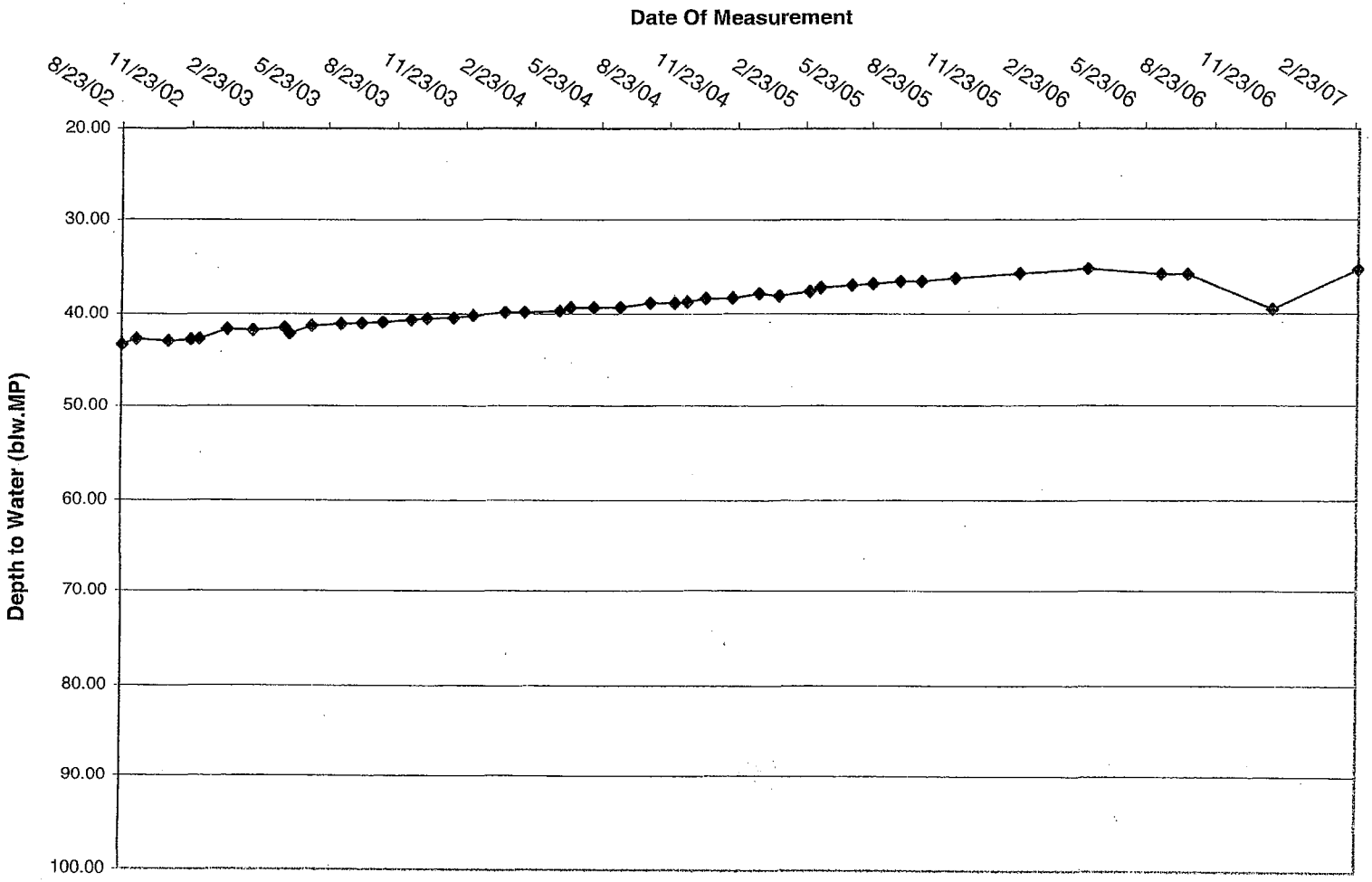
White Mesa Temporary Well (4-10) Over Time



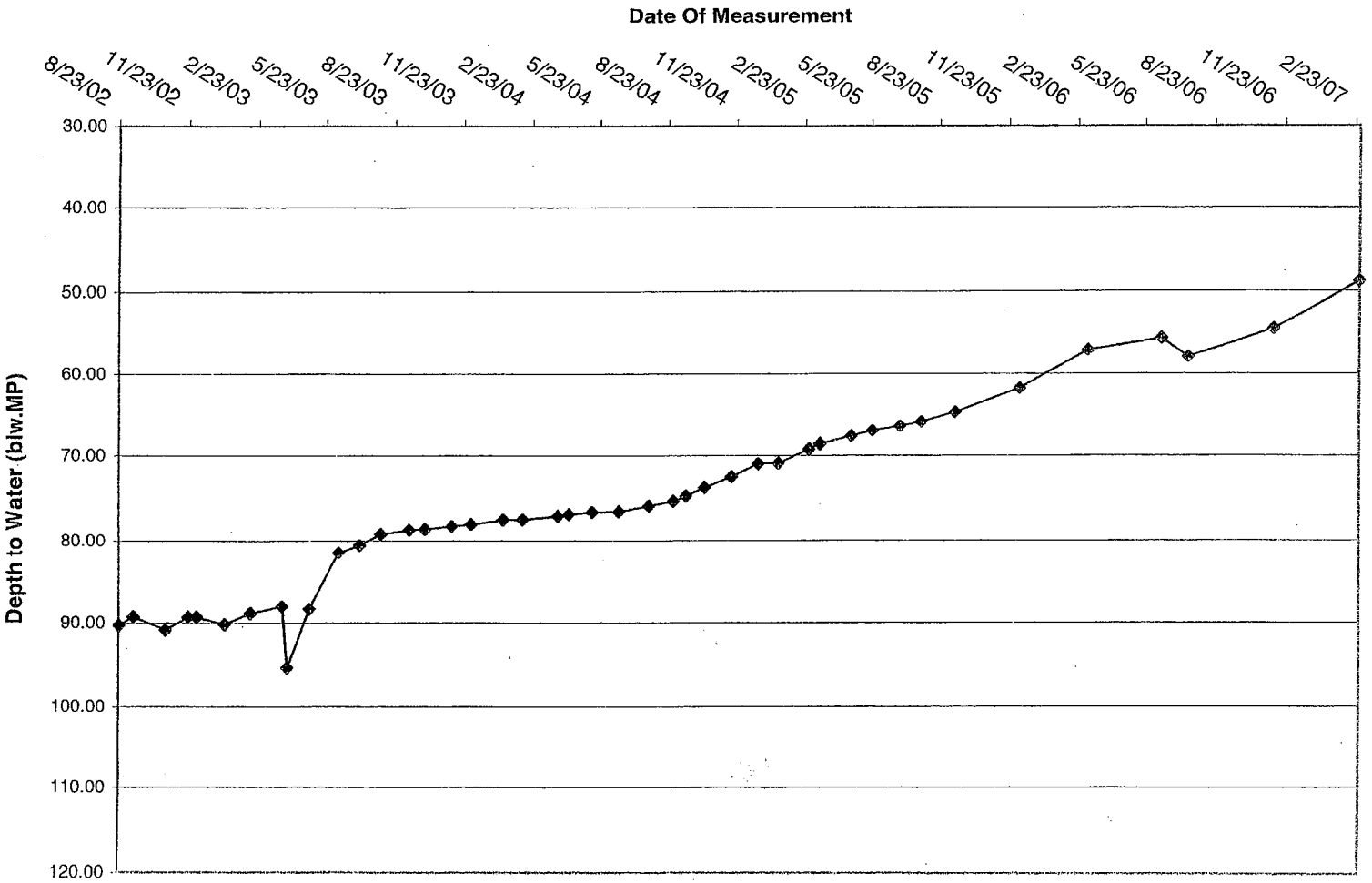
White Mesa Temporary Well (4-11) Over Time



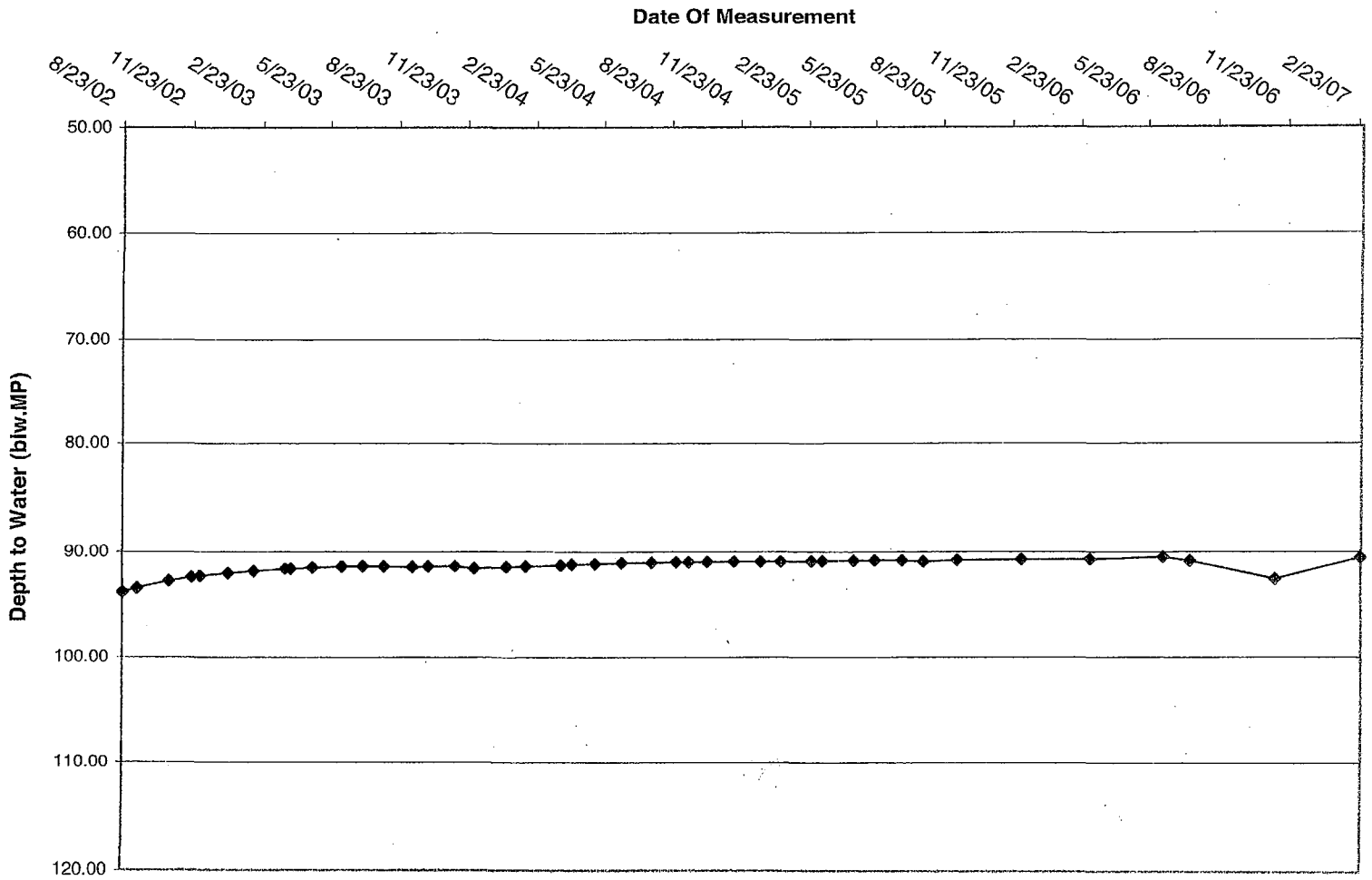
White Mesa Temporary Well (4-12) Over Time



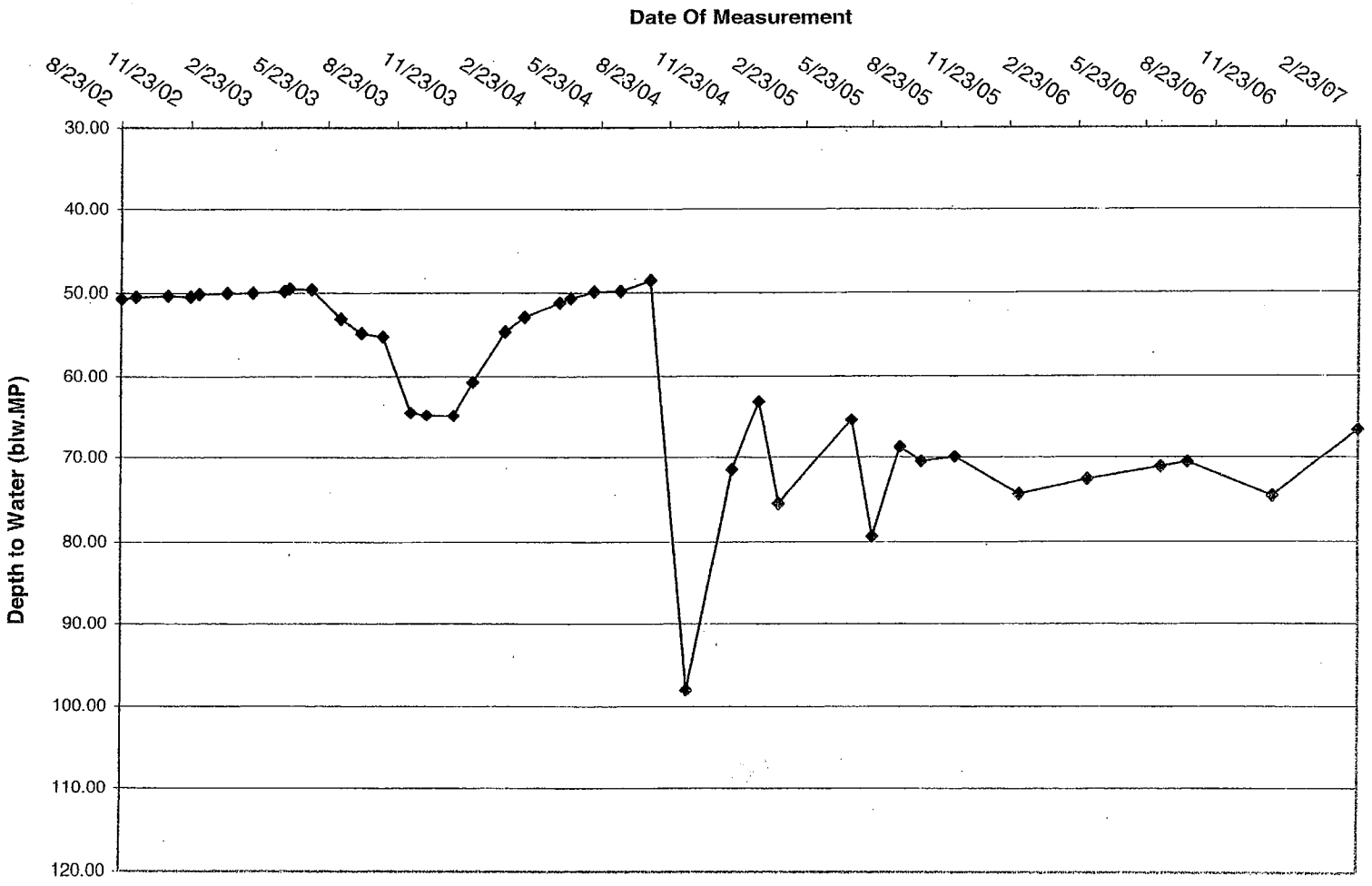
White Mesa Temporary Well (4-13) Over Time



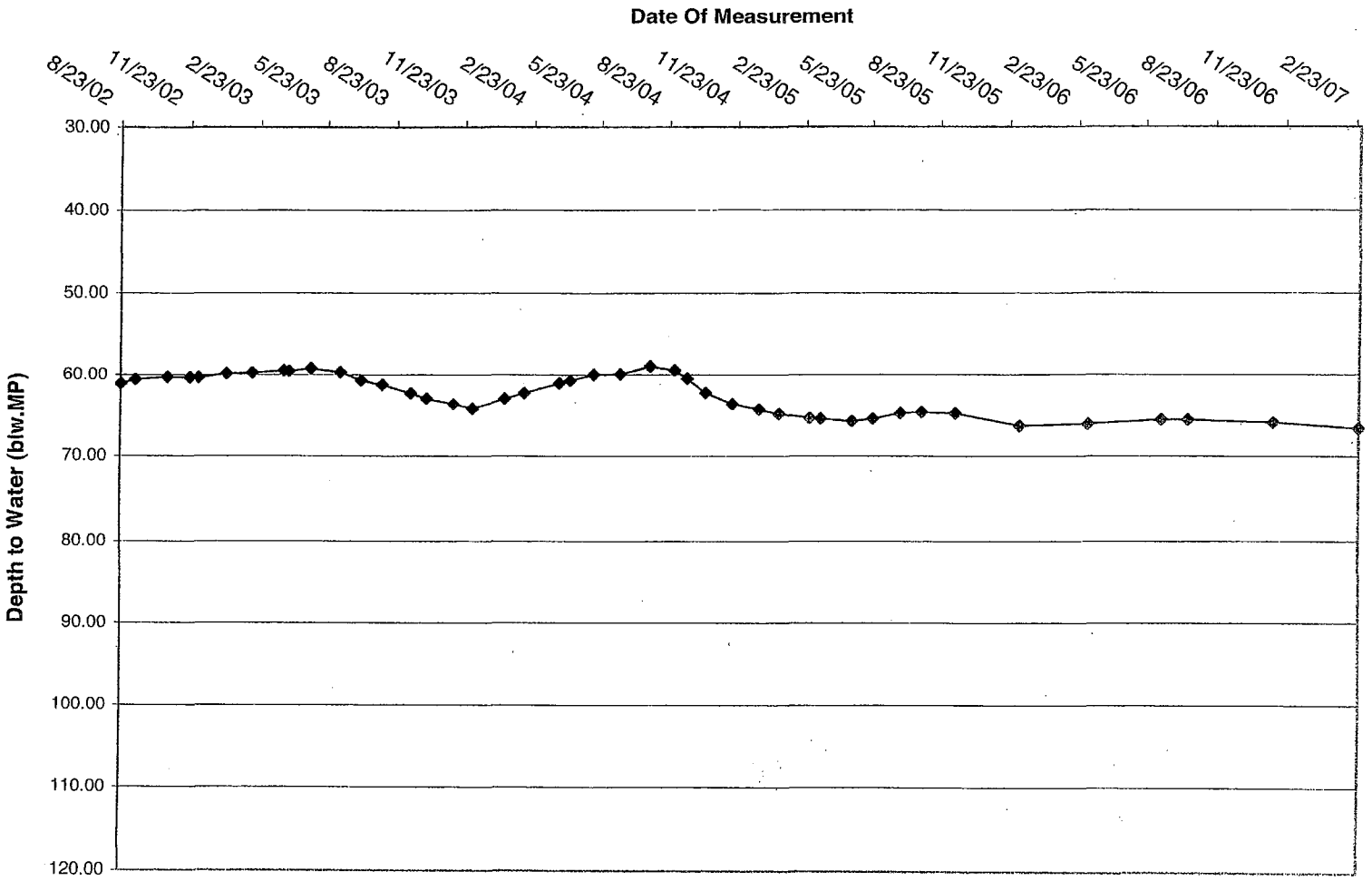
White Mesa Temporary Well (4-14) Over Time



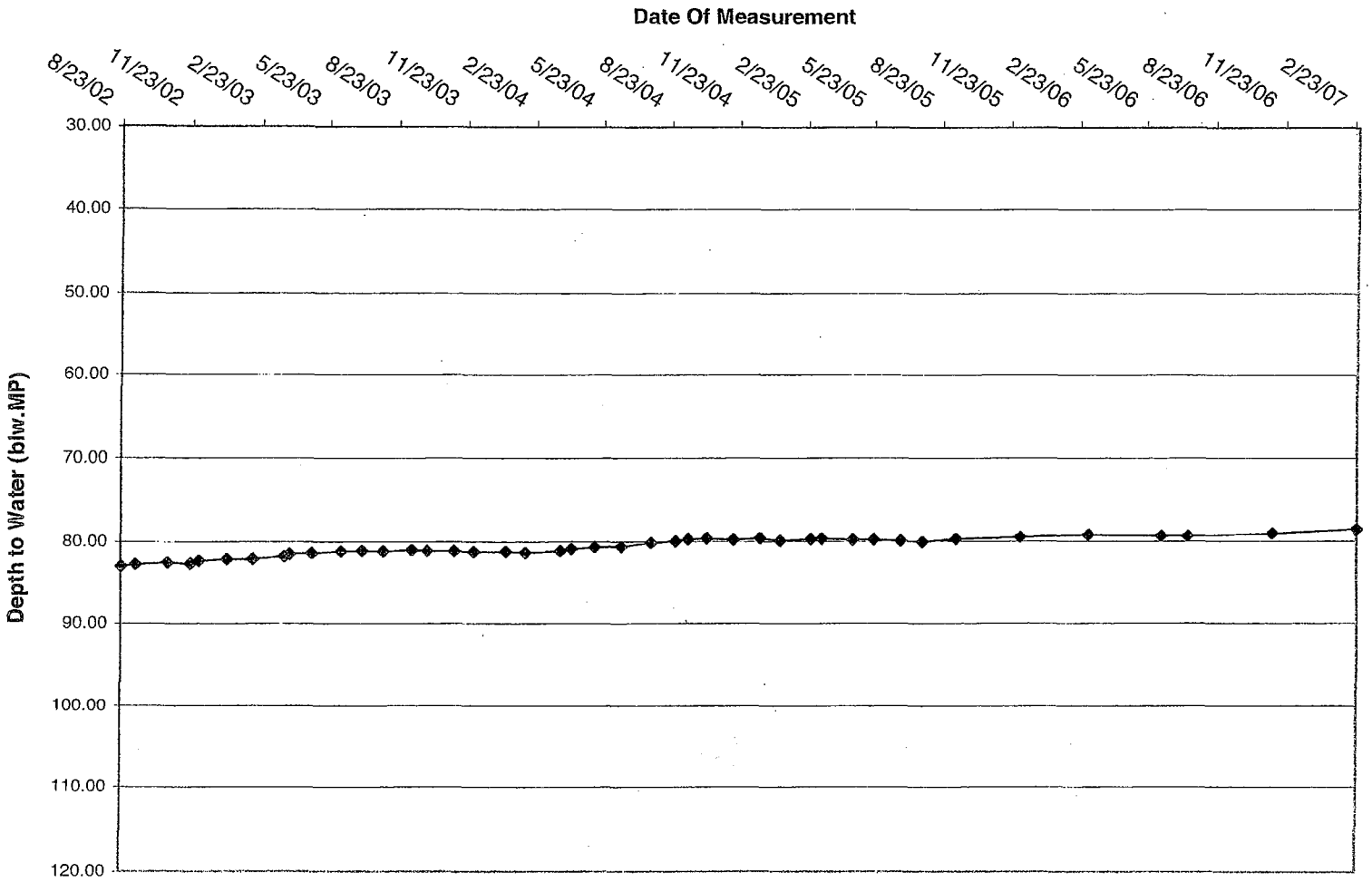
White Mesa Temporary Well (4-15) (MW-26) Over Time



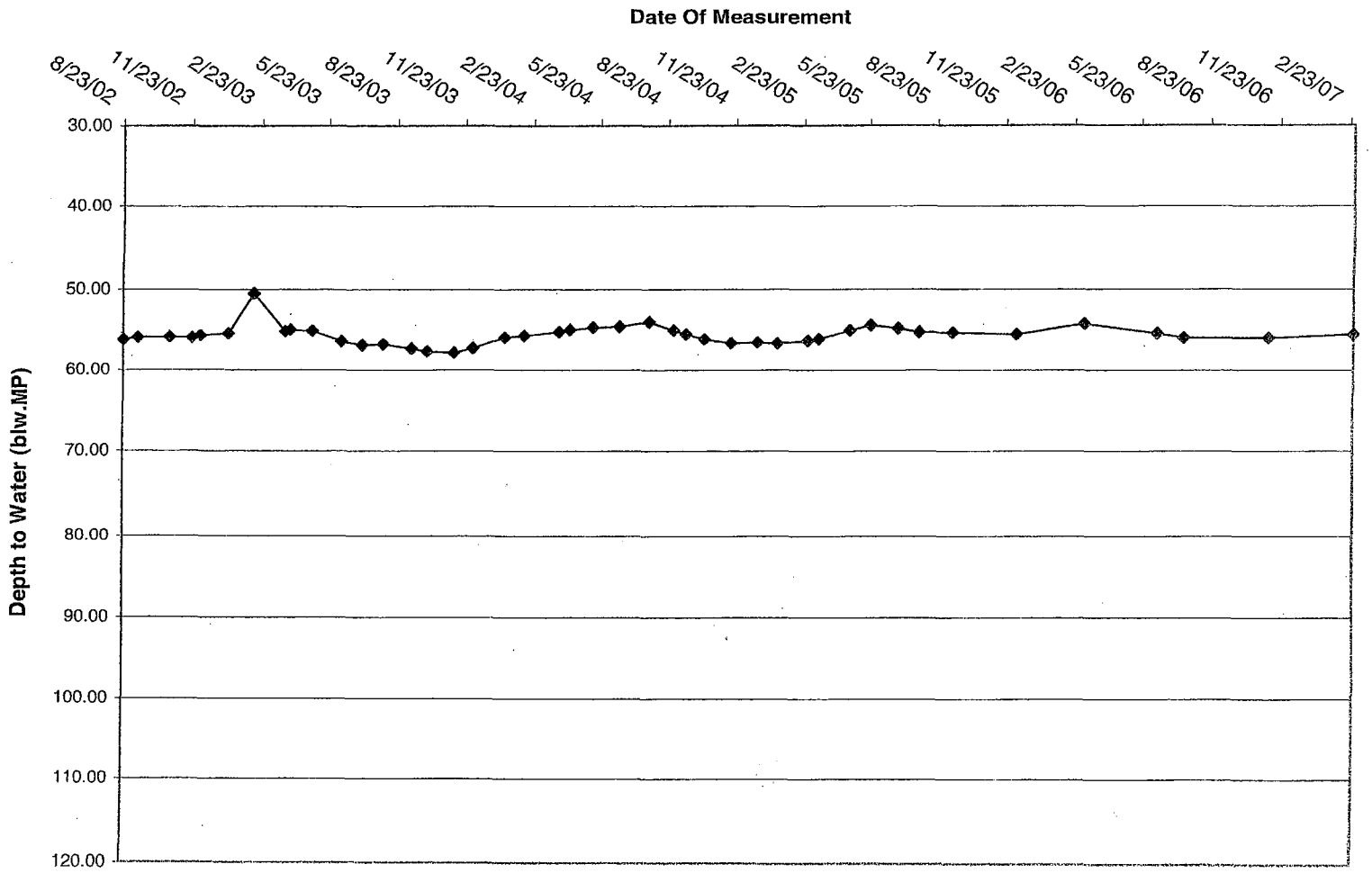
White Mesa Temporary Well (4-16) Over Time



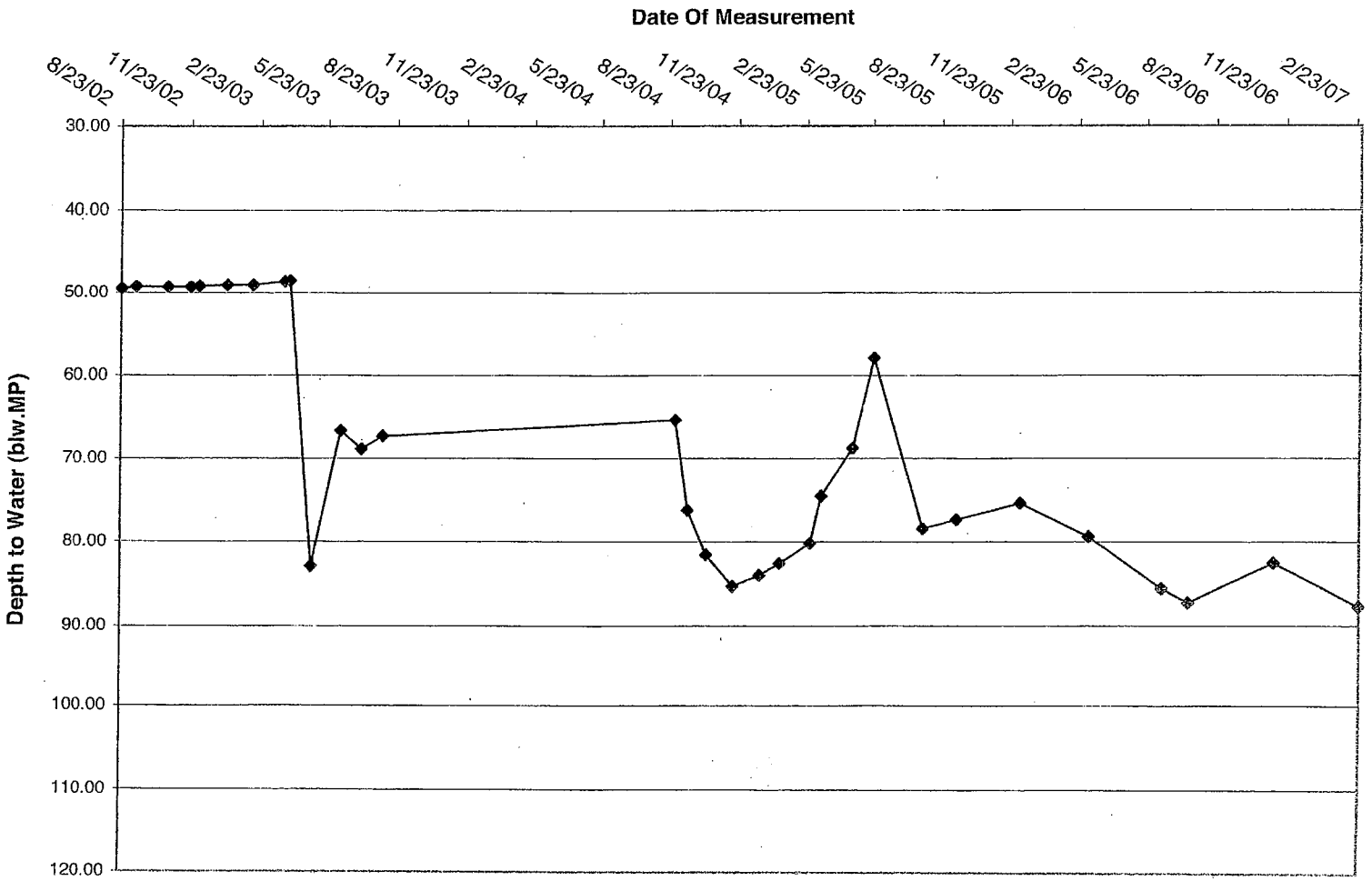
White Mesa Temporary Well (4-17) (MW-32) Over Time



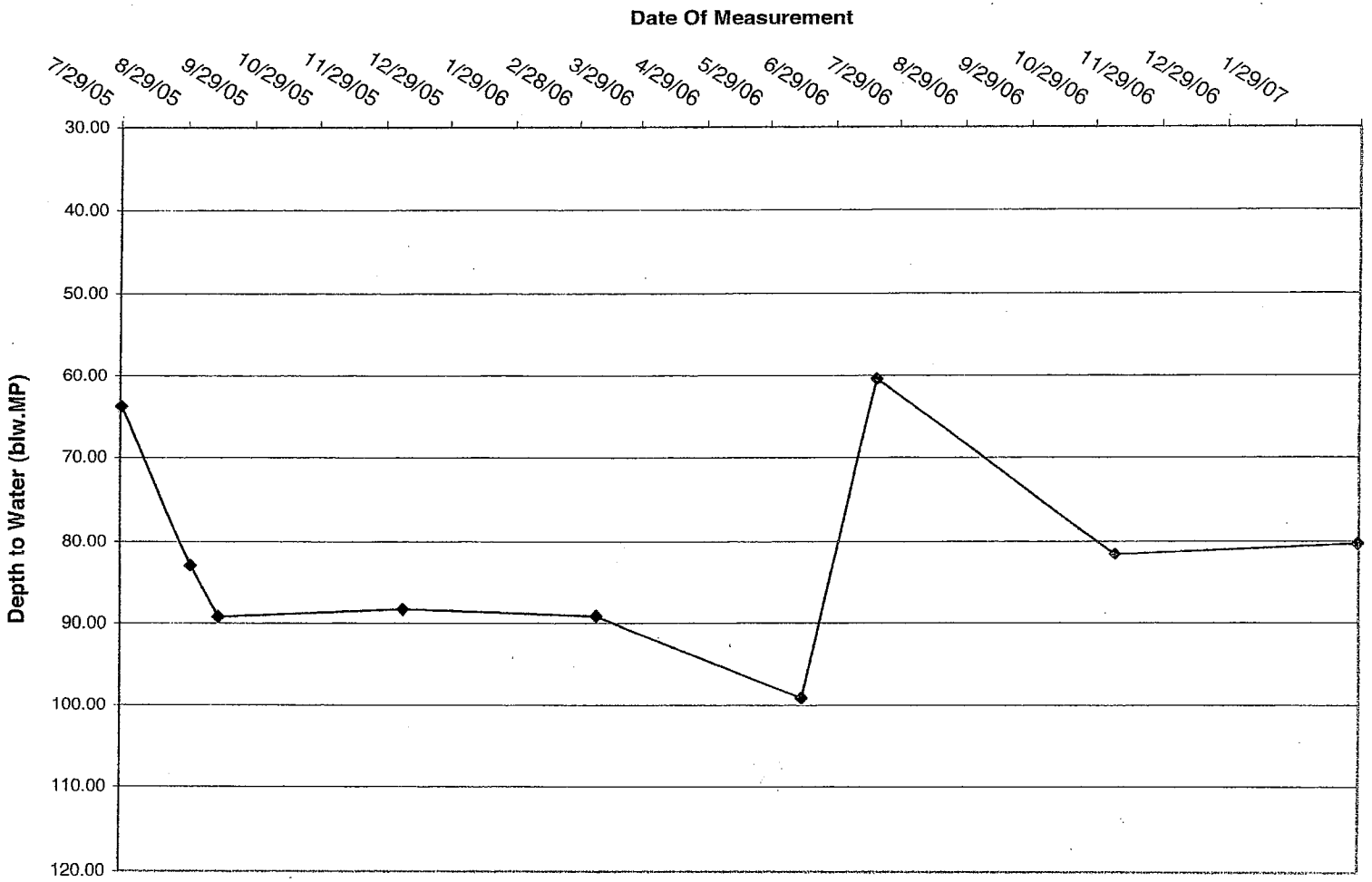
White Mesa Temporary Well (4-18) Over Time



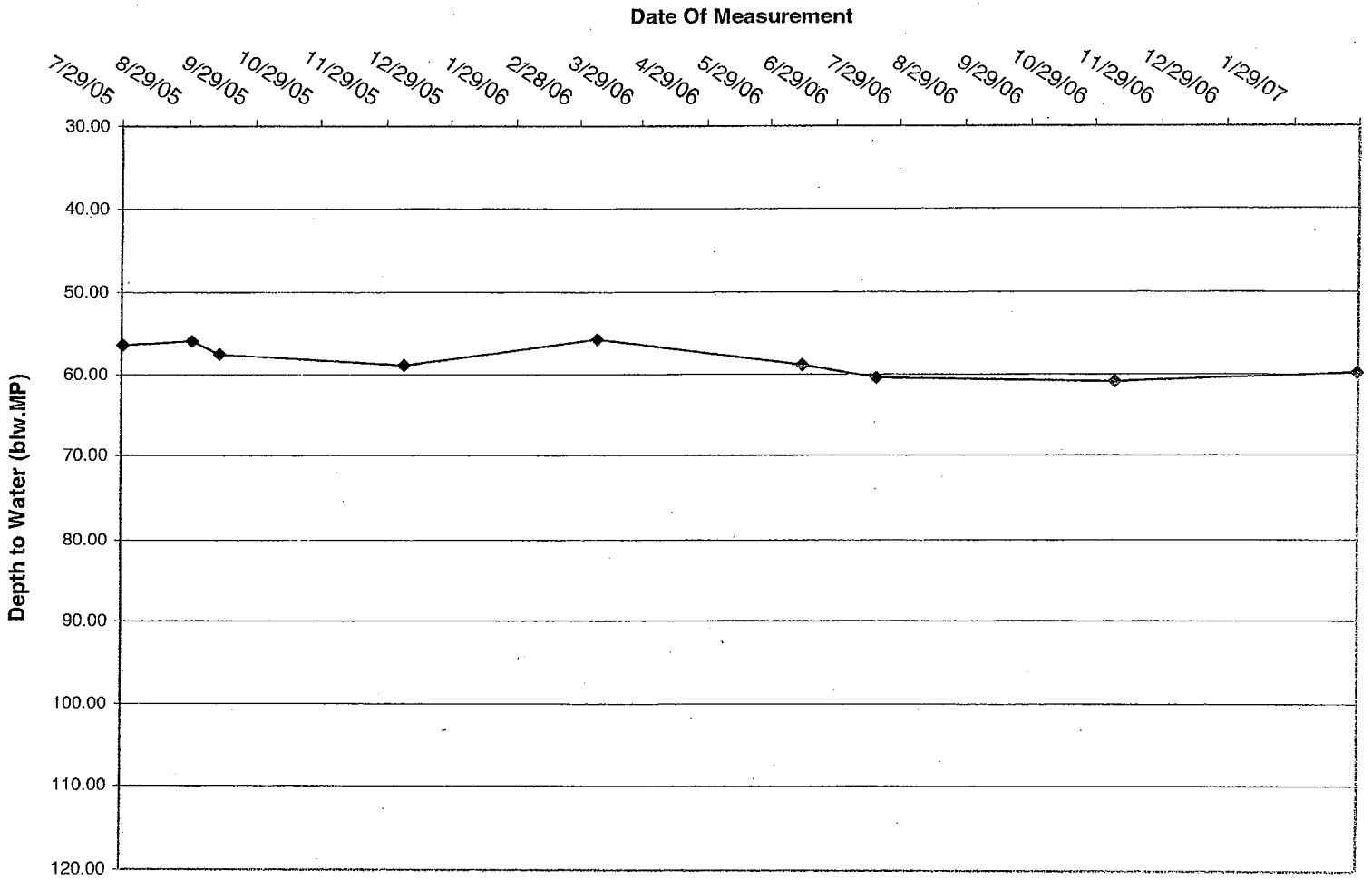
White Mesa Temporary Well (4-19) Over Time



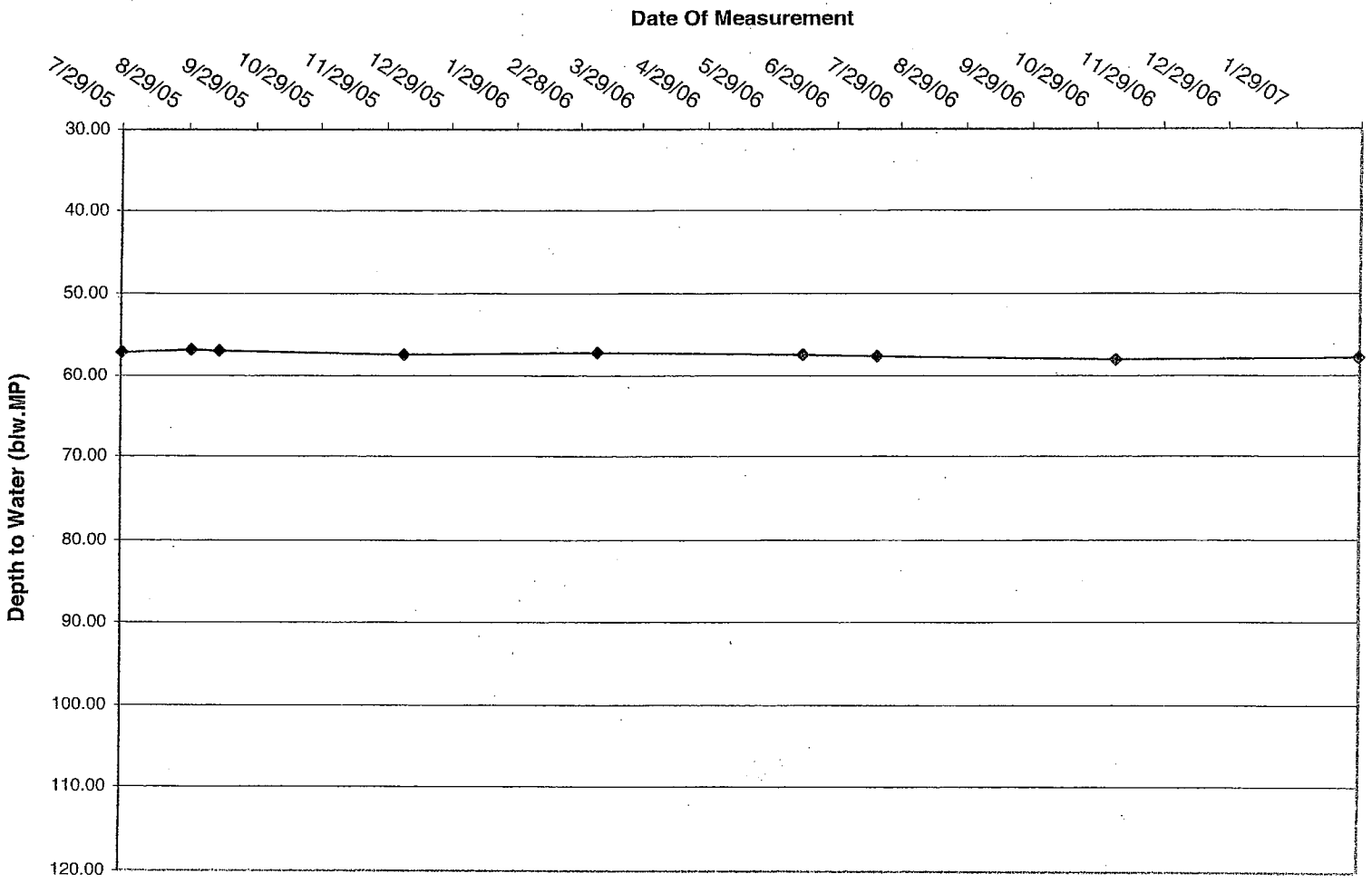
White Mesa Temporary Well (4-20) Over Time



White Mesa Temporary Well (4-21) Over Time

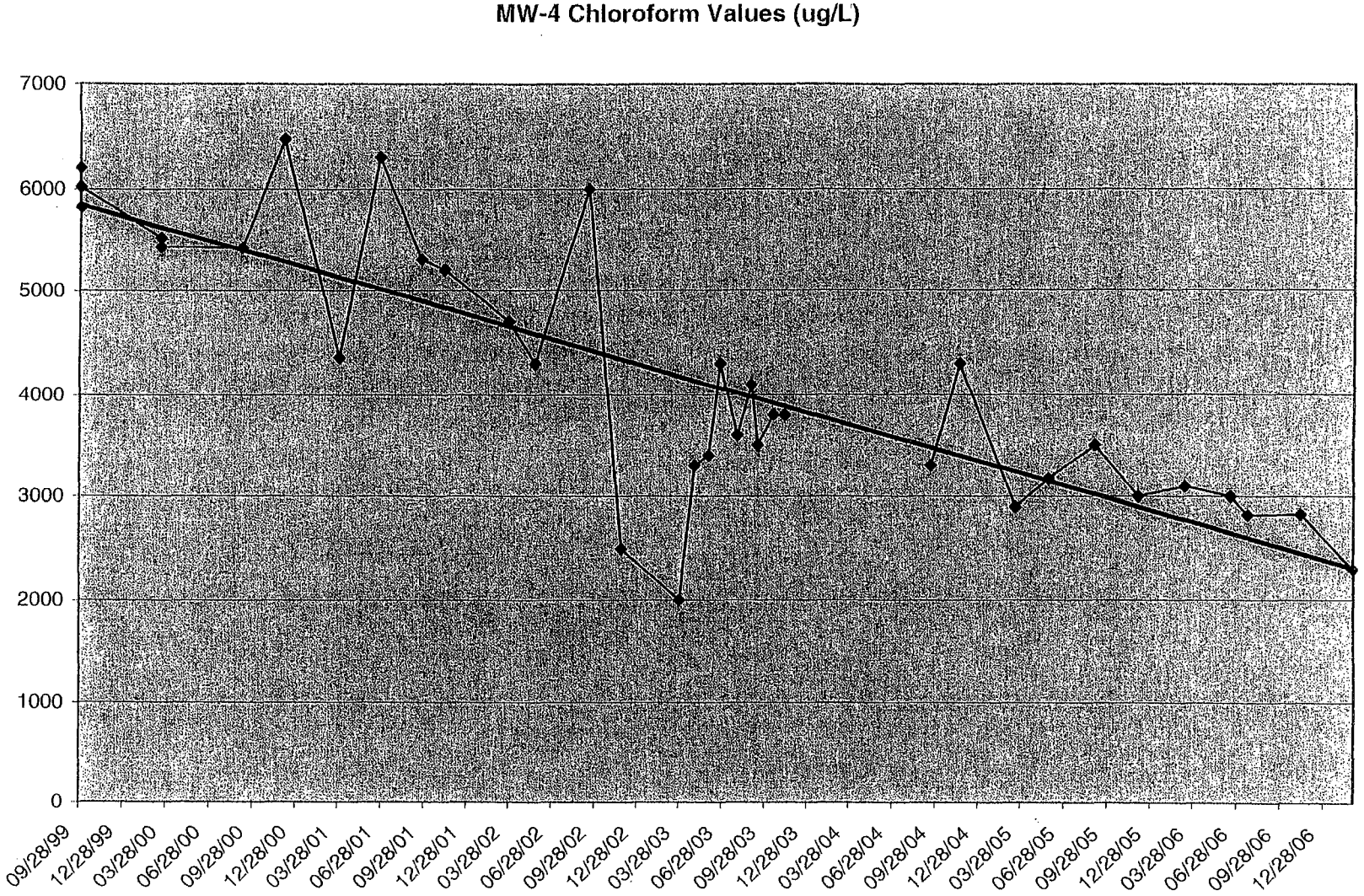


White Mesa Temporary Well (4-22) Over Time



APPENDIX B

CHLOROFORM INVESTIGATION WELL CHLOROFORM CONCENTRATION GRAPHS


MW-4 Chloroform Values (ug/L)
7000
6000
5000
4000
3000
2000
1000
0
09/28/99
12/28/99
03/28/00
06/28/00
09/28/00
12/28/00
03/28/01
06/28/01
09/28/01
12/28/01
03/28/02
06/28/02
09/28/02
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03/28/04
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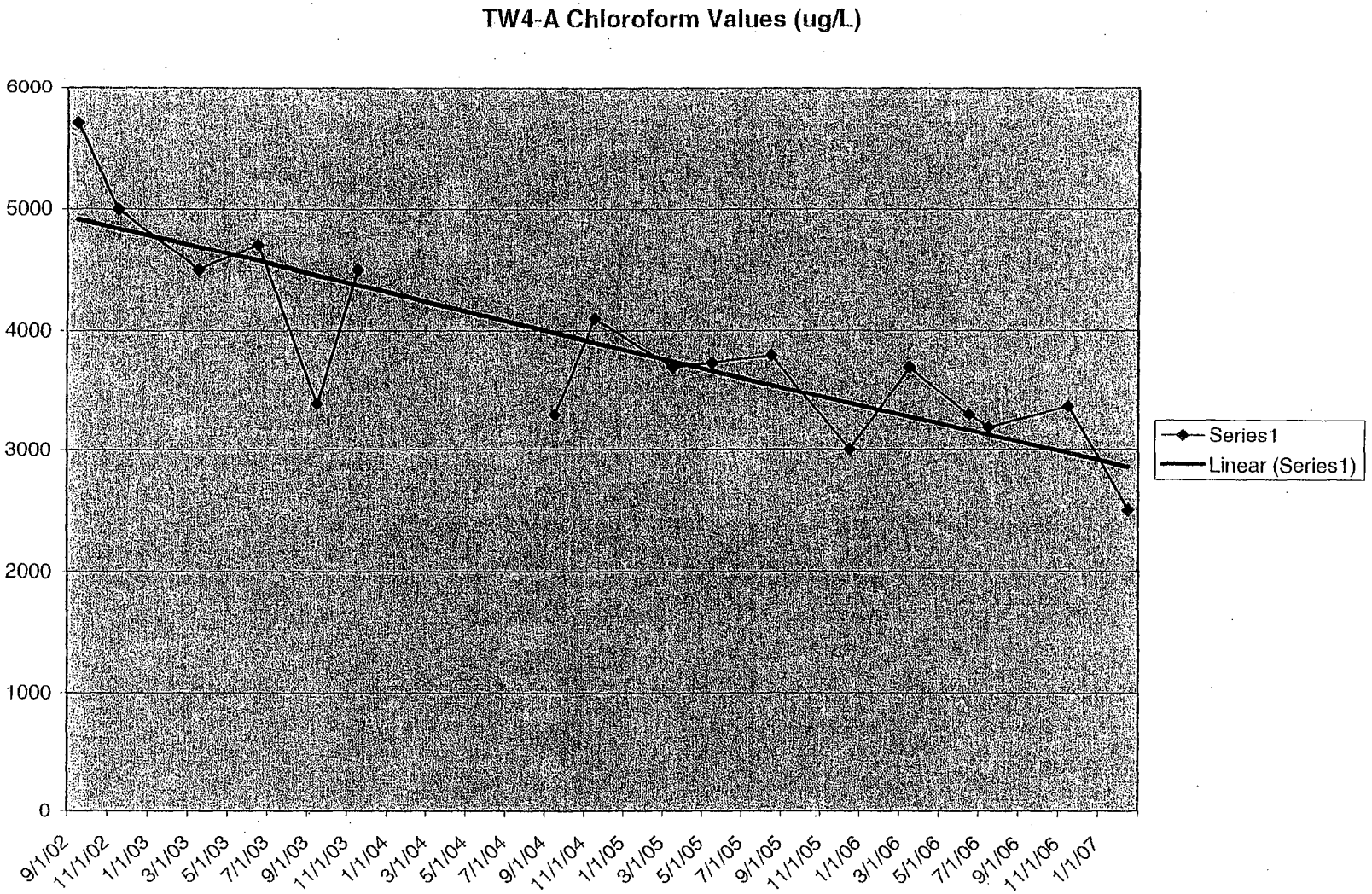
03/28/06
06/28/06
09/28/06
12/28/06


TW4-A Chloroform Values (ug/L)
6000
5000
4000
3000
2000
1000
0
9/1/02
11/1/02
1/1/03
3/1/03
5/1/03
7/1/03
9/1/03
11/1/03
1/1/04
3/1/04
5/1/04
7/1/04
9/1/04
11/1/04
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5/1/05
7/1/05
9/1/05
11/1/05
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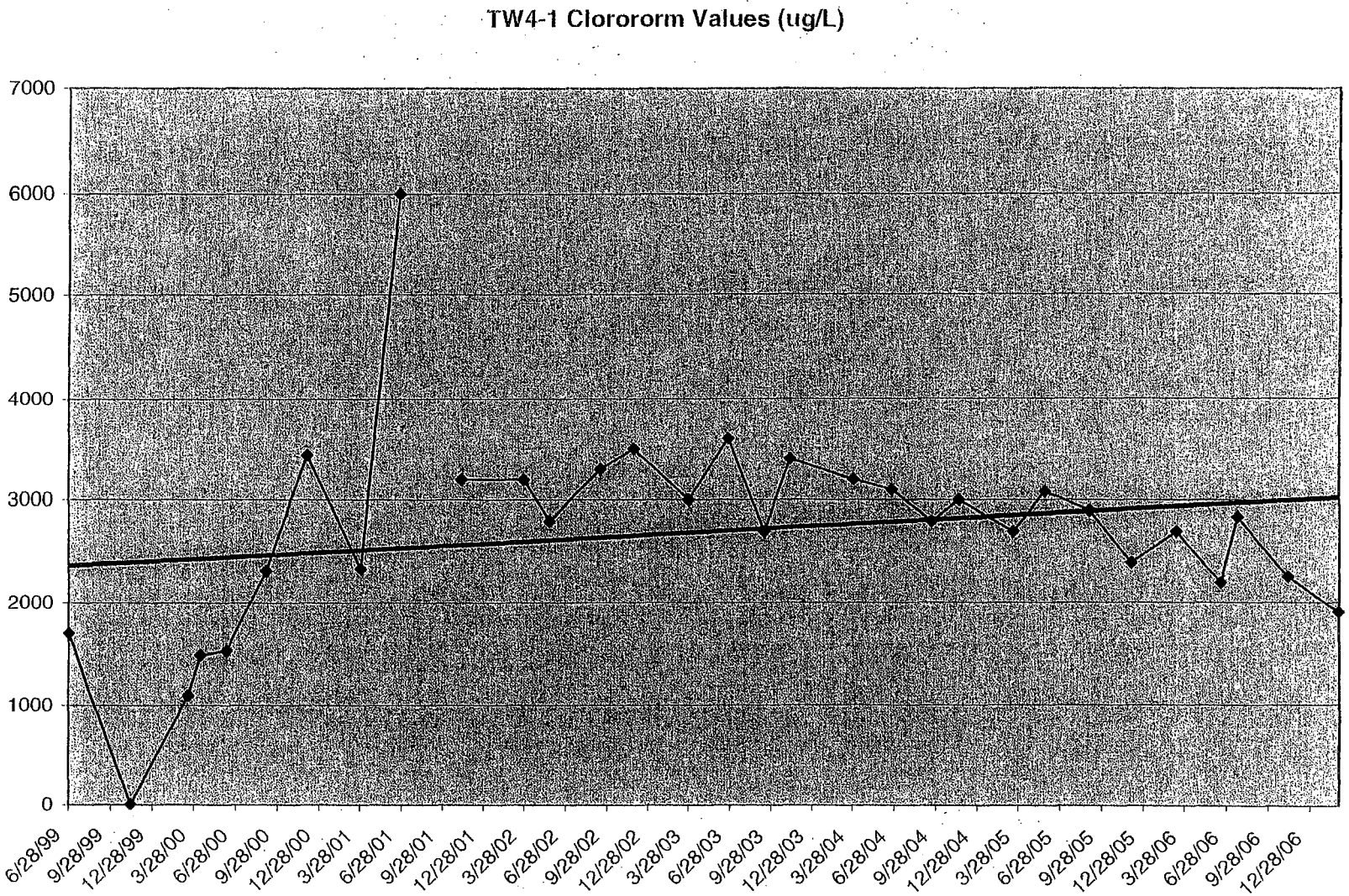
9/1/06
11/1/06
1/1/07
Series1
Linear (Series1)


TW4-1 Clororom Values (ug/L)
7000
6000
5000
4000
3000
2000
1000
0
6/28/99
9/28/99
12/28/99
3/28/00
6/28/00
9/28/00
12/28/00
3/28/01
6/28/01
9/28/01
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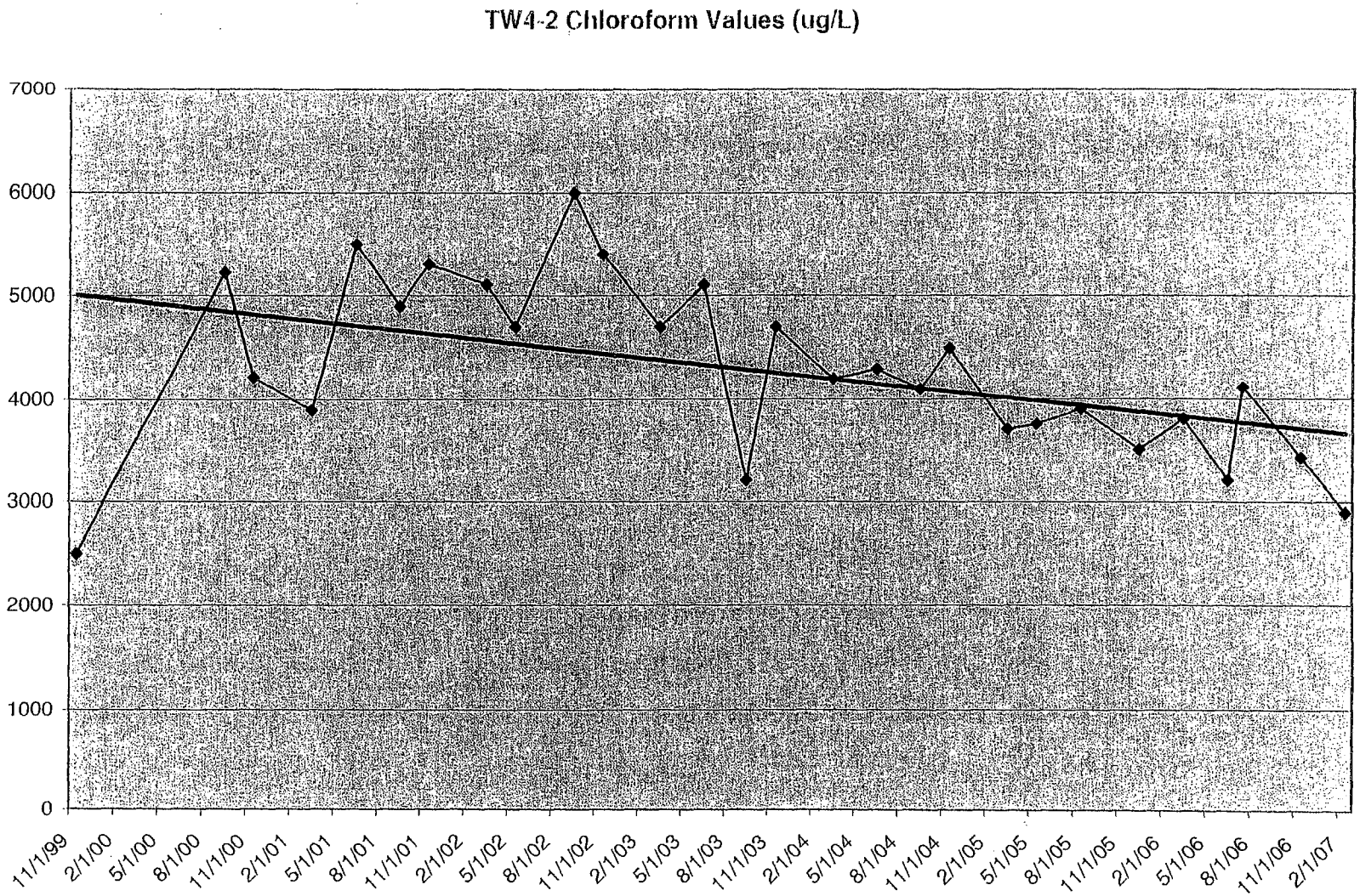
6/28/06
9/28/06
12/28/06


TW4-2 Chloroform Values (ug/L)
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6000
5000
4000
3000
2000
1000
0
11/1/99
2/1/00
5/1/00
8/1/00
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2/1/01
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2/1/02
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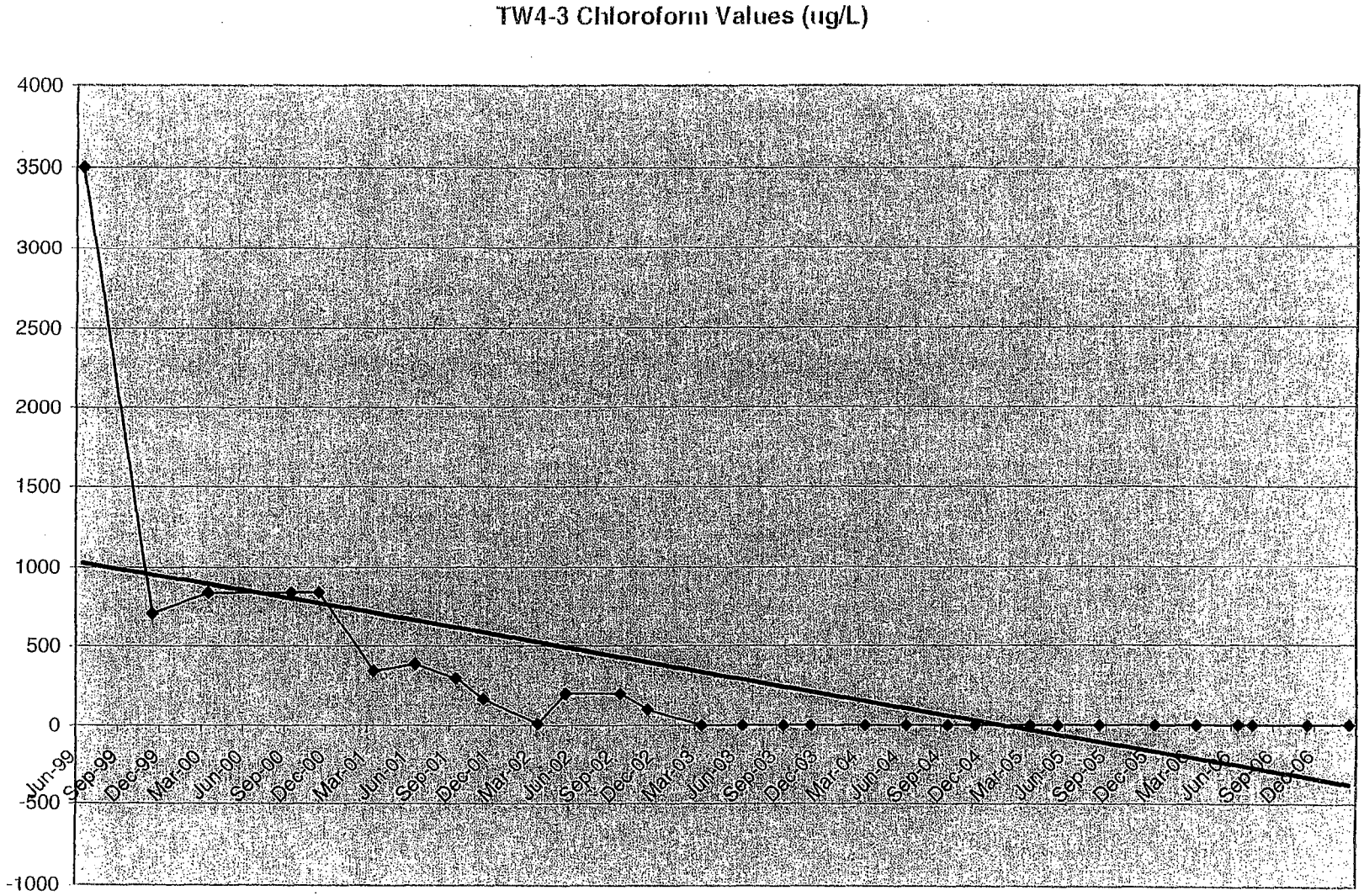
5/1/06
8/1/06
11/1/06
2/1/07


TW4-3 Chloroform Values (ug/L)
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
Jun-99
Sep-99
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Jun-01
Sep-01
Dec-01
Mar-02
Jun-02
Sep-02
Dec-02
Mar-03
Jun-03
Sep-03
Dec-03
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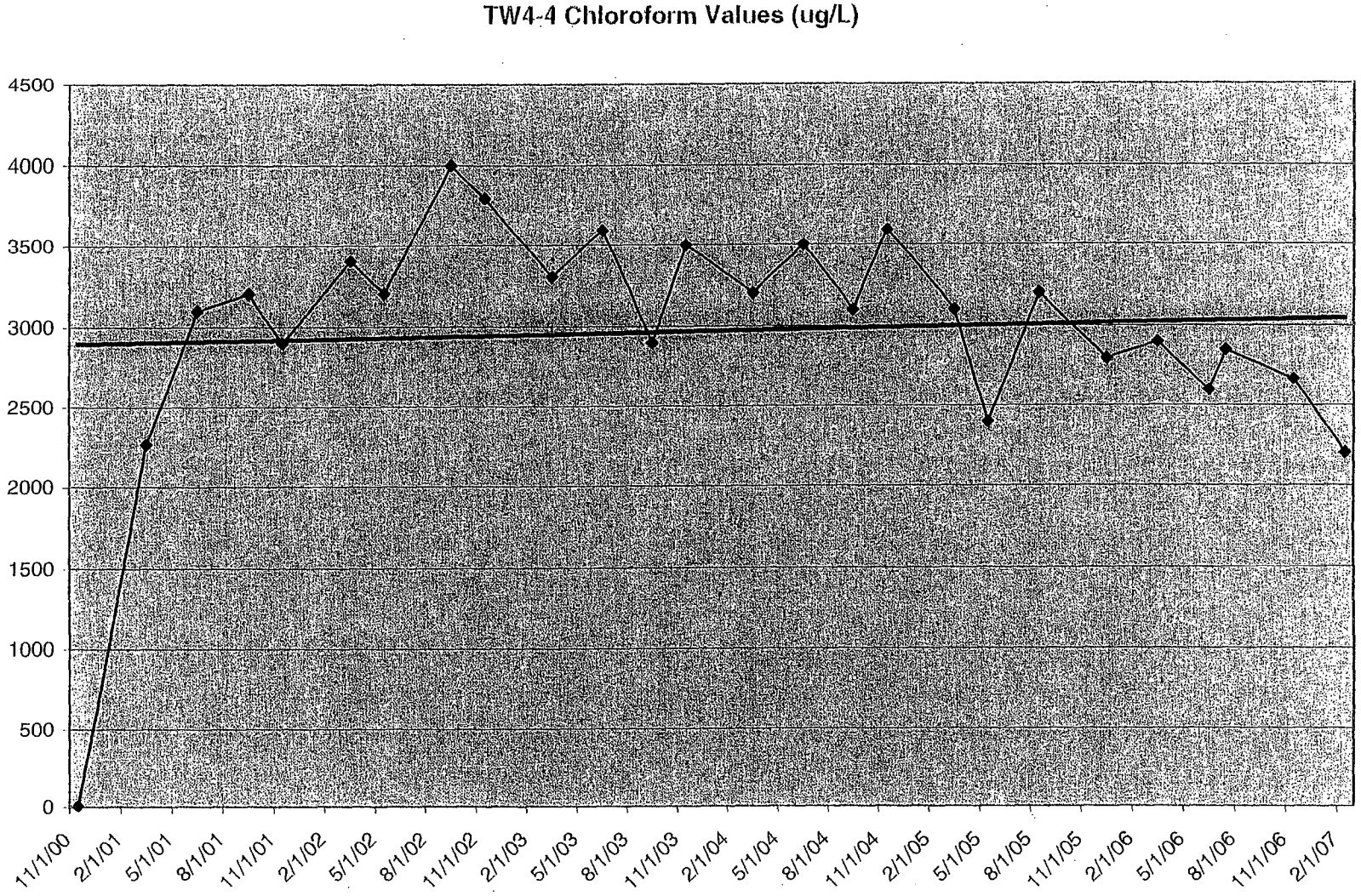
Sep-05
Dec-05
Mar-06
Jun-06
Sep-06
Dec-06


TW4-4 Chloroform Values (ug/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
11/1/00
2/1/01
5/1/01
8/1/01
11/1/01
2/1/02
5/1/02
8/1/02
11/1/02
2/1/03
5/1/03
8/1/03
11/1/03
2/1/04
5/1/04
8/1/04
11/1/04
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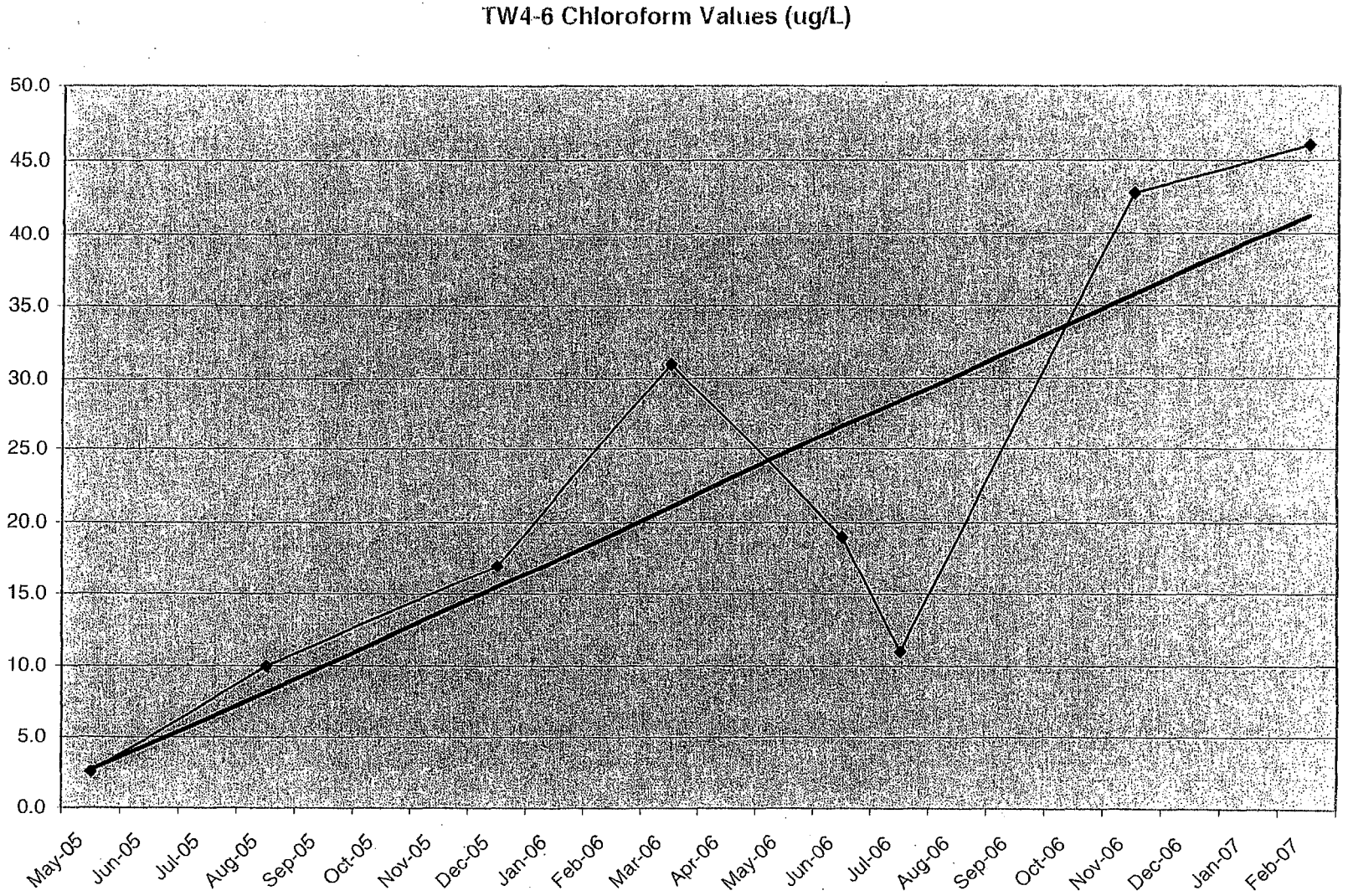
5/1/06
8/1/06
11/1/06
2/1/07


TW4-6 Chloroform Values (ug/L)
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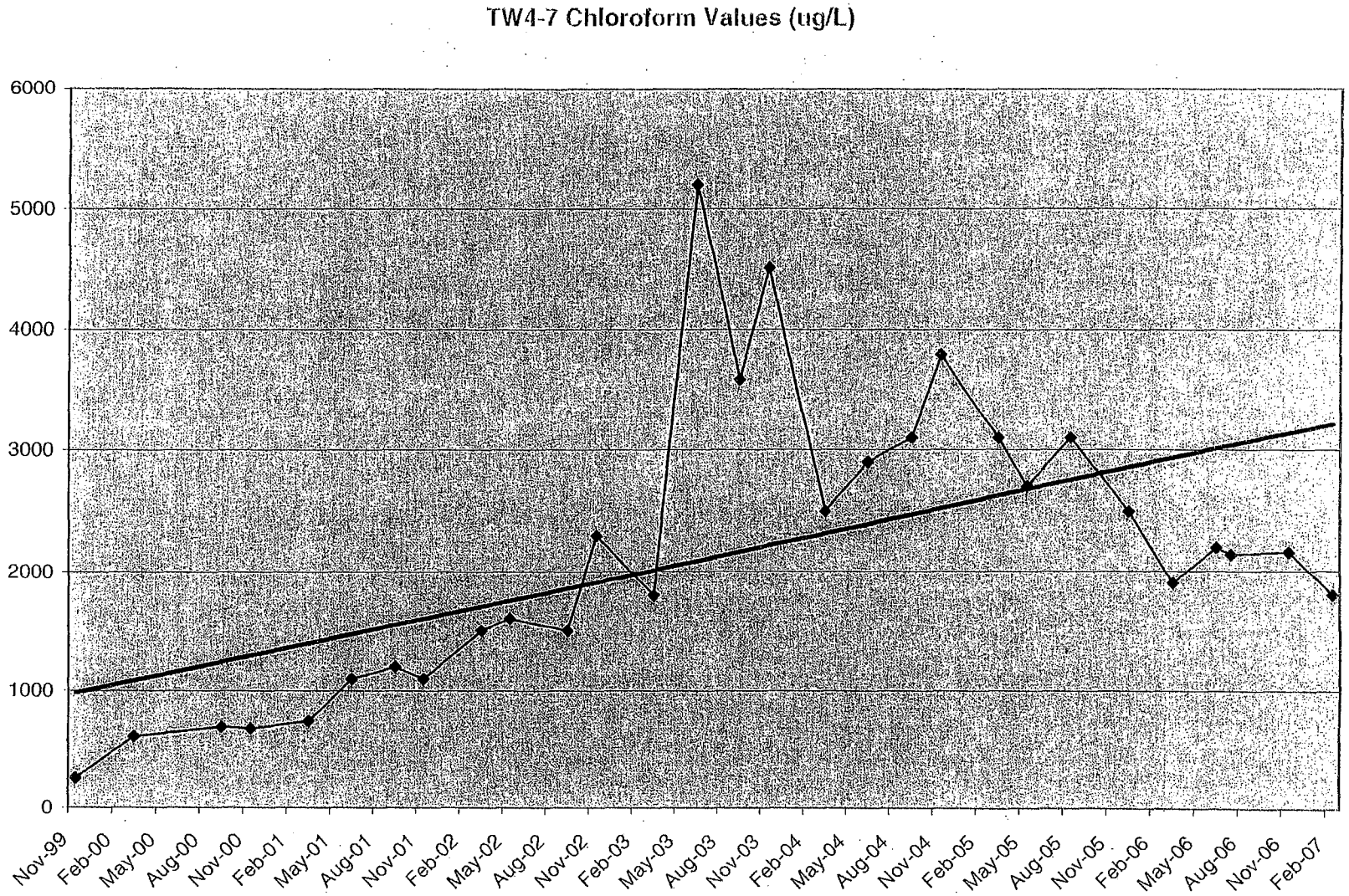
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07


TW4-7 Chloroform Values (ug/L)
6000
5000
4000
3000
2000
1000
0
Nov-99
Feb-00
May-00
Aug-00
Nov-00
Feb-01
May-01
Aug-01
Nov-01
Feb-02
May-02
Aug-02
Nov-02
Feb-03
May-03
Aug-03
Nov-03
Feb-04
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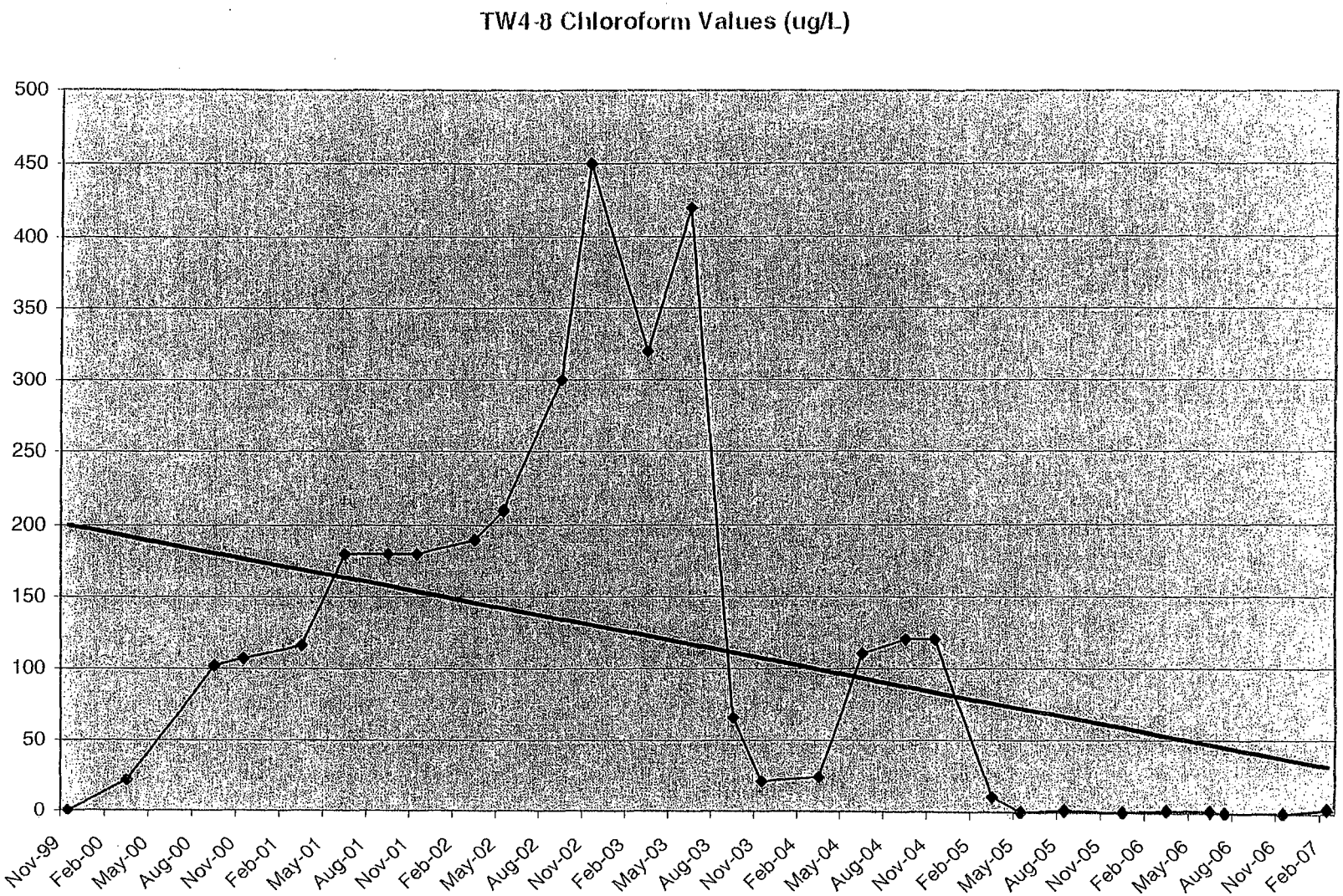
Feb-07


TW4-8 Chloroform Values (ug/L)
500
450
400
350
300
250
200
150
100
50
0
Nov-99
Feb-00
May-00
Aug-00
Nov-00
Feb-01
May-01
Aug-01
Nov-01
Feb-02
May-02
Aug-02
Nov-02
Feb-03
May-03
Aug-03
Nov-03
Feb-04
May-04
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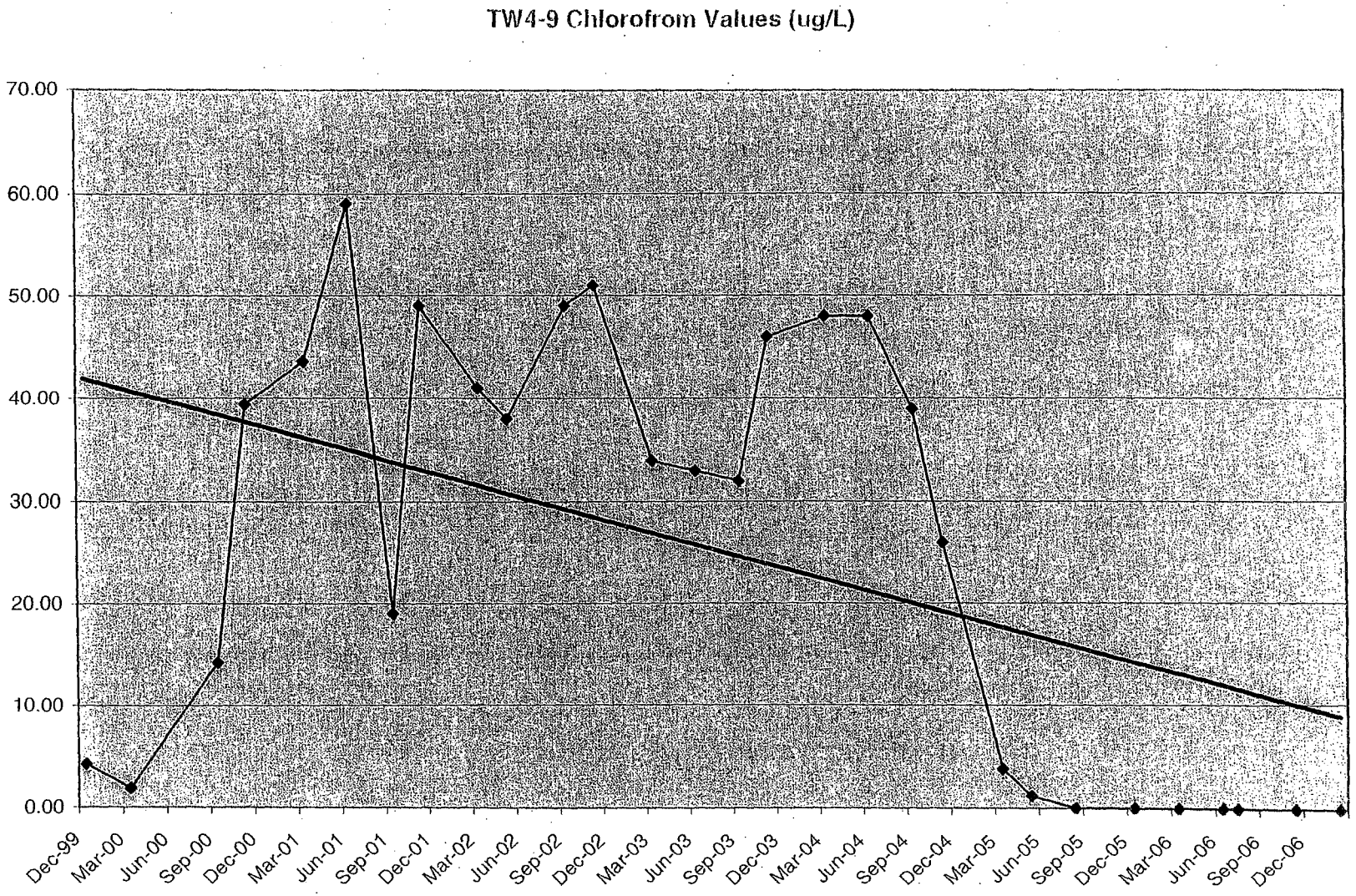
Feb-07


TW4-9 Chlorofrom Values (ug/L)
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Dec-99
Mar-00
Jun-00
Sep-00
Dec-00
Mar-01
Jun-01
Sep-01
Dec-01
Mar-02
Jun-02
Sep-02
Dec-02
Mar-03
Jun-03
Sep-03
Dec-03
Mar-04
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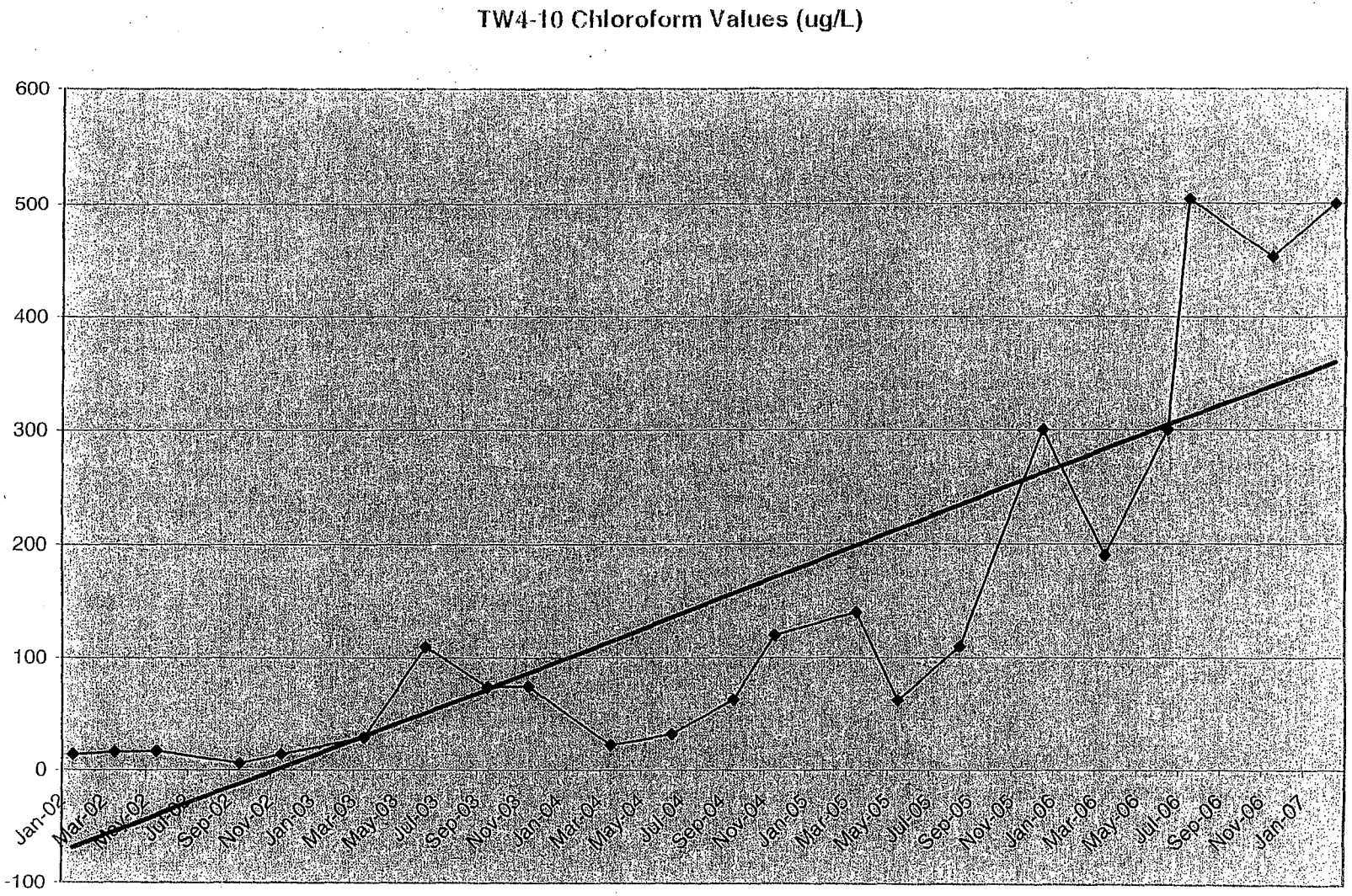
Jun-05
Sep-05
Dec-05
Mar-06
Jun-06
Sep-06
Dec-06


TW4-10 Chloroform Values (ug/L)
600
500
400
300
200
100
0
-100
Jan-02
Mar-02
May-02
Jul-02
Sep-02
Nov-02
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
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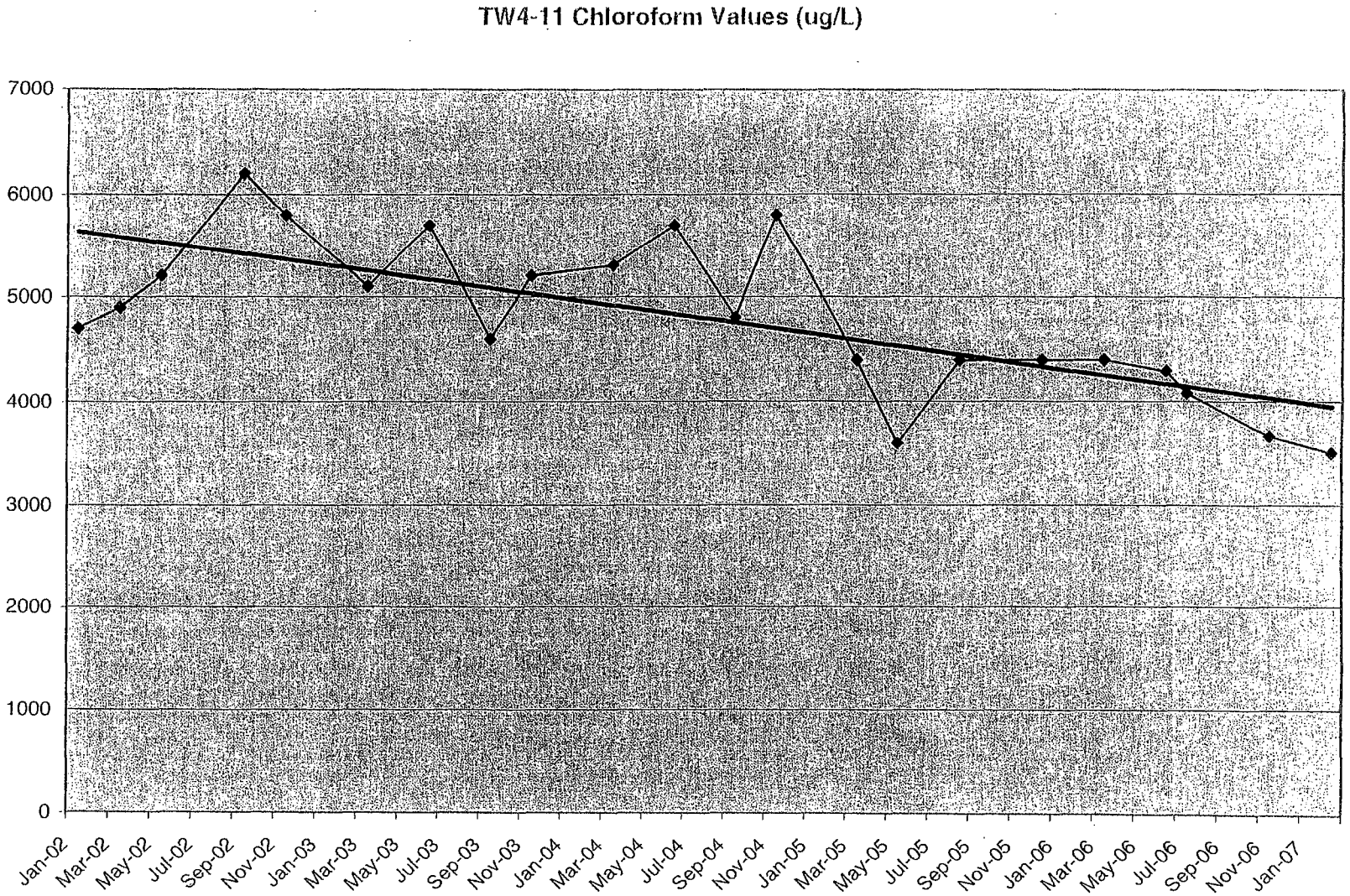
Nov-06
Jan-07


TW4-11 Chloroform Values (ug/L)
7000
6000
5000
4000
3000
2000
1000
0
Jan-02
Mar-02
May-02
Jul-02
Sep-02
Nov-02
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05
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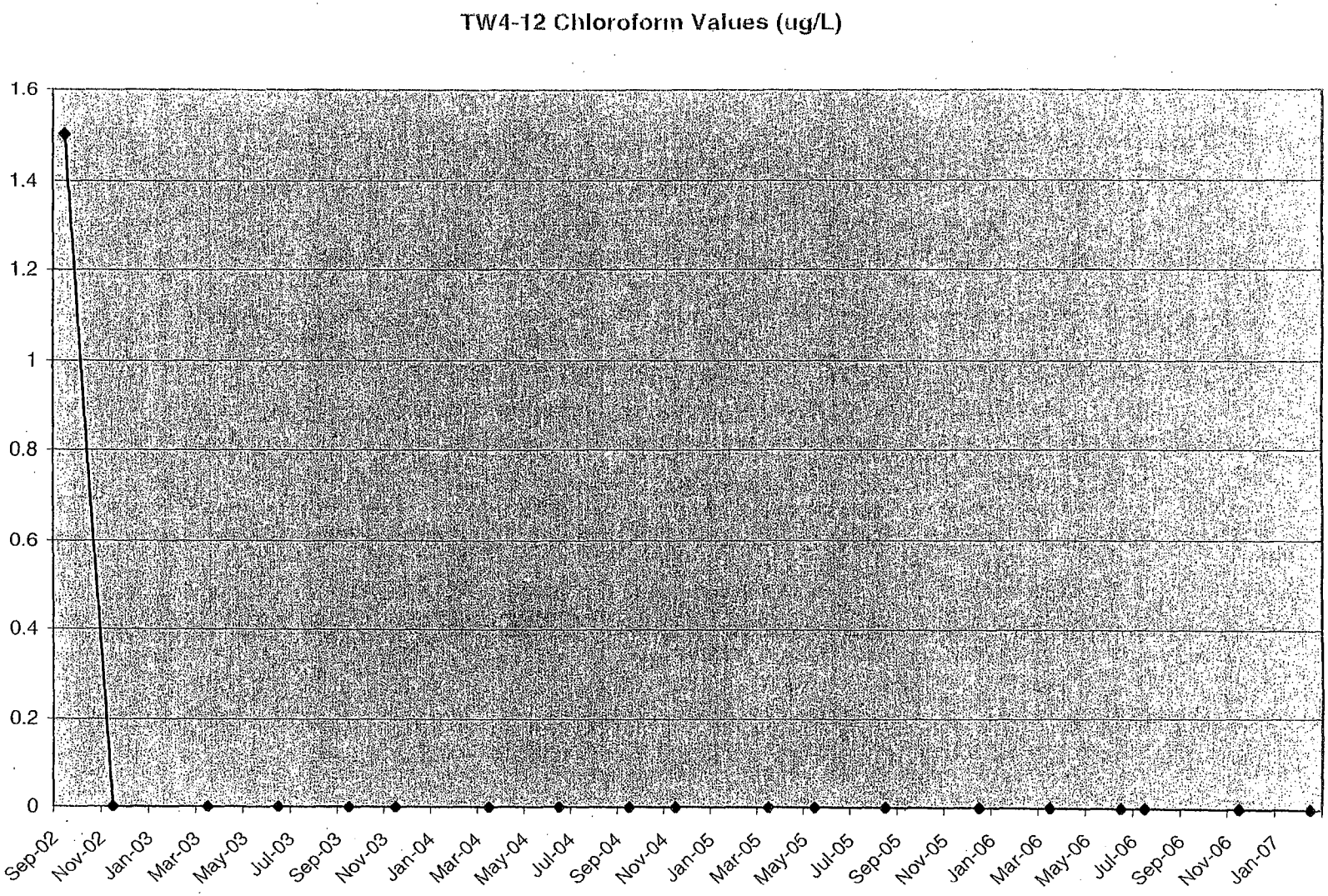
Nov-06
Jan-07


TW4-12 Chloroform Values (ug/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Sep-02
Nov-02
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05
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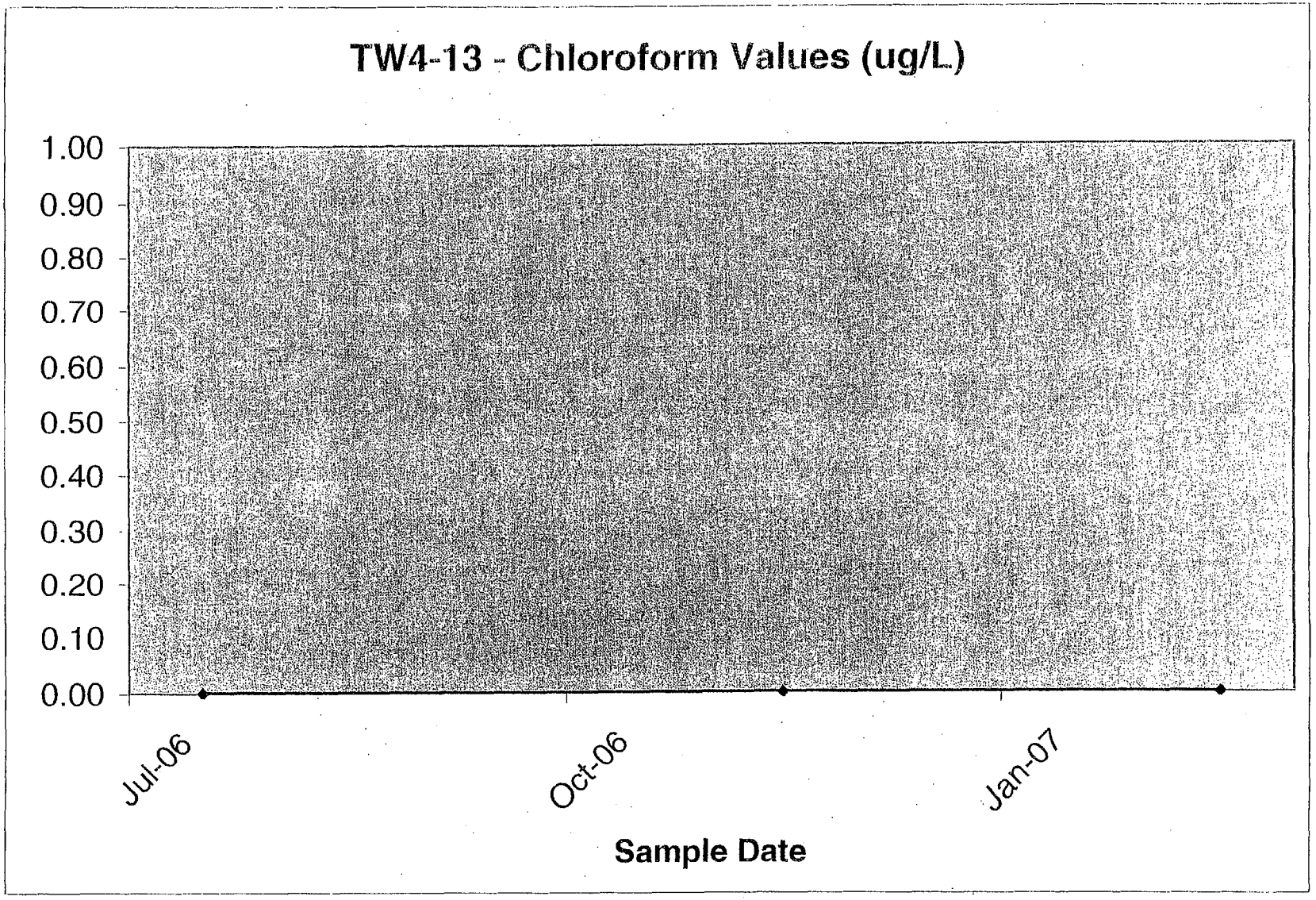
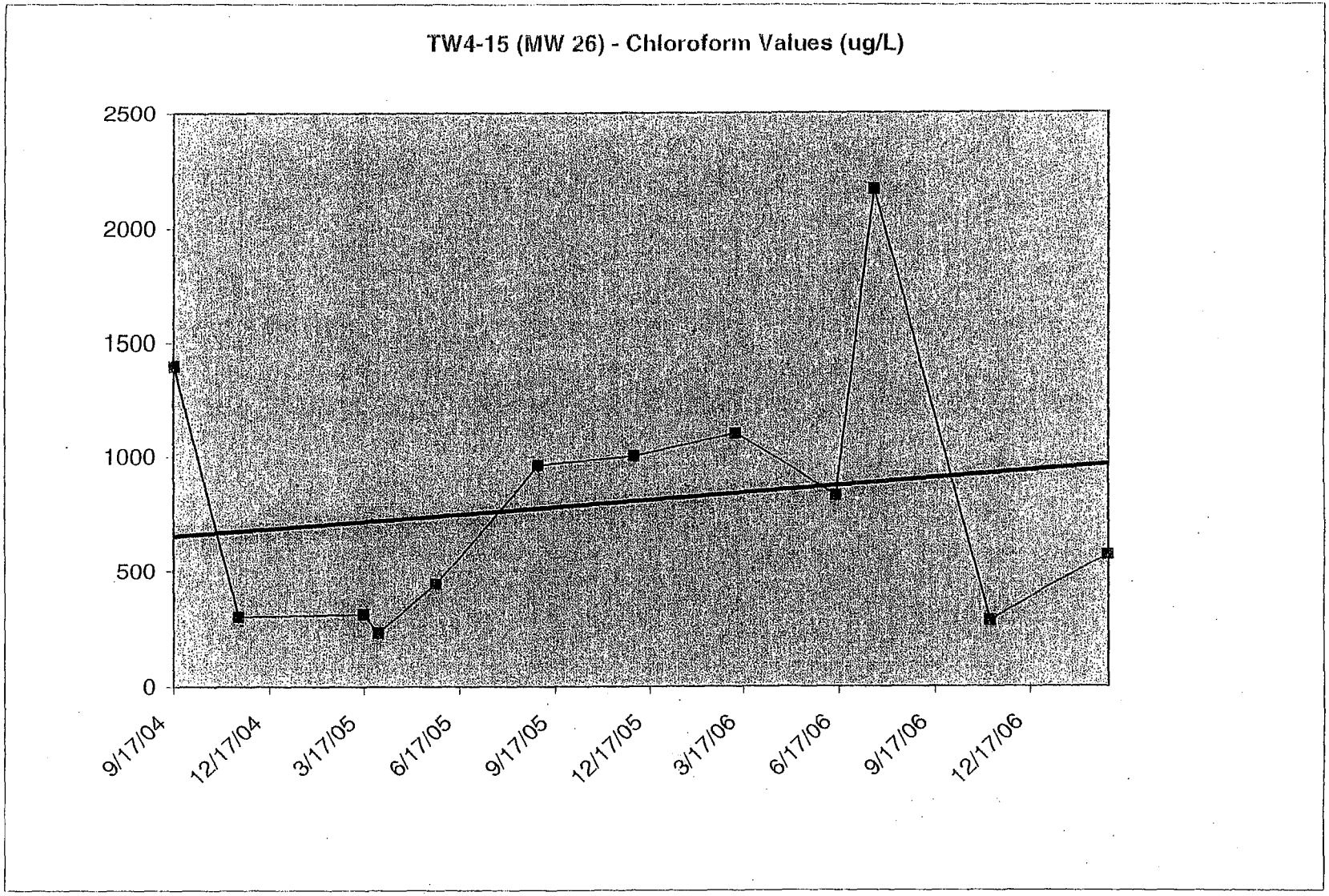
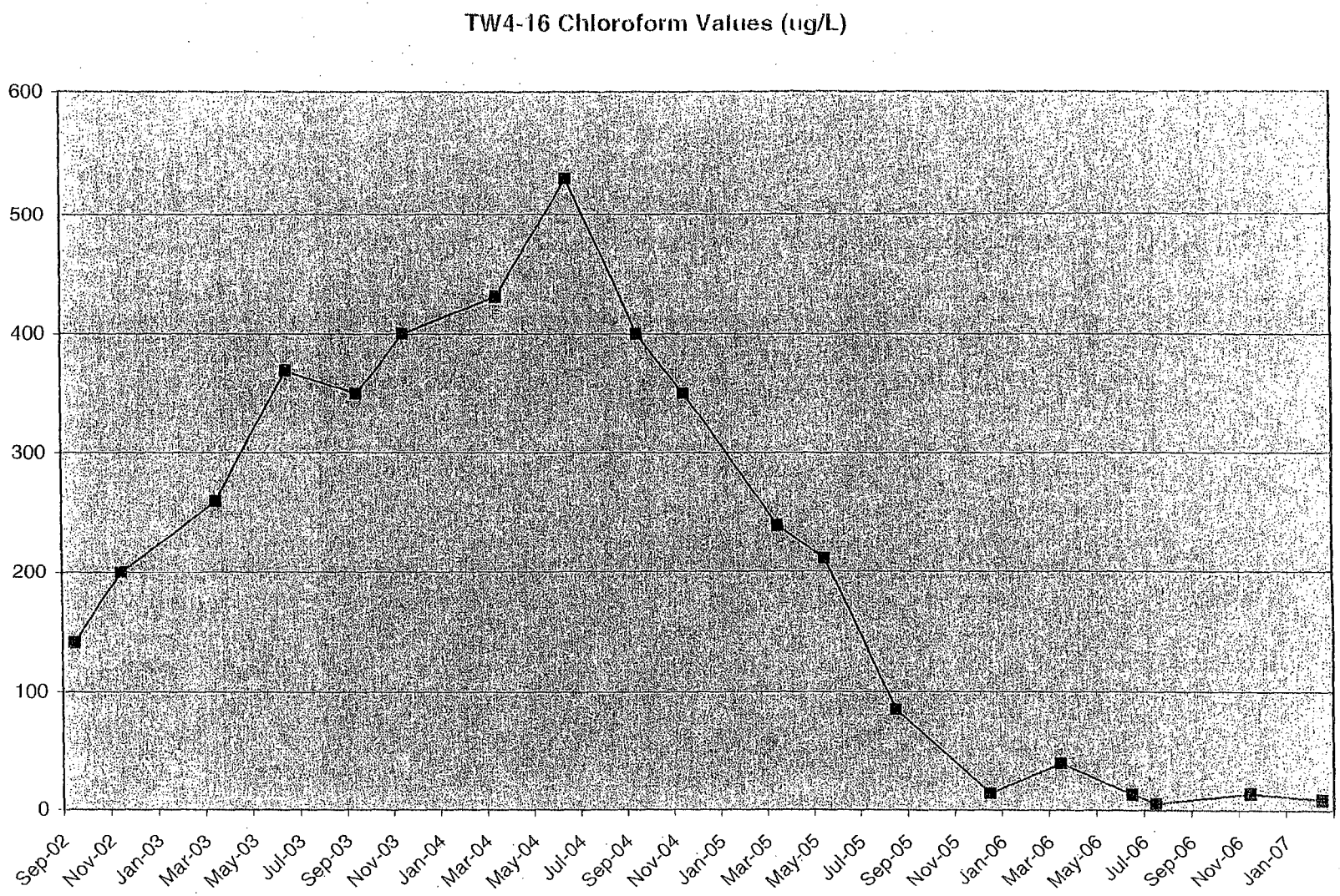
Nov-06
Jan-07


TW4-13 - Chloroform Values (ug/L)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Jul-06
Oct-06
Jan-07
Sample Date


TW4-15 (MW 26) - Chloroform Values (ug/L)
2500
2000
1500
1000
500
0
9/17/04
12/17/04
3/17/05
6/17/05
9/17/05
12/17/05
3/17/06
6/17/06
9/17/06
12/17/06


TW4-16 Chloroform Values (ug/L)
600
500
400
300
200
100
0
Sep-02
Nov-02
Jan-03
Mar-03
May-03
Jul-03
Sep-03
Nov-03
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05
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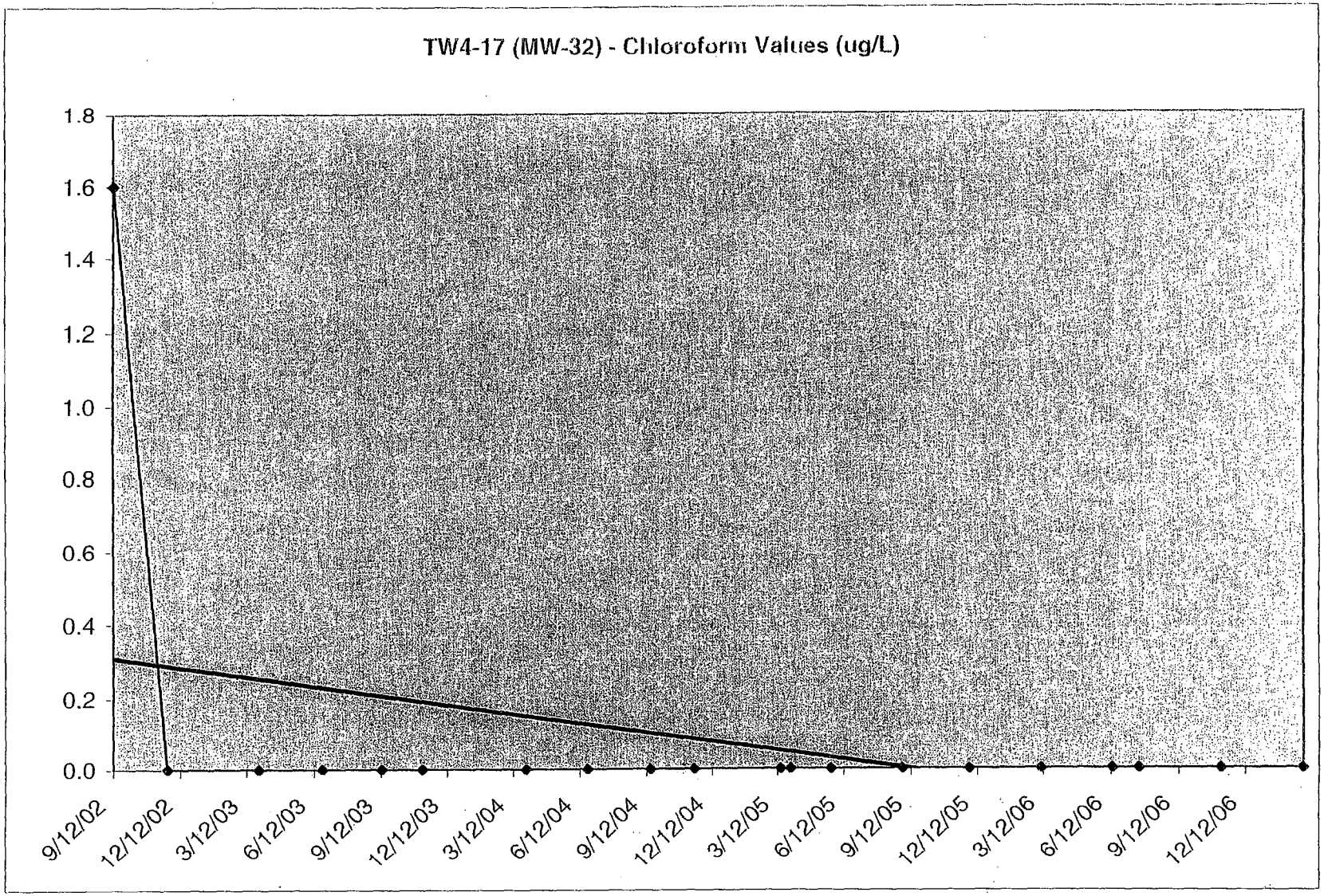
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07


TW4-17 (MW-32) - Chloroform Values (ug/L)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
9/12/02
12/12/02
3/12/03
6/12/03
9/12/03
12/12/03
3/12/04
6/12/04
9/12/04
12/12/04
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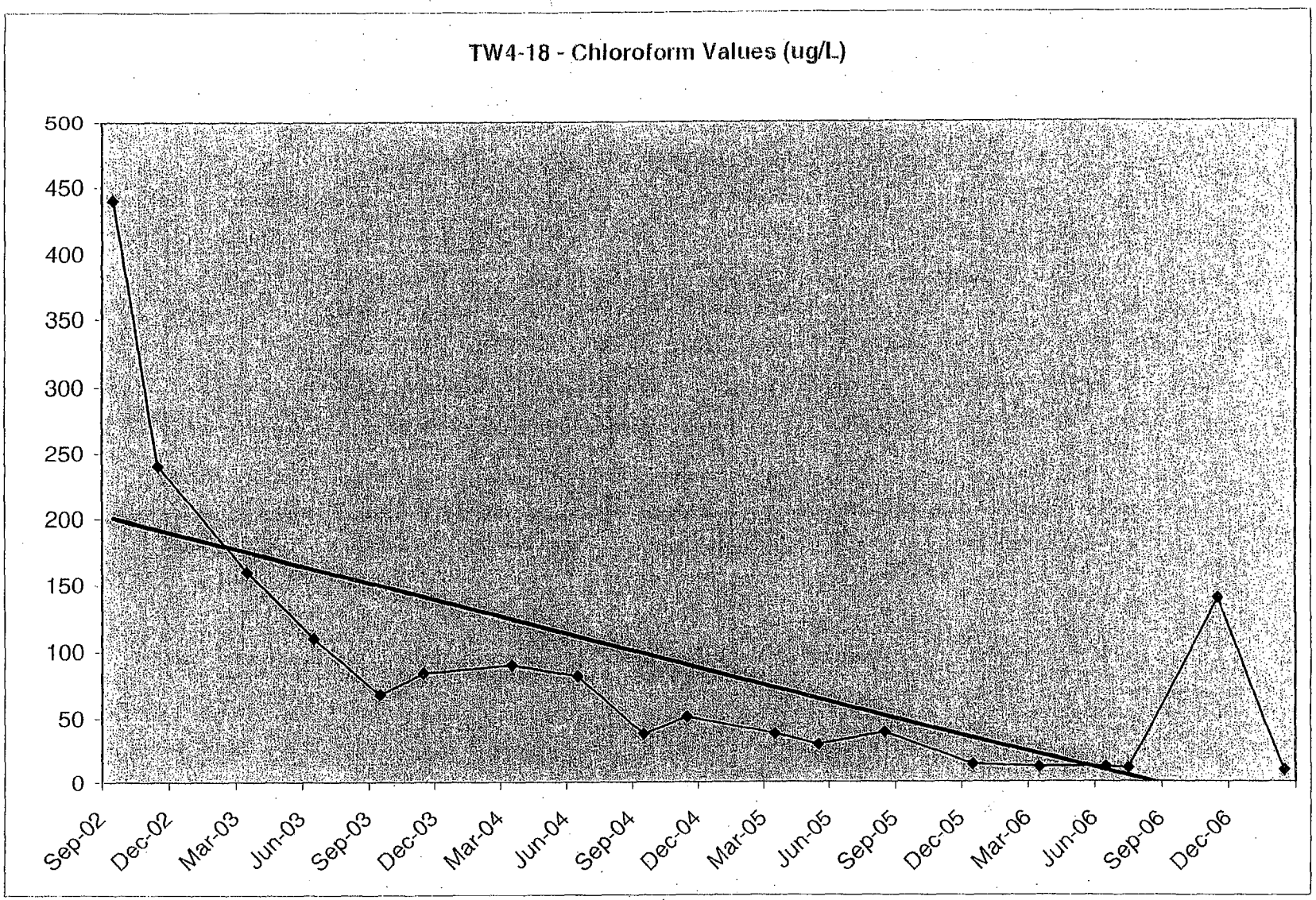
3/12/06
6/12/06
9/12/06
12/12/06


TW4-18 - Chloroform Values (ug/L)
500
450
400
350
300
250
200
150
100
50
0
Sep-02
Dec-02
Mar-03
Jun-03
Sep-03
Dec-03
Mar-04
Jun-04
Sep-04
Dec-04
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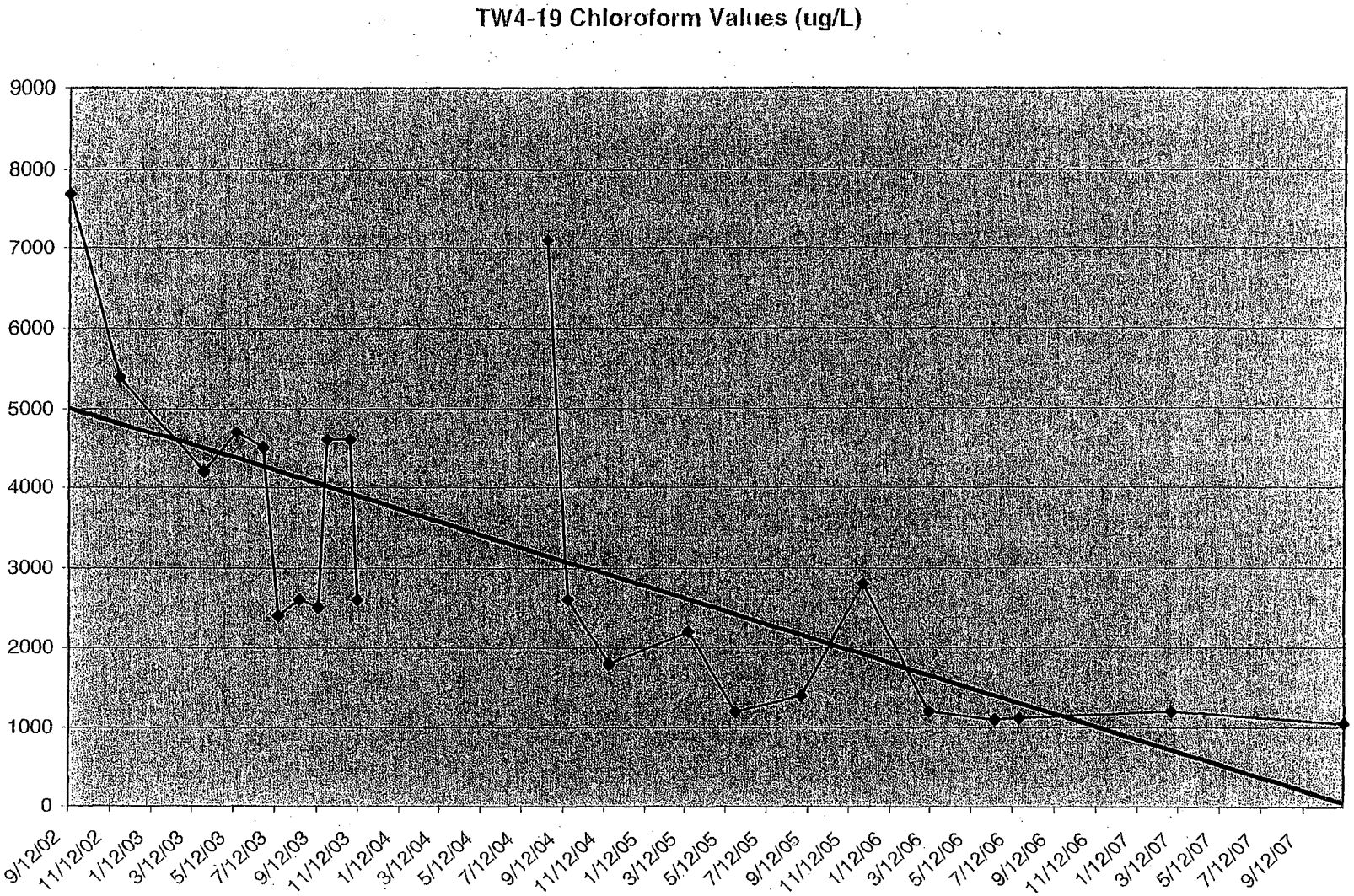
Jun-05
Sep-05
Dec-05
Mar-06
Jun-06
Sep-06
Dec-06


TW4-19 Chloroform Values (ug/L)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
9/12/02
11/12/02
1/12/03
3/12/03
5/12/03
7/12/03
9/12/03
11/12/03
1/12/04
3/12/04
5/12/04
7/12/04
9/12/04
11/12/04
1/12/05
3/12/05
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9/12/05
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3/12/06
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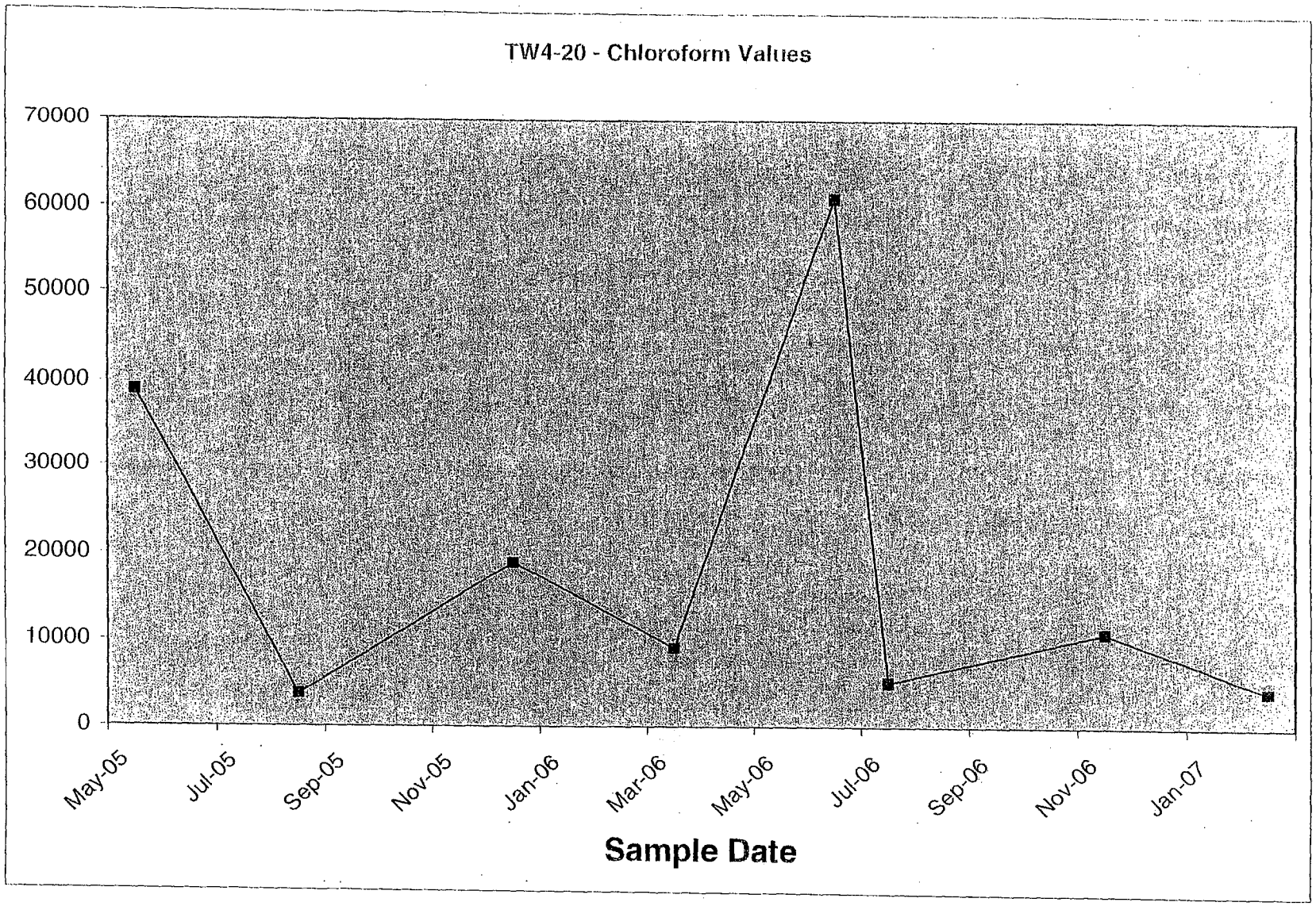
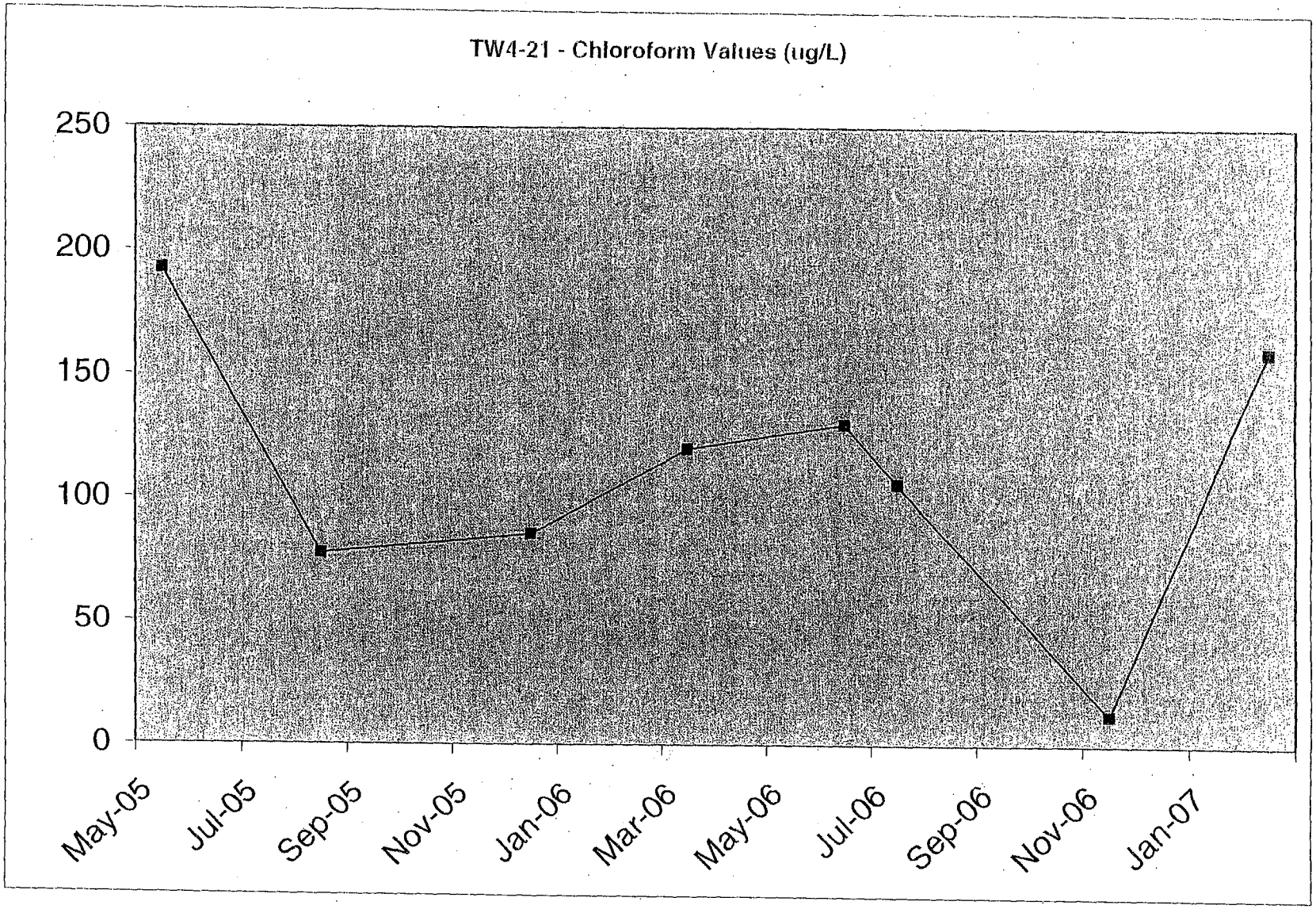
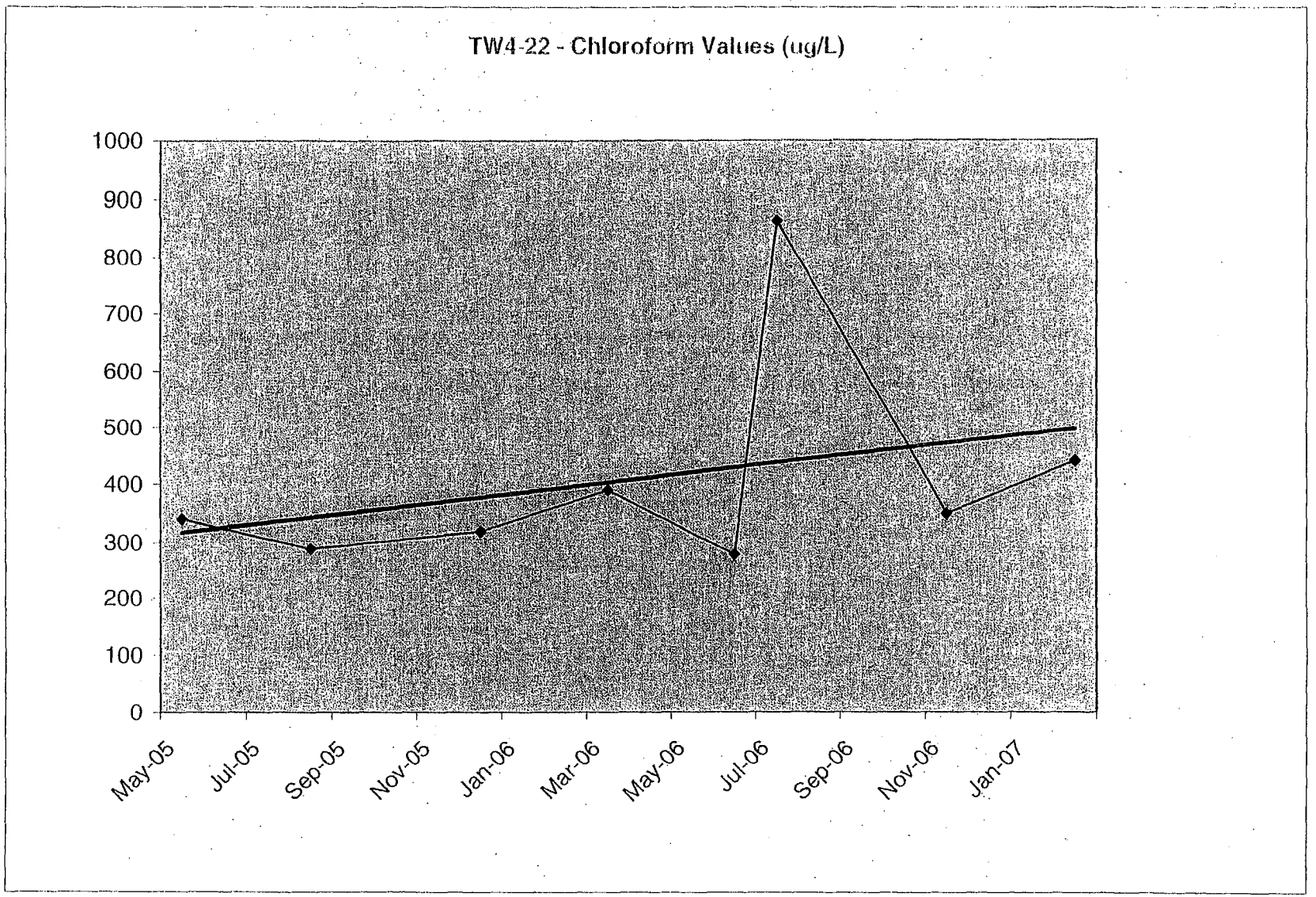
3/12/07
5/12/07
7/12/07
9/12/07


TW4-20 - Chloroform Values
70000
60000
50000
40000
30000
20000
10000
0
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Sample Date


TW4-21 - Chloroform Values (ug/L)
250
200
150
100
50
0
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07


TW4-22 - Chloroform Values (ug/L)
1000
900
800
700
600
500
400
300
200
100
0
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07

APPENDIX C

CHLOROFORM MASS REMOVAL VIA NATURAL IN-SITU DEGRADATION

CHLOROFORM MASS REMOVAL VIA NATURAL IN-SITU DEGRADATION

In-situ breakdown of chloroform via biologically mediated and abiotic means is expected to occur within the perched zone chloroform plume at the White Mesa site. The possible degradation mechanisms include:

- reductive dechlorination (abiotic degradation)
- anaerobic reductive dechlorination (anaerobic biodegradation)
- cometabolic processes (aerobic biodegradation)

Reductive dechlorination of chloroform involves successive replacement of chloroform atoms by hydrogen. This process occurs relatively rapidly under anaerobic conditions in the presence of naturally occurring anaerobic bacteria, but can also occur, albeit slowly, without the aid of bacteria.

Degradation of chloroform can also occur under aerobic conditions by cometabolic processes. Cometabolism involves incidental biodegradation of one compound while another compound is used as a food source by the naturally occurring bacteria. Within the perched zone, naturally occurring organic carbon might be used as such a food source, allowing chloroform to be cometabolized.

Based on rates provided in HydroGeoLogic, 1999, anaerobic reductive dechlorination could reduce detected concentrations by more than three orders of magnitude within a few years, provided conditions were favorable. However, this mechanism is likely to be minimal, because

the nitrate associated with the chloroform plume at the site indicates that the perched zone is aerobic. Nitrate would not be persistent under anaerobic conditions and would be expected to degrade relatively rapidly.

Abiotic reductive dechlorination is likely to be quite slow based on studies by Jeffers, et al, 1989, and Mabey and Mill, 1978, with expected half lives for chloroform of 1850 to 3650 years at neutral pH. Degradation would be more rapid at higher pH, with expected half lives of 25 to 37 years at pH 9. However, perched water at the site is generally near neutral, so the lower rates (higher half lives) would be likely for the perched zone.

Cometabolic degradation can occur relatively rapidly if sufficient organic carbon is present in the perched zone that could serve as a food source for an indigenous methanotrophic population. Under ideal conditions, this process would be expected to proceed at rates higher than anaerobic rates. However, in natural groundwater, this mechanism is not expected to be dominant.

One method of estimating the actual degradation rates of chloroform is to look for the daughter products of reductive dechlorination, methylene chloride (DCM) and chloromethane (CM). Both have been detected at the site in low concentrations (typically a few µg/L). Chloroform degrades via reductive dechlorination to DCM, then CM. DCM is commonly used in analytical laboratories and its detection in some cases may have resulted from laboratory contamination. However, assuming that detections are representative of site conditions, chloroform degradation rates can be estimated by assuming the following:

- the detected DCM is a degradation product of chloroform,
- the rate of DCM depletion is fast compared to chloroform (because, unlike chloroform, DCM can degrade relatively rapidly under aerobic conditions), and
- the concentrations of detected DCM are in pseudo steady state.

The last assumption implies that the DCM degrades about as fast as it is produced. A range of zero order aerobic degradation rate constants for DCM are provided in Aronson, et al, 1999. These range from 0.0036/day to 0.533/day, with a recommended rate of 0.0546/day. These rates are relatively large and imply fast rates of DCM degradation under aerobic conditions. The rates imply that degradation of DCM would be much faster (by orders of magnitude) than would be expected for chloroform which is expected to degrade very slowly under aerobic conditions.

DCM was detected in perched zone wells TW4-11, TW4-15, TW4-16, and TW4-20 in the first quarter of 2007 at concentrations ranging from 1.1 to 6.5 µg/L, and the same four wells in the fourth quarter of 2006, at concentrations ranging from 1.3 to 9.2 µg/L. Because DCM was detected in the same four wells during both quarters, these detections are likely representative of site conditions, and not random laboratory analytical error. Furthermore, the similarity in DCM concentrations over the two quarters suggests a pseudo steady state condition. The average DCM concentration at these four wells over the two quarters is 3.8 µg/L.

The amount of chloroform degradation implied by these DCM concentrations can be estimated by using the expected rate of DCM degradation (0.0546/day) and assuming, on a molar basis, that the amount of chloroform degraded is equal to the amount of DCM degraded. The

expected amount of DCM degraded per day can be calculated using the following first order rate equation:

$$\ell n \frac{C}{C_0} = -k\Delta t$$

Where:

C = the observed concentration
C_0 = the concentration at time zero (initial concentration)
k = the rate constant (1/day)
Δt = the elapsed time (days)

Assuming that Δt = 1 day, C_0 = 3.8 µg/L, k = 0.0546/day, and solving for C, C = 3.60 µg/L

The implied change in DCM concentration per day is 3.8 µg/L - 3.6 µg/L, or 0.20 µg/L. On a molar basis, this implies that 0.28 µg/L chloroform was degraded to replace the 0.20 µg/L DCM that was degraded in the same day.

During the first quarter of 2007 and the third quarter of 2006, the chloroform concentrations at TW4-11, TW4-15, and TW4-16 ranged from 9 µg/L to 11,000 µg/L and averaged 2929 µg/L. A reduction of between one and two orders of magnitude would be needed to bring these chloroform concentrations to the action level of 70 µg/L. To calculate the rate of chloroform degradation implied by the daily amount of 0.28 µg/L chloroform degraded as calculated above, the same first order rate equation can be used:

$$\ell n \frac{C}{C_0} = -k\Delta t$$

Using 2929 µg/L for C_0, assuming C = 2929 – 0.28 = 2928.72 µg/L, rearranging and solving for k, k = -0.00010/day. This rate is more than an order of magnitude lower than the lowest anaerobic rate of -0.004/day reported for chloroform in HydroGeoLogic, 1999.

The calculated chloroform degradation rate of -0.00010/day can then be used in the first order rate equation after solving for Δt to calculate the time needed to reduce chloroform concentrations by one and two orders of magnitude ($C/C_0 = 0.1$, and $C/C_0 = 0.01$, respectively). By rearranging and solving for Δt,

$$\Delta t = \frac{\ell n(0.1)}{-0.00010/day} = 23{,}025 \text{ days or } 63 \text{ years for a one order of magnitude reduction,}$$

And

$$\Delta t = \frac{\ell n(0.01)}{-0.00010/day} = 46{,}052 \text{ days or } 126 \text{ years for a two orders of magnitude reduction.}$$

To reduce the highest concentration ever detected at the site (61,000 µg/L at TW4-20) to the action level would require three orders of magnitude reduction in concentration. Performing a similar calculation where $C/C_0 = 0.001$ yields

$$\Delta t = \frac{\ell n(0.001)}{-0.00010/day} = 69{,}077 \text{ days or } 189 \text{ years for a three orders of magnitude reduction.}$$

These calculations assume that reductions in chloroform concentrations occur only through biological means, and do not account for additional natural attenuation mechanisms that

include hydrodynamic dispersion, volatilization, and abiotic degradation. When considering the results of the above calculations in addition to 1) the other natural attenuation mechanisms that will act to reduce concentrations within the plume, 2) the chloroform mass removal by pumping, and 3) the estimated perched zone travel times of a few feet per year in the areas south and southwest of the chloroform plume, it is unlikely that chloroform concentrations exceeding the action level will ever migrate south or southwest of the tailings impoundments.

REFERENCES

Aronson, et al. 1999. Aerobic Biodegradation of Organic Chemicals in Environmental Media: A Summary of Field and Laboratory Studies. Environmental science Center, Syracuse Research Corporation, North Syracuse, NY. Submitted to U S Environmental Protection Agency.

HydroGeoLogic, Inc. 1999. Anaerobic Degradation Rates of Organic Chemicals in Groundwater: A Summary of Field and Laboratory Studies. Submitted to U. S. Environmental Protection Agency Office of Solid Waste.

Jeffers, et al.1989. Homogeneous Hydrolysis Rate Constants for Selected Chlorinated Methanes, Ethanes, Ethenes, and Propanes. Environ. Sci. Technol., Vol 23, No. 8, pp 965-969.

Mabey, W., and T. Mill, 1989. Critical Review of Hydrolysis of Organic Compounds in Water Under Environmental Conditions. Journal of Physical and Chemical Reference Data, Vol 7, No. 2, pp 383-415.