Leaching Analysis Report, Revision 1
Three Kids Mine
Henderson, Nevada

Prepared for:

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August 17, 2022

Project No. 14-01-156

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August 17, 2022 Project No. 14-01-156

Alan Pineda, PE
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Bureau of Industrial Site Cleanup
Nevada Division of Environmental Protection
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Las Vegas, NV 89119

Attn: Mr. Pineda

Re: Leaching Analysis Report, Revision 1
Three Kids Mine, Henderson, Nevada

Dear Mr. Pineda,

Broadbent & Associates, Inc. (Broadbent) is pleased to submit this *Leaching Analysis Report, Revision 1* for the former Three Kids Mine located in Henderson, Nevada.

Please do not hesitate to contact us if you should have any questions or require additional information.

Sincerely,
BROADBENT & ASSOCIATES, INC.

Kirk Stowers, CEM
Principal Geologist

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Leaching Analysis Report, Revision 1
Three Kids Mine
Henderson, Nevada

REVIEW AND APPROVAL:

JURAT: I, Kirk Stowers, hereby certify that I am responsible for the services in this document and for the preparation of this document. The services described in this document have been provided in a manner consistent with the current standards of the profession and to the best of my knowledge comply with all applicable federal, state and local statutes, regulation and ordinances.

8/17/2022

Kirk Stowers | **Date**
CEM #1549, Exp 10/11/2022

The following individuals contributed significantly to the preparation of this document:

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EXECUTIVE SUMMARY

Broadbent & Associates, Inc. (Broadbent) has prepared this Leaching Analysis Report, Revision 1 to evaluate whether site related chemicals including metals, organic compounds, and semi-volatile organic compounds in soils, rock, and mining waste at the Three Kids Mine site in Henderson, Nevada could potentially mobilize in meteoric water and impact surface and groundwater. This evaluation is necessary since the presumptive remedy for the joint issues of deep pits on the site and stockpiled mine tailings and waste rock is to fill the former with the latter. The leaching analysis was performed in general accordance with Revision 1 of Broadbent's Work Plan for Leaching Analysis of Hydro Pit Fill dated December 23, 2021 (Broadbent, 2021b) and approved by the Nevada Division of Environmental Protection (NDEP) on January 13, 2022 (NDEP, 2022).

Data collected during Broadbent's execution of the Phase II Sampling and Analysis Plan (Broadbent, 2021a) included the collection of samples for soil properties, moisture content, hydraulic properties, minerology analysis, and analysis by the meteoric water mobility procedure (MWMP). In addition, groundwater is approximately 200 feet below the bottom of the Hydro Pit, the deepest pit on the site. Using these data and considerations, geochemical and infiltration models were prepared.

The leaching models were run for three scenarios on the site: the Hydro Pit Scenario, the Central Valley Scenario, and the Hulin and A-B Pit Scenario. The Central Valley Scenario was run over 72 years for to match the available climate data for the McCarran airport, and the Hydro Pit and Hulin/A-B Pit Scenarios were run over 70 years for simplicity as they are not dependent on daily climate value inputs.

Model results suggested the following conclusions:

- The leaching analysis and model show that downward migration of metals is retarded by sorption reactions and solubility limits for constituents like calcium and sulfate. Regarding the deepest pit on the site, the Hydro Pit, the model shows no vertical migrations below the bottom of the pit due to 1) an impervious liner at the top of the backfilled pit as a part of a proposed detention basin and 2) a high moisture retention of the backfill materials. Similarly, the model predicts no downward migration of organic compounds owing to low seepage velocity, sorption, and natural decay.

- In reclaimed areas using an earthen and vegetated cover, natural infiltration of meteoric water is as low as 0.8 inches per year owing to low rainfall and evapotranspiration.

- The mine tailings have a high proportion of clays, swelling clays, and benign carbon compounds that bind organic constituents. As a result, calculated equilibrium concentrations of organic compounds expected in pore water in tailings placed in the Hydro Pit or modeled concentrations at the Hydro Pit bottom are below applicable limits.

- Geochemical conditions and constituent concentrations do not vary significantly as a function of depth within the backfilled mine waste in pits. This, in concert with predicted range of pH and redox conditions, is not expected to mobilize site constituents above levels detected in MWMP leachates. Anticipated leachate concentrations in the bottom of the three fill scenarios modeled are comparable to concentrations in leachate from the Muddy Creek Formation and the Tsm geologic unit, which is present at the bottom of the three pits.

- Fate and transport simulation of the Central Valley Scenario shows that, for non-reactive conservative constituents, the rate of migration through the Muddy Creek Formation is 763 years due to limited infiltration and longer considering natural attenuation, and retardation. However, the SRCs like arsenic are reactive and travel at slower rates owing to geochemical retardation during transport.

Reviewing the results of these models, we believe the presumptive remedy for the site is acceptable from a leaching perspective.

1.0 INTRODUCTION

This report was prepared by Broadbent & Associates, Inc. (Broadbent) and EA Engineering, Science, and Technology, Inc. PBC (EA) on behalf of Lakemoor Ventures, LLC (Lakemoor) for the Three Kids Mine (site) located in Clark County, Nevada, just east of the City of Henderson. The site is being remediated and reclaimed by Lakemoor in conjunction with residential development. The report is being submitted to the Nevada Division of Environmental Protection (NDEP), Bureau of Industrial Site Cleanup, the lead agency overseeing the reclamation of the site, for review and approval.

Manganese exploration, mining, and milling activities at the site conducted intermittently between 1917 and 1961 have not been significantly reclaimed since closure of the mine and mill. The environmental effects were left unstudied until the 1980s and 1990s (Zenitech, 2007). Early investigations indicated that the metals and constituents present in soils, rock, and mine waste present at the site included arsenic, lead, manganese, copper, zinc, diesel-range organic (DRO) constituents, and semi-volatile organic compounds that could potentially mobilize in meteoric water and impact surface and groundwater (Zenitech, 2007). The hydrologic and leachability assessments (Leaching Analysis) described in this report were conducted to support further site characterization, remediation, and reclamation plans.

A Phase I Environmental Site Assessment (ESA) completed by Zenitech Environmental, LLC (Zenitech) in 2007 summarized known conditions and extent of contamination at the site and recommended an evaluation of background concentrations of site related chemicals (SRC) in soils, rock, and mine wastes. In late 2020, Lakemoor hired Broadbent teamed with EA to reinitiate investigation work at the site. The Broadbent team implemented the Phase II Sampling and Analysis Plan (SAP; Broadbent, 2021a) that includes collection of samples for particle size, compaction and consolidation, shear strength, initial moisture content, unsaturated and saturated hydraulic properties, meteoric water mobility procedure (MWMP), and mineralogy analyses, including clay speciation. To complete the Leaching Analysis, information from both Phase I and II ESAs are used and described. Additionally, this work was conducted in general conformance to the Work Plan for Leaching Analysis of Hydro Pit Fill, Revision 1 (Work Plan; Broadbent, 2021b) approved by NDEP on January 13, 2022 (NDEP, 2022).

The Leaching Analysis includes a comprehensive review of site conditions, geology, hydrology, configurations of closed mine facilities, climate, vegetation, mine waste, backfill, and cover material characteristics. The objective of this analysis is to evaluate and develop best management practices for waste rock and tailings planned to be used as backfill in three locations at the site identified as the Hydro Pit, the Central Valley, and the Hulin/A-B Pits. The analysis evaluated characteristics of backfill mixtures at various waste rock and tailings ratios with respect to leaching potential and potential impacts to waters of the State of Nevada. Using these data, geochemical and infiltration models were prepared.

1.1 SITE BACKGROUND

1.1.1 Location and Extent

The Three Kids Mine is located approximately five miles northeast of central Henderson, Nevada along East Lake Mead Parkway (State Road 564). The property occupies most of Section 35 and parts of Sections 26, 34, and 36 of Township 21S, Range 63E, Mount Diablo Meridian and encompasses about 1,300 acres in its entirety. The approximate center of the site is at 36°05’00”N latitude and 114°54’50”W longitude.

Access to most of the site is gained via a locked gate and unpaved road in the northeast corner of the site. A small portion of the site is located north of Lake Mead Parkway and can be accessed by foot. A general location map is provided in Figure 1.

1.1.2 Physiography

The site is located in the Mojave Desert Biome. Native flora of the Mojave includes sparsely populated creosote bush, tumbleweed, occasional grasses, perennial wildflowers, and cacti.

Mining activities, primarily in the 1940s and 50s, changed the topography through the excavation of large open pits, the construction of tailings ponds, and the emplacement of upgradient dams to prevent washes from emptying into pit operations. Site elevations within the subject property range from 1,555 feet in the bottom of the Hydro Pit to 2,515 feet at a nearby peak in the River Mountains with large portions of the site near 1,800 feet in elevation. Most of the surface area of the mill site, although modified by mill activities, is currently close to the pre-mining elevations of approximately 1,800 to 1,870 feet (Zenitech, 2007). A topographic map from 1983 is provided in Appendix A.1, Figure 7 of the Phase I ESA.

1.2 NATURAL SETTING

1.2.1 Climate

Regional climate of the Mojave is arid with coldest month temperatures averaging above 32 degrees Fahrenheit (°F), leading to a Köppen classification of BWh or hot desert climates typically found under the subtropical ridge in the lower middle latitudes, often between 20° and 33° north and south latitude (Zenitech, 2007). Average summer temperatures range from 70 to 104.5°F though highs of greater than 115°F are not uncommon. Average winter temperatures range from 34 to 70°F (Western Regional Climate Center, 2021) with very little precipitation occurring as snow (Table 1).

Annual rainfall averages 4.15 inches per year (Table 1) with an annual evaporation rate of greater than 70 inches per year (Zenitech, 2007) which indicates that the potential rate of areal infiltration and recharge in the area is very limited. High resolution measurements of evaporation on Lake Mead were a total of 7.5 feet of water evaporated across the average lake area from January 1998 to December 1999 (USGS, 2006). The process of plant interception of precipitation and root uptake and transpiration of soil moisture is commonly referred to as evapotranspiration (ET) and potential ET (PET) is a function of climate and also limits ground infiltration of meteoric water.

The location is generally windy, with an annual average windspeed of nine miles per hour. Winds predominantly blow from the south and west.

A detailed compilation, review, and summary of local climate data (daily rainfall, temperature range, evaporation, transpiration, etc.) needed for infiltration modelling input was completed for the Leaching Analysis. Climate data were derived from the Western Regional Climate Center. Long term daily climate data from the McCarran airport were used for the model climate input requirements associated with both the geochemical and infiltration model (Appendix A). The historic local climate record provides a best conceptual model of the range of climate variability that is expected at the site.

Although the Work Plan suggested that climate data from the Boulder City, Nevada station would be used for model input, the McCarran airport climate database was selected owing to proximity and completeness and applicability to the Three Kids Mine site modeling. While the site is slightly higher in elevation and impacted by orographic and lake effects from the River Mountains and Lake Mead, the historical McCarran climate data is suitable for predictive simulations under expected changes resulting from expanded development and heat island effects plus global climate trends (WeatherSpark, 2022). The climate record was downloaded from September 6, 1948 to December 24, 2021 and is included in Appendix A. The 72-year period of record is representative of long-term climate cycles in the area and provides a sufficiently long predictive simulation dataset for migration of select metals under meteoric precipitation driven infiltration and downward percolation through site materials after land reclamation.

1.2.2 Geology and Geomorphology

The regional geology around the site is provided in Figure 2, and the site-specific geology is shown in Figures 3A and 3B. The site is situated in the transition area from Las Vegas Wash into the playa and pediment covered foothills near the northern end of the River Mountains in southern Nevada and is part of the Basin and Range province. Prior to mining activities which resulted in the excavation of open mine pits and placement of tailings and waste rock across the site (Figure 4), the site was predominantly a gently northwest-sloping, thin alluvial plain deposit within the basin. A generic cross section and conceptual model of a mine pit is shown in Figure 5. Historical maps show the plain to have been dissected by rills and gullies (Zenitech, 2007).

Much of the site is overlain by grey to black tailings and waste rock (Figure 4) with other thin cover materials and vegetation over waste rock. The Tertiary Muddy Creek Formation is exposed in the mine pits and where there is no mine waste (Bell and Smith, 1980) and consists of extensive basin fill sediments of lacustrine and subaerial origin. Some beds within this unit contain gypsiferous siltstone and massive beds of gypsum. Across the site the unit is moderately to highly altered by hydrothermal activity and veined by bedded quartzite. The unit is poorly sorted and interbedded with siltstone, gravel, cobbles, and clay. Some beds are shaley to massive at the site. Surficial alluvial deposits and soils are derived from reworking of the Muddy Creek Formation by ephemeral streams and shallow weathering, respectively. In addition, recent erosion of all three pit walls has resulted in accumulation of fine silt and clay at the bottom with an unknown depth.

The site is surrounded on the south, east, and north by Tertiary volcanic units of the River Mountains. The volcanics are also exposed in the mine pits (Figures 3 and 4) and consist of numerous flows of dark-grey to black porphyritic andesite three to 15 feet thick (Bell and Smith, 1980). Some flows are cut by sills and dikes of dark grey dacite with feldspar and mica phenocrysts. The unit is more resistant to weathering than the Muddy Creek Formation and forms steep slopes and scarps in places especially in the mine pit wall exposures. Slickensides on the volcanic fault scarp exposures indicate normal fault movement with the River Mountains on the upthrown side. The dip of the volcanic sequences is to the east and north and the occurrence of volcanics and igneous rocks on the north side of Lake Mead Parkway and at 219 feet below ground surface in the Clark County well (log #111218 drilled in 2008) indicates that volcanic and igneous rocks form the basement below the Muddy Creek Formation valley fill across the site.

Another significant rock formation is the Manganiferous Sedimentary rocks of the Three Kids Mine (Bell and Smith, 1980). This unit (Tsm on Figure 3) is a grey to black manganese-rich tuff and tuffaceous sandstone and siltstone moderately to well bedded. It is dominantly of pyroclastic origin reworked by water. It crops out mostly in the mine pits and along the fault contacts between the River Mountain volcanics and Muddy Creek Formation (USBM, 1945). It is locally sheared along the fault contact with the River Mountain volcanics and is intermixed with fragments of volcanic rock and Muddy Creek sediments. It is steeply dipping along the fault contact with the volcanics (Figure 6) but is believed to dip at a shallower angle beneath the pits (Figure 7 and Figures 8B, C, and D) based on cross sections of the ore in a US Bureau of Mines report (USBM, 1945). The fault slices exposed in the pits are relatively thin, approximately 20 to 30 feet thick, but the Tsm unit thickens to about 50 to 200 feet beneath the pits and Muddy Creek Formation to the north away from the fault contacts. Dip angles of the Tsm measured next to the fault and mine cuts are variable such that exact thicknesses are not certain, but the range provides a confident minimum thickness of 50 ft below the pits where exposures are laterally extensive (Figure 3A). The full extent of the unit to the north is not known (Figure 6) but it is projected to completely underlie the Hulin, Hydro, and A-B Pits (Figures 8B, 8C, and 8D).

Bedded deposits of manganese oxide are widely distributed in the basal sedimentary rocks of the Muddy Creek Formation and in the Lake Mead region of southern Nevada and northwestern Arizona (McKelvey et al., 1949). The sedimentary rocks are late Tertiary in age and were deposited in lake or playa settings, and consist of tuffaceous siltstone and sandstone, conglomerate, and gypsum. The sediments are locally intercalated pillow basalt and other volcanics. They lie in several more-or-less connected basins, generally folded and faulted near their margins by recent uplift of the enclosing hills. The manganese oxide, generally wad, is found mostly in the tuffaceous sandstones and siltstones, but in places it occurs in minor amounts in the other sedimentary rocks as well. The Muddy Creek and Tsm formations are the hosts of the manganese ore and manganese rich waste rock that were mined and milled at the site, so the tailings consist mostly of the milled matrix rock and sediments from these formations. In addition, most of the waste rock at the site is sub ore grade Muddy Creek overburden and thinner alluvial deposits and soils.

Phase II sampling includes collection of representative samples of mined and milled materials and soils of processing facilities (Figure 4). The tailings that were derived from the native manganese ore and the waste rock from the overburden material consisting mostly of Muddy Creek Formation. In addition, unmined and unprocessed samples of in-place volcanic rocks, manganese ore, Muddy Creek Formation, alluvium, and recent pit deposits have been analyzed to evaluate the geochemical and physical properties of mine pit wall rock and underlying formations. The chemical analyses and physical properties derived from the sample analyses are used to assess the geochemical reactivity of and infiltration rates through the three identified backfill scenarios through modeling described in this report.

1.2.3 Soils

Site soils tend to be gypsiferous with clasts of dacite, basalt, and tuff (Zenitech, 2007). Gypsum content is locally highly variable. Fill is observed in various portions of the site and is composed of tailings, overburden/low-grade ore, and manganese nodules from mining operations. The fill ranges from less than an inch to near 90 feet in thickness. Areas of thick fill from tailings disposal show little or no soil development and are classified as regoliths or regosols. Appearance, texture, and grain size of tailings sediments indicate silty to clayey silt soils and are typically gypsiferous or calicaceous in composition. Tailings are dry and dusty at or near the surface and may become damp several feet below ground surface (bgs).

Phase II sampling includes collection of representative samples of site soils and overburden. The chemical analyses and physical properties derived from analysis of the samples were used to assess the geochemical reactivity of and infiltration rates through the Hydro Pit backfill and cover through modeling described in this report.

1.2.4 Groundwater

Groundwater is encountered at a significant depth at the site. There are four wells located near the site. These wells include:

- A test well drilled by Three Kids Partnership in the northeast corner of the site (log #35212 drilled in 1991)
- A municipal/industrial well at Laker Plaza located at 2310 Lake Mead Drive (log #82441 drilled in 2001)
- A monitoring well owned by Clark County 0.5-mile northwest of the Hydro Pit (log #111218 drilled in 2008)
- A monitoring well owned by the United States Government on Lake Mead Parkway 0.75-mile west of the Hydro Pit (log #111266 installed in 2008)

Well locations are depicted in Figure 4, and well logs are provided in Appendix B. The Driller's Reports shed light on local geology and hydrology. Groundwater information exists for the test well and Laker Plaza well. The lithologic logs provided by the well driller for these wells are instructive for understanding the relationship between the River Mountain volcanics and the Muddy Creek Formation.

The Government well (111266) is located 0.75 miles west of the Hydro Pit. To its total depth of 411 feet, unaltered Muddy Creek Formation was encountered consisting of reddish-brown claystone, siltstone, and sandstone that is weakly cemented. Thinly bedded gypsum was encountered below 402 ft bgs.

From surface to 219 feet, the Clark County well (111218) is completed in unaltered Muddy Creek Formation, logged as weakly cemented brownish siltstone with gypsum. At 219 ft bgs is the contact with dacite of the River Mountain volcanics, marking the thickness of sedimentary deposits at this location. Well 111218 terminated in dacite at 270 feet bgs. It is believed this well is dry.

The Three Kids Partnership test well (35212) was drilled on the east side of the proposed development, in River Mountain volcanics and undifferentiated Muddy Creek Formation. After penetrating what may be alluvium to 47 feet bgs, Muddy Creek Formation then River Mountain volcanics were encountered in the test well to a total depth of 1,100 feet bgs. Groundwater in well 35212 is first encountered at 720 feet bgs. Surface elevation at the well location is approximately 1,820 feet, placing the water-bearing zone at 1,100 feet above mean seal level (amsl). A static water level was measured at 535.97 ft bgs (or 1,258 ft amsl) in November 2021, indicating confined conditions which are sometimes encountered in fractured aquifers. A groundwater sample analysis result indicates the water is brine with 2,880 milligrams per liter (mg/l) total dissolved solids (TDS) and a sulfate concentration of 1,200 mg/l. The sample was measured at 92-94ºF and contained arsenic at a concentration of 0.064 mg/l. The warm temperature and high mineralization of the sample is indicative of water influenced by geothermal conditions (Zenitech, 2007). Based on these findings, this water could not be considered a viable drinking water source without treatment for arsenic and dissolved solids.

The Laker Plaza property well (82441) was drilled at 2310 Lake Mead Parkway through the Muddy Creek Formation including 350 feet of cemented gravel which may be River Mountain conglomerate of Muddy

Creek Formation (Scott, 1997) to 410 ft bgs where limestone (possibly Horse Springs Formation) was encountered. The Laker Plaza well terminates in limestone at 600 feet bgs. Groundwater was first noted at 480 feet bgs. A static water level was measured after well placement in February of 2001 at 160 ft bgs, indicating confined conditions similar to the test well discussed above, albeit at a much higher potentiometric surface elevation. Ground elevation at the well location is approximately 1,810 feet amsl. The groundwater is considered "very hard," with an average total dissolved solids content of 2800 ± 1100 mg/l and neutral pH 7.37 ± 0.22 pH units (Zenitech, 2007). Arsenic and lead analyses are not available for this well.

The water level data from the four wells suggest that the depth to first water bearing zones at the Three Kids Mine is in the range of 500 to 700 ft bgs. Water does not seep into and accumulate in the pits, indicating groundwater elevations lower than the base of the Hydro Pit. Relationships between known information from well logs and subsequent data can be used to estimate the thickness of native materials between the base of the Hydro Pit and water bearing zones (WBZ) as presented in Figure 8C. Based on these relationships, the following conclusions are derived: 1) the Clark County well terminates in dacite and is thought to be dry; 2) the Three Kids Mine well is separated from the Laker Plaza well and the U.S. Government well by a fault and has a much lower water level; and 3) the Laker Plaza well and U.S. Government well are on the west side of the fault and have comparable depths to first WBZ.

In general groundwater is expected to flow west and north away from the River Mountains towards the Las Vegas Wash.

1.2.5 Surface water

Prior to the onset of mining activities, most of the present-day disturbed area sat upon an alluvial plain at the north end of the River Mountains. Most surface water, both local and that draining from the River Mountains, flowed in a combination of narrow channels and washes that exited the site at the northwest boundary. At that location it joined a larger drainage system known historically as the Three Kids Wash, which flowed north approximately one mile to the Las Vegas Wash (Zenitech, 2007). Currently, no perennial or intermittent streams are present on site, but there is visual evidence of contemporary surface water flow following heavy storm events. Also, tailings dams and mine pits constrain most disturbed area surface water from exiting the site. Following reclamation, runoff and detention of stormwater will be managed via engineering controls as part of the development master plan.

2.0 METHODOLOGY

Infiltration and geochemical reaction models were developed for the Leaching Analysis. The Leaching Analysis model simulations were used to evaluate the leachability of tailings, waste rock, and mine site soil mixtures in various ratios placed into the pits and low areas. The rate of infiltration and fate and transport of metals are evaluated per NDEP guidelines (BMRR, 2018a). The conceptual models, inputs, selection of code, implementation, and calibration for the model is described below. Methods are broken out into the geochemical reaction model, the infiltration model, and analysis of potential for leaching of organic constituents. The final section (Section 2.4) includes a list of deviations from the Work Plan.

2.1 GEOCHEMICAL REACTION MODEL

2.1.1 Conceptual Geochemical Model

A conceptual geochemical model of the site was developed based on previous studies, results from Phase II sampling and analysis, and guidelines from NDEP (BMRR, 2018b,c). A schematic of the mine pit cross section and geochemical conceptual model is provided in Figure 5. Figure 5 identifies the various water balance, chemical reaction, and transport mechanisms that are of importance the site. This is the first step prior to simulation with a numerical model (Nordstrom and Nicholson, 2017). As the availability of water drives geochemical reactions, it is impossible to isolate the conceptual geochemical model from the conceptual infiltration and water movement model, but additional explanation of the conceptual infiltration model will be provided in Section 2.2.1 below. The leaching and transport of select metals (arsenic, lead, manganese, and iron) and other major ion constituents were simulated to evaluate whether leaching of these metals poses a threat to groundwater. These metals were selected from the SRC list because they exceeded either Regional Screening Levels (RSLs) or Background Threshold Values (BTVs) (Broadbent, 2022a) in the mine wastes, either by total metals analysis or by MWMP, at levels that warrant analysis. Modeling of organic chemicals was also based on potential exceedances of RSLs and or maximum contaminant levels (MCLs) as described in Section 2.3.

The Hydro Pit scenario includes backfill with tailings and placement of an impermeable synthetic cover. The other two model scenarios are similar, except that there will not be a synthetic impermeable geomembrane cover and fill material will not include tailings. In the Hulin/A-B Pit scenario and the Central Valley scenario, the current reclamation plan includes backfill with waste rock and a 10-foot clean cover. The three scenarios modeled are summarized in the table below. The representative element volume (REV) of these scenarios is conceptualized as a large diameter column through which meteoric water or another infiltrate, if any, moves downward through the column and regraded stratigraphy. In the unsaturated zone water movement will be predominantly vertical owing to gravitational forces.

Scenario	Fill	Cover	Type of Model	Type of Results
Hydro Pit	tailings and waste rock	synthetic liner	geochemical transport	metals concentrations and velocity
Central Valley	waste rock	10 feet of clean cover	infiltration	infiltration rate and travel time
A-B and Hulin Pits	waste rock	10 feet of clean cover	geochemical transport	metals concentrations and velocity

The REV of mine pit backfill is conceptualized as a large diameter column filled with a mixture of tailings and waste rock that will be excavated from the site during reclamation and placed in the pits (Figure 5). Meteoric water or other infiltrate, if any, that makes it through the cover comes in contact with backfill material. As the moisture availability and precipitation events are infrequent, matrix minerals in the backfill and other materials react with dissolved constituents before being displaced by moving water under matric suction potential and downward migrating pulses of meteoric water. The resulting reactions between infiltrate and solids result in solubilization of select metals in the downward moving leachate unless all components are in equilibrium. Hence MWMP tests simulate the water rock contact process and resulting leachate effluents include the dissolved constituents that build up over time in pore moisture. As conceptualized by Earley et al. (2000), the one-dimensional model profiles at selected locations are composed of REVs of the subsurface stratigraphy including backfill materials. Pit wall rock reactions with Muddy Creek Formation and River Mountain Volcanics are expected to have leachate concentrations that are relatively dilute compared to targeted metal concentrations in backfill leachates. In addition, vertical intersects from the top of the backfill pass through thinner backfill sequences than at the base, which results in additional dilution effects. Owing to pit wall drying and the expected low relative hydraulic conductivity of the pit walls compared to the backfill, the inferred no-flow boundary condition in the one-dimensional reactive transport model is a first order approximation of the system.

The geochemical model is based on this column flow reactor concept and defines the most likely reaction(s) that may occur, including mineral dissolution, ion exchange, sorption, and oxidation/reduction. The conceptual model (Figure 5) informed the development of aspects of the numerical geochemical model providing information to help establish boundary and initial conditions, potential range of metals concentrations, and other conditions related to potential leaching reactions such as:

- Atmospheric boundary conditions, and available moisture from precipitation
- Initial moisture content of mine waste or geologic layer and pore water chemistry
- Layer thickness of cover, mine waste backfill, underlying natural soils or geologic formations, and water bearing zone elevation
- Vertical flow boundaries such as no flow low permeability formations
- Mineralogy and pore water chemistry in rocks and materials above the water table
- Geothermal gradients and temperature

The moisture content of the backfill and other construction materials used for backfill was adjusted in the model to account for optimization of compaction and dust suppression and have been determined by hydraulic, Proctor, and other geotechnical testing on mine wastes and waste blends.

MWMP testing is critical for the geochemical model because it provided information on the initial pore water chemistry of mine wastes (Table 2) after backfilling and regrading. MWMP data also provides estimates of in situ and contact water with native and borrow materials (Table 3).

Layer thicknesses of covers and mine waste backfill have been calculated from reclamation grading plans and estimates of the depth to water bearing zones at the site but may vary from location to location across the site. Model sections and contacts and faults are known from reclamation plans and geologic maps (Figures 6, 7, and 8). Figure 7 shows the locations selected for the leaching model profiles described below.

Geothermal gradients estimated from groundwater temperature measurements and published studies (Nevada Bureau of Mines, 2010) indicate that the average temperature difference from top of the model to the base will not be significant so an isothermal condition of 25 degrees Celsius is used for the system temperature. Temperature input for the climate model is only used in calculating PET at the land surface so this input does not conflict with the assumption of isothermal conditions in the backfill.

Mineralogy is known from reports on the Three Kids ore deposit (Van Glider, 1963) and from X-ray diffraction analyses (XRD) on mine wastes (Table 4). The tailings have no detectable sulfide minerals but do have a very high swelling clay content that binds organics and metals. Given the high redox potential of manganese minerals in ore residual tailings, the syngenetic deposition of native sulfide minerals is not thermodynamically possible at this site. Minerals provide the metals and other constituent source terms, solubility limits, pH, and redox potential (Eh) controls in the model and attenuate metals and organic compounds by oxidation, ion exchange, and sorption reactions. These parameters are accounted for in the model by thermodynamic equilibrium reaction. For example, the mass-action and dissolution-precipitation reactions:

$$CaCO_3 + CO_2 + H_2O = Ca^{+2} + 2HCO_3^-$$

$$CaSO_4 \bullet 2H_2O = Ca^{+2} + SO_4^{-2} + 2H_2O$$

are important reactions simulated by the model because site materials contain calcite and gypsum. The backfill is simulated as a closed system to gas transfer owing to relatively deep burial and low permeability pit walls. It is likely that there is some slow gas diffusion in the unsaturated materials but that the system is in local equilibrium. Equilibrium conditions are simulated using geochemical models using equilibrium constants, $K_{sp,calcite}$, $K_{sp,gypsum}$, etc., which are usually referenced to standard state temperature and pressure conditions 25 degrees Celsius and 1 bar pressure (approximately average atmosphere). However, reaction kinetic limitations may slow the attainment of equilibrium conditions in some systems.

Figure 9a is an Eh - pH diagram showing the stability ranges of minerals and dissolved aqueous species detected at the site by XRD (Table 4, Van Glider, 1963). Eh (pe) and pH conditions should remain relatively oxidizing or suboxic and neutral to alkaline owing to the presence of manganese and iron oxides (Figure 9b) and carbonates in tailings and in mine wastes and natural geologic materials. Conceptually, iron and manganese oxides can also react with and oxidize natural and contaminant organics (Johnson et al. 2017, Schwarzenbach, 1993) and mineralize carbon dioxide via reactions like the following for site related minerals goethite and manganosite:

Goethite $FeO(OH)_{[s]} + CH_2O = FeCO_3 + 3/2H_2$

Manganosite $MnO_{2[s]} + CH_2O = MnCO_3 + H_2$

As the materials will be buried but not saturated, the system is not buffered by the atmosphere but gas exchange from pore gas to the leachate is simulated (Figure 5). The current site is not reclaimed and tailings and waste rock are exposed at the surface and buried to relatively shallow depths as compared to the backfill depths. Weathering and oxidation of this material has occurred for more than 60 years and has probably resulted in some oxidation of the material. In the presence of residual manganese and iron oxides the oxidation of residual organics is likely accelerated. For example, organic breakdown by manganese oxides in mine wastes has been demonstrated using organic dyes (Johnson et al., 2017).

Surface sorption reactions are also simulated in the model including arsenic sorption onto iron hydroxide (i.e., goethite) surfaces via reactions like:

$\equiv FeOH^o + AsO_4^{3-} + 3H^+ = \equiv FeH_2AsO_4^o + H_2O$ [Arsenate]

Goethite is present in site tailings and waste rock and goethite in ferruginous manganese ore is a strong sorbent for arsenic and ferruginous manganese ore (Chakravarty et al., 2002).

In summary, the geochemical conceptual model includes the following steps:

1. Precipitation occurs at the surface.
2. A small percentage of precipitation infiltrates, as demonstrated by the Central Valley Scenario (CVS) model.
3. Water infiltrates through the cover material, if any, and interacts with pore water in the cover material (pore water chemistry based on MWMP results).
4. Water infiltrates through the backfill material (either tailings or a tailings-waste rock mixture), and initial pore water chemistry is based on MWMP results.
5. Water-rock interactions occur as water moves through the backfill material, resulting in changes in chemistry.
6. Below the backfill, free drainage occurs through the underlying geology to the water table.

2.1.2 Geochemical Data Compilation for Model Input

2.1.2.1 <u>Critical Data Review</u>

A critical review of Phase I and Phase II data was conducted as part of the Leaching Analysis. Appendices C, D, and E contain Phase II datasets. The data reviewed includes results of tailings and waste rock compositions, MWMP (ASTM, 2007; Tables 2 and 3), mineralogy and clay mineralogy by XRD (Table 4), particle size analysis (ASTM, 2016), and geomechanical and hydraulic testing such as soil water characteristic curve (SWCC) measurements (Stephens, 1996; EPA, 1996, Tables 5 and 6) that were performed to characterize the physical properties of backfill mixtures. Mineralogical and MWMP data provide model input for initial chemical conditions including concentrations of major and trace constituents, pH, and redox (pe). Selected acid base accounting (ABA) analyses were conducted to evaluate whether site materials contain any acid generating potential that might enhance leaching (Table 7).

The MWMP data (Tables 2 and 3 and Appendix C) provide the most direct information on site contact and pore water. In addition, the concentrations of constituents in the MWMP leachates are useful in understanding the chemistry of site recharge to groundwater and groundwater chemistry. MWMP leachates can be described as circumneutral to slightly alkaline and are dominantly calcium sulfate type water. This is expected given the widespread occurrence of gypsum in the Muddy Creek Formation, which is the largest source of natural and mined materials. The manganese ore itself contains manganese oxides and is not sulfide bearing as confirmed by ABA testing results (Table 7). Neutral to alkaline conditions are also expected owing to the presence of carbonates in the geologic and mine materials (Table 4, Figure 9, and Van Glider, 1963).

2.1.2.2 <u>Assessment of Parameter Variability and Statistics</u>

MWMP

A statistical summary of MWMP data was prepared (Table 2) where data were sufficient to inform model input parameter selection and evaluate parameter variability. Laboratory reports are included as Appendix C. The results can be summarized by the following bullets:

- The most common SRC that exceeds background values is arsenic which is two to 100 times Nevada Profile I water quality concentrations in MWMP leachates (Tables 2 and 3, Figure 10). All MWMP sample leachates exceed Profile I standards including samples from naturally occurring geologic materials at the site.

- The mean tailings arsenic concentration (based on 20 samples collected in 2021) is 0.64 mg/l and the mean waste rock arsenic concentration is 0.71 mg/l (based on 39 samples collected in 2021). These values are quite similar given that the tailings represent the remains of manganese ore that has been beneficiated and processed and the waste rock is sub ore grade overburden consisting mostly of Muddy Creek sediments.

- The maximum and minimum arsenic concentrations in MWMP tailings leachate are 1.02 mg/l and 0.27 mg/l, respectively, and in waste rock leachate are 2.23 mg/l and 0.10 mg/l, respectively (Table 2 and Figure 10). The maximum waste rock arsenic concentration in the sample population of MWMP leachates is approximately 1.7 times the maximum arsenic concentration in tailings MWMP leachates. Arsenic may be associated with manganese oxide minerals and concentrations in tailings may have been reduced as compared to the mined ore during mineral processing (Chakravarty et al., 2002).

Statistical analysis of other site materials was not possible given the limited number of samples collected for each natural and impacted material (Table 3), but the following comparisons, which can be visualized in Figure 10, are beneficial in summarizing the MWMP leachate concentrations:

- The alluvium samples have the lowest concentrations (Figure 10) and the tailings and waste rock have the highest concentrations of dissolved arsenic in MWMP leachates.

- The maximum arsenic concentrations in alluvium, Muddy Creek, Tsm, and other site material MWMP leachates are not as high as for the tailings and waste rock, but the overall range is similar to the mean and minimum tailings and waste rock concentrations (Tables 2 and 3).

- The alluvium samples have the lowest arsenic concentrations in MWMP leachates but even the minimum concentration is still higher than Profile I concentration (0.01 mg/l).

- The Muddy Creek and volcanic sample MWMP leachate arsenic concentrations are the next highest group but lower than the mine impacted wastes.

- The ore yard and mill site arsenic concentration ranges are similar to the tailings.

- One sample of sediments collected at the bottom of the A-B Pit had an arsenic leachate concentration similar to the median Muddy Creek sample.

- The Tsm samples also collected at the bottom of the A-B pit had the highest arsenic concentrations of native geologic formation materials tested by MWMP (maximum of 0.546 mg/l). The Tsm sample arsenic concentrations are slightly lower than the mean tailing and waste rock arsenic concentrations but higher than the minimums. However, given that the Tsm hosted ore horizons at the footwall and the average grade of manganese is lower than the cutoff grade (McKelvey, et al. 1949), it is likely that the possible range of arsenic concentrations in MWMP leachates from residual manganese ore at the bottom of the pits is higher. For example, pre-mining drill core assay samples have arsenic concentrations up to 760 mg/kg (USBM, 1945). The tonnage of remaining low-grade ore is approximately twice the amount mined during open pit operations (McKelvey, et al. 1949).

- Only one isolated exceedance of Profile I standards occurred in MWMP leachate concentration results for SRCs other than manganese and arsenic for lead in one mill site sample (Table 3).

In summary, native geologic and mine waste materials have arsenic concentrations in MWMP leachates that exceed Nevada Profile I standards, and some of the natural material samples yield MWMP leachates that have arsenic concentrations that are within the range of mine waste leachate concentrations. Other isolated exceedances of Profile I standards occurred in MWMP leachate concentration results for manganese in tailings samples and lead in one mill site sample (Tables 2 and 3).

Hydraulic Testing

The saturated hydraulic conductivity (K_{sat}) and SWCC parameters derived from samples tested at Daniel B. Stephens & Associates (DBS&A) Soil Testing and Research Laboratory and used in the infiltration model are summarized in Tables 5 and 6 (DBS&A reports are compiled in Appendix D). The retention curve computer program RETC is a program for analyzing the hydraulic conductivity properties of unsaturated soils. The parametric models of Brooks-Corey and van Genuchten are used to represent the soil water retention curve. The SWCC values are used in RETC to calculate the van Genuchten - Mualem model parameters in Hydrus 1D (Šimůnek, et al., 2018). The hydraulic properties of these materials are a complex function of the texture and composition (Stephens, 1996): determination of the rate of water flow through geologic materials is a function of moisture content for a given gradient of matric potential.

The K_{sat} values were provided from data collected in falling head flexible wall column tests and corrected for oversize content, if any (Hlavacikova et al., 2016). The other parameters are derived by fitting to the test data. In general, fine-grained materials tend to have higher moisture retention (Θ_r) and porosity (Θ_s) but lower K_{sat}. However, complex poorly sorted materials like the Muddy Creek Formation may have less predictable values. This can be seen in Table 5 where the 90/10 tailings to waste rock mixture has a lower moisture retention point (Θ_r) and higher K_{sat} than the 50/50 blend. Coarse grained material may be less conductive under low moisture conditions than fine grained materials owing to less surface area and capillary tension. However, as the material reaches saturation, water flows through coarse grained material much faster.

The range of K_{sat} parameters across the site provides an indication of relative permeability under conditions of high moisture content for a given gradient. Oversize-corrected K_{sat} ranged from $1X10^{-7}$ to

$1X10^{-3}$ cm/sec owing to the wide range of material textures and compositions. K_{sat} results for native geologic materials (including the Muddy Creek Formation, alluvium, and the Tsm geologic unit) were on the order of $1X10^{-4}$. One tailings sample had a lower K_{sat} than native materials on the order of $1X10^{-5}$, and the three tailings-waste rock blends had even lower K_{sat} ranging from the order of $1X10^{-6}$ to $1X10^{-7}$. Given the heterogeneity of the materials the range in K_{sat} is relatively low when considering the tailings as one lower hydraulic conductivity group, as expected, and coarser materials such as waste rock and Muddy Creek Formation in another higher K_{sat} group. The potential range of hydraulic conductivity (or permeability) possible in geologic media which is about 10 orders of magnitude (Oelkers, 1996) but the relative hydraulic conductivity can vary as much for a given sample of material depending upon moisture content (Appendix D).

Saturated conditions are not likely at the site owing to low rainfall, high PET, and deep groundwater conditions. The only time saturated conditions were present at the surface of the site was during active operation of the tailings ponds and occasionally during ephemeral stream flow during storm events. Hydrus 1D predicts surface runoff in cases where precipitation exceeds the rate of infiltration for a given antecedent moisture condition. This only occurs during longer periods of precipitation or back-to-back storm events. As most of the storm runoff will be controlled by constructed diversion features after reclamation, the development's stormwater detention does not promote infiltration into the subsurface materials. The detention basin is a peaking basin, so no standing or ponded water will be present for more than 24 hours. Subsurface saturation will not occur under these conditions.

Mineralogy by X-Ray Diffraction (XRD)

Table 4 shows the results of XRD analyses of tailings samples. The samples contain a high proportion of amorphous material (11 to 33 weight percent) which is predominantly expandable clays such as montmorillonite as identified by oriented mount XRD analyses of clay separates (Appendix E). Typical rock forming silicates such as quartz and feldspars are the second most abundant minerals which are the mill process residues from the matrix of the ore host rock (Muddy Creek Formation). These are relatively inert and are not likely sources of metals in leachates compared to other minerals in the samples. Several carbonate minerals were also identified. The primary manganese minerals identified are rhodochrosite, kutnahorite, manganosite, ramsdellite, and todorokite. The sulfates celestine and gypsum were also detected in tailings. The iron oxide mineral goethite was also detected in all the samples. No arsenic or lead minerals were detected in tailing samples, but other investigations indicate that lead is associated with carbonate and manganese minerals such as cerussite and coronadite in the manganese ore, respectively (Van Glider, 1963).

Total carbon content by Leco analysis in three tailings samples is also provided in Table 4 with the XRD analyses. Based on the carbonate contents the maximum total organic content is equal to or less than 0.1 weight percent and may be a result of organic breakdown over several decades since tailings operations were closed.

2.1.3 Selection of Geochemical Modeling Code

The hydrogeochemical modeling code Hydrus-1D, a variably saturated hydrologic modeling code described further in Section 2.2 below, and HP1 geochemical modeling subroutine (Šimůnek, et al., 2018) was selected following guidelines in Nordstrom and Nicholson (2017). The Hydrus-1D software and code is approved by to NDEP (BMRR, 2018b,c) and is able to simulate a wide range of solid leachate reactions for select metals used in the geochemical modeling of leaching and other reactions that may occur owing to infiltration of meteoric water through the site backfill scenarios under variably saturated conditions. Infiltration rates were determined by standalone infiltration modeling with Hydrus-1D without HP1 as described further in Section 2.2 below. The Hydrus-1D variably saturated flow code with HP1 reaction capabilities was used to determine partitioning and retardation owing to sorption and precipitation reactions along flow paths according to aqueous electrolyte theory and thermodynamic equilibrium calculations. Site constituents like arsenic can be simulated accurately using this approach as current data suggests that leachate pH is circumneutral to slightly alkaline, carbonate buffered, and relatively oxidized owing to unsaturated air-filled pores in the waste rock. Equilibrium constants and sorption coefficients, which are pH and Eh (pe) dependent, are calculated in the model using the PHREEQC database and extension PHREEQCU. The model with this database uses the extended Debye-Hückel activity model for calculation of activity coefficients and equilibrium aqueous speciation of dissolved ions in solutions with variable ionic strength (Parkhurst and Appelo, 1999).

HP1 is one of the most complex modeling tool in terms of available chemical and biological reactions (Šimůnek et al., 2008). The HP1 (acronym for HYDRUS1D–PHREEQC, Version 1) (Jacques and Šimůnek, 2005; Jacques et al., 2006). The combined code contains modules simulating (i) transient water flow in variably saturated media, (ii) the transport of multiple components, (iii) mixed equilibrium–kinetic biogeochemical reactions, and (iv) heat transport. PHREEQC is a The HP1 program is a significant expansion of the individual HYDRUS-1D and PHREEQC programs by combining and preserving most of their original features and capabilities into a single numerical model. The HYDRUS-1D code uses the Richards equation for variably saturated flow and advection–dispersion type equations for heat and solute transport; however, the HP1 extension can simulate also a broad range of low-temperature reactions in water, the vadose zone, and groundwater systems, including interactions with minerals, gases, exchangers, and sorption surfaces, based on thermodynamic equilibrium, kinetics, or mixed equilibrium–kinetic reactions.

2.1.3.1 Geochemical Model Validation

The geochemical model Hydrus 1D and HP1 have been validated by comparison with published and widely accepted case studies as described in Jacques and Šimůnek, J. (2005). The PC Progress site (2021) also provides additional validation studies for Hydrus 1D and HP1. Several modeling case studies are presented in Nordstrom and Nicholson (2017). Other references to the appropriate application of geochemical and hydrologic modeling are provided in the INAP GARD guide (2021). These peer reviewed modeling studies have been reviewed, and relevant modeling results were used to guide calibration and base case predictive simulations for the site. There are eight published studies referenced in the reference bibliographies that have modeling components that are directly relevant for comparison (Zeng et al., 2018, Jacques and Šimůnek, J. 2005).

Jacques et al. (2003, 2008a,b), Jacques and Šimůnek (2005), and Šimůnek et al. (2006b) demonstrated the versatility of HP1 on several examples such as (i) the transport of heavy metals subject to multiple cation exchange reactions, (ii) transport with mineral dissolution, (iii) heavy metal transport in a medium with a pH-dependent cation exchange complex, (iv) infiltration of a hyperalkaline solution in a clay sample with kinetic precipitation–dissolution of matrix minerals, (v) long-term transient flow and transport of major cations and heavy metals (in a soil profile), (vi) Cd leaching in acid sandy soils, (vii) radionuclide transport (uranium and its aqueous complexes), and (viii) the fate and subsurface transport of explosive compounds (Šimůnek et al., 2008).

2.1.4 Geochemical Model Implementation

Below is a discussion of key model inputs. Specific values are tabulated for each scenario in Appendices G, H, and I. Values changed from defaults are included in Tables 1G, 1H, and 1I.

2.1.4.1 Development of Equilibrium and Kinetic Assumptions and Calculations

The geochemical conceptual model identifies the potential equilibrium and kinetic reactions that may occur between the backfill minerals, chemical compounds, and leachate under variable moisture, temperature, and chemical conditions, such as ionic strength, pH, and Eh. The appropriate numerical model reaction expressions, partition coefficients, thermodynamic data, and kinetic rate functions were developed using the geochemical modeling and reactive transport code HP1 in Hydrus-1D for the most important and reactive system constituents.

System pH was calculated by the model by balancing acid-base reactions based on molar concentrations of mineral and dissolved aqueous species using a published and maintained thermodynamic database PHREEQCU included with the HP1 module (Jacques and Šimůnek, 2005). System electrical balance and pe (calculated from system redox potential) was determined by thermodynamic reaction calculations in the model which balances paired, half reactions based on molar concentrations of mineral and dissolved aqueous species with variable redox states like iron and manganese.

The basis aqueous species and components selected for reactive transport simulation include water, alkalinity, arsenic, calcium, carbon, iron, lead, magnesium, manganese, sodium, and sulfate. While dissolved calcium and sodium are not highly significant from a health perspective, they are significant for approximation of overall electrical balance, aqueous solution chemistry and ionic strength, and thermodynamic calculations. Other significant rock forming elements and components silica and aluminum were omitted because they are not present in MWMP leachates in significant amounts and the aluminosilicate rock forming minerals are relatively inert over the timeframes important to this analysis.

The equilibrium phases that can potentially precipitate or dissolve in the system are gypsum ($CaSO_4 \bullet 2H_2O$), scorodite ($FeAsO_4 \cdot 2H_2O$), calcite ($CaCO_3$), rhodochrosite ($MnCO_3$), goethite ($FeOOH$), and cerrusite ($PbCO_3$) as indicated in Nordstrom and Alpers (1999). Calcite and gypsum are found in tailings and other mine materials in XRD analyses, and all solutions were equilibrated with one weight percent calcite and gypsum. This phase assemblage provides conservative upper solubility limits to concentrations as they are most likely to be in equilibrium with the pore water aqueous phase at the site. Temperature corrections were not needed for thermodynamic constants based on an average geothermal gradient of 0.0243 degrees Celsius (°C) per meter or 0.0074°C per foot (NV Bureau of Mines, 2010).

2.1.4.2 Empirical Fitting and Scaling Factors

Model input parameters required calibration by empirical fitting with respect to sorption site density and mineralogical controls on leachate chemistry. The calibration results are described below. It is noted that site materials have been exposed for six decades since the end of mining and milling activities at the site. Generation of new sources is insignificant since that time. The widespread exposure of mined and mill process materials to weathering has resulted in leaching reactions that release constituents. The rates of initial leaching are relatively fast compared to rates over longer periods of time owing to high initial surface area and exposure. Hence it is expected that weathering of these materials has already released significant masses of constituents in incident meteoric precipitation and in infiltrating water. Across most of the site, reclamation and revegetation is sparse so very little root uptake can occur to remove meteoric water that precipitates across the site.

In the Central Valley model scenario, relative concentration scaling is applied to facilitate more complex boundary conditions for simulation of ground infiltration by precipitation with ET driven by vegetation. However, the relative concentrations are related to site constituents (i.e., arsenic) in the description of results. In addition, the two pit backfill scenarios (Hydro Pit and Hulin/A-B) are scaled relative to maximum depths, but the actual pit backfill depths vary across the site with variations in mine cuts and topography (Figures 8A through 8D). The model inputs are selected to be conservative to account for uncertainties and expected variations in actual field values.

2.1.4.3 <u>Model Period and Discretization</u>

The model period or time boundaries and spatial discretization were adjusted to achieve the best numerical simulation stability and resolution appropriate for the site and modeling objectives (Nordstrom and Nicholson, 2017). The model period of 72 years (average human lifespan according Ourworlddata, 2022) was selected to correspond with the reference climate period for the CVS simulations described in Section 4.2.1 which is sufficiently long for practicable timeframes for human risk analysis given the thickness of anticipated backfill, depth to water bearing zones, and time required for meteoric water to wet, percolate, and achieve steady state conditions. The Hydro, A-B, and Hulin pit models did not require daily climate input values and were set at 70 years for simplicity. Model predictions for timeframes greater than 100 years are not considered practical given the uncertainties of human use of resources and technological advancements.

The numerical model domain for all scenarios was set at 100 meters (328 feet) with one dimensional vertical finite element cells discretized at one meter. As the climate record is a daily summary calculation, time stepping did not exceed one day. The default numerical calculation settings in Hydrus 1D were used in most cases, except for the maximum time step and maximum number of iterations. Maximum iterations were increased to 100 owing to the calculation demands of HP1. Some numerical dispersion was observed at boundaries but did not affect the findings of the Leaching Analysis.

The model simulations for the Hydro, A-B, and Hulin backfilled pits used the MINDIS example from the Hydrus-1D software package (Šimůnek, et al., 2018; Jacques and Šimůnek, 2005) as a starting template. The template provided a predetermined basis for setting numerical iteration criteria etc. The maximum time step and maximum number of iterations was increased to 100 and one day to account for the larger spatial and temporal model domains and complexity. This did not affect the simulation results and Peclet and Courant numbers were always below one.

2.1.4.4 <u>Sub-Models</u>

Subroutines in the model or independent model calculations or simulations were used to adjust model input parameters or model output and to accurately simulate complicated geochemistry. For example, within the Hydrus-1D software platform, the code HP1 combines the geochemical model PHREEQC as a sub-model coupled with the infiltration and transport code Hydrus-1D (Jacques and Šimůnek, 2005), but highly complicated and kinetically limited systems are, from a practical standpoint, difficult to simulate owing to inherently low numerical stability of non-linear equations involved and resulting long run times.

Given the slow rate of water movement through the materials in the arid climate of the site, closed system models can provide an indication of reaction limited transport mechanisms. Hence the sub-model Act2 in the Geochemist's Workbench modeling platform (Bethke et al., 2020) was used to generate an Eh pH diagram (Figure 9a) that shows the changes in dissolved aqueous and solid mineral species. These changes may result in pH and Eh changes occurring as a result of reaction with redox active minerals, like manganese and iron oxides, owing to their importance in metal attenuation and breakdown of organics. Organics are discussed in more detail in Section 2.3.

2.1.4.5 <u>Sulfide Oxidation and Reactive Rock Mass Estimation</u>

MWMP (Tables 2 and 3) and mineralogical data (Table 4) indicate that leachates are circumneutral and carbonate buffered. Three tailings and three waste rock samples were submitted for (modified Sobek method) for confirmation. Table 7 shows that the samples contain sulfate sulfur but very little sulfide sulfur. Hence these samples are categorized as non-acid generating on the basis of acid generating potential calculated from sulfide sulfur according to Nevada standards (NDEP, 2014).

MWMP results were not scaled to account for water-pit wall rock interactions because although the water to rock ratio is much less than 1:1 in the MWMP tests, the rocks are crushed to minus two-inch material which biases the sample towards finer grained material. Hence the more dilute 1:1 water to rock ratio used in MWMP is counterbalanced by sample disturbance during sampling and crushing of oversized material to provide more reactive surface area. In addition, it is noted that the metal and other leachate concentrations in Muddy Creek sample MWMP from the A-B Pit (sample "Muddy Creek AB TP1" in Table 3) are very similar to the MWMP leachate concentrations in the pit bottom sample (sample "AB Pit Bot-01" in Table 3). The pit bottom sediments have mud cracks that indicate that water occasionally collects in the bottom of the A-B Pit after precipitation events. The bottom sediments are silty sand composition (Appendix D) and are likely derived from the Muddy Creek pit walls as the volcanics are competent rock. Hence the similarity of MWMP leachates in the Muddy Creek sample from the A-B Pit as compared to the pit bottom sediments that have been in contact with meteoric precipitation indicates that MWMP leachates are appropriate for the initial composition of pore water leachates in the model. Moreover, it also indicates that the composition of the leachates is not highly sensitive to the effective water to rock ratio as the pit bottom sediments have likely been in contact with more meteoric water runoff than the in-situ sample of Muddy Creek Formation sediments resulting from surface recharge by incident rainfall. This supports the model assumption that water rock reaction is dominated by local solubility equilibrium of moisture with matrix minerals, surface sorption, and ion exchange reactions (Helfferich, 1995).

2.1.4.6 <u>Probabilistic Analysis</u>

The former mine pits' dimensions and other site conditions are known with a high degree of certainty, and the range of other model input parameters such as MWMP leachate concentrations was quantified through statistical analysis where sufficient data was available. Hence there is little need for probabilistic analysis in the Leaching Analysis as the backfilled pits' hydrologic and geochemical system resistance to external loading is high (Ganoulis, 1994). The mine waste geochemistry is highly buffered by reactive minerals like calcite and gypsum that control major ion concentrations and pH. In addition, iron oxides and manganese oxides buffer changes in redox conditions. Furthermore, probabilistic analysis based on random selection of ion concentrations as applied to water quality does not maintain charge balance and natural correlation of anions and cations. Charge balancing is used on major ions like sulfate, but randomization of counterions may induce unrealistic ion paring and overall water chemistry. Hence model uncertainty is addressed by a sensitivity analysis which results in more realistic input water chemistries.

2.1.4.7 Geochemical Model Calibration

Broadbent collected samples from native soils and formations underneath the tailings for chemical analysis. The depth of migration and concentrations were used to test and calibrate the predictive accuracy of the geochemical reactive transport model as described in the calibration section below.

2.2 INFILTRATION MODEL

2.2.1 Conceptual Infiltration Model

As with the conceptual geochemical model, a conceptual infiltration model of the site was developed based on previous studies, results from Phase II sampling and analysis, and guidelines from NDEP (BMRR, 2018a,c) and Nordstrom and Nicholson (2017). Following the geochemical conceptual model described in Section 2.1.1, the Hydro Pit backfill is conceptualized by a large diameter column filled with a mixture of tailings and waste rock that is excavated from the site and placed in the pit (Figure 5). For practical purposes, the pit walls are essentially no flow boundaries with respect to unsaturated water and mass transport. One aspect of the current reclamation plan includes backfill of the Hydro Pit and placement of a final cover consisting of an impermeable synthetic cover using geomembranes that detain precipitation and runoff. It is estimated that standing water will only be present in the detention basin for a maximum of 24 hours and for most precipitation events only a few hours. Hence the only moisture available for reaction is the initial moisture of the material as it is placed in the pit. The moisture content will be determined for maximum compaction and dust suppression. However, drying of the pit walls over time since mine closure results in some lateral moisture transfer until steady state is achieved. The model does not include this process, so the simulation results are conservative with respect to downward moisture movement.

The Hulin/A-B Pits are also conceptualized by a large diameter column filled with waste rock. In these scenarios, meteoric water that makes it through an earthen cover flows vertically through the backfill, which is variably saturated, and drains freely from the bottom at some point above the water table. The conceptual infiltration model guided the development of the CVS model, providing information to help establish realistic boundary and initial conditions, the potential range of hydraulic properties, and rate of net infiltration that governs unsaturated flow.

In the CVS scenario, hydrologic conditions included initial and transient moisture conditions, climate and atmospheric conditions, vegetation rooting density and depth, subsurface material layers, textures, and contact water reactions with site mine wastes native soil, rock, and borrow soils.

2.2.2 Hydraulic Data Compilation

A critical review of the Phase I and Phase II data was conducted as part of the Leaching Analysis and is described above in Section 2.1.2.2. Hydraulic data was adjusted and scaled if necessary to compensate for oversized materials (Hlavacikova et al., 2016). In general, gravel and larger low permeability particles in porous materials decreases saturated hydraulic conductivity as water particles travel around the particle which increases tortuosity.

2.2.3 Selection of Infiltration Modeling Code

The hydrogeochemical modeling code Hydrus-1D (Šimůnek, et al., 2018), a variably saturated hydrologic modeling code described in Section 2.1.3, was used as the infiltration model. Some additional information on water balance and water flow simulation criteria outside of the geochemical model are provided in the following sections.

2.2.4 Model Period and Discretization

The model period or time boundaries and spatial discretization were adjusted to achieve the best numerical simulation stability and resolution appropriate for the site and modeling objectives (Nordstrom and Nicholson, 2017). Climate station data is summarized daily and the time-dependent soil-air surface boundary conditions were discretized according to daily input variables. As described in Section 2.1.4.3 above, the model period was extended to practicable timeframes for human risk analysis given the thickness of anticipated backfill, depth to water bearing zones, and time required for meteoric water to wet, percolate, and achieve steady state conditions. Model predictions for timeframes greater than 72 years are not considered practical given the uncertainties of human use of resources and technological advancements. Owing to the unit base of Hydrus 1D, some figures showing model domain grid and profile results are represented in metric rather than English units. Similarly, some of the chemical units are molar corresponding with the native units of Hydrus-1D, but the text provides English units for major results and findings.

In the CVS discussed below, HP1 was not used because only conservative (non-reactive) reactive transport by advection and dispersion was simulated in order to gain insights on site scale rates of recharge and the shortest travel times to groundwater. The model simulations for the CVS used the ROOTUPTK example from the Hydrus-1D software package (Šimůnek, et al., 2018) as a starting template. The template provided a predetermined basis for setting numerical iteration criteria. The maximum number of iterations was increased to 100 to account for the larger spatial and temporal model domains and complexity. This did not affect the simulation results and Peclet and Courant numbers were always below one. The upper and lower boundary conditions for solute transport were changed to concentration and zero concentration gradient to better represent the conceptual transport of conservative constituents in this model under free drainage conditions. The lower boundary concentration is unknown so the zero concentration gradient is appropriate.

2.2.5 Water Balance and Model Calibration

In the design of a backfill cover, the infiltration of meteoric precipitation into the cover and downward flow through backfill is reduced by the amount of ET of soil moisture by plants established on the cover during reclamation. The following soil water balance equation:

$$S + D = I - ET \qquad [1]$$

shows that storage (S) of water infiltration (I) into the cover material pore spaces and drainage (D) through the cover into the underlying waste rock are reduced by increasing ET. Infiltration is equal to precipitation (P) unless runoff (R) occurs at the surface as shown in the following equation:

$$I = P - R \qquad [2]$$

The water balance components are also illustrated in Figure 5. The cover must store infiltration long enough for the plants to take up pore water into roots and transpire the water as vapor. The rate of plant transpiration is partially controlled by potential evapotranspiration (ET_o) which is the maximum potential rate of moisture the atmosphere can receive by plant leaf transpiration.

Calculated model PET, using the formula developed by Hargreaves et al. (2003), was used to estimate the expected vegetated soil ET assuming successful reclamation and mature revegetation (BMRR, 2016). This formula only requires precipitation plus maximum and minimum temperatures, which is supported by most climate monitoring stations on a long-term basis. The Penman-Monteith equation requires more meteorological parameters which may be missing, prone to errors or long hiatuses in some climate records.

Surface water flow is managed in residential areas by the construction of lined drainage infrastructure at the site to divert runoff (R) away from backfilled mine pits and other areas where infiltration may generate metals containing leachate. In addition, the potential impacts from landscape irrigation and water line and liner leaks for the water detention basin were considered as potential sources of water for leachate generation. The City of Henderson has provided information that approximately 121,000 gallons of water are lost based upon three quarters of data in 2021 (Appendix F). This indicates a loss of 160,000 gallons per year. To put this information in terms of infiltration, the City of Henderson contains approximately 300,000 people which equates to 0.54 gallons per person per year. For a house with an average family of four people per household, the unit loss is 2.16 gallons per lot per year (0.29 ft^3/year). If an average lot is 5,000 ft^2, then the average rate of infiltration is 0.0007 inches per year within developed areas with water conveyance infrastructure. This rate is only 0.02 percent of annual precipitation which is 4.15 inches (Table 1) in the arid climate of Henderson and the Las Vegas area of southern Nevada. Hence this source of water for leachate generation was not simulated, and institutional controls are in place to keep water leaks from seeping into the subsurface for extended periods of time.

Newer developments in the desert southwestern U.S. are even more keenly aware of the need for water conservation and data on current water losses is conservative with respect to site infrastructure. Moreover, a large percentage of the area will be paved after development and covered by homes with roofs. These features intercept precipitation to be routed to stormwater conveyance systems and subsequently to offsite systems. Hence the actual amount of precipitation available for infiltration is much less than the model considers. Hence, the model results are conservative with respect to available water from incident precipitation.

2.2.6 Solute Mass Balance and Transport

Hydrus-1D solves the Richards equation that describes water flow in variably saturated porous media (Jacques and Šimůnek, 2005). Solute mass balance and transport is tracked in the infiltration and variably saturated flow model to simulate movement of metals into the cover and backfill. Over time, moisture conditions in the cover and backfill transition to a steady state condition that balances the rate of infiltration and equilibration with wall rock moisture and other boundary and material properties such as:

- Initial metals concentrations
- Porosity, dispersion, and flow path directions

- Solubility and attenuation capacity
- Matrix mineralogy

Hydrus-1D assumes that solutes can exist in all three phases (liquid, solid, and gaseous) and that the decay, retardation, and production processes can be different in each phase. Interactions between the solid and liquid phases may be described by nonlinear nonequilibrium equations, while interactions between the liquid and gaseous phases are assumed to be linear and instantaneous. Hydrus-1D simulates solute transport by convection and dispersion in the liquid phase as well as by diffusion in the gas phase. The adsorption isotherm relating soil and leachate concentrations is described by generalized nonlinear equations like the Freundlich, Langmuir, and linear adsorption equations, which are special cases of adsorption. However, the Leaching Analysis uses the electrostatic sorption model in HP1 which couples Hydrus 1D with PHREEQC (Šimůnek, et al., 2018) such that it can accurately predict attenuation as a function of pH. The rate of equilibration to steady state is affected by moisture uptake by soil and backfill minerals and weathering products. Hence steady state conditions are achieved slowly, but the model period is extended until steady state is approached in all simulations as tracked by soil water balance.

HP1 does not include the capability of simulating changes in hydraulic properties that may arise from geochemical reactions or geotechnical processes such as compaction etc. These are generally not included in reactive transport simulators but may be important over long time periods. Some models use empirical relationships of porosity to permeability to simulate long term effects of geochemical dissolution and precipitation on porosity and permeability (Bethke, et al. 2020).

2.3 Analysis of Leaching Potential From Organics

Organic contaminants exist in tailings owing to the use of diesel and other organic chemicals during manganese mineral processing (Zenitech, 2007). Organic compounds are typically present in mine tailings facilities owing to the common use of various organic chemicals in mineral processing of a wide variety of metals and minerals including manganese (Zhang, et al. 2020). DRO concentrations are the highest of organic constituents and range from below detection to one weight percent, but most concentrations range from approximately 100 to 12,400 milligrams per kilogram. Hence, the tailings contain DRO components including VOCs, SVOCs, and polycyclic aromatic hydrocarbons (PAH). It is likely that organic contaminants have partitioned into natural organics and organic residues in the tailings and mine materials used in the process such as plant derived oils and tannins for emulsification of the ore slurry (Zenitech, 2007).

Table 8 is a statistical summary of the organic SRCs analyzed in tailings and other site solids. The 95% upper confidence limit (UCL) of the unknown population mean was computed for each sample data set with at least four detected sample results. As recommended by U.S. EPA (2015), the procedure used to compute the UCL was determined from the distribution of the detected sample results as follows:

Distribution of Detected Sample Results	Goodness of Fit Test for Assumed Distribution	Method for Computing 95% UCL
No. Detects < 4	Not applicable (NA)	Maximum detected result
Normal	Null hypothesis not rejected for both Shapiro Wilk Test and Lilliefors Test at 95% confidence level	Student's *t*-statistic
Approximate Normal	Null hypothesis not rejected for either Shapiro Wilk Test or Lilliefors Test at 95% confidence level	Student's *t*-statistic
Gamma	Null hypothesis not rejected for both Anderson-Darling Test or Kolmogorov-Smirnov Test at 95% confidence level	Adjusted Gamma UCL (n < 50) or Approximate Gamma (n ≥ 50)
Nonparametric	All GOF tests for normal and gamma distributions rejected at 95% confidence level	Chebychev UCL

For data sets with non-detect sample results, the mean and standard deviation were computed using their Kaplan-Meier product limit estimators.

The Corrective Action Plan includes excavation of PAH-impacted soil from the mill site area and drainages, and tailings from former impoundments, followed by placement in the Hydro Pit (Broadbent, 2022b). The estimated volume of PAH-impacted soil is 77,000 cubic yards, while the estimated volume of tailings is 1.6 million cubic yards. As a result, material containing organic constituents to be disposed in the Hydro Pit will contain approximately 95% tailings and 5% mill site soil. Based on this ratio, a source strength was calculated for each SRC from the 95% upper confidence limits of the mean (UCLMs). Only the Hydro Pit will be backfilled with organic-contaminated materials.

The UCLM (95 percentile) of the backfill mixture was selected as the upper range of concentrations to compare to RSLs for protection of groundwater (EPA, 2022a). Five organic compounds exceed RSLs with an applied dilution attenuation factor of 20 (DAF 20) (NDEP, 2020):

- 1,2,4 Trimethylbenzene
- Benzene
- Ethylbenzene
- Naphthalene
- Benzo(a)anthracene

The current organic contents reflect post-operational residues as some degradation and loss have occurred in the past 60 years. In the subsurface environment, organic chemicals are subjected to many physical, chemical, and biological processes including sorption-desorption, volatilization, photolysis, oxidation-reduction, and biodegradation (Šimůnek, et al., 2018). The extent and rate of reaction determines the persistence and mobility of a compound in the subsurface (Chiou, 1989).

The Hydrus-1D model was used to simulate the concentrations of the five organic compounds exceeding RSLs at DAF 20 dissolved in the aqueous phase through 1) the transport processes of sorption-desorption, 2) volatilization from the solid and liquid phase and gas phase transport, and 3) first order decay of organic compounds. For calculation of the organic compound decay rate, an empirical first order reaction rate equation in Hydrus 1D is used rather than the thermodynamic equilibria equations used in HP1 for metals fate and transport. Hence separate chemical fate and transport simulations were performed for the organic compounds using the same hydrologic flow processes and hydraulic input properties. The Hydro Pit flow simulation for organics still uses a constant pressure head top boundary condition of zero meters to reflect lack of infiltration owing to the detention pond liner. However, the initial moisture during backfilling and compaction can still migrate under a vertical gradient and free drainage bottom boundary condition depending upon the SWCC properties and moisture retention characteristics. The organic specific model input parameters are provided in Table 9. Each of these inputs is described in detail in Sections 2.3.1 through 2.3.3.

2.3.1 Solid-Water Sorption-Desorption and Partitioning

Rehandling and mixing of tailings and PAH-impacted soil may stimulate biological and other degradation reactions until the backfill is buried in the Hydro Pit. Hence there may be a decrease in the concentrations of organic SRCs during remediation and reclamation. However, the model input assumes that the composition of the mixture initially placed in the pit is the UCLM concentration (Tables 8 and 9). The initial pore water composition in the model is assumed to be in equilibrium with the solid concentration as calculated by the partition equation (Johnston, 1996):

$$C_w = \frac{C_s}{K_{omw} * f_{omw}}$$

Where:

C_w is the concentration of the organic species in water;

C_s is the concentration of the organic species in the solid;

K_{omw} is the distribution coefficient of the organic species (o) for mineral (m) or the octanol-water coefficient (K_{om} or K_{ow} in Table 9); and

F_{omw} is the weight fraction of the mineral or organic sorbent in the tailings.

K_{ow} is known with a high degree of certainty and $\log K_{ow}$ shows strong inverse correlations with the log of organic compound saturation in water (Schwarzenbach et al., 1993). Table 9 shows the calculated initial dissolved concentration of major organic species assuming at least 0.1 weight percent organic carbon or expandable clays in the tailings (or tailings-waste rock mixtures). It is estimated that in low organic matter environments, with less than one gram of organic carbon per kilogram of sorbent, PAHs also partition onto mineral surfaces and result in mineral organic matter reactions (Johnson et al., 2017). Mn oxides have been shown to sorb PAH compounds and in some cases catalyze their degradation (Johnson et al. 2007; Schwarzenbach et al. 1993).

Given the long period time that DRO-contaminated tailings have been exposed at the site and subject to meteoric precipitation, highly labile organic contaminants have likely already been released or degraded in the tailings. Moreover, given the high abundance of organic carbon and exchangeable clays in the tailings, it is likely that any remaining PAHs and other organic contaminants are adsorbed to benign organics used in the process or are bound within clay interlayer exchange sites (Johnston, 1996). Celadonite also occurs in the Tsm unit and fault contact units (Van Glider, 1963) beneath the pits, and it also has high organic exchange capacity.

The XRD data (Table 4) indicate that the clay content of the tailings is at least 10 weight percent or more such that there will be more than one weight percent expandable clays. In addition, the use of natural organic surfactants in the mill's manganese flotation process might indicate the presence of organic matter residue in the tailings. However, from limited total carbon analyses and quantitative XRD analysis of carbonates in the tailings, the calculated amount of potential organic carbon in the tailings is approximately 0.1 weight percent or less (Table 4). A higher content of organic carbon may have been in the tailings during operations given the addition of organic reagents required to separate relatively high concentrations of manganese minerals in processed ore during floatation operations in the second mill (Zenitech, 2007). However, as noted above, organic degradation is likely to due to dry, unsaturated, and oxidizing conditions at the site over several decades since tailings operations ceased.

Schwarzenbach et al. (1993) estimate that the effects of mineral surfaces start to be felt when the organic fraction of the solid is less than 0.2 weight percent. Therefore, the combined masses of expandable clays and organic matter in tailings and tailings-waste rock mixture will be greater than 0.1 weight percent, and the calculated partitioning of organic constituents in Table 9 provides a conservative estimate (upper concentration) of dissolved organic constituents in the pit backfill mixture following reclamation.

2.3.2 Volatilization and Gas Phase Transport

Hydrus-1D calculates the concentration of a volatile organic compound in gas filled pores using Henry's Law and assuming equilibrium between the aqueous and gas phases residing in wetted and non-wetted pore space in the backfill. Transport of organics in the gas phase is simulated by Fickian diffusion equation using the diffusivity of each gas component. Dimensionless Henry's Law constants and gas diffusivities used in the model for each organic compound are listed in Table 9 and were calculated using EPA online tools for site assessment calculation (EPA, 2022b). Gas diffusivity values are orders of magnitude greater than water diffusivities and organic transport by gas diffusion is much more rapid than by water transport for compounds with relatively high vapor pressures.

2.3.3 Oxidation-Reduction and Biodegradation

The model calculates the concentration of organic compounds using an empirical first order decay constant published in the literature (Table 9) which can include different reaction depending upon subsurface conditions. The backfilled tailings and soils mixture will be unsaturated hence anaerobic reactions are less important than aerobic reactions. Aerobic to suboxic conditions will continue in the unsaturated backfill environment although airflow will be restricted. Thermodynamic analysis shows that any organic molecule with a redox potential of less than 0.6 V should be oxidized by manganese oxides present in the Three Kids tailings (Figure 9). Clarke et al. (2012) showed that manganese oxides in mine wastes are capable of oxidizing PAH compounds in the absence of oxygen. However, reaction kinetics limit the rate of oxidation and the rate varies with pH, Eh, and bacterial or mineralogical activity or catalysis. To account for the reaction kinetics the first order decay rate parameter of the Hydrus-1D model input were derived from the estimated field rates for unsaturated contaminated sites that have been published in the literature (Table 9). Variable decay rates are a source of uncertainty that is bracketed by sensitivity analysis. In the model it was assumed that degradation reactions resulted in benign reaction products. Photolysis can result in decay of organic compounds but is only active at the surface where tailings and soils are exposed to sunlight. Therefore, it is not simulated by the model, but photolysis may result in some breakdown during material excavation and transport to the pit. In general, the use of UCLM values in the model with no allowance for organic content reduction by remediation and reclamation activities results in a conservative estimate of initial source strengths and subsequent fate and transport for the five organic compounds that exceed RSLs at DAF 20.

Section 3.1 describes the Hydro Pit model scenario that will be used to model the fate and transport of both organic and inorganic constituents. The model results for fate and transport of organics will be included in Section 4.1 below under the Hydro Pit as the backfill material will contain the five organic compounds that currently exceed RSLs.

2.4 DEVIATIONS FROM WORK PLAN

The following changes to the work plan were made as the work progressed and reclamation plans were developed:

- Pit wall contributions to pit backfill leachates were not simulated because the Work Plan considered reclamation alternatives where the A-B and Hulin pits would be partially backfilled, and that pit wall runoff contact water would be infiltrating the backfill. The current reclamation design considered in this report completely backfills and regrades the A-B and Hulin pits such that pit wall runoff will not occur. In the current designs, pit wall infiltration will migrate vertically downward, and most flow paths will not intersect the backfill wastes. Hence the infiltrate chemistry in pit wall rock will be no different than it is in the current condition and for natural infiltration into the Muddy Creek and River Mountain volcanic formations.
- The Work Plan describes the evaluation of four different mixtures of tailings and waste rock in the Hydro Pit backfill. Subsequent reclamation analysis has resulted in the estimated tailings to waste rock ratio will be 90:10 on a percentage basis. The 85:15 scenario was not modeled because results would be very similar to 90:10, and the ratio is not currently anticipated to be used. The 50:50 and 67:33 ratios were evaluated on the basis of hydrologic properties in this report as an indicator of relative rates of water movement through different waste ratios that may exist in the backfill in segments where the mixture varies from the average ratio. The geochemical properties in the Hydro Pit simulations were always based on tailings MWMP because the tailings are more reactive and representative of the leachate at the bottom of the pit after leachate evolution through the pile mixes with the entire volume. Hence the geochemical result at the observation point below the pit will be insensitive to layering, whereas the hydrologic performance of the backfill can be affected by heterogeneous layering.
- The current reclamation plan only includes a geosynthetic impermeable cover for the Hydro Pit while the Work Plan also considered the possibility of an evapotranspiration cover alternative.

The ET cover alternative for Hydro Pit was not considered in this Leaching Analysis Report as it was removed from the possible alternatives during reclamation design planning.

- Constituents considered in the Work Plan were based on the Phase I list (Zenitech, 2007) including arsenic, lead, manganese, copper, zinc, diesel-range organic compounds, and semi-volatile organic compounds. Evaluation of MWMP data and soil boring chemical data indicates that copper and zinc are always below detection in MWMP leachates so only arsenic, lead, manganese, and iron plus other major ion constituents are considered in the leaching analysis model.
- The risk of organic contamination was evaluated using comparison of UCLMs to RSLs at DAF 20. The organic compounds 1,2,4-trimethylbenzene, benzene, ethylbenzene, naphthalene and benzo(a)anthracene were further evaluated in the model because they are the only contaminants that were above RSLs at DAF 20.
- Although the Work Plan suggested that climate data from the Boulder City, Nevada station would be used for model input, the McCarran airport climate database was selected for the base case modeling scenarios owing to proximity and completeness and applicability to the Three Kids Mine site modeling. Sensitivity analyses using the Boulder City climate database show that there is very little increase in simulated net infiltration and this change does not affect the useability or validity of the leaching analysis results.

3.0 MODEL SCENARIOS

Described below are modeling scenarios for the Hydro Pit, Central Valley, and Hulin and A-B Pits. A list of leaching analysis model inputs and boundaries and model requirements is provided in Table 10. Section 3.5 describes the sensitivity scenarios were developed for alternative reclamation configurations and materials that were deemed important to bracket the range of outcomes. The primary objective of leaching model simulations is to evaluate the leachability, fate, and transport of arsenic and other select metals under a range of conditions at the site given reasonable flexibility in final regrading configuration and mine material placement. The model was not used to design mine regrading and reclamation plans, but the results can be used to interpret leachability under a wide range of modifications if necessary.

3.1 HYDRO PIT SCENARIO

As described in the Work Plan, modeling scenarios were developed and simulated to predict the rate of infiltration and flow and metals transport through alternative Hydro Pit backfill mixtures based on the possible range of mixtures of waste rock and tailings covered with a synthetic geomembrane material (Figure 8C).

The 90:10 apportionment of tailings to waste rock volumes deposited in the Hydro Pit represents the currently favored ratio according to reclamation designers. Current projections indicate that the entire volume of tailings can be placed into the Hydro Pit at this ratio. Other model scenarios using other relative percentages were simulated for future reference in case a modified reclamation plan requires a different ratio. Scenarios with greater waste rock volumes than tailings volumes were not simulated as they are not relevant to the current reclamation plan. Hence, the following blends of waste rock and tailings were simulated based on testing of hydrologic properties:

- 50 percent tailings to 50 percent waste rock
- 67 percent tailings to 33 percent waste rock
- 90 percent tailings to 10 percent waste rock

The hydraulic properties are taken from Table 5 for each mixture as determined on actual blends generated in the laboratory. Lamontagne et al. (2000) provide a discussion on the potential geochemical effects of mixing mine waste rock and tailings.

Each Hydro Pit scenario simulates the potential generation of leachate from deep fill areas in the deepest thickness of the backfill across this area. The thicknesses vary across the backfilled pit area as the pit walls slope inward, but the variation in concentrations within the backfill waste with thickness can be determined from model profile information such that concentrations and hydraulic conditions at the base are known for all thicknesses. The initial leachate concentrations in all simulations are derived from the tailings MWMP leachate concentrations (Table 2). The finer grained tailings will be more reactive and conduct flow preferentially under unsaturated conditions compared to the waste rock. However, the concentrations of calcium and sulfate are calculated by the model on the basis of gypsum solubility and charge balance, respectively. This assumption was made in all model scenarios based on the presence of gypsum in tailings XRD analyses (Table 4). Similarly, the solutions are saturated with respect to calcite and goethite in all model scenarios based on the presence of calcite and goethite in tailings XRD analyses (Table 4).

The completely backfilled Hydro Pit will be covered with an impermeable geosynthetic liner system and detention pond to collect and detain runoff stormwater from the River Mountains. Hence all the Hydro Pit model simulations assumed no infiltration. The initial moisture content of the backfill is the only significant moisture that can drain to the subsurface towards groundwater. The hydraulic property reports (Appendix D) indicate that initially placed backfill compacted moisture contents, at 85 to 95 percent of the Proctor maximum content, will be between 20 and 35 percent by volume as calculated in Hydrus 1D at steady state conditions (Appendix G). The model starting input was adjusted for each Hydro Pit simulation to the expected initial moisture contents after backfilling. A shallow gradient of moisture contents was applied across the vertical domain to represent a range of moisture contents expected as drying occurs from the pit bottom to the top as the wall rock and pit floor moisture contents will be lower than the backfill. Hence, initially the top of backfill has a moisture content that is 4 to 5 percent higher than the bottom pit backfill material in the model. The moisture conditions change during the simulation as a result of free drainage at the bottom of the model.

Groundwater elevation measurements and occurrence depths on driller's logs indicate that groundwater may be as deep as 200 feet (61 meters) below the pit bottom; however, the exact depth is uncertain. No seeps have been reported in the Hydro or other pits (Zenitech, 2007). The bottom of the Hydro Pit is at 1,555 feet amsl and underlain by Tsm. The top of the pit is at approximately 1,820 feet amsl so the backfill thickness will be approximately 290 feet thick (88.4 meters). This thickness of backfill will have a moisture content of approximately 80 to 90 percent of the optimal compacted density (20 to 30 percent moisture by volume). As the exact groundwater depth is unknown it was taken, conservatively, to be 73 feet (22 meters) below the bottom of the pit to complete a 328-foot (100 meter) model section.

The Hydro Pit model utilizes the HP1 reactive transport subroutine to evaluate whether geochemical conditions in the backfilled pits result in pH or pe conditions that enhance or discourage leaching of constituents. The model utilizes the TP1 calibration parameters (Section 3.4) for material surface site density parameters for different site materials. A table of model input parameters for the Hydro Pit simulations is available in Appendix G (Table 1G).

For the base case scenario, which is the expected set of conditions in the backfill as placed, the average tailings MWMP concentrations are used for initial pore water leachate composition and for the upper boundary condition. The SWCC hydraulic properties are taken from the laboratory reports summarized in Table 5 for each mixture ratio. The initial moisture profile at Proctor 90 for the base case is derived from the complete SWCC results compiled in Appendix D.

3.2 CENTRAL VALLEY SCENARIO

The CVS scenario shown conceptually in Figure 8A (also see Figure 4 and model domain in Appendix H), focuses on detailed water balance and daily infiltration tracking with conservative constituent transport using a standard solute transport algorithm. Because much of the site will be developed with extensive roof and pavement areas draining to stormwater conveyance systems, the actual amount of incident precipitation falling on ground surfaces is less than the natural or present land surfaces. Additionally, irrigation of small plots of grass for homes and parks is not a large source of water for leachate generation. Xeriscape features have plant and rock mulch cover.

Given this concept, a one-dimensional infiltration model that uses available rainfall for potential infiltration is a conservative estimate of the balance of impervious to pervious post reclamation land surfaces. Hence the McCarran climate dataset is used as the atmospheric boundary condition for this simulation with and without root uptake to test the effects of vegetation on net infiltration into underlying materials including waste rock fill. It is noted that the current surface is sparsely vegetated and uncovered such that infiltration is only limited by surface evaporation which is relatively small compared to evapotranspiration. The model uses root uptake parameters that are suitable for established desert landscape vegetation, but established native vegetation is more efficient at evapotranspiration than well-established desert plants which will result in more root uptake of available soil water. For example, the P50 value (pressure head at which root uptake efficiency falls to 50 percent of PET) of -10 meters in the S-shaped root uptake model of van Genuchten used in the model (Šimůnek, et al., 2018) results in moderately less water stress on the plant and more uptake at higher soil moisture contents than a lower value of P50 that is more appropriate for irrigated crops (Zeng, et al., 2018). Highly adapted desert plants can utilize water at much lower suction where P50 values would be approximately -100 meters. Also, the model does not include leaf interception and the CVS model is moderately conservative (results in greater net infiltration to the subsurface) with respect to root uptake by native vegetation. Plant uptake salinity stress is not expected at the site as the post mining land use is suburban development and not irrigation with return flows. Hence salinity stress is not included in the model.

The CVS represents leaching and transport of select metals in an area in the west central part of the site extending west from areas covered by Tailings Pond 1 (TP1) and Tailings Pond 3 (TP3) and north from the River Mountains to Lake Mead Parkway. This is a relatively low-lying area and regrading is accomplished with waste rock infilling, approximately 40 feet thick maximum, and 10 feet of clean cover consisting of Alluvium Borrow TP1 or Older Alluvial Fan materials (Figure 8A). Table 6 provides the cover SWCC properties that are derived from these samples for each. The Older Alluvium Fan Deposits are very coarse and will be used largely for rip rap and buttressing. The one-dimensional simulation tracks the potential movement of arsenic and other constituents as a result of infiltration of sparse precipitation on reclaimed and developed soil surface underlain by clean cover and waste rock backfill (Figure 8A and Appendix H). The bottom layer represents Muddy Creek Formation down to the approximate estimated depth to water bearing zones provided in Section 1.2.4. A 155-meter (508.5 feet) type section was selected on the basis of estimated depths to water bearing zones or bedrock across this area (Figure 8A). The CVS model domain extends to the greatest depth of water bearing zones reported in site wells to examine if conservative transport of constituents results in significant transport to the highest estimated water bearing zones. A table of model input parameters for the CVS simulations is available in Appendix H (Table 1H). The initial moisture profile at Proctor 90 for the base case is derived from the complete SWCC results compiled in Appendix D.

In the CVS base case simulation, a daily atmospheric boundary condition climate dataset from the McCarran airport was used to simulate precipitation, ET, and resulting infiltration into alluvial cover materials (Table 1 and Appendix A) and movement, if any, of moisture through underlying waste rock material and into the Muddy Creek Formation to groundwater.

The model also tracks the movement of a conservative tracer with initial relative concentrations of 0.1 in cover pore water, 10 in the waste rock, and one in the lower part of the section. The value of one represents an equivalent arsenic concentration of 75 µg/l. These concentrations are selected to represent, the approximate range of arsenic equivalent concentrations that were taken from MWMP data for the Alluvium Borrow TP, Waste Rock, and Muddy Creek AB TP1 samples (Tables 2 and 3). The actual arsenic concentrations in leachates were 52 µg/l (Material 1 and 3 in Appendix H, page 1), 710 µg/l (Material 2 in Appendix H, page 1), and 172 µg/l (Material 4 in Appendix H, page 1), respectively. In reality, arsenic mobility is not conservative (Allison et al., 1991), but the equivalent concentrations provide an estimate of worst-case rates of migration from high concentrations in waste rock leachates.

3.3 A-B AND HULIN PIT SCENARIO

The Hulin Pit is a steep-walled cylindrical pit like the Hydro Pit but is only about 235 feet deep below the top of the planned backfill surface (Figure 8B). The A-B Pit is more extensive, less conical, and is approximately 230 feet deep at the maximum depth of planned backfill (Figure 8D). However, reclamation of the Hulin and A-B pits have similar cover designs with 10 feet of cover over waste rock backfill. No tailings will be placed in either the Hulin or A-B pits. Therefore, the same model domain and backfill profile was used for both pits. Again, intermediate depth results from the model could be used for different thicknesses but the thickest sequence should yield the highest concentrations of constituents at the bottom of the backfill. For this scenario, the hydraulic and MWMP properties of the cover (Alluvium Borrow TP) and average waste rock are used. The sample WR07E-WR07N SWCC results from Table 6 were used in the model for hydraulic properties.

The deepest points of the A-B and Hulin pits are approximately 1,680 and 1,655 ft amsl, respectively (Figures 8D and 8B). The final pit reclamation plan is still being developed but entails backfilling. Given that the approximate depths of the once backfilled pits are similar, one profile was developed for model simulation of leaching and transport of constituents. In addition, both pits have eastern walls that expose and follow the hanging wall of the Lowney fault. Hence the backfill and lithologic intersects of the pit profiles are similar. The pit model utilizes the HP reactive transport subroutine to evaluate whether geochemical conditions in the backfilled pits result in pH or pe conditions that enhance or discourage leaching of constituents. The model utilizes the TP1 calibration parameters (Section 3.4) for material surface site density parameters for different site materials.

The profile starts with 10 feet of cover over waste rock backfill, represented by its characteristic physical and chemical properties, to the bottom of the 328-foot (100 meters) model domain. However, the chemistry of the leachate is tracked at the expected pit bottoms at approximately 230 to 235 ft bgs (Figures 8B and 8D). The extra length of model domain does not affect the predictions at these depths and allows thicker sequences to be tracked in the future if necessary, owing to changes in development plans. The backfill materials lie on top of 50 feet or more of Tsm (the Tsm is not included in the model domain but is shown in Figures 8D and 8B).

The A-B and Hulin pit model simulations, shown conceptually in Figures 8B and 8D, respectively, use a relatively simple steady state meteoric infiltration assumption based on the CVS results, but employ a more complex geochemical leaching and transport algorithm. The reason for the dual modeling approaches stems from the computational difficulties of simulation of daily climate boundary conditions to calculate infiltration on a daily basis coupled with heterogeneous multicomponent reactive transport. However, conservative assumptions are applied in both types of simulations to balance the simplifications made in either approach. Combining the results provides a complementary analysis of potential leaching of arsenic and other SRCs.

A table of model input parameters for the A-B/Hulin Pit simulations is available in Appendix I (Table 1I) For the base case the average waste rock MWMP concentrations (Table 2) are used for initial pore water leachate composition and the alluvium MWMP (Alluvium Borrow TP) for the upper boundary condition at the cover. The SWCC hydraulic properties are taken from the laboratory reports summarized in Table 6 for each mixture ratio.

In the base case simulation, the initial composition of the waste rock backfill pore moisture is represented by average waste rock MWMP concentrations and the upper boundary solution is represented by the Alluvium Borrow TP sample MWMP result (Table 3). However, the equilibrium phases in the model are the same as for the Hydro Pit simulations. The rate of infiltration was set to the long-term drainage rate (0.8 inches per year) calculated by the CVS base case simulation. As explained in Section 4.2 above, this is a conservative rate of infiltration for this site. The initial moisture profile at Proctor 90 for the base case is derived from the complete SWCC results compiled in Appendix D.

3.4 Model Calibration

Owing to the lack of seeps and springs at the site for direct calibration to water quality, the HP1 numerical transport model was calibrated with respect to geochemical parameters such as sorption site density using total metals concentrations of boring cuttings at the toe of the TP1 tailings pond. The location is shown in Figure 7. The log with soil concentration results is provided as Table 11. The HP1 geochemical vertical model domain was designed to represent a 100-meter profile section that included the layers shown in Table 11 including the tailings clay, sand, gypsiferous siltstone (likely Muddy Creek Formation), and one five-foot section of interbedded silty clay at 79 to 84 feet bgs. The initial concentrations of model constituents assumed the same composition as MWMP leachate for the Muddy Creek TP1 sample (Table 3). The tailings were assumed to have the same composition as the average tailings boundary condition of the infiltrate MWMP (Table 2). A constant head condition of zero was applied to simulate the pond that existed during the mine and mill operation life until steady state drainage was achieved. Owing to water demand by the mill and high rates of evaporation it is likely that the pond depth was not deep for long periods of time. The model tracks the migration of constituents through the profile and the sorbed fractions.

Calibration simulations were performed until the site density of the sorbate produced an arsenic profile that matched the soil composition data (Figure 11). The range of site densities (0.287 to 0.000287 mol/1000 cm^3 of water) was consistent with estimates for bulk soil or rock (Langmuir, 1997). Clay layers, which have the highest expected site densities, matches, and sand layers, which has the lowest expected site densities, matches. The relatively homogeneous sand layer may represent a drain blanket material that was laid down to enhance drainage of tailing pond infiltrate and is not representative of other materials that will be used for fill and backfill during reclamation. Hence the lowest site density calibration result for that layer was not used in the model simulations. The sands were likely materials of different size distributions (Jacques and Šimůnek, 2005). The clay layer, derived from cyclone tails which accounts for the relatively high manganese concentrations as compared to other site metals. The arsenic concentrations below that layer are relatively low indicating that very little pond water leached to the native Muddy Creek Formation during mine and mill operations.

The Hydro and A-B/Hulin Pit model domains also synchronize with the calibration runs and discretization to ensure accurate calculations over the scale of interest. As the tailings are the backfill material in the Hydro Pit the calibration is applicable with respect to site densities in tailings materials as derived from the calibration at TP1. In addition, the site densities are applicable to Muddy Creek Formation which underlies TP1 and to a lesser extent waste rock which is derived from Muddy Creek overburden removed during mining. Hence the site density calibration results can be used for the CVS and A/B-Hulin models for the sections in Muddy Creek Formation and waste rock. Due to the predictive nature of the unsaturated flow model and lack of springs or seeps, or water in the bottom of the pits there are limited data for model calibration except at the TP1 site. Diffusion was not considered as the model cell length is too large to capture diffusion effects on the centimeter scale within the model time domain. However, dispersity (longitudinal in the 1D model) was set conservatively at 10 meters in all model runs and dominates over diffusion when simulating fill and backfill transport over 100 to 155 meter model domains used in the backfilled pit and CVS models, respectively. The Peclet and Courant numbers in the calibration and all other model runs were below one and numerically stable (Šimůnek, et al., 2018).

3.5 MODEL UNCERTAINTY AND SENSITIVITY

The assessment of model uncertainty is needed to determine the level of confidence in predictive results and sensitivity analysis through sensitivity simulations is the primary method that is used to build a quantitative assessment of the level of confidence that can be placed in the simulation results (CREM, 2003). Geochemical characterization data, including leachate chemistry testing, and hydrologic characterization data that are used as input to the model and affect the certainty of predictive results have been identified. Section 2.1.2.2 provides an assessment of data variability and statistics. On this basis sensitivity simulations have been performed to bracket the range of model results that may result from data limitations or uncertainties. The results of sensitivity analysis are described below. Summary tables of base case and sensitivity simulation model inputs for all scenarios are provided in the results appendices (Appendix G, H, and I).

The sensitivity and uncertainty analysis applies to the model input requirements summarized in Table 10. A range of model input parameter values that spans the expected and statistically derived variability of measured soil and mine waste geochemical and hydrologic properties at the site were varied according to Table 12. This results in a range of model predictions that covers the possible concentration at key site locations (Figure 7) and at model boundaries. The results have small errors in predictive capabilities in terms of acceptable risk. Two types of sensitivity were evaluated, geochemical and hydrological.

3.5.1 Geochemical Sensitivity

Geochemical models will be most sensitive when there are disequilibrium conditions in the system causing variability in reaction rates. To compensate for model uncertainty and sensitivity, conservative but realistic input values were used in the base case simulations and sensitivity simulations to forecast the most probable nature and extent of SRCs for seven decades following reclamation and the effect of changing input model parameter values on the forecast.

The backfill materials are derived from former mining of the site, so they have similar geochemical characteristics as native rock formations. However, since they were mined, they have finer grain size distributions and are more reactive than the native formations. The tailings have been processed and contain some residues of process chemicals. Therefore, geochemical sensitivity is determined by using the range of MWMP leachate properties in addition to the average properties of tailings for the Hydro Pit and waste rock for the A-B and Hulin Pits. The possible range of initial leachate chemistry included the maximum and minimum concentrations of constituents in tailings and waste rock MWMP results shown in Table 2. The upper boundary condition concentration was always taken as the internal MWMP concentrations for the Hydro Pit base case and sensitivity scenarios as no meteoric water can infiltrate from the surface covered with an impermeably synthetic material. In all model scenarios the backfill is simulated as a closed system with no gas transfer. This is conservative with respect to arsenic which is more mobile and toxic in its trivalent state under reducing conditions (Smith and Huyck, 1999). However, as the model results in Section 4 will show, oxide minerals buffer pe at conditions that result in dominance of pentavalent arsenic species.

The initial organic concentrations in the model are selected as the UCLM values which are greater than the mean and are conservative selections of initial concentrations in the tailings and other site material mixtures. This reduces the probability that model sensitivity to this variable will result in a predicted outcome that underestimates the nature and extent of contaminant migration after reclamation. Similarly, the rate of decay in the base case organic simulation was set at a tenth of the literature values cited in Table 9. Hence the rate of decay in the base case simulation predicts less biological or other organic breakdown that has been observed at the sites studied in these reports. This selection reduces the chance that the model has not accounted for lower biological activity or other factors that may limit the rate of decay in the backfill system. Hence the model may overpredict organic compound mobility but the probability of under estimation of mobility and impacts is low.

For the A-B/Hulin Pit scenarios, the upper boundary source strength concentrations were always selected as the Alluvium Borrow TP MWMP sample concentrations as infiltration was very slow and the model results for the base of the profile was insensitive to the upper boundary condition. Charge balancing on sulfate was applied in all HP1 simulations for the Hydro and A-B/Hulin Pits as the initial sample analyses may contain small charge balance errors. Also, when applying statistical variation of leachate concentration values in geochemical simulations the charge imbalances are usually larger than for individual samples. However, sulfate is a major ion component and charge balancing does not have a high percentage effect on leachate concentrations. Moreover, sulfate is not considered to be a SRC as background sulfate is high in the gypsiferous surface deposits at the site.

Uncertainty in the thermodynamic database is a less likely source of significant uncertainty in the predictive results but selection of reactive phases is a more common source of uncertainty and sensitivity in geochemical models (Nordstrom and Alpers, 1999). Only the most soluble low temperature minerals for each metal were used in the model in order to reduce the likelihood of underprediction of metal concentrations. Mineral sorption site densities (based on ferric hydroxide sorption site availability) were determined by calibration as described in Section 3.4. This reduced the degree of uncertainty in the model, and mineral sorption site availability is not a significant source of model sensitivity. The initial sorption site loading was calculated by equilibration with the initial fluid, and occupancy of metals at these sites does not change significantly during the simulation because of the slow rates of moisture movement in the backfill.

3.5.2 Hydrological Sensitivity

The primary source of uncertainty with respect to hydrology is climate and the hydrologic properties of the backfill, cover, and native geologic materials. Root uptake parameters were selected to be very conservative assuming poorly adapted plant communities and with no leaf interception as quantification of the reclamation plant cover is difficult to quantify. The rate of infiltration is driven by climate, and the Boulder City climate dataset was used to test the CVS model with respect to selection of climate inputs. The range of net average annual infiltration rates from these sensitivity runs were also used in the A-B and Hulin sensitivity simulations to test the pit backfill model for sensitivity with respect to the rate of infiltration which was set as a constant rate in the upper boundary condition of this model.

The SWCC data were collected from a wide variety of materials at the site for modeling and reclamation design purposes. Tailings and waste rock SWCC parameters from Tables 5 and 6 were used in the Hydro Pit, Hulin/A-B, and CVS scenarios for backfill and regrading fill requirements. A sensitivity analysis also included SWCC parameters from other sites published in the literature. The TP1WN-TP1E tailings SWCC parameters were used in one sensitivity simulation for the Hydro Pit. The Muddy Creek Formation SWCC parameters were used for a sensitivity analysis of the Hulin/A-B pit backfill and CVS regrade fill materials as the waste rock was derived largely from stripping Muddy Creek overburden during mining.

In summary, sensitivity simulation scenarios covered a wide range of leachate compositions and boundary conditions such as precipitation and infiltration. An example analysis of Hydrus 1D parameter sensitivity in irrigation simulations is provided in Zeng, et al. (2018).

Dispersivity is a parameter can be a source of uncertainty in transport modeling. Given that field dispersivity cannot be measured directly in the laboratory as it is a scale dependent variable, a conservative estimate of 10 percent of the path length (i.e., model domain) was used for dispersity input into all simulations. This is an upper limit of field measured dispersivity in heterogeneous granular materials (Oelkers, 1996) and results in a dispersivity of 10 meters for a 100-meter model domain.

3.5.3 Hydro Pit Scenario Sensitivity Analysis Results

The Hydro Pit model inputs for the base case and sensitivity simulations are included in Appendix G (Table 1G). The results of sensitivity simulations for the Hydro Pit are summarized in Tables 13a for metals and 13b for organics. In all but one simulation, pH and pe conditions do not vary appreciably from the base case. The one exception, simulation #8 where the simulated pe rose to 14.9, may have resulted from different flow conditions created by alternative SWCC input. However, conditions are relatively oxidizing in all simulations.

Downward migration of leachate is very slow (<0.031 inches per year except with the alternative tailings SWCC which resulted in a velocity of 0.247 inches per year, simulation #8) owing to the impervious cover and unsaturated backfill pores. The effect of higher and lower initial moisture contents (simulations #6 and #7) did not affect the leachate velocity significantly with rates in the hundredths of inches. The low rate of flow makes the model insensitive to input dispersity.

In Table 13a, simulations #4 and #5, manganese concentrations in leachate range significantly owing to the significant range in minimum and maximum MWMP input starting values. The range is 6.5 (simulation #5) to 3,137 micrograms per liter (µg/l; simulation #4) and rhodochrosite saturation was reached in the maximum MWMP simulation. The range in arsenic concentrations also varied from 194 to 960 µg/l. Iron concentrations were very low and not highly variable owing to goethite solubility control. Lead concentrations in the simulated leachate ranged from 0.1 to 1.2 µg/l but the maximum (simulation #4) was well below the NDEP Profile I standard of 15 µg/l.

None of the organic fate and transport sensitivity simulations showed breakthrough below the Hydro Pit and concentrations below the pit were well below the EPA MCL after the 70-year simulation period (Table 13b).

3.5.4 CVS Sensitivity Analysis Results

CVS model inputs for the base case and sensitivity runs are included in Table 14 and Appendix I (Table 1I). Because the McCarran airport climate data spans 72 years, the simulation results capture the response of ET efficiency and transport over time through wet and dry climate cycles owing to El Niño and other variations. In addition, climate data from Boulder City was used as an alternative climate dataset for sensitivity analysis. As shown in Table 14 the average precipitation of 4.15 inches over the climate record generated an average rate of net infiltration of 0.8 inches per year which is 19.3 percent of average precipitation. A graph of daily precipitation and root uptake is presented in Figure 12 for the McCarran airport. Cycles of more frequent and intense precipitation correlate with higher amounts of root uptake. Hence net cover infiltration does not increase in proportion with precipitation as a result of vegetation response to available moisture.

In the Boulder City climate simulation #2 (Table 14), the average rate of rainfall is 5.55 inches per year and the net infiltration rate is 0.9 inches per year or 16.2 percent of annual precipitation. Because root uptake adapts to moisture availability in the model increasing the rate of rainfall by over an inch only resulted in 0.1 inches of additional net infiltration in this simulation. The effect of using an alternative cover material (Older Alluvium Deposits TP1) with different hydraulic properties also resulted in a relatively small difference in net infiltration (range of approximately 17 to 21 percent of net infiltration) with either the McCarran or Boulder Climate data (simulations #3 and # 4, Table 14). Changing the fill hydraulic properties (simulation #5) and initial fill moisture conditions (simulations #6 and #7) in the simulation resulted in net infiltration that are within that range (Table 14).

In addition, the low rate of flows predicted by model decreases sensitivity to the dispersivity input.

3.5.5 A-B and Hulin Pits Scenario Sensitivity Analysis Results

The A-B/Hulin Pits scenario model inputs for the base case and sensitivity runs are included in Table 15. Maximum MWMP input values in the model result in simulated exceedances of NDEP Profile I standards for manganese and arsenic (simulation #2) whereas the base case simulation result only produces an exceedance with respect to arsenic. The maximum MWMP manganese concentration is limited by rhodochrosite solubility, as saturation with respect to rhodochrosite was reached during the entire calculation period during sensitivity simulation #2. No other simulation in the sensitivity model runs reached saturation with respect to rhodochrosite, but saturation with respect to gypsum, calcite, and goethite was maintained in all simulations and simulation periods. Leachate drainage fluxes directly below the backfilled pit are the same for average, maximum and minimum MWMP inputs at 0.012 inches per year or one foot per hundred years (simulations #1, #2, and #3). The entire range of drainage fluxes for simulations #1 through #6 is 0.011 to 0.013 inches per year but for simulation #7 with the alternative backfill SWCC the drainage flux is lower at 0.002 inches per year. The low rate of flow makes the model not very sensitive to dispersivity.

4.0 LEACHING ANALYSIS RESULTS

The predictive results of the Leaching Analysis geochemical and infiltration modeling are summarized and presented in this section. A final summary of the results that integrates the geochemical and infiltration modeling are provided in the conclusions with summary bullet points providing the highlighted findings and overall conclusion on the Hydro Pit reclamation approach and backfill design. This section also describes scenarios for the Central Valley Fill area, the Hulin Pit, and the A-B Pit. The predicted performance is referenced to accepted cover and leachate reduction performance by industry standards (Dwyer et al., 2000; MEND, 2004; Zhan, et al., 2014).

4.1 HYDRO PIT SIMULATIONS

4.1.1 Inorganic Constituents

The model simulation results for the 90:10 tailings to waste rock backfill alternative reclamation scenario are shown in Table 16a. With the exception of pH and arsenic, Nevada Profile I standards were not exceeded for the constituents at the base of the section in the backfill after 72 years of backfill drain down. The model calculated pH values were about 5.9 for pit backfill mixture scenarios as a result of increased dissolved CO_2 in the closed system model. The leachate pe may be higher if there are significant air exchanges through unsaturated pore spaces. Similarly, the pe values which were about 3.23 in each model result may be higher if the system is open or partially open to the atmosphere. This pe is expected given the mineralogy of the tailings and the presence of some organic carbon (Figure 9b).

The constituent results presented are pH, pe, Mn, As, Fe, and Pb (Table 16a). The downward velocity of the leachate is is 0.017 inches per year for the 90:10 backfill mixture and hydraulic properties simulated. In addition, sources of other metals are relatively insoluble such that the concentrations in pore water are always below Profile I standards as indicated by MWMP results. A small amount of inorganic carbon in the amount of 0.01 molar (120 mg/l) was added to the initial solution to represent carbonate equilibria.

Arsenic was in local equilibrium with backfill material as a result of sorption reactions at depth. Arsenic concentrations exceeded Profile I standards in the backfill mixtures but were similar to average arsenic concentrations in MWMP leachates on Tsm samples (Table 16a). Moreover, given that the Tsm hosted ore horizons at the footwall and the average grade of manganese is lower than the cutoff grade (McKelvey, et al. 1949), it is likely that the possible range of arsenic concentrations in MWMP leachates from native geologic materials is the same or higher than backfill materials. For example, pre-mining drill core assay samples have arsenic concentrations up to 760 mg/kg (USBM, 1945). This indicates that placement of tailings and waste rock in the pits will not increase constituent concentrations with respect to metals because of high concentrations in leachate from native materials.

Table 16a (condensed)
Hydro Pit Bottom Base Case Simulation Metal Concentrations and Velocity at 70 years

Tailing:Waste Rock Ratios	pH	pe	Mn, µg/l	As, µg/l	Fe, µg/l	Pb, µg/l	Velocity, in/yr
Tsm MWMP (Table 4)		NA	**0.9**	**414**	**4.4**	**0.3**	NA
NDEP Profile I	**6.5-8.5**	NA	**100**	**10**	**600**	**15**	NA
Hydro Pit Backfill Base Case Simulation							
90:10 Average MWMP #1	5.9	3.2	625	454	1.96E-05	0.25	0.017

Notes:
µg/l = micrograms per liter
NA = not applicable
in/yr = inches per year
= simulation number

Additional model results for the base case are shown in Appendix G including water content and pressure head profiles for the three backfill mixtures.

4.1.2 Organic Constituents

The base case model simulation results for organic compounds (i.e., the 90:10 tailings to waste rock backfill alternative reclamation scenario) are shown in Table 16b and no organic breakthrough occurs below the bottom of the Hydro Pit in this simulation. The boundary and hydrologic input parameters are the same as for the Table 16a base case simulation, so the rate of water flux below the bottom of the pit is the same.

Table 16b (condensed)
Hydro Pit Bottom Base Case Simulation Organic Concentrations at 70 years

Tailing:Waste Rock Ratios	1,2,4-Trimethylbenzene mg/l	Benzene mg/l	Ethylbenzene mg/l	Naphthalene mg/l	Benzo(a)anthracene mg/l	Velocity in/yr
UCLM, mg/kg (Table 8)	**5.835**	**0.0145**	**0.3246**	**3.265**	**0.655**	**NA**
Dissolved Concentration, mg/l (Table 9)	**0.00929**	**0.00754**	**0.00396**	**0.01834**	**0.00002**	**NA**
Hydro Pit Backfill Base Case Simulations						
90:10, foc = 0.001, with Table 9 Decay Rate # 9	0.000000	0.000000	0.000000	0.000000	0.000000	0.0175

Notes:
UCLM = upper confidence limit on the mean
mg/l = milligrams per liter
NA = not applicable
in/yr = inches per year
foc = fraction of organic matter
# = simulation number

4.2 Central Valley Simulation

The CVS base case simulation results are summarized in Table 17. Figure 13 and the results in Appendix H show that the conservative (non-reactive) metals concentrations with depth do not change significantly with simulated root uptake in the 72-year simulation period representing the full climate daily dataset. Because of low rainfall and high rates of evaporation and transpiration by root uptake, the net rate of drainage through the alluvial cover is relatively small. Over the 72-year simulation period, the average drainage below the alluvium cover is 0.8 inches per year (Table 17). This value is approximately 20 percent of mean annual precipitation of approximately four inches per year and is a very conservative estimate of the estimated performance for a store and release cover (Zhan et al., 2014; INAP, 2021). A multilayer cover for example could achieve a higher level of moisture removal but is not necessary given the arid to semi-arid site conditions and very low total precipitation at the site.

The travel time for a conservative constituent through the 508.5 feet of the CVS section is estimated by the following formula:

$$T = \frac{D}{V} * \theta$$

where T is the travel time in years, D is the total vertical distance to groundwater/bedrock (508.5 feet) through the Muddy Creek Formation, and Θ is the volumetric water content (Szymkiewicz et al., 2018). Using the average rate of drainage and water content (0.10) calculated by the model over the simulation period, the calculated travel time is 763 years (Table 17). With attenuation and retardation of non-conservative metals like arsenic the travel time is longer.

Given the very slow rate of vertical migration of water and attenuation potential of the Muddy Creek Formation, the potential impacts to groundwater resulting from leaching of metals from waste rock in the reclaimed Central Valley area are minimal. The equivalent increase in arsenic concentration is only 0.075 µg/l just below the waste rock fill (Table 17) and at the top of the Muddy Creek Formation (see Appendix H profile for the observation point location in the model domain). Samples of Muddy Creek Formation yield MWMP extracts with arsenic concentrations above Profile I levels (Table 3), hence this increase is not responsible for exceedances of the Profile I standard. Moreover, Figure 13 shows that downward moving leachate from overlying waste rock is diluted quickly in the pore leachate of the Muddy Creek Formation owing to the very slow rate of flow.

Table 17 (condensed). Central Valley Fill Bottom Base Case Simulation Results

Central Valley Scenario 72 year Climate Simulation	Net Infiltration inches per year	Net Infiltration percent of mean precipitation	Increase in Conservative Concentration at Base of Waste Rock millimol per m^3	Increase in Conservative Concentration, As equivalent µg/l	Travel Time to Groundwater, Years
Root Uptake with Alluvium Borrow TP Cover McCarran Climate #1	0.80	19.3%	1.00E-03	0.0749	763

Notes:
µg/l = micrograms per liter
= simulation number

4.3 A-B and Hulin Pits Simulation

The A-B and Hulin Pits base case scenario results are provided in Table 18 which shows that in the base case simulation #1, no constituents other than arsenic and pH exceeded NDEP Profile I standards at the bottom of the section after 72 years of infiltration. The simulate pH was 6.2 and the pe was 3.1. The simulated waste rock backfill pH and pe conditions are similar to the tailings backfill (Table 13a).

In this simulation, arsenic was in local equilibrium with backfill material as a result of sorption reactions at depth and relatively slow rates of transport. Arsenic concentrations exceeded Profile I standards in the backfill mixtures at the bottom of the pit but were similar to average arsenic concentrations in MWMP leachates on Tsm samples (Table 3). This indicates that placement of waste rock in the pits will not increase constituent concentrations with respect to metals because of high arsenic concentrations in leachate from native materials.

Table 18 (condensed). A-B and Hulin Base Case Pit Bottom Concentrations and Velocities at 70 years

Tailing/Waste Rock Ratios	pH	pe	Mn, µg/l	As, µg/l	Fe, µg/l	Pb, µg/l	Velocity, in/yr
Tsm MWMP (Table 4)		***NA***	***0.9***	***414***	***4.4***	***0.3***	***NA***
NDEP Profile I	***6.5-8.5***	***NA***	***100***	***10***	***600***	***15***	***NA***
Hulin and AB Waste Rock Backfill Base Case Simulations							
Hulin/AB Pits Average MWMP #1	6.2	3.1	63.0	548	1.09E-05	1.8	0.012

µg/l = micrograms per liter
NA = not applicable
in/yr = inches per year
= simulation number

5.0 CONCLUSIONS

The Leaching Analysis was conducted to evaluate the leachability and mobility of risk-based selection of SRCs with respect to mine and milling generated materials, native sediments, and rock. The following conclusions are drawn from this analysis.

On the basis of comprehensive analysis of site climate, hydrology, geochemistry, and reclamation configurations, three different model scenarios for primary mine features were developed and simulated to estimate the potential for constituent transport at the site. The scenarios are:

1. Hydro Pit backfilled with tailings and lesser amounts of waste rock with an impermeable geosynthetic cover for water detention,
2. Central Valley (Figure 4) with a 40-foot layer of waste rock and ten feet of clean earthen cover, and
3. A-B and Hulin Pits backfilled with waste rock and ten feet of clean earthen cover.

These models were supported by comprehensive site data including geochemical, hydrologic, and geotechnical Phase II investigations. These are summarized in the following bullets:

- The Three Kids Mine site has a relatively arid climate with only 4.15 inches of rain per year which limits contact of mine waste with meteoric water and infiltration of meteoric water to groundwater. Groundwater is encountered approximately 200 feet below the Hydro Pit which is the deepest mine pit with a maximum bottom elevation of 1,555 feet amsl.

- Mine wastes and geologic material at the site have highly variable hydrologic and geochemical properties. The tailings have low permeability and other site materials, and geologic formations are moderately permeable. The earthen materials have compositions dominated by natural silicate minerals with lesser manganese processing chemicals and breakdown products that have formed over several decades of exposure at the site surface.

- Natural geologic processes have resulted in ore to sub ore grade manganese deposits in the greater Lake Mead area and are associated with naturally higher concentrations of other metals like arsenic in soils and rocks. However, the mine wastes at this site are characteristically non-sulfidic and non-acid generating and have net neutralizing potential as confirmed by ABA analyses.

- Calculated UCLMs of organic compounds expected in pore water in the backfill materials that will be placed in the Hydro Pit are below RSLs at DAF 20, except for 1,2,4-trimethylbenzene, benzene, ethylbenzene, naphthalene, and benzo(a)anthracene. However, the model simulation showed no organic breakthrough occurs below the bottom of the Hydro Pit of those five constituents. Additionally, XRD results and partition coefficient calculations indicate that the tailings have a high proportion of clays and swelling clays that bind organic constituents. The dissolved concentrations of organic compounds from breakdown of DRO partition strongly onto the organics in clays and other organic carbon solid compounds in the tailings. Mine materials contaminated with organics will not be placed in outside of the Hydro Pit.

- MWMP tests indicate that arsenic and other metals leach from both mine wastes and natural rock and soil and such that Profile I standards are exceeded with respect to manganese and arsenic. In particular, the natural Tsm rock formation has high manganese and arsenic concentrations in MWMP leachates that fall within the range for mine waste leachates. The Tsm unit is significant in that it extends directly below the mine pits to a depth of 50 ft or more. Hence natural levels of arsenic in site leachates exceed Nevada Profile I standards, and the range of arsenic concentrations in natural geologic pore fluids is similar to backfill materials.

- Numerical modeling shows that concentrations of constituents in the pore space of in-situ materials will not be exceeded, owing to the limited amount of infiltration that can occur through reclamation backfill and construction materials. However, the occurrences of mine materials containing these other constituents is limited relative to other sources and it is unlikely that placing backfill materials in pits will result in an exceedance of Profile I levels or MWMP results from the Muddy Creek Formation or the Tsm unit. Substantial resources of residual low grade manganese ore were left in the pits owing to economic cutoff grades. The residual ore formations are associated with high concentrations of arsenic and other metals that were deposited by geologic processes.

- The Leaching Analysis data review and calibration model results show that downward migration of metals and organics is retarded to variable degrees by sorption and degradation reactions and by solubility limits for constituents like calcium and sulfate. The reactive transport model shows little vertical migration below the bottom of the backfilled pits because of low rates of precipitation, infiltration, and resulting low seepage velocities at the base of backfilled pits and other reclamation areas. Sorption and degradations reactions via clays and iron oxide minerals present in tailings and natural materials also retards SRC mobility. Furthermore, calibration results are consistent with similar studies at comparable sites and confirm model applicability to the site.

- The majority of the Hydro Pit simulations show less than a tenth of an inch downward migration of moisture, with one sensitivity result at approximately one quarter of an inch, or constituents based on a 70-year simulation period that represented an impermeable geosynthetic liner that prevents any infiltration of natural meteoric water. Geochemical conditions, pH and pe, and constituent concentrations do not vary significantly as a function of depth within the backfilled mine waste in pits. Moreover, the predicted pH and pe conditions is not expected to mobilize site constituents above levels that have been detected in MWMP leachates. The simulated pH of tailings backfill is 5.9 as a result of trapped carbon dioxide gas which results from dissolution of calcite at depth. However, anoxic conditions will not be present in tailings or other mine waste backfill because of the electrochemical poise of the system by iron and manganese oxide minerals. The balance of electron transfer by these minerals governs Eh and pe conditions and limits sulfate reduction and methane production. Modeled pe is 3.2 in the Hydro Pit simulations with the inclusion of electron donors from carbon compounds.

- The Hydro Pit model simulation results also show that the five organic compounds that exceed RSLs at DAF 20, 1,2,4-trimethylbenzene benzene, ethylbenzene, naphthalene and benzo(a)anthracene, do not breakthrough the bottom of the pit after 70 years, and initial concentrations degrade to undetectable levels that are far below MCLs.

- Fate and transport model simulations in the Central Valley show that because the rate of water movement is slow, the rate of migration of hypothetical conservative (i.e., unattenuated) constituents is undetectable. Natural infiltration of meteoric water is simulated to be approximately 0.8 inches per year based on a selection of model inputs that result in highly conservative predictive results in terms of constituent transport. For such non-reactive conservative constituents, the rate of migration over hundreds of feet of Muddy Creek Formation is 763 years. It is added that reactive and mobile constituents like arsenic move, if at all, even more slowly because of limited infiltration, attenuation, and retardation.

- For the Hulin and A-B pits, which have similar reclamation and backfill configurations and materials, the model predictive results indicate that pH, pe, and constituent concentrations do not vary as a function of depth and are not conducive to metal leaching. Hence limited infiltration through the 10 feet of clean earthen cover does not mobilize site constituents above levels that have been detected in MWMP leachates of materials beneath the pit floors. Moreover, movement of moisture and constituents through the proposed earthen cover and backfill is greatly limited by the arid climate at the site and uptake of soil moisture by landscape vegetation. Modeled pe for the Hulin and A-B pits is approximately three, as a result of equilibrium with iron and manganese oxides.

- Finally, additional modeling would not be beneficial owing to high concentrations of manganese and arsenic in the natural geologic formations that exist beneath the site and lack of organic mobility and persistence in the Hydro Pit backfill. In other words, recharge from these natural materials results in exceedances of applicable groundwater standards and backfill leachate contributes little additional increases to constituent levels that are native to the site. The measured and model predicted concentrations of all other constituents is very low to undetectable and meet applicable water quality standards for Nevada.

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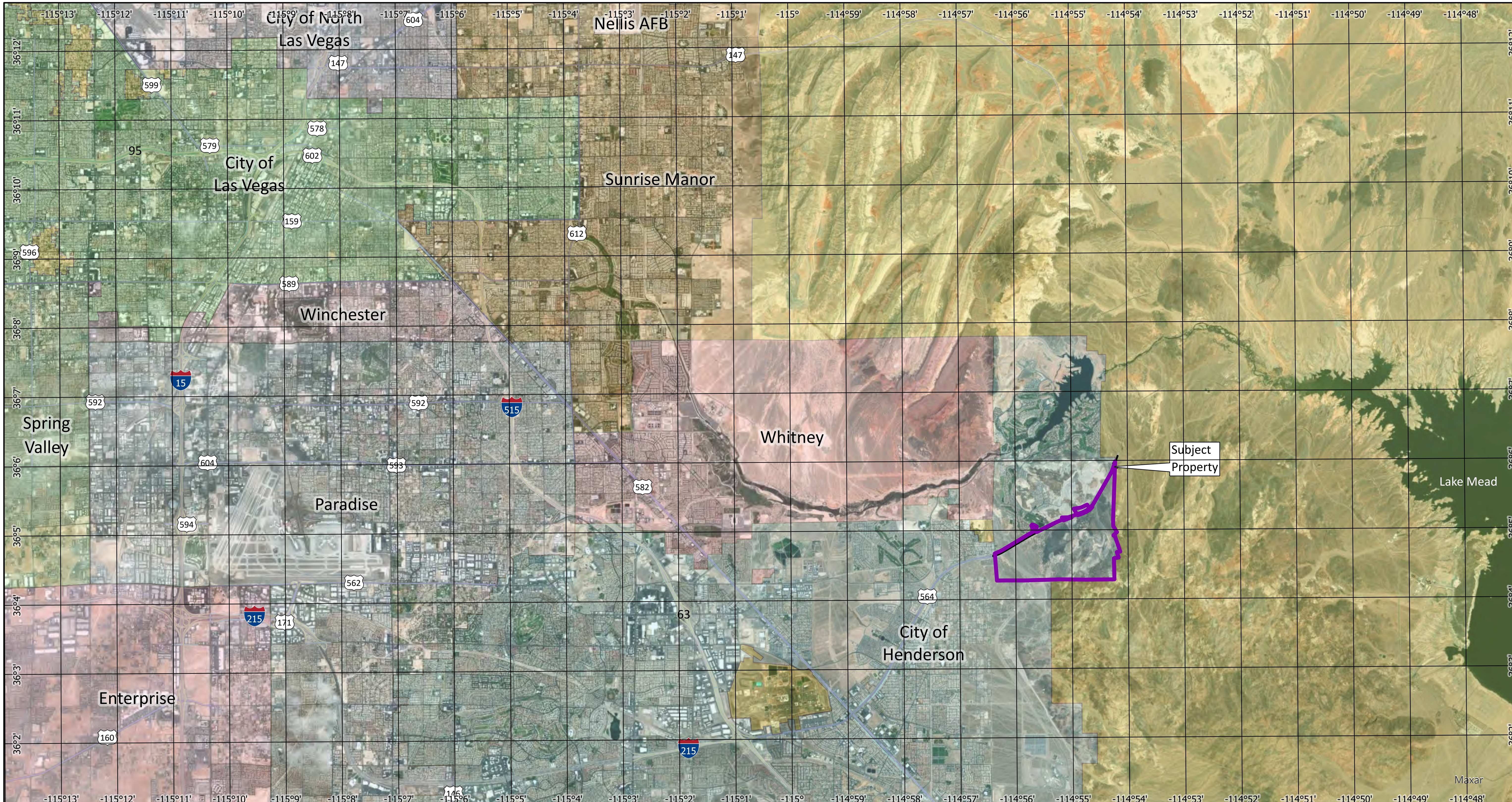
ACRONYMS

ABA	Acid base accounting
amsl	Above mean sea level
ASTM	American Society for Testing and Materials
bgs	Below Ground Surface
Broadbent	Broadbent & Associates, Inc.
BTV	Background Threshold Values
°C	Celsius
CVS	Central Valley Simulation
DAF	Dilution attenuation factor
DBS&A	Daniel B. Stephens & Associates
DRO	Diesel-range organic
ESA	Environmental Site Assessment
ET	Evapotranspiration
EA	EA Engineering, Science, and Technology, Inc. PBC
Eh	Redox potential
°F	Fahrenheit
ft	Foot/feet
K_{sat}	Saturated hydraulic conductivity
Lakemoor	Lakemoor Development, LLC
mg/l	Milligrams per liter
MWMP	Meteoric Water Mobility Procedure
NDEP	Nevada Division of Environmental Protection
PAH	Polycyclic Aromatic Hydrocarbons
REV	Representative element volumes
RSL	Regional screening level
SAP	Sampling and Analysis Plan
Site	Three Kids Mine, Clark County, Nevada
SRC	Site-related chemical
SSL	Screening levels in soil
SWCC	Soil water characteristic curve
TDS	Total dissolved solids
TP	Tailings Pond
Tsm	Manganiferous sedimentary rocks of the Three Kids Mine
UCL	Upper confidence limit
UCLM	Upper confidence limit of mean
WBZ	Water bearing zones
Work Plan	Work Plan for Leaching Analysis of Hydro Pit Fill, Revision 1
XRD	X-ray diffraction analysis
µg/l	Micrograms per liter
θ_r	Moisture retention point

FIGURES



Legend:

Subject Property	Nellis AFB
City of Henderson	Paradise
City of Las Vegas	Spring Valley
City of North Las Vegas	Sunrise Manor
Unincorporated Clark County	Whitney
Enterprise	Winchester

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Political Boundary Source: Clark County GIS Management Office.
4. Parcel Boundary Source: Clark County Assessor.
5. Roads Source: Nevada DOT GeoHub.
6. Geographic grid divided at every minute of latitude and longitude.

BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 10/7/2021

Nevada

N

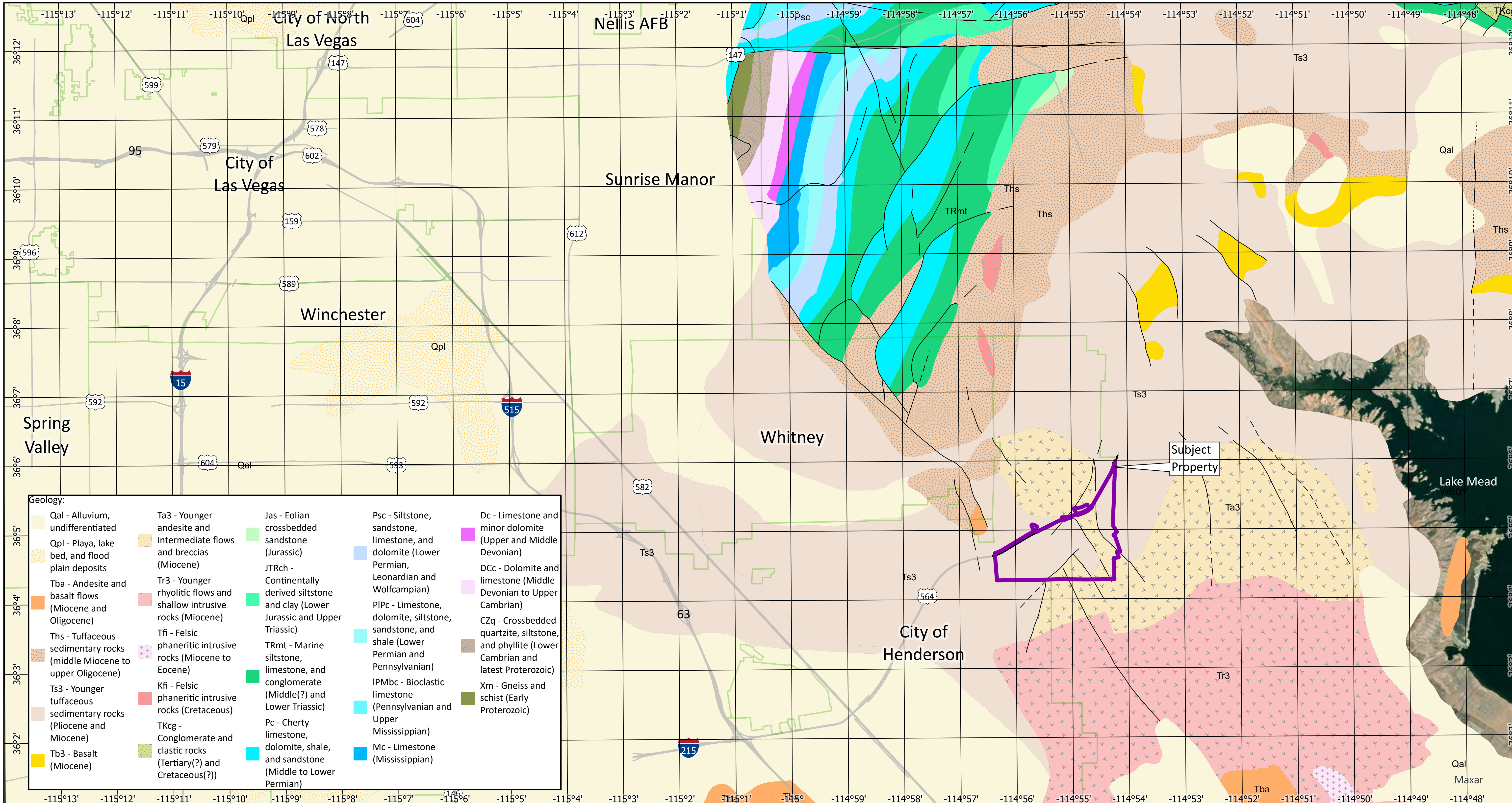
1 0.5 0 1 Miles

Figure 1

Site Location

Former Three Kids Mine

Designed	
Drawn	JCM
Approved	



BROADBENT

8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 9/9/2021

Legend:
- Subject Property
- Political_Boundaries

Faults
- Known fault
- Inferred fault
- Concealed fault

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Political Boundary Source: Clark County GIS Management Office.
4. Parcel Boundary Source: Clark County Assessor.
5. Roads Source: Nevada DOT GeoHub.
6. Geology Source: Crafford, A.E.J., 2007, Geologic Map of Nevada: U.S. Geological Survey Data Series 249, 1 CD-ROM, 46 p., 1 plate.
7. Geographic grid on map divided at every minute of latitude and longitude.

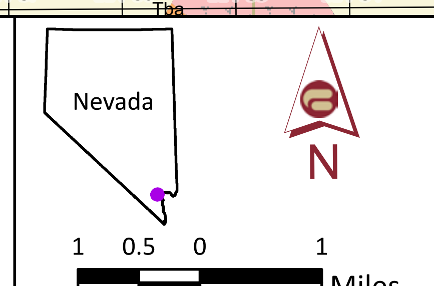
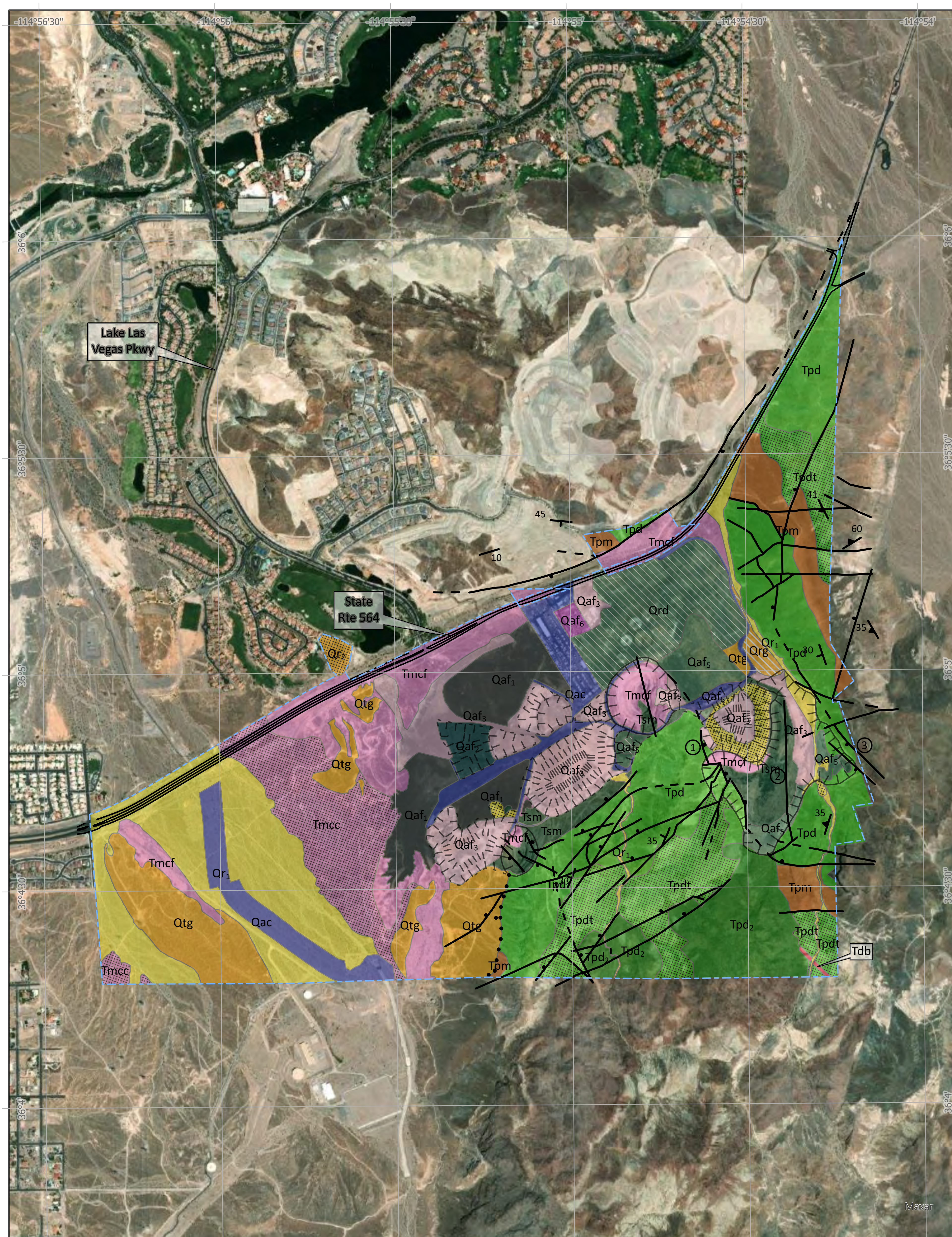


Figure 2	
Regional Geology	
Former Three Kids Mine	
Designed	
Drawn	JCM
Approved	



Legend:

Project Area

Lithology

Qac	Qaf_3	Qrd	Tpd
Qaf_1	Qaf_4	Qrg	Tpd_2
Qaf_2	Qaf_5	Qtg	Tpdt
	Qaf_6	Tdb	Tpm
	Qr_1	Tmcc	Tsm
	Qr_2	Tmcf	

Nevada

N

1,000 500 0 1,000 Feet

Figure 3A

Site Geology

Former Three Kids Mine

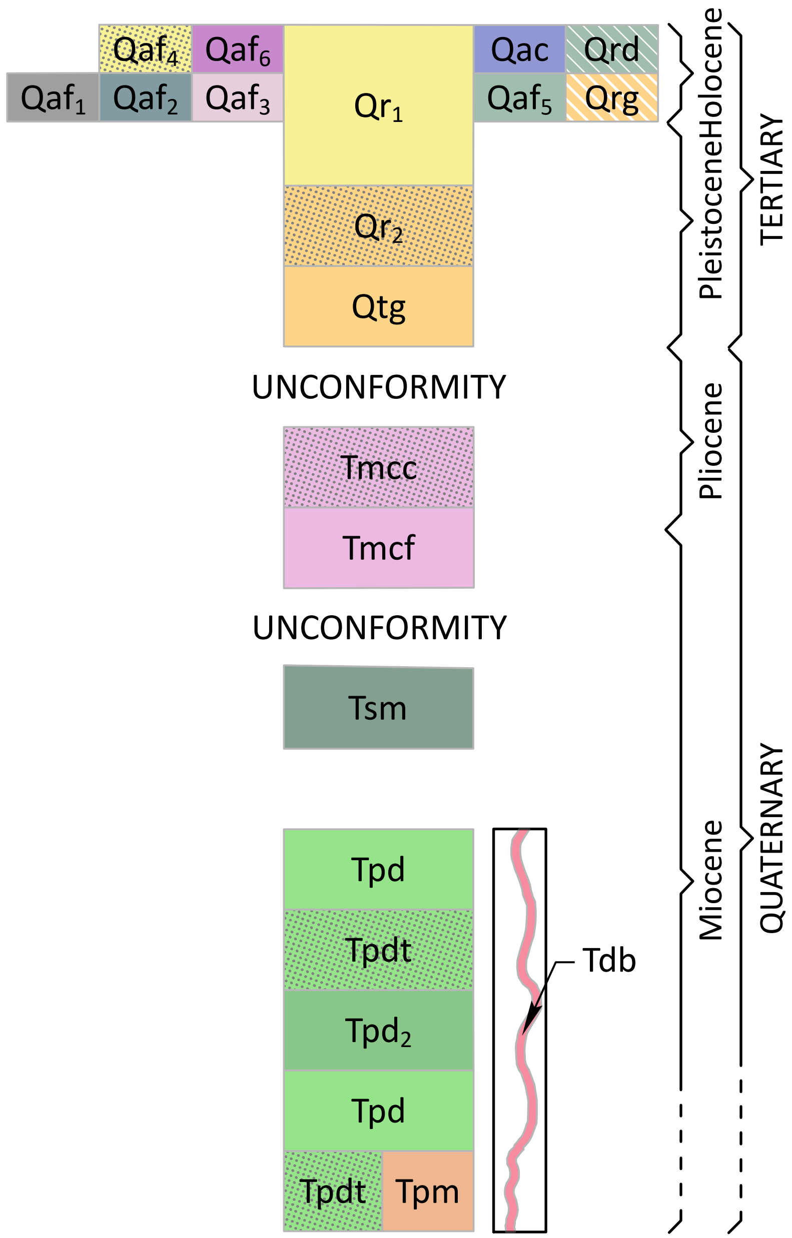
BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 9/9/2021

Notes:
1. Imagery Source: Esri World Imagery
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Not a survey. Grid origin at southwest corner of Section 34, Township 21 S., Range 63 E. Mount Diablo Meridian, Index grids on 500 foot intervals. Sample grid size is 100 feet.
4. Geographic grid on map divided at 30 seconds of latitude and longitude.

Designed	
Drawn	JCM
Approved	

LITHOLOGIC KEY



DETAILED LITHOLOGY

LATE HOLOCENE AND MINE RELATED DEPOSITS (LATE QUATERNARY)

Qac – Compacted alluvium. Roads and reworked alluvium or overburden. Compacted roadways (paved and unpaved) or graded and currently developed/occupied properties. In the west of the Three Kids Mine area, a large swath is a former ultra light landing strip. Comparative topography from 1917 data suggests many of these roads are "built up" or elevated above natural topography.

Qrg – Graded pediment / alluvial plain deposit. Alluvial deposits typically composed of decomposing Powerline Road volcanic materials from the River Mountains. Locally graded or compacted based on the presence of building foundations, but not commingled with other material from the area.

Qrd – Disturbed, graded, commingled, alluvial deposits. Former alluvial deposits of Powerline Road volcanics and Muddy Creek materials which have been graded, transported, and commingled or covered with product, and/or Tsm material. This is typical of the former mill site in the Three Kids Mine area, where dark sediments produced by mill activities cover the area from a few inches to feet thick and large area grading is evident. Mining debris and modern refuse are common.

Qaf_1 – Tailings. Tailings of the former Three Kids Mine and Mill Site. Unit composed of dark colored clay, silt, and sand sized particles. Materials were flow deposited into artificial ponds created by damming drainages. Tails are lead and arsenic laden residues containing diesel-range petroleum constituents, polar organic compounds (Oronite-S, linoleic acid, oleic acid, and wood tannin), water, iron, other metals, silica, and alumina. The upper portion of the tailings material is dry and silty and prone to eolian deflation and transport. Within ponds, approximately five feet below ground surface, the material is a highly viscous semi-solid prone to liquefaction when agitated.

Qaf_2 – Wind blown tailings. Suspect eolian deposits of tailings creating a dune field within an area mottled with overburden from various sources. Tailings are well sorted and sand sized. Overburden material up to boulder size are somewhat evenly scattered in the area and eolian deposits sit between the boulders. Unit occurs in only one, well demarcated area, leading to some question as to actual deposition origin of the sandy material. Windblown deposits typically do not follow demarked boundaries; however, the overburden may be acting as dune anchors and windbreaks.

Qaf_3 – Muddy Creek overburden. Gypsum, sandstone, and other sedimentary units derived from the Muddy Creek formation. Material was overburden to the mining operation and is typically found in the form of terraced overburden piles or as a construction material in tailings pond damns and dikes. Contains plentiful massive gypsum boulders with clasts of red siltstone and sandstones. May contain minor amounts of manganiferous sedimentary rock (source: Tsm) and River Mountains (source: Tpd) materials.

Qaf_4 – River Mountains alluvium / overburden. Alluvium and rock from Powerline Road volcanic units similar in origin to Qrg. May be remnants of the original alluvial plain in place or relocated alluvial plain overburden from mining operations. Largest deposit forms the base terrace of a multi-terraced overburden pile north of the A/B Pit. Surface in this location is covered with Tsm fines or tailings 1-6 inches thick. Particle sizes typically no larger than cobble and dominantly sand and silt sized.

Qaf_5 – Manganiferous sedimentary fill. Pyroclastics, sandstones and other material derived from Tertiary manganiferous sedimentary units (Tsm). Material may have been low-grade ore, overburden, or stockpile. Found in the form of dams, ramps, and unterraced overburden piles. Most significant deposit is thought to have been used to create the ore stockpile yards just south of, and overlooking, the former mill area.

Qaf_6 – Artificial fill. Transported, compacted, and graded fill of fine sand to gravel sized particles. Material is composed of commingled Qaf_3, Qaf_4, and Qaf_5 that have been used to "build up" an area along Lake Mead Parkway within a developed property. Distinguished from Qac by its high manganiferous fill content (Qaf_5).

EARLIER QUATERNARY DEPOSITS

Qr_1 – Wash Deposits. Alluvial deposits derived mainly from the River Mountains (Powerline road volcanics). Dominantly sand and silt sized particles with minor contributions of up to boulder sized volcanics. Deposits become more gypsiferous and contain Muddy Creek formation material within the drainage on the east side of the Three Kids Mine and Mill Site where the drainage intersects with Highway 564.

Qr_2 – Pediment and fan deposits of River Mountains material. Undisturbed pediment or fan deposits derived from Powerline Road host material. Dominantly sand and silt sized particles. May be gypsiferous from contributions of Muddy Creek material, especially further from the drainage mouth.

Qtg – Older alluvial fan deposits and pediments. Sandy pebble to boulder gravels with desert pavement surfaces. Generally gypsiferous with dacite and other volcanic clasts originating from the River Mountains. Pediment former. Surface typically unconformably overlying Tmcc of Tmcf. Units range from 1-30 feet thick (Bell and Smith, 1980).

LATE TERTIARY DEPOSITS

Tmcc – Muddy Creek fanglomerate. Coarse gypsiferous reddish to yellow fanglomerate. Well cemented coarse sandy, pebble to cobble gravels. Upper portion is well bedded with volcanic pebble clasts (River Mountains in origin). Locally may contain gypsiferous siltstone interbedding. Lower portion is poorly to moderately bedded with igneous and reworked sedimentary clasts.

Tmcf – Muddy Creek Formation. Sedimentary beds of red siltstone, sandy siltstone, and claystone, with dominate white to light pink, massive gypsum occurring in the upper portion. Claystone interbedding locally occurring. Locally manganiferous within gypsum according to Bell and Smith, 1980. Badland and bluff former in the region although, at Three Kids Mine, the unit is mainly buried or has been distributed through mining activity. These units unconformably overlie Tsm and Tpd in the Three Kids area. They are thought to have been "lapped" into a graben structure of the River Mountains that is the location of the Three Kids Mine and Mill Site.

Tsm – Manganiferous sedimentary rocks of the Three Kids Mine. Top of unit is well defined beds of light gray, red, and black manganese rich tuff, tuffaceous volcanic sandstone, and siltstones. Forms a "bacon rind" appearance many tens of feet thick feet where exposed. A basal sub-unit of Tsm as exposed at the Hulin pit is comprised of a thick (up to 100 feet), poorly bedded, unsorted breccia with clasts from <1 inch to >3 feet in diameter and of volcanic origin. Sub-unit probably deposited as mud or debris flow(s) and appears to represent a single large, or limited series of large deposition events.

Tsm was originally mapped as part of the Muddy Creek formation (McKelvey et al., 1949; Longwell et al., 1965). Bell and Smith, 1980, present that the Tsm may be closer associated to the Powerline Road units that comprise the River Mountains in the area. It may also be a remnant of an interstitial unit that has been mostly eroded away. Hydrothermal transport and deposition from, and within, this unit into faults and fractures may have been the petrogenetic mechanism of high-grade manganese ore (wad) formation. Chemical data from fault gauge within the Tsm at the Hulin pit indicates high arsenic and lead. Tsm, where present, underlies and unconformably contacts the Muddy Creek formation, observable in the Hulin pit. This contact appears to be gradiated at the Hulin pit and some fluvial reworking may have occurred during Muddy Creek deposition.

MID TERTIARY ROCKS

Tpd – Resistant volcanic units of Powerline Road. Numerous dacite flows. Units are texturally variable, plagioclase, biotite, and hornblende bearing. Flows are commonly banded. Bell and Smith noted large amplitude flow folds. Unit as mapped is a ridge former in the River Mountains. Dacite varies in color from gray on fresh surfaces to reddish black on well weathered surfaces. Upper and lower parts of many flows, and at the contact between Tpd and Tpdt, are brecciated.

Tpdt – Saddle forming volcanic units of Powerline Road. Tuffaceous interbedded units in the River Mountains. Units consist of interbedded pyroclastic, breccia, dacite, zeolitized, and perlitic flows. Breccias often contain purple/red andesite xenoliths. Rock units are dark grey, buff or tan. Previously mapped by Bell and Smith (1980) as part of the Tpd, the units are separately mapped here due to their fissle/less resistant qualities. These units are easily decomposed and are saddle formers in the River Mountains.

Tpd_2 – Resistant volcanic units of Powerline Road. Grayish red to red dacite flows. Contain numerous clasts/xenoliths of grey andesite. Bell and Smith (1980) noted vertical thickness of 150-200 feet. The unit is a resistant ridge former in the River Mountains and considered a marker horizon for the northern part of the mountain range. At the Three Kids Mine the unit outcrops exclusively in the southeastern area of the site within the "House" region.

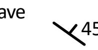
Tpm – Resistant volcanic units of Powerline Road. Interbedded basalt and andesite flows of the River Mountains. Basalts are typically vesicular and mafic containing phenocrysts of augite and olivine. Andesites are reddish purple with plagioclase, hornblende, and augite phenocrysts. These are ridge formers in the River Mountains and occur mainly on the eastern boundary of the Three Kids Mine and Mill Site.

Tdb – Dikes. Basalt/Andesite composition dikes of Miocene age. Associated with Tpd and Tpdt in the Three Kids Mine area. Thickness variable. Only dikes >10 feet thick are mapped.

KEY TO MAP SYMBOLS

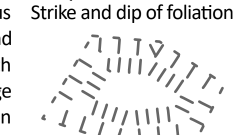
Contact. Dashed where approximate or concealed.

Fault. Dashed where approximate or inferred, dotted where concealed, ball on downthrown side.



Strike and dip of beds

Strike and dip of foliation



Mine Waste

Pit

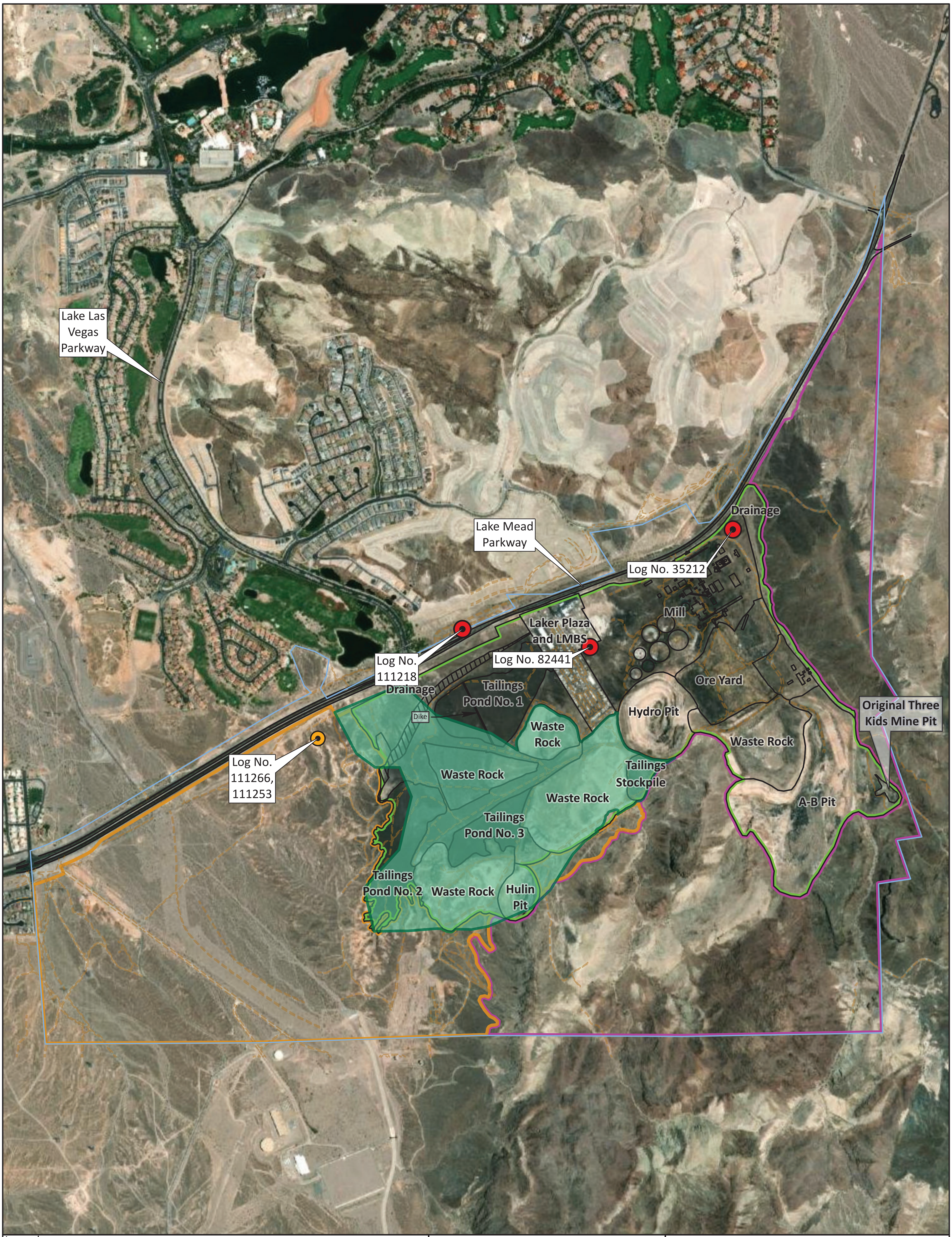
BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 9/9/2021

Legend:
As shown above.

Notes:
1. Source: 2005-2008 Field and Aerial data combined with data from Bell and Smith, 1980, *Geologic map of the Henderson Quadrangle, Nevada*, Nevada Bureau of Mines and Geology, Map 67, and Hunt, et. al., 1942, *Three Kids Manganese District Clark County, Nevada*, United States Department of the Interior, Bulletin 936-L.

Figure 3B	
Detailed Geologic Map Key	
Former Three Kids Mine	
Designed	
Drawn	JCM
Approved	



Legend:

- Central Valley Area
- Site Feature
- Unimproved Road
- Tailings Dam
- Project Area
- Mine Site
- Sedimentary Units (alluvium and Muddy Creek Formation)
- River Mountain Volcanics
- Active Well
- Plugged Well

Nevada

N

Scale: 1:14,000

1,000 500 0 1,000 Feet

Figure 4

Central Valley Area, Site Facilities, and Groundwater Well Locations

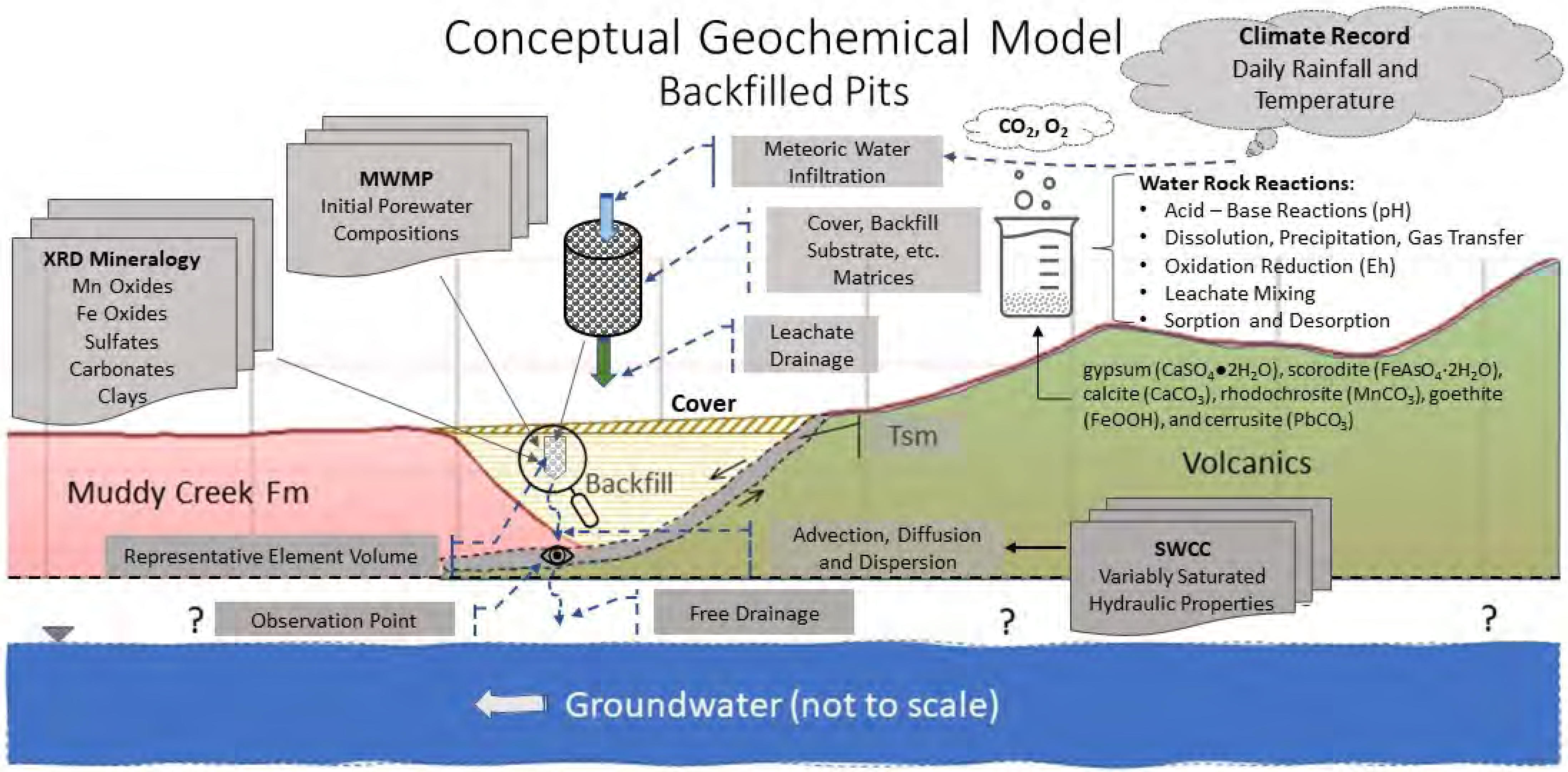
Three Kids Mine

BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) • (702) 563-0610 (F)

Job # 14-01-156 Date: 8/10/2022

Notes:
1. Imagery Source: Esri World Imagery (Maxar)
2. Datum: NAD 1983 StatePlane Nevada East FIPS 2701 Feet
3. Not a survey. Derived from aerial imagery.

Designed	
Drawn	JCM
Approved	



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

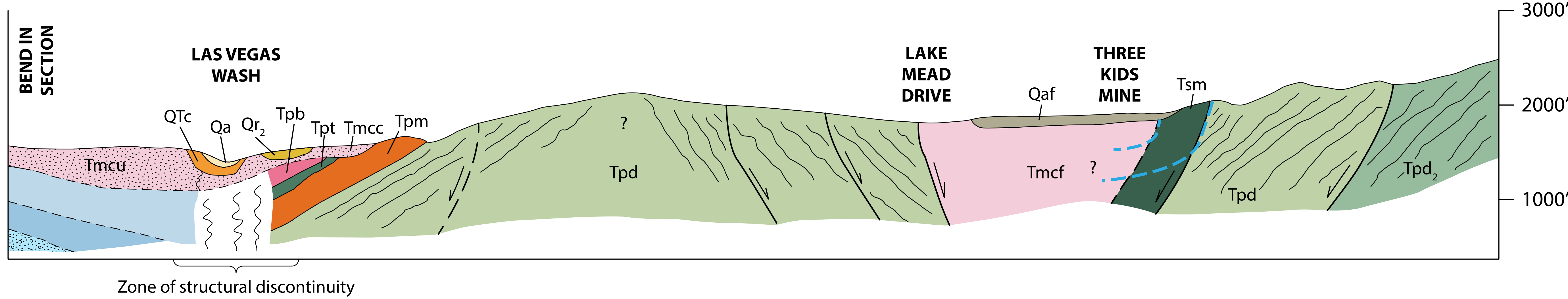
Job # 14-01-156 Date: 05/26/2022

Legend:

Notes:
XRD = X-ray Diffraction
MWMP = Meteoric Water Mobility Procedure
SWCC = Soil Water Characteristic Curve
CO_2 = Carbon Dioxide Gas
O_2 = Oxygen Gas

Figure 5	
Conceptual Geochemical Model for Backfilled Mine Pits	
Three Kids Mine	
Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\05_3KIDS_CONCEPTUAL_GEOCHEM_MODEL.ai



BROADBENT

8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/01/2022

Legend:

- Qa - Modern Wash Deposits
- Qaf - Artificial Fill
- Qf_2 - Pediment and Fan Deposits
- QTc - Conglomerate of Las Vegas Wash
- Tmcc, Tmcf, Tmcu - Muddy Creek Formation
- Tsm - Manganiferous Sedimentary Rocks of the Three Kids Mine
- Tpd - Dacite
- Tpm
- Tpt -
- Tpb -
- Tpb_2 -

(Tpm, Tpt, Tpb, Tpb_2:) Volcanic Rocks of Powerline Road

Notes:
1. Geologic section through site modified from Bell and Smith, 1980.

Figure 6	
Geologic Cross Section	
Three Kids Mine	
Designed	
Drawn	EC
Approved	

BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/01/2022

Legend:

Central Valley Area

Notes:

Nevada

N

Scale: 1:9,000

750 375 0 750 Feet

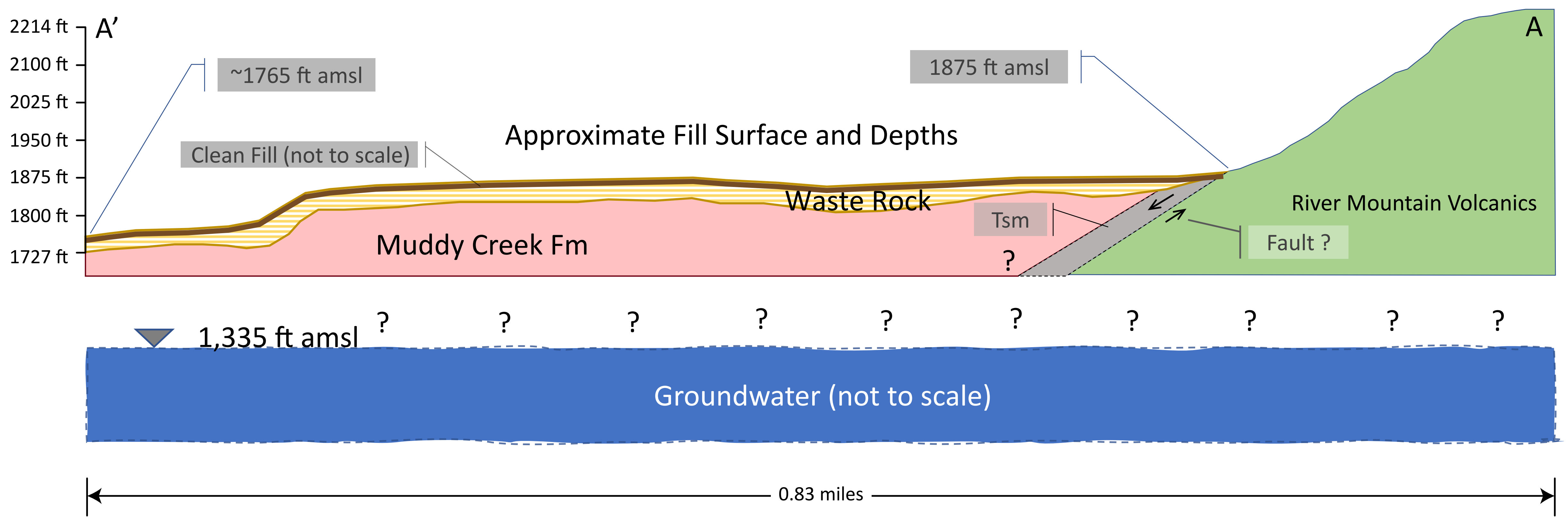
Figure 7

Locations of model profiles for Hydro, AB, Hulin, and Central Valley simulations

Three Kids Mine

Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\07_3KIDS_MODEL_PROFILES.ai



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

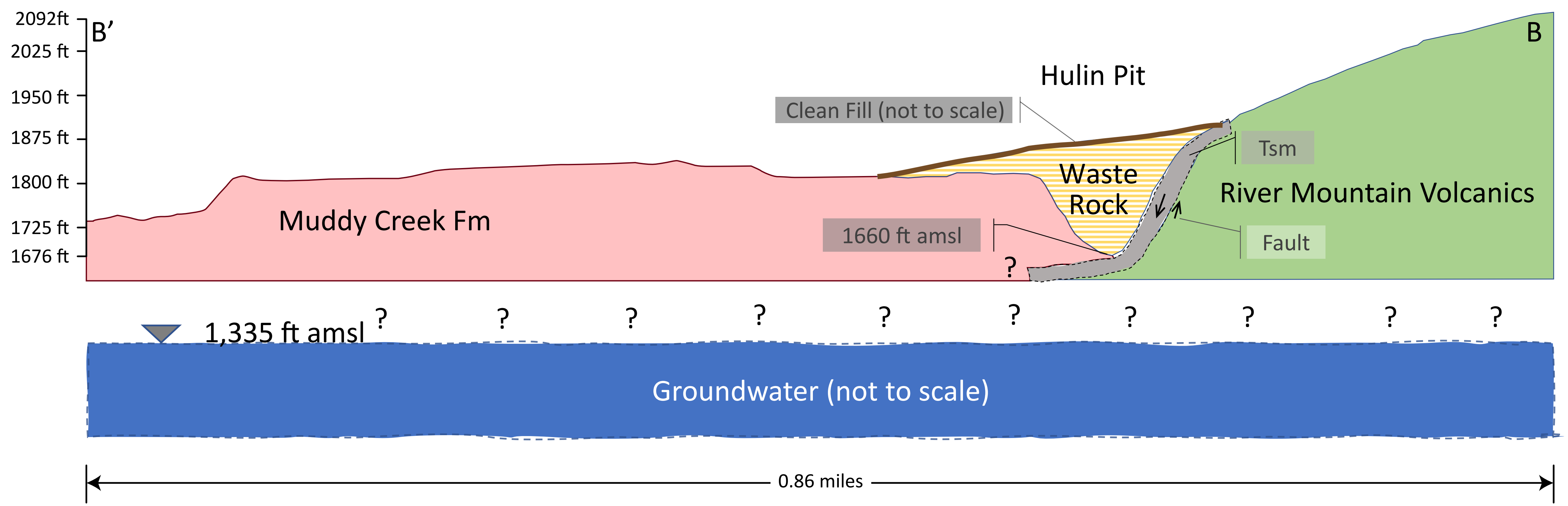
Job # 14-01-156 Date: 03/07/2022

Legend:
- Tsm = Manganiferous sedimentary rocks of the Three Kids Mine
- Waste Rock
- Clean Fill
- Fm = Formation
- amsl = Above mean sea level
- ft = feet

Notes:
Elevation is based on assumption that groundwater is approximately 200 feet below the bottom of the Hydro Pit.

Figure 8A	
Central Valley Profile	
Three Kids Mine	
Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\08A_3KIDS_CENTRAL_PROFILE.ai



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/07/2022

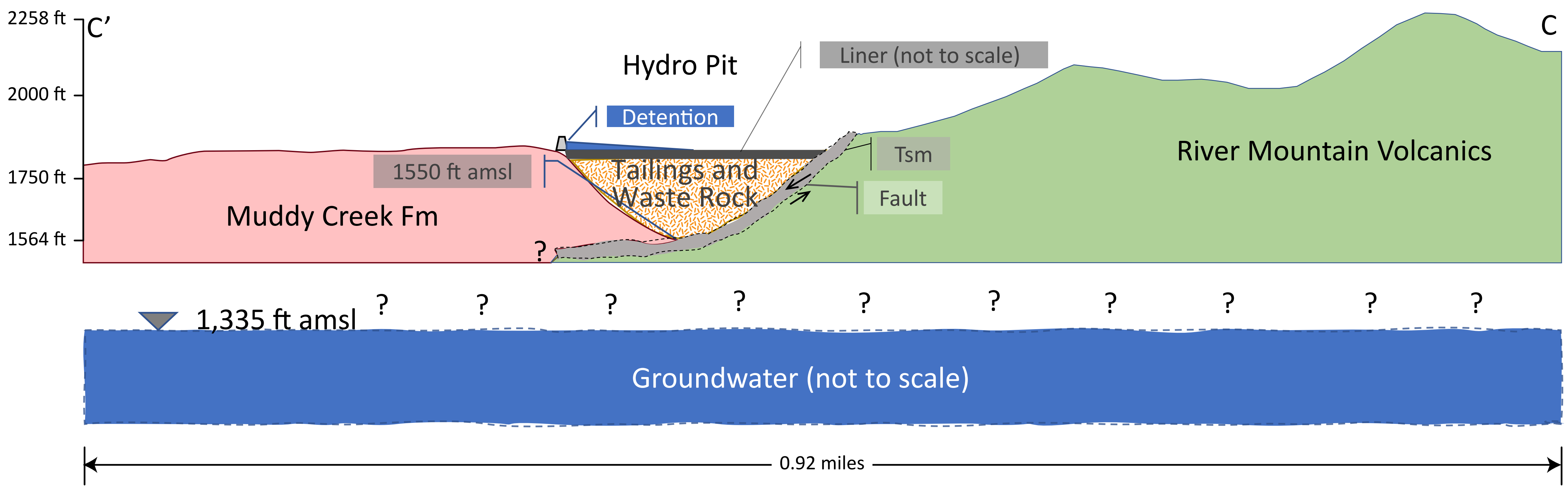
Legend:

- Tsm = Manganiferous sedimentary rocks of the Three Kids Mine
- Waste Rock
- Clean Fill
- Fm = Formation
- amsl = Above mean sea level
- ft = feet

Notes:
Elevation is based on assumption that groundwater is approximately 200 feet below the bottom of the Hydro Pit.

Figure 8B	
Hulin Pit Profile	
Three Kids Mine	
Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\08B_3KIDS_HULIN_PROFILE.ai



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/07/2022

Legend:
- Tsm = Manganiferous sedimentary rocks of the Three Kids Mine
- Tailings and Waste Rock
- Liner
- Fm = Formation
- amsl = Above mean sea level
- ft = feet

Notes:
Elevation is based on assumption that groundwater is approximately 200 feet below the bottom of the Hydro Pit.

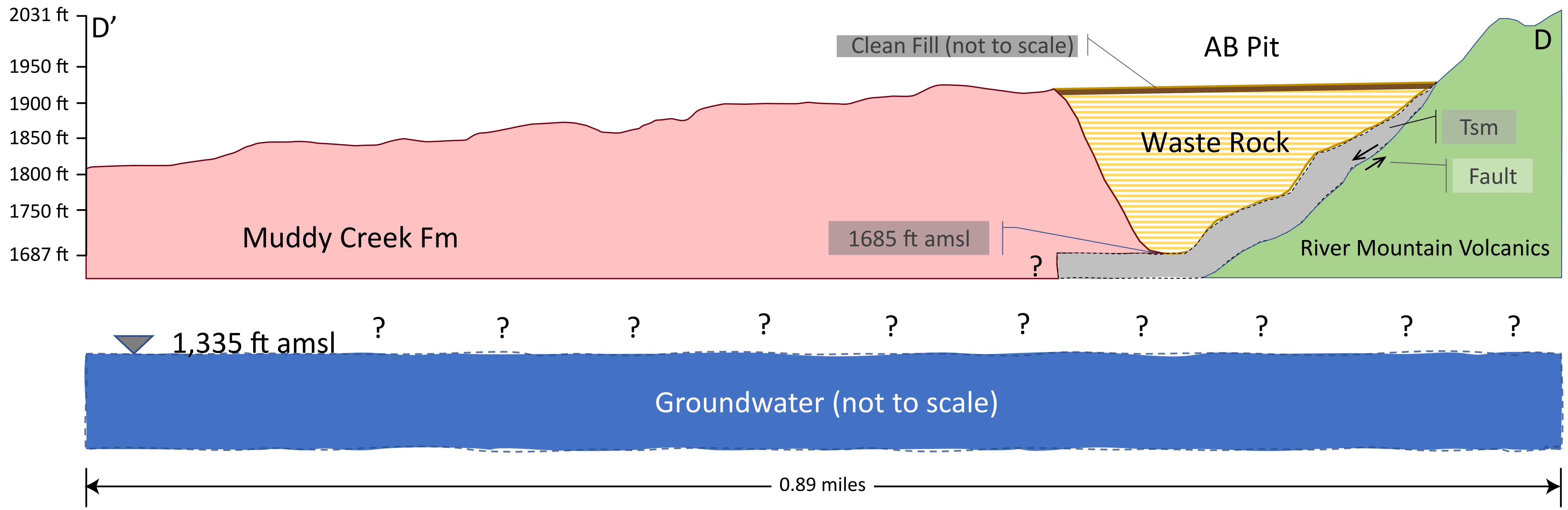
Figure 8C

Hydro Pit Profile

Three Kids Mine

Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\08C_3KIDS_HYDRO_PIT_PROFILE.ai



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/07/2022

Legend:
- Tsm = Manganiferous sedimentary rocks of the Three Kids Mine
- Waste Rock
- Clean Fill
- Fm = Formation
- amsl = Above mean sea level
- ft = feet

Notes:
Elevation is based on assumption that groundwater is approximately 200 feet below the bottom of the Hydro Pit.

Figure 8D

AB Pit Profile

Three Kids Mine

Designed	
Drawn	EC
Approved	

Figure 9a

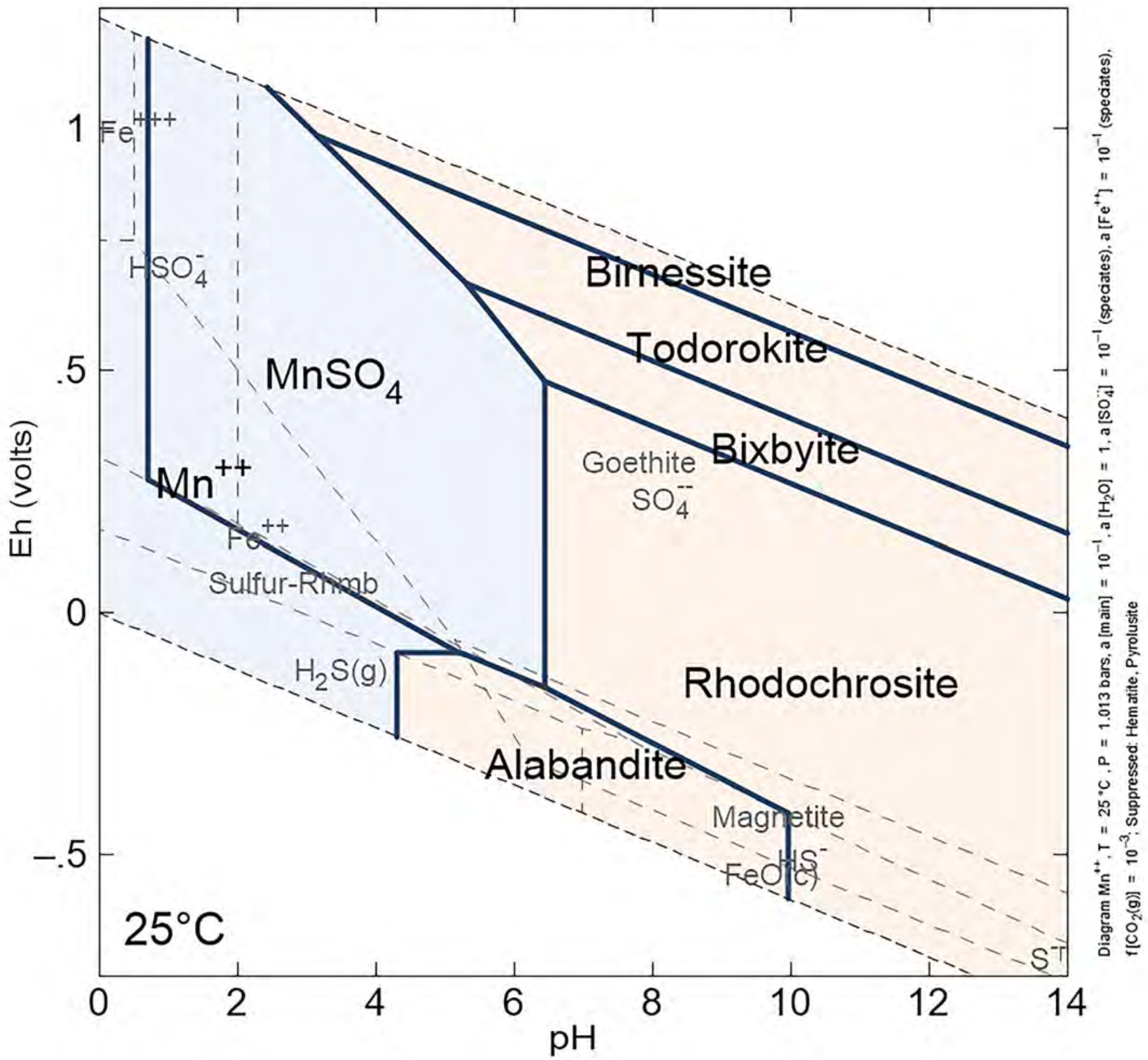
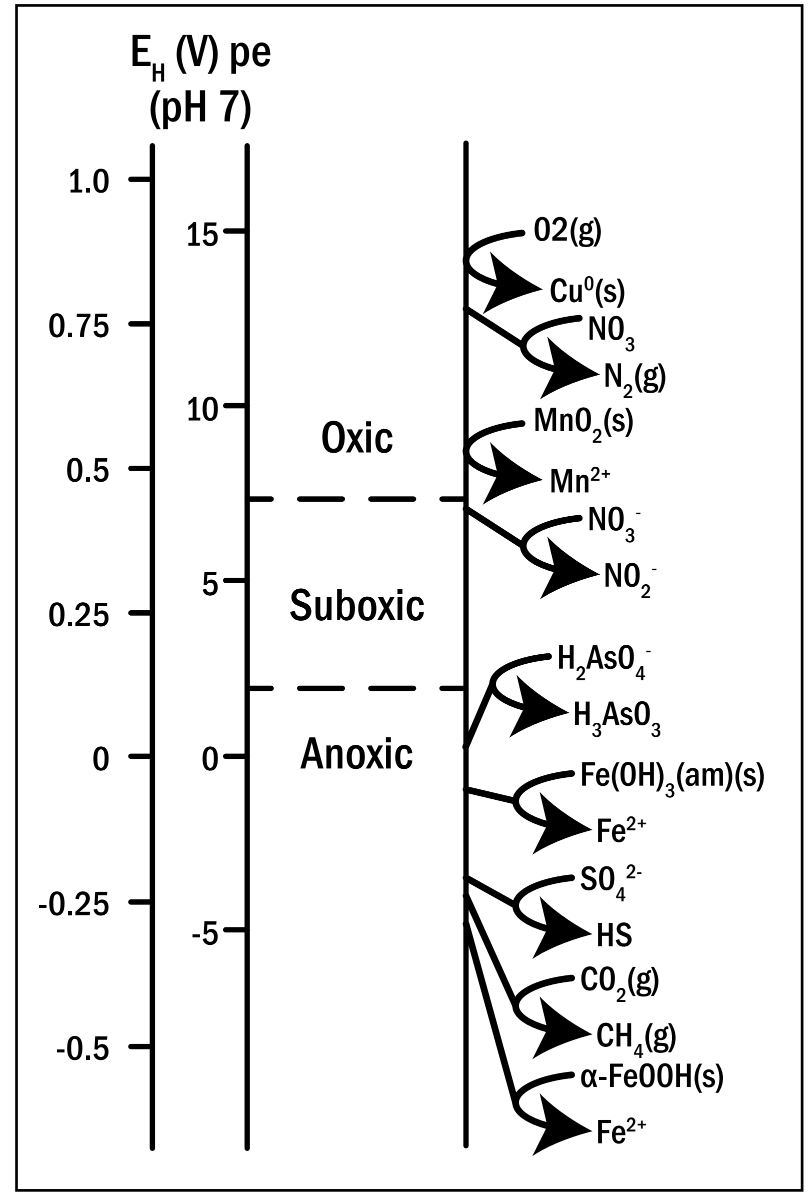


Figure 9b



Legend

- Aqueous field (no solids)
- Solid stability field in aqueous solution

Fe^{++} = aqueous iron(II)

Fe^{+++} = aqueous iron(III)

HS^{-} = aqueous bisulfide

SO_4^{--} = aqueous sulfate

Sulfur Rhmb = rhombohedral sulfur (solid S)

$H_2S^{(g)}$ = aqueous dihydrogen sulfide

SO_4^{--} = aqueous sulfate

FeO(c) = aqueous iron(II) oxide

S = sulfur

Mn^{++} = Manganese

$MnSO_4$ = Manganese sulfate

BROADBENT

8 West Pacific Avenue
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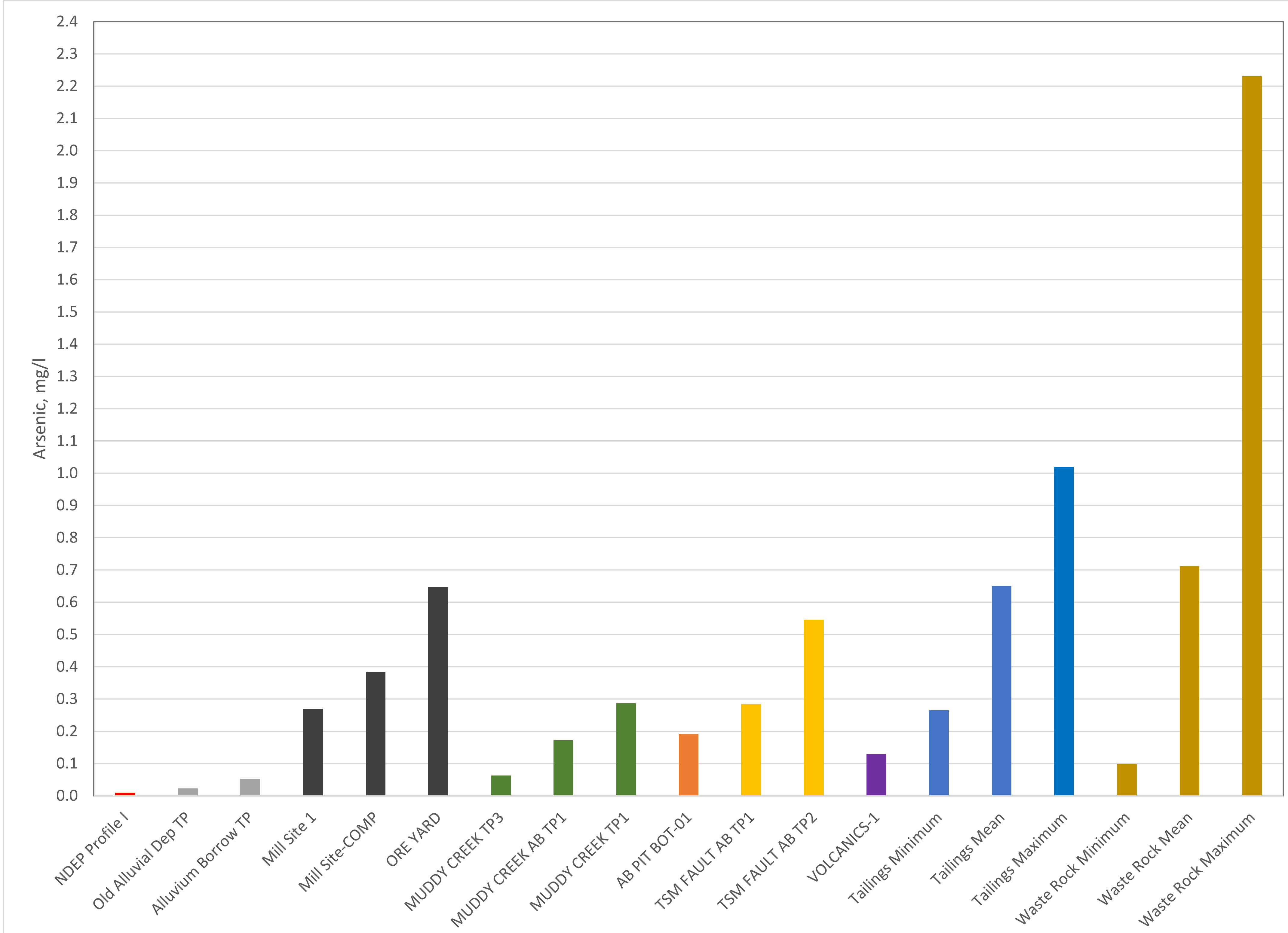
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/07/2022

Legend:
Redox couples of important dissolved aqueous species, solids denoted by the letter s in parentheses (s), and gases denoted by the letter g in parentheses (g). Electron potential (Eh) in volts with respect to the standard hydrogen electrode. The parallel oxidation reduction potential parameter pe is the negative log of the electron activity which is similar to pH which is the negative log of the hydrogen ion (H+) activity.

Notes:
Eh = Redox potential measured by the electron potential relative to the standard hydrogen electrode (SHE).
pe = Redox potential measured by the negative log of the electron activity.
Figure 1 in Borch, T., Kretzchmar, R., Kappler, A., Van Cappellen, P., Ginder-Vogel, M., Voegelin, A. and Campbell, K., 2010. Biogeochemical Redox Processes and their Impact on Contaminant Dynamics. Environ. Sci. Technol. 44, p. 15-23.

Figure 9	
Eh pH diagram with stability fields for manganese and iron oxides and other site species (9a), and redox ladder showing examples of environmentally relevant redox couples (9b).	
Three Kids Mine	
Designed	
Drawn	EC
Approved	



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/30/2022

Legend:

Notes:
mg/l = milligrams per liter of leachate

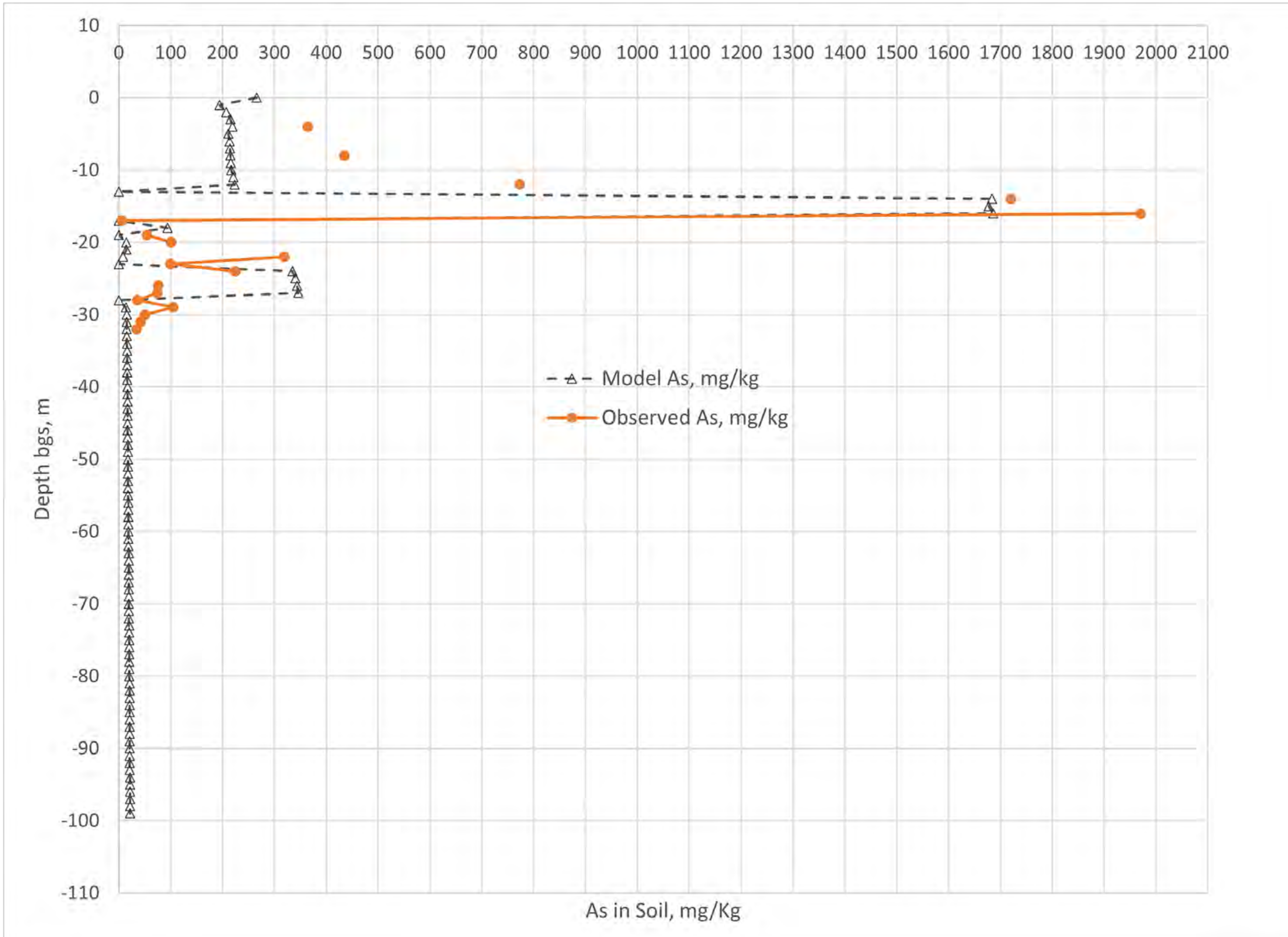
Figure 10

Bar chart showing relative arsenic concentrations in MWMP leachates.

Three Kids Mine

Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\10_3KIDS_RELATIVE_ARSENIC_MWMP.ai



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/09/2022

Legend:

Notes:
Soil boring samples collected in September 2021 (depths of 15 to 56 feet bgs) were analyzed for total metals at Pace National of Mount Juliet, Tennessee via EPA Method 6020A. Soil boring samples collected in December 2021 (depths of 59 to 109 feet bgs) were analyzed for total metals at Veritas Laboratories of Las Vegas, Nevada via EPA Method 6010B.
bgs = below ground surface
mg/kg = milligrams per kilogram of soil
m= meters
As = arsenic

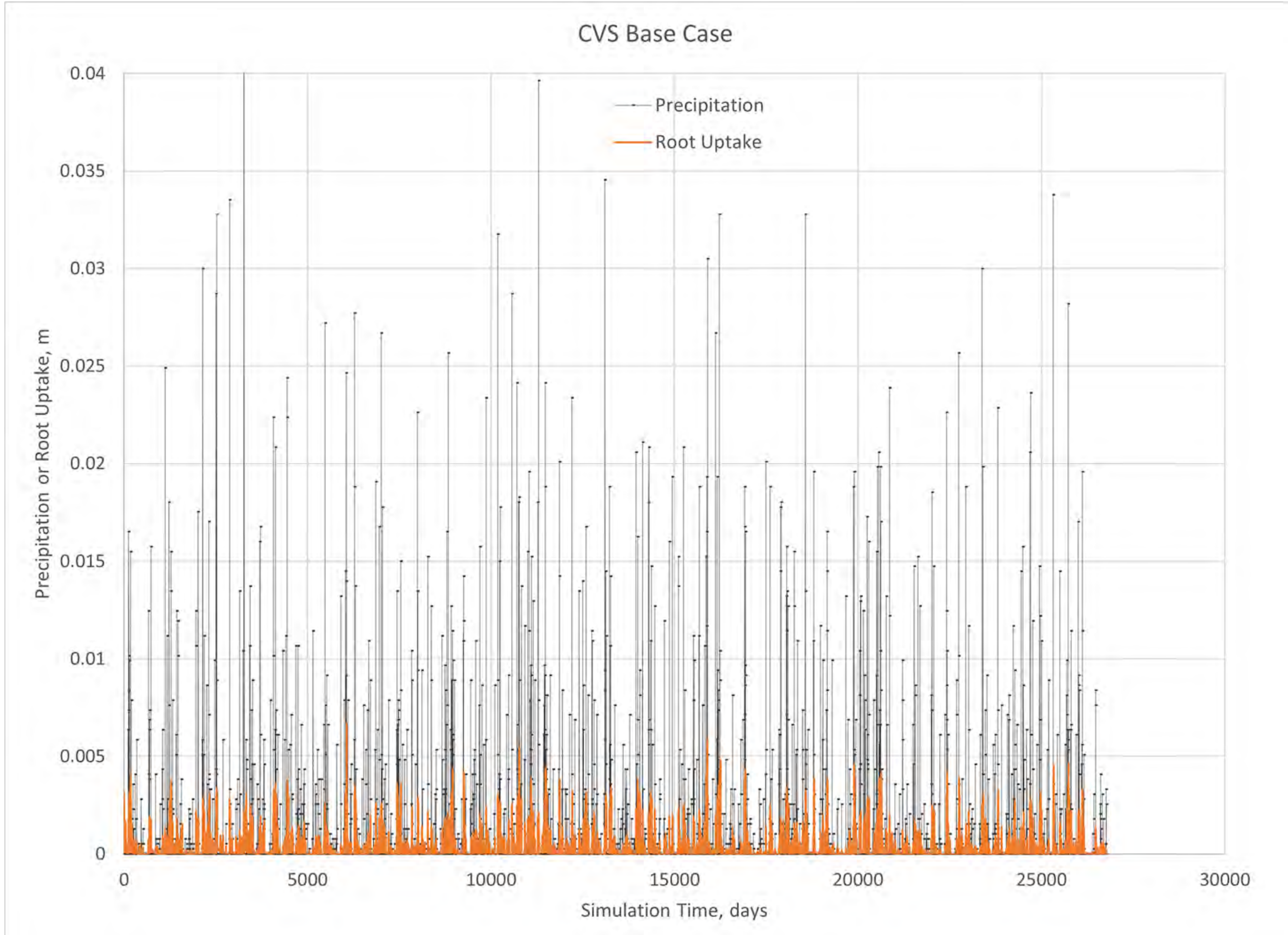
Figure 11

Model Calibration to Soil Boring Data in Tailings Pond 1

Three Kids Mine

Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\10_3KIDS_MODEL_CALIBRATION_XRF_TP1.ai



BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 06/08/2022

Legend:

Notes:
m = meters

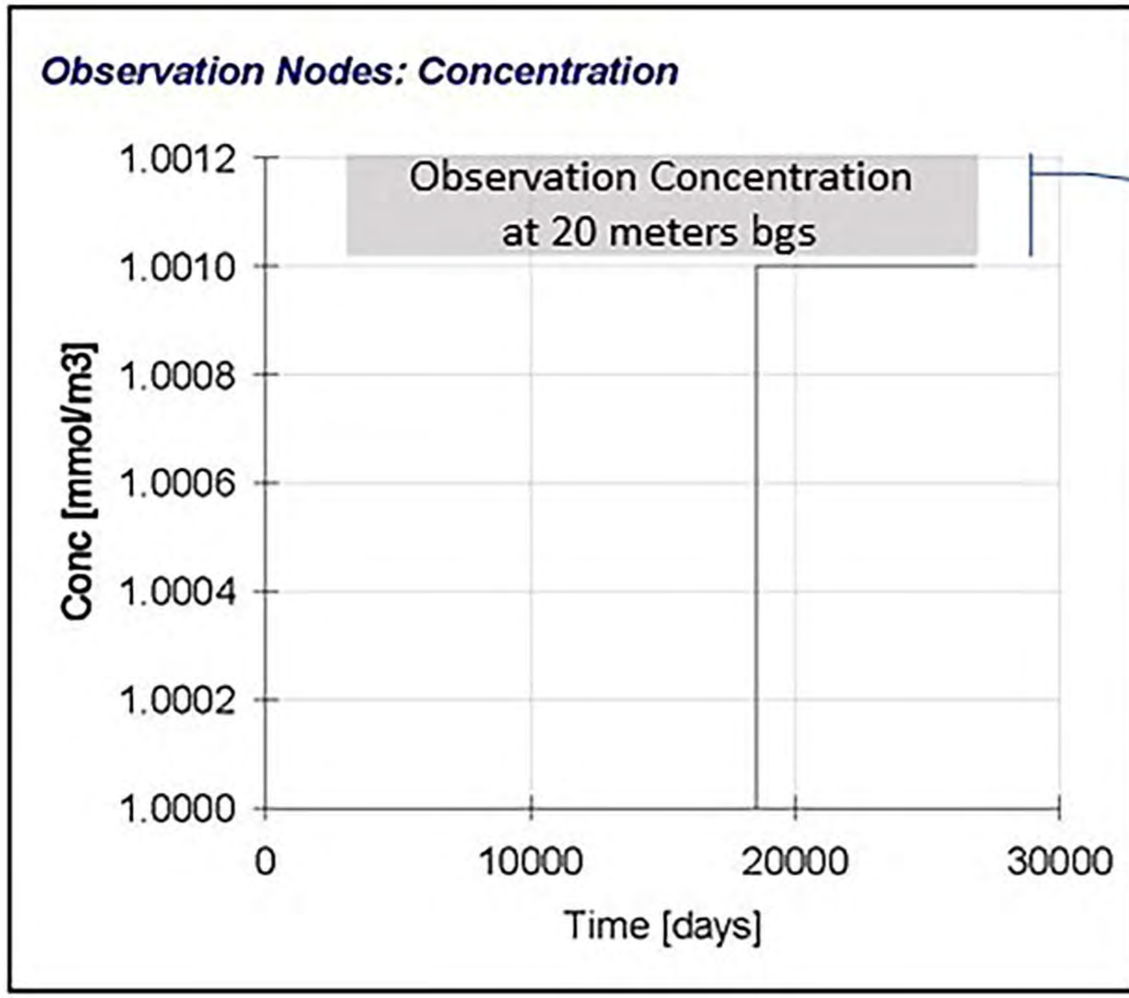
Figure 12

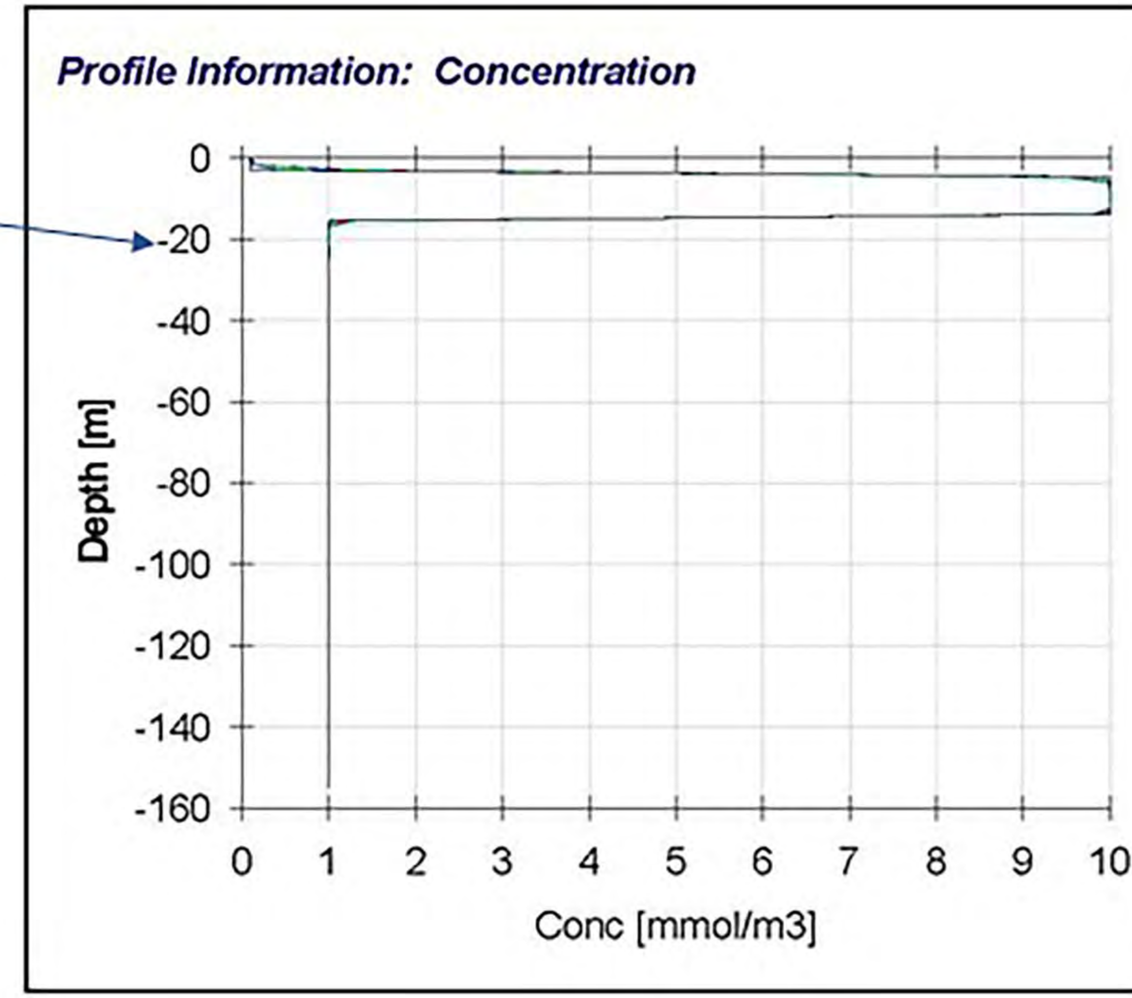
McCarran Airport, NV Precipitation and CVS Base Case Simulated Root Uptake.

Three Kids Mine

Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\13_3KIDS_MCCARRAN_AP_NV_PRECIP_CVS_BASE.ai





BROADBENT
8 West Pacific Avenue
Henderson, NV, 89015
(702) 563-0600 (P) * (702) 563-0610 (F)

Job # 14-01-156 Date: 03/01/2022

Legend:

Notes:
bgs = below ground surface
mmol/m3 = millimole per cubic meter

Figure 13

Conservative concentration profiles for 72-year period of simulation for the Central Valley Simulation Alluvium Borrow TP cover scenario (Appendix H).

Three Kids Mine

Designed	
Drawn	EC
Approved	

Y:\gis2\Commercial\1612501_01_BROADBENT_3KIDS_MINE\11_3KIDS_AB_HULING_SIMULATION.ai

TABLES

TABLE 1

Climate Summary for Las Vegas McCarran Airport, Nevada

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	57.2	62.5	69.5	78.2	88.4	98.6	104.5	102.3	94.8	81.3	66.5	57.2	80.1
Average Min. Temperature (F)	34.6	39	44.5	51.9	61.2	70.1	76.8	75.1	66.8	54.6	42.1	34.9	54.3
Average Total Precipitation (in.)	0.5	0.57	0.43	0.2	0.14	0.07	0.43	0.45	0.33	0.27	0.36	0.41	4.15
Average Total SnowFall (in.)	0.7	0	0	0	0	0	0	0	0	0	0.1	0.1	0.9
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes:

Western Regional Climate Center, wrcc@dri.edu

Period of Record Monthly Climate Summary

Period of Record : 09/06/1948 to 12/24/2021

TABLE 2
Summary MWMP Results Statistics for Tailing and Waste Rock Samples

	Units	NDEP Profile I	Tailings			Waste Rock		
			Mean	Max	Min	Mean	Max	Min
pH	su	6.5 - 8.5	7.8	8.0	7.4	7.9	8.6	7.4
Total Dissolved Solids	mg/L	1000	2960	5140	1010	4472	6680	2490
Alkalinity, Total (as CaCO3)	mg/L		116	223	47	42	68	27
Total Nitrogen	mg/L	10	5.9	14.0	2.0	10.7	43.0	2.0
Nitrogen, total Kjeldahl (TKN)	mg/L		1.0	4.0	0.2	0.6	3.9	0.0712
Cyanide, WAD	mg/L	0.2	0.01	0.01	0.01	0.01	0.01	0.01
Moisture Content	%		22.9	34.0	7.4	10.8	18.3	3.6
Anions								
Alkalinity, bicarbonate as HCO3	mg/L		162	199	130	44	76	31
Chloride	mg/L		49	219	10	163	778	2
Fluoride	mg/L		1.8	3.2	0.5	1.6	4.4	0.4
Nitrogen, Nitrate-Nitrite (as N)	mg/L		4.5	10.8	0.6	8.4	30.6	1.0
Sulfate	mg/L		1525	2800	514	2555	4120	1520
Cations								
Calcium	mg/L		281	517	57	473	555	339
Magnesium	mg/L		76	152	15	101	199	31
Potassium	mg/L		44	64	2	45	84	23
Sodium	mg/L		360	660	123	622	1450	46
Dissolved Metals								
Aluminum	mg/L	0.2	0.04	0.14	0.01	0.08	0.38	0.01
Antimony	mg/L	0.006	0.004	0.004	0.004	0.007	0.011	0.004
Arsenic	mg/L	0.01	0.64	1.27	0.27	0.66	2.23	0.10
Barium	mg/L	2	0.05	0.10	0.05	0.05	0.10	0.05
Beryllium	mg/L	0.004	0.001	0.002	0.001	0.001	0.002	0.001
Boron	mg/L		2.27	9.56	0.79	14.14	45.70	0.25
Cadmium	mg/L	0.005	0.001	0.002	0.001	0.001	0.002	0.001
Chromium	mg/L	0.1	0.01	0.01	0.01	0.01	0.01	0.01
Copper	mg/L	1	0.03	0.04	0.02	0.01	0.01	0.01
Iron	mg/L	0.6	0.01	0.02	0.01	0.01	0.02	0.01
Lead	mg/L	0.015	0.001	0.002	0.001	0.001	0.002	0.001

TABLE 2

Summary MWMP Results Statistics for Tailing and Waste Rock Samples

	Units	NDEP Profile I	Tailings			Waste Rock		
			Mean	Max	Min	Mean	Max	Min
Manganese	mg/L	0.1	1.82	14.90	0.02	0.09	3.51	0.00
Mercury	mg/L	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Nickel	mg/L		0.01	0.01	0.01	0.01	0.01	0.01
Selenium	mg/L	0.05	0.010	0.012	0.006	0.143	0.663	0.000
Silver	mg/L	0.1	0.01	0.01	0.01	0.01	0.01	0.01
Thallium	mg/L	0.002	0.003	0.003	0.003	0.01	0.05	0.00
Zinc	mg/L	5	0.01	0.01	0.01	0.03	0.03	0.03

Notes:

% = percent

mg/L = milligrams per liter

su = standard unit

Reference:

ndep.nv.gov/uploads/documents/20141027_Profile_I_List.pdf

TABLE 3
MWMP Results for Mined, Processed, and Native Materials

		Location	AB PIT BOT-01	Alluvium Borrow TP	Mill Site 1	Mill Site-COMP
		Sample Name	AB PIT BOT-01 (Mined)	ALLUVIUM BORROW TP (Native)	MILL SITE (Processed)	MILL SITE 2 (Processed)
		Sample Date	11/10/2021	11/10/2021	11/10/2021	11/18/2021
Method	**Analyte**	**Unit**	**Result**	**Result**	**Result**	**Result**
ASTM E2242-13	pH of extract	su	7.8	8.53	7.64	7.73
ASTM E2242-13	pH of extraction water	su	6.21	6.21	6.21	6.09
ASTM E2242-13	pH of final effluent	su	7.81	8.5	7.62	7.7
EPA 200.7	Aluminum	mg/L	0.03	0.07	< 0.00817 U	0.04
EPA 200.7	Beryllium	mg/L	< 0.000123 U	< 0.000123 U	< 0.000123 U	< 0.000123 U
EPA 200.7	Boron	mg/L	1.37	0.12	0.28	0.26
EPA 200.7	Calcium	mg/L	492	7	126	538
EPA 200.7	Chromium	mg/L	< 0.000685 U	< 0.000685 U	0.01	< 0.000685 U
EPA 200.7	Iron	mg/L	< 0.00442 U	0.04	< 0.00442 U	< 0.00442 U
EPA 200.7	Magnesium	mg/L	53	2	24	32
EPA 200.7	Manganese	mg/L	0.04	< 0.00087 U	< 0.00087 U	< 0.00087 U
EPA 200.7	Nickel	mg/L	< 0.000937 U	< 0.000937 U	< 0.000937 U	< 0.000937 U
EPA 200.7	Potassium	mg/L	54	10	10	81
EPA 200.7	Sodium	mg/L	121	50	48	24
EPA 200.7	Zinc	mg/L	< 0.00682 U	< 0.00682 U	< 0.00682 U	< 0.00682 U
EPA 200.8	Antimony	mg/L	< 0.000131 U	< 0.000131 U	< 0.000131 U	< 0.000131 U
EPA 200.8	Arsenic	mg/L	0.191	0.052	0.270	0.384
EPA 200.8	Barium	mg/L	< 0.000147 U	< 0.000147 U	< 0.000147 U	< 0.000147 U
EPA 200.8	Cadmium	mg/L	< 0.000106 U	< 0.000106 U	< 0.000106 U	< 0.000106 U
EPA 200.8	Copper	mg/L	< 0.00149 U	< 0.00149 U	< 0.00149 U	< 0.00149 U
EPA 200.8	Lead	mg/L	< 0.000295 U	< 0.000295 U	0.018	< 0.000295 U
EPA 200.8	Selenium	mg/L	< 0.000125 U	< 0.000125 U	< 0.000125 U	< 0.000125 U
EPA 200.8	Silver	mg/L	< 0.000119 U	< 0.000119 U	< 0.000119 U	< 0.000119 U
EPA 200.8	Thallium	mg/L	< 0.000232 U	< 0.000232 U	< 0.000232 U	< 0.000232 U
EPA 245.1	Mercury	mg/L	< 0.0000202 U	< 0.0000202 U	< 0.0000202 U	< 0.0000202 U
EPA 300.0	Chloride	mg/L	25.8	6	3	< 1.12 U
EPA 300.0	Sulfate	mg/L	1660	26	498	1590
EPA 351.2	Total Kjeldahl Nitrogen [TKN]	mg/L	1.8	< 0.0712 U	0.2	0.4
EPA 353.2	Nitrogen as nitrate + nitrite	mg/L	6.4	0.5	1.1	1.5
CALCULATION	Calculated Total Nitrogen	mg/L	8	< 0.1 U	1	2
SM2320B	Alkalinity, Bicarbonate [As CaCO3]	mg/L	72	113	36	44
SM2320B	Alkalinity, Bicarbonate [As HCO3]	mg/L	87	125	44	54
SM2540B	Total Dissolved Solids [TDS]	mg/L	2720	290	850	2580
SM4500-CN	Cyanide,Weak/Dissociable	mg/L	< 0.00435 U	< 0.00435 U	< 0.00435 U	< 0.00435 U
SM4500F-C	Fluoride	mg/L	0.9	1.5	0.3	0.5
SM4500H-B	pH	pH units	7.8	8.6	7.7	7.7

Notes:
< = less than
mg/L = milligrams per liter
su = standard unit
U = Analyte not detected

TABLE 3
MWMP Results for Mined, Processed, and Native Materials

		Location	MUDDY CREEK AB TP1	MUDDY CREEK TP1	MUDDY CREEK TP3	Old Alluvial Dep TP
		Sample Name	MUDDY CREEK AB TP1 (Native)	MUDDY CREEK TP1 (Native)	MUDDY CREEK TP3 (Native)	OLDER ALLUVIAL FAN DEPOSIT TP (Native)
		Sample Date	11/10/2021	11/10/2021	11/10/2021	11/10/2021
Method	**Analyte**	**Unit**	**Result**	**Result**	**Result**	**Result**
ASTM E2242-13	pH of extract	su	7.8	7.25	7.7	7.4
ASTM E2242-13	pH of extraction water	su	6.21	6.21	6.21	6.21
ASTM E2242-13	pH of final effluent	su	7.76	7.24	7.4	7.37
EPA 200.7	Aluminum	mg/L	0.04	0.04	0.04	< 0.00817 U
EPA 200.7	Beryllium	mg/L	< 0.000123 U	< 0.000123 U	< 0.000123 U	< 0.000123 U
EPA 200.7	Boron	mg/L	4.79	1.14	1.80	0.38
EPA 200.7	Calcium	mg/L	516	494	589	85
EPA 200.7	Chromium	mg/L	< 0.000685 U	< 0.000685 U	< 0.000685 U	< 0.000685 U
EPA 200.7	Iron	mg/L	< 0.00442 U	< 0.00442 U	< 0.00442 U	< 0.00442 U
EPA 200.7	Magnesium	mg/L	191	28	44	16
EPA 200.7	Manganese	mg/L	< 0.00087 U	< 0.00087 U	< 0.00087 U	< 0.00087 U
EPA 200.7	Nickel	mg/L	< 0.000937 U	< 0.000937 U	< 0.000937 U	< 0.000937 U
EPA 200.7	Potassium	mg/L	41	31	41	13
EPA 200.7	Sodium	mg/L	181	403	401	100
EPA 200.7	Zinc	mg/L	< 0.00682 U	< 0.00682 U	< 0.00682 U	< 0.00682 U
EPA 200.8	Antimony	mg/L	< 0.000131 U	< 0.000131 U	< 0.000131 U	< 0.000131 U
EPA 200.8	Arsenic	mg/L	0.172	0.286	0.063	0.023
EPA 200.8	Barium	mg/L	< 0.000147 U	< 0.000147 U	< 0.000147 U	< 0.000147 U
EPA 200.8	Cadmium	mg/L	< 0.000106 U	< 0.000106 U	< 0.000106 U	< 0.000106 U
EPA 200.8	Copper	mg/L	< 0.00149 U	< 0.00149 U	< 0.00149 U	< 0.00149 U
EPA 200.8	Lead	mg/L	< 0.000295 U	< 0.000295 U	< 0.000295 U	< 0.000295 U
EPA 200.8	Selenium	mg/L	0.288	< 0.000125 U	0.012	< 0.000125 U
EPA 200.8	Silver	mg/L	< 0.000119 U	< 0.000119 U	< 0.000119 U	< 0.000119 U
EPA 200.8	Thallium	mg/L	0.002	< 0.000232 U	< 0.000232 U	< 0.000232 U
EPA 245.1	Mercury	mg/L	< 0.0000202 U	< 0.0000202 U	< 0.0000202 U	< 0.0000202 U
EPA 300.0	Chloride	mg/L	24.7	107	568	18
EPA 300.0	Sulfate	mg/L	2240	1930	1480	460
EPA 351.2	Total Kjeldahl Nitrogen [TKN]	mg/L	< 0.0712 U	0.4	< 0.0712 U	< 0.0712 U
EPA 353.2	Nitrogen as nitrate + nitrite	mg/L	27.7	10.5	43.2	0.8
CALCULATION	Calculated Total Nitrogen	mg/L	28	11	43	< 0.1 U
SM2320B	Alkalinity, Bicarbonate [As CaCO3]	mg/L	24	29	25	36
SM2320B	Alkalinity, Bicarbonate [As HCO3]	mg/L	30	35	30	44
SM2540B	Total Dissolved Solids [TDS]	mg/L	3690	3460	3750	840
SM4500-CN	Cyanide,Weak/Dissociable	mg/L	< 0.00435 U	< 0.00435 U	< 0.00435 U	< 0.00435 U
SM4500F-C	Fluoride	mg/L	2.7	0.6	0.2	0.3
SM4500H-B	pH	pH units	7.4	7.5	7.4	7.7

Notes:

< = less than

mg/L = milligrams per liter

su = standard unit

U = Analyte not detected

TABLE 3
MWMP Results for Mined, Processed, and Native Materials

		Location	ORE YARD	TSM FAULT AB TP1	TSM FAULT AB TP2	VOLCANICS-1
		Sample Name	ORE YARD (Processed)	TSM FAULT AB TP1 (Native)	TSM FAULT AB TP2 (Native)	VOLCANICS-1 (Native)
		Sample Date	11/10/2021	11/10/2021	11/10/2021	11/10/2021
Method	**Analyte**	**Unit**	**Result**	**Result**	**Result**	**Result**
ASTM E2242-13	pH of extract	su	7.68	7.5	7.42	8
ASTM E2242-13	pH of extraction water	su	6.21	6.21	6.21	6.21
ASTM E2242-13	pH of final effluent	su	7.67	7.49	7.41	8.03
EPA 200.7	Aluminum	mg/L	< 0.00817 U	0.02	< 0.00817 U	0.07
EPA 200.7	Beryllium	mg/L	< 0.000123 U	< 0.000123 U	< 0.000123 U	< 0.000123 U
EPA 200.7	Boron	mg/L	0.38	1.73	1.79	0.29
EPA 200.7	Calcium	mg/L	138	293	159	2
EPA 200.7	Chromium	mg/L	< 0.000685 U	< 0.000685 U	< 0.000685 U	0.01
EPA 200.7	Iron	mg/L	< 0.00442 U	< 0.00442 U	< 0.00442 U	0.10
EPA 200.7	Magnesium	mg/L	20	36	47	< 0.0581 U
EPA 200.7	Manganese	mg/L	< 0.00087 U	< 0.00087 U	< 0.00087 U	0.01
EPA 200.7	Nickel	mg/L	< 0.000937 U	< 0.000937 U	< 0.000937 U	< 0.000937 U
EPA 200.7	Potassium	mg/L	13	17	26	3
EPA 200.7	Sodium	mg/L	71	145	348	28
EPA 200.7	Zinc	mg/L	< 0.00682 U	< 0.00682 U	< 0.00682 U	< 0.00682 U
EPA 200.8	Antimony	mg/L	< 0.000131 U	< 0.000131 U	< 0.000131 U	< 0.000131 U
EPA 200.8	Arsenic	mg/L	0.646	0.283	0.546	0.129
EPA 200.8	Barium	mg/L	< 0.000147 U	< 0.000147 U	< 0.000147 U	< 0.000147 U
EPA 200.8	Cadmium	mg/L	< 0.000106 U	< 0.000106 U	< 0.000106 U	< 0.000106 U
EPA 200.8	Copper	mg/L	< 0.00149 U	< 0.00149 U	< 0.00149 U	< 0.00149 U
EPA 200.8	Lead	mg/L	0.007	< 0.000295 U	< 0.000295 U	< 0.000295 U
EPA 200.8	Selenium	mg/L	0.009	0.316	0.060	< 0.000125 U
EPA 200.8	Silver	mg/L	< 0.000119 U	< 0.000119 U	< 0.000119 U	< 0.000119 U
EPA 200.8	Thallium	mg/L	< 0.000232 U	< 0.000232 U	< 0.000232 U	< 0.000232 U
EPA 245.1	Mercury	mg/L	< 0.0000202 U	< 0.0000202 U	< 0.0000202 U	< 0.0000202 U
EPA 300.0	Chloride	mg/L	3	105	68.1	6
EPA 300.0	Sulfate	mg/L	597	966	1090	37
EPA 351.2	Total Kjeldahl Nitrogen [TKN]	mg/L	< 0.0712 U	0.5	0.1	0.3
EPA 353.2	Nitrogen as nitrate + nitrite	mg/L	1.9	14.1	5.1	2.8
CALCULATION	Calculated Total Nitrogen	mg/L	2	15	5	3
SM2320B	Alkalinity, Bicarbonate [As CaCO3]	mg/L	27	22	42	26
SM2320B	Alkalinity, Bicarbonate [As HCO3]	mg/L	33	27	51	32
SM2540B	Total Dissolved Solids [TDS]	mg/L	990	1830	2040	170
SM4500-CN	Cyanide,Weak/Dissociable	mg/L	< 0.00435 U	< 0.00435 U	< 0.00435 U	< 0.00435 U
SM4500F-C	Fluoride	mg/L	0.5	0.5	0.6	0.5
SM4500H-B	pH	pH units	7.5	7.4	7.7	7.6

Notes:
< = less than
mg/L = milligrams per liter
su = standard unit
U = Analyte not detected

TABLE 4
X-Ray Diffraction Mineralogical Analysis: Tailings Samples

Mineral Phase	Nominal Atomic Formula	TP1E-TSP01-12	TP1E-TSP01-60	TP1C-TSP02-12	TP1C-TSP02-48	TP1WN-TSP03-96	TP1WN-TSP03-12	TP02-TSP04-48	TP02-TSP04-96	TP3W-TSP07-48	TP3W-TSP07-96	TP03-TSP08-48	TP03-TSP08-96
		Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings	Tailings
quartz	SiO_2	11.5	11.2	16.1	14.3	17.6	17.3	13.4	13.2	12.1	14.3	14.9	23.2
K-feldspar	$KAlSi_3O_8$	6.7	5	5.7	5.5	7.2	4.7	9.8	6.7	5.7	5.3	5	7.4
plagioclase	$(Na,Ca)(Si,Al)_4O_8$	13.7	17.3	26.3	21	23.5	20.3	30.3	17.5	11.1	10.7	10.7	18.3
mica	$KAl_2(Si_3Al)O_{10}(OH)_2$	19.6	19.8	16.6	14.5	14	12.5	7.6	10.7	21.2	23.9	18.2	14.7
hornblende	$NaCa_2(Mg,Fe)_4Al_3Si_6O$	<1.0	<1.0	<1.0	<1.0	<1.0	2.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
clinoptilolite	$(Na,K,Ca)_{2.5}Al_3(Al,Si)_2S$	6.5	5.9	10.8	10.5	9.3	11.2	7.1	5.7	6.2	6.4	5.1	5.2
kaolinite	$Al_2Si_2O_5(OH)_4$	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.3	1.7	2.7	3.5	1.2	<1.0
magnesite	$MgCO_3$	<1.0	<1.0	<1.0	<1.0	<1.0	1.9	<1.0	<1.0	1.2	1.2	1.3	<1.0
calcite	$CaCO_3$	1.1	1.2	<1.0	2	<1.0	<1.0	1.9	1.3	<1.0	<1.0	<1.0	<1.0
aragonite	$CaCO_3$	1.2	1.7	2.1	1	1.9	1.2	1.8	1.7	<1.0	<1.0	1.1	1.3
dolomite	$CaMg(CO_3)_2$	<1.0	<1.0	<1.0	1.3	1.2	<1.0	<1.0	1.1	<1.0	1.3	<1.0	<1.0
kutnahorite	$CaMn(CO_3)_2$	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
rhodochrosite	$MnCO_3$	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1	<1.0	<1.0
manganosite	MnO_2	<1.0	<1.0	<1.0	<1.0	<1.0	5.6	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
ramsdellite	MnO_2	<1.0	<1.0	<1.0	1.6	1.4	1.3	1.2	0.9	<1.0	<1.0	<1.0	<1.0
todorokite	Mn_6O_{12}	<1.0	<1.0	1.4	<1.0	1.7	1	<1.0	<1.0	<1.0	1	<1.0	<1.0
celestine	$SrSO_4$	4.1	2.7	1.2	1.6	1	1.9	11	6.7	2.4	<1.0	5	1.8
gypsum	$CaSO_4(H_2O)_2$	<1.0	<1.0	1.6	1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
goethite	FeO(OH)	1.3	<1.0	<1.0	<1.0	<1.0	1.1	1	<1.0	<1.0	1.3	<1.0	<1.0
amorphous	micro/non-crystalline	32.6	32.1	15.3	24.4	19.1	16.5	11	31.2	28.1	25.2	32.5	24.2
Carbon as Carbonate[1]	C	--	--	--	0.60	--	0.59	--	0.58	--	--	--	--
Total C by Leco analysis[2]	C	--	--	--	0.701	--	0.358	--	0.650	--	--	--	--
Organic Carbon[3]	C	--	--	--	0.10	--	-0.23	--	0.07	--	--	--	--

Notes:

Units in weight percent.

The high concentration of amorphous material is composed of swelling clays (montmorillonite) and other clay and amorphous components. The high concentrations of amorphous material made quantification of trace minerals difficult but detection of "trace minerals" (<1.0 wt pct) was verified by X-ray diffraction analysis of coarse to mid grain size fractions. Trace minerals detected but not quantified were reported as less than 1.0 percent by weight.

< = less than

1 Calculated from X-ray diffraction results as sum of carbon in carbonate minerals. One half the detection limit is the value used for carbonates < 1.0 weight percent.

2 Average of duplicate sample analyses.

3 Calculated by difference, total carbon minus carbonate carbon.

TABLE 5
Summary of Hydraulic Properties for Model Tailing/Waste Rock Blends

Sample Number	α (cm^{-1})	N (dimensionless)	Θ_r (% vol)	Θ_s (% vol)	Oversize Corrected Θ_r (% vol)	Oversize Corrected Θ_s (% vol)	K_{sat} (cm/sec)	Corrected K_{sat} (cm/sec)
50/50 Blend (95%)	0.0015	1.5480	6.64	40.64	5.97	36.52	1.2E-06	1.0E-06
67/33 Blend (95%)	0.0010	1.4719	5.91	39.37	5.42	36.11	2.6E-07	2.2E-07
90/10 Blend (95%)	0.0022	1.3126	2.88	45.96	2.64	42.23	2.8E-06	2.5E-06

Notes:

α = inverse of air entry suction

cm = centimeter

cm/sec = centimeter per second

K_{sat} = saturated hydraulic conductivity

N = meaure of pore size distribution

Θ_r = residual water content

Θ_s = saturated water content

% vol = percent volume

TABLE 6
Summary of Calculated Unsaturated Hydraulic Properties

Sample Number[1]	α (cm^{-1})	N (dimensionless)	Θ_r (% vol)	Θ_s (% vol)	Oversize Corrected Θ_r (% vol)	Oversize Corrected Θ_s (% vol)	K_{sat} (cm/sec)	Corrected K_{sat} (cm/sec)
TSM Fault AB TP2 (~90%)	0.0196	1.2099	0.00	56.86	0.00	53.32	9.7E-04	8.4E-04
TSM Fault AB TP1 (~90%)	0.0607	1.2253	0.00	42.66	0.00	37.97	6.7E-04	5.5E-04
Muddy Creek AB TP1 (~90%)	0.1131	1.1611	0.00	49.35	NA	NA	4.5E-04	NA
Muddy Creek TP1 (~90%)	0.0688	1.3822	2.32	36.84	2.22	35.18	9.2E-04	8.6E-04
Muddy Creek TP3 (~90%)	0.0889	1.2931	2.97	38.05	2.79	35.73	4.3E-04	3.9E-04
Alluvium Borrow TP (~90%)	0.0196	1.6626	3.70	33.97	3.53	32.42	5.2E-04	4.9E-04
Older Alluvium Fan Deposits (~90%)	0.3750	1.1950	0.00	34.75	0.00	29.29	4.3E-04	3.4E-04
Mill Site (~90%)	0.0599	1.5011	2.57	35.73	2.26	31.39	1.1E-03	9.2E-04
Ore Yard (~90%)	0.0673	1.1595	0.00	41.73	---	---	1.0E-03	---
AB Pit Bot 01 (~90%)	0.0020	1.2381	0.00	57.82	NA	NA	1.3E-05	NA
TP1WN-TP1E (~90%)	0.0078	1.2654	0.00	47.51	0.00	44.53	9.6E-05	8.6E-05
WR07E-WR07N (~90%)	0.0307	1.1572	0.00	45.81	NA	NA	3.0E-04	NA

Notes:

[1] ~90% indicates sample repacked to 90% standard proctor density

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

α = inverse of air entry suction

cm = centimeter

cm/sec = centimeter per second

K_{sat} = saturated hydraulic conductivity

N = meaure of pore size distribution

NA = not applicable

Θ_r = residual water content

Θ_s = saturated water content

% vol = percent volume

TABLE 7
Acid Base Accounting (ABA) Results for Representative Tailings and Waste Rock Samples

Analyte	Units	TSPOIE-TSP01-60	TP1C-TSP02-120	TP3W-TSP07-144	WR09-TSP14-96	WR02N-TS09-96	WR05-TSP-132
Paste pH		7.4	7.8	7.4	7.7	8.5	7.8
Tot. S	%	0.49	0.17	0.16	1.28	10.8	3.11
Insol. S - LECO	%	0.10	0.02	0.03	0.19	1.37	0.34
SO_4 - S	%	0.38	0.16	0.13	1.10	9.40	2.78
HCL Insol S - LECO	%	<	<	0.01	0.02	0.03	<
HCL S - SO4 S	%	0.10	0.02	0.01	0.17	1.34	0.34
HNO_3 Insol. S- LECO	%	<	<	<	<	<	<
HNO_3 - Non-Ext. S	%	<	<	<	<	<	<
HNO_3 - Pyr. S	%	<	<	0.01	0.02	0.03	<
AGP Tot. S	$CaCO_3$ eq.	15.3	5.3	5.0	40.0	338	97.2
AGP InSol. S	$CaCO_3$ eq.	<	<	0.31	0.63	0.94	<
AGP Pyr. S	$CaCO_3$ eq.	<	<	0.3	0.6	0.9	<
ANP (Sid.?)	$CaCO_3$ eq.	37.2	61.0	431	47.1	59.0	93.2
NNP (Tot. S)	$CaCO_3$ eq.	21.9	55.7	426	7.10	-278.50	-3.99
NNP (Pyr. S)	$CaCO_3$ eq.	37.2	61.0	431	46.5	58.1	93.2
ANP/AGP-Tot. S		2.43	11.5	86	1.18	0.17	0.96
ANP/AGP-Pyr. S		> 10	> 10	1379	75.4	62.9	> 10

Notes:

Explanation of parameters and source of calculations: http://www.gardguide.com/index.php?title=Chapter_5b#5.4.10_Net_Acid_or_ARD_Potential

< = below detection

AGP - Tot. S = Acid Generation Potential from Total Sulfur. Total sulphur content is used to calculate AP is as follows: AP (kg CaCO3/tonne)[1] = 31.25 x Tot. S (%).

AGP - InSol. S = Acid Generation Potential from Insoluble Sulfur. Insoluble sulphur content is used to calculate AP is as follows: AP (kg CaCO3/tonne)[1] = 31.25 x HCL - LECO S (%).

AGP - Pyr. S = Acid Generation Potential. Pyritic sulphur content is used to calculate AP is as follows: AP (kg CaCO3/tonne)[1] = 31.25 x HNO3 S (%).

ANP (Sid.) = Acid neutralizing potential

ANP/AGP = ratio of ANP to AGP

eq. = equivalent tons of CaCO3 per kiloton rock

HCL S - LECO = HCL insoluble sulfur by LECO analysis

HCL S - SO4 S = HCL soluble sulfur

HNO3 - LECO = HNO3 insoluble sulfur by LECO analysis

HNO_3 - Non-Ext. S. = HNO3 non-extractable Sulfur

Insol. S - LECO = Hot water insoluble Sulfur by LECO analysis

NNP (Sid.) = Net neutralizing potential

pct. = weight percent

(Sid.) = siderite correction

SO_4 S = Sulfate Sulfur - Hot water extractable

Tot. S = total sulfur

Table 8
Organic Compound UCLM Concentrations in Tailings and Mill Site Soils Compared to RSLs

Organic Solute	RSL at DAF 1 mg/kg	RSL at DAF 20 mg/kg	Tailings 95% UCLM mg/kg	Mill site soil to Hydro Pit 95% UCLM mg/kg	Source strength based on 20:1 tailings to mill site soil ratio in Hydro Pit mg/kg
VOCs					
1,2,4-trimethylbenzene	0.081	1.62	**6.14**	0.00612	**5.83**
1,3,5-trimethylbenzene	0.087	1.74	1.36	0.00343	1.29
acetone	3.7	74	0.0659	2.81	0.203
benzene	0.00023	0.0046	**0.0149**	**0.00665**	**0.0145**
dichloromethane (methylene chloride)*	0.0029	0.058	0.0562	0.00882	0.054
ethylbenzene	0.0017	0.034	**0.342**	0.00124	**0.325**
naphthalene	0.00038	0.0076	**3.44**	**0.0174**	**3.26**
n-propylbenzene	1.2	24	0.798	0.0116	0.759
toluene	0.76	15.2	0.168	0.00279	0.160
xylenes (total)	0.19	3.8	1.95	0.00649	1.86
PAHs					
benzo(a)anthracene	0.011	0.22	**0.271**	**9.33**	**0.724**
benzo(a)pyrene	2.2	44	0.0871	4.21	0.293
benzo(b)fluoranthene	0.3	6	0.428	**29.5**	1.88
benzo(g,h,i)perylene	13	260	0.147	17.0	0.99
chrysene	9	180	0.675	15.6	1.42
dibenzo(a,h)anthracene	0.096	1.92	0.0248	**5.25**	0.286
indeno(1,2,3-cd)pyrene	0.98	19.6	0.112	18.7	1.04
phenanthrene	58	1160	3.29	8.02	3.53
pyrene	13	260	1.06	121	7.03

Notes:
USEPA Regional Screening Level (RSL) for risk-based soil screening level for protection of groundwater (TR=1E-06, HQ=0.1), May 2022.
* Kaplan Meier mean for tailings data because there were no detections
Surrogates used: pyrene for benzo(g,h,i)perylene, and anthracene for phenanthrene.
Bold indicates concentration exceeds RSL at DAF 20
Orange highlight indicates organic compound concentrations in backfill mixtures exceeding RSL at DAF 20
DAF = dilution attenuation factor
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
UCLM = upper confidence limit on the mean
VOCs = volatile organic compounds

Table 9
Model Input Parameters for Organic Constituents Exceeding RSLs at DAF 20

Organic Solute	RSL at DAF 20, mg/kg	Source strength based on 20:1 tailings to mill site soil ratio in Hydro Pit mg/kg	Formula Weight	log K_{ow}[1] Octanol Water	$Kd = K_{om} \bullet f_{oc}$[2]	Equilibrium Aqueous Concentration, mg/l	Gas Diffusivity square meters/day[3]	Water Diffusivity square meters/day[3]	1st Order Decay Rate 1/d[4,5,6]	Henry's Constant[3,4]
1,2,4-trimethylbenzene	1.62	5.83	120.2	3.8	628	9.29E-03	0.577	6.20E-05	0.498	0.27
benzene	0.0046	0.0145	78.1	2.13	1.92	7.54E-03	0.802	8.90E-05	0.00231	0.227
ethylbenzene	0.034	0.325	106.2	3.1	81.96	3.96E-03	0.652	7.11E-05	0.00231	0.322
naphthalene	0.0076	3.26	128.2	3.35	178.01	1.83E-02	0.597	6.90E-05	0.0534	0.0197
benzo(a)anthracene	0.22	0.724	228.3	5.61	30877	2.34E-05	0.412	4.53E-05	0.00011	0.00014

Notes:

RSL = Regional Screening Level times Dilution Attenuation Factor (DAF) equal to 20.

UCLM = upper confidence limit of mean (95th percentile)

K_{ow} = octanol water partition coefficient

K_{om} = organic matter partition coefficient

K_d = bulk partition coefficient

foc = fraction of organic matter

1/d = per day

Sources:

[1]Internationally Peer Reviewed Chemical Safety Information https://inchem.org/#/

[2]fraction organic/mineral matter used in calculation = 0.001

[3]EPA 2022b. EPA On-line Tools for Site Assessment Calculation. https://www3.epa.gov/ceampubl/learn2model/part-two/onsite

[4] 1,2,4-trimethylbenzene, published rate multiplied by 0.1; Höhener et al., 2003

[5] benzene, ethylbenzene, published rate multiplied by 0.1; Zanello et al., 2021

[6] naphthalene and benzo(a)anthracene, published rate multiplied by 0.1; Thiele-Bruhn and Brümmer 2005

Table 10
Data Quality Objectives Worksheet: Leaching Analysis and Modeling Inputs and Boundaries

Model Need	Model Inputs	Data Use in Model Development
Boundaries		
Top, Transient Atmospheric Boundary	Climate Data in Appendix A.	Used to Simulate Water Balance in Cover and Amount of Water if any Passing Root Zone and into Subgrade Waste.
Top, Constant Head (because of water detention pond liner on top of Hydro Pit backfill)	Assumed Constant Head of 0 meters in Hydro Pit Model with Simulated Impervious Cover.	Hydro Pit Simulations for Metals and Organics (Table 16a,b).
Top, Constant Flux Infiltration	Derive from Central Valley Simulation (CVS) with 72 Year Climate Simulation Output in Figure 12 and Table 17.	A-B and Hulin Pit Simulations with Planned Earthen Cover on Top of Backfill (Figure 8 and Table 18 Results).
Bottom Boundary Condition	Free Drainage Assumed at Base of Model in All Scenarios.	Base of CVS Simulation and Bottom of Pit Backfill.
Lateral, No Flow for 1D Vertical, Sloping for 2D	No Flow Boundaries in 1D Model, 2D Not Modeled.	Representative Profiles and Backfill Depths Provided in Figure 8.
Layer Types/Thicknesses	Yes, Backfill Grading and Covers, Conceptual Cross Sections in Figure 8. Depth to Groundwater from Analysis of Well Logs and Monitoring in Appendix B.	Model Layer Structure and Discretization. Assignment of Model Hydraulic and Geochemical Parameters. Determine Soil Suitability for Covers.
Faults	Not Modeled but Considered in Site Geology Analysis in Figures 2, 3, 6, 7, and 8 for Model Development and Boundaries.	Not Simulated.
Temporal, approximately 70 years predictive post remediation	Used Climate Data in Appendix A to Develop Simulation Time Boundary.	Period of Climate Record Long Enough to Capture Expected Future Variations in Predictive Model.
Hydraulic Parameters		
SWCC (van Genuchten)	DBS&A Hydraulic Testing Data Summarized in Tables 5 and 6 and in Appendix D.	Unsaturated Flow in Hydrus 1D and Initial Moisture Conditions.
Surface Infiltration, Daily Precipitation, and Fate and Transport	Daily Precipitation over 72 Year Period of Record input from McCarran Airport Climate Data in Appendix A. Simulated Infiltration in Central Valley Simulations using Root Uptake Model and Infiltration Results Presented in Table 17 for Conservative Transport Simulation.	Used to Estimate Long Term Average Infiltration and Residence Times of Constituent Transport to Groundwater.
Temperature	Geothermal Gradient Estimates and Groundwater Temperatures Used to Estimate Temperatures At Depth in Pits and at Base of CVS Model. Groundwater Temperatures (Zenitech, 2007) Indicate 30 degrees C at Base of CVS Model but had No effect on Geochemistry above 25 degree C Reference Thermodynamic Data.	Considered as Heats of Reaction in PhreeqcU thermodynamic database used in the HP1 model. Found to be not a Significant Effect over Model Depths Simulated.
Rooting Depth and Density	Rooting Depth Observed to be Approximately 3 ft or Deeper with Assumed linear rooting density. Root uptake simulated by S-Shape water stress factor in Hydrus 1D model. A P50 factor of 10 meters was used in All Root Uptake Models for CVS Simulations. No Solute Stress Assumed.	Representative Profiles and Backfill Depths Provided in Figure 8.

Table 10
Data Quality Objectives Worksheet: Leaching Analysis and Modeling Inputs and Boundaries

Model Need	Model Inputs	Data Use in Model Development
Chemical/Geochemical		
Wall Rock Geology and Geochemistry	Used to project Muddy Creek and Tsm Formation Subsurface Depths and Pit Bottom Substrate shown in Figure 8 that Receives Downward Migrating Leachate.	Identification of Contact Formations Model Boundaries and Hydraulic and Geochemical Properties.
Pre-Mining Geology and Mineralogy	Pre-mining Topography Used for Estimation of Central Valley Regrading Depths. Used USBM report Cross Sections to Determine Location of Tsm and Faults at Depth Along with Exploration Boreholes. Mineralogy Report of Van Glider 1963 Used to Determine Mineralogy of Site Materials along with XRD Report Summarized as Table 4 in Report and Appendix E.	Identification of Mine and Natural Geologic Material Properties to Use in Model from Laboratory Testing.
Mine Waste Leachate Pore Water Chemistry for Initial and Boundary Chemistry Conditions in Variably Saturated Materials.	Derived from MWMP Data Presented in Tables 2 and 3 and Appendix C.	Used to Estimate Geochemical Reactivity and Transport and Compare to Receiving Groundwater and Formation Porewater Below Backfill.
Thermodynamic Data	PhreeqcU database in HP1 Model (Simunek, et al., 2009 and Jacques and Šimůnek, 2005).	Used to Calculate Aqueous Species Geochemical Reactions and Solubility Limits of Constituents, pH and pe.
Kd, Partition Coefficient for Attenuation Simulation	Assumed Conservative transport in Central Valley Model to Evaluate Maximum Rates of Transport. Estimated Dissolved Concentrations in Contact Water using Partition Coefficients in Table 9. Use electrostatic Adsorption Model in HP1 to Simulate Sorption in Pit Backfill Simulations but used Conservative, Non-Attenuated Assumption in Central Valley.	Simulations to Estimate Maximum Possible Rates of Transport of Constituents and Residence Times to Groundwater Arrival.
Organic Compound Concentrations	Yes, for Organic Sources in Tailings and Mill site soil to be disposed in Hydro Pit, Listed in Table 8.	Potential for Leaching of Organics from Tailings with Diesel Range Organic Processing Residues. Found to be Highly Immobile.
Development Water Infrastructure and Surfaces	City of Henderson Water Infrastructure Maintenance Records and Leak Estimates in Appendix F.	Used to Estimate Potential for Infiltration to Backfill from Water Infrastructure but not Considered to be Significant and Accounted for by Conservative Assumptions in Model Input. Pavement and Roof Runoff Conveyance in Storm Drainage System will Reduce Incident Precipitation of Meteoric Water.

TABLE 11

Tailings Pond 1 Soil Composition Profile for Model Calibration

Boring ID	Depth (ft bgs)	Date	Arsenic (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Lithology
			>20.85[1]	>400[2]	>1800[2]	
			Lab	Lab	Lab	
TA-212-03	15	9/14/2021	364	4090	83700	tailings
TA-212-03	30	9/14/2021	435	4370	74700	tailings
TA-212-03	44	9/14/2021	773	11100	151000	tailings
TA-212-03	46	9/14/2021	1720	11200	25600	clay
TA-212-03	56	9/14/2021	1970	12800	31500	clay
TA-212-03	59	12/21/2021	12	31	2800	well-graded sand; alluvium?
TA-212-03	64	12/21/2021	17	2.9	430	gypsiferous siltstone; MCF
TA-212-03	69	12/21/2021	26	1.2	120	gypsiferous siltstone; MCF
TA-212-03	74	12/21/2021	73	32	320	gypsiferous siltstone; MCF
TA-212-03	79	12/21/2021	99	23	290	silty clay with interbedded gypsum; MCF
TA-212-03	84	12/21/2021	180	5.4	110	silty clay with interbedded gypsum; MCF
TA-212-03	89	12/21/2021	320	25	5.0	silt with interbedded gypsum; MCF
TA-212-03	90	12/21/2021				
TA-212-03	94	12/21/2021	36	0.54	17	gypsum rock; MCF
TA-212-03	99	12/21/2021	18	1.0	45	gypsum rock; MCF
TA-212-03	104	12/21/2021	42	5.5	91	gypsiferous siltstone
TA-212-03	109	12/21/2021	41	0.90	33	gypsum rock; MCF

Notes:

Soil boring samples collected in September 2021 (depths of 15 to 56 feet bgs) were analyzed for total metals at Pace National of Mount Juliet, Tennessee via EPA Method 6020A. Soil boring samples collected in December 2021 (depths of 59 to 109 feet bgs) were analyzed for total metals at Veritas Laboratories of Las Vegas, Nevada via EPA Method 6010B.

[1] Three Kids Mine Background Threshold Values (BTVs) for Metals associated with the Muddy Creek Formation. For parametric distributions, the BTV is the 95% Upper Tolerance Limit (UTL) with 95% coverage. UTLs computed usng ProUCL (version 5.1) with Kaplan-Meier estimation for data sets with non-detect results.
2 USEPA Regional Screening Level (RSL) for Residential Soil (TR=1E-06, HQ=1), November 2021.

ft bgs = feet below ground surface

mg/kg = milligram per kilogram

MCF = Muddy Creek Formation

Table 12
Model Sensitivity Simulation Matrix

	Base Case	Wetter Climate	Maximum MWMP	Minimum MWMP	Higher Initial Moisture	Lower Initial Moisture	Alluvium Cover	Older Alluvium Cover	Rock /Tailings Rock SWCC
Climate	**McCarran**	**Boulder City**	**McCarran**	**McCarran**	**McCarran**	**McCarran**	**McCarran**	**McCarran**	**McCarran**
CVS	Yes	Yes	-	-	-	-	-	-	-
Hydro Pit	NA	NA (no surface I)	-	-	-	-	-	-	-
A-B and Hulin Pit	same as CVS	Yes (same I as CVS)	-	-	-	-	-	-	-
MWMP Concentrations Tailings/Waste Rock	**Average**	**McCarran**	**Maximum**	**Minimum**	**Average**	**Average**	**Average**	**Average**	**Average**
CVS	Yes	-	NA	NA	-	-	-	-	-
Hydro Pit	Yes	-	Yes	Yes	-	-	-	-	-
A-B and Hulin Pit	Yes	-	Yes	Yes	-	-	-	-	-
Initial Moisture of Fill/Backfill	**~90 pct Proctor**	**~90 pct Proctor**	**~90 pct Proctor**	**~90 pct Proctor**	**~95 pct Proctor**	**~85 pct Proctor**	**~90 pct Proctor**	**~90 pct Proctor**	**~90 pct Proctor**
CVS	Yes	-	-	-	Yes	Yes	-	-	-
Hydro Pit	Yes	-	-	-	Yes	Yes	-	-	-
A-B and Hulin Pit	Yes	-	-	-	Yes	Yes	-	-	-
SWCC Cover (Backfill for Hydro for 3 Ratios Completed)	**DBS Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Older Alluvium Cover**	**Older Alluvium Cover**
CVS	Yes	-	-	-	-	-	Yes	Yes	-
Hydro Pit Backfill SWCC Input	50:50, 67:33, 90:10[1]	-	-	-	-	-	NA (no surface I)	NA (no surface I)	-
A-B and Hulin Pit	same as CVS	-	-	-	-	-	-	Yes (same I as CVS)	-
SWCC Fill Backfill (Backfill for Hydro for 3 Ratios Completed)	**DBS SWCC**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Alluvium Cover**	**Older Alluvium Cover**	**From Tables 5 and 6**
CVS	Yes	-	-	-	-	-	-	-	Yes (Waste Rock Fill)
Hydro Pit Backfill SWCC Input	50:50, 67:33, 90:10[1]	-	-	-	-	-	-	-	Yes (Tailings Backfill)
A-B and Hulin Pit	same as CVS	-	-	-	-	-	-	-	Yes (Waste Rock Backfill)

Notes:

MWMP = Meteoric Water Mobility Procedure

SWCC = Soil Water Characteristic Curve

NA = not applicable

I = infiltration

pct = percent

- Off diagonal of sensitivity input matrix

[1]Tailings to Waste Rock Mixtures

Table 13a
Hydro Pit Bottom Sensitivity Simulation Concentrations and Velocities at 70 Years

Tailing:Waste Rock Ratios	pH	pe	Mn, µg/l	As, µg/l	Fe, µg/l	Pb, µg/l	Velocity, in/yr	Notes[1]
Tsm MWMP (Table 4)		**NA**	**0.9**	**414**	**4.4**	**0.3**	**NA**	
NDEP Profile I	**6.5-8.5**	**NA**	**100**	**10**	**600**	**15**	**NA**	
Hydro Pit Sensitivity Simulations for Metals								
67:33 Avg MWMP #2	5.9	3.2	622	464	2.05E-05	0.28	0.006	67 percent tailings and 33 percent waste rock
50:50 Avg MWMP #3	5.9	3.1	622	468	2.09E-05	0.29	0.021	50 percent tailings and 50 percent waste rock
90:10 Max MWMP #4[2]	6.0	3.2	3137	960	1.70E-05	1.2	0.017	Mn concentration at rhodochrosite saturation
90:10 Min MWMP #5[2]	5.9	3.1	6.5	194	2.40E-05	0.10	0.017	
90:10 Proctor 95 MWMP #6[3]	5.9	3.1	626	450	1.93E-05	0.24	0.031	
90:10 Proctor 85 MWMP #7[3]	5.9	3.2	624	457	1.99E-05	0.26	0.011	
90:10 Alt Tail SWCC Avg MWMP #8[2]	6.0	14.9	541	440	1.83E-05	0.34	0.247	

Notes:
µg/l = micrograms per liter
NA = not applicable
NDEP = Nevada Division of Environmental Protection
MWMP = Meteoric Water Mobility Procedure
Avg = average
Max = maximum
Min = minimum
# = simulation number
[1]All solutions saturated with respect to gypsum, calcite, and goethite.
[2]Initial pressure head gradient set to attain the target moisture condition with respect to expected Proctor compaction target. For simulations 4, 5, and 8, the target moisture content is 90 percent of Proctor.
[3]Initial pressure head gradient set to attain the target moisture condition with respect to expected Proctor compaction target. For simulations 6 and 7, the target moisture content is 95 and 85 percent of Proctor, respectively.
NDEP Profile I: https://ndep.nv.gov/uploads/land-mining-regs-guidance-docs/20210830_NDEP_Profile1_List_ADA.pdf

Table 13b
Hydro Pit Bottom Sensitivity Simulation Organic Concentrations at 70 Years

Tailing:Waste Rock Ratios	1,2,4-Trimethylbenzene mg/l	Benzene mg/l	Ethylbenzene mg/l	Naphthalene mg/l	Benzo(a)anthracene mg/l	Velocity in/yr	Notes[1]
UCLM, mg/kg (Table 8)	**5.835**	**0.0145**	**0.3246**	**3.265**	**0.655**	**NA**	
Dissolved Concentration, mg/l (Table 9)	**0.00929**	**0.00754**	**0.00396**	**0.01834**	**0.00002**	**NA**	
Hydro Pit Sensitivity Simulations for Organics							
90:10, foc = 0.001, with 0.1X Table 9 Decay Rate #10	0.000000	0.000029	0.000015	0.000000	0.000000	0.0175	Concentrations all below EPA MCLs
90:10, foc = 0.001, with 10X Table 9 Decay Rate #11	0.000000	0.000000	0.000000	0.000000	0.000000	0.0175	Concentrations all below EPA MCLs
90:10, foc = 0.0001, with Table 9 Decay Rate #12	0.000000	0.000000	0.000000	0.000000	0.000000	0.0175	Concentrations all below EPA MCLs
90:10, foc = 0.01, with Table 9 Decay Rate #13	0.000000	0.000000	0.000000	0.000000	0.000000	0.0175	Concentrations all below EPA MCLs

Notes:

UCLM = upper confidence limit on the mean

mg/l = milligrams per liter

NA = not applicable

in/yr = inches per year

foc = fraction of organic matter

= simulation number

EPA = Environmental Protection Agency

MCL = Maximum Contaminant Level, https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

[1]Same hydrologic input and results as Hydro Pit metals base case simulation #1 for all organic sensitivity simulations

Table 14
Central Valley Fill Bottom Sensitivity Simulation Results at 72 Years

Central Valley Scenario 72 year Climate Simulation	Annual Average Precipitation, inches per year	Net Infiltration, inches per year	Net Infiltration, percent of mean precipitation	Increase in Conservative Concentration at Base of Waste Rock (Figure 8A), millimol per m^3	Increase in Conservative Concentration, As equivalent, µg/l	Travel Time to Groundwater, Years
Root Uptake, Alluvium Borrow TP Cover, Boulder City Climate #2	5.55	0.90	16.2%	1.00E-03	0.0749	678
Root Uptake, Old Alluvium Fan Deposit Cover, McCarran Climate #3	4.15	0.87	21.0%	1.00E-03	0.0749	701
Root Uptake, Old Alluvium Fan Deposit Cover, Boulder City Climate #4	5.55	0.70	16.9%	1.00E-03	0.0749	872
Root Uptake, Alluvium Borrow TP Cover, Alternative Waste Rock, McCarran Climate #5	4.15	0.80	19.3%	2.80E-03	0.2098	763
Root Uptake, Alluvium Borrow TP Cover, 100 Pct Proctor, McCarran Climate #6	4.15	0.73	17.6%	1.60E-01	12.0	836
Root Uptake, Alluvium Borrow TP Cover, 80 Pct Proctor, McCarran Climate #7	4.15	0.82	19.8%	1.00E-03	0.0749	744

Notes:

µg/l = micrograms per liter

= simulation number

Pct = percent

Table 15
A-B and Hulin Pit Bottom Sensitivity Concentrations and Velocities at 70 Years

Tailing:Waste Rock Ratios	pH	pe	Mn, µg/l	As, µg/l	Fe, µg/l	Pb, µg/l	Velocity, in/yr	Notes[1]
Tsm MWMP (Table 4)		**NA**	**0.9**	**414**	**4.4**	**0.3**	**NA**	
NDEP Profile I	**6.5-8.5**	**NA**	**100**	**10**	**600**	**15**	**NA**	
A-B and Hulin Backfill Simulations								
0:100 for A-B Hulin Pits Max MWMP #2	6.5	3.0	1648	2059	6.29E-06	5.6	0.012	Mn concentration at rhodochrosite saturation
0:100 for A-B Hulin Pits Min MWMP #3	6.1	2.8	0.52	81.7	1.39E-05	1.2	0.012	
0:100 for A-B and Hulin Pit Proctor 85 Avg MWMP #4	6.2	3.1	63.1	548	1.09E-05	1.8	0.011	
0:100 for A-B and Hulin Pit Proctor 95 Avg MWMP #5	6.2	2.9	62.9	547	1.09E-05	1.8	0.013	
0:100 for A-B and Hulin Pits Avg MWMP Boulder City Climate #6	6.2	3.1	63.0	548	1.09E-05	1.8	0.012	
0:100 for A-B and Hulin Pits Avg MWMP alternative SWCC #7	6.1	3.6	86.8	604	1.24E-05	2.9	0.002	

Notes:
MWMP = Meteoric Water Mobility Procedure
NDEP = Nevada Division of Environmental Protection
µg/l = micrograms per liter
NA = not applicable
[1]All solutions saturated with respect to gypsum, calcite, and goethite.
yr = year
in = inches
Avg = average
Max = maximum
Min = minimum
# = simulation number
NDEP Profile I: https://ndep.nv.gov/uploads/land-mining-regs-guidance-docs/20210830_NDEP_Profile1_List_ADA.pdf

Table 16a

Hydro Pit Bottom Base Case Simulation Concentrations and Velocity at 70 years

Tailing:Waste Rock Ratio	pH	pe	Mn, µg/l	As, µg/l	Fe, µg/l	Pb, µg/l	Velocity, in/yr	Notes[1]
Tsm MWMP (Table 4)		**NA**	**0.9**	**414**	**4.4**	**0.3**	**NA**	
NDEP Profile I	**6.5-8.5**	**NA**	**100**	**10**	**600**	**15**	**NA**	
Hydro Pit Backfill Mixture Simulation								
90:10 Avg MWMP #1	5.9	3.2	625	454	1.96E-05	0.25	0.017	90 percent tailings and 10 percent waste rock

Notes:

µg/l = micrograms per liter

NA = not applicable

MWMP = Meteoric Water Mobility Procedure

NDEP = Nevada Division of Environmental Protection

[1]All solutions saturated with respect to gypsum, calcite, and goethite.

= simulation number

NDEP Profile I: https://ndep.nv.gov/uploads/land-mining-regs-guidance-docs/20210830_NDEP_Profile1_List_ADA.pdf

Table 16b
Hydro Pit Bottom Base Case Simulation Organic Concentrations at 70 Years

Tailing:Waste Rock Ratio	1,2,4-Trimethylbenzene mg/l	Benzene mg/l	Ethylbenzene mg/l	Naphthalene mg/l	Benzo(a)anthracene mg/l	Velocity in/yr	Notes
UCLM, mg/kg (Table 8)	**5.835**	**0.0145**	**0.3246**	**3.265**	**0.655**	**NA**	
Dissolved Concentration, mg/l (Table 9)	**0.00929**	**0.00754**	**0.00396**	**0.01834**	**0.00002**	**NA**	
Hydro Pit Backfill Base Case Simulations							
90:10, foc = 0.001, with Table 9 Decay Rate # 9	0.000000	0.000000	0.000000	0.000000	0.000000	0.0175	Same hydrologic input and results as Hydro Pit metals base case simulation #1 with 5 percent Mill Site Soil. Concentrations all below EPA MCLs

Notes:
UCLM = upper confidence limit on the mean
mg/l = milligrams per liter
NA = not applicable
in/yr = inches per year
foc = fraction of organic matter
EPA = U.S. Environmental Protection Agency
MCL = maximum contaminant level
# = simulation number

Table 17
Central Valley Fill Bottom Base Case Simulation Results at 72 Years

Central Valley Scenario 72 year Climate Simulation	Net Infiltration inches per year	Net Infiltration percent of mean precipitation	Increase in Conservative Concentration at Base of Waste Rock millimol per m^3	Increase in Conservative Concentration, As equivalent µg/l	Travel Time to Groundwater, Years	Notes
Root Uptake with Alluvium Borrow TP Cover McCarran Climate #1	0.80	19.3%	1.00E-03	0.0749	763	Travel time calculation assumes water content of 10 percent

Notes:

m^3 = cubic meters

µg/l = micrograms per liter

= simulation number

Table 18
A-B and Hulin Base Case Pit Bottom Concentrations and Velocity at 70 Years

Tailing:Waste Rock Ratios	pH	pe	Mn, µg/l	As, µg/l	Fe, µg/l	Pb, µg/l	Velocity, in/yr	Notes[1]
Tsm MWMP (Table 4)		**NA**	**0.9**	**414**	**4.4**	**0.3**	**NA**	
NDEP Profile I	**6.5-8.5**	**NA**	**100**	**10**	**600**	**15**	**NA**	
A-B and Hulin Backfill Simulation								
0:100 for A-B and Hulin Pits Average MWMP #1	6.2	3.1	63.0	548	1.09E-05	1.8	0.012	0 percent tailings and 100 percent waste rock

Notes:

MWMP = Meteoric Water Mobility Procedure

NDEP = Nevada Division of Environmental Protection

µg/l = micrograms per liter

NA = not applicable

[1]All solutions saturated with respect to gypsum, calcite, and goethite.

= simulation number

NDEP Profile I: https://ndep.nv.gov/uploads/land-mining-regs-guidance-docs/20210830_NDEP_Profile1_List_ADA.pdf

APPENDICES

APPENDIX A

McCarran Airport Climate Data
(submitted electronically)

APPENDIX B

Site Well Logs

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

STATE OF NEVADA
DIVISION OF WATER RESOURCES

WELL DRILLER'S REPORT

Please complete this form in its entirety

PRINT OR TYPE ONLY

OFFICE USE ONLY
Log No. 35212
Permit No. 55268
Basin 212

NOTICE OF INTENT NO. 5222

1. OWNER Three Kids Partnership
MAILING ADDRESS 3624 Goldfield St.
N. Las Vegas, Nev. 89030

ADDRESS AT WELL LOCATION

2. LOCATION lot 3 1/4 1/4 Sec. 26 T. 21 N/S R. 63 E Clark County
PERMIT NO. 55268 Issued by Water Resources | Parcel No. | Subdivision Name

3. TYPE OF WORK
New Well ☒ Recondition ☐
Deepen ☐ Other ☐

4. PROPOSED USE
Domestic ☐ Irrigation ☐ Test ☒
Municipal ☐ Industrial ☐ Stock ☐

5. TYPE WELL
Cable ☐ Rotary ☒
Other ☐

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Sandy black volcanic rock		0	47	47
brown hard silty clay		47	85	38
gray sandstone & black silty mixture		85	152	67
sand, gravel, clay conglomerate		152	230	78
yellow clay sand gravel		230	260	30
cemented gravel		260	293	45
red clay sand & gravel		293	315	22
yellow " " "		315	325	10
balck cemented rock		325	435	110
gravel conglomerate		435	690	255
cemented conglomerate	720	690	720	30
yellow sandstone		720	735	15
cemented green brittle stone	770	735	827	92
green stone & quartz-type	825	827	835	8
stone	866	835	860	25
red sandstone	970	860	1005	145
green brittle stone	1010	1005	1100	95

Date started Jan. 2, 1991
Date completed Jan. 30, 1991

7. WELL TEST DATA

Pump RPM	G.P.M.	Draw Down	After Hours Pump

RECEIVED
FEB 12 1991
Div. of Water Resources
Branch Office - Las Vegas, NV

BAILER TEST
G.P.M. .... Draw down .... feet .... hours
G.P.M. .... Draw down .... feet .... hours
G.P.M. .... Draw down .... feet .... hours

8. WELL CONSTRUCTION
Diameter 10 inches Total depth 1100 feet
.... inches
.... inches
Casing record
Weight per foot .... Thickness ....

Diameter	From	To
inches	feet	feet
inches	feet	feet
inches	feet	feet
inches	feet	feet
inches	feet	feet
inches	feet	feet

Surface seal: Yes ☐ No ☐ Type ....
Depth of seal .... feet
Gravel packed: Yes ☐ No ☐
Gravel packed from .... feet to .... feet

Perforations:
Type perforation ....
Size perforation ....
From .... feet to .... feet
From .... feet to .... feet
From .... feet to .... feet
From .... feet to .... feet
From .... feet to .... feet

9. WATER LEVEL
Static water level .... feet below land surface
Flow .... G.P.M. .... P.S.I.
Water temperature .... °F Quality ....

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Allen Drilling, Inc.
Contractor
Address 4847 So. Valley View Blvd.
Contractor
Nevada contractor's license number issued by the State Contractor's Board 0018917
Nevada contractor's driller's number issued by the Division of Water Resources 1301
Nevada driller's license number issued by the Division of Water Resources, the on-site driller 1661
Signed [signature]
By driller performing actual drilling on site or contractor
Date 2-8-91

WHITE—DIVISION OF WATER RESOURCES
CANARY—CLIENT'S COPY
PINK—WELL DRILLER'S COPY

PRINT OR TYPE ONLY
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STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

OFFICE USE ONLY
Log No. 82441
Permit No. 66108
Basin 212

NOTICE OF INTENT NO. 21635

1. OWNER PAUL ADDI/DAVID GROSSHEIM
MAILING ADDRESS 2319 E. LAKE MEAD DR.
HENDERSON, NV 89014

ADDRESS AT WELL LOCATION 2310 Lake Mead Dr. Henderson

2. LOCATION NE ¼ NW ¼ Sec. 35 T 21 N/S R 63 E CLARK County
PERMIT NO. 66108 (Issued by Water Resources) 160-35-101-004 (Parcel No.) Subdivision Name

3. WORK PERFORMED
☒ New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Abandon ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test ☒ Municipal/Industrial ☐ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☒ Rotary ☐ RVC ☒ Air ☐ Other

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
LOOSE GRAVEL		0	15	15
RED CLAY		15	40	25
CEMENTED GRAVEL		40	390	350
RED CLAY		390	410	20
LIMESTONE		410	470	60
RED CLAY		470	480	10
CEMENTED GRAVEL	X	480	520	40
LIMESTONE	X	520	600	80

MAR 14 2001

Date started 2/8/01, XX
Date completed 2/13/01, XX

7. WELL TEST DATA

TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)

8. WELL CONSTRUCTION

Depth Drilled 600 Feet Depth Cased 600 Feet

HOLE DIAMETER (BIT SIZE)

Inches	From (Feet)	To (Feet)
11	0	600

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
6 5/8	12.9	.188	+1	600

Perforations:
Type perforation SAW
Size perforation 1/8 X 3 6 ROWS
From 520 feet to 580 feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

Surface Seal: ☒ Yes ☐ No
Depth of Seal 50
Placement Method: ☐ Pumped ☒ Poured
Seal Type: ☐ Neat Cement ☐ Cement Grout ☒ Concrete Grout

Gravel Packed: ☒ Yes ☐ No
From 50 feet to 600 feet

9. WATER LEVEL
Static water level 160 feet below land surface
Artesian flow G.P.M. P.S.I.
Water temperature °F Quality

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.

Name WATER WELL SERVICES (Contractor)
Address 6475 GARY AVE. (Contractor)
LAS VEGAS, NV 89139

Nevada contractor's license number issued by the State Contractor's Board 22311B

Nevada driller's license number issued by the Division of Water Resources, the on-site driller 1594

Signed [signature] By driller performing actual drilling on site or contractor

Date 2/20/01

(Rev. 3-91) USE ADDITIONAL SHEETS IF NECESSARY (O)-627

STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

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Basin

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Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

NOTICE OF INTENT NO. 33613

1. OWNER Clark County
MAILING ADDRESS 500 S. Grand Central Pkwy
Las Vegas, NV 89115

ADDRESS AT WELL LOCATION
Subdivision Name: County: Clark

2. LOCATION NW ¼ NW ¼ Sec 35 T 21S N/S R 63 E
PERMIT/WAIVER No. 160-35-199-002 (Parcel No.)
Issued by Water Resources

Latitude 36.08542 Longitude -114.9211
UTM E 851966.03 N 26737087.85 ☐ NAD 27 ☒ NAD 83/WGS 84

3. WORKED PERFORMED
☒ New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Irrigation ☐ Test ☐ Municipal/Industrial ☒ Monitor ☐ Stock

5. WELL TYPE
☐ Cable ☐ Rotary ☐ RVC ☐ Air ☒ Other core

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
Sand		0	8	8
Silty Gypsum-white to pale yellow brown, very fine to fine grained, extremely weak		8	16	8
Sandstone/siltstone-very fine to fine grained, weak mod weathered		16	25	9
Silty Gypsum-lt brown to gray some fine grained sand, weak		25	41	16
Sandstone/siltstone-pale brn. weak, fine grained		41	53	12
Gypsum-silty, lt brown to gray mod weak to strong, sand		53	111	58
Siltstone-lt brownish gray, weak		111	116	5
gypsum-lt yellowish gray to pale olive, mod strong,		116	121	5
Siltstone/gypsum-olive gray, weak, some silt/sand		121	141	20
Siltstone-weak, very fine to fine,		141	208	67
Sandstone/siltstone- lt brown to med brown, fine to med. grain weak, some clay		208	219	11
Dacite-pale greenish yellow to pale orange, weak, porous		219	270	51

Date started: 25-Mar, 20 2008
Date completed: 4-Apr, 20 2008

7. *Water Level*
Static water level: n/a feet below land surface
Artesian Flow: G.P.M. P.S.I.
Water Temperature: °F
Quality:

8. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)

9. *WELL CONSTRUCTION*
Depth Drilled 270 Feet Depth Cased Feet

HOLE DIAMETER (BIT SIZE)

Inches	From (Feet)	To (Feet)
6	0	270

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
1.5"		Sch. 40	0	253

Perforations:
Type of perforation Slotted PVC
Size of perforation 10-slot
From 253 feet to 270 feet

Annular Seal: ☒ Yes ☐ No
☐ Neat Cement to ☐ Pumped ☐ Poured
☒ Cement Grout 0 to 250 ☐ Pumped ☒ Poured
☐ Concrete Grout to ☐ Pumped ☐ Poured
☐ ≥30% Bentonite Grout to ☐ Pumped ☐ Poured
Gravel Pack: ☒ Yes ☐ No 253 to 270 ☐ Pumped ☒ Poured
Type: 10 – 20
Bentonite Chips: ☒ Yes ☐ No 250 to 253 ☐ Pumped ☒ Poured
Type:

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Crux Subsurface, Inc. (Contractor)
Address 16707 E. Euclid Ave., Spokane Valley, WA 99216 (Contractor)

Nevada contractor's license number issued by the *State Contractor's Board* 0060707
Nevada driller's license number issued by the Division of Water Resources, the *on-site driller* m-2314

Signed [signature]
By driller performing actual drilling on site or contractor
Date 2/24/2010

USE ADDITIONAL SHEETS IF NECESSARY

(Rev 08-00)

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STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S REPORT

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NOTICE OF INTENT NO. 33614

1. OWNER USA - US Government
MAILING ADDRESS Washington, DC

ADDRESS AT WELL LOCATION
Subdivision Name: County: Clark

2. LOCATION SW ¼ NE ¼ Sec 34 T 21S N/S R 63 E
PERMIT/WAIVER No. (Issued by Water Resources) 160-35-101-008 Parcel No.

Latitude 36.08169 Longitude -114.92749
UTM E 8500073.62 ☐ NAD 27
N 26735717.82 ☒ NAD 83/WGS 84

3. WORKED PERFORMED
☒ New Well ☐ Replace ☐ Recondition ☐ Deepen ☐ Other

4. PROPOSED USE
☐ Domestic ☐ Municipal/Industrial ☐ Irrigation ☒ Monitor ☐ Test ☐ Stock

5. WELL TYPE
☐ Cable ☐ Air ☐ Rotary ☒ Other ☐ RVC core

6. LITHOLOGIC LOG

Material	Water Strata	From	To	Thickness
sand		0	4	4'
Claystone-reddish orange to reddish brown, very fine to med very weak, slightly weathered		4	12	8
Sandstone- reddish orange, fresh very weak to fiable, silt to sand		12	13	1
Congomerate-med brown, fine to coarse grained, very weak		13	90	77
Claystone/sandstone-reddish orange to reddish brown, fresh very weak, low hardiness		90	159	69
Siltstone/sandstone-brown/gray		159	167	8
Siltstone-pale brown		167	181	14
Sandstone-pale reddish brown		181	186	5
Siltstone-reddish brown/gray		186	191	5
Siltsone-gray, light and porous		191	200	9
Sandstone-pale reddish brown		200	206	6
Siltstone/Claystone- reddish		206	223	17
Sandstone-pale brown		223	229	6
Claystone/Siltstone-reddish brn		229	236	7
Siltstone/sandstone-lt brown		236	281	45
Siltstone-lt gray, porous		281	291	10
Claystone/sandstone- reddish orange to reddish brown,		291	402	111
Siltstone-reddish brown, thinly embedded gypsum		402	411	9

Date started: 6-Apr, 20 2008
Date completed: 9-Apr, 20 2008

9. WELL CONSTRUCTION
Depth Drilled 408 Feet Depth Cased Feet

HOLE DIAMETER (BIT SIZE)

		From		To	
6	Inches	0	Feet	411	Feet
	Inches		Feet		Feet
	Inches		Feet		Feet

CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
1.5"		Sch. 40	0	390

Perforations:
Type of perforation Slotted PVC
Size of perforation 10-slot
From 390 feet to 411 feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

Annular Seal: ☒ Yes ☐ No
☐ Neat Cement to ☐ Pumped ☐ Poured
☒ Cement Grout 0 to 383 ☒ Pumped ☐ Poured
☐ Concrete Grout to ☐ Pumped ☐ Poured
☐ ≥30% Bentonite Grout to ☐ Pumped ☐ Poured
Gravel Pack: ☒ Yes ☐ No 390 to 411 ☐ Pumped ☒ Poured
Type: 10 – 20
Bentonite Chips: ☒ Yes ☐ No 383 to 390 ☐ Pumped ☒ Poured
Type:

7. *Water Level*
Static water level: n/a feet below land surface
Artesian Flow: G.P.M. P.S.I.
Water Temperature: °F
Quality:

8. WELL TEST DATA
TEST METHOD: ☐ Bailer ☐ Pump ☐ Air Lift

G.P.M.	Draw Down (Feet Below Static)	Time (Hours)

10. DRILLER'S CERTIFICATION
This well was drilled under my supervision and the report is true to the best of my knowledge.
Name Crux Subsurface, Inc (Contractor)
Address 16707 E. Euclid Ave., Spokane Valley, WA 99216 (Contractor)

Nevada contractor's license number issued by the State Contractor's Board 0060707
Nevada driller's license number issued by the Division of Water Resources, the on-site driller m-2314

Signed [signature]
by driller performing actual drilling on site or contractor
Date 2/24/2010

USE ADDITIONAL SHEETS IF NECESSARY

(Rev. 8-00)

STATE OF NEVADA
DIVISION OF WATER RESOURCES
WELL DRILLER'S PLUGGING REPORT

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Permit No.
Basin

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Please complete this form in its entirety in accordance with NRS 534.170 and NAC 534.340

NOTICE OF INTENT NO. 35298

1 OWNER U.S.A.
MAILING ADDRESS Washington DC

ADDRESS AT WELL LOCATION Henderson
RMT3-125
Subdivision Name: *County:* Clark

2 LOCATION NW ¼ NW ¼ Sec 35 T 21S *N/S* R 63 *E*
PERMIT/WAIVER No. 160-35-101-008
Issued by Water Resources *Parcel No.*

Latitude 36.05568 UTM E ☐ NAD 27
Longitude 114.56575 N ☒ NAD 83/WGS 84

3 TYPE OF WELL
☐ Domestic ☐ Irrigation ☐ Test
☐ Municipal/Industrial ☒ Monitor ☐ Stock

Is this well being plugged because a replacement well was drilled? No
If yes, what is replacement well NOI?

Is there an existing well log? No
If yes, what is NDWR well log #?

4 *EXISTING WELL CONSTRUCTION*
Depth Drilled N/A Feet Depth Cased 408 Feet

EXISTING CASING SCHEDULE

Size O.D. (Inches)	Weight/Ft. (Pounds)	Wall Thickness (Inches)	From (Feet)	To (Feet)
1.900		Sch 40	0	408

Existing Perforations:
Type of perforation N/A
Size of perforation
From feet to feet
From feet to feet
From feet to feet
From feet to feet
From feet to feet

5 *WATER LEVEL*
Static water level 81.1 feet below land surface
Artesian flow G.P.M. P.S.I
Water temperature °F Quality

6 Additional Notes or Comments

Pressure grout well, drilled out upper 5' concrete cap.

RECEIVED
MAY 1 1 2010
LAS VEGAS OFFICE

7 WELL PLUGGING PROCEDURE
Was well cleaned out to total depth? ☒ yes ☐ no
If well was not cleaned out to total depth, please explain why:

Was the well contaminated? ☐ yes ☒ no
Was the casing pulled? ☐ yes ☒ no
Was the casing over drilled? ☒ yes ☐ no
If casing was left in place, please show where additional perforations were made:
Additional Perforations:
Type of perforater used: n/a
From feet to feet Number of perfs per linear foot
From feet to feet Number of perfs per linear foot
From feet to feet Number of perfs per linear foot
From feet to feet Number of perfs per linear foot
From feet to feet Number of perfs per linear foot
From feet to feet Number of perfs per linear foot

8 WELL PLUGGING MATERIALS

From	feet to	Material Used	Pumped	Poured
1	408	Bentonite Grout	☒	☐
0	1	Concrete	☐	☒
			☐	☐
			☐	☐
			☐	☐
			☐	☐

Neat Cement Fluid Weight lbs/gal
Bentonite Grout 20 % bentonite
Date Started 5/5/2010
Date Completed 5/5/2010

9 DRILLER'S CERTIFICATION
This well was plugged and abandoned under my supervision and the report is true to the best of my knowledge.
Name WDC Exploration & Wells
Contractor
Address 570 Corinthian Way
Contractor
N. Las Vegas, NV, 89030
Nevada contractor's license number issued by the *State Contractor's Board* 0012852
Nevada driller's license number issued by the Division of Water Resources, the on-site driller M-2381
Signed [signature]
By driller performing actual drilling on site or contractor
Date 5-10-10

(Rev. 05-06)

USE ADDITIONAL SHEETS IF NECESSARY

APPENDIX C

Pace Laboratory Meteoric Water Mobility Procedure Reports
(submitted electronically)

APPENDIX D

DBS&A Laboratory Reports on Site Material Hydraulic Properties

Laboratory Report for
Broadbent

3 Kids Mine, 14-01-156

May 18, 2021

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

May 18, 2021

Victoria Tyson-Bloyd
Broadbent
8 W Pacific Ave.
Henderson, NV 89015
(702) 563.0600

Re: DBS&A Laboratory Report for the Broadbent 3 Kids Mine, 14-01-156 Project

Dear Ms. Tyson-Bloyd:

Enclosed is the report for the Broadbent 3 Kids Mine, 14-01-156 project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Broadbent and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines
Laboratory Manager

Enclosure

Daniel B. Stephens & Associates, Inc.
Soil Testing & Research Laboratory
4400 Alameda Blvd. NE, Suite C
Albuquerque, NM 87113
505-889-7752
FAX 505-889-0258

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
33/67 Blend (95%)	X	X					X	X		X	X			X								
50/50 Blend (95%)	X	X					X	X		X	X			X								
67/33 Blend (95%)	X	X					X	X		X	X			X								

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
Three total samples were received between March 12, 2021 and March 15, 2021. Each sample was received in two full 5-gallon buckets sealed with lids and tape, and all were received in good order.

Sample Preparation and Testing Notes:
A portion of each sample was remolded into a testing ring to target 95% of the respective maximum dry bulk density at the respective optimum moisture content, based on client provided modified proctor compaction testing results. Each of these remolded sub-samples was subjected to initial properties analysis, saturation, and the hanging column and pressure chamber portions of the moisture retention testing. Secondary sub-samples were also prepared, using the same target remold parameters. The secondary sub-samples were then extruded from the testing ring and subjected to saturated hydraulic conductivity testing via the flexible wall method. The actual percentage of maximum dry bulk density achieved was added to each sub-sample ID. Separate sub-samples were obtained for the heat dissipation sensor, dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

Material larger than 3/8” was removed from the bulk material prior to remolding the sub-samples. Oversize correction calculations are provided based on the client provided particle size analysis and specific gravity test results.

Summary of Oversize Corrected Sample Preparation and Volume Changes

	Modified Proctor Compaction Data		Target Remold Parameters[1]			Actual Remold Data Oversize Corrected[2]			Volume Change Post Saturation[3]			Volume Change Post Drying Curve[3]		
	Optimum Moisture Content	Max. Dry Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density
Sample Number	(%, g/g)	(pcf)	(%, g/g)	(pcf)	(%)	(%, g/g)	(pcf)	(%)	(pcf)	(%)	(%)	(pcf)	(%)	(%)
33/67 Blend (95%)	11.1	118.1	11.1	112.20	95%	11.7	112.3	95.1%	109.5	+2.9%	92.7%	109.0	+3.5%	92.3%
50/50 Blend (95%)	13.9	114.7	13.9	108.97	95%	14.7	108.7	94.8%	106.3	+2.6%	92.7%	106.3	+2.6%	92.7%
67/33 Blend (95%)	14.6	112.8	14.6	107.16	95%	14.6	107.4	95.2%	106.1	+1.4%	94.0%	106.1	+1.4%	94.0%

[1]Target Remold Parameters: 95% of the respective maximum dry bulk density at the respective optimum moisture content, based on modified proctor compaction testing results provided by the requestor.

[2]Actual Remold Data: The actual density and moisture content achieved, oversize corrected based on the client provided particle size analysis and specific gravity test results.

[3]Volume Change Post Saturation and Post Drying Curve: Volume change measurements were obtained after saturated hydraulic conductivity testing, and throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point. The dry bulk densities are oversize corrected to represent the bulk sample.

Notes: "+" indicates sample swelling, "-" indicates sample settling, "---" indicates no volume change occurred, and "NA" indicates not applicable.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	As Remolded Moisture Content: Test Sample Gravimetric (%, g/g)	As Remolded Moisture Content: Test Sample Volumetric (%, cm^3/cm^3)	As Remolded Moisture Content: Oversize Corrected Gravimetric (%, g/g)	As Remolded Moisture Content: Oversize Corrected Volumetric (%, cm^3/cm^3)	Dry Bulk Density: Test Sample (pcf)	Dry Bulk Density: Oversize Corrected (pcf)	Calculated Porosity: Test Sample (%)	Calculated Porosity: Oversize Corrected (%)
33/67 Blend (95%)	14.1	24.5	11.7	20.4	108.3	112.3	34.5	26.3
50/50 Blend (95%)	17.0	28.5	14.7	24.5	104.3	108.7	36.9	33.1
67/33 Blend (95%)	16.5	27.5	14.6	24.5	104.3	107.4	36.9	32.9

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head Flexible Wall	Method of Analysis: Falling Head Flexible Wall
33/67 Blend (95%)	2.1E-06	1.7E-06		X
50/50 Blend (95%)	1.2E-06	1.0E-06		X
67/33 Blend (95%)	2.6E-07	2.2E-07		X

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
33/67 Blend (95%)	0	38.9 ‡‡
	25	39.2 ‡‡
	76	39.1 ‡‡
	154	39.1 ‡‡
	337	36.1 ‡‡
	3045	22.4 ‡‡
	206306	10.1 ‡‡
	555485	7.7 ‡‡
	848426	8.0 ‡‡
50/50 Blend (95%)	0	40.5 ‡‡
	25	40.4 ‡‡
	76	40.2 ‡‡
	154	39.8 ‡‡
	337	37.4 ‡‡
	1523	26.3 ‡‡
	233126	8.9 ‡‡
	611574	6.8 ‡‡
	848426	7.2 ‡‡
67/33 Blend (95%)	0	39.1 ‡‡
	59	39.0 ‡‡
	154	38.9 ‡‡
	337	37.8 ‡‡
	2120	27.0 ‡‡
	230373	9.1 ‡‡
	560380	7.0 ‡‡
	848426	7.3 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
33/67 Blend (95%)	0.0015	1.4528	6.82	39.40	5.90	34.03
50/50 Blend (95%)	0.0015	1.5480	6.64	40.64	5.97	36.52
67/33 Blend (95%)	0.0010	1.4719	5.91	39.37	5.42	36.11

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	As Remolded Moisture Content: Test Sample: Gravimetric (%, g/g)	As Remolded Moisture Content: Test Sample: Volumetric (%, cm^3/cm^3)	As Remolded Moisture Content: Oversize Corrected: Gravimetric (%, g/g)	As Remolded Moisture Content: Oversize Corrected: Volumetric (%, cm^3/cm^3)	Dry Bulk Density: Test Sample (pcf)	Dry Bulk Density: Oversize Corrected (pcf)	Calculated Porosity: Test Sample (%)	Calculated Porosity: Oversize Corrected (%)
33/67 Blend (95%)	14.1	24.5	11.7	20.4	108.3	112.3	34.5	26.3
50/50 Blend (95%)	17.0	28.5	14.7	24.5	104.3	108.7	36.9	33.1
67/33 Blend (95%)	16.5	27.5	14.6	24.5	104.3	107.4	36.9	32.9

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 33/67 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

	As Received	Remolded
Test Date:	NA	23-Mar-21
Field weight of sample* (g):		828.01
Tare weight, ring (g):		212.60
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		539.16
Sample volume (cm^3):		310.79
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		14.1
Volumetric Moisture Content (% vol):		24.5
Dry bulk density (g/cm^3):		1.73
Wet bulk density (g/cm^3):		1.98
Calculated Porosity (% vol):		34.5
Percent Saturation:		71.0

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.00
Sample Number:	50/50 Blend (95%)
Project:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	23-Mar-21
Field weight of sample* (g):		829.30
Tare weight, ring (g):		213.42
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		526.19
Sample volume (cm^3):		314.91
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		17.0
Volumetric Moisture Content (% vol):		28.5
Dry bulk density (g/cm^3):		1.67
Wet bulk density (g/cm^3):		1.96
Calculated Porosity (% vol):		36.9
Percent Saturation:		77.1

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 67/33 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

	As Received	Remolded
Test Date:	NA	23-Mar-21
Field weight of sample* (g):		827.24
Tare weight, ring (g):		215.26
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		525.51
Sample volume (cm^3):		314.40
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		16.5
Volumetric Moisture Content (% vol):		27.5
Dry bulk density (g/cm^3):		1.67
Wet bulk density (g/cm^3):		1.95
Calculated Porosity (% vol):		36.9
Percent Saturation:		74.5

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Saturated Hydraulic Conductivity

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head Flexible Wall	Method of Analysis: Falling Head Flexible Wall
33/67 Blend (95%)	2.1E-06	1.7E-06		X
50/50 Blend (95%)	1.2E-06	1.0E-06		X
67/33 Blend (95%)	2.6E-07	2.2E-07		X

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 33/67 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	615.49
Diameter (cm):	7.316
Length (cm):	7.389
Area (cm^2):	42.04
Volume (cm^3):	310.62
Dry Density (g/cm^3):	1.74
Dry Density (pcf):	108.7
Water Content (%, g/g):	13.8
Water Content (%, vol):	24.0
Void Ratio (e):	0.44
Porosity (%, vol):	30.3
Saturation (%):	79.0

Post Permeation Sample Properties

Saturated Mass (g):	683.62
Dry Mass (g):	541.02
Diameter (cm):	7.414
Length (cm):	7.390
*Deformation (%)**:*	0.01
Area (cm^2):	43.17
Volume (cm^3):	319.04
Dry Density (g/cm^3):	1.70
Dry Density (pcf):	105.9
Water Content (%, g/g):	26.4
Water Content (%, vol):	44.7
Void Ratio(e):	0.47
Porosity (%, vol):	32.2
Saturation (%):*	138.9

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	5
Split:	3/8"
Percent Coarse Material (%):	17
Particle Density(g/cm^3):	2.5 ☑ Provided ☐ Measured
Cell pressure (PSI):	82.0
Influent pressure (PSI):	80.1
Effluent pressure (PSI):	80.0
Panel Used:	☑ D ☐ E ☐ F
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.98	3/26/21 705
B-Value (% saturation) post to test:	1.00	3/27/21 850

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

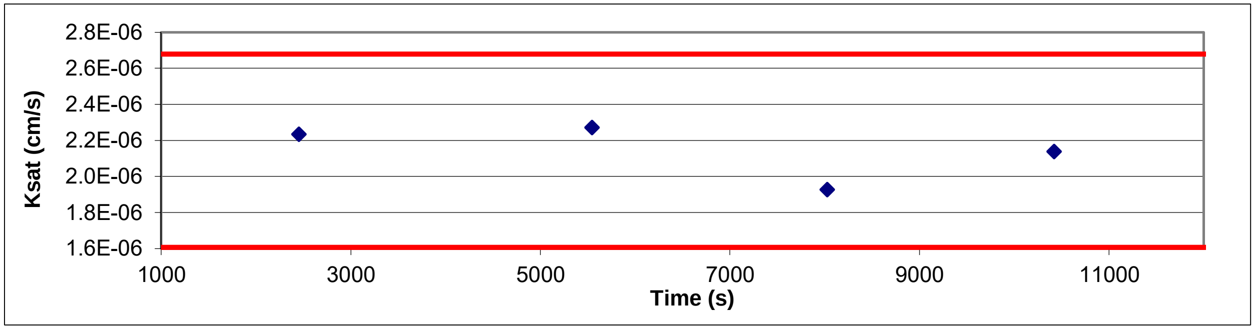
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 33/67 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
26-Mar-21	08:12:28	20.0	11.00	19.00	2.20	0.43	2451	1.00	7%	2.23E-06	2.23E-06
26-Mar-21	08:53:19	20.0	11.50	18.50	2.05						
Test # 2:											
26-Mar-21	10:28:56	20.0	12.50	17.50	1.73	0.43	3094	1.00	9%	2.27E-06	2.27E-06
26-Mar-21	11:20:30	20.0	13.00	17.00	1.58						
Test # 3:											
27-Mar-21	07:24:00	19.9	10.00	20.00	2.51	0.43	2483	1.00	6%	1.92E-06	1.93E-06
27-Mar-21	08:05:23	19.9	10.50	19.50	2.36						
Test # 4:											
27-Mar-21	08:05:23	19.9	10.50	19.50	2.36	0.43	2392	1.00	7%	2.13E-06	2.14E-06
27-Mar-21	08:45:15	19.9	11.00	19.00	2.20						

***Average Ksat* (cm/sec):** **2.14E-06**
Calculated Gravel Corrected Average Ksat (cm/sec): 1.74E-06



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 1.61E-06

Ksat (+25%) (cm/s): 2.68E-06

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 50/50 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	616.18
Diameter (cm):	7.316
Length (cm):	7.483
Area (cm^2):	42.04
Volume (cm^3):	314.57
Dry Density (g/cm^3):	1.68
Dry Density (pcf):	105.1
Water Content (%, g/g):	16.4
Water Content (%, vol):	27.6
Void Ratio (e):	0.57
Porosity (%, vol):	36.5
Saturation (%):	75.6

Post Permeation Sample Properties

Saturated Mass (g):	682.27
Dry Mass (g):	529.4
Diameter (cm):	7.431
Length (cm):	7.503
*Deformation (%)**:*	0.27
Area (cm^2):	43.37
Volume (cm^3):	325.40
Dry Density (g/cm^3):	1.63
Dry Density (pcf):	101.6
Water Content (%, g/g):	28.9
Water Content (%, vol):	47.0
Void Ratio(e):	0.63
Porosity (%, vol):	38.6
Saturation (%):*	121.7

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded ☑ Remolded Sample
Number of Lifts:	5
Split:	3/8"
Percent Coarse Material (%):	14
Particle Density(g/cm^3):	2.65 ☑ Provided ☐ Measured
Cell pressure (PSI):	82.0
Influent pressure (PSI):	80.2
Effluent pressure (PSI):	79.8
Panel Used:	☐ D ☑ E ☐ F
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	3/26/21 708
B-Value (% saturation) post to test:	1.00	3/27/21 847

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

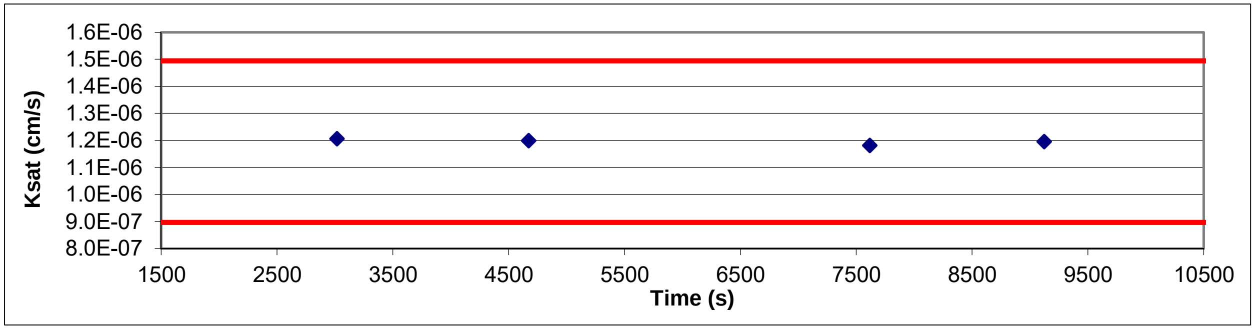
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 50/50 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
26-Mar-21	08:18:47	20.0	4.00	22.00	6.52	0.87	3016	1.00	5%	1.21E-06	1.21E-06
26-Mar-21	09:09:03	20.0	5.00	21.00	6.21						
Test # 2:											
26-Mar-21	10:00:29	20.0	6.00	20.00	5.90	0.43	1656	1.00	3%	1.20E-06	1.20E-06
26-Mar-21	10:28:05	20.0	6.50	19.50	5.75						
Test # 3:											
27-Mar-21	07:25:00	19.9	3.00	23.00	6.83	0.87	2944	1.00	5%	1.18E-06	1.18E-06
27-Mar-21	08:14:04	19.9	4.00	22.00	6.52						
Test # 4:											
27-Mar-21	08:14:04	19.9	4.00	22.00	6.52	0.43	1506	1.00	2%	1.19E-06	1.20E-06
27-Mar-21	08:39:10	19.9	4.50	21.50	6.37						

***Average Ksat* (cm/sec): 1.20E-06**
Calculated Gravel Corrected Average Ksat (cm/sec): 1.01E-06



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 8.96E-07

Ksat (+25%) (cm/s): 1.49E-06

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 67/33 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties		Post Permeation Sample Properties		Test and Sample Conditions	
Initial Mass (g):	612.29	*Saturated Mass (g):*	664.70	*Permeant liquid used:*	Tap Water
Diameter (cm):	7.314	*Dry Mass (g):*	525.44	*Sample Preparation:*	☐ In situ sample, extruded
Length (cm):	7.481	*Diameter (cm):*	7.397		☑ Remolded Sample
Area (cm^2):	42.01	*Length (cm):*	7.486	*Number of Lifts:*	5
Volume (cm^3):	314.31	*Deformation (%)**:*	0.07	*Split:*	3/8"
Dry Density (g/cm^3):	1.67	*Area (cm^2):*	42.97	*Percent Coarse Material (%):*	11
Dry Density (pcf):	104.4	*Volume (cm^3):*	321.70	*Particle Density(g/cm^3):*	2.61 ☑ Provided ☐ Measured
Water Content (%, g/g):	16.5	*Dry Density (g/cm^3):*	1.63	*Cell pressure (PSI):*	82.0
Water Content (%, vol):	27.6	*Dry Density (pcf):*	102.0	*Influent pressure (PSI):*	80.2
Void Ratio (e):	0.56	*Water Content (%, g/g):*	26.5	*Effluent pressure (PSI):*	79.8
Porosity (%, vol):	35.9	*Water Content (%, vol):*	43.3	*Panel Used:*	☐ D ☐ E ☑ F
Saturation (%):	76.9	*Void Ratio(e):*	0.60	*Reading:*	☐ Annulus ☑ Pipette
		Porosity (%, vol):	37.4		
		Saturation (%):*	115.7		

		Date/Time
B-Value (% saturation) prior to test*:	0.99	3/26/21 710
B-Value (% saturation) post to test:	1.00	3/27/21 857

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

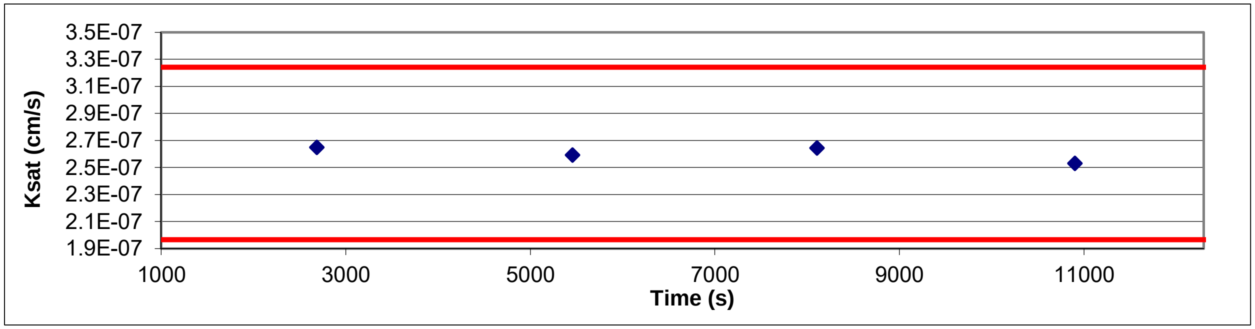
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 67/33 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
26-Mar-21	09:03:50	20.0	3.40	22.60	6.72	0.17	2687	1.00	1%	2.60E-07	2.60E-07
26-Mar-21	09:48:37	20.0	3.60	22.40	6.66						
Test # 2:											
26-Mar-21	09:48:37	20.0	3.60	22.40	6.66	0.17	2772	1.00	1%	2.54E-07	2.54E-07
26-Mar-21	10:34:49	20.0	3.80	22.20	6.60						
Test # 3:											
27-Mar-21	07:25:00	19.9	3.00	23.00	6.84	0.17	2650	1.00	1%	2.59E-07	2.59E-07
27-Mar-21	08:09:10	19.9	3.20	22.80	6.78						
Test # 4:											
27-Mar-21	08:09:10	19.9	3.20	22.80	6.78	0.17	2795	1.00	1%	2.48E-07	2.48E-07
27-Mar-21	08:55:45	20.0	3.40	22.60	6.72						

***Average Ksat* (cm/sec):** **2.55E-07**
Calculated Gravel Corrected Average Ksat (cm/sec): 2.23E-07



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 1.92E-07

Ksat (+25%) (cm/s): 3.19E-07

Moisture Retention Characteristics

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
33/67 Blend (95%)	0	38.9 ‡‡
	25	39.2 ‡‡
	76	39.1 ‡‡
	154	39.1 ‡‡
	337	36.1 ‡‡
	3045	22.4 ‡‡
	206306	10.1 ‡‡
	555485	7.7 ‡‡
	848426	8.0 ‡‡
50/50 Blend (95%)	0	40.5 ‡‡
	25	40.4 ‡‡
	76	40.2 ‡‡
	154	39.8 ‡‡
	337	37.4 ‡‡
	1523	26.3 ‡‡
	233126	8.9 ‡‡
	611574	6.8 ‡‡
	848426	7.2 ‡‡
67/33 Blend (95%)	0	39.1 ‡‡
	59	39.0 ‡‡
	154	38.9 ‡‡
	337	37.8 ‡‡
	2120	27.0 ‡‡
	230373	9.1 ‡‡
	560380	7.0 ‡‡
	848426	7.3 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
33/67 Blend (95%)	0.0015	1.4528	6.82	39.40	5.90	34.03
50/50 Blend (95%)	0.0015	1.5480	6.64	40.64	5.97	36.52
67/33 Blend (95%)	0.0010	1.4719	5.91	39.37	5.42	36.11

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Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample* (g):	539.16
Job Number:	DB21.1124.00	*Tare wt., ring* (g):	212.60
Sample Number:	33/67 Blend (95%)	*Tare wt., screen & clamp* (g):	26.96
Project:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3):	310.79
Depth:	NA	*Initial dry bulk density* (g/cm^3):	1.73
		Provided particle density (g/cm^3):	2.50
		Initial calculated total porosity (%):	30.61

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	26-Mar-21	12:00	903.07	0	38.88	‡‡
	2-Apr-21	14:30	904.72	25.0	39.16	‡‡
	9-Apr-21	12:15	904.47	76.0	39.09	‡‡
	16-Apr-21	15:00	904.36	154.0	39.05	‡‡
Pressure plate:	26-Apr-21	11:45	894.80	337	36.08	‡‡
HD Sensor:	17-May-21	9:06	850.82	3045	22.41	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	319.87	+2.92%	1.69	32.58
	25.0	321.72	+3.52%	1.68	32.97
	76.0	321.72	+3.52%	1.68	32.97
	154.0	321.72	+3.52%	1.68	32.97
Pressure plate:	337	321.72	+3.52%	1.68	32.97
HD Sensor:	3045	321.72	+3.52%	1.68	32.97

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: 33/67 Blend (95%)

Initial sample bulk density (g/cm^3)*:* 1.73
Fraction of test sample used (<2.00mm fraction) (%): 77.11

Dry weight of dew point potentiometer sample* (g)*:* 160.62
Tare weight, jar (g)*:* 115.49

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	30-Mar-21	8:42	164.14	206306	10.08	‡‡
	29-Mar-21	8:50	163.32	555485	7.73	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	206306	321.72	+3.52%	1.68	32.97
	555485	321.72	+3.52%	1.68	32.97

Dry weight of relative humidity box sample* (g)*:* 82.29
Tare weight (g)*:* 44.52

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Relative humidity box:	1-Apr-21	12:45	84.62	848426	7.97	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	321.72	+3.52%	1.68	32.97

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

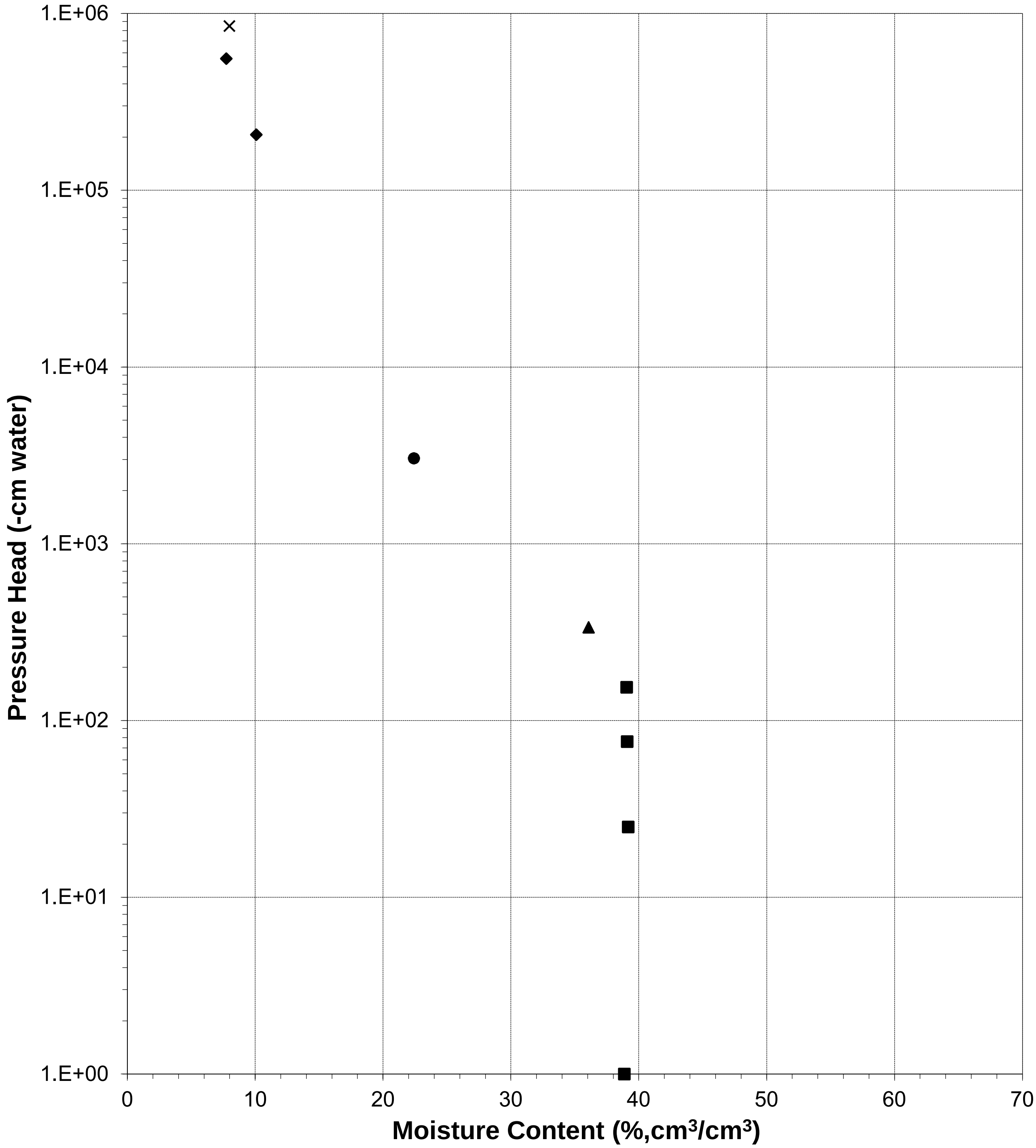
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

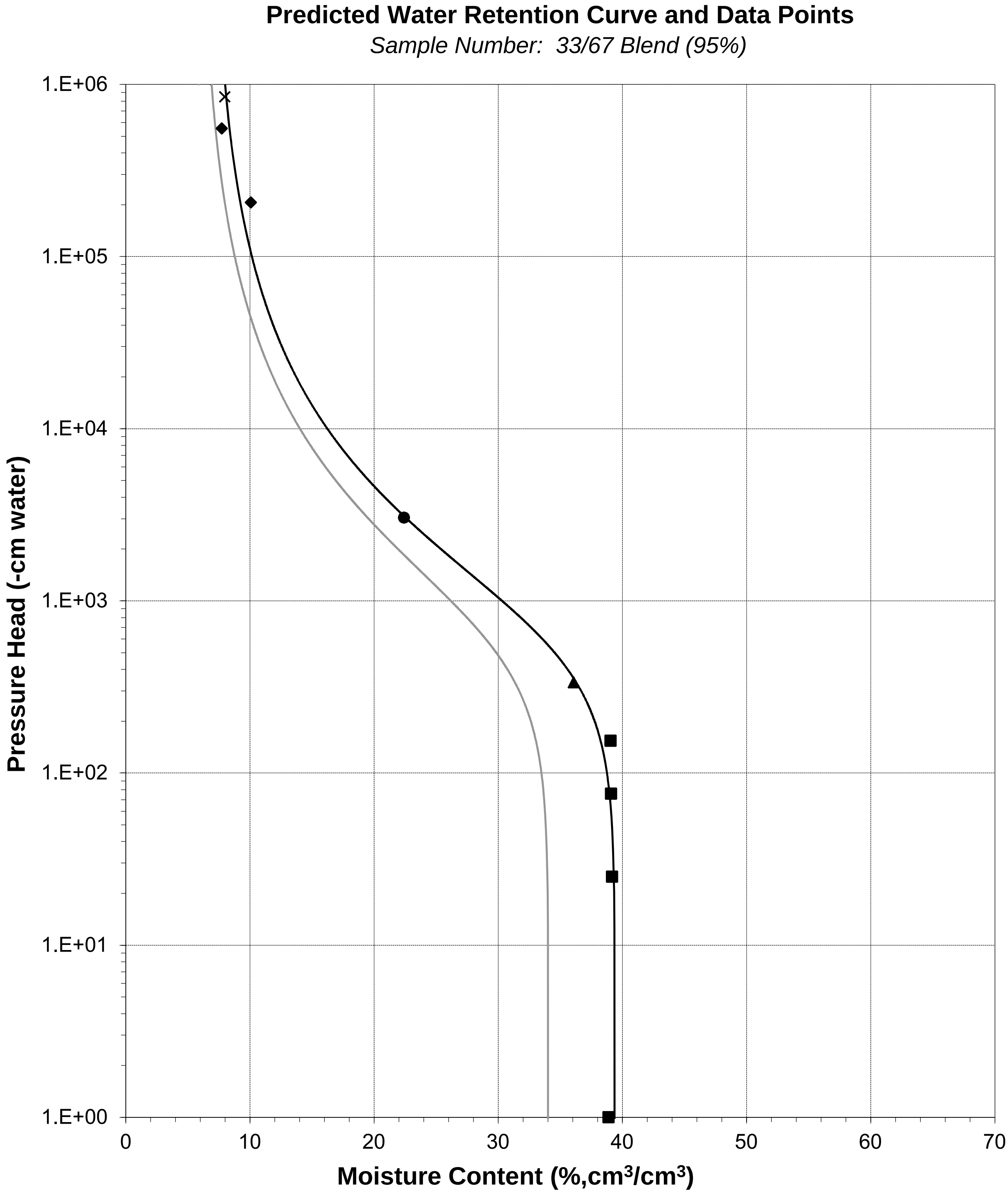
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Water Retention Data Points

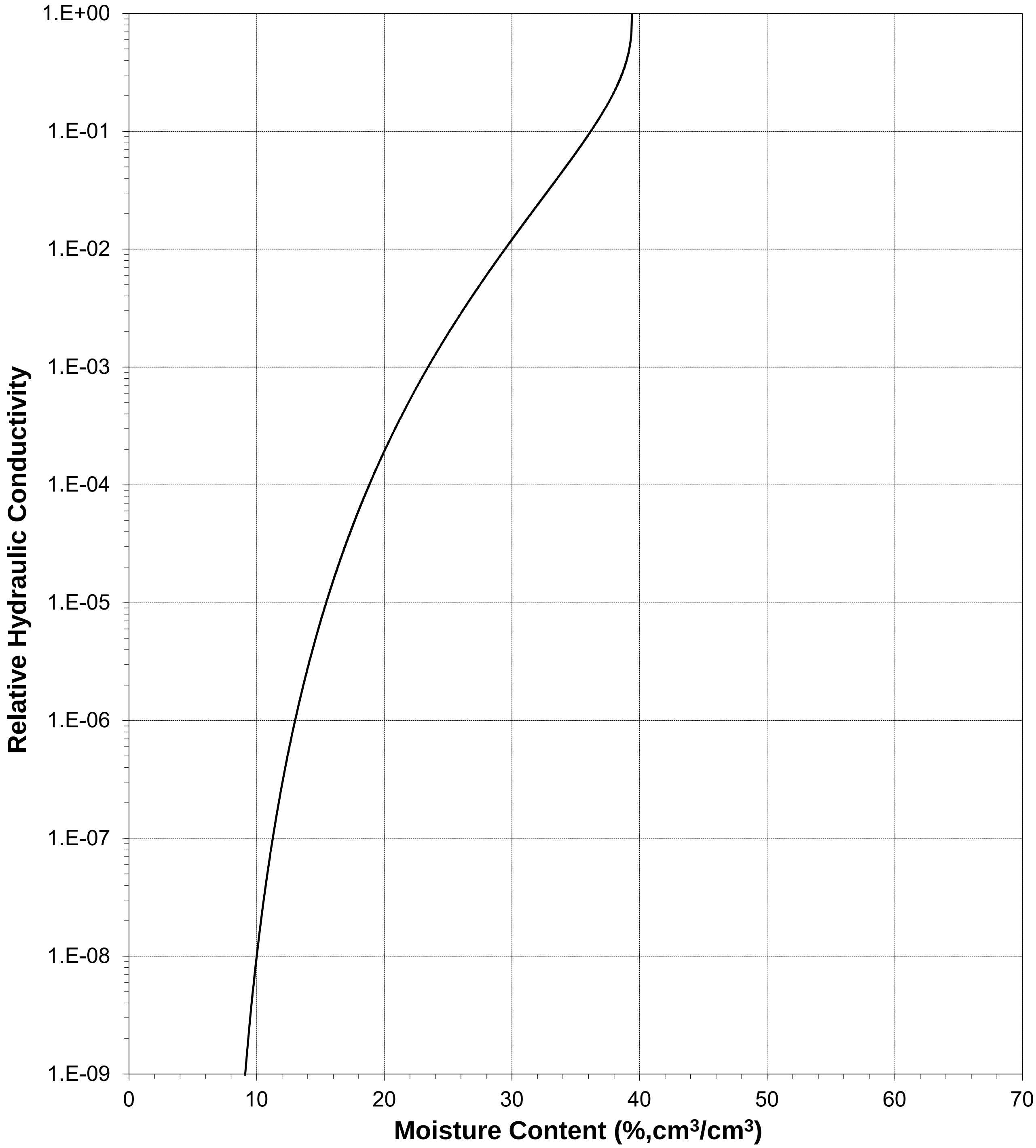
Sample Number: 33/67 Blend (95%)

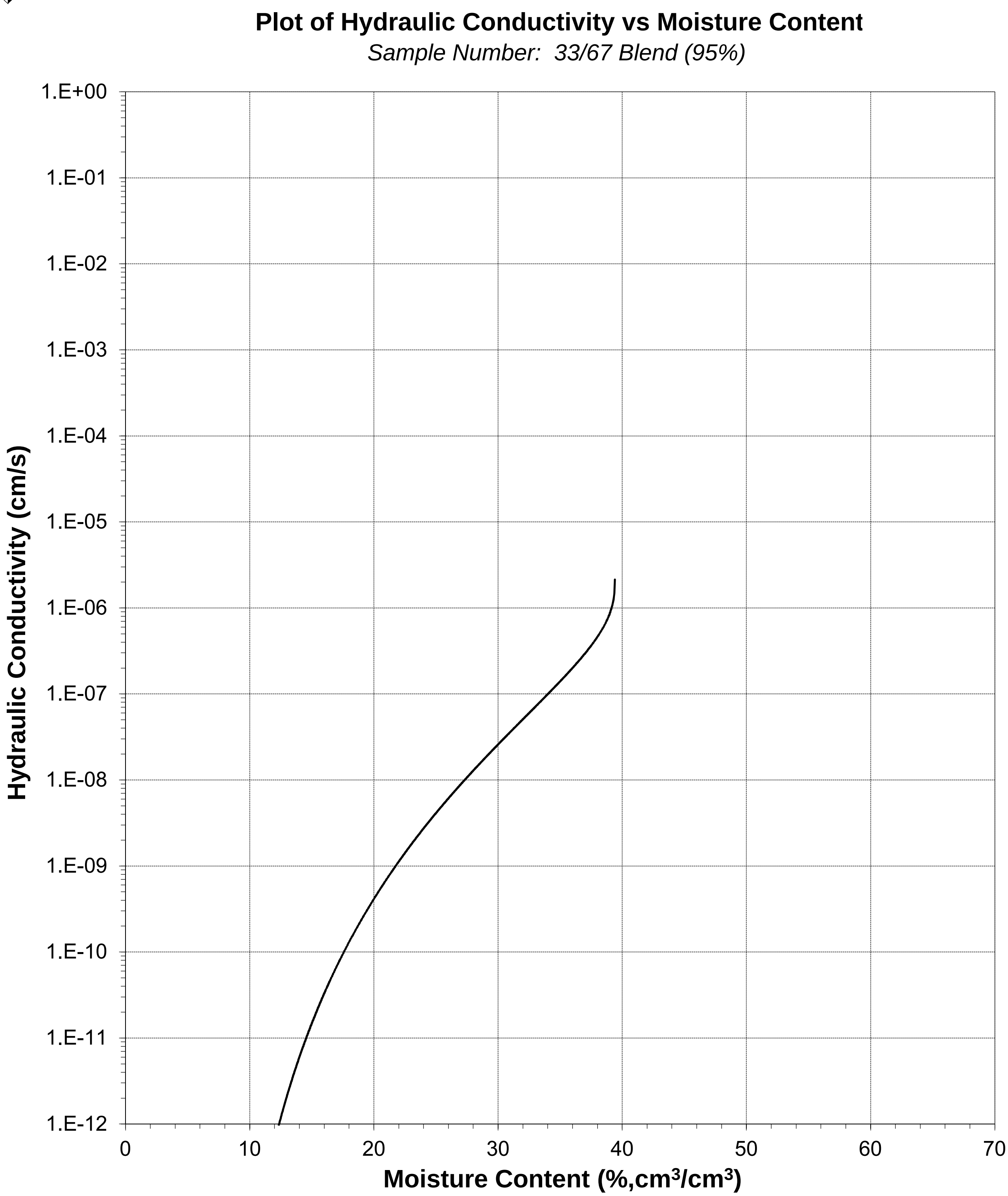



Predicted Water Retention Curve and Data Points
Sample Number: 33/67 Blend (95%)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Pressure Head (-cm water)
0
10
20
30
40
50
60
70
Moisture Content (%,cm3/cm3)

Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: 33/67 Blend (95%)

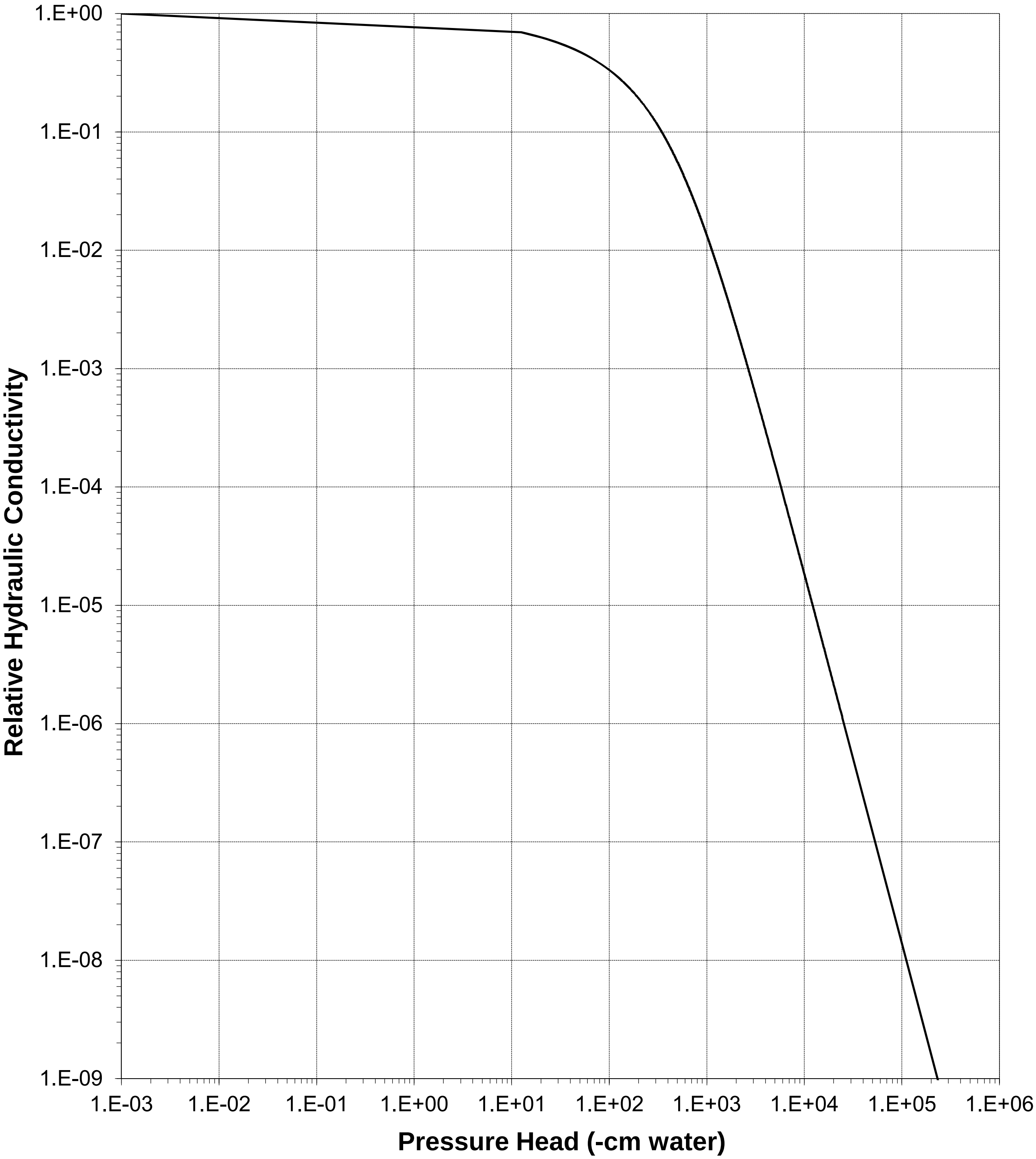




Plot of Hydraulic Conductivity vs Moisture Content
Sample Number: 33/67 Blend (95%)
Hydraulic Conductivity (cm/s)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
0
10
20
30
40
50
60
70
Moisture Content (%,cm3/cm3)

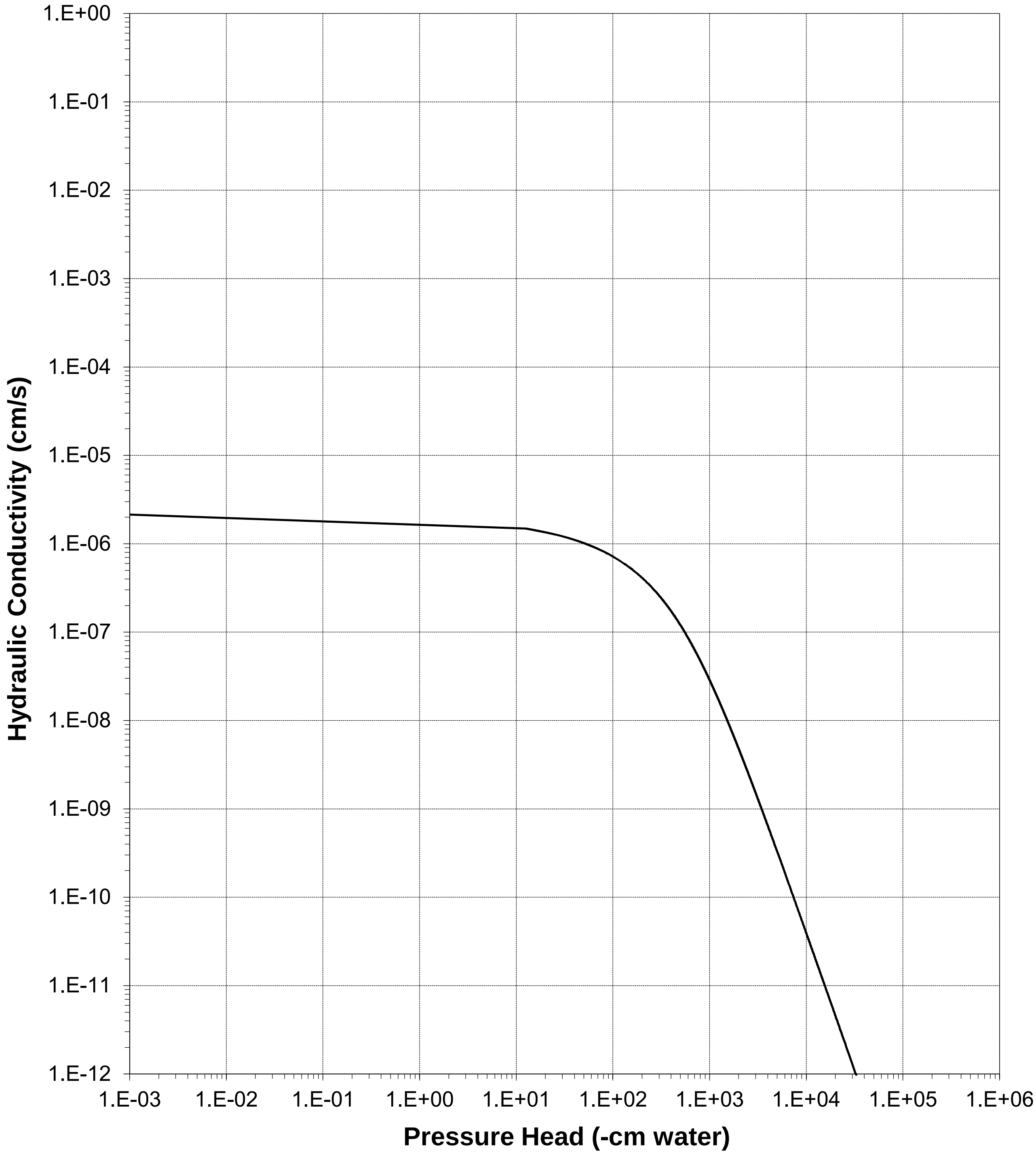
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: 33/67 Blend (95%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: 33/67 Blend (95%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 33/67 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/8"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	17.00	83.00	100.00
Mass Fraction (%):	17.00	83.00	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.19	1.73	1.80
Calculated Porosity (% vol):	0.00	30.61	26.33
Volume of Solids (cm^3):	7.76	33.20	40.96
Volume of Voids (cm^3):	0.00	14.64	14.64
Total Volume (cm^3):	7.76	47.84	55.61
Volumetric Fraction (%):	13.96	86.04	100.00
Initial Moisture Content (% vol):	0.00	24.53	21.11
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.19	1.69	1.75
Calculated Porosity (% vol):	0.00	32.58	28.14
Volume of Solids (cm^3):	7.76	33.20	40.96
Volume of Voids (cm^3):	0.00	16.04	16.04
Total Volume (cm^3):	7.76	49.24	57.00
Volumetric Fraction (%):	13.62	86.38	100.00
Saturated Moisture Content (% vol):	0.00	39.40	34.03
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.19	1.68	1.75
Calculated Porosity (% vol):	0.00	32.97	28.50
Volume of Solids (cm^3):	7.76	33.20	40.96
Volume of Voids (cm^3):	0.00	16.33	16.33
Total Volume (cm^3):	7.76	49.53	57.29
Volumetric Fraction (%):	13.55	86.45	100.00
Residual Moisture Content (% vol):	0.00	6.82	5.90
Ksat (cm/sec):	NM	2.1E-06	1.7E-06

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample* (g):	526.19
Job Number:	DB21.1124.00	*Tare wt., ring* (g):	213.42
Sample Number:	50/50 Blend (95%)	*Tare wt., screen & clamp* (g):	26.51
Project:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3):	314.91
Depth:	NA	*Initial dry bulk density* (g/cm^3):	1.67
		Provided particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	36.95

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	26-Mar-21	12:10	896.99	0	40.52	‡‡
	2-Apr-21	14:30	896.48	25.0	40.37	‡‡
	9-Apr-21	12:15	895.90	76.0	40.19	‡‡
	16-Apr-21	15:00	894.63	154.0	39.79	‡‡
Pressure plate:	26-Apr-21	12:00	887.01	337	37.43	‡‡
HD Sensor:	17-May-21	9:06	851.17	1523	26.34	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	322.94	+2.55%	1.63	38.51
	25.0	322.94	+2.55%	1.63	38.51
	76.0	322.94	+2.55%	1.63	38.51
	154.0	322.94	+2.55%	1.63	38.51
Pressure plate:	337	322.94	+2.55%	1.63	38.51
HD Sensor:	1523	322.94	+2.55%	1.63	38.51

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: 50/50 Blend (95%)

Initial sample bulk density (g/cm^3)*:* 1.67
Fraction of test sample used (<2.00mm fraction) (%): 80.23

Dry weight of dew point potentiometer sample* (g)*:* 160.75
Tare weight, jar (g)*:* 112.72

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	30-Mar-21	8:36	164.03	233126	8.93	‡‡
	29-Mar-21	8:46	163.23	611574	6.75	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	233126	322.94	+2.55%	1.63	38.51
	611574	322.94	+2.55%	1.63	38.51

Dry weight of relative humidity box sample* (g)*:* 78.92
Tare weight (g)*:* 45.51

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Relative humidity box:	1-Apr-21	12:45	80.76	848426	7.17	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	322.94	+2.55%	1.63	38.51

Comments:

1 Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

2 Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

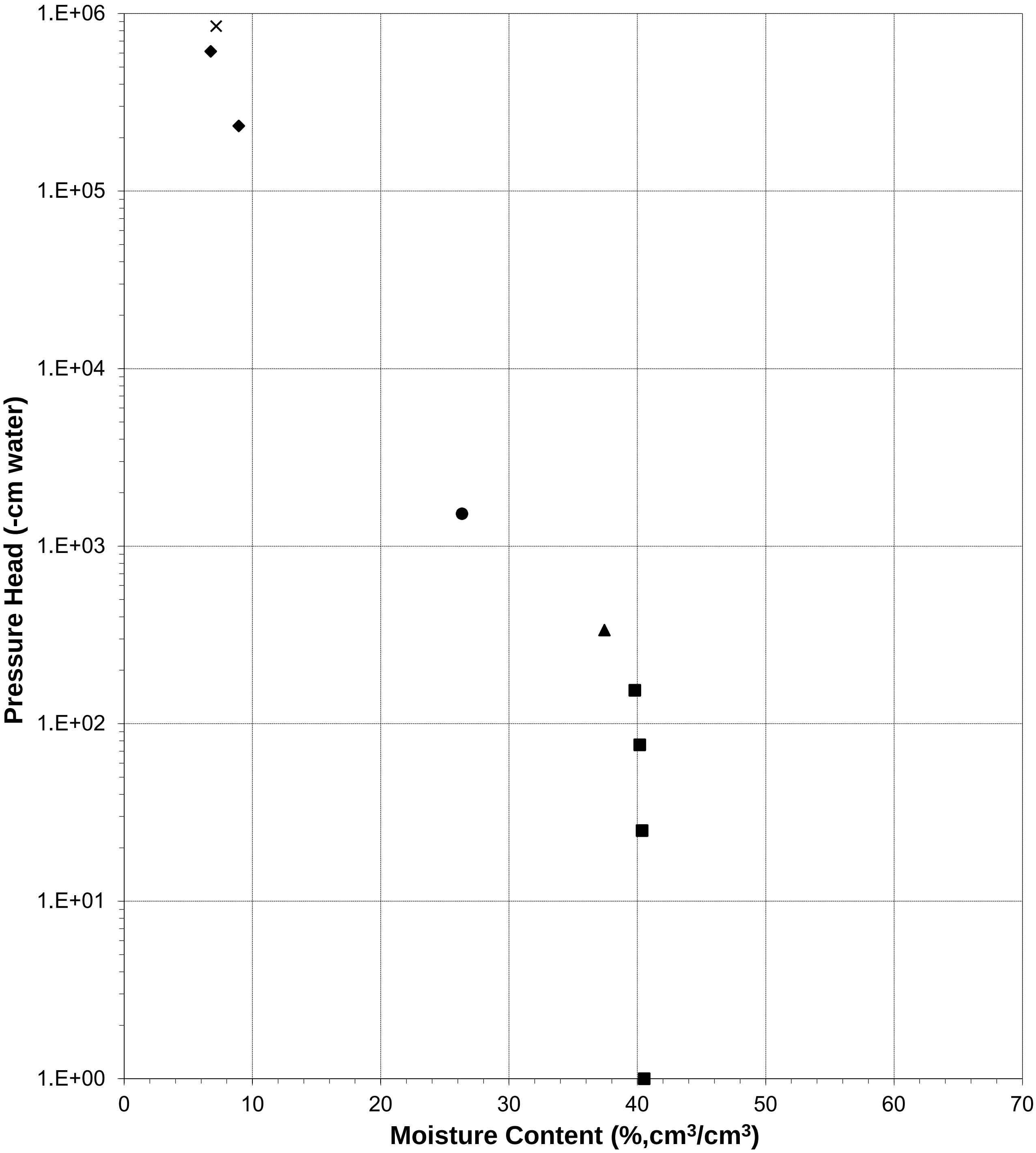
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

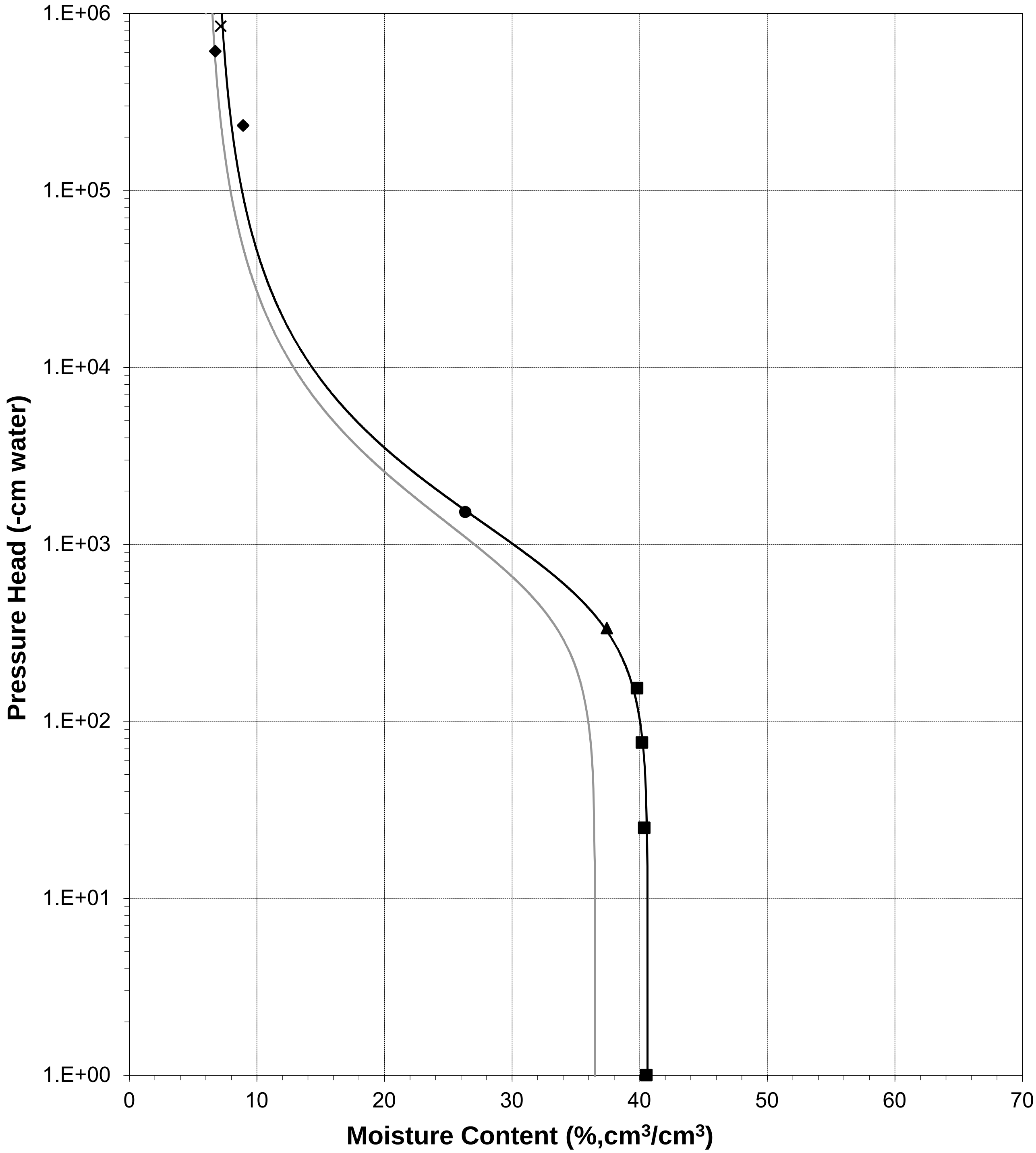
Water Retention Data Points

Sample Number: 50/50 Blend (95%)



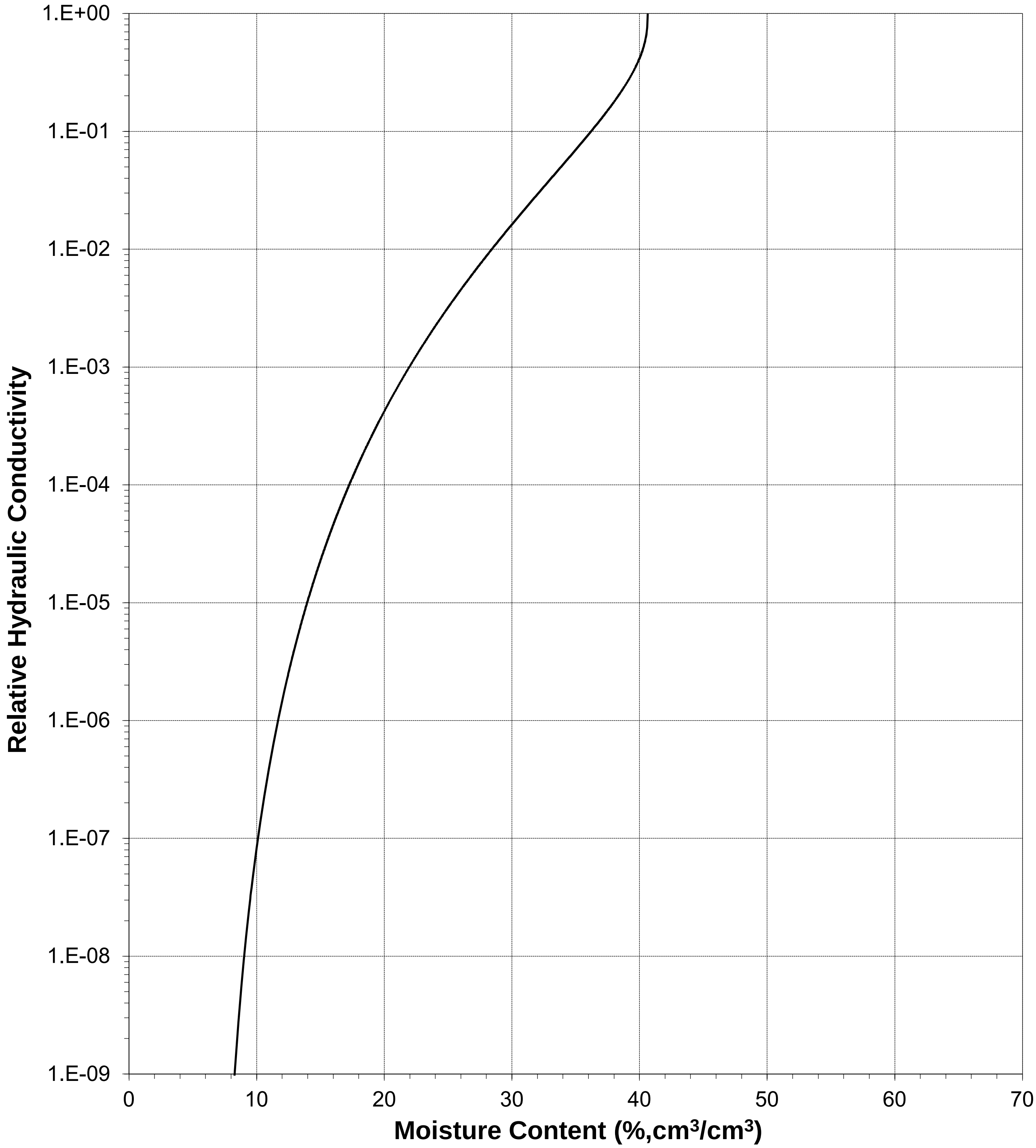
Predicted Water Retention Curve and Data Points

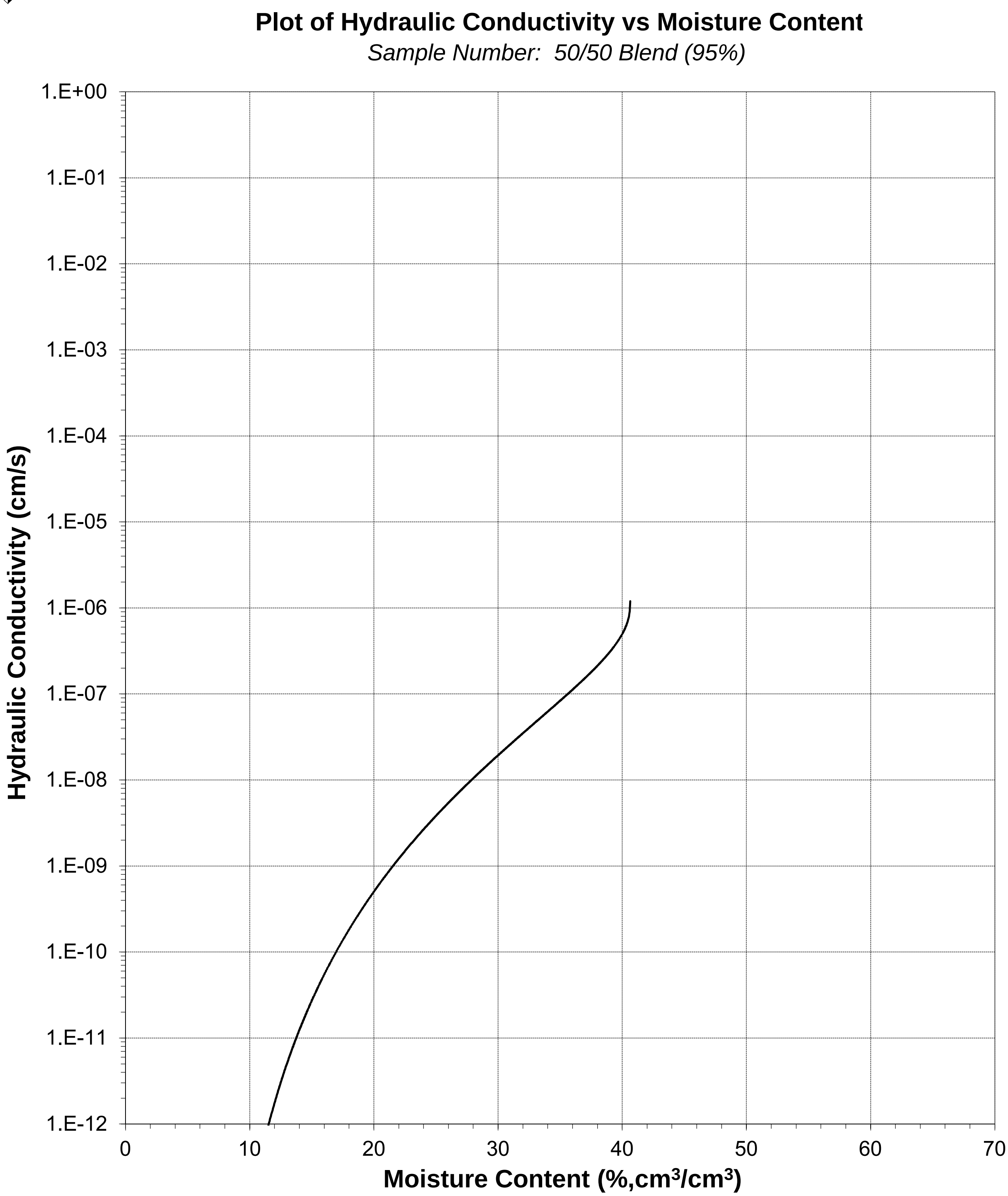
Sample Number: 50/50 Blend (95%)



Plot of Relative Hydraulic Conductivity vs Moisture Content

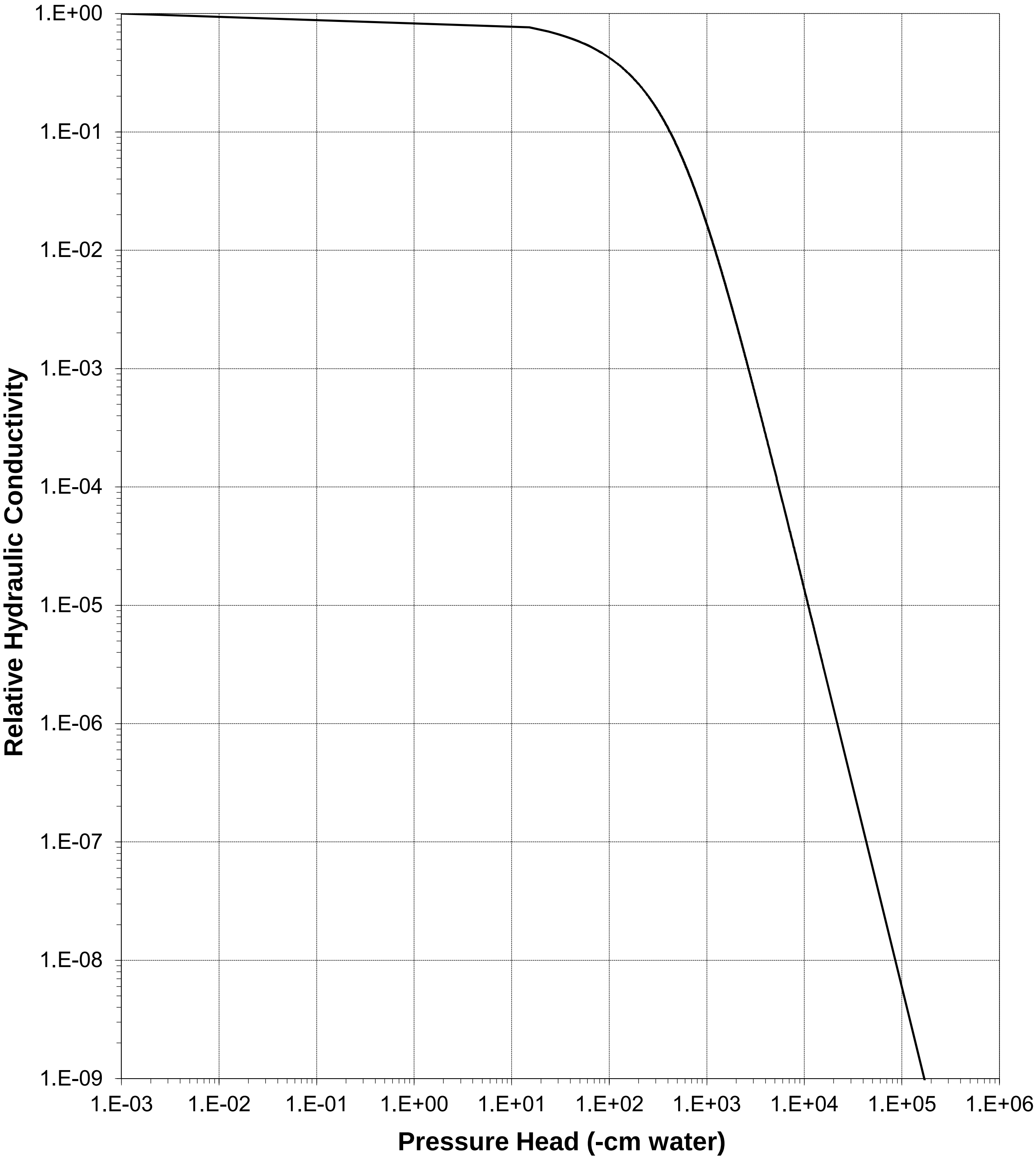
Sample Number: 50/50 Blend (95%)

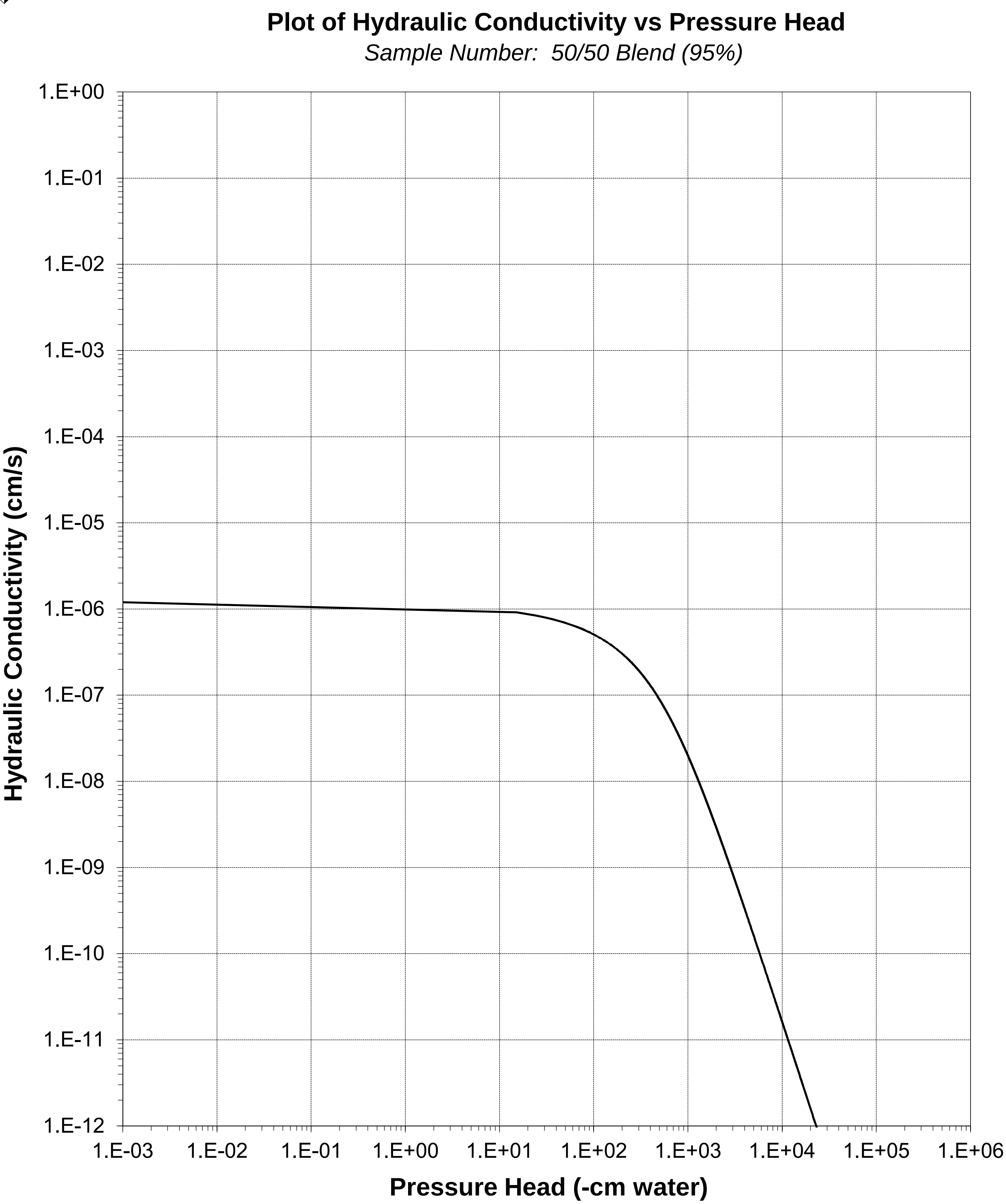



Plot of Hydraulic Conductivity vs Moisture Content
Sample Number: 50/50 Blend (95%)
Hydraulic Conductivity (cm/s)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
0
10
20
30
40
50
60
70
Moisture Content (%,cm³/cm³)

Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: 50/50 Blend (95%)




Plot of Hydraulic Conductivity vs Pressure Head
Sample Number: 50/50 Blend (95%)
Hydraulic Conductivity (cm/s)
Pressure Head (-cm water)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06

Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name:	Broadbent
Job Number:	DB21.1124.00
Sample Number:	50/50 Blend (95%)
Project:	3 Kids Mine, 14-01-156
Depth:	NA
Split (3/4", 3/8", #4):	3/8"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	14.00	86.00	100.00
Mass Fraction (%):	14.00	86.00	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.35	1.67	1.74
Calculated Porosity (% vol):	0.00	36.95	33.11
Volume of Solids (cm^3):	5.96	32.45	38.41
Volume of Voids (cm^3):	0.00	19.02	19.02
Total Volume (cm^3):	5.96	51.47	57.43
Volumetric Fraction (%):	10.37	89.63	100.00
Initial Moisture Content (% vol):	0.00	28.48	25.53
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.35	1.63	1.70
Calculated Porosity (% vol):	0.00	38.51	34.61
Volume of Solids (cm^3):	5.96	32.45	38.41
Volume of Voids (cm^3):	0.00	20.33	20.33
Total Volume (cm^3):	5.96	52.78	58.74
Volumetric Fraction (%):	10.14	89.86	100.00
Saturated Moisture Content (% vol):	0.00	40.64	36.52
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.35	1.63	1.70
Calculated Porosity (% vol):	0.00	38.51	34.61
Volume of Solids (cm^3):	5.96	32.45	38.41
Volume of Voids (cm^3):	0.00	20.33	20.33
Total Volume (cm^3):	5.96	52.78	58.74
Volumetric Fraction (%):	10.14	89.86	100.00
Residual Moisture Content (% vol):	0.00	6.64	5.97
Ksat (cm/sec):	NM	1.2E-06	1.0E-06

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample (g):*	525.51
Job Number:	DB21.1124.00	*Tare wt., ring (g):*	215.26
Sample Number:	67/33 Blend (95%)	*Tare wt., screen & clamp (g):*	27.74
Project:	3 Kids Mine, 14-01-156	*Initial sample volume (cm^3):*	314.40
Depth:	NA	*Initial dry bulk density (g/cm^3):*	1.67
		Provided particle density (g/cm^3):	2.61
		Initial calculated total porosity (%):	35.96

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	26-Mar-21	12:30	893.29	0	39.14	‡‡
	2-Apr-21	14:30	892.92	59.0	39.02	‡‡
	9-Apr-21	12:20	892.44	154.0	38.87	‡‡
Pressure plate:	19-Apr-21	11:30	888.87	337	37.75	‡‡
HD Sensor:	17-May-21	9:06	854.72	2120	27.04	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	318.81	+1.40%	1.65	36.84
	59.0	318.81	+1.40%	1.65	36.84
	154.0	318.81	+1.40%	1.65	36.84
Pressure plate:	337	318.81	+1.40%	1.65	36.84
HD Sensor:	2120	318.81	+1.40%	1.65	36.84

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: 67/33 Blend (95%)

Initial sample bulk density (g/cm^3)*:* 1.67
Fraction of test sample used (<2.00mm fraction) (%): 84.27

Dry weight of dew point potentiometer sample* (g)*:* 155.46
Tare weight, jar (g)*:* 114.45

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	30-Mar-21	8:48	158.15	230373	9.11	‡‡
	29-Mar-21	9:05	157.52	560380	6.98	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	230373	318.81	+1.40%	1.65	36.84
	560380	318.81	+1.40%	1.65	36.84

Dry weight of relative humidity box sample* (g)*:* 75.46
Tare weight (g)*:* 41.72

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Relative humidity box:	1-Apr-21	12:45	77.24	848426	7.30	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	318.81	+1.40%	1.65	36.84

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

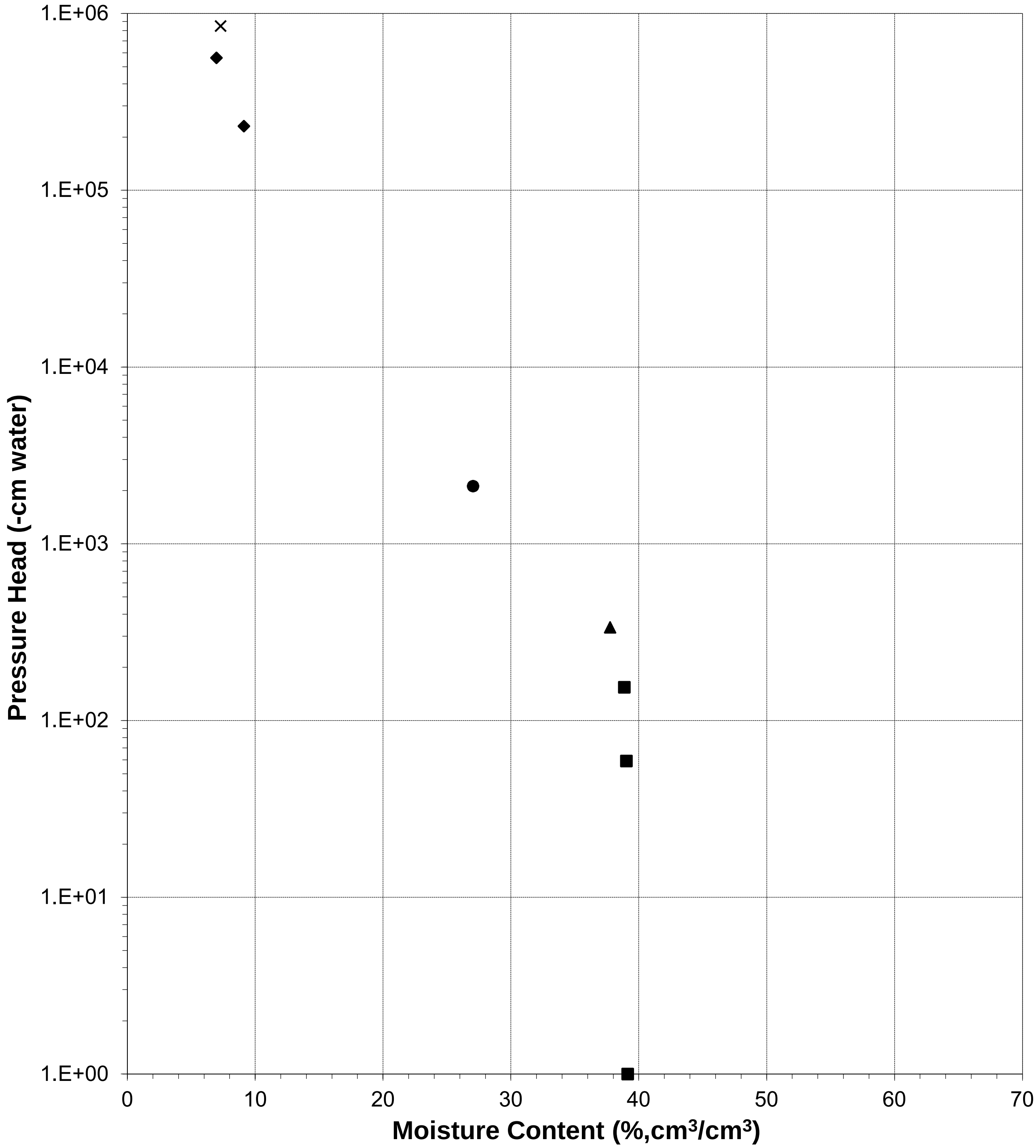
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

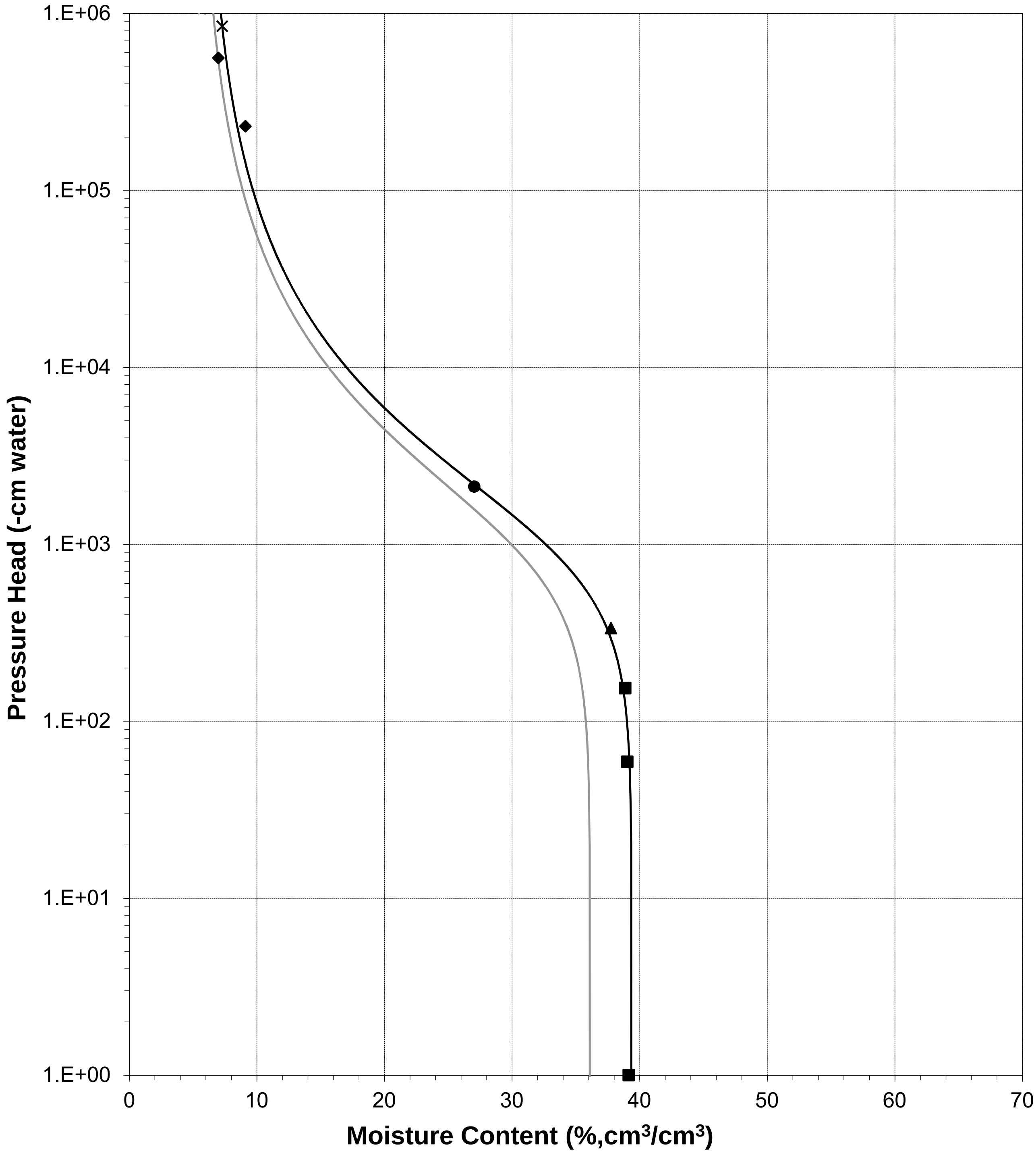
Water Retention Data Points

Sample Number: 67/33 Blend (95%)



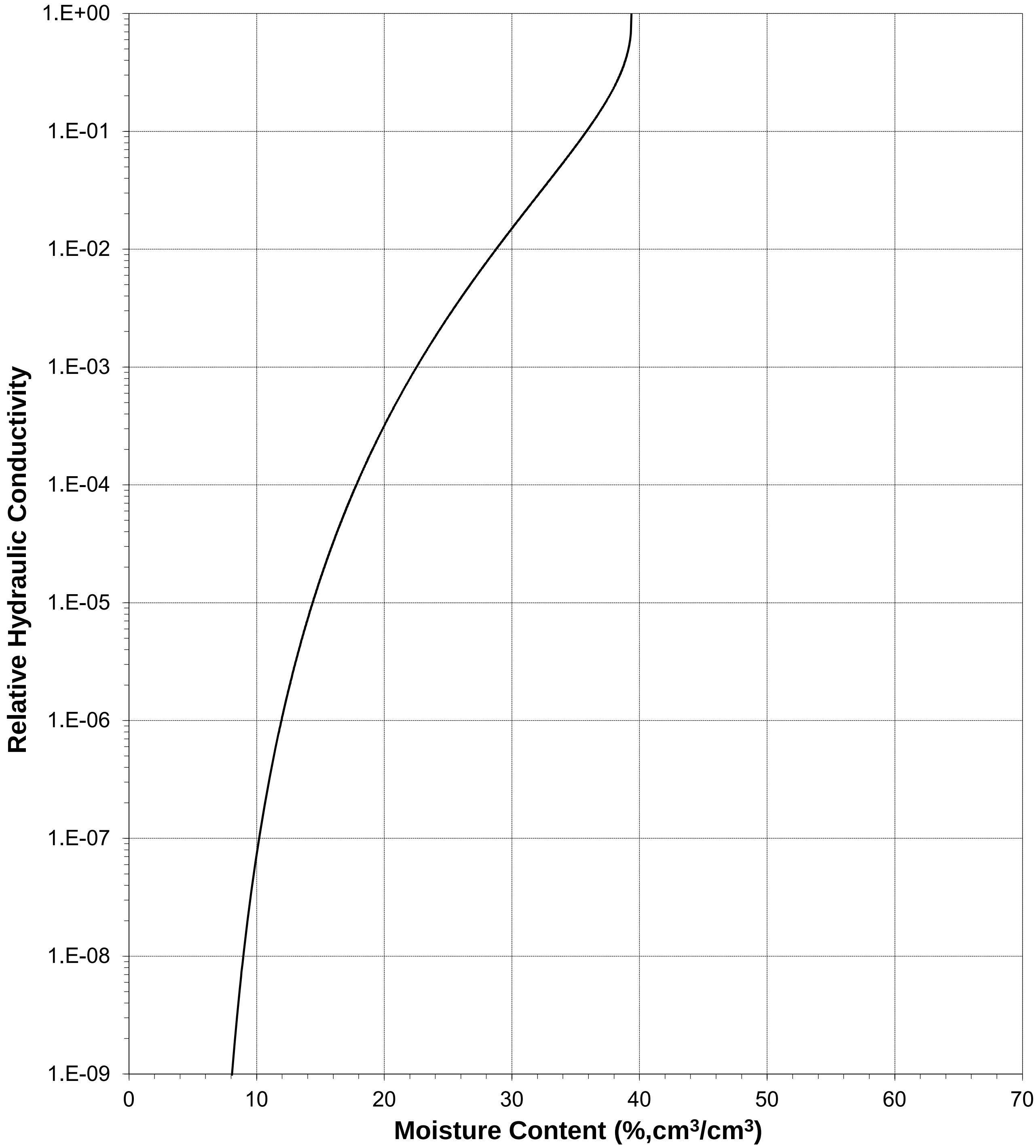
Predicted Water Retention Curve and Data Points

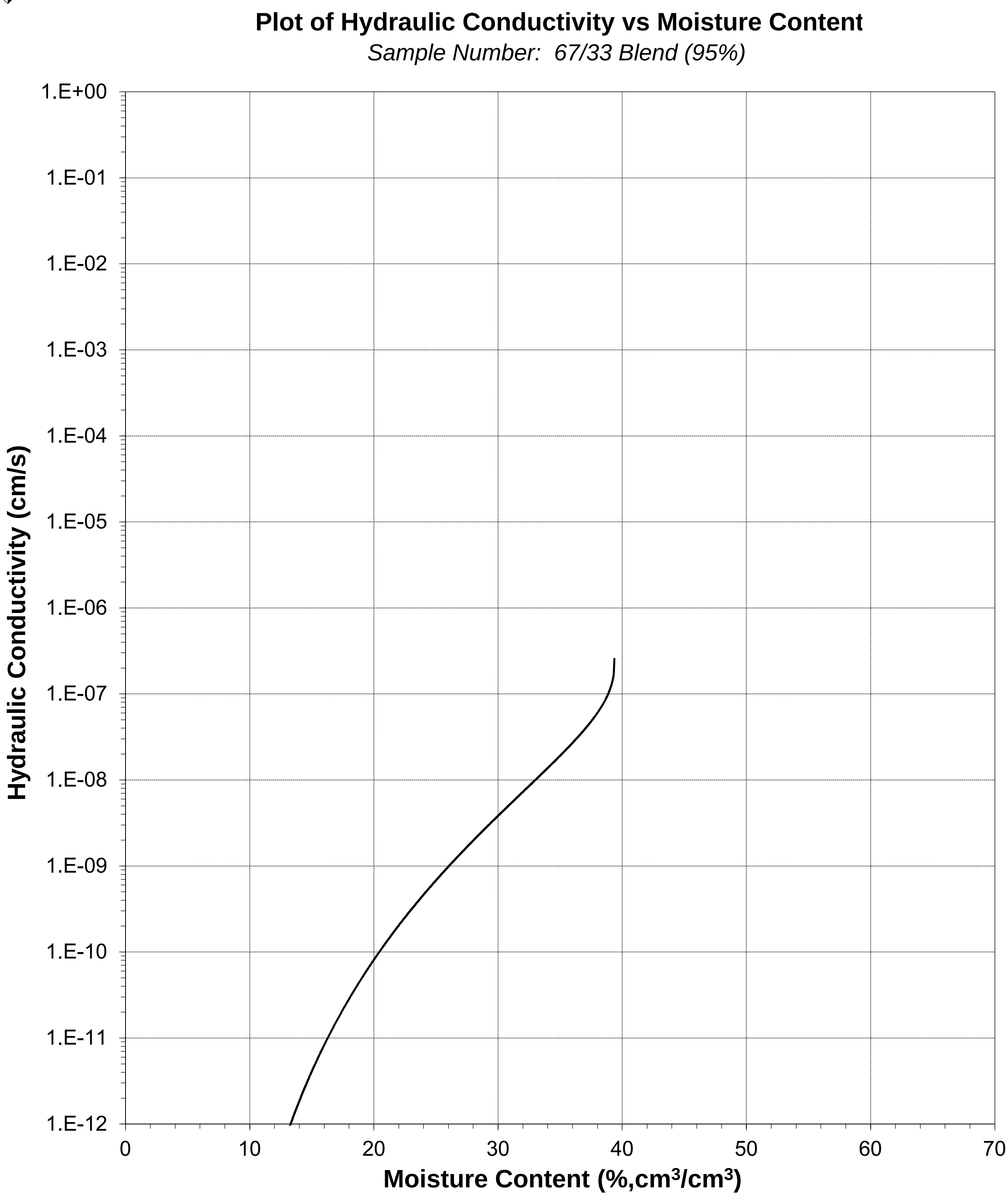
Sample Number: 67/33 Blend (95%)



Plot of Relative Hydraulic Conductivity vs Moisture Content

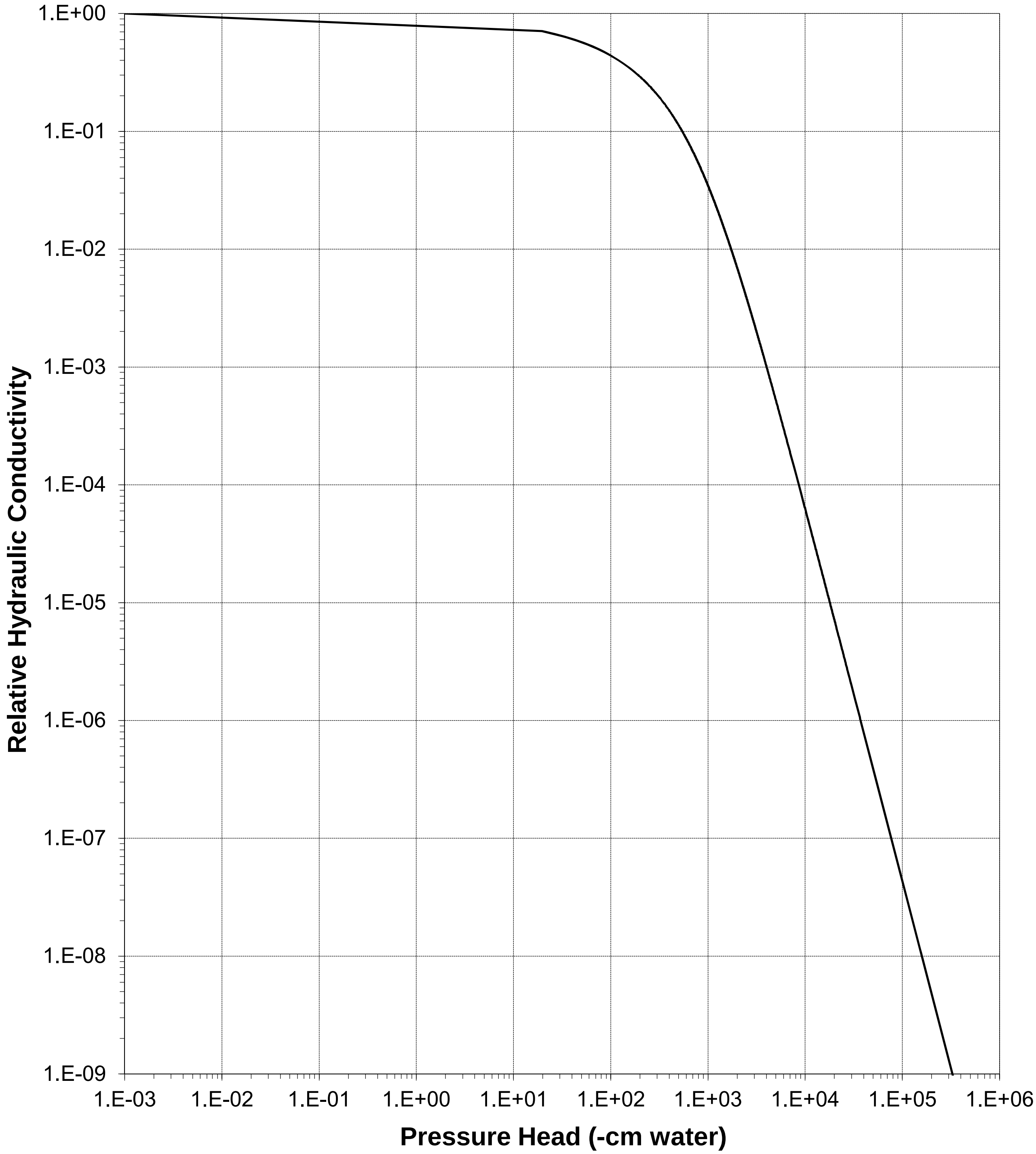
Sample Number: 67/33 Blend (95%)




Plot of Hydraulic Conductivity vs Moisture Content
Sample Number: 67/33 Blend (95%)
Hydraulic Conductivity (cm/s)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
0
10
20
30
40
50
60
70
Moisture Content (%,cm³/cm³)

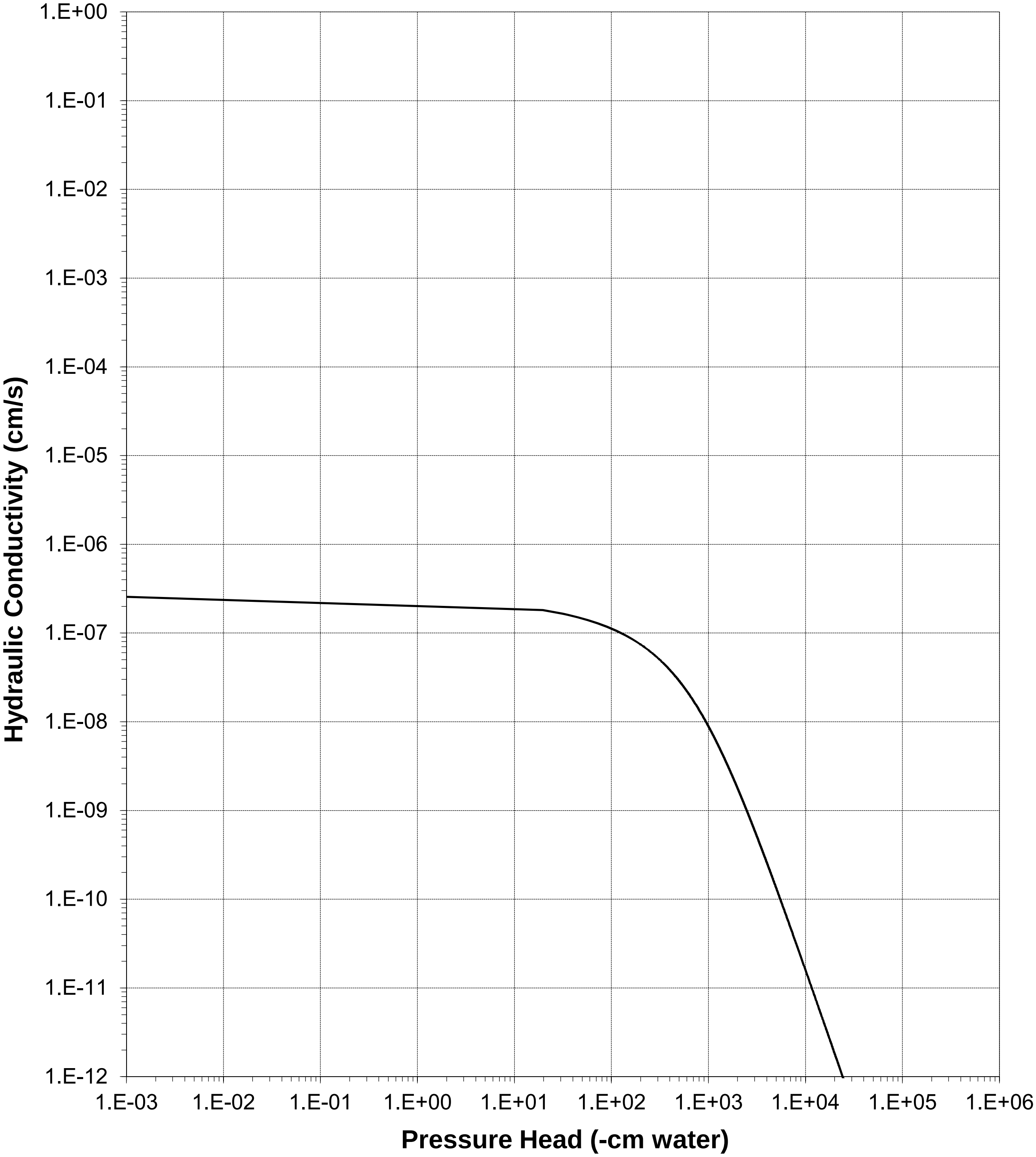
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: 67/33 Blend (95%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: 67/33 Blend (95%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 67/33 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/8"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	11.00	89.00	100.00
Mass Fraction (%):	11.00	89.00	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.26	1.67	1.72
Calculated Porosity (% vol):	0.00	35.96	32.95
Volume of Solids (cm^3):	4.87	34.10	38.97
Volume of Voids (cm^3):	0.00	19.15	19.15
Total Volume (cm^3):	4.87	53.25	58.11
Volumetric Fraction (%):	8.38	91.62	100.00
Initial Moisture Content (% vol):	0.00	27.50	25.20
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.26	1.65	1.70
Calculated Porosity (% vol):	0.00	36.84	33.80
Volume of Solids (cm^3):	4.87	34.10	38.97
Volume of Voids (cm^3):	0.00	19.89	19.89
Total Volume (cm^3):	4.87	53.99	58.86
Volumetric Fraction (%):	8.27	91.73	100.00
Saturated Moisture Content (% vol):	0.00	39.37	36.11
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.26	1.65	1.70
Calculated Porosity (% vol):	0.00	36.84	33.80
Volume of Solids (cm^3):	4.87	34.10	38.97
Volume of Voids (cm^3):	0.00	19.89	19.89
Total Volume (cm^3):	4.87	53.99	58.86
Volumetric Fraction (%):	8.27	91.73	100.00
Residual Moisture Content (% vol):	0.00	5.91	5.42
Ksat (cm/sec):	NM	2.6E-07	2.2E-07

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263, ASTM D2216
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity: Falling Head Rising Tail: (Flexible Wall)	ASTM D5084
Hanging Column Method:	ASTM D6836 (modified apparatus)
Pressure Plate Method:	ASTM D6836
Water Potential (Dewpoint Potentiometer) Method:	ASTM D6836
Relative Humidity (Box) Method:	Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis. Part 1. American Society of Agronomy, Madison, WI; Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325
Heat Dissipation Sensor:	229 Heat Dissipation Matric Water Potential Sensor Instruction Manual (Rev. 5/09). Campbell Scientific, Inc., Logan, UT; Flint, A.L., et al. Calibration and Temperature Correction of Heat Dissipation Matric Potential Sensors. Soil Sci. Soc. Am. J. 66.1439 1445 (2002); van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Coarse Fraction (Gravel) Correction (calc):	ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose Zones. Groundwater Vol. 22, No. 6

Laboratory Report for

Broadbent

3 Kids Mine, 14-01-156

September 14, 2021

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

September 14, 2021

Victoria Tyson-Bloyd
Broadbent
8 W Pacific Ave.
Henderson, NV 89015
(702) 563.0600

Re: DBS&A Laboratory Report for the Broadbent 3 Kids Mine, 14-01-156 Project

Dear Ms. Tyson-Bloyd:

Enclosed is the report for the Broadbent 3 Kids Mine, 14-01-156 project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Broadbent and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines
Laboratory Manager

Enclosure

Daniel B. Stephens & Associates, Inc.
Soil Testing & Research Laboratory
4400 Alameda Blvd. NE, Suite C
Albuquerque, NM 87113
505-889-7752
FAX 505-889-0258

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Permeability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
90/10 Blend (95%)	X	X					X	X		X	X			X								

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method

[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall

[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity

[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer

[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
One sample was received as loose material in a 3-gallon bucket sealed with a lid on July 8, 2021. The sample was received in good order.

Sample Preparation and Testing Notes:
A portion of the sample was remolded into a testing ring to target 95% of the maximum dry bulk density at the optimum moisture content, based on client provided modified proctor compaction testing results. The remolded sub-sample was subjected to initial properties analysis, saturation, and the hanging column and pressure chamber portions of the moisture retention testing. A secondary sub-sample was also prepared, using the same target remold parameters. The secondary sub-sample was extruded from the testing ring and subjected to saturated hydraulic conductivity testing via the flexible wall method. The actual percentage of maximum dry bulk density achieved was added to sub-sample ID. Separate sub-samples were obtained for the heat dissipation sensor, dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

Material larger than 4.75mm was removed from the bulk material prior to remolding the sub-samples. Oversize correction calculations are provided based on the client provided particle size analysis and specific gravity test results.

Summary of Oversize Corrected Sample Preparation and Volume Changes

	Modified Proctor Compaction Data		Target Remold Parameters[1]			Actual Remold Data Oversize Corrected[2]			Volume Change Post Saturation[3]			Volume Change Post Drying Curve[3]		
	Optimum Moisture Content	Max. Dry Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Moist. Cont.	Dry Bulk Density	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density	Dry Bulk Density	% Volume Change	% of Max. Density
Sample Number	(%, g/g)	(pcf)	(%, g/g)	(pcf)	(%)	(%, g/g)	(pcf)	(%)	(pcf)	(%)	(%)	(pcf)	(%)	(%)
90/10 Blend (95%)	16.4	107.2	16.4	101.84	95%	16.5	102.0	95.1%	99.2	+3.1%	92.5%	98.0	+4.5%	91.4%

[1]Target Remold Parameters: 95% of the respective maximum dry bulk density at the respective optimum moisture content, based on modified proctor compaction testing results provided by the requestor.

[2]Actual Remold Data: The actual density and moisture content achieved, oversize corrected based on the client provided particle size analysis and specific gravity test results.

[3]Volume Change Post Saturation and Post Drying Curve: Volume change measurements were obtained after saturated hydraulic conductivity testing, and throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point. The dry bulk densities are oversize corrected to represent the bulk sample.

Notes: "+" indicates sample swelling, "-" indicates sample settling, "---" indicates no volume change occurred, and "NA" indicates not applicable.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	As Remolded Moisture Content: Test Sample Gravimetric (%, g/g)	As Remolded Moisture Content: Test Sample Volumetric (%, cm^3/cm^3)	As Remolded Moisture Content: Oversize Corrected Gravimetric (%, g/g)	As Remolded Moisture Content: Oversize Corrected Volumetric (%, cm^3/cm^3)	Dry Bulk Density: Test Sample (pcf)	Dry Bulk Density: Oversize Corrected (pcf)	Calculated Porosity: Test Sample (%)	Calculated Porosity: Oversize Corrected (%)
90/10 Blend (95%)	18.7	29.3	16.6	26.1	97.9	102.0	40.8	37.4

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head Flexible Wall	Method of Analysis: Falling Head Flexible Wall
90/10 Blend (95%)	2.8E-06	2.5E-06		X

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
90/10 Blend (95%)	0	44.6 ‡‡
	24	45.8 ‡‡
	81	45.8 ‡‡
	180	45.1 ‡‡
	337	39.5 ‡‡
	2805	26.7 ‡‡
	267086	9.3 ‡‡
	564153	7.4 ‡‡
	848426	6.5 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
90/10 Blend (95%)	0.0022	1.3126	2.88	45.96	2.64	42.23

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	As Remolded Moisture Content: Test Sample: Gravimetric (%, g/g)	As Remolded Moisture Content: Test Sample: Volumetric (%, cm^3/cm^3)	As Remolded Moisture Content: Oversize Corrected: Gravimetric (%, g/g)	As Remolded Moisture Content: Oversize Corrected: Volumetric (%, cm^3/cm^3)	Dry Bulk Density: Test Sample (pcf)	Dry Bulk Density: Oversize Corrected (pcf)	Calculated Porosity: Test Sample (%)	Calculated Porosity: Oversize Corrected (%)
90/10 Blend (95%)	18.7	29.3	16.6	26.1	97.9	102.0	40.8	37.4

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.00
Sample Number:	90/10 Blend (95%)
Project:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	4-Aug-21
Field weight of sample* (g):		556.12
Tare weight, ring (g):		139.40
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		351.05
Sample volume (cm^3):		223.79
Provided particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		18.7
Volumetric Moisture Content (% vol):		29.3
Dry bulk density (g/cm^3):		1.57
Wet bulk density (g/cm^3):		1.86
Calculated Porosity (% vol):		40.8
Percent Saturation:		71.9

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Saturated Hydraulic Conductivity

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Constant Head Flexible Wall	Method of Analysis: Falling Head Flexible Wall
90/10 Blend (95%)	2.8E-06	2.5E-06		X

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 90/10 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties		Post Permeation Sample Properties		Test and Sample Conditions	
Initial Mass (g):	411.91	*Saturated Mass (g):*	459.74	*Permeant liquid used:*	Tap Water
Diameter (cm):	6.099	*Dry Mass (g):*	349.00	*Sample Preparation:*	☐ In situ sample, extruded
Length (cm):	7.585	*Diameter (cm):*	6.318		☑ Remolded Sample
Area (cm^2):	29.22	*Length (cm):*	7.600	*Number of Lifts:*	5
Volume (cm^3):	221.60	*Deformation (%)**:*	0.19	*Split:*	3/8"
Dry Density (g/cm^3):	1.57	*Area (cm^2):*	31.35	*Percent Coarse Material (%):*	NA
Dry Density (pcf):	98.3	*Volume (cm^3):*	238.26	*Particle Density(g/cm^3):*	2.65 ☑ Provided ☐ Measured
Water Content (%, g/g):	18.0	*Dry Density (g/cm^3):*	1.46	*Cell pressure (PSI):*	95.0
Water Content (%, vol):	28.4	*Dry Density (pcf):*	91.4	*Influent pressure (PSI):*	80.0
Void Ratio (e):	0.68	*Water Content (%, g/g):*	31.7	*Effluent pressure (PSI):*	80.0
Porosity (%, vol):	40.6	*Water Content (%, vol):*	46.5	*Panel Used:*	☐ D ☑ E ☐ F
Saturation (%):	70.0	*Void Ratio(e):*	0.81	*Reading:*	☐ Annulus ☑ Pipette
		Porosity (%, vol):	44.7		
		Saturation (%):*	103.9		

		Date/Time
B-Value (% saturation) prior to test*:	1.00	8/8/21 825
B-Value (% saturation) post to test:	1.00	8/10/21 1015

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

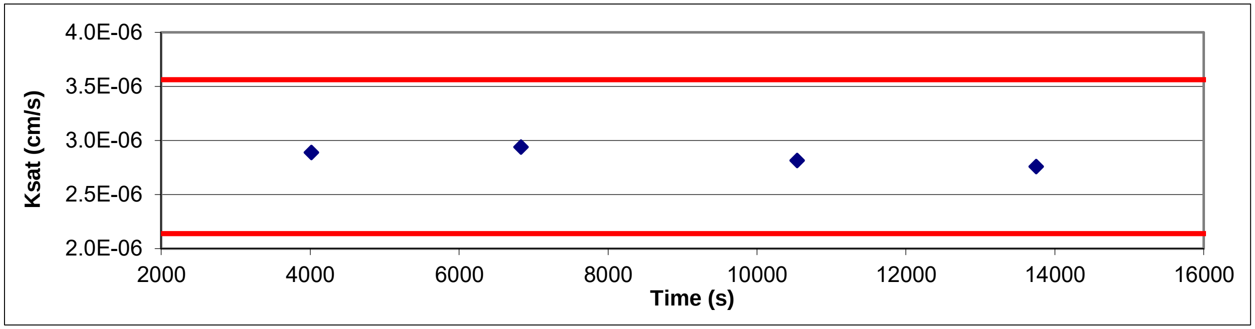
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 90/10 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
09-Aug-21	08:35:00	22.0	2.00	24.00	3.34	1.04	4015	1.00	11%	3.03E-06	2.89E-06
09-Aug-21	09:41:55	22.0	3.20	22.80	2.98						
Test # 2:											
09-Aug-21	10:43:47	22.2	4.20	21.80	2.67	0.61	2817	1.00	8%	3.10E-06	2.94E-06
09-Aug-21	11:30:44	22.3	4.90	21.10	2.46						
Test # 3:											
10-Aug-21	07:15:00	22.0	5.90	20.10	2.16	0.61	3705	1.00	10%	2.95E-06	2.81E-06
10-Aug-21	08:16:45	22.0	6.60	19.40	1.94						
Test # 4:											
10-Aug-21	09:06:14	22.1	7.10	18.90	1.79	0.43	3214	1.00	8%	2.90E-06	2.76E-06
10-Aug-21	09:59:48	22.2	7.60	18.40	1.64						

***Average Ksat* (cm/sec):** **2.85E-06**
Calculated Gravel Corrected Average Ksat (cm/sec): 2.45E-06



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 2.14E-06

Ksat (+25%) (cm/s): 3.56E-06

Moisture Retention Characteristics

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
90/10 Blend (95%)	0	44.6 ‡‡
	24	45.8 ‡‡
	81	45.8 ‡‡
	180	45.1 ‡‡
	337	39.5 ‡‡
	2805	26.7 ‡‡
	267086	9.3 ‡‡
	564153	7.4 ‡‡
	848426	6.5 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
90/10 Blend (95%)	0.0022	1.3126	2.88	45.96	2.64	42.23

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample (g):*	351.05
Job Number:	DB21.1124.00	*Tare wt., ring (g):*	139.40
Sample Number:	90/10 Blend (95%)	*Tare wt., screen & clamp (g):*	28.28
Project:	3 Kids Mine, 14-01-156	*Initial sample volume (cm^3):*	223.79
Depth:	NA	*Initial dry bulk density (g/cm^3):*	1.57
		Provided particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	40.80

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)	
Hanging column:	9-Aug-21	11:55	621.70	0	44.64	‡‡
	16-Aug-21	9:00	626.13	24.0	45.82	‡‡
	23-Aug-21	11:30	625.76	81.0	45.78	‡‡
	30-Aug-21	11:40	624.07	180.0	45.06	‡‡
Pressure plate:	9-Sep-21	6:45	611.14	337	39.53	‡‡
HD Sensor:	11-Aug-21	6:06	581.22	2805	26.73	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	230.67	+3.08%	1.52	42.57
	24.0	234.38	+4.73%	1.50	43.48
	81.0	233.79	+4.47%	1.50	43.34
	180.0	233.79	+4.47%	1.50	43.34
Pressure plate:	337	233.79	+4.47%	1.50	43.34
HD Sensor:	2805	233.79	+4.47%	1.50	43.34

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: 90/10 Blend (95%)

Initial sample bulk density (g/cm^3)*:* 1.57
Fraction of test sample used (<2.00mm fraction) (%): 95.58

Dry weight of dew point potentiometer sample* (g)*:* 162.07
Tare weight, jar (g)*:* 113.16

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	13-Aug-21	10:27	165.24	267086	9.30	‡‡
	12-Aug-21	13:38	164.59	564153	7.39	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	267086	233.79	+4.47%	1.50	43.34
	564153	233.79	+4.47%	1.50	43.34

Dry weight of relative humidity box sample* (g)*:* 59.67
Tare weight (g)*:* 44.19

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Relative humidity box:	10-Aug-21	14:00	60.37	848426	6.54	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	848426	233.79	+4.47%	1.50	43.34

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

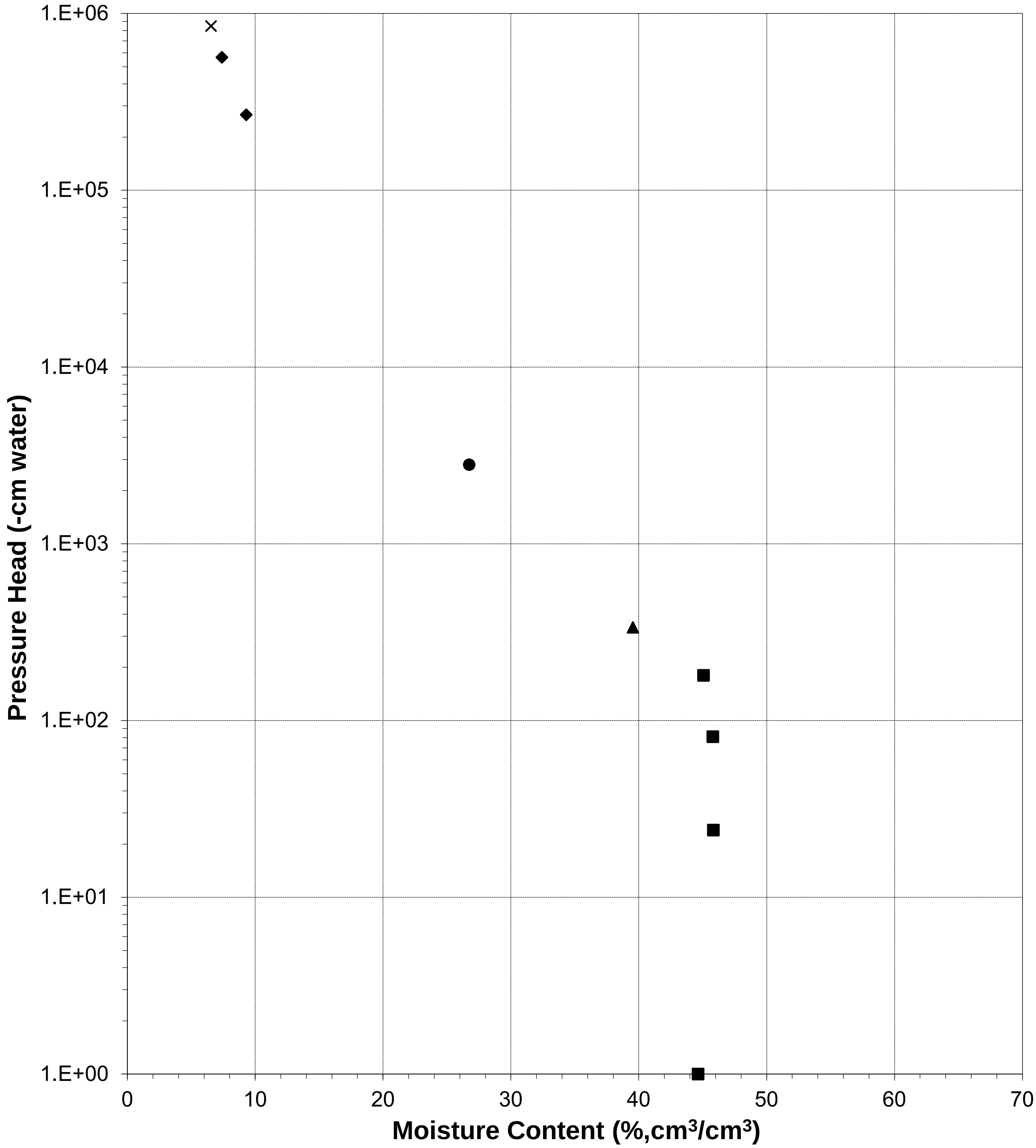
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

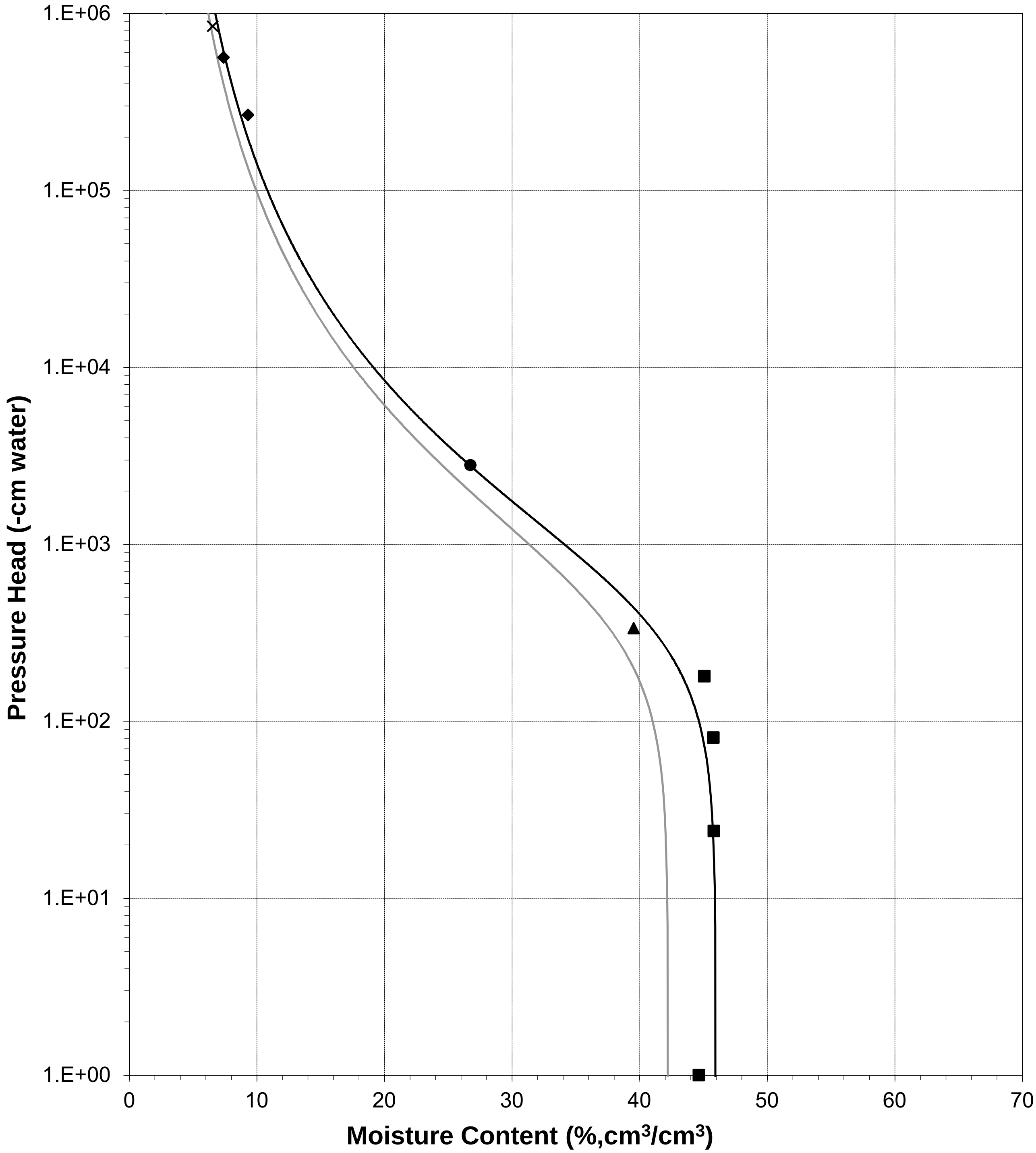
Water Retention Data Points

Sample Number: 90/10 Blend (95%)



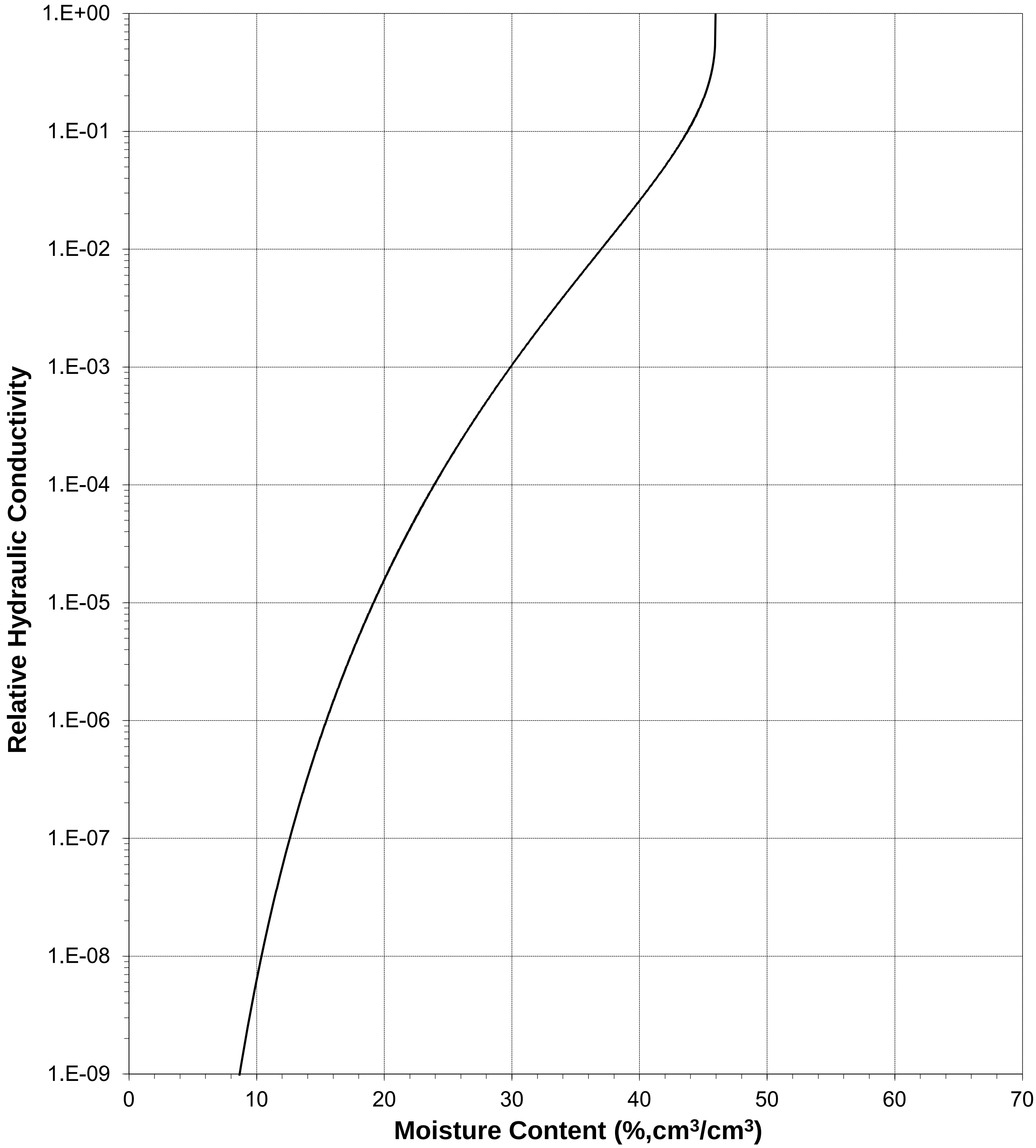
Predicted Water Retention Curve and Data Points

Sample Number: 90/10 Blend (95%)



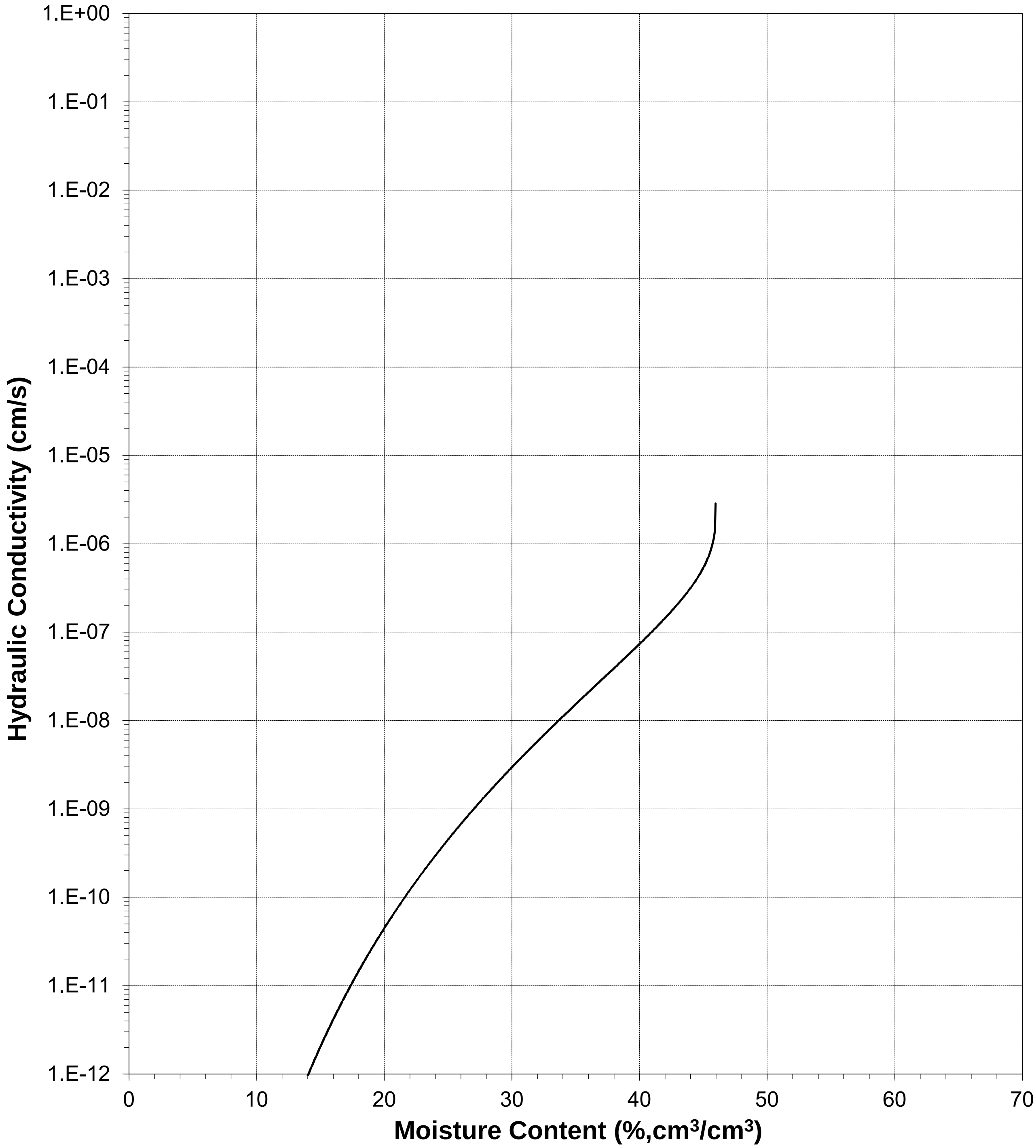
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: 90/10 Blend (95%)



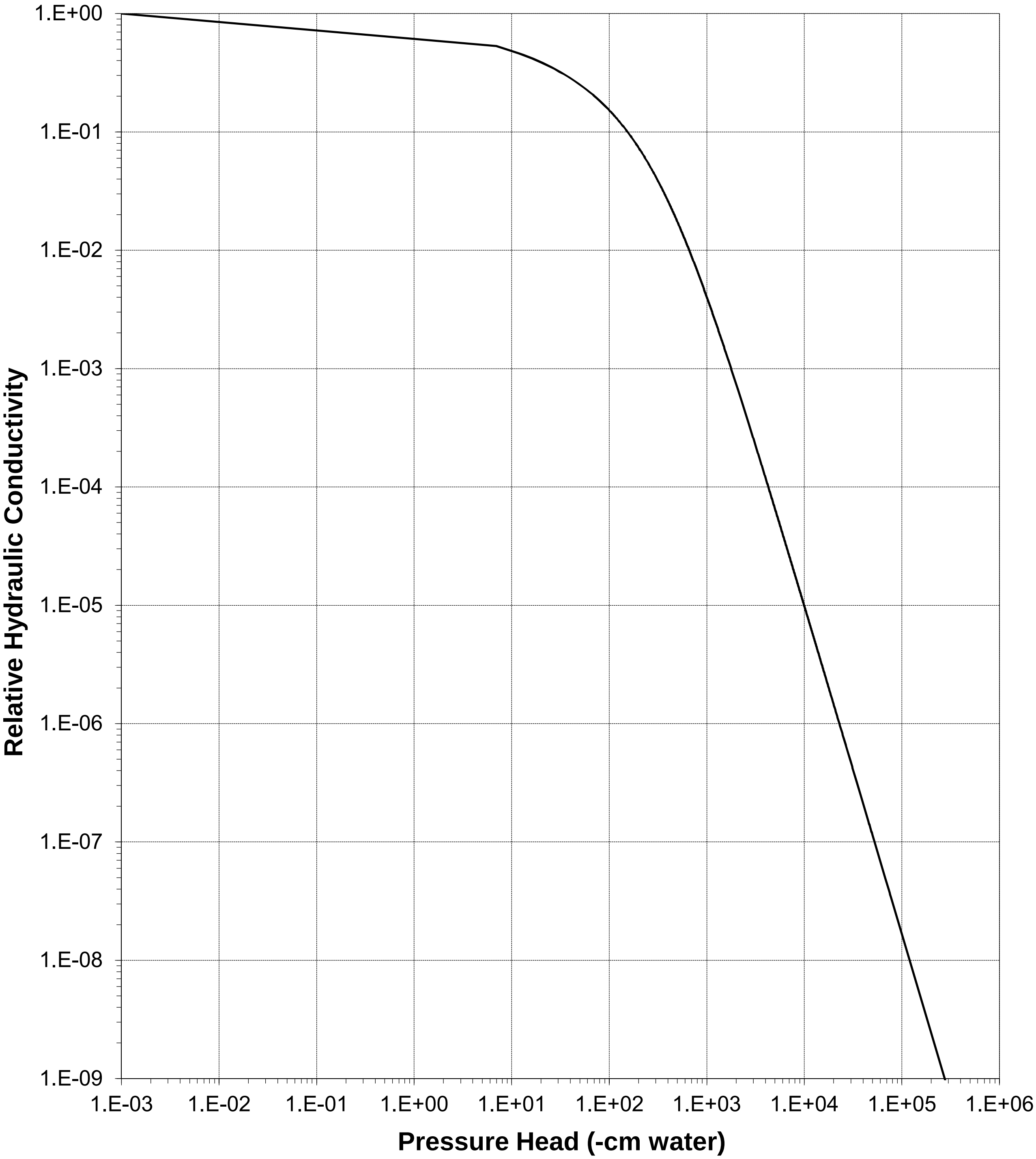
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: 90/10 Blend (95%)



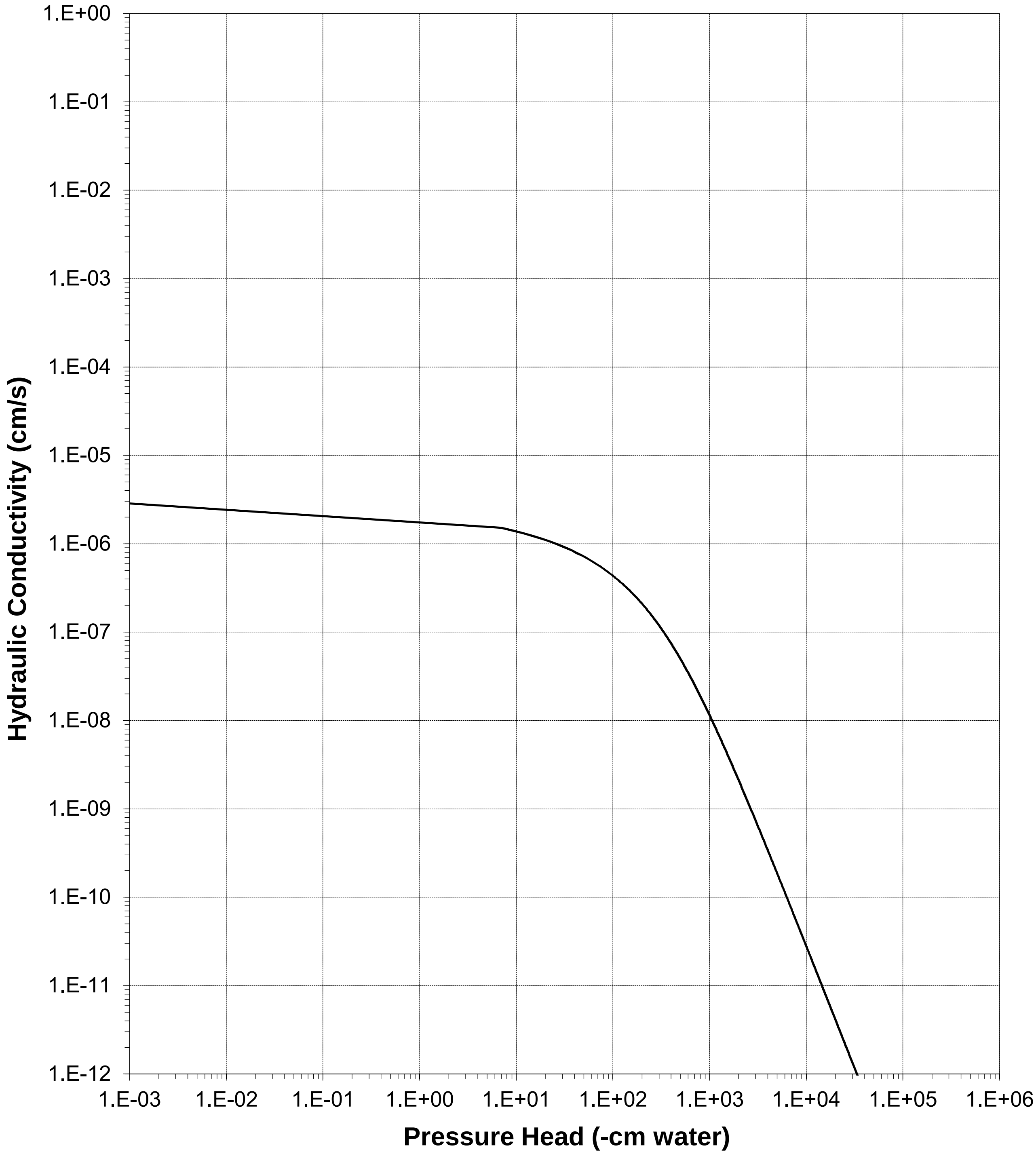
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: 90/10 Blend (95%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: 90/10 Blend (95%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: 90/10 Blend (95%)
Project: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): #4

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	12.00	88.00	100.00
Mass Fraction (%):	12.00	88.00	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.35	1.57	1.63
Calculated Porosity (% vol):	0.00	40.80	37.40
Volume of Solids (cm^3):	5.11	33.21	38.31
Volume of Voids (cm^3):	0.00	22.89	22.89
Total Volume (cm^3):	5.11	56.10	61.20
Volumetric Fraction (%):	8.34	91.66	100.00
Initial Moisture Content (% vol):	0.00	29.34	26.90
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.35	1.52	1.59
Calculated Porosity (% vol):	0.00	42.57	39.12
Volume of Solids (cm^3):	5.11	33.21	38.31
Volume of Voids (cm^3):	0.00	24.62	24.62
Total Volume (cm^3):	5.11	57.82	62.93
Volumetric Fraction (%):	8.11	91.89	100.00
Saturated Moisture Content (% vol):	0.00	45.96	42.23
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.35	1.50	1.57
Calculated Porosity (% vol):	0.00	43.34	39.86
Volume of Solids (cm^3):	5.11	33.21	38.31
Volume of Voids (cm^3):	0.00	25.40	25.40
Total Volume (cm^3):	5.11	58.61	63.71
Volumetric Fraction (%):	8.01	91.99	100.00
Residual Moisture Content (% vol):	0.00	2.88	2.64
Ksat (cm/sec):	NM	2.8E-06	2.5E-06

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263, ASTM D2216
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity:	
Falling Head Rising Tail: (Flexible Wall)	ASTM D5084
Hanging Column Method:	ASTM D6836 (modified apparatus)
Pressure Plate Method:	ASTM D6836
Water Potential (Dewpoint Potentiometer) Method:	ASTM D6836
Relative Humidity (Box) Method:	Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis. Part 1. American Society of Agronomy, Madison, WI; Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325
Heat Dissipation Sensor:	229 Heat Dissipation Matric Water Potential Sensor Instruction Manual (Rev. 5/09). Campbell Scientific, Inc., Logan, UT; Flint, A.L., et al. Calibration and Temperature Correction of Heat Dissipation Matric Potential Sensors. Soil Sci. Soc. Am. J. 66.1439 1445 (2002); van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Coarse Fraction (Gravel) Correction (calc):	ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose Zones. Groundwater Vol. 22, No. 6

Laboratory Report for

Broadbent

3 Kids Mine, 14-01-156

December 28, 2021

Daniel B. Stephens & Associates, Inc.

4400 Alameda Blvd. NE, Suite C • Albuquerque, New Mexico 87113

December 28, 2021

Karen Gastineau
Broadbent
8 W Pacific Ave.
Henderson, NV 89015
(702) 563.0600

Re: DBS&A Laboratory Report for the Broadbent 3 Kids Mine, 14-01-156 Project

Dear Karen Gastineau:

Enclosed is the report for the Broadbent 3 Kids Mine, 14-01-156 project samples. Please review this report and provide any comments as samples will be held for a maximum of 30 days. After 30 days samples will be returned or disposed of in an appropriate manner.

All testing results were evaluated subjectively for consistency and reasonableness, and the results appear to be reasonably representative of the material tested. However, DBS&A does not assume any responsibility for interpretations or analyses based on the data enclosed, nor can we guarantee that these data are fully representative of the undisturbed materials at the field site. We recommend that careful evaluation of these laboratory results be made for your particular application.

The testing utilized to generate the enclosed report employs methods that are standard for the industry. The results do not constitute a professional opinion by DBS&A, nor can the results affect any professional or expert opinions rendered with respect thereto by DBS&A. You have acknowledged that all the testing undertaken by us, and the report provided, constitutes mere test results using standardized methods, and cannot be used to disqualify DBS&A from rendering any professional or expert opinion, having waived any claim of conflict of interest by DBS&A.

We are pleased to provide this service to Broadbent and look forward to future laboratory testing on other projects. If you have any questions about the enclosed data, please do not hesitate to call.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.
SOIL TESTING & RESEARCH LABORATORY

Joleen Hines

Joleen Hines
Laboratory Manager

Enclosure

Daniel B. Stephens & Associates, Inc.
Soil Testing & Research Laboratory
4400 Alameda Blvd. NE, Suite C
Albuquerque, NM 87113
505-889-7752
FAX 505-889-0258

Summaries

Summary of Tests Performed

Laboratory Sample Number	Initial Soil Properties[1]			Saturated Hydraulic Conductivity[2]			Moisture Characteristics[3]								Particle Size[4]			Specific Gravity[5]		Air Perm-eability	Atterberg Limits	Proctor Compaction
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
TSM Fault AB TP2 (~90%)	X	X				X	X			X	X			X								
TSM Fault AB TP1 (~90%)	X	X				X	X			X				X								
Muddy Creek AB TP1 (~90%)	X	X				X	X			X				X								
Muddy Creek TP1 (~90%)	X	X				X	X			X				X								
Muddy Creek TP3 (~90%)	X	X				X	X			X				X								
Alluvium Borrow TP (~90%)	X	X				X	X	X		X	X			X								
Older Alluvium Fan Deposits (~90%)	X	X				X	X			X	X			X								
Mill Site (~90%)	X	X				X	X			X	X			X								
Ore Yard (~90%)	X	X				X	X			X				X								
AB Pit Bot 01 (~90%)	X	X				X	X	X		X				X								
TP1WN-TP1E (~90%)	X	X				X	X	X		X	X			X								
WR07E-WR07N (~90%)	X	X				X	X	X		X				X								

[1] G = Gravimetric Moisture Content, VM = Volume Measurement Method, VD = Volume Displacement Method
[2] CH = Constant Head Rigid Wall, FH = Falling Head Rigid Wall, FW = Falling Head Rising Tail Flexible Wall
[3] HC = Hanging Column, PP = Pressure Plate, FP = Filter Paper, DPP = Dew Point Potentiometer, RH = Relative Humidity Box, EP = Effective Porosity, WHC = Water Holding Capacity, Kunsat = Calculated Unsaturated Hydraulic Conductivity
[4] DS = Dry Sieve, WS = Wet Sieve, H = Hydrometer
[5] F = Fine (<4.75mm), C = Coarse (>4.75mm)

Notes

Sample Receipt:
Twelve samples, each as loose material in one or two full 5-gallon buckets sealed with lids and tape, were received on November 11, 2021. The samples were received in good order.

Sample Preparation and Testing Notes:
A portion of each sample was remolded into a testing ring using a firm compactive effort in order to achieve a density that would approximate 90% of standard proctor compaction testing, based on technician experience and judgement. This target was chosen in order to 1) mimic the in-situ conditions after being driven over by heavy trucks, and 2) mimic a potential placement density for the borrow materials. Prior to remolding, the sub-samples were moisture adjusted in order to achieve a moisture content that would facilitate compaction. The remolded sub-samples were subjected to initial properties analysis, saturation, and the hanging column and pressure chamber portions of the moisture retention testing. Secondary sub-samples were also prepared, using the same target remold parameters. The secondary sub-samples were extruded from the testing rings and subjected to saturated hydraulic conductivity testing via the flexible wall method. Separate sub-samples were obtained for the dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

Material larger than either 3/8" or 3/4", as appropriate, were removed from the bulk material prior to remolding the sub-samples. In an effort to minimize deviation from in-situ field soil conditions, neither additional hand grinding nor the use of an electric soil grinder was used to further break down of the material. Oversize correction calculations are provided if the fraction removed was greater than 5% of the bulk sample mass.

Porosity calculations are based on the use of an assumed specific gravity value of either 2.65 or 2.75.

Summary of Oversize Corrected Sample Preparation and Volume Changes

	Target Remold Parameters[1]		Remold Data, Oversize Corrected[2]		Volume Change Post Saturation[3]			Volume Change Post Drying Curve[3]		
Sample Number	Moist. Cont. (%, g/g)	Dry Bulk Density (g/cm^3)	Moist. Cont. (%, g/g)	Dry Bulk Density (g/cm^3)	Dry Bulk Density (g/cm^3)	% Volume Change (%)	% of Initial Density (%)	Dry Bulk Density (g/cm^3)	% Volume Change (%)	% of Initial Density (%)
TSM Fault AB TP2 (~90%)	~opt.	~90%	27.7	1.28	1.28	---	100.0%	1.28	---	100.0%
TSM Fault AB TP1 (~90%)	~opt.	~90%	14.1	1.61	1.61	---	100.0%	1.61	---	100.0%
Muddy Creek AB TP1 (~90%)	~opt.	~90%	23.1	1.34	1.34	---	100.0%	1.34	---	100.0%
Muddy Creek TP1 (~90%)	~opt.	~90%	8.2	1.75	1.84	-5.1%	105.1%	1.84	-5.1%	105.1%
Muddy Creek TP3 (~90%)	~opt.	~90%	11.6	1.68	1.73	-3.4%	103.3%	1.73	-3.4%	103.3%
Alluvium Borrow TP (~90%)	~opt.	~90%	5.6	1.80	1.80	---	100.0%	1.80	---	100.0%
Older Alluvium Fan Deposits (~90%)	~opt.	~90%	6.7	1.86	1.86	---	100.0%	1.75	+7.6%	94.0%
Mill Site (~90%)	~opt.	~90%	5.0	1.85	1.85	---	100.0%	1.85	---	100.0%

[1]Target Remold Parameters: Approximately 90% of standard proctor compaction testing at approximately optimum moisture content, based on technician experience and judgement.

[2]Actual Remold Data: The actual density and moisture content achieved, oversize corrected (if applicable) based on the client provided particle size analysis results.

[3]Volume Change Post Saturation and Post Drying Curve: Volume change measurements were obtained after saturated hydraulic conductivity testing, and throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point. The dry bulk densities are oversize corrected (if applicable) to represent the bulk sample.

Notes: "+" indicates sample swelling, "-" indicates sample settling, "---" indicates no volume change occurred, and "NA" indicates not applicable.

Summary of Oversize Corrected Sample Preparation and Volume Changes (Continued)

Sample Number	Target Remold Parameters[1] Moist. Cont. (%, g/g)	Target Remold Parameters[1] Dry Bulk Density (g/cm^3)	Remold Data, Oversize Corrected[2] Moist. Cont. (%, g/g)	Remold Data, Oversize Corrected[2] Dry Bulk Density (g/cm^3)	Volume Change Post Saturation[3] Dry Bulk Density (g/cm^3)	Volume Change Post Saturation[3] % Volume Change (%)	Volume Change Post Saturation[3] % of Initial Density (%)	Volume Change Post Drying Curve[3] Dry Bulk Density (g/cm^3)	Volume Change Post Drying Curve[3] % Volume Change (%)	Volume Change Post Drying Curve[3] % of Initial Density (%)
Ore Yard (~90%)	~opt.	~90%	13.9	1.61	1.61	---	100.0%	1.61	---	100.0%
AB Pit Bot 01 (~90%)	~opt.	~90%	39.5	1.20	1.20	---	100.0%	1.16	+3.5%	96.6%
TP1WN-TP1E (~90%)	~opt.	~90%	20.5	1.53	1.53	---	100.0%	1.51	+1.3%	98.8%
WR07E-WR07N (~90%)	~opt.	~90%	22.3	1.48	1.48	---	100.0%	1.46	+1.1%	98.9%

[1]Target Remold Parameters: Approximately 90% of standard proctor compaction testing at approximately optimum moisture content, based on technician experience and judgement.

[2]Actual Remold Data: The actual density and moisture content achieved, oversize corrected (if applicable) based on the client provided particle size analysis results.

[3]Volume Change Post Saturation and Post Drying Curve: Volume change measurements were obtained after saturated hydraulic conductivity testing, and throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point. The dry bulk densities are oversize corrected (if applicable) to represent the bulk sample.

Notes: "+" indicates sample swelling, "-" indicates sample settling, "---" indicates no volume change occurred, and "NA" indicates not applicable.

Summary of Oversize Corrected Sample Preparation and Volume Changes (pcf)

	Target Remold Parameters[1]		Remold Data, Oversize Corrected[2]		Volume Change Post Saturation[3]			Volume Change Post Drying Curve[3]		
Sample Number	Moist. Cont. (%, g/g)	Dry Bulk Density (pcf)	Moist. Cont. (%, g/g)	Dry Bulk Density (pcf)	Dry Bulk Density (pcf)	% Volume Change (%)	% of Initial Density (%)	Dry Bulk Density (pcf)	% Volume Change (%)	% of Initial Density (%)
TSM Fault AB TP2 (~90%)	~opt.	~90%	27.7	79.7	79.7	---	100.0%	79.7	---	100.0%
TSM Fault AB TP1 (~90%)	~opt.	~90%	14.1	100.4	100.4	---	100.0%	100.4	---	100.0%
Muddy Creek AB TP1 (~90%)	~opt.	~90%	23.1	84.0	84.0	---	100.0%	84.0	---	100.0%
Muddy Creek TP1 (~90%)	~opt.	~90%	8.2	109.3	114.9	-5.1%	105.1%	114.9	-5.1%	105.1%
Muddy Creek TP3 (~90%)	~opt.	~90%	11.6	104.8	108.2	-3.4%	103.3%	108.2	-3.4%	103.3%
Alluvium Borrow TP (~90%)	~opt.	~90%	5.6	112.3	112.3	---	100.0%	112.3	---	100.0%
Older Alluvium Fan Deposits (~90%)	~opt.	~90%	6.7	116.4	116.4	---	100.0%	109.4	+7.6%	94.0%
Mill Site (~90%)	~opt.	~90%	5.0	115.6	115.6	---	100.0%	115.6	---	100.0%

[1]Target Remold Parameters: Approximately 90% of standard proctor compaction testing at approximately optimum moisture content, based on technician experience and judgement.

[2]Actual Remold Data: The actual density and moisture content achieved, oversize corrected (if applicable) based on the client provided particle size analysis results.

[3]Volume Change Post Saturation and Post Drying Curve: Volume change measurements were obtained after saturated hydraulic conductivity testing, and throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point. The dry bulk densities are oversize corrected (if applicable) to represent the bulk sample.

Notes: "+" indicates sample swelling, "-" indicates sample settling, "---" indicates no volume change occurred, and "NA" indicates not applicable.

Summary of Oversize Corrected Sample Preparation and Volume Changes (pcf) (Continued)

	Target Remold Parameters[1]		Remold Data, Oversize Corrected[2]		Volume Change Post Saturation[3]			Volume Change Post Drying Curve[3]		
	Moist. Cont.	Dry Bulk Density	Moist. Cont.	Dry Bulk Density	Dry Bulk Density	% Volume Change	% of Initial Density	Dry Bulk Density	% Volume Change	% of Initial Density
Sample Number	(%, g/g)	(pcf)	(%, g/g)	(pcf)	(pcf)	(%)	(%)	(pcf)	(%)	(%)
Ore Yard (~90%)	~opt.	~90%	13.9	100.4	100.4	---	100.0%	100.4	---	100.0%
AB Pit Bot 01 (~90%)	~opt.	~90%	39.5	74.9	74.9	---	100.0%	72.4	+3.5%	96.6%
TP1WN-TP1E (~90%)	~opt.	~90%	20.5	95.4	95.4	---	100.0%	94.2	+1.3%	98.8%
WR07E-WR07N (~90%)	~opt.	~90%	22.3	92.3	92.3	---	100.0%	91.4	+1.1%	98.9%

[1]Target Remold Parameters: Approximately 90% of standard proctor compaction testing at approximately optimum moisture content, based on technician experience and judgement.

[2]Actual Remold Data: The actual density and moisture content achieved, oversize corrected (if applicable) based on the client provided particle size analysis results.

[3]Volume Change Post Saturation and Post Drying Curve: Volume change measurements were obtained after saturated hydraulic conductivity testing, and throughout hanging column and pressure plate testing. The 'Volume Change Post Drying Curve' values represent the final sample dimensions after the last pressure plate point. The dry bulk densities are oversize corrected (if applicable) to represent the bulk sample.

Notes: "+" indicates sample swelling, "-" indicates sample settling, "---" indicates no volume change occurred, and "NA" indicates not applicable.

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
TSM Fault AB TP2 (~90%)	NA	NA	32.0	37.7	1.18	1.56	57.1
TSM Fault AB TP1 (~90%)	NA	NA	17.2	25.5	1.48	1.73	44.2
Muddy Creek AB TP1 (~90%)	NA	NA	23.1	31.1	1.34	1.66	49.3
Muddy Creek TP1 (~90%)	NA	NA	8.8	15.1	1.71	1.86	35.4
Muddy Creek TP3 (~90%)	NA	NA	12.8	20.7	1.62	1.82	38.9
Alluvium Borrow TP (~90%)	NA	NA	6.0	10.5	1.76	1.86	33.7
Older Alluvium Fan Deposits (~90%)	NA	NA	8.6	14.8	1.72	1.87	35.2
Mill Site (~90%)	NA	NA	6.0	10.5	1.74	1.85	34.3
Ore Yard (~90%)	NA	NA	14.0	22.5	1.60	1.83	41.7
AB Pit Bot 01 (~90%)	NA	NA	39.5	47.4	1.20	1.67	56.4
TP1WN-TP1E (~90%)	NA	NA	23.0	33.4	1.45	1.79	45.1
WR07E-WR07N (~90%)	NA	NA	22.3	33.0	1.48	1.81	44.2

NA = Not analyzed
--- = This sample was not remolded

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Falling Head Flexible Wall
TSM Fault AB TP2 (~90%)	9.7E-04	8.4E-04	X
TSM Fault AB TP1 (~90%)	6.7E-04	5.5E-04	X
Muddy Creek AB TP1 (~90%)	4.5E-04	NA	X
Muddy Creek TP1 (~90%)	9.2E-04	8.6E-04	X
Muddy Creek TP3 (~90%)	4.3E-04	3.9E-04	X
Alluvium Borrow TP (~90%)	5.2E-04	4.9E-04	X
Older Alluvium Fan Deposits (~90%)	4.3E-04	3.4E-04	X
Mill Site (~90%)	1.1E-03	9.2E-04	X
Ore Yard (~90%)	1.0E-03	---	X
AB Pit Bot 01 (~90%)	1.3E-05	NA	X
TP1WN-TP1E (~90%)	9.6E-05	8.6E-05	X
WR07E-WR07N (~90%)	3.0E-04	NA	X

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NA = Not applicable

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
TSM Fault AB TP2 (~90%)	0	60.0
	8	54.7
	14	53.8
	46	48.1
	202	43.0
	9076	22.7
	47523	14.6
	158681	7.7
	849860	4.0
TSM Fault AB TP1 (~90%)	0	42.7
	7	41.1
	13	37.9
	44	31.0
	204	26.0
	13461	10.4
	44055	6.9
	176425	4.2
	790039	2.5
Muddy Creek AB TP1 (~90%)	0	49.6
	8	45.1
	16	41.7
	47	36.6
	203	31.0
	173570	12.2
	305430	7.9
	721916	6.1

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
Muddy Creek TP1 (~90%)	0	37.2 ‡‡
	8	32.7 ‡‡
	15	30.8 ‡‡
	43	25.0 ‡‡
	207	13.5 ‡‡
	21008	6.1 ‡‡
	68021	3.9 ‡‡
	213852	2.7 ‡‡
	521526	2.1 ‡‡
Muddy Creek TP3 (~90%)	0	38.5 ‡‡
	8	33.3 ‡‡
	16	31.4 ‡‡
	48	26.5 ‡‡
	203	16.9 ‡‡
	143894	6.2 ‡‡
	325418	4.6 ‡‡
	534783	3.7 ‡‡
Alluvium Borrow TP (~90%)	0	33.4
	8	33.0
	24	32.7
	76	22.5
	337	12.3
	15501	5.9
	37937	4.3
	191314	3.3
	849860	2.6

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
Older Alluvium Fan Deposits (~90%)	0	35.3
	6	25.7 ‡‡
	15	23.7 ‡‡
	55	22.2 ‡‡
	210	16.6 ‡‡
	15399	5.6 ‡‡
	59964	3.3 ‡‡
	289215	2.5 ‡‡
	849860	2.3 ‡‡
Mill Site (~90%)	0	35.0
	5	34.1
	11	32.9
	40	20.9
	204	12.5
	12646	5.1
	47421	3.0
	205898	2.4
	849860	2.0
Ore Yard (~90%)	0	42.2
	8	39.0
	15	37.4
	51	33.3
	212	27.8
	75159	11.7
	154602	9.8
	345202	7.9
	789121	6.1

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
AB Pit Bot 01 (~90%)	0	58.0
	22	57.7 ‡‡
	73	57.0 ‡‡
	170	54.4 ‡‡
	337	52.9 ‡‡
	51908	20.0 ‡‡
	93312	16.6 ‡‡
	213240	13.3 ‡‡
	270349	12.3 ‡‡
TP1WN-TP1E (~90%)	0	47.2
	15	47.0 ‡‡
	32	46.9 ‡‡
	93	41.5 ‡‡
	337	35.3 ‡‡
	41812	10.9 ‡‡
	59250	9.2 ‡‡
	149197	6.8 ‡‡
	849860	4.4 ‡‡
WR07E-WR07N (~90%)	0	46.0
	8	45.7 ‡‡
	24	41.2 ‡‡
	76	37.5 ‡‡
	337	33.1 ‡‡
	105651	14.3 ‡‡
	246996	10.8 ‡‡
	596175	8.0 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
TSM Fault AB TP2 (~90%)	0.0196	1.2099	0.00	56.86	0.00	53.32
TSM Fault AB TP1 (~90%)	0.0607	1.2253	0.00	42.66	0.00	37.97
Muddy Creek AB TP1 (~90%)	0.1131	1.1611	0.00	49.35	NA	NA
Muddy Creek TP1 (~90%)	0.0688	1.3822	2.32	36.84	2.22	35.18
Muddy Creek TP3 (~90%)	0.0889	1.2931	2.97	38.05	2.79	35.73
Alluvium Borrow TP (~90%)	0.0196	1.6626	3.70	33.97	3.53	32.42
Older Alluvium Fan Deposits (~90%)	0.3750	1.1950	0.00	34.75	0.00	29.29
Mill Site (~90%)	0.0599	1.5011	2.57	35.73	2.26	31.39
Ore Yard (~90%)	0.0673	1.1595	0.00	41.73	---	---
AB Pit Bot 01 (~90%)	0.0020	1.2381	0.00	57.82	NA	NA
TP1WN-TP1E (~90%)	0.0078	1.2654	0.00	47.51	0.00	44.53
WR07E-WR07N (~90%)	0.0307	1.1572	0.00	45.81	NA	NA

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NA = Not applicable

Initial Properties

Summary of Initial Moisture Content, Dry Bulk Density Wet Bulk Density and Calculated Porosity

Sample Number	Moisture Content: As Received Gravimetric (%, g/g)	Moisture Content: As Received Volumetric (%, cm^3/cm^3)	Moisture Content: Remolded Gravimetric (%, g/g)	Moisture Content: Remolded Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
TSM Fault AB TP2 (~90%)	NA	NA	32.0	37.7	1.18	1.56	57.1
TSM Fault AB TP1 (~90%)	NA	NA	17.2	25.5	1.48	1.73	44.2
Muddy Creek AB TP1 (~90%)	NA	NA	23.1	31.1	1.34	1.66	49.3
Muddy Creek TP1 (~90%)	NA	NA	8.8	15.1	1.71	1.86	35.4
Muddy Creek TP3 (~90%)	NA	NA	12.8	20.7	1.62	1.82	38.9
Alluvium Borrow TP (~90%)	NA	NA	6.0	10.5	1.76	1.86	33.7
Older Alluvium Fan Deposits (~90%)	NA	NA	8.6	14.8	1.72	1.87	35.2
Mill Site (~90%)	NA	NA	6.0	10.5	1.74	1.85	34.3
Ore Yard (~90%)	NA	NA	14.0	22.5	1.60	1.83	41.7
AB Pit Bot 01 (~90%)	NA	NA	39.5	47.4	1.20	1.67	56.4
TP1WN-TP1E (~90%)	NA	NA	23.0	33.4	1.45	1.79	45.1
WR07E-WR07N (~90%)	NA	NA	22.3	33.0	1.48	1.81	44.2

NA = Not analyzed
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.00
Sample Number:	TSM Fault AB TP2 (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3499.00
Tare weight, ring (g):		253.42
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		2458.77
Sample volume (cm^3):		2086.53
Assumed particle density (g/cm^3):		2.75
Gravimetric Moisture Content (% g/g):		32.0
Volumetric Moisture Content (% vol):		37.7
Dry bulk density (g/cm^3):		1.18
Wet bulk density (g/cm^3):		1.56
Calculated Porosity (% vol):		57.1
Percent Saturation:		66.0

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.01
Sample Number:	TSM Fault AB TP1 (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3856.42
Tare weight, ring (g):		255.39
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3072.55
Sample volume (cm^3):		2076.17
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		17.2
Volumetric Moisture Content (% vol):		25.5
Dry bulk density (g/cm^3):		1.48
Wet bulk density (g/cm^3):		1.73
Calculated Porosity (% vol):		44.2
Percent Saturation:		57.6

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.02
Sample Number:	Muddy Creek AB TP1 (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3219.39
Tare weight, ring (g):		220.07
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		2436.49
Sample volume (cm^3):		1811.71
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		23.1
Volumetric Moisture Content (% vol):		31.1
Dry bulk density (g/cm^3):		1.34
Wet bulk density (g/cm^3):		1.66
Calculated Porosity (% vol):		49.3
Percent Saturation:		63.1

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.03
Sample Number:	Muddy Creek TP1 (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3940.31
Tare weight, ring (g):		241.83
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3399.34
Sample volume (cm^3):		1986.33
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		8.8
Volumetric Moisture Content (% vol):		15.1
Dry bulk density (g/cm^3):		1.71
Wet bulk density (g/cm^3):		1.86
Calculated Porosity (% vol):		35.4
Percent Saturation:		42.5

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.04
Sample Number:	Muddy Creek TP3 (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3985.42
Tare weight, ring (g):		252.88
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3308.99
Sample volume (cm^3):		2045.26
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		12.8
Volumetric Moisture Content (% vol):		20.7
Dry bulk density (g/cm^3):		1.62
Wet bulk density (g/cm^3):		1.82
Calculated Porosity (% vol):		38.9
Percent Saturation:		53.2

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Broadbent
Job Number: DB21.1124.05
Sample Number: Alluvium Borrow TP (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		822.06
Tare weight, ring (g):		222.26
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		565.85
Sample volume (cm^3):		321.86
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		6.0
Volumetric Moisture Content (% vol):		10.5
Dry bulk density (g/cm^3):		1.76
Wet bulk density (g/cm^3):		1.86
Calculated Porosity (% vol):		33.7
Percent Saturation:		31.3

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.06
Sample Number:	Older Alluvium Fan Deposits (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3895.50
Tare weight, ring (g):		239.36
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3366.61
Sample volume (cm^3):		1960.17
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		8.6
Volumetric Moisture Content (% vol):		14.8
Dry bulk density (g/cm^3):		1.72
Wet bulk density (g/cm^3):		1.87
Calculated Porosity (% vol):		35.2
Percent Saturation:		42.0

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Broadbent
Job Number: DB21.1124.07
Sample Number: Mill Site (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		798.84
Tare weight, ring (g):		216.81
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		549.08
Sample volume (cm^3):		315.20
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		6.0
Volumetric Moisture Content (% vol):		10.5
Dry bulk density (g/cm^3):		1.74
Wet bulk density (g/cm^3):		1.85
Calculated Porosity (% vol):		34.3
Percent Saturation:		30.5

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Broadbent
Job Number: DB21.1124.08
Sample Number: Ore Yard (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		3664.09
Tare weight, ring (g):		229.00
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		3013.24
Sample volume (cm^3):		1878.18
Assumed particle density (g/cm^3):		2.75
Gravimetric Moisture Content (% g/g):		14.0
Volumetric Moisture Content (% vol):		22.5
Dry bulk density (g/cm^3):		1.60
Wet bulk density (g/cm^3):		1.83
Calculated Porosity (% vol):		41.7
Percent Saturation:		53.9

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.09
Sample Number:	AB Pit Bot 01 (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		734.63
Tare weight, ring (g):		213.79
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		373.34
Sample volume (cm^3):		311.10
Assumed particle density (g/cm^3):		2.75
Gravimetric Moisture Content (% g/g):		39.5
Volumetric Moisture Content (% vol):		47.4
Dry bulk density (g/cm^3):		1.20
Wet bulk density (g/cm^3):		1.67
Calculated Porosity (% vol):		56.4
Percent Saturation:		84.1

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name: Broadbent
Job Number: DB21.1124.10
Sample Number: TP1WN-TP1E (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		777.28
Tare weight, ring (g):		215.50
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		456.73
Sample volume (cm^3):		314.21
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		23.0
Volumetric Moisture Content (% vol):		33.4
Dry bulk density (g/cm^3):		1.45
Wet bulk density (g/cm^3):		1.79
Calculated Porosity (% vol):		45.1
Percent Saturation:		74.0

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Data for Initial Moisture Content, Bulk Density, Porosity, and Percent Saturation

Job Name:	Broadbent
Job Number:	DB21.1124.11
Sample Number:	WR07E-WR07N (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA

	As Received	Remolded
Test Date:	NA	12-Nov-21
Field weight of sample* (g):		786.07
Tare weight, ring (g):		216.50
Tare weight, pan/plate (g):		0.00
Tare weight, other (g):		0.00
Dry weight of sample (g):		465.72
Sample volume (cm^3):		314.87
Assumed particle density (g/cm^3):		2.65
Gravimetric Moisture Content (% g/g):		22.3
Volumetric Moisture Content (% vol):		33.0
Dry bulk density (g/cm^3):		1.48
Wet bulk density (g/cm^3):		1.81
Calculated Porosity (% vol):		44.2
Percent Saturation:		74.6

Laboratory analysis by:	D. O'Dowd
Data entered by:	D. O'Dowd
Checked by:	J. Hines

Comments:

* Weight including tares
NA = Not applicable
--- = This sample was not remolded

Saturated Hydraulic Conductivity

Summary of Saturated Hydraulic Conductivity Tests

Sample Number	K_{sat} (cm/sec)	Oversize Corrected K_{sat} (cm/sec)	Method of Analysis: Falling Head Flexible Wall
TSM Fault AB TP2 (~90%)	9.7E-04	8.4E-04	X
TSM Fault AB TP1 (~90%)	6.7E-04	5.5E-04	X
Muddy Creek AB TP1 (~90%)	4.5E-04	NA	X
Muddy Creek TP1 (~90%)	9.2E-04	8.6E-04	X
Muddy Creek TP3 (~90%)	4.3E-04	3.9E-04	X
Alluvium Borrow TP (~90%)	5.2E-04	4.9E-04	X
Older Alluvium Fan Deposits (~90%)	4.3E-04	3.4E-04	X
Mill Site (~90%)	1.1E-03	9.2E-04	X
Ore Yard (~90%)	1.0E-03	---	X
AB Pit Bot 01 (~90%)	1.3E-05	NA	X
TP1WN-TP1E (~90%)	9.6E-05	8.6E-05	X
WR07E-WR07N (~90%)	3.0E-04	NA	X

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NA = Not applicable

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: TSM Fault AB TP2 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1290.80
Diameter (cm):	10.184
Length (cm):	10.169
Area (cm^2):	81.46
Volume (cm^3):	828.33
Dry Density (g/cm^3):	1.18
Dry Density (pcf):	73.7
Water Content (%, g/g):	31.9
Water Content (%, vol):	37.7
Void Ratio (e):	1.33
Porosity (%, vol):	57.0
Saturation (%):	66.1

Post Permeation Sample Properties

Saturated Mass (g):	1457.22
Dry Mass (g):	978.55
Diameter (cm):	10.196
Length (cm):	10.154
*Deformation (%)**:*	0.15
Area (cm^2):	81.65
Volume (cm^3):	829.04
Dry Density (g/cm^3):	1.18
Dry Density (pcf):	73.7
Water Content (%, g/g):	48.9
Water Content (%, vol):	57.7
Void Ratio(e):	1.33
Porosity (%, vol):	57.1
Saturation (%):*	101.2

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded ☑ Remolded Sample
Number of Lifts:	3
Split:	3/4
Percent Coarse Material (%):	13.4
Particle Density(g/cm^3):	2.75 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☑ D ☐ E ☐ F
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/2/21 925
B-Value (% saturation) post to test:	1.00	12/3/21 715

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

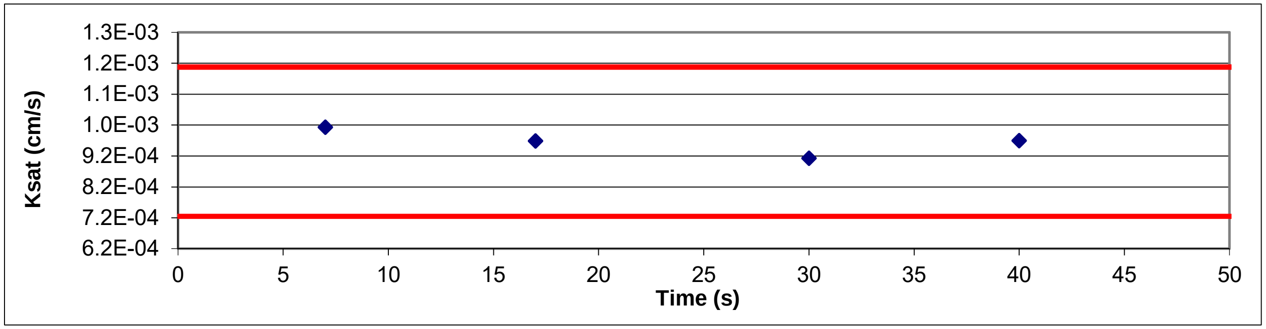
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: TSM Fault AB TP2 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
02-Dec-21	10:15:42	20.7	11.00	19.00	0.91	0.43	7	1.00	12%	1.03E-03	1.01E-03
02-Dec-21	10:15:49	20.7	11.50	18.50	0.80						
Test # 2:											
02-Dec-21	10:15:59	20.7	12.00	18.00	0.68	0.43	10	1.00	17%	9.85E-04	9.69E-04
02-Dec-21	10:16:09	20.7	12.50	17.50	0.57						
Test # 3:											
03-Dec-21	06:42:30	20.7	10.00	20.00	1.14	0.87	13	1.00	20%	9.27E-04	9.13E-04
03-Dec-21	06:42:43	20.7	11.00	19.00	0.91						
Test # 4:											
03-Dec-21	06:43:01	20.7	12.00	18.00	0.68	0.43	10	1.00	17%	9.85E-04	9.70E-04
03-Dec-21	06:43:11	20.7	12.50	17.50	0.57						

***Average Ksat* (cm/sec):** **9.66E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 8.37E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 7.25E-04

Ksat (+25%) (cm/s): 1.21E-03

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.01
Sample Number: TSM Fault AB TP1 (~90%)
Ring Number: 4 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1438.81
Diameter (cm):	10.182
Length (cm):	10.195
Area (cm^2):	81.42
Volume (cm^3):	830.12
Dry Density (g/cm^3):	1.48
Dry Density (pcf):	92.2
Water Content (%, g/g):	17.4
Water Content (%, vol):	25.7
Void Ratio (e):	0.80
Porosity (%, vol):	44.3
Saturation (%):	58.0

Post Permeation Sample Properties

Saturated Mass (g):	1584.77
Dry Mass (g):	1225.4
Diameter (cm):	10.195
Length (cm):	10.165
*Deformation (%)**:*	0.29
Area (cm^2):	81.63
Volume (cm^3):	829.82
Dry Density (g/cm^3):	1.48
Dry Density (pcf):	92.2
Water Content (%, g/g):	29.3
Water Content (%, vol):	43.3
Void Ratio(e):	0.79
Porosity (%, vol):	44.3
Saturation (%):*	97.8

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded; ☑ Remolded Sample
Number of Lifts:	3
Split:	3/4
Percent Coarse Material (%):	18.1
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ D ☑ E ☐ F
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	12/2/21 928
B-Value (% saturation) post to test:	1.00	12/3/21 718

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

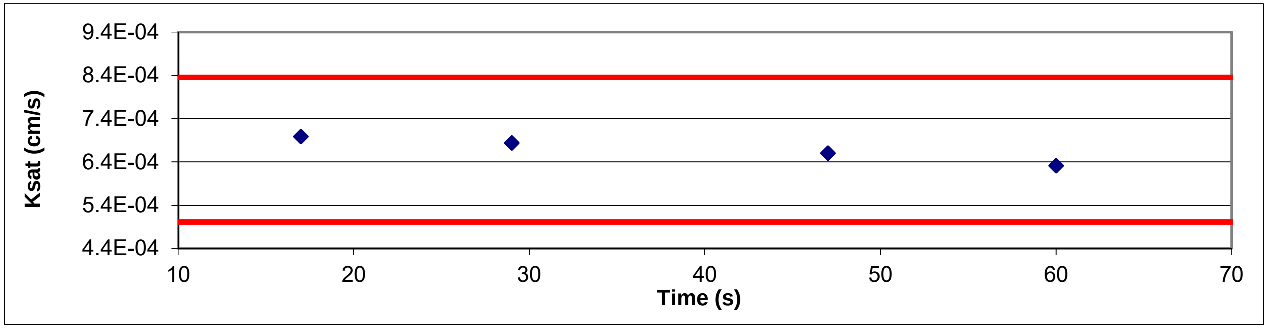
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.01
Sample Number: TSM Fault AB TP1 (~90%)
Ring Number: 4 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
02-Dec-21	10:17:30	20.7	10.00	20.00	1.14	0.87	17	1.00	20%	7.10E-04	6.98E-04
02-Dec-21	10:17:47	20.7	11.00	19.00	0.91						
Test # 2:											
02-Dec-21	10:17:57	20.7	11.50	18.50	0.80	0.43	12	1.00	14%	6.95E-04	6.83E-04
02-Dec-21	10:18:09	20.7	12.00	18.00	0.68						
Test # 3:											
03-Dec-21	06:44:30	20.7	10.00	20.00	1.14	0.87	18	1.00	20%	6.71E-04	6.60E-04
03-Dec-21	06:44:48	20.7	11.00	19.00	0.91						
Test # 4:											
03-Dec-21	06:44:59	20.7	11.50	18.50	0.80	0.43	13	1.00	14%	6.42E-04	6.32E-04
03-Dec-21	06:45:12	20.7	12.00	18.00	0.68						

***Average Ksat* (cm/sec):** **6.68E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 5.48E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 5.01E-04

Ksat (+25%) (cm/s): 8.36E-04

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.02
Sample Number: Muddy Creek AB TP1 (~90%)
Ring Number: 5 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1369.07
Diameter (cm):	10.185
Length (cm):	10.176
Area (cm^2):	81.47
Volume (cm^3):	829.07
Dry Density (g/cm^3):	1.34
Dry Density (pcf):	83.5
Water Content (%, g/g):	23.5
Water Content (%, vol):	31.4
Void Ratio (e):	0.98
Porosity (%, vol):	49.5
Saturation (%):	63.4

Post Permeation Sample Properties

Saturated Mass (g):	1540.54
Dry Mass (g):	1108.75
Diameter (cm):	10.207
Length (cm):	10.152
*Deformation (%)**:*	0.24
Area (cm^2):	81.83
Volume (cm^3):	830.65
Dry Density (g/cm^3):	1.33
Dry Density (pcf):	83.3
Water Content (%, g/g):	38.9
Water Content (%, vol):	52.0
Void Ratio(e):	0.99
Porosity (%, vol):	49.6
Saturation (%):*	104.7

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☑ In situ sample, extruded ☐ Remolded Sample
Number of Lifts:	3
Split:	3/4
Percent Coarse Material (%):	0.0
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☑ O ☐ P ☐ Q
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	12/2/21 930
B-Value (% saturation) post to test:	1.00	12/3/21 722

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

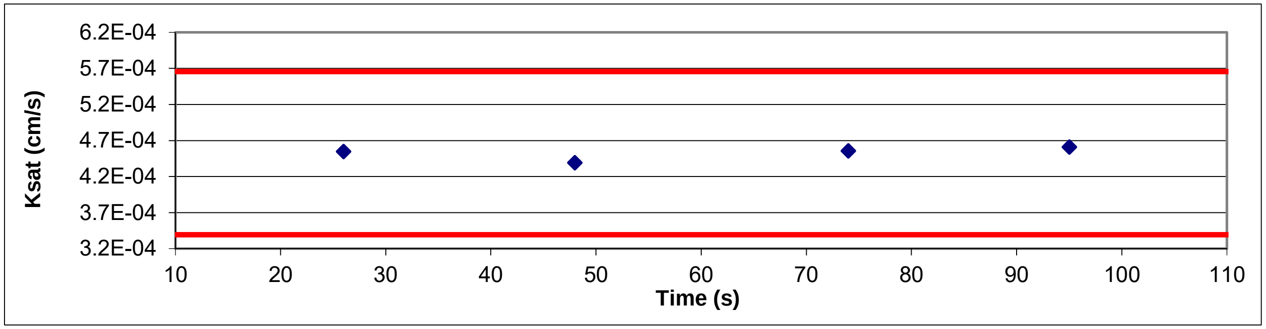
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.02
Sample Number: Muddy Creek AB TP1 (~90%)
Ring Number: 5 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
02-Dec-21	10:23:00	20.7	10.00	20.00	1.14	0.87	26	1.00	20%	4.63E-04	4.55E-04
02-Dec-21	10:23:26	20.7	11.00	19.00	0.91						
Test # 2:											
02-Dec-21	10:24:04	20.7	12.00	18.00	0.68	0.43	22	1.00	17%	4.47E-04	4.39E-04
02-Dec-21	10:24:26	20.7	12.50	17.50	0.57						
Test # 3:											
03-Dec-21	06:46:30	20.7	10.00	20.00	1.14	0.87	26	1.00	20%	4.63E-04	4.56E-04
03-Dec-21	06:46:56	20.7	11.00	19.00	0.91						
Test # 4:											
03-Dec-21	06:47:29	20.7	12.00	18.00	0.68	0.43	21	1.00	17%	4.68E-04	4.61E-04
03-Dec-21	06:47:50	20.7	12.50	17.50	0.57						

***Average Ksat* (cm/sec):** **4.53E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): NA



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 3.39E-04

Ksat (+25%) (cm/s): 5.66E-04

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.03
Sample Number: Muddy Creek TP1 (~90%)
Ring Number: 6 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1547.27
Diameter (cm):	10.154
Length (cm):	10.191
Area (cm^2):	80.98
Volume (cm^3):	825.24
Dry Density (g/cm^3):	1.72
Dry Density (pcf):	107.4
Water Content (%, g/g):	9.0
Water Content (%, vol):	15.4
Void Ratio (e):	0.54
Porosity (%, vol):	35.1
Saturation (%):	43.9

Post Permeation Sample Properties

Saturated Mass (g):	1699.62
Dry Mass (g):	1420.12
Diameter (cm):	10.181
Length (cm):	10.176
*Deformation (%)**:*	0.14
Area (cm^2):	81.41
Volume (cm^3):	828.44
Dry Density (g/cm^3):	1.71
Dry Density (pcf):	107.0
Water Content (%, g/g):	19.7
Water Content (%, vol):	33.7
Void Ratio(e):	0.55
Porosity (%, vol):	35.3
Saturation (%):*	95.5

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☑ In situ sample, extruded ☐ Remolded Sample
Number of Lifts:	3
Split:	3/4
Percent Coarse Material (%):	6.5
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ O ☑ P ☐ Q
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/2/21 932
B-Value (% saturation) post to test:	1.00	12/3/21 725

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

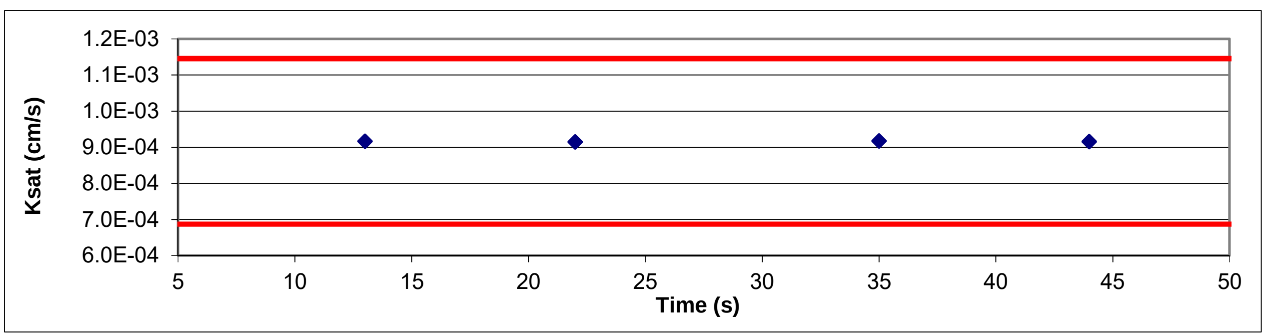
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.03
Sample Number: Muddy Creek TP1 (~90%)
Ring Number: 6 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
02-Dec-21	10:26:30	20.7	10.00	20.00	1.13	0.87	13	1.00	20%	9.32E-04	9.17E-04
02-Dec-21	10:26:43	20.7	11.00	19.00	0.91						
Test # 2:											
02-Dec-21	10:26:51	20.7	11.50	18.50	0.91	0.43	9	1.00	14%	9.30E-04	9.15E-04
02-Dec-21	10:27:00	20.7	12.00	18.00	0.79						
Test # 3:											
03-Dec-21	06:49:00	20.7	10.00	20.00	0.79	0.87	13	1.00	20%	9.32E-04	9.18E-04
03-Dec-21	06:49:13	20.7	11.00	19.00	0.68						
Test # 4:											
03-Dec-21	06:49:21	20.7	11.50	18.50	0.57	0.43	9	1.00	14%	9.30E-04	9.16E-04
03-Dec-21	06:49:30	20.7	12.00	18.00	0.45						

***Average Ksat* (cm/sec):** **9.16E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 8.57E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 6.87E-04

Ksat (+25%) (cm/s): 1.15E-03

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.04
Sample Number: Muddy Creek TP3 (~90%)
Ring Number: 7 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1518.18
Diameter (cm):	10.177
Length (cm):	10.172
Area (cm^2):	81.34
Volume (cm^3):	827.44
Dry Density (g/cm^3):	1.63
Dry Density (pcf):	101.6
Water Content (%, g/g):	12.8
Water Content (%, vol):	20.8
Void Ratio (e):	0.63
Porosity (%, vol):	38.6
Saturation (%):	53.9

Post Permeation Sample Properties

Saturated Mass (g):	1657.58
Dry Mass (g):	1345.99
Diameter (cm):	10.277
Length (cm):	10.161
*Deformation (%)**:*	0.11
Area (cm^2):	82.95
Volume (cm^3):	842.84
Dry Density (g/cm^3):	1.60
Dry Density (pcf):	99.7
Water Content (%, g/g):	23.1
Water Content (%, vol):	37.0
Void Ratio(e):	0.66
Porosity (%, vol):	39.7
Saturation (%):*	93.0

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☑ In situ sample, extruded ☐ Remolded Sample
Number of Lifts:	3
Split:	3/4
Percent Coarse Material (%):	9.3
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ O ☐ P ☑ Q
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/2/21 935
B-Value (% saturation) post to test:	1.00	12/3/21 725

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

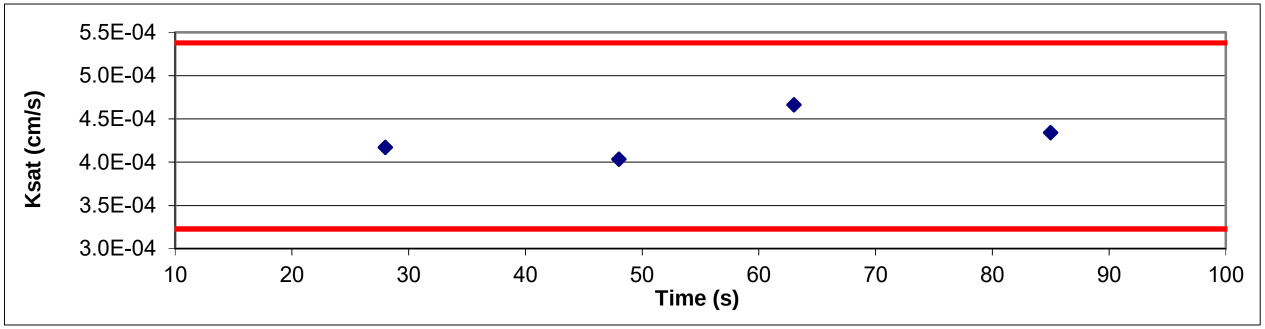
Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name:	Broadbent
Job Number:	DB21.1124.04
Sample Number:	Muddy Creek TP3 (~90%)
Ring Number:	7 Kids Mine, 14-01-156
Depth:	NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
02-Dec-21	10:28:30	20.7	10.00	20.00	1.13	0.87	28	1.00	20%	4.24E-04	4.17E-04
02-Dec-21	10:28:58	20.7	11.00	19.00	0.91						
Test # 2:											
02-Dec-21	10:29:15	20.7	11.50	18.50	0.91	0.43	20	1.00	14%	4.10E-04	4.03E-04
02-Dec-21	10:29:35	20.7	12.00	18.00	0.79						
Test # 3:											
03-Dec-21	06:50:52	20.7	11.00	19.00	0.79	0.43	15	1.00	12%	4.74E-04	4.66E-04
03-Dec-21	06:51:07	20.7	11.50	18.50	0.68						
Test # 4:											
03-Dec-21	06:51:26	20.7	12.00	18.00	0.57	0.43	22	1.00	17%	4.41E-04	4.34E-04
03-Dec-21	06:51:48	20.7	12.50	17.50	0.45						

***Average Ksat* (cm/sec):** **4.30E-04**

Calculated Gravel Corrected Average Ksat (cm/sec): 3.90E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 3.23E-04

Ksat (+25%) (cm/s): 5.38E-04

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.05
Sample Number: Alluvium Borrow TP (~90%)
Ring Number: 8 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	587.23
Diameter (cm):	7.313
Length (cm):	7.504
Area (cm^2):	42.00
Volume (cm^3):	315.19
Dry Density (g/cm^3):	1.76
Dry Density (pcf):	109.7
Water Content (%, g/g):	6.0
Water Content (%, vol):	10.5
Void Ratio (e):	0.51
Porosity (%, vol):	33.7
Saturation (%):	31.3

Post Permeation Sample Properties

Saturated Mass (g):	658.79
Dry Mass (g):	554.02
Diameter (cm):	7.262
Length (cm):	7.495
*Deformation (%)**:*	0.12
Area (cm^2):	41.42
Volume (cm^3):	310.44
Dry Density (g/cm^3):	1.78
Dry Density (pcf):	111.4
Water Content (%, g/g):	18.9
Water Content (%, vol):	33.7
Void Ratio(e):	0.48
Porosity (%, vol):	32.7
Saturation (%):*	103.4

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	3/8"
Percent Coarse Material (%):	6.7
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☑ A ☐ B ☐ C
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/7/21 1542
B-Value (% saturation) post to test:	1.00	12/8/21 1025

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated or skewed during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

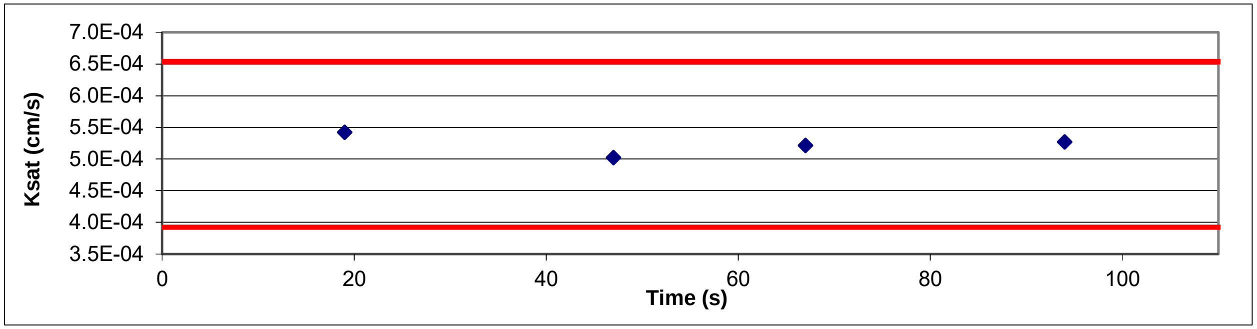
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.05
Sample Number: Alluvium Borrow TP (~90%)
Ring Number: 8 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:09:02	20.8	11.00	19.00	1.23	0.43	19	1.00	12%	5.53E-04	5.42E-04
07-Dec-21	16:09:21	20.8	11.50	18.50	1.08						
Test # 2:											
07-Dec-21	16:09:43	20.8	12.00	18.00	0.92	0.43	28	1.00	17%	5.12E-04	5.02E-04
07-Dec-21	16:10:11	20.8	12.50	17.50	0.77						
Test # 3:											
08-Dec-21	10:18:31	20.3	11.00	19.00	1.23	0.43	20	1.00	12%	5.25E-04	5.21E-04
08-Dec-21	10:18:51	20.3	11.50	18.50	1.08						
Test # 4:											
08-Dec-21	10:19:13	20.3	12.00	18.00	0.92	0.43	27	1.00	17%	5.31E-04	5.27E-04
08-Dec-21	10:19:40	20.3	12.50	17.50	0.77						

***Average Ksat* (cm/sec):** **5.23E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 4.88E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 3.92E-04

Ksat (+25%) (cm/s): 6.54E-04

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.06
Sample Number: Older Alluvium Fan Deposits (~90%)
Ring Number: 9 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1549.03
Diameter (cm):	10.185
Length (cm):	10.186
Area (cm^2):	81.47
Volume (cm^3):	829.88
Dry Density (g/cm^3):	1.72
Dry Density (pcf):	107.1
Water Content (%, g/g):	8.8
Water Content (%, vol):	15.0
Void Ratio (e):	0.54
Porosity (%, vol):	35.2
Saturation (%):	42.7

Post Permeation Sample Properties

Saturated Mass (g):	1711.94
Dry Mass (g):	1424.28
Diameter (cm):	10.099
Length (cm):	10.172
*Deformation (%)**:*	0.13
Area (cm^2):	80.10
Volume (cm^3):	814.84
Dry Density (g/cm^3):	1.75
Dry Density (pcf):	109.1
Water Content (%, g/g):	20.2
Water Content (%, vol):	35.3
Void Ratio(e):	0.52
Porosity (%, vol):	34.0
Saturation (%):*	103.7

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded ☑ Remolded Sample
Number of Lifts:	3
Split:	3/4"
Percent Coarse Material (%):	22.3
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ G ☑ H ☐ I
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	12/7/21 1535
B-Value (% saturation) post to test:	1.00	12/8/21 1010

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

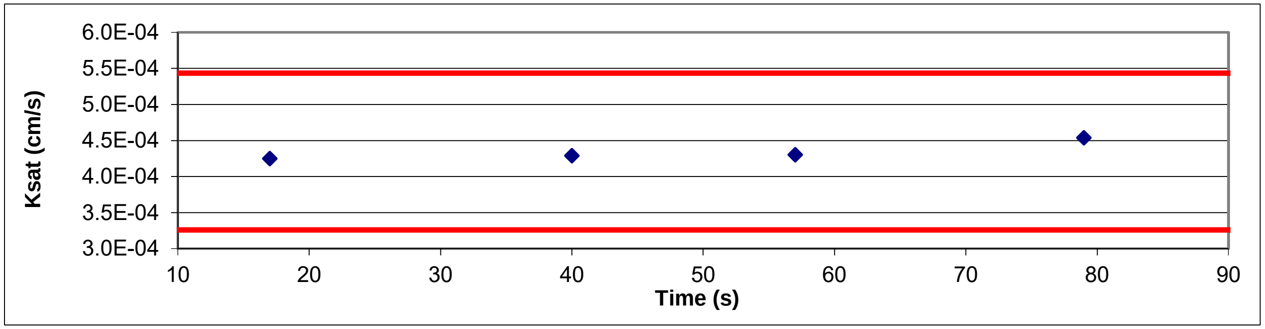
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.06
Sample Number: Older Alluvium Fan Deposits (~90%)
Ring Number: 9 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:15:57	20.8	11.00	19.00	0.91	0.43	17	1.00	12%	4.33E-04	4.25E-04
07-Dec-21	16:16:14	20.8	11.50	18.50	0.79						
Test # 2:											
07-Dec-21	16:16:31	20.8	12.00	18.00	0.68	0.43	23	1.00	17%	4.37E-04	4.29E-04
07-Dec-21	16:16:54	20.8	12.50	17.50	0.57						
Test # 3:											
08-Dec-21	09:57:25	20.3	11.00	19.00	0.91	0.43	17	1.00	12%	4.33E-04	4.30E-04
08-Dec-21	09:57:42	20.3	11.50	18.50	0.79						
Test # 4:											
08-Dec-21	09:58:01	20.3	12.00	18.00	0.68	0.43	22	1.00	17%	4.57E-04	4.54E-04
08-Dec-21	09:58:23	20.3	12.50	17.50	0.57						

***Average Ksat* (cm/sec): 4.35E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): 3.38E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 3.26E-04

Ksat (+25%) (cm/s): 5.43E-04

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.07
Sample Number: Mill Site (~90%)
Ring Number: 10 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	579.90
Diameter (cm):	7.304
Length (cm):	7.504
Area (cm^2):	41.90
Volume (cm^3):	314.42
Dry Density (g/cm^3):	1.74
Dry Density (pcf):	108.4
Water Content (%, g/g):	6.2
Water Content (%, vol):	10.8
Void Ratio (e):	0.53
Porosity (%, vol):	34.5
Saturation (%):	31.2

Post Permeation Sample Properties

Saturated Mass (g):	654.86
Dry Mass (g):	546.08
Diameter (cm):	7.273
Length (cm):	7.492
*Deformation (%)**:*	0.17
Area (cm^2):	41.54
Volume (cm^3):	311.23
Dry Density (g/cm^3):	1.75
Dry Density (pcf):	109.5
Water Content (%, g/g):	19.9
Water Content (%, vol):	35.0
Void Ratio(e):	0.51
Porosity (%, vol):	33.8
Saturation (%):*	103.4

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded ☑ Remolded Sample
Number of Lifts:	3
Split:	3/8"
Percent Coarse Material (%):	17.4
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ A ☐ B ☑ C
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	12/7/21 1539
B-Value (% saturation) post to test:	1.00	12/8/21 1020

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated or skewed during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

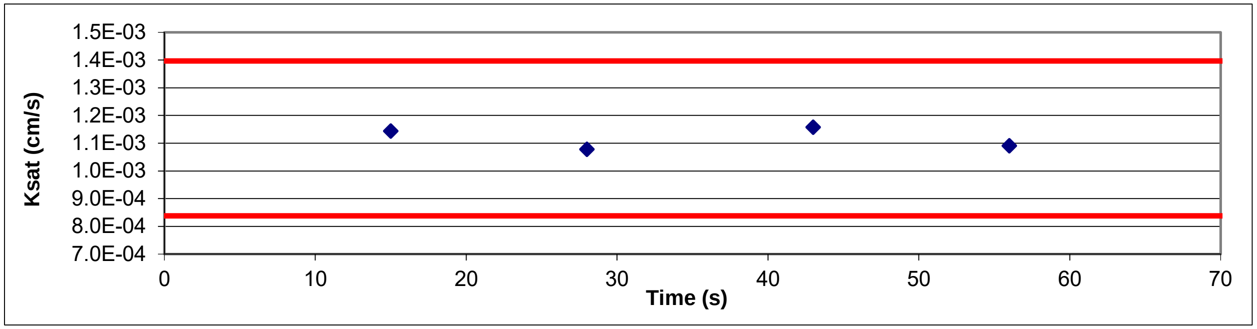
Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name:	Broadbent
Job Number:	DB21.1124.07
Sample Number:	Mill Site (~90%)
Ring Number:	10 Kids Mine, 14-01-156
Depth:	NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:09:00	20.8	10.00	20.00	1.54	0.87	15	1.00	20%	1.17E-03	1.14E-03
07-Dec-21	16:09:15	20.8	11.00	19.00	1.23						
Test # 2:											
07-Dec-21	16:09:35	20.8	12.00	18.00	0.92	0.43	13	1.00	17%	1.10E-03	1.08E-03
07-Dec-21	16:09:48	20.8	12.50	17.50	0.77						
Test # 3:											
08-Dec-21	10:16:00	20.3	10.00	20.00	1.54	0.87	15	1.00	20%	1.17E-03	1.16E-03
08-Dec-21	10:16:15	20.3	11.00	19.00	1.23						
Test # 4:											
08-Dec-21	10:16:36	20.3	12.00	18.00	0.92	0.43	13	1.00	17%	1.10E-03	1.09E-03
08-Dec-21	10:16:49	20.3	12.50	17.50	0.77						

***Average Ksat* (cm/sec):** **1.12E-03**

Calculated Gravel Corrected Average Ksat (cm/sec): 9.23E-04



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 8.38E-04

Ksat (+25%) (cm/s): 1.40E-03

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.08
Sample Number: Ore Yard (~90%)
Ring Number: 11 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	1512.16
Diameter (cm):	10.179
Length (cm):	10.189
Area (cm^2):	81.38
Volume (cm^3):	829.15
Dry Density (g/cm^3):	1.60
Dry Density (pcf):	99.8
Water Content (%, g/g):	14.1
Water Content (%, vol):	22.6
Void Ratio (e):	0.72
Porosity (%, vol):	41.9
Saturation (%):	53.9

Post Permeation Sample Properties

Saturated Mass (g):	1645.60
Dry Mass (g):	1324.9
Diameter (cm):	10.146
Length (cm):	10.178
*Deformation (%)**:*	0.11
Area (cm^2):	80.85
Volume (cm^3):	822.89
Dry Density (g/cm^3):	1.61
Dry Density (pcf):	100.5
Water Content (%, g/g):	24.2
Water Content (%, vol):	39.0
Void Ratio(e):	0.71
Porosity (%, vol):	41.5
Saturation (%):*	94.0

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	3/4"
Percent Coarse Material (%):	0.7
Particle Density(g/cm^3):	2.75 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ G ☐ H ☑ I
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/7/21 1538
B-Value (% saturation) post to test:	1.00	12/8/21 1013

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

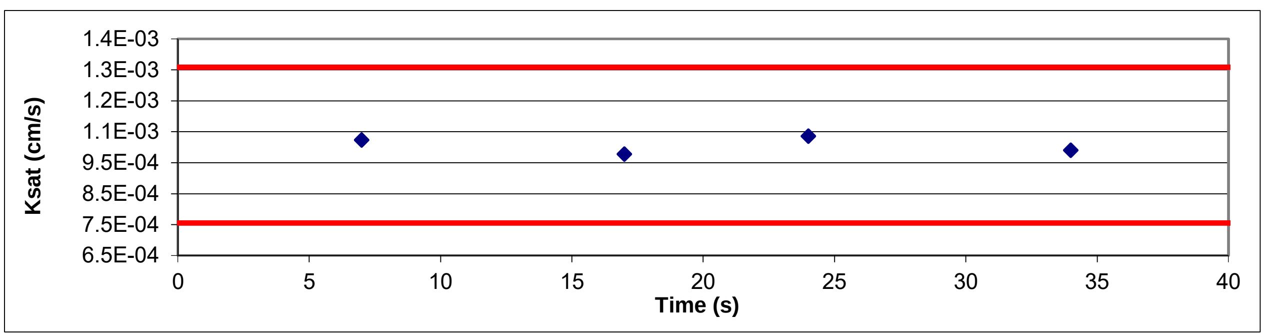
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.08
Sample Number: Ore Yard (~90%)
Ring Number: 11 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:14:13	20.8	11.00	19.00	1.13	0.43	7	1.00	12%	1.04E-03	1.02E-03
07-Dec-21	16:14:20	20.8	11.50	18.50	0.91						
Test # 2:											
07-Dec-21	16:14:29	20.8	12.00	18.00	0.91	0.43	10	1.00	17%	9.97E-04	9.78E-04
07-Dec-21	16:14:39	20.8	12.50	17.50	0.79						
Test # 3:											
08-Dec-21	09:57:12	20.3	11.00	19.00	0.79	0.43	7	1.00	12%	1.04E-03	1.04E-03
08-Dec-21	09:57:19	20.3	11.50	18.50	0.68						
Test # 4:											
08-Dec-21	09:57:28	20.3	12.00	18.00	0.57	0.43	10	1.00	17%	9.97E-04	9.90E-04
08-Dec-21	09:57:38	20.3	12.50	17.50	0.45						

***Average Ksat* (cm/sec):** **1.01E-03**
Calculated Gravel Corrected Average Ksat (cm/sec): NA



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 7.55E-04

Ksat (+25%) (cm/s): 1.26E-03

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.09
Sample Number: AB Pit Bot 01 (~90%)
Ring Number: 12 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	527.15
Diameter (cm):	7.302
Length (cm):	7.500
Area (cm^2):	41.88
Volume (cm^3):	314.08
Dry Density (g/cm^3):	1.20
Dry Density (pcf):	75.2
Water Content (%, g/g):	39.4
Water Content (%, vol):	47.4
Void Ratio (e):	1.28
Porosity (%, vol):	56.2
Saturation (%):	84.4

Post Permeation Sample Properties

Saturated Mass (g):	568.90
Dry Mass (g):	378.24
Diameter (cm):	7.353
Length (cm):	7.511
*Deformation (%)**:*	0.15
Area (cm^2):	42.46
Volume (cm^3):	318.95
Dry Density (g/cm^3):	1.19
Dry Density (pcf):	74.0
Water Content (%, g/g):	50.4
Water Content (%, vol):	59.8
Void Ratio(e):	1.32
Porosity (%, vol):	56.9
Saturation (%):*	105.1

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded
	☑ Remolded Sample
Number of Lifts:	3
Split:	3/8"
Percent Coarse Material (%):	0.0
Particle Density(g/cm^3):	2.75 ☑ Assumed ☐ Measured
Cell pressure (PSI):	84.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☑ O ☐ P ☐ Q
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	0.99	12/7/21 1546
B-Value (% saturation) post to test:	0.99	12/8/21 900

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

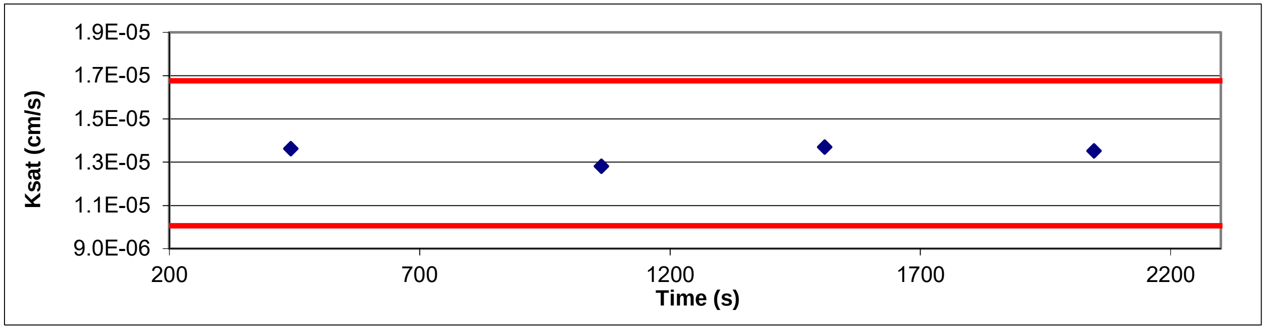
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.09
Sample Number: AB Pit Bot 01 (~90%)
Ring Number: 12 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:11:40	20.8	6.00	19.00	1.13	0.43	443	1.00	8%	1.39E-05	1.36E-05
07-Dec-21	16:19:03	20.8	6.50	18.50	0.91						
Test # 2:											
07-Dec-21	16:34:59	20.8	7.50	17.50	0.91	0.43	620	1.00	10%	1.31E-05	1.28E-05
07-Dec-21	16:45:19	20.8	8.00	17.00	0.79						
Test # 3:											
08-Dec-21	08:20:14	20.3	6.00	19.00	0.79	0.43	446	1.00	8%	1.38E-05	1.37E-05
08-Dec-21	08:27:40	20.3	6.50	18.50	0.68						
Test # 4:											
08-Dec-21	08:35:30	20.3	7.00	18.00	0.57	0.43	538	1.00	9%	1.36E-05	1.35E-05
08-Dec-21	08:44:28	20.3	7.50	17.50	0.45						

***Average Ksat* (cm/sec):** **1.34E-05**
Calculated Gravel Corrected Average Ksat (cm/sec): NA



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 1.01E-05

Ksat (+25%) (cm/s): 1.68E-05

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.10
Sample Number: TP1WN-TP1E (~90%)
Ring Number: 13 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties	
Initial Mass (g):	561.91
Diameter (cm):	7.304
Length (cm):	7.501
Area (cm^2):	41.90
Volume (cm^3):	314.29
Dry Density (g/cm^3):	1.45
Dry Density (pcf):	90.3
Water Content (%, g/g):	23.6
Water Content (%, vol):	34.2
Void Ratio (e):	0.83
Porosity (%, vol):	45.4
Saturation (%):	75.2

Post Permeation Sample Properties	
Saturated Mass (g):	609.09
Dry Mass (g):	454.48
Diameter (cm):	7.321
Length (cm):	7.510
*Deformation (%)**:*	0.12
Area (cm^2):	42.10
Volume (cm^3):	316.14
Dry Density (g/cm^3):	1.44
Dry Density (pcf):	89.7
Water Content (%, g/g):	34.0
Water Content (%, vol):	48.9
Void Ratio(e):	0.84
Porosity (%, vol):	45.8
Saturation (%):*	106.9

Test and Sample Conditions	
Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded ☑ Remolded Sample
Number of Lifts:	3
Split:	3/8"
Percent Coarse Material (%):	10.9
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ O ☑ P ☐ Q
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/7/21 1548
B-Value (% saturation) post to test:	1.00	12/8/21 828

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

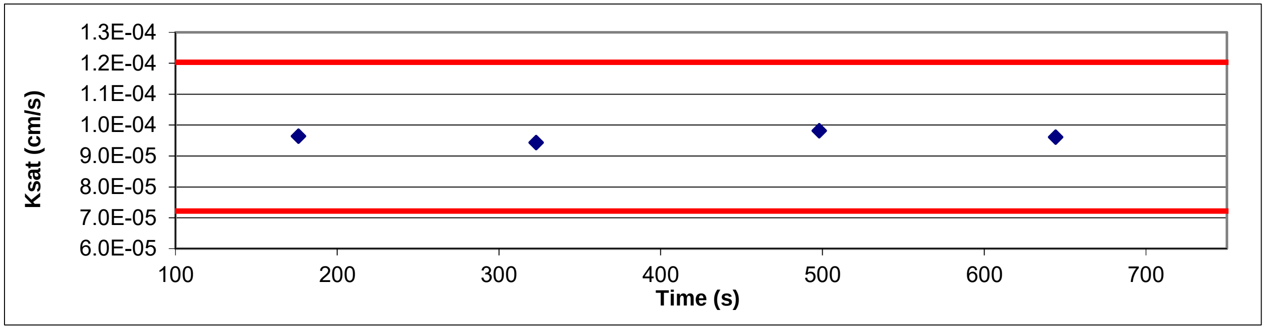
Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.10
Sample Number: TP1WN-TP1E (~90%)
Ring Number: 13 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:01:00	20.8	10.00	20.00	1.13	0.87	176	1.00	20%	9.83E-05	9.64E-05
07-Dec-21	16:03:56	20.8	11.00	19.00	0.91						
Test # 2:											
07-Dec-21	16:08:00	20.8	12.00	18.00	0.91	0.43	147	1.00	17%	9.61E-05	9.43E-05
07-Dec-21	16:10:27	20.8	12.50	17.50	0.79						
Test # 3:											
08-Dec-21	08:12:00	20.3	10.00	20.00	0.79	0.87	175	1.00	20%	9.88E-05	9.81E-05
08-Dec-21	08:14:55	20.3	11.00	19.00	0.68						
Test # 4:											
08-Dec-21	08:18:49	20.3	12.00	18.00	0.57	0.43	146	1.00	17%	9.68E-05	9.61E-05
08-Dec-21	08:21:15	20.3	12.50	17.50	0.45						

***Average Ksat* (cm/sec):** **9.63E-05**
Calculated Gravel Corrected Average Ksat (cm/sec): 8.58E-05



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 7.22E-05

Ksat (+25%) (cm/s): 1.20E-04

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.11
Sample Number: WR07E-WR07N (~90%)
Ring Number: 14 Kids Mine, 14-01-156
Depth: NA

Remolded or Initial Sample Properties

Initial Mass (g):	570.54
Diameter (cm):	7.303
Length (cm):	7.503
Area (cm^2):	41.89
Volume (cm^3):	314.29
Dry Density (g/cm^3):	1.48
Dry Density (pcf):	92.4
Water Content (%, g/g):	22.7
Water Content (%, vol):	33.6
Void Ratio (e):	0.79
Porosity (%, vol):	44.2
Saturation (%):	76.0

Post Permeation Sample Properties

Saturated Mass (g):	621.68
Dry Mass (g):	464.96
Diameter (cm):	7.27
Length (cm):	7.527
*Deformation (%)**:*	0.32
Area (cm^2):	41.51
Volume (cm^3):	312.46
Dry Density (g/cm^3):	1.49
Dry Density (pcf):	92.9
Water Content (%, g/g):	33.7
Water Content (%, vol):	50.2
Void Ratio(e):	0.78
Porosity (%, vol):	43.8
Saturation (%):*	114.4

Test and Sample Conditions

Permeant liquid used:	Tap Water
Sample Preparation:	☐ In situ sample, extruded ☑ Remolded Sample
Number of Lifts:	3
Split:	3/8"
Percent Coarse Material (%):	0.0
Particle Density(g/cm^3):	2.65 ☑ Assumed ☐ Measured
Cell pressure (PSI):	81.0
Influent pressure (PSI):	80.0
Effluent pressure (PSI):	80.0
Panel Used:	☐ O ☐ P ☑ Q
Reading:	☐ Annulus ☑ Pipette

		Date/Time
B-Value (% saturation) prior to test*:	1.00	12/7/21 1550
B-Value (% saturation) post to test:	1.00	12/8/21 820

* Per ASTM D5084 percent saturation is ensured (B-Value ≥ 95%) prior to testing, as post test saturation values may be exaggerated during depressurizing and sample removal.
**Percent Deformation: based on initial sample length and post permeation sample length.

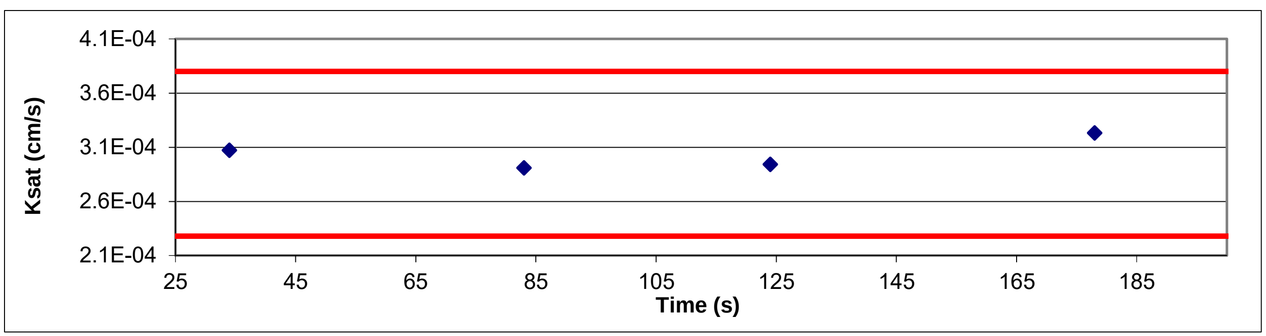
Laboratory analysis by: D. O'Dowd
Data entered by: D. O'Dowd
Checked by: J. Hines

Saturated Hydraulic Conductivity
Flexible Wall Falling Head-Rising Tail Method

Job Name: Broadbent
Job Number: DB21.1124.11
Sample Number: WR07E-WR07N (~90%)
Ring Number: 14 Kids Mine, 14-01-156
Depth: NA

Date	Time	Temp (°C)	Influent Pipette Reading	Effluent Pipette Reading	Gradient (ΔH/ΔL)	Average Flow (cm^3)	Elapsed Time (s)	Ratio (outflow to inflow)	Change in Head (Not to exceed 25%)	k_{sat} T°C (cm/s)	k_{sat} Corrected (cm/s)
Test # 1:											
07-Dec-21	16:03:01	20.3	11.00	19.00	1.13	0.43	34	1.00	12%	3.09E-04	3.07E-04
07-Dec-21	16:03:35	20.3	11.50	18.50	0.91						
Test # 2:											
07-Dec-21	16:04:17	20.3	12.00	18.00	0.91	0.43	49	1.00	17%	2.93E-04	2.91E-04
07-Dec-21	16:05:06	20.3	12.50	17.50	0.79						
Test # 3:											
07-Dec-21	08:14:24	20.3	11.50	18.50	0.79	0.43	41	1.00	14%	2.96E-04	2.94E-04
07-Dec-21	08:15:05	20.3	12.00	18.00	0.68						
Test # 4:											
07-Dec-21	08:15:44	20.3	12.50	17.50	0.57	0.43	54	1.00	20%	3.26E-04	3.23E-04
07-Dec-21	08:16:38	20.3	13.00	17.00	0.45						

***Average Ksat* (cm/sec):** **3.04E-04**
Calculated Gravel Corrected Average Ksat (cm/sec): NA



ASTM Required Range (+/- 25%)

Ksat (-25%) (cm/s): 2.28E-04

Ksat (+25%) (cm/s): 3.80E-04

Moisture Retention Characteristics

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
TSM Fault AB TP2 (~90%)	0	60.0
	8	54.7
	14	53.8
	46	48.1
	202	43.0
	9076	22.7
	47523	14.6
	158681	7.7
	849860	4.0
TSM Fault AB TP1 (~90%)	0	42.7
	7	41.1
	13	37.9
	44	31.0
	204	26.0
	13461	10.4
	44055	6.9
	176425	4.2
	790039	2.5
Muddy Creek AB TP1 (~90%)	0	49.6
	8	45.1
	16	41.7
	47	36.6
	203	31.0
	173570	12.2
	305430	7.9
	721916	6.1

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
Muddy Creek TP1 (~90%)	0	37.2 ‡‡
	8	32.7 ‡‡
	15	30.8 ‡‡
	43	25.0 ‡‡
	207	13.5 ‡‡
	21008	6.1 ‡‡
	68021	3.9 ‡‡
	213852	2.7 ‡‡
	521526	2.1 ‡‡
Muddy Creek TP3 (~90%)	0	38.5 ‡‡
	8	33.3 ‡‡
	16	31.4 ‡‡
	48	26.5 ‡‡
	203	16.9 ‡‡
	143894	6.2 ‡‡
	325418	4.6 ‡‡
	534783	3.7 ‡‡
Alluvium Borrow TP (~90%)	0	33.4
	8	33.0
	24	32.7
	76	22.5
	337	12.3
	15501	5.9
	37937	4.3
	191314	3.3
	849860	2.6

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
Older Alluvium Fan Deposits (~90%)	0	35.3
	6	25.7 ‡‡
	15	23.7 ‡‡
	55	22.2 ‡‡
	210	16.6 ‡‡
	15399	5.6 ‡‡
	59964	3.3 ‡‡
	289215	2.5 ‡‡
	849860	2.3 ‡‡
Mill Site (~90%)	0	35.0
	5	34.1
	11	32.9
	40	20.9
	204	12.5
	12646	5.1
	47421	3.0
	205898	2.4
	849860	2.0
Ore Yard (~90%)	0	42.2
	8	39.0
	15	37.4
	51	33.3
	212	27.8
	75159	11.7
	154602	9.8
	345202	7.9
	789121	6.1

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Moisture Characteristics of the Initial Drainage Curve (Continued)

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
AB Pit Bot 01 (~90%)	0	58.0
	22	57.7 ‡‡
	73	57.0 ‡‡
	170	54.4 ‡‡
	337	52.9 ‡‡
	51908	20.0 ‡‡
	93312	16.6 ‡‡
	213240	13.3 ‡‡
	270349	12.3 ‡‡
TP1WN-TP1E (~90%)	0	47.2
	15	47.0 ‡‡
	32	46.9 ‡‡
	93	41.5 ‡‡
	337	35.3 ‡‡
	41812	10.9 ‡‡
	59250	9.2 ‡‡
	149197	6.8 ‡‡
	849860	4.4 ‡‡
WR07E-WR07N (~90%)	0	46.0
	8	45.7 ‡‡
	24	41.2 ‡‡
	76	37.5 ‡‡
	337	33.1 ‡‡
	105651	14.3 ‡‡
	246996	10.8 ‡‡
	596175	8.0 ‡‡

‡‡ Volume adjustments are applicable at this matric potential (see data sheet for this sample).

Summary of Calculated Unsaturated Hydraulic Properties

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (% vol)	θ_s (% vol)	Oversize Corrected θ_r (% vol)	Oversize Corrected θ_s (% vol)
TSM Fault AB TP2 (~90%)	0.0196	1.2099	0.00	56.86	0.00	53.32
TSM Fault AB TP1 (~90%)	0.0607	1.2253	0.00	42.66	0.00	37.97
Muddy Creek AB TP1 (~90%)	0.1131	1.1611	0.00	49.35	NA	NA
Muddy Creek TP1 (~90%)	0.0688	1.3822	2.32	36.84	2.22	35.18
Muddy Creek TP3 (~90%)	0.0889	1.2931	2.97	38.05	2.79	35.73
Alluvium Borrow TP (~90%)	0.0196	1.6626	3.70	33.97	3.53	32.42
Older Alluvium Fan Deposits (~90%)	0.3750	1.1950	0.00	34.75	0.00	29.29
Mill Site (~90%)	0.0599	1.5011	2.57	35.73	2.26	31.39
Ore Yard (~90%)	0.0673	1.1595	0.00	41.73	---	---
AB Pit Bot 01 (~90%)	0.0020	1.2381	0.00	57.82	NA	NA
TP1WN-TP1E (~90%)	0.0078	1.2654	0.00	47.51	0.00	44.53
WR07E-WR07N (~90%)	0.0307	1.1572	0.00	45.81	NA	NA

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NA = Not applicable

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: TSM Fault AB TP2 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Dry wt. of sample (g): 2458.77
Tare wt., ring (g): 253.42
Tare wt., screen & clamp (g): 57.30
Initial sample volume (cm^3): 2086.53
Initial dry bulk density (g/cm^3): 1.18
Assumed particle density (g/cm^3): 2.75
Initial calculated total porosity (%): 57.15

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	15-Nov-21	15:20	4020.90	0	59.98
	22-Nov-21	13:40	3911.34	8.0	54.72
	30-Nov-21	15:00	3892.09	14.0	53.80
	7-Dec-21	12:15	3773.92	46.0	48.14
	14-Dec-21	12:15	3665.90	202.0	42.96

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	14.0	---	---	---	---
	46.0	---	---	---	---
	202.0	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TSM Fault AB TP2 (~90%)

Initial sample bulk density (g/cm^3)*:* 1.18
Fraction of test sample used (<2.00mm fraction) (%): 45.41

Dry weight of dew point potentiometer sample* (g)*:* 157.66
Tare weight, jar (g)*:* 112.69

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	20-Dec-21	12:05	176.75	9076	22.72
	16-Dec-21	7:35	169.91	47523	14.58
	10-Dec-21	8:55	164.13	158681	7.70

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	9076	---	---	---	---
	47523	---	---	---	---
	158681	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 77.50
Tare weight (g)*:* 42.90

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	1-Dec-21	13:00	80.07	849860	3.96

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	849860	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

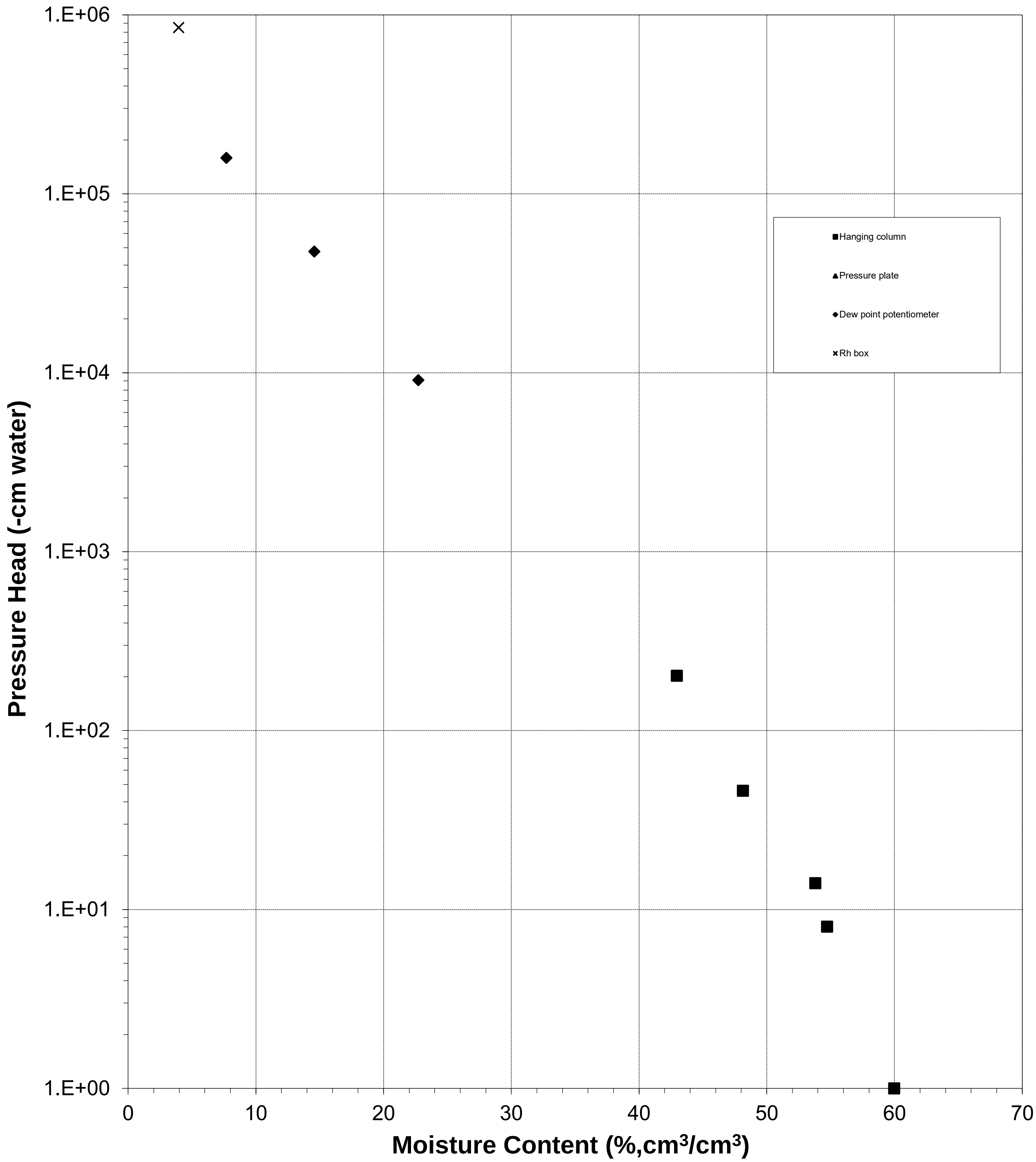
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

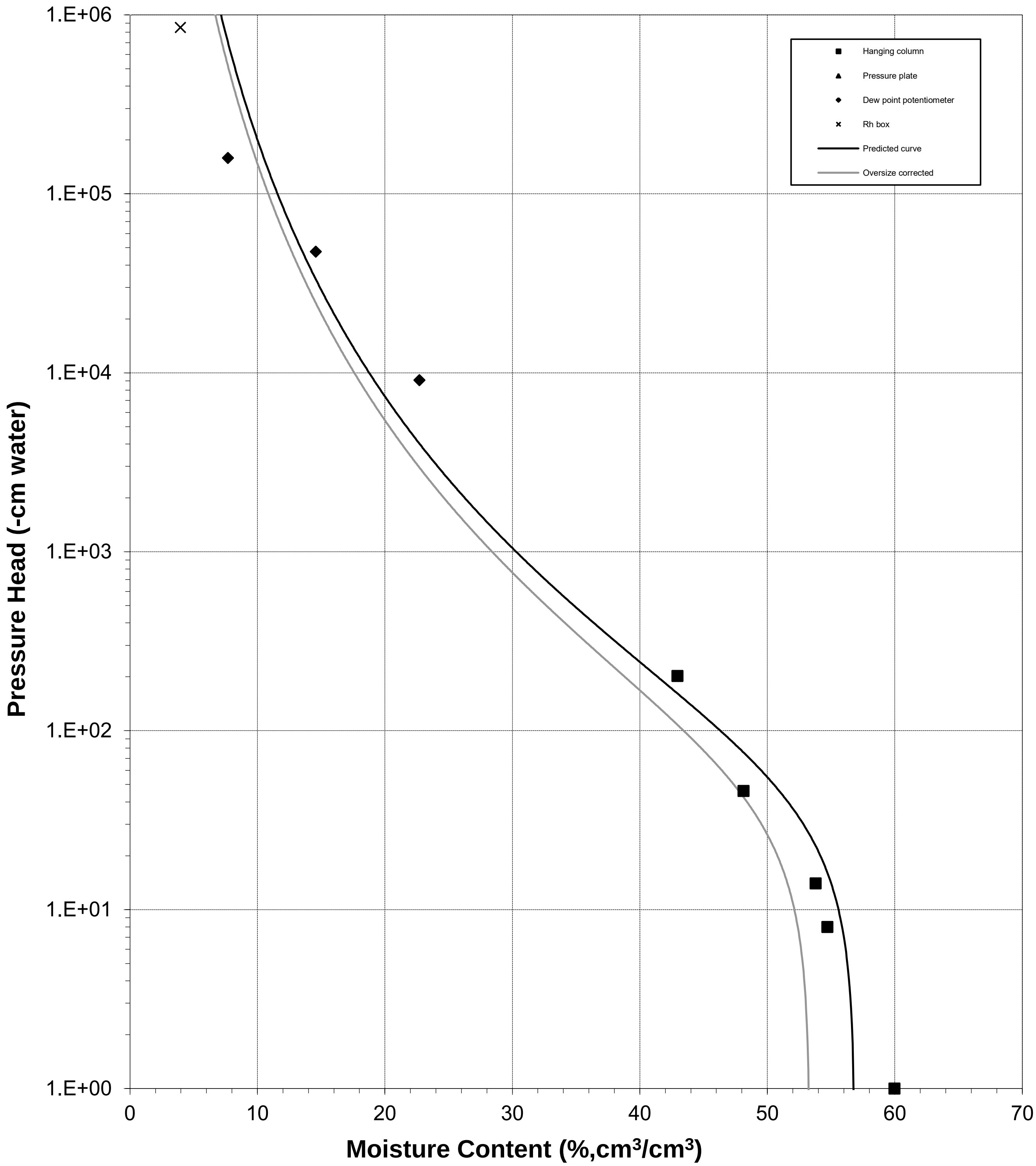
Water Retention Data Points

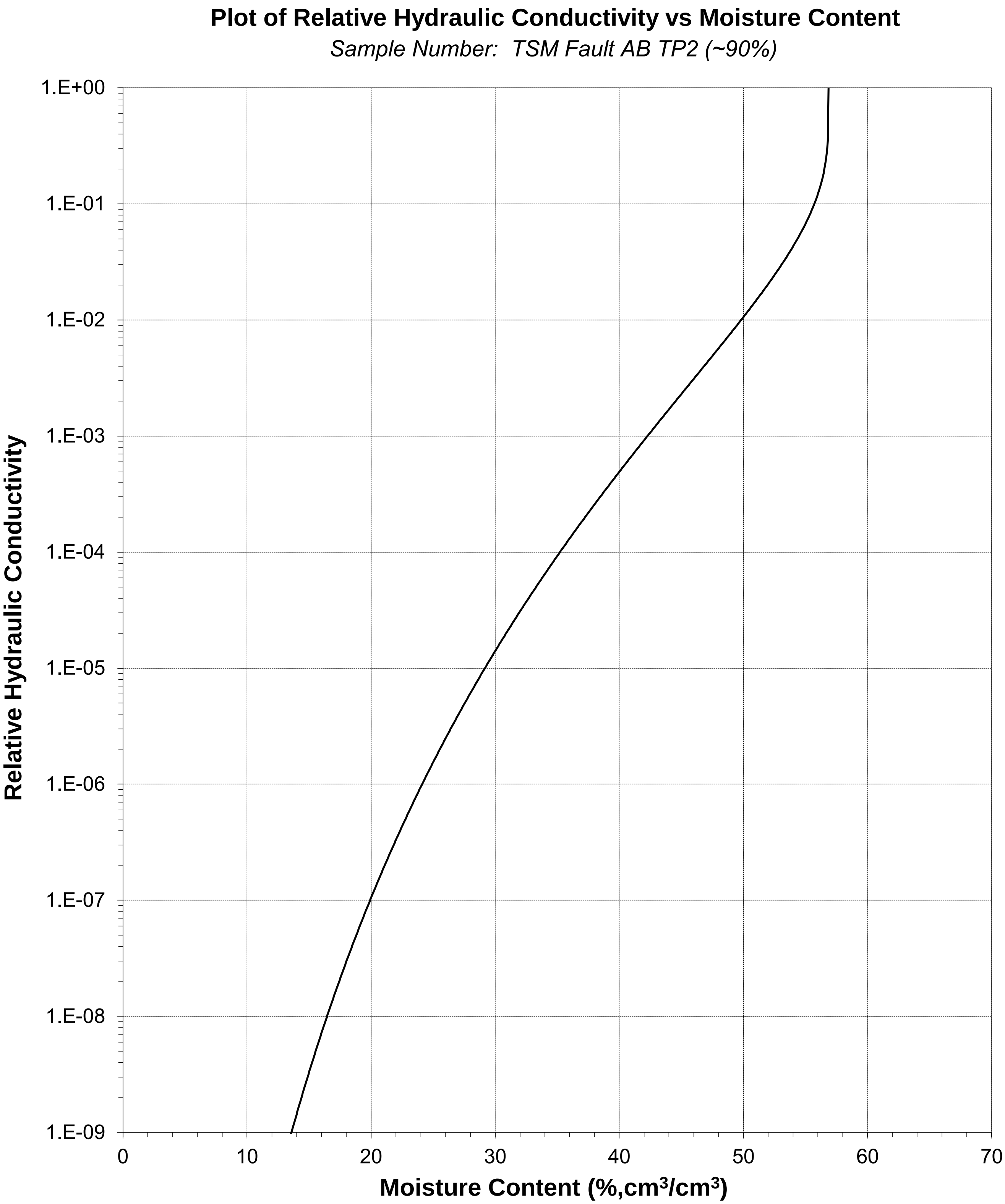
Sample Number: TSM Fault AB TP2 (~90%)



Predicted Water Retention Curve and Data Points

Sample Number: TSM Fault AB TP2 (~90%)

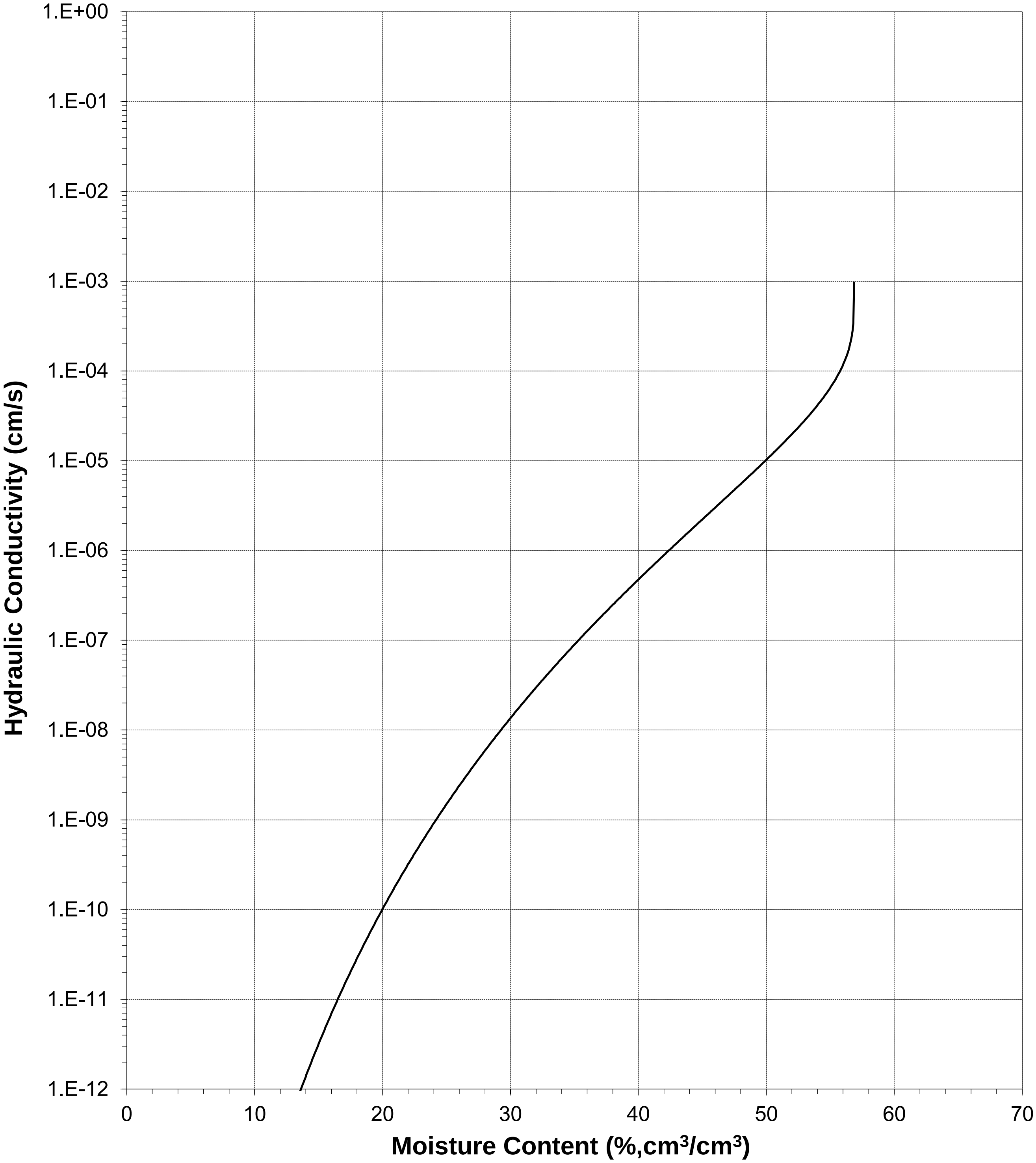




Plot of Relative Hydraulic Conductivity vs Moisture Content
Sample Number: TSM Fault AB TP2 (~90%)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
0
10
20
30
40
50
60
70
Relative Hydraulic Conductivity
Moisture Content (%,cm3/cm3)

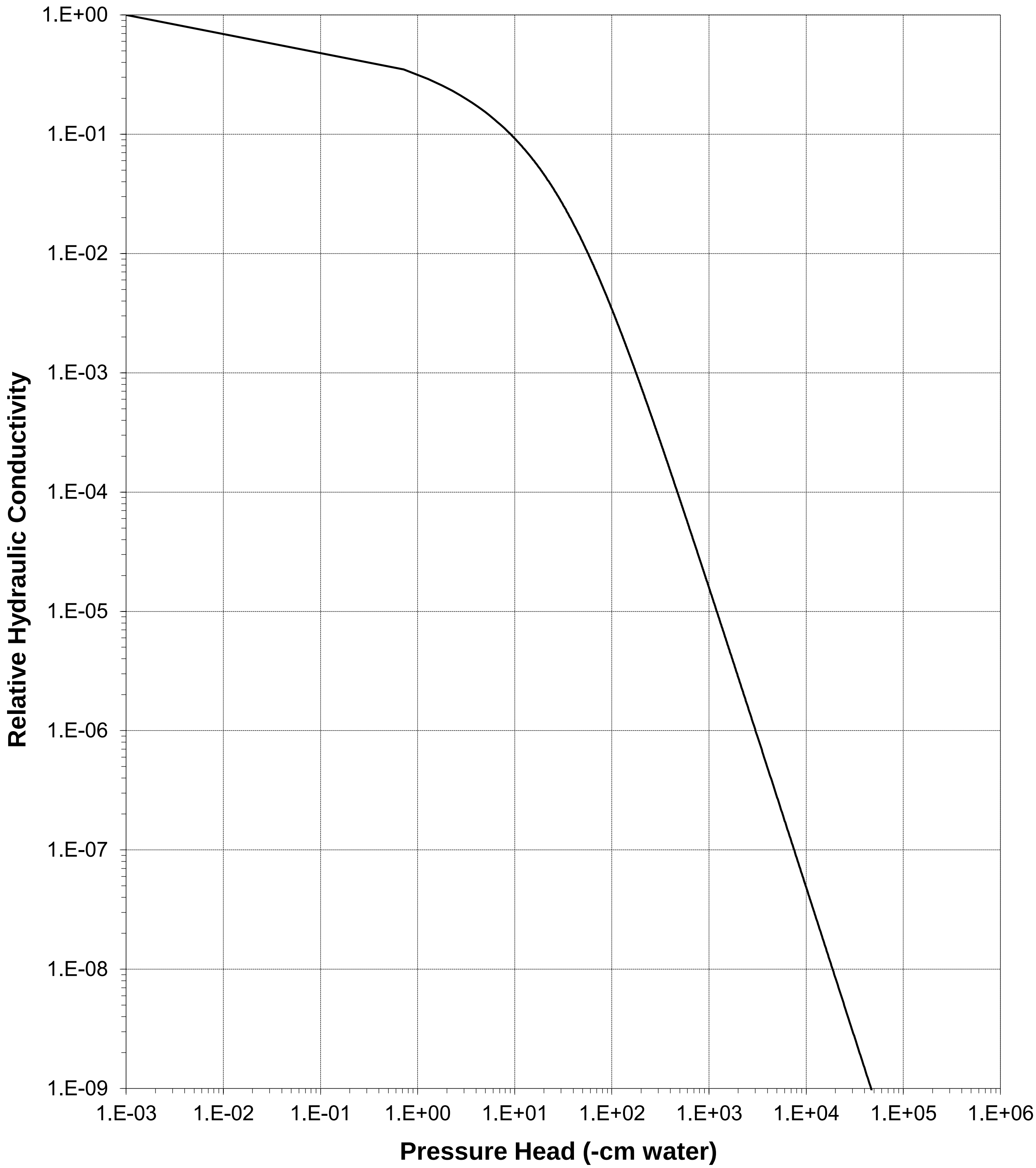
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TSM Fault AB TP2 (~90%)



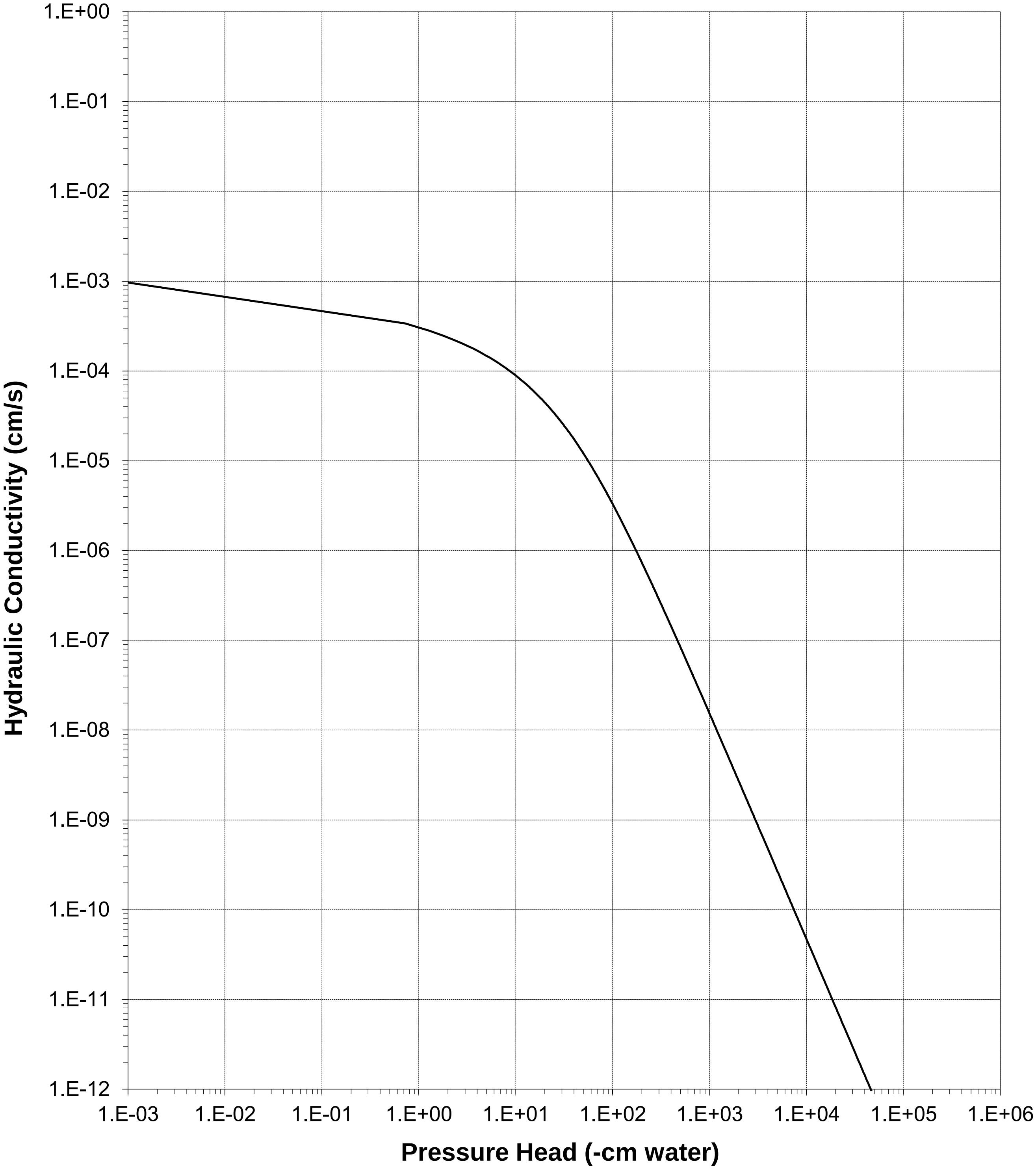
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TSM Fault AB TP2 (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TSM Fault AB TP2 (~90%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.00
Sample Number: TSM Fault AB TP2 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/4"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	2710.00	17500.00	20210.00
Mass Fraction (%):	13.41	86.59	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.75	1.18	1.28
Calculated Porosity (% vol):	0.00	57.15	53.59
Volume of Solids (cm^3):	985.45	6363.64	7349.09
Volume of Voids (cm^3):	0.00	8486.96	8486.96
Total Volume (cm^3):	985.45	14850.60	15836.05
Volumetric Fraction (%):	6.22	93.78	100.00
Initial Moisture Content (% vol):	0.00	37.71	35.36
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.75	1.18	1.28
Calculated Porosity (% vol):	0.00	57.15	53.59
Volume of Solids (cm^3):	985.45	6363.64	7349.09
Volume of Voids (cm^3):	0.00	8486.96	8486.96
Total Volume (cm^3):	985.45	14850.60	15836.05
Volumetric Fraction (%):	6.22	93.78	100.00
Saturated Moisture Content (% vol):	0.00	56.86	53.32
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.75	1.18	1.28
Calculated Porosity (% vol):	0.00	57.15	53.59
Volume of Solids (cm^3):	985.45	6363.64	7349.09
Volume of Voids (cm^3):	0.00	8486.96	8486.96
Total Volume (cm^3):	985.45	14850.60	15836.05
Volumetric Fraction (%):	6.22	93.78	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	9.7E-04	8.4E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name: Broadbent
Job Number: DB21.1124.01
Sample Number: TSM Fault AB TP1 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Dry wt. of sample (g): 3072.55
Tare wt., ring (g): 255.39
Tare wt., screen & clamp (g): 79.74
Initial sample volume (cm^3): 2076.17
Initial dry bulk density (g/cm^3): 1.48
Assumed particle density (g/cm^3): 2.65
Initial calculated total porosity (%): 44.15

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	15-Nov-21	14:30	4293.70	0	42.68
	22-Nov-21	13:05	4260.54	7.0	41.08
	30-Nov-21	14:00	4195.40	13.0	37.94
	7-Dec-21	11:45	4050.83	44.0	30.98
	14-Dec-21	10:45	3947.15	204.0	25.98

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	7.0	---	---	---	---
	13.0	---	---	---	---
	44.0	---	---	---	---
	204.0	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TSM Fault AB TP1 (~90%)

Initial sample bulk density (g/cm^3)*:* 1.48

Fraction of test sample used (<2.00mm fraction) (%): 39.21

Dry weight of dew point potentiometer sample* (g)*:* 169.01

Tare weight, jar (g)*:* 116.65

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	17-Dec-21	9:48	178.38	13461	10.38
	14-Dec-21	7:22	175.25	44055	6.92
	10-Dec-21	9:12	172.82	176425	4.22
	8-Dec-21	9:17	171.27	790039	2.50

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	13461	---	---	---	---
	44055	---	---	---	---
	176425	---	---	---	---
	790039	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

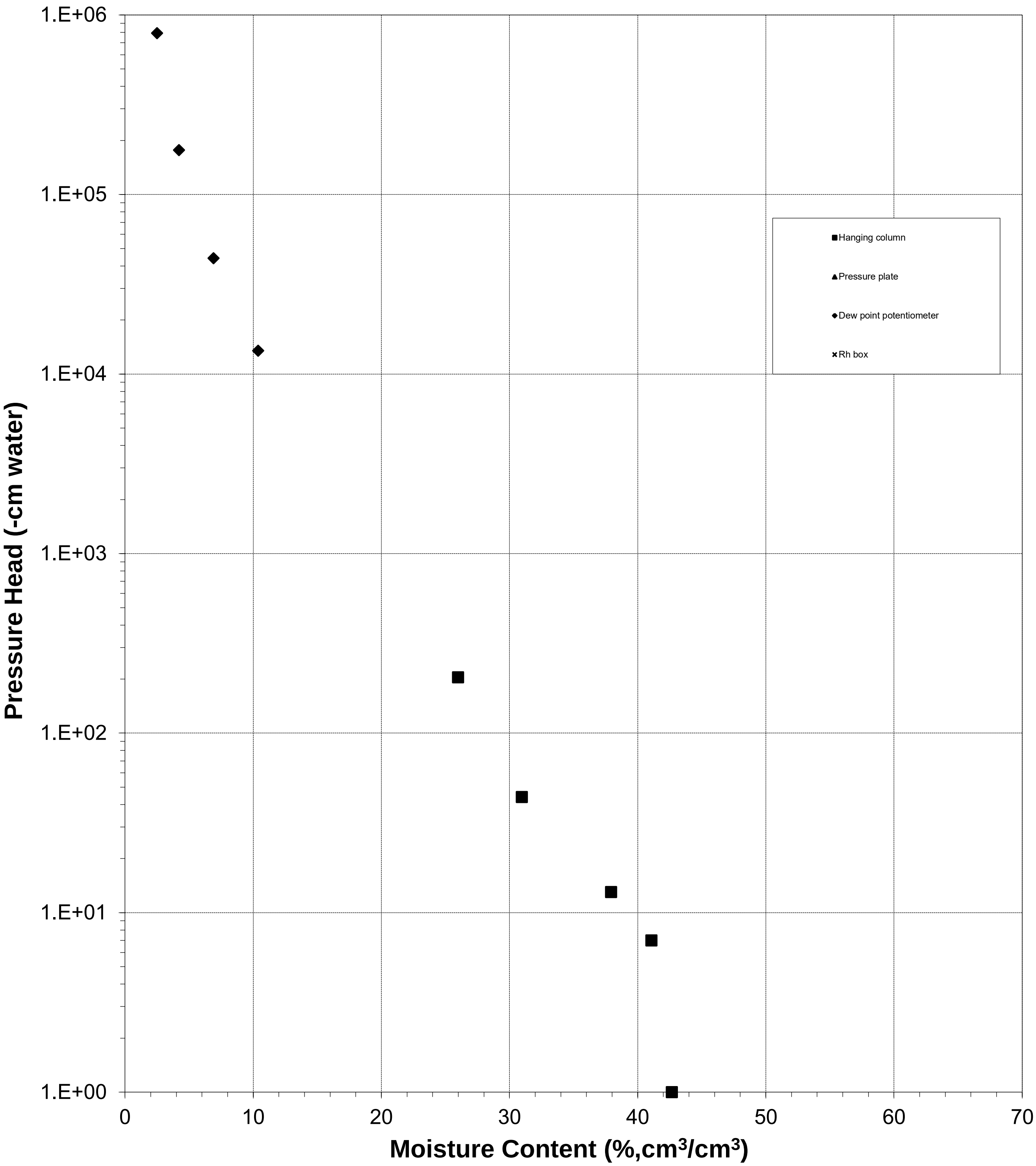
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

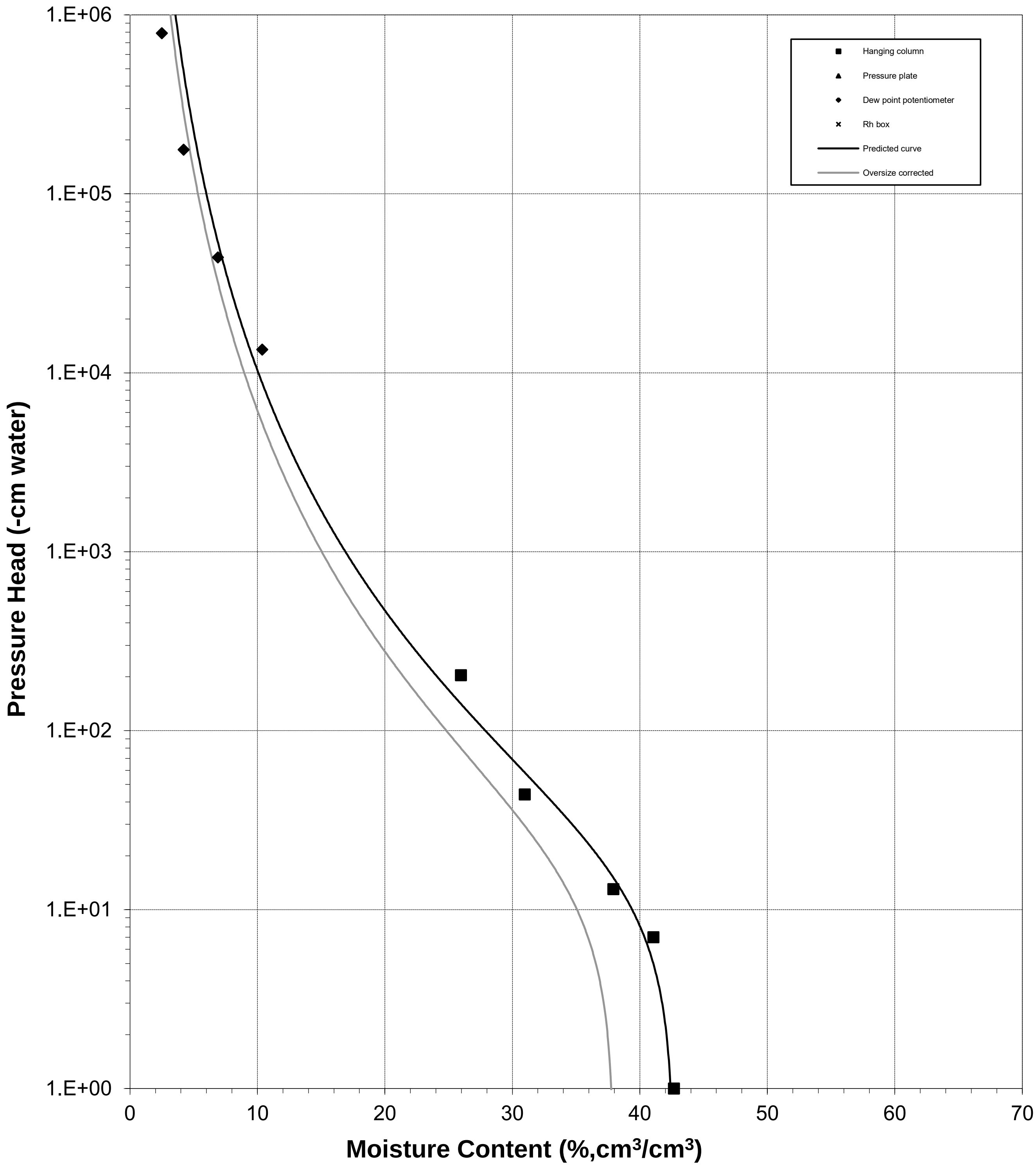
Water Retention Data Points

Sample Number: TSM Fault AB TP1 (~90%)



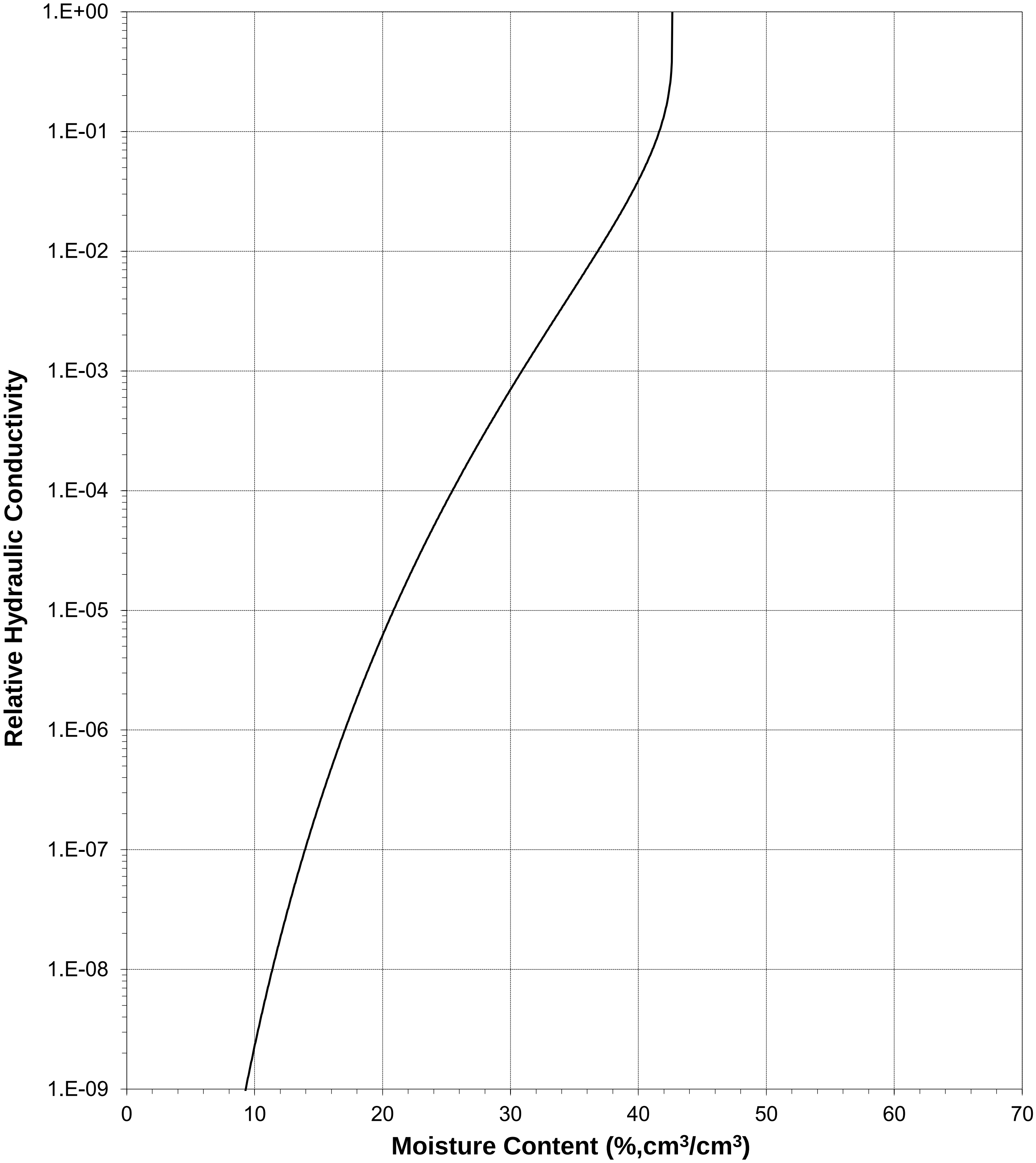
Predicted Water Retention Curve and Data Points

Sample Number: TSM Fault AB TP1 (~90%)



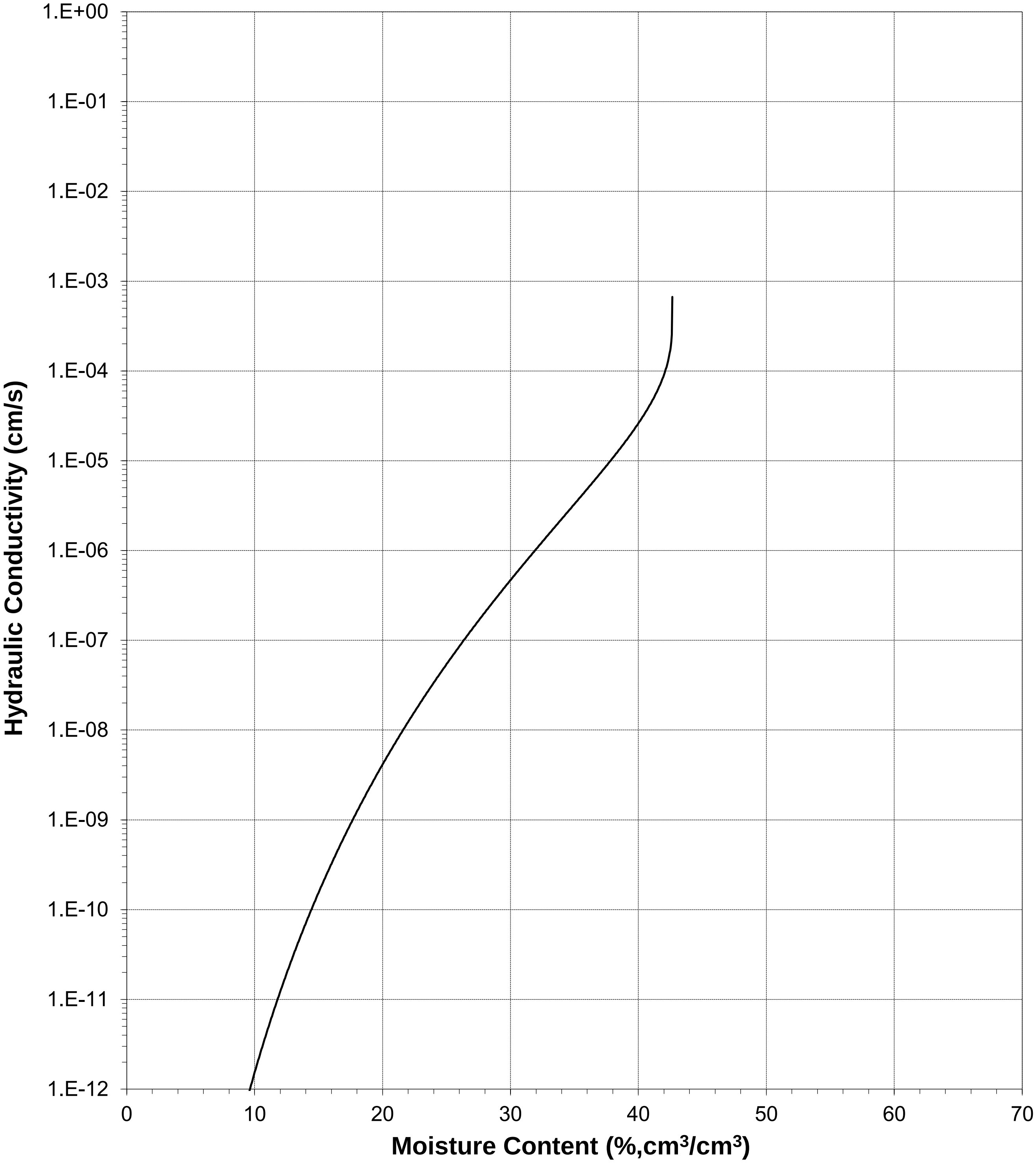
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TSM Fault AB TP1 (~90%)



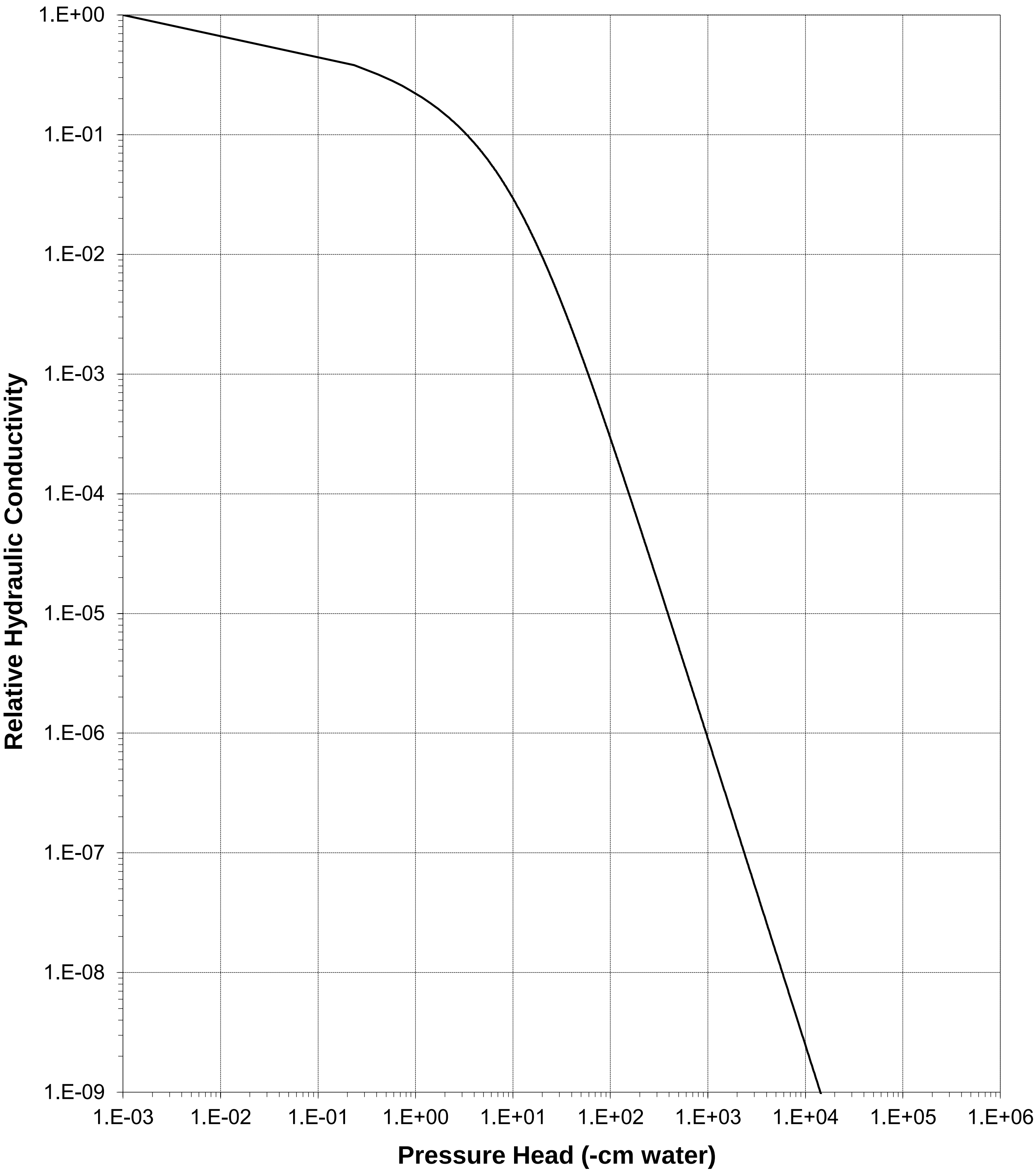
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TSM Fault AB TP1 (~90%)



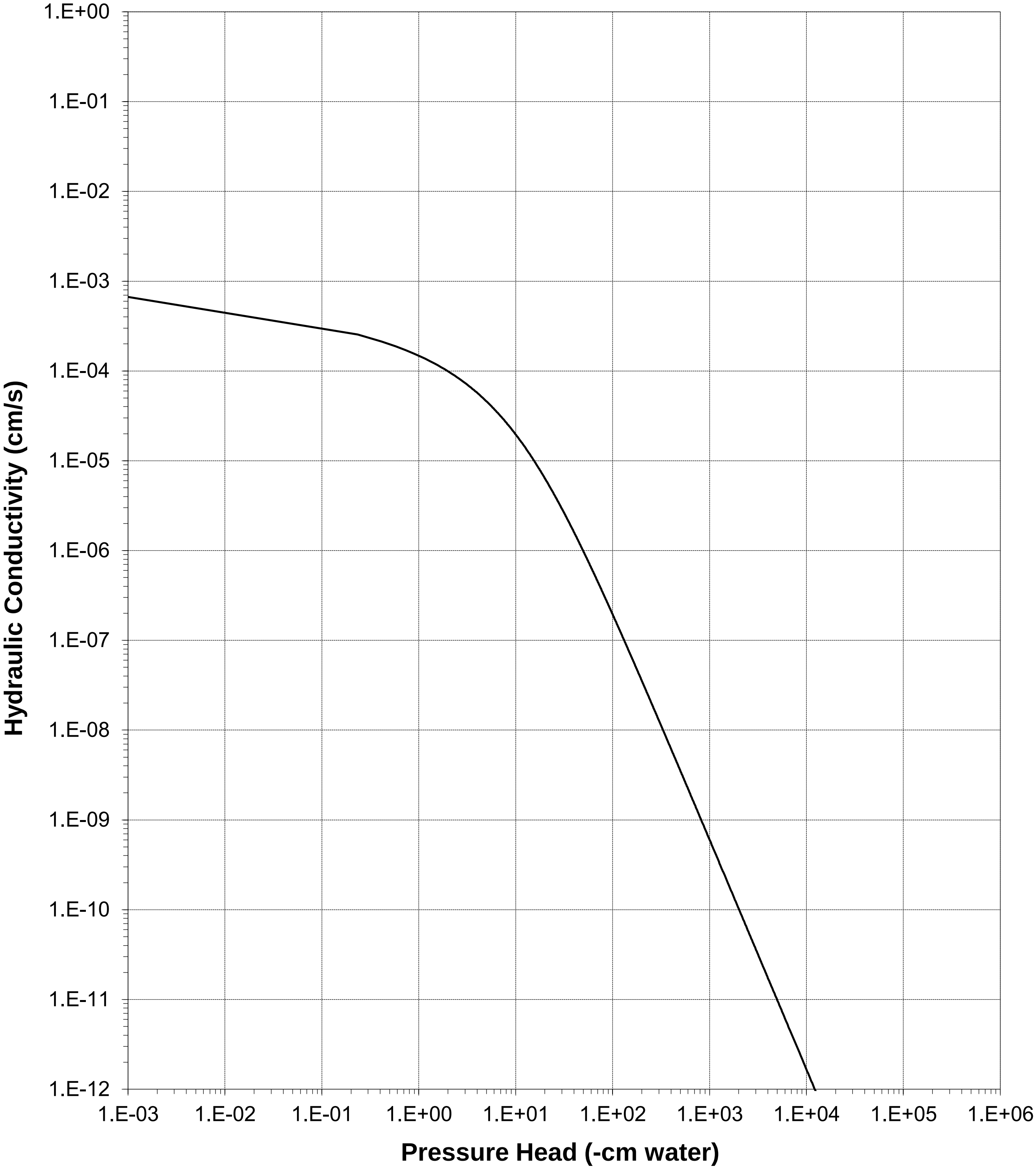
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TSM Fault AB TP1 (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TSM Fault AB TP1 (~90%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.01
Sample Number: TSM Fault AB TP1 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/4"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	4590.00	20780.00	25370.00
Mass Fraction (%):	18.09	81.91	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.48	1.61
Calculated Porosity (% vol):	0.00	44.15	39.31
Volume of Solids (cm^3):	1732.08	7841.51	9573.58
Volume of Voids (cm^3):	0.00	6199.88	6199.88
Total Volume (cm^3):	1732.08	14041.39	15773.46
Volumetric Fraction (%):	10.98	89.02	100.00
Initial Moisture Content (% vol):	0.00	25.45	22.66
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.48	1.61
Calculated Porosity (% vol):	0.00	44.15	39.31
Volume of Solids (cm^3):	1732.08	7841.51	9573.58
Volume of Voids (cm^3):	0.00	6199.88	6199.88
Total Volume (cm^3):	1732.08	14041.39	15773.46
Volumetric Fraction (%):	10.98	89.02	100.00
Saturated Moisture Content (% vol):	0.00	42.66	37.97
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.48	1.61
Calculated Porosity (% vol):	0.00	44.15	39.31
Volume of Solids (cm^3):	1732.08	7841.51	9573.58
Volume of Voids (cm^3):	0.00	6199.88	6199.88
Total Volume (cm^3):	1732.08	14041.39	15773.46
Volumetric Fraction (%):	10.98	89.02	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	6.7E-04	5.5E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample* (g):	2436.49
Job Number:	DB21.1124.02	*Tare wt., ring* (g):	220.07
Sample Number:	Muddy Creek AB TP1 (~90%)	*Tare wt., screen & clamp* (g):	63.07
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3):	1811.71
Depth:	NA	*Initial dry bulk density* (g/cm^3):	1.34
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	49.25

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	15-Nov-21	15:12	3618.10	0	49.59
	22-Nov-21	13:35	3537.58	8.0	45.15
	30-Nov-21	15:00	3474.48	16.0	41.67
	7-Dec-21	12:15	3383.02	47.0	36.62
	14-Dec-21	12:15	3281.08	203.0	30.99

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	16.0	---	---	---	---
	47.0	---	---	---	---
	203.0	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Muddy Creek AB TP1 (~90%)

Initial sample bulk density (g/cm^3)*:* 1.34
Fraction of test sample used (<2.00mm fraction) (%): 72.03

Dry weight of dew point potentiometer sample* (g)*:* 172.19
Tare weight, jar (g)*:* 122.11

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	13-Dec-21	14:15	178.50	173570	12.21
	9-Dec-21	10:38	176.29	305430	7.93
	8-Dec-21	9:35	175.35	721916	6.11

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	173570	---	---	---	---
	305430	---	---	---	---
	721916	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

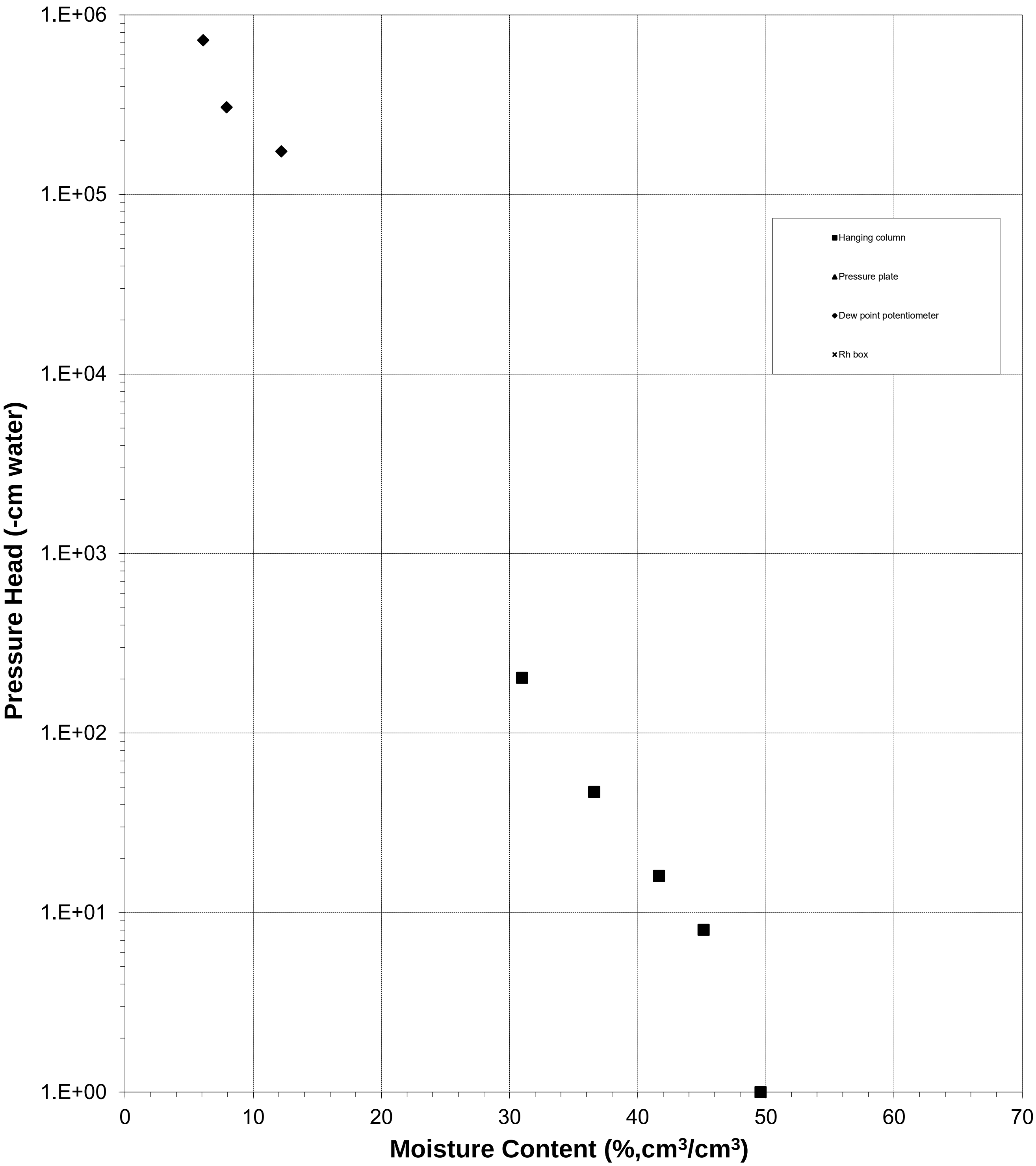
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

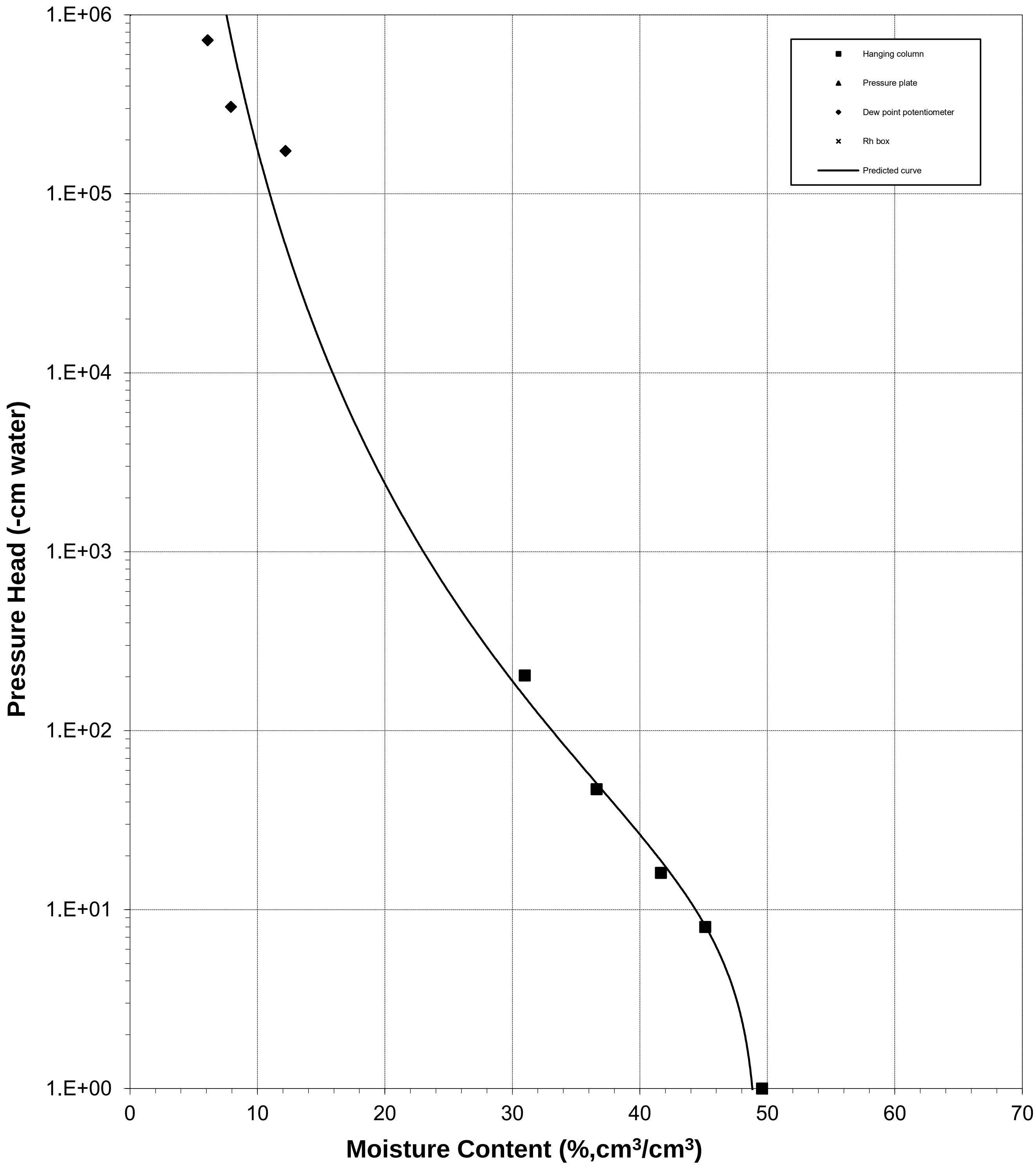
Water Retention Data Points

Sample Number: Muddy Creek AB TP1 (~90%)



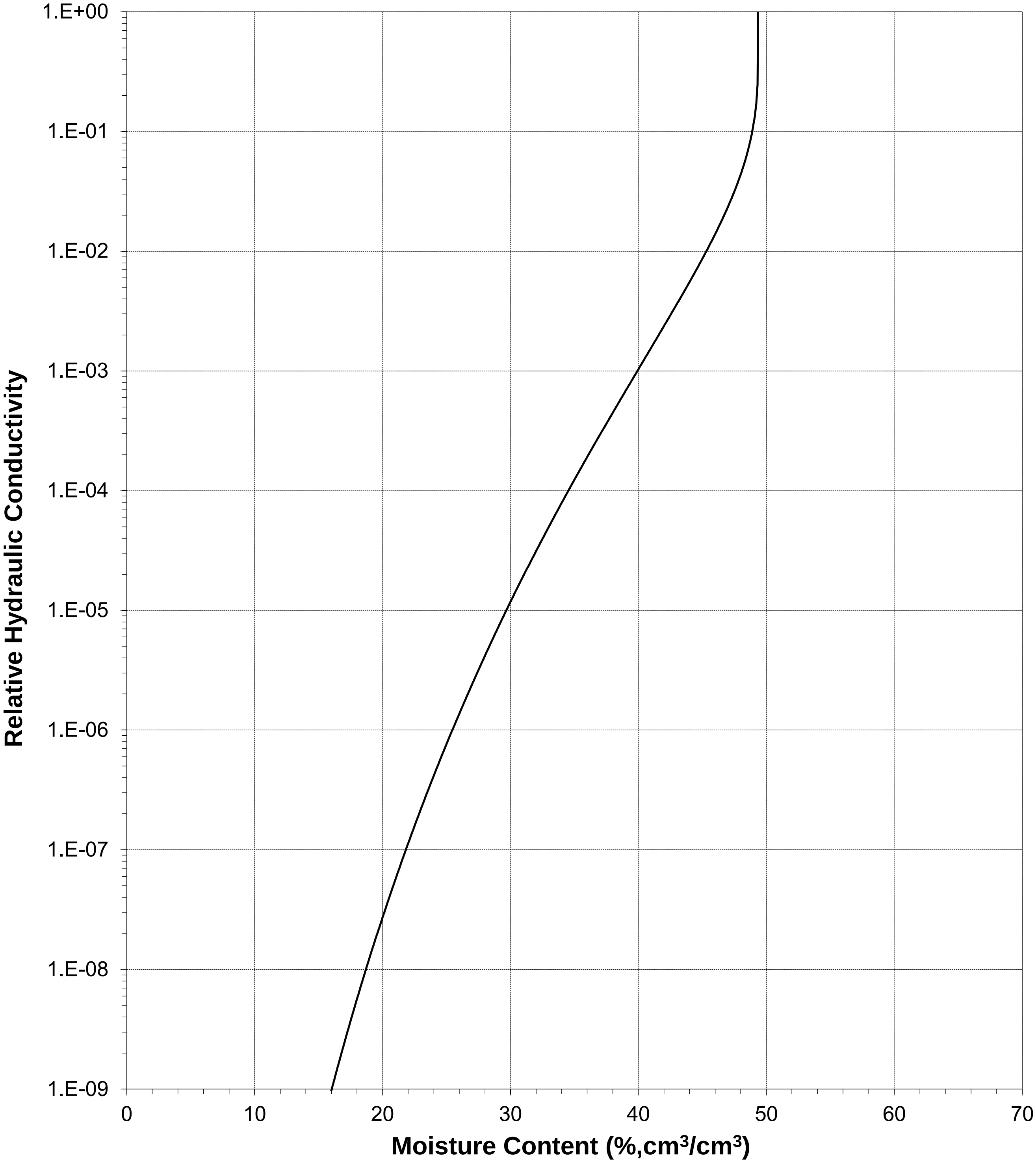
Predicted Water Retention Curve and Data Points

Sample Number: Muddy Creek AB TP1 (~90%)



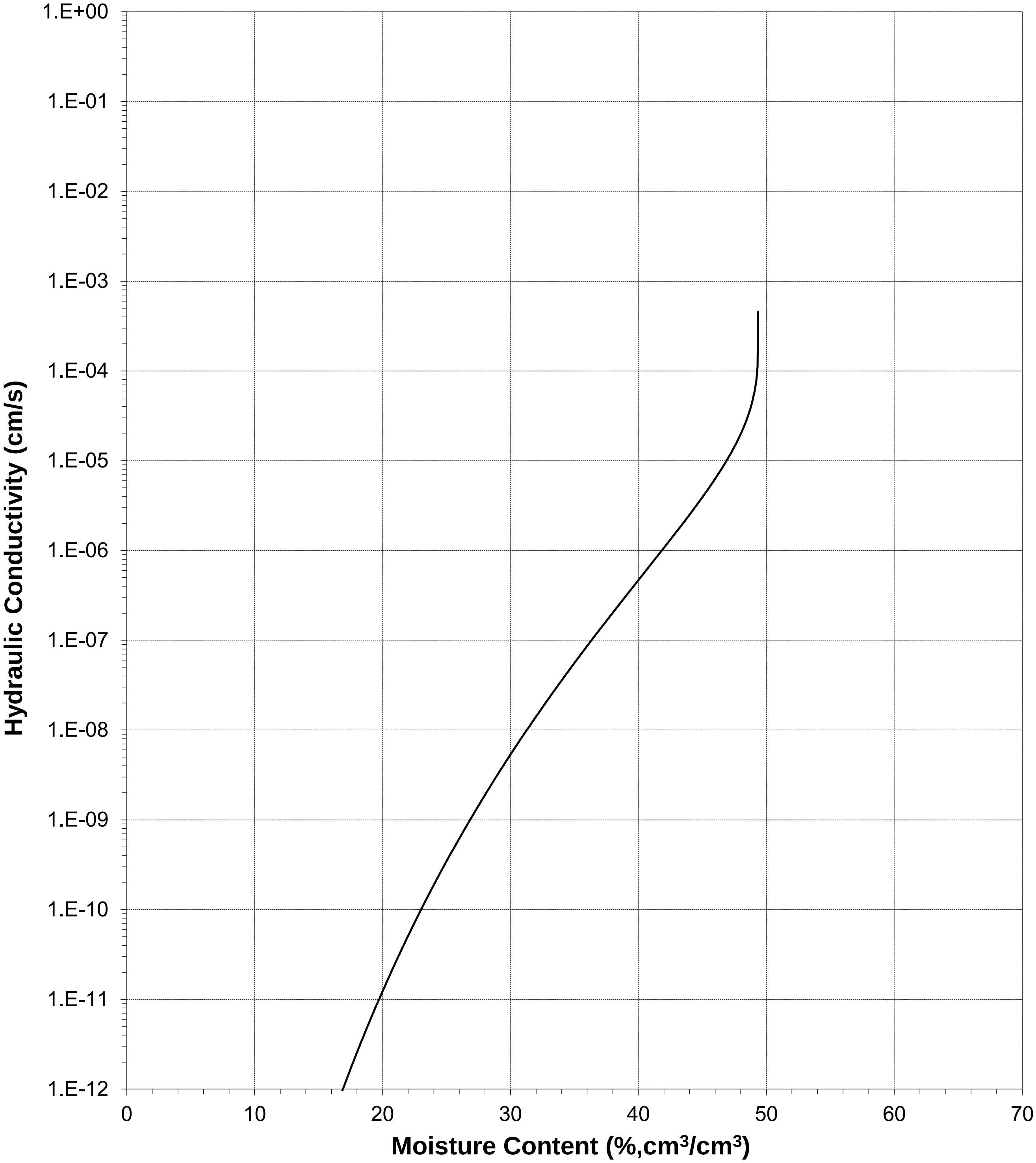
Plot of Relative Hydraulic Conductivity vs Moisture Content

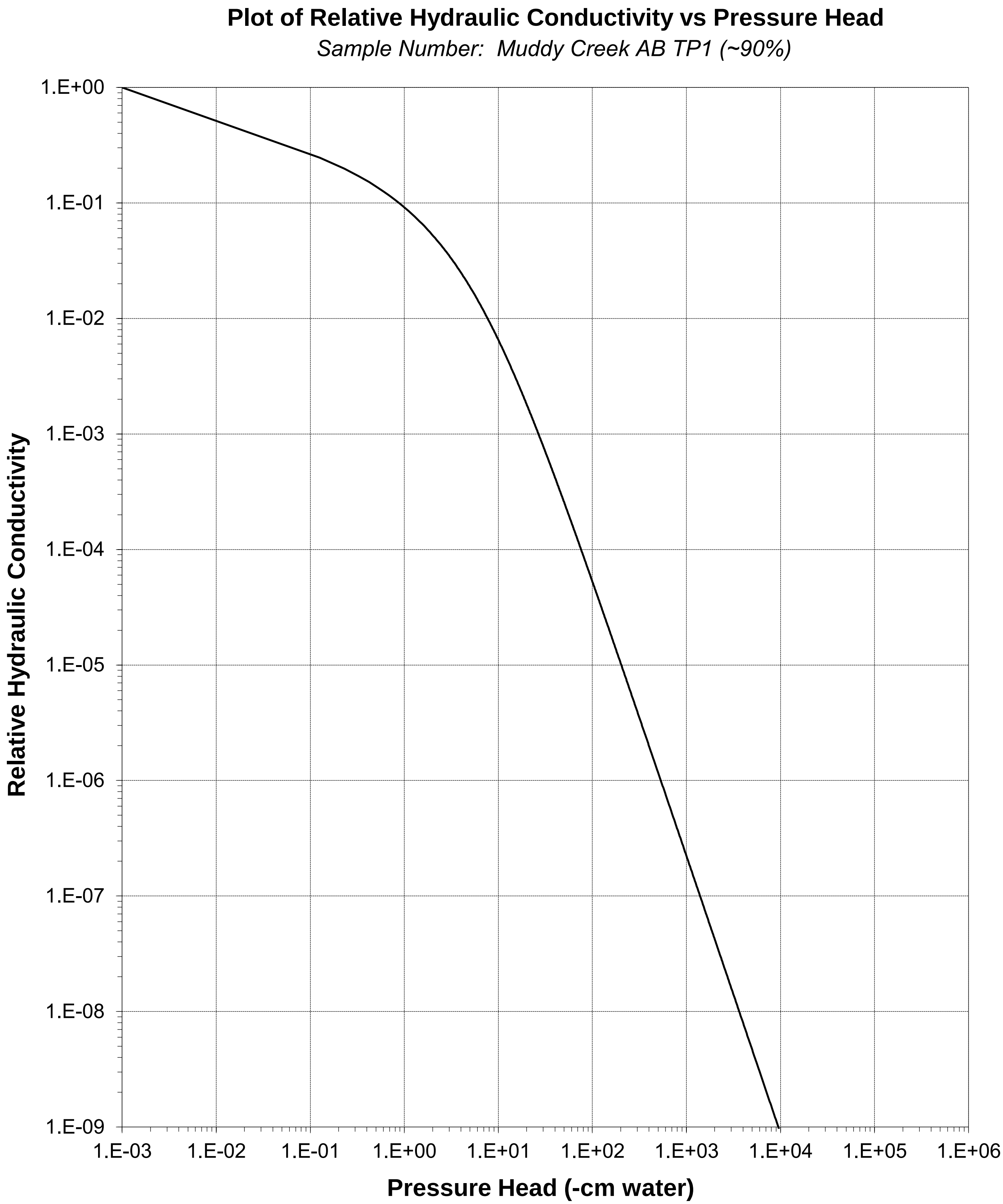
Sample Number: Muddy Creek AB TP1 (~90%)



Plot of Hydraulic Conductivity vs Moisture Content

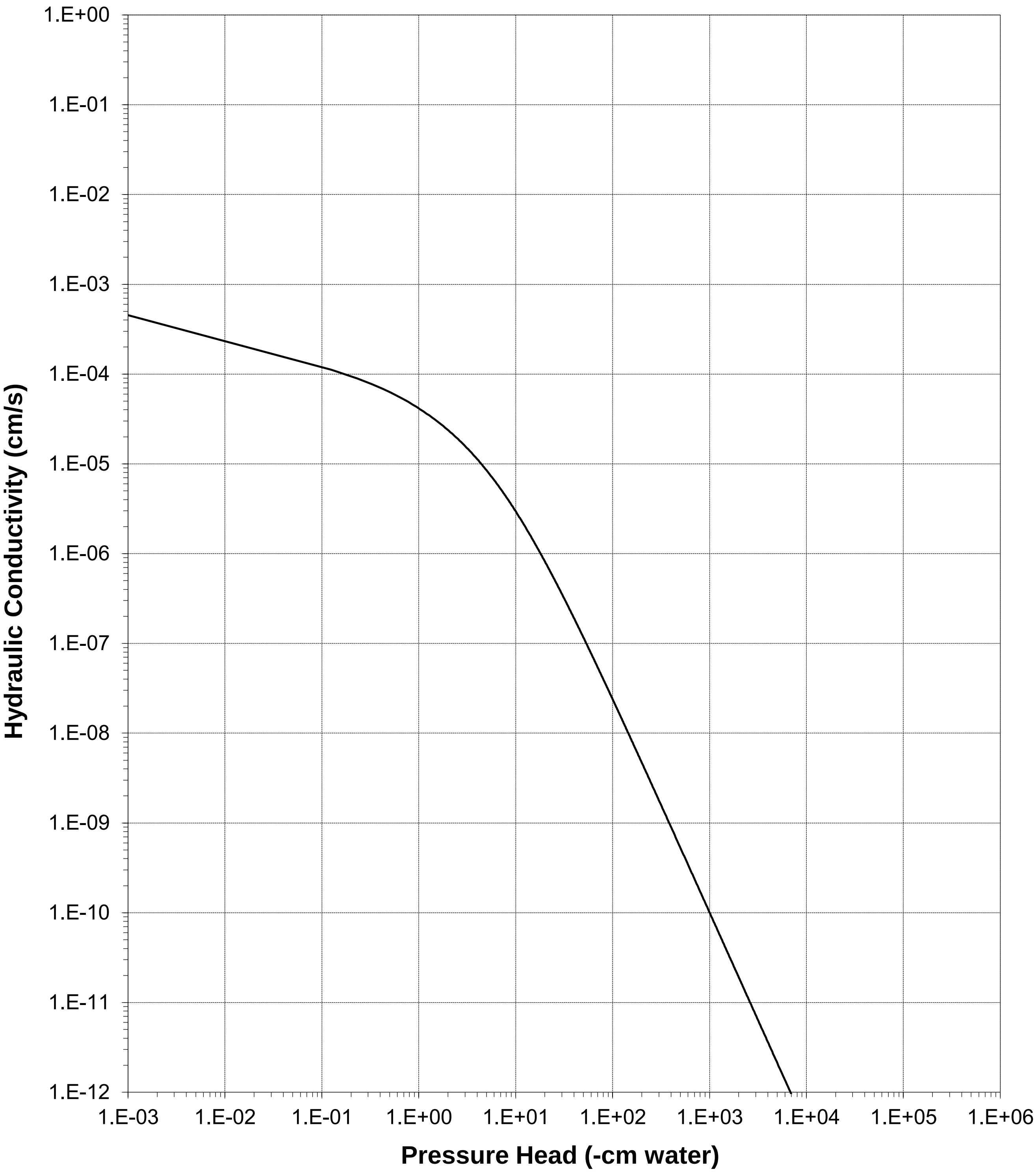
Sample Number: Muddy Creek AB TP1 (~90%)




Plot of Relative Hydraulic Conductivity vs Pressure Head
Sample Number: Muddy Creek AB TP1 (~90%)
Relative Hydraulic Conductivity
Pressure Head (-cm water)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06

Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Muddy Creek AB TP1 (~90%)



Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample (g):*	3399.34
Job Number:	DB21.1124.03	*Tare wt., ring (g):*	241.83
Sample Number:	Muddy Creek TP1 (~90%)	*Tare wt., screen & clamp (g):*	77.79
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume (cm^3):*	1986.33
Depth:	NA	*Initial dry bulk density (g/cm^3):*	1.71
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	35.42

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	15-Nov-21	14:45	4420.50	0	37.21	‡‡
	22-Nov-21	13:10	4334.86	8.0	32.67	‡‡
	30-Nov-21	14:00	4299.69	15.0	30.80	‡‡
	7-Dec-21	11:45	4189.56	43.0	24.96	‡‡
	14-Dec-21	10:45	3972.58	207.0	13.45	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	1885.21	-5.09%	1.80	31.96
	8.0	1885.21	-5.09%	1.80	31.96
	15.0	1885.21	-5.09%	1.80	31.96
	43.0	1885.21	-5.09%	1.80	31.96
	207.0	1885.21	-5.09%	1.80	31.96

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Muddy Creek TP1 (~90%)

Initial sample bulk density (g/cm^3)*:* 1.71
Fraction of test sample used (<2.00mm fraction) (%): 48.95

Dry weight of dew point potentiometer sample* (g)*:* 180.80
Tare weight, jar (g)*:* 113.33

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	16-Dec-21	7:44	185.45	21008	6.08	‡‡
	13-Dec-21	13:52	183.81	68021	3.94	‡‡
	9-Dec-21	9:55	182.88	213852	2.72	‡‡
	8-Dec-21	9:10	182.43	521526	2.13	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	21008	1885.21	-5.09%	1.80	31.96
	68021	1885.21	-5.09%	1.80	31.96
	213852	1885.21	-5.09%	1.80	31.96
	521526	1885.21	-5.09%	1.80	31.96

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

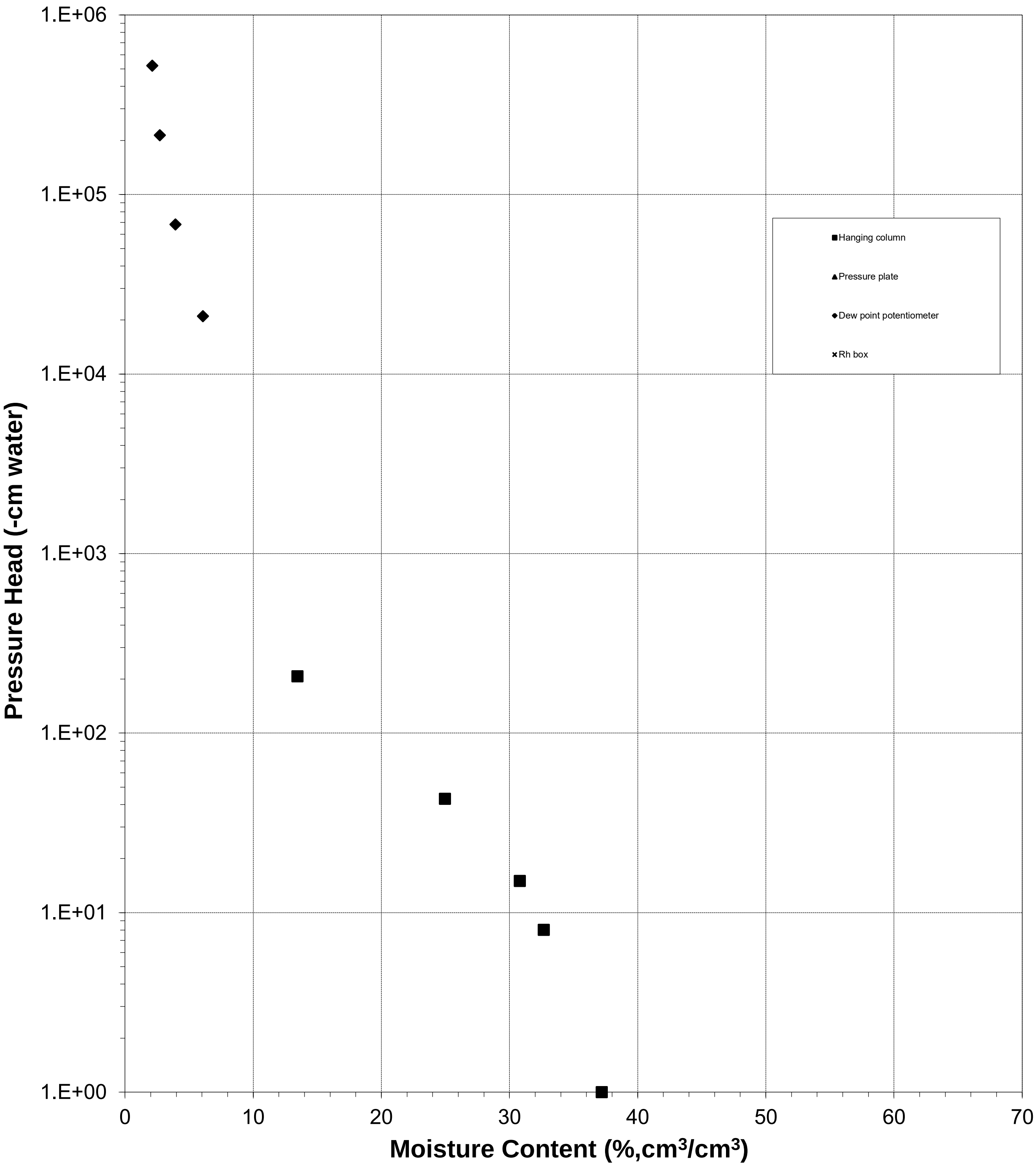
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

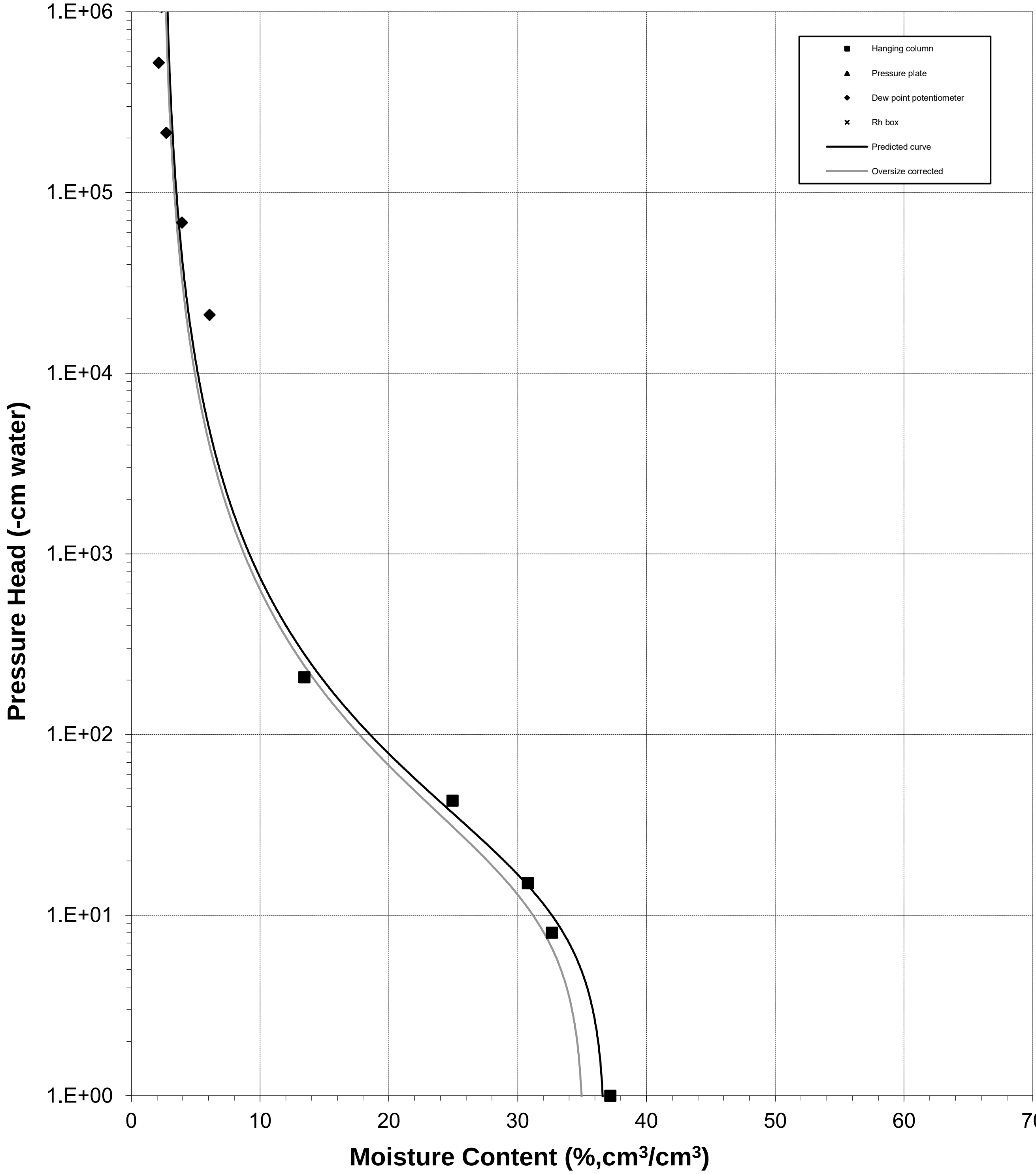
Water Retention Data Points

Sample Number: Muddy Creek TP1 (~90%)



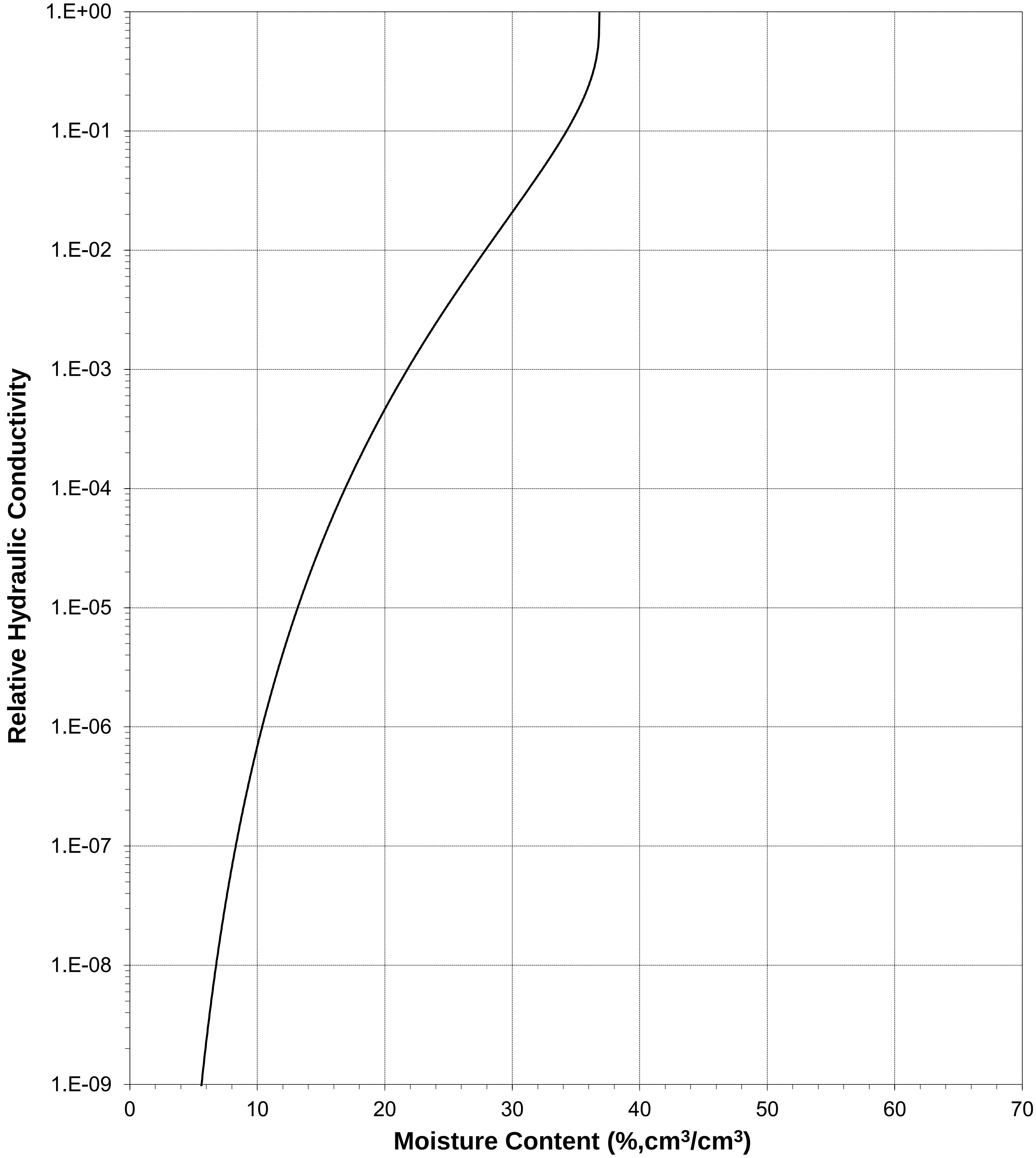
Predicted Water Retention Curve and Data Points

Sample Number: Muddy Creek TP1 (~90%)



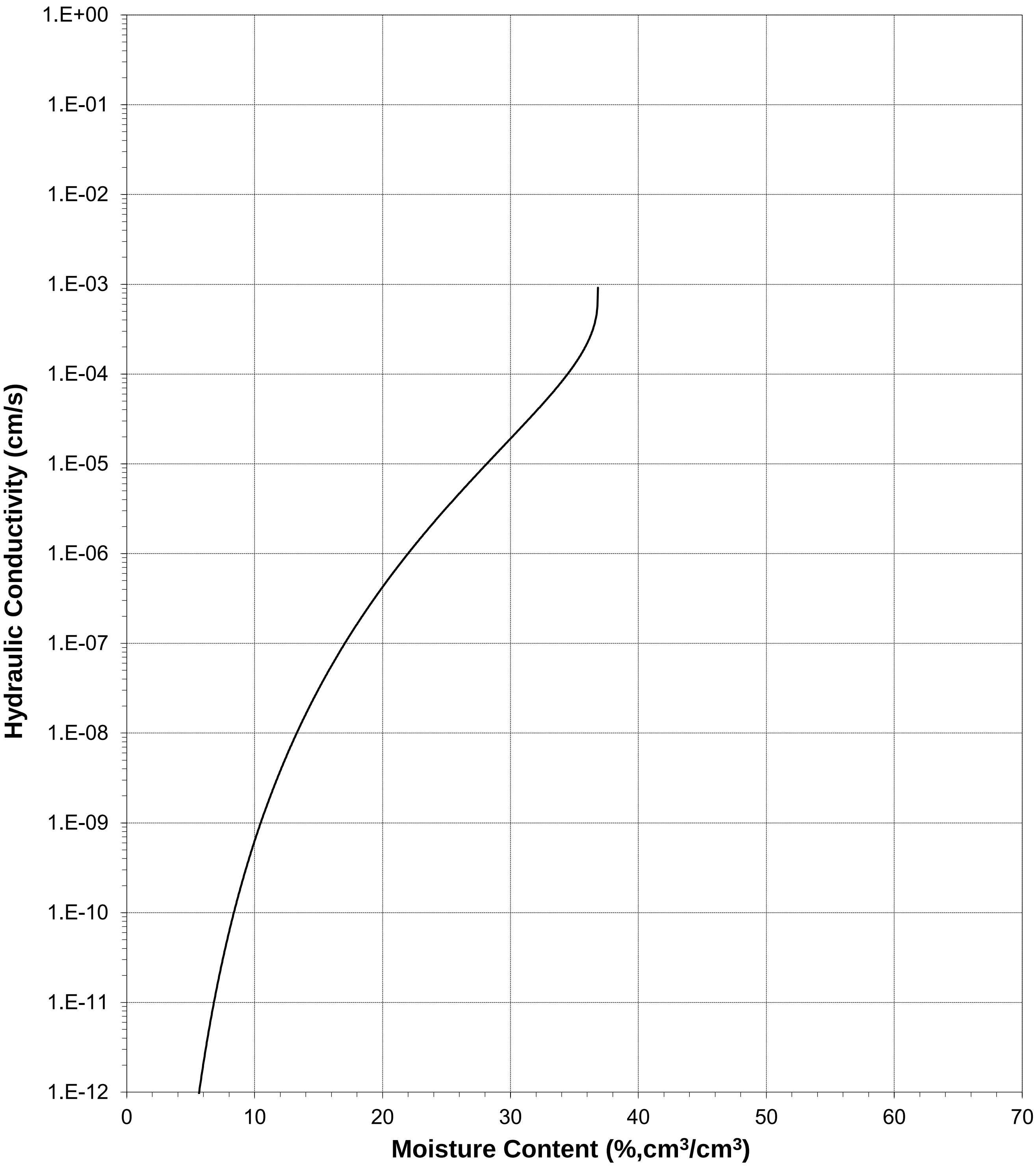
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: Muddy Creek TP1 (~90%)



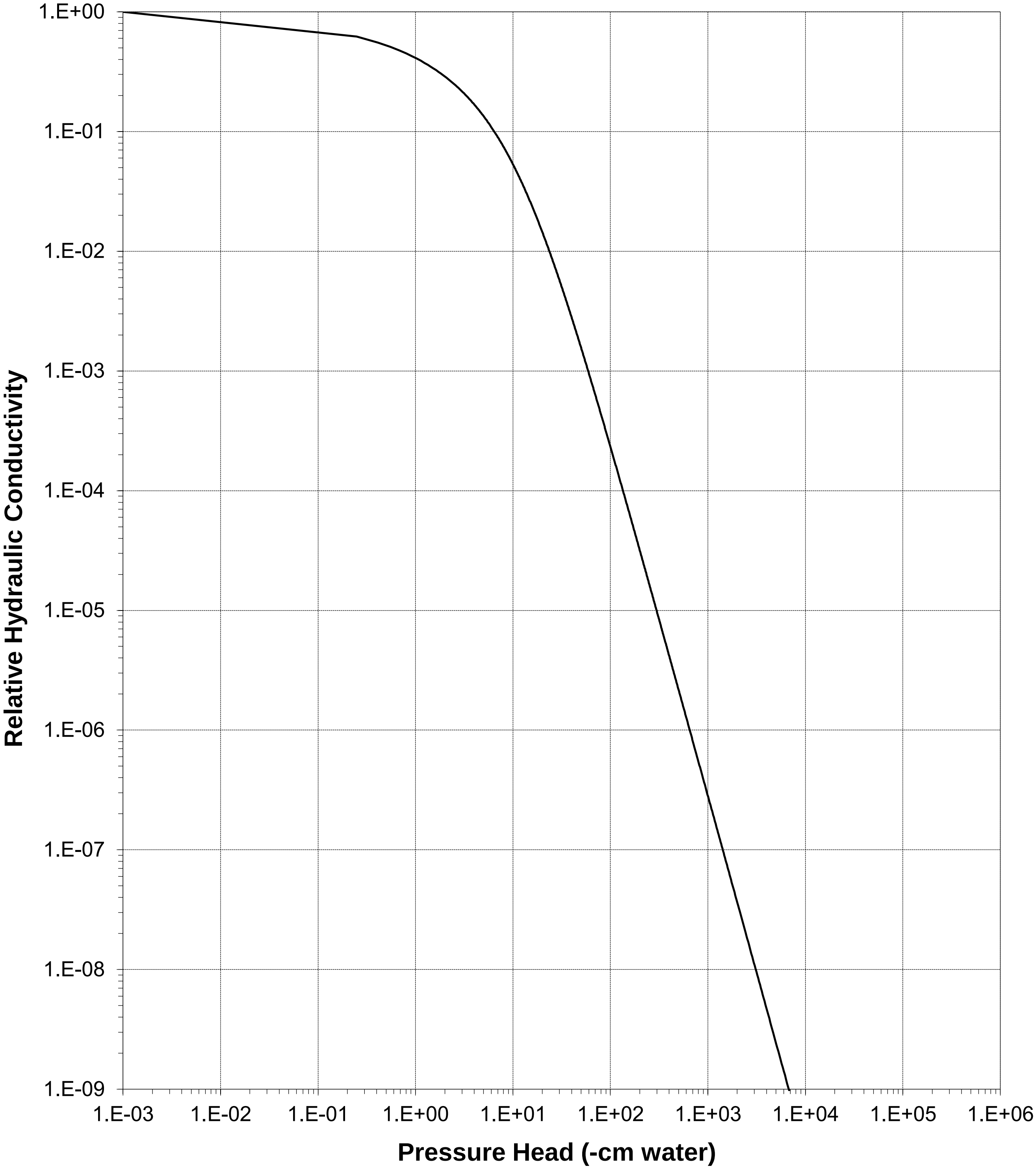
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: Muddy Creek TP1 (~90%)



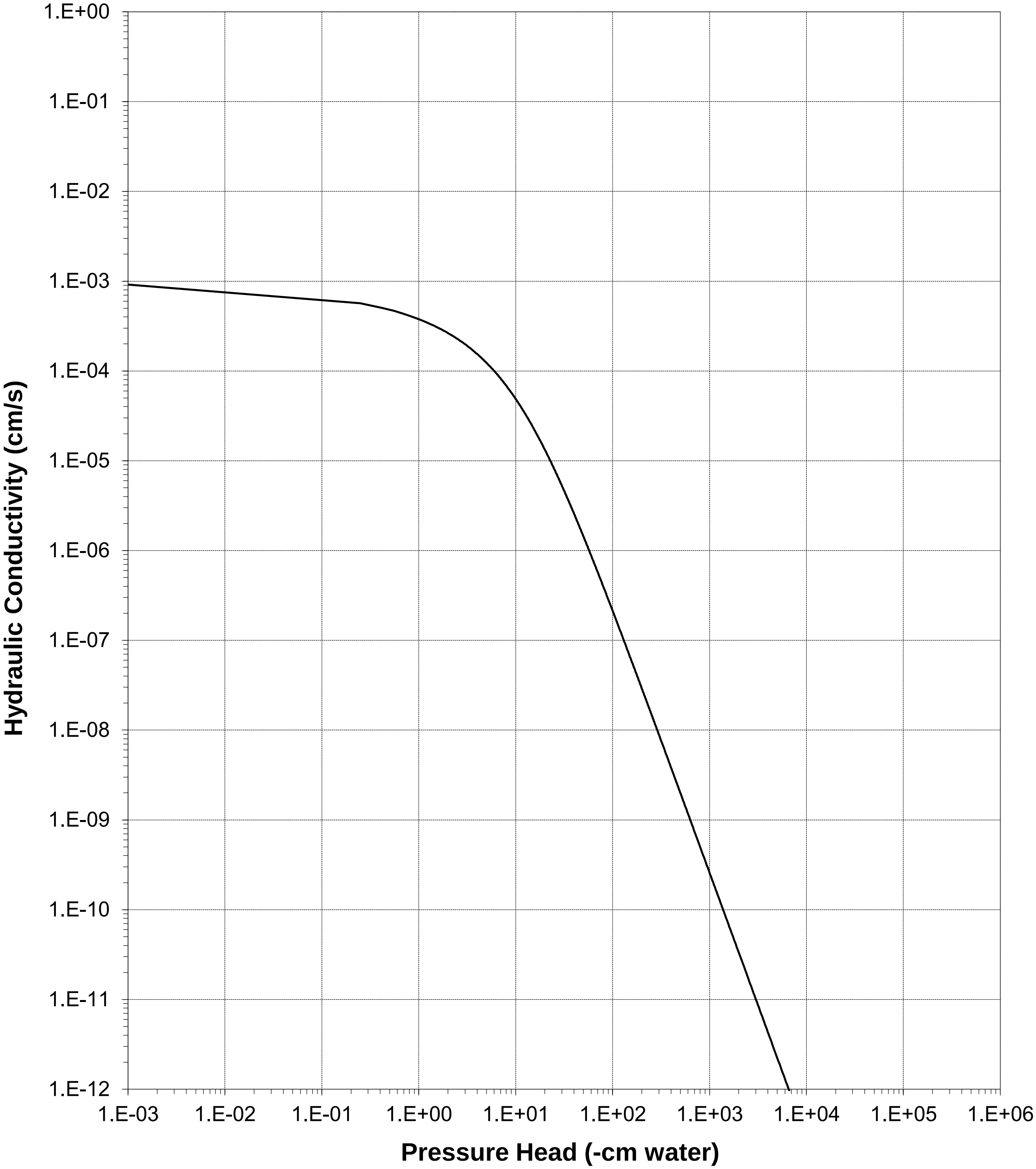
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: Muddy Creek TP1 (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Muddy Creek TP1 (~90%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.03
Sample Number: Muddy Creek TP1 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/4"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	2650.00	38350.00	41000.00
Mass Fraction (%):	6.46	93.54	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.71	1.75
Calculated Porosity (% vol):	0.00	35.42	33.91
Volume of Solids (cm^3):	1000.00	14471.70	15471.70
Volume of Voids (cm^3):	0.00	7937.30	7937.30
Total Volume (cm^3):	1000.00	22409.00	23409.00
Volumetric Fraction (%):	4.27	95.73	100.00
Initial Moisture Content (% vol):	0.00	15.06	14.42
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.80	1.84
Calculated Porosity (% vol):	0.00	31.96	30.52
Volume of Solids (cm^3):	1000.00	14471.70	15471.70
Volume of Voids (cm^3):	0.00	6796.54	6796.54
Total Volume (cm^3):	1000.00	21268.24	22268.24
Volumetric Fraction (%):	4.49	95.51	100.00
Saturated Moisture Content (% vol):	0.00	36.84	35.18
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.80	1.84
Calculated Porosity (% vol):	0.00	31.96	30.52
Volume of Solids (cm^3):	1000.00	14471.70	15471.70
Volume of Voids (cm^3):	0.00	6796.54	6796.54
Total Volume (cm^3):	1000.00	21268.24	22268.24
Volumetric Fraction (%):	4.49	95.51	100.00
Residual Moisture Content (% vol):	0.00	2.32	2.22
Ksat (cm/sec):	NM	9.2E-04	8.6E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample* (g):	3308.99
Job Number:	DB21.1124.04	*Tare wt., ring* (g):	252.88
Sample Number:	Muddy Creek TP3 (~90%)	*Tare wt., screen & clamp* (g):	48.44
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3):	2045.26
Depth:	NA	*Initial dry bulk density* (g/cm^3):	1.62
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	38.95

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)	
Hanging column:	15-Nov-21	14:50	4370.96	0	38.49	‡‡
	22-Nov-21	13:20	4267.50	8.0	33.25	‡‡
	30-Nov-21	14:00	4230.91	16.0	31.40	‡‡
	7-Dec-21	11:50	4133.48	48.0	26.47	‡‡
	14-Dec-21	10:45	3943.80	203.0	16.87	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	1976.48	-3.36%	1.67	36.82
	8.0	1976.48	-3.36%	1.67	36.82
	16.0	1976.48	-3.36%	1.67	36.82
	48.0	1976.48	-3.36%	1.67	36.82
	203.0	1976.48	-3.36%	1.67	36.82

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Muddy Creek TP3 (~90%)

Initial sample bulk density (g/cm^3)*:* 1.62
Fraction of test sample used (<2.00mm fraction) (%): 69.18

Dry weight of dew point potentiometer sample* (g)*:* 172.71
Tare weight, jar (g)*:* 115.12

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	9-Dec-21	10:30	175.81	143894	6.23	‡‡
	8-Dec-21	9:30	175.02	325418	4.65	‡‡
	7-Dec-21	10:30	174.55	534783	3.70	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	143894	1976.48	-3.36%	1.67	36.82
	325418	1976.48	-3.36%	1.67	36.82
	534783	1976.48	-3.36%	1.67	36.82

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

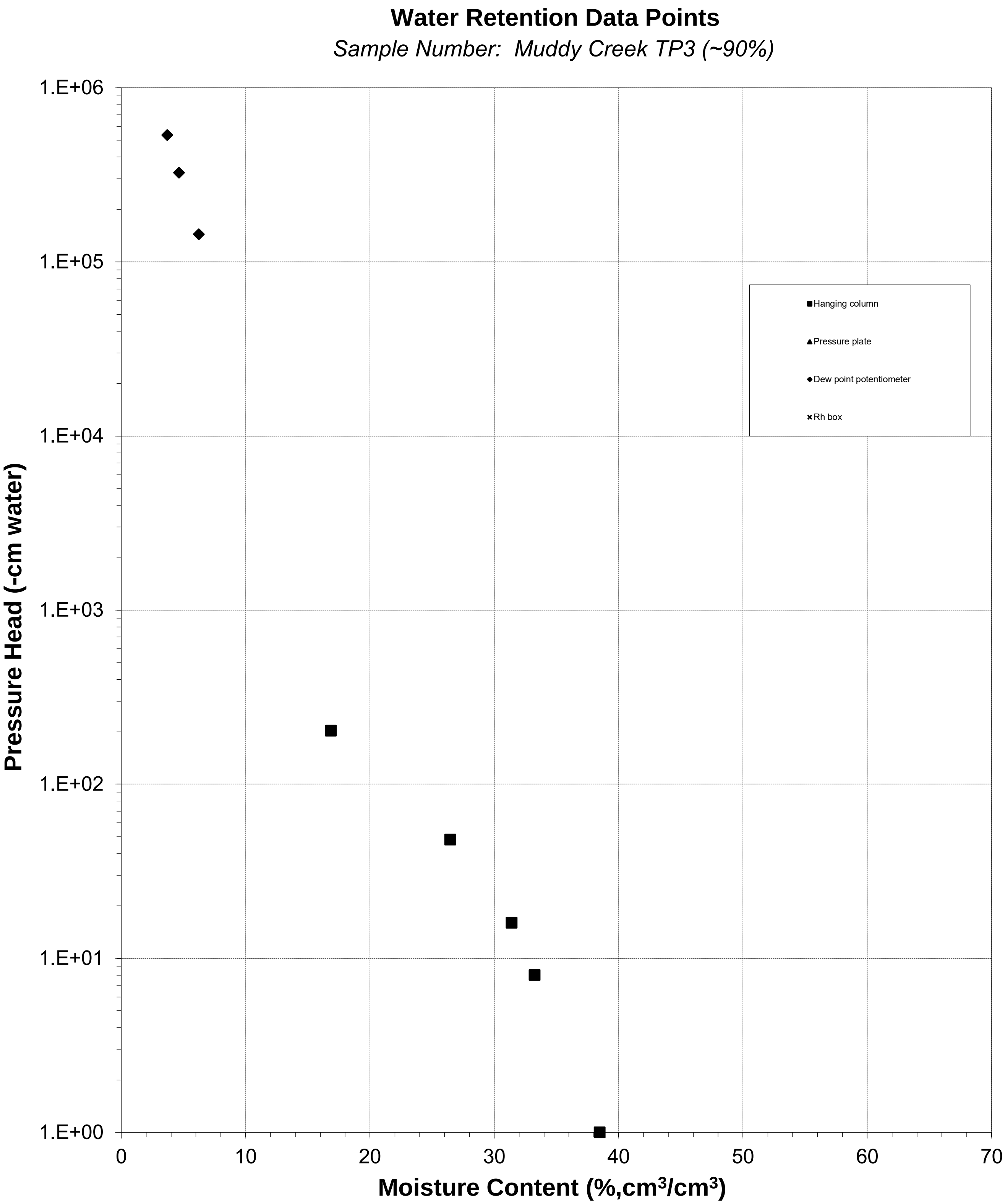
[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

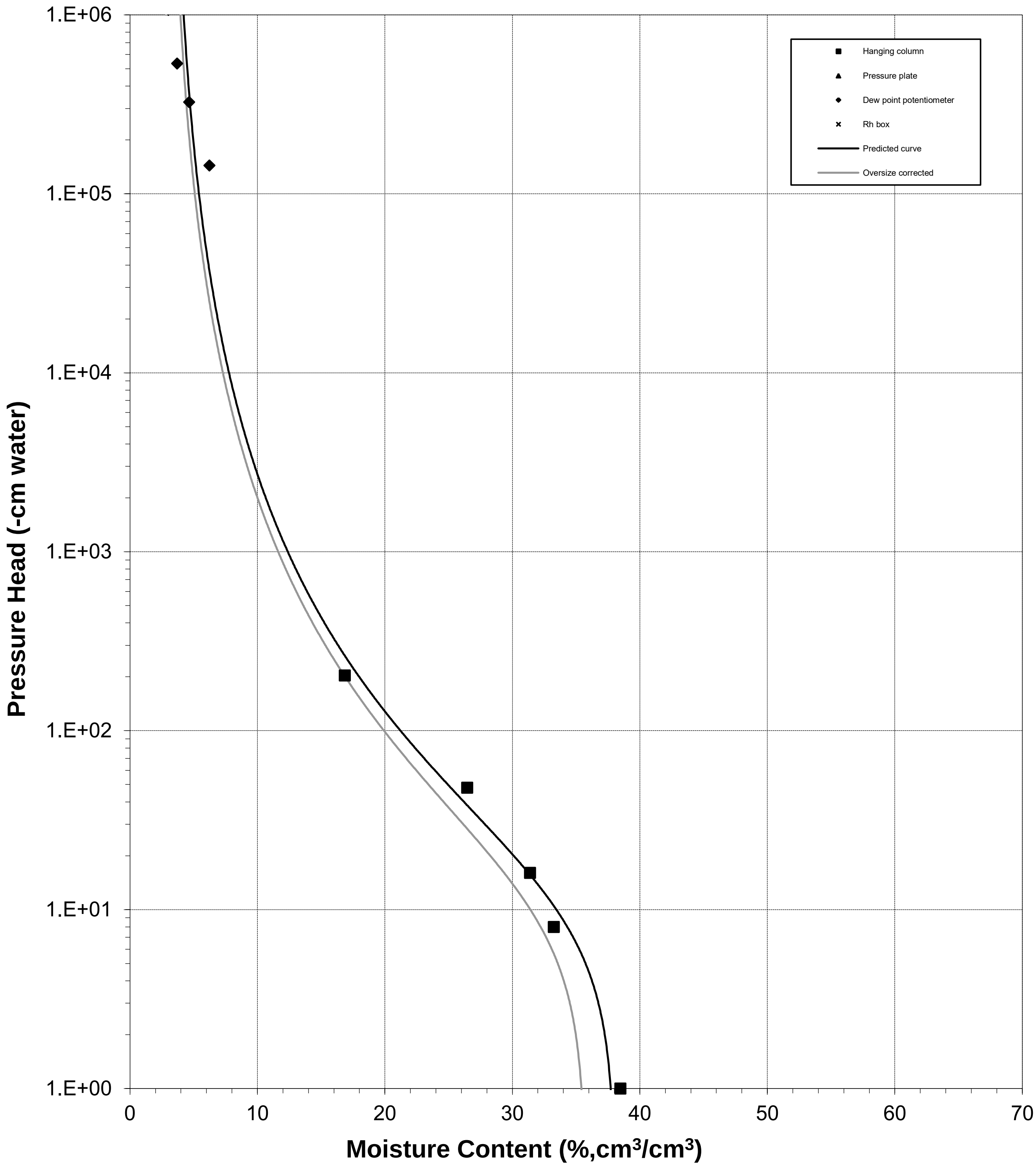
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines


Water Retention Data Points
Sample Number: Muddy Creek TP3 (~90%)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
70
Moisture Content (%,cm3/cm3)
Hanging column
Pressure plate
Dew point potentiometer
Rh box

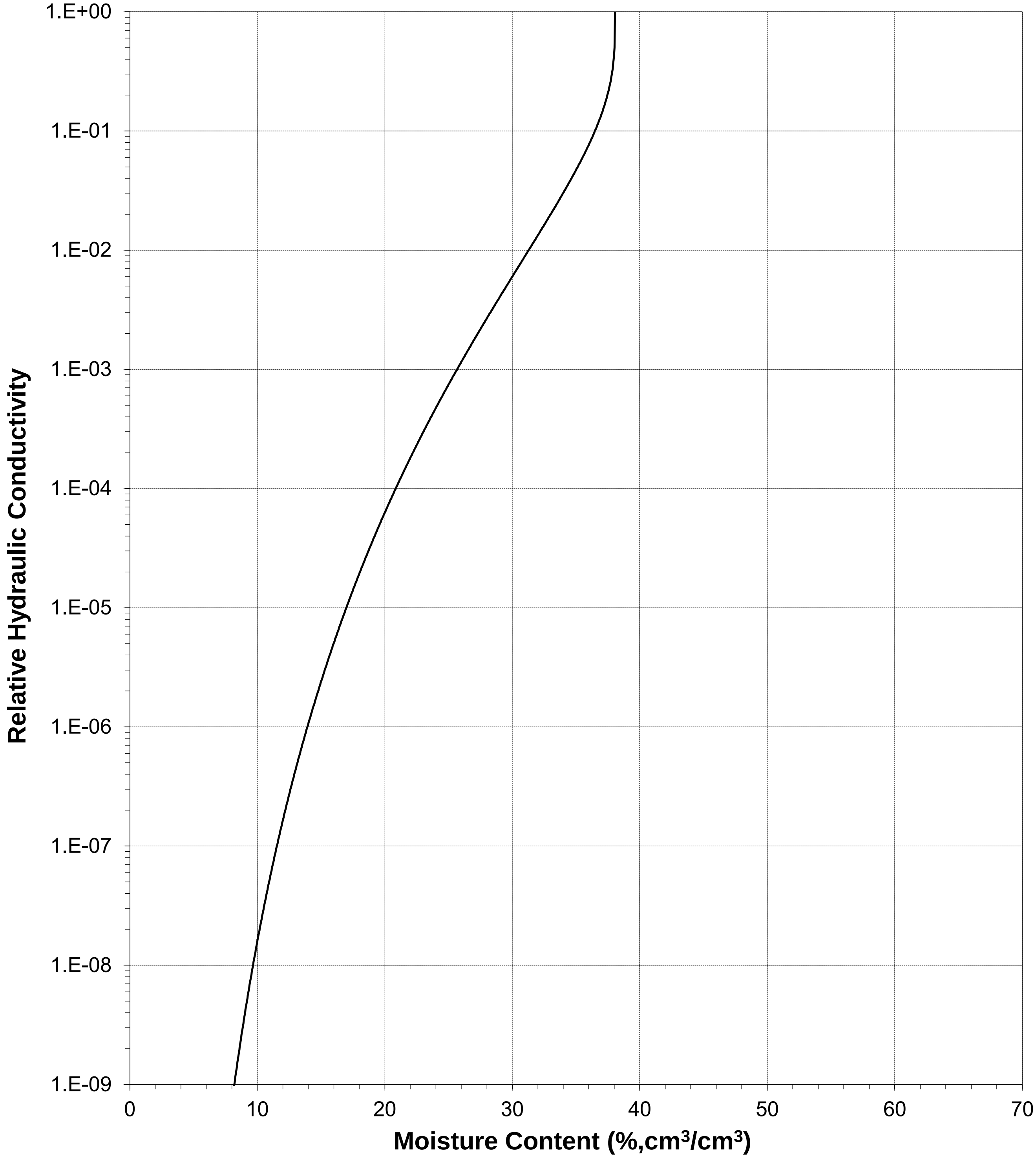
Predicted Water Retention Curve and Data Points

Sample Number: Muddy Creek TP3 (~90%)



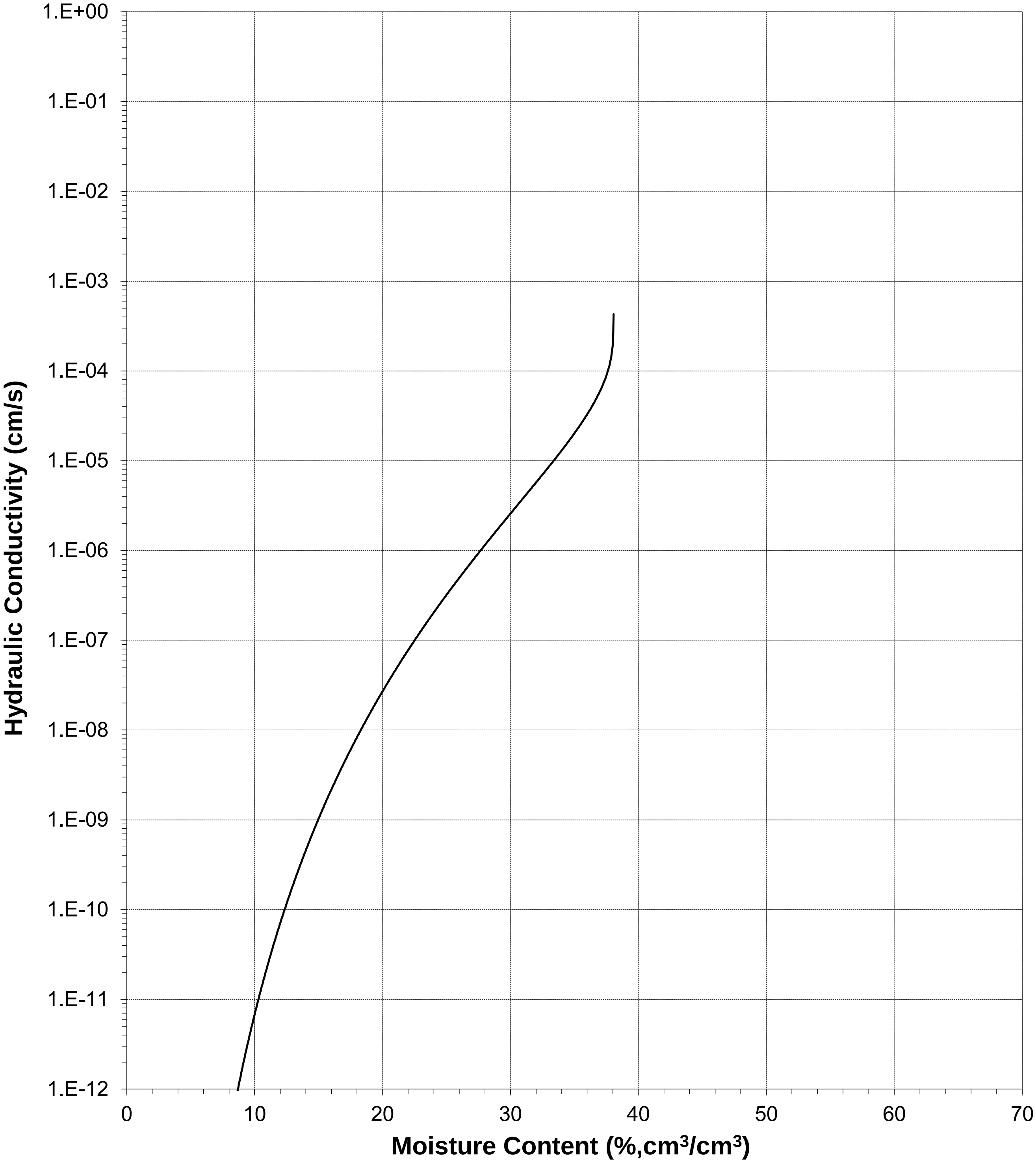
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: Muddy Creek TP3 (~90%)



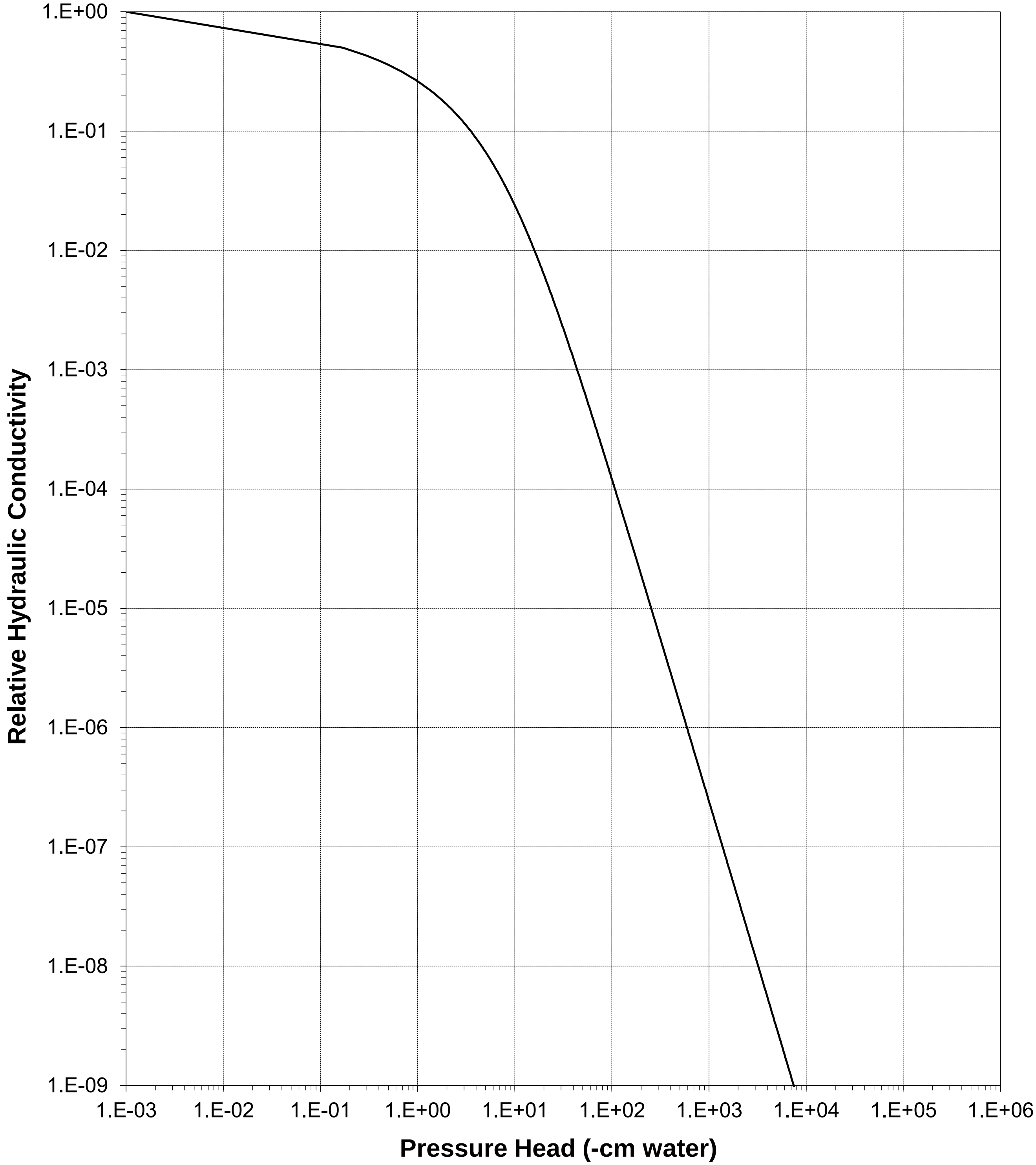
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: Muddy Creek TP3 (~90%)



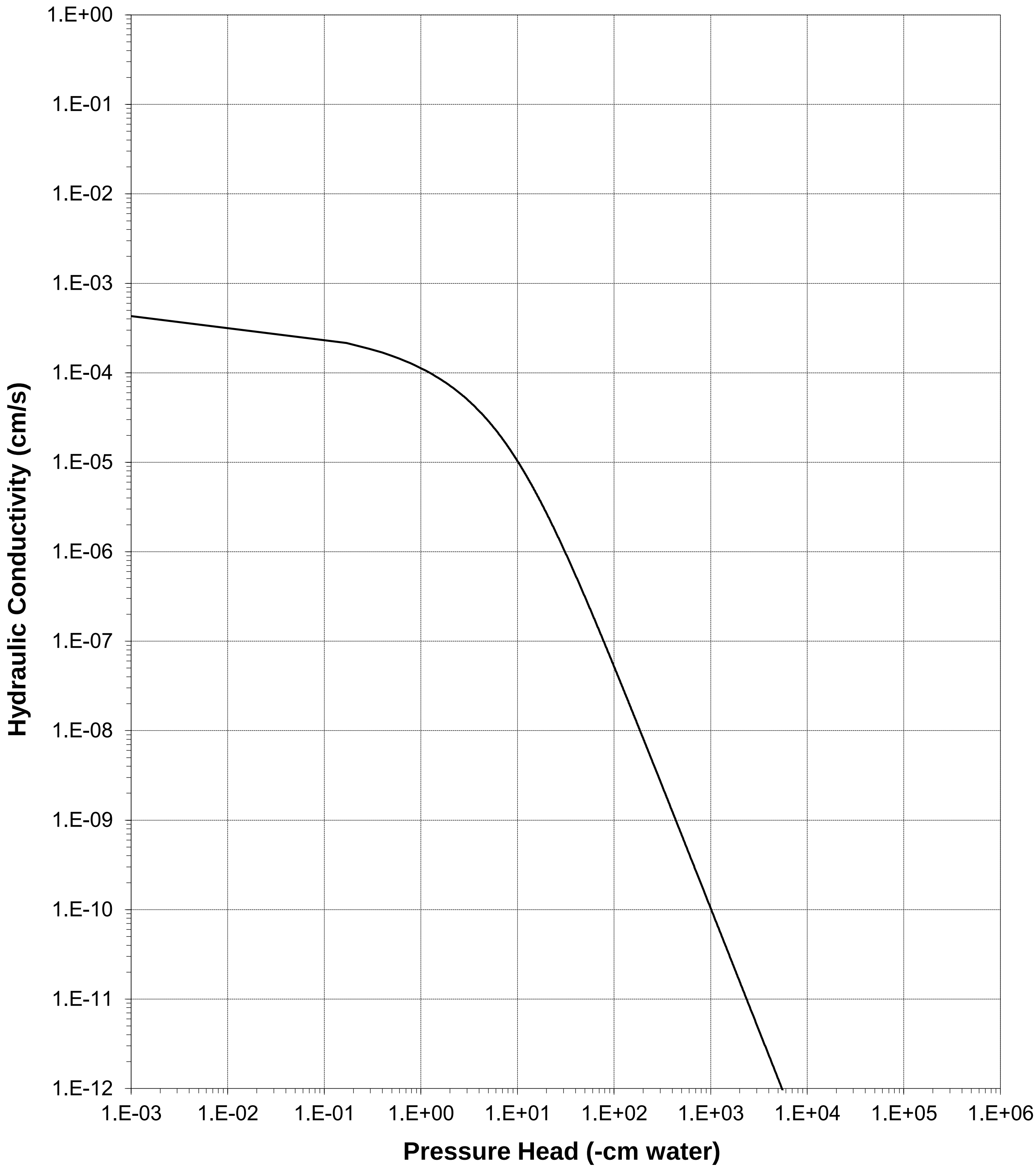
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: Muddy Creek TP3 (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Muddy Creek TP3 (~90%)



Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.04
Sample Number: Muddy Creek TP3 (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/4"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	2540.00	24700.00	27240.00
Mass Fraction (%):	9.32	90.68	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.62	1.68
Calculated Porosity (% vol):	0.00	38.95	36.65
Volume of Solids (cm^3):	958.49	9320.75	10279.25
Volume of Voids (cm^3):	0.00	5946.13	5946.13
Total Volume (cm^3):	958.49	15266.89	16225.38
Volumetric Fraction (%):	5.91	94.09	100.00
Initial Moisture Content (% vol):	0.00	20.71	19.49
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.67	1.73
Calculated Porosity (% vol):	0.00	36.82	34.58
Volume of Solids (cm^3):	958.49	9320.75	10279.25
Volume of Voids (cm^3):	0.00	5432.72	5432.72
Total Volume (cm^3):	958.49	14753.47	15711.96
Volumetric Fraction (%):	6.10	93.90	100.00
Saturated Moisture Content (% vol):	0.00	38.05	35.73
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.67	1.73
Calculated Porosity (% vol):	0.00	36.82	34.58
Volume of Solids (cm^3):	958.49	9320.75	10279.25
Volume of Voids (cm^3):	0.00	5432.72	5432.72
Total Volume (cm^3):	958.49	14753.47	15711.96
Volumetric Fraction (%):	6.10	93.90	100.00
Residual Moisture Content (% vol):	0.00	2.97	2.79
Ksat (cm/sec):	NM	4.3E-04	3.9E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample (g):*	565.85
Job Number:	DB21.1124.05	*Tare wt., ring (g):*	222.26
Sample Number:	Alluvium Borrow TP (~90%)	*Tare wt., screen & clamp (g):*	26.37
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3)*:*	321.86
Depth:	NA	*Initial dry bulk density* (g/cm^3)*:*	1.76
		Assumed particle density (g/cm^3)*:*	2.65
		Initial calculated total porosity (%):	33.66

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	15-Nov-21	16:00	922.00	0	33.41
	22-Nov-21	13:45	920.79	8.0	33.03
	30-Nov-21	15:00	919.68	24.0	32.69
	7-Dec-21	12:15	887.04	76.0	22.54
Pressure plate:	16-Dec-21	8:15	854.09	337	12.31

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	24.0	---	---	---	---
	76.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Alluvium Borrow TP (~90%)

Initial sample bulk density (g/cm^3)*:* 1.76
Fraction of test sample used (<2.00mm fraction) (%): 70.71

Dry weight of dew point potentiometer sample* (g)*:* 176.27
Tare weight, jar (g)*:* 111.91

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	14-Dec-21	7:53	179.34	15501	5.93
	10-Dec-21	9:43	178.49	37937	4.29
	8-Dec-21	9:36	178.00	191314	3.34

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	15501	---	---	---	---
	37937	---	---	---	---
	191314	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 84.14
Tare weight (g)*:* 38.68

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	1-Dec-21	13:00	85.09	849860	2.58

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	849860	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

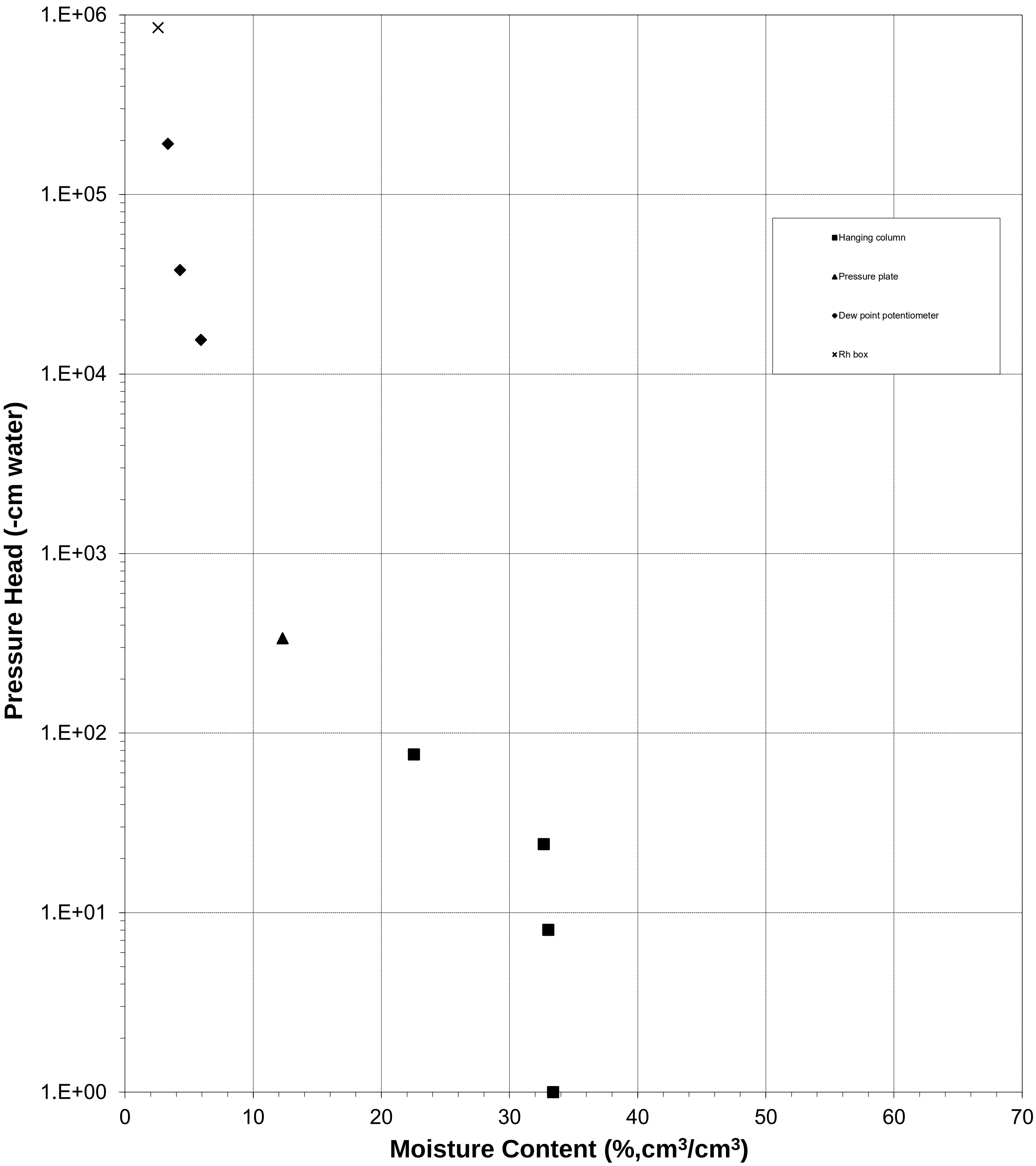
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

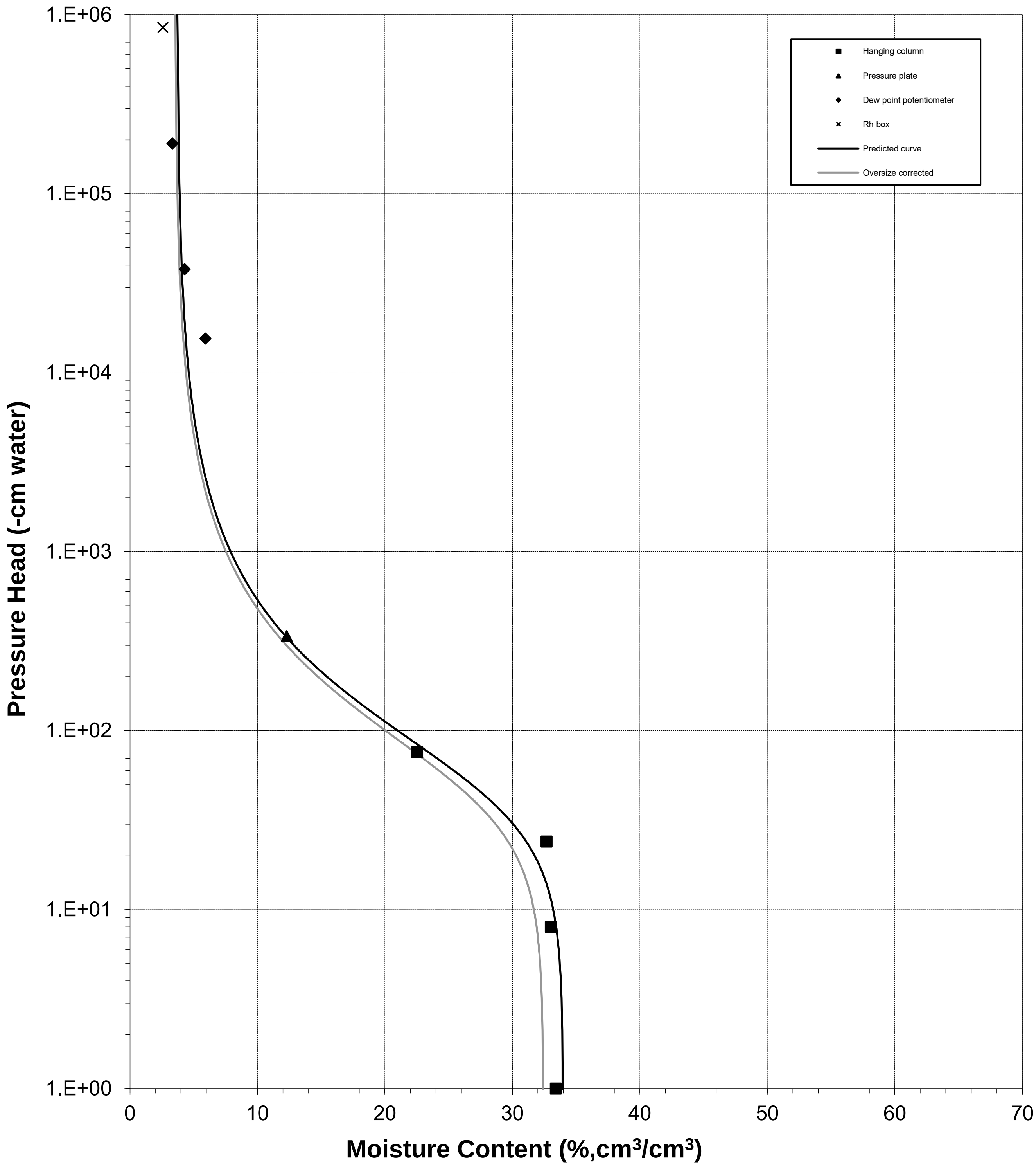
Water Retention Data Points

Sample Number: Alluvium Borrow TP (~90%)



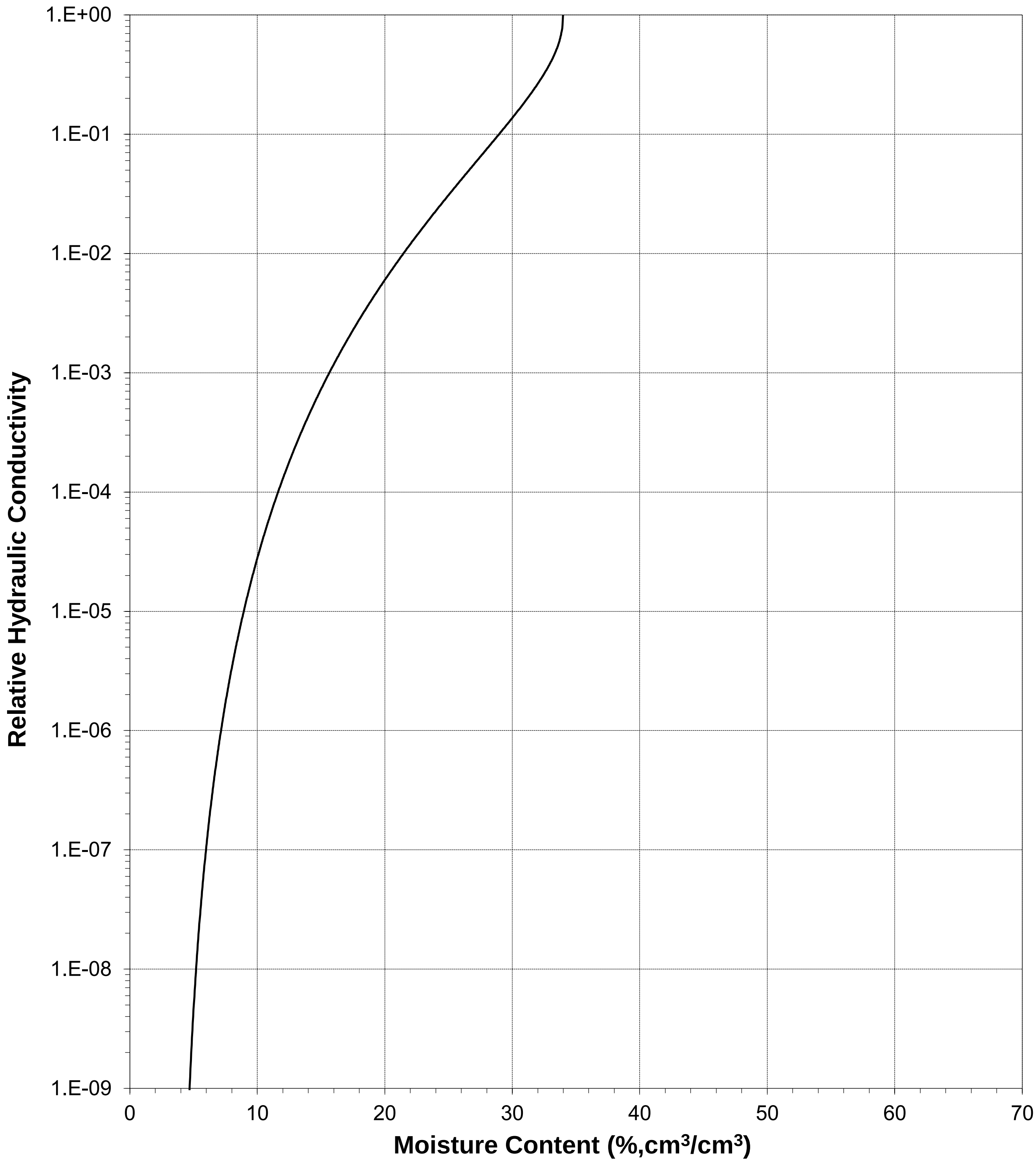
Predicted Water Retention Curve and Data Points

Sample Number: Alluvium Borrow TP (~90%)



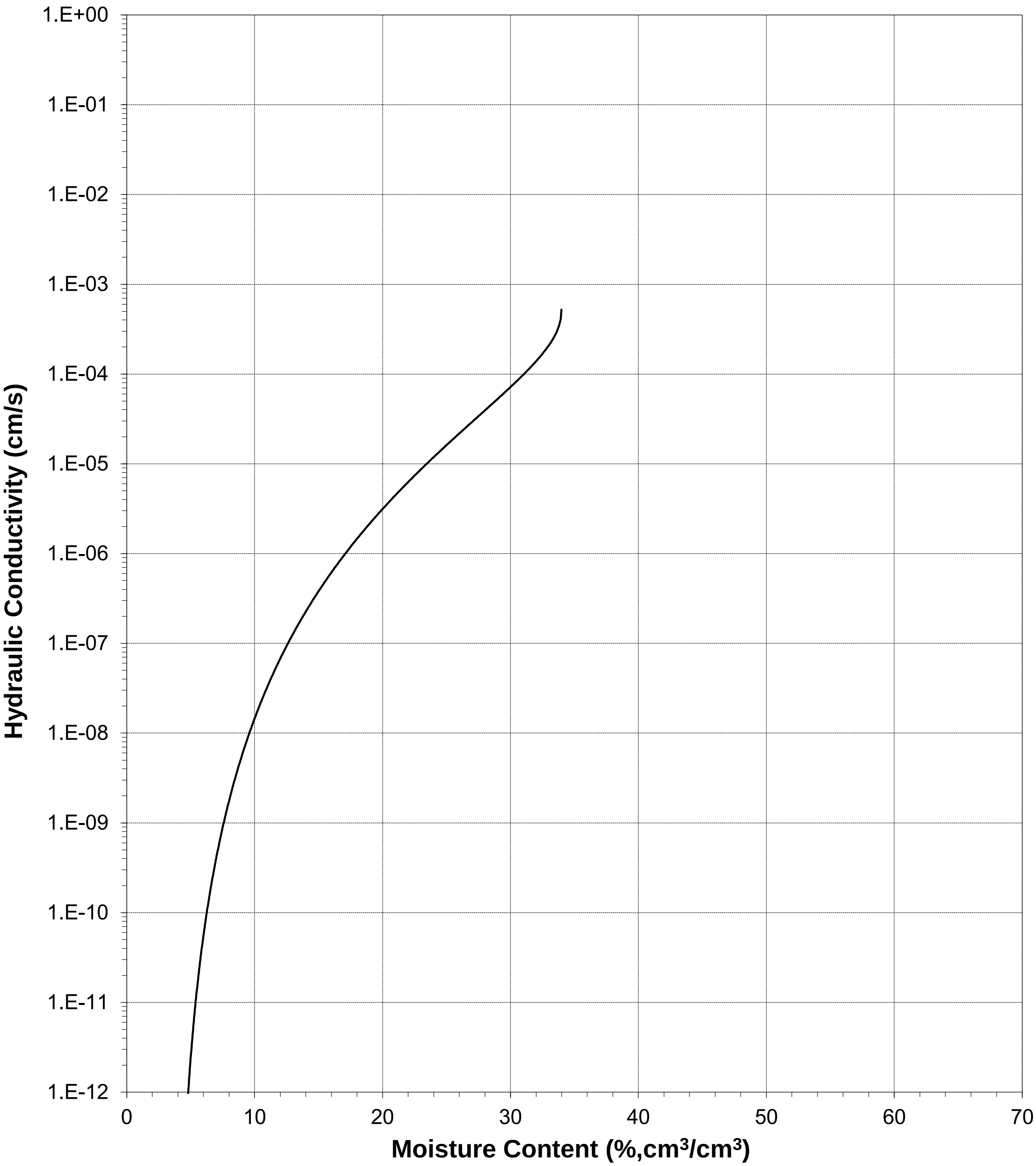
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: Alluvium Borrow TP (~90%)



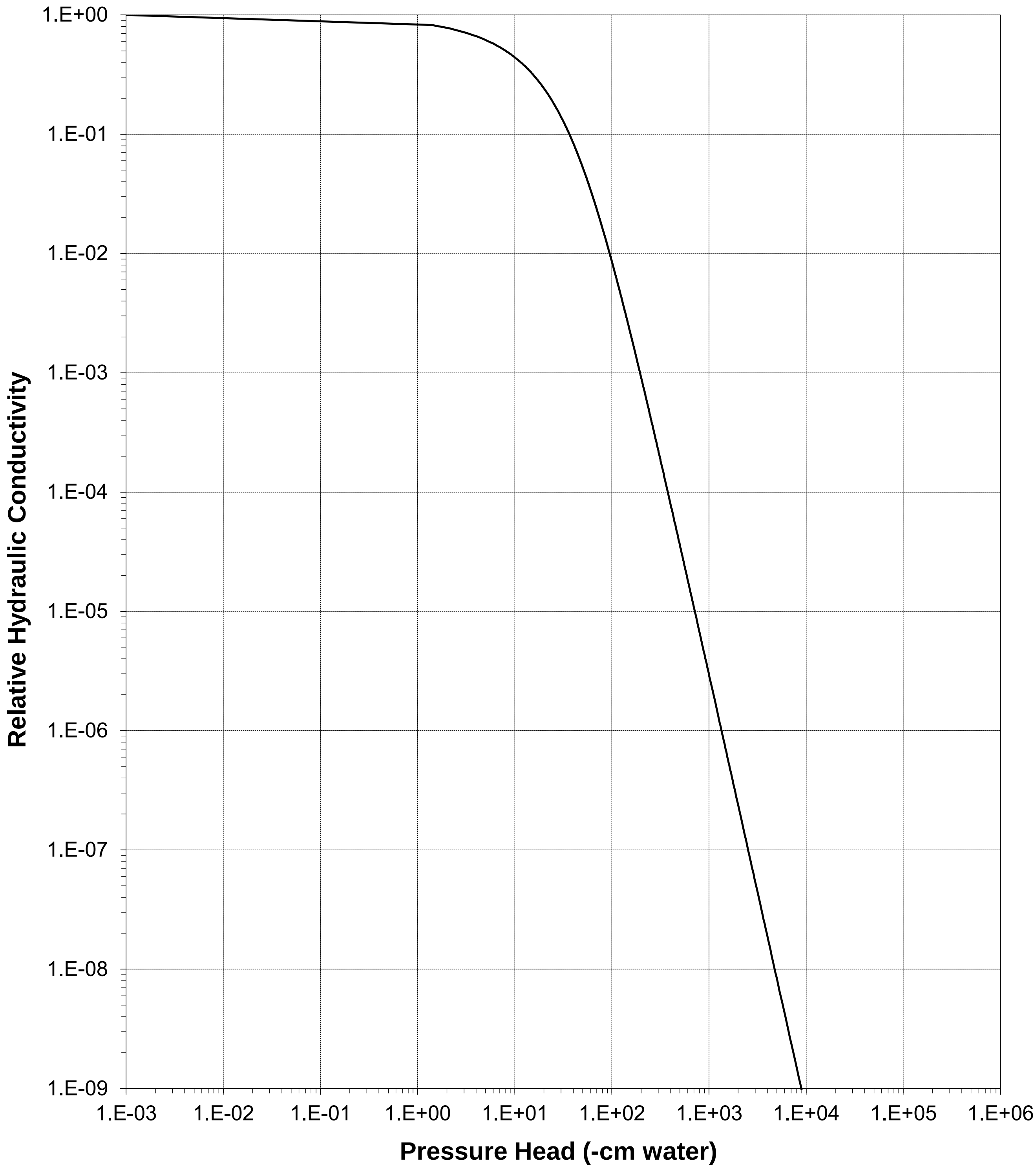
Plot of Hydraulic Conductivity vs Moisture Content

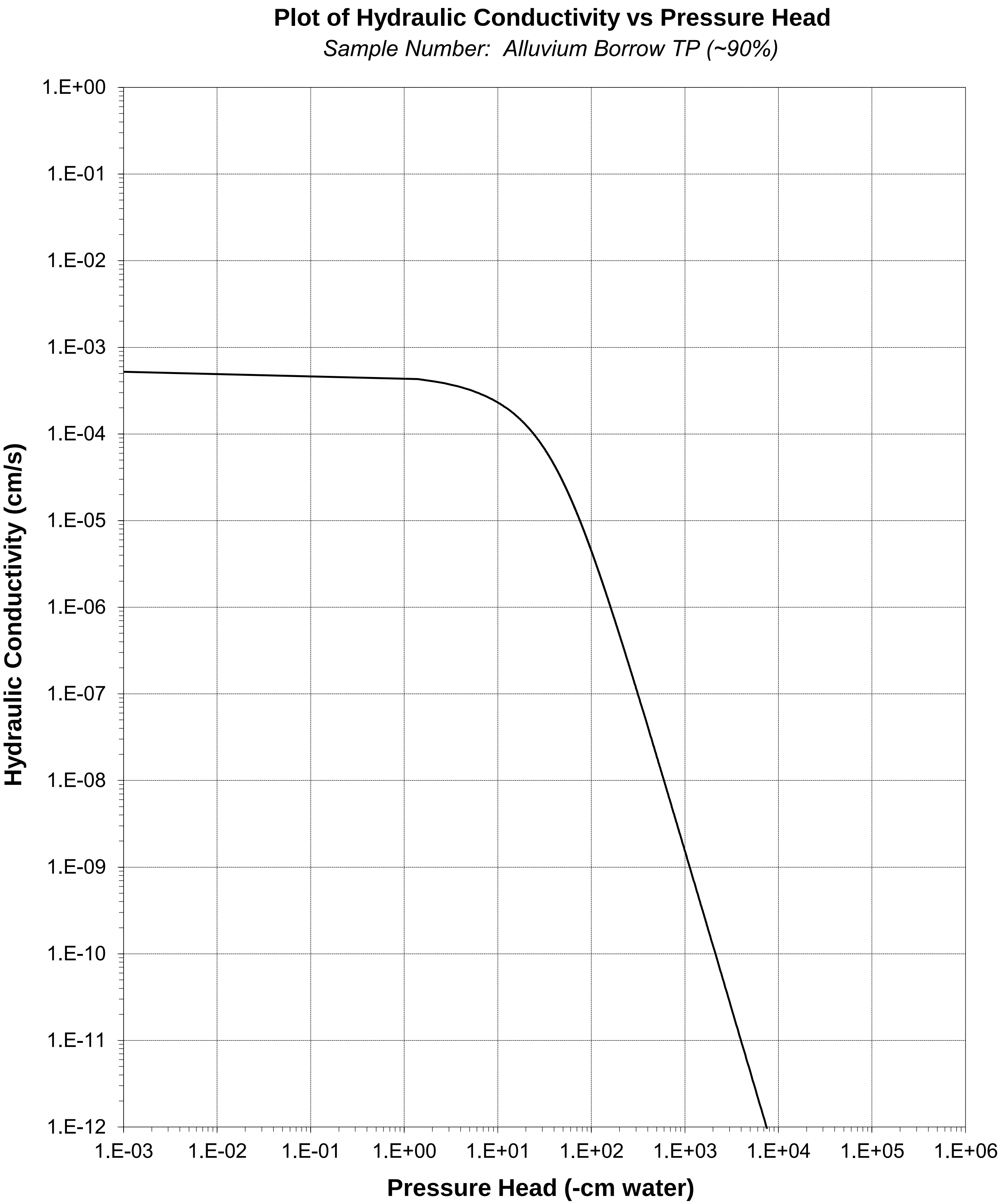
Sample Number: Alluvium Borrow TP (~90%)



Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: Alluvium Borrow TP (~90%)




Plot of Hydraulic Conductivity vs Pressure Head
Sample Number: Alluvium Borrow TP (~90%)
Hydraulic Conductivity (cm/s)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
Pressure Head (-cm water)

Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.05
Sample Number: Alluvium Borrow TP (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/8"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	2190.00	30280.00	32470.00
Mass Fraction (%):	6.74	93.26	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.76	1.80
Calculated Porosity (% vol):	0.00	33.66	32.12
Volume of Solids (cm^3):	826.42	11426.42	12252.83
Volume of Voids (cm^3):	0.00	5796.90	5796.90
Total Volume (cm^3):	826.42	17223.32	18049.74
Volumetric Fraction (%):	4.58	95.42	100.00
Initial Moisture Content (% vol):	0.00	10.55	10.07
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.76	1.80
Calculated Porosity (% vol):	0.00	33.66	32.12
Volume of Solids (cm^3):	826.42	11426.42	12252.83
Volume of Voids (cm^3):	0.00	5796.90	5796.90
Total Volume (cm^3):	826.42	17223.32	18049.74
Volumetric Fraction (%):	4.58	95.42	100.00
Saturated Moisture Content (% vol):	0.00	33.97	32.42
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.76	1.80
Calculated Porosity (% vol):	0.00	33.66	32.12
Volume of Solids (cm^3):	826.42	11426.42	12252.83
Volume of Voids (cm^3):	0.00	5796.90	5796.90
Total Volume (cm^3):	826.42	17223.32	18049.74
Volumetric Fraction (%):	4.58	95.42	100.00
Residual Moisture Content (% vol):	0.00	3.70	3.53
Ksat (cm/sec):	NM	5.2E-04	4.9E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name: Broadbent
Job Number: DB21.1124.06
Sample Number: Older Alluvium Fan Deposits (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Dry wt. of sample (g): 3366.61
Tare wt., ring (g): 239.36
Tare wt., screen & clamp (g): 58.15
Initial sample volume (cm^3): 1960.17
Initial dry bulk density (g/cm^3): 1.72
Assumed particle density (g/cm^3): 2.65
Initial calculated total porosity (%): 35.19

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)	
Hanging column:	15-Nov-21	15:00	4356.10	0	35.30	
	22-Nov-21	13:30	4201.59	6.0	25.68	‡‡
	30-Nov-21	14:15	4164.84	15.0	23.74	‡‡
	7-Dec-21	12:05	4132.17	55.0	22.19	‡‡
	14-Dec-21	12:10	4014.31	210.0	16.60	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	6.0	2093.20	+6.79%	1.61	39.31
	15.0	2109.17	+7.60%	1.60	39.77
	55.0	2109.17	+7.60%	1.60	39.77
	210.0	2109.17	+7.60%	1.60	39.77

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Older Alluvium Fan Deposits (~90%)

Initial sample bulk density (g/cm^3)*:* 1.72
Fraction of test sample used (<2.00mm fraction) (%): 53.83

Dry weight of dew point potentiometer sample* (g)*:* 184.24
Tare weight, jar (g)*:* 114.79

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Dew point potentiometer:	16-Dec-21	8:00	188.76	15399	5.59	‡‡
	10-Dec-21	9:22	186.91	59964	3.30	‡‡
	8-Dec-21	9:24	186.26	289215	2.50	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	15399	2109.17	+7.60%	1.60	39.77
	59964	2109.17	+7.60%	1.60	39.77
	289215	2109.17	+7.60%	1.60	39.77

Dry weight of relative humidity box sample* (g)*:* 90.35
Tare weight (g)*:* 34.18

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Relative humidity box:	1-Dec-21	13:00	91.87	849860	2.32	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	849860	2109.17	+7.60%	1.60	39.77

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

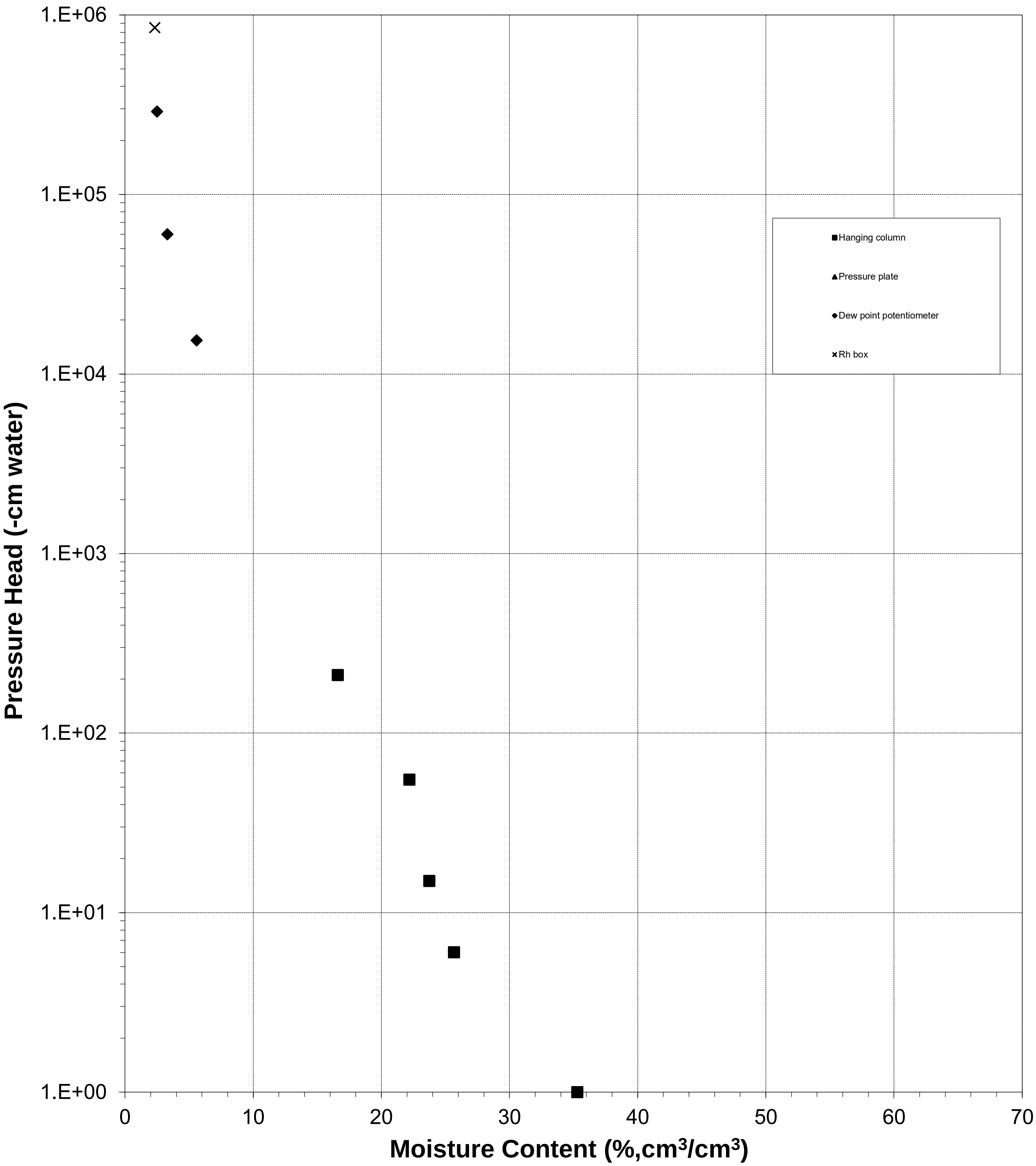
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Water Retention Data Points

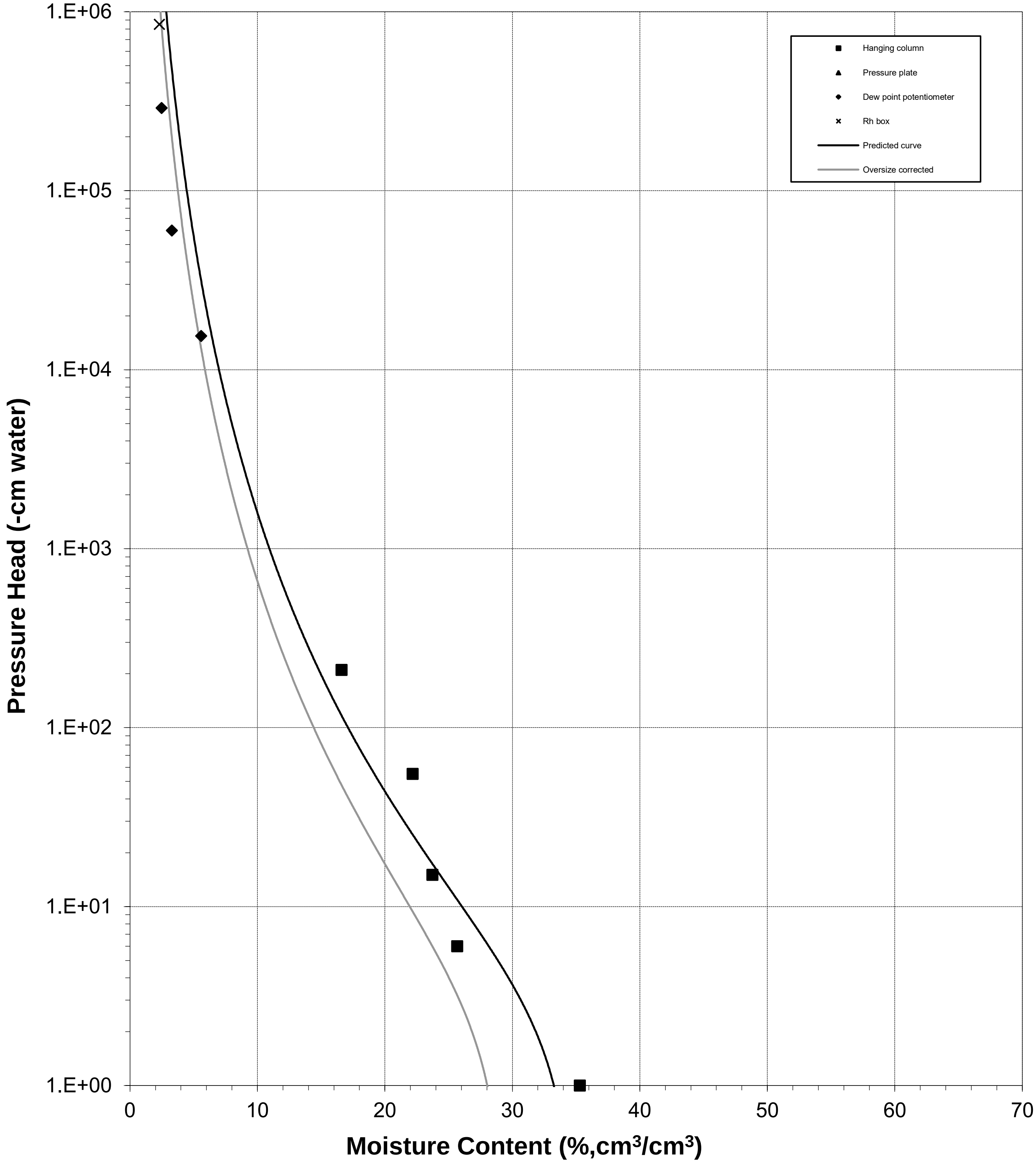
Sample Number: Older Alluvium Fan Deposits (~90%)



Daniel B. Stephens & Associates, Inc.

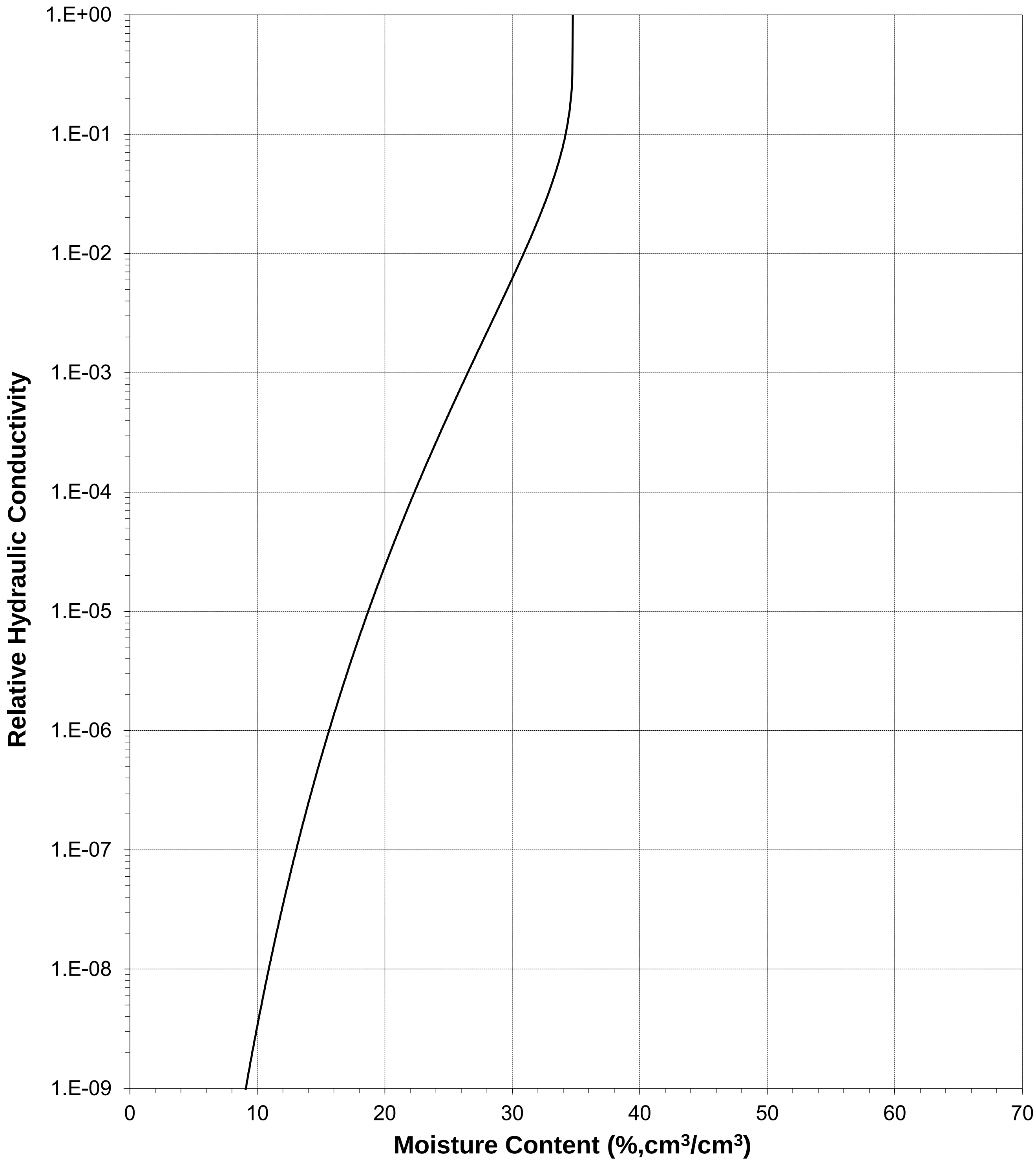
Predicted Water Retention Curve and Data Points

Sample Number: Older Alluvium Fan Deposits (~90%)



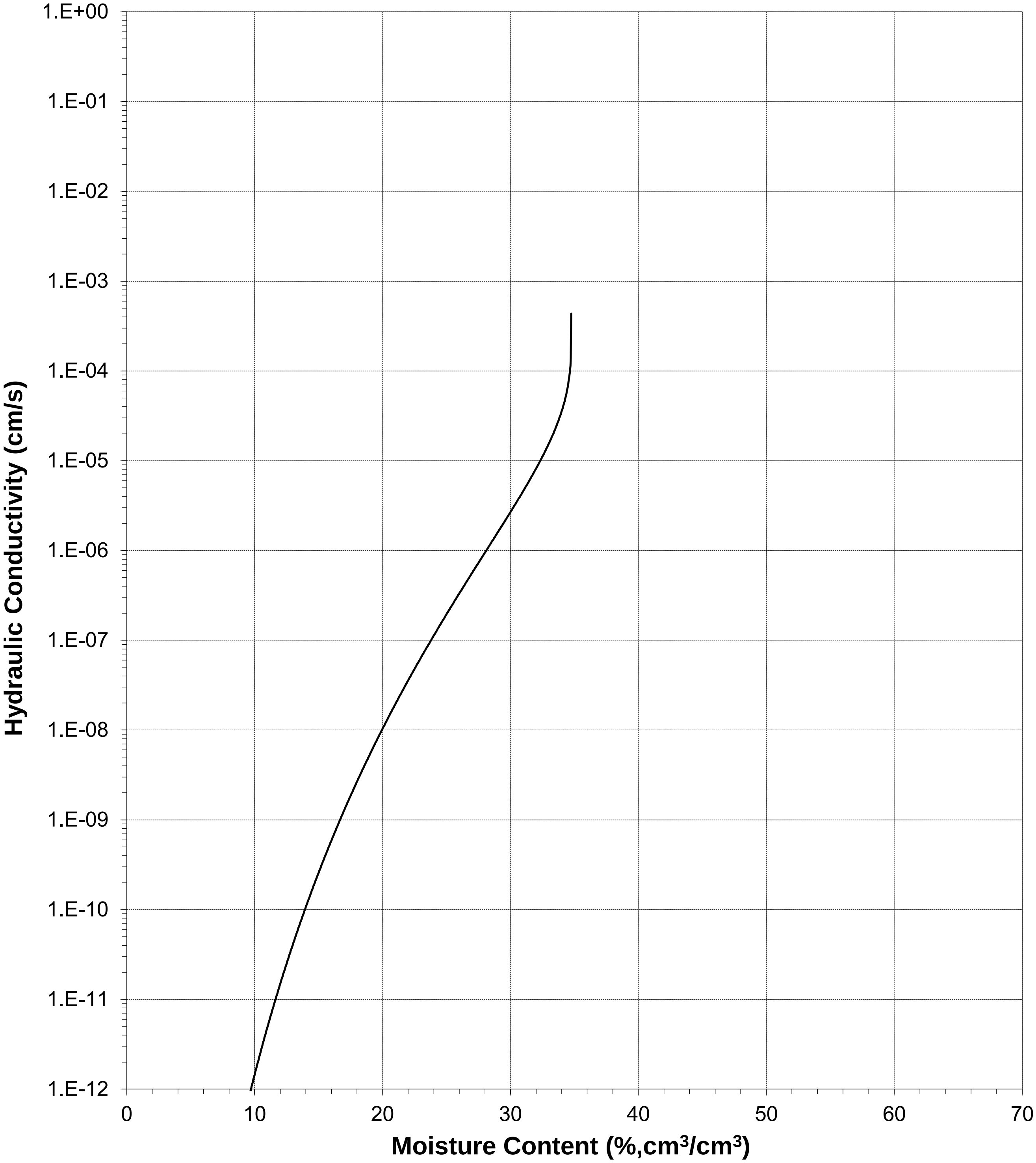
Plot of Relative Hydraulic Conductivity vs Moisture Content

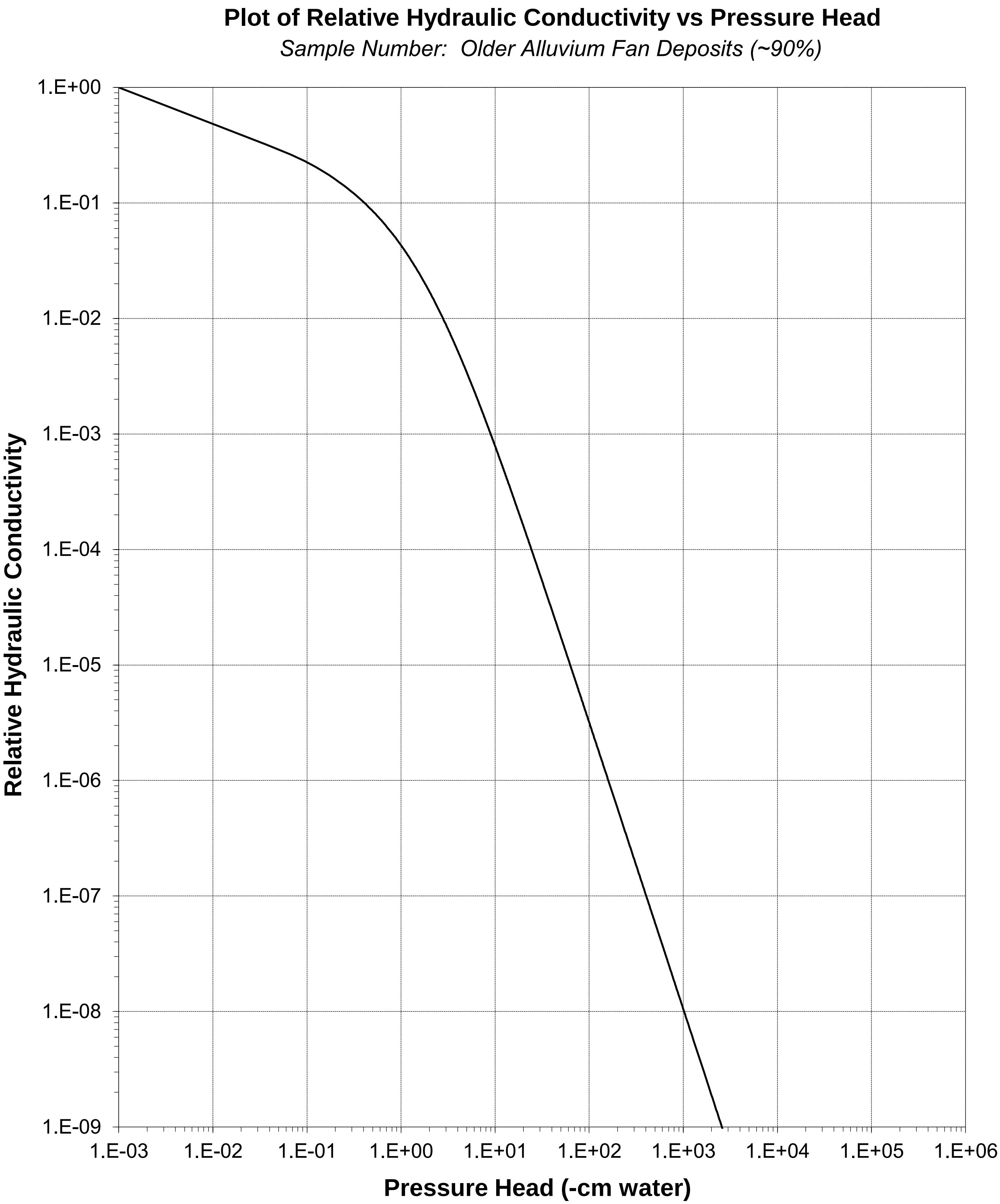
Sample Number: Older Alluvium Fan Deposits (~90%)



Plot of Hydraulic Conductivity vs Moisture Content

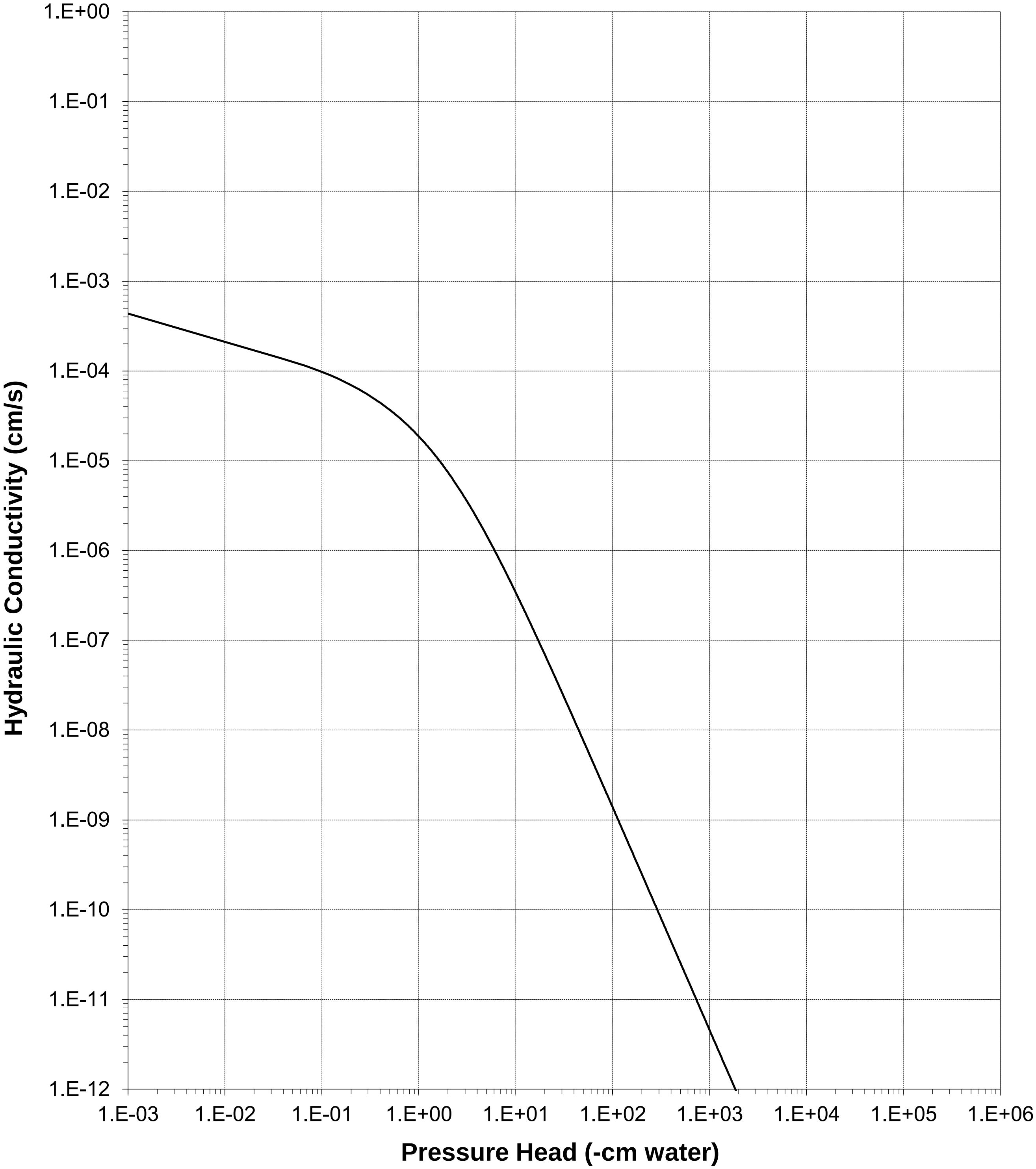
Sample Number: Older Alluvium Fan Deposits (~90%)




Plot of Relative Hydraulic Conductivity vs Pressure Head
Sample Number: Older Alluvium Fan Deposits (~90%)
Relative Hydraulic Conductivity
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
Pressure Head (-cm water)

Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Older Alluvium Fan Deposits (~90%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.06
Sample Number: Older Alluvium Fan Deposits (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/4"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	7030.00	24430.00	31460.00
Mass Fraction (%):	22.35	77.65	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.72	1.86
Calculated Porosity (% vol):	0.00	35.19	29.66
Volume of Solids (cm^3):	2652.83	9218.87	11871.70
Volume of Voids (cm^3):	0.00	5005.22	5005.22
Total Volume (cm^3):	2652.83	14224.09	16876.92
Volumetric Fraction (%):	15.72	84.28	100.00
Initial Moisture Content (% vol):	0.00	14.77	12.45
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.72	1.86
Calculated Porosity (% vol):	0.00	35.19	29.66
Volume of Solids (cm^3):	2652.83	9218.87	11871.70
Volume of Voids (cm^3):	0.00	5005.22	5005.22
Total Volume (cm^3):	2652.83	14224.09	16876.92
Volumetric Fraction (%):	15.72	84.28	100.00
Saturated Moisture Content (% vol):	0.00	34.75	29.29
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.60	1.75
Calculated Porosity (% vol):	0.00	39.77	33.89
Volume of Solids (cm^3):	2652.83	9218.87	11871.70
Volume of Voids (cm^3):	0.00	6086.41	6086.41
Total Volume (cm^3):	2652.83	15305.28	17958.11
Volumetric Fraction (%):	14.77	85.23	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	4.3E-04	3.4E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample* (g):	549.08
Job Number:	DB21.1124.07	*Tare wt., ring* (g):	216.81
Sample Number:	Mill Site (~90%)	*Tare wt., screen & clamp* (g):	26.99
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3):	315.20
Depth:	NA	*Initial dry bulk density* (g/cm^3):	1.74
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	34.26

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	15-Nov-21	14:33	903.20	0	35.00
	22-Nov-21	13:05	900.30	5.0	34.08
	30-Nov-21	14:00	896.69	11.0	32.94
	7-Dec-21	11:45	858.82	40.0	20.92
	14-Dec-21	10:45	832.14	204.0	12.46

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	5.0	---	---	---	---
	11.0	---	---	---	---
	40.0	---	---	---	---
	204.0	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Mill Site (~90%)

Initial sample bulk density (g/cm^3)*:* 1.74
Fraction of test sample used (<2.00mm fraction) (%): 48.93

Dry weight of dew point potentiometer sample* (g)*:* 155.60
Tare weight, jar (g)*:* 113.09

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	16-Dec-21	7:50	158.15	12646	5.11
	10-Dec-21	9:37	157.11	47421	3.03
	8-Dec-21	9:30	156.80	205898	2.41

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	12646	---	---	---	---
	47421	---	---	---	---
	205898	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 66.01
Tare weight (g)*:* 35.49

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	1-Dec-21	13:00	66.74	849860	2.03

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Relative humidity box:	849860	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

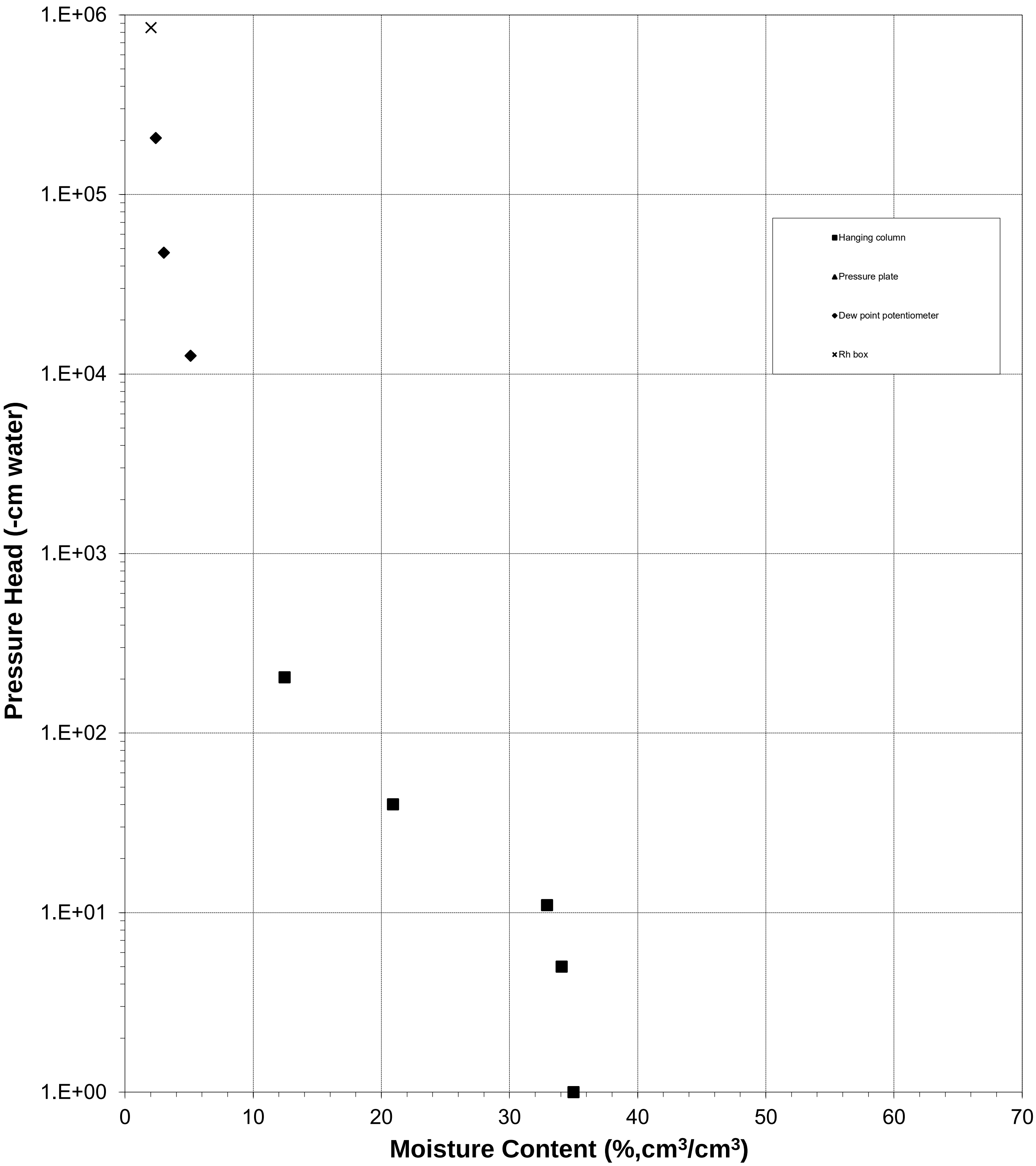
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

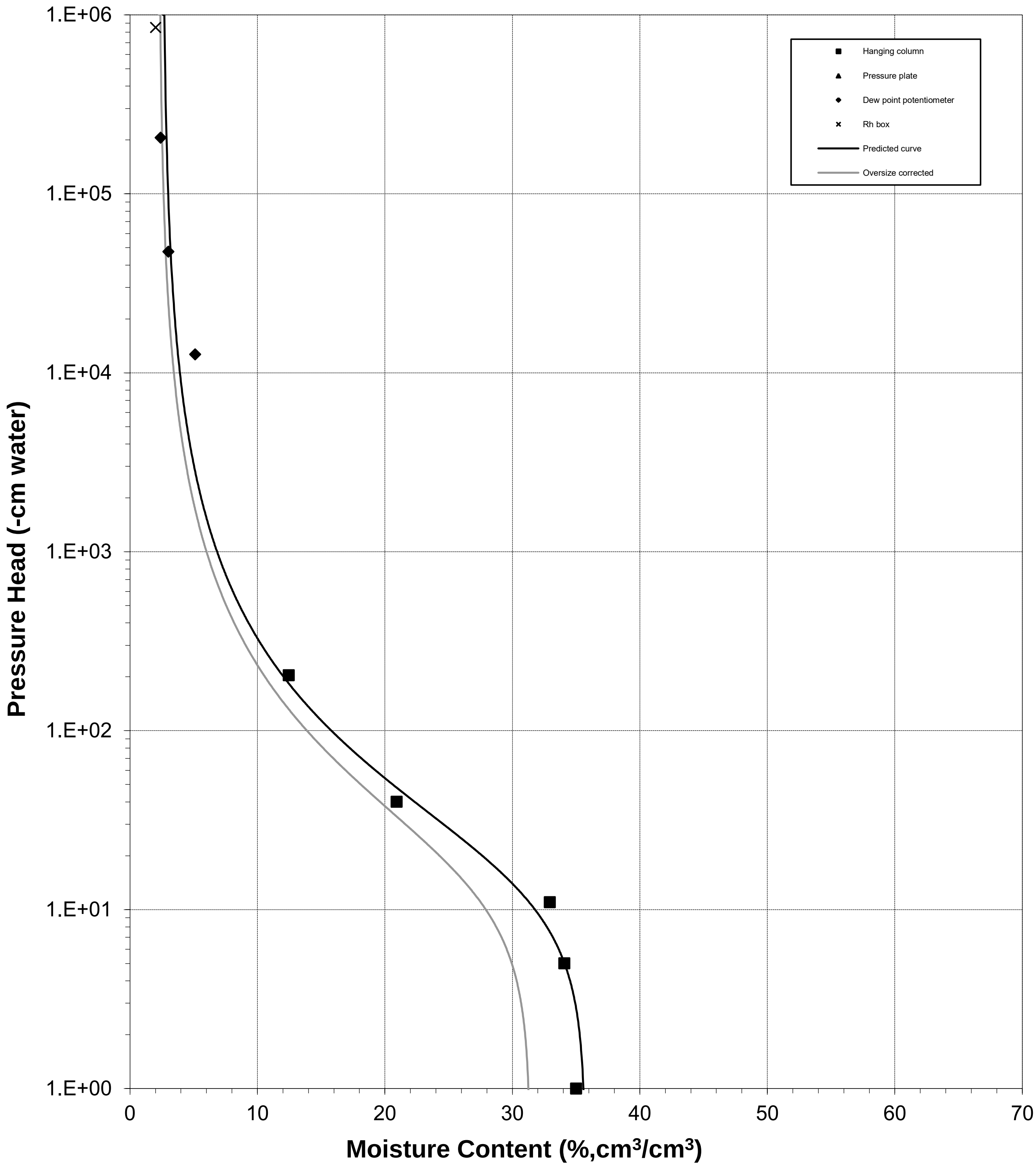
Water Retention Data Points

Sample Number: Mill Site (~90%)



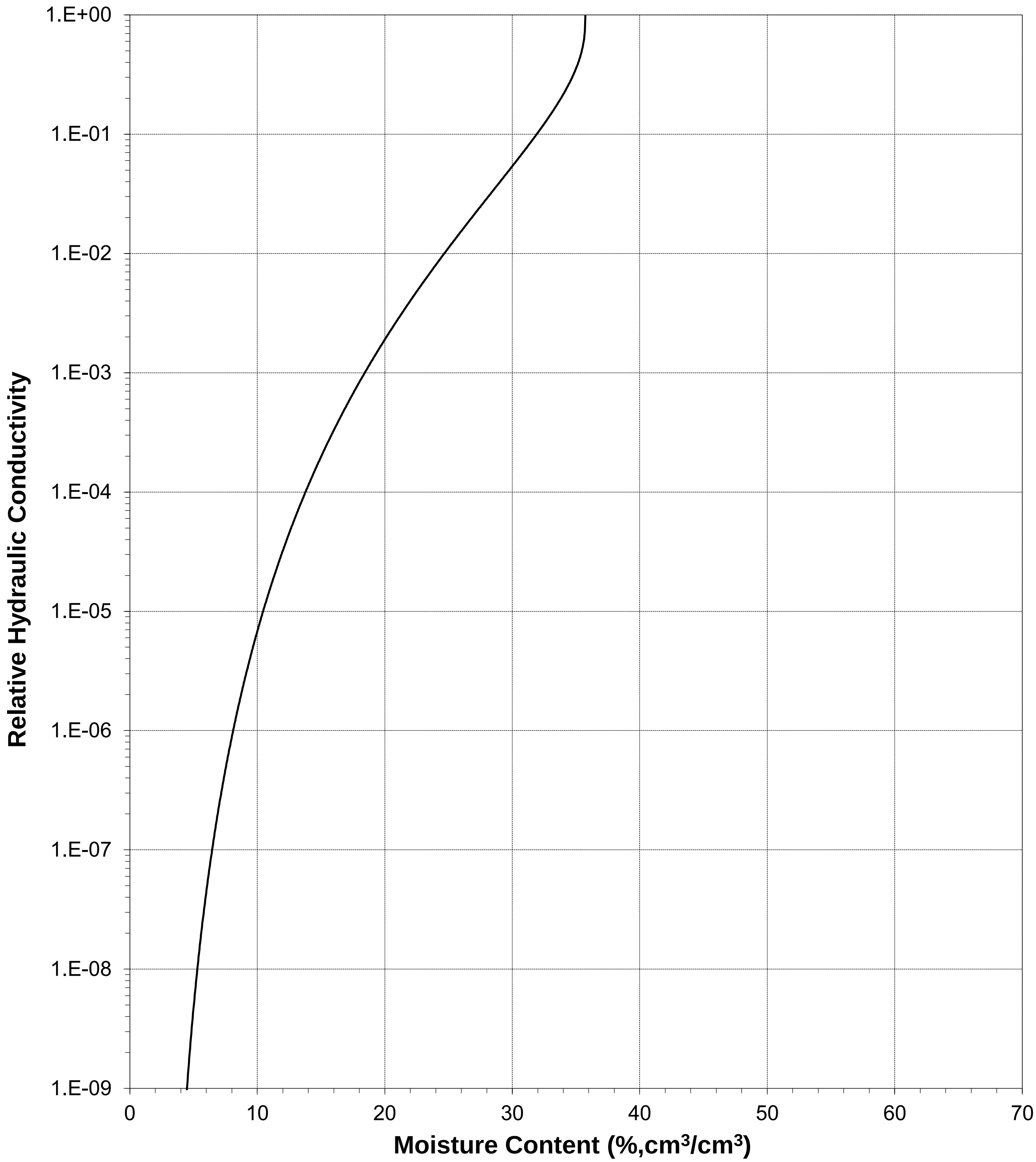
Predicted Water Retention Curve and Data Points

Sample Number: Mill Site (~90%)



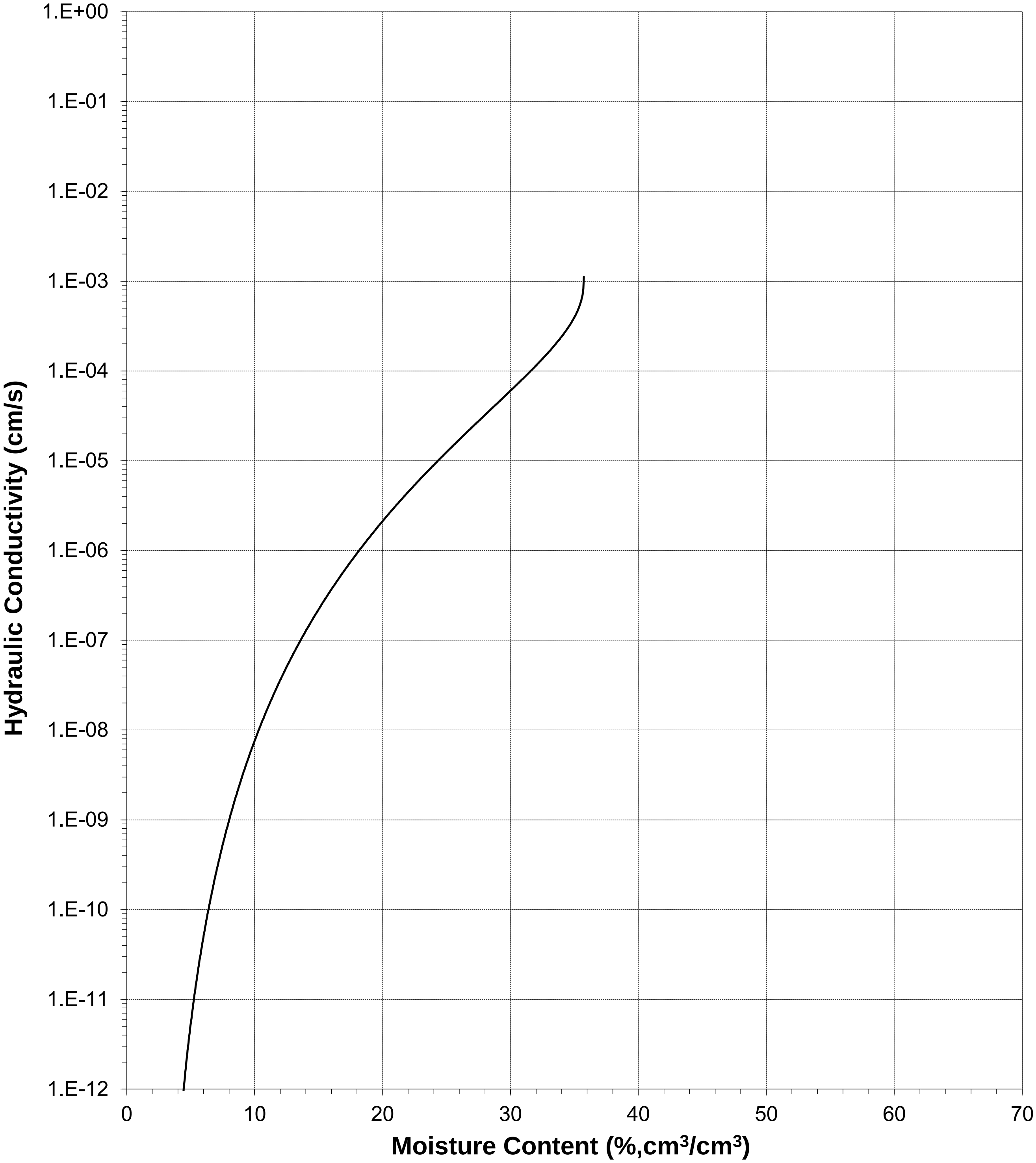
Plot of Relative Hydraulic Conductivity vs Moisture Content

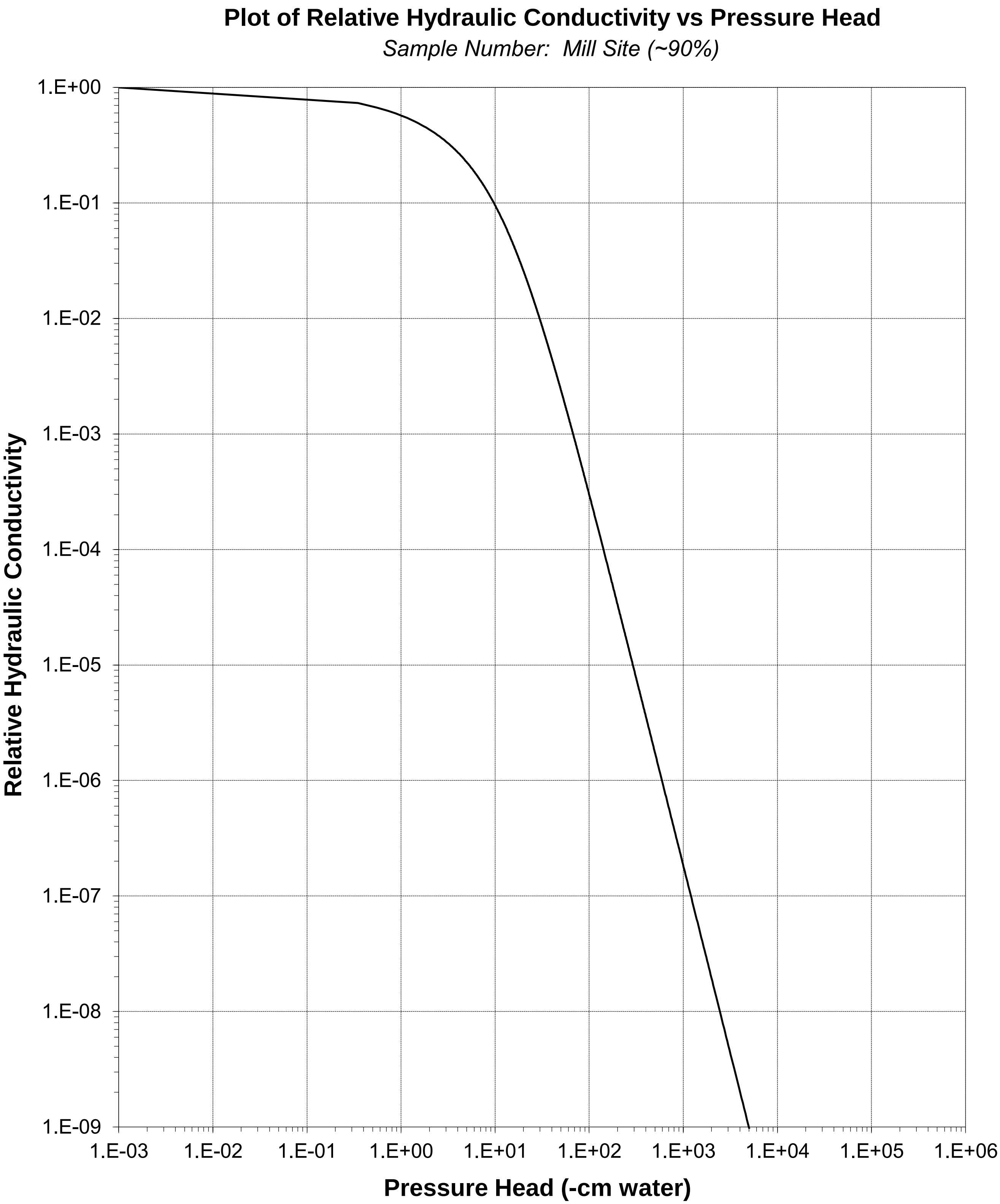
Sample Number: Mill Site (~90%)



Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: Mill Site (~90%)

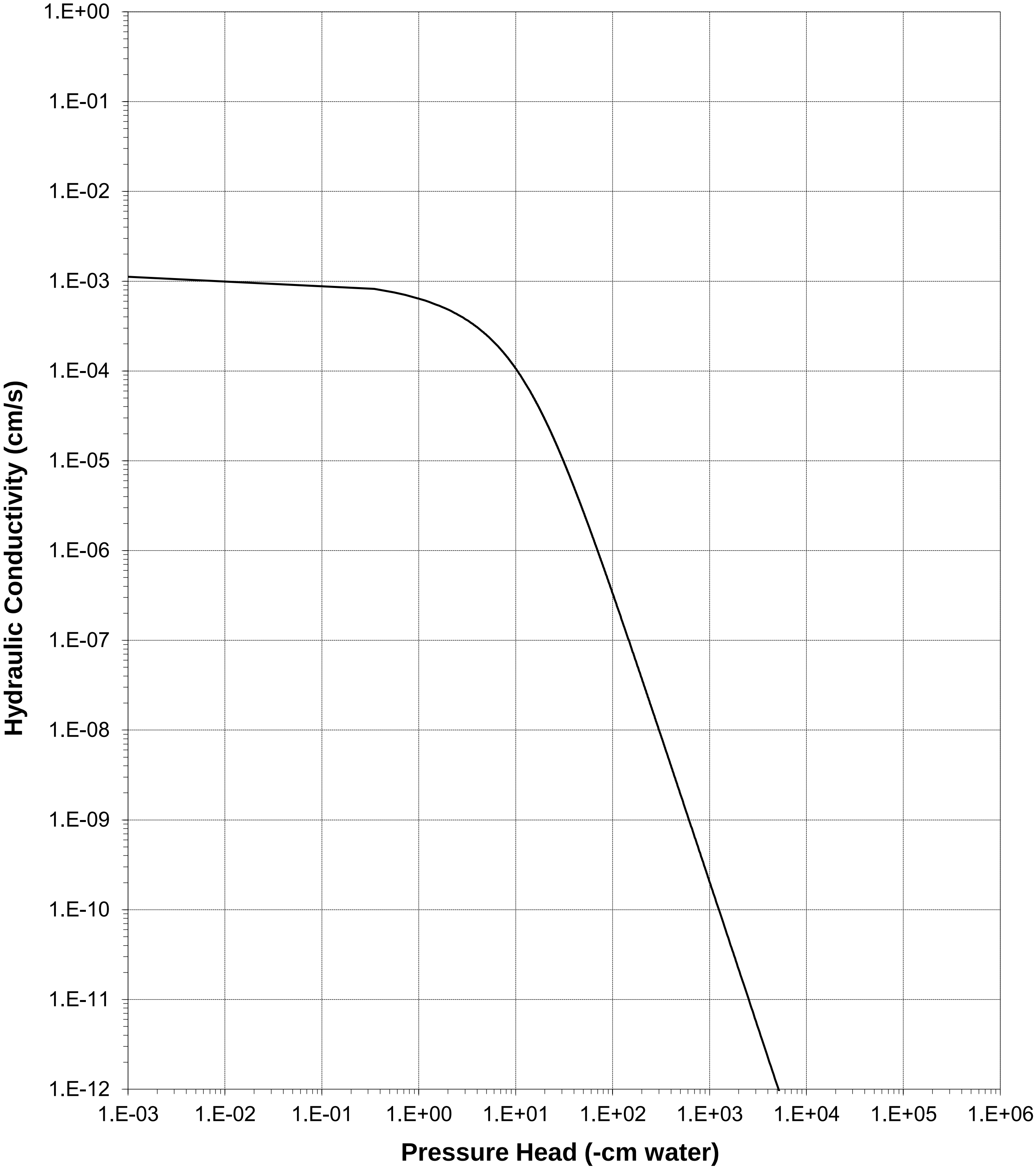




Plot of Relative Hydraulic Conductivity vs Pressure Head
Sample Number: Mill Site (~90%)
Relative Hydraulic Conductivity
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
1.E+06
Pressure Head (-cm water)

Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Mill Site (~90%)



Oversize Correction Data Sheet

Job Name:	Broadbent
Job Number:	DB21.1124.07
Sample Number:	Mill Site (~90%)
Ring Number:	3 Kids Mine, 14-01-156
Depth:	NA
Split (3/4", 3/8", #4):	3/8"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	5910.00	28120.00	34030.00
Mass Fraction (%):	17.37	82.63	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.74	1.85
Calculated Porosity (% vol):	0.00	34.26	30.10
Volume of Solids (cm^3):	2230.19	10611.32	12841.51
Volume of Voids (cm^3):	0.00	5530.80	5530.80
Total Volume (cm^3):	2230.19	16142.12	18372.31
Volumetric Fraction (%):	12.14	87.86	100.00
Initial Moisture Content (% vol):	0.00	10.45	9.18
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.74	1.85
Calculated Porosity (% vol):	0.00	34.26	30.10
Volume of Solids (cm^3):	2230.19	10611.32	12841.51
Volume of Voids (cm^3):	0.00	5530.80	5530.80
Total Volume (cm^3):	2230.19	16142.12	18372.31
Volumetric Fraction (%):	12.14	87.86	100.00
Saturated Moisture Content (% vol):	0.00	35.73	31.39
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.74	1.85
Calculated Porosity (% vol):	0.00	34.26	30.10
Volume of Solids (cm^3):	2230.19	10611.32	12841.51
Volume of Voids (cm^3):	0.00	5530.80	5530.80
Total Volume (cm^3):	2230.19	16142.12	18372.31
Volumetric Fraction (%):	12.14	87.86	100.00
Residual Moisture Content (% vol):	0.00	2.57	2.26
Ksat (cm/sec):	NM	1.1E-03	9.2E-04

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name: Broadbent
Job Number: DB21.1124.08
Sample Number: Ore Yard (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Dry wt. of sample (g): 3013.24
Tare wt., ring (g): 229.00
Tare wt., screen & clamp (g): 74.28
Initial sample volume (cm^3): 1878.18
Initial dry bulk density (g/cm^3): 1.60
Assumed particle density (g/cm^3): 2.75
Initial calculated total porosity (%): 41.66

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	15-Nov-21	15:00	4109.90	0	42.24
	22-Nov-21	13:30	4049.92	8.0	39.05
	30-Nov-21	14:00	4018.27	15.0	37.36
	7-Dec-21	12:00	3942.16	51.0	33.31
	14-Dec-21	12:05	3837.97	212.0	27.76

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	---	---	---	---
	15.0	---	---	---	---
	51.0	---	---	---	---
	212.0	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: Ore Yard (~90%)

Initial sample bulk density (g/cm^3)*:* 1.60

Fraction of test sample used (<2.00mm fraction) (%): 84.82

Dry weight of dew point potentiometer sample* (g)*:* 163.77

Tare weight, jar (g)*:* 112.49

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	13-Dec-21	13:25	168.18	75159	11.70
	10-Dec-21	8:53	167.47	154602	9.82
	9-Dec-21	9:45	166.74	345202	7.88
	8-Dec-21	9:00	166.06	789121	6.08

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	75159	---	---	---	---
	154602	---	---	---	---
	345202	---	---	---	---
	789121	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

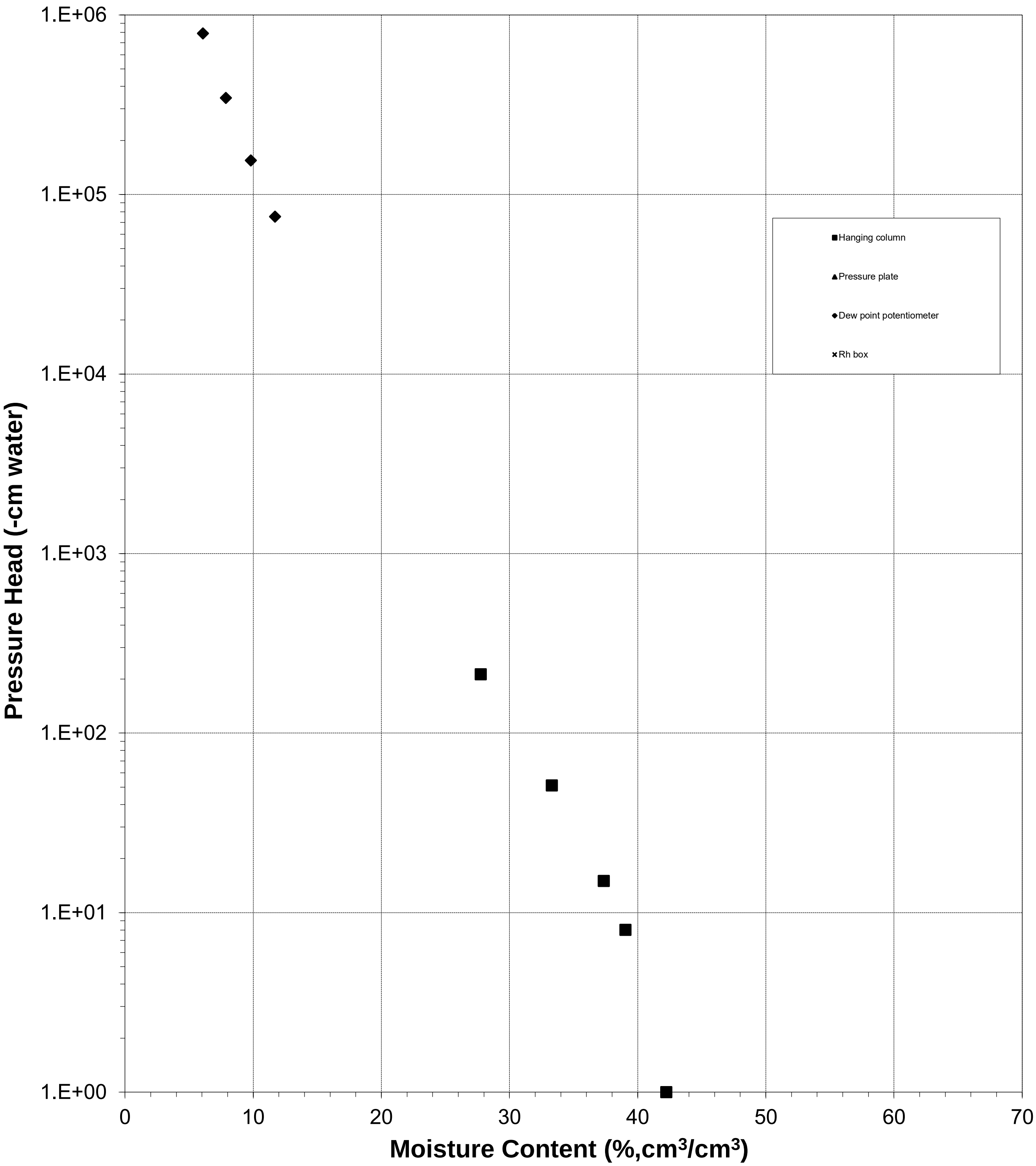
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

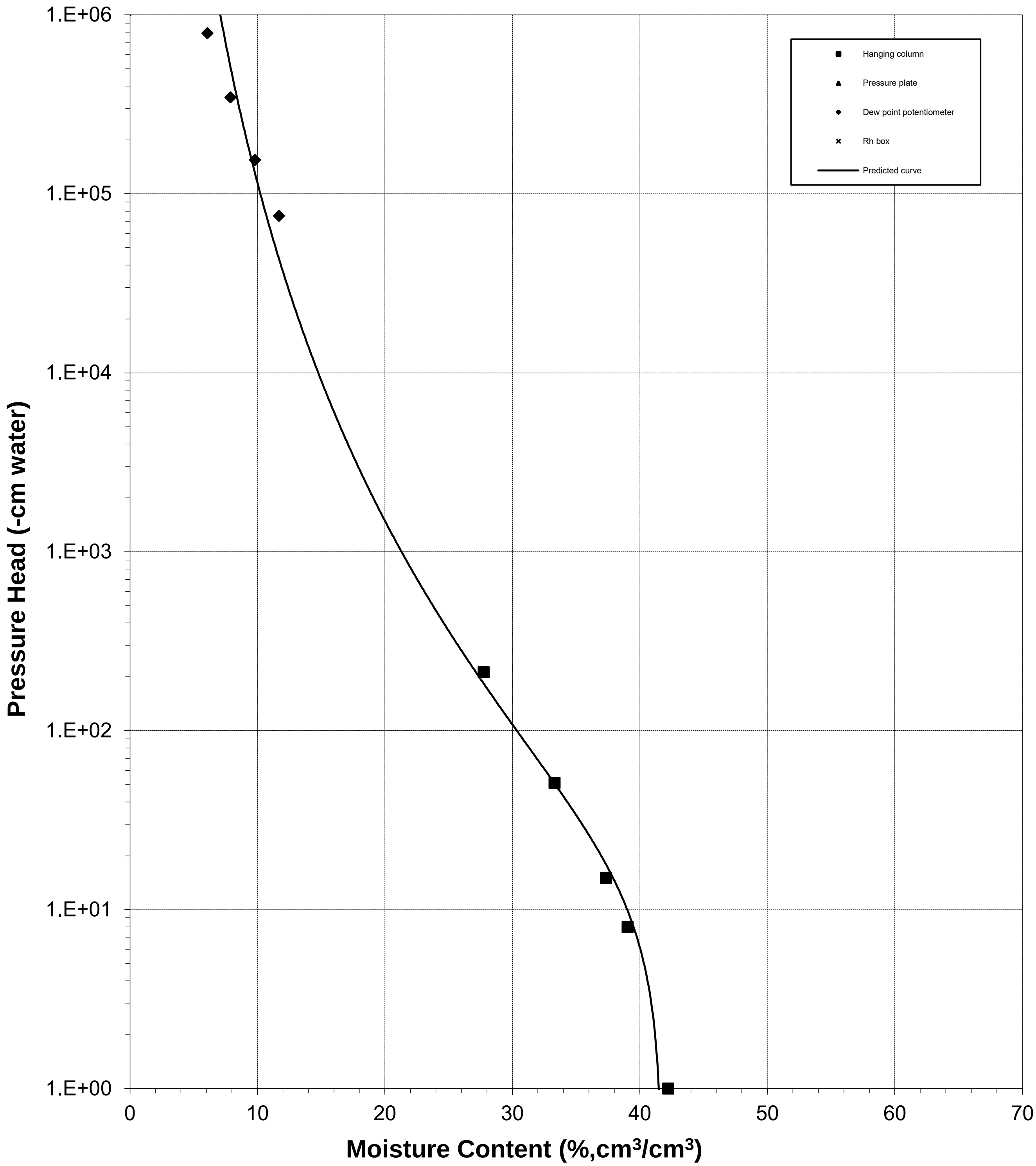
Water Retention Data Points

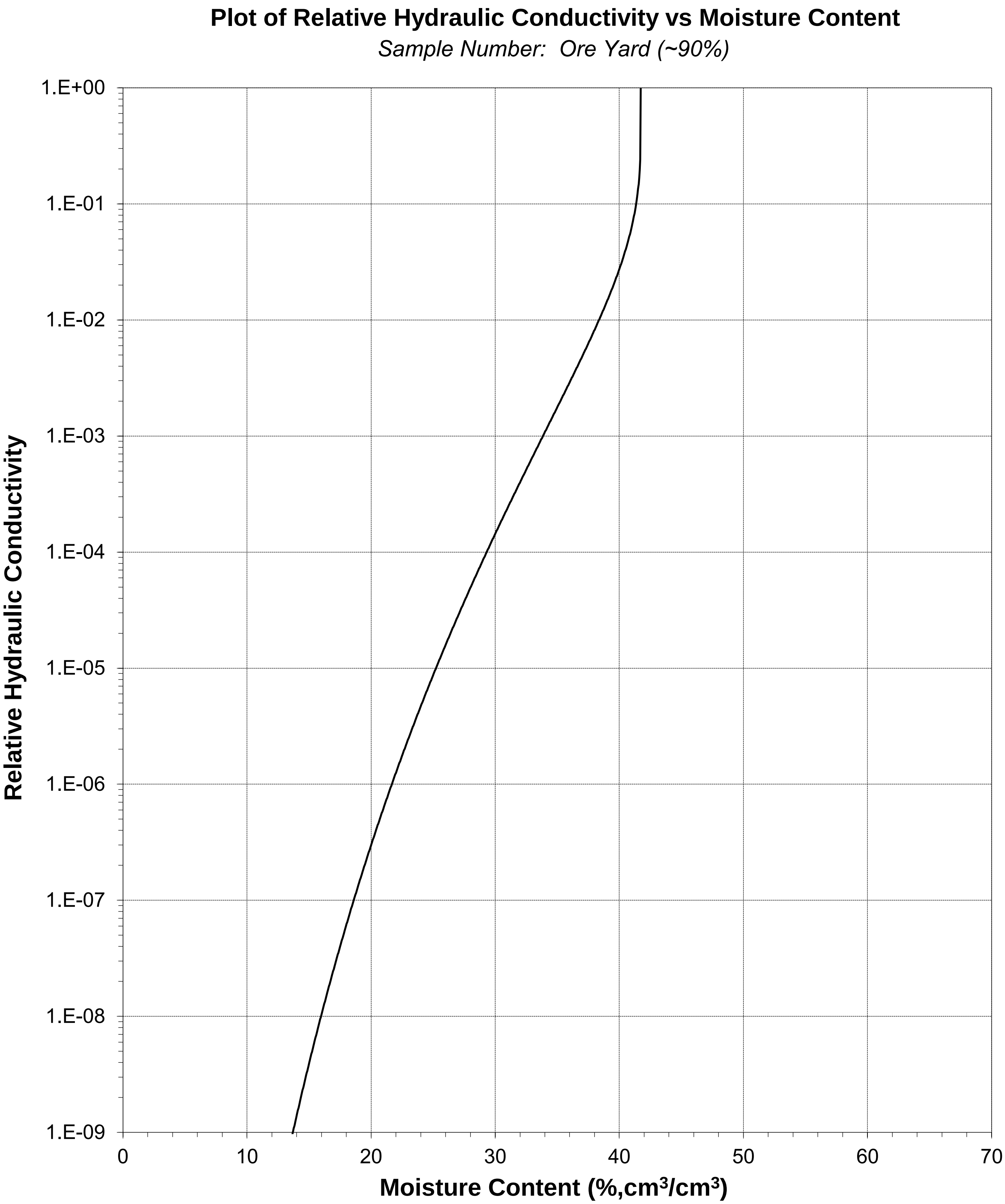
Sample Number: Ore Yard (~90%)



Predicted Water Retention Curve and Data Points

Sample Number: Ore Yard (~90%)

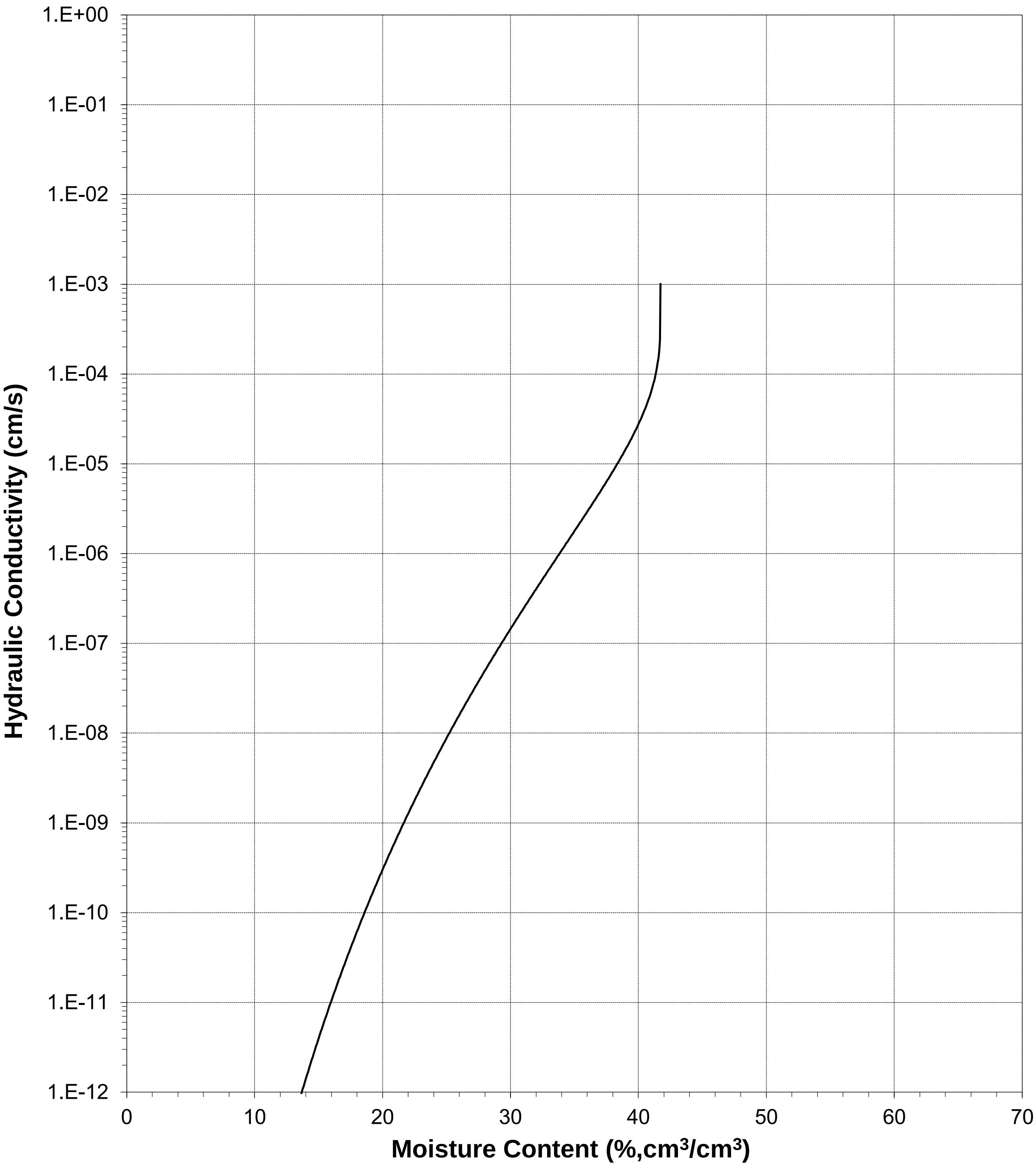




Plot of Relative Hydraulic Conductivity vs Moisture Content
Sample Number: Ore Yard (~90%)
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
0
10
20
30
40
50
60
70
Relative Hydraulic Conductivity
Moisture Content (%,cm3/cm3)

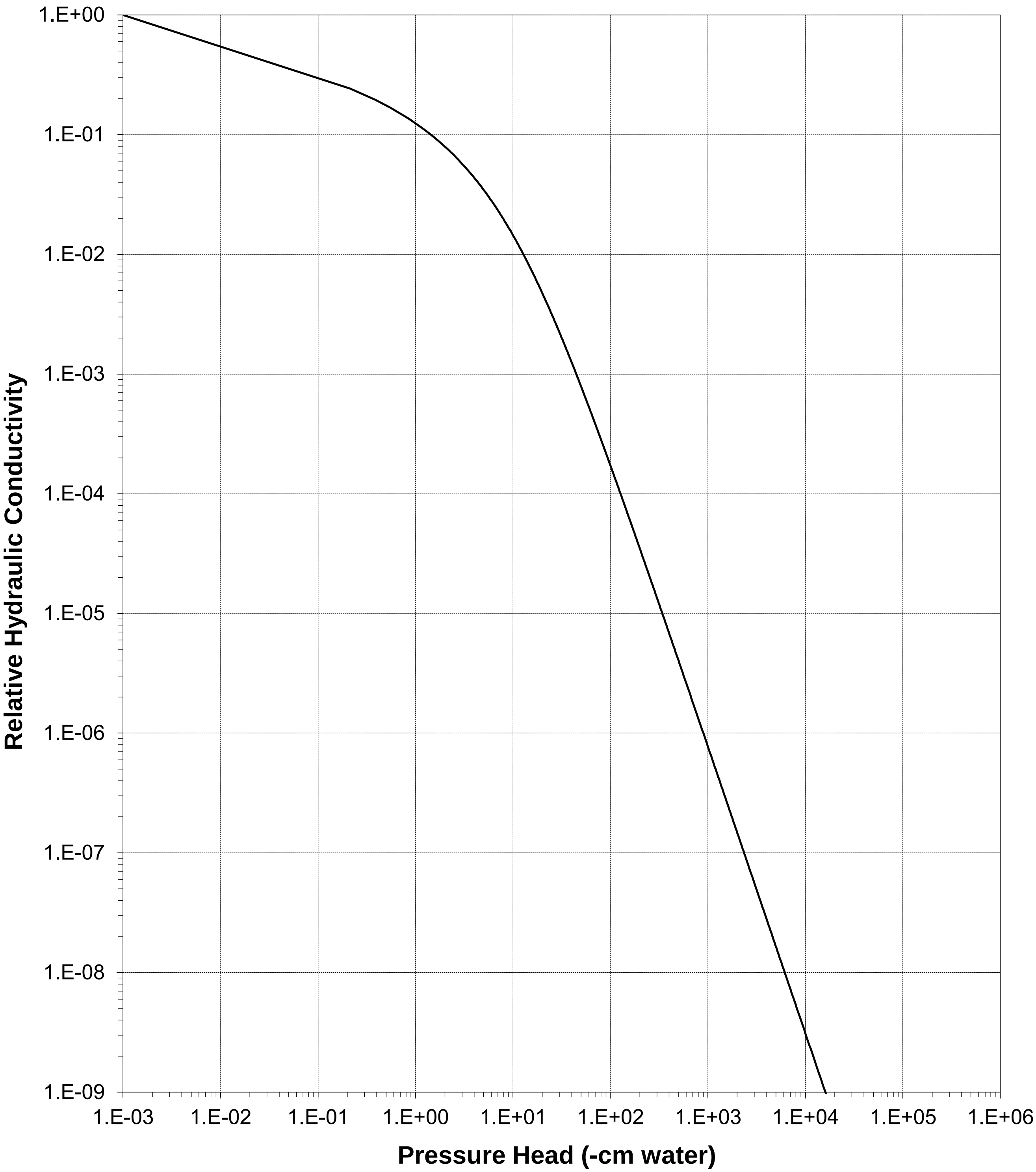
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: Ore Yard (~90%)



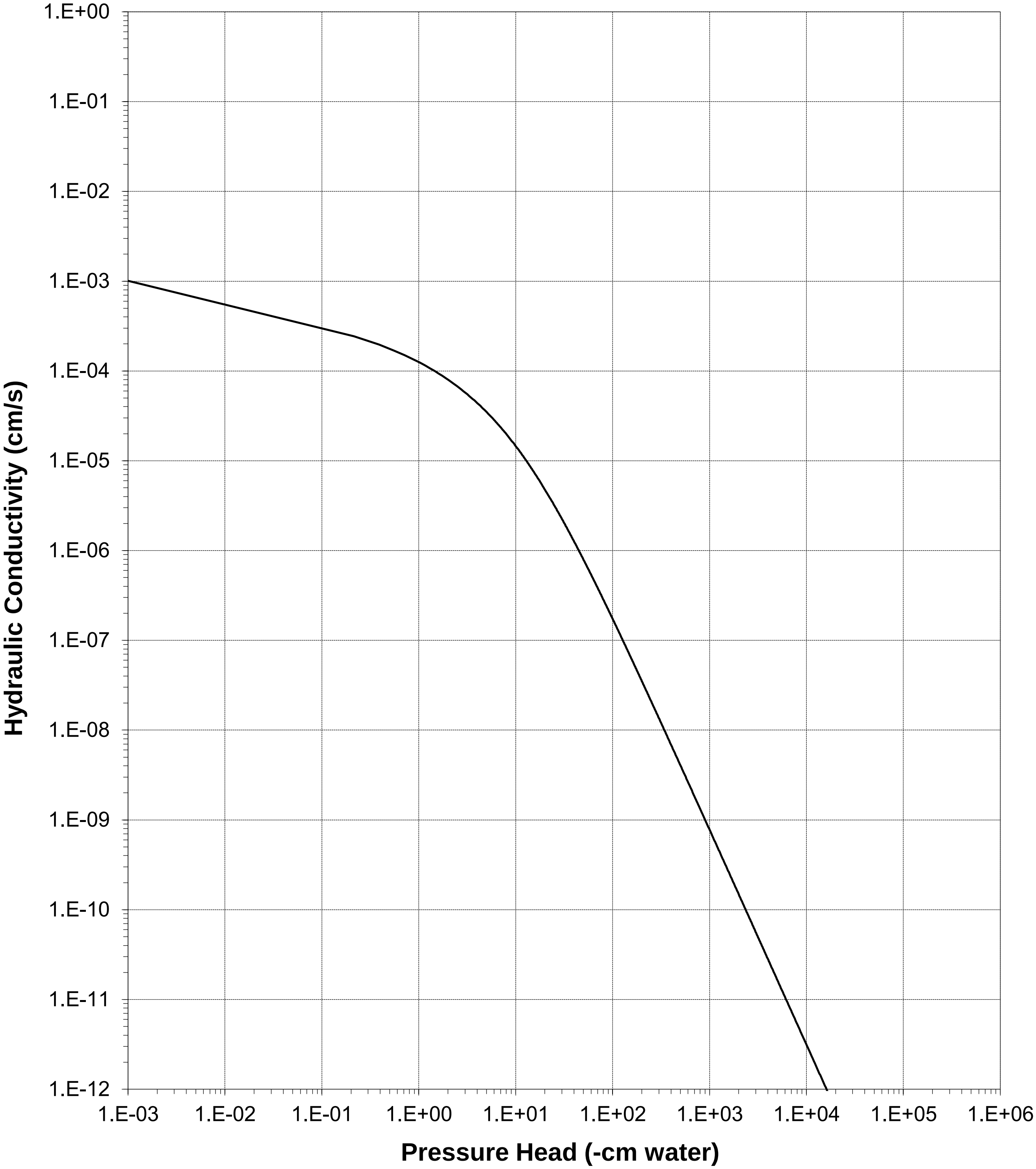
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: Ore Yard (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: Ore Yard (~90%)



Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.08
Sample Number: Ore Yard (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/4"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	170.00	25380.00	25550.00
Mass Fraction (%):	0.67	99.33	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.75	1.60	1.61
Calculated Porosity (% vol):	0.00	41.66	41.50
Volume of Solids (cm^3):	61.82	9229.09	9290.91
Volume of Voids (cm^3):	0.00	6590.49	6590.49
Total Volume (cm^3):	61.82	15819.58	15881.40
Volumetric Fraction (%):	0.39	99.61	100.00
Initial Moisture Content (% vol):	0.00	22.46	---
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.75	1.60	1.61
Calculated Porosity (% vol):	0.00	41.66	41.50
Volume of Solids (cm^3):	61.82	9229.09	9290.91
Volume of Voids (cm^3):	0.00	6590.49	6590.49
Total Volume (cm^3):	61.82	15819.58	15881.40
Volumetric Fraction (%):	0.39	99.61	100.00
Saturated Moisture Content (% vol):	0.00	41.73	---
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.75	1.60	1.61
Calculated Porosity (% vol):	0.00	41.66	41.50
Volume of Solids (cm^3):	61.82	9229.09	9290.91
Volume of Voids (cm^3):	0.00	6590.49	6590.49
Total Volume (cm^3):	61.82	15819.58	15881.40
Volumetric Fraction (%):	0.39	99.61	100.00
Residual Moisture Content (% vol):	0.00	0.00	---
Ksat (cm/sec):	NM	1.0E-03	---

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample (g):*	373.34
Job Number:	DB21.1124.09	*Tare wt., ring (g):*	213.79
Sample Number:	AB Pit Bot 01 (~90%)	*Tare wt., screen & clamp (g):*	27.49
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume (cm^3):*	311.10
Depth:	NA	*Initial dry bulk density (g/cm^3):*	1.20
		Assumed particle density (g/cm^3):	2.75
		Initial calculated total porosity (%):	56.36

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	15-Nov-21	15:50	795.20	0	58.05	
	22-Nov-21	13:59	801.87	22.0	57.70	‡‡
	30-Nov-21	15:00	799.63	73.0	57.01	‡‡
	7-Dec-21	10:05	789.94	170.0	54.45	‡‡
Pressure plate:	16-Dec-21	8:15	784.89	337	52.88	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	22.0	324.50	+4.31%	1.15	58.16
	73.0	324.50	+4.31%	1.15	58.16
	170.0	321.99	+3.50%	1.16	57.84
Pressure plate:	337	321.99	+3.50%	1.16	57.84

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: AB Pit Bot 01 (~90%)

Initial sample bulk density (g/cm^3)*:* 1.20
Fraction of test sample used (<2.00mm fraction) (%): 100.00

Dry weight of dew point potentiometer sample* (g)*:* 152.45
Tare weight, jar (g)*:* 116.63

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)	
Dew point potentiometer:	13-Dec-21	13:56	158.63	51908	20.00	‡‡
	10-Dec-21	9:18	157.58	93312	16.61	‡‡
	9-Dec-21	10:04	156.56	213240	13.30	‡‡
	8-Dec-21	9:17	156.24	270349	12.27	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	51908	321.99	+3.50%	1.16	57.84
	93312	321.99	+3.50%	1.16	57.84
	213240	321.99	+3.50%	1.16	57.84
	270349	321.99	+3.50%	1.16	57.84

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

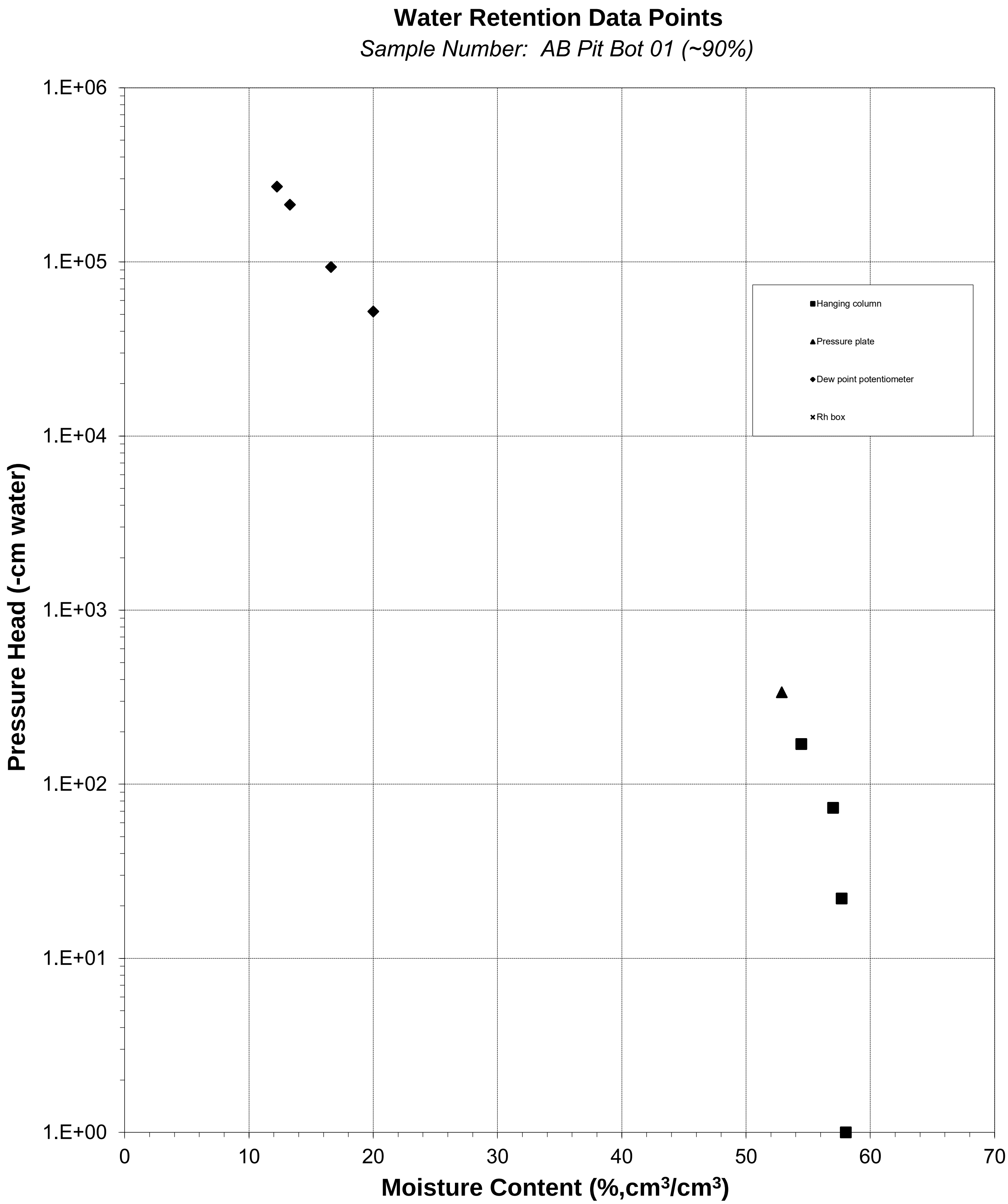
[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

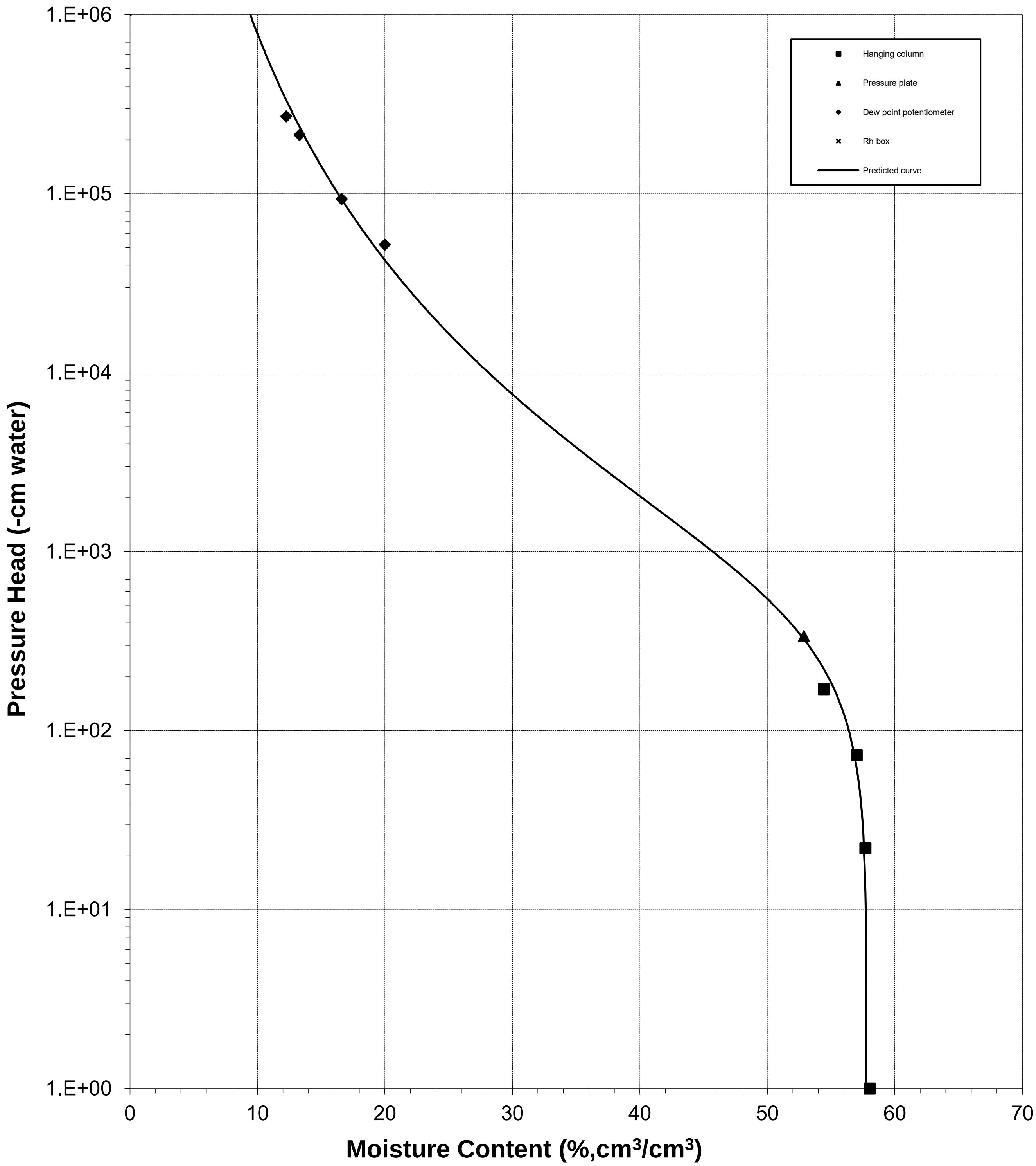
Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines


Water Retention Data Points
Sample Number: AB Pit Bot 01 (~90%)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
Moisture Content (%,cm3/cm3)
0
10
20
30
40
50
60
70
Hanging column
Pressure plate
Dew point potentiometer
Rh box

Daniel B. Stephens & Associates, Inc.

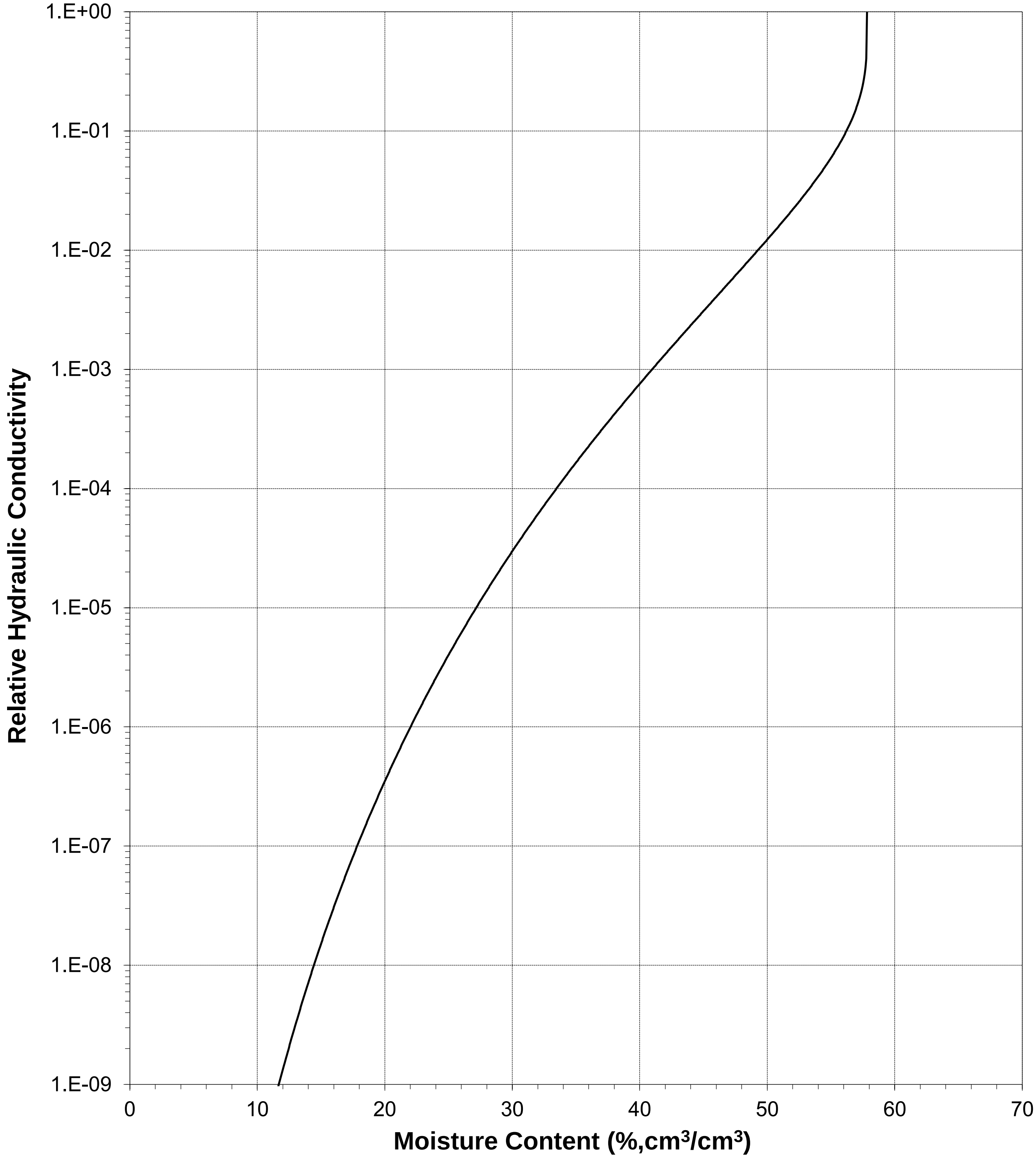
Predicted Water Retention Curve and Data Points

Sample Number: AB Pit Bot 01 (~90%)



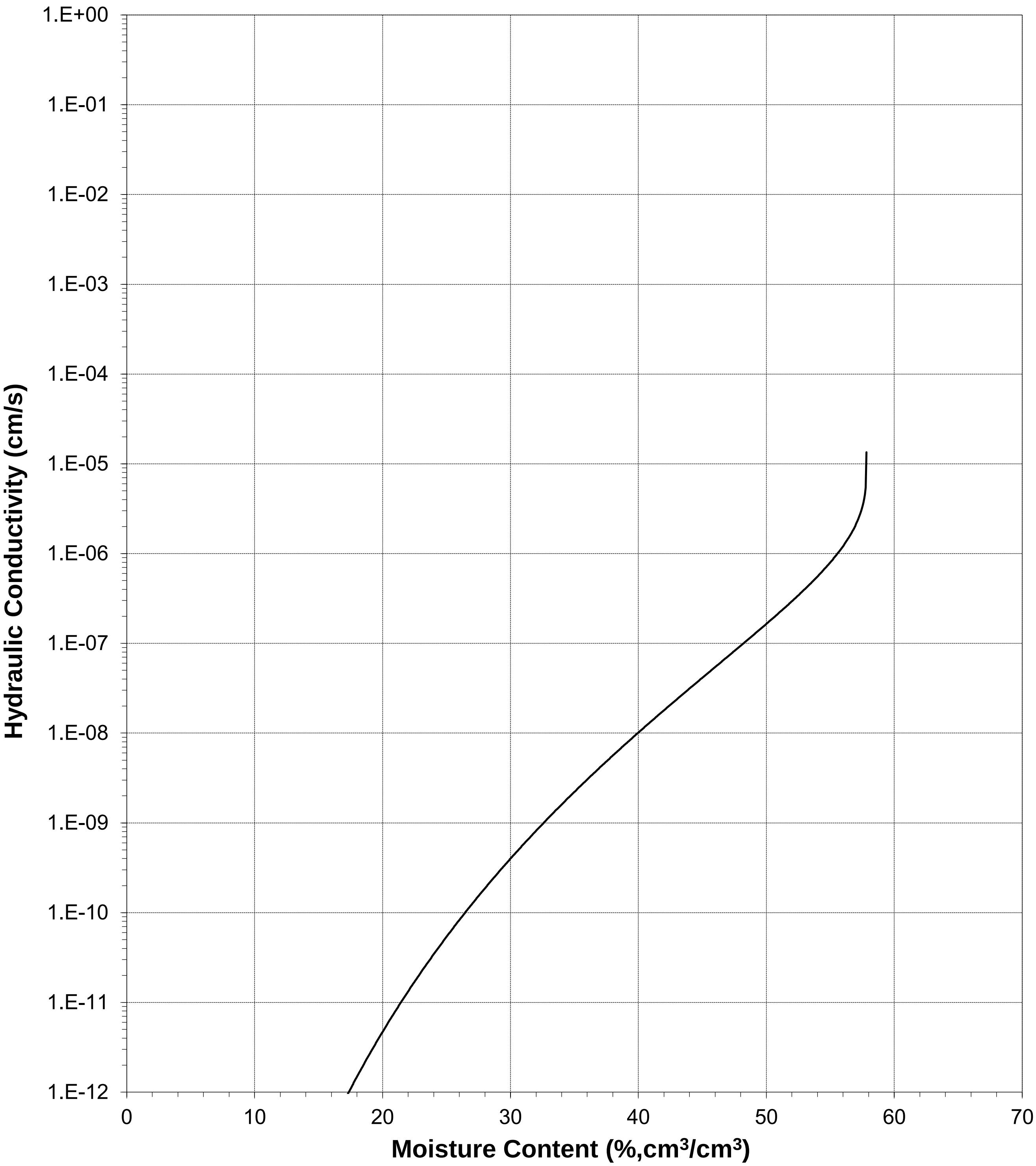
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: AB Pit Bot 01 (~90%)



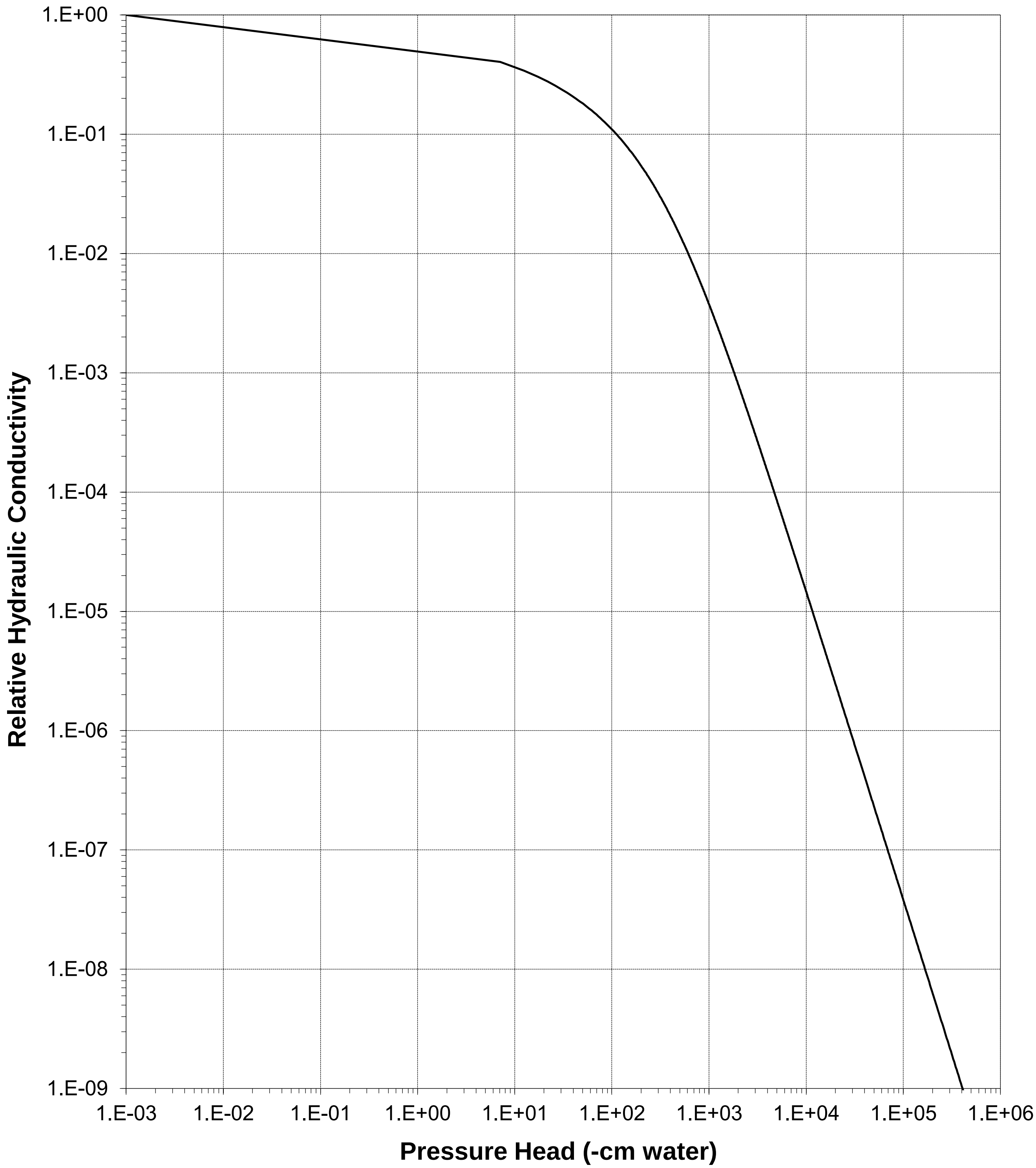
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: AB Pit Bot 01 (~90%)



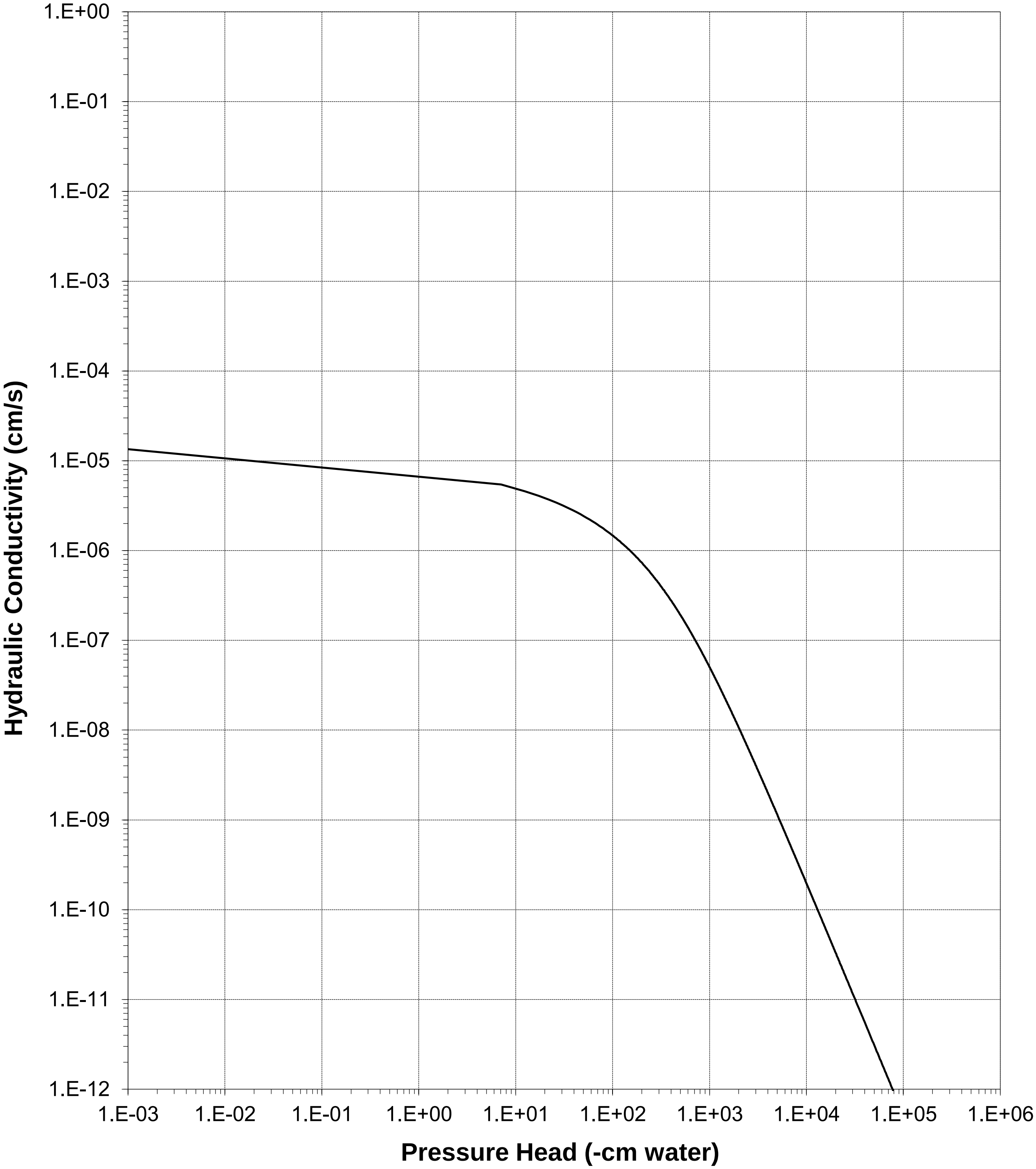
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: AB Pit Bot 01 (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: AB Pit Bot 01 (~90%)



Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample (g):*	456.73
Job Number:	DB21.1124.10	*Tare wt., ring (g):*	215.50
Sample Number:	TP1WN-TP1E (~90%)	*Tare wt., screen & clamp (g):*	27.79
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume (cm³):*	314.21
Depth:	NA	*Initial dry bulk density (g/cm³):*	1.45
		Assumed particle density (g/cm³):	2.65
		Initial calculated total porosity (%):	45.15

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	15-Nov-21	15:55	848.30	0	47.19	
	22-Nov-21	14:00	849.72	14.5	47.01	‡‡
	30-Nov-21	15:00	849.20	32.0	46.85	‡‡
	7-Dec-21	10:00	832.22	93.0	41.52	‡‡
Pressure plate:	16-Dec-21	8:15	812.56	337	35.34	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	14.5	318.41	+1.33%	1.43	45.87
	32.0	318.41	+1.33%	1.43	45.87
	93.0	318.41	+1.33%	1.43	45.87
Pressure plate:	337	318.41	+1.33%	1.43	45.87

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: TP1WN-TP1E (~90%)

Initial sample bulk density (g/cm³)*:* 1.45
Fraction of test sample used (<2.00mm fraction) (%): 70.60

Dry weight of dew point potentiometer sample* (g)*:* 157.24
Tare weight, jar (g)*:* 113.45

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Dew point potentiometer:	13-Dec-21	13:56	161.94	41812	10.87	‡‡
	10-Dec-21	9:25	161.20	59250	9.16	‡‡
	8-Dec-21	9:20	160.16	149197	6.75	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	41812	318.41	+1.33%	1.43	45.87
	59250	318.41	+1.33%	1.43	45.87
	149197	318.41	+1.33%	1.43	45.87

Dry weight of relative humidity box sample* (g)*:* 85.95
Tare weight (g)*:* 45.50

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Relative humidity box:	1-Dec-21	13:00	87.72	849860	4.44	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	849860	318.41	+1.33%	1.43	45.87

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

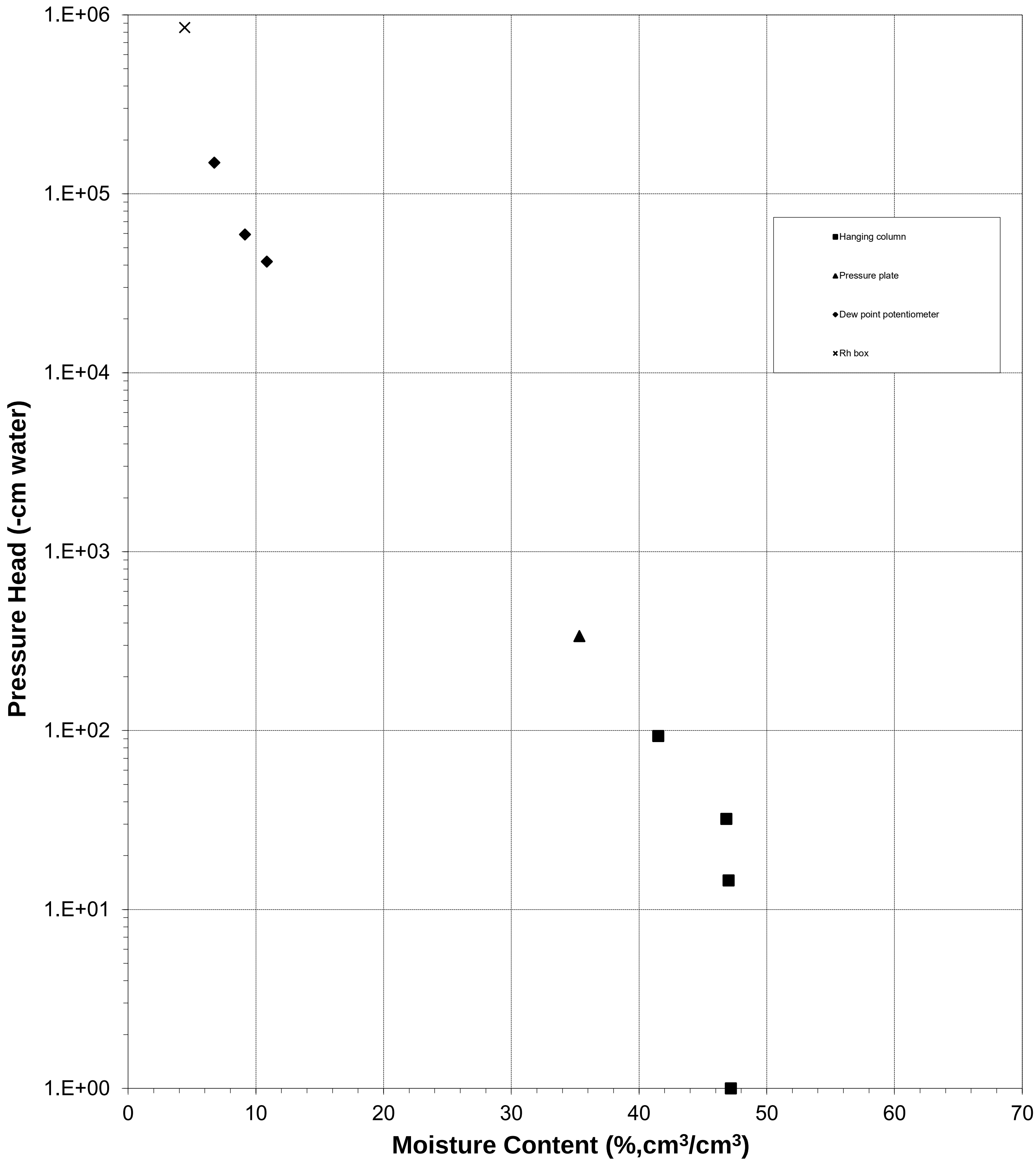
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

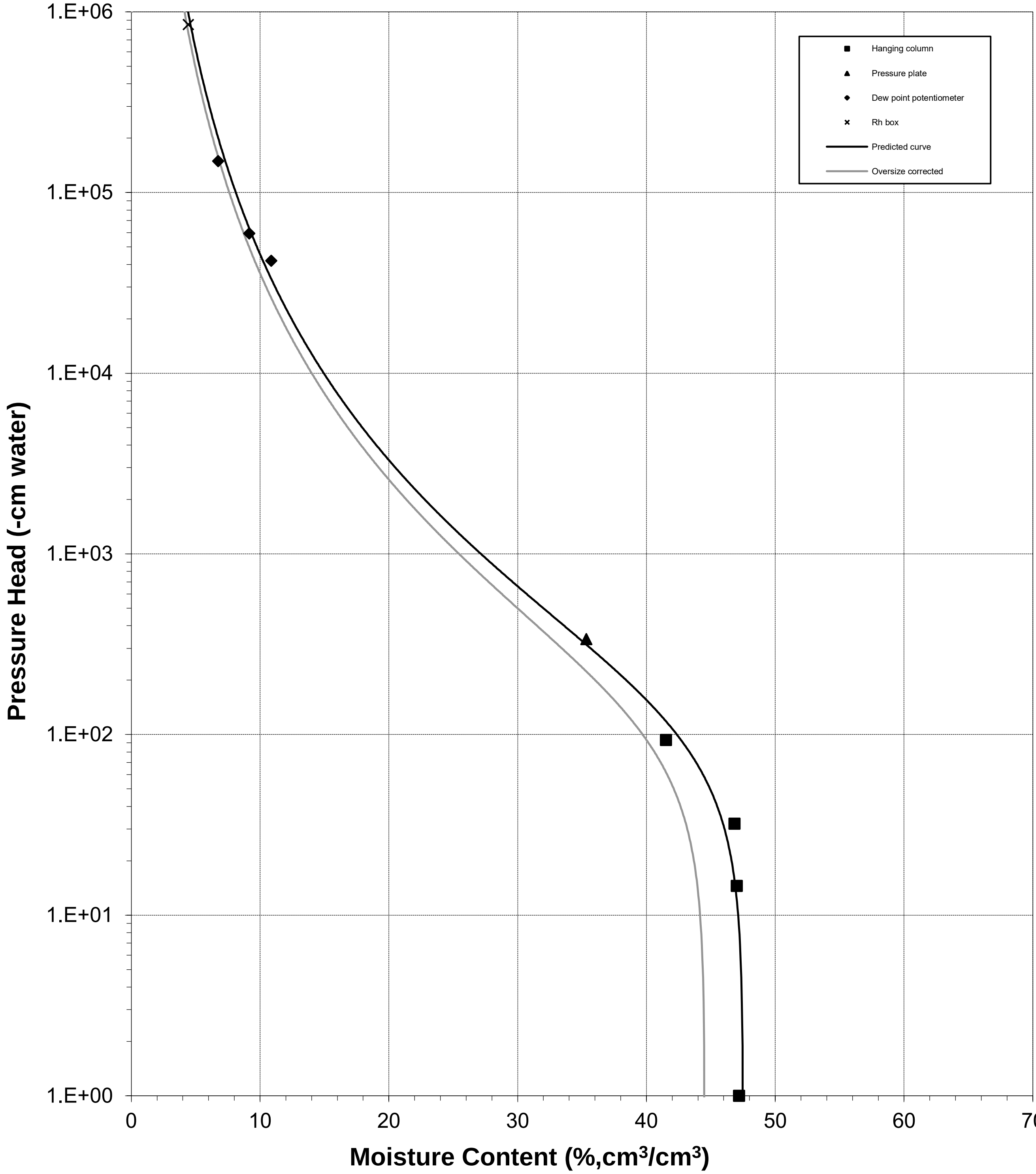
Water Retention Data Points

Sample Number: TP1WN-TP1E (~90%)



Predicted Water Retention Curve and Data Points

Sample Number: TP1WN-TP1E (~90%)



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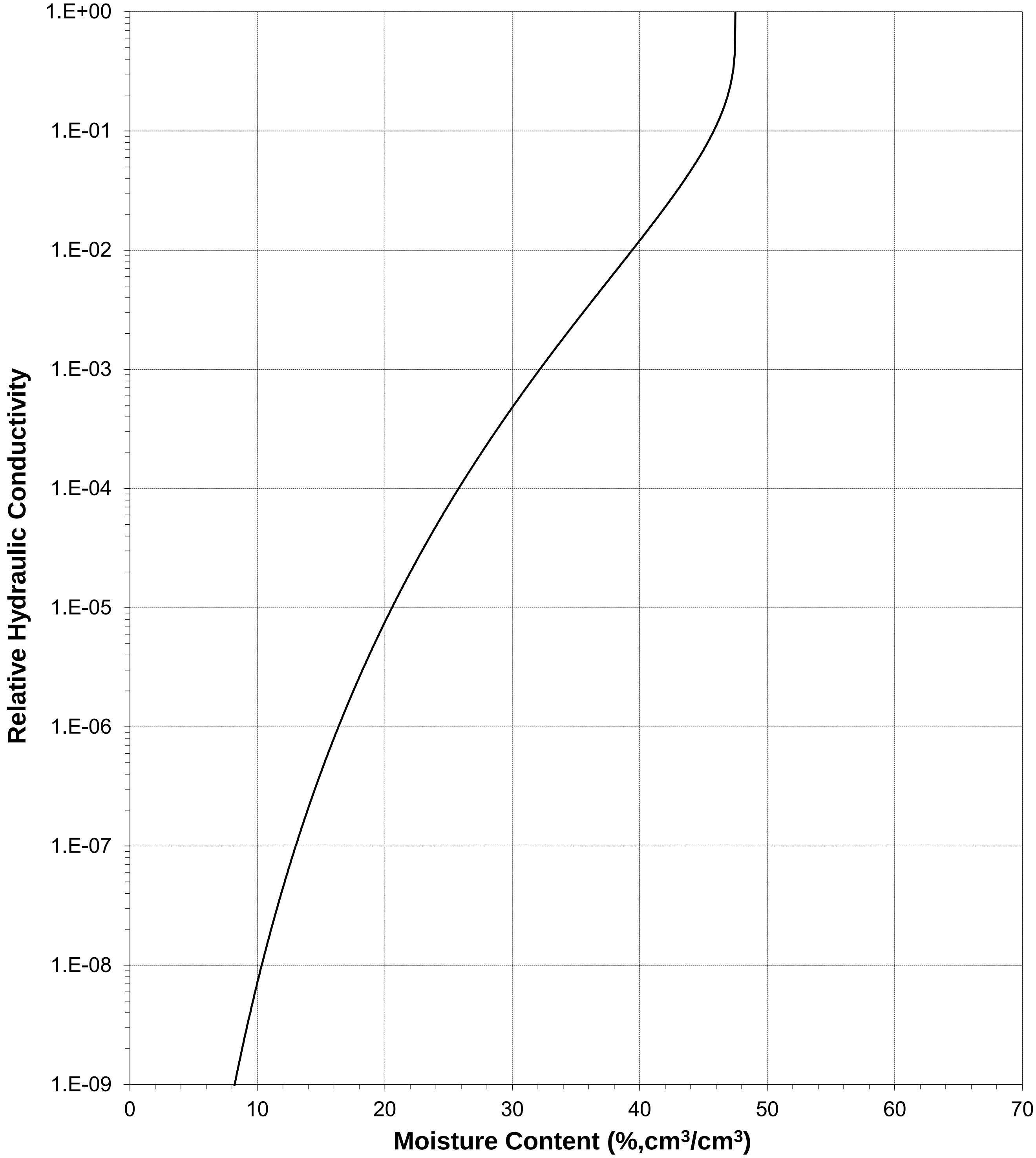
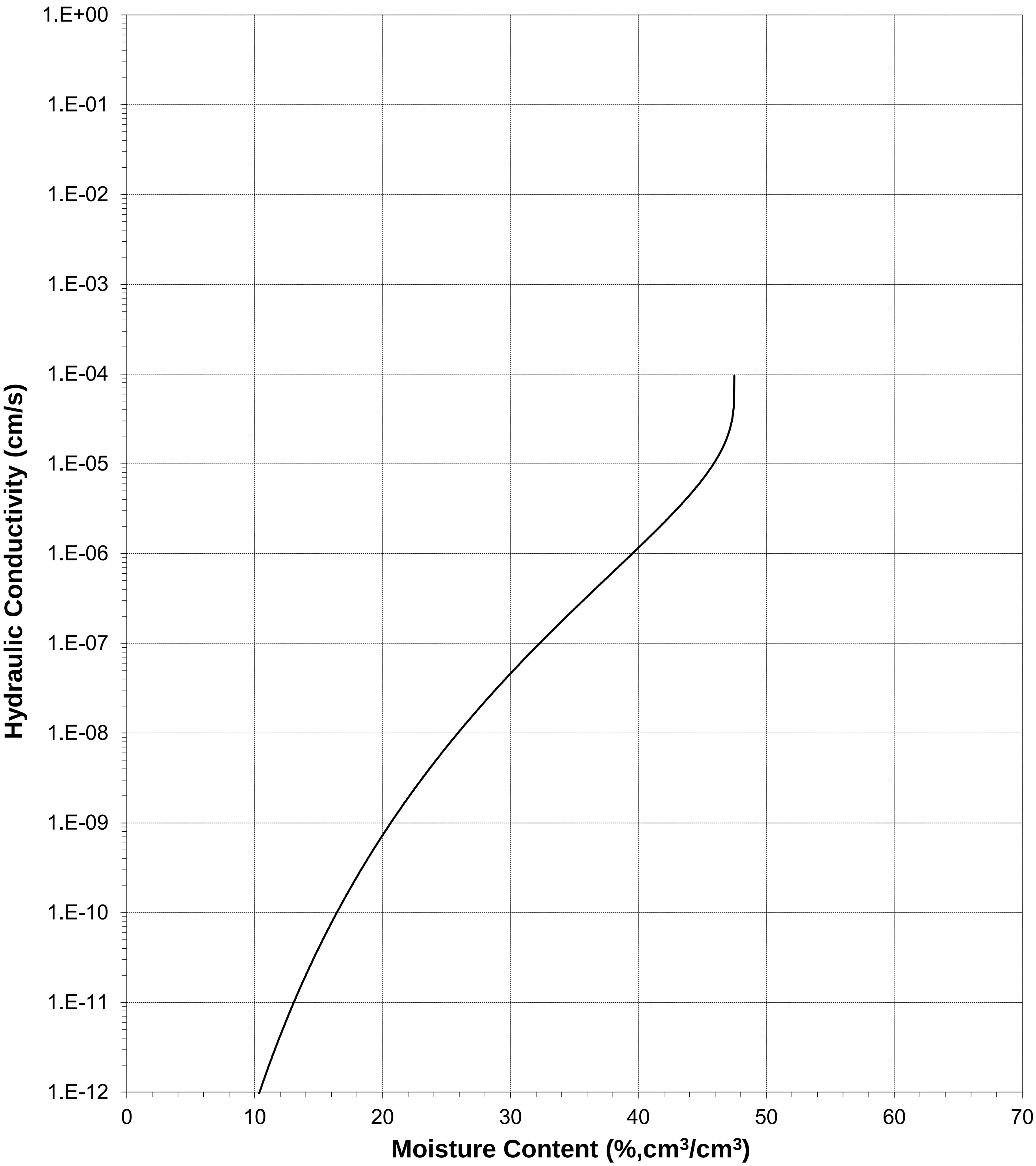
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: TP1WN-TP1E (~90%)



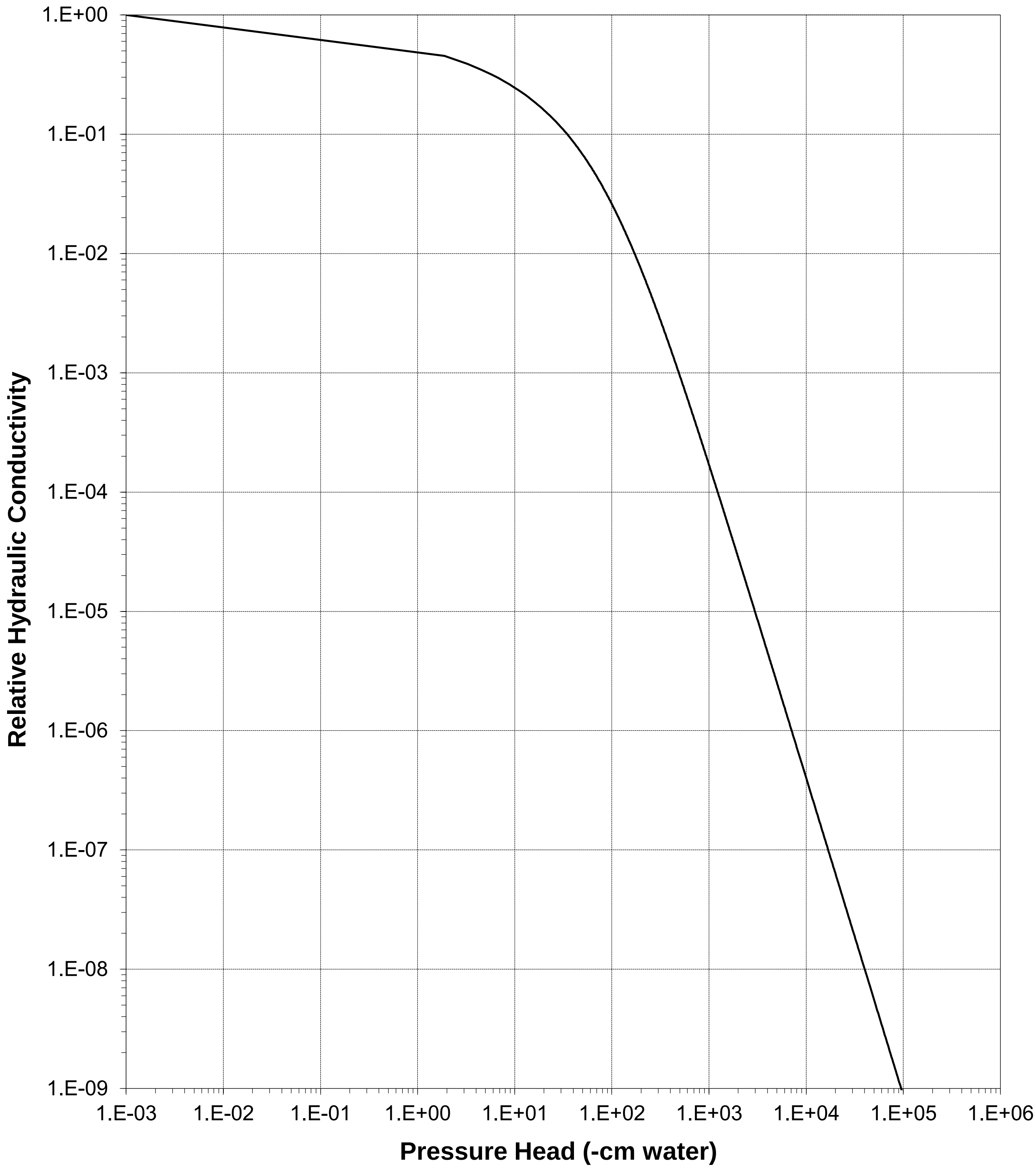
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: TP1WN-TP1E (~90%)



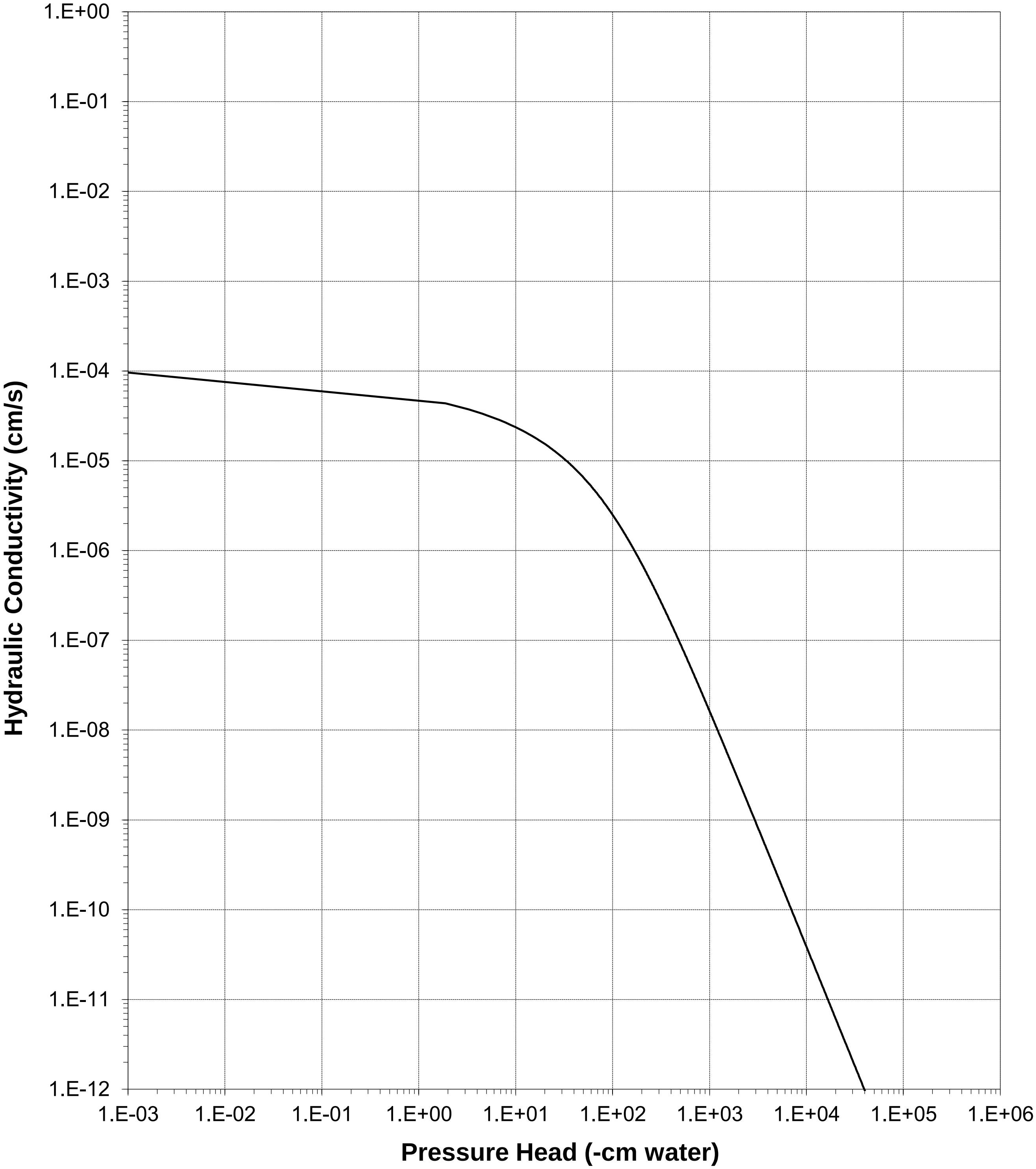
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: TP1WN-TP1E (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: TP1WN-TP1E (~90%)



Daniel B. Stephens & Associates, Inc.

Oversize Correction Data Sheet

Job Name: Broadbent
Job Number: DB21.1124.10
Sample Number: TP1WN-TP1E (~90%)
Ring Number: 3 Kids Mine, 14-01-156
Depth: NA

Split (3/4", 3/8", #4): 3/8"

	Coarse Fraction*	Fines Fraction**	Composite
Subsample Mass (g):	2580.00	21150.00	23730.00
Mass Fraction (%):	10.87	89.13	100.00
Initial Sample θ_i			
Bulk Density (g/cm^3):	2.65	1.45	1.53
Calculated Porosity (% vol):	0.00	45.15	42.32
Volume of Solids (cm^3):	973.58	7981.13	8954.72
Volume of Voids (cm^3):	0.00	6569.36	6569.36
Total Volume (cm^3):	973.58	14550.49	15524.07
Volumetric Fraction (%):	6.27	93.73	100.00
Initial Moisture Content (% vol):	0.00	33.43	31.34
Saturated Sample θ_s			
Bulk Density (g/cm^3):	2.65	1.45	1.53
Calculated Porosity (% vol):	0.00	45.15	42.32
Volume of Solids (cm^3):	973.58	7981.13	8954.72
Volume of Voids (cm^3):	0.00	6569.36	6569.36
Total Volume (cm^3):	973.58	14550.49	15524.07
Volumetric Fraction (%):	6.27	93.73	100.00
Saturated Moisture Content (% vol):	0.00	47.51	44.53
Residual Sample θ_r			
Bulk Density (g/cm^3):	2.65	1.43	1.51
Calculated Porosity (% vol):	0.00	45.87	43.03
Volume of Solids (cm^3):	973.58	7981.13	8954.72
Volume of Voids (cm^3):	0.00	6763.60	6763.60
Total Volume (cm^3):	973.58	14744.73	15718.31
Volumetric Fraction (%):	6.19	93.81	100.00
Residual Moisture Content (% vol):	0.00	0.00	0.00
Ksat (cm/sec):	NM	9.6E-05	8.6E-05

* = Porosity and moisture content of coarse fraction assumed to be zero.
** = Volume adjusted, if applicable. See notes on Moisture Retention Data pages.
NM = Not measured

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data
Hanging Column / Pressure Plate
(Soil-Water Characteristic Curve)

Job Name:	Broadbent	*Dry wt. of sample* (g):	465.72
Job Number:	DB21.1124.11	*Tare wt., ring* (g):	216.50
Sample Number:	WR07E-WR07N (~90%)	*Tare wt., screen & clamp* (g):	28.05
Ring Number:	3 Kids Mine, 14-01-156	*Initial sample volume* (cm^3):	314.87
Depth:	NA	*Initial dry bulk density* (g/cm^3):	1.48
		Assumed particle density (g/cm^3):	2.65
		Initial calculated total porosity (%):	44.19

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	15-Nov-21	15:45	855.00	0	45.96	
	22-Nov-21	13:45	855.56	8.0	45.66	‡‡
	30-Nov-21	15:00	841.26	24.0	41.16	‡‡
	7-Dec-21	12:15	829.50	76.0	37.47	‡‡
Pressure plate:	16-Dec-21	8:15	815.54	337	33.08	‡‡

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	8.0	318.22	+1.06%	1.46	44.77
	24.0	318.22	+1.06%	1.46	44.77
	76.0	318.22	+1.06%	1.46	44.77
Pressure plate:	337	318.22	+1.06%	1.46	44.77

Comments:

[1] Applicable if the sample experienced volume changes during testing. ‘Volume Adjusted’ values represent each of the volume change measurements obtained after saturated hydraulic conductivity testing and throughout hanging column/pressure plate testing. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Assumed density of water is 1.0 g/cm^3

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: WR07E-WR07N (~90%)

Initial sample bulk density (g/cm^3)*:* 1.48
Fraction of test sample used (<2.00mm fraction) (%): 90.63

Dry weight of dew point potentiometer sample* (g)*:* 169.96
Tare weight, jar (g)*:* 117.02

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content† (% vol)	
Dew point potentiometer:	10-Dec-21	9:01	175.67	105651	14.31	‡‡
	9-Dec-21	9:50	174.26	246996	10.77	‡‡
	7-Dec-21	9:10	173.16	596175	8.02	‡‡

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm^3)	% Volume Change [2] (%)	Adjusted Density (g/cm^3)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	105651	318.22	+1.06%	1.46	44.77
	246996	318.22	+1.06%	1.46	44.77
	596175	318.22	+1.06%	1.46	44.77

Comments:

[1] Applicable if the sample experienced volume changes during testing. 'Volume Adjusted' values represent the volume change measurements obtained after the last hanging column or pressure plate point. "---" indicates no volume changes occurred.

[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* Weight including tares

† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

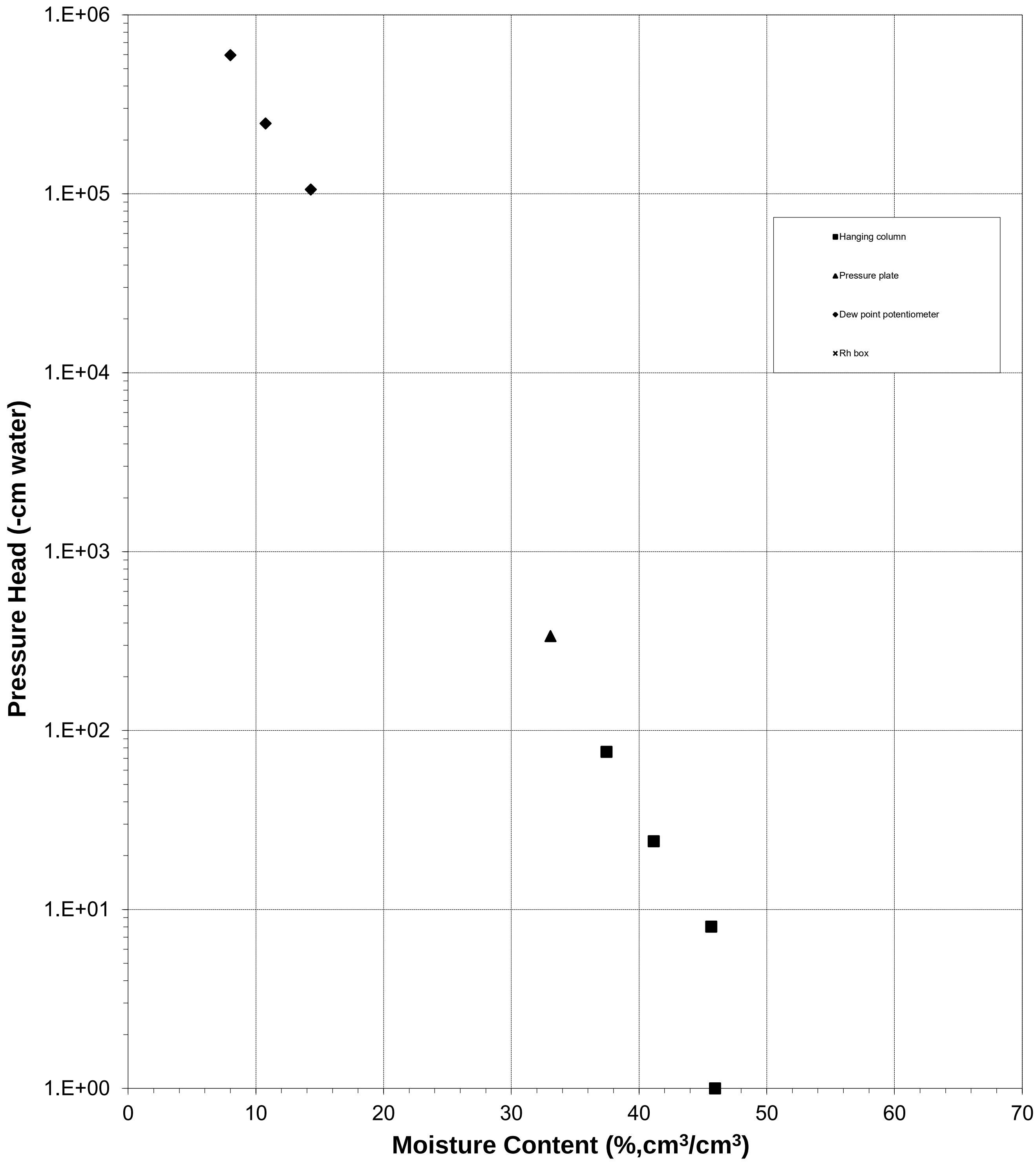
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: J. Newcomer
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

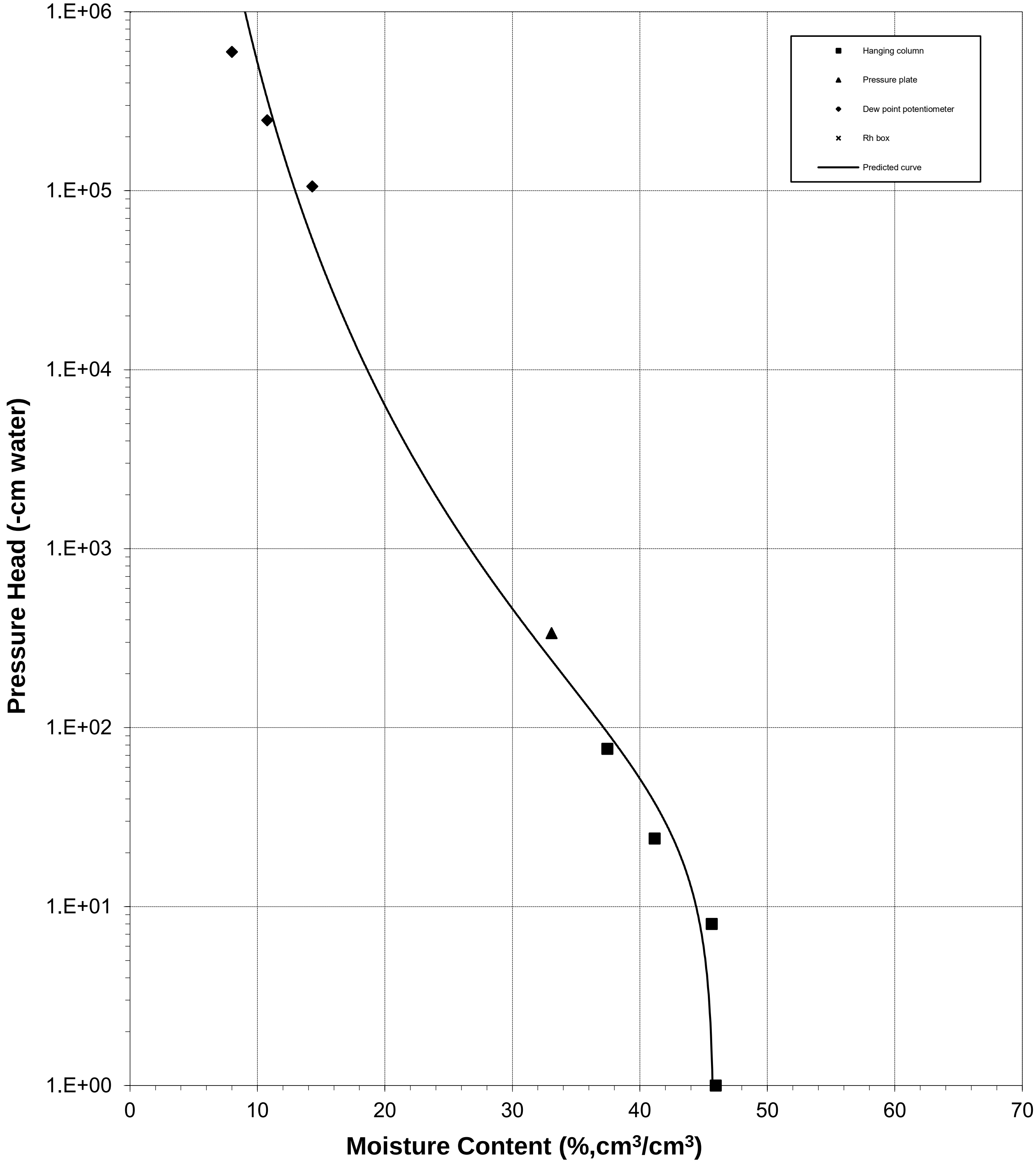
Water Retention Data Points

Sample Number: WR07E-WR07N (~90%)



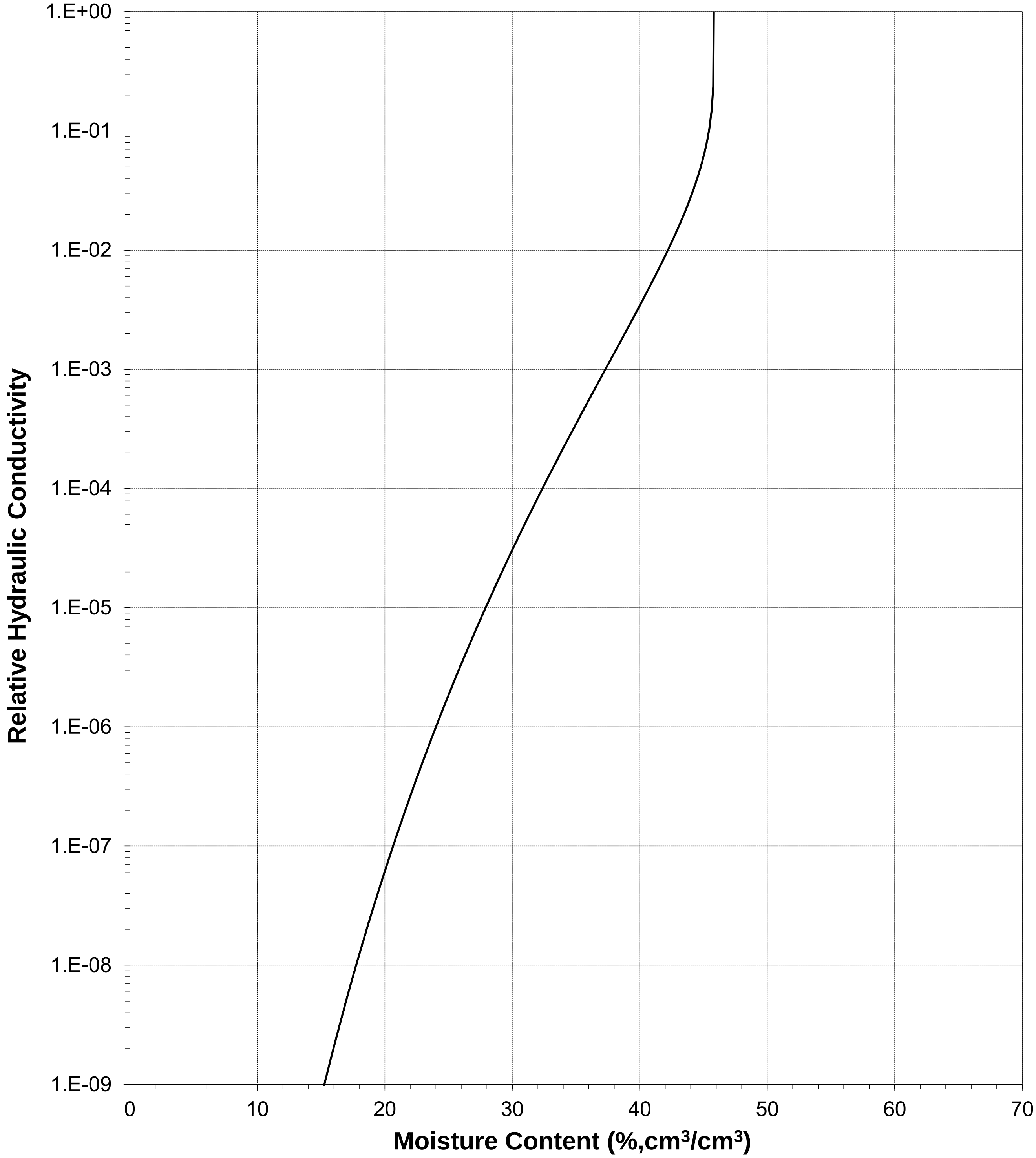
Predicted Water Retention Curve and Data Points

Sample Number: WR07E-WR07N (~90%)



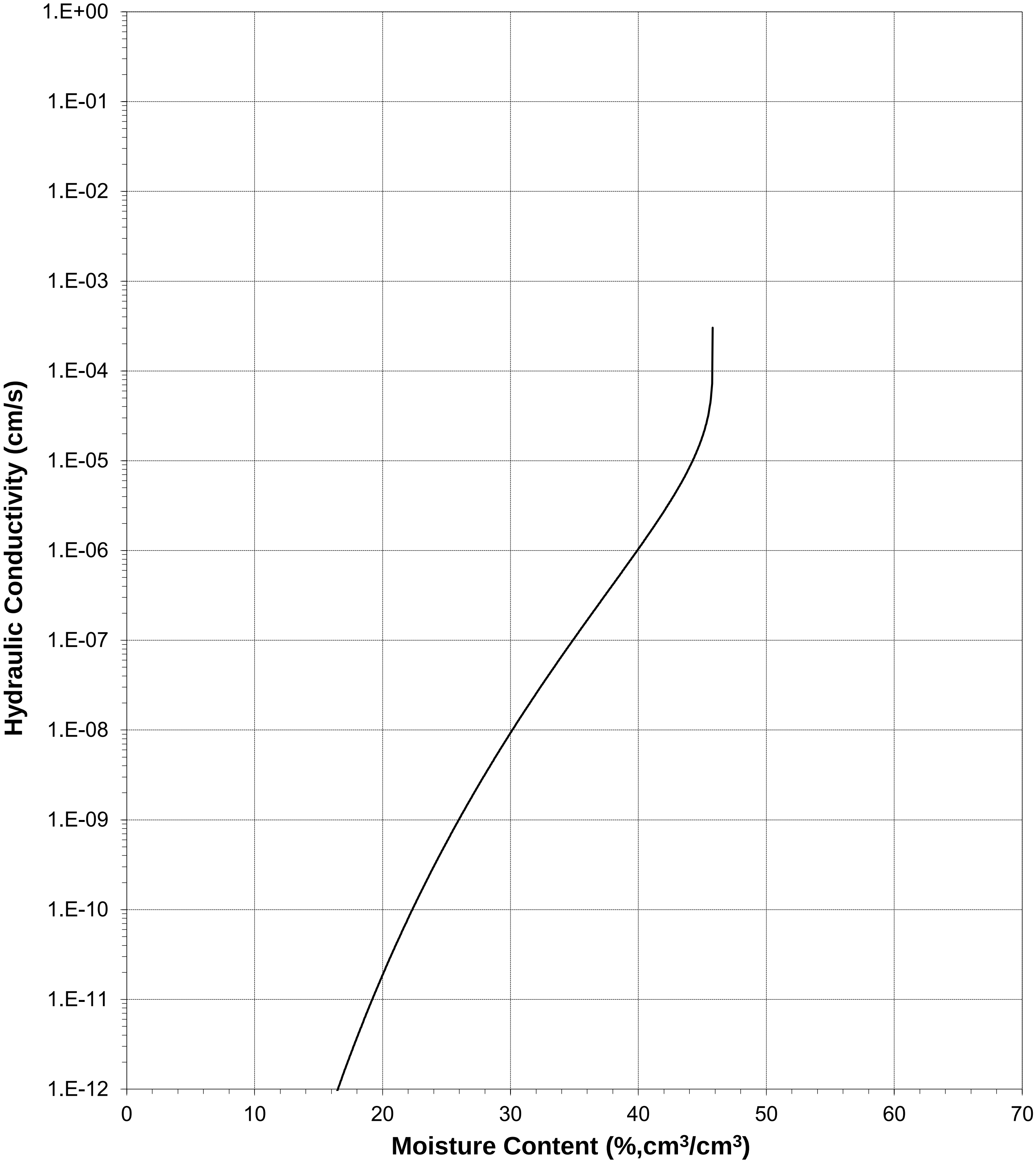
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: WR07E-WR07N (~90%)



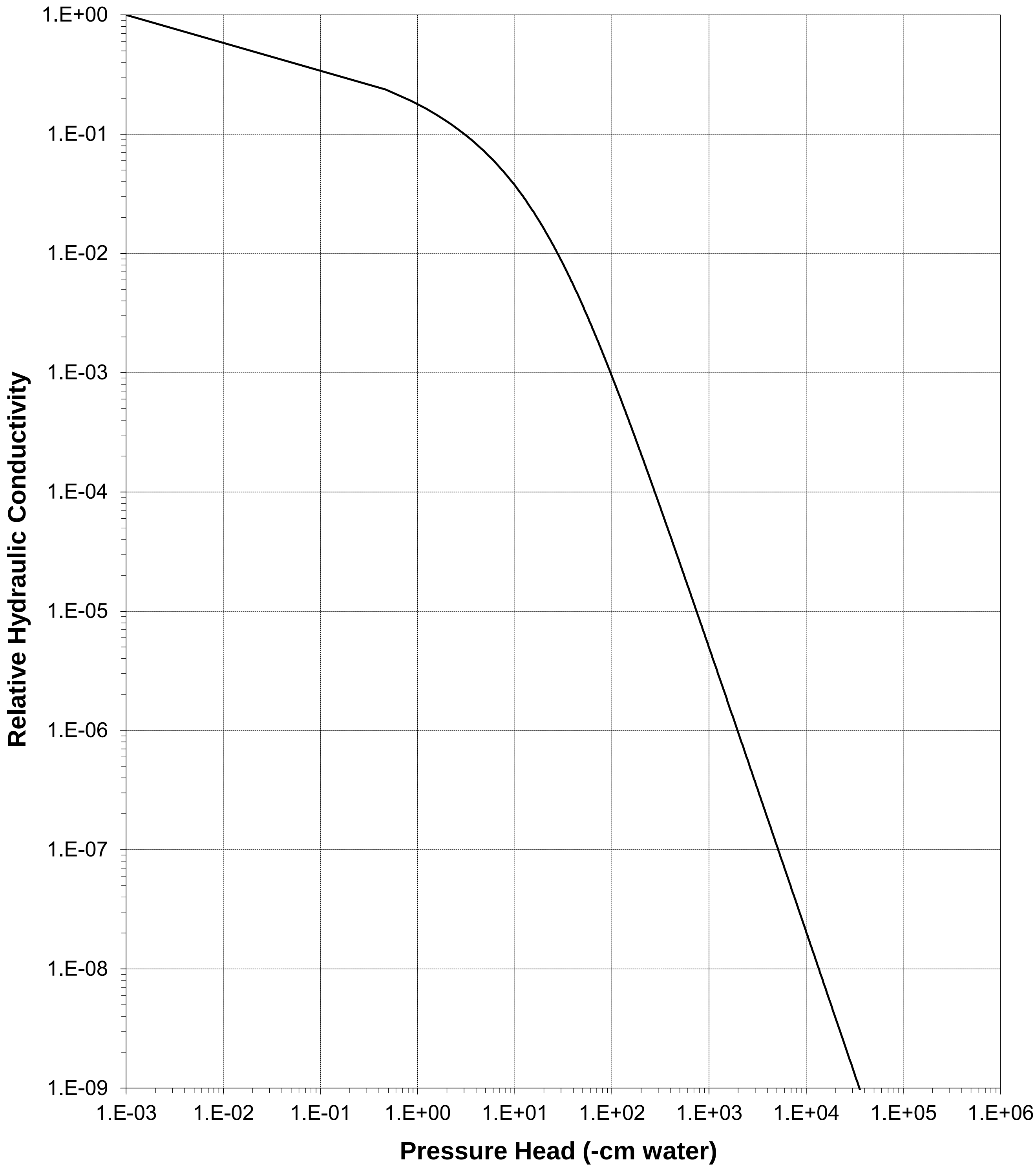
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: WR07E-WR07N (~90%)



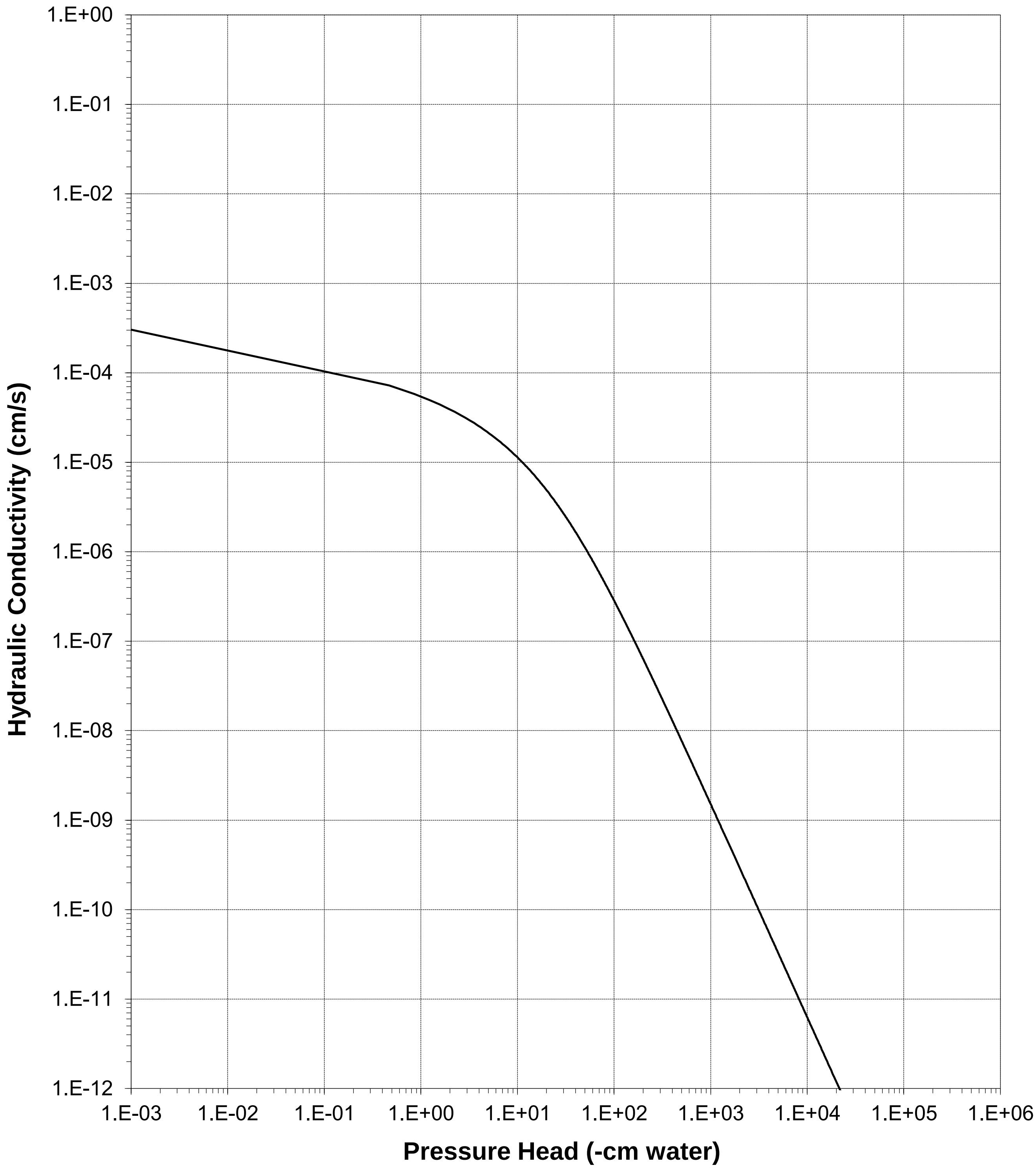
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: WR07E-WR07N (~90%)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: WR07E-WR07N (~90%)



Laboratory Tests and Methods

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263, ASTM D2216
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity:	
Falling Head Rising Tail: (Flexible Wall)	ASTM D5084
Hanging Column Method:	ASTM D6836 (modified apparatus)
Pressure Plate Method:	ASTM D6836
Water Potential (Dewpoint Potentiometer) Method:	ASTM D6836
Relative Humidity (Box) Method:	Campbell, G. and G. Gee. 1986. Water Potential: Miscellaneous Methods. Chp. 25, pp. 631-632, in A. Klute (ed.), Methods of Soil Analysis. Part 1. American Society of Agronomy, Madison, WI; Karathanasis & Hajek. 1982. Quantitative Evaluation of Water Adsorption on Soil Clays. SSA Journal 46:1321-1325
Heat Dissipation Sensor:	229 Heat Dissipation Matric Water Potential Sensor Instruction Manual (Rev. 5/09). Campbell Scientific, Inc., Logan, UT; Flint, A.L., et al. Calibration and Temperature Correction of Heat Dissipation Matric Potential Sensors. Soil Sci. Soc. Am. J. 66.1439 1445 (2002); van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Moisture Retention Characteristics & Calculated Unsaturated Hydraulic Conductivity:	ASTM D6836; van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. SSSAJ 44:892-898; van Genuchten, M.T., F.J. Leij, and S.R. Yates. 1991. The RETC code for quantifying the hydraulic functions of unsaturated soils. Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Ada, Oklahoma. EPA/600/2091/065. December 1991
Coarse Fraction (Gravel) Correction (calc):	ASTM D4718; Bouwer, H. and Rice, R.C. 1984. Hydraulic Properties of Stony Vadose Zones. Groundwater Vol. 22, No. 6

APPENDIX E

PMET Laboratory Reports on Tailings and Mine Site Material Mineralogy

Pittsburgh
Mineral &
Environmental
Technology, Inc.

March 5, 2021

Ms. Victoria Tyson-Bloyd
Broadbent & Associates
8 West Pacific Ave.
Henderson, NV 89015

Dear Ms. Tyson-Bloyd:

This report summarizes the results of quantitative mineral phase analysis and qualitative clay analysis of 12 tailings samples from the Three Kids Mine, Las Vegas, Nv. The samples were received at PMET's laboratory on January 22, 2021 in glass jars. A Broadbent chain of custody document accompanied the samples. A request for analysis and sample description was received from Mr. Casey Korby along with the samples. A purchase order was received for Broadbent Project No: 14-01-156 from Mr. Jeremy Boucher.

The purpose of the analysis was to determine the presence and amount of crystalline mineral phases and amorphous material, and to determine the species and relative amounts of clay minerals in the tailing samples.

The as-received samples were removed into tared pans and dried at 25°C for 48 hours in a vented 3M oven to minimize moisture content. Temperature was measured using a calibrated thermometer traceable to a NIST standard thermometer. The dried as-received samples were then crushed to -35 mesh (500µ). The -35 mesh material was then added to a 1L beaker with 500ml acetone and stirred for two hours to remove hydrocarbon residues from the flotation circuit. The acetone was allowed to settle overnight, then poured off. An additional 500 ml of acetone was added to the material and stirred with a spatula. This acetone wash settled overnight and was then the poured off. The acetone washed material was dried at 75°C for two hours.

Following the acetone wash the -35mesh sample material was split using a rotary riffle splitter (Max. error 0.42%) to obtain analytical aliquots for QXRD and clay speciation. The analytical aliquots were then stage crushed to 100% -70 mesh (210µ).

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The aliquots for QXRD were split using a riffle splitter to obtain a 30-gram aliquot. The QXRD aliquots were then pulverized to 100% -400 mesh (37 µ) for x-ray diffraction analysis.

X-ray Diffraction Analysis

X-ray powder diffraction (XRD) and Rietveld quantification analyses were used to determine the mineralogical composition of the samples. XRD sample preparation included grinding an aliquot of the sample using the BICO Model VP-1989 mill with a 3.5-inch ring and puck. The pulverized material was mixed with High-Grade Fluorspar (CaF_2, N.B.S. SRM 180) on a 90:10 weight basis and mixed using a SPEX Industries Mixer/Mill for 10 minutes. Standard spike intensity was used as a reference to determine the amorphous content of the samples.

Step-scanned XRD data were collected by the Siemens D500 computer-automated diffractometer using Bragg-Brentano geometry. Cu radiation was produced at a power of 45kV and 30 mA. The diffracted beam was collimated by a 0.05° receiving slit. The data was collected in the 2θ range of 4.9°–66.1° with a step size of 0.015° and a dwell time of 1.2 sec/step using a Ketek Vitus H150 high resolution silicon drift detector with an Amptek PX5 pulse processor.

Qualitative analysis of the XRD patterns was performed using proprietary Bruker AXS software Diffrac Plus EVA (v. 7001, 2001) peak search algorithm. The reference database for the crystal pattern search/match is the International Center for Diffraction Data database (ICDD, 2001). A chemical screen using SEM-EDX elemental data was used to narrow the data base for the search.

Trace phases were confirmed by screening a -70mesh aliquot of several samples at 100mesh (149µ) to reduce the harder coarse minerals and at 500mesh (25µ) to remove some of the clay fraction. This allowed confirmation of several phases such as todorokite, ramsdellite, and kutnahorite. Images of two scans are shown in Figures 26-27. Since these phases cannot be easily quantified due to the high amount of amorphous swelling clay, their concentrations are reported as less than one percent in the data tables.

Quantitative analysis was performed using the whole pattern fitting function of Diffrac Plus Topas R, a proprietary Bruker AXS software (v. 2.0, 2000) that is based on the Rietveld method (Rietveld 1969). The reference database for quantitative analysis of crystal structures is the Inorganic Crystal Structure Database (NIST ICSD, 2010, v.2). Images of the diffractograms are shown in Figures14-25 below.

Clay Speciation

Aliquots for clay speciation were split on the rotary riffle splitter. These aliquots were wet screened using a 500-mesh sieve (25µ) to remove most of the silt and sand fractions. The clay fines were then added to a tall beaker in deionized water and treated with an ultrasonic probe for 5 minutes. After the material settled the clay minerals formed the top layer (Stokes Law). The top layer of the clay column was removed to glass slides using a small pipette. The clay slides were allowed to dry. One dried slide was scanned to produce the oriented pattern.

This slide was then heated at 350°C, scanned, and then heated at 550°C, and scanned again to produce patterns of the heated clay fraction. A second slide was placed in a covered dish over glycol and heated for 4 hours at 250°C and scanned to produce a glycolated pattern.

The four patterns were overlayed. (See Figures 1-12). The patterns show a consistent high amount of the swelling clay montmorillonite (bentonite). This mineral expands after glycolation (blue pattern) and collapses after heating (red patterns). There was also a high amount of mica (possibly dioctahedral illite) present in all samples. Trace to minor amounts of kaolinite and a few occurrences of kaolinite-smectite were identified. The table of clay speciation results also shows the amount of amorphous material detected. This data represents the swelling clay and possibly some amorphous illite.

<u>QA/QC</u>

Samples were logged, identified, prepared, and analyzed according to PMET's Standard Operating Procedures. All sample preparation work and standard measurements are recorded in a lab notebook. SEM and XRD data are captured and recorded as digital data and backed using a daily cloud backup.

PMET is certified for XRD analysis by the State of Nevada DCNR Division of Environmental Protection, having met the requirement of NV Code NAC 445A. PMET's Certificate Number PA0500120209-1 expires July 31, 2021. Calibration curves for goniometer and detector resolution are shown in Figure 13.

<u>Discussion</u>

Due to the high amount of amorphous clay, there is an error range in the quantification for the trace to minor phases. The Rietveld refinement distinguishes background counts from peak counts using a least-squares fitting algorithm. This tends to attribute some background counts to the smallest peaks. To reduce this effect, a minimum crystallite size of peaks of trace phases was fixed in the refinement algorithm. These phases are reported as "<1.0%."

The clay speciation indicates trace amounts of kaolinite in all the samples, but the QXRD data shows that the kaolinite could not be detected or quantified in several samples. Most kaolinite results are reported as "<1.0%." The estimated error range for these trace phases is +/-10%.

Ms. Tyson-Bloyd, please email or call me if you would like to discuss these results. Thank you for using PMET's laboratory services on this project.

Sincerely,

Randolph W. Shannon
Laboratory Manager

RFA 7138

Table 1
Sample Identification, As-received Weight,
Post low-temp dried & Acetone wash Weights, Analytical Aliquot Weights

PMET I.D.	Broadbent Description	Date	as-received wt. (g)	dried & acetone wash (g)	QXRD split (g)	clay speciation split (g)
7138-1	TP1E-TSP01-12	1-18-21	750.92	700	58	145
7138-2	TP1E-TSP01-60	1-18-21	794.21	754	62	125
7138-3	TP1C-TSP02-12	1-18-21	781.25	612	51	64
7138-4	TP1C-TSP02-48	1-18-21	789.79	675	56	58
7138-5	TP1WN-TSP03-96	1-18-21	805.44	597	50	62
7138-6	TP1WN-TSP03-12	1-18-21	844.97	621	52	65
7138-7	TP02-TSP04-48	1-18-21	936.80	864	53	72
7138-8	TP02-TSO04-96	1-18-21	894.59	655	54	68
7138-9	TP3W-TSP07-48	1-18-21	749.12	582	49	62
7138-10	TP3W-TSP07-96	1-18-21	828.57	539	46	67
7138-11	TP03-TSP08-48	1-19-21	969.08	825	65	69
7138-12	TP03-TSP08-96	1-19-21	899.65	742	62	62

Table 2a
QXRD Results
Wt.%

Mineral Phase	Nominal Atomic Formula	TP1E-TSP01-12	TP1E-TSP01-60	TP1C-TSP02-12	TP1C-TSP02-48
quartz	SiO_2	11.5	11.2	16.1	14.3
K-feldspar	$KAlSi_3O_8$	6.7	5.0	5.7	5.5
plagioclase	$(Na,Ca)(Si,Al)_4O_8$	13.7	17.3	26.3	21.0
mica	$KAl_2(Si_3Al)O_{10}(OH)_2$	19.6	19.8	16.6	14.5
hornblende	$NaCa_2(Mg,Fe)_4Al_3Si_6O_{22}(OH)_2$	<1.0	<1.0	<1.0	<1.0
clinoptilolite	$(Na,K,Ca)_{2.5}Al_3(Al,Si)_2Si_{13}O36\text{-}12H_2O$	6.5	5.9	10.8	10.5
kaolinite	$Al_2Si_2O_5(OH)_4$	<1.0	<1.0	<1.0	<1.0
magnesite	$MgCO_3$	<1.0	<1.0	<1.0	<1.0
calcite	$CaCO_3$	1.1	1.2	<1.0	2.0
aragonite	$CaCO_3$	1.2	1.7	2.1	1.0
dolomite	$CaMg(CO_3)_2$	<1.0	<1.0	<1.0	1.3
kutnahorite	$CaMn(CO_3)_2$	<1.0	<1.0	<1.0	<1.0
rhodochrosite	$MnCO_3$	<1.0	<1.0	<1.0	<1.0
manganosite	MnO_2	<1.0	<1.0	<1.0	<1.0
ramsdellite	MnO_2	<1.0	<1.0	<1.0	1.6
todorokite	Mn_6O_{12}	<1.0	<1.0	1.4	<1.0
celestine	$SrSO_4$	4.1	2.7	1.2	1.6
gypsum	$CaSO_4(H_2O)_2$	<1.0	<1.0	1.6	1.0
goethite	FeO(OH)	1.3	<1.0	<1.0	<1.0
amorphous	micro/non- crystalline	32.6	32.1	15.3	24.4

Table 2b
QXRD Results
Wt.%

Mineral Phase	Nominal Atomic Formula	TP1WN-TSP03-96	TP1WN-TSP03-12	TP02-TSP04-48	TP02-TSO04-96
quartz	SiO_2	17.6	17.3	13.4	13.2
K-feldspar	$KAlSi_3O_8$	7.2	4.7	9.8	6.7
plagioclase	$(Na,Ca)(Si,Al)_4O_8$	23.5	20.3	30.3	17.5
mica	$KAl_2(Si_3Al)O_{10}(OH)_2$	14.0	12.5	7.6	10.7
hornblende	$NaCa_2(Mg,Fe)_4Al_3Si_6O_{22}(OH)_2$	<1.0	2.1	<1.0	<1.0
clinoptilolite	$(Na,K,Ca)_{2.5}Al_3(Al,Si)_2Si_{13}O36\text{-}12H_2O$	9.3	11.2	7.1	5.7
kaolinite	$Al_2Si_2O_5(OH)_4$	<1.0	<1.0	1.3	1.7
magnesite	$MgCO_3$	<1.0	1.9	<1.0	<1.0
calcite	$CaCO_3$	<1.0	<1.0	1.9	1.3
aragonite	$CaCO_3$	1.9	1.2	1.8	1.7
dolomite	$CaMg(CO_3)_2$	1.2	<1.0	<1.0	1.1
kutnahorite	$CaMn(CO_3)_2$	<1.0	<1.0	<1.0	<1.0
rhodochrosite	$MnCO_3$	<1.0	<1.0	<1.0	<1.0
manganosite	MnO_2	<1.0	5.6	<1.0	<1.0
ramsdellite	MnO_2	1.4	1.3	1.2	0.9
todorokite	Mn_6O_{12}	1.7	1.0	<1.0	<1.0
celestine	$SrSO_4$	1.0	1.9	11.0	6.7
gypsum	$CaSO_4(H_2O)_2$	<1.0	<1.0	<1.0	<1.0
goethite	$FeO(OH)$	<1.0	1.1	1.0	<1.0
amorphous	micro/non- crystalline	19.1	16.5	11.0	31.2

Table 2c
QXRD Results
Wt.%

Mineral Phase	Nominal Atomic Formula	TP3W-TSP07-48	TP3W-TSP07-96	TP03-TSP08-48	TP03-TSP08-96
quartz	SiO_2	12.1	14.3	14.9	23.2
K-feldspar	$KAlSi_3O_8$	5.7	5.3	5.0	7.4
plagioclase	$(Na,Ca)(Si,Al)_4O_8$	11.1	10.7	10.7	18.3
mica	$KAl_2(Si_3Al)O_{10}(OH)_2$	21.2	23.9	18.2	14.7
hornblende	$NaCa_2(Mg,Fe)_4Al_3Si_6O_{22}(OH)_2$	<1.0	<1.0	<1.0	<1.0
clinoptilolite	$(Na,K,Ca)_{2.5}Al_3(Al,Si)_2Si_{13}O36\text{-}12H_2O$	6.2	6.4	5.1	5.2
kaolinite	$Al_2Si_2O_5(OH)_4$	2.7	3.5	1.2	<1.0
magnesite	$MgCO_3$	1.2	1.2	1.3	<1.0
calcite	$CaCO_3$	<1.0	<1.0	<1.0	<1.0
aragonite	$CaCO_3$	<1.0	<1.0	1.1	1.3
dolomite	$CaMg(CO_3)_2$	<1.0	1.3	<1.0	<1.0
kutnahorite	$CaMn(CO_3)_2$	<1.0	<1.0	<1.0	<1.0
rhodochrosite	$MnCO_3$	<1.0	1.0	<1.0	<1.0
manganosite	MnO_2	<1.0	<1.0	<1.0	<1.0
ramsdellite	MnO_2	<1.0	<1.0	<1.0	<1.0
todorokite	Mn_6O_{12}	<1.0	1.0	<1.0	<1.0
celestine	$SrSO_4$	2.4	<1.0	5.0	1.8
gypsum	$CaSO_4(H_2O)_2$	<1.0	<1.0	<1.0	<1.0
goethite	FeO(OH)	<1.0	1.3	<1.0	<1.0
amorphous	micro/non- crystalline	28.1	25.2	32.5	24.2

Table 3
Clay Speciation
Relative Amounts

Clay Mineral	TP1E-TSP01-12	TP1E-TSP01-60	TP1C-TSP02-12	TP1C-TSP02-48
montmorillonite	major	major	major	major
mica (illite)	major	major	major	major
kaolinite	trace	trace	trace	trace
kaolinite-smectite	n/d	n/d	n/d	Trace
amorphous %	32.6	32.1	15.3	24.4
Clay Mineral	**TP1WN-TSP03-96**	**TP1WN-TSP03-12**	**TP02-TSP04-48**	**TP02-TSO04-96**
montmorillonite	major	major	major	major
mica (illite)	major	major	major	major
kaolinite	trace	trace	minor	minor
kaolinite-smectite	n/d	trace	n/d	minor
amorphous %	19.1	16.5	11.0	31.2
Clay Mineral	**TP3W-TSP07-48**	**TP3W-TSP07-96**	**TP03-TSP08-48**	**TP03-TSP08-96**
montmorillonite	major	major	major	major
mica (illite)	major	major	major	major
kaolinite	trace	trace	trace	trace
kaolinite-smectite	trace	trace	n/d	n/d
amorphous %	28.1	25.2	32.5	24.2

Table 3
XRD Results of Midsize fraction
Approximate Wt.%

Mineral Phase	Nominal Atomic Formula	TP1C-TSP02-12	TP1C-TSP02-48	TP1WN-TSP03-12
quartz	SiO_2	29.8	26.4	31.6
K-feldspar	$KAlSi_3O_8$	9.5	10.2	7.7
plagioclase	$(Na,Ca)(Si,Al)_4O_8$	31.2	32.1	27.2
mica	$KAl_2(Si_3Al)O_{10}(OH)_2$	7.4	5.0	3.9
hornblende	$NaCa_2(Mg,Fe)_4Al_3Si_6O_{22}(OH)_2$	2.7	1.3	1.1
clinoptilolite	$(Na,K,Ca)_{2.5}Al_3(Al,Si)_2Si_{13}O36\text{-}12H_2O$	9.6	10.2	10.6
kaolinite	$Al_2Si_2O_5(OH)_4$		0.9	
magnesite	$MgCO_3$	1.0	0.7	3.4
calcite	$CaCO_3$		1.6	0.2
aragonite	$CaCO_3$	2.7	2.6	1.7
dolomite	$CaMg(CO_3)_2$	1.8	1.7	1.1
kutnahorite	$CaMn(CO_3)_2$	0.8	0.7	1.0
rhodochrosite	$MnCO_3$	0.5		
manganosite	MnO_2	0.3	0.3	5.8
ramsdellite	MnO_2	2.1	2.9	1.5
todorokite	Mn_6O_{12}	1.2	1.0	1.0
celestine	$SrSO_4$	1.4	1.5	1.6
gypsum	$CaSO_4(H_2O)_2$	0.5		
goethite	FeO(OH)	0.5	0.9	0.6
amorphous	micro/non- crystalline	n/a	n/a	n/a

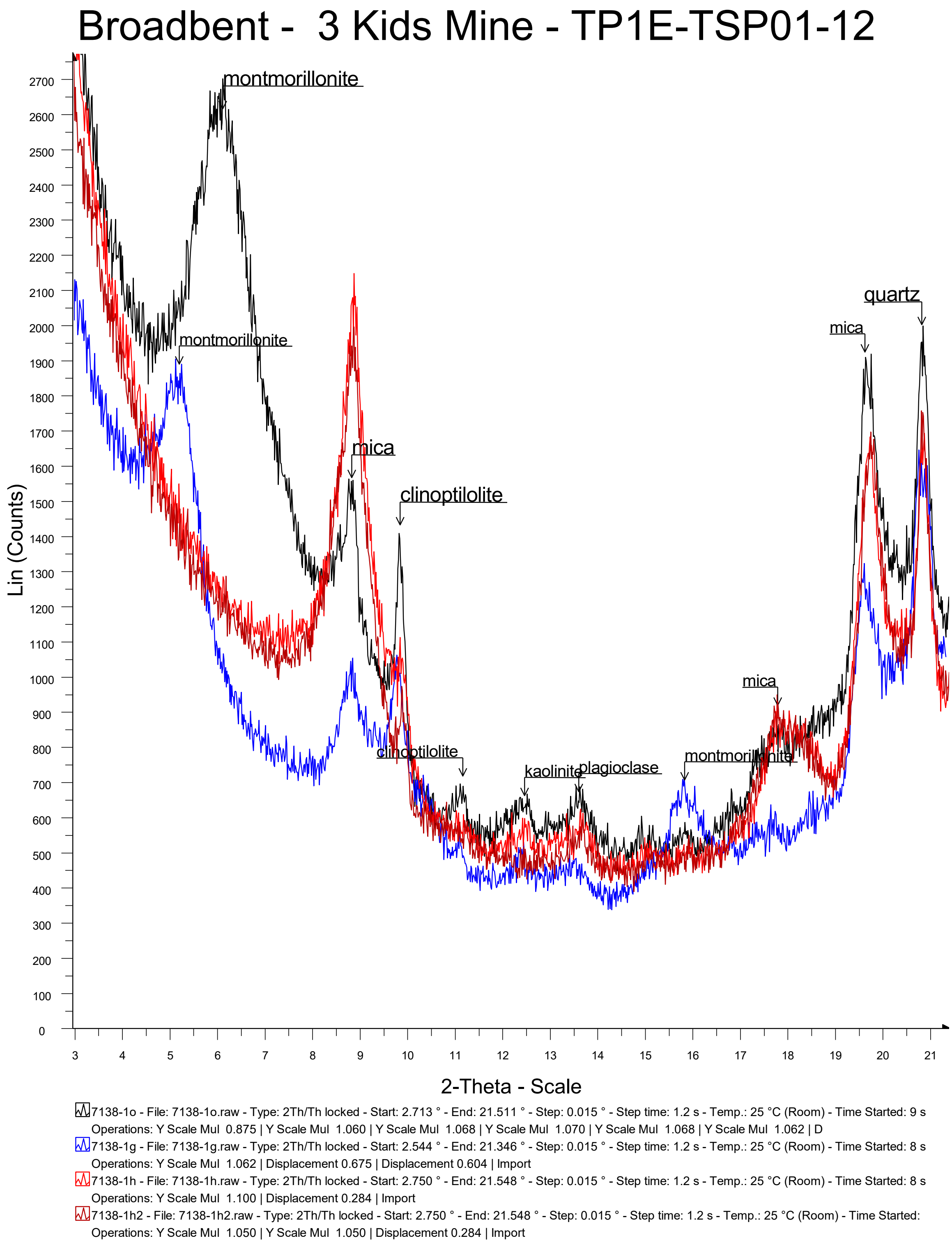

Broadbent - 3 Kids Mine - TP1E-TSP01-12
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
clinoptilolite
kaolinite
plagioclase
montmorillonite
mica
mica
quartz
7138-1o - File: 7138-1o.raw - Type: 2Th/Th locked - Start: 2.713 ° - End: 21.511 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 0.875 | Y Scale Mul 1.060 | Y Scale Mul 1.068 | Y Scale Mul 1.070 | Y Scale Mul 1.068 | Y Scale Mul 1.062 | D
7138-1g - File: 7138-1g.raw - Type: 2Th/Th locked - Start: 2.544 ° - End: 21.346 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 1.062 | Displacement 0.675 | Displacement 0.604 | Import
7138-1h - File: 7138-1h.raw - Type: 2Th/Th locked - Start: 2.750 ° - End: 21.548 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 1.100 | Displacement 0.284 | Import
7138-1h2 - File: 7138-1h2.raw - Type: 2Th/Th locked - Start: 2.750 ° - End: 21.548 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 1.050 | Y Scale Mul 1.050 | Displacement 0.284 | Import

Figure 1

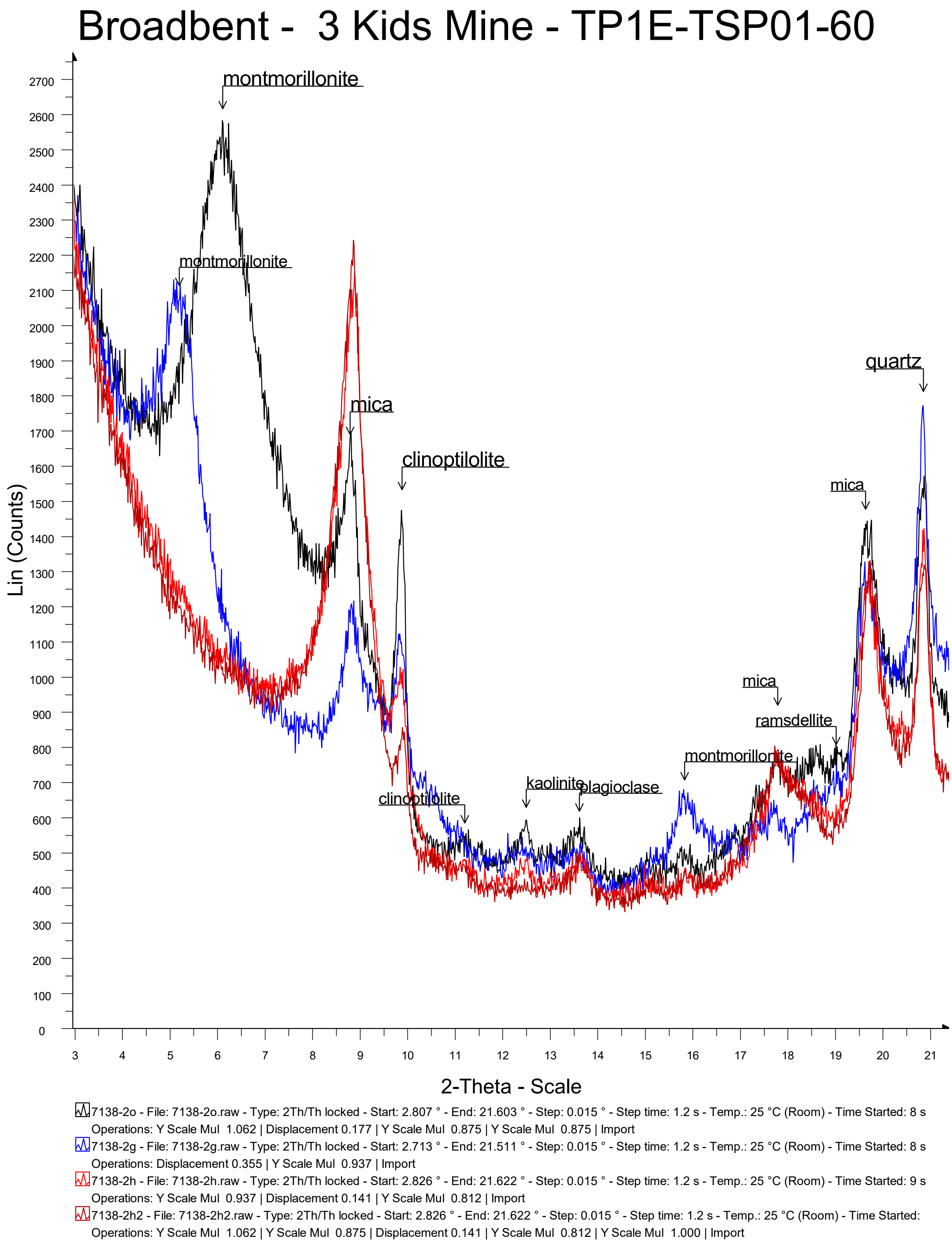
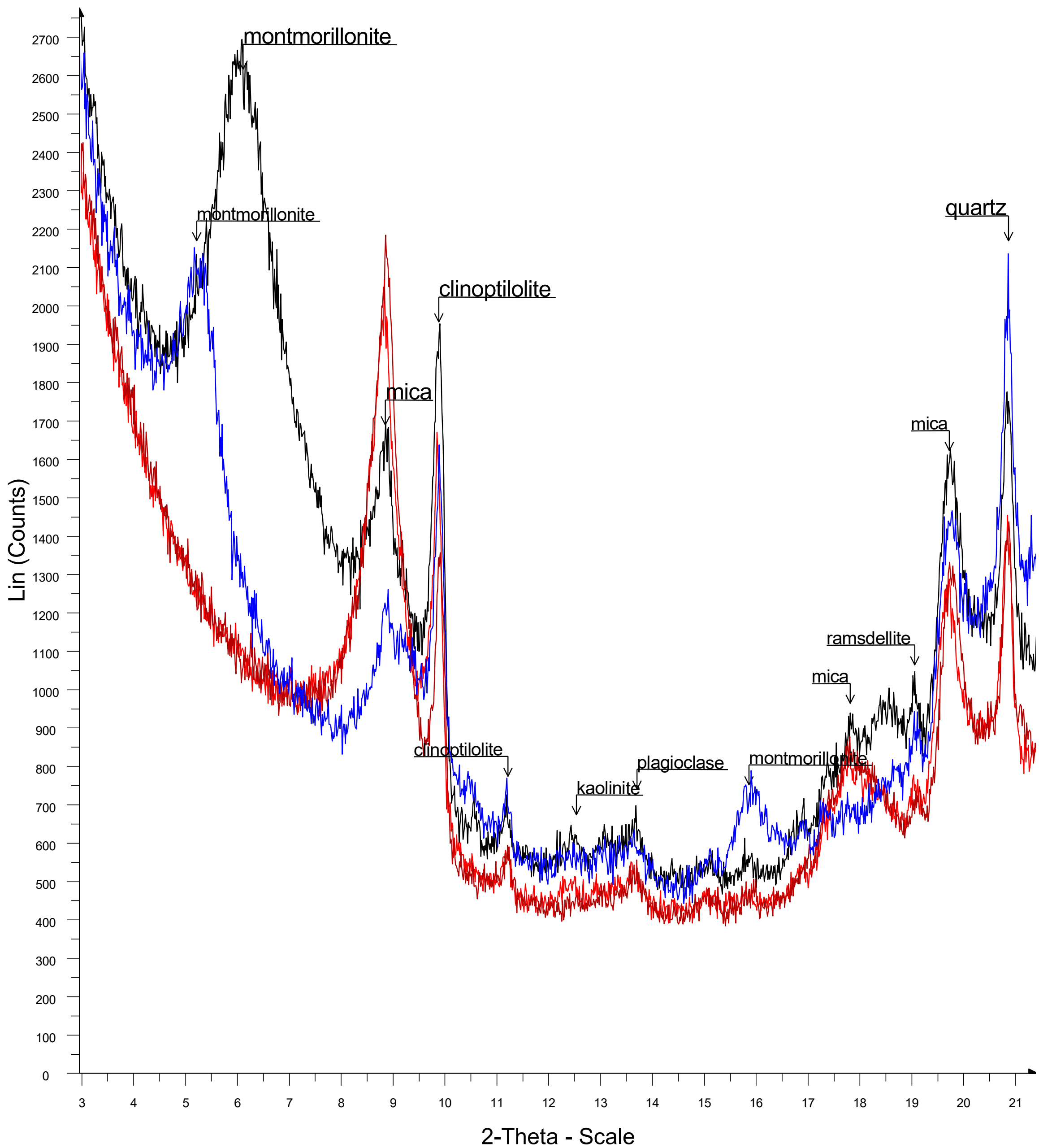

Broadbent - 3 Kids Mine - TP1E-TSP01-60
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
clinoptilolite
kaolinite
plagioclase
montmorillonite
mica
ramsdellite
mica
quartz
7138-2o - File: 7138-2o.raw - Type: 2Th/Th locked - Start: 2.807 ° - End: 21.603 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 1.062 | Displacement 0.177 | Y Scale Mul 0.875 | Y Scale Mul 0.875 | Import
7138-2g - File: 7138-2g.raw - Type: 2Th/Th locked - Start: 2.713 ° - End: 21.511 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Displacement 0.355 | Y Scale Mul 0.937 | Import
7138-2h - File: 7138-2h.raw - Type: 2Th/Th locked - Start: 2.826 ° - End: 21.622 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 0.937 | Displacement 0.141 | Y Scale Mul 0.812 | Import
7138-2h2 - File: 7138-2h2.raw - Type: 2Th/Th locked - Start: 2.826 ° - End: 21.622 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 1.062 | Y Scale Mul 0.875 | Displacement 0.141 | Y Scale Mul 0.812 | Y Scale Mul 1.000 | Import

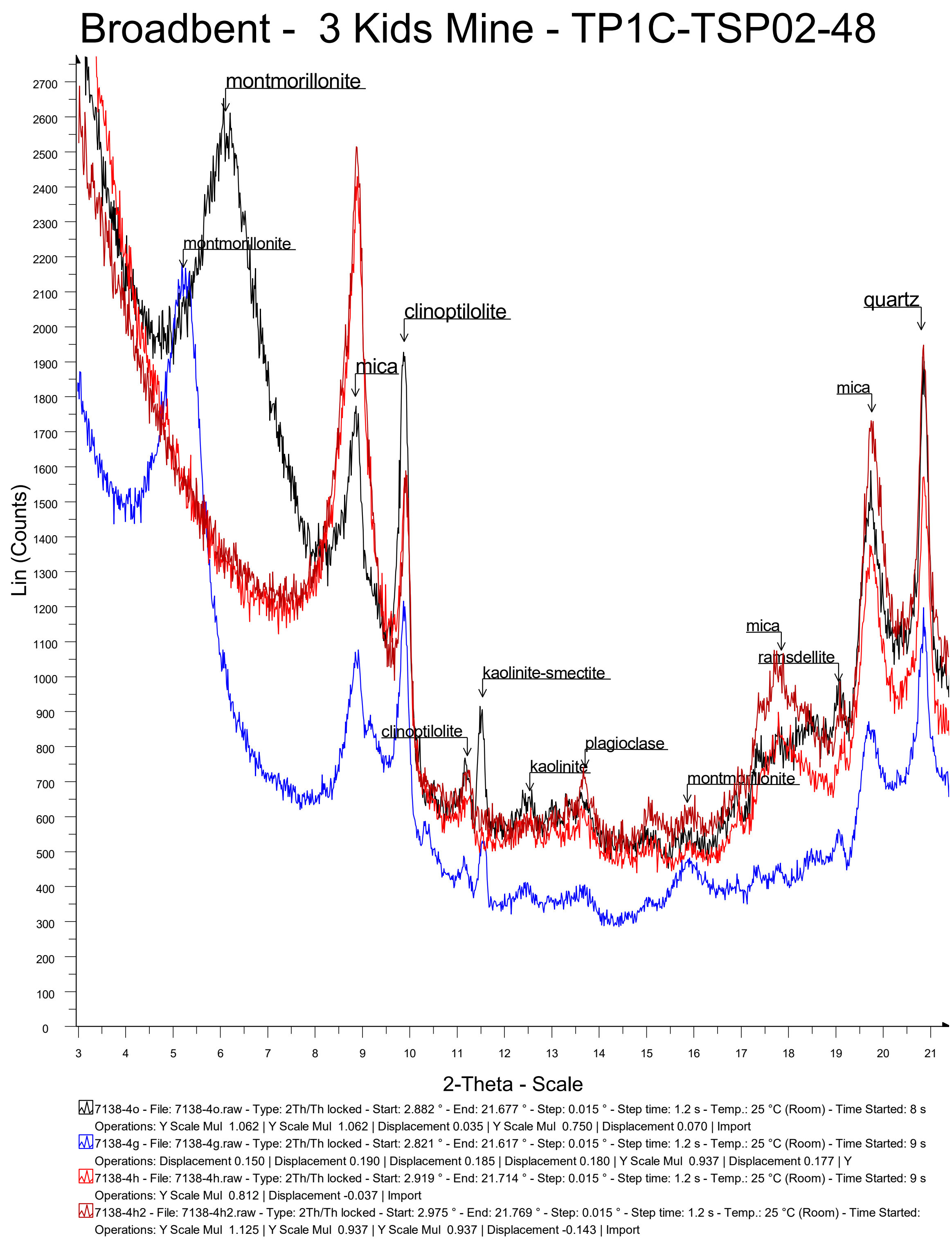
Figure 2

Broadbent - 3 Kids Mine - TP1C-TSP02-12



7138-3o - File: 7138-3o.raw - Type: 2Th/Th locked - Start: 2.900 ° - End: 21.695 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 1.062 | Y Scale Mul 1.120 | Displacement 0.000 | Y Scale Mul 0.917 | Y Scale Mul 0.812 | Import
7138-3g - File: 7138-3g.raw - Type: 2Th/Th locked - Start: 2.769 ° - End: 21.567 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 1.250 | Displacement 0.248 | Displacement 0.284 | Y Scale Mul 0.875 | Displacement 0.319 | Y Scale Mul 0.937 | D
7138-3h - File: 7138-3h.raw - Type: 2Th/Th locked - Start: 2.863 ° - End: 21.659 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Displacement 0.070 | Displacement -0.001 | Y Scale Mul 0.750 | Import
7138-3h2 - File: 7138-3h2.raw - Type: 2Th/Th locked - Start: 2.919 ° - End: 21.714 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Displacement -0.037 | Y Scale Mul 0.750 | Import

Figure 3



Broadbent - 3 Kids Mine - TP1C-TSP02-48
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
clinoptilolite
kaolinite-smectite
kaolinite
plagioclase
montmorillonite
mica
ramsdellite
mica
quartz
7138-4o - File: 7138-4o.raw - Type: 2Th/Th locked - Start: 2.882 ° - End: 21.677 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 1.062 | Y Scale Mul 1.062 | Displacement 0.035 | Y Scale Mul 0.750 | Displacement 0.070 | Import
7138-4g - File: 7138-4g.raw - Type: 2Th/Th locked - Start: 2.821 ° - End: 21.617 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Displacement 0.150 | Displacement 0.190 | Displacement 0.185 | Displacement 0.180 | Y Scale Mul 0.937 | Displacement 0.177 | Y
7138-4h - File: 7138-4h.raw - Type: 2Th/Th locked - Start: 2.919 ° - End: 21.714 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 0.812 | Displacement -0.037 | Import
7138-4h2 - File: 7138-4h2.raw - Type: 2Th/Th locked - Start: 2.975 ° - End: 21.769 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 1.125 | Y Scale Mul 0.937 | Y Scale Mul 0.937 | Displacement -0.143 | Import

Figure 4

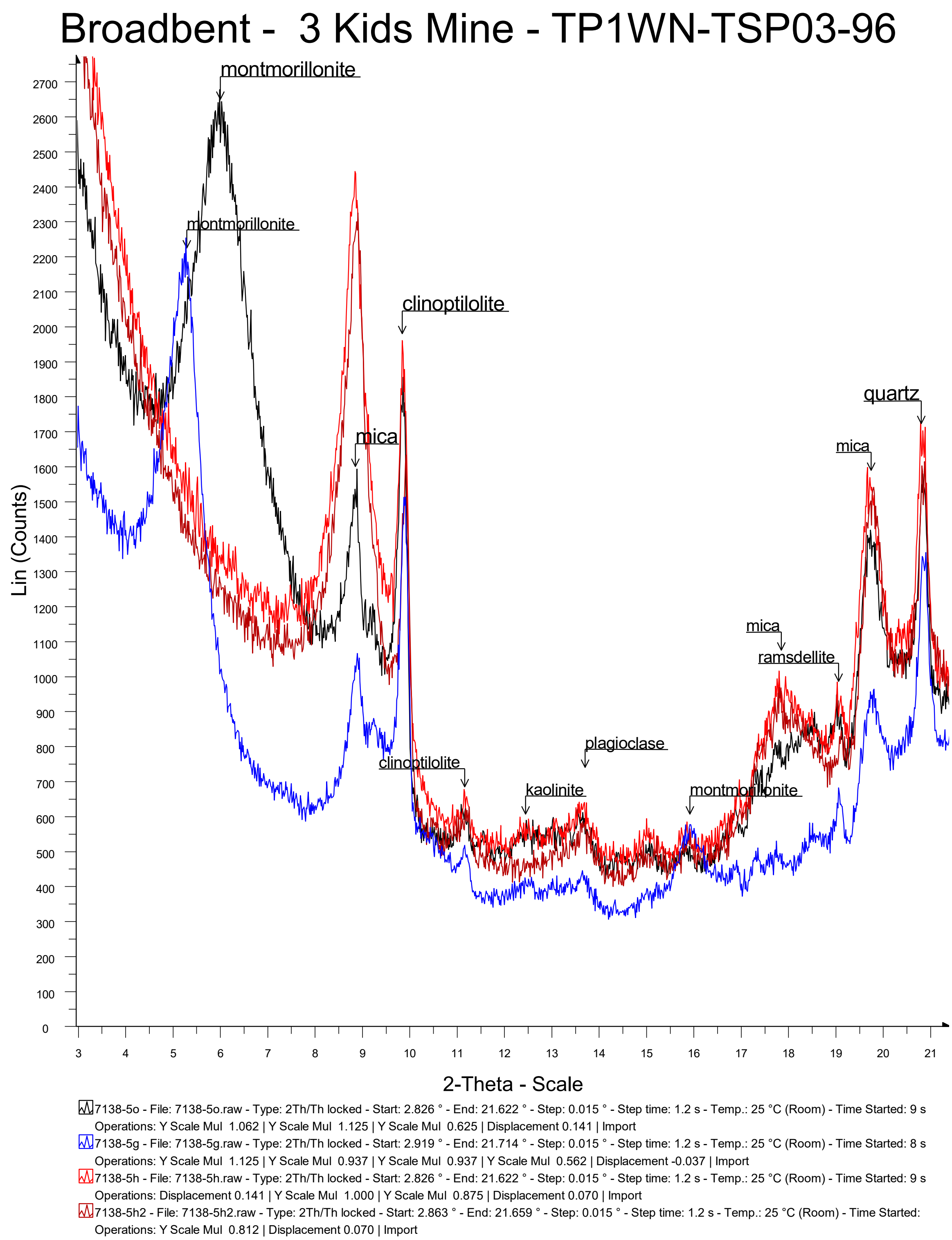

Broadbent - 3 Kids Mine - TP1WN-TSP03-96
montmorillonite
montmorillonite
clinoptilolite
mica
quartz
mica
mica
ramsdellite
plagioclase
clinoptilolite
kaolinite
montmorillonite
Lin (Counts)
2-Theta - Scale
7138-5o - File: 7138-5o.raw - Type: 2Th/Th locked - Start: 2.826 ° - End: 21.622 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 1.062 | Y Scale Mul 1.125 | Y Scale Mul 0.625 | Displacement 0.141 | Import
7138-5g - File: 7138-5g.raw - Type: 2Th/Th locked - Start: 2.919 ° - End: 21.714 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 1.125 | Y Scale Mul 0.937 | Y Scale Mul 0.937 | Y Scale Mul 0.562 | Displacement -0.037 | Import
7138-5h - File: 7138-5h.raw - Type: 2Th/Th locked - Start: 2.826 ° - End: 21.622 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Displacement 0.141 | Y Scale Mul 1.000 | Y Scale Mul 0.875 | Displacement 0.070 | Import
7138-5h2 - File: 7138-5h2.raw - Type: 2Th/Th locked - Start: 2.863 ° - End: 21.659 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.812 | Displacement 0.070 | Import

Figure 5

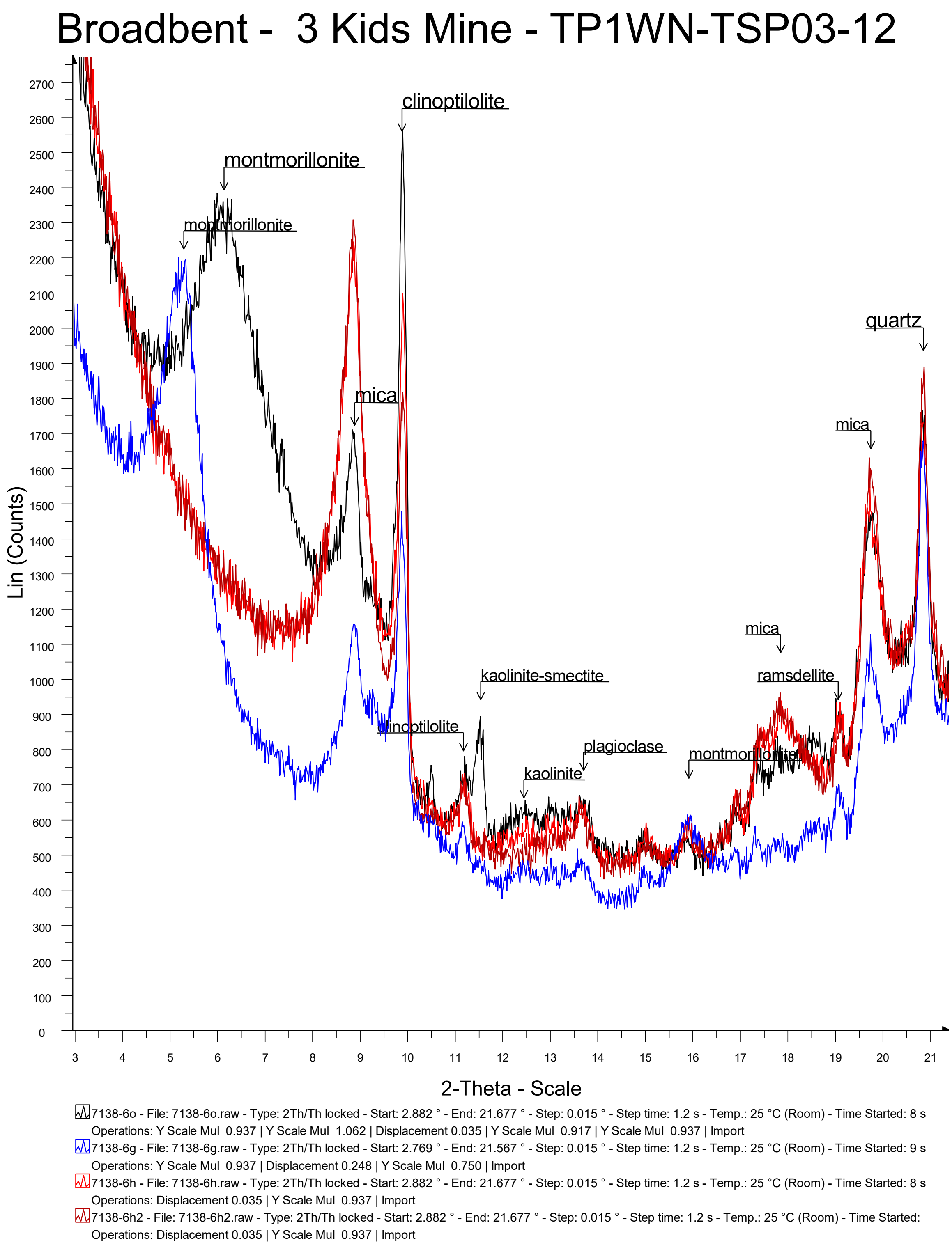

Broadbent - 3 Kids Mine - TP1WN-TSP03-12
clinoptilolite
montmorillonite
montmorillonite
mica
quartz
mica
mica
ramsdellite
kaolinite-smectite
clinoptilolite
plagioclase
kaolinite
montmorillonite
Lin (Counts)
2-Theta - Scale
7138-6o - File: 7138-6o.raw - Type: 2Th/Th locked - Start: 2.882 ° - End: 21.677 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 0.937 | Y Scale Mul 1.062 | Displacement 0.035 | Y Scale Mul 0.917 | Y Scale Mul 0.937 | Import
7138-6g - File: 7138-6g.raw - Type: 2Th/Th locked - Start: 2.769 ° - End: 21.567 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 0.937 | Displacement 0.248 | Y Scale Mul 0.750 | Import
7138-6h - File: 7138-6h.raw - Type: 2Th/Th locked - Start: 2.882 ° - End: 21.677 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Displacement 0.035 | Y Scale Mul 0.937 | Import
7138-6h2 - File: 7138-6h2.raw - Type: 2Th/Th locked - Start: 2.882 ° - End: 21.677 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Displacement 0.035 | Y Scale Mul 0.937 | Import

Figure 6

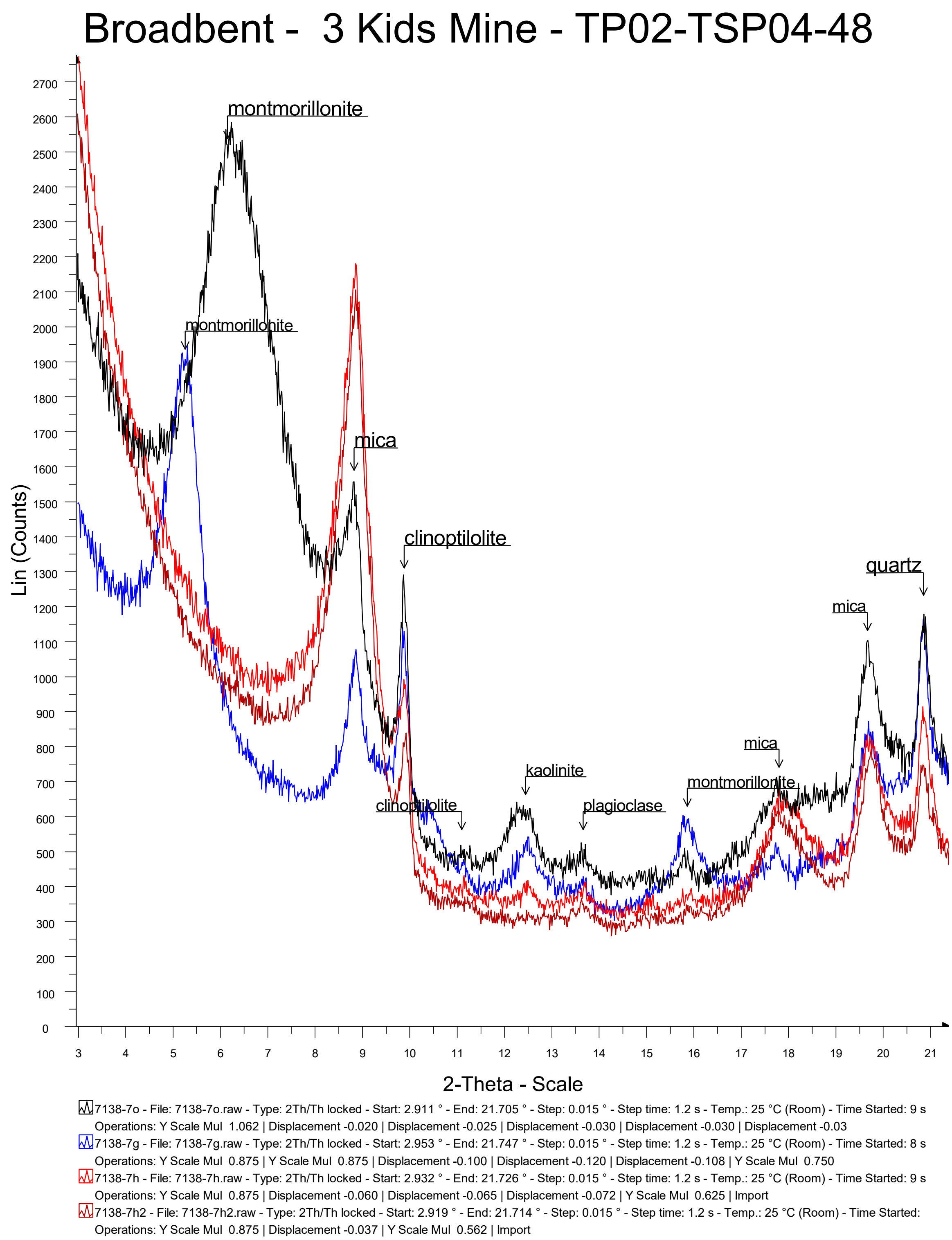

Broadbent - 3 Kids Mine - TP02-TSP04-48
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
quartz
mica
mica
kaolinite
montmorillonite
plagioclase
clinoptilolite
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
7138-7o - File: 7138-7o.raw - Type: 2Th/Th locked - Start: 2.911 ° - End: 21.705 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 1.062 | Displacement -0.020 | Displacement -0.025 | Displacement -0.030 | Displacement -0.030 | Displacement -0.03
7138-7g - File: 7138-7g.raw - Type: 2Th/Th locked - Start: 2.953 ° - End: 21.747 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 0.875 | Y Scale Mul 0.875 | Displacement -0.100 | Displacement -0.120 | Displacement -0.108 | Y Scale Mul 0.750
7138-7h - File: 7138-7h.raw - Type: 2Th/Th locked - Start: 2.932 ° - End: 21.726 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 0.875 | Displacement -0.060 | Displacement -0.065 | Displacement -0.072 | Y Scale Mul 0.625 | Import
7138-7h2 - File: 7138-7h2.raw - Type: 2Th/Th locked - Start: 2.919 ° - End: 21.714 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.875 | Displacement -0.037 | Y Scale Mul 0.562 | Import

Figure 7

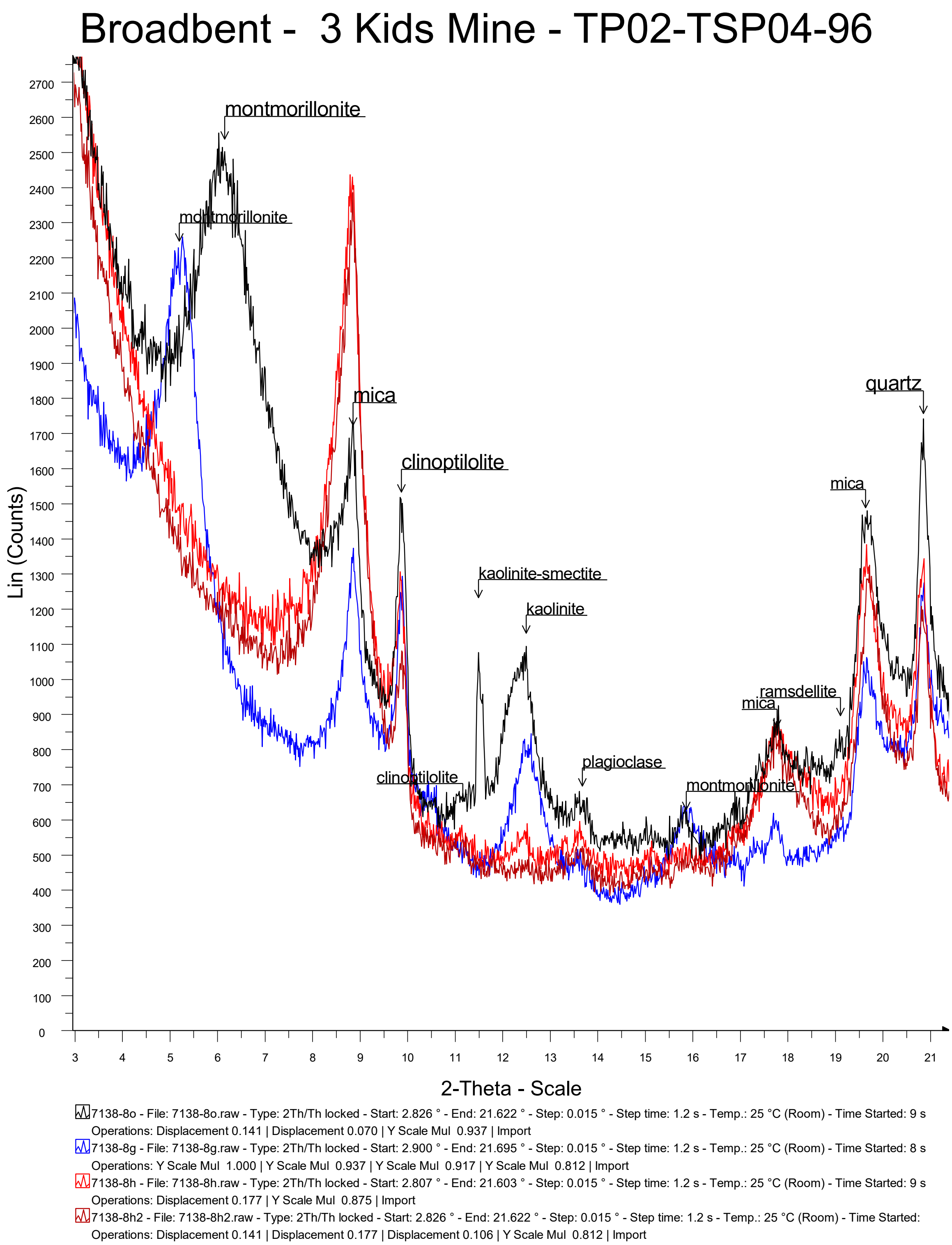

Broadbent - 3 Kids Mine - TP02-TSP04-96
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
kaolinite-smectite
kaolinite
clinoptilolite
plagioclase
montmorillonite
mica
ramsdellite
mica
quartz
7138-8o - File: 7138-8o.raw - Type: 2Th/Th locked - Start: 2.826 ° - End: 21.622 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Displacement 0.141 | Displacement 0.070 | Y Scale Mul 0.937 | Import
7138-8g - File: 7138-8g.raw - Type: 2Th/Th locked - Start: 2.900 ° - End: 21.695 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 1.000 | Y Scale Mul 0.937 | Y Scale Mul 0.917 | Y Scale Mul 0.812 | Import
7138-8h - File: 7138-8h.raw - Type: 2Th/Th locked - Start: 2.807 ° - End: 21.603 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Displacement 0.177 | Y Scale Mul 0.875 | Import
7138-8h2 - File: 7138-8h2.raw - Type: 2Th/Th locked - Start: 2.826 ° - End: 21.622 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Displacement 0.141 | Displacement 0.177 | Displacement 0.106 | Y Scale Mul 0.812 | Import

Figure 8

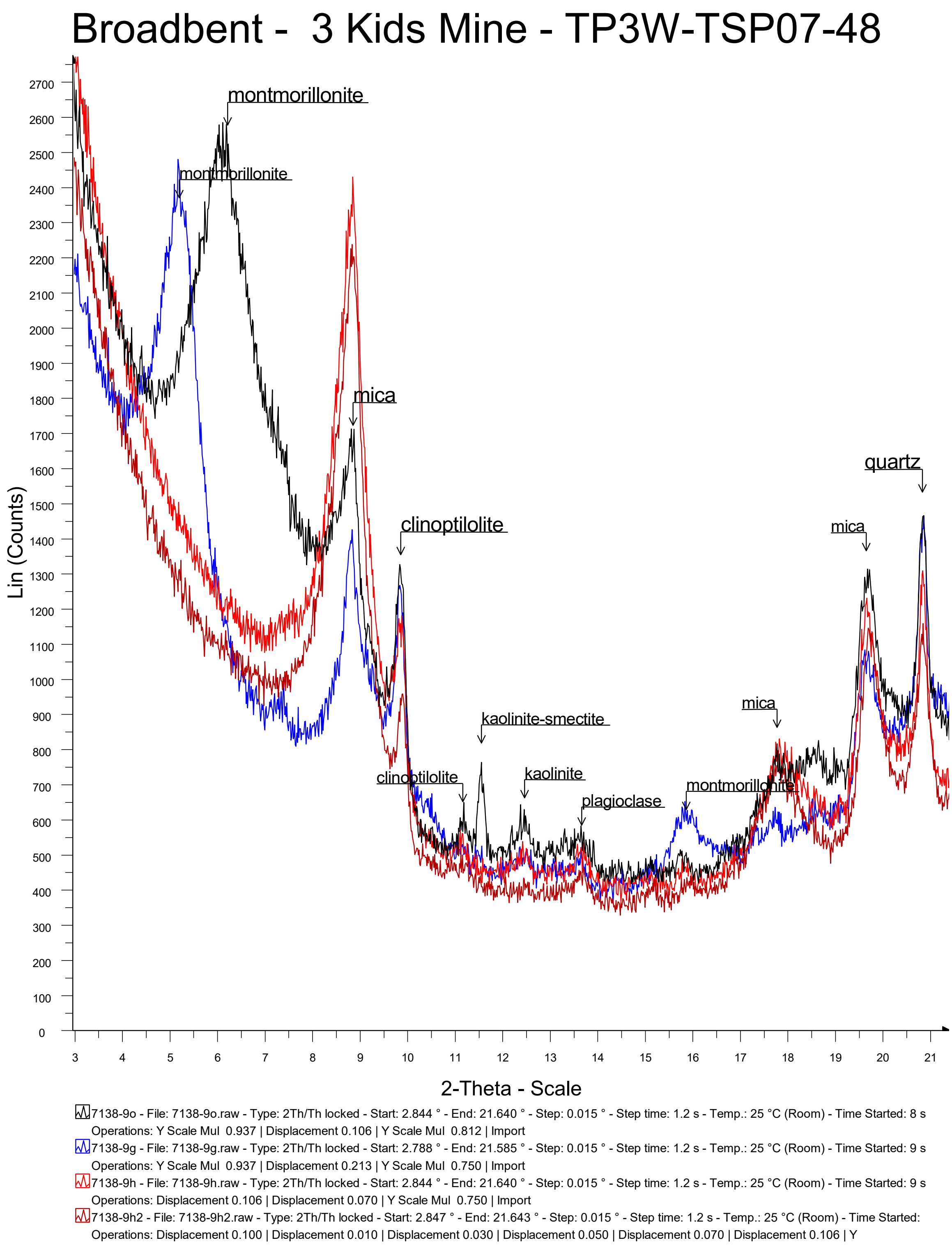

Broadbent - 3 Kids Mine - TP3W-TSP07-48
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
quartz
mica
mica
kaolinite-smectite
kaolinite
clinoptilolite
plagioclase
montmorillonite
7138-9o - File: 7138-9o.raw - Type: 2Th/Th locked - Start: 2.844 ° - End: 21.640 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 8 s
Operations: Y Scale Mul 0.937 | Displacement 0.106 | Y Scale Mul 0.812 | Import
7138-9g - File: 7138-9g.raw - Type: 2Th/Th locked - Start: 2.788 ° - End: 21.585 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Y Scale Mul 0.937 | Displacement 0.213 | Y Scale Mul 0.750 | Import
7138-9h - File: 7138-9h.raw - Type: 2Th/Th locked - Start: 2.844 ° - End: 21.640 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started: 9 s
Operations: Displacement 0.106 | Displacement 0.070 | Y Scale Mul 0.750 | Import
7138-9h2 - File: 7138-9h2.raw - Type: 2Th/Th locked - Start: 2.847 ° - End: 21.643 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Displacement 0.100 | Displacement 0.010 | Displacement 0.030 | Displacement 0.050 | Displacement 0.070 | Displacement 0.106 | Y

Figure 9

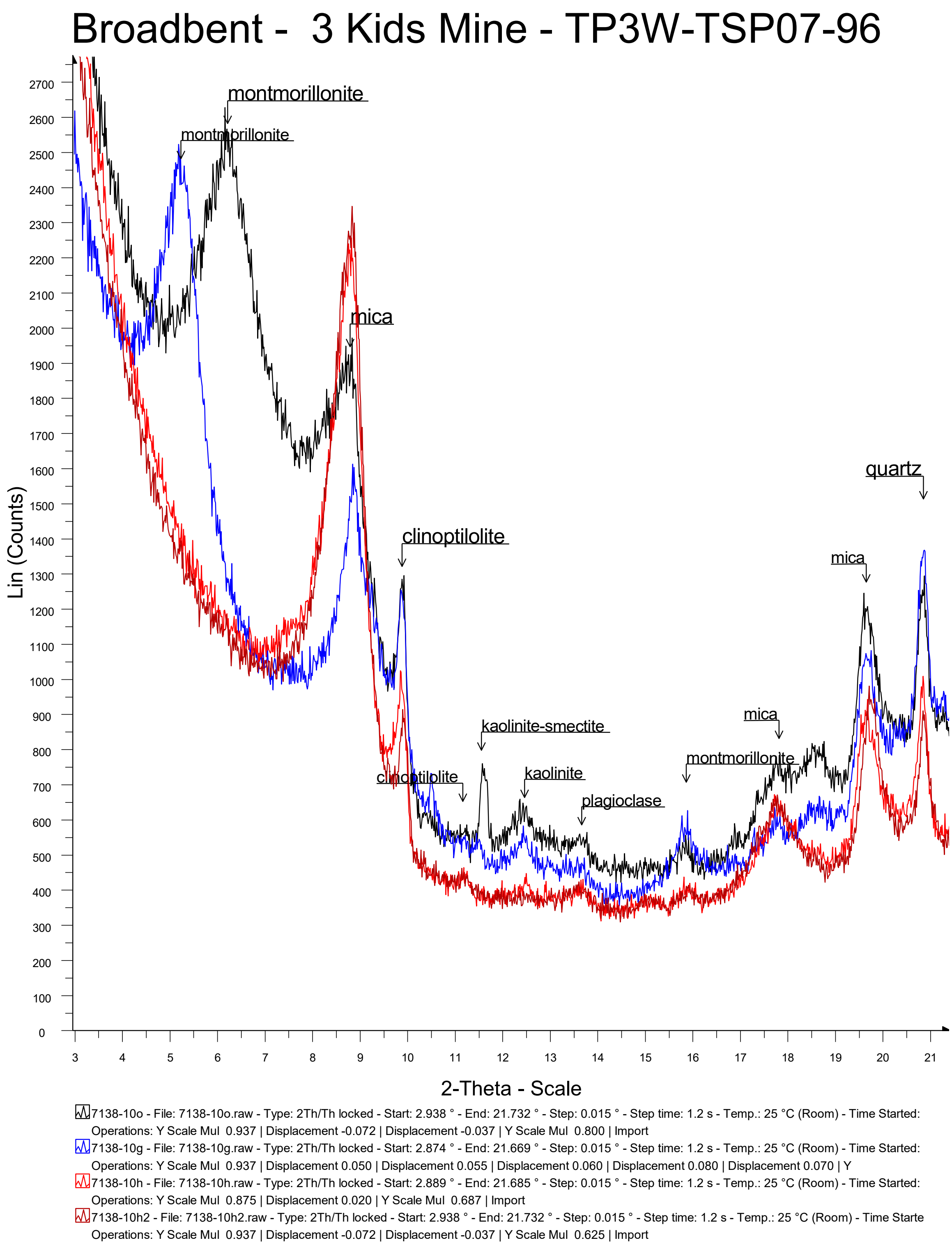

Broadbent - 3 Kids Mine - TP3W-TSP07-96
montmorillonite
montmorillonite
mica
clinoptilolite
quartz
mica
mica
kaolinite-smectite
montmorillonite
clinoptilolite
kaolinite
plagioclase
Lin (Counts)
2700
2600
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
2-Theta - Scale
7138-10o - File: 7138-10o.raw - Type: 2Th/Th locked - Start: 2.938 ° - End: 21.732 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.937 | Displacement -0.072 | Displacement -0.037 | Y Scale Mul 0.800 | Import
7138-10g - File: 7138-10g.raw - Type: 2Th/Th locked - Start: 2.874 ° - End: 21.669 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.937 | Displacement 0.050 | Displacement 0.055 | Displacement 0.060 | Displacement 0.080 | Displacement 0.070 | Y
7138-10h - File: 7138-10h.raw - Type: 2Th/Th locked - Start: 2.889 ° - End: 21.685 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.875 | Displacement 0.020 | Y Scale Mul 0.687 | Import
7138-10h2 - File: 7138-10h2.raw - Type: 2Th/Th locked - Start: 2.938 ° - End: 21.732 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Starte
Operations: Y Scale Mul 0.937 | Displacement -0.072 | Displacement -0.037 | Y Scale Mul 0.625 | Import

Figure 10

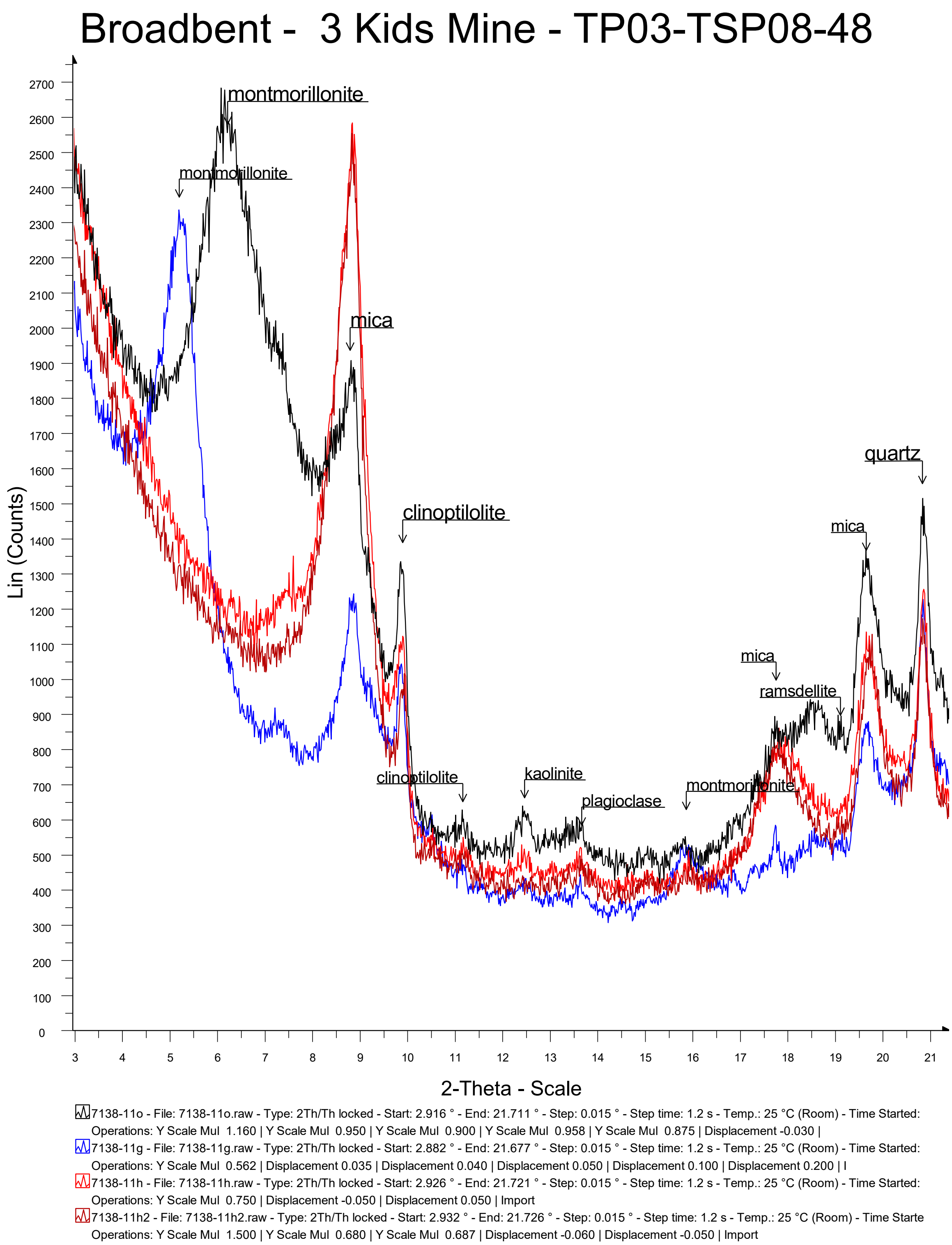

Broadbent - 3 Kids Mine - TP03-TSP08-48
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
clinoptilolite
kaolinite
plagioclase
montmorillonite
mica
ramsdellite
mica
quartz
7138-11o - File: 7138-11o.raw - Type: 2Th/Th locked - Start: 2.916 ° - End: 21.711 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 1.160 | Y Scale Mul 0.950 | Y Scale Mul 0.900 | Y Scale Mul 0.958 | Y Scale Mul 0.875 | Displacement -0.030 |
7138-11g - File: 7138-11g.raw - Type: 2Th/Th locked - Start: 2.882 ° - End: 21.677 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.562 | Displacement 0.035 | Displacement 0.040 | Displacement 0.050 | Displacement 0.100 | Displacement 0.200 | I
7138-11h - File: 7138-11h.raw - Type: 2Th/Th locked - Start: 2.926 ° - End: 21.721 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.750 | Displacement -0.050 | Displacement 0.050 | Import
7138-11h2 - File: 7138-11h2.raw - Type: 2Th/Th locked - Start: 2.932 ° - End: 21.726 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Starte
Operations: Y Scale Mul 1.500 | Y Scale Mul 0.680 | Y Scale Mul 0.687 | Displacement -0.060 | Displacement -0.050 | Import

Figure 11

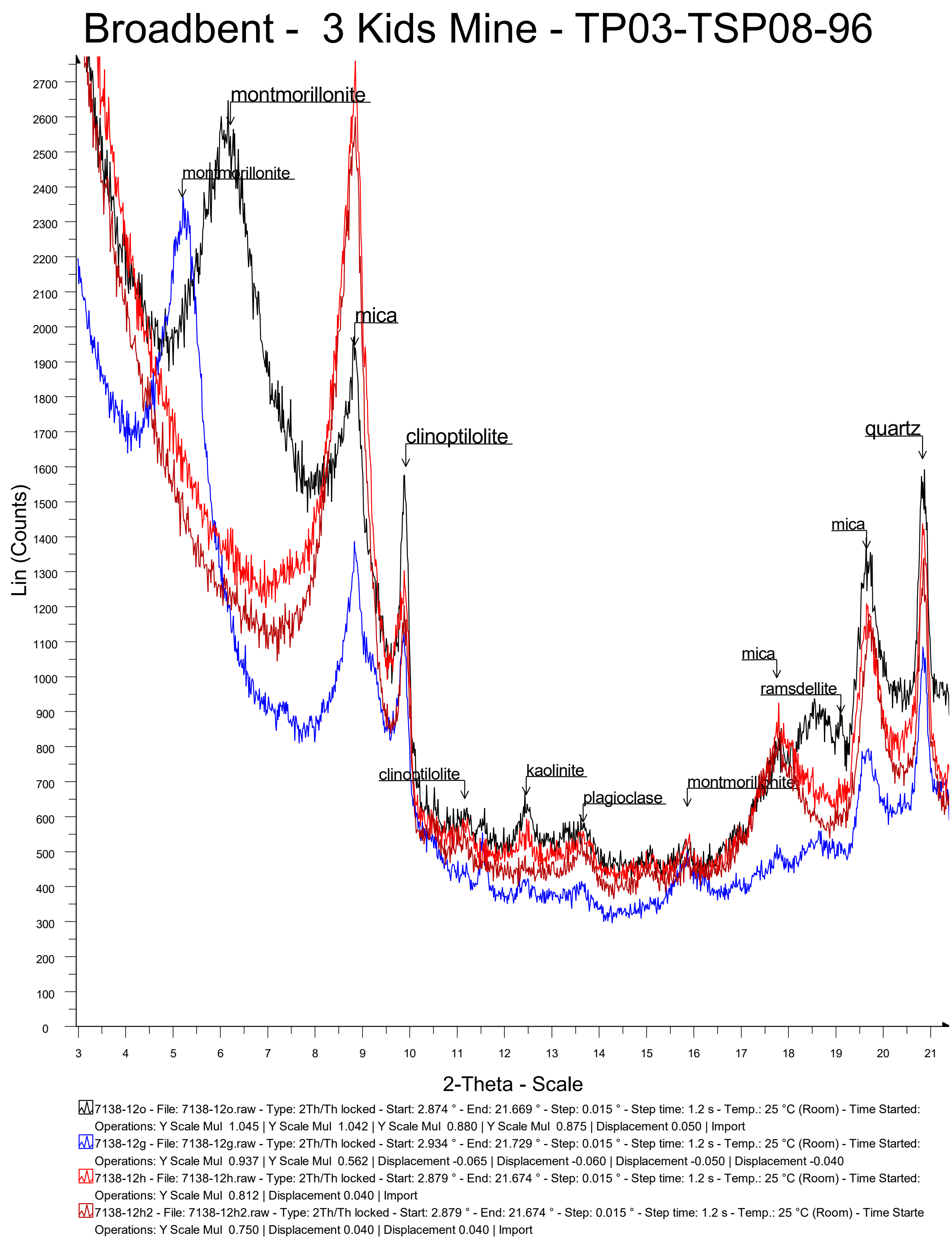
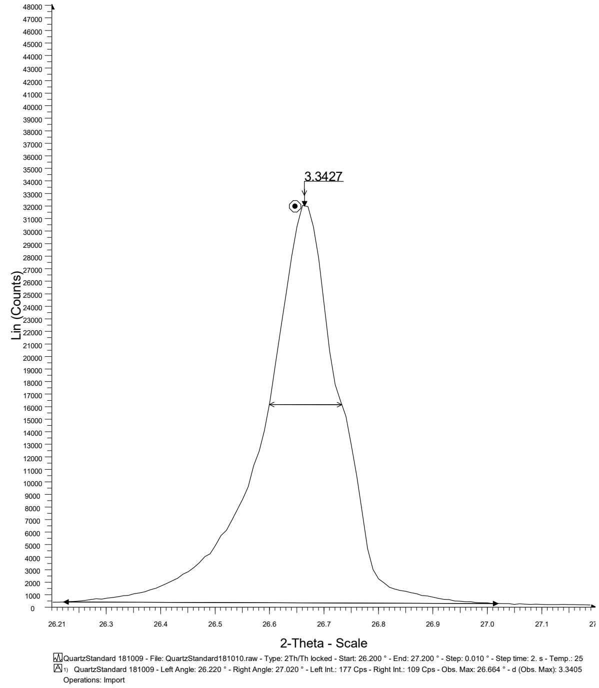

Broadbent - 3 Kids Mine - TP03-TSP08-96
Lin (Counts)
2-Theta - Scale
montmorillonite
montmorillonite
mica
clinoptilolite
quartz
mica
mica
ramsdellite
clinoptilolite
kaolinite
plagioclase
montmorillonite
7138-12o - File: 7138-12o.raw - Type: 2Th/Th locked - Start: 2.874 ° - End: 21.669 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 1.045 | Y Scale Mul 1.042 | Y Scale Mul 0.880 | Y Scale Mul 0.875 | Displacement 0.050 | Import
7138-12g - File: 7138-12g.raw - Type: 2Th/Th locked - Start: 2.934 ° - End: 21.729 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.937 | Y Scale Mul 0.562 | Displacement -0.065 | Displacement -0.060 | Displacement -0.050 | Displacement -0.040
7138-12h - File: 7138-12h.raw - Type: 2Th/Th locked - Start: 2.879 ° - End: 21.674 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Started:
Operations: Y Scale Mul 0.812 | Displacement 0.040 | Import
7138-12h2 - File: 7138-12h2.raw - Type: 2Th/Th locked - Start: 2.879 ° - End: 21.674 ° - Step: 0.015 ° - Step time: 1.2 s - Temp.: 25 °C (Room) - Time Starte
Operations: Y Scale Mul 0.750 | Displacement 0.040 | Displacement 0.040 | Import

Figure 12

10/10/2018 Calibration Error = 0.009%



10/10/2018 Resolution FOM = 2.27

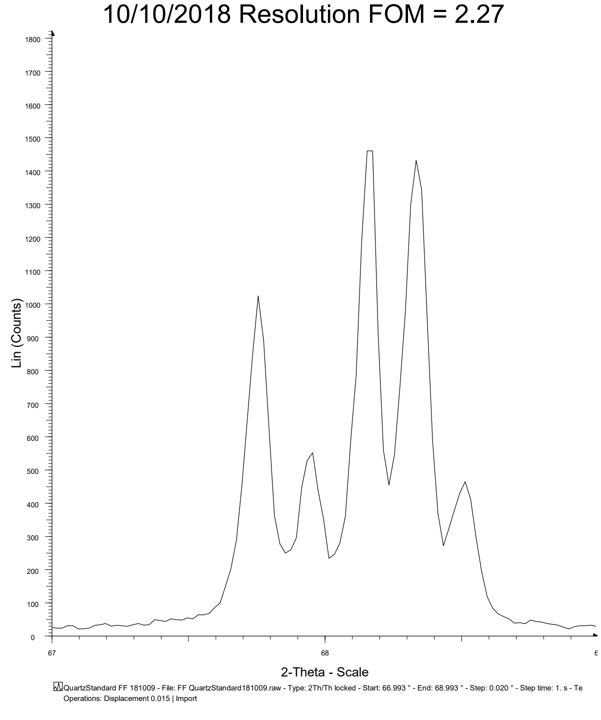


Figure 13
XRD Calibration Curves
FOM minimum = 2.0

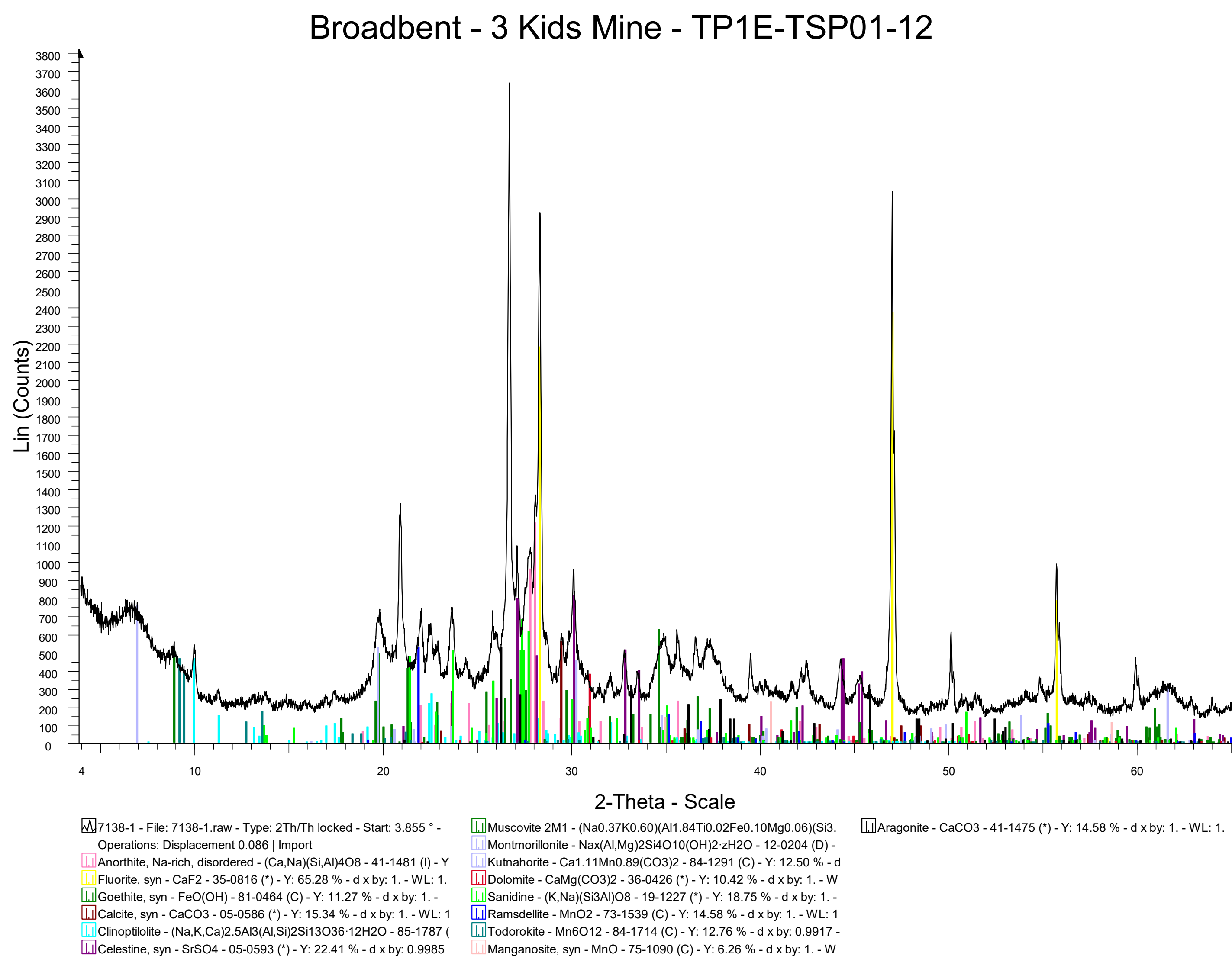

Broadbent - 3 Kids Mine - TP1E-TSP01-12
Lin (Counts)
2-Theta - Scale
7138-1 - File: 7138-1.raw - Type: 2Th/Th locked - Start: 3.855 ° - Operations: Displacement 0.086 | Import
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 65.28 % - d x by: 1. - WL: 1.
Goethite, syn - FeO(OH) - 81-0464 (C) - Y: 11.27 % - d x by: 1. -
Calcite, syn - CaCO3 - 05-0586 (*) - Y: 15.34 % - d x by: 1. - WL: 1
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 22.41 % - d x by: 0.9985
Muscovite 2M1 - (Na0.37K0.60)(Al1.84Ti0.02Fe0.10Mg0.06)(Si3.
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) -
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 12.50 % - d
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 10.42 % - d x by: 1. - W
Sanidine - (K,Na)(Si3Al)O8 - 19-1227 (*) - Y: 18.75 % - d x by: 1. -
Ramsdellite - MnO2 - 73-1539 (C) - Y: 14.58 % - d x by: 1. - WL: 1
Todorokite - Mn6O12 - 84-1714 (C) - Y: 12.76 % - d x by: 0.9917 -
Manganosite, syn - MnO - 75-1090 (C) - Y: 6.26 % - d x by: 1. - W
Aragonite - CaCO3 - 41-1475 (*) - Y: 14.58 % - d x by: 1. - WL: 1.

Figure 14

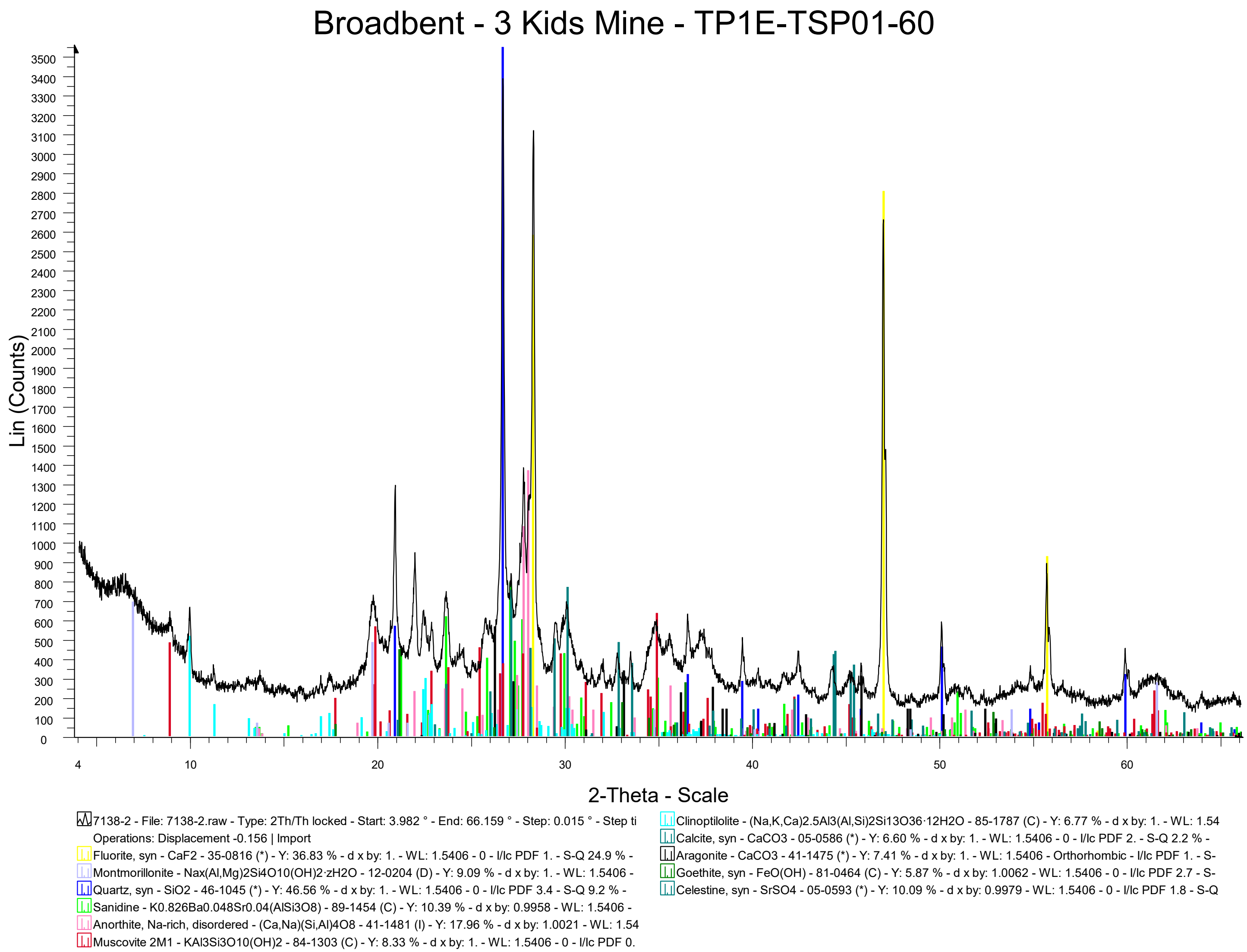

Broadbent - 3 Kids Mine - TP1E-TSP01-60
Lin (Counts)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
3500
4
10
20
30
40
50
60
2-Theta - Scale
7138-2 - File: 7138-2.raw - Type: 2Th/Th locked - Start: 3.982 ° - End: 66.159 ° - Step: 0.015 ° - Step ti
Operations: Displacement -0.156 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 36.83 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 24.9 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 46.56 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 9.2 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 10.39 % - d x by: 0.9958 - WL: 1.5406 -
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 17.96 % - d x by: 1.0021 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 8.33 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 6.77 % - d x by: 1. - WL: 1.54
Calcite, syn - CaCO3 - 05-0586 (*) - Y: 6.60 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 2. - S-Q 2.2 % -
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Goethite, syn - FeO(OH) - 81-0464 (C) - Y: 5.87 % - d x by: 1.0062 - WL: 1.5406 - 0 - I/Ic PDF 2.7 - S-
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 10.09 % - d x by: 0.9979 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q

Figure 15

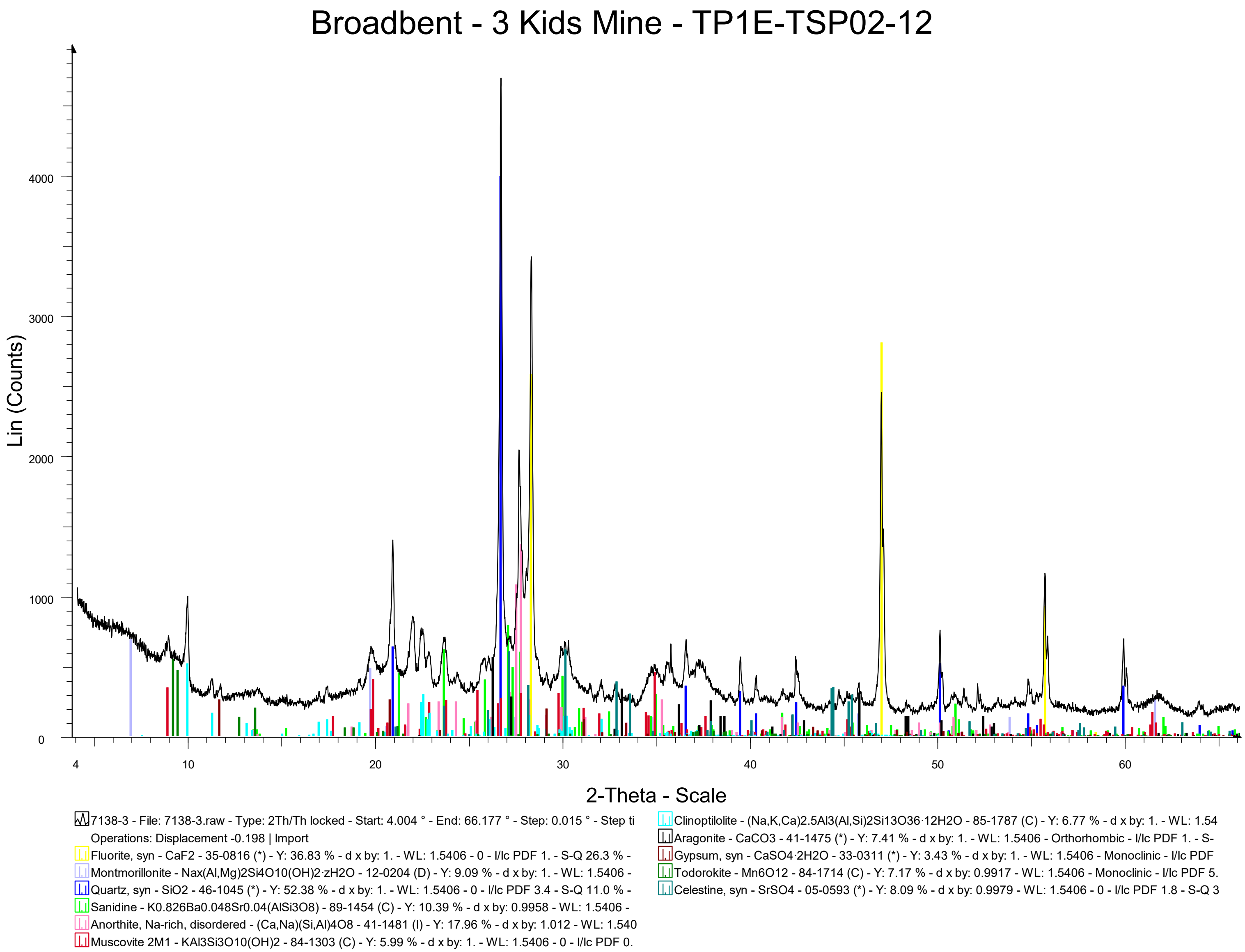

Broadbent - 3 Kids Mine - TP1E-TSP02-12
Lin (Counts)
4000
3000
2000
1000
0
4
10
20
30
40
50
60
2-Theta - Scale
7138-3 - File: 7138-3.raw - Type: 2Th/Th locked - Start: 4.004 ° - End: 66.177 ° - Step: 0.015 ° - Step ti
Operations: Displacement -0.198 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 36.83 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 26.3 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 52.38 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 11.0 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 10.39 % - d x by: 0.9958 - WL: 1.5406 -
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 17.96 % - d x by: 1.012 - WL: 1.540
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 5.99 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 6.77 % - d x by: 1. - WL: 1.54
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Gypsum, syn - CaSO4·2H2O - 33-0311 (*) - Y: 3.43 % - d x by: 1. - WL: 1.5406 - Monoclinic - I/Ic PDF
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 - WL: 1.5406 - Monoclinic - I/Ic PDF 5.
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 8.09 % - d x by: 0.9979 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 3

Figure 16

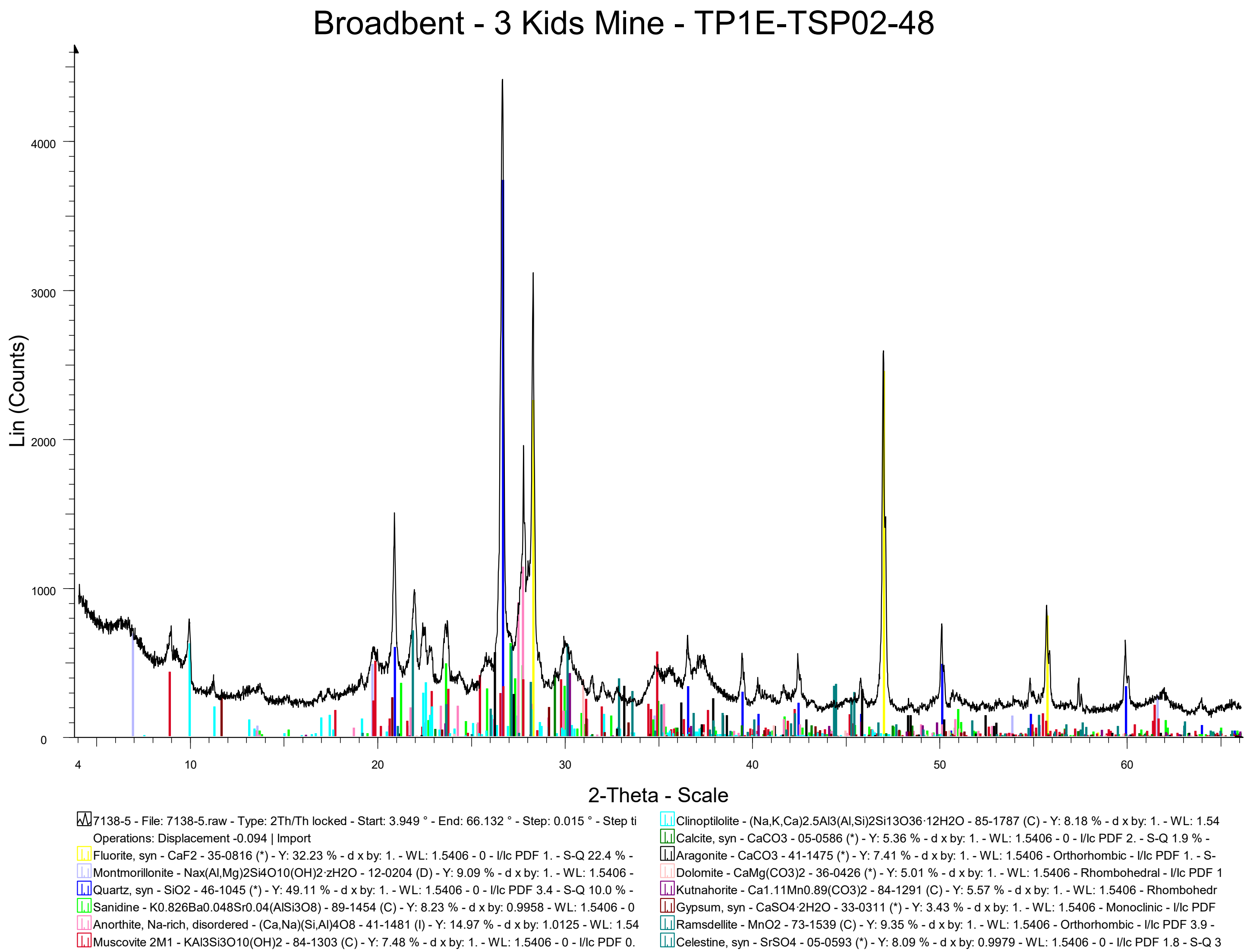

Broadbent - 3 Kids Mine - TP1E-TSP02-48
Lin (Counts)
0
1000
2000
3000
4000
4
10
20
30
40
50
60
2-Theta - Scale
7138-5 - File: 7138-5.raw - Type: 2Th/Th locked - Start: 3.949 ° - End: 66.132 ° - Step: 0.015 ° - Step ti
Operations: Displacement -0.094 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 32.23 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 22.4 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 49.11 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 10.0 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 8.23 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 14.97 % - d x by: 1.0125 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 7.48 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 8.18 % - d x by: 1. - WL: 1.54
Calcite, syn - CaCO3 - 05-0586 (*) - Y: 5.36 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 2. - S-Q 1.9 % -
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.01 % - d x by: 1. - WL: 1.5406 - Rhombohedral - I/Ic PDF 1
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 5.57 % - d x by: 1. - WL: 1.5406 - Rhombohedr
Gypsum, syn - CaSO4·2H2O - 33-0311 (*) - Y: 3.43 % - d x by: 1. - WL: 1.5406 - Monoclinic - I/Ic PDF
Ramsdellite - MnO2 - 73-1539 (C) - Y: 9.35 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 3.9 -
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 8.09 % - d x by: 0.9979 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 3

Figure 17

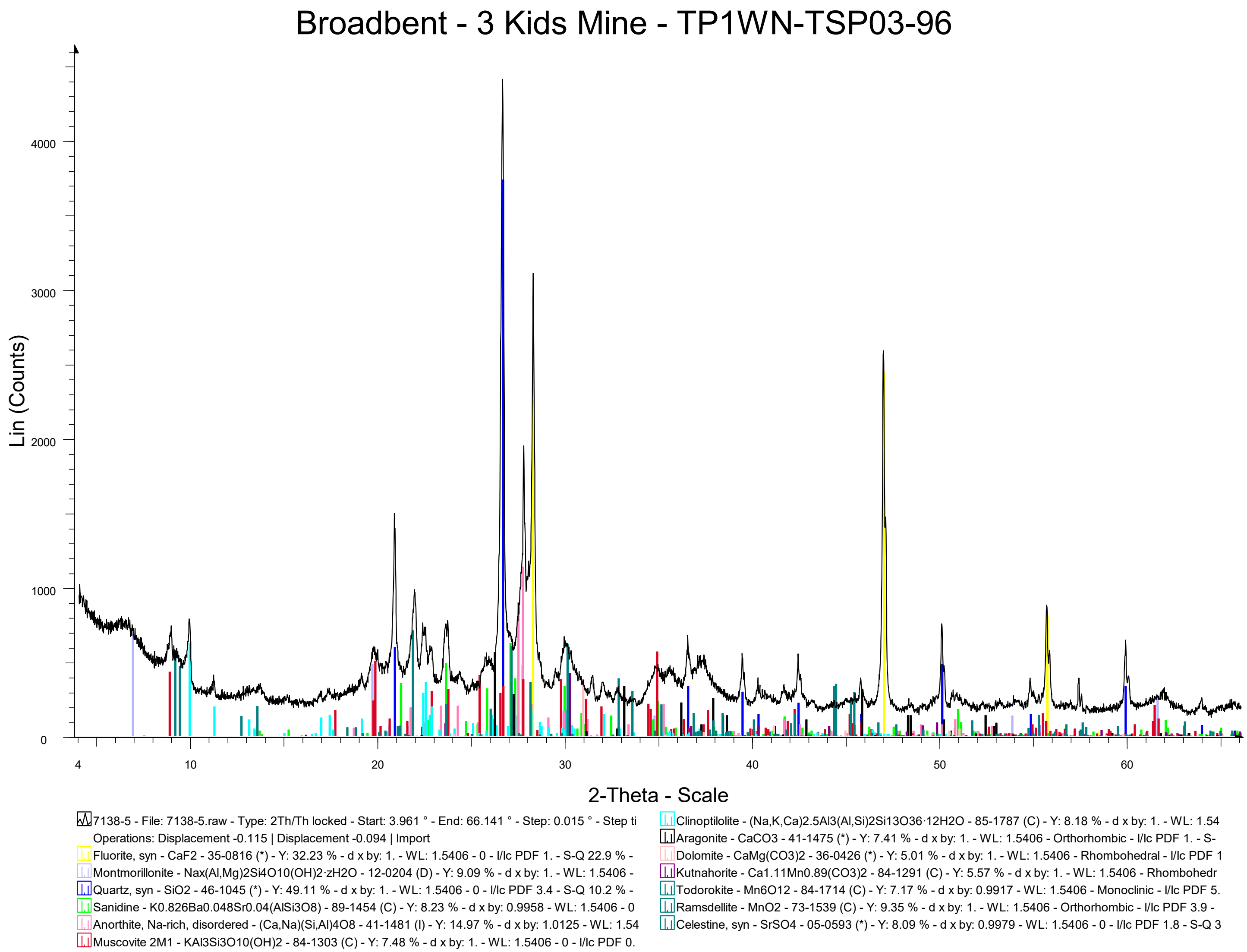

Broadbent - 3 Kids Mine - TP1WN-TSP03-96
Lin (Counts)
0
1000
2000
3000
4000
4
10
20
30
40
50
60
2-Theta - Scale
7138-5 - File: 7138-5.raw - Type: 2Th/Th locked - Start: 3.961 ° - End: 66.141 ° - Step: 0.015 ° - Step ti
Operations: Displacement -0.115 | Displacement -0.094 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 32.23 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 22.9 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 49.11 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 10.2 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 8.23 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 14.97 % - d x by: 1.0125 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 7.48 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 8.18 % - d x by: 1. - WL: 1.54
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.01 % - d x by: 1. - WL: 1.5406 - Rhombohedral - I/Ic PDF 1
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 5.57 % - d x by: 1. - WL: 1.5406 - Rhombohedr
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 - WL: 1.5406 - Monoclinic - I/Ic PDF 5.
Ramsdellite - MnO2 - 73-1539 (C) - Y: 9.35 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 3.9 -
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 8.09 % - d x by: 0.9979 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 3

Figure 18

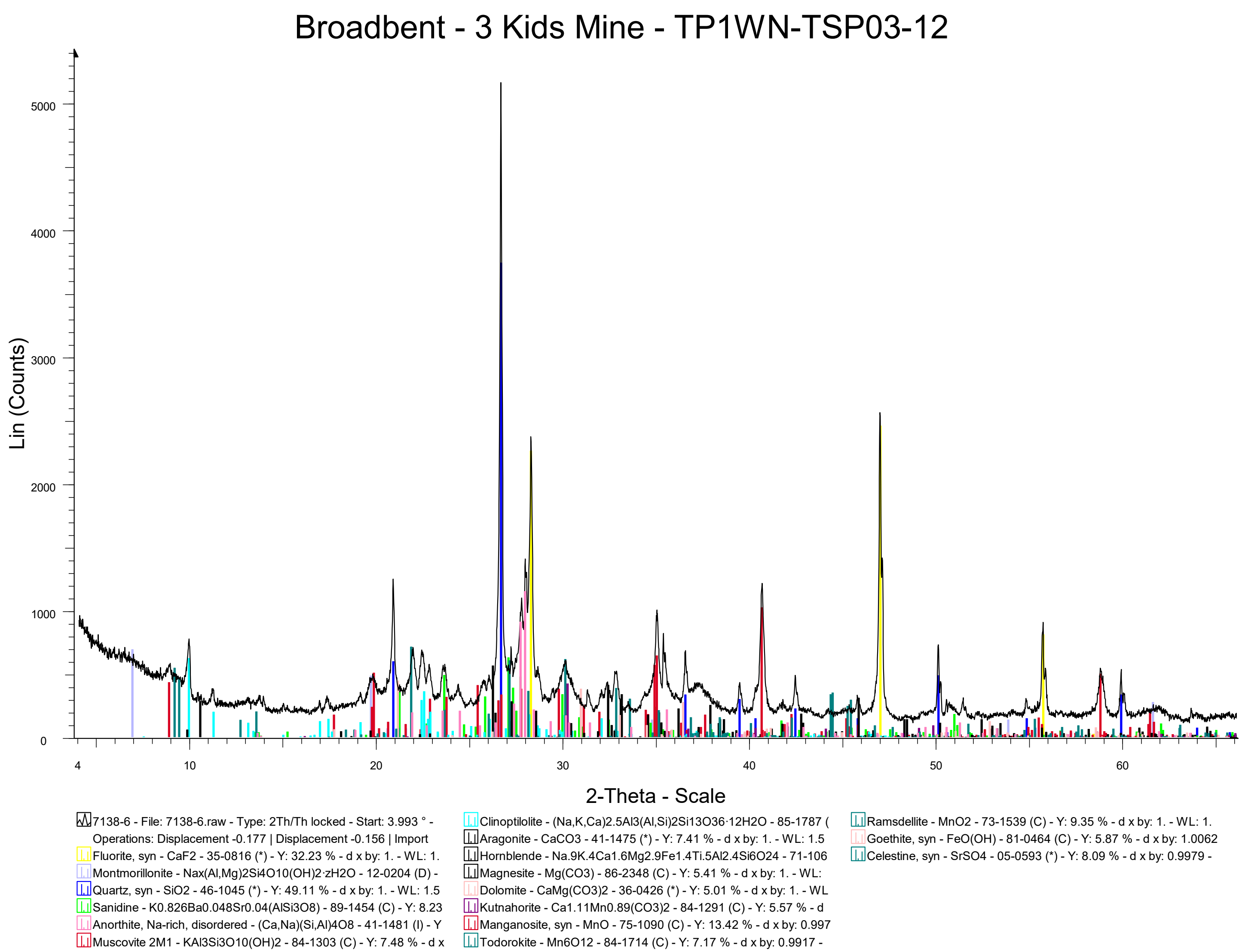

Broadbent - 3 Kids Mine - TP1WN-TSP03-12
Lin (Counts)
0
1000
2000
3000
4000
5000
4
10
20
30
40
50
60
2-Theta - Scale
7138-6 - File: 7138-6.raw - Type: 2Th/Th locked - Start: 3.993 ° -
Operations: Displacement -0.177 | Displacement -0.156 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 32.23 % - d x by: 1. - WL: 1.
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 49.11 % - d x by: 1. - WL: 1.5
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 8.23
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 7.48 % - d x
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5
Hornblende - Na.9K.4Ca1.6Mg2.9Fe1.4Ti.5Al2.4Si6O24 - 71-106
Magnesite - Mg(CO3) - 86-2348 (C) - Y: 5.41 % - d x by: 1. - WL:
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.01 % - d x by: 1. - WL
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 5.57 % - d
Manganosite, syn - MnO - 75-1090 (C) - Y: 13.42 % - d x by: 0.997
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 -
Ramsdellite - MnO2 - 73-1539 (C) - Y: 9.35 % - d x by: 1. - WL: 1.
Goethite, syn - FeO(OH) - 81-0464 (C) - Y: 5.87 % - d x by: 1.0062
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 8.09 % - d x by: 0.9979 -

Figure 19

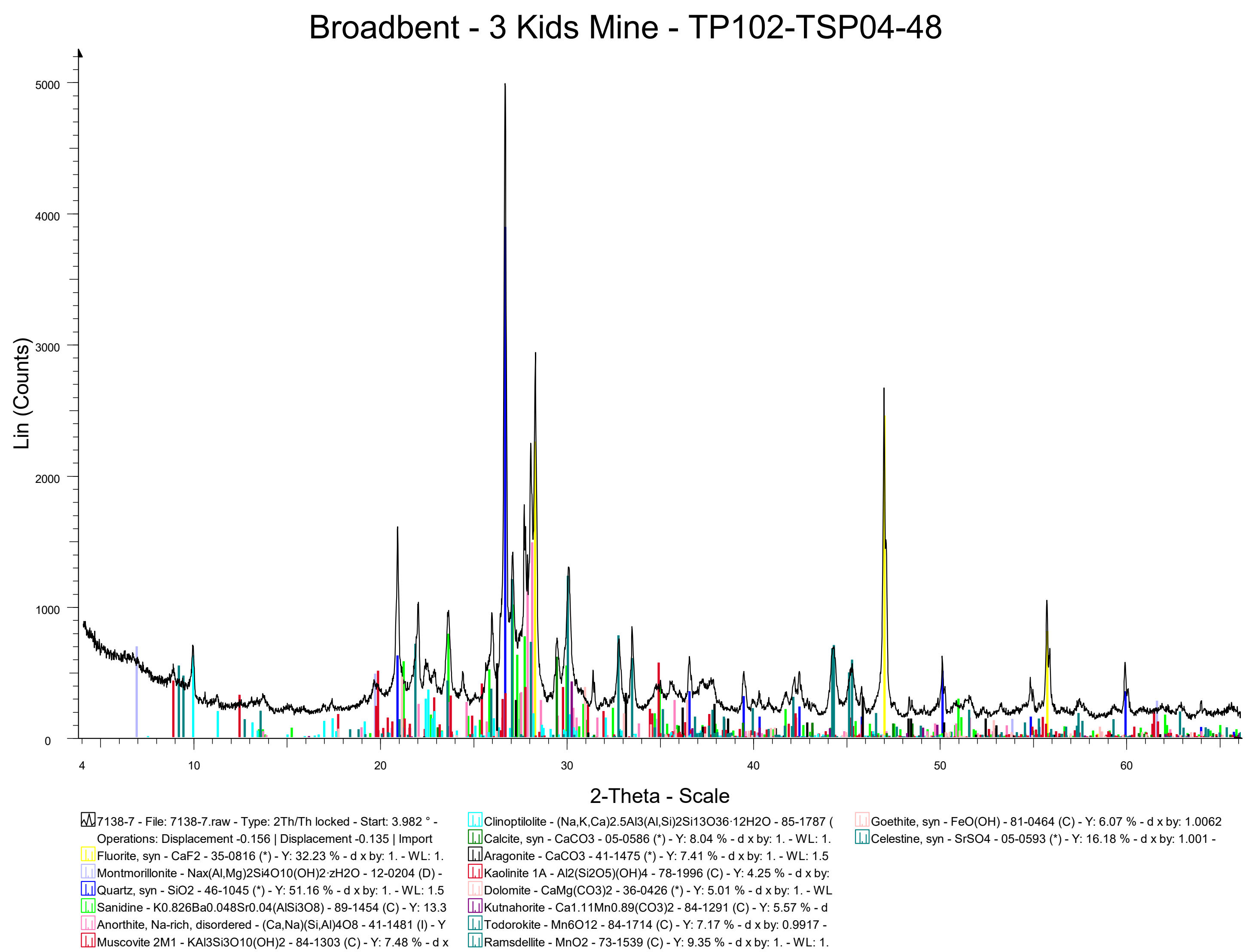

Broadbent - 3 Kids Mine - TP102-TSP04-48
Lin (Counts)
5000
4000
3000
2000
1000
0
4
10
20
30
40
50
60
2-Theta - Scale
7138-7 - File: 7138-7.raw - Type: 2Th/Th locked - Start: 3.982 ° -
Operations: Displacement -0.156 | Displacement -0.135 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 32.23 % - d x by: 1. - WL: 1.
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 51.16 % - d x by: 1. - WL: 1.5
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 13.3
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 7.48 % - d x
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (
Calcite, syn - CaCO3 - 05-0586 (*) - Y: 8.04 % - d x by: 1. - WL: 1.
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5
Kaolinite 1A - Al2(Si2O5)(OH)4 - 78-1996 (C) - Y: 4.25 % - d x by:
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.01 % - d x by: 1. - WL
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 5.57 % - d
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 -
Ramsdellite - MnO2 - 73-1539 (C) - Y: 9.35 % - d x by: 1. - WL: 1.
Goethite, syn - FeO(OH) - 81-0464 (C) - Y: 6.07 % - d x by: 1.0062
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 16.18 % - d x by: 1.001 -

Figure 20

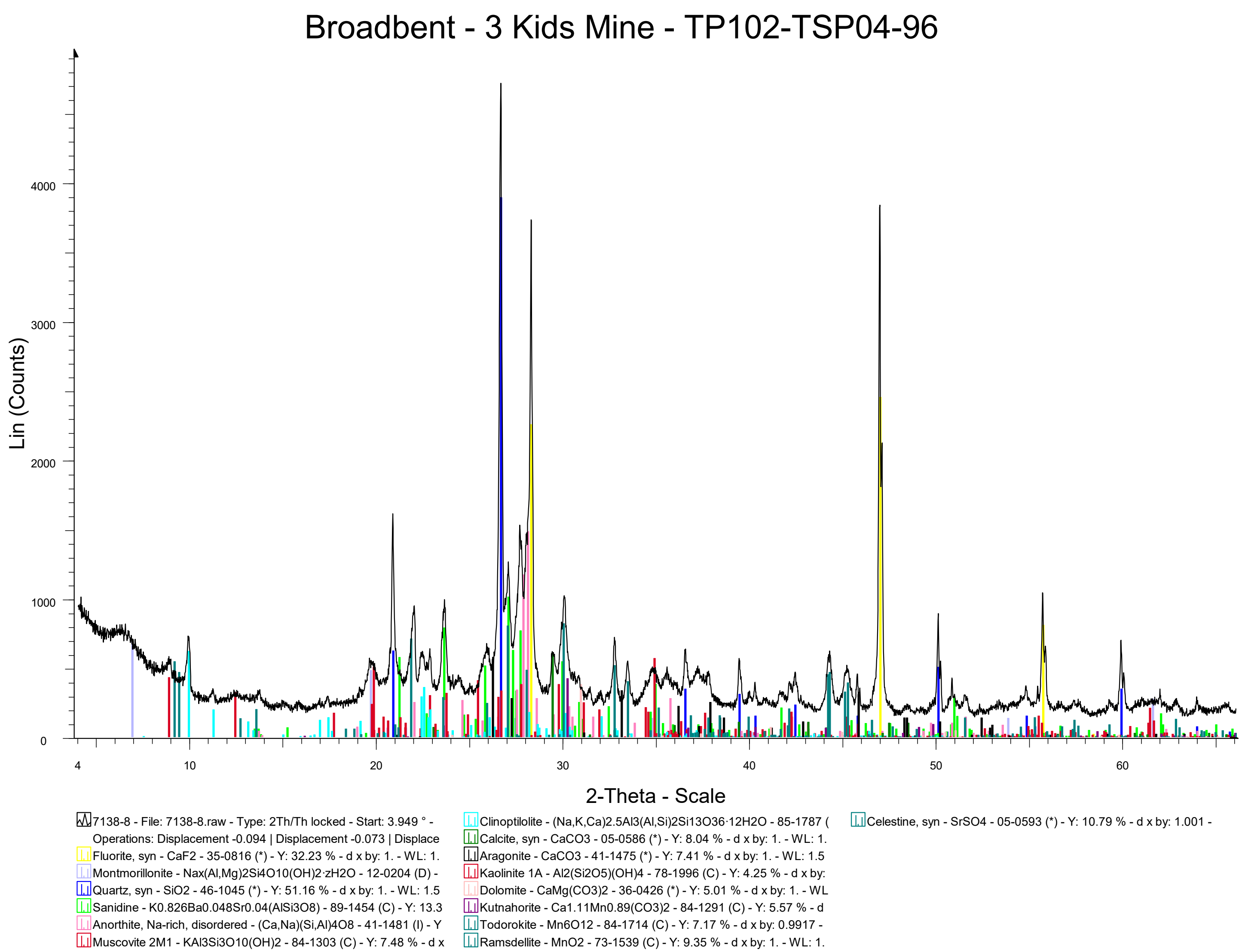

Broadbent - 3 Kids Mine - TP102-TSP04-96
Lin (Counts)
0
1000
2000
3000
4000
4
10
20
30
40
50
60
2-Theta - Scale
7138-8 - File: 7138-8.raw - Type: 2Th/Th locked - Start: 3.949 ° -
Operations: Displacement -0.094 | Displacement -0.073 | Displace
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 32.23 % - d x by: 1. - WL: 1.
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 51.16 % - d x by: 1. - WL: 1.5
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 13.3
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 7.48 % - d x
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (
Calcite, syn - CaCO3 - 05-0586 (*) - Y: 8.04 % - d x by: 1. - WL: 1.
Aragonite - CaCO3 - 41-1475 (*) - Y: 7.41 % - d x by: 1. - WL: 1.5
Kaolinite 1A - Al2(Si2O5)(OH)4 - 78-1996 (C) - Y: 4.25 % - d x by:
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.01 % - d x by: 1. - WL
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 5.57 % - d
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 -
Ramsdellite - MnO2 - 73-1539 (C) - Y: 9.35 % - d x by: 1. - WL: 1.
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 10.79 % - d x by: 1.001 -

Figure 21

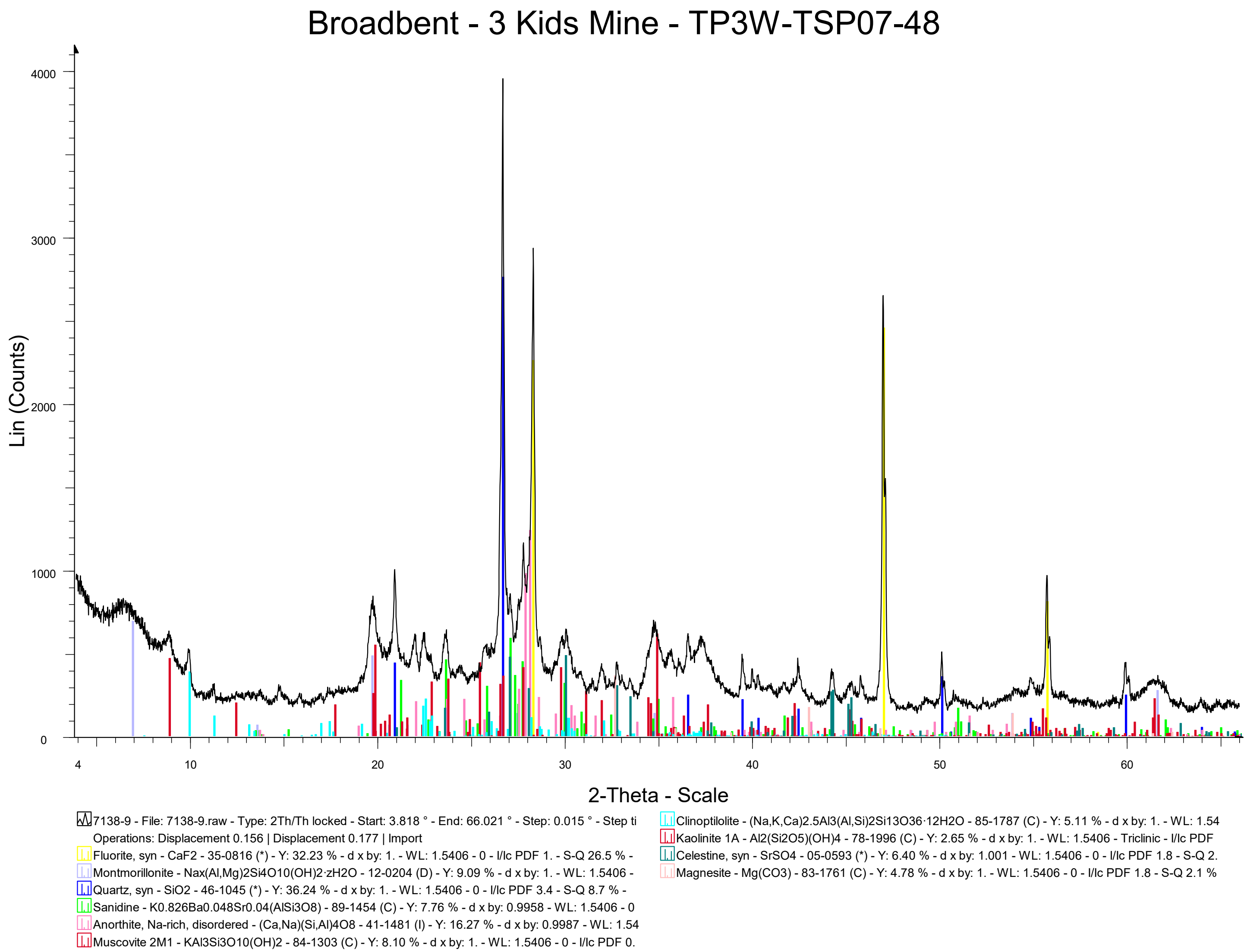

Broadbent - 3 Kids Mine - TP3W-TSP07-48
Lin (Counts)
4000
3000
2000
1000
0
4
10
20
30
40
50
60
2-Theta - Scale
7138-9 - File: 7138-9.raw - Type: 2Th/Th locked - Start: 3.818 ° - End: 66.021 ° - Step: 0.015 ° - Step ti
Operations: Displacement 0.156 | Displacement 0.177 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 32.23 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 26.5 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 36.24 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 8.7 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 7.76 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 16.27 % - d x by: 0.9987 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 8.10 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 5.11 % - d x by: 1. - WL: 1.54
Kaolinite 1A - Al2(Si2O5)(OH)4 - 78-1996 (C) - Y: 2.65 % - d x by: 1. - WL: 1.5406 - Triclinic - I/Ic PDF
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 6.40 % - d x by: 1.001 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 2.
Magnesite - Mg(CO3) - 83-1761 (C) - Y: 4.78 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 2.1 %

Figure 22

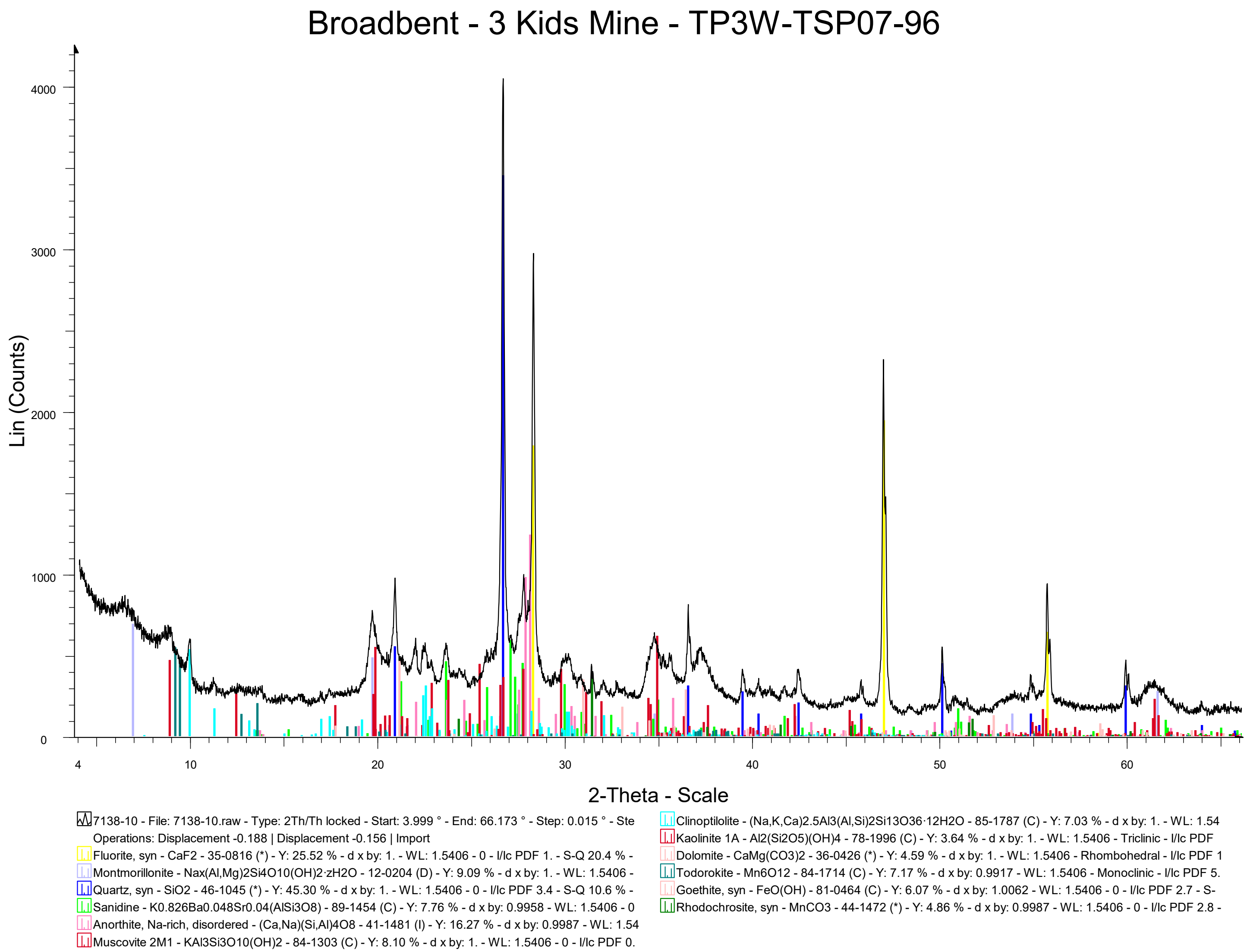

Broadbent - 3 Kids Mine - TP3W-TSP07-96
Lin (Counts)
0
1000
2000
3000
4000
2-Theta - Scale
4
10
20
30
40
50
60
7138-10 - File: 7138-10.raw - Type: 2Th/Th locked - Start: 3.999 ° - End: 66.173 ° - Step: 0.015 ° - Ste
Operations: Displacement -0.188 | Displacement -0.156 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 25.52 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 20.4 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 45.30 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 10.6 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 7.76 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 16.27 % - d x by: 0.9987 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 8.10 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 7.03 % - d x by: 1. - WL: 1.54
Kaolinite 1A - Al2(Si2O5)(OH)4 - 78-1996 (C) - Y: 3.64 % - d x by: 1. - WL: 1.5406 - Triclinic - I/Ic PDF
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 4.59 % - d x by: 1. - WL: 1.5406 - Rhombohedral - I/Ic PDF 1
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 - WL: 1.5406 - Monoclinic - I/Ic PDF 5.
Goethite, syn - FeO(OH) - 81-0464 (C) - Y: 6.07 % - d x by: 1.0062 - WL: 1.5406 - 0 - I/Ic PDF 2.7 - S-
Rhodochrosite, syn - MnCO3 - 44-1472 (*) - Y: 4.86 % - d x by: 0.9987 - WL: 1.5406 - 0 - I/Ic PDF 2.8 -

Figure 23

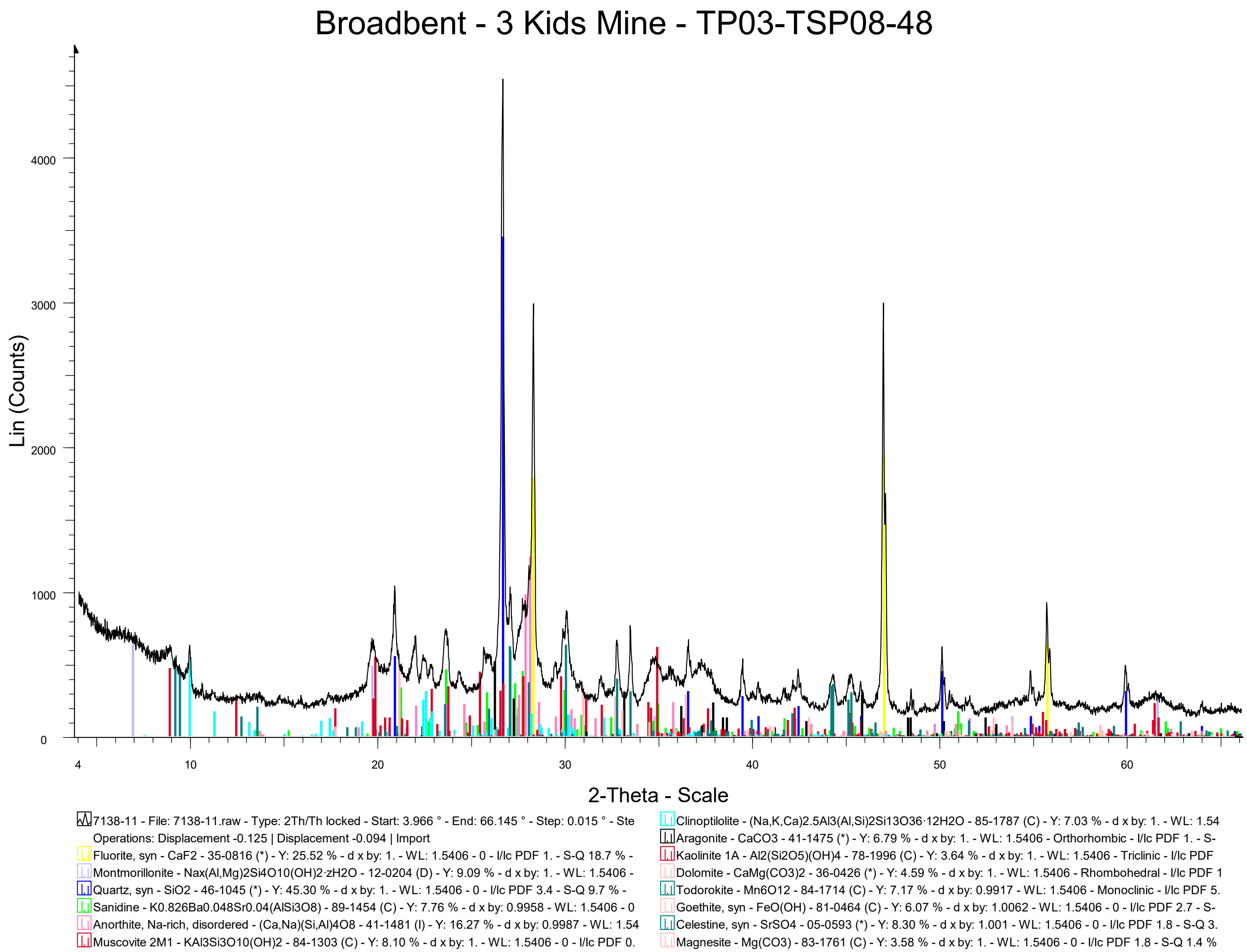
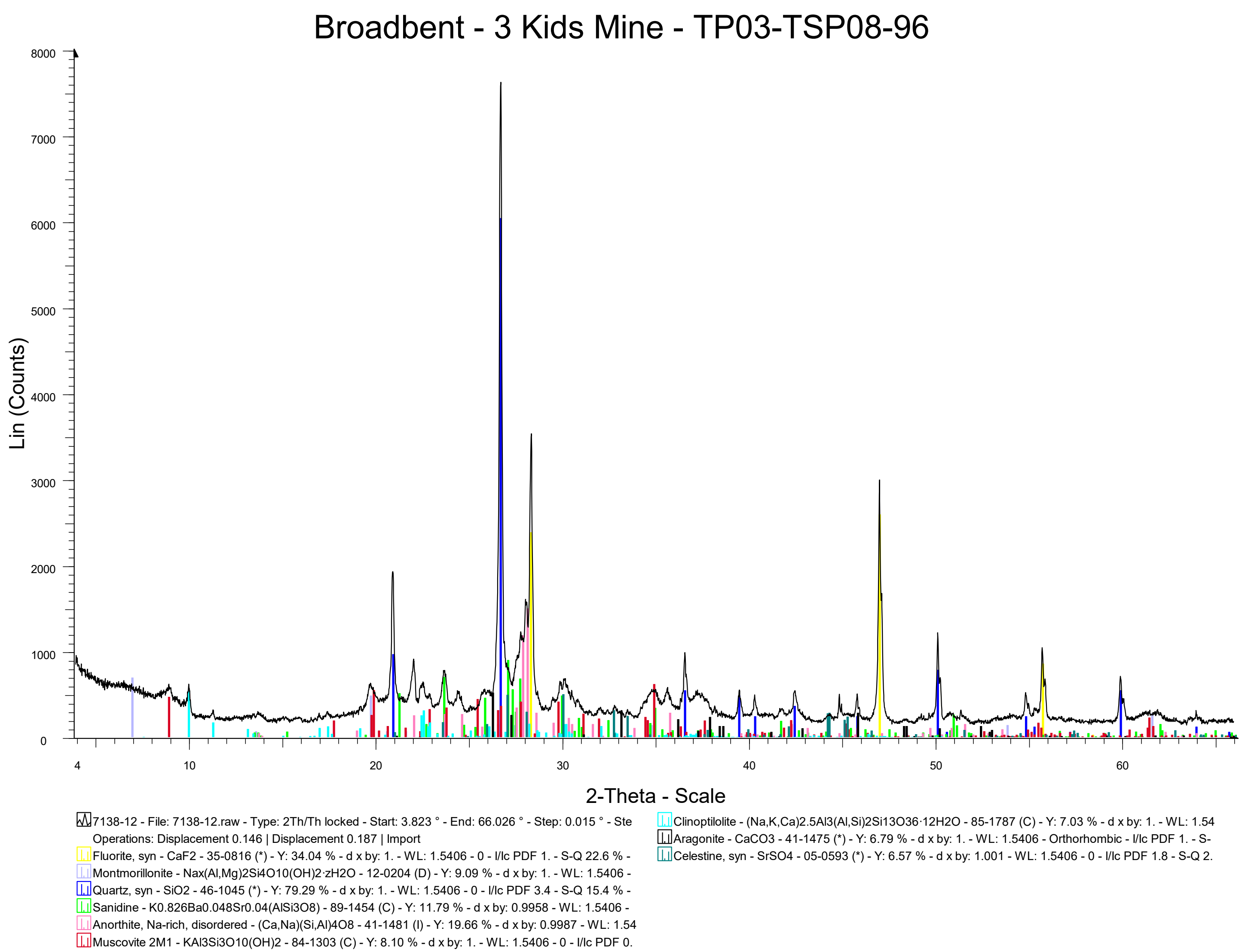

Broadbent - 3 Kids Mine - TP03-TSP08-48
Lin (Counts)
0
1000
2000
3000
4000
2-Theta - Scale
4
10
20
30
40
50
60
7138-11 - File: 7138-11.raw - Type: 2Th/Th locked - Start: 3.966 ° - End: 66.145 ° - Step: 0.015 ° - Ste
Operations: Displacement -0.125 | Displacement -0.094 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 25.52 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 18.7 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 45.30 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 9.7 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 7.76 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 16.27 % - d x by: 0.9987 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 8.10 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 7.03 % - d x by: 1. - WL: 1.54
Aragonite - CaCO3 - 41-1475 (*) - Y: 6.79 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Kaolinite 1A - Al2(Si2O5)(OH)4 - 78-1996 (C) - Y: 3.64 % - d x by: 1. - WL: 1.5406 - Triclinic - I/Ic PDF
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 4.59 % - d x by: 1. - WL: 1.5406 - Rhombohedral - I/Ic PDF 1
Todorokite - Mn6O12 - 84-1714 (C) - Y: 7.17 % - d x by: 0.9917 - WL: 1.5406 - Monoclinic - I/Ic PDF 5.
Goethite, syn - FeO(OH) - 81-0464 (C) - Y: 6.07 % - d x by: 1.0062 - WL: 1.5406 - 0 - I/Ic PDF 2.7 - S-
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 8.30 % - d x by: 1.001 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 3.
Magnesite - Mg(CO3) - 83-1761 (C) - Y: 3.58 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 1.4 %

Figure 24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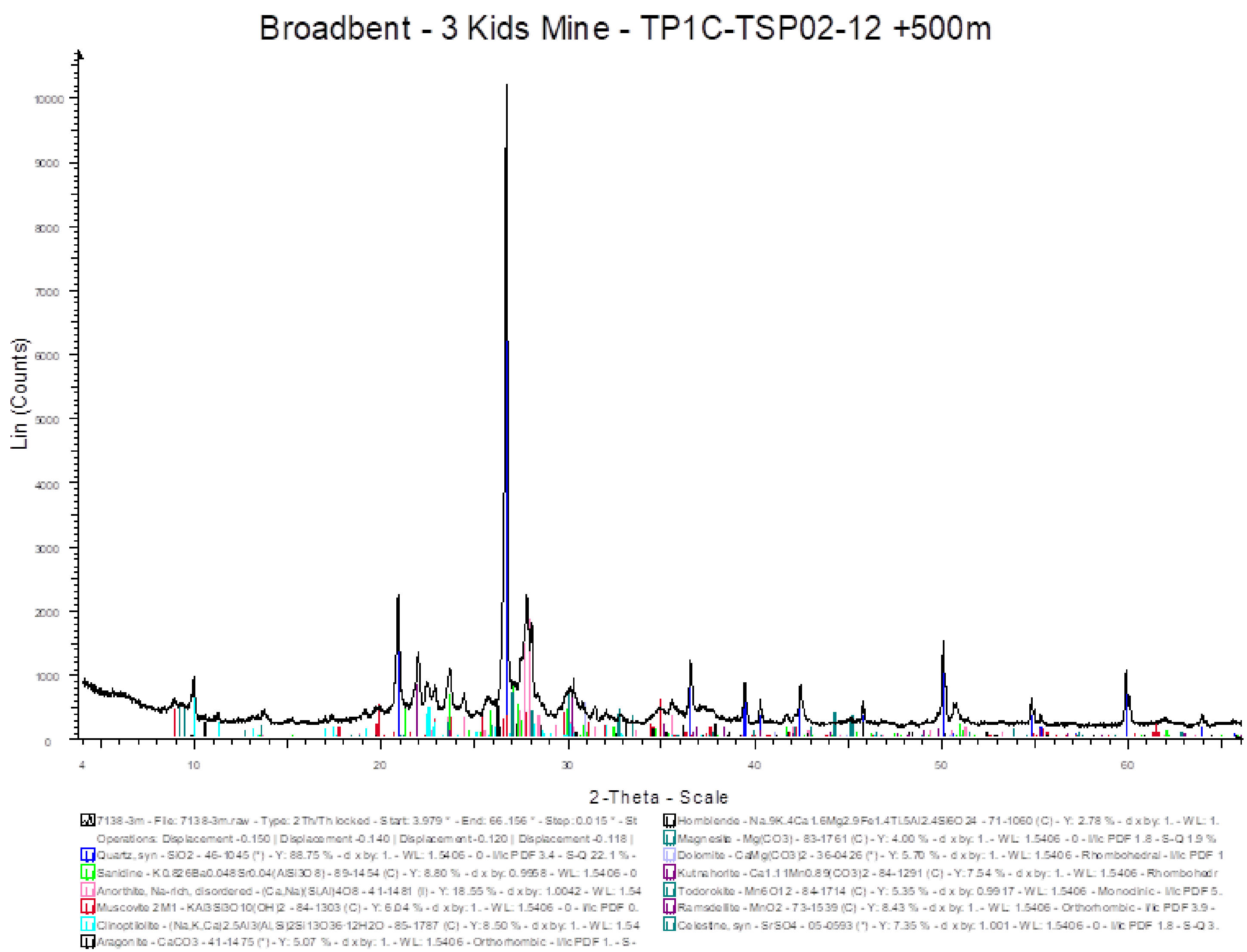
1000
2000
3000
4000
5000
6000
7000
8000
2-Theta - Scale
4
10
20
30
40
50
60
7138-12 - File: 7138-12.raw - Type: 2Th/Th locked - Start: 3.823 ° - End: 66.026 ° - Step: 0.015 ° - Ste
Operations: Displacement 0.146 | Displacement 0.187 | Import
Fluorite, syn - CaF2 - 35-0816 (*) - Y: 34.04 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1. - S-Q 22.6 % -
Montmorillonite - Nax(Al,Mg)2Si4O10(OH)2·zH2O - 12-0204 (D) - Y: 9.09 % - d x by: 1. - WL: 1.5406 -
Quartz, syn - SiO2 - 46-1045 (*) - Y: 79.29 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 15.4 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 11.79 % - d x by: 0.9958 - WL: 1.5406 -
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 19.66 % - d x by: 0.9987 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 8.10 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 7.03 % - d x by: 1. - WL: 1.54
Aragonite - CaCO3 - 41-1475 (*) - Y: 6.79 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 6.57 % - d x by: 1.001 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 2.

Figure 25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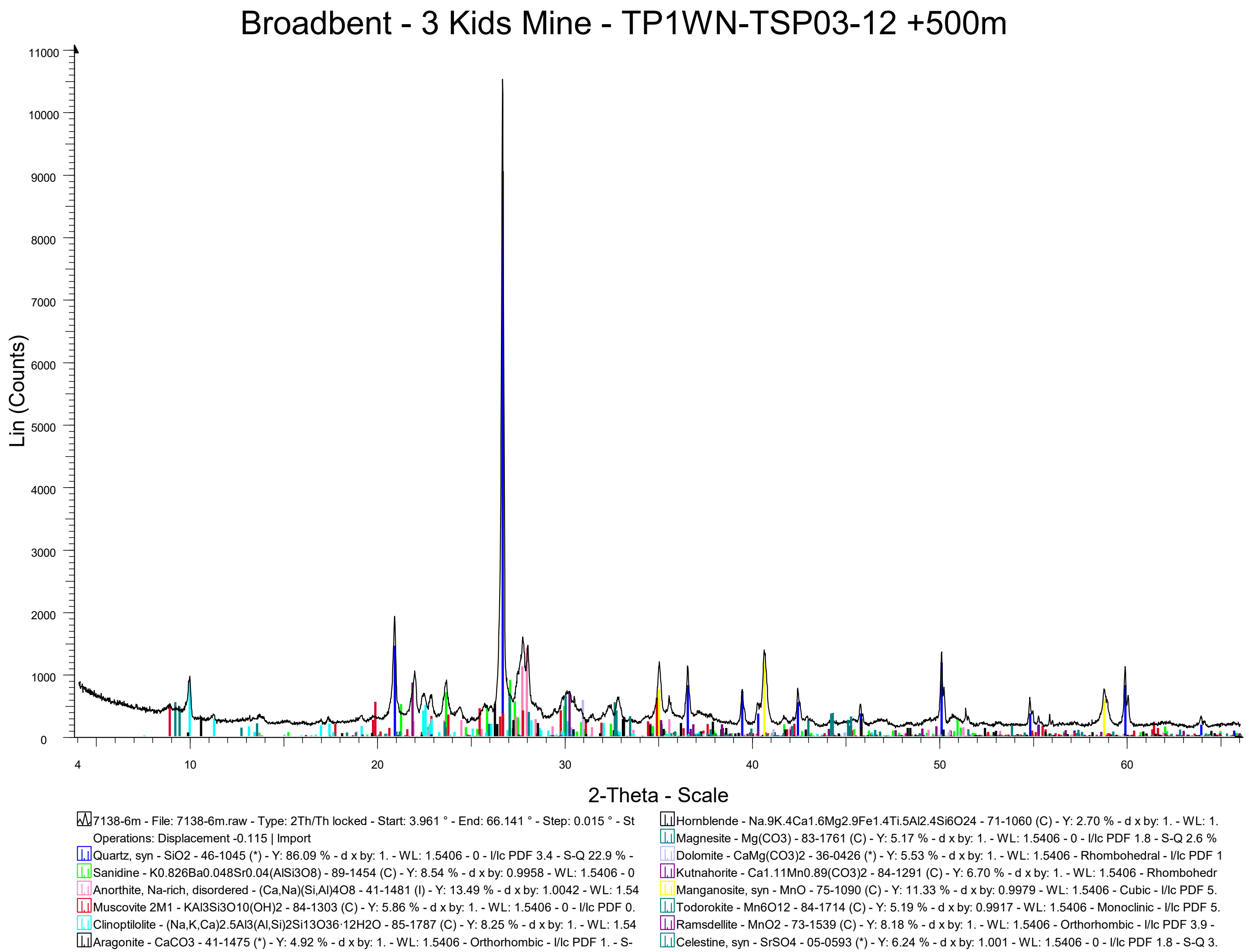
Lin (Counts)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
4
10
20
30
40
50
60
2-Theta - Scale
7138-3m - File: 7138-3m.raw - Type: 2Th/Th locked - Start: 3.979 ° - End: 66.156 ° - Step: 0.015 ° - St
Operations: Displacement -0.150 | Displacement -0.140 | Displacement -0.120 | Displacement -0.118 |
Quartz, syn - SiO2 - 46-1045 (*) - Y: 88.75 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 22.1 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 8.80 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 18.55 % - d x by: 1.0042 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 6.04 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 8.50 % - d x by: 1. - WL: 1.54
Aragonite - CaCO3 - 41-1475 (*) - Y: 5.07 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Hornblende - Na.9K.4Ca1.6Mg2.9Fe1.4Ti.5Al2.4Si6O24 - 71-1060 (C) - Y: 2.78 % - d x by: 1. - WL: 1.
Magnesite - Mg(CO3) - 83-1761 (C) - Y: 4.00 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 1.9 %
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.70 % - d x by: 1. - WL: 1.5406 - Rhombohedral - I/Ic PDF 1
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 7.54 % - d x by: 1. - WL: 1.5406 - Rhombohedr
Todorokite - Mn6O12 - 84-1714 (C) - Y: 5.35 % - d x by: 0.9917 - WL: 1.5406 - Monoclinic - I/Ic PDF 5.
Ramsdellite - MnO2 - 73-1539 (C) - Y: 8.43 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 3.9 -
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 7.35 % - d x by: 1.001 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 3.

Figure 26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Lin (Counts)
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
4
10
20
30
40
50
60
2-Theta - Scale
7138-6m - File: 7138-6m.raw - Type: 2Th/Th locked - Start: 3.961 ° - End: 66.141 ° - Step: 0.015 ° - St
Operations: Displacement -0.115 | Import
Quartz, syn - SiO2 - 46-1045 (*) - Y: 86.09 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 3.4 - S-Q 22.9 % -
Sanidine - K0.826Ba0.048Sr0.04(AlSi3O8) - 89-1454 (C) - Y: 8.54 % - d x by: 0.9958 - WL: 1.5406 - 0
Anorthite, Na-rich, disordered - (Ca,Na)(Si,Al)4O8 - 41-1481 (I) - Y: 13.49 % - d x by: 1.0042 - WL: 1.54
Muscovite 2M1 - KAl3Si3O10(OH)2 - 84-1303 (C) - Y: 5.86 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 0.
Clinoptilolite - (Na,K,Ca)2.5Al3(Al,Si)2Si13O36·12H2O - 85-1787 (C) - Y: 8.25 % - d x by: 1. - WL: 1.54
Aragonite - CaCO3 - 41-1475 (*) - Y: 4.92 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 1. - S-
Hornblende - Na.9K.4Ca1.6Mg2.9Fe1.4Ti.5Al2.4Si6O24 - 71-1060 (C) - Y: 2.70 % - d x by: 1. - WL: 1.
Magnesite - Mg(CO3) - 83-1761 (C) - Y: 5.17 % - d x by: 1. - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 2.6 %
Dolomite - CaMg(CO3)2 - 36-0426 (*) - Y: 5.53 % - d x by: 1. - WL: 1.5406 - Rhombohedral - I/Ic PDF 1
Kutnahorite - Ca1.11Mn0.89(CO3)2 - 84-1291 (C) - Y: 6.70 % - d x by: 1. - WL: 1.5406 - Rhombohedr
Manganosite, syn - MnO - 75-1090 (C) - Y: 11.33 % - d x by: 0.9979 - WL: 1.5406 - Cubic - I/Ic PDF 5.
Todorokite - Mn6O12 - 84-1714 (C) - Y: 5.19 % - d x by: 0.9917 - WL: 1.5406 - Monoclinic - I/Ic PDF 5.
Ramsdellite - MnO2 - 73-1539 (C) - Y: 8.18 % - d x by: 1. - WL: 1.5406 - Orthorhombic - I/Ic PDF 3.9 -
Celestine, syn - SrSO4 - 05-0593 (*) - Y: 6.24 % - d x by: 1.001 - WL: 1.5406 - 0 - I/Ic PDF 1.8 - S-Q 3.

Figure 27

Pittsburgh Mineral & Environmental Technology
700 5th Ave
New Brighton, PA 15066
www.pmet-inc.com

Date: May 19, 2022
Attention: Ms. Karen Gastineau
Senior Hydrologist
Broadbent & Associates, Inc.
8 West Pacific Ave.
Henderson, NV 89015

PMET Laboratory Reference number: RFA 7138

Dear Ms. Gastineau:

This report summarizes the results of analysis for carbon and sulfur on 3 tailings samples from the 3 Kids Mine, Las Vegas, NV. The samples were received at PMET's laboratory on January 22, 2021. A PMET chain of custody document was received via email.

The purpose of the analysis was to determine total carbon and total sulfur in the samples. Duplicate analyses and a calibration standard were run using an Eltra CS800 with IR detector.

Table 1
Sample Identification
As-received Wt.

PMET I.D.	Broadbent Description	C1	C2	S1	S2	1.17% C Standard
7138-4	TP1C-TSP02-48	0.6855	0.7155	0.2425	0.2459	1.1612
7138-6	TP1WN-TSP03-12	0.3665	0.3489	0.2819	0.2695	
7138-8	TP02-TSP04-96	0.6565	0.6433	0.8819	0.8689	

Warm regards,

Randolph W. Shannon
PMET Laboratory Manager
Randys@pmet-inc.com
(724) 843-5000 ext. 15
(724) 462-3469 (cell)

APPENDIX F

City of Henderson Water Service Maintenance Statement on Water Loss Estimates for Fiscal Year 2021

City of Henderson

Department of Utility Services

12/13/2021

Original Request—COH maintenance history for water main repairs and corrective service line replacements associated with system leaks along with response times to make these repairs (so that we can compare that to potential leaching timing).

The Department of Utility Services (DUS) takes leak repair very seriously, responding to all as quickly as is safely possible. There are several Key Performance Indicators (KPI) and facts about our organizational structure that demonstrates that, they are:

1. We have a Standby Response crew that responds to and repairs these types of issues on call 24/7. Main and service lateral leaks average around 5.5 incidents per quarter of year since October of 2017 when current KPI was implemented.
2. DUS also has a Leak Detection crew that inspects approximately 15,000 assets per quarter, proactively looking for leaks. The majority of these are service laterals.
3. Currently, we are replacing approximately 250 service laterals a quarter. These include identified and confirmed leaks, as well as proactive replacements of laterals based on several conditions that predict potential future leakage.
4. Based on an internal audit that was recently completed, reported water line leaks have an average response time of 1 day.
5. CY2021 first 3 quarters approx. total losses from unplanned line break events are 121,800 gals.
6. FY2020 Total number of unplanned water main breaks= 17. Of that only one of these events lasted longer than 12 hrs. to repair.

APPENDIX G

Hydro Pit Model Simulation Results

Table 1G
Hydro Pit Base Case model simulation and sensitivity simulation input parameters.

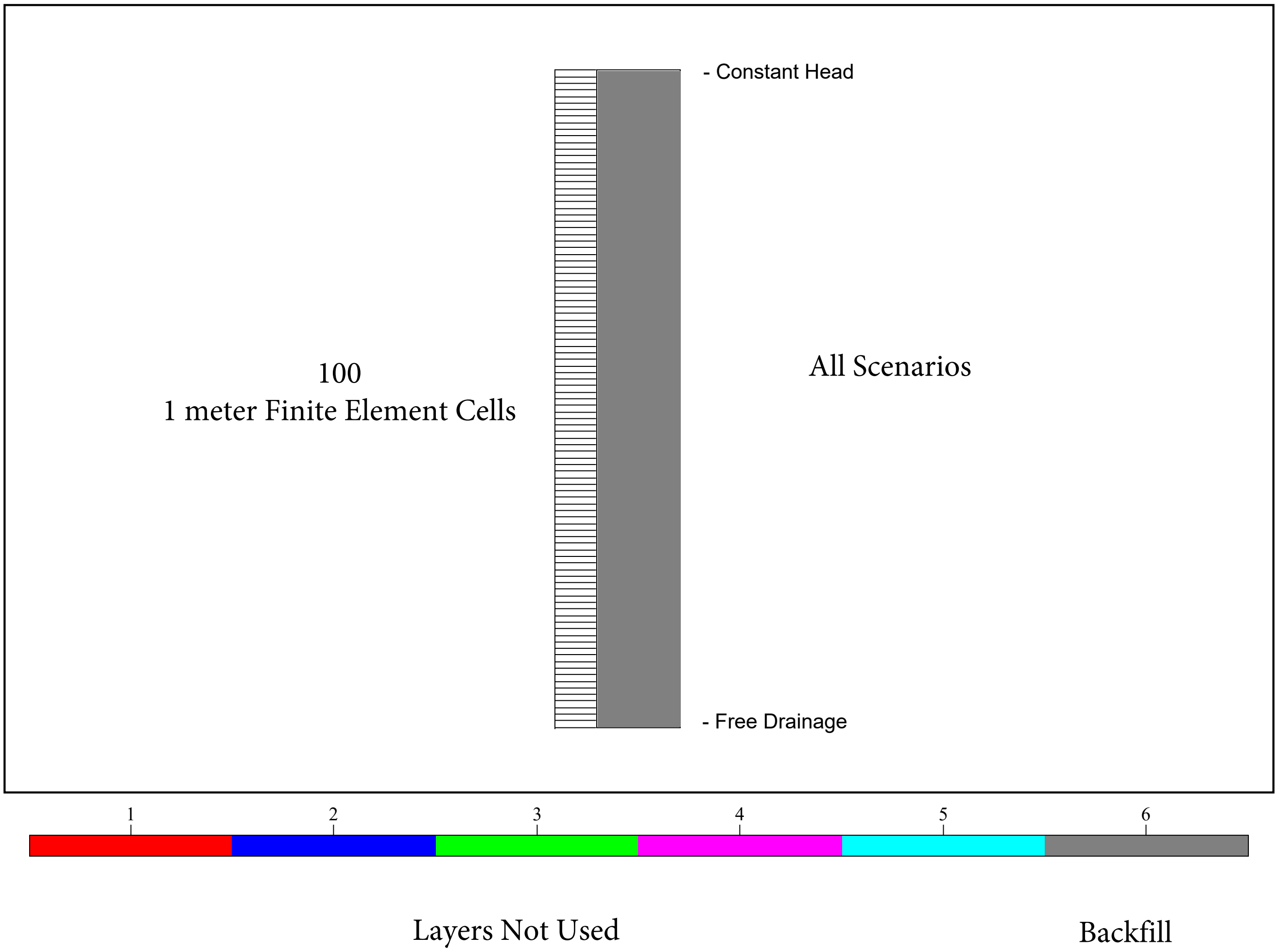
Description	Hydro Base Case Alternative 90:10 (Tailing to Waste Rock Mixture) with Impervious Cover[1]	Hydro Alternative 67:33 (Tailing to Waste Rock Mixture) with Impervious Cover	Hydro Alternative 50:50 (Tailing to Waste Rock Mixture) with Impervious Cover	Hydro Maximum Tailing MWMP Alternative 90:10 with Impervious Cover	Hydro Minimum Tailing MWMP Alternative 90:10 with Impervious Cover	Hydro Proctor 100 Initial Moisture Alternative 90:10 with Impervious Cover	Hydro Proctor 80 Initial Moisture Alternative 90:10 with Impervious Cover	Hydro Tailing SWCC Alternative 90:10 with Impervious Cover
Hydro Run Number	1 (Base Case)	2	3	4	5	6	7	8
Dimension	1D, no-flow horizontal boundary condition							
Time Domain, yr	70							
Initial Time, d	0							
Final Time, d	25550							
Initial Time Step, d	0.001							
Minimum Time Step, d	0.00001							
Maximum Time Step, d	1							
Maximum Number of Iterations	100							
Depth, m	100							
Average Annual Precipitation, in	NA Impervious Cover							
PET Estimation	NA Impervious Cover							
Cover Unit	NA Impervious Cover							
Fill Unit Mix and Initial MWMP Concentrations	90:10, Average MWMP Tailings	67:33, Average MWMP Tailings	50:50, Average MWMP Tailings	90:10, Maximum MWMP Tailings	90:10, Minimum MWMP Tailings	90:10, Average MWMP Tailings	90:10, Average MWMP Tailings	TP1WN-TP1E (~90%) Table 6, Average MWMP Tailings
Geologic Substrate Unit	Tsm (~90%)							
Cover Thickness, m	NA Impervious Cover							
Backfill Thickness, m	88.4							
Geologic Substrate Thickness, m	11.6							
Hydraulic Properties	SWCC, Tables 5 and 6							
Soil Hydraulic Model	van Genuchten - Maulem, no hysteresis							
Upper Boundary Condition	Constant Pressure Head							
Lower Boundary Condition	Free Drainage							
S-Shape root uptake function P50 [m]	NA Impervious Cover							
S-Shape root uptake function P3, [-]	NA Impervious Cover							
Solute Stress	NA Impervious Cover							
Climate Data	NA Impervious Cover							
Percent Cover for Leaf Area Index	NA Impervious Cover							
Root Depth, m	NA Impervious Cover							
Root Density	NA Impervious Cover							
Solute Transport	HP1 with Components: Water C, Mn, Na, Fe, Mg, S, Ca, As, Pb, Alkalinity, surface Hfo_w, gypsum, scorodite, calcite, rhodochrosite, goethite, cerrusite;phreeqcU.dat thermodynamic database							
Dispersivity, m	10							
Initial Condition Top, Pressure Head, [-m][2]	15	25	15	15	15	10	20	3
Initial Condition Bottom, Pressure Head, [-m][2]	25	35	25	25	25	20	30	10
Numerical Simulator	Finite Element 1 meter length cells, (see input files for other details concerning numerical settings, tolerances, print times etc.)							
Hydrus Modified Example Template	Model input parameters not provided in Table 1H are the same as the Hydrus-1D software template input file MINDIS.h1d provided with the software and tested by the developers (Šimůnek et al., 2018)							
Software Manuals								
Hydrus 1D	Šimůnek, J., Šejna, H., Saito, H., Sakai, M., van Genuchten, M. Th., 2018. The Hydrus-1D Software Package for Simulating the One-Dimensional Movement of Water, Heat, and Multiple Solutes in Variably-Saturated Media. Version 4.17, July 2018. https://www.pc-progress.com/en/Default.aspx?H1D-description#k1							
HP1	Jacques, D and Šimůnek, J. 2005. User Manual of the Multicomponent Variably-Saturated Flow and Transport Model HP1, Description, Verification and Examples, Version 1.0, SCK•CEN-BLG-998, Waste and Disposal, SCK•CEN, Mol, Belgium, 79 pp.							

Notes:

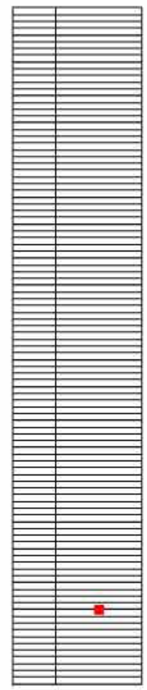
[1]Same hydrologic unsaturated flow model parameters used for organics fate and transport model.

[2]Initial pressure head gradient set to attain the target moisture condition with respect to expected Proctor compaction target. For simulations 1 - 5 and 8, the target moisture content is 90 percent of Proctor.

MWMP = Meteoric Water Mobility Procedure
SWCC = Soil Water Characteristic Curve
yr = year
d = day
m = meter
in = inches
PET = Potential Evapotranspiration
P50 = Root water uptake at this pressure head is reduced by 50%.
P3 = The exponent, p, in the root water uptake response function associated with water stress.
NA = Not Applicable



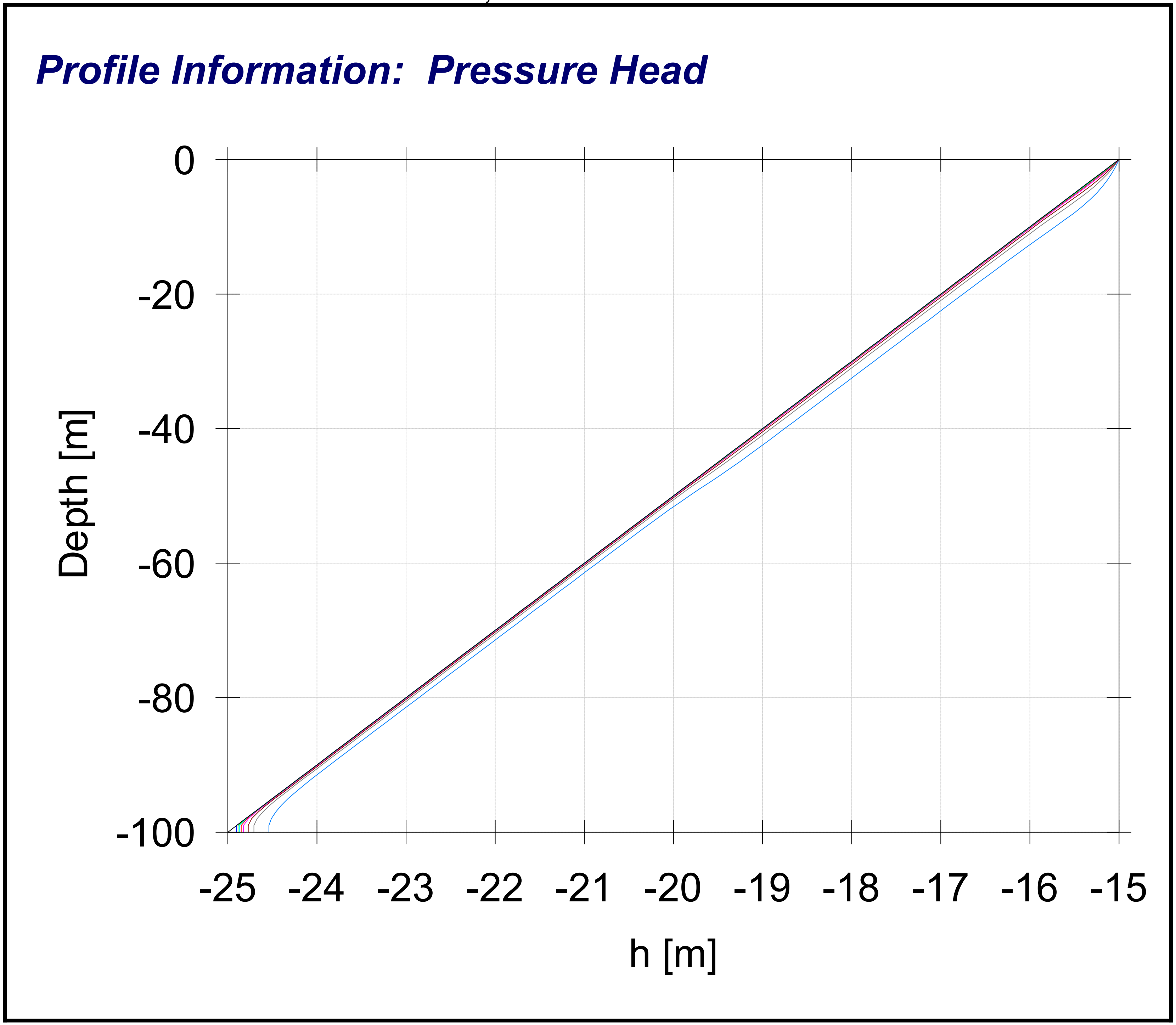
- Constant Head
100
1 meter Finite Element Cells
All Scenarios
- Free Drainage
1
2
3
4
5
6
Layers Not Used
Backfill



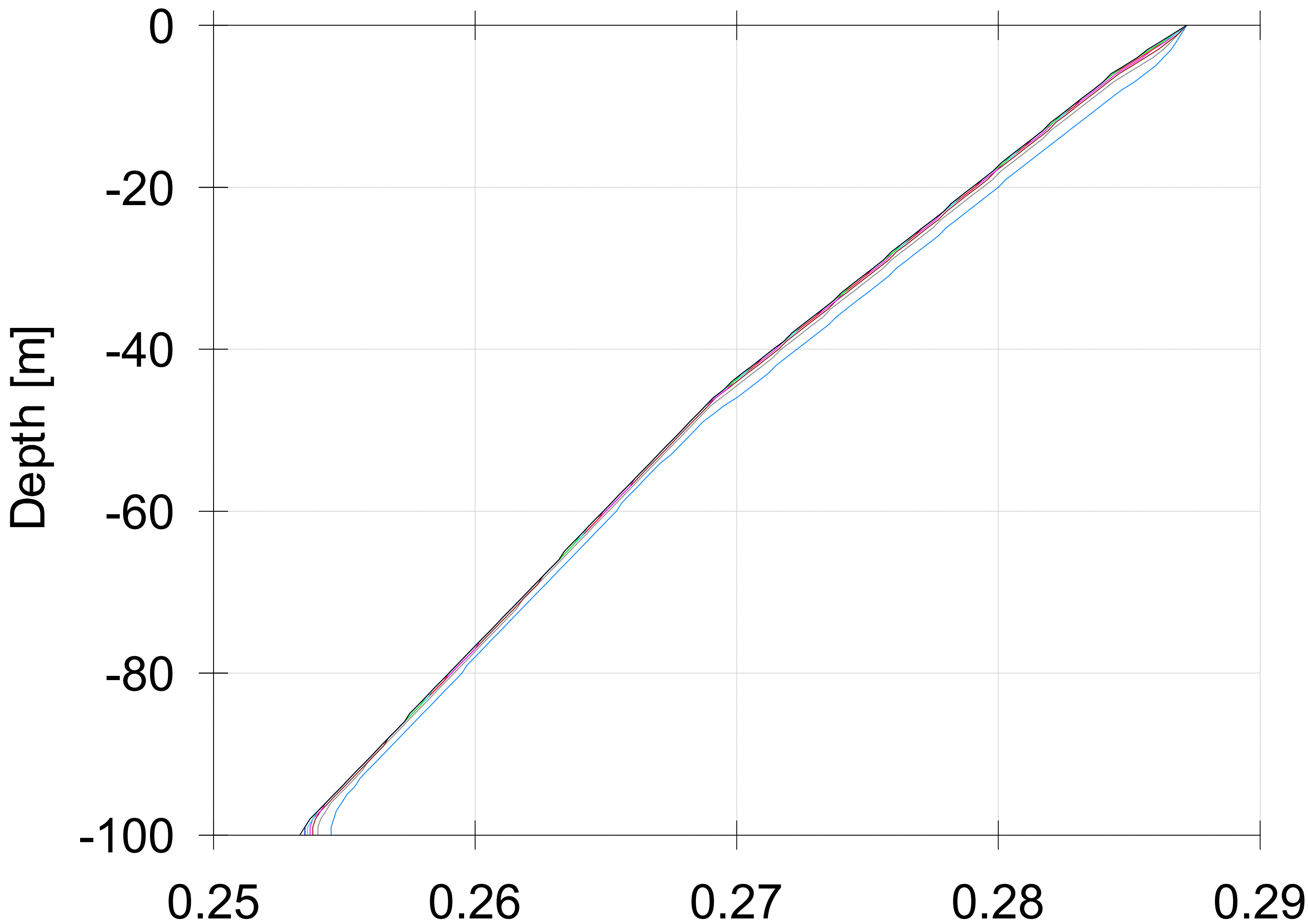
All Scenarios

- Observation point below pit bottom at 90m bgs

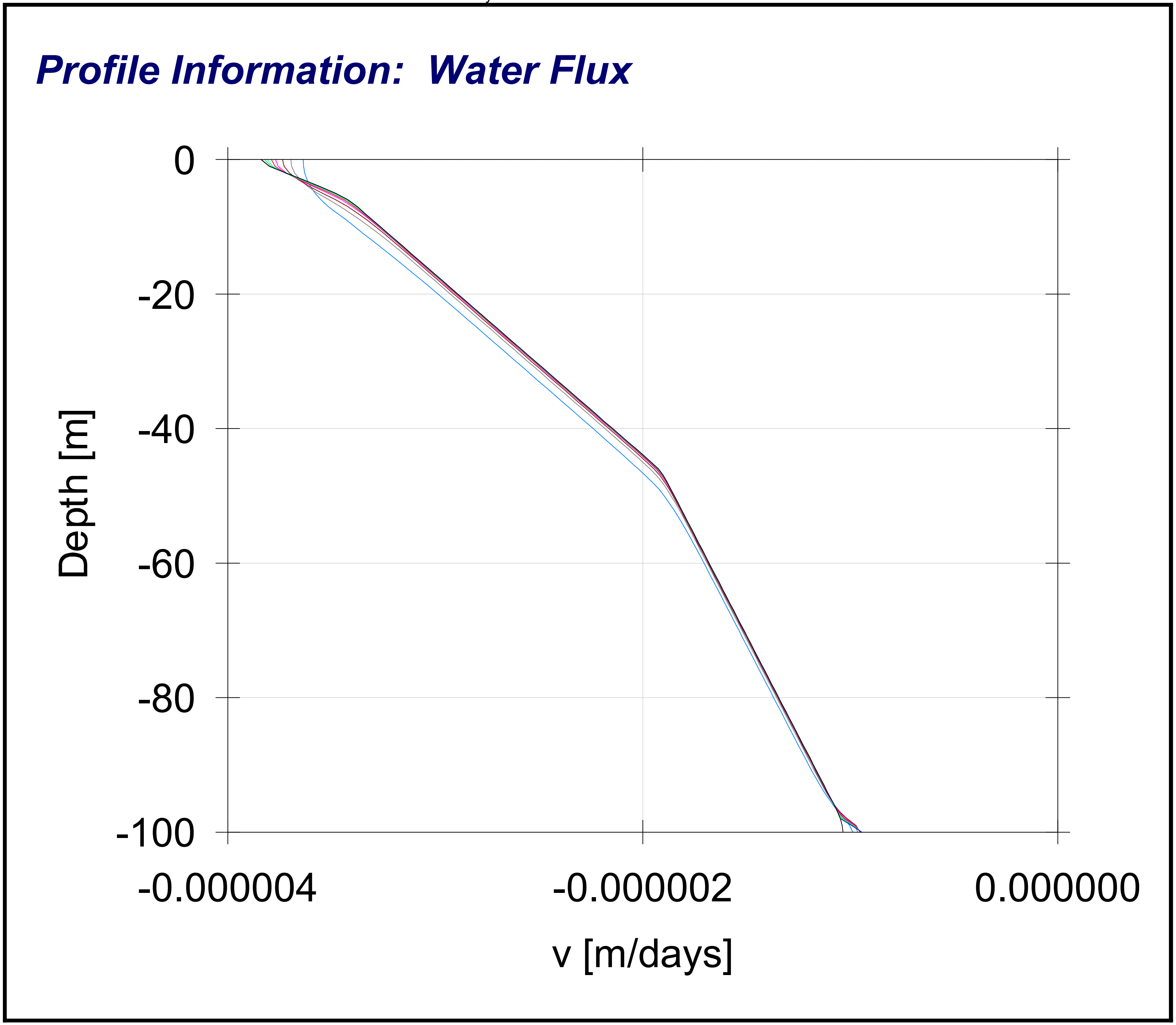
Hydro Pit Simulation 1 Base Case



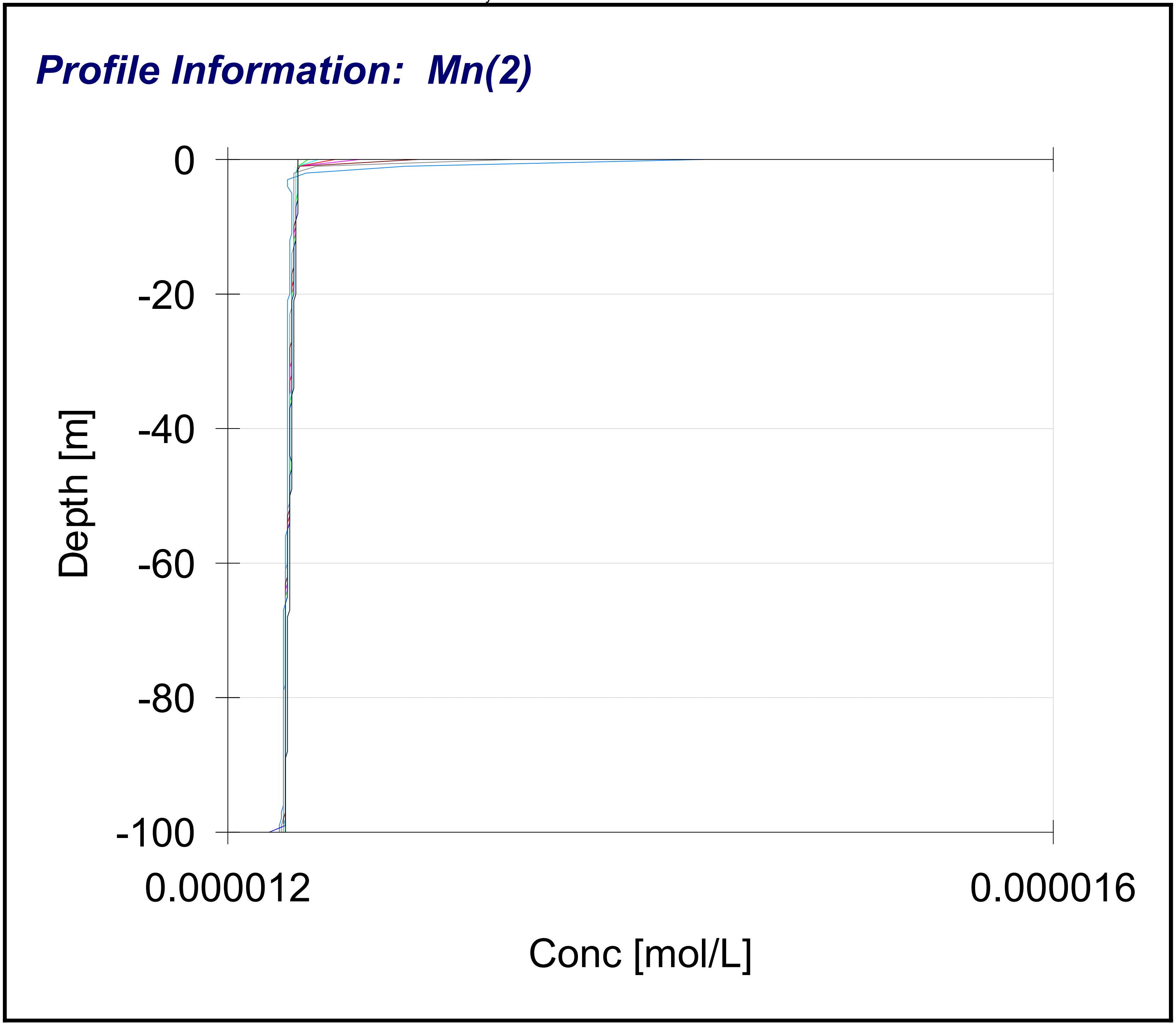
Profile Information: Water Content

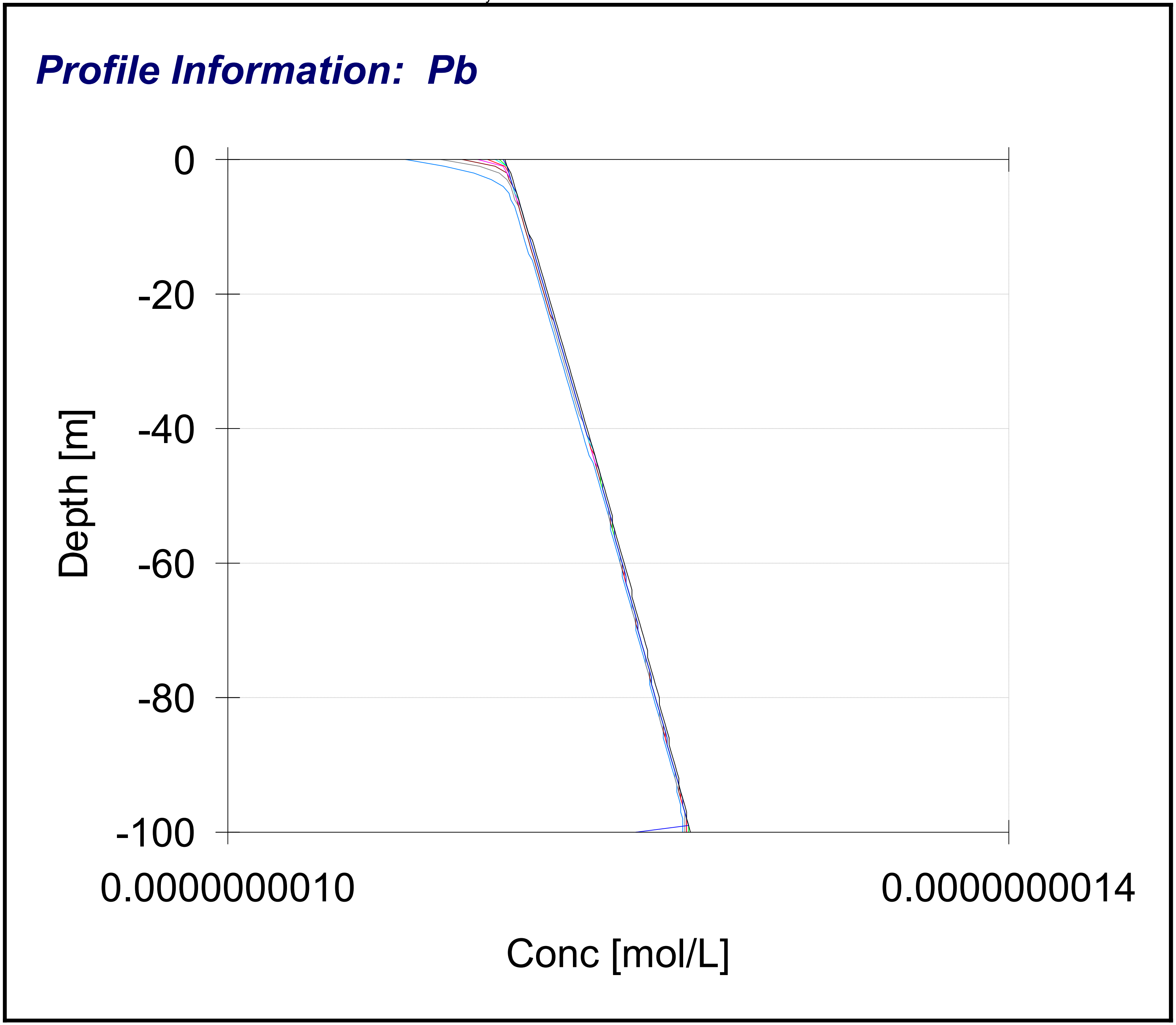


Hydro Pit Simulation 1 Base Case



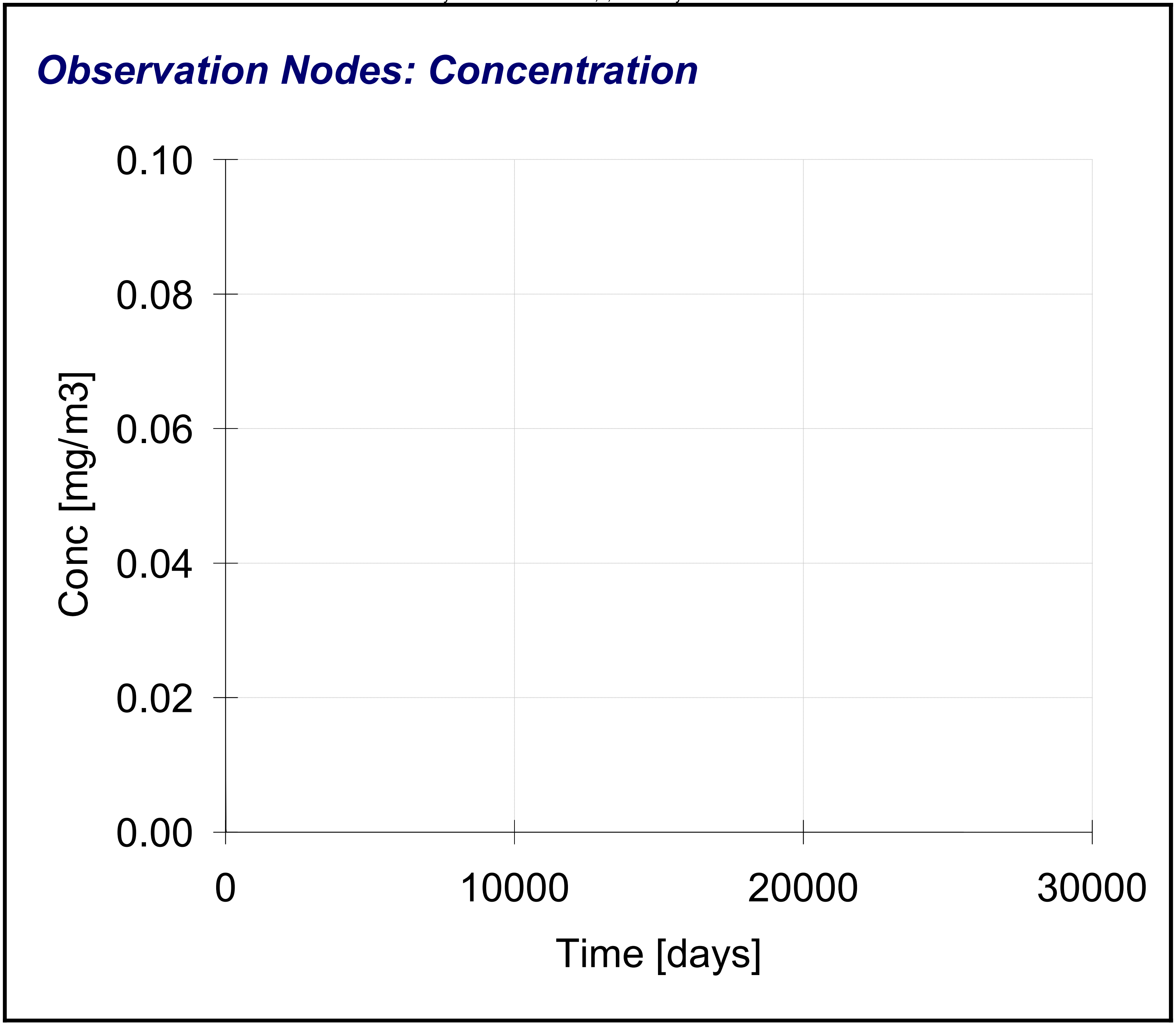
Hydro Pit Simulation 1 Base Case



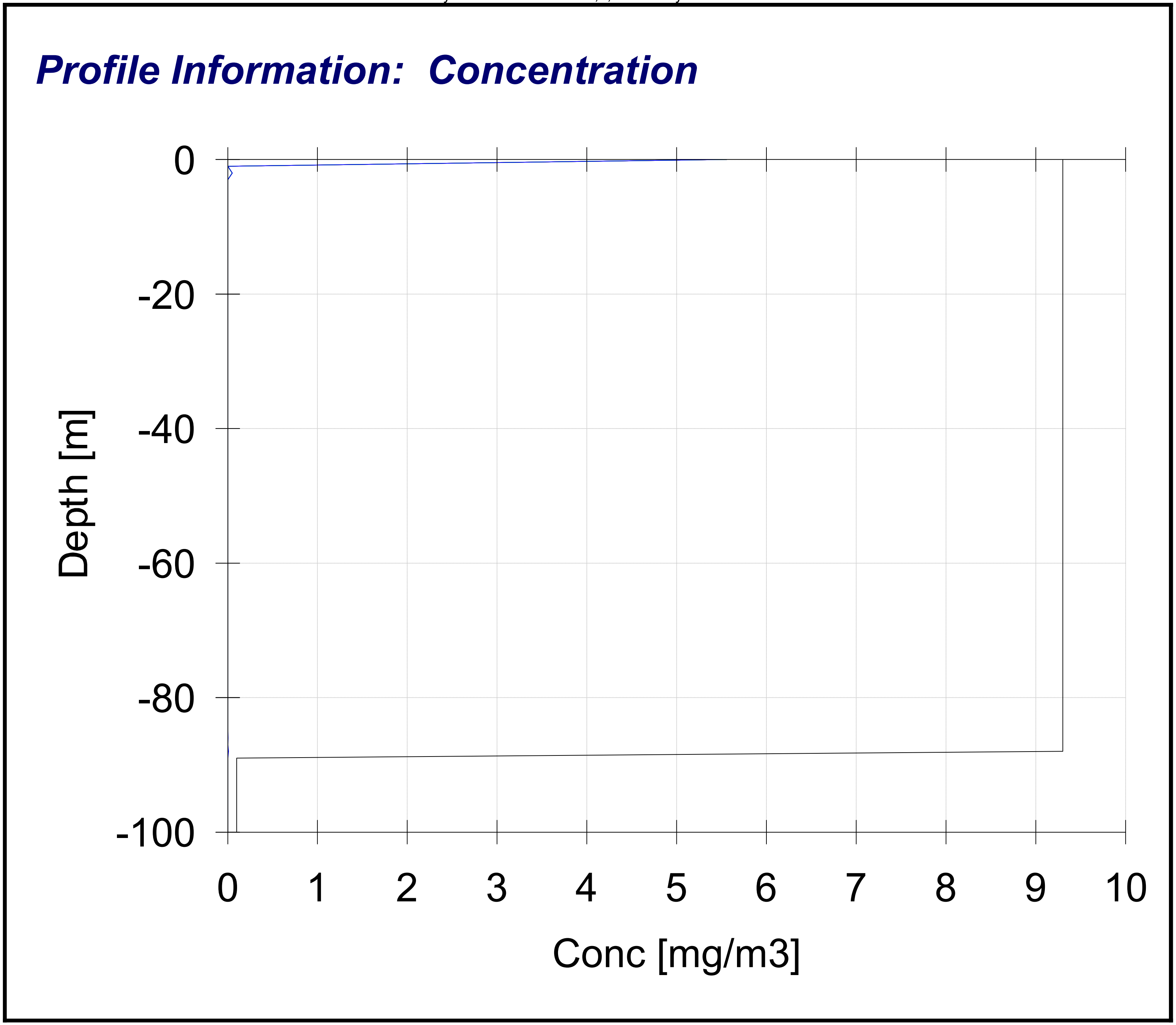


Profile Information: Pb
0
-20
-40
-60
-80
-100
Depth [m]
0.0000000010
0.0000000014
Conc [mol/L]

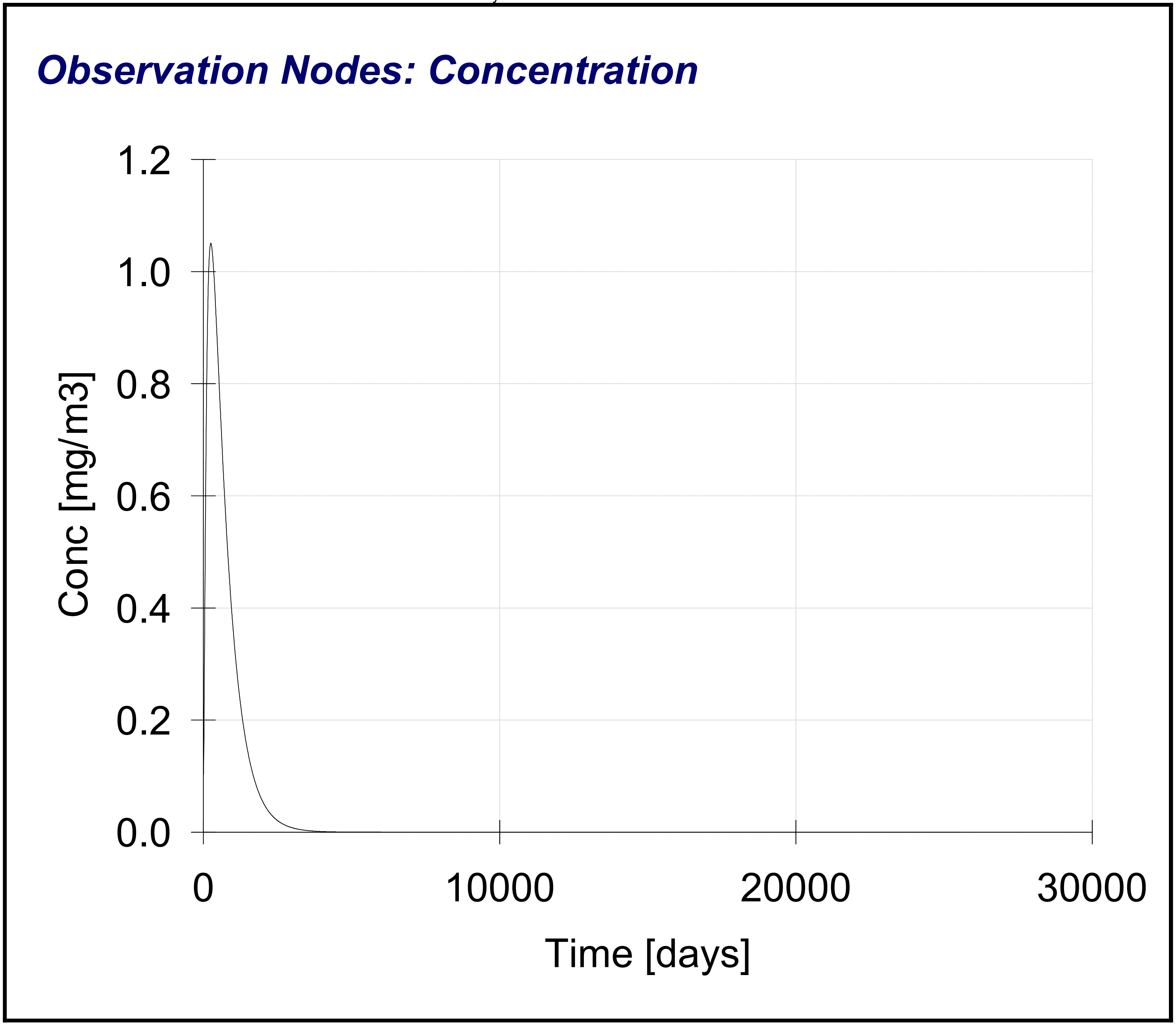
Hydro Pit Simulation 9 1,2,4 Trimethylbenzene



Hydro Pit Simulation 9 1,2,4 Trimethylbenzene

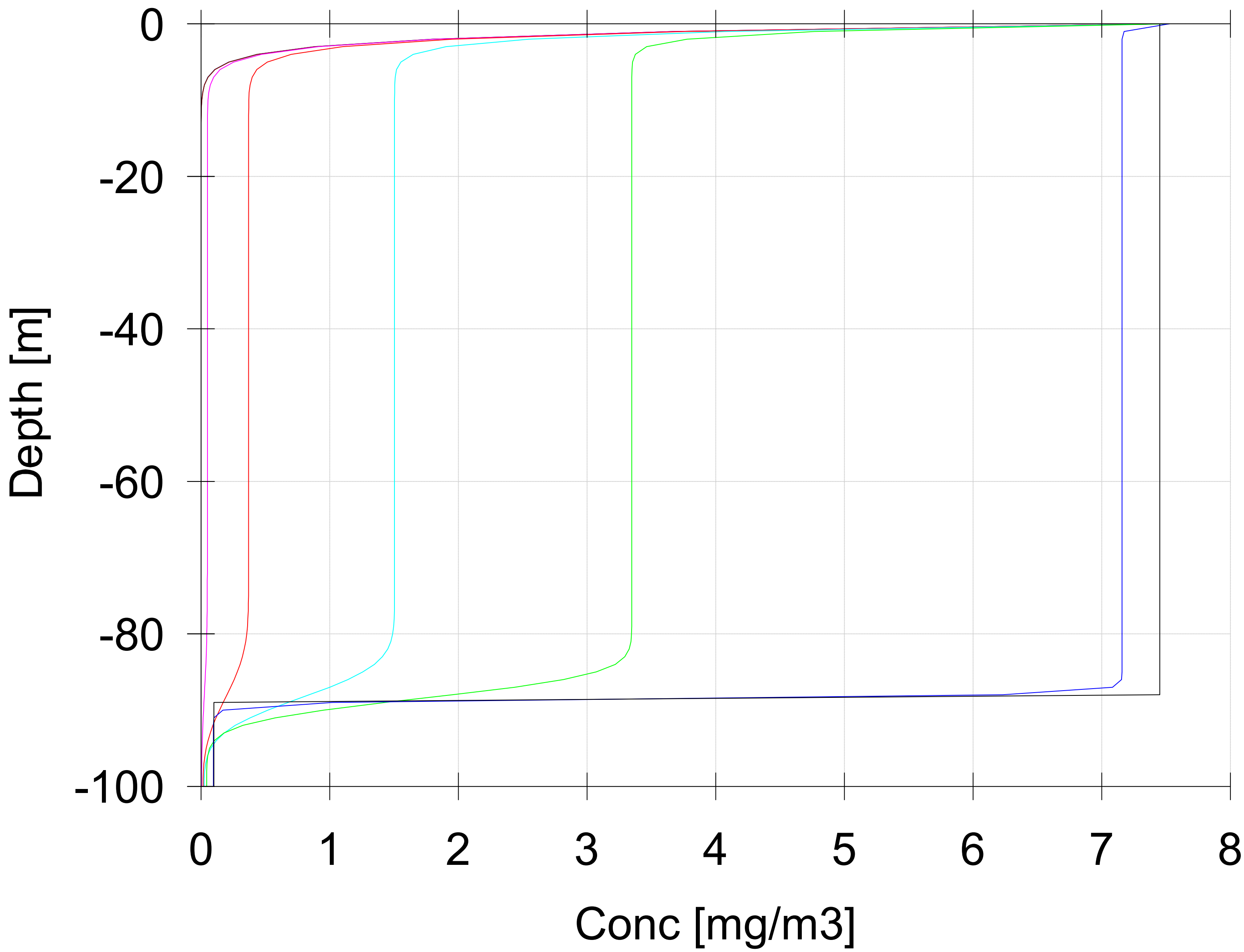


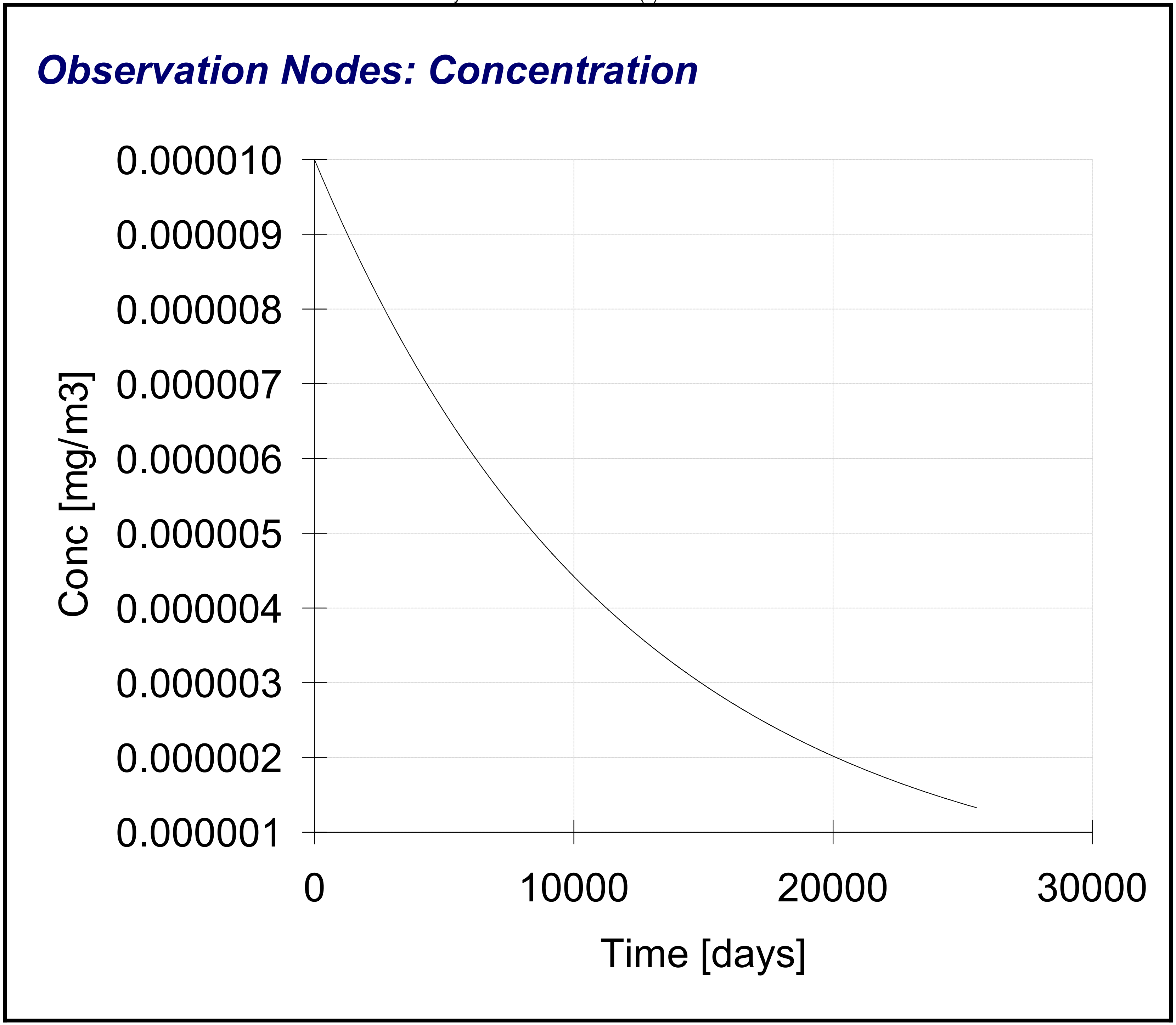
Hydro Pit Simulation 9 Benzene



Hydro Pit Simulation 9 Benzene

Profile Information: Concentration




Observation Nodes: Concentration
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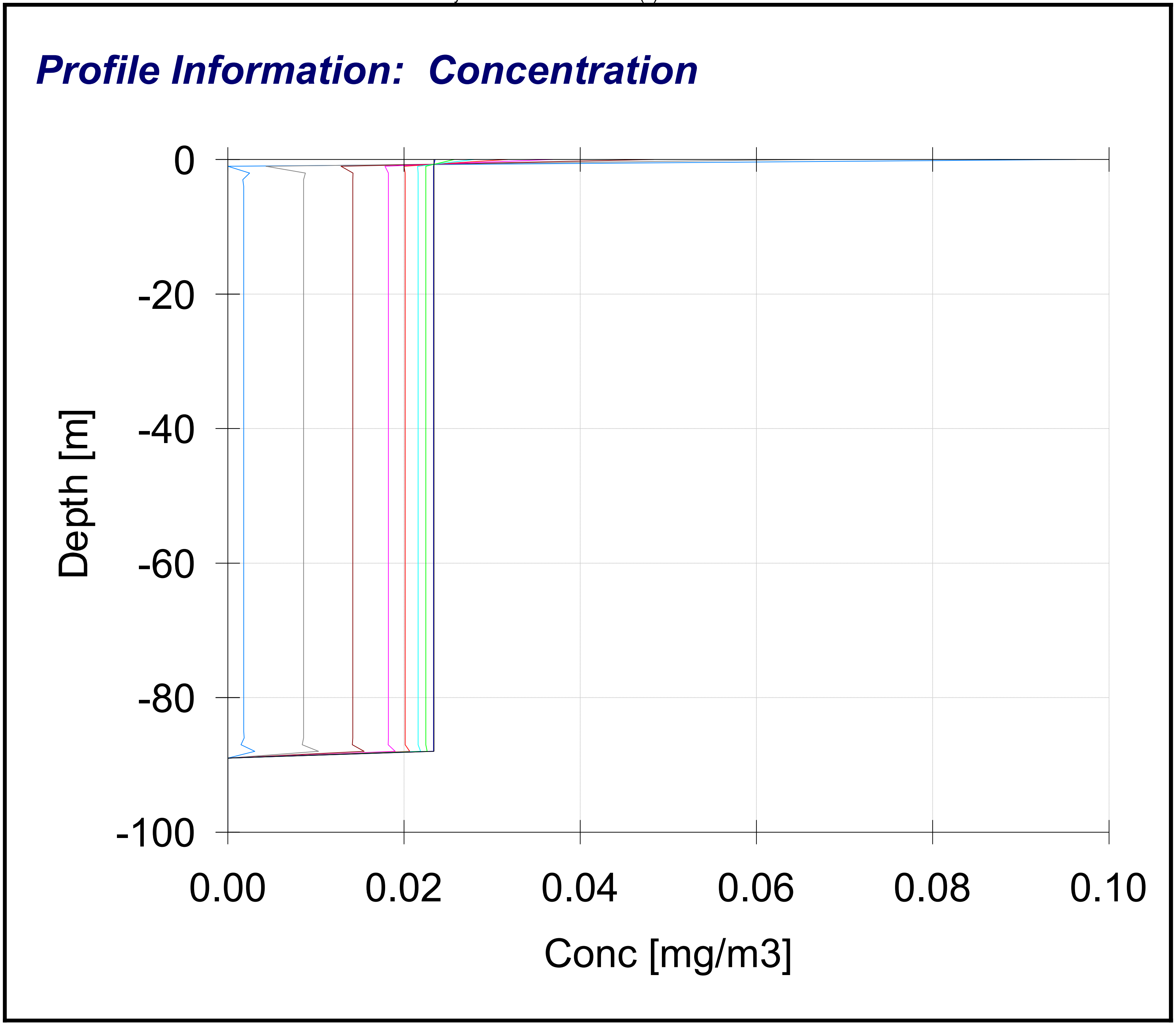
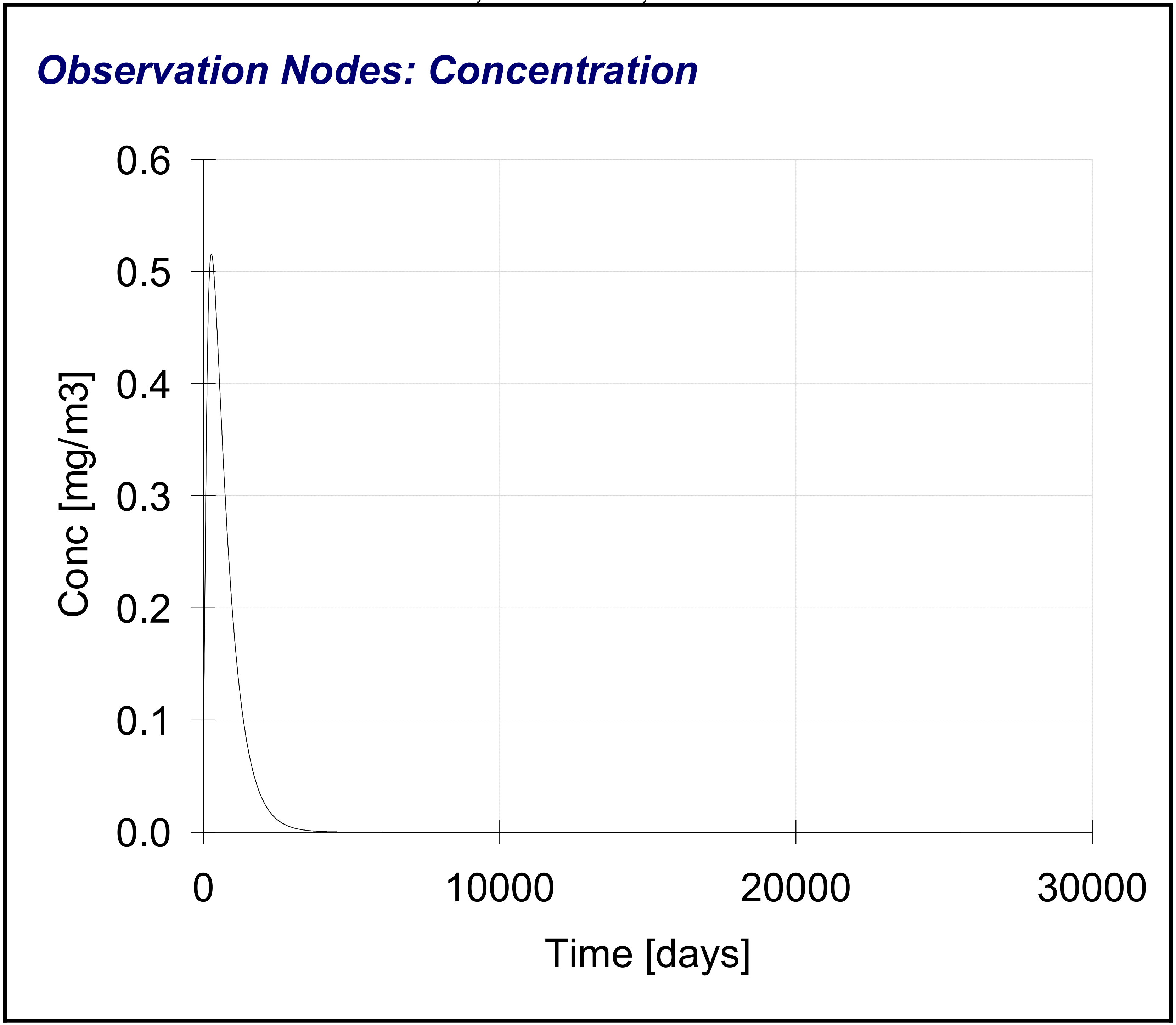
0.000009
0.000008
0.000007
0.000006
0.000005
0.000004
0.000003
0.000002
0.000001
Conc [mg/m3]
0
10000
20000
30000
Time [days]

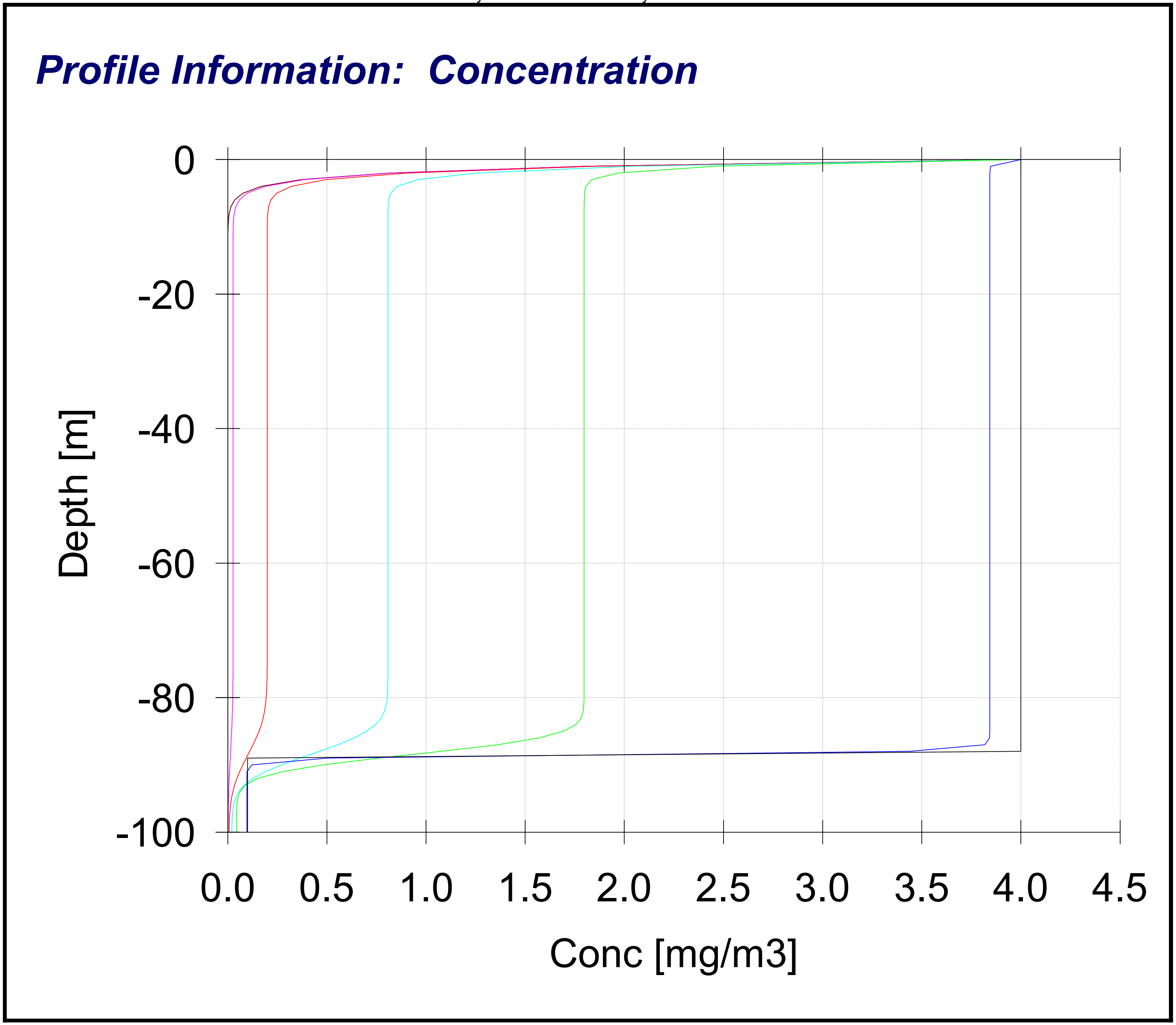
Hydro Pit Simulation 9 Benzo(a)anthracene



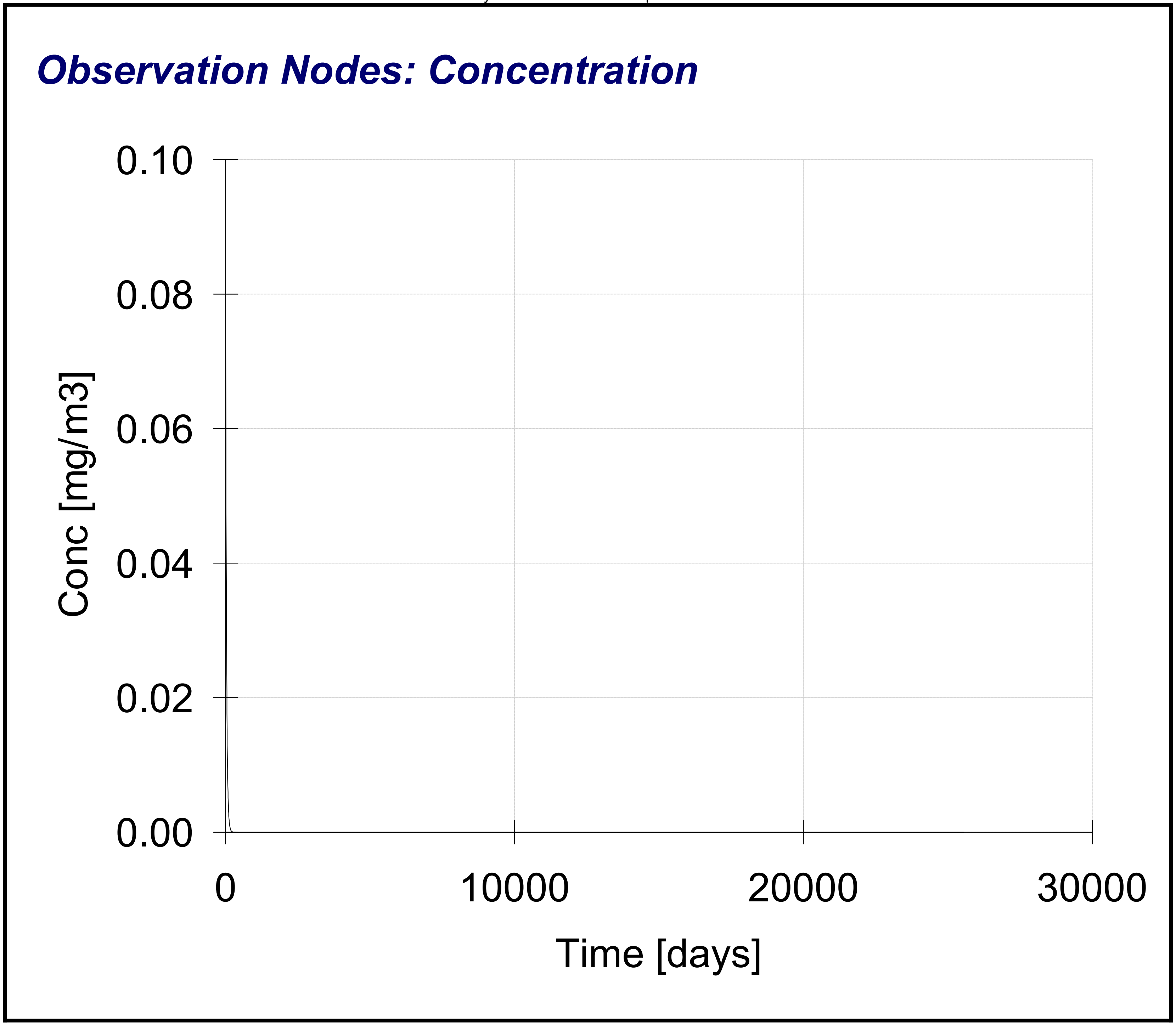
Hydro Pit Simulation 9 Ethylbenzene



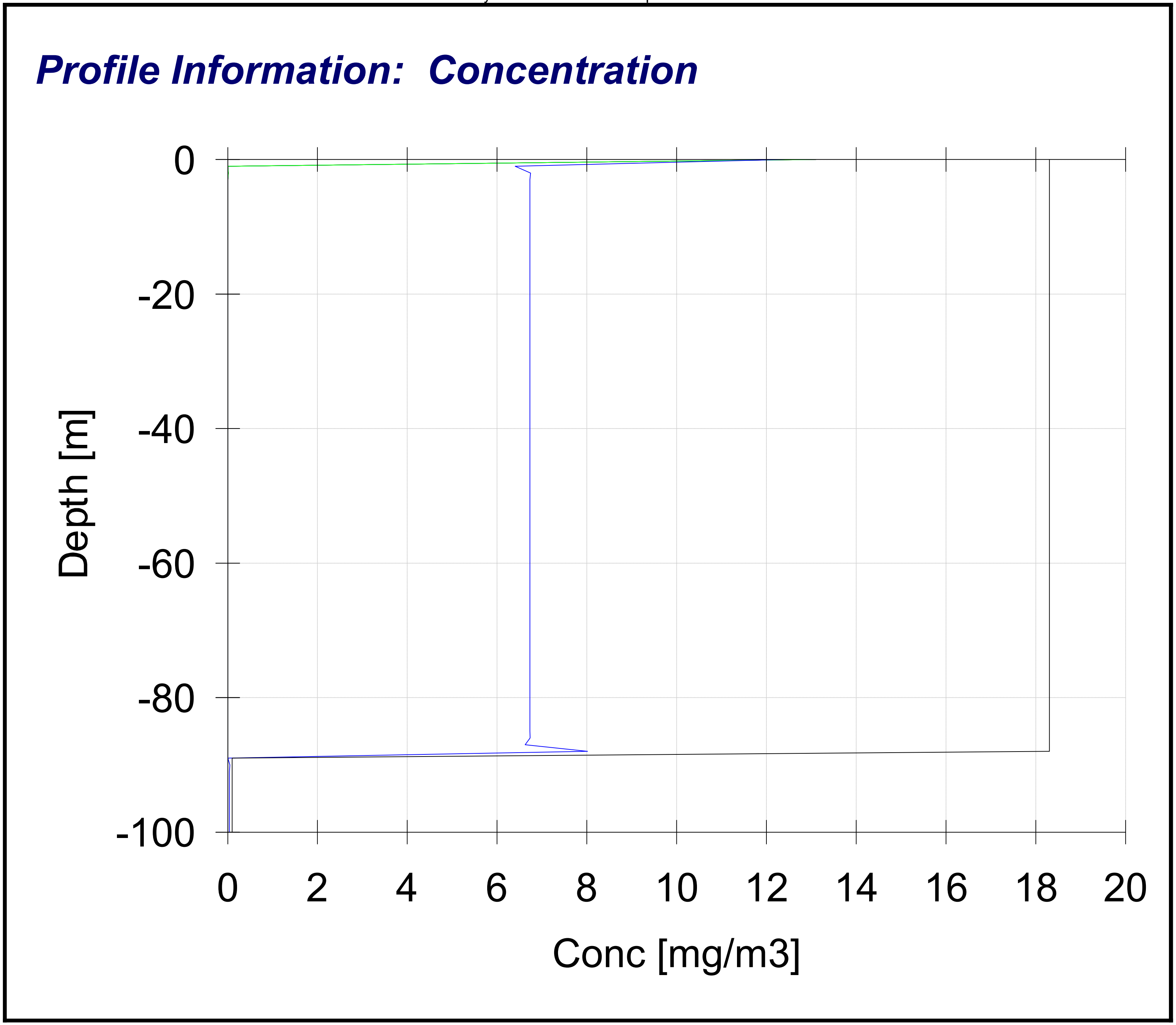
Hydro Pit Simulation 9 Ethylbenzene



Hydro Pit Simulation 9 Napthalene



Hydro Pit Simulation 9 Napthalene



APPENDIX H

Central Valley Model Simulation Results

Table 1H

CVS Base Case Model Simulation and Sensitivity Simulation Input Parameters

Description	**CVS Preferred Alternative with Root Uptake**	**CVS Alternate Climate with Root Uptake**	**CVS Alternate Cover with Root Uptake**	**CVS Alternate Cover and Climate with Root Uptake**	**CVS Alternate Fill with Root Uptake**	**CVS Proctor 95 percent with Root Uptake**	**CVS Proctor 85 percent with Root Uptake**
CVS Run Number	1 (Base Case)	2	3	4	5	6	7
Dimension	1D, no-flow horizontal boundary condition						
Time Domain, yr	72	52	72	52	72	72	72
Initial Time, d	0	0	0	0	0	0	0
Final Time, d	26768	19106	26768	19106	26768	26768	26768
Initial Time Step, d	0.01						
Minimum Time Step, d	0.0001						
Maximum Time Step, d	1						
Maximum Number of Iterations	100						
Depth, m	155						
Average Annual Precipitation, in	4.15	5.55	4.15	5.55	4.15	4.15	4.15
PET Estimation	Hargreaves Formula						
Cover Unit	Alluvium Borrow TP	Alluvium Borrow TP	Older Alluvium Fan Deposits	Older Alluvium Fan Deposits	Alluvium Borrow TP	Alluvium Borrow TP	Alluvium Borrow TP
Fill Unit	Waste Rock WR07E-WR07N	Waste Rock WR07E-WR07N	Waste Rock WR07E-WR07N	Waste Rock WR07E-WR07N	Earley et al., 2001 Table 1	Waste Rock WR07E-WR07N	Waste Rock WR07E-WR07N
Geologic Substrate Unit	Muddy Creek TP3						
Cover Thickness, m	3						
Waste Thickness, m	12						
Geologic Substrate Thickness, m	140						
Hydraulic Properties	SWCC, Table 6 Cover, Fill and Geologic Subsrate Units						
Soil Hydraulic Model	van Genuchten - Maulem, no hysteresis						
Upper Boundary Condition	Atmospheric with Surface Runoff						
Lower Boundary Condition	Free Drainage						
S-Shape root uptake function P50 [m]	-10 (Van Genuchten)						
S-Shape root uptake function P3, [-]	3 (Van Genuchten)						
Solute Stress	None						
Climate Data	McCarran Airport Las Vegas, NV	Boulder City, NV	McCarran Airport Las Vegas, NV	Boulder City, NV	McCarran Airport Las Vegas, NV	McCarran Airport Las Vegas, NV	McCarran Airport Las Vegas, NV
Percent Cover for Leaf Area Index	No leaf interception						
Root Depth, m	1.5						
Root Density	Linear decrease from surface						
Solute Transport	Conservative, Equilibrium Model						
Dispersivity (longitudinal), m	10						
Initial Condition Top, Pressure Head, [-m][1]	10	10	10	10	10	5	15
Initial Condition Bottom, Pressure Head, [-m][1]	100	100	100	100	100	15	30
Numerical Simulator	Finite Element 1 meter length cells, (see input files for other details concerning numerical settings, tolerances, print times etc.)						
Hydrus Modified Example Template	**Model input parameters not provided in Table 1H are the same as the Hydrus-1D software template input file ROOTUPTK.h1d provided with the software and tested by the developers (Šimůnek et al., 2018)**						
Software Manual							
Hydrus 1D	Šimůnek, J., Šejna, H., Saito, H., Sakai, M., van Genuchten, M. Th., 2018. The Hydrus-1D Software Package for Simulating the One-Dimensional Movement of Water, Heat, and Multiple Solutes in						

Notes:

[1]Initial pressure head gradient set to attain the target moisture condition with respect to expected Proctor compaction target. For simulations 1 - 5 the target moisture content is 90 percent of Proctor. For simulations 6 and 7 it is 95 and 85 percent of Proctor, respectively.

MWMP = Meteoric Water Mobility Procedure

SWCC = Soil Water Characteristic Curve

yr = year

d = day

m = meter

in = inches

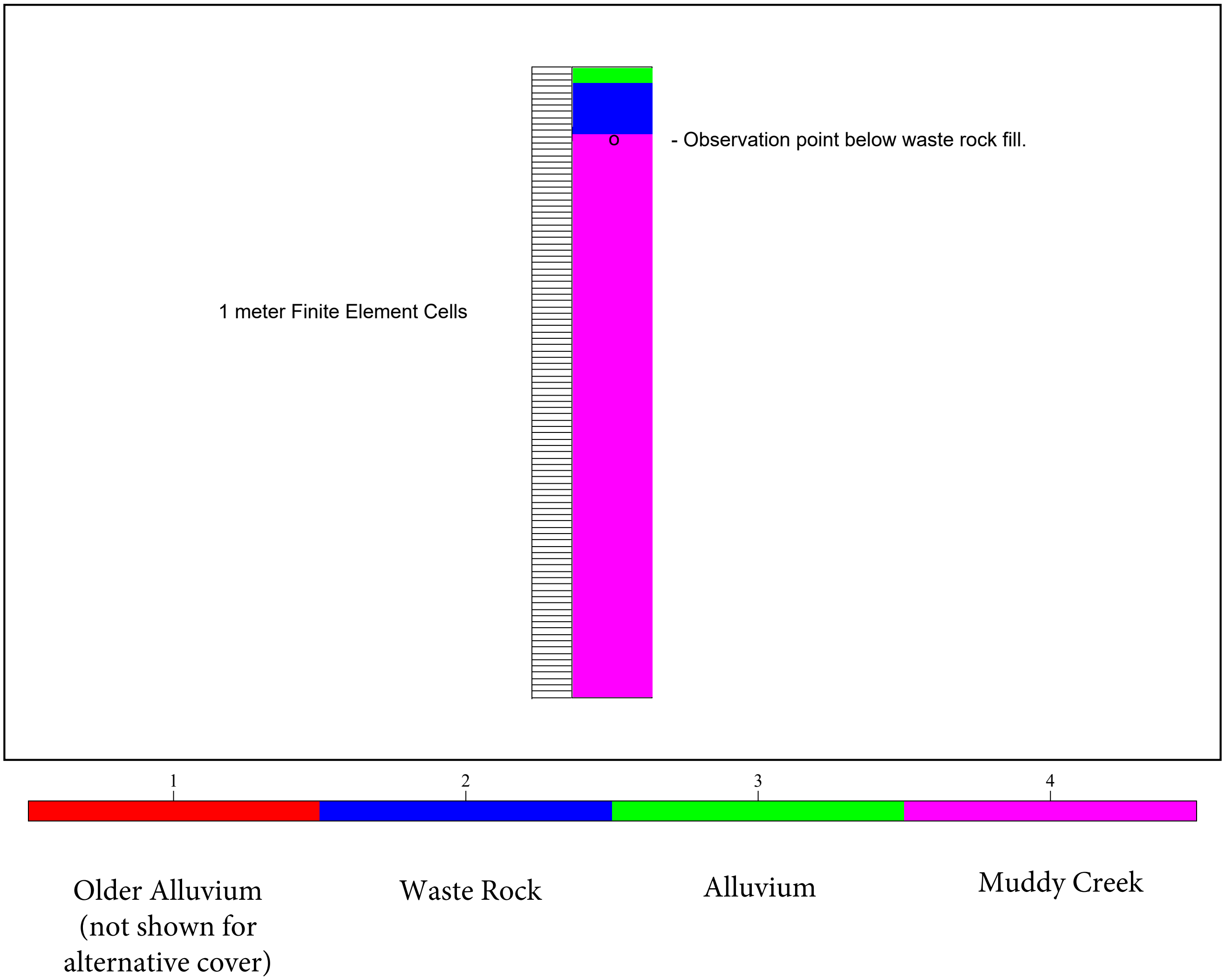
PET = Potential Evapotranspiration

P50 = Root water uptake at this pressure head is reduced by 50%.

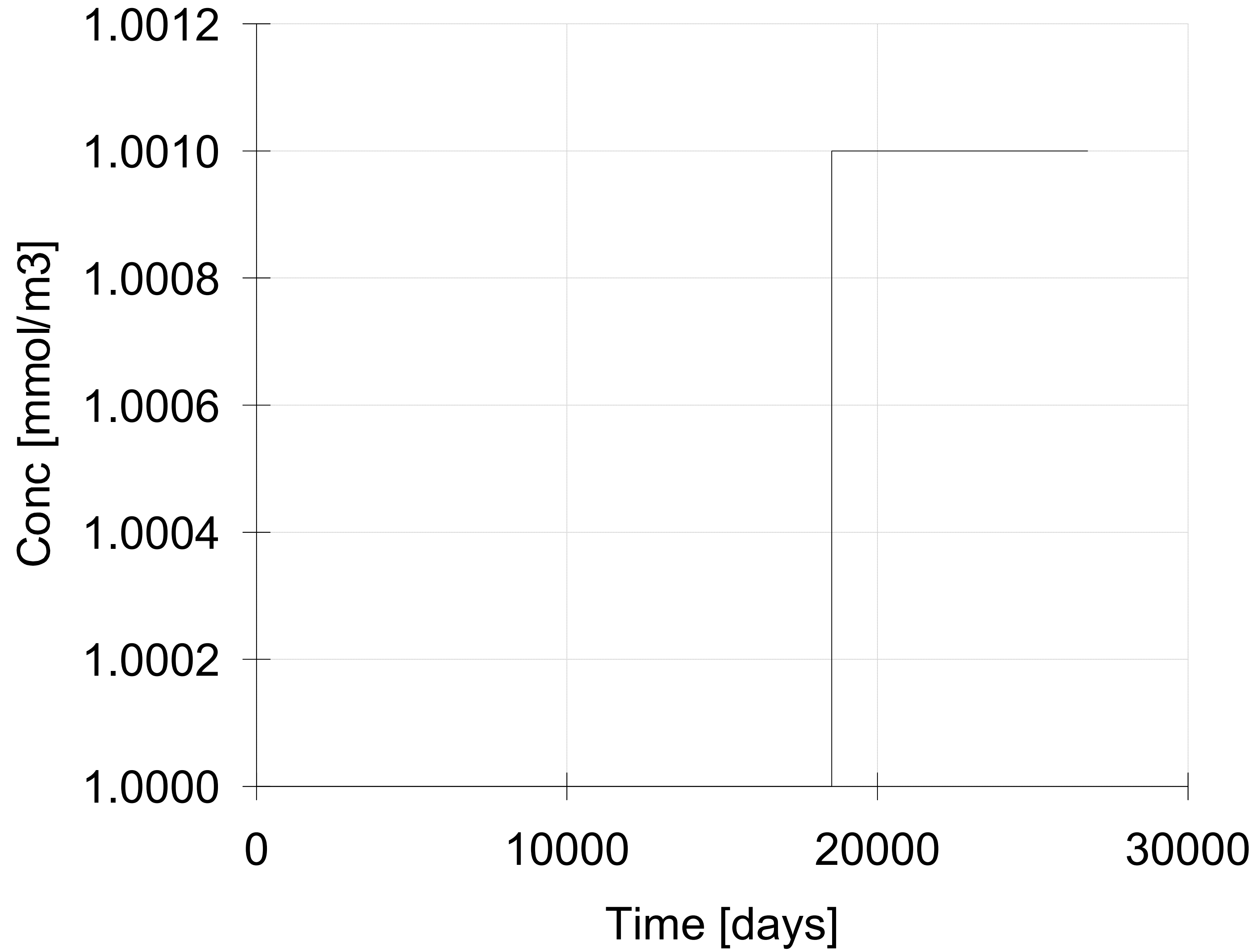
P3 = The exponent, p, in the root water uptake response function associated with water stress.

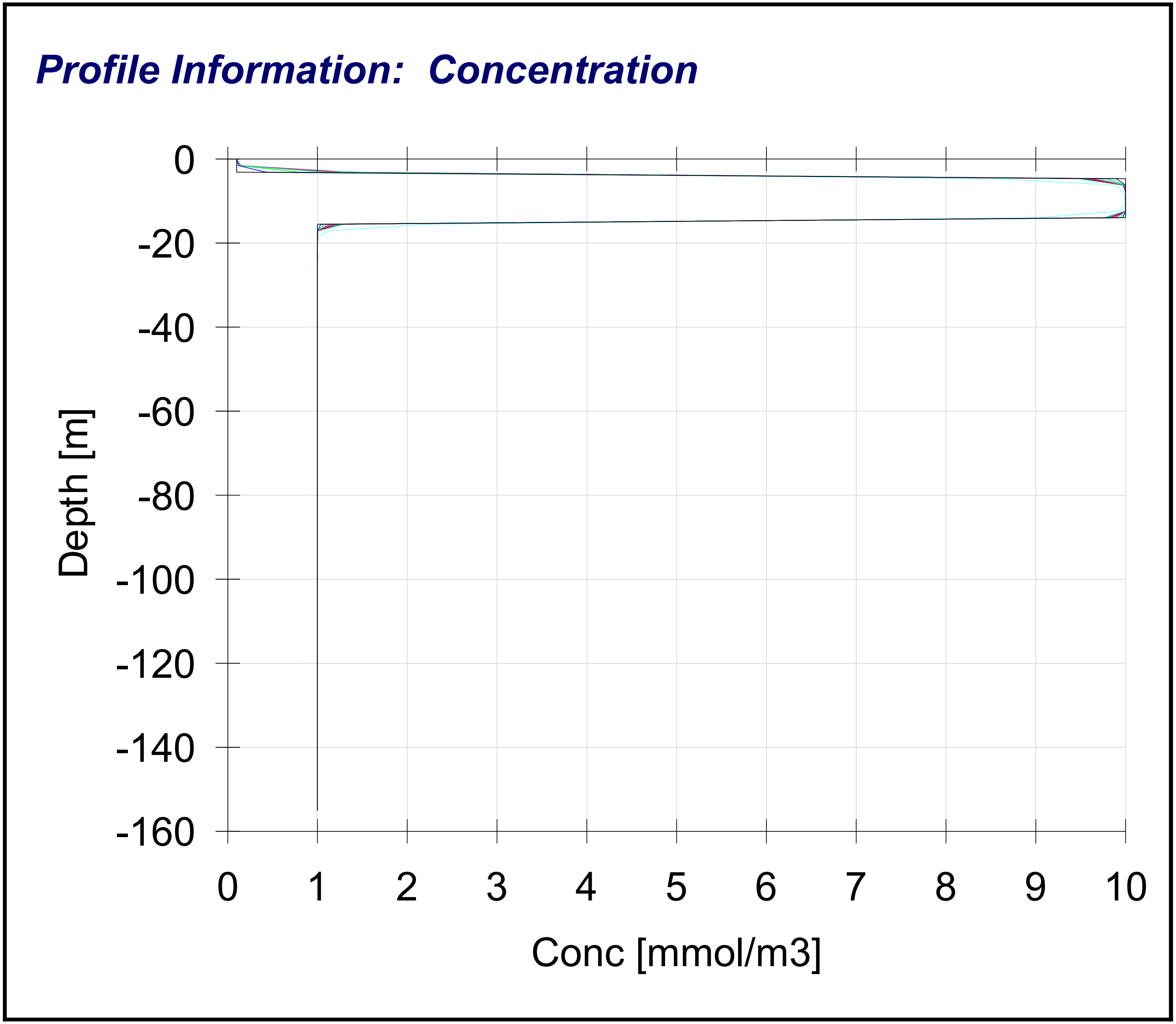
NA = Not Applicable

Central Valley Model Base Case Domain and Profile, 155 meters (508.5 feet) Deep Below Ground Surface

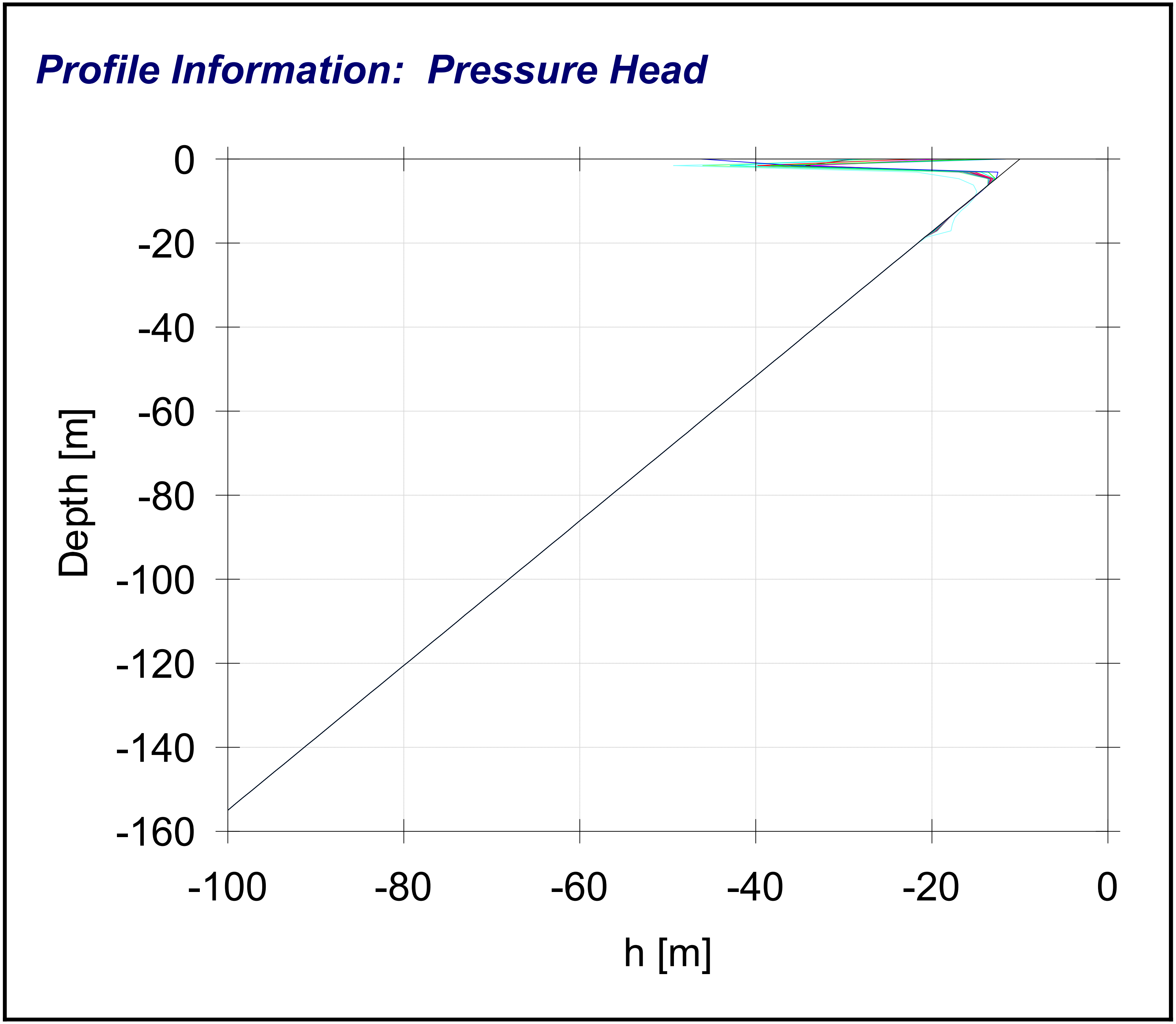


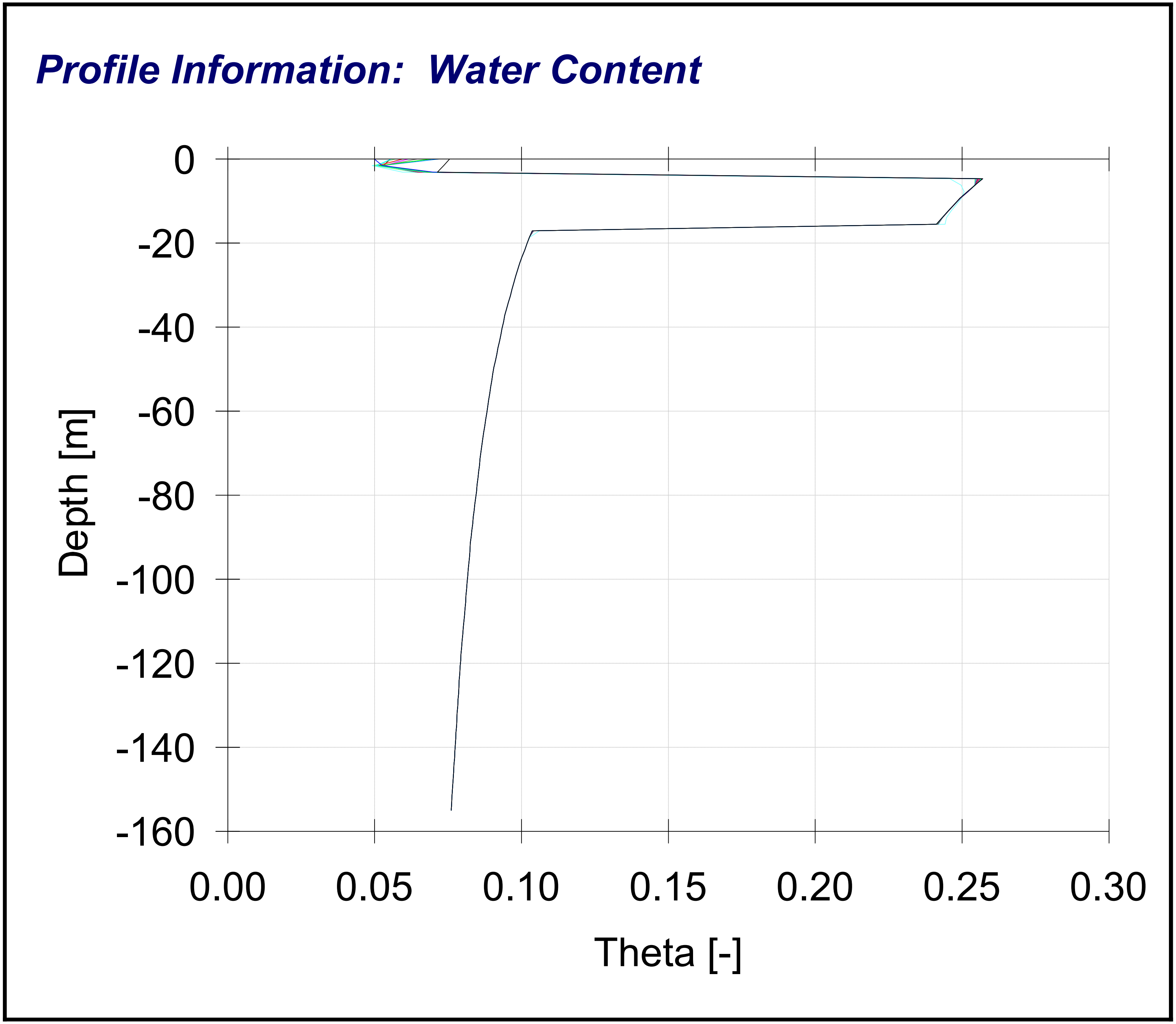
Observation Nodes: Concentration



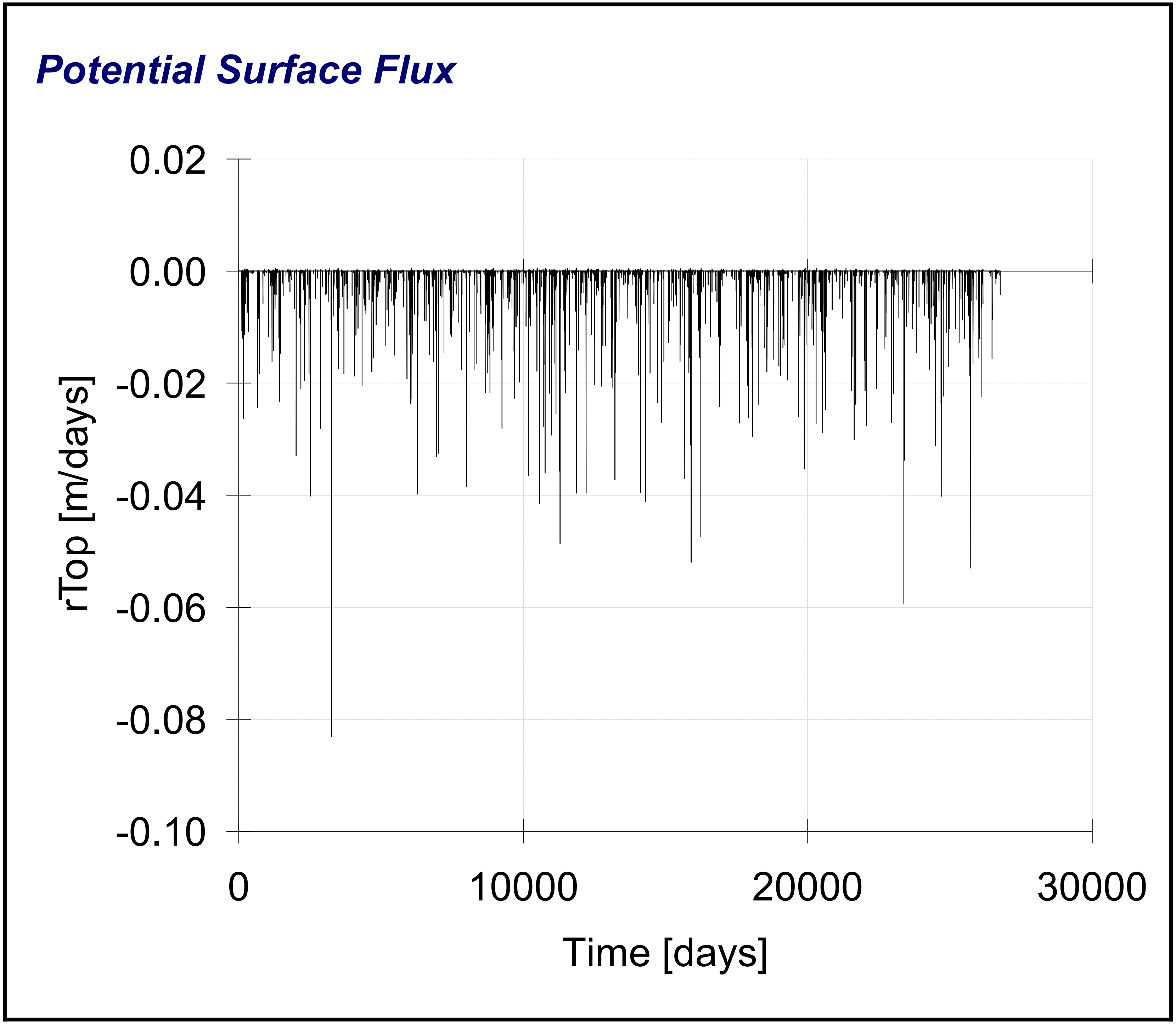


Profile Information: Concentration
0
-20
-40
-60
-80
-100
-120
-140
-160
Depth [m]
0
1
2
3
4
5
6
7
8
9
10
Conc [mmol/m3]

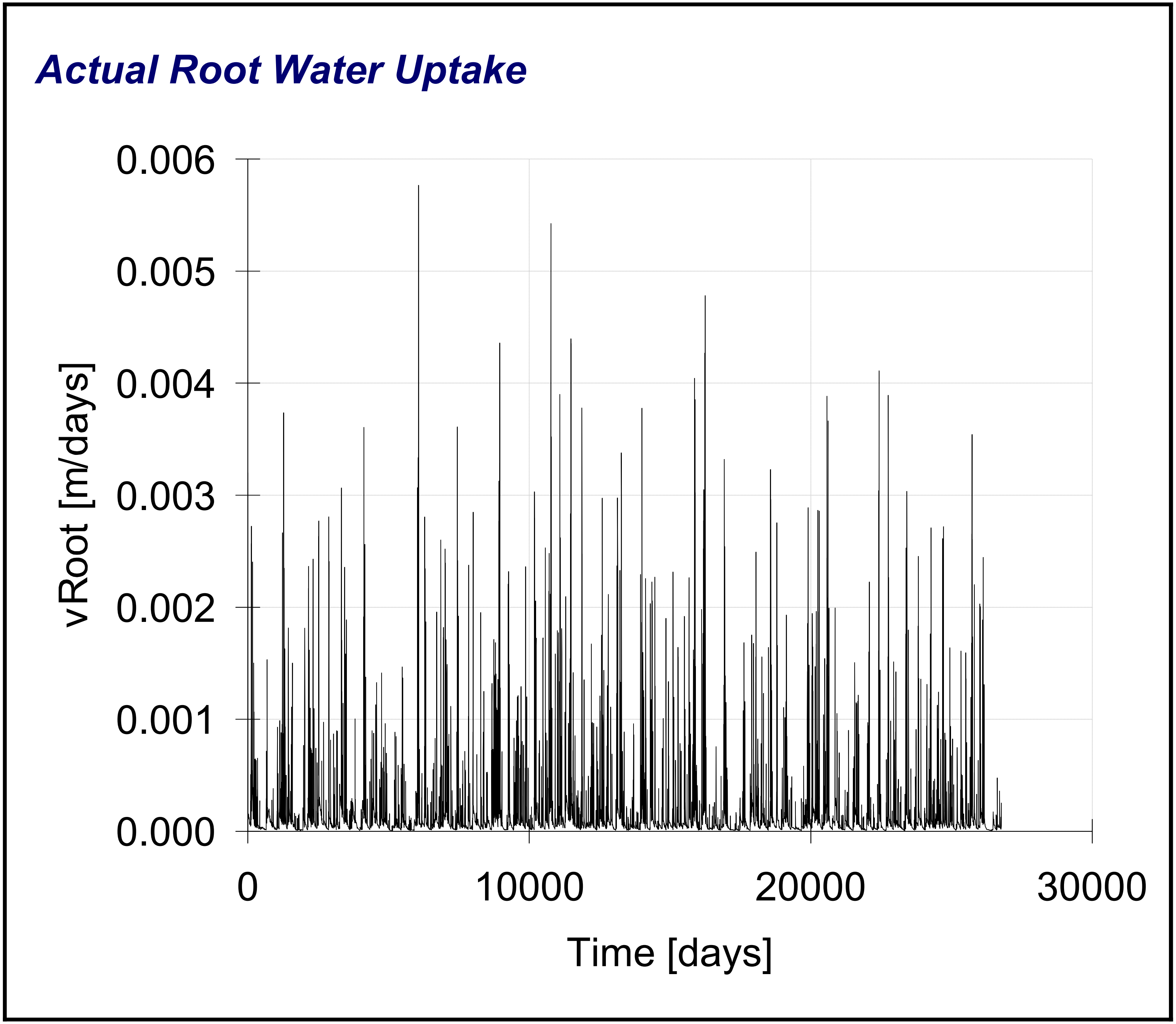

Profile Information: Pressure Head
0
-20
-40
-60
-80
-100
-120
-140
-160
Depth [m]
-100
-80
-60
-40
-20
0
h [m]



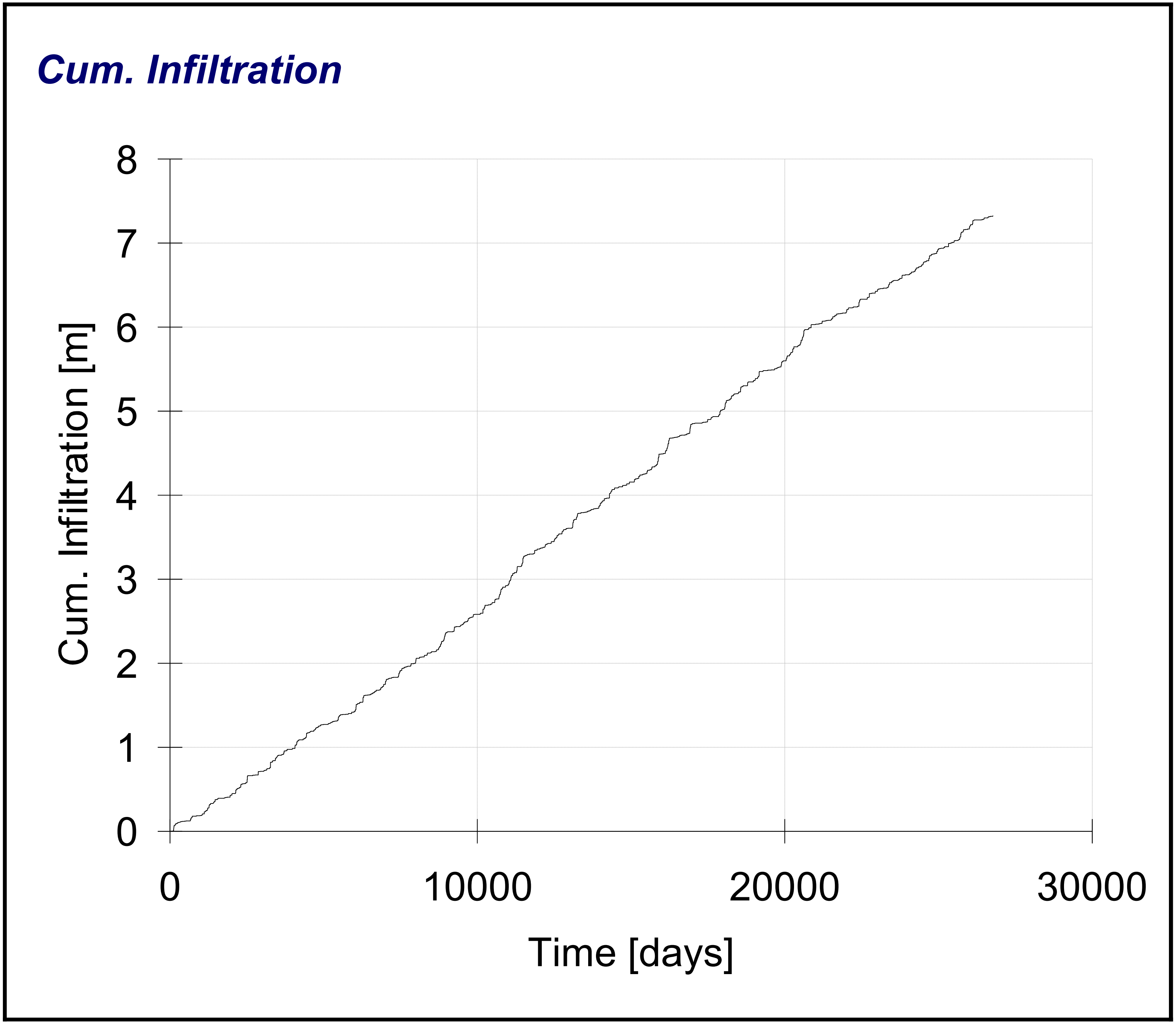
Profile Information: Water Content
0
-20
-40
-60
-80
-100
-120
-140
-160
Depth [m]
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Theta [-]



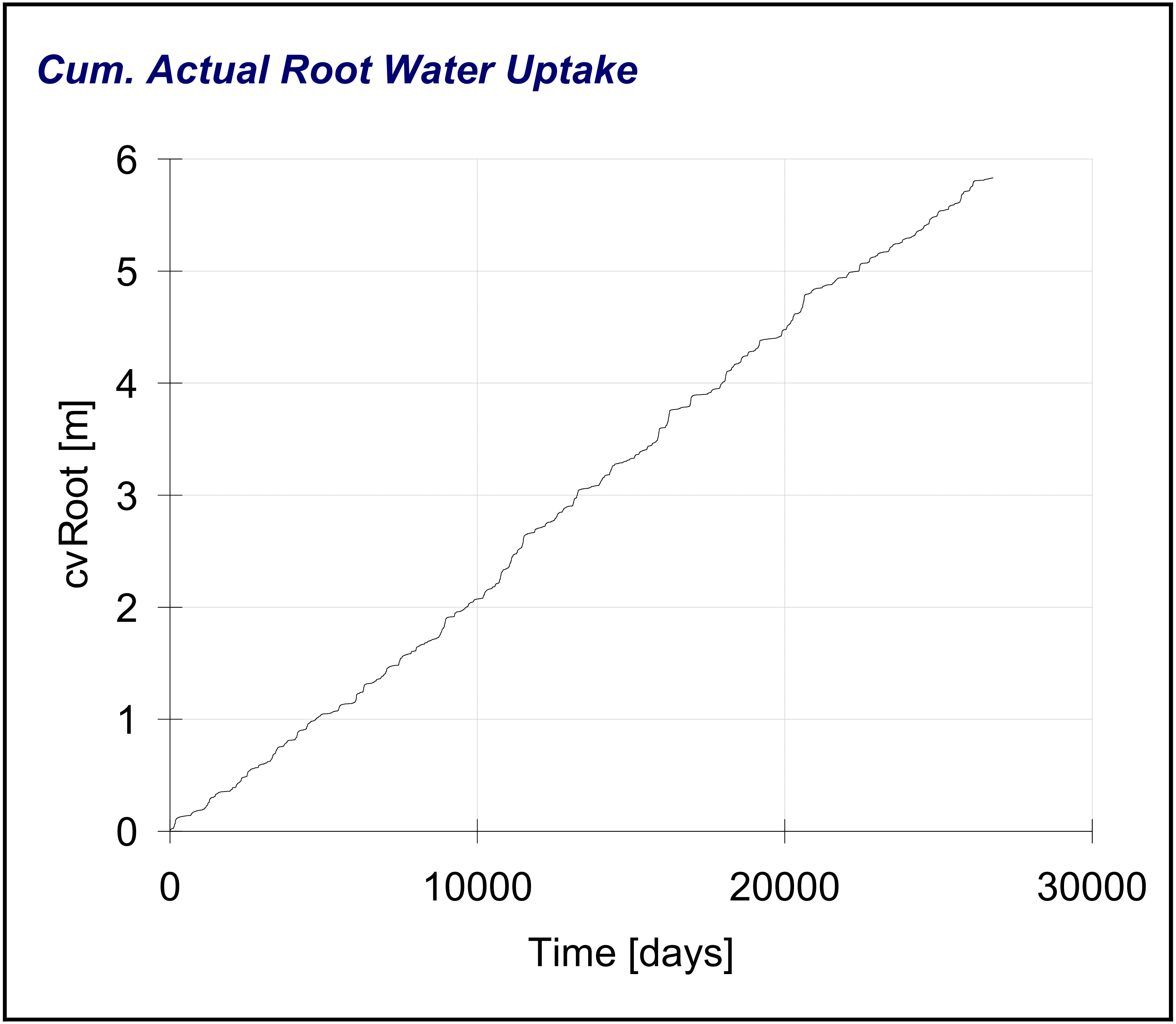
Potential Surface Flux
0.02
0.00
-0.02
-0.04
-0.06
-0.08
-0.10
rTop [m/days]
0
10000
20000
30000
Time [days]



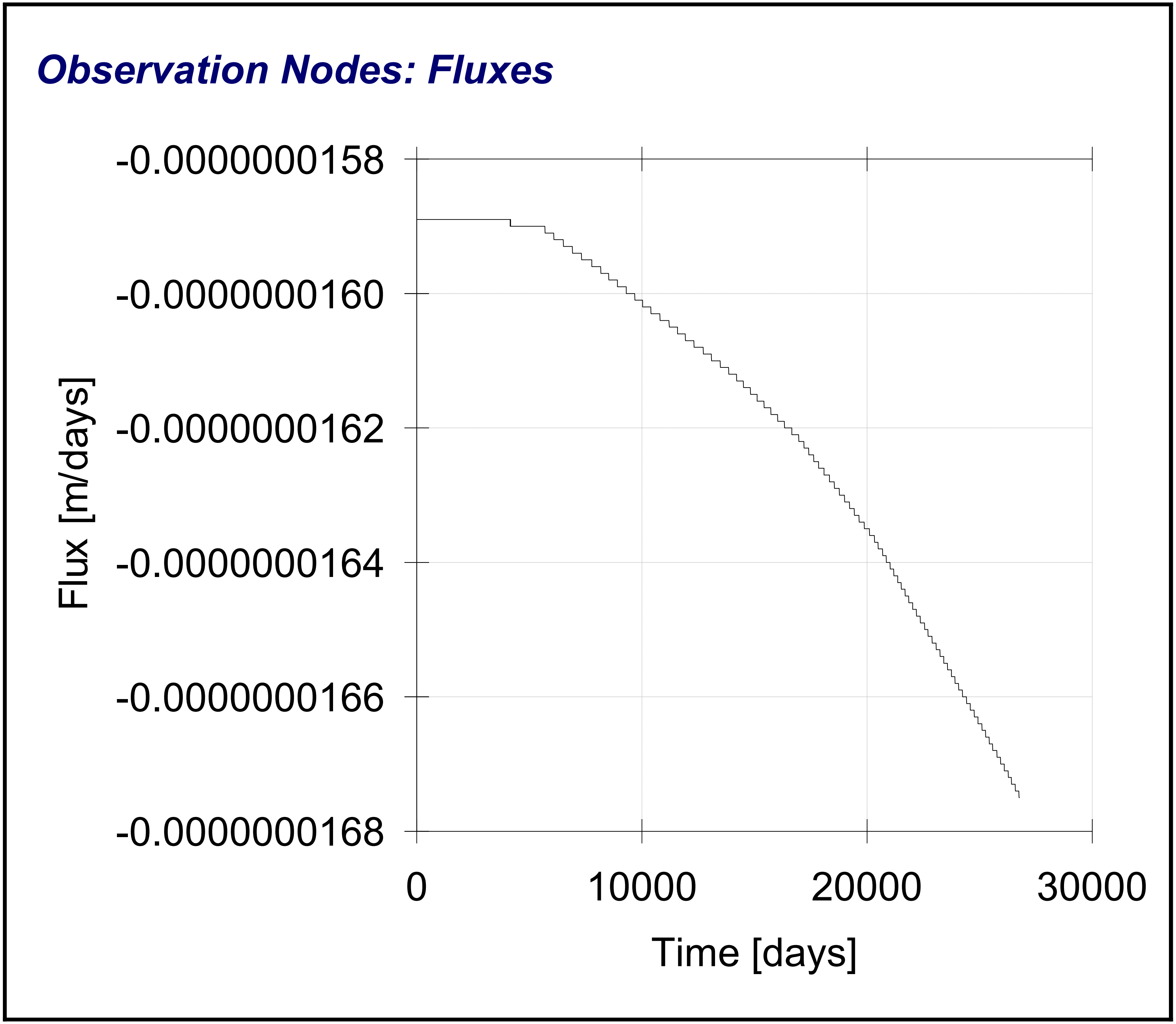
Actual Root Water Uptake
0.006
0.005
0.004
0.003
0.002
0.001
0.000
vRoot [m/days]
0
10000
20000
30000
Time [days]



Cum. Infiltration
Cum. Infiltration [m]
0
1
2
3
4
5
6
7
8
0
10000
20000
30000
Time [days]



Cum. Actual Root Water Uptake
cvRoot [m]
0
1
2
3
4
5
6
0
10000
20000
30000
Time [days]



Observation Nodes: Fluxes
-0.000000158
-0.000000160
-0.000000162
-0.000000164
-0.000000166
-0.000000168
Flux [m/days]
0
10000
20000
30000
Time [days]

APPENDIX I

Hulin and A-B Pit Model Simulation Results

Table 1I

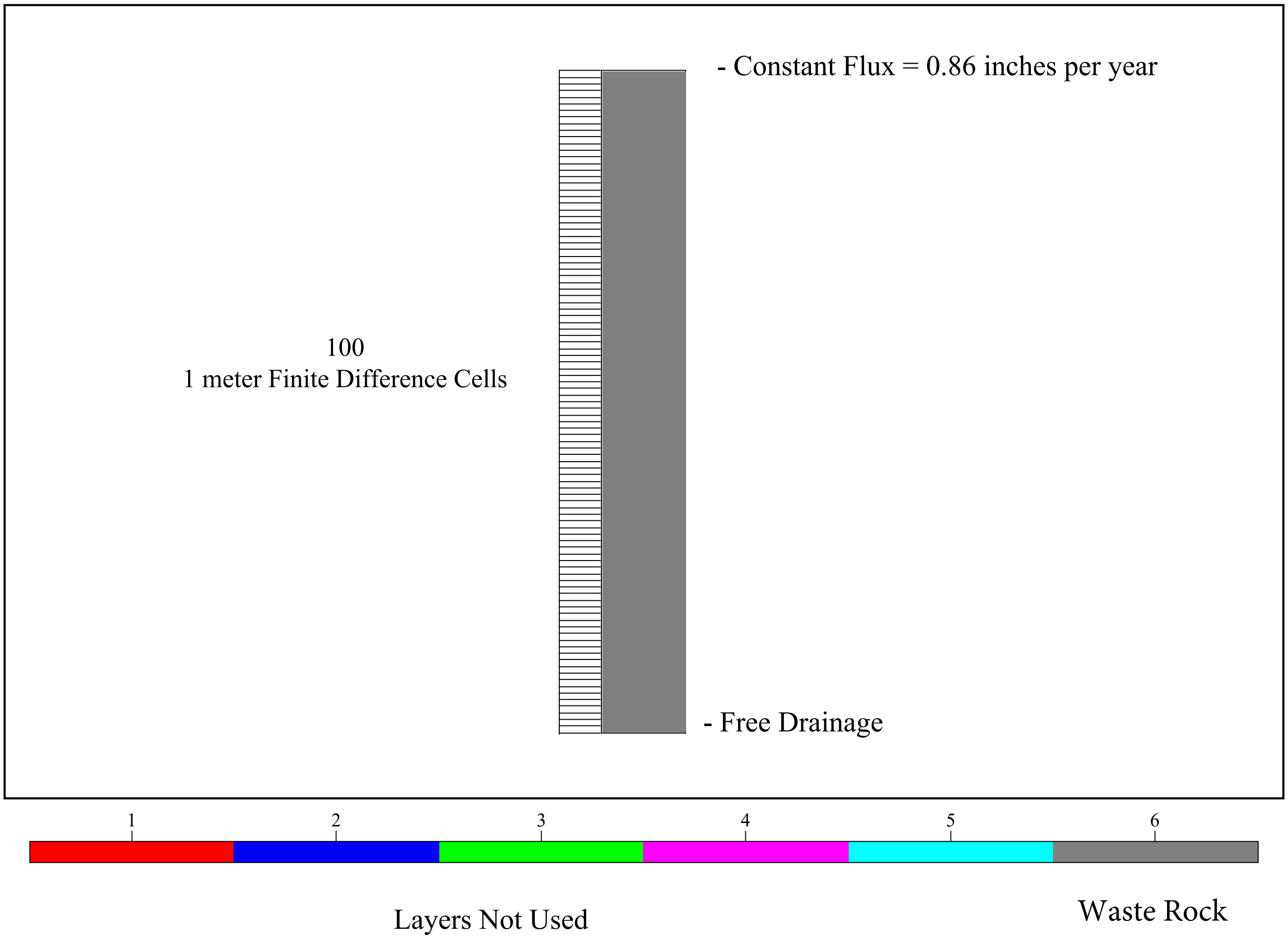
A-B and Hulin Pit Base Case plus model simulation and sensitivity simulation input parameters.

Description	**A-B and Hulin Preferred Alternative Average Waste Rock Backfill with Constant Infiltration**	**A-B and Hulin Preferred Alternative Maximum MWMP Waste Rock Backfill with Constant Infiltration**	**A-B and Hulin Preferred Alternative Minimum MWMP Waste Rock Backfill with Constant Infiltration**	**A-B and Hulin Proctor 80 Alternative with Constant Infiltration**	**A-B and Hulin Proctor 100 Alternative with Constant Infiltration**	**A-B and Hulin Alternative Climate with Constant Infiltration**	**A-B and Hulin SWCC Alternative with Constant Infiltration**
Hydro Run Number	1 (Base Case)	2	3	4	5	6	7
Dimension	1D, no-flow horizontal boundary condition						
Time Domain, yr	70						
Initial Time, d	0						
Final Time, d	25550						
Initial Time Step, d	0.001						
Minimum Time Step, d	0.00001						
Maximum Time Step, d	1						
Depth, m	100						
Average Annual Precipitation, in	4.15	4.15	4.15	4.15	4.15	5.55	4.15
PET Estimation	Hargreaves Formula						
Cover Unit	Alluvium Borrow TP	Alluvium Borrow TP	Alluvium Borrow TP	Alluvium Borrow TP	Alluvium Borrow TP	Alluvium Borrow TP	Alluvium Borrow TP
Fill Unit and Initial MWMP Concentrations	Average MWMP for Waste Rock	Maximum MWMP for Waste Rock	Minimum MWMP for Waste Rock	Average MWMP for Waste Rock	Average MWMP for Waste Rock	Average MWMP for Waste Rock	WR07E-WR07N Table 6, Average MWMP Waste Rock
Geologic Substrate Unit	Tsm (~90%)						
Cover Thickness, m	3						
Backfill Thickness, m	71						
Geologic Substrate Thickness, m	26						
Hydraulic Properties	SWCC, Table 6 Waste Rock WR07E - WR07N						SWCC, Table 6 Muddy Creek TP1 (~90%)
Soil Hydraulic Model	van Genuchten - Maulem, no hysteresis						
Upper Boundary Condition Constant Infiltration Rate, m/d	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.00E-05	6.30E-05	6.00E-05
Lower Boundary Condition	Free Drainage						
S-Shape root uptake function P50 [m]	NA Constant Infiltration						
S-Shape root uptake function P3, [-]	NA Constant Infiltration						
Solute Stress	NA Constant Infiltration						
Climate Data	McCarran Airport Las Vegas, NV	McCarran Airport Las Vegas, NV	McCarran Airport Las Vegas, NV	McCarran Airport Las Vegas, NV	McCarran Airport Las Vegas, NV	Boulder City, NV	McCarran Airport Las Vegas, NV
Percent Cover for Leaf Area Index	NA Constant Infiltration						
Root Depth, m	NA Constant Infiltration						
Root Density	NA Constant Infiltration						
Solute Transport	HP1 with Components: Water C, Mn, Na, Fe, Mg, S, Ca, As, Pb, Alkalinity, surface Hfo_w, gypsum, scorodite, calcite, rhodochrosite, goethite, cerrusite;phreeqcU.dat thermodynamic database						
Dispersivity, m	10						
Initial Condition Top, Pressure Head, [-m][1]	10	10	10	15	5	10	10
Initial Condition Bottom, Pressure Head, [-m][1]	50	50	50	30	15	50	50
Numerical Simulator	Finite Element 1 meter length cells, (see input files for other details concerning numerical settings, tolerances, print times etc.)						
Hydrus Modified Example Template	Model input parameters not provided in Table 1H are the same as the Hydrus-1D software template input file MINDIS.h1d provided with the software and tested by the developers (Šimůnek et al., 2018)						
Software Manuals							
Hydrus 1D	Šimůnek, J., Šejna, H., Saito, H., Sakai, M., van Genuchten, M. Th., 2018. The Hydrus-1D Software Package for Simulating the One-Dimensional Movement of Water, Heat, and Multiple Solutes in Variably-Saturated Media. Version 4.17, July 2018. https://www.pc-progress.com/en/Default.aspx?H1D-description#k1						
HP1	Jacques, D and Šimůnek, J. 2005. User Manual of the Multicomponent Variably-Saturated Flow and Transport Model HP1, Description, Verification and Examples, Version 1.0, SCK•CEN-BLG-998, Waste and						

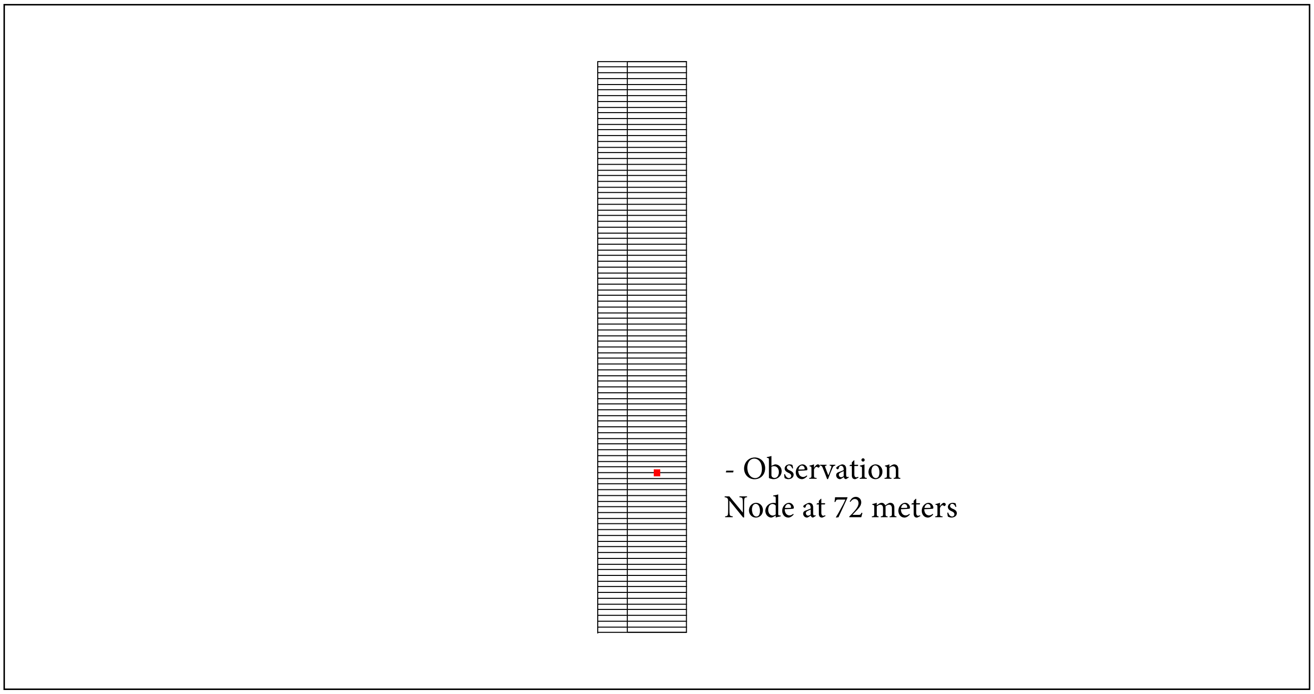
Notes:

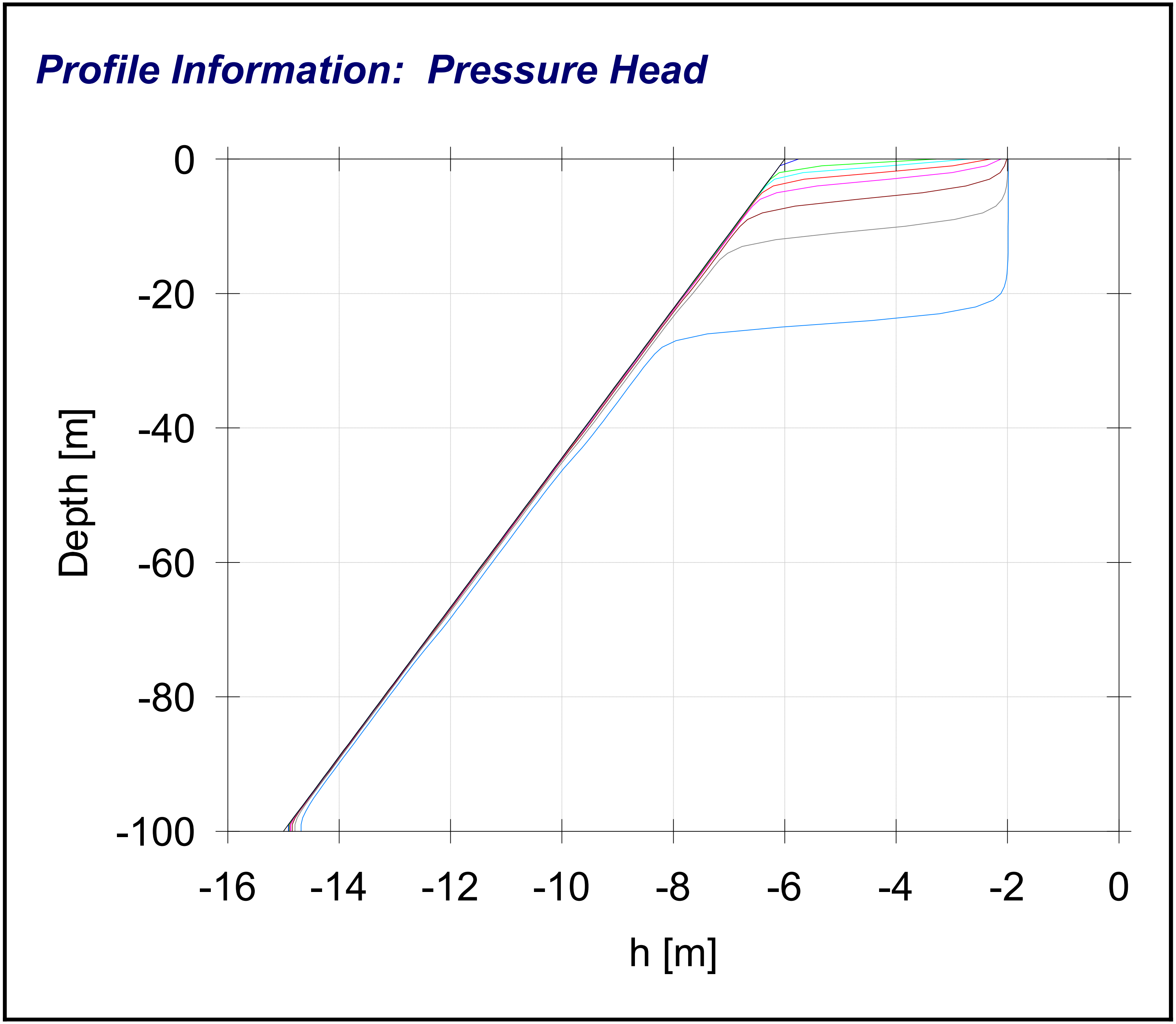
[1]Initial pressure head gradient set to attain the target moisture condition with respect to expected Proctor compaction target. For simulations 1, 2, 3, 6, and 7 the target moisture content is 90 percent of Proctor.

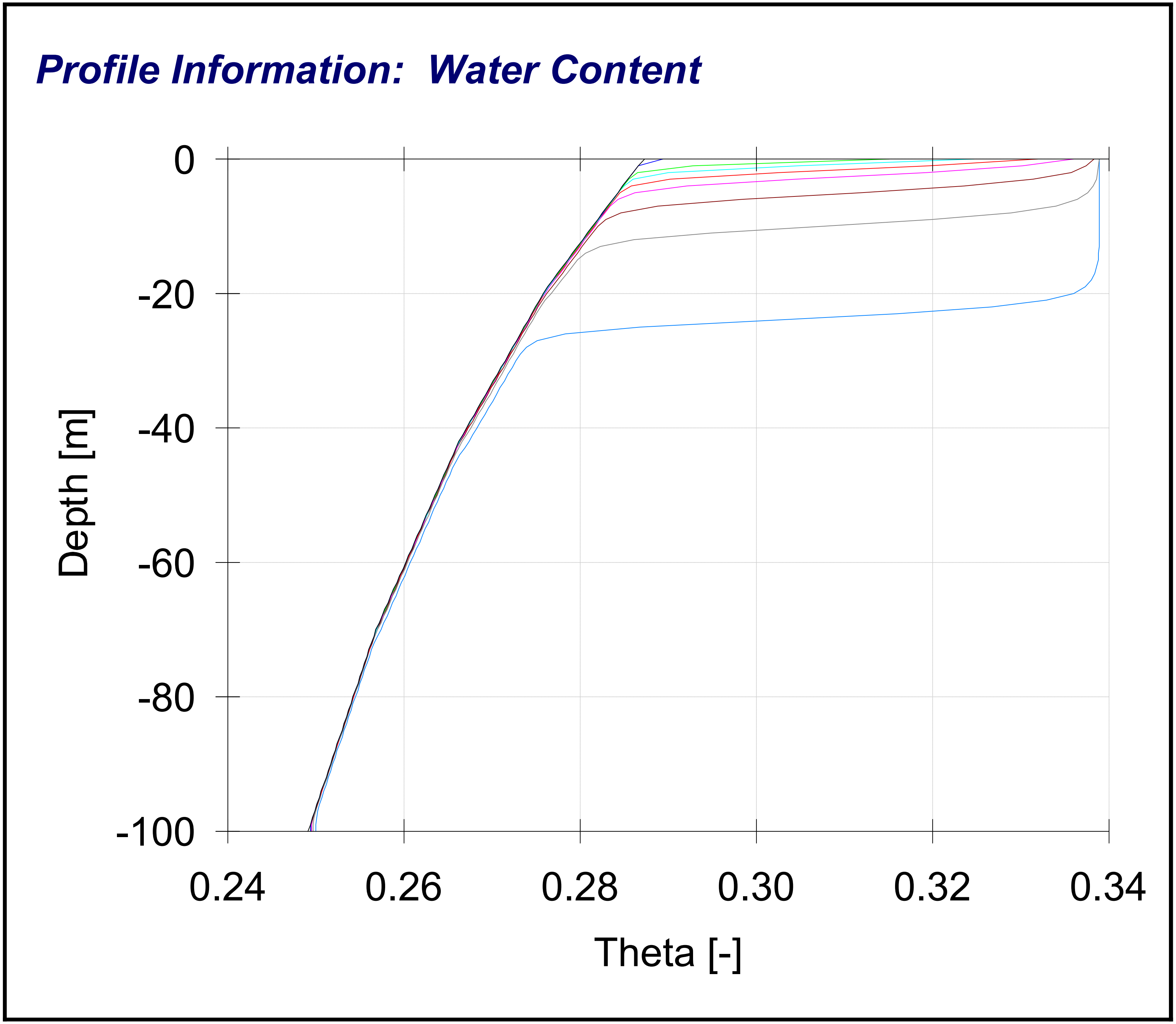
MWMP = Meteoric Water Mobility Procedure
SWCC = Soil Water Characteristic Curve
yr = year
d = day
m = meter
in = inches
PET = Potential Evapotranspiration
P50 = Root water uptake at this pressure head is reduced by 50%.
P3 = The exponent, p, in the root water uptake response function associated with water stress.
NA = Not Applicable


- Constant Flux = 0.86 inches per year
100
1 meter Finite Difference Cells
- Free Drainage
1
2
3
4
5
6
Layers Not Used
Waste Rock

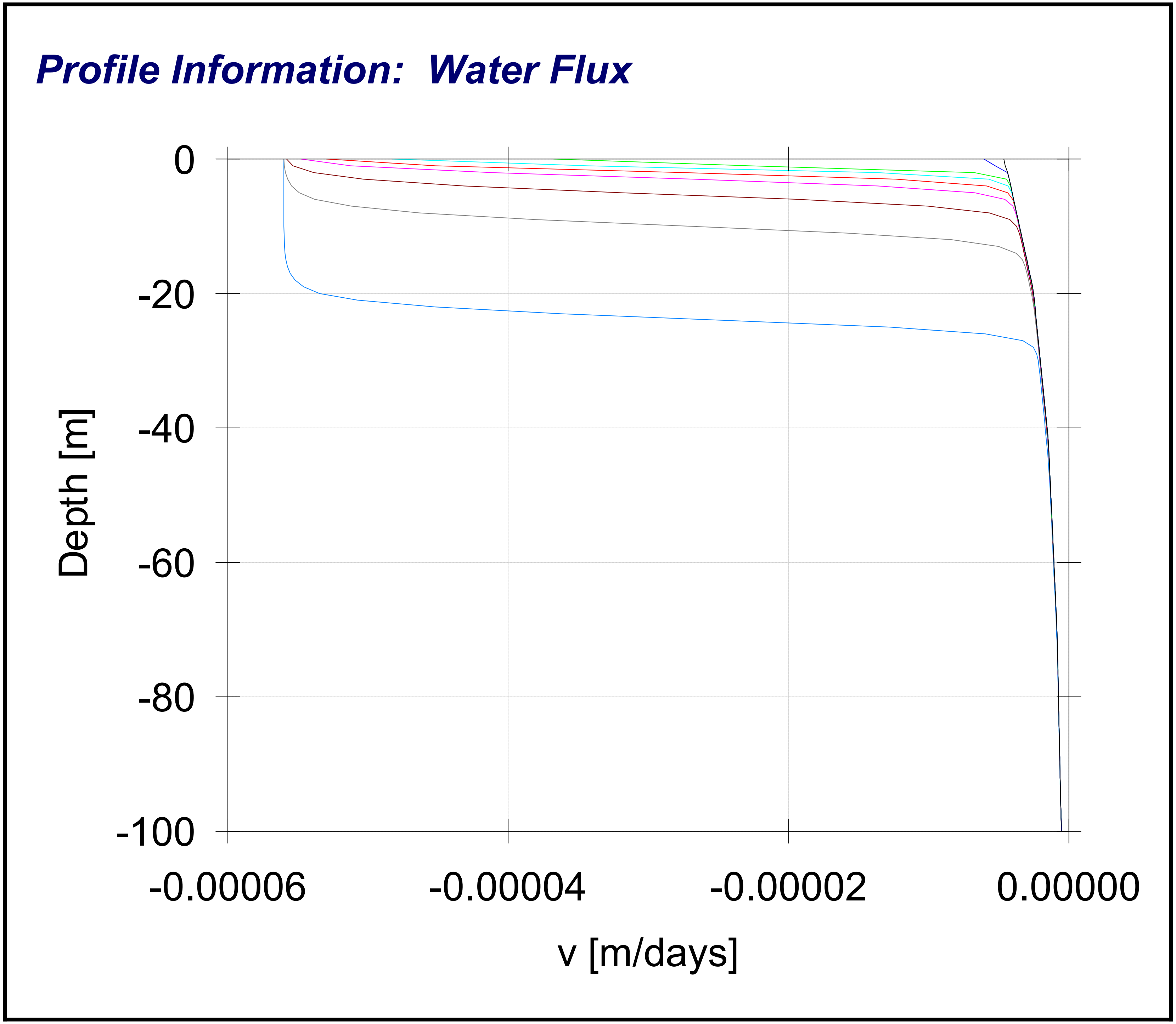
A-B and Hulin Pit Model Base Case Scenario



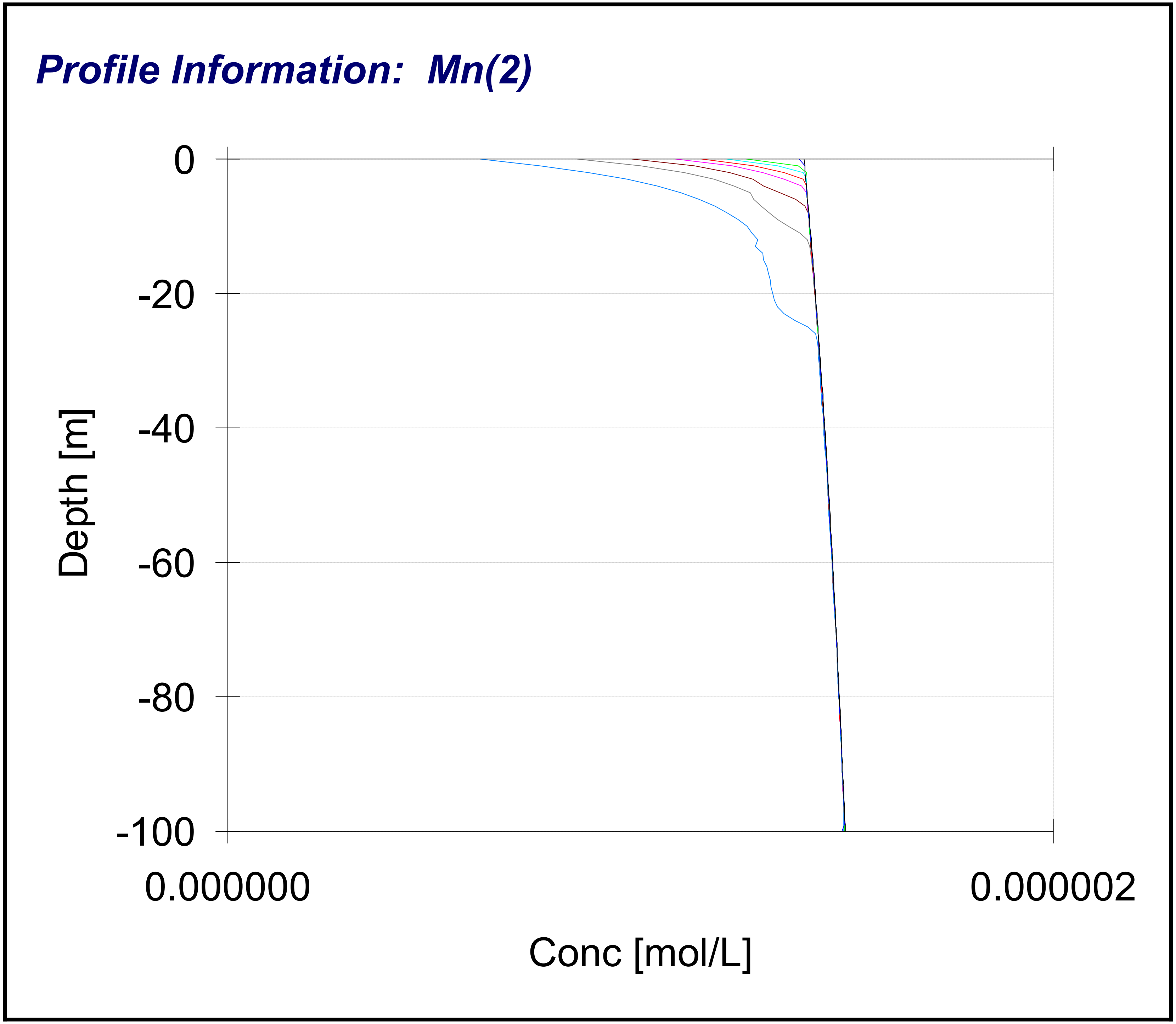

Profile Information: Pressure Head
0
-20
-40
-60
-80
-100
Depth [m]
-16
-14
-12
-10
-8
-6
-4
-2
0
h [m]

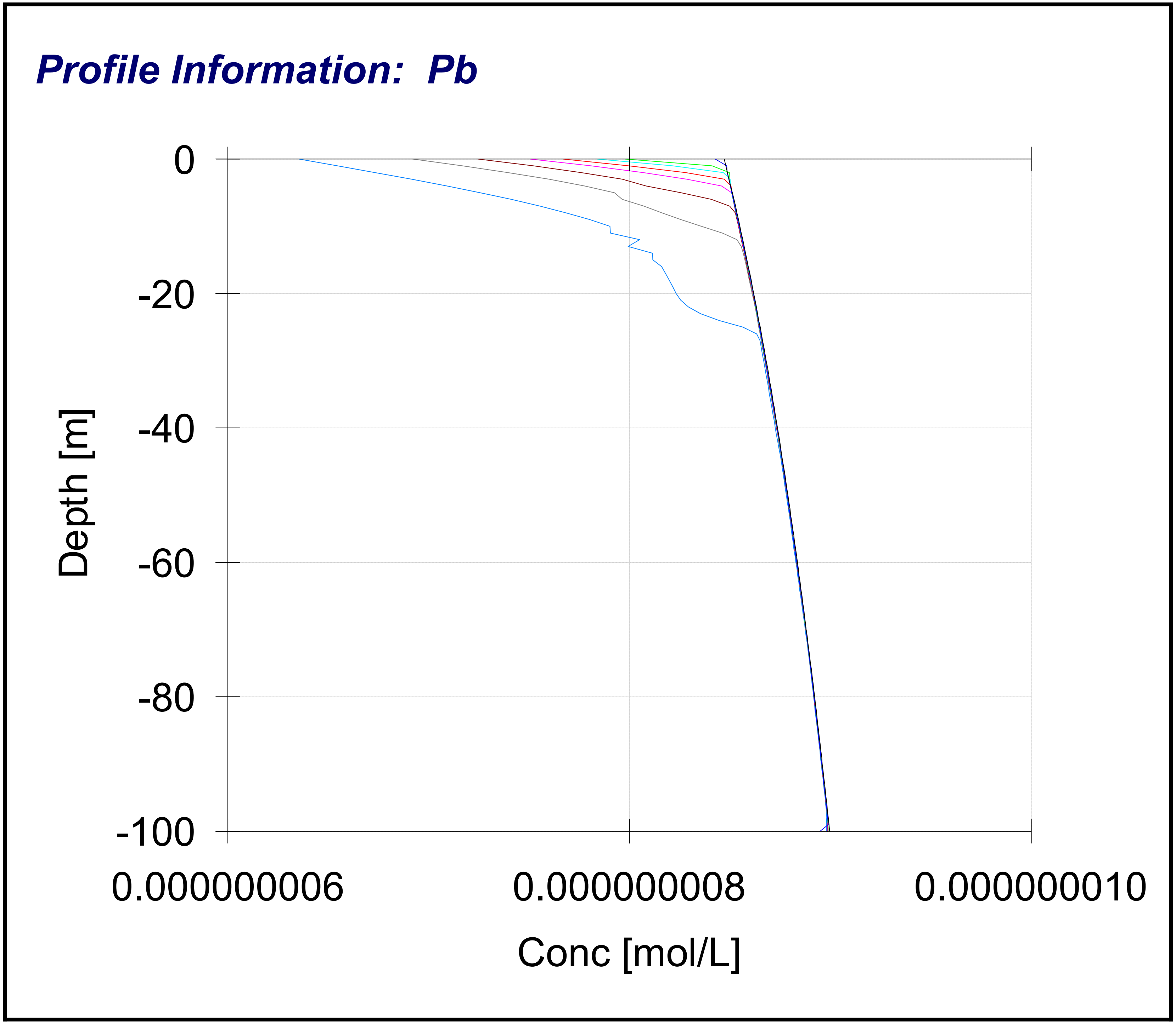


Profile Information: Water Content
0
-20
-40
-60
-80
-100
Depth [m]
0.24
0.26
0.28
0.30
0.32
0.34
Theta [-]



Profile Information: Water Flux
0
-20
-40
-60
-80
-100
Depth [m]
-0.00006
-0.00004
-0.00002
0.00000
v [m/days]


Profile Information: Mn(2)
0
-20
-40
-60
-80
-100
Depth [m]
0.000000
0.000002
Conc [mol/L]


Profile Information: Pb
0
-20
-40
-60
-80
-100
Depth [m]
0.000000006
0.000000008
0.000000010
Conc [mol/L]