Rio Algom Mining LLC

October 29, 2021

Mr. Doug Hansen
Utah Division of Environmental Quality
Division of Waste Management and Radiation Control (DWMRC)
PO Box 144880
195 North, 1950 West
Salt Lake City, Utah
84114-4880

RE: Hydrological Supplemental Site Assessment, Phase 4 Report, Natural Recharge and Water Balance Modeling Report, and Background Groundwater Quality Report, Rio Algom Mining LLC Lisbon Facility, San Juan County, Utah Radioactive Materials License Number UT 1900481

Rio Algom Mining LLC (RAML) respectfully submits the following reports for the RAML Lisbon Facility (site) in San Juan County, Utah, for DWMRC review and comment:

1. *Hydrogeological Supplemental Site Assessment, Phase 4 Report* (HSSA4 Report)
2. *Natural Recharge and Water Balance Modeling Report: Performance Assessment of Upper and Lower Tailing Impoundment Covers* (NR-WB Report)
3. *Background Groundwater Quality Report: Lisbon Facility* (Background Report)

These documents are submitted in accordance with the July 30, 2019 Stipulation and Consent Agreement (SCA) between RAML and the Utah Division of Waste Management and Radiation Control (DWMRC) to document the data collection and evaluation activities described in the June 21, 2019 *Final Work Plan for the Hydrogeological Supplemental Site Assessment, Phase 4* (HSSA4 Work Plan). These documents build on RAML's prior work at the Lisbon Facility and address an April 17, 2019 Request for Additional Information (RAI) that DWMRC provided based on its review of the tailing impoundments water balance modeling report and hydrogeological supplemental site assessment report that RAML submitted in August 2018. DWMRC concluded that additional fieldwork, data collection, evaluation, and modeling was needed to better develop a model of conceptual groundwater flow, geochemical processes, and numerical modeling. The HSSA4 Report, NR-WB Report, and Background Report address these needs.

Two hard copies of the HSSA4 Report, NR-WB Report, and Background Report are being sent to your attention, and a link through which you can download an electronic copy of the reports is provided in the email message that transmits this cover letter.

HSSA4 Report

The HSSA4 Report presents the results of hydrogeological and geochemical field investigations and data analysis that were performed since 2017. The HSSA4 Report is a comprehensive technical body of work that is intended to put on record the data collected pursuant to the SCA. Using this technical body of work, the HSSA4 Report presents new insight into the groundwater system dynamics and the movement of constituents in groundwater associated with the former Lisbon uranium mill. The report provides an updated conceptual site model (CSM) and an updated groundwater flow and transport model that is informed by the CSM. The report addresses the SCA requirement that RAML provides updated values for Alternative Concentration Limits (ACL) and Target Action Levels (TAL), and provides a preliminary evaluation of potential groundwater treatment options.

Field data and numerical modeling predictions presented in the HSSA4 Report indicate that the current groundwater remedy is not adequate to meet the compliance limits established for the point of compliance (POC), point of exposure (POE), and trend wells that are specified in Radioactive Materials License Number UT 1900481 (the License). Recent data show that mill-related groundwater impacts have migrated beyond the northwest boundary of the preliminary long-term surveillance and maintenance (LTSM) boundary. Though potential sensitive areas are currently unimpacted, the numerical model predicts that uranium from the former Lisbon mill will reach two domestic wells and a surface water body (West Coyote Wash) in approximately 70 years. The drivers of the expansion and longevity of the mill-related groundwater plume are (1) constituent mass that is currently in the groundwater system; and (2) assumed ongoing mass loading from the tailing impoundments to groundwater. Therefore, additional work is required before ACLs and TALs can be revised. To that end, the HSSA4 Report provides a preliminary evaluation of potential source control and groundwater treatment options that may be suitable for the site, noting site-specific advantages and disadvantages of the different concepts.

Key data gaps regarding the mill-related groundwater plume as of October 2021 are:

- Characterization: how uncertain are the groundwater model predictions, and are there groundwater plume flow paths or migration rates that are not adequately reflected in the current predictions? Specifically:
    - What is the flow path and volume of groundwater flowing across the LVF into the Navajo sandstone, and are there potential sensitive areas or receptors on the west side of the LVF south of well MW-132S?
    - What is the hydrogeological relationship between the BCA and West Coyote Wash/Rattlesnake Spring northwest of the current groundwater monitoring well network?
- Groundwater treatment: what is the most effective corrective action, or combination of corrective actions, to address the mill-related groundwater plume?

Future groundwater-related characterization at the Lisbon facility must support rigorous and resilient treatment decisions. To meet this objective, RAML intends to initiate a groundwater uncertainty analysis/data worth evaluation in early 2022. The uncertainty analysis/data worth process will test groundwater flow and transport parameters and may identify additional characterization opportunities to inform and refine the predictive simulations and potentially the scope of future corrective actions. For this reason, the data gaps identified above should be regarded as preliminary.

NR-WB Report

The NR-WB Report presents the results of a cover performance assessment that evaluated the as-built cover system on the two closed tailing impoundments at the Lisbon facility. The report documents field data collection since 2019 to better characterize the seepage rate from the tailing impoundments to the underlying groundwater system. Long-term percolation rates through the existing tailing impoundment covers were simulated using both HELP and HYDRUS models, and natural recharge to groundwater near the site (away from the tailing impoundments) was estimated for comparison purposes.

The NR-WB Report provides a comprehensive picture of the evaporative zone depth and related processes governing percolation through the as-built tailing impoundment covers. Estimation of percolation rates through UMTRCA-style rock covers involves uncertainty and technical difficulty, and the close agreement of estimated percolation rates by the chloride mass balance method in natural analog locations and the HELP and HYDRUS models provides confidence in the overall results. Calculated percolation rates were higher in the areas on the tailing impoundments that were used as evaporation cells in the early 1990s as part of a corrective action program than in areas on the tailing impoundments that were not used as evaporation cells. The NR-WB Report presents estimated ranges of long-term percolation rates for the tailing impoundments for use in the numerical groundwater flow and transport model and concludes that percolation through the covers could be reduced.

The key data gap regarding the two tailing impoundments covers is:

- To what extent would a hypothetical modification of the existing tailing impoundment covers reduce the mass loading from the tailings into groundwater and improve RAML's ability to comply with the groundwater standards applicable to License termination?

Background Report

The Background Report presents a technical evaluation of background groundwater quality at the site and responds to DWMRC's request in its RAIs and the SCA for (1) an updated statistical evaluation of background conditions on an intrawell basis; and (2) an updated list of site constituents of concern. The report explains the statistical evaluation process through which background concentrations were calculated, and provides an updated list of suitable background wells and their current concentrations of the site compliance parameters (i.e., the parameters for which compliance concentrations are specified in the License). The Background Report establishes three background groundwater regions that are distinguished by unique geochemical and hydrogeological characteristics. The report proposes adding total nitrate/nitrite to the monitoring program and License as a compliance parameter, and recommends calculating background concentrations for total nitrate/nitrite after the second quarter of 2022 when at least eight data points will be available. No significant data gaps related to site background characterization were identified.

RAML's recommended path forward for the Lisbon facility

The three enclosed reports are a culmination of more than two years of additional data collection to address data gaps identified from previous site work and the RAIs provided by DWMRC. The reports present an enhanced technical understanding of the site groundwater system and the performance of the as-built tailing impoundment covers, and conclude that the approved MNA remedy is not performing as expected at the time that site ACLs were initially approved. Therefore, RAML proposes the following tasks to develop, license, and implement a protective groundwater corrective action program.

Step 1. Prepare a Corrective Action Assessment Work Plan (CAAWP) and submit to DWMRC for review by November 15, 2022. This plan will direct the collection and interpretation of data needed to evaluate corrective action measures. The CAAWP will include a proposed schedule and milestones for the fieldwork and reporting described in Steps 2 through 4.

The CAAWP will present a scope of work that builds on the data and conclusions of the HSSA4, NR-WB, and Background reports, and will be informed by an uncertainty analysis/data worth evaluation that RAML intends to undertake in parallel with the CAAWP. The CAAWP will be designed to fill data gaps that currently prevent selection of a corrective action remedy, including:

a. Hydrogeology and geochemistry further down- and cross-gradient from current investigation areas, as informed by the groundwater model uncertainty analysis; potential focus areas are the Navajo sandstone and the Burro Canyon Aquifer northwest of the current groundwater monitoring well network,
b. Sensitivity of the groundwater plume to potential tailing impoundment cover improvements, and
c. Treatability studies, as warranted, for potential groundwater treatment options to determine optimal location(s), technologies, and implementation details for potential full-scale application.

Step 2. Conduct the Corrective Action Assessment by implementing the scope of work identified in the CAAWP (Step 1). RAML proposes that execution of the CAAWP would begin in the 2023 field season, following DWMRC review and approval of the CAAWP.

Step 3. Prepare and submit a Corrective Action Assessment Report to document the work performed in Step 2. The report will present the new field and analytical data and treatability study performance information. The report will screen source control and groundwater treatment technologies against appropriate performance criteria and proposed site-specific compliance goals. The Corrective Action Assessment Report is anticipated to be submitted in fall of 2024 and will:

- Re-evaluate site ACLs, the proposed LTSM boundary, and land use controls.

- Provide a narrative description of the proposed groundwater corrective action measures, including a demonstration that the action will address the appropriate performance factors and criteria.
- Propose source term (tailing impoundments) mitigation measures as warranted to support the effectiveness of the groundwater corrective action.
- Review the available groundwater monitoring wells and, if appropriate, recommend optimizations to the Licensed well network to more effectively monitor the groundwater plume and compliance with License conditions.

Step 4. Prepare and submit a proposed Corrective Action Plan (CAP) for approval by the Director. The proposed CAP will explain the construction and operation of the preferred groundwater corrective action and provide a schedule for implementation and estimated time of completion. RAML will finalize or amend the CAP in consultation with DWMRC to document the approved corrective action program.

RAML anticipates releasing an explanation of the construction and operation of the proposed corrective action for public comment before the CAP is approved. RAML defers to DWMRC's guidance and interpretation of the Utah Administrative Code for the method and timing for public release of the proposed CAP.

In conclusion, the HSSA4 Report, NR-WB Report, and Background Report provide an improved technical base and robust tools upon which to develop and implement a groundwater corrective action program. RAML is committed to protecting human health and the environment, and following DWMRC's regulatory process to terminate the License.

RAML would be pleased to host one or more meetings with DWMRC staff to discuss any questions you may have about the content of these reports and the actions RAML proposes to take towards a groundwater corrective action program. The timing and format of the meeting(s) will be arranged at DWMRC staff's convenience. We look forward to this opportunity to collaborate on the path to License termination for the Lisbon Facility.

If you have any questions or need additional information, please do not hesitate to contact me at (916) 947-7637.

Sincerely,
Rio Algom Mining LLC

Sandra L Ross

Sandra L. Ross
Manager US Legacy Assets

Appendix F
Statistical Analysis of Background Wells
(Electronic Files)

This appendix includes the results for statistical analysis of constituents of concern (arsenic, molybdenum, selenium, and uranium) and total dissolved solids (TDS) for background wells in the following background groundwater areas identified for the Lisbon Facility: north Burro Canyon Aquifer (NBCA), south Burro Canyon Aquifer (SBCA), and wells completed in the Burro Canyon Aquifer that are within 400 feet of the surface expression of the Lisbon Valley Fault (fault wells). Statistical analysis was possible for the following wells included in each background area:

- NBCA: MW-5, LW-1, MW-100
- SBCA: MW-120, UW-1, MW-13, MW-105
- Fault: MW-125, MW-116, MW-126, MW-128, MW-107S, MW-107D, MW-118, RL-6

Statistical analysis followed Flowchart 3 (**Appendix B**) and is based on statistical guidance from the United States Environmental Protection Agency (USEPA, 2009, 2015). Due to the iterative nature of statistical analysis, the results included in this appendix are separated into three different trials. In the first trial, the data were analyzed without making any changes to the datasets. Results from this trial are preliminary for censored datasets (i.e., datasets that include non-detect [ND] values). In the second, trial, appropriate substitutions were made for censored datasets depending on the percentage of ND values. When ND values were less than 10%, the ND values were substituted with half the reporting limit. When ND values were between 11% and 50%, imputed values from the Regression on Order Statistics (ROS) method were substituted for ND values. In the third trial, appropriate substitutions for ND values were maintained and outliers determined to be extreme based on the criteria outlined in Section 5.3.3 were removed prior to statistical analysis. The third trial also includes the linear regression results for parametric datasets performed with appropriate substitutions (when necessary) and extreme outliers removed.

REFERENCES

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. EPA-530-R-09-007.

_____. 2015. Computing Upper Limits to Estimate Background Threshold Values Based Upon Uncensored Data Sets without Nondetect Observations in The ProUCL Version 5.0 Technical Guidance. EPA/600/R-07/041.

Attachments:

1. Hydrogeological Supplemental Site Assessment, Phase 4 Report (2 hard copies)
2. Natural Recharge and Water Balance Modeling Report: Performance Assessment of Upper and Lower Tailing Impoundment Covers (2 hard copies)
3. Background Groundwater Quality Report: Lisbon Facility (2 hard copies)

cc: Phil Goble, DWMRC (electronic only)
Jason Nguyen, LM DOE (electronic only)

Natural Recharge and Water Balance Modeling Report: Performance Assessment of Upper and Lower Tailing Impoundment Covers

Rio Algom Mining LLC, Lisbon Facility
San Juan County, Utah

Radioactive Material License Number UT 1900481

Prepared for:

Rio Algom Mining LLC
P.O. Box 218
Grants, NM 87020

Prepared by:

INTERA

2440 Louisiana Boulevard NE, Suite 700
Albuquerque, New Mexico 87110

REGISTERED PROFESSIONAL ENGINEER
10.29.21
No. 11463
Larry M. Coons
STATE OF UTAH

October 29, 2021

EXECUTIVE SUMMARY

This natural recharge (NR) and water balance (WB) modeling report (NR-WB Report) presents the results of an enhanced cover performance assessment (Assessment) conducted by INTERA Incorporated (INTERA) to evaluate the as-built cover system on the closed tailing impoundments at the Rio Algom Mining LLC (RAML) Lisbon Facility in San Juan County, southeast Utah (Site). The WB modeling was conducted for RAML as part of a Phase 4 Hydrogeological Supplemental Site Assessment (HSSA4) (INTERA, 2021b) under Radioactive Materials License Number UT 1900481 (the License), regulated by the Utah Department of Environmental Quality, Division of Waste Management and Radiation Control (DWMRC).

This NR-WB Report was completed in response to a Request for Additional Information (RAI) from DWMRC for a previous tailing impoundments water balance report (INTERA, 2018) that was submitted as part of the Phase 3 Hydrogeological Supplemental Site Assessment (HSSA3) Report (HSSA3 Report, INTERA, 2018 Rev. 2021a). As such, this NR-WB Report contains the results of additional field investigations, laboratory analyses, and modeling, and is therefore considered an enhanced Assessment of WB of the as-built cover system on the closed tailing impoundments.

In response to the RAI, RAML submitted a work plan (Work Plan) (INTERA, 2019) for the HSSA4 of the Lisbon facility. The Work Plan, and the elements of the Work Plan salient to this Assessment, are included by reference in a Stipulation and Consent Agreement (SCA) between the DWMRC and RAML, dated August 6, 2019. Delivery of this NR-WB Report is in fulfillment of the Work Plan submitted by RAML to DWMRC. All elements of the Work Plan associated with the Assessment, as agreed to by DWMRC and RAML as part of the SCA, are fulfilled except for the simulation of long-term flux rates for hypothetical cover configurations. Simulation of any possible future cover configurations will be completed when further information is considered and/or obtained as part of a holistic corrective action assessment for the Site.

Both the Hydrologic Evaluation of Landfill Performance (HELP) and HYDRUS models were used for the Assessment to refine estimates of long-term percolation rates through the Upper Tailing Impoundment (UTI) and Lower Tailing Impoundment (LTI) calculated using the HELP model in 2018 for the as-built covers at the Site (initial HELP Modeling). Modeling conducted for this Assessment is considered an enhancement of the initial HELP modeling. To that end, additional data (enhanced field and laboratory data) were obtained, including a refined climate data set, consideration of future climate change on cover performance, on-site and off-site test pits, off-site auger borings, installation of soil moisture sensors (SMSs) in selected test pits, and laboratory analyses of selected material samples from the auger borings.

Using the enhanced data for this Assessment, NR to groundwater in the vicinity of the Site was calculated using the chloride mass balance (CMB) method. The estimated NR rate range of 0.28 to 0.61 inches per year (in/yr) (2.26E-08 to 4.92E-08 centimeters per second [cm/s]) using the CMB method compares very favorably to model-simulated recharge rates using both HELP and HYDRUS for this Assessment.

For the enhanced HELP and HYDRUS modeling of the existing covers, and as informed by the enhanced data collection for this Assessment, the final reclaimed surface areas of the UTI and LTI were segregated into those areas within the former evaporation cells of the UTI and LTI (INCAPP), and those areas outside the former evaporation cells of the UTI and LTI (OUTCAPP). The INCAPP areas on the UTI and LTI, used to store and evaporate impacted groundwater pumped at the Site in the early 1990s as part of a corrective action program (CAP), currently exhibit features distinct from the OUTCAPP areas.

The tabular summary of the enhanced HELP and HYDRUS modeling, compared with the estimates of NR near the Site, is provided below. The flux range values provided in the table represent quasi steady-state long-term percolation rate estimates of tailing source fluid through the tailing impoundments for current cover conditions.

Location	Method	Flux[1] Range (in/yr)	Flux[1] Range (cm/s)	Average Flux[1] (in/yr)
TSF OUTCAPP	HELP	0.44 – 0.83	3.55E-08 – 6.69E-08	0.64
	HYDRUS	0.02 - 0.59	1.32E-09 – 4.78E-08	0.30
TSF INCAPP	HELP	1.49 – 3.89	1.20E-07 – 3.14E-07	2.69
	HYDRUS	0.29	2.34E-08	0.29
Site NR	HELP	0.38 – 0.70	3.06E-08 – 5.64E-08	0.54
	HYDRUS	0.24 – 0.66	3.70E-08 – 5.43E-08	0.45
	CMB	0.28 – 0.61	2.26E-08 – 4.92E-08	0.45
SW Utah NR[2]	Literature Value	0.8	6.44E-08	0.8

Notes: [1]Average rate of percolation through the TSF over quasi steady-state conditions
[2](Heilweil et al., 2005; Marston and Heilweil, 2012)
NR = Natural Recharge
CMB = Chloride Mass Balance
TSF = Tailing Storage Facility
OUTCAPP = Outside footprint of former Corrective Action Plan Evaporation Pond
INCAPP = Inside footprint of former Corrective Action Plan Evaporation Pond
SW = Southwest

To facilitate simulation (modeling) of fate and transport of solutes in groundwater at the Site as part of HSSA4, the range of long-term percolation rates through the TSFs are recommended as shown below.

	INCAPP Percolation	OUTCAPP Percolation
Minimum	0.3 in/yr (2.4E-08 cm/s)	0.3 in/yr (2.4E-08 cm/s)
Maximum	3.9 in/yr (3.2E-07 cm/s)	0.8 in/yr (6.7E-08 cm/s)

The percolation ranges consider the results of the enhanced HELP model, the HYDRUS model, estimate of NR near the Site, and the sensitivity of the existing covers to perform with changing climate conditions.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
ACL	Alternate Concentration Limit
Assessment	enhanced cover performance assessment
bgs	below ground surface
CAP	Corrective Action Program
CMB	chloride mass balance
cm/s	centimeters per second
CN	curve number
CWR	Cutler Formation waste rock
DBS&A	Daniel B. Stephens & Associates, Inc.
DOE	Department of Energy, United States
DOS	disk operating system
DWMRC	Utah Division of Environmental Quality, Division of Waste Management and Radiation Control
ENSO	El Niño Southern Oscillation
ERG	Environmental Restoration Group
ET	evapotranspiration
EZD	evaporative zone depth
FE	finite element
ft	foot/feet
GCM	general circulation model
GIR	Geotechnical Investigation Report
HEAL	Hall Environmental Analysis Laboratory
HELP	Hydrologic Evaluation of Landfill Performance
HSSA3	Hydrogeological Supplemental Site Assessment, Phase 3
HSSA3 Report	INTERA (2018, Rev. 2021a)
HSSA4	Phase 4 Hydrogeological Supplemental Site Assessment
HSSA4 Work Plan	INTERA (2019)
ID	inner diameter
in/yr	inches per year
INCAPP	For the enhanced HELP and HYDRUS modeling of the existing covers, areas within the former evaporation cells of the UTI and LTI
INTERA	INTERA Incorporated
IPCC	Intergovernmental Panel on Climate Change
JRA	Job Risk Assessment
LAI	leaf area index

LEC	Lower Evaporation Cell
License	Radioactive Materials License Number UT 1900481
LTI	lower tailing impoundment
mg/kg	milligram per kilogram
mg/L	milligrams per liter
MSW	municipal solid waste
ND	non-detect
NR	natural recharge
NRB	natural recharge boring
NRC	Nuclear Regulatory Commission
NR-WB Report	natural recharge and water balance modeling report
OSHA	Occupational Safety and Health Administration
OUTCAPP	For the enhanced HELP and HYDRUS modeling of the existing covers, areas outside the former evaporation cells of the UTI and LTI
PDO	Pacific Decadal Oscillation
PET	potential evapotranspiration
RAI	Request for Additional Information
RAML	Rio Algom Mining LLC
SCA	Stipulation and Consent Agreement
SCS	Soils Conservation Service
Site	Rio Algom Mining LLC Lisbon Facility in San Juan County, southeast Utah
SMS	soil moisture sensor
TSF	tailing storage facility
UEC	Upper Evaporation Cell
UMTRCA	Uranium Mill Tailings Radiation Control Act
UTI	upper tailing impoundment
WB	water balance

1.0 INTRODUCTION

This natural recharge (NR) and water balance (WB) modeling report (NR-WB Report) presents the results of an enhanced cover performance assessment (Assessment) conducted by INTERA Incorporated (INTERA) to evaluate the as-built cover system on the closed tailing impoundments at the Rio Algom Mining LLC (RAML) Lisbon Facility in San Juan County, southeast Utah (Site). The Site is in the Lisbon Valley, approximately 4 miles southwest of the small agricultural town of La Sal and approximately 30 miles southeast of Moab (**Figure 1.1**). The WB modeling was conducted for RAML in support of a Phase 4 Hydrogeological Supplemental Site Assessment (HSSA4) (INTERA, 2021b) under Radioactive Materials License Number UT 1900481 (the License), regulated by the Utah Department of Environmental Quality, Division of Waste Management and Radiation Control (DWMRC).

This NR-WB Report was completed in response to a Request for Additional Information (RAI) from DWMRC in response to *Tailing Impoundments Water Balance Modeling Report: Cover Performance Assessment of the Upper and Lower Tailings Impoundments* (INTERA, 2018) that was submitted as part of the Phase 3 Hydrogeological Supplemental Site Assessment (HSSA3) Report (HSSA3 Report, INTERA, 2018 Rev. 2021a). As such, this NR-WB Report contains the results of additional field investigations, laboratory analyses, and modeling, and is therefore considered an enhanced Assessment of WB of the as-built cover system on the closed tailing impoundments.

The primary objective of this study was to address the following RAI submitted by DWMRC in response to the HSSA3 Report:

> *The Division has requested a plan and time schedule to better characterize long-term percolation values for the current cover, and proposed improvements (updated design) to the Facility tailings impoundment covers to reduce percolation rates into the groundwater. The proposed updates to the design cover should consider the long-term maintenance issues referenced in Utah Administrative Code R313-24 and provide isolation of the tailings and reduction of tailings wastewater from percolation into the groundwater to the degree practicably achievable.*

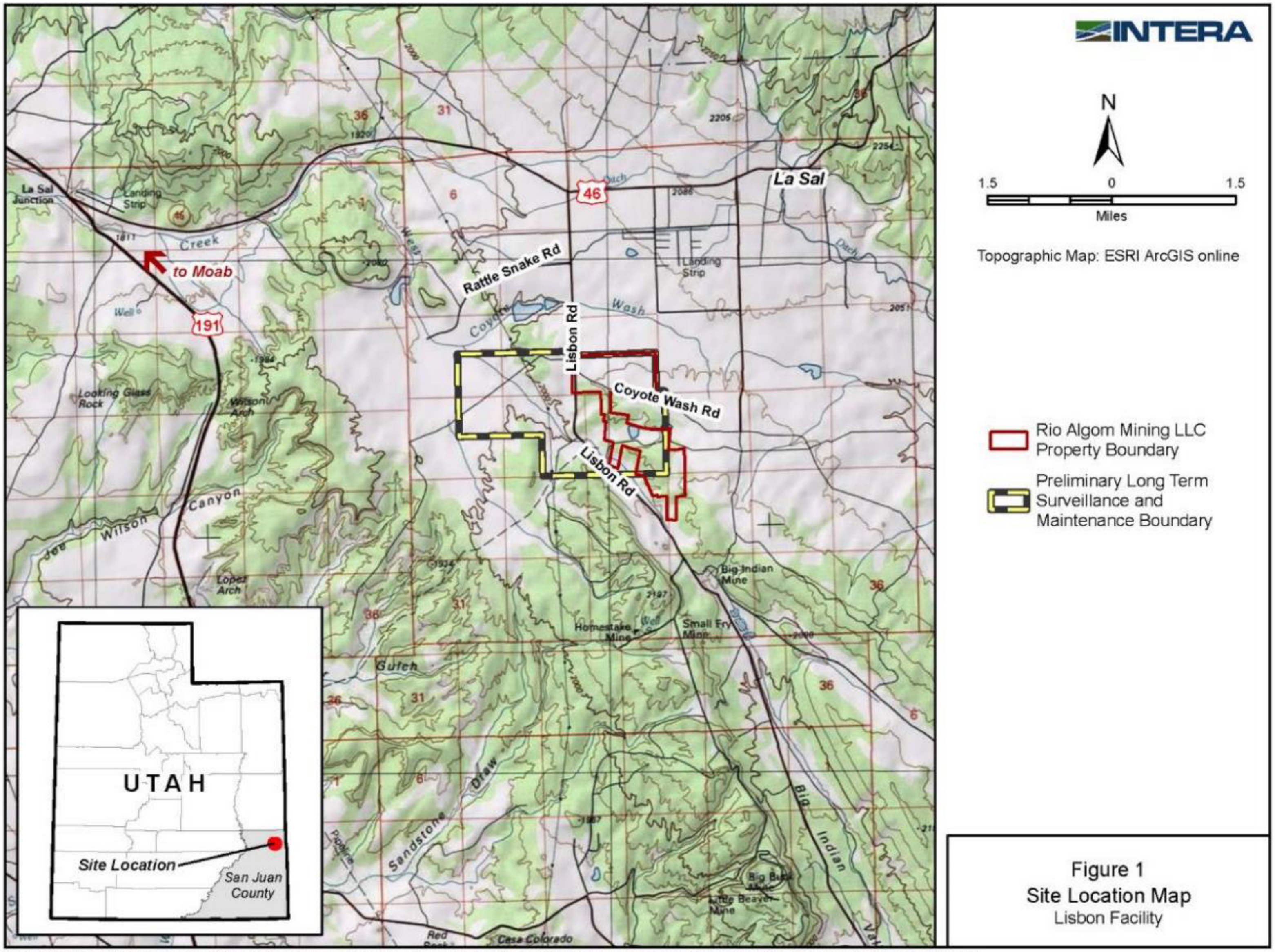
In response to the RAI, RAML proposed the following as part of a work plan (HSSA4 Work Plan) (INTERA, 2019) for the HSSA4 of the Lisbon Facility:

- Collect data to estimate the NR rate to groundwater at selected locations in the vicinity of the Site. The chloride mass balance (CMB) method will be used to estimate NR.

- Develop Hydrologic Evaluation of Landfill Performance (HELP) model profile(s) simulating the surrounding natural conditions and calibrate the HELP model to the estimated NR.
- Collect data to better understand the evaporative zone depth of the current covers over the Upper Tailing Impoundment (UTI) and Lower Tailing Impoundment (LTI).
- Simulate moisture flux through the current UTI and LTI covers using the calibrated HELP model and refined evaporative zone depth data in order to update long-term estimated flux values for the existing impoundment covers (as appropriate).
- Apply the calibrated HELP model to simulation of long-term flux rates through the UTI and LTI for hypothetical future cover configurations and source input to the groundwater flow and transport model.
- Develop a Natural Recharge and Water Balance Modeling Report.

The Work Plan, and the elements of the Work Plan salient to this Assessment as listed above, are included by reference in a Stipulation and Consent Agreement (SCA) between the DWMRC and RAML, dated August 6, 2019.

Delivery of this NR-WB Report is in fulfillment of the HSSA4 Work Plan submitted by RAML to DWMRC. All other elements of the Work Plan associated with the Assessment, as agreed to by DWMRC and RAML as part of the SCA, are fulfilled as presented herein with the exception of the second-to-last item bulleted above (simulation of long-term flux rates for hypothetical cover configurations). Simulation of any possible future cover configurations is planned for a later date when further information is considered and/or obtained as part of a holistic corrective action assessment for the Site.



FILE: S:\ABQ\Rio_Lisbon_SupplementalSiteCharacterization\Engineering\Dams-TailingsCharacterization-DSR\GIR-WaterBalance\Graphics\GIS\MapDocs\DrillBids\01_SiteLocation.mxd 10/20/2021

Figure 1.1 Site Location Map.

The information contained herein is used by INTERA for the HSSA4, which includes transport modeling of solutes in groundwater (INTERA, 2021b). In conformance with the RAI and associated SCA, the information presented in this NR-WB Report provides a range of estimated moisture flux values from the impoundments as input to long-term flow and transport modeling at the Site (INTERA, 2021b).

It is not within the scope of this Assessment to attempt to model the complex operational history of the tailing impoundments at the Site (see Section 2.2). Instead, the modeling conducts simplified forward predictions in time using present-day conditions for the final cover and tailings.

In support of the objectives of the Assessment and this NR-WB Report, the remaining sections present the following:

- Section 2: Site Climate and Operational History
- Section 3: Initial (2018) HELP Modeling Summary
- Section 4: Enhanced Field and Laboratory Data Collection
- Section 5: Enhanced Source Data
- Section 6: Enhanced Water Balance Modeling
- Section 7: Enhanced Model Results
- Section 8: Summary, Conclusions, and Recommendations
- Section 9: References

2.0 SITE CLIMATE AND OPERATIONAL HISTORY

This section provides information about the climate of the Site and a brief summary of the history of the Lisbon mine and mill. The HSSA3 Report (INTERA, 2018 Rev. 2021a) and HSSA4 Report (INTERA, 2021b) provide a detailed Site assessment, including an in-depth geologic, hydrologic, and geochemical evaluation.

2.1 Climate

The climate of the Lisbon Valley area has a Köppen-Geiger classification of cold, semiarid (Köppen, 1936; Peel et al., 2007), with hot summers, cold winters, and potential evapotranspiration (PET) exceeding precipitation throughout the year. The cold semiarid climate is further characterized by large diurnal and annual ranges in temperature and large interannual variability in precipitation amounts. The Site, located within the Lisbon Valley, is approximately 4 miles southwest of the small agricultural town of La Sal, Utah. **Table 2.1** provides the average monthly minimum and maximum temperature and average monthly precipitation for the period of record (1978-present) for the La Sal weather station (La Sal 1 SW) (NOAA/NWS, 2021). Minimum temperatures range from 14 to 55 degrees Fahrenheit (°F) with an annual mean of 34 °F, and maximum temperatures range from 37 to 98 °F with an annual mean of 61 °F for the period of record. Precipitation ranges from 0.7 inches in June to 1.55 inches in September with a mean total annual precipitation of 12.63 inches. The normal variation in precipitation, reference evapotranspiration (ET), and temperature in La Sal, Utah, throughout the year is shown in **Figure 2.1**. Reference ET was calculated from the daily La Sal minimum and maximum temperature using the Hargeaves-Samani equation (Hargreaves and Samani, 1985) in R using the Evapotranspiration package (R Core Team, 2020; Guo et al., 2016).

Table 2.1 La Sal 1 SW Monthly Mean Statistics.

Month	Minimum Temperature (°F)	Maximum Temperature (°F)	Precipitation (inches)
January	14.07	36.69	0.81
February	18.19	40.95	0.74
March	25.78	50.42	0.94
April	31.28	59.16	0.92
May	39 68	98.00	0.92
June	47.87	81.10	0.67
July	55.23	86.66	1.30
August	53.98	84.00	1.50
September	45.81	75.68	1.55
October	34.61	62.98	1.51
November	23.62	48.63	1.00
December	15.37	38.01	0.77
Annual	33.73	61.10	12.63

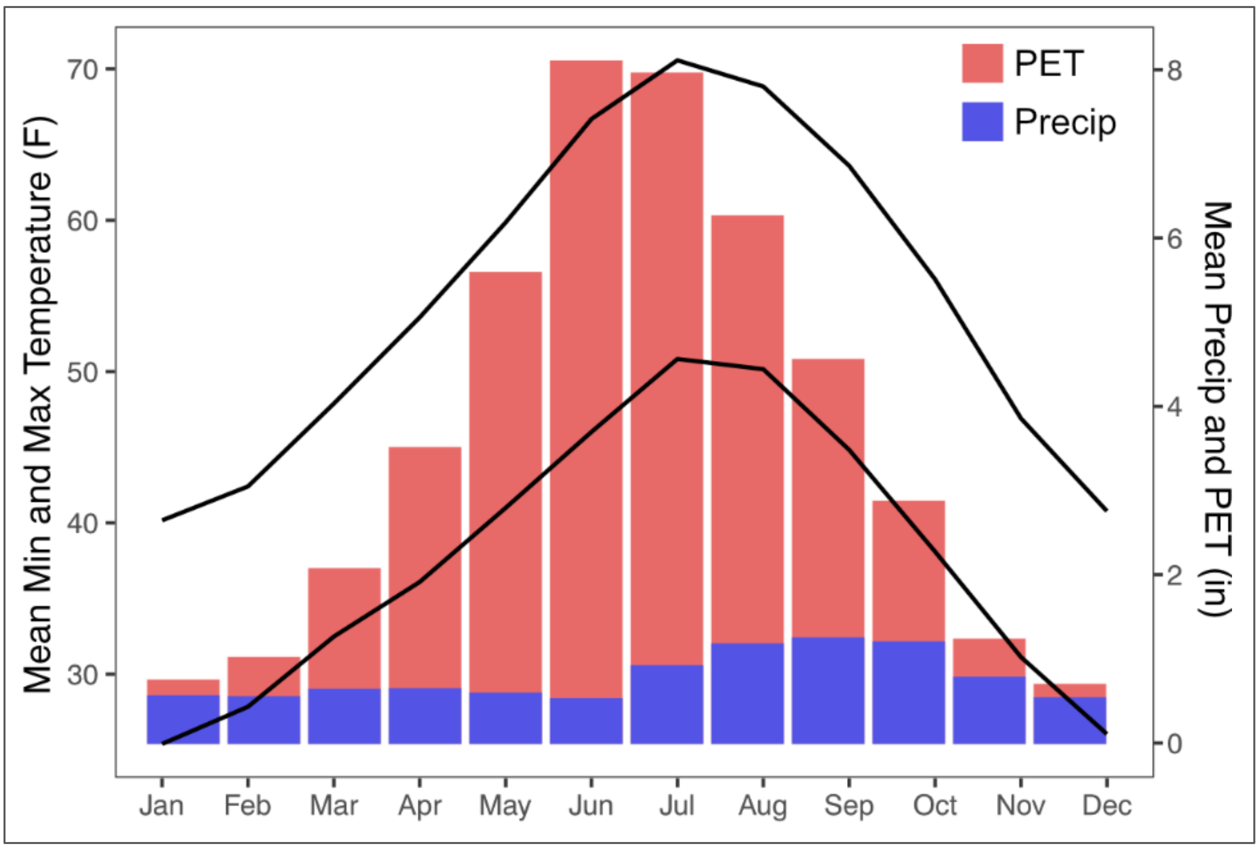


Figure 2.1 La Sal Weather Station Climate Normals for the Period of 1980-2010.

Summer precipitation at the Site follows a monsoonal pattern typical of the high desert Colorado Plateau, originating as warm moisture-laden air masses from the Gulf of California and the Gulf of Mexico and falling as localized, intense, and short-lived precipitation during the months of July through September (Blanchard, 1990; Masbruch and Shope, 2014). Winter precipitation at the Site, typically occurring from October through April, derives from Pacific air masses and falls primarily as snow at elevations higher than the Site (Blanchard, 1990; Masbruch and Shope, 2014). These winter events often fall as snow at the Site, but typically melt out instead of accumulating to form a seasonal snowpack. Vegetation in the area consists of sagebrush, juniper, and piñon in the hills and steeper slopes, while desert grasses, rubber rabbitbrush, and sagebrush sparsely cover the Lisbon Valley floor. Desert grasses and rubber rabbitbrush are the predominant vegetation on the tailing impoundments (see cover photo) and are described in greater detail in Section 3.2.

2.1.1 Historical Trend Analysis

Climate trends at the Site can be used to inform near-term climate projections, though these trends are limited by the observation record and by the assumption that past trends will hold. Golder (2018) conducted a trend analysis of temperature, potential evapotranspiration, and precipitation metrics for the La Sal 1 SW station for the time period of 1981-2016, with missing data infilled using NLDAS-II reanalysis data (Mitchell et al., 2004), and we summarize them here. They noted a statistically significant increasing trend (0.7 °F per decade) in mean annual temperatures and statistically significant decreasing trend in total annual precipitation (0.15 inches per decade) for the observational record. The precipitation trend may be statistically significant; however, it is perhaps not attributable to anthropogenic climate change, as it includes wet years during the start of the observation period (1981-1990) followed by a long period of below-normal precipitation (1991-2012). A full attribution would require a longer precipitation timeseries and more work to eliminate "natural" interannual variability, such as the El Niño Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) influence on precipitation amounts. Indeed, tree ring studies have found evidence for "mega-droughts" in the U.S. Southwest and suggest that the 1981-1990 period was anomalously wet given longer precipitation records (Griffin et al., 2013). Golder (2018) also found that the distribution of precipitation is changing, with fewer heavy (i.e., precipitation amount greater than 0.39 inches) precipitation days and a non-significant trend in more dry days, though these statistics are similarly limited by the observational record. Overall, the period of meteorological record for the Site indicates the climate has warmed and suggests that both the amount and distribution of precipitation is changing, though these trends are far less confident given the limited observational period.

2.1.2 Climate Change Projections

Anthropogenic climate change has been attributed to warming and increased drought and wildfire frequency and intensity in the U.S. Southwest, which are expected to worsen over time in a warming climate (Garfin et al., 2014). In mountainous areas such as the Lisbon Valley, increased temperatures are shifting the fraction of winter precipitation from snow to rain and causing the snowmelt season to shift earlier. This has downstream implications for streamflow, but also for mountain-front and mountain-block recharge (Markovich et al., 2019). While general circulation models (GCMs) can forecast temperature increases through the end of the century based on emissions scenarios with reasonable confidence, precipitation changes remain highly uncertain. This is due to the coarse scale of GCMs (250- to 600-kilometer grid resolution) relative to the scale of moisture convection and cloud formation (meters to kilometers), which are key physical processes needed to accurately model precipitation.

Despite the limitations in precipitation projections, GCMs are still useful for understanding the range of uncertainty and sensitivity to emissions scenario of climate variables, particularly by employing ensemble-based approaches. Golder (2018) conducted an ensemble GCM analysis for the Site, using the projection results from multiple GCMs and multiple emissions scenarios from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (IPCC, 2013) to generate probabilistic results for the Lisbon area. The main focus of the Golder (2018) climate change assessment was on precipitation projections, given that they would have the largest impact to mine closure activities. They found a steady increase of 3% and 6% in annual precipitation at the 50th percentile (i.e., the mean of the ensemble anomalies is positive) in the 2050s and 2080s climate conditions, respectively. They also noted an increase in the maximum precipitation amount and an increase in the amount of precipitation during high-intensity events, while also a decrease in the number of precipitation events (Golder, 2018). A wetter climate and more intense precipitation events pose risks to tailing storage facility (TSF) cover performance; hence INTERA developed an approach to incorporate climate change into the WB modeling.

2.1.3 INTERA Climate Change Approach

The uncertainty in future climate variables combined with the long timescales (100s to 1,000s of years) of uranium mill closure projects can be thought of as “deep uncertainty” or uncertainty that defies confident assignment of probability distributions to the outcomes (Brown et al., 2019). Recognition of deep uncertainty in long-lived infrastructure projects, such as a mill closure, has motivated interest in resilience design. Brown et al. (2019) defines a resilient infrastructure system as “one that can maintain its function and services over a wide range of future conditions.” At its core, resilience theory addresses the deep uncertainty of climate change by shifting focus away from deterministic or stochastic methods of predicting future climate and towards characterizing the system behavior and response (including thresholds and tipping points) to a range of future conditions.

Resilience theory in the context of the Site can be conceptualized as a ball and cup diagram (**Figure 2.2**), where the ball represents the current TSF system, including hydrogeologic properties, flow directions, and water velocities. The TSF system is dynamic yet stable in its current state due to internal and external feedbacks such as redistribution, runoff, and ET. The underlying conditions are forces on the system state that change slowly, such as climate and, consequently, recharge. Triggering perturbations, on the other hand, occur as fast-changing variables such as extreme precipitation events and drought. Climate change is expected to shift the underlying conditions and amplify the triggering perturbations, which decreases the system's ability to adapt as well as increases the forces acting on the system that may cause it to move into a new state (**Figure 2.2)**. In this framework, the indicator or response variable provides a metric for quantifying the resistance to moving to a new state given the change in underlying conditions and triggering perturbations. In the case of the Site WB modeling, the key indicator variable is deep drainage from the TSF to the regional groundwater flow system (e.g., the source term for the Lisbon HSSA4 flow and transport model (INTERA, 2021b).

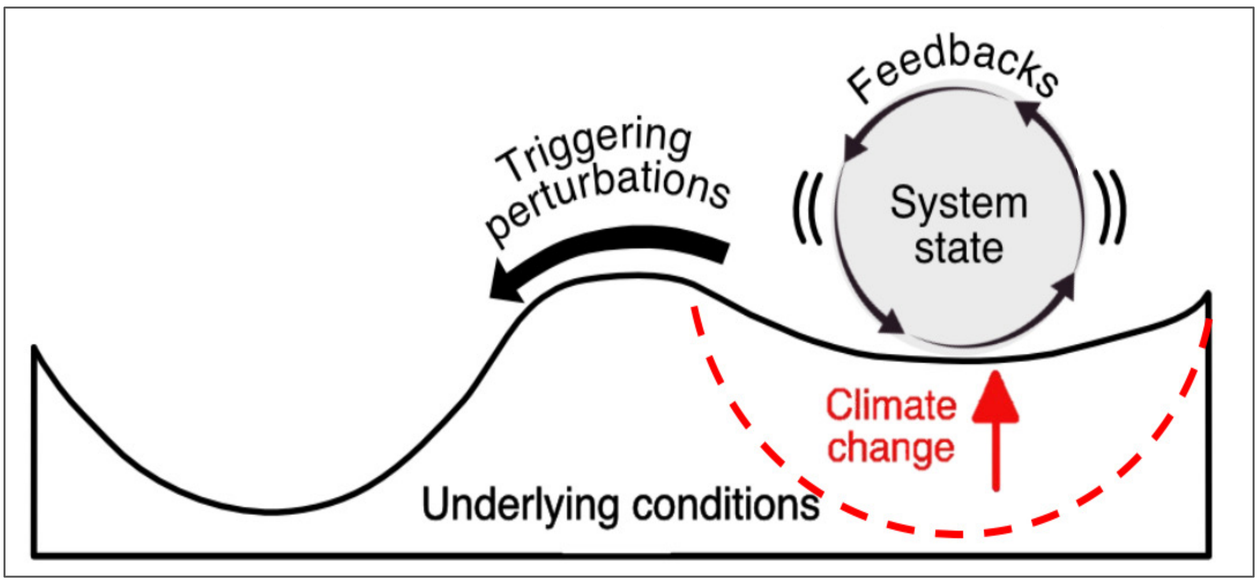


Figure 2.2 Conceptual Diagram of the Climate Change Resilience Framework.

Within this resilience framework, the main question INTERA seeks to answer is the following: if we know the deep drainage behavior of the TSF test columns given the current climate, how resilient is that indicator variable to a changing climate? The approach tests changes in underlying conditions and triggering perturbations through a climate change sensitivity analysis of the WB modeling. The sensitivity analysis scenarios draw from the "worst-case" temperature and precipitation projections within the 95th percentile from the Golder (2018) ensemble results. This percentile was chosen to be within the realm of probable future conditions while also representing the conditions which might disrupt the stable pattern of TSF drainage. The scenarios include a baseline, high temperature, high precipitation, and high temperature and precipitation increase for a total of four scenarios. This will allow for the isolation of the TSF drainage response to temperature versus precipitation, as well as interaction of the two. Worth noting is that precipitation decrease was not included in the scenarios, despite being almost as equally probable as an increase, as it is expected to confer resilience in the TSF by decreasing the moisture available to the system.

2.2 TSF History and Description

The Lisbon TSF consists of two tailing impoundments, shown in **Figures 2.3** and **2.4**. The former milling facility at the Site was operated between 1972 and 1989, to extract uranium oxide (yellow cake, U_3O_8) using an alkaline leach process. Ore for the mill was provided primarily from the Lisbon mine located approximately 2,750 feet (ft) below ground surface (bgs) near the former mill site. During operations, tailing from the mill were pumped via slurry pipeline to the UTI and LTI, located west of the former mill site, and discharged from a spigot system. Both the UTI and LTI each cover an area of approximately 50 acres (**Figure 2.4**). Earthen embankments were constructed in 1974 between the UTI and LTI, and at the western end of the LTI (Dames and Moore, 1980). The UTI and LTI were constructed on top of prepared subgrade but without a bottom liner (Lewis, 2001; Guernsey, 2013).

An investigative program began in 1973 to address tailing seepage followed by interim remedial measures implemented during the 1980s. A remediation process started in 1984 to pump groundwater from a recovery well located adjacent to the UTI (OW-UT-9) to remove contaminated groundwater below the UTI. Groundwater was discharged to the UTI until construction of the reclamation cover began in 1989 and groundwater discharge was switched to the LTI. Discharge water was used on the tailings for dust suppression and to maintain moisture requirements on unreclaimed tailings (Lewis, 2001).

When milling operations terminated in 1989, Cutler Formation waste rock (CWR) removed from the mine during operation was placed on the UTI to initiate stabilization of the tailings and to provide support for construction equipment to place subsequent layers of the final cap. The CWR included soils with approximately 35% passing a #200 screen (silt and clay) (Guernsey, 2013).

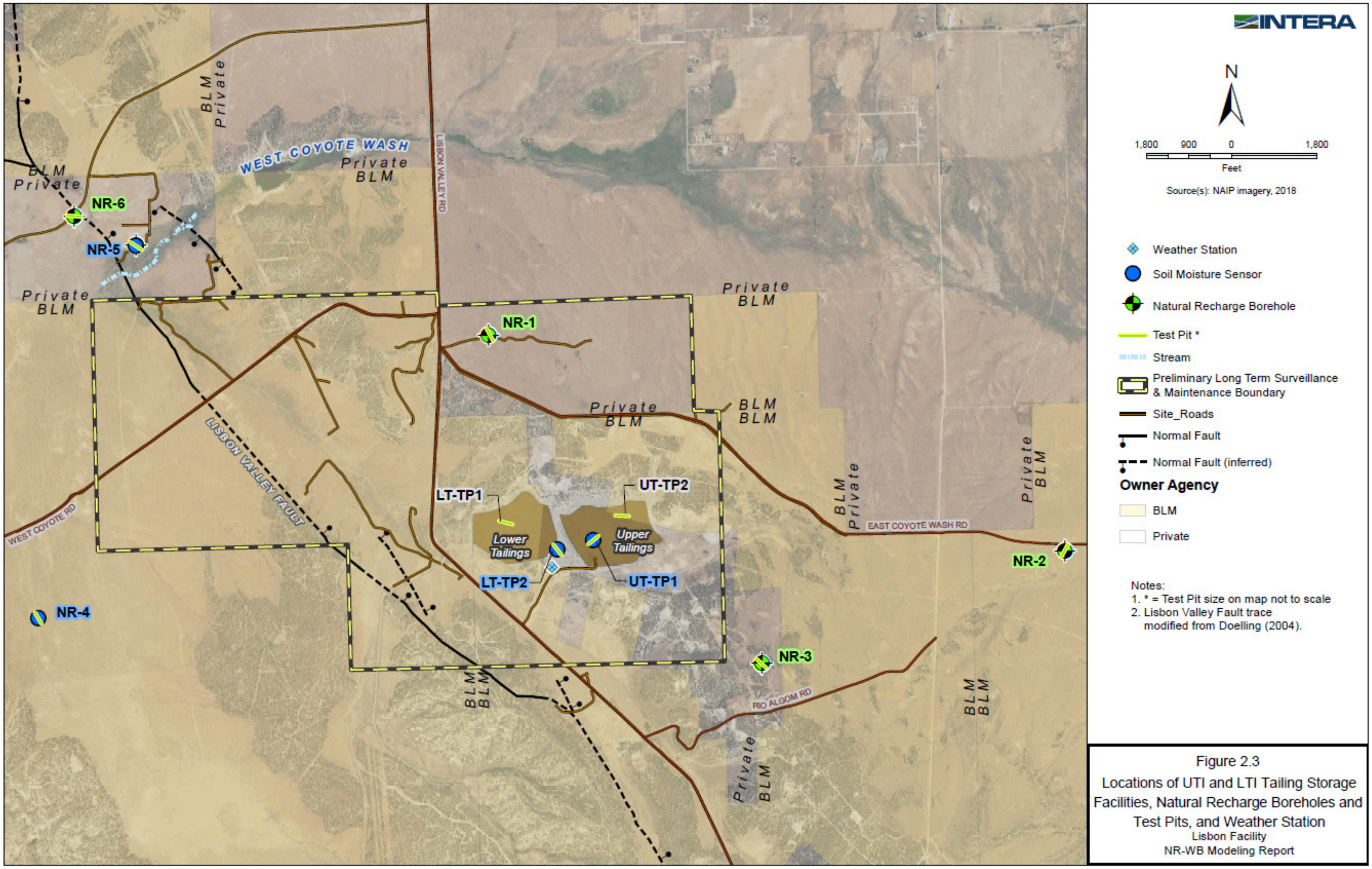


Figure 2.3 Locations of UTI and LTI Tailing Storage.

Figure 2.4 Locations of 2018 Soil Borings, NR-WB Test Pits and Soil Moisture Sensors, and Former CAP Evaporation Cells.

2.2.1 CAP Evaporation Cells

Site closure requirements included implementation of a groundwater Corrective Action Program (CAP), approved by the United States Nuclear Regulatory Commission (NRC) in 1990, to address tailings seepage and groundwater contamination. The CAP was designed to intercept and mitigate impacted groundwater by pumping from multiple recovery wells and discharging the groundwater to two clay-lined evaporation ponds located on top of the impoundments. **Figure 2.4** shows the approximate footprints of the former evaporation cells on UTI and LTI.

The Upper Evaporation Cell (UEC) was constructed with a clay liner on the UTI to collect, store, and provide an evaporative surface for the groundwater collected during the CAP (Guernsey, 2013). Construction of the UEC in 1990 coincided with the construction of the radon barrier on the UTI. The UEC covered approximately 16 acres of the UTI with a maximum capacity of 75 acre-ft (Earthfax Engineering, 1991; Lewis, 2001).

Construction of the radon barrier portion of the final cap began on the LTI in 1990 and was completed in 1992, followed by the start of construction of a clay-lined Lower Evaporation Cell (LEC). Installation of the LEC was completed the following year in 1993. The LEC covered approximately 23 acres of the LTI (Earthfax Engineering, 1992).

An enhanced evaporation sprinkler system was installed on the LEC in 1996 and on the UEC the following year to increase evaporation rates and storage capacity (Lewis, 2001). In 2003, erosion protection rock was placed on portions of both the UTI and LTI not covered by the evaporation cells. The CAP was determined to be largely ineffective in restoring water quality to Site standards and was terminated in 2004 with the NRC approval of an Alternate Concentration Limit (ACL) Application and Long-Term Groundwater Monitoring Program (Komex, 2004). Over 616 million gallons of groundwater were pumped during the CAP program from 1990-2004, according to pond elevation and well pumping records. The evaporation cells were reclaimed as part of site-wide closure activities between 2004 and 2006. The cells containing groundwater discharge were allowed to fully evaporate, followed by placement of additional radon barrier material and rock for erosion protection (Guernsey, 2013).

2.2.2 Previous Tailing Model Results

A tailing infiltration and seepage modeling evaluation was conducted by Lewis Water Consultants (2001) as part of the ACL feasibility study to estimate long-term seepage from the impoundments and determine the source loading functions for their chemical transport and groundwater flow model. Hydrus-2D and UNSAT-H modeling codes were used to develop a tailing profile model and two cover profile models, one for the LTI and another for the UTI. Results of this modeling effort suggested that the covered tailings were draining along a drain-down curve at a rate of approximately 20.7 inches per year (in/yr) after 1 year, 1.7 in/yr after 10 years, 0.23 in/yr after 100 years and 0.019 in/yr after 1000 years. An important assumption of this tailing drainage model to emphasize was their assumption that the impoundment cover would provide an effective barrier to eliminate infiltration of precipitation. The Lewis (2001) model profiles of the cover system did not include the erosion protection cover rock and assigned properties to layers based on designed material types (including an upper layer of loose silt underlain by a compacted silt layer above the clay barrier), not as-built conditions. Their cover modeling results indicated a net upward flow gradient to evaporation which led them to set the upper boundary condition on their tailing seepage model as a no flow boundary, which means no recharge from precipitation in their simulations. This misrepresentation of the water balance system assuming no recharge infiltrates through the impoundment cover led to their prediction that once the saturated tailings had drained, groundwater quality would ultimately be restored by the process of natural attenuation and flushing, as there would be no ongoing contamination source percolating through the unlined impoundments once the tailings were dry.

3.0 INITIAL (2018) HELP MODELING SUMMARY

This section provides a brief summary of the HELP modeling conducted in 2018 for the UTI and LTI reclaimed covers (INTERA, 2018). This effort, referred to herein as "initial HELP modeling" or "2018 HELP modeling," was done to estimate the present and future contribution of pore fluid flux from the tailing impoundments to the underlying groundwater system at the Site. This information was used by INTERA for the HSSA3 Report, which includes transport modeling of solutes in groundwater (INTERA, 2018 Rev. 2021a). The information presented in the HSSA3 Report provides both aqueous chemistry of the pore fluid and a range of estimated moisture flux values from the impoundments as input to long-term flow and transport modeling at the Site (INTERA, 2018 Rev. 2021a).

3.1 HELP Model

HELP (Schroeder et al., 1994) is a quasi-two-dimensional hydrologic model that uses numerical solution techniques to account for the effects of surface storage, snowmelt, runoff, infiltration, ET, vegetative growth, soil moisture storage, lateral subsurface drainage, unsaturated vertical drainage, geomembranes, and composite liners. HELP model v3.07, a disk operating system (DOS) application of the HELP model, was used for this WB Assessment. Version 3.07 ET model uses the Penman method (Penman, 1948) for calculating ET, which incorporates wind and humidity effects as well as long-wave radiation losses.

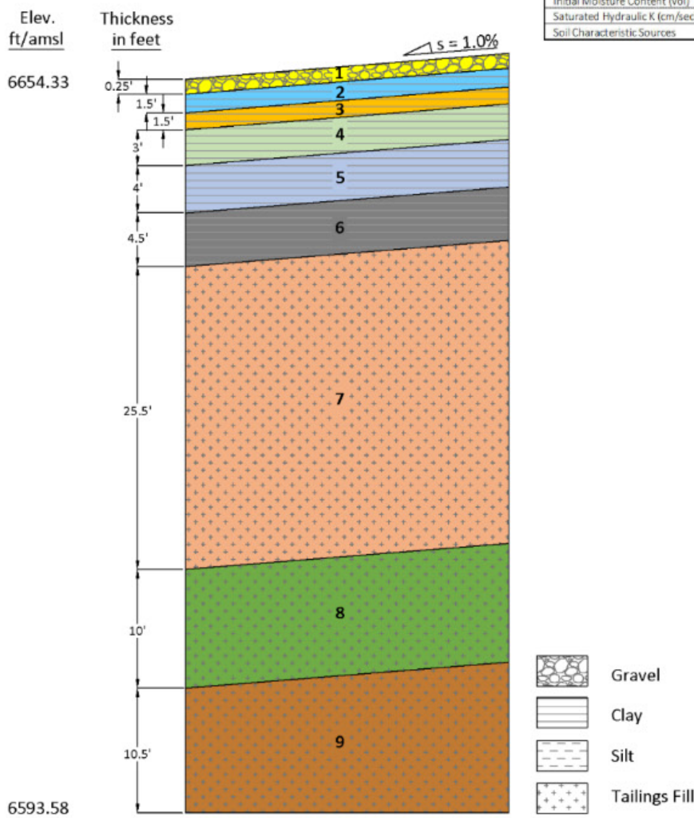
HELP was developed for the United States Environmental Protection Agency by Schroeder et al. (1994) of the U.S. Army Engineer Waterways Experiment Station in Vicksburg, Mississippi, to evaluate movement of water through landfills. It has become a requirement for obtaining operating permits for municipal solid waste (MSW) landfills in the United States. HELP has been effective in assessment of groundwater recharge rates (Stephens and Coons, 1994), and the use of the model for predicting infiltration of water through earthen covers has compared favorably with other, more sophisticated two-dimensional numerical models (Coons et al., 2000). While HELP was originally developed for use in design and evaluation of MSW landfills, HELP treats solid waste as a porous medium with soil hydraulic properties within a layered sequence. As such, any impoundment designed and constructed to contain regulated soil-like materials, such as the tailing impoundments at the Site, can be evaluated using HELP.

The final reclaimed covers placed on the UTI and LTI at the Site are characteristically rock-style covers used for reclaiming Title I and Title II uranium mill sites under the Uranium Mill Tailings Radiation Control Act (UMTRCA) (DOE, 1989, 2014; IAEA, 2004). Such a cover, in a general sense, includes a coarse (1- to 3-inch diameter) rock material, typically 3 to 12 inches thick, placed on top of a soil frost protection layer, which is underlain by the soil radon barrier. Beneath the radon barrier may be some thickness of interim soil cover or general fill that brings the final cover to the proper final grade. Tailing underlies this cover profile, which is underlain by foundational material (placed and natural, as appropriate).

The quasi physically based routing scheme in HELP makes it simple to apply and efficient to run, particularly for rock-style covers; however, results can overestimate the rate of percolation calculated by the model (Schroeder and Peyton, 1988; Khire et al, 1997 in Albright et al., 2002). HELP is a quasi-numerical routing model and does not use Richard's equation (Richards, 1931), which allows upward movement of moisture in the soil profile by capillarity (as appropriate). As such, any moisture that moves below the prescribed evaporative zone depth (EZD) in HELP is added to the cover/tailing profile in the model, which may lead to an overestimate of percolation. A more robust discussion of the use of HYDRUS (Šimůnek et al., 2013) as part of this enhanced modeling effort to compare to HELP modeling is provided in Sections 6 and 8. As described in Sections 6 and 8, physically based models such as HYDRUS struggle to converge in upper rock boundary layers of the final cover due to the sharp contrast in hydraulic properties between the permeable rock cover and underlying material. This can lead to underestimation of percolation through the cover/tailing profile in HYDRUS TSF models. Given the limitations in both the quasi and fully physically based approaches, INTERA applied both HYDRUS and HELP to bound the range of possible upper and lower bounds of estimated percolation of moisture through the rock-style final covers (and underlying tailing) at the Site, which is one of the objectives of the enhanced modeling discussed herein.

The HELP model was used to assess the WB of the UTI and LTI impoundments for the 2018 HELP modeling, based on the tailing characterization information of four boring profiles (UTB-1, LTB-2, LTB-1, and UTB-2) described in the Geotechnical Investigation Report (GIR) for the Site (INTERA, 2017). **Figures 3.1** through **3.4** represent the HELP model profiles developed for the 2018 HELP modeling based upon the four boring profiles (respectively) in the GIR. **Appendix A** includes copies of the boring logs from the GIR (INTERA, 2017) and Tables 2 and 3 from the GIR (INTERA, 2017) summarizing geotechnical testing laboratory results for the TSF cover samples and tailing (respectively) for the four borings. **Figure 2.4** shows the locations of 2016 borings UTB-1, LTB-2, LTB-1, and UTB-2.

LOWER TAILINGS IMPOUNDMENT



Soil and Design Parameters	LTB-1 Layer Number								
	1	2	3	4	5	6	7	8	9
Layer Type	Vertical Percolation	Vertical Percolation	Barrier Soil Liner	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation	Vertical Percolation
Description	Surface gravel	Cover fill - clay	Cover fill - clay	Cover fill - clay	Cover fill - clay	Cover fill - clay	Tailings fill - clay	Tailings fill - silt	Tailings fill - clay
Thickness (ft)	3 in (0.25')	18 in (1.5')	18 in (1.5')	36 in (3')	48 in (4')	54 in (4.5')	306 in (25.5')	120 in (10')	126 in (10.5')
Depth Interval (ft)	+ 0.25'	0-18" (0 - 1.5')	18-36" (1.5' - 3')	36-72" (3' - 6')	72 -120" (6 -10')	120- 174" (10-14.5')	174 - 480" (14.5' - 40')	480 - 600" (40' -50')	600 - 726" (50' -60.5')
Soil Texture (Help Code)	Gravel (21)	Moderately Compacted Clay CL (25)	Moderately Compacted Clay CL (25)	Moderately Compacted Clay CL (25)	Moderately Compacted Clay CL (25)	Moderately Compacted Clay CL (25)	Moderately Compacted Clay CL (25)	Moderately Compacted Silt ML (22)	Moderately Compacted Clay CL (25)
Porosity	0.397	0.338	0.338	0.382	0.447	0.544	0.437	0.3902	0.366
Field Capacity (vol)	0.032	0.315	0.315	0.373	0.373	0.373	0.389	0.307	0.360
Wilting Point (vol)	0.013	0.150	0.150	0.266	0.266	0.266	0.195	0.180	0.266
Initial Moisture Content (vol)	0.020	0.317	0.317	0.353	0.447	0.514	0.426	0.388	0.330
Saturated Hydraulic K (cm/sec)	3.00E-01	5.30E-07	5.30E-07	1.90E-06	3.60E-06	3.60E-06	3.60E-06	3.60E-07	2.40E-07
Soil Characteristic Sources	Soil boring logs (Appendix A), field observation, lab results, HELP default values								

Default HELP values	Values from lab results
User input values based on field observation and HELP model requirements	

Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	14.11	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Temperature (annual avg., F°)	47.1	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Maximum Leaf Area Index (LAI)	2.0	HELP Model User guide LAI is 2.0 for fair stand of grass
Evaporative Zone depth (in.)	9 - 18	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.3	Lisbon Weather Station (2 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Cover Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Vegetation Type (1-5)	2	2 is for Poor Grass; evident during site visits
HELP Model Curve No. (CN)	54.9	Calculated by HELP based on top layer parameters
Slope (%)	1	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	0.7 - 1	Value of 1 assumes 100% of cover drains (no ponding)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 3.1 2018 HELP Model Layer Profile LTB-1

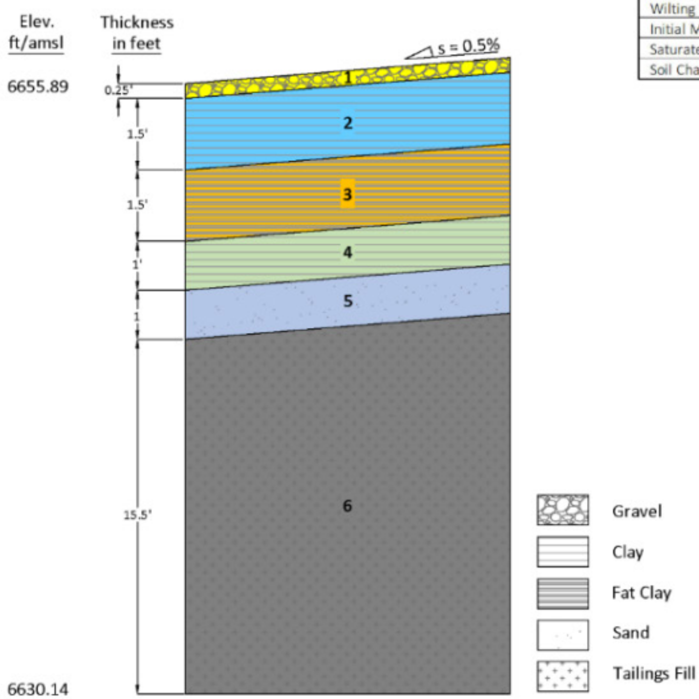
LISBON FACILITY, RIO ALGOM MINING LLC

Date 7/10/2018

File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\HELPmodel\LayerProfilesUPDATE.DWG

Figure 3.1 2018 HELP Model Layer Profile LTB-1.

LOWER TAILINGS IMPOUNDMENT



Soil and Design Parameters	LTB-2 Layer Number					
	1	2	3	4	5	6
Layer Type	Vertical Percolation	Vertical Percolation	Barrier Soil Liner	Vertical Percolation	Vertical Percolation	Vertical Percolation
Description	Surface gravel	Cover fill - clay	Cover fill - fat clay	Cover fill - clay	Cover fill - sand	Tailings fill - clay
Thickness (ft)	3 in (0.25')	18 in (1.5')	18 in (1.5')	12 in (1')	12 in (1')	186 in (15.5')
Depth Interval (ft)	+0.25'	0-18" (0 - 1.5')	18 -36" (1.5' - 3')	36 -48" (3 -4')	48 - 60" (4-5')	60 -246" (5' - 20.5')
Soil Texture (Help Code)	Gravel (21)	Moderately Compacted Clay CL (25)	Moderately Compacted Fat Clay CH (28)	Moderately Compacted Clay CL (25)	Moderately Compacted Clayey Sand SC (24)	Moderately Compacted Clay CL (25)
Porosity	0.397	0.373	0.372	0.308	0.490	0.402
Field Capacity (vol)	0.032	0.300	0.370	0.300	0.305	0.373
Wilting Point (vol)	0.013	0.140	0.231	0.250	0.168	0.266
Initial Moisture Content (vol)	0.020	0.145	0.231	0.250	0.168	0.402
Saturated Hydraulic K (cm/sec)	3.00E-01	1.20E-04	1.20E-06	3.20E-05	2.70E-06	9.80E-07
Soil Characteristic Sources	Soil boring logs (Appendix A), field observation, lab results, HELP default values					

Default HELP values	Values from lab results
User input values based on field observation and HELP model requirements	

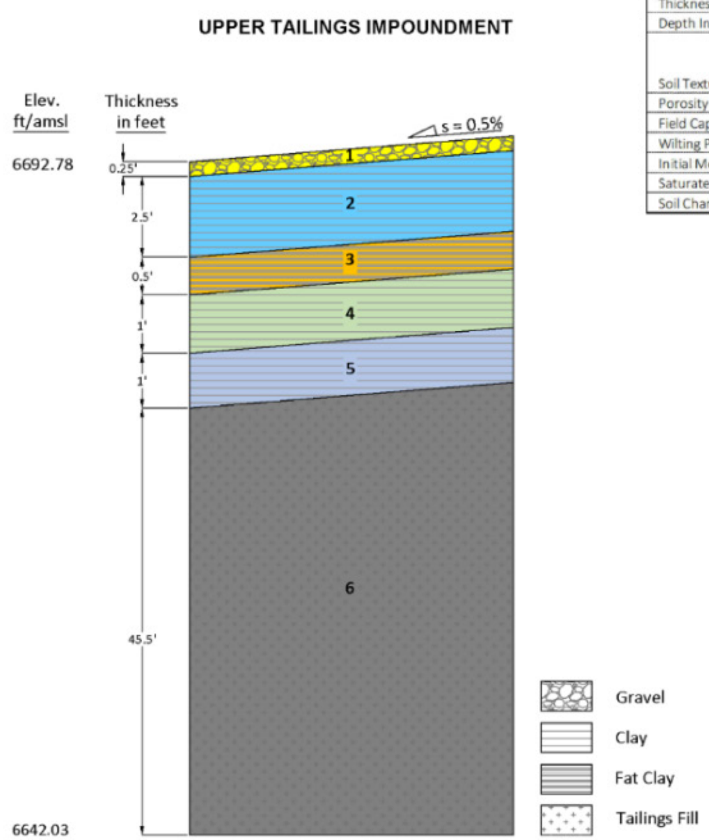
Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	14.11	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Temperature (annual avg., F°)	47.1	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Maximum Leaf Area Index (LAI)	2.0	HELP Model User guide LAI is 2.0 for fair stand of grass
Evaporative Zone depth (in.)	9 - 18	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.3	Lisbon Weather Station (2 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Cover Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Vegetation Type (1-5)	2	2 is for Poor Grass; evident during site visits
HELP Model Curve No. (CN)	53.8	Calculated by HELP based on top layer parameters
Slope (%)	0.5	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	0.7 - 1	Value of 1 assumes 100% of cover drains (no ponding)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 3.2 2018 HELP Model Layer Profile LTB-2
LISBON FACILITY, RIO ALGOM MINING LLC

Date 7/10/2018
File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\HELPmodel\LayerProfilesUPDATE.DWG

Figure 3.2 2018 HELP Model Layer Profile LTB-2.



Soil and Design Parameters	UTB-1 Layer Number					
	1	2	3	4	5	6
Layer Type	Vertical Percolation	Vertical Percolation	Barrier Soil Liner	Vertical Percolation	Vertical Percolation	Vertical Percolation
Description	Surface gravel	Cover fill - clay	Cover fill - fat clay	Cover fill - clay	Cover fill - clay	Tailings fill - clay
Thickness (ft)	3 in (0.25')	30 in (2.5')	6 in (0.5')	12 in (1')	12 in (1')	546 in (45.5')
Depth Interval (ft)	+0.25'	0-30" (0 - 2.5')	30-36" (2.5' - 3')	36 -48" (3 -4')	48 - 60" (4-5')	60 - 606" (5' - 50.5')
Soil Texture (Help Code)	Gravel (21)	Moderately Compacted Clay CL (25)	Moderately Compacted Fat Clay CH (28)	Moderately Compacted Silty Sand SC (24)	Moderately Compacted Lean Clay CL (25)	Moderately Compacted Clay CL (25)
Porosity	0.397	0.370	0.349	0.344	0.437	0.399
Field Capacity (vol)	0.032	0.365	0.345	0.305	0.373	0.390
Wilting Point (vol)	0.013	0.266	0.22	0.142	0.266	0.213
Initial Moisture Content (vol)	0.020	0.313	0.316	0.142	0.266	0.399
Saturated Hydraulic K (cm/sec)	3.00E-01	3.40E-07	5.20E-08	2.70E-06	3.60E-06	3.65E-07
Soil Characteristic Sources	Soil boring logs (Appendix A), field observation, lab results, HELP default values					

Default HELP values	Values from lab results
User input values based on field observation and HELP model requirements	

Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	14.11	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Temperature (annual avg., F°)	47.1	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Maximum Leaf Area Index (LAI)	2.0	HELP Model User guide LAI is 2.0 for fair stand of grass
Evaporative Zone depth (in.)	9 - 18	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.3	Lisbon Weather Station (2 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Cover Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Vegetation Type (1-5)	2	2 is for Poor Grass; evident during site visits
HELP Model Curve No. (CN)	53.8	Calculated by HELP based on top layer parameters
Slope (%)	0.5	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	0.7 - 1	Value of 1 assumes 100% of cover drains (no ponding)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

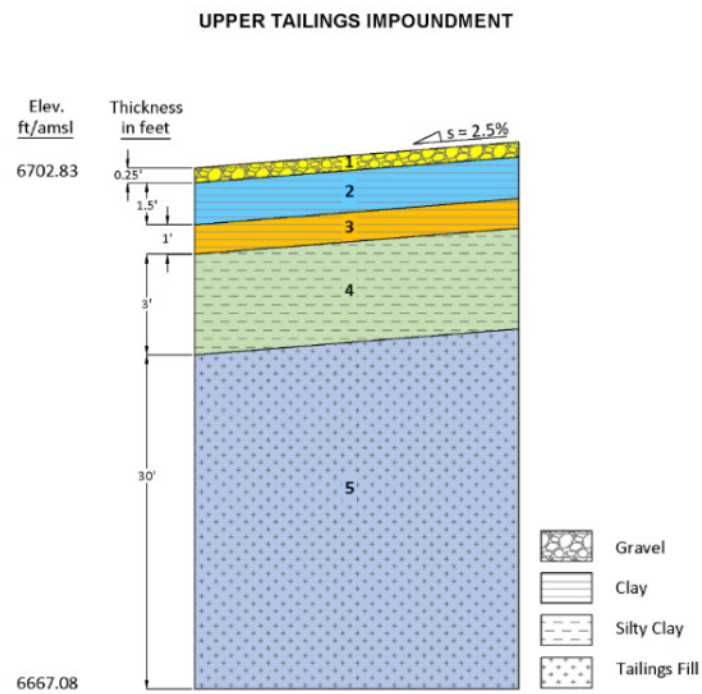
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110

Phone 505-246-1600
www.intera.com

Figure 3.3 2018 HELP Model Layer Profile UTB-1
LISBON FACILITY, RIO ALGOM MINING LLC

Date 7/10/2018
File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\HELPmodel\LayerProfilesUPDATE.DWG

Figure 3.3 2018 HELP Model Layer Profile UTB-1.



Soil and Design Parameters	UTB-2 Layer Number				
	1	2	3	4	5
Layer Type	Vertical Percolation	Vertical Percolation	Barrier Soil Liner	Vertical Percolation	Vertical Percolation
Description	Surface gravel	Cover fill - clay	Cover fill - clay	Cover fill - silty clay	Tailings fill - clay
Thickness (ft)	3 in (0.25')	18 in (1.5')	12 in (1')	36 in (3')	360 in (30')
Depth Interval (ft)	+0.25'	0-18" (0 - 1.5')	18-30" (1.5 - 2.5')	30-66" (2.5' - 5.5')	66-426" (5.5' - 35.5')
Soil Texture (Help Code)	Gravel (21)	Moderately Compacted Clay CL (25)	Moderately Compacted Clay CL (25)	Moderately Compacted Silty Clay CL (26)	Moderately Compacted Clay CL (25)
Porosity	0.397	0.384	0.384	0.395	0.437
Field Capacity (vol)	0.032	0.373	0.373	0.345	0.315
Wilting Point (vol)	0.013	0.266	0.266	0.155	0.161
Initial Moisture Content (vol)	0.020	0.269	0.269	0.308	0.393
Saturated Hydraulic K (cm/sec)	3.00E-01	2.50E-06	2.50E-06	1.40E-05	3.60E-06
Soil Characteristic Sources	Soil boring logs (Appendix A), field observation, lab results, HELP default values				

Default HELP values	Values from lab results
User input values based on field observation and HELP model requirements	

Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	14.11	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Temperature (annual avg., F°)	47.1	US Climate Data (https://www.usclimatedata.com/climate/la-sal/utah/)
Maximum Leaf Area Index (LAI)	2.0	HELP Model User guide LAI is 2.0 for fair stand of grass
Evaporative Zone depth (in.)	9 - 18	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.3	Lisbon Weather Station (2 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Cover Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Vegetation Type (1-5)	2	2 is for Poor Grass; evident during site visits
HELP Model Curve No. (CN)	56.4	Calculated by HELP based on top layer parameters
Slope (%)	2.5	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	0.7 - 1	Value of 1 assumes 100% of cover drains (no ponding)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 3.4 2018 HELP Model Layer Profile UTB-2
LISBON FACILITY, RIO ALGOM MINING LLC

Date 7/10/2018
File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\HELPmodel\LayerProfilesUPDATE.DWG

Figure 3.4 2018 HELP Model Layer Profile UTB-2.

3.2 Summary of 2018 Input Data

The two main categories of input data for HELP, soil/design data and climatological data are briefly summarized here for the 2018 HELP modeling.

3.2.1 Soil/Design Data

The soil boring logs and hydraulic properties of the existing UTI and LTI materials (**Appendix A**), identified in the 2016 geotechnical investigation (INTERA, 2017) were utilized to develop the representative profile geometry based on the four profiles described in the GIR (INTERA, 2017).

Two general layer types were utilized in the 2018 HELP modeling, including vertical percolation and barrier soil liner. The majority of the profile layers were modeled as vertical percolation layers which permit unsaturated vertical drainage downward due to gravity and upward vertical gradients due to ET, modeled as extraction. The primary role of the vertical percolation layer is to provide moisture storage. Each profile also contained a low-permeability barrier soil liner layer, which is intended to restrict vertical drainage. The barrier soil layer designation permits percolation only when there is a positive head on the top surface of the liner (Schroeder et al., 1994). There are no geosynthetic liners within the Lisbon Facility impoundments.

Soil mechanical and hydraulic properties (including porosity, field capacity [-0.33 bar suction], wilting point [-15 bar suction], moisture contents, and saturated hydraulic conductivity) were obtained from laboratory testing of soil samples (INTERA, 2017). Initial moisture contents were specified for each layer based on the volumetric moisture contents measured by the lab in the 2016 investigation (INTERA, 2017).

Generally, for the four cover/tailing profiles modeled, the layering consisted of (from the surface down) loose, coarse gravel; three to five layers of soil material representing the cover profiles (as appropriate for the specific profile); and one to three layers of soil material representing the tailing profiles (as appropriate for the specific profiles in **Figures 3.1** through **3.4**). Updates to the profiles applied in the enhanced models are discussed in Section 6.3.

3.2.2 Meteorological Data

Weather data required in the HELP model includes mean annual precipitation, mean annual temperature, ET, average annual windspeed, and solar radiation. Climate data essentially serves as an upper boundary condition in WB modeling. The synthetic weather generator in HELP v3.07 generates up to 100 years of representative climatological data, based on the local historical climate data entered by the user.

The initial HELP modeling utilized a nearly 30-year historical climate record from 1981-2010 from the La Sal 1 SW station (INTERA, 2017), as well as HELP default data derived from the nearest preprogrammed city of Grand Junction, Colorado, (65 miles northeast of the Site, elevation 4,593 ft). Solar radiation data was generated synthetically by the HELP model based upon default coefficients for Grand Junction and a La Sal station latitude of 38.30 degrees. Climate change was not applied during the 2018 HELP Modeling. The refined climate dataset applied in the enhanced models are discussed in Sections 2.1 and 5.1.

3.2.3 Vegetation Data

The HELP model input parameters representing vegetation include the duration of the growing season, maximum leaf area index (LAI), EZD (similar to rooting depth), runoff curve number (CN), and vegetation density. CN ranged from 53.8 to 56.4 for each simulation depending on the slope, which ranged from 0.5 to 2.5%. The runoff fraction, or the fraction of the cover that will shed precipitation, was varied between 0.7 to 1 to represent scenarios with temporary ponding and others with 100% runoff for comparison. A unit surface area of 1 acre was assumed for this application. A maximum LAI of 2.0 was assumed for all four initial models, based on default values provided by the HELP manual representing a poor stand of grass. Updates to the LAI input parameters applied in the enhanced models are discussed in Section 5.2.

3.2.4 Evaporative Zone Depth Data

The EZD is the maximum depth from which water may be removed by ET. The boundary defined by the maximum EZD is theoretically a zero-flux plane, defined by the reversal in the direction of the unsaturated hydraulic gradient (Dreiss and Anderson, 1985). Above this zero-flux plane, the gradient is vertically upward and all the decreases in water content are assumed to result from ET. Below this plane, the hydraulic gradient is vertically downward and all the decreases in soil water content are assumed to reflect a net infiltration of water vertically downward through the tailings.

The EZD was varied between 9 and 18 inches for all four profiles modeled. Based upon the layering and texture of final cover components over the UTI and LTI, and the minimal root zone data obtained during the 2016 geotechnical investigation (INTERA, 2017), an EZD of 9 to 18 inches was considered reasonable for this Assessment. As part of a sensitivity analysis of EZD to percolation, an EZD of 32 inches was used.

3.3 Summary of 2018 Results

The HELP model was run for a duration of 100 years for each of the four impoundment profiles beginning at current, "as-drilled" conditions, based on the 2016 geotechnical investigation data

(INTERA, 2017). No attempt has been made for the Assessment to back-model or calibrate present-day conditions due to the complex operations history of the impoundments.

3.3.1 Percolation Rates

The initial HELP modeling predicted an average simulated percolation (flux) through the tailings (combined UTI and LTI) of 1.58 in/yr (1.27E-7 centimeters per second [cm/s]) after 100 years from current conditions assuming an EZD of 9 to 18 inches. Considering the four borehole locations on the UTI and LTI and associated cover and tailings profiles, percolation rates through the tailings ranged from 0.70 to 3.24 in/yr, dependent primarily on EZD. The average annual estimated deep percolation through the impoundments that would become recharge (1.58 in/yr) represents approximately 11% of the mean annual precipitation.

As a comparison, Marston and Heilweil (2012) estimated recharge from natural infiltration of precipitation for the Sand Hollow Basin and Hurricane Bench study area in southwest Utah as part of a numerical simulation of groundwater movement study from Sand Hollow Reservoir in Washington County. They estimated recharge using water budget equations and a least squares linear regression between surficial parameters and percentage of precipitation that becomes net infiltration based on environmental tracer data from excavations and boreholes in the study area (Heilweil et al., 2005). The average recharge was estimated at 0.8 in/yr (6.4E-8 cm/s) which is approximately 10% of the precipitation in that area of Utah.

3.3.2 Sensitivity and Uncertainty

Water balance modeling simplifies complex processes of the real world. As such, it is important to recognize the limitations of models used to predict vadose zone processes. Sub-layer-scale heterogeneities within the cover materials and tailings, regarding material properties and moisture contents, are not reflected in the simplified layering of the model.

The HELP modeling used the approach of selecting the best set of input parameters available to estimate percolation through the tailings. This is a reasonable approach given the amount of information that was collected during the 2016 geotechnical investigation (INTERA, 2017) that represents present-day cover and tailings profile conditions. A global sensitivity analysis of all input parameters was not conducted since most of the input variables are reasonably constrained and percolation was relatively insensitive to the majority of input parameters. Instead, a targeted sensitivity analysis was performed for the input parameters that percolation was most sensitive to, including EZD, surface slope, and runoff potential.

- EZD: Percolation is sensitive to prescribed EZD. A sensitivity study was performed to determine the relative impact on percolation through the tailings by increasing EZD. As anticipated, percolation decreases with increasing EZD. On average for the four boring locations on UTI and LTI, percolation is reduced by a factor of 5 by increasing the EZD from 9 inches to 32 inches.

- Slope and Runoff Potential: Runoff potential refers to the percentage of rainfall excess that has the potential to run off the subject area. A runoff potential of 100% creates a model condition whereby rainfall excess is not retained on the subject area. In contrast, a runoff potential of 70% creates a model condition whereby 30% of the rainfall excess is retained on the subject area and is subject to increased percolation through the cover. Results of the simulations for varying slope and runoff potential reveal very little sensitivity to varying surface slope or rainfall excess. As long as a gravel surface is assumed for the impoundment surfaces and related CN is low, neither slope nor runoff potential will greatly impact resulting percolation through the tailings.

3.4 Summary and Conclusions of 2018 HELP Modeling

3.4.1 Summary

- The HELP model, v3.07, was used to estimate long-term percolation of tailings pore fluids through the UTI and LTI at the Site.
- Model input was derived from a combination of site-specific data obtained from a geotechnical investigation of the UTI and LTI in 2016, and from local and regional climatological data.
- Numerous model runs were made for a period of 100 years, each synthetically generating precipitation using the local and regional climatological data.
- Based upon the construction of the final cover over the UTI and LTI, and limited observations made regarding shallow root development in the covers during the 2016 geotechnical investigation, the EZD considered to be appropriate for the Site, and as used in the simulations, varied between 9 and 18 inches.
- Based upon Site conditions, including (but not limited to) surface slope and a rock layer that overlies the final covers, a relatively low runoff CN of approximately 55 was generated by the model and used in the simulations.
- Using these assumed and model-generated data, HELP calculated a mean percolation rate of 1.58 in/yr (1.27E-7 cm/s) after 100 years of simulation, with a range of percolation from 0.70 in/yr (5.64E-8 cm/s) to 3.24 in/yr (2.60E-7 cm/s) for the four boring locations modeled on UTI and LTI. The calculated mean percolation rate range is equal to 5.0 to 23.0% of the average annual precipitation of 14.11 inches used in the model.

- Sensitivity analyses indicate that increasing the EZD will decrease the long-term percolation rate, and that changing slope and runoff potential has no significant impact on percolation rate as long as CN remains low (which reflects the surface conditions at the Site).

3.4.2 Conclusions

- Long-term percolation of tailing pore fluids through the UTI and LTI is ultimately dictated by the performance of the cover systems constructed as part of Site reclamation.
- The final covers are designed to meet long-term performance objectives of limiting radon flux to the atmosphere and associated protection of the radon barrier component of the cover from erosion, frost damage, and desiccation from drying.
- The final covers are not specifically designed and constructed as ET covers, which act to maximize the EZD and consumptive use of precipitation by storage of water in the rooting zone and subsequent ET.
- To protect the final covers from erosion during very large storm events, the top layer of the covers is rock, which acts as a mulch and limits evaporation from the surface, thereby enhancing deep percolation.
- Given the current configuration of the final covers, available information for use as input to the model, and limitations associated with simulations of a complex process (WB); the estimated range of long-term percolation values for the UTI and LTI at the Site is likely between 0.5 to 5 in/yr (4E-8 cm/s to 4E-7 cm/s), and a value of 1.6 in/yr (1.27E-7 cm/s) has been recommended for use in the flow and transport model of the Site (INTERA, 2021b).
- Because of the design and construction of the final covers on the UTI and LTI as described above to protect the radon barrier component of the covers, it is reasonable to consider the long-term percolation rate of pore fluids through the tailings to groundwater is equal to or greater than the NR of precipitation to groundwater at the Site.

4.0 ENHANCED FIELD AND LABORATORY DATA COLLECTION

On RAML's behalf, INTERA conducted work at the Site to collect information to support the enhanced Assessment. In 2019, a characterization program was executed to collect both geotechnical information targeted at dam safety-related analyses and information specific to the enhanced Assessment. The drilling, sampling, and laboratory testing associated with the dam safety work is not included in this NR-WB Report. This section presents the 2019 data collection specific to this enhanced Assessment, including excavation of four test pits on the tailing impoundments (UT-TP1, UT-TP2, LT-TP1, and LT-TP2); six test pits in the area surrounding the TSF (NR-1 through NR-6); and drilling five off-tailing boreholes (NRB-1 through NRB-3, and NRB-5 and NRB-6). **Figure 2.4** shows the locations of the NR-WB test pits and borings.

As discussed in this section and in Section 5, information collected from the test pits on the tailing impoundments is used to better understand the material properties and performance of the cover for this enhanced Assessment. Information collected from the off-tailing test pits and borings is used to estimate long-term historical NR (Section 5.4) and validation of the modeling (Sections 6 and 7).

4.1 Natural Recharge Investigation

The NR-WB Assessment was conducted to estimate NR rates and to better characterize the present and future contribution of pore fluid flux from the tailing impoundments to the underlying groundwater system. The natural analogue (off-tailing) portion of the field investigation included test pit excavation, soil moisture sensor (SMS) installation, drilling, and sampling of the upper layer of alluvium to characterize long-term percolation rates and evaporative zone conditions in undisturbed areas surrounding the TSF. The natural analogue information provides data to estimate the historical recharge rate of precipitation to groundwater on-site in a natural setting.

The NR analogue field locations (NR-1 through NR-6; **Figure 2.3**) were selected to target undisturbed natural settings with slopes similar to the impoundment covers (0.5-3%). At each natural analogue field location, a shallow test pit was excavated to document the rooting and evaporative zone depth profiles and to install SMSs in select test pits, soil condition permitting. In close proximity (within 20 ft) to the test pits, an auger hole was drilled through the unconsolidated alluvium to collect moisture content, hydraulic conductivity, and chloride values through the soil profile. The soil chloride values were used to calculate NR using the CMB method (Allison and Hughes, 1978; Allison et al., 1994) (see Section 5.4.1).

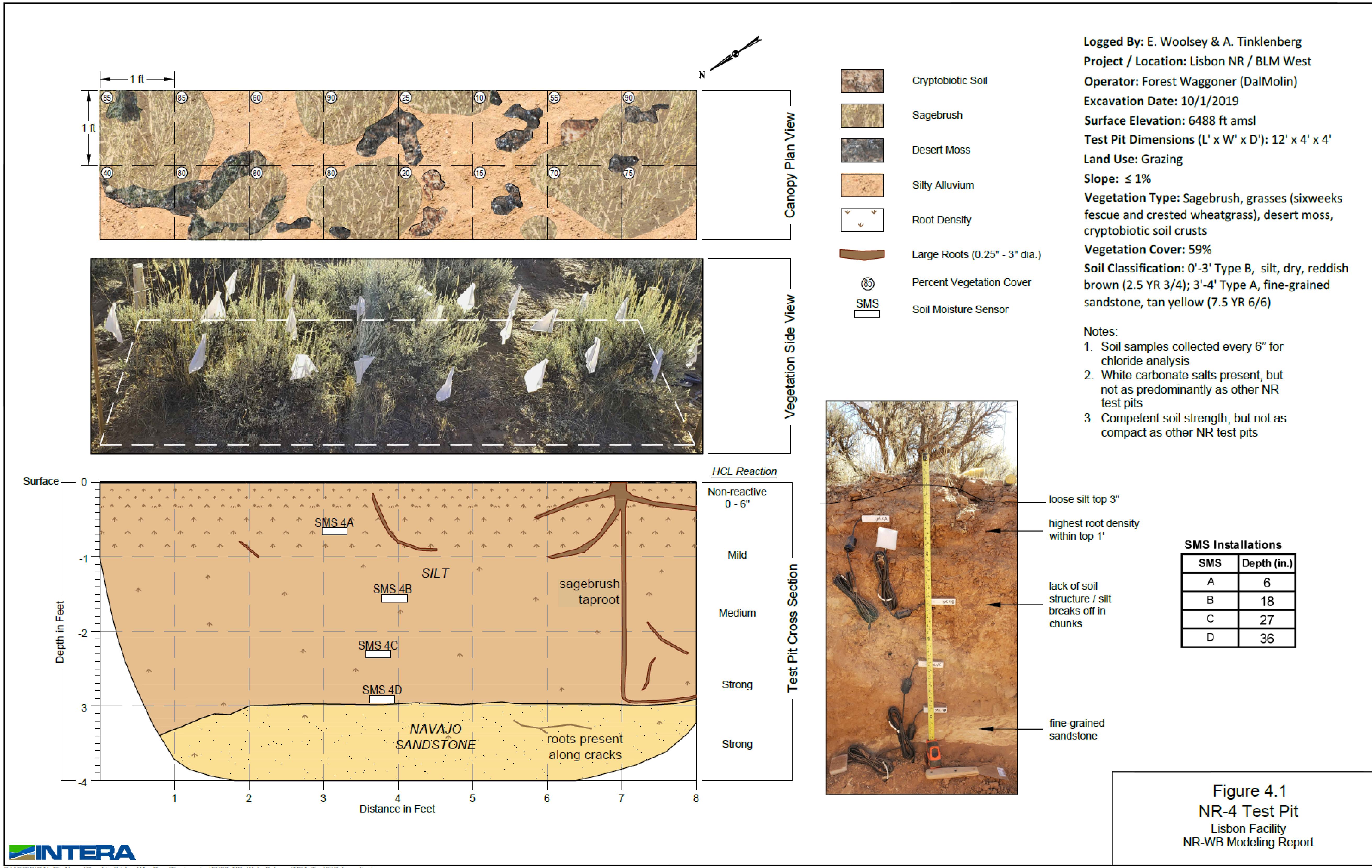
4.1.1 Test Pits

Six shallow test pits (NR-1 through NR-6) were excavated in the natural analogue study areas surrounding the TSF (**Figure 2.3**) from September 27 to October 1 of 2019. Test pits were excavated by DalMolin Excavating using a rubber-tired backhoe to a maximum depth of 4 ft. Each test pit was excavated, soil profile documented, SMS installed (if applicable), and backfilled within the same day. A test pit log for each location is included in **Appendix B,** and a select photolog documenting the vegetation study and test pit excavation is included in **Appendix C**.

Prior to excavation of each test pit, a Job Risk Assessment (JRA) was reviewed to identify hazards and a ground disturbance permit was issued that designates a Competent Person with Occupational Safety and Health Administration (OSHA) Excavation Safety training. Underground utility surveys were conducted by Sunbelt Geophysics prior to commencement of the NR field program. No subsurface features or utilities were detected at the Proposed NR locations. The test pits were excavated to a maximum of 4 ft and constructed with a sloped access ramp wide enough to safely enter and inspect soil properties.

The surface setting at each test pit location including vegetation type and density within an 8-ft x 2-ft rectangular plot, land use, erosion, disturbance, slope, etc. was documented before disturbance of the work area occurred. Soils encountered during excavation were recorded on the ground disturbance permits as Type A, B, or C, from most stable (A) to least stable (C) and evaluated for competency before personnel entry was granted. Soil profile descriptions were documented on test pit logs including features such as horizon layer designation, color, texture, moisture, structure, root penetration depth, root growth patterns, particle-size distribution, accumulated salts, minerals, rocks, animal burrows, etc. Once the soil profile investigation was complete, test pits were backfilled in lifts and compacted to grade using the excavated materials.

Figure 4.1 provides an example test pit log for NR-4 with a plan view of the vegetation canopy, side view photo of the vegetation plot, and a cross-section of the soil profile indicating the SMS installation locations. The cross-section background pattern density corresponds to root density, which is highest in the top 1 ft in this example. At NR-4, the sagebrush taproots extend to a depth of 3 ft until encountering the Navajo Sandstone, then take a 90° turn and extend horizontally above bedrock. The SMS data for NR-4 and the other three SMS locations is presented in Section 5.3. **Appendix B** includes the full set of test pit diagrams including copies of the original field logs.



SMS	Depth (in.)
A	6
B	18
C	27
D	36

Figure 4.1 NR-4 Test Pit Diagram and SMS Installation Profile.

4.1.1.1 TSF Test Pits

Four shallow test pits were excavated on the tailing impoundments as shown on **Figure 2.4**. Test pits UT-TP1 and LT-TP1 are located within the limits of the former CAP evaporation ponds and are co-located with the boreholes drilled during the 2016 geotechnical investigation. Test pits UT-TP2 and LT-TP2 are located outside the limits of the former CAP evaporation ponds and are also co-located with the boreholes drilled during the 2016 geotechnical investigation (INTERA, 2017). Excavation of the test pit depths was limited to the cover material only, and no tailing was excavated during the process.

The tailing impoundment test pit excavations were conducted under a Radiation Work Permit with supervision from Environmental Restoration Group (ERG). Prior to excavation, the rock cover was scraped away and stockpiled for replacement after the test pit was backfilled. ERG performed pre- and post-excavation gamma radiation surveys of the test pit locations to demonstrate that the work did not increase radiation levels at the surface of the UTI and LTI. The test pits were excavated through the cover material only and did not intrude into the tailing material. The exclusion zone around the excavation work area was dismantled at all four TSF tailing locations since no tailing was encountered during excavation of the impoundment cover materials. After completion, test pits were backfilled and compacted to grade using the excavated spoils. Cover materials segregated during excavation were placed back in their proper positions in 8-inch to 12-inch lifts, with each lift being tamped/compacted using the bucket of the backhoe or excavator.

General excavation safety precautions and documentation of the TSF test pits followed the same methodology as described above for the off-tailing test pits. **Figure 4.2** provides an example tailing impoundment test pit log for UT-TP1 illustrating the cover rock, sparse vegetation (4% canopy cover), shallow grass roots, and a moist clay soil profile observed within the footprint of the former evaporation pond. The test pit log for LT-TP2 is included as **Figure 4.3** to illustrate the variability of the tailing impoundment cover profiles. LT-TP2, located outside of the former evaporation pond perimeter, displays more vegetation (51% canopy cover) with deeper roots than UT-TP1 and a soil profile consisting of an approximately 1.3-ft layer of sandy silt above clay. **Appendix B** includes the full set of test pit diagrams, including copies of the original field logs.

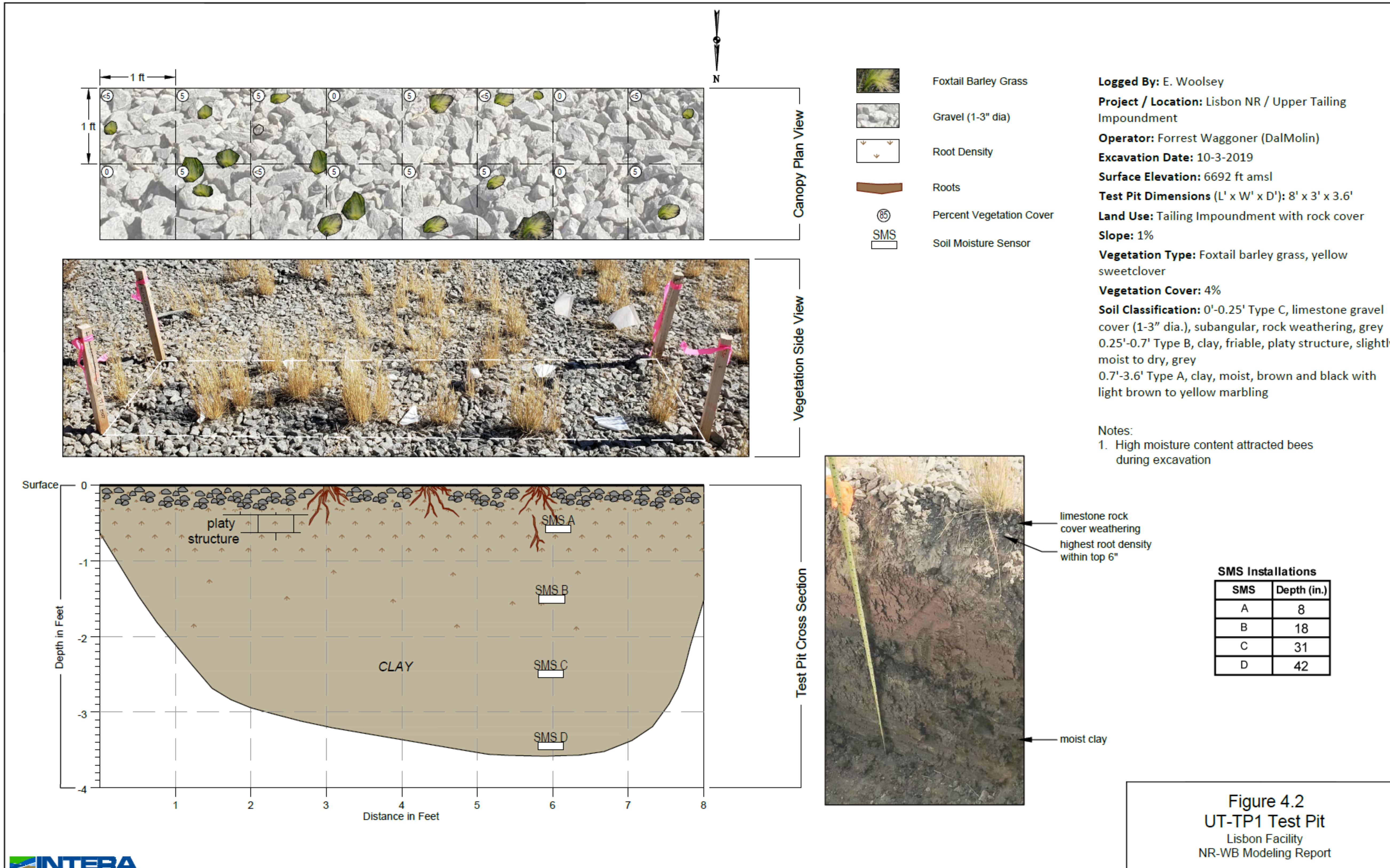


Figure 4.2 UT-TP1 Test Pit Diagram.

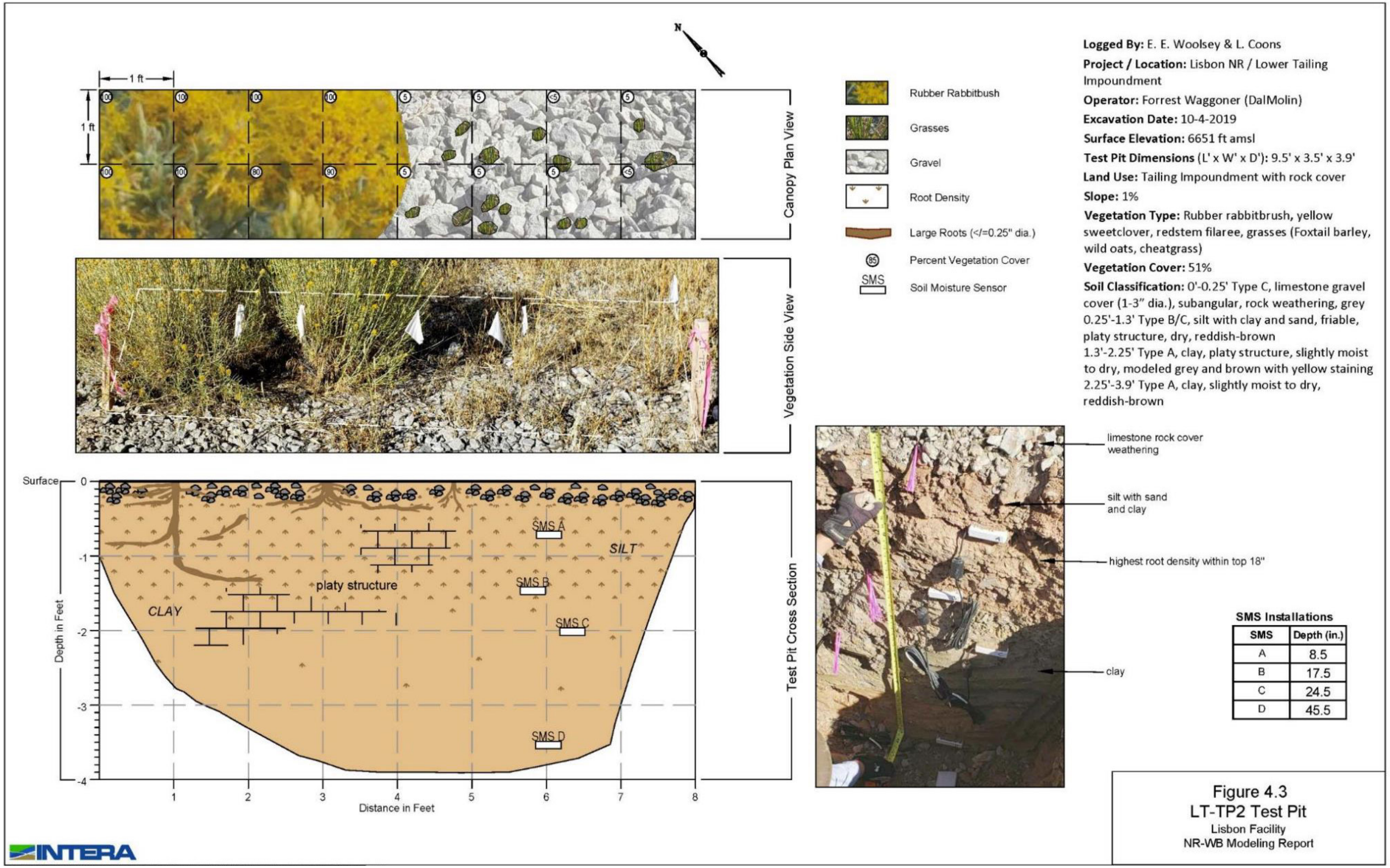


Figure 4.3 LT-TP2 Test Pit Diagram.

4.1.2 SMS Installation

SMSs were installed in four of the test pits, including two in the NR areas (NR-4 and NR-5; **Figure 2.3**) and two on the tailing impoundments (UT-TP1 and LT-TP2; **Figure 2.4**). Attempts to install SMSs in other NR locations were unsuccessful due to high soil strength and caliche cementation. The TEROS 12 series SMS, manufactured by METER Group and selected for this Assessment, have three stainless steel prongs with sensors capable of measuring volumetric moisture content, temperature, and bulk electrical conductivity. SMSs were installed in a series of four to collect data along a depth profile to assist in quantifying relative infiltration, runoff, storage, and either recharge in the natural setting surrounding the TSF or percolation through the tailings cover system. METER ZL6 data loggers were installed at each SMS location. Section 5.3 presents the SMS timeseries moisture content data from installation in fall 2019 to spring 2021.

4.1.3 Borings

Five borings were advanced off-site at the locations shown on **Figure 2.3**. A sixth boring, NRB-4, was planned adjacent to test pit NR-4 but was not drilled because of the shallow thickness of alluvium at that location as determined from the test pit. The borings were completed by Yellow Jacket Drilling Services, LLC, using a CME 95 portable hollow-stem auger drill rig on October 2 and 3, 2019. All drilling and sampling were conducted under the direction of INTERA on behalf of RAML.

Appendix D includes the boring logs for off-site borings NRB-1 through NRB-3, and NRB-5 and NRB-6. **Appendix E** includes selected photographs of the drilling and sampling. The borings ranged from a minimum total depth of 3 ft bgs (NRB-3) to a maximum depth of 26.5 ft bgs (NRB-1). Materials from surface to total depth generally consisted of unconsolidated sandy silt (alluvium). Drilling and sampling continued to auger refusal in underlying bedrock. Drive samples of the material were collected at 6 inches bgs to 24 inches; then 24 inches to 42 inches below grade using an 18-inch long, 3-inch outer diameter split-spoon ring sampler. Where possible (prior to refusal), drive samples were also collected below 5 ft depth at 5-ft intervals to total depth.

Material samples from the borings were packaged by INTERA and transported to Daniel B. Stephens & Associates, Inc. (DBS&A), in Albuquerque, New Mexico, for laboratory testing. A total of 29 samples were hand-delivered by INTERA to DBS&A on December 6, 2019. Seven samples were received as loose material in a one-gallon Ziploc bag. Nineteen samples were received as 6-inch x 2.5-inch inner diameter (ID) stainless steel sleeves sealed with end caps and duct tape. The remaining three samples were received as stacked 2.5-inch ID x 6-inch brass rings sealed with end caps and duct tape. **Appendix F** includes the laboratory report from DBS&A for the material samples. The boring logs in **Appendix D** include selected laboratory test results for the samples. Section 5.4.1 of this NR-WB Report addresses the salient laboratory results as they relate to estimation of NR using the CMB method.

5.0 ENHANCED SOURCE DATA

This section provides a summary of the source data obtained for use in the NR-WB Assessment following the 2018 HELP modeling described in Section 3. As described herein, the enhanced source data include climate sensitivity analysis, vegetation observations, rooting depth and density characteristics, SMS readings, and estimation of NR at the Site.

5.1 Climate

The enhanced modeling uses a more refined dataset over a longer period of record, spanning over 41 water years from 1978 to present (Section 2.1), than was applied in the initial HELP modeling (Section 3.2.2). Statistical analysis on the larger dataset revealed a decrease in the average annual precipitation from 14.11 in/yr used in the initial HELP modeling to 12.63 in/yr used in the enhanced HELP modeling. Climate change was not applied during the 2018 HELP Modeling. The enhanced modeling does incorporate climate change sensitivity based on the strategy described in the following section. The climate dataset (Section 2.1) and approach to assessing climate change (Section 2.1.3) for the enhanced NR-WB modeling are consistent with that used for the HSSA4 modeling.

A weather station was installed in spring of 2016 near the southwest side of the LTI (see **Figure 2.3**) to provide site-specific meteorological data including temperature, precipitation, and wind speed. The five years of on-site weather data (April 2016 to present) provides only a limited record of information for this Assessment, as a minimum of a 30-year historical record is recommended for precipitation and temperature inputs to the model. However, the Lisbon weather station data was used to evaluate SMS data (Section 5.3) and provide site-specific wind speed for the HELP model.

5.1.1 Inputs for the Climate Change Sensitivity Analysis

Following the approach outlined in Section 2.1.3, synthetic climate change datasets were created to test sensitivity to increasing temperature and precipitation, both independently and simultaneously. First, the extended observational dataset (41 water years) was repeated to produce a 120-year dataset, from 1978-2100. The 1978-2000 period was included in the sensitivity analysis datasets to allow for sufficient lead time for the initial conditions and model spin-up to not influence the sensitivity analysis results. The 100-year climate dataset is defined as the period of 2000-2100, with climate anomalies applied to temperature and precipitation from 2021-2100. No anomaly was applied to historical 2000-2020 period as it already includes the effects of anthropogenic climate change. As the original extended dataset includes a historical trend in temperature, the repeated time periods were adjusted according to the historical trend slope. For example, the 2021-2062 time period was adjusted by adding 1.38 degrees Celsius (°C) to the daily average temperature to reflect the average annual warming that occurred between 1978 and 2020. The 2063-2100 time period was adjusted upwards by 2.76 °C, assuming a constant rate of warming from the 84 years preceding. The resultant baseline temperature dataset is shown in **Figure 5.1** as the black line. As no significant trend in total annual precipitation was found in the historical dataset, no change was made to the 2021-2100 time period precipitation data in the Base Scenario (**Figure 5.2**, black bars).

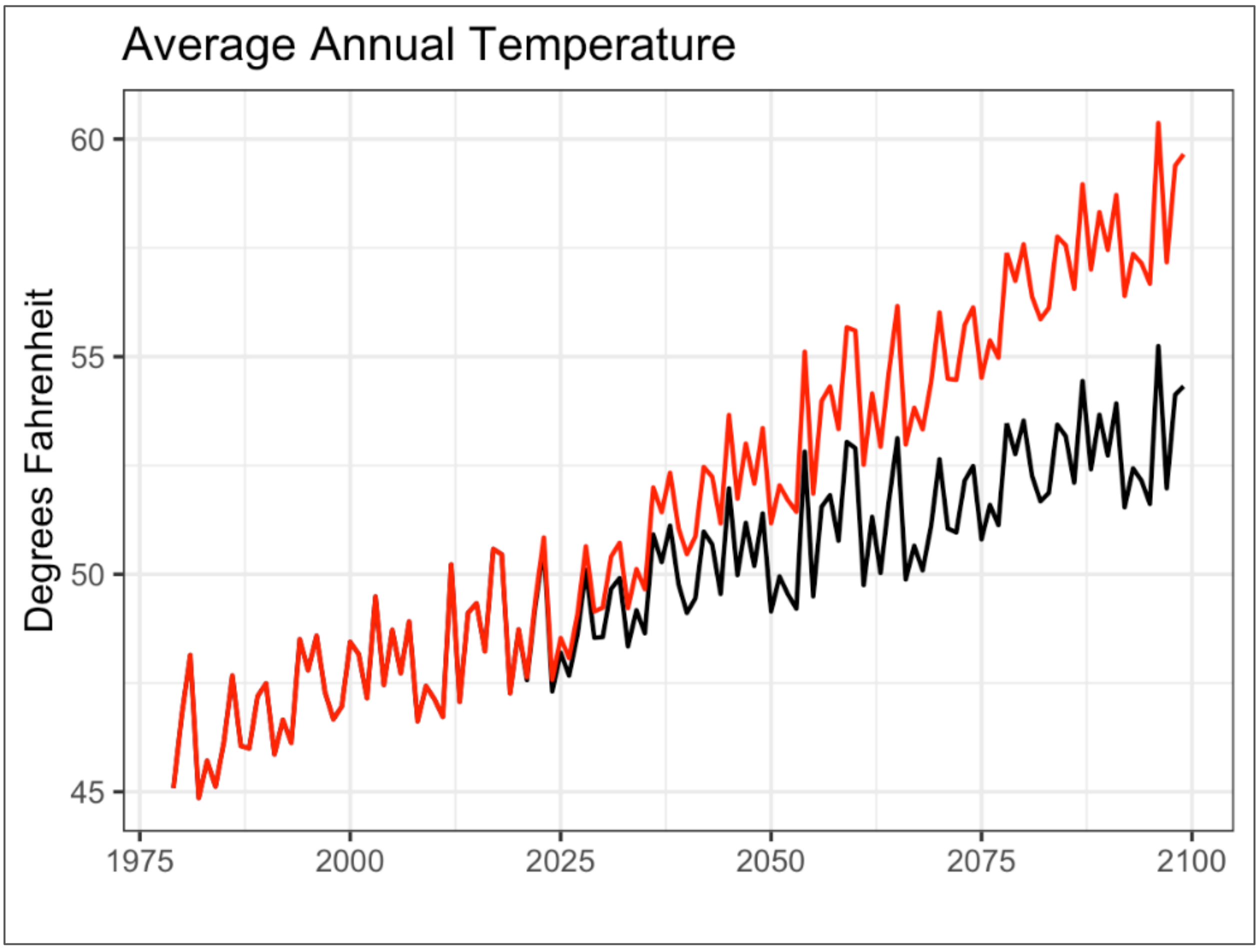


Figure 5.1 Mean Annual Temperature for the Baseline (black) and Increased Temperature (red) Scenarios.

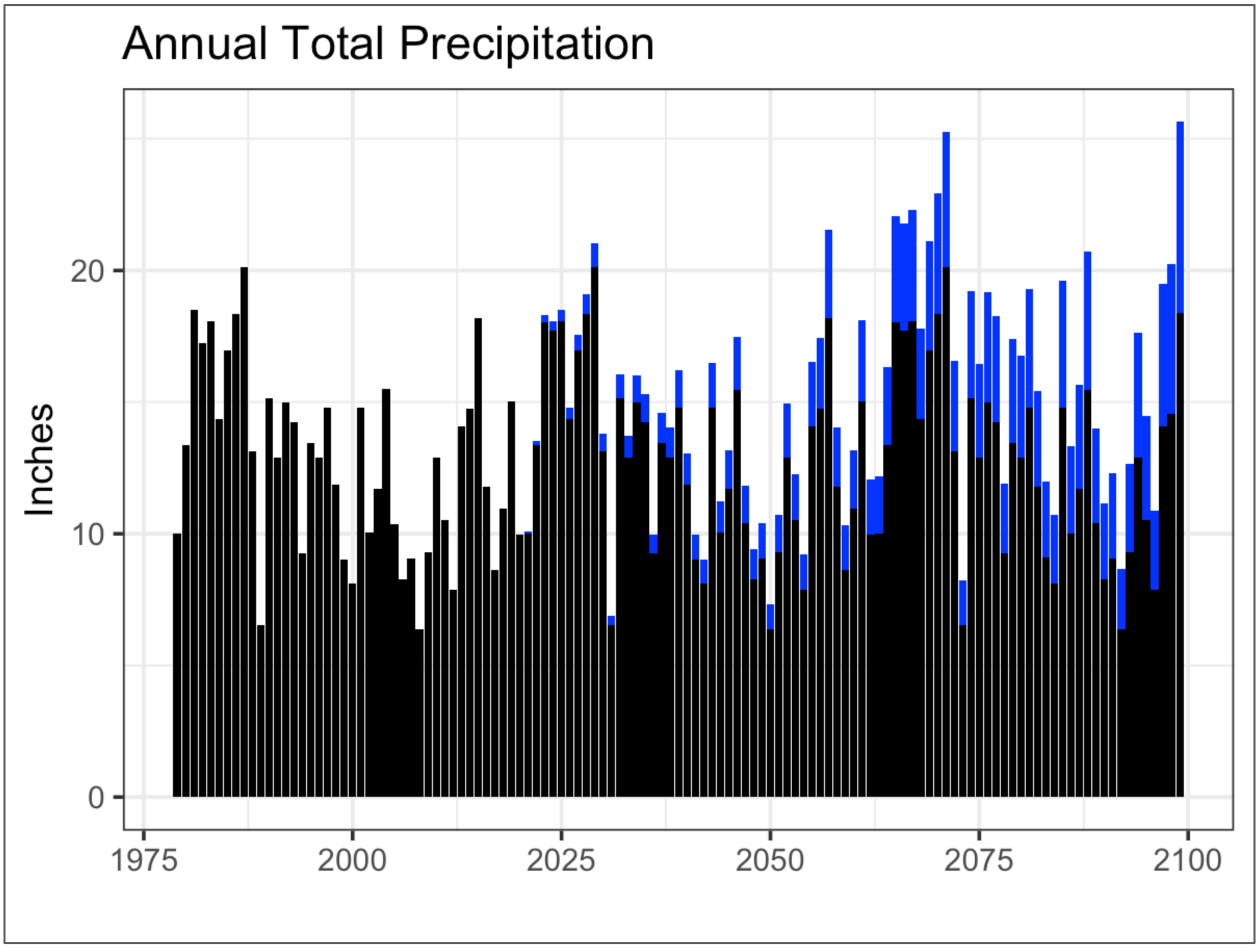


Figure 5.2 Annual Total Precipitation for the Baseline (black) and Increased Precipitation (blue) Scenarios.

In addition to the Base Scenario, which assumes the historical trend in temperature will continue and assumes no change in the total annual precipitation, three climate change scenarios were developed for the sensitivity analysis. These are an increased temperature case, an increased precipitation case, and an increased temperature and precipitation case. For the increased temperature case, average annual temperature from 2021-2100 is assumed to increase linearly to 7°C at the end of the century relative to the climate normal period of 1980-2010 (**Figure 5.1**, red line). For the increased precipitation dataset, total annual precipitation from 2021-2100 increases linearly to 40% by the end of the century relative to the climate normal (**Figure 5.2**, blue bars). Finally, the increased temperature and precipitation case combines the temperature and precipitation increases into one scenario. The end-of-century precipitation and temperature anomalies were extrapolated from the 95th percentile of the 2080s ensemble projection results for the Site (Golder, 2018).

While no scenario was developed to test sensitivity to the changing distribution of precipitation, the increased precipitation scenario somewhat incorporates this projection. By linearly increasing a multiplier on the daily precipitation timeseries, the distribution shifts towards fewer small precipitation events and extends the tail of the distribution with higher rainfall amounts during the extremely low-frequency events. Taken together, the scenarios encompass a baseline from which to compare, a worst-case scenario of no change in the trend in annual temperature and increased precipitation, a best-case scenario of increased annual temperatures and no change in the precipitation amount, and a scenario to test the interaction of increased temperature and precipitation on TSF percolation. The relative response of modeled TSF percolation to this range of future conditions will provide an understanding of system resilience and potential underlying conditions or triggering perturbations which may lead to a shift from current performance.

5.2 Leaf Area Index

The maximum LAI values were revised for the enhanced modeling analysis to reflect the vegetation survey observations at each test pit location (Section 4.1.1) and for consistency with a more extensive review of literature values. The maximum LAI value of 2.0 used in the initial 2018 modeling was based on default values provided by the HELP manual. Literature on LAI for the predominant vegetation and climate at the Site is limited. Asner et al. (2003) suggests an average LAI around 2.0 for grasslands and shrublands and around 1.3 for desert environments. While these values are based on a small number of samples, the biomes they represent are consistent with the general biome at the Site. Values from the Alternative Cover Assessment Program report average LAI of 0.8 at the nearby Monticello site in southeast Utah based on a survey with 54 samples (Waugh et al., 2008). Vegetation at the Monticello site is dominated by wheatgrass and sagebrush surrounded by rabbitbrush. Rabbitbrush is one of the predominant species of the vegetated portion of the impoundments and exists throughout the Site surrounding the impoundments as explained in Section 2.1. A remote sensing study at the Monticello site using the same 54-sample dataset (Im et al., 2012) reports values greater than 0.8 for the surrounding area dominated by rabbitbrush. Linear regressions between percent cover and LAI in Monticello using data from Waugh et al. (2008) suggest a value of 0.94 for a percent cover canopy equal to 50% and a value of 0.10 for a percent cover canopy equal to 5%. This logic was applied to the enhanced model profiles as described in Section 6 with maximum LAI values ranging from 0.1 to 1 on the impoundments and 1.2 in the surrounding natural setting. A sensitivity analysis was conducted on LAI values ranging from 0 (to represent conditions with no vegetation) up to 3.5 to better understand impact on modeled percolation results.

5.3 Soil Moisture Sensors

Data collected from the four SMS test pit installations is presented in this section, including two on the tailing impoundments (UT-TP1 and LT-TP2) and two in the surrounding NR areas (NR-4 and NR-5; **Figure 2.3** and **Appendix B**). SMSs were installed in a series of four to collect data along a depth profile to assist in quantifying relative infiltration, runoff, storage, and breakthrough percolation into the tailings cover system. Site SMS data include volumetric moisture content, temperature, and bulk electrical conductivity.

Figures 5.3 through **5.6** include stacked plots of volumetric moisture content with precipitation and temperature from the on-site weather station to illustrate how the shallow soil system responds to seasonal meteorological events and precipitation pulses. The timeseries data only contains one full annual climate cycle starting at SMS installation in October 2019 through the most recent data download in May 2021. The shallow moisture sensors, from 6 to 8.5 inches in depth (blue line), are within the highest root density zone, record the most variability, and respond rapidly to weather events such as snow melt, monsoonal storms, and dry periods. The intermediate sensors, ranging from 18 to 25 inches (orange and green lines), typically have a lagged response to weather events and provide indications of moisture storage trends. The deep sensors, ranging from 36 to 45.5 inches, can offer insight to conditions that cause breakthrough percolation beyond the EZD.

The NR-4 SMS timeseries (**Figure 5.3**) plot captures important infiltration and storage trends described in the following interpretation. The weather-responsive shallow sensor records initial infiltration data. The intermediate sensors placed in the central and lower portion of the EZD show a sharp rise of moisture content in the spring due to snowmelt, which persists through mid-summer. The intermediate depths maintain moisture levels much longer than shallow sensors and are interpreted to slowly release moisture to ET during hot summer months. The three upper sensors show a strong response to snowmelt in early spring when the average temperatures start to rise above freezing and to the heavy summer rain event in early June 2020. This data highlights the importance of the spring period on soil moisture when ET demand is low and threshold behavior in response to large storm events that can overwhelm ET uptake deficits. There is a slow upward trend in moisture content at the deep sensor (36 inches) that peaks after the June 2020 precipitation spike. The increase in moisture content at 36 inches could indicate recharge entering the underlying Navajo Sandstone (**Figure 4.1** and **Appendix B, Figure B4**).

The NR-5 data shows a similar increase in soil moisture from late winter to early spring precipitation as average temperatures rise above freezing (**Figure 5.4**). Moisture content increases with depth in this soil profile for the majority of the period of record. The NR-5 soil profile (**Appendix B, Figure B5**) indicates a slightly moist, silty sand with pebbles and cobbles up to 1 ft in length at the base of the test pit. This SMS installation is within 150 yards of Coyote Wash and may be experiencing groundwater influence and/or capillary rise effects that need to be further investigated. The rise in moisture content corresponds with peak flows from snowmelt in Coyote Wash, which would also provide peak recharge to shallow groundwater.

The sensors installed on the LTI at LT-TP2 (**Figure 4.3** and **Appendix B, Figure B8**) are located in a vegetated area outside of the footprint of the former evaporation cell. The moisture contents follow the same sharp increase with late winter and early spring precipitation as observed in the off-tailing NR locations (**Figure 5.5**). Moisture appears to be stored temporarily within the shallow to intermediate depths like a sponge slowly releasing moisture to ET during the hot summer months. The spikes in moisture content within the deepest sensor at 45.5 inches (located below the estimated EZD of 36 inches) in 2020 and again in 2021 as temperatures rise above freezing may be an indication of breakthrough percolation through the cover soils and into the tailings. Although the TSF covers were not designed as an ET cover, the moisture content data in the vegetated portion of the impoundments does respond in a similar fashion to an ET cover.

The UT-TP1 SMS data shown in **Figure 5.6** is collected from the UTI within the former evaporation cell area with only 4% vegetation cover consisting of annual grasses (**Figure 4.2** and **Appendix B, Figure B9**). These moisture content values are out of the typical range and much higher than porosity, which suggests the need for additional calibration of the sensors, potentially as a result of the high salt content within the soils of the former evaporative cells. Regardless, these high SMS readings are indicative of highly saturated soils, which aligns with test pit observations and nearby auger boring (UTB-1) data.

The SMS data was ultimately used on a qualitative level to better understand how soil moisture at different depths and layers, both in the tailing cover system and within the surrounding natural environment, respond to various weather patterns. Although relative SMS depth profile responses were compared with model results, attempts to match exact moisture content values were unsuccessful as the SMS observations are based on a correlation between electrical conductivity, soil chemistry, and moisture that would require further calibration for each soil type. The models did convey the major trends captured in the SMS record, such as the decreasing soil moisture variability with depth, increases of soil moisture from late winter to early spring, and threshold percolation breakthrough behavior in response to heavy precipitation events which tend to overwhelm upward ET flux. SMS data in conjunction with soil profiles and rooting surveys of the test pits were also utilized to confirm EZD estimates and narrow down EZD ranges according to the moisture trends and responses of sensors at various depths.

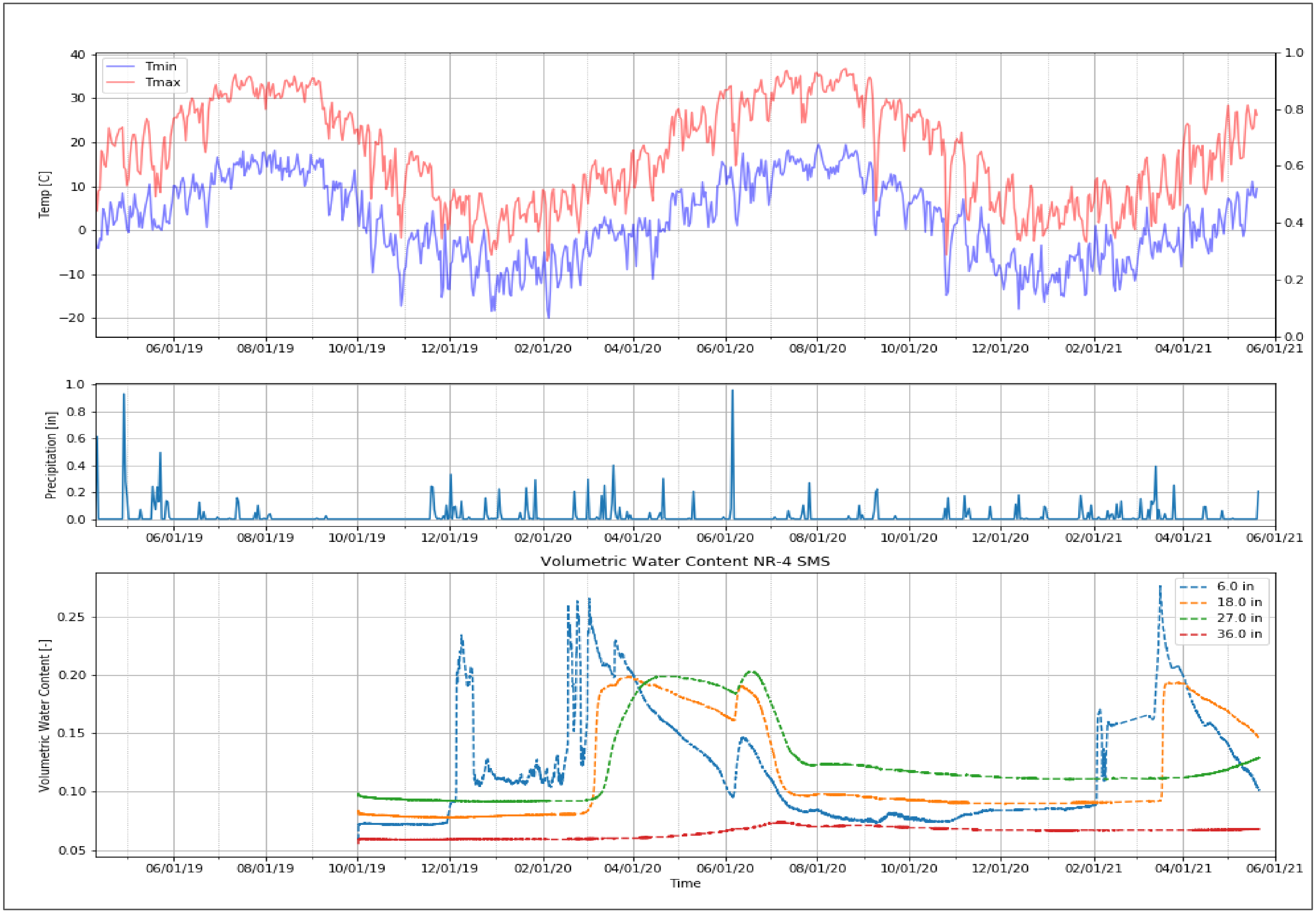


Figure 5.3 NR-4 SMS Timeseries of Water Content with On-site Meteorological Data.

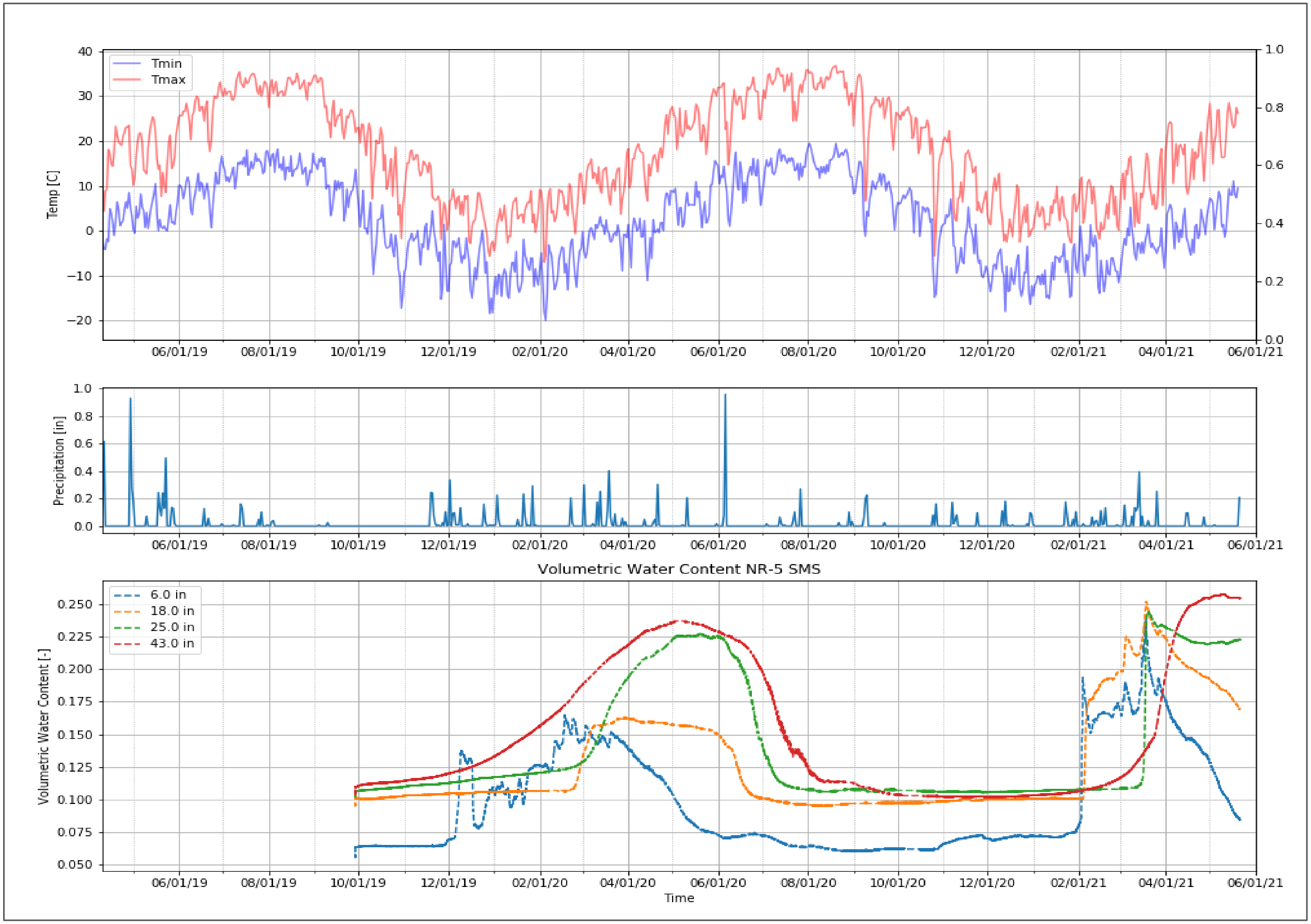


Figure 5.4 NR-5 SMS Timeseries of Water Content with On-site Meteorological Data.

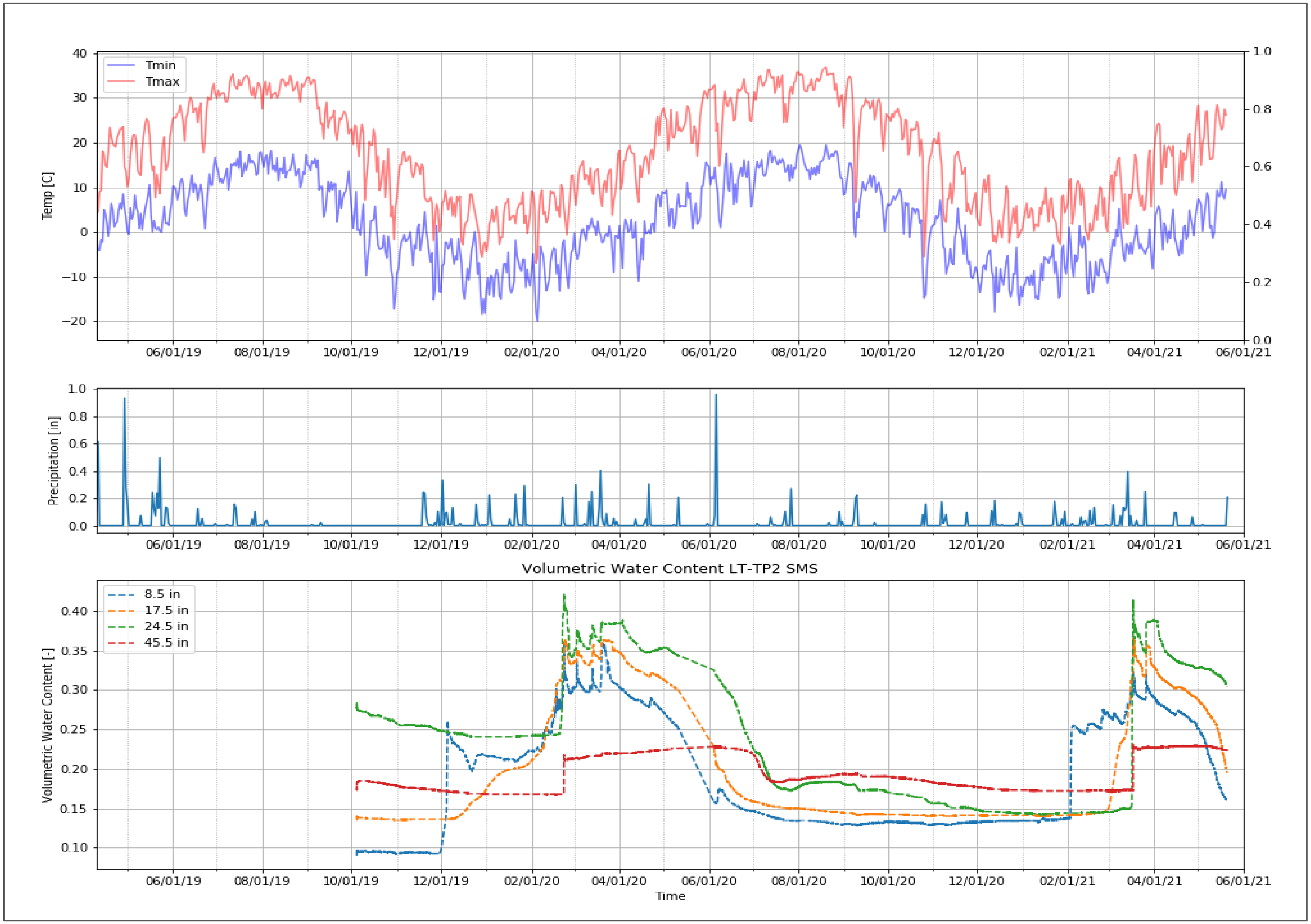


Figure 5.5 LT-TP2 SMS Timeseries of Water Content with On-site Meteorological Data.

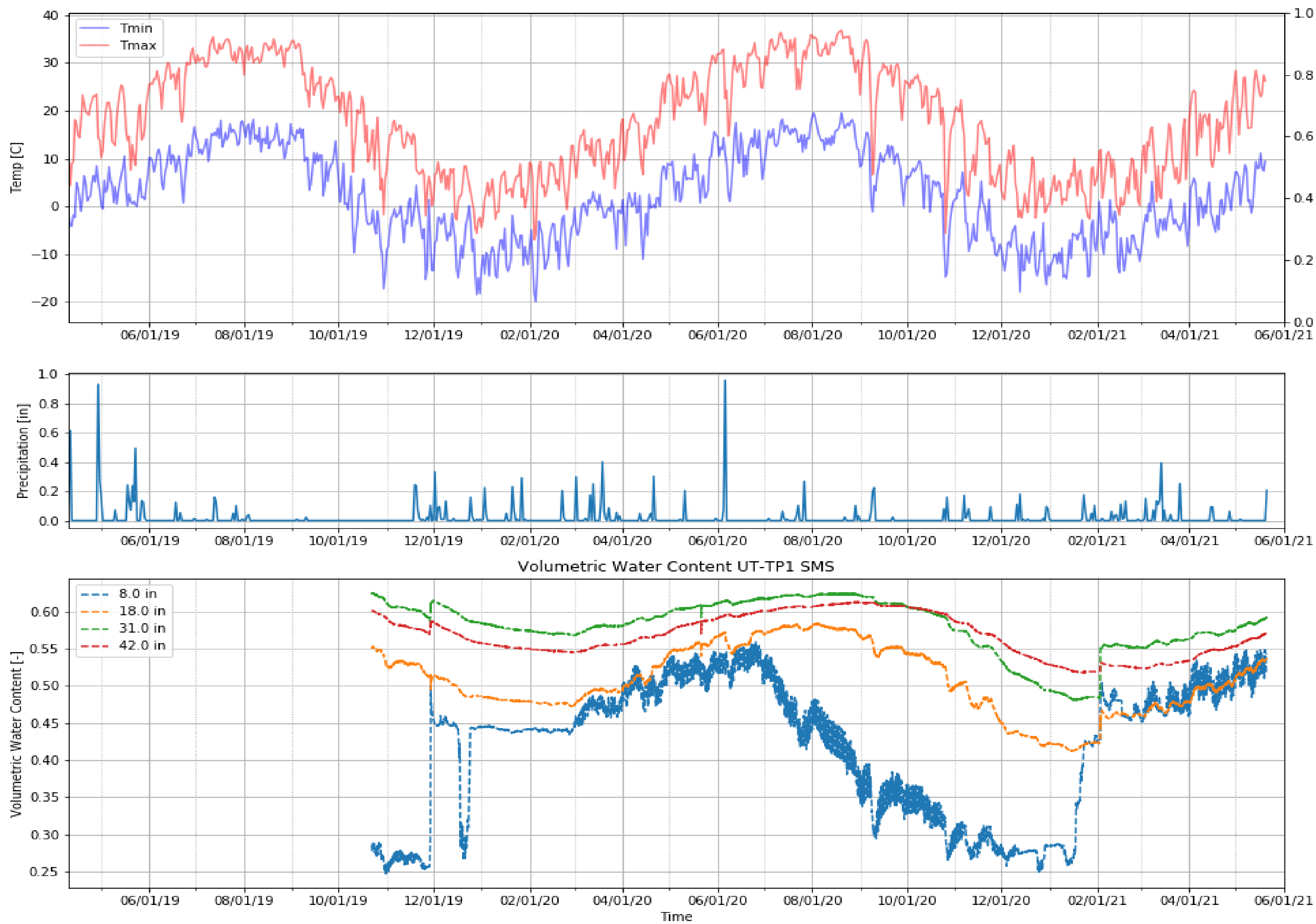


Figure 5.6 UT-TP1 SMS Timeseries of Water Content with On-site Meteorological Data.

5.4 Natural Recharge

Natural recharge is defined as that fraction of the WB that infiltrates deeply below the depth of near-surface consumptive use by runoff (rainfall excess), transpiration, and evaporation to underlying groundwater. As applied for this enhanced Assessment, estimates of NR presented herein are considered diffuse, over a large area, rather than necessarily concentrated in low-lying areas or localized areas such as streams. Additionally, the NR estimates are representative of a near-surface profile of alluvium overlying bedrock. Similar to, but distinct from recharge over natural (undisturbed) areas near the Site, percolation as discussed in this NR-WB Report refers to that fraction of the WB that percolates deeply below the depth of near-surface consumptive use by runoff (rainfall excess), transpiration, and evaporation, to underlying groundwater under disturbed surface conditions – in the case of this enhanced Assessment, percolation through the engineered and anthropogenic constructed cover systems over the tailing impoundments, through the underlying tailing profile, and to groundwater. As such, NR is analogous to percolation, and estimating NR near the Site is very useful for assessing the estimated long-term percolation rates presented in Section 7 of this NR-WB Report. Two methods of estimating NR at the Site have been used as described below.

5.4.1 CMB Method

Appendix G includes INTERA Calculation No. RIOAL.M001.LIS-NRWB-01CMB that details the estimation of NR near the Site using the CMB method. The following is a summary of the detailed calculation provided in **Appendix G**.

The CMB method recognizes that the principal source of chloride ions in soil water (the vadose zone) is from chloride in precipitation (Allison and Hughes, 1978; Allison et al., 1994). As water infiltrates, chloride accumulates in the soil profile and is concentrated by ET in the root zone. At equilibrium, the mass rate of chloride in equals the mass rate out percolating below the root zone.

Chloride in soil water Cl_{sw} was determined in the laboratory from samples collected during the drilling of the borings, and is summarized as follows:

- Soil samples from the natural recharge boring (NRB) boreholes were submitted by INTERA to DBS&A Laboratory in Albuquerque, New Mexico, for testing of soil physical properties and chloride in soil moisture (Section 4.1.2 and **Appendix F**).
- The DBS&A Laboratory submitted samples for chloride analyses to Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, New Mexico (**Appendix F**).
- HEAL used the protocol detailed in **Appendix G** for determination of chloride in moisture from the soil samples.

- To determine the concentration of chloride in the dry soil (milligrams per liter [mg/L]), the following conversion was done:
  - Determine equivalent dry mass (10 mg (wet) / 1 + gravimetric water content)
  - Multiply the milligram per kilogram [mg/kg] result in the report by (calculated dry mass/30)
- The *Chloride in Soil Moisture* values plotted on the borehole logs (**Appendix D**) are the resultant dry soil moisture values; with a laboratory Reporting Limit of 60 mg/kg, it has been assumed that the lower bound of reporting for chloride in dry soil is 20 mg/L as identified as non-detect (ND) on the borehole logs for non-detect.

The range of measured (adjusted) Cl_{sw} is narrow, ranging from a low value of 20 mg/L (ND) to a high of 44 mg/L.

In consideration of the Site-specific data and range of possible variability of input parameters used to determine recharge, the following summarizes estimation of average annual recharge at the Site:

- Average annual recharge is likely within the range of **2.26E-08 cm/s to 4.92E-08 cm/s (0.28 in/yr to 0.61 in/yr)**
- A lower-bound value of average annual recharge is estimated to be **1.45E-08 cm/s (0.18 in/yr)**
- An upper-bound value of average annual recharge is estimated to be **6.69E-08 cm/s (0.83 in/yr)**

The following are important assumptions in understanding the calculations provided herein, and their validity in relying on the results to estimate recharge at the Site:

- Precipitation, chloride in precipitation, and evapotranspiration represent long-term averages.
- Moisture infiltrating below the root zone becomes recharge to groundwater.
- Chloride concentration increases with depth; the value is constant below the depth of ET.
- Data collected from the NRB borings are representative of the surrounding natural Site and historical conditions.

5.4.2 Conceptual Model Method

INTERA (2021b) estimated NR at the Site using a method that considers the source, and temporal and spacial variability of recharge at the Site. Stable water isotopes, the Site weather station, La Sal weather station, groundwater levels, and SMS data were used for this method. A HYDRUS model was used to simulate temporal variability of recharge at the Site using a column of materials consisting of Quaternary alluvium overlying the Burro Canyon Aquifer. A full description of the data and methodology is presented in INTERA (2021b).

Average annual modeled recharge using HYDRUS is **0.45 in/yr (3.70E-08 cm/s)**, with a range of **0.24 in/yr (1.97E-08 cm/s)** to **0.66 in/yr (5.43E-08 cm/s)** (INTERA, 2021b).

6.0 ENHANCED WATER BALANCE MODELING

This section presents a summary of the enhanced modeling of the NR conditions and TSF final cover performance using both the HELP model and the HYDRUS model. **Appendix G** provides the details of the HYDRUS modeling. Section 7 provides a summary of both the HELP and HYDRUS modeling results.

Section 6.1 describes the concepts of INCAPP and OUTCAPP for the purposes of the modeling. Section 6.2 presents a narrative describing the use of both models in this enhanced Assessment, including their strengths, limitations, and collective value in WB modeling of both the existing final covers at the Site and recommendations for potential future improvements to reduce long-term percolation through the TSFs. Sections 6.3 and 6.4 provide a summary of the HELP and HYDRUS models, respectively, as applied for this enhanced Assessment

6.1 INCAPP and OUTCAPP Modeling Concepts

For the purposes of modeling and related discussions of the results in this NR-WB Report, "INCAPP" and "OUTCAPP" have been used as modifiers to describe the areas within the former corrective action program evaporation cells and outside the areas of within the former CAP evaporation cells, respectively, on top of the TSFs as shown on **Figure 2.4**.

Figure 6.1 helps to compare and contrast the INCAPP and OUTCAPP areas on the TSFs as they relate to this NR-WB Report. In a general sense, the areas within the former CAP evaporation cells (INCAPP) exhibit the following surficial characteristics:

- Surficial salt deposits.
- Sparse to no vegetation.
- Moderate to extensive weathering/dissolution of the limestone cover rock.
- Apparent heaving of the underlying clayey soil and mixing of the cover rock with underlying soil.
- Moisture retention, ponding of precipitation, and soil pumping (an expression of near-surface excess pore water pressure) under load.

In a general sense, the areas outside the former CAP evaporation cells (OUTCAPP) exhibit the following surficial characteristics:

- No surficial salt deposits
- Moderate vegetation

- Higher limestone cover rock quality (less weathering/dissolution)
- No observed heaving of underlying silty soil or mixing of cover rock into underlying soil
- Less ponding of precipitation and little to no pumping

Given these distinct surficial characteristics, the INCAPP and OUTCAPP areas are also distinct in modeling results, and in the conclusions and recommendations made in the subsequent sections of this NR-WB Report.

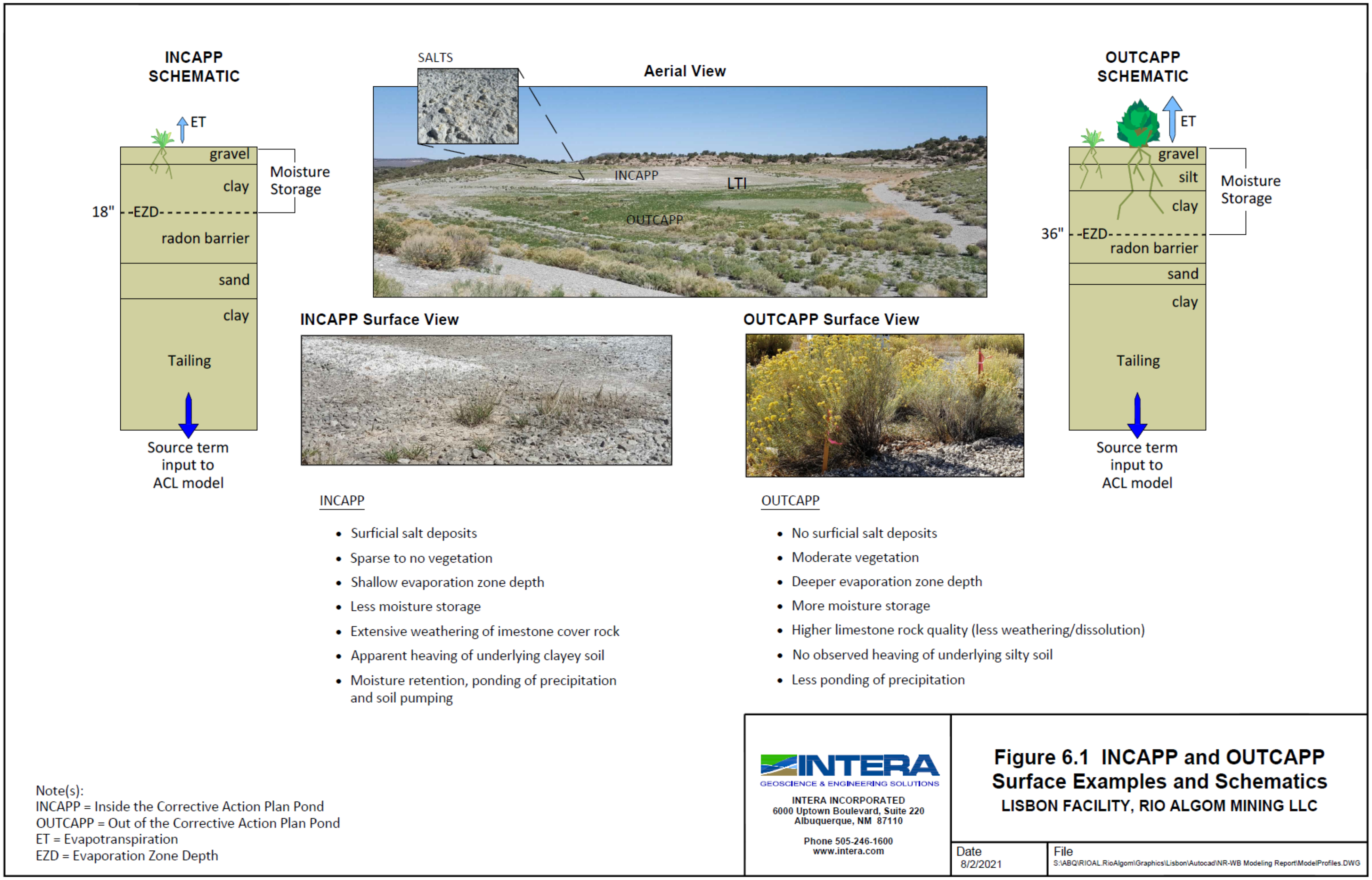


Figure 6.1 INCAPP and OUTCAPP Surface Examples and Schematics.

6.2 Use of HELP and HYDRUS for Water Balance Performance Assessment of the TSFs

As described in Section 3, HELP was used in 2018 to estimate the WB performance of the existing final TSF covers. With limited input data, HELP was used as a relatively simple tool to estimate percolation. HELP is a reasonable tool to use during preliminary phases of design and investigation in advance of employing more complex codes, as was done in this enhanced Assessment (Khire et al., 1997). Driven largely by potential future impacts to groundwater resulting from the TSFs and by the RAI from DWMRC (see Section 1), enhancement of the initial estimates was needed to obtain better confidence in the 2018 estimated percolation rates. Parallel with efforts to refine estimated percolation rates has been efforts to refine the conceptual geologic/hydrogeologic model of the Lisbon Site, and the fate and transport model to predict future concentrations of solute in groundwater at the Site (INTERA, 2021b).

The final covers on the UTI and LTI are UMTRCA-style rock covers (see Section 3.1). WB modeling of rock covers, using any available code, likely yields somewhat inaccurate estimates of percolation as a result of the complex near-surface interactions of the top rock layer with the atmosphere and the underlying soil. For Title I sites under the Uranium Mill Tailings Remedial Action Project, the United States Department of Energy (DOE) simply estimated percolation through a conceptual final rock cover by multiplying the saturated hydraulic conductivity of the radon barrier by a unit vertical (downward) hydraulic gradient (DOE, 1989).

While HELP likely overestimates percolation, HYDRUS likely underestimates percolation for a rock-style cover (Berger et al., 1996, Khire et al., 1997, Albright et al., 2002, Scanlon et al., 2002). Thus, and as presented in the following sections of this NR-WB Report, modeling results for HELP and HYDRUS can be considered to bound the upper and lower estimates of long-term percolation rates, with the likelihood that a reasonable estimate of percolation lies somewhere within the bounds of the values calculated by the two models.

For simulating an ET-type cover (or natural conditions away from the TSFs) without the top layer of rock used in the UMTRCA-style rock covers, both HELP and HYDRUS likely yield results that are relatively more accurate than percolation calculated for a rock cover; and the resultant calculated percolation rates are similar. As such, there is a higher level of confidence in the percolation rates estimated by both models for ET conditions than for the existing rock covers.

6.3 Enhanced HELP Model Summary

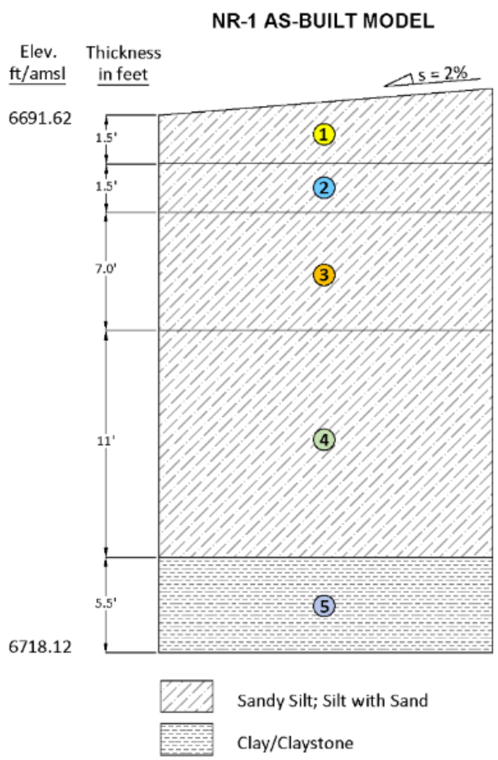
The 2019 field investigation resulted in new insight and data sources to apply to the initial HELP WB modeling effort. The input data used to assess site-specific NR conditions and the enhanced TSF final cover performance is tabulated in **Figures 6.2** through **Figure 6.5** and described in the following subsections. Section 3.1 provides a summary of the HELP model v3.07 used for this WB Assessment. A detailed overview of the HELP model WB algorithm is described by Schroeder et al. (1994) and Khire et al. (1997).

6.3.1 Natural Recharge Analogue Models

By placing a final earthen cover over the two tailing impoundments, some analogue to surrounding natural conditions has been constructed. The percolation rate through the tailing profile is analogous to water percolating below the root zone in the natural (non-reclaimed impoundment) setting which becomes recharge to groundwater. Two NR analogue models were developed to characterize long-term recharge rates and evaporative zone conditions in undisturbed areas surrounding the TSF. One of the model profiles was created to represent the as-drilled conditions observed at NR-1, the deepest NR auger boring of the 2019 field investigation. A composite model was created to combine data from the five borehole and six test pit locations (**Figure 2.4**). The layer profiles and input data for both NR analogue models are presented in **Figure 6.2** and **6.3**. Input data for the HELP model are subdivided into categories of soil/design, vegetation, and climatological data. Soil, vegetation, and profile design data is described below, and climate data inputs are covered in Section 3.2.2 and 5.1.

The soil boring logs and hydraulic properties of the NR materials were utilized to develop the representative profile layers. Shallow soil properties were supplemented with test pit data such as root zone observations key to determining the EZD. All layers of the NR models are set to vertical percolation to permit unsaturated vertical drainage downward due to gravity and upward gradients due to ET, modeled as an extraction. The primary role of the vertical percolation layer is to provide moisture storage (Schroeder et al., 1994).

Soil mechanical and hydraulic properties (including porosity, field capacity [-0.33 bar suction], wilting point [-15 bar suction], moisture contents, and saturated hydraulic conductivity) were obtained from laboratory testing of NR soil samples and soil characteristic curves (**Appendix F**). The soil input parameters tabulated in **Figures 6.2** and **6.3** were derived from lab results (blue boxes), default HELP values (grey boxes), and user input values based on engineering judgement, field observation and/or HELP model requirements (beige boxes). Alluvium, consisting of reddish-brown sandy silt with clay, was present at each NR location with slight variations in particle size, distribution, and abundance of carbonate lenses. Initial moisture contents were specified for each layer based on lab-measured volumetric moisture content. The NR soil columns were dry during the fall 2019 investigation with moisture content data at or just above the wilting point.



Layer #	1	2	3	4	5
Layer Type	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)
Description **(USCS Texture Class)**	Sandy Silt **s(ML)**; dry	Sandy Silt **s(ML)**; dry	Silt with Sand **(ML)s**; dry	Sandy Silt **s(ML)**; dry	Clay/Claystone **(CH)s**; dry
Thickness (ft)	18 in (1.5')	18 in (1.5')	84 in (7')	132 (11')	66 in (5.5')
Depth Interval (ft)	0-18" (0-1.5')	18-36" (1.5-3')	36-120" (3-10')	120-252" (10-21')	252-318" (21-26.5')
Soil Texture (Help Code)	Silty Loam - 9	Silty Loam - 9	Loam - 8	Silty Loam - 9	Silty clay - 14
Porosity	0.392	0.398	0.406	0.402	0.446
Field Capacity (vol)	0.284	0.293	0.232	0.277	0.371
Wilting Point (vol)	0.086	0.087	0.077	0.110	0.250
Initial Moisture Content (vol)	0.086	0.087	0.077	0.110	0.250
Saturated Hydraulic K (cm/sec)	1.2E-04	1.90E-04	3.70E-04	4.3E-04	2.50E-05

Default HELP values	Values from lab results
User input values based on field observation and HELP model requirements	

Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	12.63	La Sal SW 1 Weather Station
Temperature (annual avg., F°)	48.7	La Sal SW 1 Weather Station
Maximum Leaf Area Index (LAI)	1.2	Estimated Maximum LAI based on vegetation and literature values
Evaporative Zone depth (in.)	18	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.2	Lisbon Weather Station (5 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Ground Surface Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Model Curve No. (CN)	70.2	Calculated based on surface conditions and literature values
Slope (%)	2	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	1	Value of 1 assumes 100% of cover drains (no ponding)

Note(s):
ET = Evapotranspiration

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 6.2 NR-1 As-Drilled HELP Model Profile
LISBON FACILITY, RIO ALGOM MINING LLC

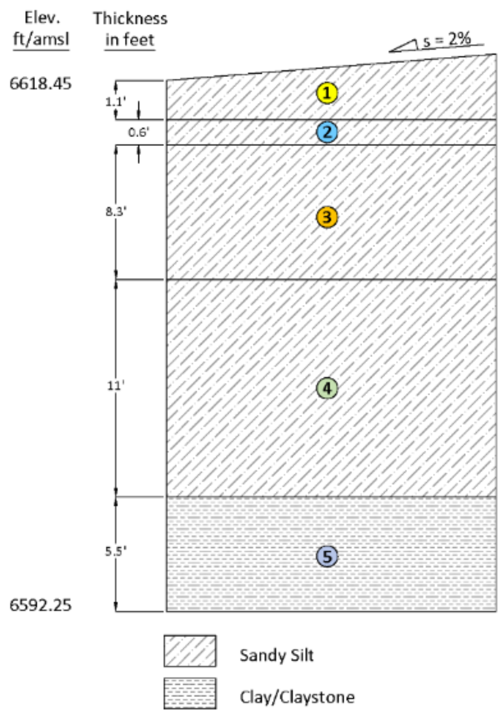
Date 8/5/2021
File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\NR-WB Modeling Report\ModelProfiles.DWG

Figure 6.2 NR-1 As-Drilled Enhanced HELP Model Profile.

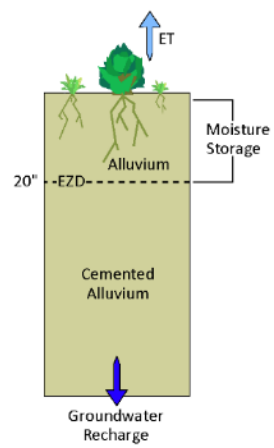
Layer #	1	2	3	4	5
Layer Type	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)
Description **(USCS Texture Class)**	Sandy Silt **s(ML)**; dry	Sandy Silt **s(ML)**; dry	Silt with Sand **(ML)s**; dry	Sandy Silt **s(ML)**; dry	Clay/Claystone **(CH)s**; dry
Thickness (ft)	18 in (1.5')	18 in (1.5')	84 in (7')	132 (11')	66 in (5.5')
Depth Interval (ft)	0-18" (0-1.5')	18-36" (1.5-3')	36-120" (3-10')	120-252" (10-21')	252-318" (21-26.5')
Soil Texture (Help Code)	Silty Loam - 9	Silty Loam - 9	Loam - 8	Silty Loam - 9	Silty clay - 14
Porosity	0.392	0.398	0.406	0.402	0.446
Field Capacity (vol)	0.284	0.293	0.232	0.277	0.371
Wilting Point (vol)	0.086	0.087	0.077	0.110	0.250
Initial Moisture Content (vol)	0.086	0.087	0.077	0.110	0.250
Saturated Hydraulic K (cm/sec)	1.2E-04	1.90E-04	3.70E-04	4.3E-04	2.50E-05

Default HELP values	Values from lab results
User input values based on field observation and HELP model requirements	

NR COMPOSITE MODEL



GENERAL COMPOSITE SCHEMATIC



Note(s):
ET = Evapotranspiration
EZD = Evaporation Zone Depth

Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	12.63	La Sal SW 1 Weather Station
Temperature (annual avg., F°)	48.7	La Sal SW 1 Weather Station
Maximum Leaf Area Index (LAI)	1.2	Estimated Maximum LAI based on vegetation and literature values
Evaporative Zone depth (in.)	20	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.2	Lisbon Weather Station (5 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Ground Surface Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Model Curve No. (CN)	70.4	Calculated based on surface conditions and literature values
Slope (%)	2	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	1	Value of 1 assumes 100% of cover drains (no ponding)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 6.3 Natural Recharge Composite HELP Model Profile
LISBON FACILITY, RIO ALGOM MINING LLC

Date 8/5/2021
File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\NR-WB Modeling Report\ModelProfiles.DWG

Figure 6.3 Natural Recharge Composite Enhanced HELP Model Profile.

6.3.1.1 NR-1 Model

The NR-1 model (**Figure 6.2**) represents the as-drilled conditions of the NRB-1 boring (**Appendix D**) supplemented with NR-1 test pit observational data. This location had the deepest auger boring (26.5 ft bgs) with the most associated lab data and was considered one of the least disturbed accessible areas on-site. The NR-1 profile has a total depth of 26.5 ft, which has been divided into five model layers to maximize the input of available lab data. Layers 1-4 represent alluvium from 0 to 21 ft bgs, and layer 5 represents the clay to claystone encountered from 21 to 26.5 ft bgs before refusal. An EZD of 18 inches was estimated from test pit NR-1 rooting depth data, which corresponds to the bottom of layer 1.

6.3.1.2 NR Composite Model

The NR composite model profile and schematic (**Figure 6.1**) represents average NR conditions observed in the six NR study areas surrounding the TSF. The composite model is similar to NR-1 with the same number of layers and total depth. Layer 1 represents the average zone with the highest root density within the top 13 inches of the profile. Layer 2 extends to 20 inches bgs to represent the average base of the EZD for the six test pits. The more cemented alluvium present below the EZD is represented by layer 3, which extends to 10 ft bgs. Layer 4 from 10 to 21 ft is separated from layer 3 to incorporate more lab data collected within that depth interval. Layer 5 represents the clay to claystone encountered from 21 to 26.5 ft bgs in the deepest borehole (NRB-1).

6.3.1.3 Vegetation Data

The general HELP model vegetation input parameters are described in Section 3.2.3. The maximum LAI was reduced from 2.0 in the initial model to 1.2 for both NR analogue models, based on vegetation type and cover canopy observed during the test pit investigation (**Appendix B**) as well as literature values available for similar vegetation and biomes (See Section 5.2; Asner, 2003). Vegetation of the NR study areas consists primarily of desert grasses, rubber rabbitbrush, and sagebrush (see Section 4.1.1). A CN of 70.3 was applied in the NR models based on the surface slope and Soils Conservation Service (SCS) runoff CNs in the literature for silty loam (USACE, 2021). The runoff fraction, or the fraction of the surface that will shed precipitation was set to 100%. A unit surface area of 1 acre was assumed for this application.

6.3.2 Tailing Impoundment Models

The enhanced tailing impoundment modeling focuses on updating two of the four initial 2018 HELP models, including UTB-1 and LTB-2. The UTB-1 model is based on the 2016 auger boring of the same name located on the UTI within the footprint of the former evaporation cell (INCAPP) and similarly, LTB-2 is located on the LTI outside (OUTCAPP) of the evaporation cell

(**Figure 2.4**). These models were chosen in particular because the test pits (UT-TP1 and LT-TP2) excavated within the vicinity of these two boring locations were instrumented with SMSs to provide moisture content and infiltration information. The test pits provided additional information on the cover system in these locations including a surface vegetation survey, soil structure, root density, and EZD, which was determined to be the most sensitive parameter during the initial modeling effort. The enhanced models, referred to as INCAPP (UTB-TP1) and OUTCAPP (LTB-TP2), combine auger boring data with test pit data to improve our understanding of Lisbon TSF cover performance.

6.3.2.1 INCAPP Model

The INCAPP areas maintain sparse annual, shallow-rooted grasses to no vegetation capable of transpiring moisture. The maximum LAI was reduced from 2.0 in the initial model to 0.1 in the enhanced simulations to better represent the sparsely vegetated cover (4%) observed at UT-TP1 (**Figure 4.2**) (See Section 5.2; Asner, 2003).

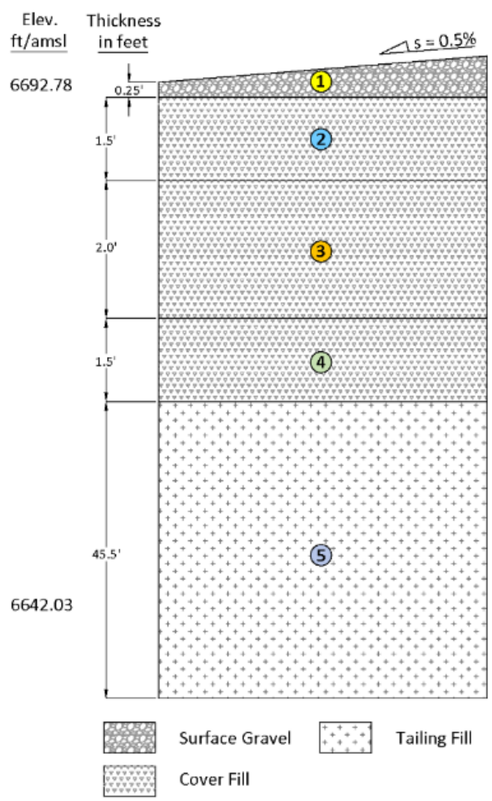
The structure of the cover portion of the UTB-TP1 profile (**Figure 6.4**) was adjusted from the original UTB-1 model (**Figure 3.3**) to reflect data from the test pit soil profile. The primary change was to the thickness and HELP layer classification of the fat clay (layer 3) with the low saturated hydraulic conductivity (K_{sat}) of 5.20E-08 cm/s. The thickness was increased from 6 inches to 24 inches and the designation was changed from “Barrier Soil Liner” to “Vertical Percolation” to allow flow to drain downwards due to gravity flow or be extracted upwards by ET. The previous designation restricted vertical flow and upon further evaluation was considered unnecessary due to the already low K_{sat} value.

The soil moisture data remains high in the enhanced model to reflect the moist to wet conditions of the original auger boring lab data as well as the moist cover soil conditions observed in test pit UT-TP1. The CN was adjusted from 53.8 to 74.6 based on surface conditions and literature values (USACE, 2021). The test pit excavation revealed grass roots within the top 10 in of the soil profile with the highest root density within the top 6 inches of gravel and clay. Root density dropped off significantly below 10 in but were sparsely visible up to 18 inches bgs. Rooting depth in the soil profile coupled with SMS data (Section 5.2) generally support the original EZD range from 9-18 inches and was adjusted only slightly to 8-18 inches.

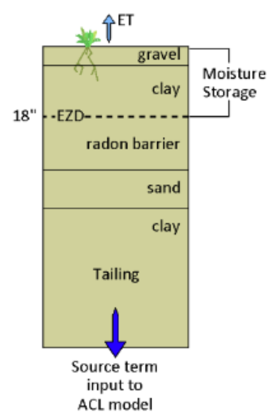
Layer #	1	2	3	4	5
Layer Type	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)
Description (**USCS Texture Class**)	Surface Gravel	Cover Fill - Lean Clay with Sand **(CL)s**; moist	Cover Fill - Fat Clay **(CH)**; moist	Cover Fill - Clayey Sand **(SC)**; s. moist	Tailings Fill- Clay with Fine Sand and Silt **(CL)s-ML**; v. moist to wet
Thickness (ft)	3 in (0.25')	18 in (1.5')	24 in (2')	18 in (1.5')	546 in (45.5')
Depth Interval (ft)	+ 0.25'	0-18" (0 - 1.5')	18-42" (1.5' - 3.5')	42 -60" (3.5 -5')	60 - 606" (5' - 50.5')
Soil Texture (Help Code)	Gravel (21)	Moderately Compacted Clay - CL (25)	Moderately Compacted Fat Clay - CH (28)	Moderately Compacted Silty Sand- SC (24)	Moderately Compacted Clay - CL (25)
Porosity	0.397	0.370	0.349	0.344	0.399
Field Capacity (vol)	0.032	0.365	0.344	0.305	0.390
Wilting Point (vol)	0.013	0.266	0.22	0.140	0.213
Initial Moisture Content (vol)	0.020	0.313	0.339	0.142	0.399
Saturated Hydraulic K (cm/sec)	3.00E-01	3.40E-07	5.20E-08	2.70E-06	3.65E-07

Values from lab results	Default HELP values
User Input values based on field observation	

UTB-TP-1 MODEL PROFILE



INCAPP SCHEMATIC



Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	12.63	La Sal SW 1 Weather Station
Temperature (annual avg., F°)	48.7	La Sal SW 1 Weather Station
Maximum Leaf Area Index (LAI)	0.1	Estimated Maximum LAI based on vegetation and literature values
Evaporative Zone depth (in.)	8 - 18	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.2	Lisbon Weather Station (5 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Cover Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Model Curve No. (CN)	74.6	Calculated based on surface conditions and literature values
Slope (%)	0.5	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	1	Value of 1 assumes 100% of cover drains (no ponding)

Note(s):
INCAPP = Inside the Corrective Action Plan Pond
ET = Evapotranspiration
EZD = Evaporation Zone Depth

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 6.4 UTB-TP-1 (INCAPP) HELP Model Profile
LISBON FACILITY, RIO ALGOM MINING LLC

Date 8/5/2021
File S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\Autocad\NR-WB Modeling Report\ModelProfiles.DWG

Figure 6.4 UTB-TP-1 (INCAPP) Enhanced HELP Model Profile.

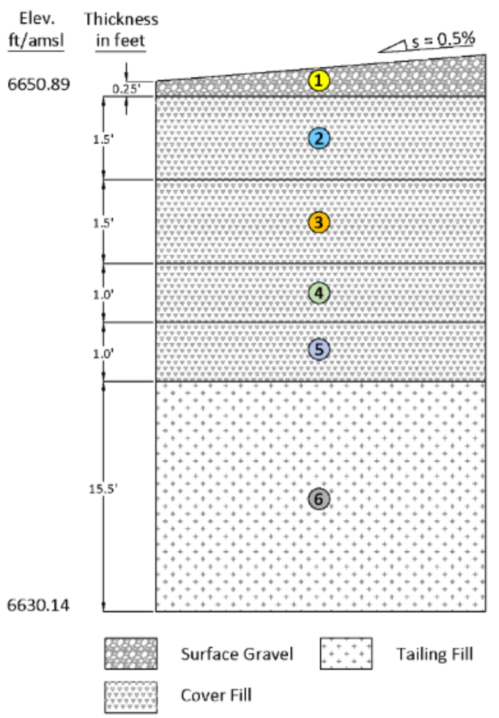
6.3.2.2 OUTCAPP Model

Although the current cover system was not designed as an ET cover, the OUTCAPP areas maintain some vegetation capable of transpiring moisture. The cover soils have the capacity to store infiltrated moisture from precipitation and release it back to the atmosphere through ET. The maximum LAI was decreased from 2.0 in the initial model to 1.0 in the enhanced model to better represent the vegetation type and cover canopy observed during the test pit investigation (**Figure 4.3**) as well as literature values of similar vegetation and biomes (See Section 5.2; Asner, 2003).

Excavation of LT-TP2 test pit (**Figure 4.3**) revealed roots visible within the soil profile down to 36 inches with the highest root density within the top 18 inches of silt with sand and clay capable of storing moisture. Root density dropped off significantly in the lower clay-dominated cover layers but were still present. Rooting depth in the soil profile coupled with SMS data (Section 5.3) support the substantial increase in EZD range from the initial 9-18 inches to 18-36 inches.

The structure of the LTB-TP2 profile (**Figure 6.5**) did not change from the original LTB-2 model (**Figure 3.2**). The enhanced model contains the same six layers, layer thicknesses, and soil retention parameter lab data. The primary updates to the model are the increase in EZD, decrease in maximum LAI, and the removal of the "Barrier Soil Liner" designation of the fat clay (layer 3) that restricted vertical flow. The CN was adjusted from 53.8 to 64.3 based on surface conditions and literature values (USACE, 2021).

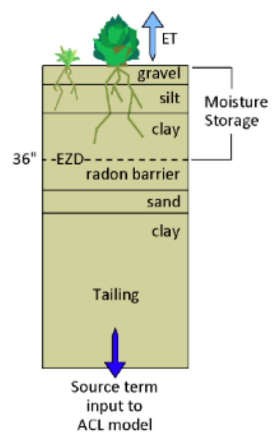
LTB-TP-2 MODEL PROFILE



Layer #	1	2	3	4	5	6
Layer Type	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)	Vertical Percolation (1)
Description **(USCS Texture Class)**	Surface Gravel	Cover Fill -Silt and Lean Clay with Sand **(CL)s; dry**	Cover Fill - Fat Clay **(CH)**; dry to s. moist	Cover Fill - Sandy Lean Clay **s(CL)**; dry to s.	Cover Fill - Clayey Sand **(SC)**; dry to s. moist	Tailings Fill - Clay and Sand **(CL)**s; moist
Thickness (ft)	3 in (0.25')	18 in (1.5')	18 in (1.5')	12 in (1')	12 in (1')	186 in (15.5')
Depth Interval (ft)	+ 0.25'	0-18" (0 - 1.5')	18 -36" (1.5' - 3')	36 -48" (3 -4')	48 - 60" (4-5')	60 - 426" (5' - 20.5')
Soil Texture (Help Code)	Gravel (21)	Moderately Compacted Clay - CL (25)	Moderately Compacted Fat Clay - CH (28)	Moderately Compacted Clay - CL (25)	Moderately Compacted Clayey Sand - SC (24)	Moderately Compacted Clay - CL (25)
Porosity	0.397	0.373	0.372	0.308	0.490	0.402
Field Capacity (vol)	0.032	0.368	0.367	0.303	0.305	0.373
Wilting Point (vol)	0.013	0.14	0.226	0.245	0.163	0.266
Initial Moisture Content (vol)	0.020	0.145	0.231	0.250	0.168	0.373
Saturated Hydraulic K (cm/sec)	3.00E-01	1.20E-04	1.20E-06	3.20E-05	2.70E-06	9.80E-07

Values from lab results	Default HELP values
User Input values based on field observation	

OUTCAPP SCHEMATIC



Climate Data	Value	Source
Location	La Sal, UT	Lisbon site is 4 miles southwest of La Sal, Utah (38.3122° N, 109.2482° W)
Precipitation (annual avg., in.)	12.63	La Sal SW 1 Weather Station
Temperature (annual avg., F°)	48.7	La Sal SW 1 Weather Station
Maximum Leaf Area Index (LAI)	1.0	Estimated Maximum LAI based on vegetation and literature values
Evaporative Zone depth (in.)	20 - 36	Estimated root zone depth range based on vegetation and soil
Growing Season (days)	184	USDA Plant Hardiness Zone Map: Growing season for Zone 6A
Average Wind Speed (mph)	3.2	Lisbon Weather Station (5 years of data)
Relative Humidity (annual avg.,%)	47	Default ET data in HELP for Grand Junction, CO
Cover Data		
Surface Area (acres)	1	Volumes calculated by model assume a unit area of one acre
Curve No. (CN)	64.3	Calculated based on surface conditions and literature values
Slope (%)	0.5	Slopes measured at boring location from survey data
Slope Length (ft.)	1000	Length of surface slope
Runoff Fraction	1	Value of 1 assumes 100% of cover drains (no ponding)

Note(s):
OUTCAPP = Out of the Corrective Action Plan Pond
ET = Evapotranspiration
EZD = Evaporation Zone Depth

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Figure 6.5 LTB-TP-2 (OUTCAPP)
HELP Model Profile
LISBON FACILITY, RIO ALGOM MINING LLC

Date 8/5/2021
File S:\ABQ\RIOAL RioAlgom\Graphics\Lisbon\Autocad\NR-WB Modeling Report\ModelProfiles.DWG

Figure 6.5 LTB-TP-2 (OUTCAPP) Enhanced HELP Model Profile.

6.4 HYDRUS Model Summary

A detailed quantification of infiltration through the tailings cover system requires a mathematical description of the water flow in the unsaturated zone, characterization of the soil hydraulic properties of the cover materials, and adequate representation of vegetation and climatic conditions of the upper boundary condition. Unsaturated flow modeling was used to complement the simulations done in HELP and evaluate site-specific soil hydraulic data, climate, and other data collected during the field program. HYDRUS (2D/3D) (Šimůnek et al., 2013) is a finite element (FE) model used to simulate water flow through two- and three-dimensional variably saturated soil columns by numerically solving the Richards equation while simultaneously incorporating a sink term to account for water removal by root water uptake. The Richards (Richards, 1931) function is a nonlinear partial differential equation, as shown below:

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x_i}\left[K\left(K_{ij}^{A}\frac{\partial h}{\partial x_j} + K_{iz}^{A}\right)\right] - S$$

where θ is the volumetric water content [L3 L^{-3}]; h is the pressure head [L]; S is a sink term [T^{-1}], x_i (i=1,2,3) are the spatial coordinates [L]; t is time [T], K_{ij}^A are components of a dimensionless anisotropy tensor K^A; K is the unsaturated hydraulic conductivity function [LT^{-1}].

For this Assessment, the HYDRUS 2D-general geometry type was used to define cross sections with a unitary width (equal to 1 cm) to simulate infiltration into one-dimensional representations of the LTI and UTI using a daily time step. Two generic models were prepared to represent the OUTCAPP and INCAPP conditions on the impoundments. These models were prepared with two different simulation lengths. The 4-year simulation models utilized the hydroclimatic data collected at the Site's weather station (2016-2020), the SMS data (2019-2021), and the moisture content data from the 2016 geotechnical investigation (INTERA, 2017) to define the initial conditions. These models used daily output between November 1, 2019, and June 30, 2021, to overlap with SMS data collected at LTI and UTI test pits and focused on evaluating cover parameterization. A second set of 246-year simulation models were prepared with the same parametrization by cycling the 41-year climate timeseries from La Sal SW 1 (Section 2.1 and 5.1) six times to evaluate infiltration after quasi steady-state conditions were reached. Annual model output was used to evaluate the temporal dynamics of the model and calculate the average infiltration throughout the cover and tailing system.

The characterization of the soil hydraulic properties HYDRUS was done using the van Genuchten-Mualem hydraulic model (van Genuchten, 1980), which provides a parametric relationship between θ, h, and K based on retention curves obtained from hollow-stem auger samples collected on the impoundments (INTERA, 2017). Profile geometry and soil hydraulic properties are consistent with the enhanced HELP model profiles (Section 6.2) and the 2016 geotechnical investigation data (INTERA, 2017). The upper boundary condition is defined using precipitation and potential ET daily timeseries derived from a nearby station (La Sal SW 1). Vegetation was simulated using several combinations of LAI and root distribution based on vegetation transects and vertical profiles observed at the LT-TP2 and UT-TP1 test pits (**Figures 4.2** and **4.3**) and a literature review of LAI values for similar environments (Section 5.2). The free drainage boundary condition was used at the bottom to represent a condition where the water table is far below tailings as explained in the conceptual model for the Site (INTERA, 2021b). **Appendix H** provides a detailed description of the FE mesh, hydraulic properties, boundary conditions, and initial conditions for the HYDRUS modeling.

7.0 ENHANCED MODEL RESULTS

This section summarizes the HELP and HYDRUS results of the modeling conducted for this enhanced Assessment. **Appendix I** includes additional details on the HYDRUS modeling results.

7.1 HELP Model Results

This section presents enhanced HELP model results for off-site natural profile conditions (NR analogue), and for the existing as-built covers on the tailing impoundments. Both the NR analogue and the enhanced tailing HELP models were run for a duration of 100 years beginning at current "as-built" conditions. The initial conditions were based on moisture conditions measured and observed during the 2016 and 2019 field investigations.

7.1.1 Natural Recharge Analogue Model

The HELP model was run as described in this section to simulate the WB of off-site natural conditions. The results are compared to other methods of estimating NR near the Site to better understand the efficacy of the of the HELP model to predict both long-term percolation of the current as-built covers on the tailing impoundments, and simulation of any future cover configurations for tailing impoundments (as may be required).

The natural recharge analogue ("NR") composite HELP model, which combines data from all six of the NR analogue locations, predicts an average percolation (flux) through the natural soil profile of 0.38 in/yr (3.06E-08 cm/s) with an EZD of 20 inches. The estimated flux for the NR-1 as-built model (the deepest NR boring) is slightly higher at 0.70 in/yr (5.64E-08 cm/s) with a shallower EZD of 18 inches. HELP-simulated average flux values were calculated over a 40-year simulation interval after the model reached quasi steady-state recharge conditions. **Table 7.1** compares the enhanced HELP-simulated NR analogue results derived from the as-drilled and composite models are compared to the calculated CMB recharge rate (Section 5.3.1), HYDRUS model results of natural conditions (Section 5.3.2), and a regional estimate of NR in southwestern Utah.

Table 7.1 Enhanced HELP-Simulated Natural Recharge Rates Comparison to Other Methods.

Natural Recharge Evaluation Method	Recharge Rate (in/yr)	Recharge Rate (cm/s)
Enhanced HELP Simulated Average[1]	0.38 – 0.70	3.06E-08 – 5.64E-08
HYDRUS Simulated Average[2]	0.24 – 0.66	3.70E-08 – 5.43E-08
CMB Calculation	0.28 – 0.61	2.26E-08 – 4.92E-08
Literature Value[3] Average for SW Utah	0.8	6.44E-08

Notes: [1]Average rate over quasi steady-state recharge conditions
[2]HYDRUS recharge model (Section 5.3.2) conducted as part of HSSA4 Report (INTERA, 2021b)
[3](Heilweil et al., 2005; Marston and Heilweil, 2012)

The results summarized in **Table 7.1** show that all methods of estimating NR near the Site are in good comparison. Additionally, the results indicate a relatively high level of confidence that the estimate of NR is likely within the ranges shown. Finally, there is a relatively high degree of confidence that both HELP and HYDRUS are useful tools for estimating both long-term NR near the Site and for simulating any possible future tailing impoundment cover configurations that may resemble a natural profile.

Figure 7.1 illustrates the relationship of the primary components of WB including precipitation, ET, runoff, and percolation values generated by HELP over a 100-year simulation for both NR analogue models. The plot shows the variation in climate data with wet years and droughts where the majority of precipitation is consumed by ET and runoff is minimal. In the overall WB, the average annual estimated deep percolation through the natural soil profile that would become recharge to groundwater is approximately 4% of the mean annual precipitation of 12.63 inches used in the model. Cumulative percolation results comparing both NR analogue models are presented in **Figure 7.2**. The simulated recharge estimates correspond closely with the CMB calculated estimates, which provides confidence and validation of the HELP model to Site conditions. **Figure 7.3** illustrates the annual percolation rates compared to cumulative rates for a 100-year simulation.

7.1.2 Tailing Impoundment (INCAPP & OUTCAPP) Model

The HELP model was run as described in this section to simulate the WB of the existing tailing impoundment covers and underlying tailing profile. As such, the percolation values estimated herein are representative of percolation of tailing fluid from the base of the tailing and into underlying foundational materials.

Figure 7.4 illustrates the relationship of precipitation, ET, runoff, and percolation values generated by HELP over a 100-year simulation for the INCAPP (solid lines) and OUTCAPP (dashed lines) models. Precipitation generated by the HELP weather simulator is the same for all enhanced models, aside from the climate change sensitivity study presented in Section 7.1.3. ET is higher in the OUTCAPP model due to the deeper EZD and higher LAI, which creates a stronger upward flux within the rooting and water storage zone compared to the INCAPP model.

Enhanced HELP model percolation rates through the tailing impoundments range from 0.44 to 3.89 in/yr (3.55-08-3.14E-07 cm/s) depending on location within (INCAPP) or outside (OUTCAPP) of the former evaporation cells (**Table 7.2**). The OUTCAPP model (LTB-TP2) predicts an average simulated flux through the tailings of 0.44 – 0.83 in/yr (3.55E-08-6.69E-08 cm/s) assuming an EZD of 20 to 36 inches. The INCAPP model (UTB-TP1) predicts an average simulated flux through the tailings of 1.49 – 3.89 in/yr (1.20E-07 cm/s-3.14E-07 cm/s) assuming an EZD of 8 to 18 inches. In the overall WB, the average annual estimated deep percolation through the bottom of the impoundments represents approximately 5% of the mean annual precipitation of 12.63 inches for the OUTCAPP model and 21% for the INCAPP model.

Figures 7.5 and **7.6** illustrate the annual simulated flux rates as well as the cumulative flux for the INCAPP and OUTCAPP models for a 100-year simulation. Average flux values for the OUTCAPP model (LTB-TP2) were calculated over an 80-year simulation interval once the model reached quasi steady-state conditions (**Figures 7.5**). Average flux values for the INCAPP model (UTB-TP1) were calculated over a 99-year simulation interval, as less time was required for the wetter initial conditions to reach quasi steady-state with the water balance inputs (**Figure 7.6**).

Table 7.2 Enhanced HELP Model Percolation Results for the Tailing Impoundments.

Enhanced HELP Model Results – Long-Term Percolation Through TSFs					
Location	**Model**	**EZD Range (in)**	**Maximum LAI**	**Percolation[1] Range (in/yr)**	**Percolation[1] Range (cm/s)**
OUTCAPP	LTB-TP2	20 – 36	1.0	0.44 – 0.83	3.55E-08 – 6.69E-08
INCAPP	UTB-TP1	8 – 18	0.1	1.49 – 3.89	1.20E-07 – 3.14E-07
Notes: [1]Average rate over quasi steady-state recharge conditions EZD: Evaporation Zone Depth LAI: Leaf Area Index					

7.1.2.1 Initial vs. Enhanced Results

A comparison of the percolation results of the initial 2018 models with the enhanced models are included in **Table 7.3** and displayed in **Figure 7.7** as cumulative percolation over the maximum EZD simulations. UTB-1 and LTB-2 are the initial profiles (**Figures 3.1** and **3.2**) based on auger boring data collected through the impoundments described in the GIR (INTERA, 2017) and summarized in Section 3 and **Appendix A**. The enhanced model profiles (UTB-TP1 and LTB-TP2; **Figures 6.4** and **6.5**) were updated to incorporate data collected from the 2019 test pit investigation.

Simulated percolation for the LTB-TP2 model (**Figure 7.7**, green line), representing the OUTCAPP scenario, reduced significantly compared to the initial LTB-2 percolation (**Figure 7.7**, dashed blue line) primarily due to the increased EZD (up to 36 inches) observed in test pit LT-TP2 (**Figure 4.3**) and incorporated into the enhanced model. The deeper EZD increases the moisture storage volume and ET uptake potential, which in turn reduces the volume of water available to percolate through the cover system and into the tailing impoundment.

Simulated percolation in the UTB-TP1 model (**Figure 7.7** orange line), representing the INCAPP scenario, increased compared to the initial UTB-1 (**Figure 7.7**; dashed yellow line) despite the maximum EZD remaining constant at 18 inches, which was confirmed in test pit UT-TP1 (**Figure 4.2**). The percolation increase is due in part to the decrease in LAI to represent the general lack of vegetation within the former evaporation cell areas. The other adjustment contributing to the percolation increase is a HELP layer classification change from "Barrier Soil Liner" to "Vertical Percolation" described in Section 6.3.1, which no longer restricts vertical flow to only permit gravity drainage when moisture content is above the field capacity.

Table 7.3 Percolation Results Comparison of Enhanced HELP Models with 2018 HELP Models.

Enhanced HELP Model Results – Long-Term Percolation Through TSFs					
HELP Model	**Location**	**EZD Range (in)**	**Maximum LAI**	**Percolation[1] Range (in/yr)**	**Percolation[1] Range (cm/s)**
Enhanced OUTCAPP	LTB-TP2	20 – 36	1.0	0.44 – 0.83	3.55E-08 – 6.69E-08
Initial - 2018	LTB-2	9 - 18	2.0	1.58 – 3.33	1.18E-07 – 2.69E-07
Enhanced INCAPP	UTB-TP1	8 - 18	0.1	1.49 – 3.89	1.20E-07 – 3.14E-07
Initial - 2018	UTB-1	9 - 18	2.0	0.77 – 1.38	6.21E-08 – 1.11E-07

Notes: [1]Average rate over quasi steady-state conditions
EZD: Evaporation Zone Depth
LAI: Leaf Area Index

7.1.3 Climate Change Sensitivity Analysis

Following the approach outlined in Section 2.1.3 and 5.1.1, synthetic climate change datasets were created to test sensitivity to increasing temperature and precipitation, both independently and simultaneously. **Figure 7.8** illustrates the relative responses of three different climate change scenarios on percolation rates through the tailings using the best case OUTCAPP model at 36 inches EZD as a baseline for comparison. The baseline simulation (green line) represents the historical climate trend represented in the 41-year dataset. Increasing the temperature by 5°C (red dashed line) linearly over the simulation interval reduced the average simulated flux from 0.23 to 0.09 in/yr and represents the best-case scenario in terms of cover performance. Linearly increasing precipitation by 40% (blue dashed line) raised the average simulated flux to 0.62 in/yr, which represents the worst-case scenario for cover performance. Simultaneously increasing temperature and precipitation (yellow dashed line) linearly over the climate normal increased the average flux to 0.52.

Percolation shows a much higher sensitivity to precipitation than temperature. Increased precipitation adds more water to the equation and in turn increases percolation. Increased temperature also increases ET which reduces the volume of water available for percolation. The HELP climate change simulations indicate that the TSF covers are not very resilient to increasing precipitation. The 40% increase in precipitation is at the upper end of the global climate change model ranges from the Golder (2018) trend analysis (Section 2.1.1) and should therefore be considered a worst-case scenario. HELP may also be overestimating the sensitivity to precipitation by not simulating Richard's equation.

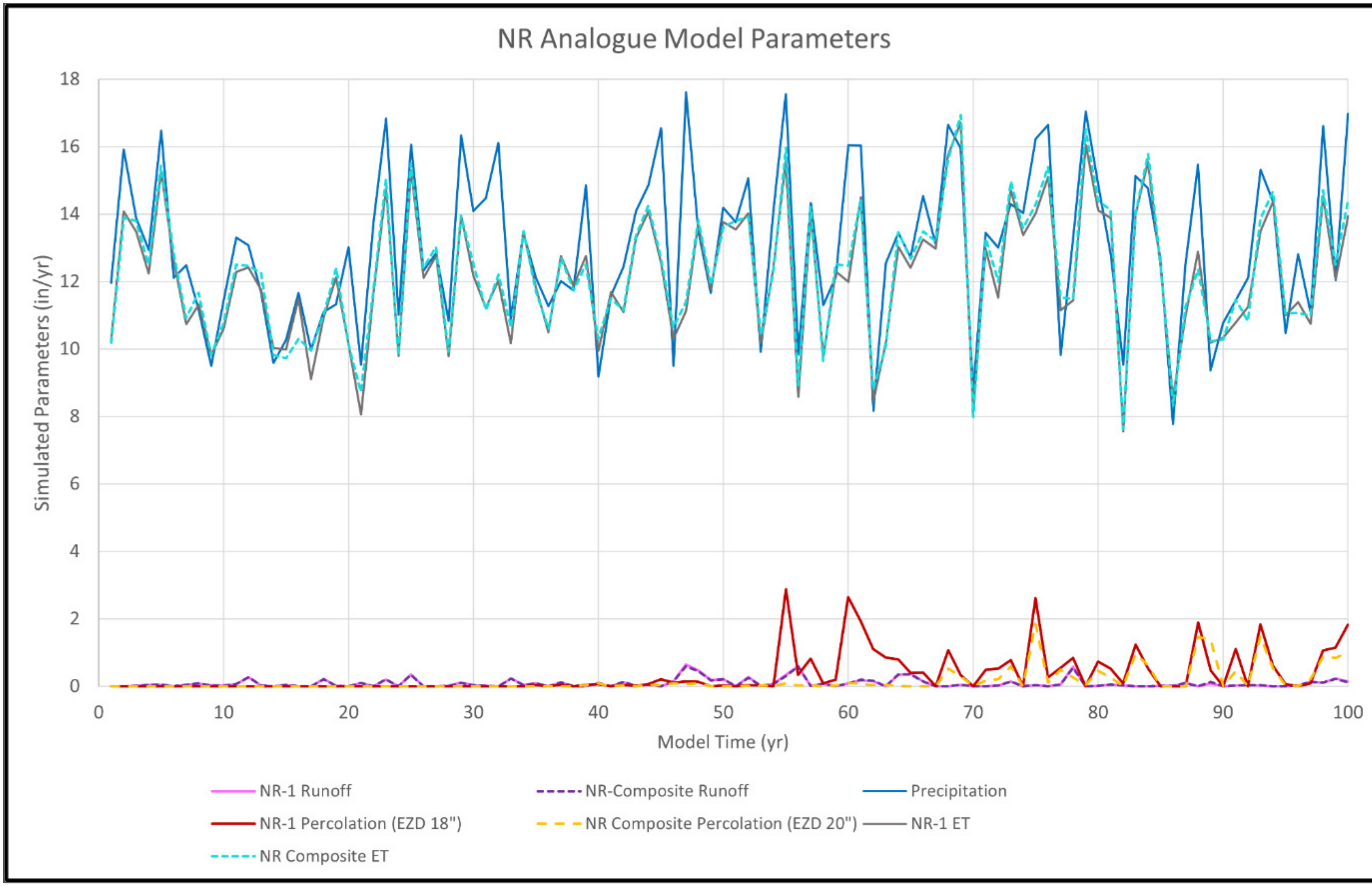


Figure 7.1 HELP Generated Precipitation, Evapotranspiration, Runoff, and Percolation for the NR Analogue Models.

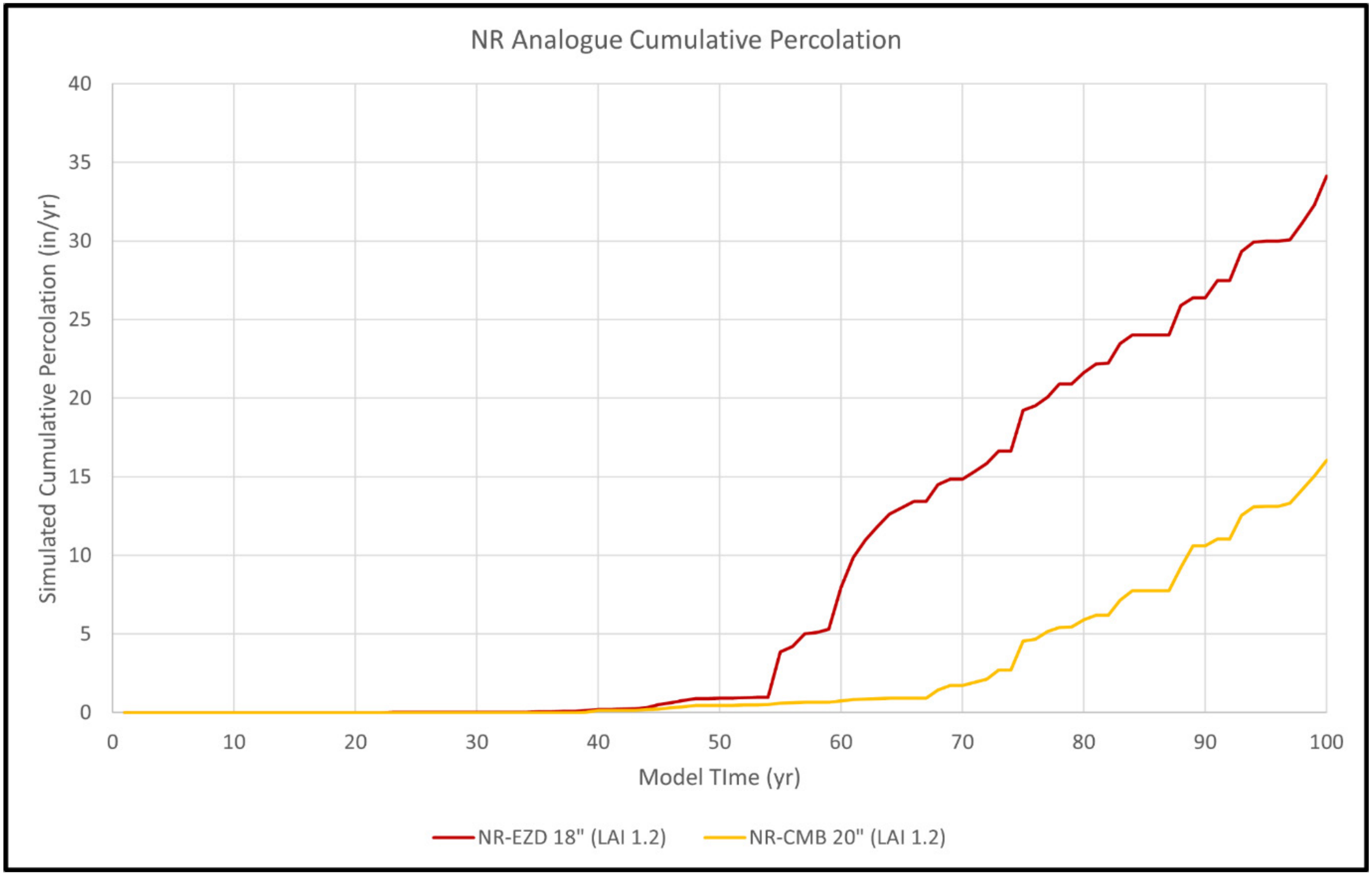


Figure 7.2 Cumulative NR-1 and NR Composite Percolation Results.

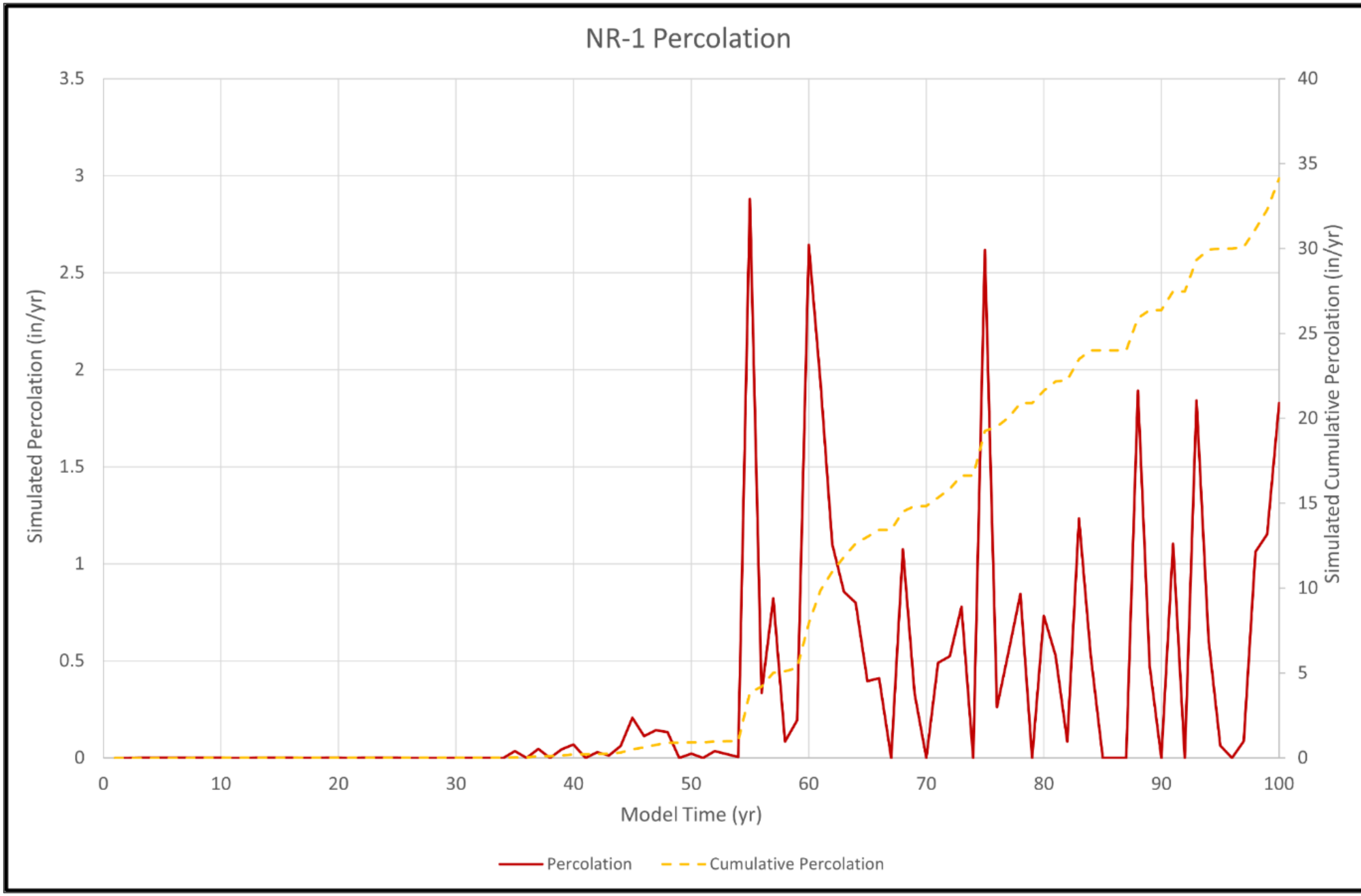


Figure 7.3 NR-1 Annual Percolation and Cumulative Percolation over 100-year Simulation.

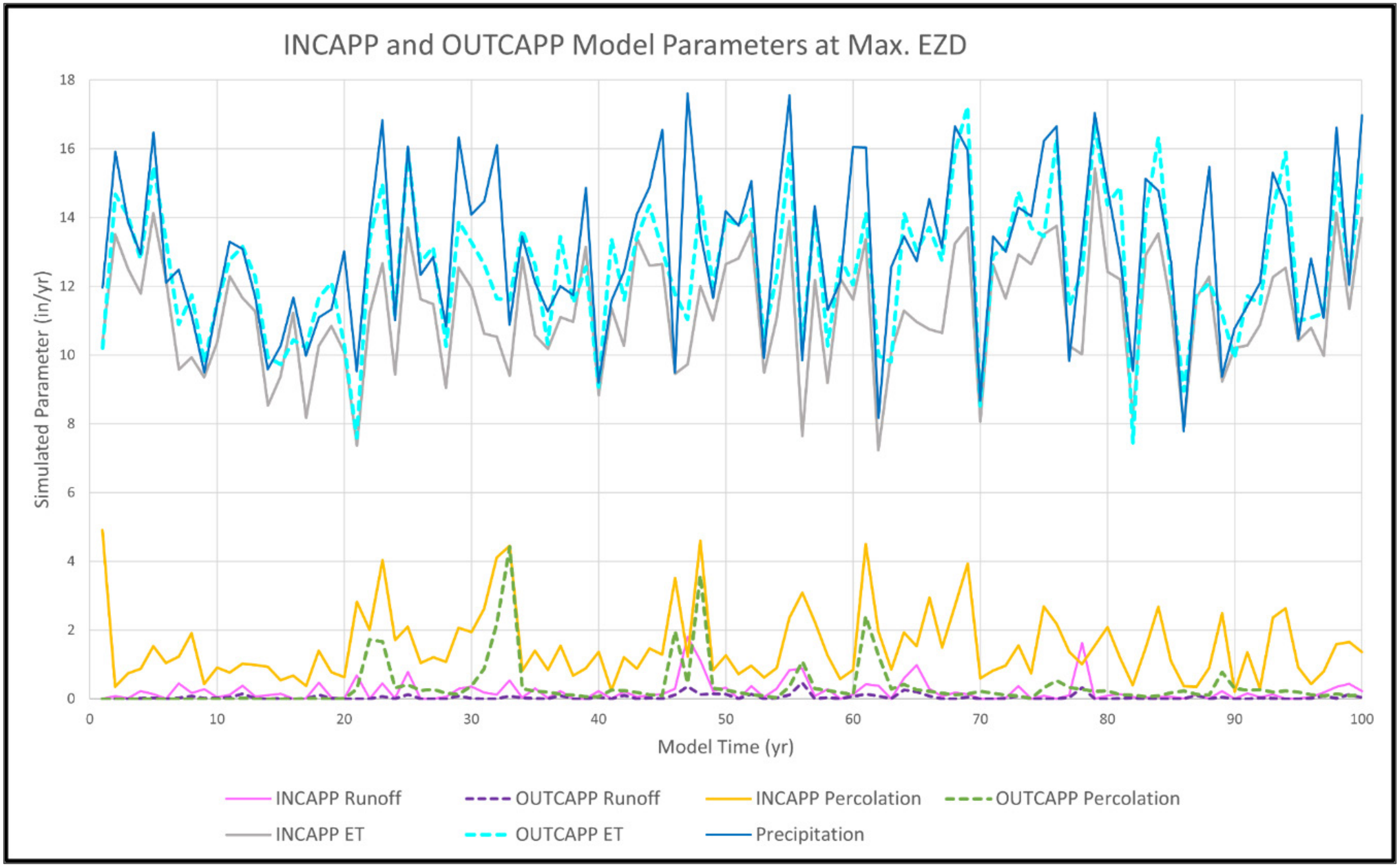


Figure 7.4 Comparison Plot of INCAPP and OUTCAPP HELP Model Results.

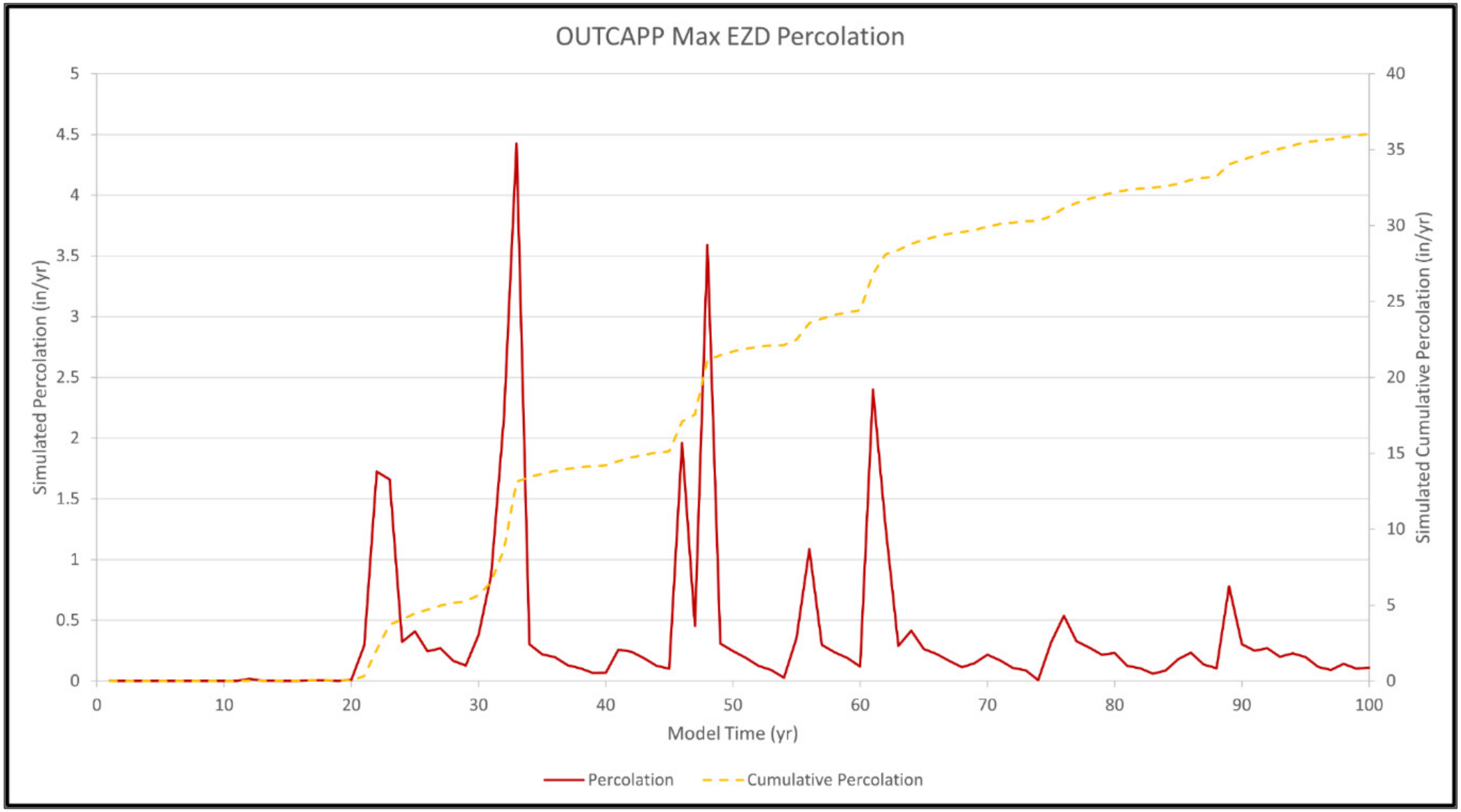


Figure 7.5 OUTCAPP Annual Percolation and Cumulative Percolation over 100-year Simulation.

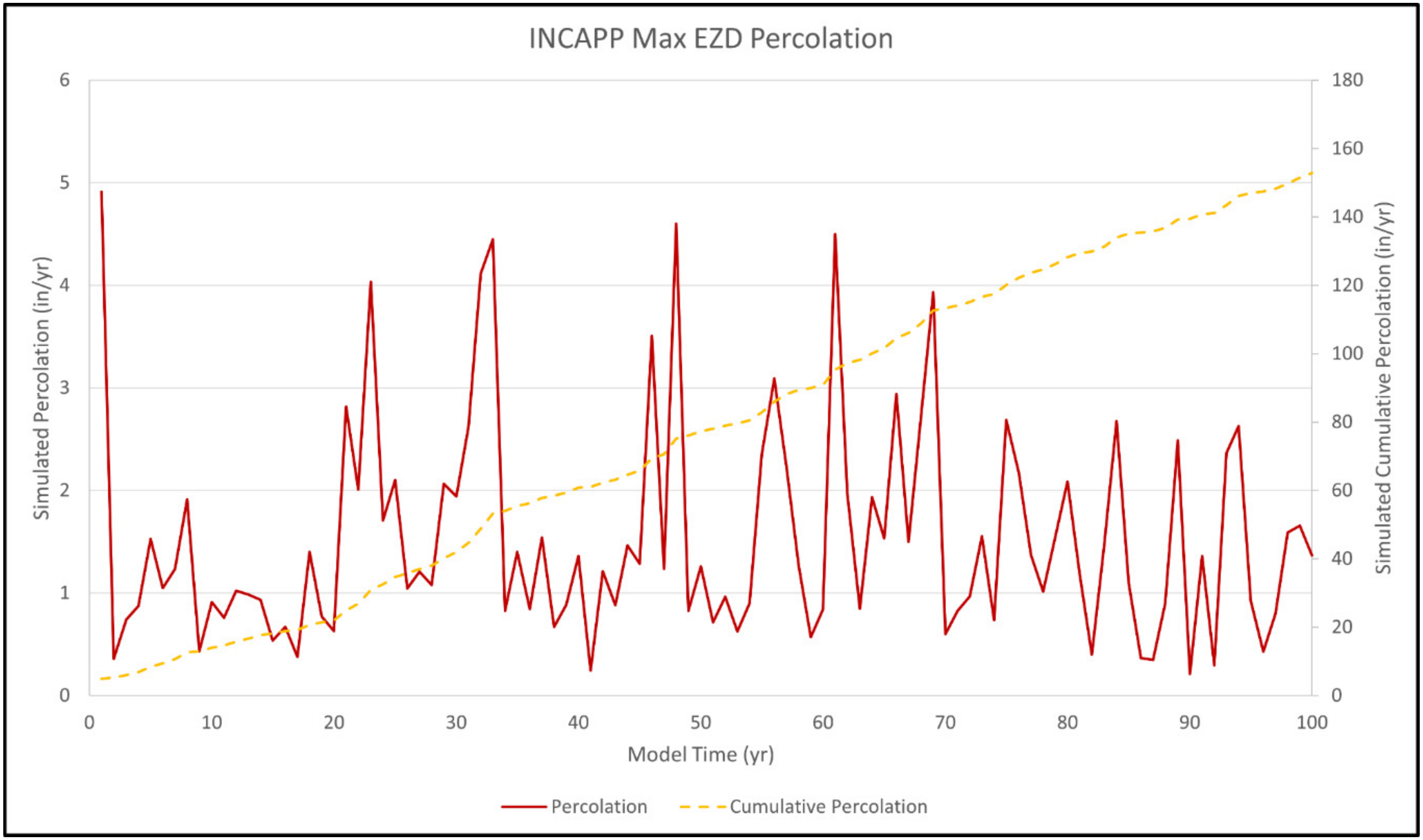


Figure 7.6 INCAPP Annual Percolation and Cumulative Percolation over 100-year Simulation.

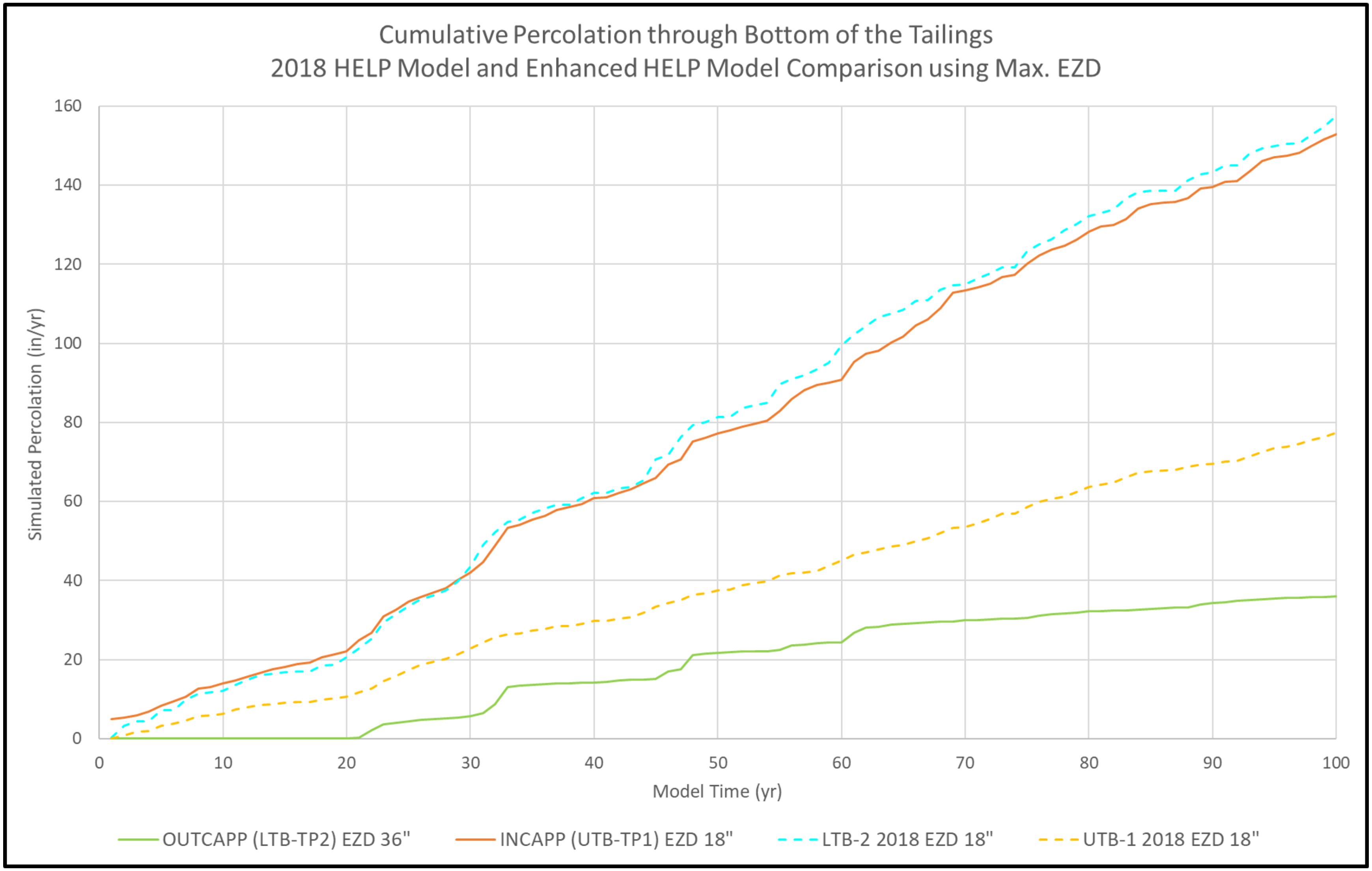


Figure 7.7 Cumulative Percolation Comparison of Enhanced HELP Model (solid lines) with 2018 HELP Model (dashed lines).

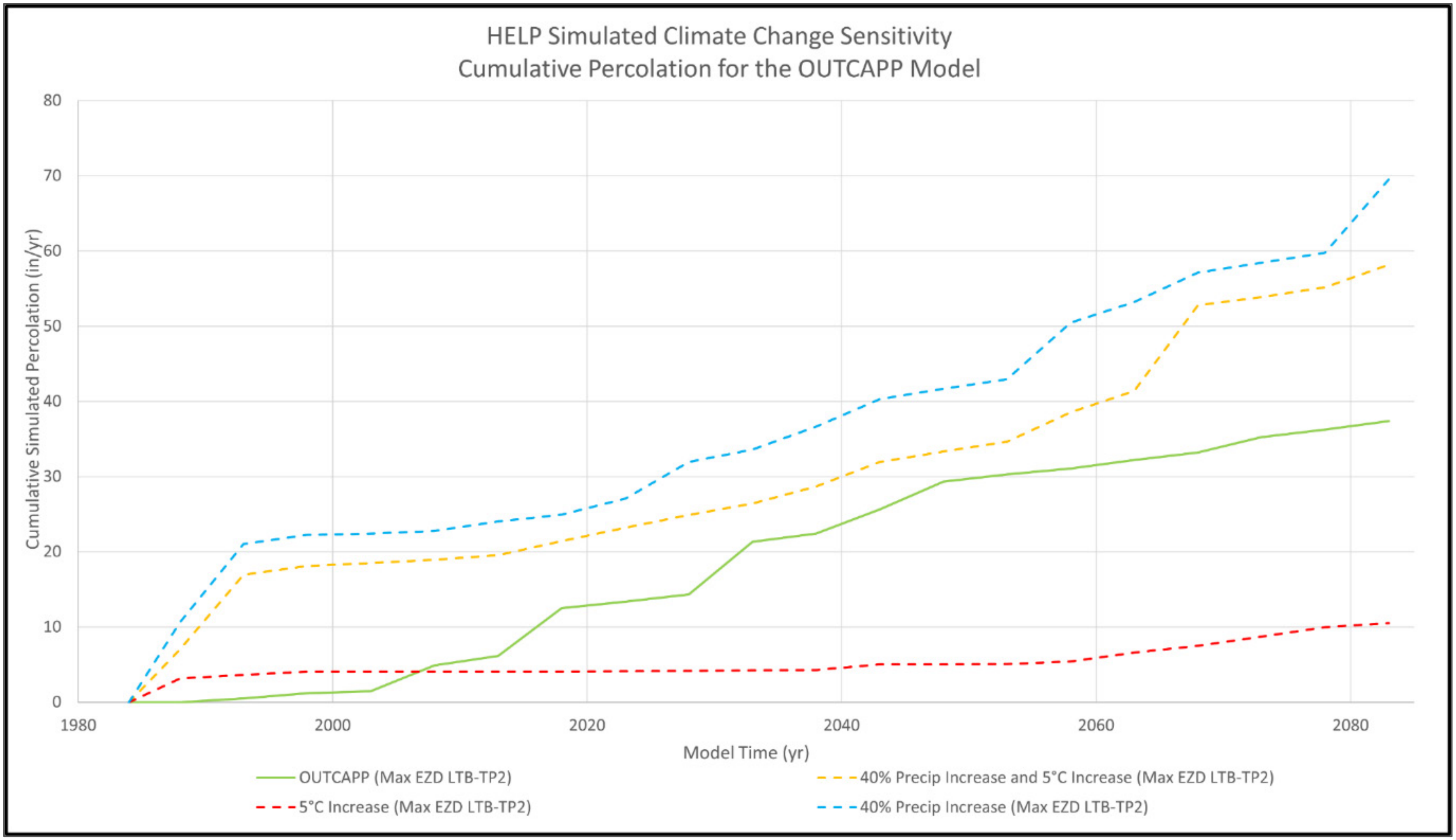


Figure 7.8 Cumulative Percolation Comparison of Climate Change Scenarios for the OUTCAPP Model.

7.2 HYDRUS Model

The HYDRUS modeling effort included an evaluation of site-specific climate and SMS data using (1) a 4-year model, (2) a methodology for the estimation of quasi-steady fluxes at the bottom of the cover and tailings using six cycles of the available 41-year climate record (246-year cycled model), and (3) a one-at-a-time sensitivity analysis to evaluate the parameterization of the atmospheric boundary condition. The models presented in this section are expected to bound conditions at the Site in terms of the observed vegetation coverage and can be refined in case of additional precision for the composite analysis. **Appendix I** provides a description of the models and results prepared in this analysis. Two of the main challenges were the high contrast between hydraulic properties of the rock cover and underlying materials and the atmospheric boundary condition at a daily time step which require very fine mesh discretization and long simulation times, respectively. Given the numerical stability limitations to solve the Richards equations under a wide range of conditions using HYDRUS 2D/3D, infiltration modeling presented in this section is presented as a check of the parameter input and assumptions used for the more conservative, flexible, and fast modeling approach provided with the enhanced HELP model. As explained in Section 6.2, it is expected that percolation calculated by HELP and HYDRUS provide higher and lower bounds, respectively. This section summarizes the evaluation using available SMS data, the reasoning and methods used to evaluate pseudo-steady fluxes at the bottom of the cover and tailings, a sensitivity analysis on the atmospheric boundary parameters, and a summary of the baseline simulations

7.2.1 Baseline selection

As presented in **Appendix I**, soil material properties and vegetation coverage, LAI, showed the greatest impact on percolation rates through both tailings impoundments. Percolation rates were evaluated at two different planes, one leaving the cover and another leaving the tailings. Given the dynamic nature of the top boundary and the free drainage boundary condition at the bottom, the models were cycled with the same climate six times and the fluxes from last two cycles were averaged to estimate a pseudo-state flux at each plane. Cover and the tailings fluxes were then averaged to obtain a representative value for each model. Sensitivity analyses concluded additional parameters influencing evapotranspiration, such as hCritA and P50 did not have a large impact on tailings percolation rates in the 246-year cycled model. Values for hCritA of 5,250 cm and P50 of -5,000 cm were chosen to provide reasonable net atmospheric fluxes and numerical stability. Through comparison of the net atmospheric fluxes, it was also determined that roots should be absent in the gravel layer as this provided lower ET rates more representative of the Site.

As vegetation is highly variable throughout both tailing impoundments, HYDRUS scenarios were developed to represent end cases at both OUTCAPP and INCAPP. Given the limited information on LAI magnitude and seasonality, two conditions with constant LAI were defined to bound OUTCAPP vegetation conditions: a no vegetation condition with LAI equal to 0 and a vegetated condition with LAI equal to 1. The OUTCAPP 36-inch root model with max density to 6 inches (LAI = 1) and an OUTCAPP model representing no vegetation (LAI = 0) developed in **Appendix I** provided a range of average tailings percolation rates between 0.016 in/yr (1.32E-09 cm/s) to 0.59 in/yr (4.78E-08 cm/s) as shown in **Table 7.4**. In the case of the INCAPP, the no vegetation condition was assumed to better represent INCAPP vegetation conditions with very low LAI with an average tailings percolation rate of 0.29 in/yr (2.34E-08 cm/s). Additional comparisons between OUTCAPP and INCAPP using the same root and vegetation parametrization showed similar fluxes despite differences in the material properties used for each cover system.

Table 7.4 HYDRUS Percolation Rates from OUTCAPP and INCAPP Baseline Models.

Representative Model	Condition	Flux Leaving Tailings (in/yr)	Flux Leaving Cover (in/yr)	Average Flux[1] (in/yr)	Average Flux[1] (cm/s)
OUTCAPP					
OUTCAPP 36" root with max intensity at 18 inches	36" roots with max intensity to 18" with no roots in gravel layer, decreasing root water uptake, LAI = 1	0.006	0.027	0.016	1.32E-09
OUTCAPP without vegetation	No Roots, LAI=0	0.550	0.637	0.593	4.78E-08
INCAPP					
INCAPP without vegetation	No Roots, LAI=0	0.305	0.274	0.290	2.34E-08

[1]Average percolation leaving the tailings (in/yr) and leaving the cover (in/yr)

8.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

8.1 Summary and Conclusions

This NR-WB Report documents that RAML has fulfilled the requirements of the HSSA4 Work Plan to conduct an enhanced Assessment to evaluate the as-built cover system on the closed tailing impoundments at the Site. The following summarizes the work completed in fulfillment of the HSSA4 Work Plan and provides conclusions with respect to the efficacy of the work to fulfill the primary objective of this Assessment to *better characterize long-term percolation values for the current cover, and proposed improvements (updated design) to the Facility tailings impoundment covers to reduce percolation rates into the groundwater*:

- **Data were collected to estimate the NR rate to groundwater at selected locations in the vicinity of the Site. The CMB method was used to estimate NR.**

  Summary

  - Site-specific data collected from both hollow-stem auger borings and associated test pit transects at six locations near (but not on) the reclaimed tailing impoundments were used to both estimate NR to groundwater using the CMB method, and to facilitate simulation of WB under natural conditions using the HELP and HYDRUS models.
  - NR to groundwater near the Site, representative of natural alluvium overlying bedrock, was estimated to be within the range of 0.28 to 0.61 in/yr (2.26E-08 to 4.92E-08 cm/s) using the CMB method and data collect at the Site as part of the Assessment.

  Conclusions

  - An estimate of NR to groundwater near the Site was successfully made using site-specific information and application of the CMB method.

- **HELP model profile(s) were developed simulating the surrounding natural conditions and the estimated NR was used to calibrate [validate] the HELP model.**

  Summary

  - HELP model profiles of the natural conditions near the Site were developed from the same set of data used for the CMB calculations.
  - The HELP model was used to simulate an estimated NR rate range of 0.38 to 0.70 in/yr (3.06E-08 to 5.64E-08 cm/s), which corresponds closely with the range estimated by the CMB method.

- While not specifically a part of the Scope of Work, the HYDRUS model was also used independently to simulate an estimated NR rate range of 0.24 to 0.66 in/yr (3.70E-08 to 5.43E-08 cm/s), which is in very close agreement to both the HELP model results and the CMB calculations.

Conclusions

- The close agreement of independently estimated ranges of NR near the Site using the CMB method and simulations using the HELP and HYDRUS models provides confidence that NR is within the range estimated by those methods.
- While not used to "calibrate" the modeling, the CMB calculations of NR have helped to *validate* that both the HELP and HYDRUS models may be used with some confidence to simulate either NR near the Site, and/or anthropogenic tailing impoundment cover profiles that closely emulate natural conditions (natural analogue covers).

- **Data were collected to better understand the evaporative zone depth of the current covers over the UTI and LTI.**

Summary

- Site-specific information from test pits excavated into the existing covers of the UTI and LTI facilitated a detailed look at the final cover profiles at those locations.
- Test pit transects were used to document root zone development, depth, and density; as well as soil material type, distribution, and condition.
- SMSs were installed in two of the four cover test pits on the tailing impoundments (one each on the UTI and LTI) to record seasonal moisture distribution and redistribution in response to climate input.

Conclusions

- Collectively, the data gathered from the tailing impoundment test pits provided a comprehensive picture of the evaporative zone depth and related processes governing percolation through the covers for areas both inside (INCAPP) and outside (OUTCAPP) of the former corrective action evaporation ponds on the UTI and LTI.
- Comparing and contrasting the information collected from the off-site (NR) test pits and the on-site (tailing impoundment) test pits is very useful in understanding the behavior of the WB of the natural profile, the final

impoundment covers as constructed, and possible future enhancements to the current covers (as may be required).

- **Moisture flux through the current UTI and LTI covers was simulated using the validated HELP model and refined evaporative zone depth data to update long-term estimated flux values for the existing impoundment covers (as appropriate).**

  <u>Summary</u>

  - Both the HELP and HYDRUS models were used to simulate long-term percolation of the existing covers and through underlying tailing within the former corrective action evaporation pond areas (INCAPP) and outside the former pond areas (OUTCAPP) (**Table 8.1**).
  - Model input was derived from site-specific investigations as part of this Assessment (enhanced field and laboratory data), a previous Site-specific investigation, and using informed literature data where site-specific data are sparse or not available.
  - Enhanced HELP modeling of the INCAPP areas estimated long-term percolation through the UTI and LTI ranging from 1.49 to 3.89 in/yr (1.20E-07 to 3.14E-07 cm/s). Enhanced HELP modeling of the OUTCAPP areas estimated long-term percolation through the UTI and LTI ranging from 0.44 to 0.83 in/yr (3.55E-08 to 6.69E-08 cm/s) (**Table 8.1**).
  - HYDRUS modeling of the INCAPP areas estimated long-term average percolation through the UTI and LTI of 0.29 in/yr (2.34E-08 cm/s). HYDRUS modeling of the OUTCAPP areas estimated long-term percolation through the UTI and LTI ranging from 0.02 to 0.59 in/yr (1.32E-09 to 4.78E-08 cm/s) (**Table 8.1**).

  <u>Conclusions</u>

  - The as-built UTI and LTI covers are a rock-style cover, and estimation of WB performance (long-term percolation) of rock-style covers by any method or model is difficult and uncertain.
  - Because of the relative inability of any model to accurately represent the complex processes at work in a rock-style cover, the modeling results should be viewed in the context of other information that help to inform the estimation of long-term percolation rates, including but not limited to, the estimate of NR rates near the Site.

- Simulated percolation in the enhanced LTB-TP2 model, representing the OUTCAPP scenario with data from boring LTB-2 and test pit LT-TP2, reduced significantly compared to the initial 2018 LTB-2 model due to the increase in EZD (up to 36 inches) observed in test pit LT-TP2.
- Simulated percolation in the enhanced UTB-TP1 model, representing the INCAPP scenario, increased compared to the initial 2018 UTB-1 model despite the maximum EZD remaining the same depth, as confirmed in test pit UT-TP1. The percolation increase is due in part to the decrease in LAI to represent the general lack of vegetation within the former evaporation pond areas. The other adjustment contributing to the percolation increase is a HELP layer classification change from "Barrier Soil Liner" to "Vertical Percolation" which has less restrictions on vertical flow.

Table 8.1 Summary of Enhanced Model Results of Long-Term Percolation (Flux) through the Tailing Impoundments Compared with Natural Recharge Estimates.

Location	Method	Flux[1] Range (in/yr)	Flux[1] Range (cm/s)	Average Flux[1] (in/yr)
TSF OUTCAPP	HELP	0.44 – 0.83	3.55E-08 – 6.69E-08	0.64
	HYDRUS	0.02 - 0.59	1.32E-09 – 4.78E-08	0.30
TSF INCAPP	HELP	1.49 – 3.89	1.20E-07 – 3.14E-07	2.69
	HYDRUS	0.29	2.34E-08	0.29
Site NR	HELP	0.38 – 0.70	3.06E-08 – 5.64E-08	0.54
	HYDRUS	0.24 – 0.66	3.70E-08 – 5.43E-08	0.45
	CMB	0.28 – 0.61	2.26E-08 – 4.92E-08	0.45
SW Utah NR[2]	Literature Value	0.8	6.44E-08	0.8

Notes: [1]Average rate over quasi-steady state conditions
[2](Heilweil et al., 2005; Marston and Heilweil, 2012)
NR = Natural Recharge
CMB = Chloride Mass Balance
TSF = Tailing Storage Facility
OUTCAPP = Outside footprint of former Corrective Action Plan Evaporation Pond
INCAPP = Inside footprint of former Corrective Action Plan Evaporation Pond
SW = Southwest

- **Application of the calibrated HELP model to the simulation of long-term flux rates through the UTI and LTI for hypothetical future cover configurations and source input to the groundwater flow and transport model.**

Summary

- Modeling of hypothetical future cover configurations, and related input to fate and transport modeling of groundwater at the Site has not been done for this Assessment.

Conclusions

- Simulation of any possible future cover configurations will be completed when further information is considered and/or obtained as part of a holistic corrective action assessment for the Site.

- **Development of a Natural Recharge and Water Balance Modeling Report.**

Summary

- This NR-WB Report has been completed documenting the Assessment described herein.

8.2 Recommendations

In consideration of the objectives and outcome of this Assessment, the following recommendations are made.

- **Long-term tailing impoundment percolation rates for use in groundwater fate and transport modeling.**
  - For use in groundwater fate and transport modeling as part of the HSSA4 assessment and report (INTERA, 2021b), **Table 8.2** presents recommended minimum and maximum tailing impoundment percolation values for both INCAPP and OUTCAPP areas of the UTI and LTI for the existing as-built final covers.

Table 8.2 Recommended Long-Term Percolation Rates for Existing TSF Covers

	INCAPP Percolation	OUTCAPP Percolation
Minimum	0.3 in/yr (2.4E-08 cm/s)	0.3 in/yr (2.4E-08 cm/s)
Maximum	3.9 in/yr (3.2E-07 cm/s)	0.8 in/yr (6.7E-08 cm/s)

  - The percolation ranges provided in **Table 8.2** consider the results of the enhanced HELP model, the HYDRUS model, estimate of NR near the Site, and the sensitivity of the existing covers to perform with changing climate conditions.

    - For the generally sparsely vegetated INCAPP areas of the TSFs, the likely **minimum** percolation is equal to the estimated natural recharge rate calculated by the CMB method, and as corroborated by simulations of natural recharge using both HELP and HYDRUS. For INCAPP areas of the TSFs, the likely **maximum** percolation is equal to the maximum rate calculated by HELP and is on the order of the saturated hydraulic conductivity of the radon barrier of the existing TSF covers.
    - For OUTCAPP areas of the TSFs which are characteristically better vegetated, the likely **minimum** percolation is equal to the estimated natural recharge rate calculated by the CMB method, and as corroborated by simulations of natural recharge using both HELP and HYDRUS. For OUTCAPP areas of the TSFs, the likely **maximum** percolation is equal to the maximum rate calculated by HELP.
  - It is likely that the HYDRUS model has somewhat underestimated percolation rates for the reasons described in this NR-WB Report. And while considered, the results of the HYDRUS modeling have largely been excluded from determination of the recommended percolation values in **Table 8.2**.
  - Results of the enhanced HELP model has been used, in conjunction with estimated NR rate near the Site, to project the long-term percolation of tailing pore fluids from the UTI and LTI (for existing cover conditions). Estimates of NR near the site have been useful for establishing likely minimum values of long-term percolation of tailing fluids for the existing rock covers.
- **Possible enhancements to the existing, as-built tailing impoundment covers.**
  - Simulation of any possible future cover configurations will be completed when further information is considered and/or obtained as part of a holistic corrective action assessment for the Site.

9.0 REFERENCES

Albright, W.H., Gee, G.W., Wilson, G.V. and Fayer, M.J. 2002. Alternative Cover Assessment Project Phase I Report. Desert Research Institute, Nevada, USA.

Allison, G.B. and M.W. Hughes. 1978. The Use of Environmental Chloride and Tritium to Estimate Total Recharge to and Unconfined Aquifer. Australian Journal of Soil Research. July 1978, vol 16, p 181-195.

Allison, G.B., G.W. Gee, and S.W. Tyler. 1994. Vadose-Zone Techniques for Estimating Groundwater Recharge in Arid and Semiarid Regions. *Soil Science Society of America Journal*. 1994, vol 58, p 6-14.

Asner, Gregory & Scurlock, Jonathan & Hicke, Jeffrey. 2003. Global Synthesis of Leaf Area Index Observations: Implications for Ecological and Remote Sensing Studies: Global Leaf Area Index. *Global Ecology and Biogeography.* 12. 191-205.

Berger, K., Melchior, S. and Miehlich, G. 1996. Suitability of Hydrologic Evaluation of Landfill Performance (HELP) model of the US Environmental Protection Agency for the simulation of the water balance of landfill cover systems. *Environmental Geology,* 28(4), pp.181-189.

Brown, C.M., Boltz, F., St. George Freeman, S., Tront, J., Rodriguez, D. 2019. Resilience by Design: a Deep Uncertainty Approach for Water Systems in a Changing World, *Water Security*, 9,100051.

Blanchard, P.J. 1990. Ground-water Conditions in the Grand County Area, Utah, Mill Creek Spanish Valley area. State of Utah Department of Natural Resources Technical Publication No. 100.

Carsel, R.F., and Parrish, R. S. 1988. Developing Joint Probability Distributions of Soil Water Retention Characteristics, *Water Resources Research,* 24, 755-769.

Coons, L.M., M.D. Ankeny, and G.M. Bulik, 2000. Alternative Earthen Final Covers for Industrial and Hazardous Waste Trenches in Southwest Idaho. Proceedings of 3rd Arid Climate Symposium. Solid Waste Association of North America, Silver Springs, MD, 14-1-14-16.

Daly, C., Halbleib, M., Smith, J.I., Gibson, W.P., Doggett, M.K., Taylor, G.H., Curtis, J. and Pasteris, P.P. 2008. Physiographically Sensitive Mapping of Climatological Temperature and Precipitation across the Conterminous United States. *International Journal of Climatology: a Journal of the Royal Meteorological Society*, 28(15), pp.2031-2064.

Dames and Moore. 1980. Report of Preliminary Tailings Management Study, Lisbon Valley Mine Tailings Disposal System. 7144-016-06.

Dreiss, S. J. and Anderson, L.D. 1985. Estimating Vertical Soil Moisture Flux at a Land Treatment Site. Ground Water Publishing Co., Westerville, 23, 503-511.

Earthfax Engineering. 1991. Field and Laboratory Data Review, Evaporation Pond No. 1 Upper Tailings Impoundment, Lisbon Uranium Mill.

______. 1992. Lower Evaporation Pond Embankment Slope Stability Analyses, Lisbon Uranium Mill.

Komex. 2004. Long Term Groundwater Monitoring Plan, Application for Alternative Concentration Limits Source Materials License SUA-1119 RAMC Lisbon Facility La Sal, Utah, February 19.

Garfin, G., G. Franco, H. Blanco, A. Comrie, P. Gonzalez, T. Piechota, R. Smyth, and R. Waskom. 2014: Ch. 20: Southwest. Climate Change Impacts in the United States: *The Third National Climate Assessment,* J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 462-486. doi:10.7930/J08G8HMN.

Golder Associates (Golder). 2018. Climate Change Assessment for Lisbon. 132 p.

Griffin, D., Woodhouse, C. A., Meko, D. M., Stahle, D. W., Faulstich, H. L., Carrillo, C., Touchan, R., Castro, C. L., and Leavitt, S. W. 2013. North American Monsoon Precipitation Reconstructed from Tree-ring Latewood, *Geophys.* Res. Lett., 40, 954– 958, doi:10.1002/grl.50184.

Guernsey & Company, C.H. (Guernsey). 2018. Final Construction Completion Report, Lisbon Mine, Utah. C.H Prepared for Rio Algom Mining, LLC. August 27.

Guo, D., Westra, S., and Maier, H. R. 2016. An R package for modeling actual, potential and reference evapotranspiration. Environmental Modeling and Software, 78, 216-224.

Hargreaves, G.H. and Samani, Z.A. 1985. Reference crop evapotranspiration from ambient air temperature. *Am. Soc. Agric. Eng.* 85-2517.

Heilweil, V.M., Susong, D.D., Gardner, P.M., and Watt, D.E. 2005. Pre- and Post-reservoir Ground-water Conditions and Assessment of Artificial Recharge at Sand Hollow, Washington County, Utah, 1995–2005: U.S. Geological Survey Scientific Investigations Report 2005−5185, 74 p.

INTERA Incorporated (INTERA). 2017. Geotechnical Investigation Report, Rio Algom Mining, LLC, Lisbon Facility, San Juan County, Utah.

_____. 2018 Tailing Impoundments Water Balance Modeling Report: Cover Performance Assessment of the Upper and Lower Tailings Impoundments Rio Algom Mining, LLC, Lisbon Facility, San Juan County, Utah.

_____. 2019. Final Work Plan for the Hydrogeological Supplemental Site Assessment, Phase 4, Lisbon Facility. Radioactive Material License Number UT1900481, San Juan County, Utah. June 21, 2019.

_____. 2021a. Hydrogeological Supplemental Site Assessment, Phase 3, Lisbon Site, Rio Algom Mining LLC, San Juan County, Utah. March 12, 2021.

_____. 2021b. Hydrogeological Supplemental Site Assessment, Phase 4, Lisbon Site, Rio Algom Mining LLC, San Juan County, Utah. October 29, 2021.

_____. 2021c. Draft Geotechnical Investigation Report, Rio Algom Mining, LLC, Lisbon Facility, San Juan County, Utah. October.

International Atomic Energy Agency (IAEA). 2004. The Long-term Stabilization of Uranium Mill Tailings. Final Report of a Co-ordiated Research Project, 200-2004. IAEA-TECDOC-1403. August.

Im, J., Jensen, J.R., Jensen, R.R., Gladden, J., Waugh, J. and Serrato, M. 2012. Vegetation Cover Analysis of Hazardous Waste Sites in Utah and Arizona Using Hyperspectral Remote Sensing. *Remote Sensing,* 4(2), pp.327-353.

Intergovernmental Panel on Climate Change (IPCC). 2013. Climate Change 2013: The Physical Science Basis. Contribution of Working Group 1 to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/report/ar5/wg1/

Khire, M.V., Benson, C.H. and Bosscher, P.J. 1997. Water Balance Modeling of Earthen Final Covers. *Journal of Geotechnical and Geoenvironmental Engineering*, 123(8), pp.744-754.

Komex. 2004. Long-Term Groundwater Monitoring Plan (LTGMP). Prepared for Rio Algom Mining LLC. February 19, 2004.

Köppen, W. 1936. Das Geographisca System der Klimate, in: *Handbuch der Klimatologie,* edited by: Köppen, W. and Geiger, G., 1. C. Gebr, Borntraeger, 1–44.

Lewis Water Consultants, Inc (Lewis). 2001. Application for Alternate Concentration Limits, Source Materials License SUA-1119, RAMC Lisbon Facility, Las Sal, Utah. March 1, 2001.

Markovich, K., H, Manning, A. H., Condon, L. E., & McIntosh, J. C. 2019. Mountain-block Recharge: A Review of Current Understanding. *Water Resources Research,* 55. https://doi.org/10.1029/2019WR025676.

Marston, T.M., and Heilweil, V.M. 2012. Numerical Simulation of Groundwater Movement and Managed Aquifer Recharge from Sand Hollow Reservoir, Hurricane Bench Area, Washington County, Utah: U.S. Geological Survey Scientific Investigations Report 2012-5236, 34 p.

Masbruch, M.D., and Shope, C.L. 2014. Groundwater and surface-water resources in the Bureau of Land Management Moab Master Leasing Plan Area and Adjacent Areas, Grand and San Juan Counties, Utah, and Mesa and Montrose Counties, Colorado. U.S. Geological Survey Open-File Report 2014-1062.

Mitchell K.E., D. Lohmann, P. R. Houser, E. F. Wood, J. C. Schaake, A. Robock, B. A. Cosgrove, J. Sheffield, Q. Duan, L. Luo, R. W. Higgins, R. T. Pinker, J. D. Tarpley, D. P. Lettenmaier, C. H. Marshall, J. K. Entin, M. Pan, W. Shi, V. Koren, J. Meng, B. H. Ramsay, A. A. Bailey, 2004: The multi-institution North American Land Data Assimilation System (NLDAS): Utilizing multiple GCIP products and partners in a continental distributed hydrological modeling system, *J. Geophys. Res.*, 109, D07S90, doi:10.1029/2003JD003823.

National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS). 2021. Cooperative Observer Program. Accessed 14 April 2021, http://scacis.rcc-acis.org/.

Peel, M. C., Finlayson, B. L., & McMahon, T. A. 2007. Updated World Map of the Koppen-Geiger Climate Classification. *Hydrology and Earth System Sciences*, 11(5), 1633–1644. https://doi.org/10.5194/hess-11-1633-2007.

Penman, H.L., 1948. Natural Evaporation from Open Water, Bare Soil and Grass. Proceedings of the Royal Society, Series A. 193:120-145.

R Core Team. 2020. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Radcliffe, D.E. and Simunek, J. 2018. Soil physics with HYDRUS: Modeling and applications. CRC press.

Richards, L.A. 1931. Capillary Conduction of Liquids through Porous Mediums. *Journal of Applied Physics,* 1, 318-333.

Scanlon, B.R., Christman, M., Reedy, R.C, Porro, I., Simunek, J. Flerchinger, G.N. 2002 Intercode Comparisons for Simulating Water Balance of Surficial Sediments in Semiarid Regions. Water Resources Research, 38.12.

Schroeder, P.R. and R.L. Peyton. 1988. Verification of the Hydrologic Evaluation of Landfill Performance (HELP) Model Using Field Data. Prepared for the United States Environmental Protection Agency Hazardous Waste Engineering Laboratory. EPA/600/52-87/050.

Schroeder, P.R., Dozier, T.S., Zappi, P.A., McEnroe, B.M., Sjostrom, J.W. and Peyton, R.L. 1994. The Hydrologic Evaluation of Landfill Performance (HELP) Model: Engineering documentation for version 3.

Schaap, M.G., Leij, F.J. and van Genuchten, M.T. 2001. Rosetta: A Computer Program for Estimating Soil Hydraulic Parameters with Hierarchical Pedotransfer functions. *Journal of Hydrology*, 251(3-4), pp.163-176.

Šimůnek, J. and Šejna, M. 2009. Notes on Spatial and Temporal Discretization.

Šimůnek, J., van Genuchten, M.T. and Šejna, M. 2012. The HYDRUS software package for simulating the two-and three-dimensional movement of water, heat, and multiple solutes in variably-saturated porous media. Technical manual, Version, 2, p.258.

Šimůnek, J., Šejna, M., Saito, H., Sakai, M. and Van Genuchten, M.T. 2013. The HYDRUS-1D software package for simulating the movement of water, heat, and multiple solutes in variably saturated media, Version 4.17. HYDRUS software series, 3, p.342.

Šimůnek, J., van Genuchten, M.T. and Šejna, M. 2018. The HYDRUS software package for simulating the two-and three-dimensional movement of water, heat, and multiple solutes in variably-saturated porous media. Technical manual, Version 3.0, PC Progress, Prague, Czech Republic, pp. 274.

Stephens, D. B. and L. M. Coons. 1994. Landfill Performance Assessment at a Semiarid Site: Modeling and Validation. *Ground Water Monitoring & Remediation,* 14(1):101-109.

U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center. 2021. HEC-HMS Technical Reference Manual, CN Tables. https://www.hec.usace.army.mil/confluence/hmsdocs/hmstrm/cn-tables.

United States Department of Energy (DOE). 1989. Moisture Contents and Unsaturated Conditions in UMTRA Project Radon Barriers. DOE/UMTRA—400656.

______. 2014. Uranium Mill Tailings Radiation Control Act Sites. Office of Legacy Management. UMTRCA Title I&II Fact Sheet.

van Genuchten, M.T. 1980. A closed-form equation for predicting the hydraulic conductivity of unsaturated soils. *Soil Science Society of America Journal,* 44(5), pp.892-898.

van Genuchten, M. T. 1987. A numerical model for water and solute movement in and below the root zone, Res. Rep. 121, U.S. Salinity Lab., Agric. Res. Serv., U.S. Dep. of Agric., Riverside, Calif.

Varado, N., I. Braud, P.J. Ross. 2006. Development and assessment of an efficient vadose zone module solving the 1D Richards' equation and including root extraction by plants. *Journal of Hydrology.* 323 (2006) 258–275.

Vrugt, J. A., J. W. Hopmans, and J. Šimůnek. 2001a. Calibration of a two-dimensional root water uptake model, Soil Sci. Soc. Am. J., 65(4), 1027-1037, 2001a.

Vrugt, J.A., M. T. van Wijk, J. W. Hopmans, and J. Šimůnek. 2001b. One-, two-, and three-dimensional root water uptake functions for transient modeling, Water Resource Res., 37(10), 2457-2470, 2001b.

Wang, T. Vitaly A. Zlotnik, Jirka Simunek, and Marcel G. Schaap. 2009. Using pedotransfer functions in vadose zone models for estimating groundwater recharge in semiarid regions. *Water Resources Research,* VOL. 45, W04412, doi:10.1029/2008WR006903, 2009

Waugh, W.J., Kastens, M.K., Sheader, L.R.L., Benson, C.H., Albright, W.H. and Mushovic, P.S. 2008. February. Monitoring the Performance of an Alternative Landfill Cover at the Monticello, Utah, Uranium Mill Tailings Disposal Site. In *Waste Management 2008 Conference,* Phoenix.

APPENDIX A

Copies of Boring Logs and Laboratory Testing Summaries from 2016 Field Investigation (GIR, 2017)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

SOIL BORING LOG

LTB - 1

Depth (ft)	Clock Time	Graphical Log	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	Lab Unified Soil Classification	Comments	Visual Field Classification
0	1006											Surface: 1/2" - 2" dia crushed limestone rock (3" thick)
				r	2,3				15.5	s CL	Soft to very soft	Cover Fill: Clay; fine sandy, dark reddish brown (5YR3/2) w/ gray, red, and yellow inclusions; moist to v. moist
				r	1,3	110.5	5.3E-7	32.2	18.2	s CL		
				r	3,4	109.8		30.5	17.3	s CL	Gamma 8-10K cpm	
				r	2,4	103.0		32.2	19.5	s CL		
5	1036			r	4,7	101.1		35.5	21.9	s CL	Soft to moderately firm; black inclusions (organics?) @ 55"-60"	
				r	3,5	102.3	1.9E-6	38.2	23.4	s CL		
				r	2,4						Soft to very soft	Cover Fill: Silty clay/clayey silt; greyish brown (2.5Y5/2) w/ yellow and black organic inclusions; v. moist to wet
				r	5,10							
				r	7,8	91.7		45.1	30.7	CL s	Moderately firm to firm; black organics and fibrous roots @ 8.5 - 9'"	
				r	8,17							
10	1112			r	12,50+						Gamma 8-10K cpm; rock in drive shoe	Cover Fill: Clay; fine sandy; dark reddish gray (5YR4/2) w/ yellow and black organic inclusions; moist
				A								
				A							Gamma 28K cpm	Cover Fill: Clay; dark reddish gray (5YR4/2) moist
				r	2,3	75.5		51.4	42.5	CL		
15	1200			r	4,6							Tailing Fill: Clay; very fine sandy to silt; gray (5YR5/1); moist
				A								
20	1315			r	4,4	103.5		41.7	25.1	CL	Gamma 47K cpm	Tailing Fill: Clay; very fine sandy to silt; grayish brown (10YR5/2); very moist
				A								
25	1322			r	2,5	104.3		40.0	24.0	CL	Gamma 66K cpm	Tailing Fill: Clay; very fine sandy to silt; grayish brown (10YR5/2); very moist to wet
				A								
30	1326			r	2,4	107.0		37.4	21.8	CL	Gamma 76K cpm	
				A								
35	1342			r	2,4	97.6		51.1	32.7	CL	Gamma 78K cpm	
				A								
40	1355			r	3,5	102.8	3.6E-7	38.8	23.5	ML	Gamma 81K cpm; saturated @40.5'	Tailing Fill: Silt; very fine sandy; dark gray (GLEY-1/4/N); wet to saturated
				A								
45	1409			r	3,4						Gamma 125K cpm	Tailing Fill: Silt; very fine sandy; very dark grayish olive (10Y3/2); wet
				A								
50	1421			r	3,7	105.7		26.4	15.6	CL	Gamma 120K cpm	Tailing Fill: Clay; very fine sandy to silt; very dark gray (GLEY-1/3/N); wet
				A								
55	1442			r	3,9	108.5		37.2	21.4	CL	Gamma 120K cpm	
				A								Tailing Fill: Silty clay/clayey silt; very dark gray (GLEY-1/3/N); wet
60	1456			r		107.8	2.4E-7	35.5	20.5	CL s	Gamma 55K cpm	
				r	50+/6"						TD @ 61' w/ sampler	Sandstone; pale yellow (5Y/8/2); weathered

SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

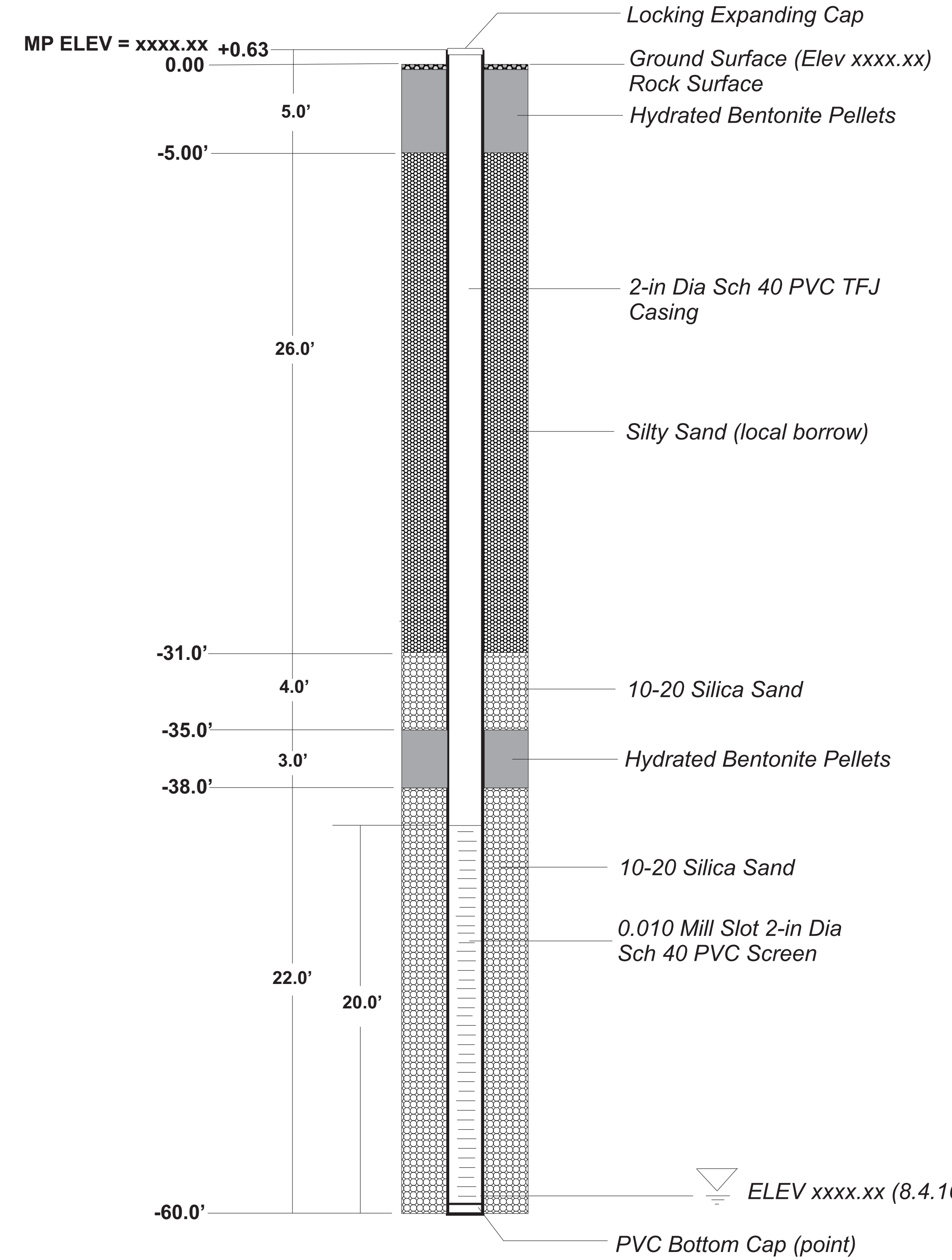
DEPTH	HOUR	DATE
59.66(a)	0848	8.4.16
60.67(b)	1430	8.6.16
None		9.14.16

(a) Below TOC (see NOTE 1)
(b) Below TOC (see NOTE 2)

LOGGED BY	L Coons
DRILLER	EDI; J Aguirre
DATE COMPLETED	8.4.16
RIG/BORING TYPE	CME 75 - HSA
SURFACE ELEVATION	
PROJECT	Lisbon Tailing Charcterization
PROJECT NUMBER	RIOAL.M001.LISBON Task F-4.2
LOCATION	Lower Tailing Impoundment

PIEZOMETER

LTZ-1



NOTES

1. Measured following well completion
2. Measured following bailing on 8.5.16
3. Geotechnical laboratory analyses:
   - DBS&A (cover samples)
   - Advanced Terra Testing (tailing samples)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110

Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-1. Boring Log and Piezometer Completion Detail - LTI-1

DATE:	REV:	BY:	SCALE:
12 Sep 16	(1) 8 Dec 16	LMC	NA

FILE: S:\ABQ\RIO-Lisbon-Engineering\Cover Assessment\Characterization\BoringLogs\LTB-1F.cdr

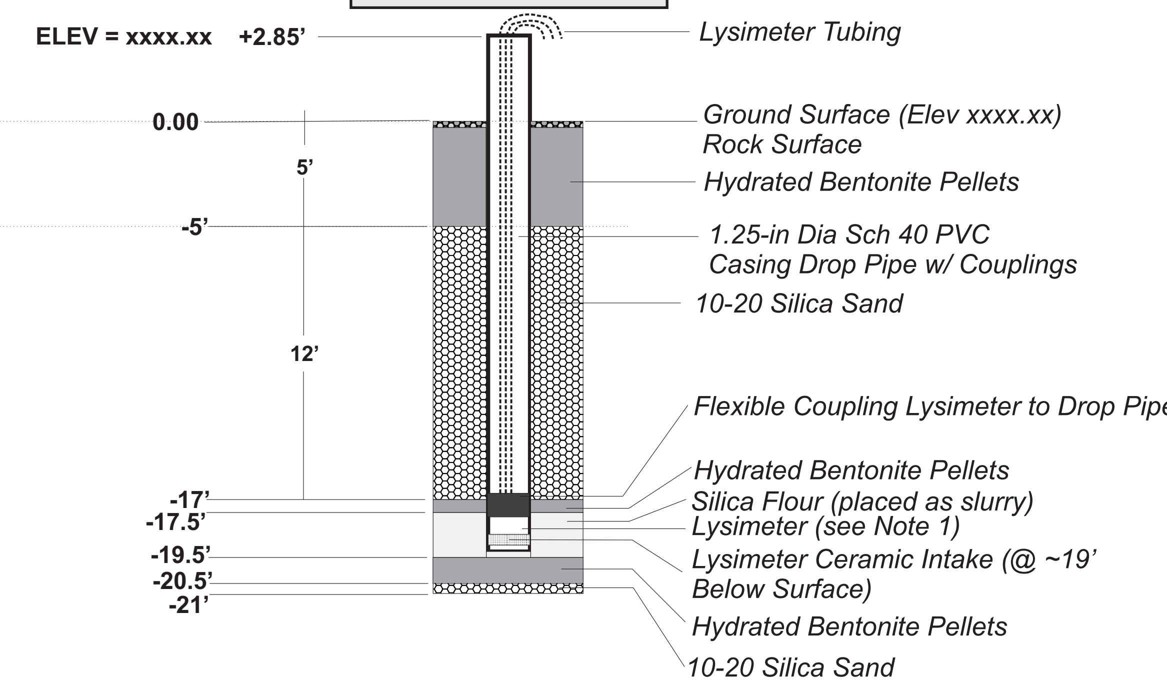
SOIL BORING LOG

LTB - 2

Depth (ft)	Clock Time	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	Lab Unified Soil Classification	Comments	Visual Field Classification
											Surface: 1/2" - 2" dia crushed limestone rock (3-1/2" thick)
0	0900		r	7,20	103.7	1.2E-4	14.5	8.7	CL s	Moderately firm to firm	Cover Fill: Clay; fine sandy; reddish brown (2.5YR5/3) w/ 2-5% white inclusions; dry
			r	15,21						Very firm; Gamma 10-12K cpm	
			r	11,20	103.8		23.1	13.9	CH		Cover Fill: Clay; gray (7.5YR5/1) w/ 5-10% yellow to rust inclusions; dry to s. moist
			r	16,26	114.4	3.2E-5	25.0	13.6	s CL		
5	0928		r	13,13	84.5		16.8	12.4	SC	Weathered sandstone; dark reddish brown (2.5YR3/4)	Cover Fill: Sand; v. fine, silty w/ clay; reddish brown (2.5YR5/4); 10-15% whit to pink inclusions; dry to s. moist
			r	8,7							
			r, A	3,4	87.6		51.4	36.6	CL s	Soft; Gamma 45K cpm	Tailing Fill: Clay; fine sandy; pinkish gray (7.5YR6/2); moist
10	0940		r, A	3,3						Soft; Gamma 18K cpm	Tailing Fill: Sand; fine w/ clay; gray (10YR5/1); moist
15	0951		r, A	6,4	100.5	9.4E-7	41.7	25.9	CL	Soft to moderately firm; Gamma 50K cpm	
20	0959		r	9,22						Firm; Gamma 11-12K cpm	Sand; fine, silty; reddish brown (5YR4/4); moist
										TD @ 21' w/ sampler	
25											
30											
35											
40											
45											
50											
55											
60											

LYSIMETER

LTY-2



SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		

LOGGED BY	L Coons
DRILLER	EDI; J Aguirre
DATE COMPLETED	8.6.16
RIG/BORING TYPE	CME 75 - HSA
SURFACE ELEVATION	
PROJECT	Lisbon Tailing Characterization
PROJECT NUMBER	RIOAL.M001.LISBON Task F-4.2
LOCATION	Lower Tailing Impoundment

NOTES:
1. Soil Measurement Systems dual chamber 2" OD, 3 outlet lysimeter and related tubing
2. Geotechnical laboratory analyses:
   - DBS&A (cover samples)
   - Advanced Terra Testing (tailing samples)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-2. Boring Log and Piezometer Completion Detail - LTI-2

DATE:	REV:	BY:	SCALE:
7 Sep16	(1) 8 Dec 16	LMC	NA

FILE: *S:\ABQ\RIO-Lisbon-Engineering\Cover Assessment\Characterization\BoringLogs\LTB-2F.cdr*

INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

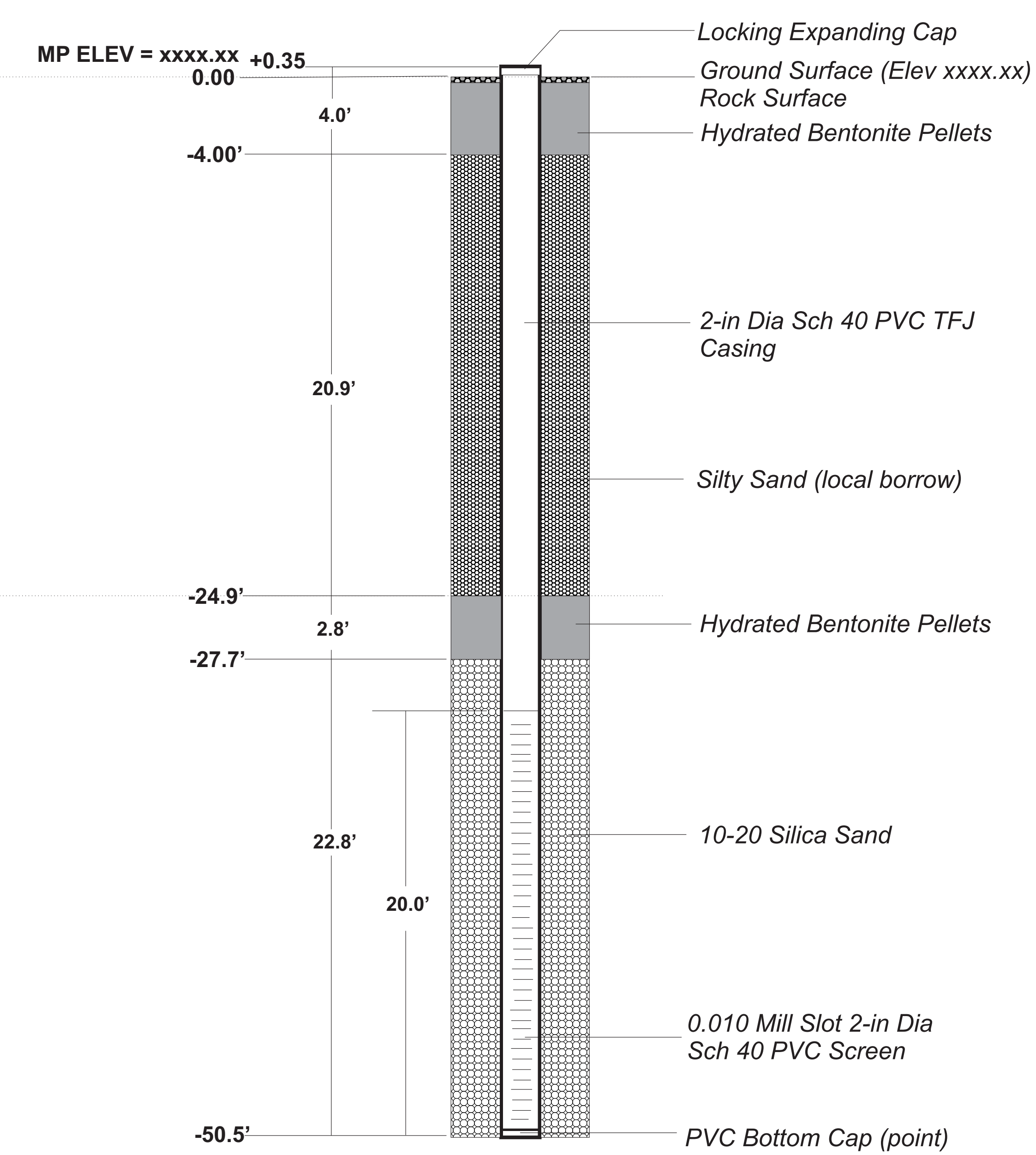
SOIL BORING LOG

UTB - 1

Depth (ft)	Clock Time	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	Lab Unified Soil Classification	Comments	Visual Field Classification
0	1108									Surface: 1/2" - 2" dia crushed limestone rock (3" thick)
		r	3,9	109.3	3.4E-7	26.4	15.1	CL s	Soft	Cover Fill: Clay; v. fine sandy; dark reddish brown (2.5YR3/3) w/ 2-5% gray and light pink inclusions; moist
		r	3,5	99.1		36.1	22.7	CL s		Cover Fill: Clay; silty, v. fine sandy; mottled reddish brown (2.5YR4/3) and gray (7.5YR/5/1) w/ 2-5% yellow to rust inclusions; moist
		r	6,13	107.8	5.2E-8	31.6	18.3	CH	Gamma 8-9K cpm	
		r	12,16	108.5	4.0E-7	14.2	8.2	SC		Cover Fill: Sand; v. fine, clay/silty; mottled gray (7.5YR/5/1) to reddish brown (2.5YR4/3); s. moist
5	1128	r	16,16	113.1		28.3	15.6	CL s		
		A							Gamma 30K cpm	Tailing Fill: Clay; fine sandy; grayish brown (10YR5/2); moist
10	1150	r / A	3,4	101.6		43.1	26.5	CL s	Soft; moist to v. moist; Gamma 42K cpm	
15	1157	r / A	4,6	102.1		39.1	23.9	CL s	Gamma 49K cpm	Tailing Fill: Sand; v. fine, silty; gray (7.5YR5/1); moist
20	1205	r / A	2,2	104.5		41.5	24.8	CL	Very soft; Gamma 66K cpm	Tailing Fill: Clay; silty; dark gray (7.5YR4/1) to black; moist to very moist
25	1214	r / A	2,3						Gamma 59K cpm	
30	1221	r / A	2,5	106.3	3.9E-7	39.1	22.9	CL s	Gamma 70K cpm	Tailing Fill: Clay; very fine sandy; black; moist
35	1239	r / A	1,3	108.4		37.6	21.7	CL	Very soft; Gamma 79K cpm	Tailing Fill: Clay; silty; dark gray (7.5YR4/1) to black; moist
40	1250	r / A	2,4						Gamma 84K cpm	Tailing Fill: Clay; very fine sandy/silty; greenish gray (GLEY-2/5/10G); moist to v. moist
45	1420	r / A	2,4	106.3	3.4E-7	38.8	22.8	CL	Gamma 75K cpm	Tailing Fill: Clay; silty; dark gray (7.5YR4/1) to black; v. moist to wet
50	1438		8,50+	113.1	4.0E-7	28.3	15.6	SM	TD @ 51' w/ sampler	Sandstone; v. fine to fine; silty; red (7.5R/5/8); s. moist; weathered
55										
60										

PIEZOMETER

UTZ-1



SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		8.4.16
None		8.6.16
None		9.14.16

LOGGED BY: L Coons
DRILLER: EDI; J Aguirre
DATE COMPLETED: 8.4.16
RIG/BORING TYPE: CME 75 - HSA
SURFACE ELEVATION:
PROJECT: Lisbon Tailing Characterization
PROJECT NUMBER: RIOAL.M001.LISBON Task F-4.2
LOCATION: Lower Tailing Impoundment

NOTES
1. Geotechnical laboratory analyses:
- DBS&A (cover samples)
- Advanced Terra Testing (tailing samples)

INTERA GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-3. Boring Log and Piezometer Completion Detail - UTI-1

DATE:	REV:	BY:	SCALE:
1 Sep16	(1) 8 Dec 16	LMC	NA

FILE: S:\ABQ\RIO-Lisbon-Engineering\Cover Assessment\Characterization\BoringLogs\UTB-1F.cdr

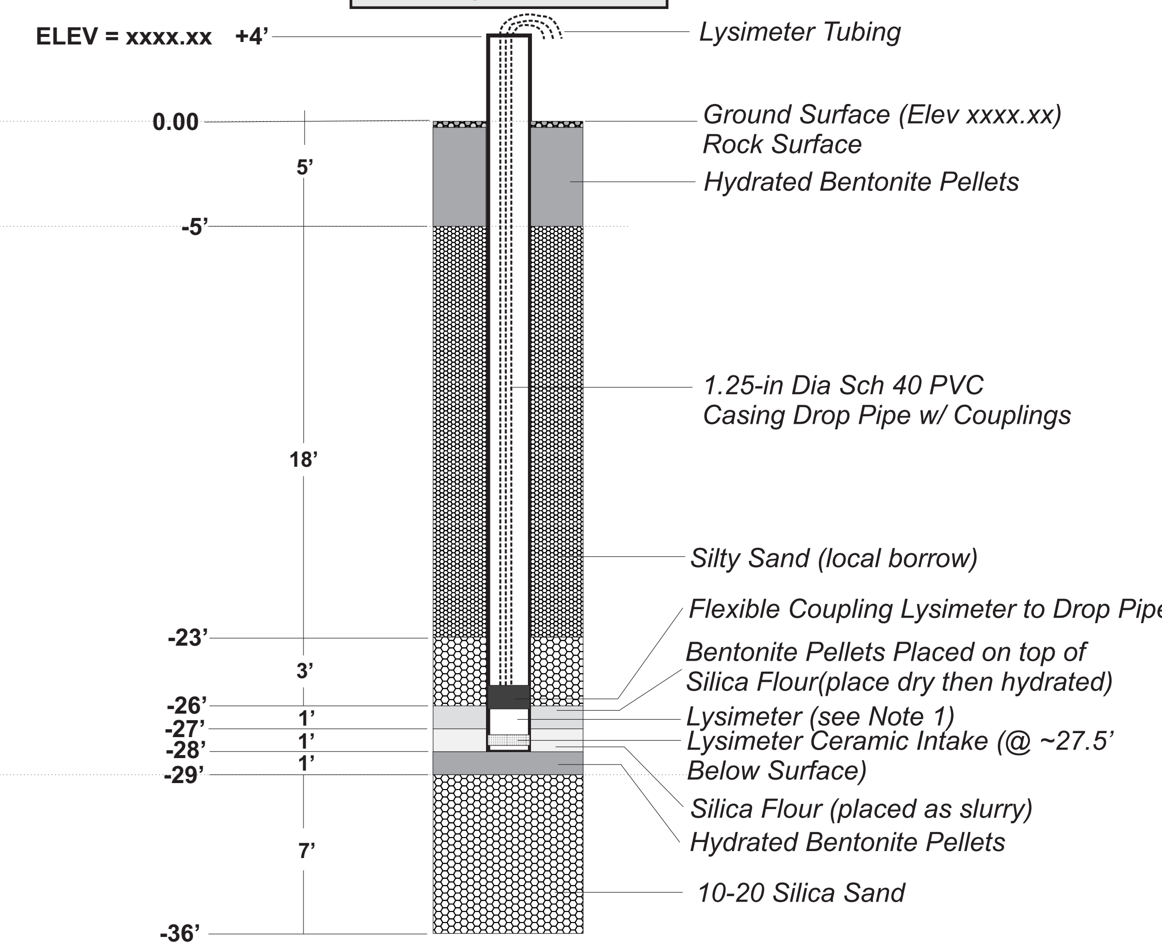
INTERA GEOSCIENCE & ENGINEERING SOLUTIONS

SOIL BORING LOG

UTB - 2

Depth (ft)	Clock Time	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	Lab Unified Soil Classification	Comments	Visual Field Classification
											Surface: 1/2" - 2" dia crushed limestone rock (3" thick)
0	0915	X	r	4,15	99.2	2.5E-6	25.8	16.2	s CL	Firm to very firm	Cover Fill: Clay; fine sandy; reddish brown (2.5YR5/4) w/ 10-15% white inclusions; moist surface to 0.3' then dry to s. moist to 1.0'
		X	r	17,12	104.7		28.0	16.7	s CL	Gamma 8-9K cpm	
		X	r	7,8	101.4	1.4E-5	30.5	18.8	CL s		Cover Fill: Silty clay/clayey silt; gray (5YR6/1) w/ 2-5% yellow to rust inclusions; moist
		X	r	5,11	99.0	6.7E-6	31.1	19.6	s CL		
5	0941	X	r	22,14						Weathered sandstone; dark reddish brown (2.5YR3/4)	Cover Fill: Silty clay/clayey silt; dark reddish brown (2.5YR3/4); 2-5% gray inclusions s. moist
		X	r / A	7,7						Moderately firm; Gamma 96K cpm	Tailing Fill: Clay; fine sandy; brown (7.5YR4/2); moist to v. moist
10	1007	X	r / A	4,4					CL s	Soft; moist to v. moist; Gamma 23K cpm	
15	1015	X	r / A	6,6	107.5		36.7	21.3	CL s	Moderately firm; Gamma 82K cpm	
20	1027	X	r / A	3,4				22.9	CL s	Soft; Gamma 38K cpm; brown (7.5YR5/3)	
25	1040	X	r / A	2,5	96.6		43.9	28.4	CL s	Soft; Gamma 88K cpm	Tailing Fill: Clay; silty, fine sandy; gray (10YR5/3); moist to v. moist
30	1047	X	r / A	4,12	108.3		37.4	21.6	CL s	Moderately firm to firm; Gamma 68K cpm; fibrous to 1/8" root @31'	Tailing Fill: Clay; silty, v. fine sandy dark grey (2.5Y4/1) to black; moist to v. moist
35	1104	X	r	11,11							
		X	r	9,11	111.1	6.7E-6	23.6	13.3	ML s	TD @ 37' w/ sampler	Sand; v. fine, silty; dark reddish brown (5YR3/3); s. moist
40											
45											
50											
55											
60											

LYSIMETER
UTY-2



SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		

LOGGED BY **L Coons**
DRILLER **EDI; J Aguirre**
DATE COMPLETED **8.5.16**
RIG/BORING TYPE **CME 75 - HSA**
SURFACE ELEVATION
PROJECT **Lisbon Tailing Characterization**
PROJECT NUMBER **RIOAL.M001.LISBON Task F-4.2**
LOCATION **Lower Tailing Impoundment**

NOTES:

1. Soil Measurement Systems dual chamber 2" OD, 3 outlet lysimeter and related tubing
2. Geotechnical laboratory analyses:
   - DBS&A (cover samples)
   - Advanced Terra Testing (tailing samples)

INTERA GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-4. Boring Log and Piezometer Completion Detail - UTI-2

DATE:	REV:	BY:	SCALE:
7 Sep16	(1) 8 Dec 16	LMC	NA

FILE: *S:\ABQ\RIO-Lisbon-Engineering\Cover Assessment\Characterization\BoringLogs\UTB-2F.cdr*

Table 2. Summary of Geotechnical Testing Laboratory Results for Tailing Impoundment Cover Samples

Geotechnical Investigation Report

Rio Algom Mining, LLC Lisbon Utah Facility, Upper and Lower Tailing Impoundments, San Juan County, Utah

Sample ID [a]	Sample Type [b]	Moisture Content		Dry Density (pcf) [c]	Placticity Index	Ksat (cm/s) [d]	USCS Classification	USCS Description	Porosity (%)	Saturation (%)	Unsaturated Hydraulic Properties				
		Grav (%)	Vol (%)								Kunsat @ m % [e]	α (cm^{-1})	N	Θ_r (% vol)	Θ_s (% vol)
LTB-1															
0"-12"	A	15.5	NA	NA	11	NA	sCL	Sandy lean clay	NA	NA					
12"-18"	r	18.7	32.4	108.4	14	5.3E-07	sCL	Sandy lean clay	34.5	94.1	2.0E-08	0.0023	1.2256	0	34.38
18"-24"	r	18.2	32.2	110.7	11	NA	sCL	Sandy lean clay	33.1	97.4					
30"-36"	r	17.3	30.5	109.8	12	NA	sCL	Sandy lean clay	33.7	90.6					
42"-48"	r	19.5	32.2	103.2	11	NA	sCL	Sandy lean clay	37.6	85.5					
54"-60"	r	21.9	35.5	101.2	10	NA	sCL	Sandy lean clay	38.8	91.4					
66"-72"	r	23.4	38.2	102.1	12	1.9E-06	sCL	Sandy lean clay	38.3	99.9					
8.5'-9'	r	30.7	45.1	91.6	12	NA	CLs	Lean clay with sand	44.7	100.9					
13.5'-14'	r	42.5	51.4	75.4	12	NA	sCL	Sandy lean clay	54.4	94.4					
LTB-2															
0"-6"	A	15.7	NA	NA	12	NA	CLs	Lean clay with sand	NA	NA					
6"-12"	r	8.7	14.5	103.7	11	1.2E-04	CLs	Lean clay with sand	37.3	38.9	7.5E-11	0.0066	1.2139	0	36.82
12"-18"	A	10.2	NA	NA	13	NA	CL	Lean clay	NA	NA					
30"-36"	r	13.9	23.1	103.8	28	-	CH	Fat clay	37.2	62					
42"-48"	r	13.6	25.0	114.4	14	3.2E-05	sCL	Sandy lean clay	30.8	81.1					
54"-60"	r	12.4	16.8	84.5	9	-	SC	Clayey sand	49.0	34.4					
UTB-1															
0"-6"	A	15.2	NA	NA	20	NA	sCL	Sandy lean clay	NA	NA					
6"-12"	r	15.1	26.4	109.3	14	3.7E-07	CLs	Lean clay with sand	33.9	77.8					
12"-18"	A	13.4	NA	NA	13	NA	sCL	Sandy lean clay	NA	NA					
18"-24"	r	22.7	36.1	99.1	22	NA	CLs	Lean clay with sand	40.1	90.0					
24"-30"	A	18.3	NA	NA	15	NA	CLs	Lean clay with sand	NA	NA					
30"-36"	r	18.3	31.6	107.8	36	5.2E-08	CH	Fat clay	34.9	90.7	4.0E-10	0.0005	1.2638	0	38.52
36"-42"	A	10.3	NA	NA	29	NA	GC	Clayey gravel	NA	NA					
42"-48"	r	8.2	14.2	108.5	11	NA	SC	Clayey sand	34.4	41.3					
4'-4.5'	A	20.7	NA	NA	29	NA	CLs	Lean clay with sand	NA	NA					
50.5'-51'	r	15.6	28.3	113.1	NA	4.0E-07	SM	Silty sand	31.6	89.4					
UTB-2															
0"-6"	A	11.3	NA	NA	NA	NA	sMLg	Sandy silt with gravel	NA	NA					
6"-12"	r	16.2	25.8	99.2	21	2.5E-06	sCL	Sandy lean clay	40	64.5					
18"-24"	r	16.7	28.0	104.7	10	NA	sCL	Sandy lean clay	36.7	76.4					
30"-36"	r	18.8	30.5	101.4	26	1.4E-05	CLs	Lean clay with sand	38.7	78.8	1.8E-08	0.0046	1.2033	0	40.46
42"-48"	r	19.6	31.1	99.0	22	NA	sCL	Sandy lean clay	40.2	77.4					
36.5'-37'	r	13.3	23.6	111.1	NA	6.7E-06	MLs	Silt with sand	32.8	71.9					

Notes: See Appendix E for complete laboratory report by Daniel B Stephens & Associates, Inc.; NA = not analyzed

[a] LTB = Lower Tailing Boring; UTB = Upper Tailing Boring (See **Figure 2** for locations).

[b] r=ring sample; A = bulk auger sample

[c] pcf = pounds per cubic foot

[d] Saturated Hydraulic Conductivity (centimeters per second)

[e] Unsaturated hydraulic conductivity (centimeters per second) at in-place volumetric moisture content

Table 3. Summary of Geotechnical Testing Laboratory Results for Tailing Impoundment Tailing Samples

Geotechnical Investigation Report

Rio Algom Mining, LLC Lisbon Utah Facility, Upper and Lower Tailing Impoundments, San Juan County, Utah

Sample ID [a]	Sample Type	Moisture Content		Dry Density (pcf) [c]	Plasticity Index	Ksat (cm/s) [d]	USCS Classification	USCS Description	Porosity (%)	Saturation (%)	Unsaturated Hydraulic Properties				
		Grav (%)	Vol (%)								Kunsat @ m % [e]	α (cm^{-1})	N	Θ_r (% vol)	Θ_s (% vol)
LTB-1															
20.5'-21'	r	25.1	41.7	103.5	26	**4.9E-07**	CL	Lean Clay			1.0E-07	0.0005	1.3268	0	0.42
25.5'-26'	r	24.0	40.1	104.3	14		CL	Lean Clay							
30.5'-31'	r	21.8	37.4	107.0	11		CL	Lean Clay							
35.5'-36'	r	32.7	51.1	97.6	12		CL	Lean Clay							
40.5'-41'	r	23.5	38.8	102.8	4	3.7E-05	ML	Silt	39	99.5					
50.5'-51'	r	15.6	26.4	105.7	15		CL	Lean Clay							
55.5'-56'	r	21.4	37.2	108.5	12		CL	Lean Clay							
60.5'-61'	r	20.5	35.5	107.8	12	2.4E-07	CL	Lean Clay with Sand	36.6	97					
LTB-2															
6.5'-7'	r	36.6	51.4	87.6	27		CL	Lean Clay with Sand							
15.5'-16'	r	25.9	41.7	100.5	23	9.4E-07	CL	Lean Clay	40.2	96.4					
UTB-1															
10.5'-11'	r	26.5	43.1	101.6	14		CL	Lean Clay with Sand							
15.5'-16'	r	23.9	39.1	102.1	12		CL	Lean Clay with Sand							
20.5'-21'	r	24.8	41.5	104.5	23	**4.9E-07**	CL	Lean Clay			2.8E-08	0.0006	1.2555	0	0.44
30.5'-31'	r	22.9	39.1	106.3	11	3.9E-07	CL	Lean Clay with Sand	37.3	95.4					
35.5'-36'	r	21.7	37.6	108.4	12		CL	Lean Clay							
45.5'-46'	r	22.8	38.8	106.3	10	3.5E-07	CL	Lean Clay	38.1	98.2					
UTB-2															
10.5'-11'	A	21.8	NA	NA	16		CL	Lean Clay with Sand							
15.5'-16'	r	21.3	36.7	107.5	15		CL	Lean Clay with Sand							
20.5'-21'	A	22.9	NA	NA	15		CL	Lean Clay with Sand							
25.5'-26'	r	28.4	43.9	96.6	13		CL	Lean Clay with Sand							
30.5'-31'	r	21.6	37.4	108.3	10	**4.9E-07**	CL	Lean Clay with Sand			8.5E-09	0.0036	1.1595	0	0.40

Notes:

See **Appendix E** for complete laboratory report by Advanced Terra Testing (ATT).; NA = not analyzed

[a] LTB = Lower Tailing Boring; UTB = Upper Tailing Boring (See **Figure 2** for locations).

[b] r=ring sample; A = bulk auger sample

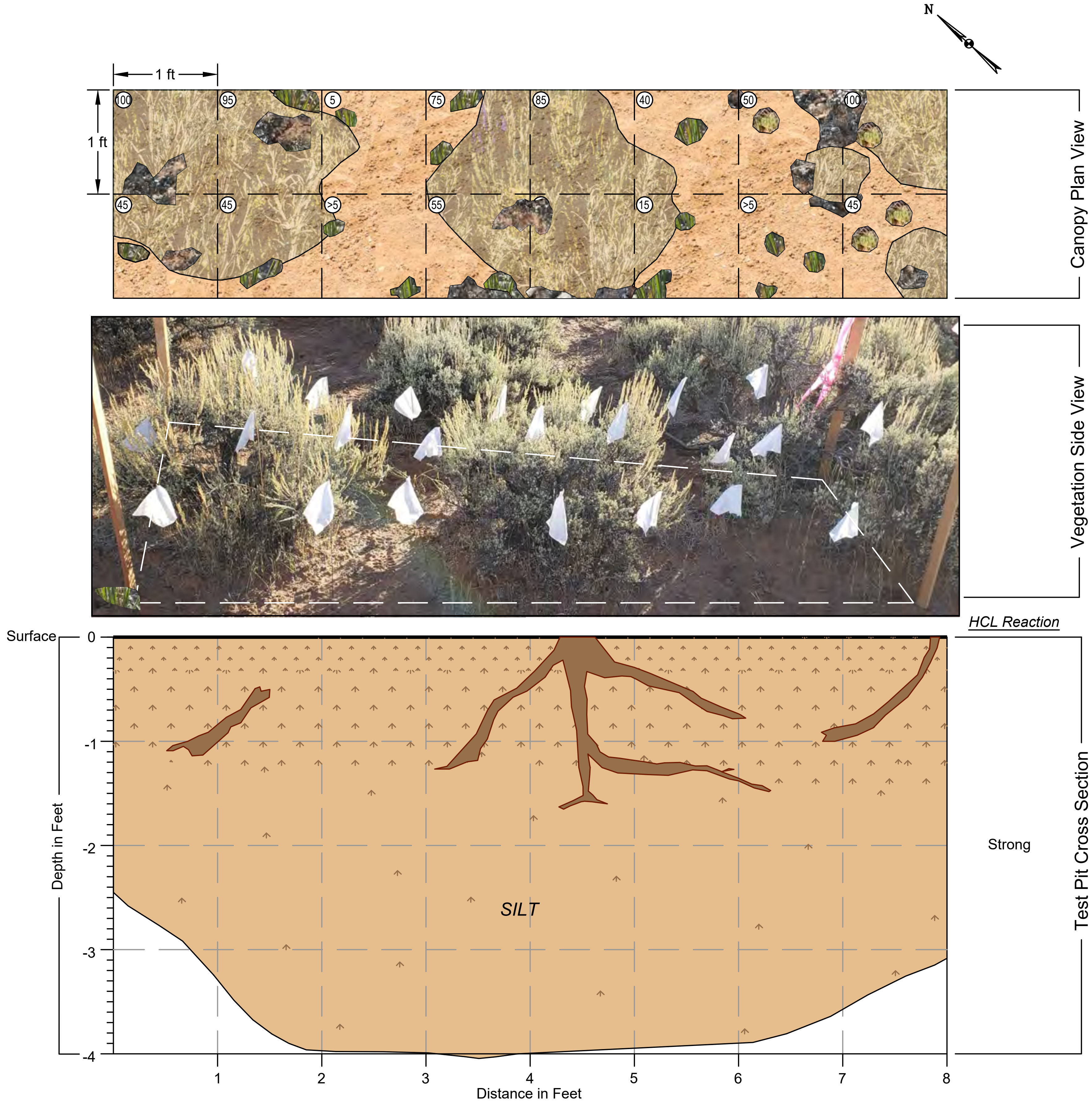
[c] pcf = pounds per cubic foot

[d] Saturated hydraulic conductivity (centimeters per second) - **bold value** is estimated (equal to arithmetic mean of other Ksat values excluding LTB-1 40.5'-41')

[e] Unsaturated hydraulic conductivity (centimeters per second) at in-place volumetric moisture content

APPENDIX B

NR-WB Test Pit Logs



Logged By: E. Woolsey & A. Tinklenberg
Project / Location: Lisbon NR / RAML North
Operator: Joseph James (DalMolin)
Surface Elevation: 6691 ft/amsl
Excavation Date: 9/28/2019
Test Pit Dimensions (L' x W' x D'): 15' x 3' x 4'
Land Use: Grazing
Slope: 2%
Vegetation Type: Sagebrush, desert moss, crested wheatgrass, prickly pear cactus
Vegetation Cover: 53%
Soil Classification: 0'-1.5' Type B, silt, dry, reddish-brown (2.5 YR 3/4)
1.5'-4' Type A, silt, dry, reddish brown (2.5 YR 4/6)

Notes:
1. Competent soil strength with high caliche content; excavation difficult below 1.25' depth

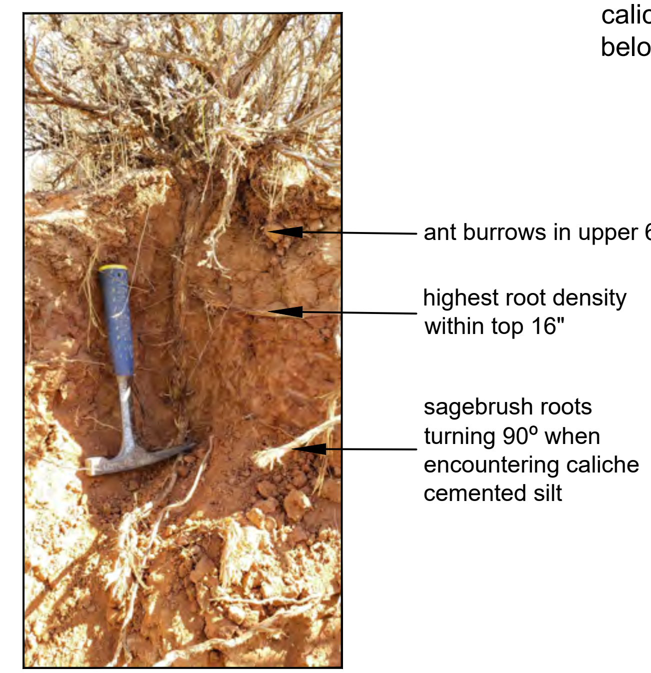
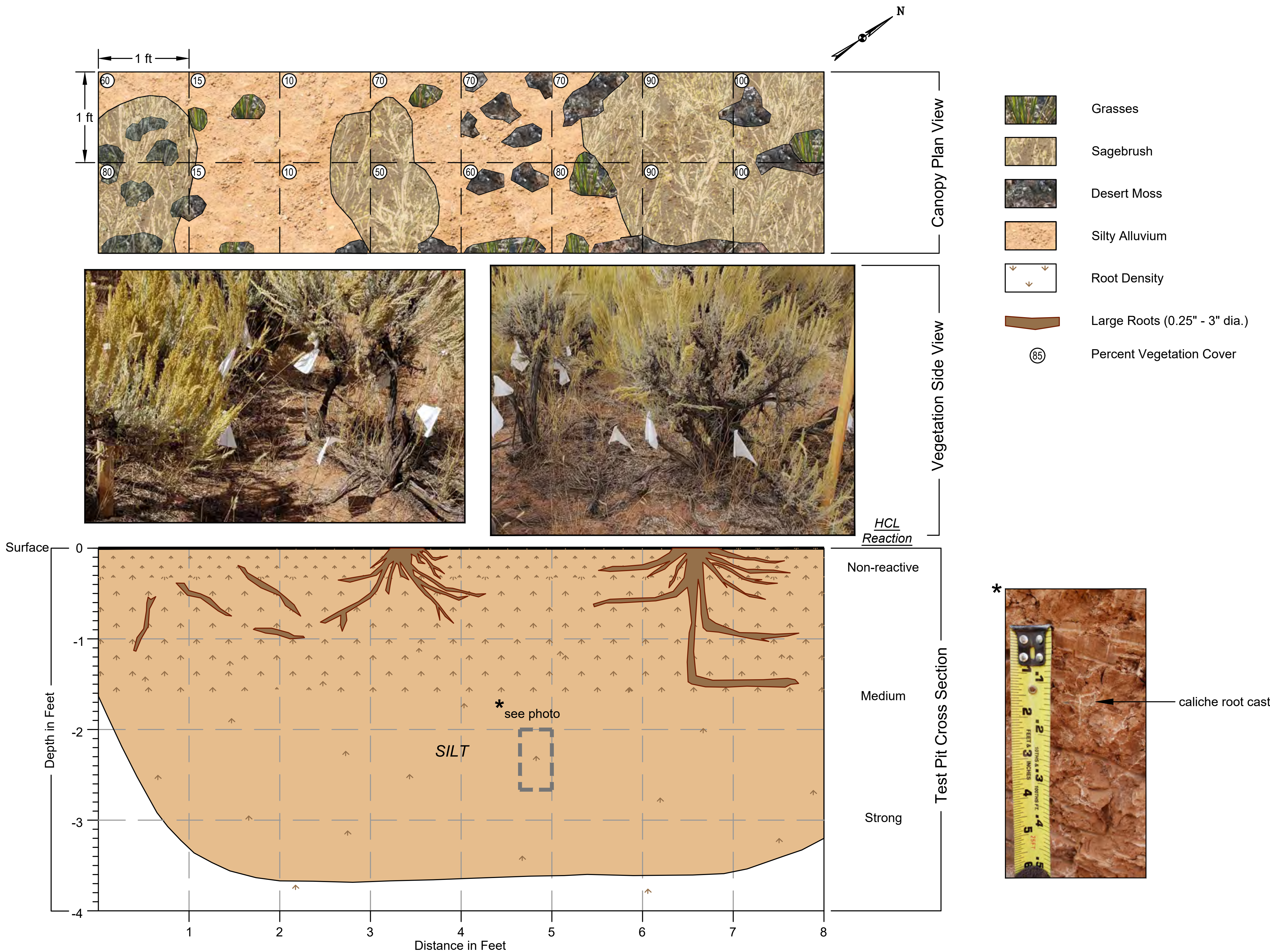


Figure B1
NR-1 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\NR1_TestPitSchematic.dwg



Logged By: E. Woolsey & A. Tinklenberg

Project / Location: Lisbon NR / BLM East

Operator: Forrest Waggoner (DalMolin)

Excavation Date: 9-29-2019

Surface Elevation: 6737 ft amsl

Test Pit Dimensions (L' x W' x D'): 12' x 3.7' x 3.5'

Land Use: Grazing, ~100' from county road

Slope: 1%

Vegetation Type: Sagebrush, desert moss, grasses (crested wheatgrass, sixweeks fescue), western stickseed, and clasping pepperweed

Vegetation Cover: 61%

Soil Classification: 0'-1.5' Type B, silt, dry, reddish-brown (2.5 YR 2.5/4)
1.5'-3.5' Type A, sandy silt w/ clay, dry, reddish-brown (2.5 YR 4/6)

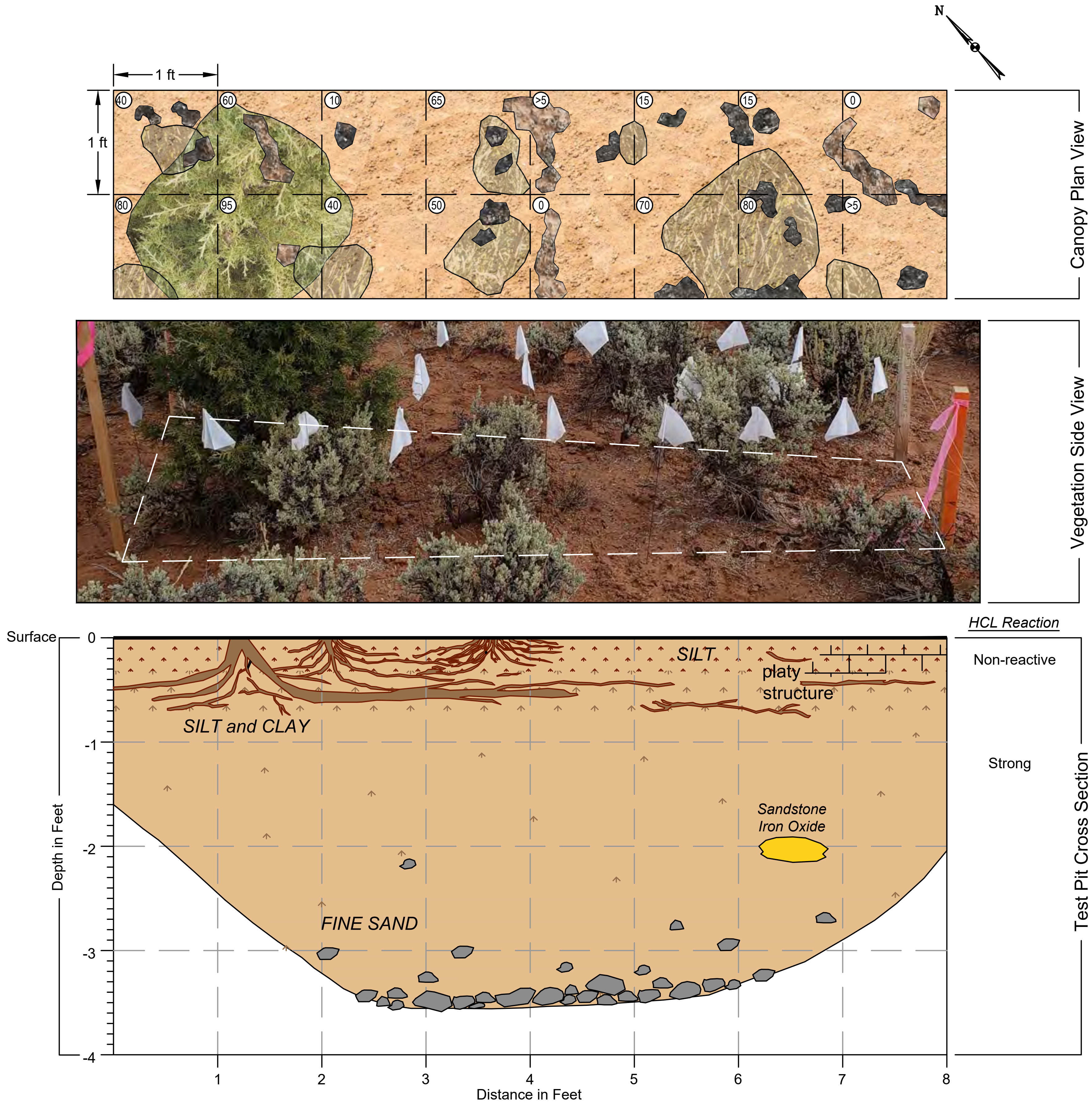
Notes:

1. Competent soil strength with high caliche content; excavation difficult below 1.5' depth

Figure B2
NR-2 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\NR2_TestPitSchematic.dwg



Juniper
Cryptobiotic Soil
Sagebrush
Desert Moss
Silty Alluvium
Root Density
Large Roots (0.25" - 3" dia.)
(85) Percent Vegetation Cover

Logged By: E. Woolsey & A. Tinklenberg
Project / Location: Lisbon NR / RAML East
Operator: Joseph James (DalMolin)
Excavation Date: 9/28/2019
Surface Elevation: 6891 ft amsl
Test Pit Dimensions (L' x W' x D'): 11' x 4.5' x 3.5'
Land Use: Grazing, hunting, top of hill
Slope: 1%
Vegetation Type: Sagebrush, juniper, desert moss, cryptobiotic soil crusts, crested wheat grass
Vegetation Cover: 39%
Soil Classification: 0"-8" Type C, silt, friable, platy structure, reddish-brown (2.5 YR 2.5/4)
8"-3.5' Type A, silt and clay with caliche, coarsening downwards to fine sand with pebbles, dry, light-grey

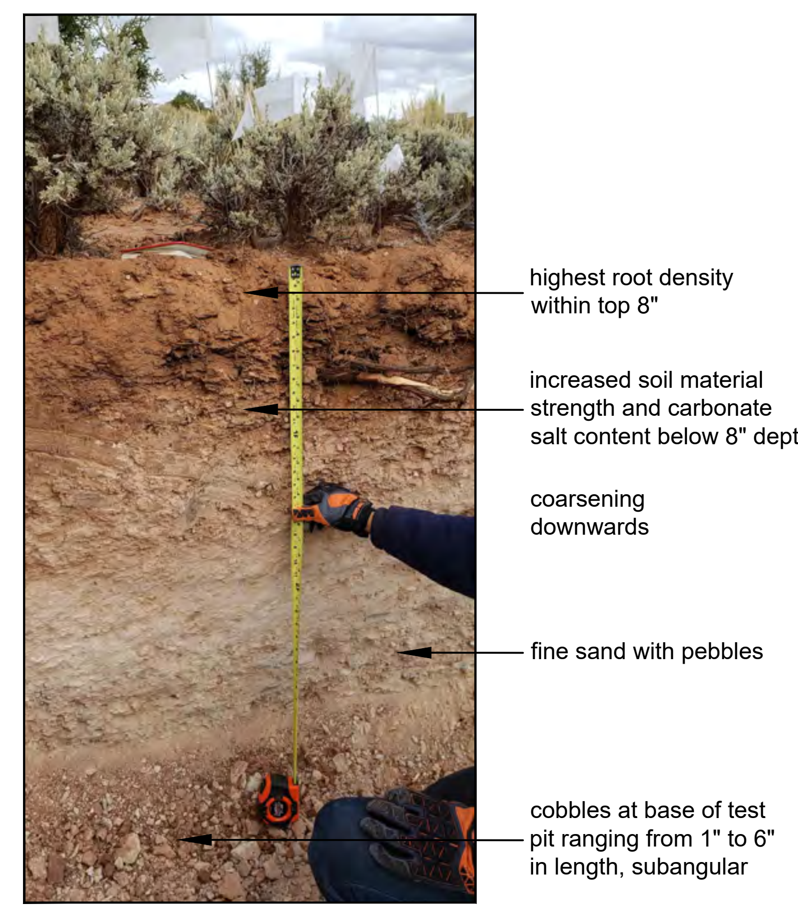
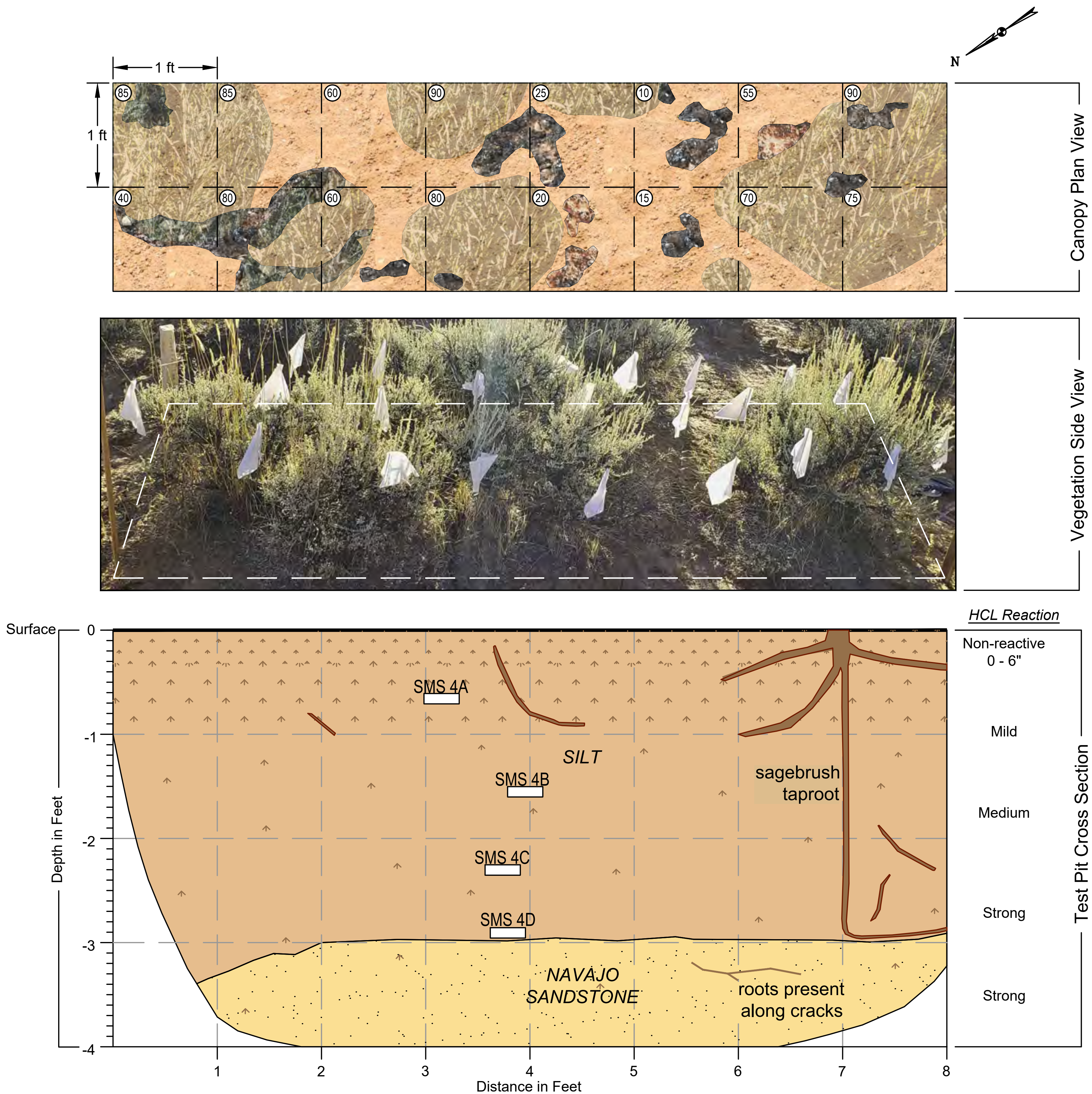


Figure B3
NR-3 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\NR3_TestPitSchematic.dwg



Cryptobiotic Soil

Sagebrush

Desert Moss

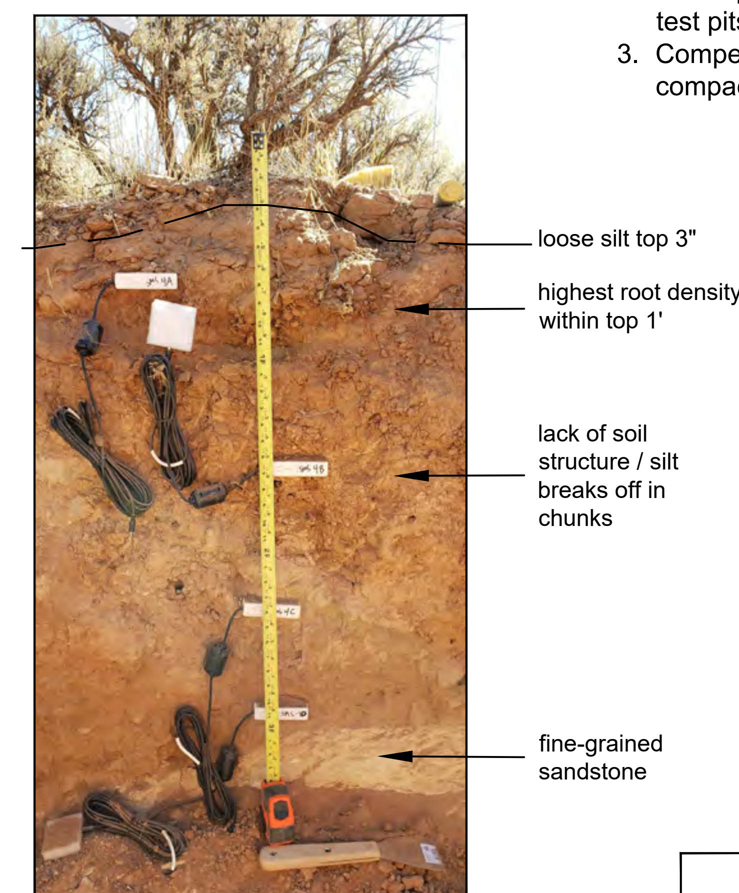
Silty Alluvium

Root Density

Large Roots (0.25" - 3" dia.)

(85) Percent Vegetation Cover

SMS Soil Moisture Sensor



Logged By: E. Woolsey & A. Tinklenberg

Project / Location: Lisbon NR / BLM West

Operator: Forest Waggoner (DalMolin)

Excavation Date: 10/1/2019

Surface Elevation: 6488 ft amsl

Test Pit Dimensions (L' x W' x D'): 12' x 4' x 4'

Land Use: Grazing

Slope: ≤ 1%

Vegetation Type: Sagebrush, grasses (sixweeks fescue and crested wheatgrass), desert moss, cryptobiotic soil crusts

Vegetation Cover: 59%

Soil Classification: 0'-3' Type B, silt, dry, reddish brown (2.5 YR 3/4); 3'-4' Type A, fine-grained sandstone, tan yellow (7.5 YR 6/6)

Notes:
1. Soil samples collected every 6" for chloride analysis
2. White carbonate salts present, but not as predominantly as other NR test pits
3. Competent soil strength, but not as compact as other NR test pits

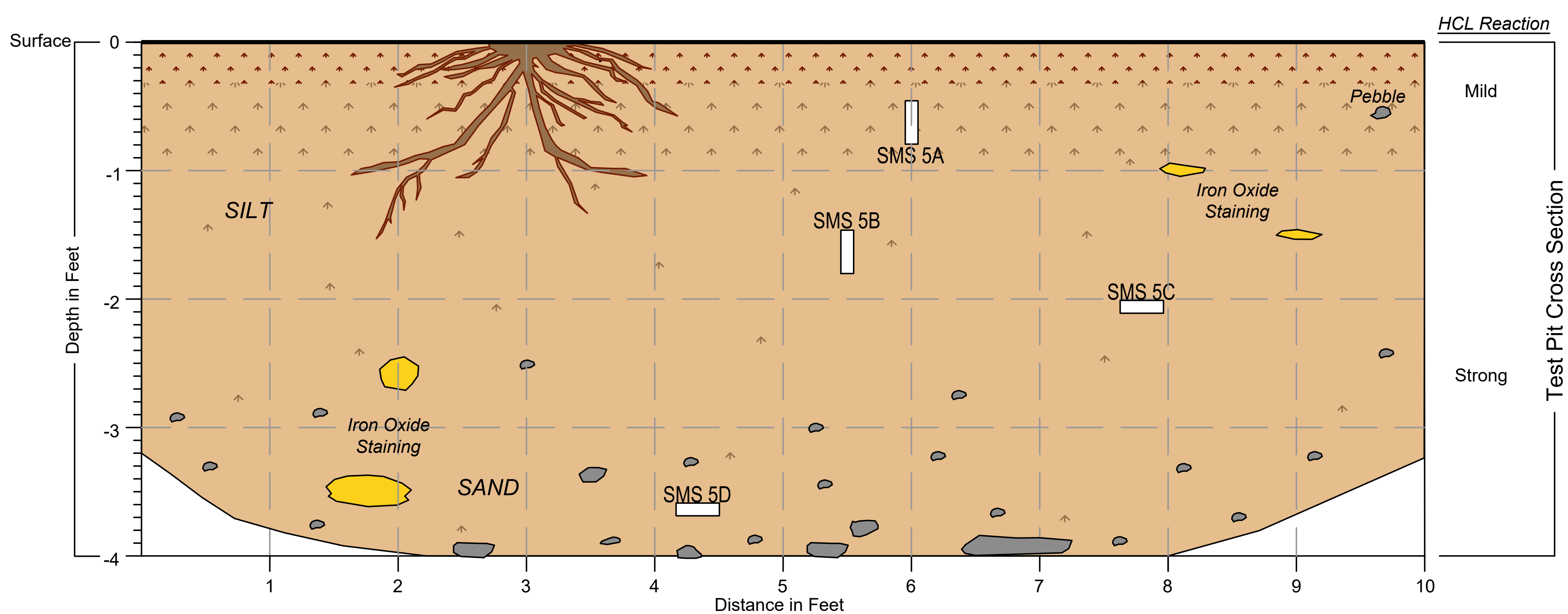
SMS Installations

SMS	Depth (in.)
A	6
B	18
C	27
D	36

Figure B4
NR-4 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\NR4_TestPitSchematic.dwg



Legend:
- Toadflax
- Rubber Rabbitbrush
- Sandbur
- Mustard
- Silty Alluvium
- Root Density
- Large Roots (</=0.25" dia.)
- (85) Percent Vegetation Cover
- SMS Soil Moisture Sensor

SMS Installations

SMS	Depth (in.)
A	6
B	18
C	25
D	43

Logged By: E. Woolsey & A. Tinklenberg

Project / Location: Lisbon NR / Rattlesnake Ranch

Operator: Joseph James and Forrest Waggoner (DalMolin)

Excavation Date: 9/28/2019

Surface Elevation: 6451 ft amsl

Test Pit Dimensions: (L' x W' x D'): 15' x 3.5' x 4'

Land Use: Intermittent grazing, prairie dog burrows, ~150 yards from Coyote Wash

Slope: 1%

Vegetation Type: Rubber rabbitbrush, sandbur, Tumble and Tansy mustard, toadflax

Vegetation Cover: 80%

Soil Classification: 0'-1' Type C, sandy silt, dry, brown (5 YR 3/4)
1'-2' Type B, sandy silt, dry, brown (5 YR 3/4)
2'-3' Type A, silt, dry, beige (7.5 YR 5/4),
3'-4' Type A, silty sand (fine to medium) with pebbles, s. moist, beige (10 YR 6/4) yellow staining in sand (2.5 Y 7/8)

Notes:
1. Beetles in rubber rabbitbrush roots

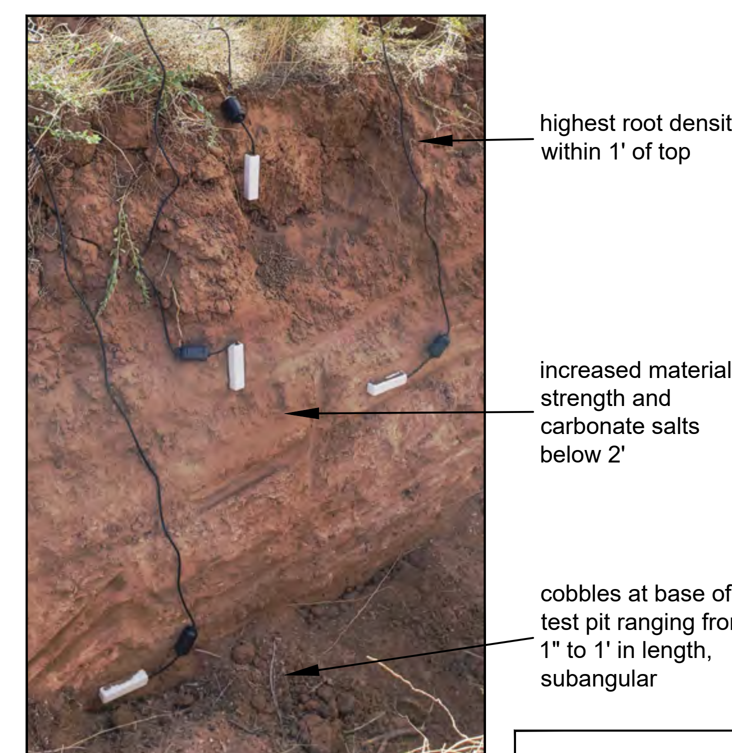
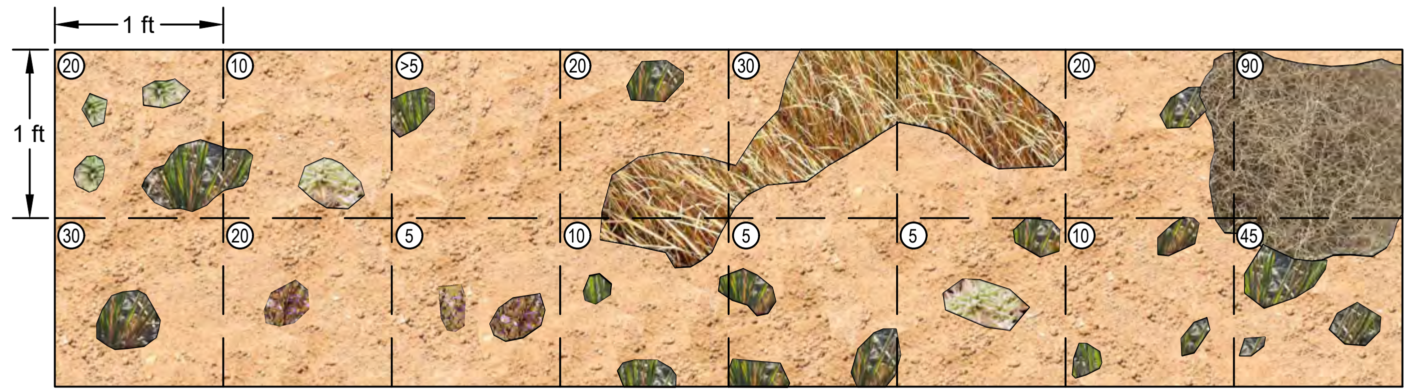


Figure B5
NR-5 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\NR5_TestPitSchematic.dwg



Canopy Plan View

Vegetation Side View

Sandbur	
Russian Thistle	
Aster	
Grasses	
Silty Alluvium	
Root Density	
Fine Roots (</=2mm dia.)	
Percent Vegetation Cover	85

Logged By: E. Woolsey & A. Tinklenberg

Project / Location: Lisbon NR / Rattlesnake Ranch

Operator: Joseph James (DalMolin)

Excavation Date: 9-27-2019

Surface Elevation: 6453 ft amsl

Test Pit Dimensions: (L' x W' x D'): 12' x 4' x 3.6'

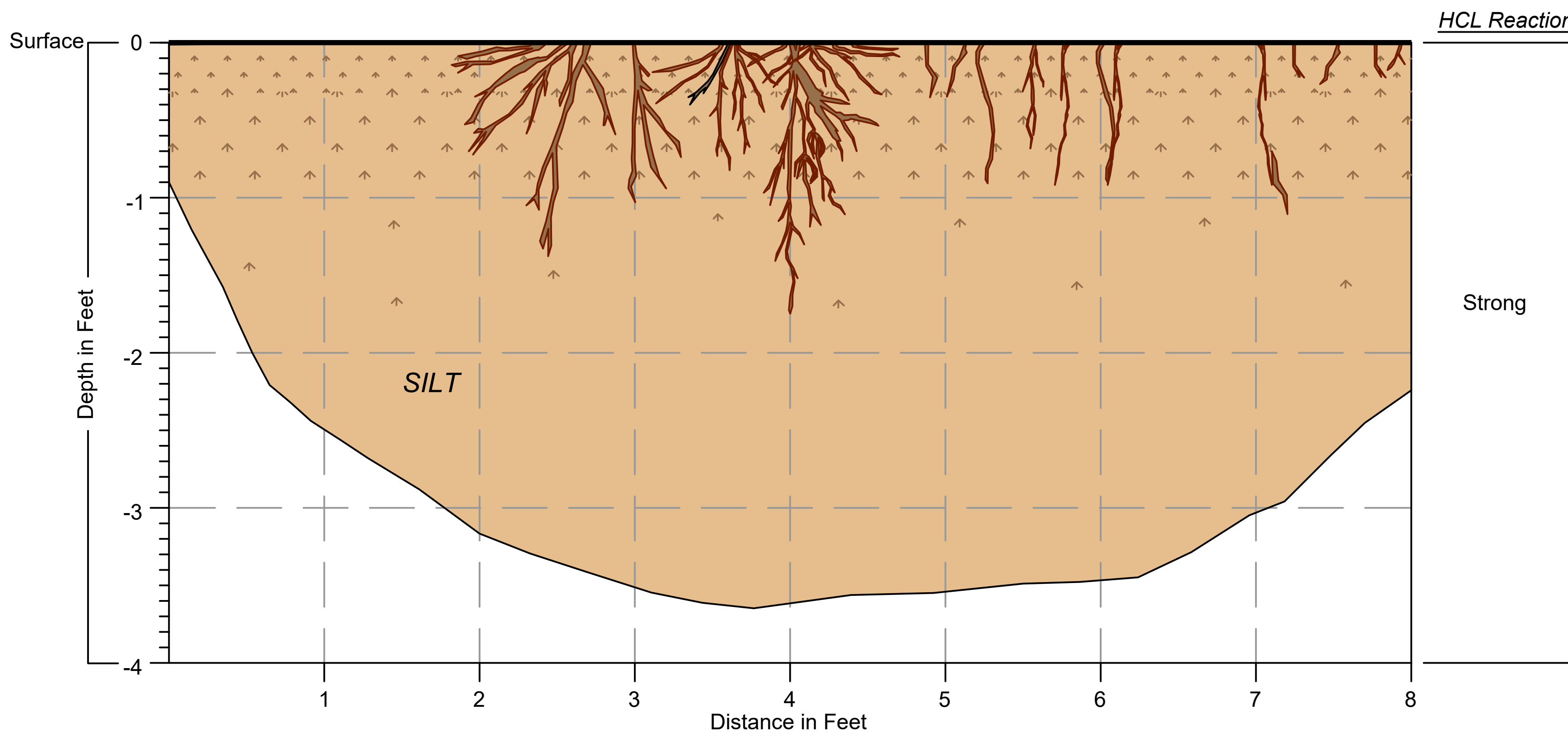
Land Use: Grazing, ~100' from county road

Slope: 1%

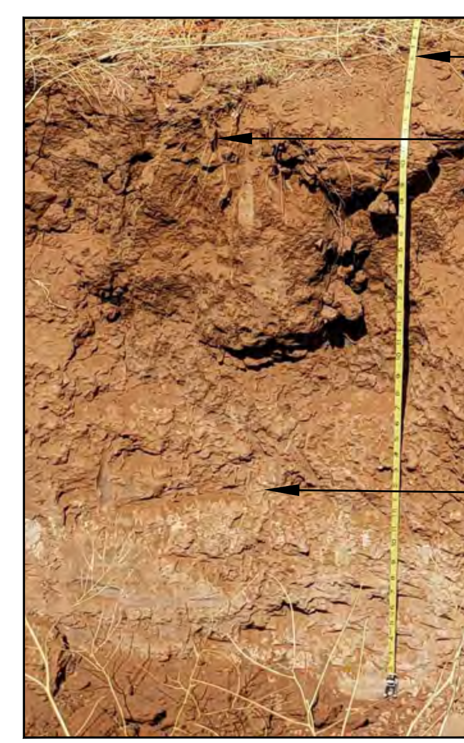
Vegetation Type: Tumble and Tansy mustard, crested wheatgrass, sandbur, Russian thistle, aster

Vegetation Cover: 22%

Soil Classification: 0'-1.75' Type B/C, silt, friable, lack of structure, dry, reddish-brown (2.5 YR 4/4)
1.75'-3.6' Type A, silt, dry, reddish-brown



Test Pit Cross Section



majority of roots originate from grass at surface that had been grazed down to 0.5"-1"

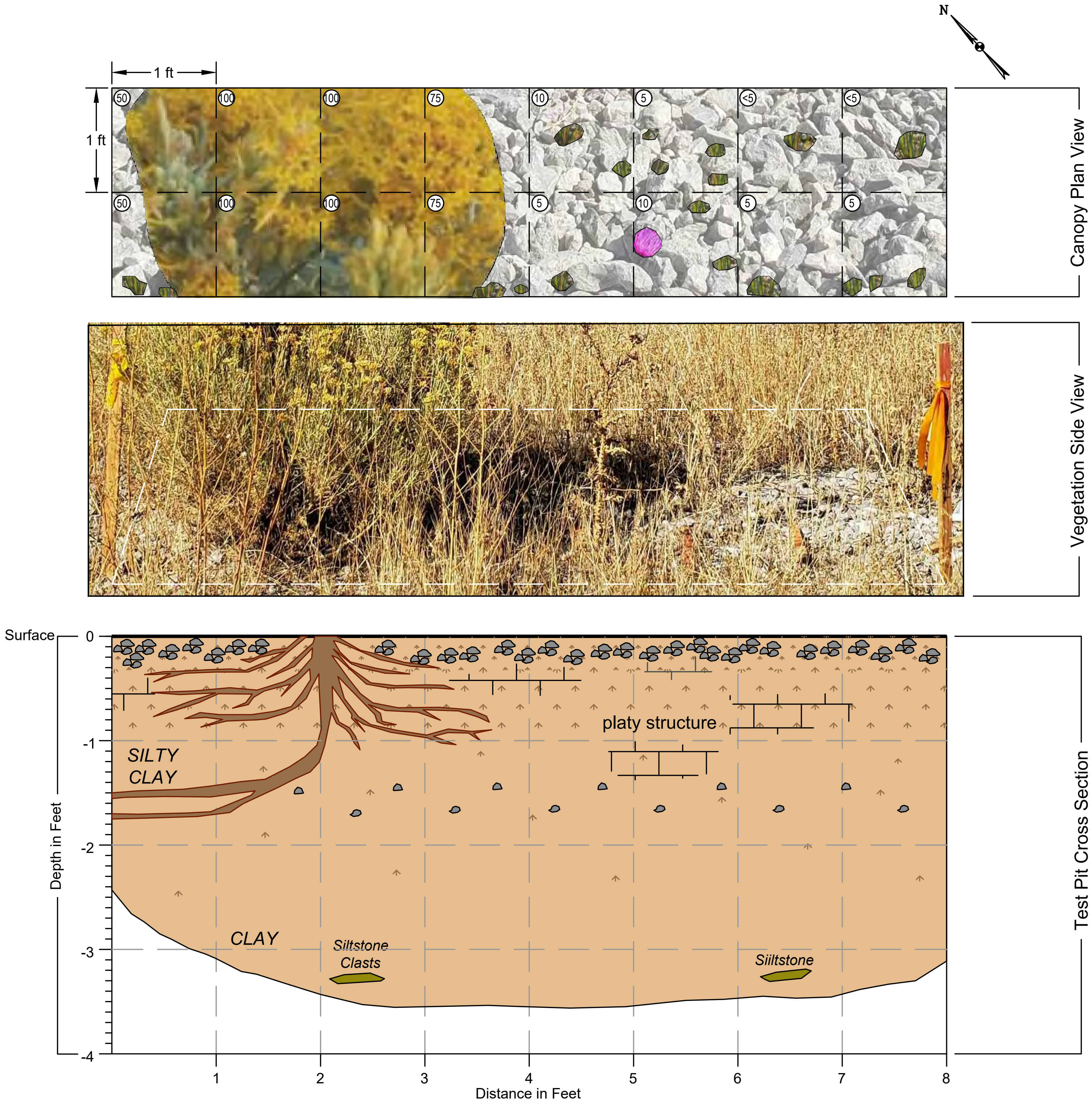
carbonate nodules and root casts

increased material strenth and carbonate salts below 20"

Figure B6
NR-6 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\NR6_TestPitSchematic.dwg



Thistle

Rubber Rabbitbush

Grasses

Gravel

Root Density

Large Roots (</=0.25" dia.)

(85) Percent Vegetation Cover

Logged By: E. Woolsey & B. Archuleta

Project / Location: Lisbon NR / Lower Tailing Impoundment

Operator: Forrest Waggoner (DalMolin)

Excavation Date: 10-4-2019

Surface Elevation: 6654 ft amsl

Test Pit Dimensions (L' x W' x D'): 9' x 2.8' x 3.6'

Land Use: Tailing Impoundment with rock cover

Slope: ≤ 1%

Vegetation Type: Rubber rabbitbrush, yellow sweetclover, thistle, grasses (Foxtail barley, wild oats, cheatgrass)

Vegetation Cover: 44%

Soil Classification: 0'-0.25' Type C, limestone gravel cover (1-3" dia.), subangular, rock weathering, grey
0.25'-0.75' Type C, silt, friable, platy structure, laminated, dry, reddish-brown
0.75'-1.5' Type A, silty clay, massive, dry, brown
1.5'-2' Type A, silty sand and gravel (≤ 0.5" dia., subangular), dry, greyish-purple with green marbling
2'-3.6' Type A, clay and mudstone with clasts of siltstone, slightly moist, variegated green and purple

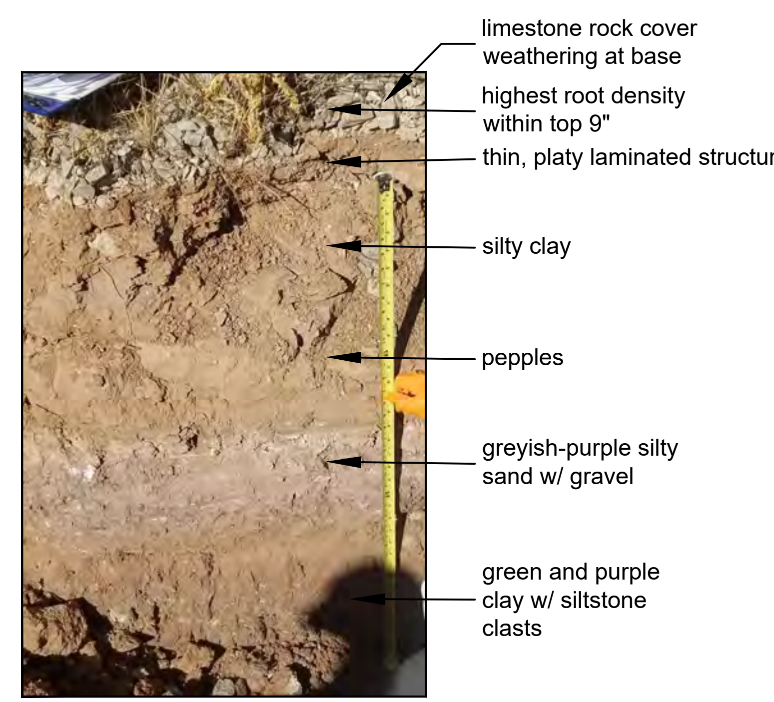
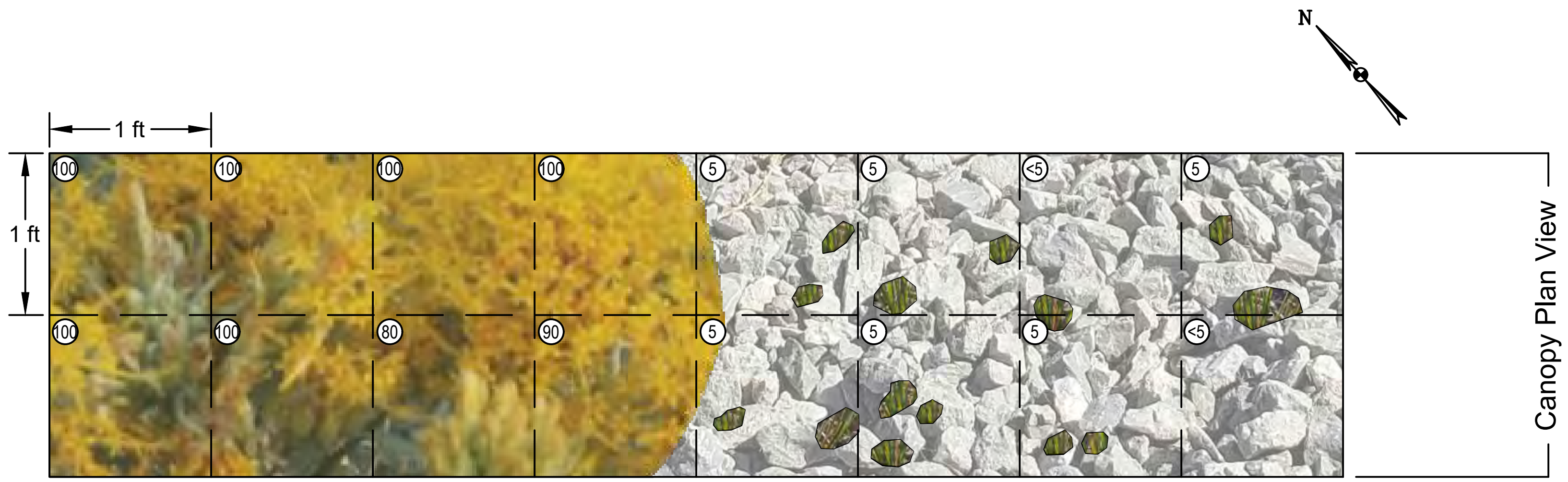


Figure B7
LT-TP1 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\LTTP1_TestPitSchematic.dwg



Rubber Rabbitbush

Grasses

Gravel

Root Density

Large Roots (</=0.25" dia.)

85 Percent Vegetation Cover

SMS Soil Moisture Sensor

Logged By: E. E. Woolsey & L. Coons

Project / Location: Lisbon NR / Lower Tailing Impoundment

Operator: Forrest Waggoner (DalMolin)

Excavation Date: 10-4-2019

Surface Elevation: 6651 ft amsl

Test Pit Dimensions (L' x W' x D')**:** 9.5' x 3.5' x 3.9'

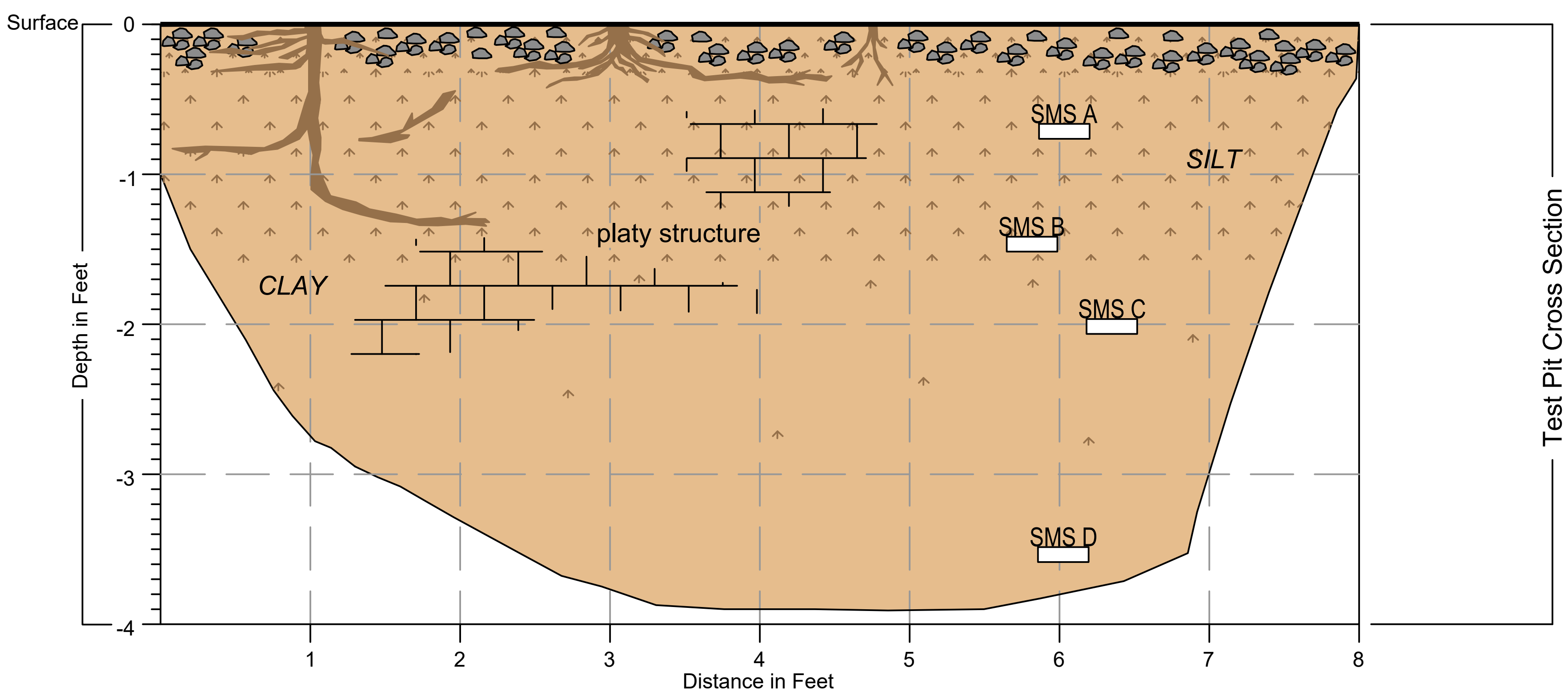
Land Use: Tailing Impoundment with rock cover

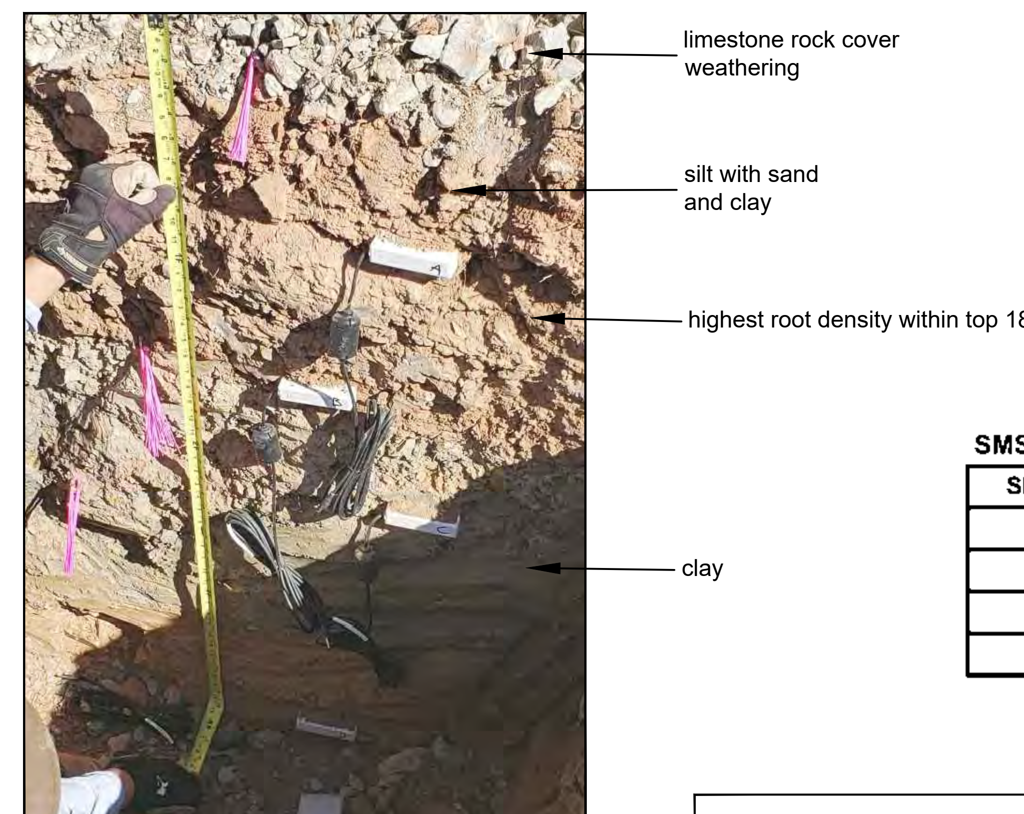
Slope: 1%

Vegetation Type: Rubber rabbitbrush**,** yellow sweetclover, redstem filaree, grasses (Foxtail barley, wild oats, cheatgrass)

Vegetation Cover: 51%

Soil Classification: 0'-0.25' Type C, limestone gravel cover (1-3" dia.), subangular, rock weathering, grey
0.25'-1.3' Type B/C, silt with clay and sand, friable, platy structure, dry, reddish-brown
1.3'-2.25' Type A, clay, platy structure, slightly moist to dry, modeled grey and brown with yellow staining
2.25'-3.9' Type A, clay, slightly moist to dry, reddish-brown





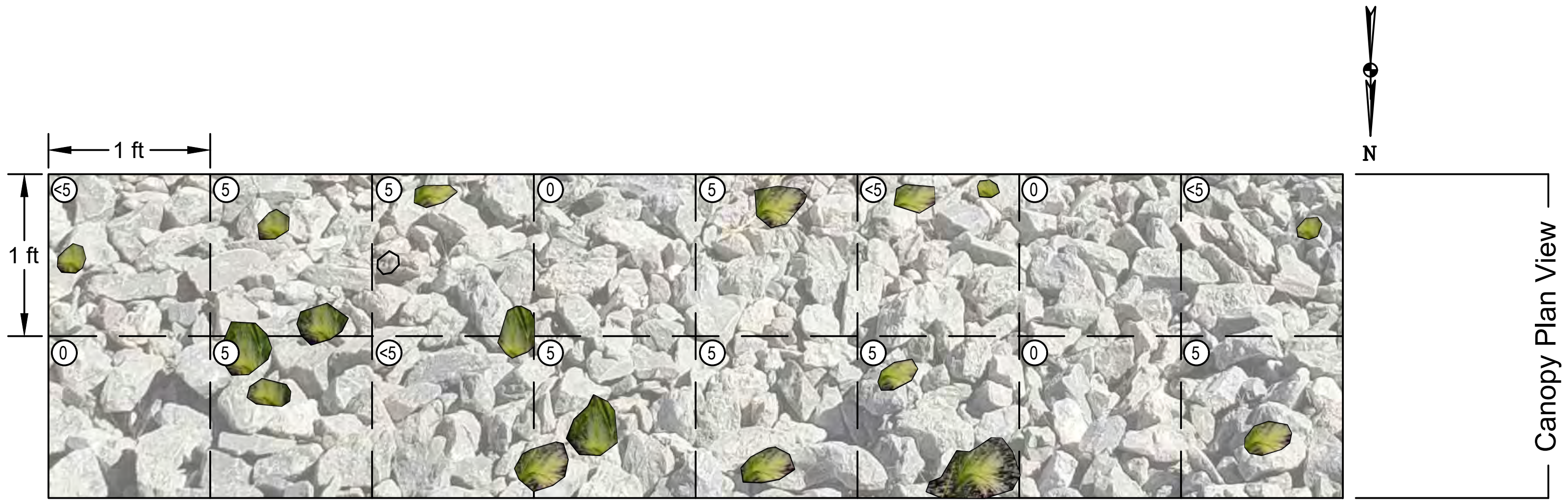
SMS Installations

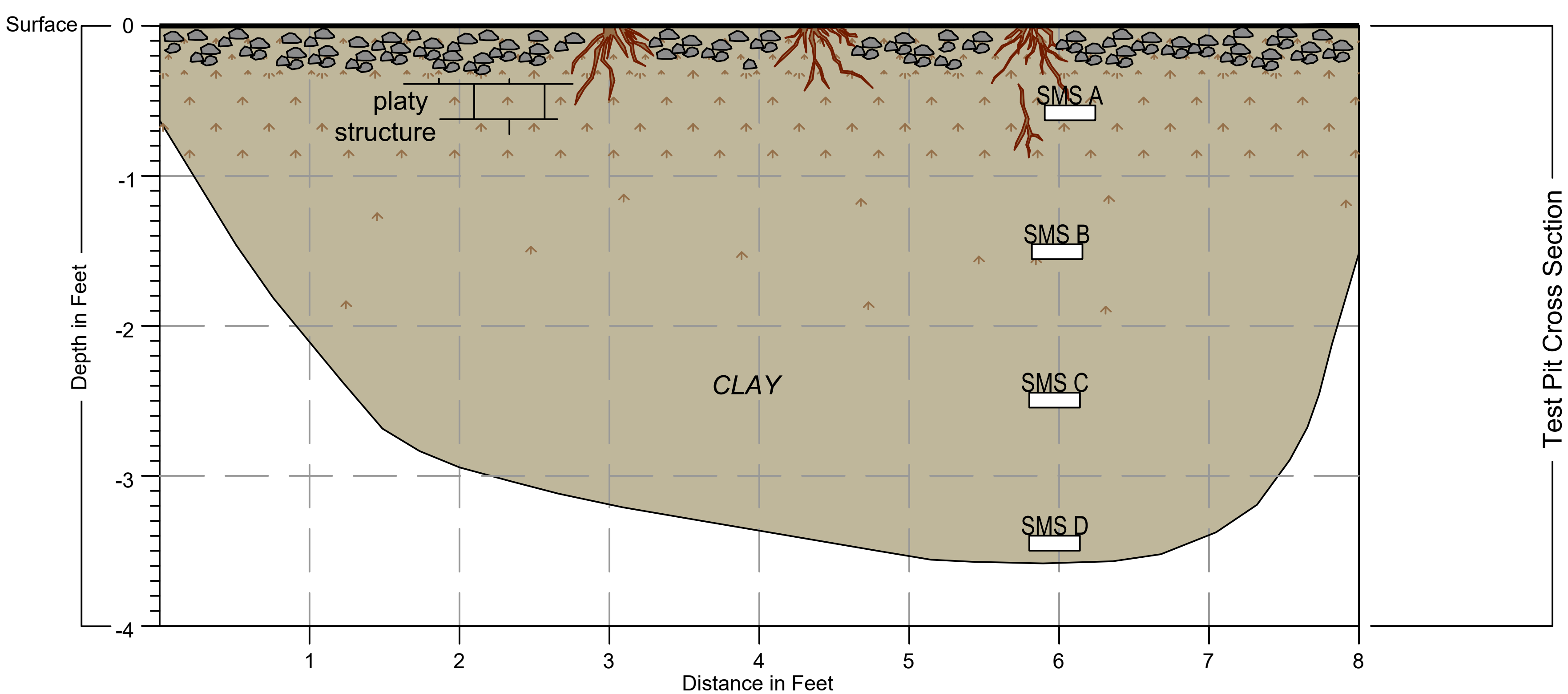
SMS	Depth (in.)
A	8.5
B	17.5
C	24.5
D	45.5

Figure B8
LT-TP2 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\LTTP2_TestPitSchematic.dwg





Foxtail Barley Grass

Gravel (1-3" dia)

Root Density

Roots

Percent Vegetation Cover

SMS Soil Moisture Sensor

Logged By: E. Woolsey

Project / Location: Lisbon NR / Upper Tailing Impoundment

Operator: Forrest Waggoner (DalMolin)

Excavation Date: 10-3-2019

Surface Elevation: 6692 ft amsl

Test Pit Dimensions (L' x W' x D'): 8' x 3' x 3.6'

Land Use: Tailing Impoundment with rock cover

Slope: 1%

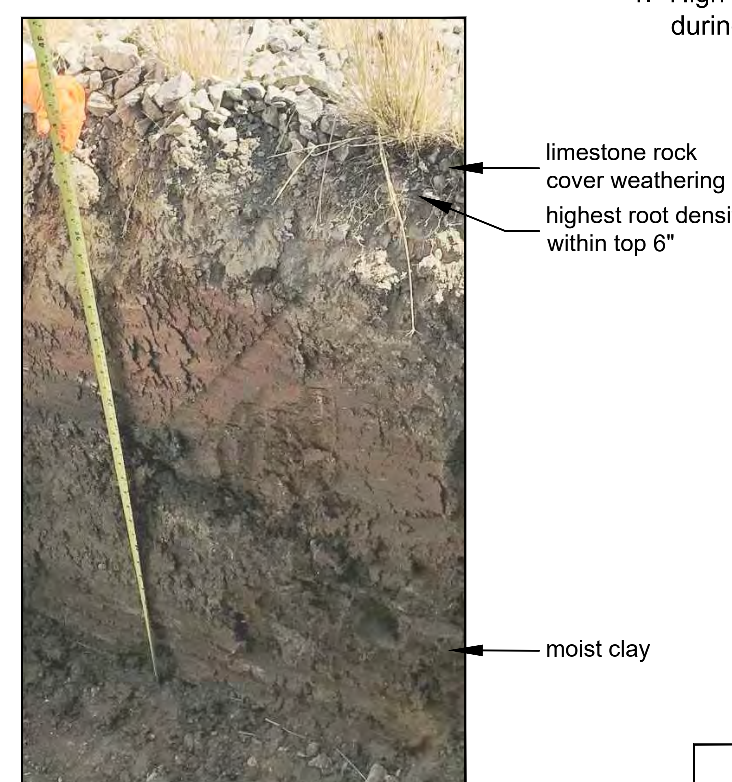
Vegetation Type: Foxtail barley grass, yellow sweetclover

Vegetation Cover: 4%

Soil Classification: 0'-0.25' Type C, limestone gravel cover (1-3" dia.), subangular, rock weathering, grey
0.25'-0.7' Type B, clay, friable, platy structure, slightly moist to dry, grey
0.7'-3.6' Type A, clay, moist, brown and black with light brown to yellow marbling

Notes:

1. High moisture content attracted bees during excavation



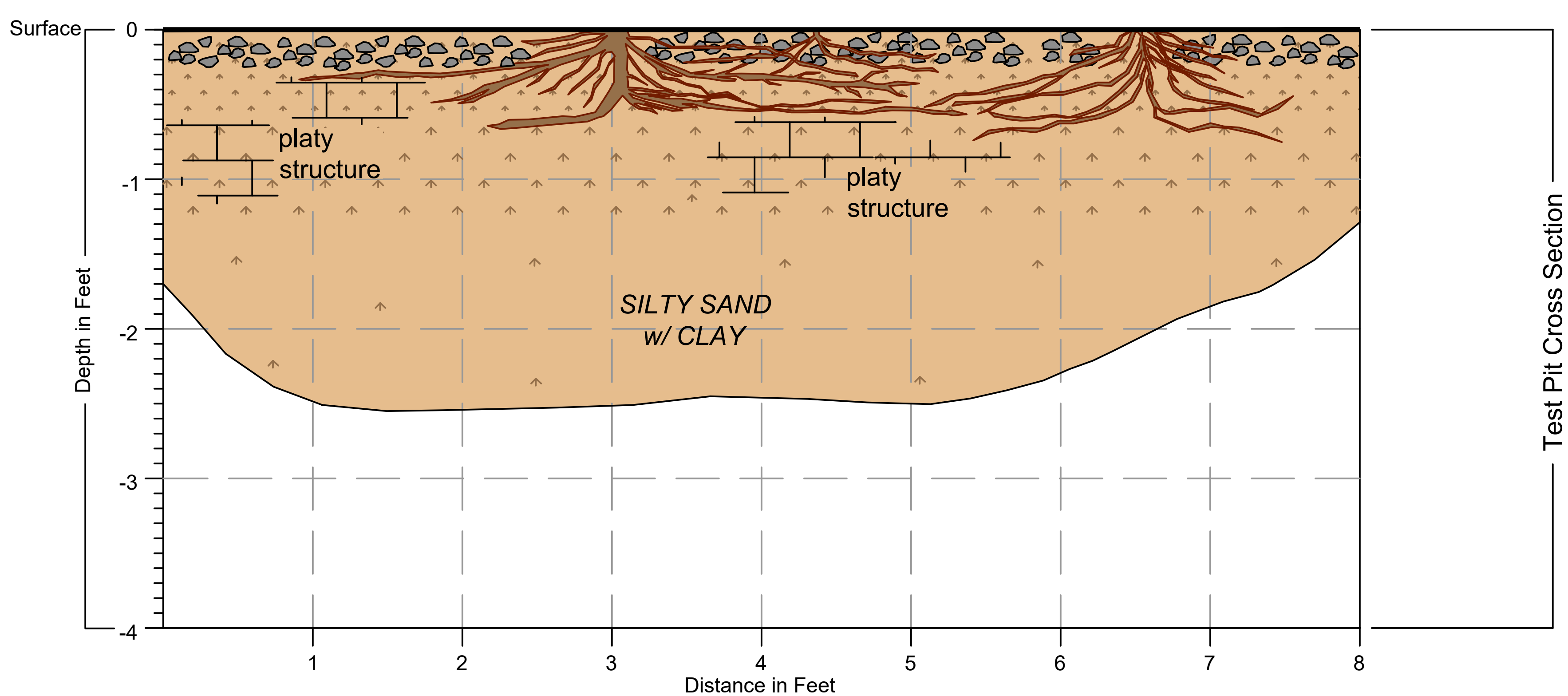
SMS Installations

SMS	Depth (in.)
A	8
B	18
C	31
D	42

Figure B9
UT-TP1 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\UTTP1_TestPitSchematic.dwg



Legend:
- Rubber Rabbitbrush
- Gravel
- Root Density
- Large Roots (0.25" - 1" dia.)
- (85) Percent Vegetation Cover

Logged By: E. Woolsey

Project / Location: Lisbon NR / Upper Tailing Impoundment

Operator: Forrest Waggoner (DalMolin)

Excavation Date: 10-3-2019

Surface Elevation: 6702 ft amsl

Test Pit Dimensions (L' x W' x D'): 8' x 3' x 2.5'

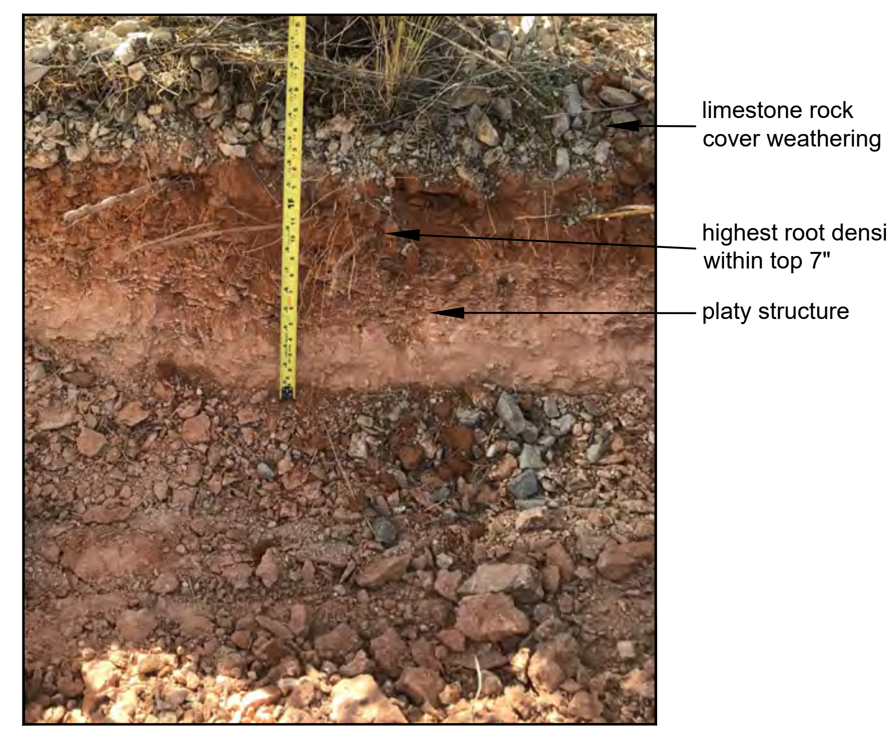
Land Use: Tailing Impoundment with rock cover

Slope: 1%

Vegetation Type: Rubber rabbitbrush, yellow sweetclover, Foxtail barley grass

Vegetation Cover: 73%

Soil Classification: 0'-0.25' Type C, limestone gravel cover (1-3” dia.), subangular, weathering, grey
0.25'-0.6' Type B, silt, friable, platy structure, slightly moist, reddish-brown
0.6'-2.5' Type A, silty sand with some clay, slightly moist to dry, light grey to tan



Photograph taken prior to excavation completion.

Figure B10
UT-TP2 Test Pit
Lisbon Facility
NR-WB Modeling Report - Appendix B

INTERA

S:\ABQ\RIOAL.RioAlgom\Graphics\Lisbon\MapDocs\Engineering\FY20_NR_WaterBalance\UTTP2_TestPitSchematic.dwg

APPENDIX C
Selected Photographs of NR-WB Test Pits

Photo 1. Emily Woolsey (INTERA) documenting vegetation at NR-1 within 8 ft x 2 ft plot prior to test pit excavation. Vegetation at NR-1 includes sagebrush, desert moss, crested wheatgrass, and prickly pear cactus.

Photo 2. NR-1 test pit profile (4 ft depth) showing highest root density within upper loose silt and increasing caliche cementation with depth.

Photo 3. Sagebrush roots in NR-1 test pit turning 90 degrees when encountering caliche cemented soils at approximately 1.5 ft depth.

Photo 4. Emily Woolsey (INTERA) documenting vegetation at NR-2 within 8 ft x 2 ft plot prior to test pit excavation. Vegetation at NR-2 includes sagebrush, desert moss, grasses (crested wheatgrass and sixweeks fesque), western stickseed, and clasping pepperweed.

Photo 5. Measuring grass root length at NR-2 test pit.

Photo 6. Measuring caliche root casts at 2.5 ft depth in NR-2 test pit.

Photo 7. Vegetation plot (2 ft x 8 ft) at NR-3 prior to test pit excavation. NR-3 vegetation includes sagebrush, juniper, desert moss, cryptobiotic soil crusts, and crested wheat grass.

Photo 8. NR-3 test pit showing platy structure and highest root density within top 8 in of silt. Roots extend horizontally above underlying layer of silt and clay with increased caliche cementation.

Photo 9. NR-3 test pit profile showing platy structure and highest root density within top 8 in of silt. Roots extend horizontally above underlying layer of silt and clay with increased caliche cementation. Soil column coarsens downward to fine sand with pebbles with cobbles at the base of the 3.5 ft depth test pit.

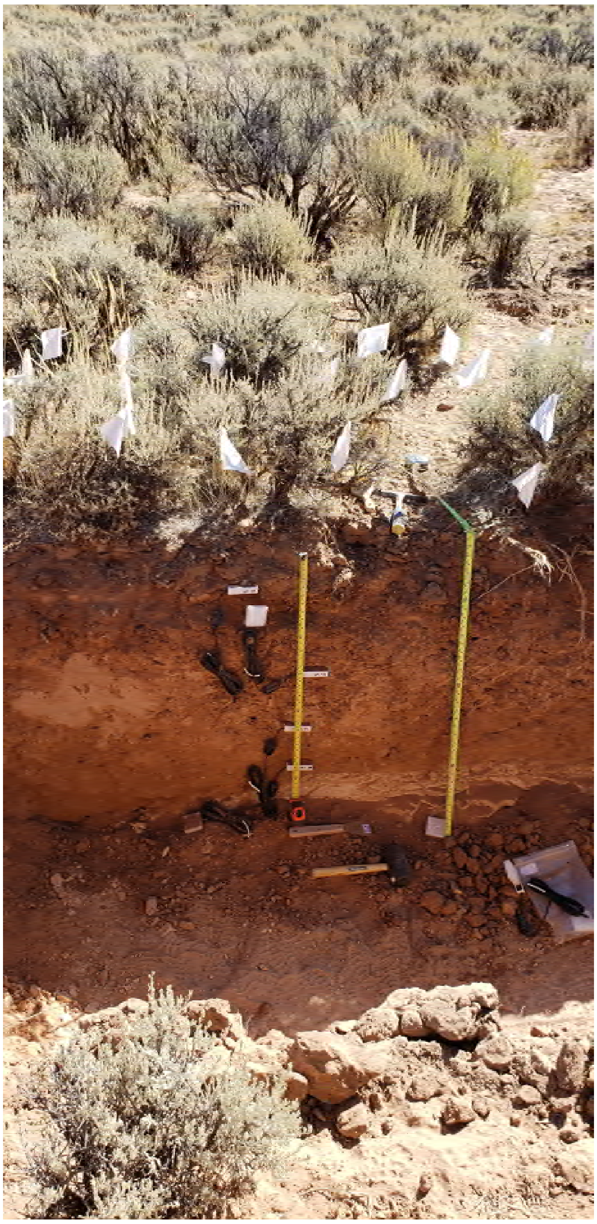


Photo 10. NR-4 test pit (4 ft depth) showing soil moisture sensor installation above Navajo Sandstone at approximately 3 ft depth. Surface vegetation includes sagebrush, grasses (sixweeks fesque and crested wheatgrass), desert moss, and cryptobiotic soil crusts.

Photo 11. Desert moss and cryptobiotic soil crusts near NR-4.

Photo 12. Joseph James (DalMolin Excavating) breaking ground on NR-5 test pit with a rubber-tired backhoe. Vegetation at NR-5 includes Rubber rabbitbrush, sandbur, Tumble and Tansy mustard, and toadflax.

Photo 13. Toadflax rhizomes at NR-5.

Photo 14. Spiky sandburs near NR-5 (photo taken in the spring).

Photo 15. Annelia Tinklenberg (INTERA) installing soil moisture sensors in the NR-5 test pit. The highest root density occurs within the top 1 ft. The bottom of the test pit at 3.5 ft consists of silty sand with pebbles and cobbles up to 1 ft in length.

Photo 16. Solar powered soil moisture sensor data logger with ports for each sensor depth. Configuring sensors and running function tests with the tablet.

Photo 17. Vegetation plot (2 ft x 8 ft) at NR-6 with 1 ft grid spacing for survey. Vegetation at NR-6 includes Tumble and Tansy mustard, crested wheatgrass, sandbur, Russian thistle, and aster.

Photo 18. NR-6 test pit excavation showing typical layout with excavated "topsoil" stockpiled on the downhill side of the test pit and excavated spoils on the uphill side. All test pits were backfilled the same day as excavation in 8 in lifts compacted using the bucket of the backhoe.

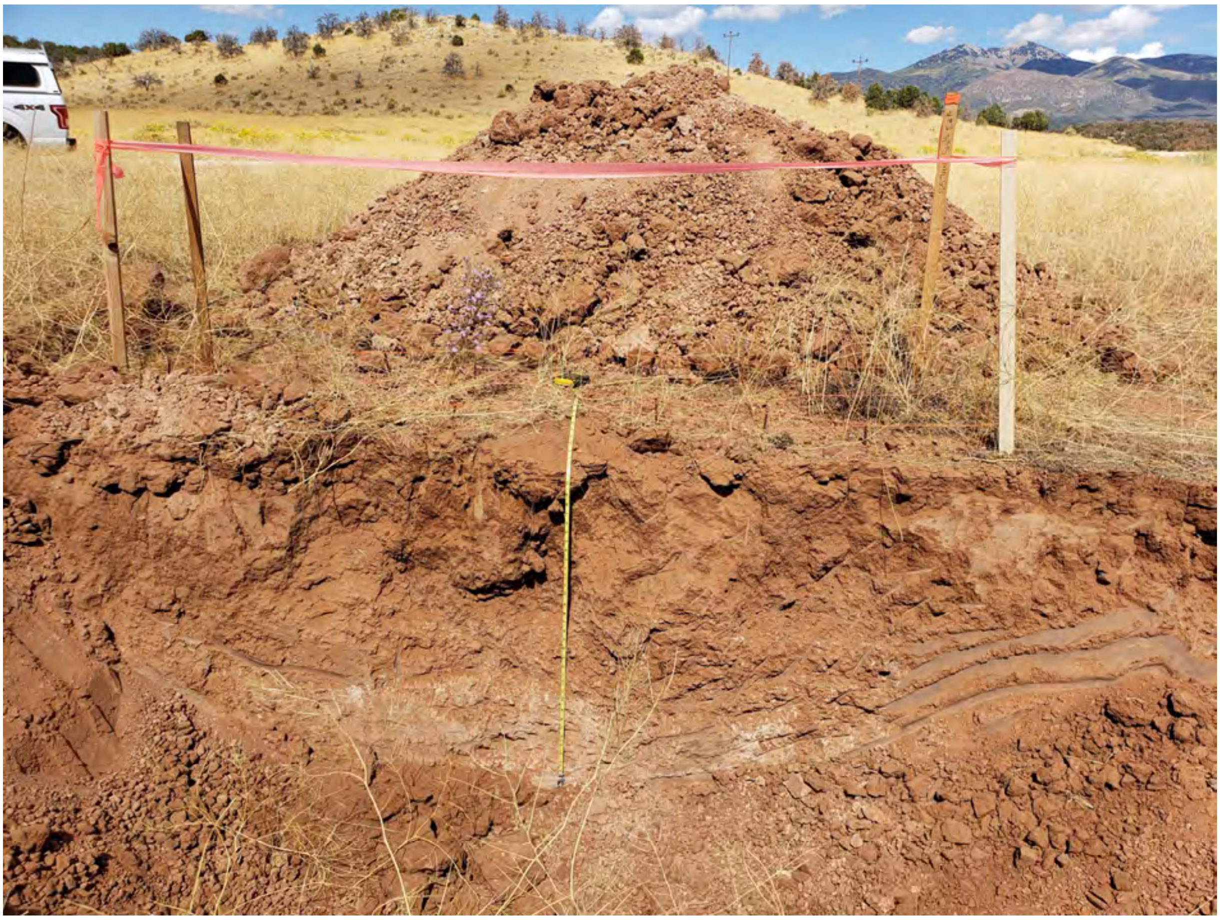


Photo 19. NR-6 test pit soil profile of dry silt with highest root density within top 1 ft. No roots visible beyond 1.75 ft depth where caliche cementation increases to the total depth of 3.6 ft.

Photo 20. LT-TP1 test pit on lower tailing impoundment cover. Vegetation at LT-TP1 includes rubber rabbitbrush, yellow sweetclover, thistle, and grasses (Foxtail barley, wild oats, and cheatgrass).

Photo 21. LT-TP1 test pit excavation. At all four test pits on the tailing impoundment cover, the limestone cover rock within the work area was scrapped into a stockpile and cover material was placed on soil cloth in separate piles in order of excavation depth to recreate the cover profile after investigation. Tailing test pits were excavated in stages to document the shallow cover soil profile before digging deeper into cover material for ALARA exposure purposes.

Photo 22. Rubber rabbitbrush root profile at LT-TP1 test pit with highest root density within top 0.75 ft and taproots extending to 1.75 ft depth.

Photo 23. Cover soil profile at LT-TP1 test pit showing a greyish-purple silty sand and gravel layer from 1.5 ft to 2 ft depth.

Photo 24. Excavation scene at LT-TP2 test pit showing work area exclusion zone set up by ERG and typical distance maintained from test pit during active excavation. Vegetation at LT-TP2 includes rubber rabbitbrush, yellow sweetclover, redstem filaree, and grasses (Foxtail barley, wild oats, and cheatgrass).

Photo 25. Soil moisture sensor installation at LT-TP2 test pit showing four sensors in series. The shallow sensor was installed in the upper silt layer within the highest density root zone. The intermediate sensors were installed within the platy structured clay layer and the deep sensor was installed in clay below the EZD near the base of the 3.9 ft excavation.

Photo 26. Vegetation plot (8 ft x 2 ft) for UT-TP1 test pit including Foxtail barley grass and yellow sweetclover.

Photo 27. Emily Woolsey (INTERA) measuring depth of UT-TP1 test pit at 3.6 ft. Cover profile contains moist clay and shallow grass root systems with highest root density within the top 8 in. Tyvek suits were worn in the first two tailing test pit excavations then reduced to only Tyvek booties as no elevated material was encountered within the cover materials.

Photo 28. Forrest Waggoner (DalMolin) spreading and compacting limestone cover gravel over backfilled UT-TP1 test pit.

Photo 29. Preparing for excavation of UT-TP2 test pit on the upper tailing impoundment outside of the footprint of the former evaporation cell. This location was the first test pit excavation on the impoundments. Vegetation at UT-TP2 includes rubber rabbitbrush, yellow sweetclover, and Foxtail barley grass.

Photo 30. Platy soil structure within top 1.25 ft of UT-TP2 test pit.

Photo 31. Shallow root profile of rubber rabbitbrush at UT-TP2 with highest root density within top 7 in.

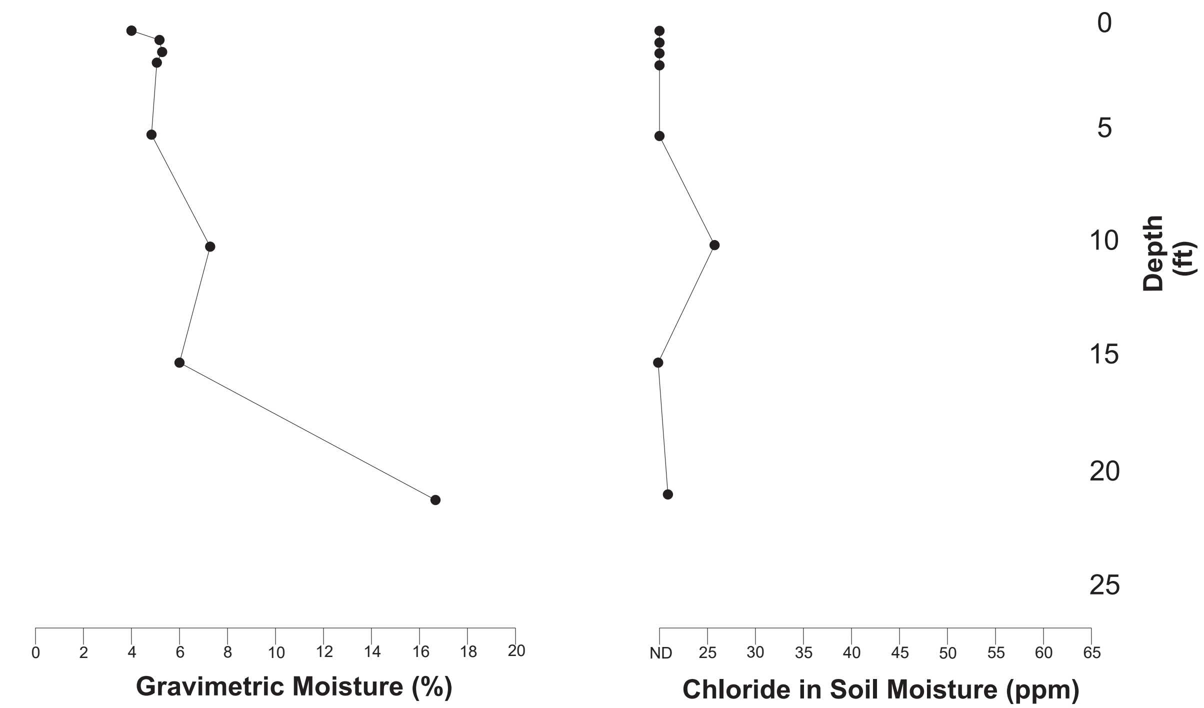
Photo 32. View of the lower tailing impoundment from the north showcasing the salt deposits within the footprint of the former evaporation cell.

APPENDIX D
NR-WB Boring Logs

SOIL BORING LOG

NRB-1

Depth (ft)	Clock Time	Graphical Log	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	USCS	Chloride in Soil (ppm)	Comments	Visual Field Classification
													Surface: Sand; fine, silty; reddish brown; dry
0	1053		X	r	7,20,36	103.6	1.2E-04	8.6	4.0	s(ML)	ND	Hard; minor roots	Silt; fine sandy; reddish brown; dry
								8.7	5.2	s(ML)	ND		
			X	r	34,42,39	103.0		8.0	5.3	s(ML)	ND	Hard; carbonate lenses; few roots	Silt; fine sandy; light reddish brown; dry
						103.0			4.9	(ML)s	ND		
	1117			A									
5			X	r	9,13,41	101.8		7.7	4.7	(ML)s	ND	Hard; carbonate lenses; few roots	Silt; fine sandy; pink to light reddish brown; dry
	1129			A									
10	1144		X	r, A	24,32,75	101.1	4.3E-04	11.9	7.4	s(ML)	26	Hard; no roots; partially indurated	Silt; fine sandy; pink to light reddish brown; dry
15	1201		X	r, A	26,35,34	104.3		10.0	6.0	(ML)s	ND	Hard	Silt; fine sandy; pink to light reddish brown; dry
20	1216		X	r, A	17,40,45	94.9		25.0	16.4	(CH)s	21	Hard; partially indurated to indurated (weathered?)	Clay/Claystone; greyish blue w/ yellow staining; dry
25	1235		X	r	20,70,--							Hard; indurated	Clay/Claystone; greyish blue; dry
												TD @ 26.5' w/ sampler	
30													
35													
40													
45													
50													
55													
60													



SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		

LOGGED BY L Coons
DRILLER Yellow Jacket
DATE COMPLETED 10.3.19
RIG/BORING TYPE CME 95 - HSA
SURFACE ELEVATION 6691.62
PROJECT Lisbon NR-WB
PROJECT NUMBER RIOAL.M001.LIS-NR-Field
LOCATION Private Land - North of Laydown

NOTES:
1. N-10436914.21; E-2274788.02
2. Survey by Red Desert Land Surveying December 16, 2019
3. State Plane Utah South NAD 83 (NAVD88)

INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-1. NRB-1 Boring Log with Chloride and Moisture Profiles

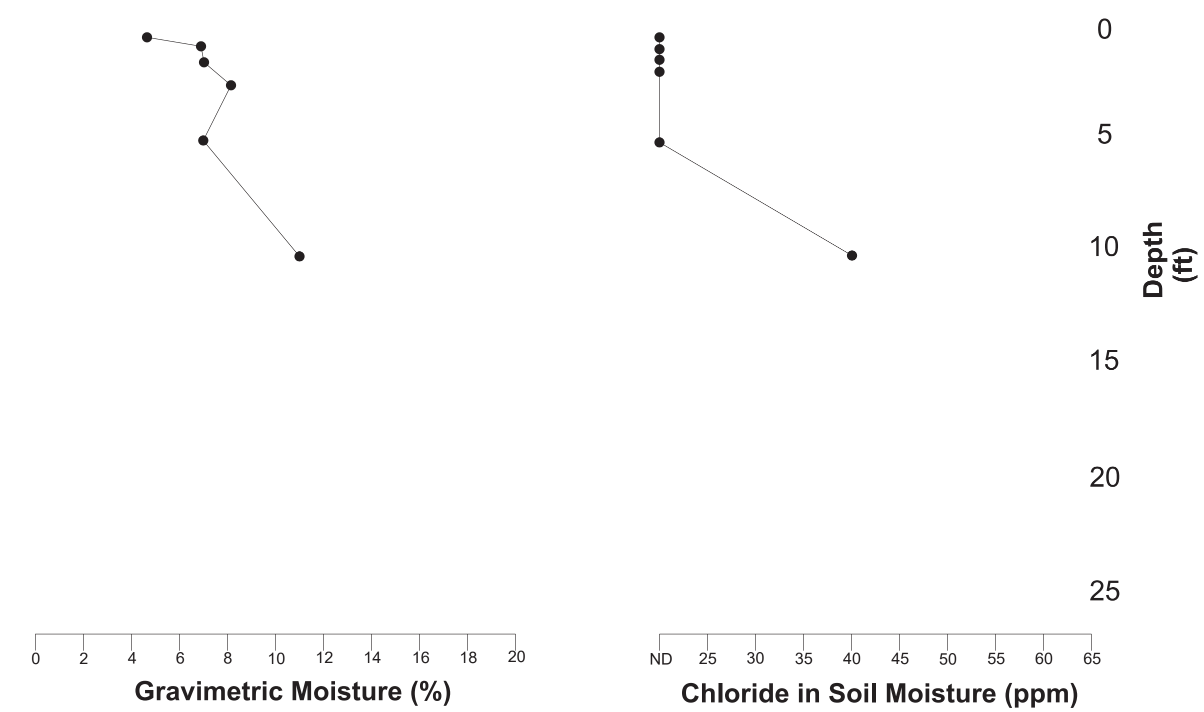
DATE:	REV:	BY:	SCALE:
5 May20		LMC	NA

FILE: S:\ABQ\RIO-Lisbon_Supplemental\SiteCharacterization\Engineering\FY20-NaturalRecharge-WaterBalance\Boring-TestPit-Logs\NRB-1-11x17.cdr

SOIL BORING LOG

NRB-2

Depth (ft)	Clock Time	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	USCS	Chloride in Soil (ppm)	Comments	Visual Field Classification
												Surface: Sand; fine, silty; reddish brown; dry
0	0900	X	r	6,1,18		1.3E-04		4.6	(CL)s	ND	Firm; carbonate lenses; some roots	Sand; fine, silty; reddish brown; dry
					99.9		10.9	6.8	(CL)s	ND		
		X	r	29,29,24	106.8		12.1	7.1	(CL)s	ND	Hard; carbonate lenses; minor fibrous roots	Sand; fine, silty; pinkish tan; dry
	0914				103.6		13.6	8.2	(CL)s	ND		
			A									
5		X	r	11,21,39	96.8		10.7	6.9	s(CL)	ND	Hard; carbonate lenses; few roots	Sand; fine, minor silt; light pinkish grey; dry
	0926		A ↓									
10	0935	X	r	40,50+,-	101.8		17.9	10.9	(CL)s	40	Hard; no roots; partially indurated; extensive carbonate; refusal at 10'8" on weathered sandstone (in drive shoe)	Sand; fine, silty; light buff to cream; dry
	0948		A									
15											**TD @ 10.6' w/ sampler**	
20												
25												
30												
35												
40												
45												
50												
55												
60												



SAMPLE TYPE

A - Auger cuttings; NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		

LOGGED BY L Coons
DRILLER Yellow Jacket
DATE COMPLETED 10.3.19
RIG/BORING TYPE CME 95 - HSA
SURFACE ELEVATION 6736.93
PROJECT Lisbon NR-WB
PROJECT NUMBER RIOAL.M001.LIS-NR-Field
LOCATION BLM Land - East Coyote Wash

NOTES:
1. N-10432366.22; E-2286965.84
2. Survey by Red Desert Land Surveying December 16, 2019
3. State Plane Utah South NAD 83 (NAVD88)

INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110

Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-2. NRB-2 Boring Log with Chloride and Moisture Profiles

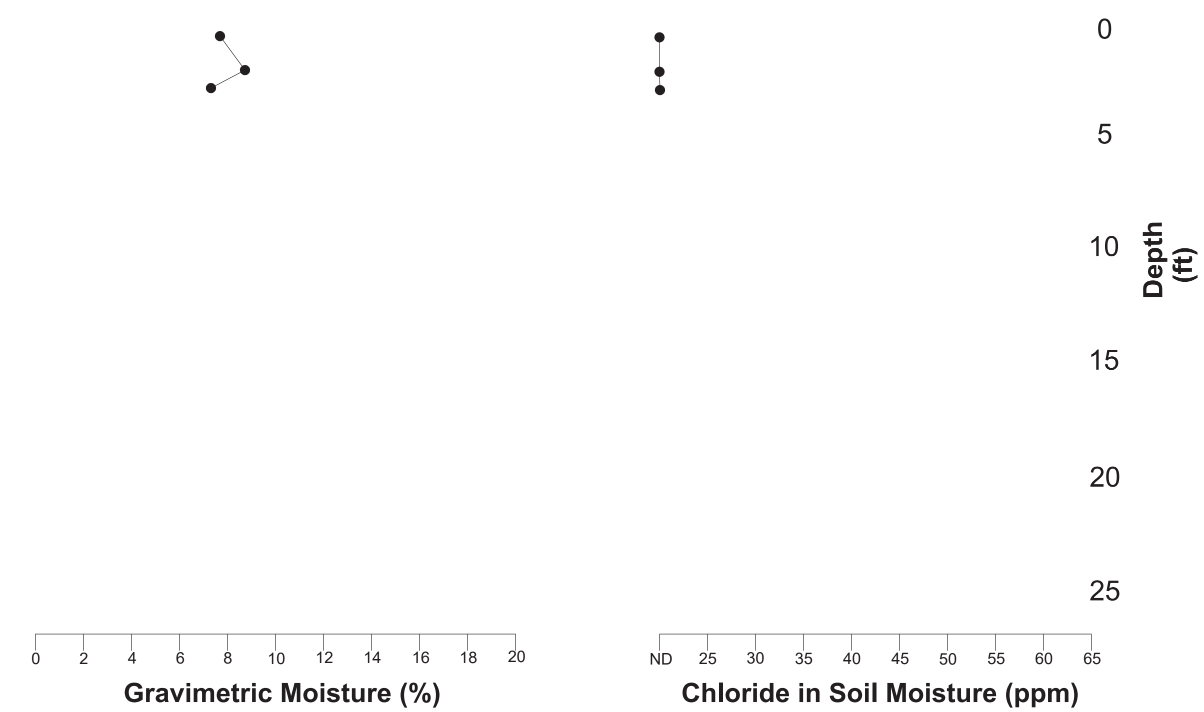
DATE:	REV:	BY:	SCALE:
5 May20		LMC	NA

FILE: *S:\ABQ\RIO-Lisbon_SupplementalSiteCharacterization\Engineering\FY20-NaturalRecharge-WaterBalance\Boring-TestPit-Logs\NRB-2-11x17.cdr*

SOIL BORING LOG

NRB-3

Depth (ft)	Clock Time	Graphical Log	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	USCS	Chloride in Soil (ppm)	Comments	Visual Field Classification
													Surface: Sand; fine, silty; reddish brown; dry
0	1453		X	r	14,18,25				7.9	s(CL)	ND	Very Firm; carbonate lenses; some fibrous roots	Clay; fine sandy; light reddish brown to pink; dry
	1501					86.8		11.8	8.5	SM	ND		Sand; fine, silty; light reddish brown to pink; dry
			X	r	19,25,-				7.3	SM	ND	Hard; refusal at 36" on sandstone (in drive shoe)	Sand; fine, silty; light reddish brown to pink; dry
	1509												
5												**TD @ 3' w/ sampler**	
10													
15													
20													
25													
30													
35													
40													
45													
50													
55													
60													



SAMPLE TYPE

A - Auger cuttings; NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		

LOGGED BY **L Coons**
DRILLER **Yellow Jacket**
DATE COMPLETED **10.2.19**
RIG/BORING TYPE **CME 95 - HSA**
SURFACE ELEVATION **6890.85**
PROJECT **Lisbon NR-WB**
PROJECT NUMBER **RIOAL.M001.LIS-NR-Field**
LOCATION **Private Land - SE of LTSM Corner**

NOTES:
1. N-10429988.41; E-2280562.09
2. Survey by Red Desert Land Surveying December 16, 2019
3. State Plane Utah South NAD 83 (NAVD88)

INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110

Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-3. NRB-3 Boring Log with Chloride and Moisture Profiles

DATE:	REV:	BY:	SCALE:
5 May20		LMC	NA

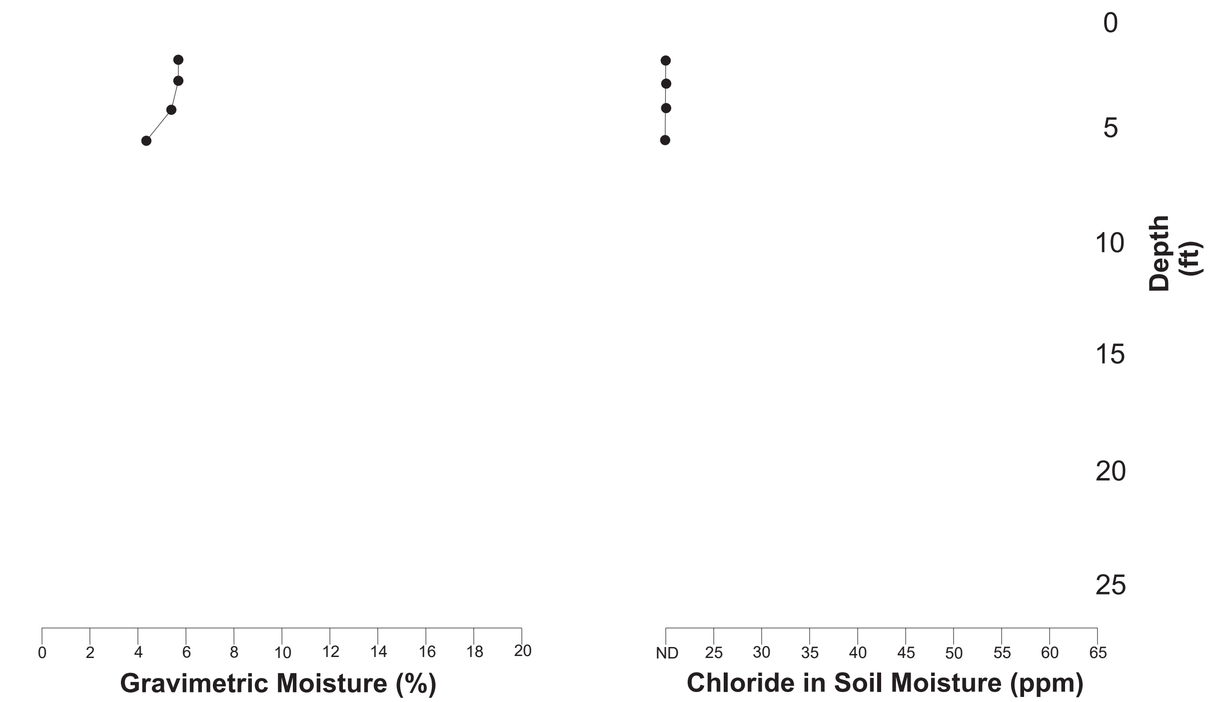
FILE: *S:\ABQ\RIO-Lisbon_SupplementalSiteCharacterization\Engineering\FY20-NaturalRecharge-WaterBalance\Boring-TestPit-Logs\NRB-3-11x17.cdr*

SOIL BORING LOG

NRB-5

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Depth (ft)	Clock Time	Graphical Log	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	USCS	Chloride in Soil (ppm)	Comments	Visual Field Classification
0	1313												Surface: Silt; fine sandy; reddish brown; dry
			X	r	4,7,13	91.8		8.6	5.8	ML	ND	Firm; carbonate lenses; some fibrous roots	Sand; fine, silty; medium reddish brown; dry
			X	r	9,13,13	108.6		10.1	5.8	(SM)g	ND	Firm; Angular rock to 1.5" dia	Sand; fine to medium; yellow-brown; dry to s. moist
						108.0		9.4	5.4	(SM)g	ND		
	1325			A					4.2		ND		
5										ML		Very Firm; carbonate lenses; few fibrous roots; medium weathered sandstone, white to yellow-brown, s. moist 5.5 to 6'	Silt; fine sandy; medium brown; dry to s. moist
			X	r	12,21,24								Sandstone; white to yellow-brown
	1345											**TD @ 6.5' w/ sampler**	
10													
15													
20													
25													
30													
35													
40													
45													
50													
55													
60													



SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE
None		

LOGGED BY **L Coons**
DRILLER **Yellow Jacket**
DATE COMPLETED **10.2.19**
RIG/BORING TYPE **CME 95 - HSA**
SURFACE ELEVATION **6451.26**
PROJECT **Lisbon NR-WB**
PROJECT NUMBER **RIOAL.M001.LIS-NR-Field**
LOCATION **Private Land - West Coyote Wash**

NOTES:
1. N-10438811.9; E-2267345.67
2. Survey by Red Desert Land Surveying December 16, 2019
3. State Plane Utah South NAD 83 (NAVD88)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-4. NRB-5 Boring Log with Chloride and Moisture Profiles

DATE:	REV:	BY:	SCALE:
5 May20		LMC	NA

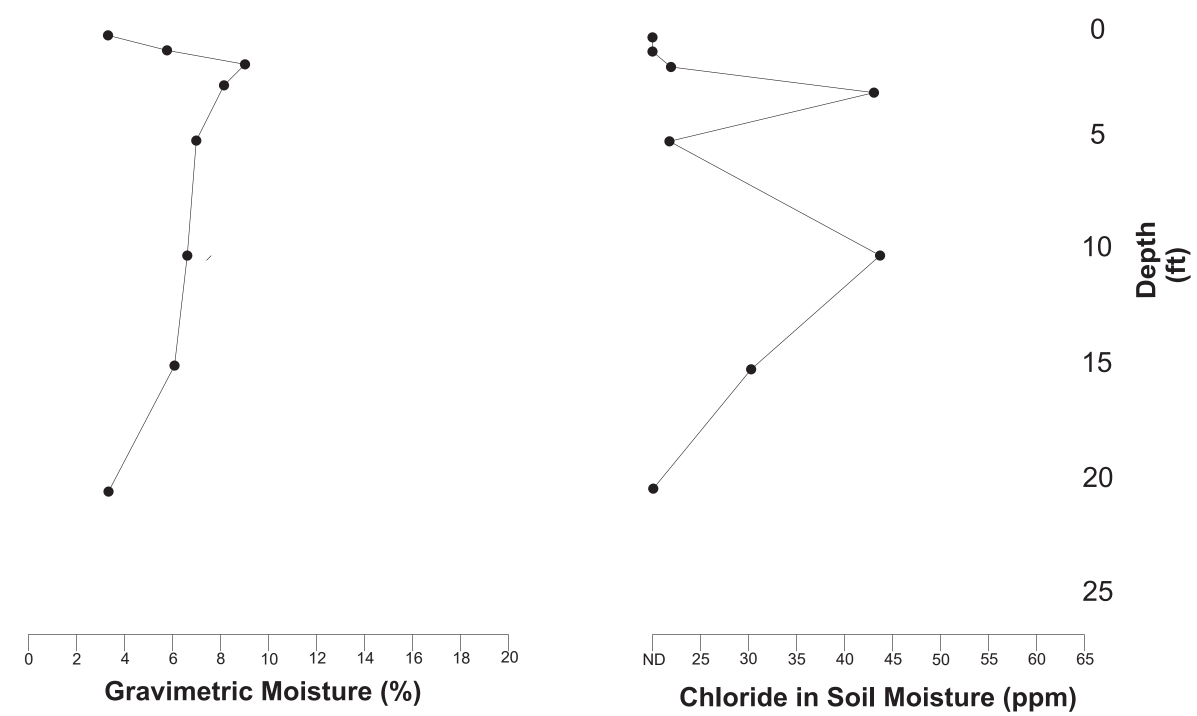
FILE: S:\ABQ\RIO-Lisbon_Supplemental\SiteCharacterization\Engineering\FY20-NaturalRecharge-WaterBalance\Boring-TestPit-Logs\NRB-5-11x17.cdr

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

SOIL BORING LOG

NRB-6

Depth (ft)	Clock Time	Graphical Log	Interval	Sample	Blow Counts** (per 6 inches)	Sample Dry Density (lb/cf)	Ksat (cm/sec)	Lab Moisture (% Vol)	Lab Moisture (% Dry Wt)	USCS	Chloride (ppm)	Comments	Visual Field Classification
													Surface: Sand; fine, silty; dark reddish brown; dry
0	1020		X	r	6,15,23	103.0		9.8	3.4 5.9	s(ML) (ML)s	ND ND	Very Firm; carbonate lenses; few roots	Silt; reddish brown; dry
	1040		X	r A	16,14,22	99.3 101.8		14.6 13.2	9.1 8.1	ML ML	22 43	Very Firm; abundant carbonate lenses; no roots	Silt; reddish brown; dry
5	1055		X	r A	5,15,26	89.9		9.8	6.8	(CL)s	22	Very Firm; few carbonate lenses	Clayey silt/silty clay; brown to black; dry
10	1105		X	r A	6,7,14	96.8		10.1	6.5	s(ML)	44	Firm; broken rock and pebbles in drive shoe; reactive to HCl	Sand; fine, silty; medium brown; dry
15	1115		X	r A	34,66,-	108.6		10.5	6.1	s(ML)	30	Hard; carbonate	Sand; fine, silty; medium reddish brown; dry
20			X	r	18,20,46				3.3	(SM)g	ND	Hard; partially indurated to indurated (weathered?) @ 21'	
	1135											**TD @ 21.5' w/ sampler**	Sandstone; weathered
25													
30													
35													
40													
45													
50													
55													
60													



SAMPLE TYPE

A - Auger cuttings: NR = No recovery
s - 2" OD 1.38" ID tube sample
u - 3" OD 2.42" ID tube sample
r - 3" OD 2.42" ID ring sample

GROUNDWATER

DEPTH	HOUR	DATE

LOGGED BY L Coons
DRILLER Yellow Jacket
DATE COMPLETED 10.2.19
RIG/BORING TYPE CME 95 - HSA
SURFACE ELEVATION 6452.31
PROJECT Lisbon NR-WB
PROJECT NUMBER RIOAL.M001.LIS-NR-Field
LOCATION Private Land - West Coyote Wash

NOTES:
1. N-10439413.9; E-2266037.74
2. Survey by Red Desert Land Surveying December 16, 2019
3. State Plane Utah South NAD 83 (NAVD88)

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE D-5. NRB-6 Boring Log with Chloride and Moisture Profiles

DATE:	REV:	BY:	SCALE:
12 May 20		LMC	NA

FILE: S:\ABQ\RIO-Lisbon_Supplemental\SiteCharacterization\Engineering\FY20-NaturalRecharge-WaterBalance\Boring-TestPit-Logs\NRB-6-11x17.cdr

APPENDIX E

Selected Photographs of NR-WB Hollow-Stem Auger Drilling and Sampling

Photo E-1-1. NRB-1.

Photo E-1-2. NRB-1 alluvium-claystone contact.

Photo E-1-3. NRB-3.

Photo E-1-4. NRB-3 alluvium-weathered sandstone contact.

Photo E-1-5. NRB-5.

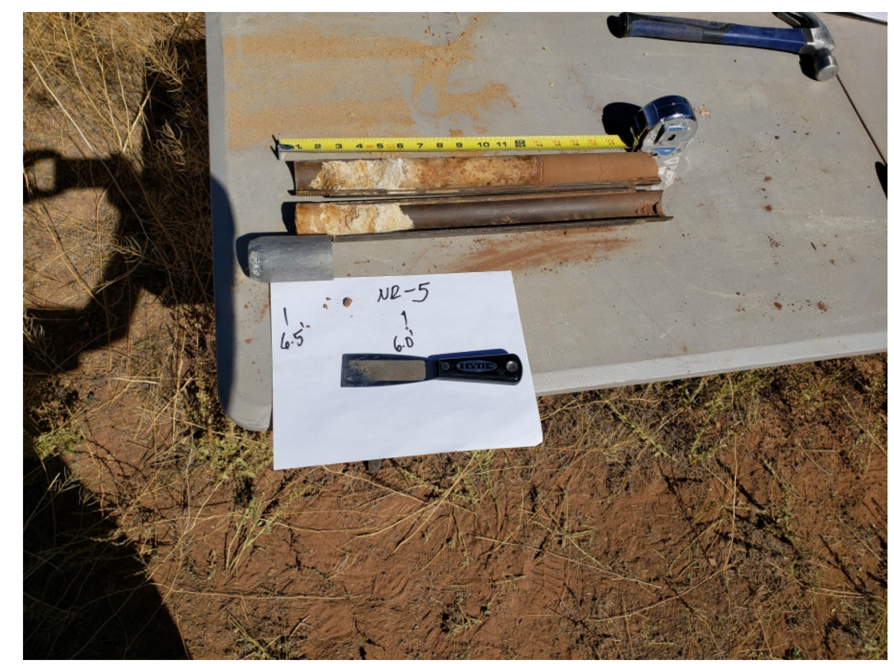


Photo E-1-6. NRB-5 alluvium-weathered sandstone contact.

NOTE: photographs taken 10.2.19 through 10.4.19

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS
INTERA INCORPORATED
6000 Uptown Boulevard, Suite 220
Albuquerque, NM 87110
Phone 505-246-1600
www.intera.com

Rio Algom Mining, LLC
Lisbon Utah Facility

FIGURE E-1. SELECTED PHOTOGRAPHS OF NR DRILLING AND SAMPLING

DATE:	REV:	BY:	SCALE:
28 Sep 21		LMC	NA

FILE: *S:\ABQ\RIO_Lisbon-SupplementalSiteCharacterization\Engineering\FY20-NaturalRecharge-WaterBalance\Report\Appendicies\E_Appendix_DrillingPhotoLogs\Photos1.cdr*

APPENDIX F
DBS&A Laboratory Report for NR Borehole Samples

Laboratory Report for

INTERA Inc.

Lisbon Site - Natural Recharge Borings

RIOAL.M001.LIS-NR FIELD

January 20, 2020

Daniel B. Stephens & Associates, Inc.

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

January 20, 2020

Larry Coons
INTERA Inc.
6000 Uptown Blvd NE Suite 220
Albuquerque, NM 87110
(505) 246-1600

Re: DBS&A Laboratory Report for the INTERA Inc. Lisbon Site - Natural Recharge Borings RIOAL.M001.LIS-NR FIELD Project

Dear Mr. Coons:

Enclosed is the report for the INTERA Inc. Lisbon Site - Natural Recharge Borings RIOAL.M001.LIS-NR FIELD 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 INTERA Inc. 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

Adam Bland
Laboratory Operations 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	Soil Chloride
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
NRB-1 (0.5-1)	X															X	X				X	X
NRB-1 (1.5-2)	X	X														X	X				X	X
NRB-1 (2.5-3)	X															X	X				X	X
NRB-1 (2.5-3) (1.65 g/cc)	X	X		X			X	X		X	X			X								
NRB-1 (3-3.5)	X	X														X	X				X	X
NRB-1 (5.5-6)	X	X														X	X				X	X
NRB-1 (10.5-11)	X															X	X				X	X
NRB-1 (10.5-11) (1.62 g/cc)	X	X		X			X	X		X	X			X								
NRB-1 (15.5-16)	X	X														X	X				X	X
NRB-1 (21-21.5)	X	X														X	X				X	X
NRB-2 (0.5-1)	X															X	X				X	X
NRB-2 (1.5-2)	X	X														X	X				X	X
NRB-2 (2.5-3)	X															X	X				X	X
NRB-2 (2.5-3) (1.71 g/cc)	X	X		X			X	X		X	X			X								
NRB-2 (3-3.5)	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)

Summary of Tests Performed (Continued)

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	Soil Chloride
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
NRB-2 (5.5-6)	X	X														X	X				X	X
NRB-2 (10-10.5)	X															X	X				X	X
NRB-2 (10-10.5) (1.63 g/cc)	X	X		X			X	X		X	X			X								
NRB-3 (0.5-1)	X															X	X				X	X
NRB-3 (1.5-2)	X	X														X	X				X	X
NRB-3 (2.5-3.5)	X															X	X				X	X
NRB-5 (1-1.5)	X	X														X	X				X	X
NRB-5 (2.5-3)	X	X														X	X				X	X
NRB-5 (3-3.5)	X	X														X	X				X	X
NRB-5 (5-5.5)	X															X	X				X	X
NRB-6 (0.5-1)	X															X	X				X	X
NRB-6 (1.5-2)	X	X														X	X				X	X
NRB-6 (2.5-3)	X	X														X	X				X	X
NRB-6 (3-3.5)	X	X														X	X				X	X
NRB-6 (5.5-6)	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)

Summary of Tests Performed (Continued)

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	Soil Chloride
	G	VM	VD	CH	FH	FW	HC	PP	FP	DPP	RH	EP	WHC	K_{unsat}	DS	WS	H	F	C			
NRB-6 (10.5-11)	X	X														X	X				X	X
NRB-6 (15.5-16)	X	X														X	X				X	X
NRB-6 (20-21.5)	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:
A total of twenty nine samples were hand-delivered on December 6, 2019. Seven samples were received as loose material in a 1-gallon Ziploc bag. Nineteen samples were received as 6" x 2.5" stainless steel sleeves sealed with end caps and duct tape. The remaining three samples were received as stacked 2.5" x 6" brass rings.

Sample Preparation and Testing Notes:
Each of the samples was subjected to as-received gravimetric moisture content determination, particle size analysis, Atterberg limits testing and soil chloride analysis.

Each of the sleeve samples was subjected to initial properties analysis.

Four of the sleeve samples were subjected to moisture retention testing. An intact sample from each of the sleeves was obtained by extruding a portion of each sample into a sleeve of the same diameter. Each of these sub-samples was subjected to saturated hydraulic conductivity via the rigid wall method, and the hanging column and pressure chamber portions of the moisture retention testing. Adjacent sample material was used for the dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

Porosity calculations, and the particle diameter calculations in the hydrometer portion of the particle size analysis testing, are based on the use of an assumed specific gravity value of 2.75.

Volumetric water contents were adjusted for changes in volume, where applicable. Due to the irregularities formed on the sample surfaces during settling or swelling, volume measurements obtained after the initial reading should be considered estimates.

Summary of Sample Preparation/Volume Changes

Sample Number	Initial Sample Data[1] Moisture Content (%, g/g)	Initial Sample Data[1] Dry Bulk Density (g/cm^3)	Volume Change Post Saturation[2] Dry Bulk Density (g/cm^3)	Volume Change Post Saturation[2] % Volume Change (%)	Volume Change Post Saturation[2] % 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 (%)
NRB-1 (2.5-3) (1.65 g/cc)	5.3	1.65	1.65	---	100.0%	1.65	---	100.0%
NRB-1 (10.5-11) (1.62 g/cc)	7.4	1.62	1.62	---	100.0%	1.59	+0.68%	98.3%
NRB-2 (2.5-3) (1.71 g/cc)	7.1	1.71	1.71	---	100.0%	1.71	---	100.0%
NRB-2 (10-10.5) (1.63 g/cc)	10.9	1.63	1.63	---	100.0%	1.63	---	100.0%

[1]Initial Sample Data: The 'as received' dry bulk density and moisture content.

[2]Volume Change Post Saturation: Volume change measurements were obtained after saturated hydraulic conductivity testing.

[3]Volume Change Post Drying Curve: Volume change measurements were obtained 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.

Notes:

"+" indicates sample swelling, "-" indicates sample settling, and "---" indicates no volume change occurred.

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 (%)
NRB-1 (0.5-1)	4.0	NA	---	---	NA	NA	NA
NRB-1 (1.5-2)	5.2	8.6	---	---	1.66	1.75	39.5
NRB-1 (2.5-3)	5.1	NA	---	---	NA	NA	NA
NRB-1 (2.5-3) (1.65 g/cc)	5.3	8.7	---	---	1.65	1.73	40.1
NRB-1 (3-3.5)	4.9	8.0	---	---	1.65	1.73	40.2
NRB-1 (5.5-6)	4.7	7.7	---	---	1.63	1.70	40.9
NRB-1 (10.5-11)	6.7	NA	---	---	NA	NA	NA
NRB-1 (10.5-11) (1.62 g/cc)	7.4	11.9	---	---	1.62	1.74	41.2
NRB-1 (15.5-16)	6.0	10.0	---	---	1.67	1.77	39.1
NRB-1 (21-21.5)	16.4	25.0	---	---	1.52	1.77	44.6
NRB-2 (0.5-1)	4.6	NA	---	---	NA	NA	NA
NRB-2 (1.5-2)	6.8	10.9	---	---	1.60	1.70	42.0

NA = Not analyzed
--- = This sample was not remolded

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

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 (%)
NRB-2 (2.5-3)	6.5	NA	---	---	NA	NA	NA
NRB-2 (2.5-3) (1.71 g/cc)	7.1	12.1	---	---	1.71	1.83	37.8
NRB-2 (3-3.5)	8.2	13.6	---	---	1.66	1.80	39.6
NRB-2 (5.5-6)	6.9	10.7	---	---	1.55	1.66	43.5
NRB-2 (10-10.5)	7.5	NA	---	---	NA	NA	NA
NRB-2 (10-10.5) (1.63 g/cc)	10.9	17.9	---	---	1.63	1.81	40.6
NRB-3 (0.5-1)	7.9	NA	---	---	NA	NA	NA
NRB-3 (1.5-2)	8.5	11.8	---	---	1.39	1.51	49.3
NRB-3 (2.5-3.5)	7.3	NA	---	---	NA	NA	NA
NRB-5 (1-1.5)	5.8	8.6	---	---	1.47	1.56	46.5
NRB-5 (2.5-3)	5.8	10.1	---	---	1.74	1.84	36.7
NRB-5 (3-3.5)	5.4	9.4	---	---	1.73	1.82	37.1

NA = Not analyzed

--- = This sample was not remolded

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

	Moisture Content						
	As Received		Remolded				
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
NRB-5 (5-5.5)	4.2	NA	---	---	NA	NA	NA
NRB-6 (0.5-1)	3.4	NA	---	---	NA	NA	NA
NRB-6 (1.5-2)	5.9	9.8	---	---	1.65	1.75	39.9
NRB-6 (2.5-3)	9.1	14.6	---	---	1.59	1.74	42.0
NRB-6 (3-3.5)	8.1	13.2	---	---	1.63	1.77	40.6
NRB-6 (5.5-6)	6.8	9.8	---	---	1.44	1.54	47.6
NRB-6 (10.5-11)	6.5	10.1	---	---	1.55	1.65	43.5
NRB-6 (15.5-16)	6.1	10.5	---	---	1.74	1.84	36.8
NRB-6 (20-21.5)	3.3	NA	---	---	NA	NA	NA

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	
			Constant Head	Falling Head
NRB-1 (2.5-3) (1.65 g/cc)	1.2E-04	NA	X	
NRB-1 (10.5-11) (1.62 g/cc)	4.3E-04	NA	X	
NRB-2 (2.5-3) (1.71 g/cc)	1.3E-04	NA	X	
NRB-2 (10-10.5) (1.63 g/cc)	7.0E-04	NA	X	

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
NRB-1 (2.5-3) (1.65 g/cc)	0	39.0
	13	38.4
	34	38.4
	102	35.1
	337	29.5
	10198	12.7
	51806	8.0
	338880	4.6
	841261	3.7
NRB-1 (10.5-11) (1.62 g/cc)	0	41.3
	13	41.3 ‡‡
	34	41.3 ‡‡
	102	38.5
	337	26.6
	17337	13.0
	69244	9.8
	279833	6.9
	841261	5.8
NRB-2 (2.5-3) (1.71 g/cc)	0	38.3
	13	38.3
	34	38.2
	102	36.9
	337	32.9
	7852	16.4
	68123	10.7
	269533	7.6
	841261	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)
NRB-2 (10-10.5) (1.63 g/cc)	0	41.0
	13	40.3
	34	37.5
	102	32.8
	337	29.1
	12849	17.4
	43342	11.6
	241591	6.0
	841261	4.0

‡‡ 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)
NRB-1 (2.5-3) (1.65 g/cc)	0.0064	1.2726	0.00	39.02	NA	NA
NRB-1 (10.5-11) (1.62 g/cc)	0.0096	1.3349	4.86	42.24	NA	NA
NRB-2 (2.5-3) (1.71 g/cc)	0.0033	1.2870	2.63	38.49	NA	NA
NRB-2 (10-10.5) (1.63 g/cc)	0.0165	1.1966	0.00	40.72	NA	NA

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
NRB-1 (0.5-1)	0.00051	0.054	0.065	127	35	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (1.5-2)	0.00016	0.057	0.068	425	126	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (2.5-3)	0.00075	0.053	0.064	85	20	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (3-3.5)	0.00053	0.049	0.058	109	27	WS/H	Silt with sand (ML)s	Loam	(Est)
NRB-1 (5.5-6)	0.0024	0.049	0.059	25	5.5	WS/H	Silt with sand (ML)s	Loam	
NRB-1 (10.5-11)	0.00014	0.059	0.068	486	203	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (15.5-16)	0.00056	0.035	0.046	82	21	WS/H	Silt with sand (ML)s	Loam	(Est)
NRB-1 (21-21.5)	0.00064	0.016	0.042	66	0.084	WS/H	Fat clay with sand (CH)s	Clay Loam	(Est)
NRB-2 (0.5-1)	0.00031	0.044	0.055	177	31	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-2 (1.5-2)	0.00021	0.037	0.047	224	23	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-2 (2.5-3)	0.00067	0.042	0.052	78	11	WS/H	Lean clay with sand (CL)s	Loam	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
NRB-2 (3-3.5)	0.00011	0.038	0.048	436	27	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-2 (5.5-6)	0.00034	0.049	0.066	194	26	WS/H	Sandy lean clay s(CL)	Loam	(Est)
NRB-2 (10-10.5)	0.00075	0.030	0.041	55	1.1	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-3 (0.5-1)	0.00054	0.053	0.068	126	14	WS/H	Sandy lean clay s(CL)	Loam	(Est)
NRB-3 (1.5-2)	0.0081	0.24	0.37	46	1.6	WS/H	Silty sand (SM)	Sandy Loam †	
NRB-3 (2.5-3.5)	0.0074	0.24	0.31	42	3.5	WS/H	Silty sand (SM)	Loamy Sand	
NRB-5 (1-1.5)	0.0017	0.058	0.072	42	11	WS/H	Sandy silt s(ML)	Sandy Loam	
NRB-5 (2.5-3)	0.017	0.24	0.40	24	1.2	WS/H	Silty sand with gravel (SM)g	Sandy Loam †	
NRB-5 (3-3.5)	0.049	0.77	1.5	31	1.3	WS/H	Silty sand with gravel (SM)g	Loamy Sand †	
NRB-5 (5-5.5)	0.0011	0.055	0.068	62	15	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-6 (0.5-1)	0.0011	0.055	0.066	60	17	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
NRB-6 (1.5-2)	0.00031	0.049	0.059	190	43	WS/H	Silt with sand (ML)s	Loam	(Est)
NRB-6 (2.5-3)	0.0010	0.033	0.041	41	6.2	WS/H	Silt (ML)	Silt Loam	(Est)
NRB-6 (3-3.5)	0.00094	0.035	0.043	46	4.2	WS/H	Silt (ML)	Loam	(Est)
NRB-6 (5.5-6)	0.00016	0.042	0.053	331	14	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-6 (10.5-11)	0.00082	0.056	0.070	85	15	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-6 (15.5-16)	0.00061	0.060	0.072	118	35	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-6 (20-21.5)	0.0074	0.87	2.1	284	4.0	WS/H	Silty sand with gravel (SM)g	Sandy Loam †	

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
NRB-1 (0.5-1)	0.0	31.7	53.9	14.3
NRB-1 (1.5-2)	0.0	34.7	51.9	13.4
NRB-1 (2.5-3)	0.0	32.0	53.0	15.0
NRB-1 (3-3.5)	0.0	24.6	61.8	13.5
NRB-1 (5.5-6)	0.0	26.1	64.4	9.5
NRB-1 (10.5-11)	0.0	32.7	50.7	16.7
NRB-1 (15.5-16)	0.0	22.3	64.2	13.4
NRB-1 (21-21.5)	0.0	27.1	36.3	36.6
NRB-2 (0.5-1)	0.0	25.0	58.2	16.8
NRB-2 (1.5-2)	0.0	18.7	62.9	18.4
NRB-2 (2.5-3)	0.0	22.5	59.5	18.0
NRB-2 (3-3.5)	0.1	21.1	56.7	22.2
NRB-2 (5.5-6)	0.0	35.8	48.4	15.7
NRB-2 (10-10.5)	0.6	18.8	59.0	21.6
NRB-3 (0.5-1)	0.2	35.9	45.1	18.8
NRB-3 (1.5-2)	8.4	60.0	25.2	6.4

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Percent Gravel, Sand, Silt and Clay* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
NRB-3 (2.5-3.5)	3.0	68.8	23.1	5.1
NRB-5 (1-1.5)	1.2	36.7	51.8	10.4
NRB-5 (2.5-3)	17.0	56.4	20.4	6.2
NRB-5 (3-3.5)	29.6	57.0	10.3	3.1
NRB-5 (5-5.5)	1.2	34.2	52.3	12.3
NRB-6 (0.5-1)	1.0	32.3	55.0	11.7
NRB-6 (1.5-2)	0.1	26.4	58.7	14.9
NRB-6 (2.5-3)	0.0	14.5	69.4	16.1
NRB-6 (3-3.5)	0.0	12.6	69.2	18.2
NRB-6 (5.5-6)	0.0	23.9	55.3	20.7
NRB-6 (10.5-11)	2.6	34.0	50.7	12.6
NRB-6 (15.5-16)	0.3	37.6	48.6	13.5
NRB-6 (20-21.5)	26.3	54.0	16.0	3.7

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
NRB-1 (0.5-1)	---	---	---	ML
NRB-1 (1.5-2)	---	---	---	ML
NRB-1 (2.5-3)	---	---	---	ML
NRB-1 (3-3.5)	---	---	---	ML
NRB-1 (5.5-6)	---	---	---	ML
NRB-1 (10.5-11)	---	---	---	ML
NRB-1 (15.5-16)	---	---	---	ML
NRB-1 (21-21.5)	50	26	24	CH
NRB-2 (0.5-1)	26	16	10	CL
NRB-2 (2.5-3)	28	17	11	CL
NRB-2 (3-3.5)	31	17	14	CL
NRB-2 (5.5-6)	30	21	9	CL
NRB-2 (10-10.5)	32	19	13	CL
NRB-3 (0.5-1)	28	18	10	CL
NRB-3 (1.5-2)	---	---	---	ML
NRB-3 (2.5-3.5)	---	---	---	ML
NRB-5 (1-1.5)	---	---	---	ML
NRB-5 (2.5-3)	---	---	---	ML
NRB-5 (5-5.5)	---	---	---	ML
NRB-6 (0.5-1)	---	---	---	ML

--- = Soil requires visual-manual classification due to non-plasticity

Summary of Atterberg Tests (Continued)

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
NRB-6 (1.5-2)	---	---	---	ML
NRB-6 (3-3.5)	---	---	---	ML
NRB-6 (5.5-6)	28	17	11	CL
NRB-6 (10.5-11)	---	---	---	ML
NRB-6 (15.5-16)	---	---	---	ML
NRB-6 (20-21.5)	---	---	---	ML

--- = Soil requires visual-manual classification due to non-plasticity

Summary of Chloride Analysis

Sample Number	Chloride (mg/kg)	Reporting Limit (mg/kg)
NRB-1 (0.5-1)	ND	60
NRB-1 (1.5-2)	ND	60
NRB-1 (2.5-3)	ND	61
NRB-1 (3-3.5)	ND	60
NRB-1 (5.5-6)	ND	60
NRB-1 (10.5-11)	85	60
NRB-1 (15.5-16)	ND	60
NRB-1 (21-21.5)	76	59
NRB-2 (0.5-1)	ND	60
NRB-2 (1.5-2)	ND	60
NRB-2 (2.5-3)	ND	60
NRB-2 (3-3.5)	ND	60
NRB-2 (5.5-6)	ND	60
NRB-2 (10-10.5)	130	60
NRB-3 (0.5-1)	ND	61
NRB-3 (1.5-2)	ND	59
NRB-3 (2.5-3.5)	ND	60
NRB-5 (1-1.5)	ND	60
NRB-5 (2.5-3)	ND	60
NRB-5 (3-3.5)	ND	60
NRB-5 (5-5.5)	ND	60
NRB-6 (0.5-1)	ND	60

Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, New Mexico

ND= Not detected at the specified reporting limit

Summary of Chloride Analysis (continued)

Sample Number	Chloride (mg/kg)	Reporting Limit (mg/kg)
NRB-6 (1.5-2)	ND	61
NRB-6 (2.5-3)	71	60
NRB-6 (3-3.5)	140	60
NRB-6 (5.5-6)	69	60
NRB-6 (10.5-11)	140	60
NRB-6 (15.5-16)	100	60
NRB-6 (20-21.5)	ND	60

Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, New Mexico

ND= Not detected at the specified reporting limit

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 (%)
NRB-1 (0.5-1)	4.0	NA	---	---	NA	NA	NA
NRB-1 (1.5-2)	5.2	8.6	---	---	1.66	1.75	39.5
NRB-1 (2.5-3)	5.1	NA	---	---	NA	NA	NA
NRB-1 (2.5-3) (1.65 g/cc)	5.3	8.7	---	---	1.65	1.73	40.1
NRB-1 (3-3.5)	4.9	8.0	---	---	1.65	1.73	40.2
NRB-1 (5.5-6)	4.7	7.7	---	---	1.63	1.70	40.9
NRB-1 (10.5-11)	6.7	NA	---	---	NA	NA	NA
NRB-1 (10.5-11) (1.62 g/cc)	7.4	11.9	---	---	1.62	1.74	41.2
NRB-1 (15.5-16)	6.0	10.0	---	---	1.67	1.77	39.1
NRB-1 (21-21.5)	16.4	25.0	---	---	1.52	1.77	44.6
NRB-2 (0.5-1)	4.6	NA	---	---	NA	NA	NA
NRB-2 (1.5-2)	6.8	10.9	---	---	1.60	1.70	42.0

NA = Not analyzed
--- = This sample was not remolded

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

	Moisture Content						
	As Received		Remolded				
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
NRB-2 (2.5-3)	6.5	NA	---	---	NA	NA	NA
NRB-2 (2.5-3) (1.71 g/cc)	7.1	12.1	---	---	1.71	1.83	37.8
NRB-2 (3-3.5)	8.2	13.6	---	---	1.66	1.80	39.6
NRB-2 (5.5-6)	6.9	10.7	---	---	1.55	1.66	43.5
NRB-2 (10-10.5)	7.5	NA	---	---	NA	NA	NA
NRB-2 (10-10.5) (1.63 g/cc)	10.9	17.9	---	---	1.63	1.81	40.6
NRB-3 (0.5-1)	7.9	NA	---	---	NA	NA	NA
NRB-3 (1.5-2)	8.5	11.8	---	---	1.39	1.51	49.3
NRB-3 (2.5-3.5)	7.3	NA	---	---	NA	NA	NA
NRB-5 (1-1.5)	5.8	8.6	---	---	1.47	1.56	46.5
NRB-5 (2.5-3)	5.8	10.1	---	---	1.74	1.84	36.7
NRB-5 (3-3.5)	5.4	9.4	---	---	1.73	1.82	37.1

NA = Not analyzed
--- = This sample was not remolded

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

	Moisture Content						
	As Received		Remolded				
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
NRB-5 (5-5.5)	4.2	NA	---	---	NA	NA	NA
NRB-6 (0.5-1)	3.4	NA	---	---	NA	NA	NA
NRB-6 (1.5-2)	5.9	9.8	---	---	1.65	1.75	39.9
NRB-6 (2.5-3)	9.1	14.6	---	---	1.59	1.74	42.0
NRB-6 (3-3.5)	8.1	13.2	---	---	1.63	1.77	40.6
NRB-6 (5.5-6)	6.8	9.8	---	---	1.44	1.54	47.6
NRB-6 (10.5-11)	6.5	10.1	---	---	1.55	1.65	43.5
NRB-6 (15.5-16)	6.1	10.5	---	---	1.74	1.84	36.8
NRB-6 (20-21.5)	3.3	NA	---	---	NA	NA	NA

NA = Not analyzed

--- = This sample was not remolded

Daniel B. Stephens & Associates, Inc.

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (0.5-1)

Project Name: Lisbon Site
Depth: 0.5-1'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	449.70	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	432.52	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	4.0	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (1.5-2)

Project Name: Lisbon Site
Depth: 1.5-2'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	785.10	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	746.58	
Sample volume (cm^3):	448.54	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	5.2	
Volumetric Moisture Content (% vol):	8.6	
Dry bulk density (g/cm^3):	1.66	
Wet bulk density (g/cm^3):	1.75	
Calculated Porosity (% vol):	39.5	
Percent Saturation:	21.8	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (2.5-3)
Project Name:	Lisbon Site
Depth:	2.5-3'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	386.35	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	367.63	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	5.1	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

* Weight including tares

NA = Not analyzed

--- = This sample was not remolded

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (2.5-3) (1.65 g/cc)

Project Name: Lisbon Site
Depth: 2.5-3'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	520.10	
Tare weight, ring (g):	137.29	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	363.70	
Sample volume (cm^3):	220.83	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	5.3	
Volumetric Moisture Content (% vol):	8.7	
Dry bulk density (g/cm^3):	1.65	
Wet bulk density (g/cm^3):	1.73	
Calculated Porosity (% vol):	40.1	
Percent Saturation:	21.6	

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

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	784.14	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	747.66	
Sample volume (cm^3):	454.40	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	4.9	
Volumetric Moisture Content (% vol):	8.0	
Dry bulk density (g/cm^3):	1.65	
Wet bulk density (g/cm^3):	1.73	
Calculated Porosity (% vol):	40.2	
Percent Saturation:	20.0	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (5.5-6)
Project Name:	Lisbon Site
Depth:	5.5-6'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	776.76	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	741.54	
Sample volume (cm^3):	456.24	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	4.7	
Volumetric Moisture Content (% vol):	7.7	
Dry bulk density (g/cm^3):	1.63	
Wet bulk density (g/cm^3):	1.70	
Calculated Porosity (% vol):	40.9	
Percent Saturation:	18.9	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (10.5-11)

Project Name: Lisbon Site
Depth: 10.5-11'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	424.60	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	397.76	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	6.7	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	Intera (12-19)
Job Number:	DB19.1451.01
Sample Number:	NRB-1 (10.5-11) (1.62 g/cc)
Project Name:	Lisbon Site
Depth:	10.5-11'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	521.56	
Tare weight, ring (g):	137.01	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	358.16	
Sample volume (cm^3):	221.45	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	7.4	
Volumetric Moisture Content (% vol):	11.9	
Dry bulk density (g/cm^3):	1.62	
Wet bulk density (g/cm^3):	1.74	
Calculated Porosity (% vol):	41.2	
Percent Saturation:	28.9	

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

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (15.5-16)
Project Name:	Lisbon Site
Depth:	15.5-16'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	807.24	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	761.80	
Sample volume (cm^3):	454.94	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	6.0	
Volumetric Moisture Content (% vol):	10.0	
Dry bulk density (g/cm^3):	1.67	
Wet bulk density (g/cm^3):	1.77	
Calculated Porosity (% vol):	39.1	
Percent Saturation:	25.5	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

* Weight including tares

NA = Not analyzed

--- = This sample was not remolded

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (21-21.5)
Project Name:	Lisbon Site
Depth:	21-21.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	805.62	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	692.14	
Sample volume (cm^3):	454.02	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	16.4	
Volumetric Moisture Content (% vol):	25.0	
Dry bulk density (g/cm^3):	1.52	
Wet bulk density (g/cm^3):	1.77	
Calculated Porosity (% vol):	44.6	
Percent Saturation:	56.1	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (0.5-1)
Project Name:	Lisbon Site
Depth:	0.5-1'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	477.50	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	456.49	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	4.6	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (1.5-2)
Project Name:	Lisbon Site
Depth:	1.5-2'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	741.52	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	694.20	
Sample volume (cm^3):	435.16	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	6.8	
Volumetric Moisture Content (% vol):	10.9	
Dry bulk density (g/cm^3):	1.60	
Wet bulk density (g/cm^3):	1.70	
Calculated Porosity (% vol):	42.0	
Percent Saturation:	25.9	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (2.5-3)
Project Name:	Lisbon Site
Depth:	2.5-3'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	416.80	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	391.34	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	6.5	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	Intera (12-19)
Job Number:	DB19.1451.02
Sample Number:	NRB-2 (2.5-3) (1.71 g/cc)
Project Name:	Lisbon Site
Depth:	2.5-3'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	545.69	
Tare weight, ring (g):	138.38	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	380.41	
Sample volume (cm^3):	222.27	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	7.1	
Volumetric Moisture Content (% vol):	12.1	
Dry bulk density (g/cm^3):	1.71	
Wet bulk density (g/cm^3):	1.83	
Calculated Porosity (% vol):	37.8	
Percent Saturation:	32.0	

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

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	804.14	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	743.41	
Sample volume (cm^3):	447.58	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	8.2	
Volumetric Moisture Content (% vol):	13.6	
Dry bulk density (g/cm^3):	1.66	
Wet bulk density (g/cm^3):	1.80	
Calculated Porosity (% vol):	39.6	
Percent Saturation:	34.3	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (5.5-6)
Project Name:	Lisbon Site
Depth:	5.5-6'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	751.50	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	702.99	
Sample volume (cm^3):	452.63	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	6.9	
Volumetric Moisture Content (% vol):	10.7	
Dry bulk density (g/cm^3):	1.55	
Wet bulk density (g/cm^3):	1.66	
Calculated Porosity (% vol):	43.5	
Percent Saturation:	24.6	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (10-10.5)

Project Name: Lisbon Site
Depth: 10-10.5'

	As Received	Remolded
Test Date:	16-Dec-19	---
Field weight of sample* (g):	367.82	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	342.12	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	7.5	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (10-10.5) (1.63 g/cc)
Project Name:	Lisbon Site
Depth:	10-10.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	535.27	
Tare weight, ring (g):	136.19	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	359.70	
Sample volume (cm^3):	220.28	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	10.9	
Volumetric Moisture Content (% vol):	17.9	
Dry bulk density (g/cm^3):	1.63	
Wet bulk density (g/cm^3):	1.81	
Calculated Porosity (% vol):	40.6	
Percent Saturation:	44.0	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (0.5-1)

Project Name: Lisbon Site
Depth: 0.5-1'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	549.60	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	509.37	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	7.9	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.	
Job Number:	DB19.1451.00	
Sample Number:	NRB-3 (1.5-2)	
Project Name:	Lisbon Site	
Depth:	1.5-2'	
	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	675.06	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	622.30	
Sample volume (cm^3):	446.14	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	8.5	
Volumetric Moisture Content (% vol):	11.8	
Dry bulk density (g/cm^3):	1.39	
Wet bulk density (g/cm^3):	1.51	
Calculated Porosity (% vol):	49.3	
Percent Saturation:	24.0	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-3 (2.5-3.5)
Project Name:	Lisbon Site
Depth:	2.5-3.5'

	As Received	Remolded
Test Date:	13-Dec-19	---
Field weight of sample* (g):	469.50	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	437.61	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	7.3	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (1-1.5)

Project Name: Lisbon Site
Depth: 1-1.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	655.90	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	619.75	
Sample volume (cm^3):	420.95	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	5.8	
Volumetric Moisture Content (% vol):	8.6	
Dry bulk density (g/cm^3):	1.47	
Wet bulk density (g/cm^3):	1.56	
Calculated Porosity (% vol):	46.5	
Percent Saturation:	18.5	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-5 (2.5-3)
Project Name:	Lisbon Site
Depth:	2.5-3'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	823.25	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	777.95	
Sample volume (cm^3):	447.05	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	5.8	
Volumetric Moisture Content (% vol):	10.1	
Dry bulk density (g/cm^3):	1.74	
Wet bulk density (g/cm^3):	1.84	
Calculated Porosity (% vol):	36.7	
Percent Saturation:	27.6	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (3-3.5)

Project Name: Lisbon Site
Depth: 3-3.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	772.71	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	732.95	
Sample volume (cm^3):	423.86	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	5.4	
Volumetric Moisture Content (% vol):	9.4	
Dry bulk density (g/cm^3):	1.73	
Wet bulk density (g/cm^3):	1.82	
Calculated Porosity (% vol):	37.1	
Percent Saturation:	25.3	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-5 (5-5.5)
Project Name:	Lisbon Site
Depth:	5-5.5'

	As Received	Remolded
Test Date:	12-Dec-19	---
Field weight of sample* (g):	242.45	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	232.76	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	4.2	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (0.5-1)
Project Name:	Lisbon Site
Depth:	0.5-1'

	As Received	Remolded
Test Date:	12-Dec-19	---
Field weight of sample* (g):	379.93	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	367.50	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	3.4	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (1.5-2)

Project Name: Lisbon Site
Depth: 1.5-2'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	712.09	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	672.13	
Sample volume (cm^3):	406.74	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	5.9	
Volumetric Moisture Content (% vol):	9.8	
Dry bulk density (g/cm^3):	1.65	
Wet bulk density (g/cm^3):	1.75	
Calculated Porosity (% vol):	39.9	
Percent Saturation:	24.6	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (2.5-3)

Project Name: Lisbon Site
Depth: 2.5-3'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	777.01	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	712.03	
Sample volume (cm^3):	446.49	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	9.1	
Volumetric Moisture Content (% vol):	14.6	
Dry bulk density (g/cm^3):	1.59	
Wet bulk density (g/cm^3):	1.74	
Calculated Porosity (% vol):	42.0	
Percent Saturation:	34.6	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	793.36	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	734.24	
Sample volume (cm^3):	449.37	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	8.1	
Volumetric Moisture Content (% vol):	13.2	
Dry bulk density (g/cm^3):	1.63	
Wet bulk density (g/cm^3):	1.77	
Calculated Porosity (% vol):	40.6	
Percent Saturation:	32.4	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (5.5-6)
Project Name:	Lisbon Site
Depth:	5.5-6'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	660.27	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	618.36	
Sample volume (cm^3):	428.79	
Assumed particle density (g/cm^3):	2.75	

Gravimetric Moisture Content (% g/g):	6.8	
Volumetric Moisture Content (% vol):	9.8	
Dry bulk density (g/cm^3):	1.44	
Wet bulk density (g/cm^3):	1.54	
Calculated Porosity (% vol):	47.6	
Percent Saturation:	20.6	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

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

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (10.5-11)
Project Name:	Lisbon Site
Depth:	10.5-11'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	737.13	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	691.99	
Sample volume (cm^3):	445.62	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	6.5	
Volumetric Moisture Content (% vol):	10.1	
Dry bulk density (g/cm^3):	1.55	
Wet bulk density (g/cm^3):	1.65	
Calculated Porosity (% vol):	43.5	
Percent Saturation:	23.3	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (15.5-16)
Project Name:	Lisbon Site
Depth:	15.5-16'

	As Received	Remolded
Test Date:	11-Dec-19	---
Field weight of sample* (g):	823.42	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	776.30	
Sample volume (cm^3):	446.96	
Assumed particle density (g/cm^3):	2.75	

	As Received	Remolded
Gravimetric Moisture Content (% g/g):	6.1	
Volumetric Moisture Content (% vol):	10.5	
Dry bulk density (g/cm^3):	1.74	
Wet bulk density (g/cm^3):	1.84	
Calculated Porosity (% vol):	36.8	
Percent Saturation:	28.6	

Laboratory analysis by:	A. Bland
Data entered by:	A. Albay-Yenney
Checked by:	J. Hines

Comments:

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

Daniel B. Stephens & Associates, Inc.

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

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (20-21.5)
Project Name:	Lisbon Site
Depth:	20-21.5'

	As Received	Remolded
Test Date:	12-Dec-19	---
Field weight of sample* (g):	247.90	
Tare weight, ring (g):	0.00	
Tare weight, pan/plate (g):	0.00	
Tare weight, other (g):	0.00	
Dry weight of sample (g):	239.96	
Sample volume (cm^3):	NA	
Assumed particle density (g/cm^3):	2.75	
Gravimetric Moisture Content (% g/g):	3.3	
Volumetric Moisture Content (% vol):	NA	
Dry bulk density (g/cm^3):	NA	
Wet bulk density (g/cm^3):	NA	
Calculated Porosity (% vol):	NA	
Percent Saturation:	NA	

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Comments:

* Weight including tares
NA = Not analyzed
--- = 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	Falling Head
NRB-1 (2.5-3) (1.65 g/cc)	1.2E-04	NA	X	
NRB-1 (10.5-11) (1.62 g/cc)	4.3E-04	NA	X	
NRB-2 (2.5-3) (1.71 g/cc)	1.3E-04	NA	X	
NRB-2 (10-10.5) (1.63 g/cc)	7.0E-04	NA	X	

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	INTERA Inc.	*Type of water used:*	TAP
Job Number:	DB19.1451.00	*Collection vessel tare* (g)*:*	29.37
Sample Number:	NRB-1 (2.5-3) (1.65 g/cc)	*Sample length* (cm)*:*	7.54
Project Name:	Lisbon Site	*Sample diameter* (cm)*:*	6.11
Depth:	2.5-3'	*Sample x-sectional area* (cm^2)*:*	29.27

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
13-Dec-19	12:27:00	19.5	8.55	30.59	1.2	300	1.2E-04	1.2E-04
13-Dec-19	12:32:00							
Test # 2:								
13-Dec-19	12:42:00	19.5	7.75	30.48	1.1	300	1.2E-04	1.2E-04
13-Dec-19	12:47:00							
Test # 3:								
13-Dec-19	12:57:00	19.5	6.9	30.36	1.0	300	1.2E-04	1.3E-04
13-Dec-19	13:02:00							

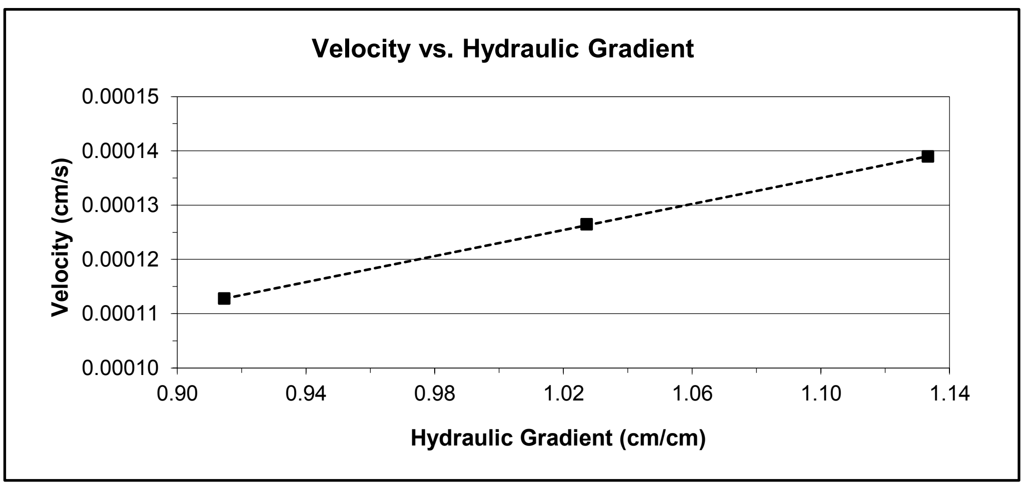
***Average Ksat* (cm/sec):** **1.2E-04**

***Oversize Corrected Ksat* (cm/sec):** **NA**

Comments:

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

NA = Not applicable



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Saturated Hydraulic Conductivity
Constant Head Method

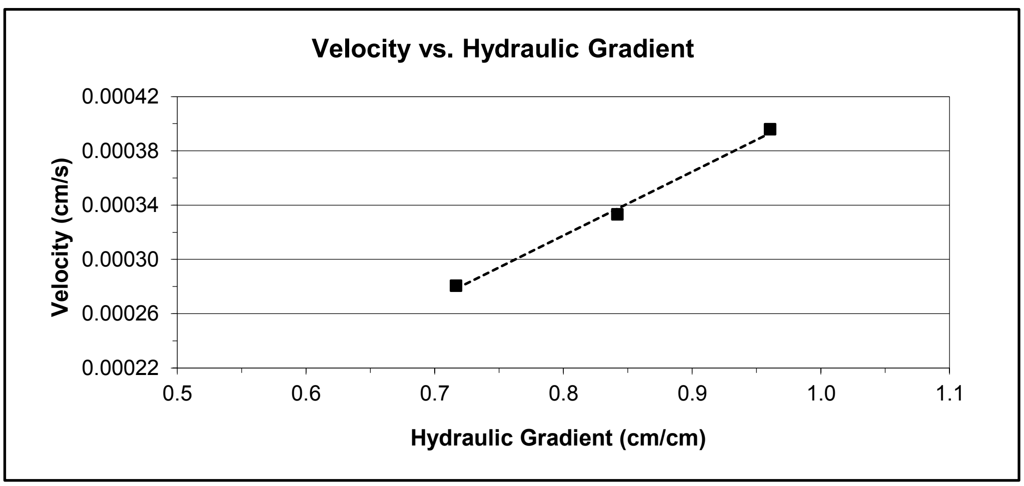
Job Name: Intera (12-19)
Job Number: DB19.1451.01
Sample Number: NRB-1 (10.5-11) (1.62 g/cc)
Project Name: Lisbon Site
Depth: 10.5-11'

Type of water used: TAP
Collection vessel tare (g): 29.49
Sample length (cm): 7.58
Sample diameter (cm): 6.10
Sample x-sectional area (cm^2): 29.23

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
13-Dec-19	12:28:30	19.5	6.9	32.96	3.5	300	4.3E-04	4.4E-04
13-Dec-19	12:33:30							
Test # 2:								
13-Dec-19	12:43:30	19.5	6	32.41	2.9	300	4.2E-04	4.3E-04
13-Dec-19	12:48:30							
Test # 3:								
13-Dec-19	12:58:30	19.5	5.05	31.95	2.5	300	4.2E-04	4.3E-04
13-Dec-19	13:03:30							

***Average Ksat* (cm/sec):** **4.3E-04**
***Oversize Corrected Ksat* (cm/sec):** **NA**

Comments:
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NA = Not applicable



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

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

Job Name:	Intera (12-19)	*Type of water used:*	TAP
Job Number:	DB19.1451.02	*Collection vessel tare* (g)*:*	29.37
Sample Number:	NRB-2 (2.5-3) (1.71 g/cc)	*Sample length* (cm)*:*	7.61
Project Name:	Lisbon Site	*Sample diameter* (cm)*:*	6.10
Depth:	2.5-3'	*Sample x-sectional area* (cm^2)*:*	29.20

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
13-Dec-19	12:27:30	19.5	8.1	30.56	1.2	300	1.3E-04	1.3E-04
13-Dec-19	12:32:30							
Test # 2:								
13-Dec-19	12:42:30	19.5	7.1	30.43	1.1	300	1.3E-04	1.3E-04
13-Dec-19	12:47:30							
Test # 3:								
13-Dec-19	12:57:30	19.5	6.2	30.29	0.9	300	1.3E-04	1.3E-04
13-Dec-19	13:02:30							

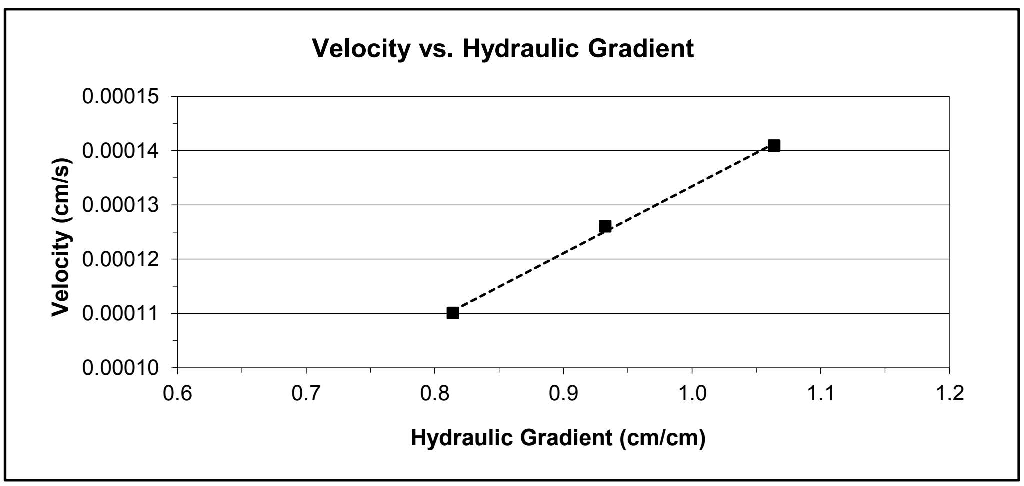
Average Ksat* (cm/sec)*: **1.3E-04**

Oversize Corrected Ksat* (cm/sec)*: **NA**

Comments:

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

NA = Not applicable



Laboratory analysis by: D. O'Dowd

Data entered by: D. O'Dowd

Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Saturated Hydraulic Conductivity
Constant Head Method

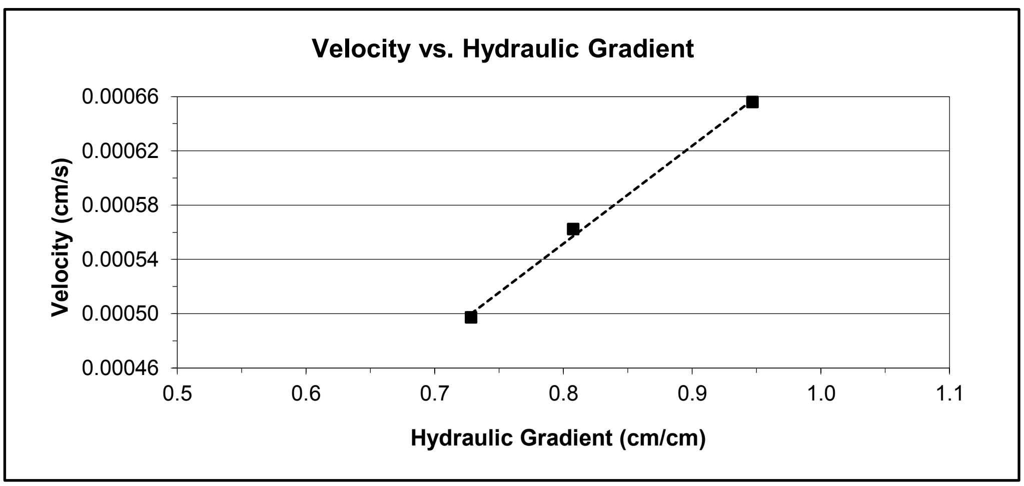
Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (10-10.5) (1.63 g/cc)
Project Name: Lisbon Site
Depth: 10-10.5'

Type of water used: TAP
Collection vessel tare (g)*:* 29.26
Sample length (cm)*:* 7.55
Sample diameter (cm)*:* 6.10
Sample x-sectional area (cm^2)*:* 29.18

Date	Time	Temp (°C)	Head (cm)	Q + Tare (g)	Q (cm^3)	Elapsed time (sec)	Ksat (cm/sec)	Ksat @ 20°C (cm/sec)
Test # 1:								
13-Dec-19	12:28:00	19.5	7.15	35.00	5.7	300	6.9E-04	7.0E-04
13-Dec-19	12:33:00							
Test # 2:								
13-Dec-19	12:43:00	19.5	6.1	34.18	4.9	300	7.0E-04	7.1E-04
13-Dec-19	12:48:00							
Test # 3:								
13-Dec-19	12:58:00	19.5	5.5	33.61	4.4	300	6.8E-04	6.9E-04
13-Dec-19	13:03:00							

Average Ksat* (cm/sec)*: **7.0E-04**
Oversize Corrected Ksat* (cm/sec)*: **NA**

Comments:
--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NA = Not applicable



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

Moisture Retention Characteristics

Summary of Moisture Characteristics of the Initial Drainage Curve

Sample Number	Pressure Head (-cm water)	Moisture Content (%, cm^3/cm^3)
NRB-1 (2.5-3) (1.65 g/cc)	0	39.0
	13	38.4
	34	38.4
	102	35.1
	337	29.5
	10198	12.7
	51806	8.0
	338880	4.6
	841261	3.7
NRB-1 (10.5-11) (1.62 g/cc)	0	41.3
	13	41.3 ‡‡
	34	41.3 ‡‡
	102	38.5
	337	26.6
	17337	13.0
	69244	9.8
	279833	6.9
	841261	5.8
NRB-2 (2.5-3) (1.71 g/cc)	0	38.3
	13	38.3
	34	38.2
	102	36.9
	337	32.9
	7852	16.4
	68123	10.7
	269533	7.6
	841261	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)
NRB-2 (10-10.5) (1.63 g/cc)	0	41.0
	13	40.3
	34	37.5
	102	32.8
	337	29.1
	12849	17.4
	43342	11.6
	241591	6.0
	841261	4.0

‡‡ 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)
NRB-1 (2.5-3) (1.65 g/cc)	0.0064	1.2726	0.00	39.02	NA	NA
NRB-1 (10.5-11) (1.62 g/cc)	0.0096	1.3349	4.86	42.24	NA	NA
NRB-2 (2.5-3) (1.71 g/cc)	0.0033	1.2870	2.63	38.49	NA	NA
NRB-2 (10-10.5) (1.63 g/cc)	0.0165	1.1966	0.00	40.72	NA	NA

--- = Oversize correction is unnecessary since coarse fraction < 5% of composite mass
NR = Not requested
NA = Not applicable

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	INTERA Inc.	*Dry wt. of sample (g):*	363.70
Job Number:	DB19.1451.00	*Tare wt., ring (g):*	137.29
Sample Number:	NRB-1 (2.5-3) (1.65 g/cc)	*Tare wt., screen & clamp (g):*	27.18
Project Name:	Lisbon Site	*Initial sample volume (cm³):*	220.83
Depth:	2.5-3'	*Initial dry bulk density (g/cm³):*	1.65
		Assumed particle density (g/cm³):	2.75
		Initial calculated total porosity (%):	40.11

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	13-Dec-19	14:00	614.28	0	38.99
	20-Dec-19	14:30	613.07	13.0	38.45
	26-Dec-19	14:30	612.90	34.0	38.37
	3-Jan-20	16:00	605.72	102.0	35.12
Pressure plate:	13-Jan-20	8:00	593.39	337	29.53

Volume Adjusted Data [1]

	Matric Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calculated Porosity (%)
Hanging column:	0.0	---	---	---	---
	13.0	---	---	---	---
	34.0	---	---	---	---
	102.0	---	---	---	---
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/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.

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: NRB-1 (2.5-3) (1.65 g/cc)

Initial sample bulk density (g/cm³): 1.65
Fraction of bulk sample used (<2.00mm fraction) (%): 100.00

Dry weight of dew point potentiometer sample* (g): 162.42
Tare weight, jar (g): 113.37

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content[†] (% vol)
Dew point potentiometer:	31-Dec-19	9:10	166.21	10198	12.73
	23-Dec-19	14:34	164.80	51806	7.99
	18-Dec-19	10:04	163.78	338880	4.57

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change[2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	10198	---	---	---	---
	51806	---	---	---	---
	338880	---	---	---	---

Dry weight of relative humidity box sample* (g): 73.40
Tare weight (g): 39.41

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content[†] (% vol)
Relative humidity box:	6-Jan-20	8:20	74.16	841261	3.70

Volume Adjusted Data[1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change[2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	841261	---	---	---	---

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

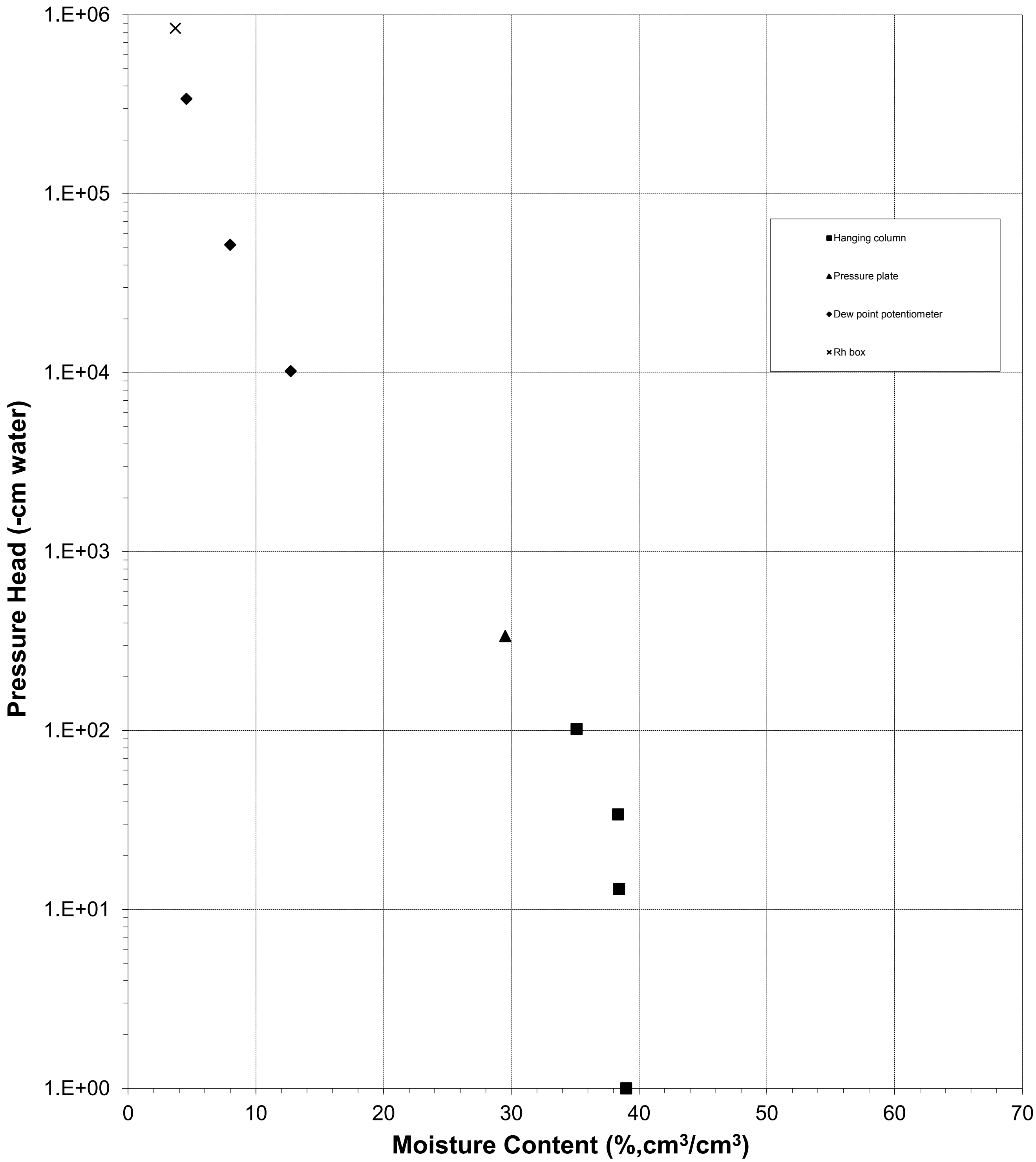
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

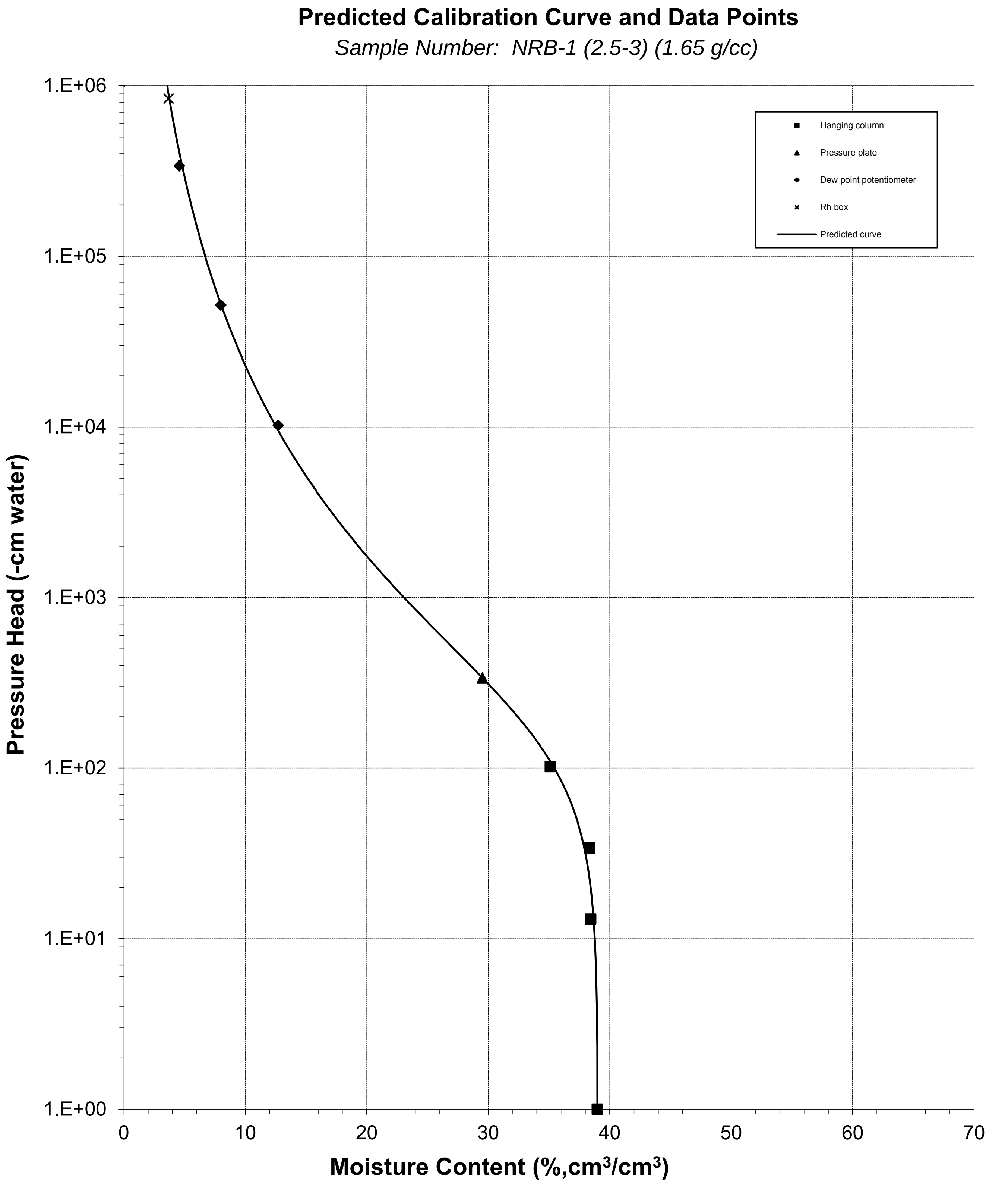
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

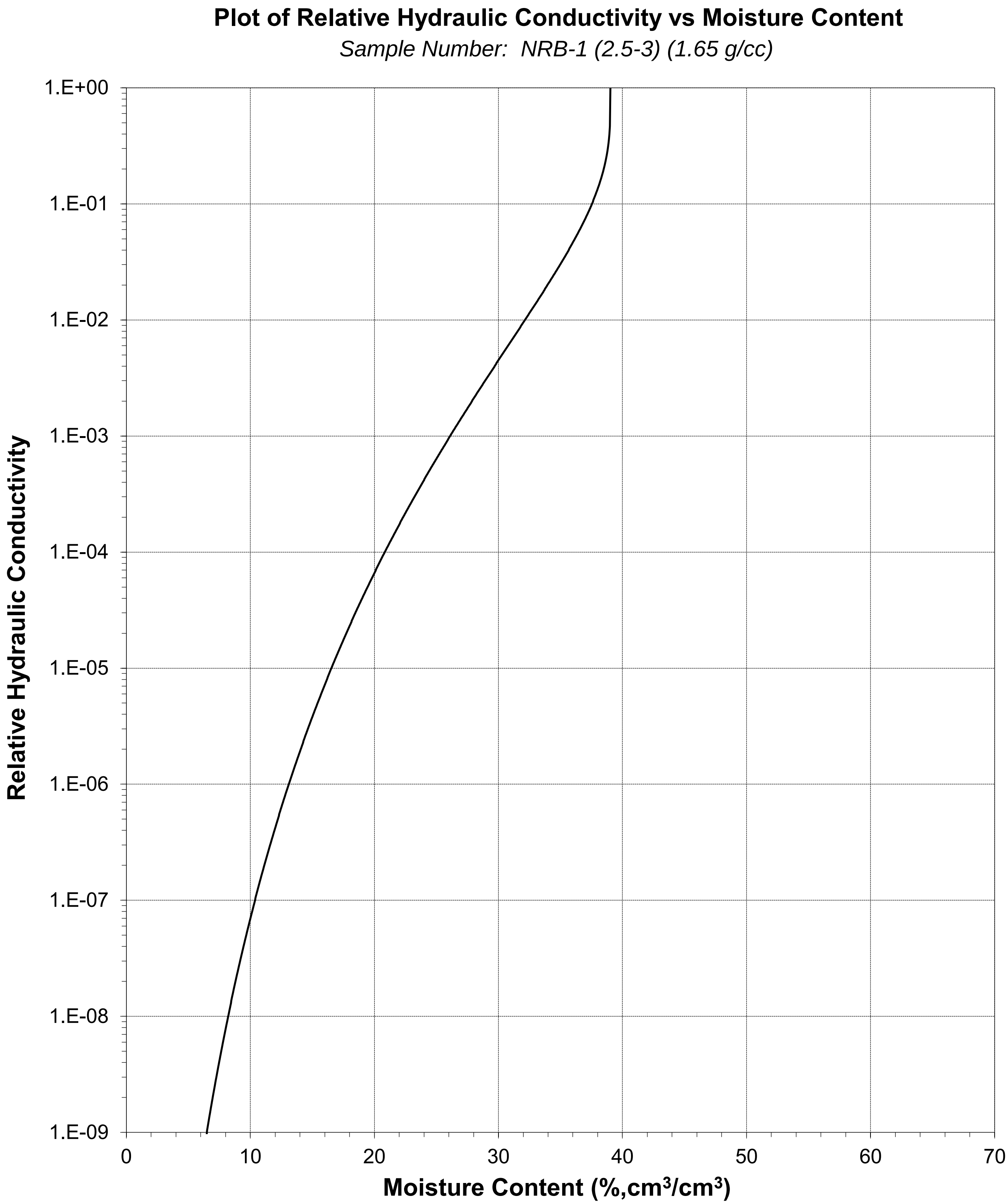
Laboratory analysis by: D. O'Dowd
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Water Retention Data Points

Sample Number: NRB-1 (2.5-3) (1.65 g/cc)

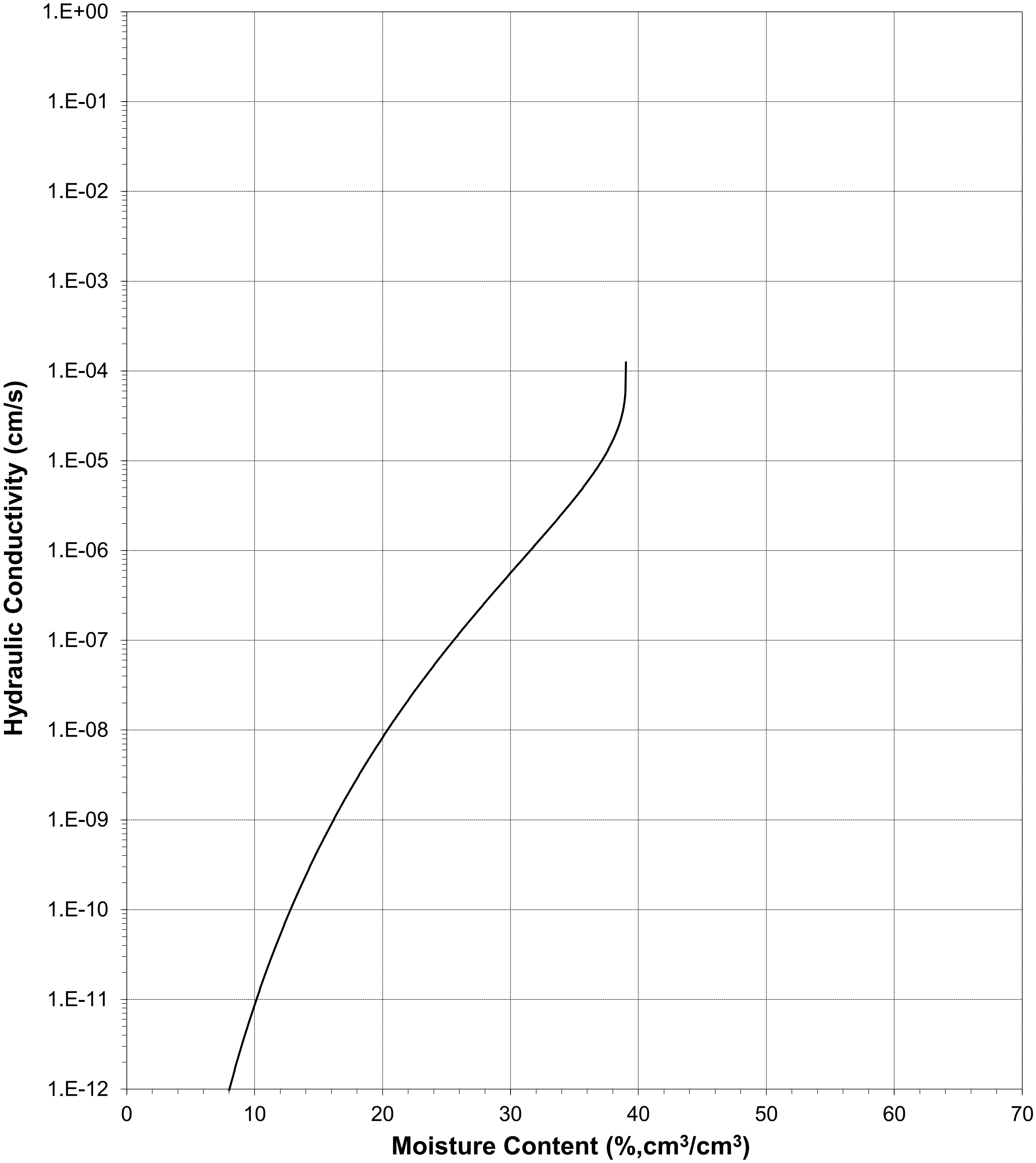



Predicted Calibration Curve and Data Points
Sample Number: NRB-1 (2.5-3) (1.65 g/cc)
Pressure Head (-cm water)
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
0
10
20
30
40
50
60
70
Moisture Content (%,cm³/cm³)
Hanging column
Pressure plate
Dew point potentiometer
Rh box
Predicted curve


Plot of Relative Hydraulic Conductivity vs Moisture Content
Sample Number: NRB-1 (2.5-3) (1.65 g/cc)
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
0
10
20
30
40
50
60
70
Moisture Content (%,cm3/cm3)

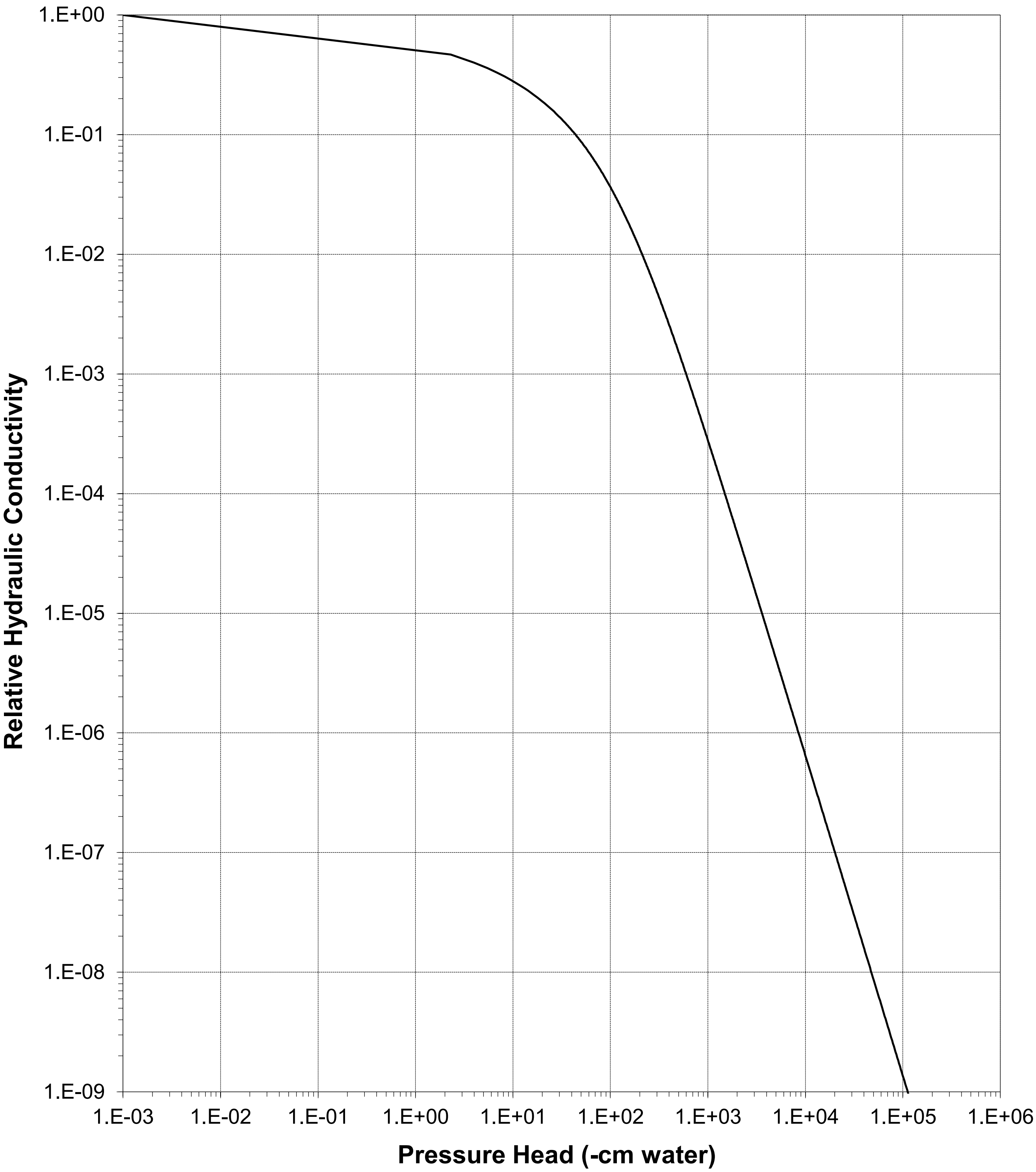
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: NRB-1 (2.5-3) (1.65 g/cc)



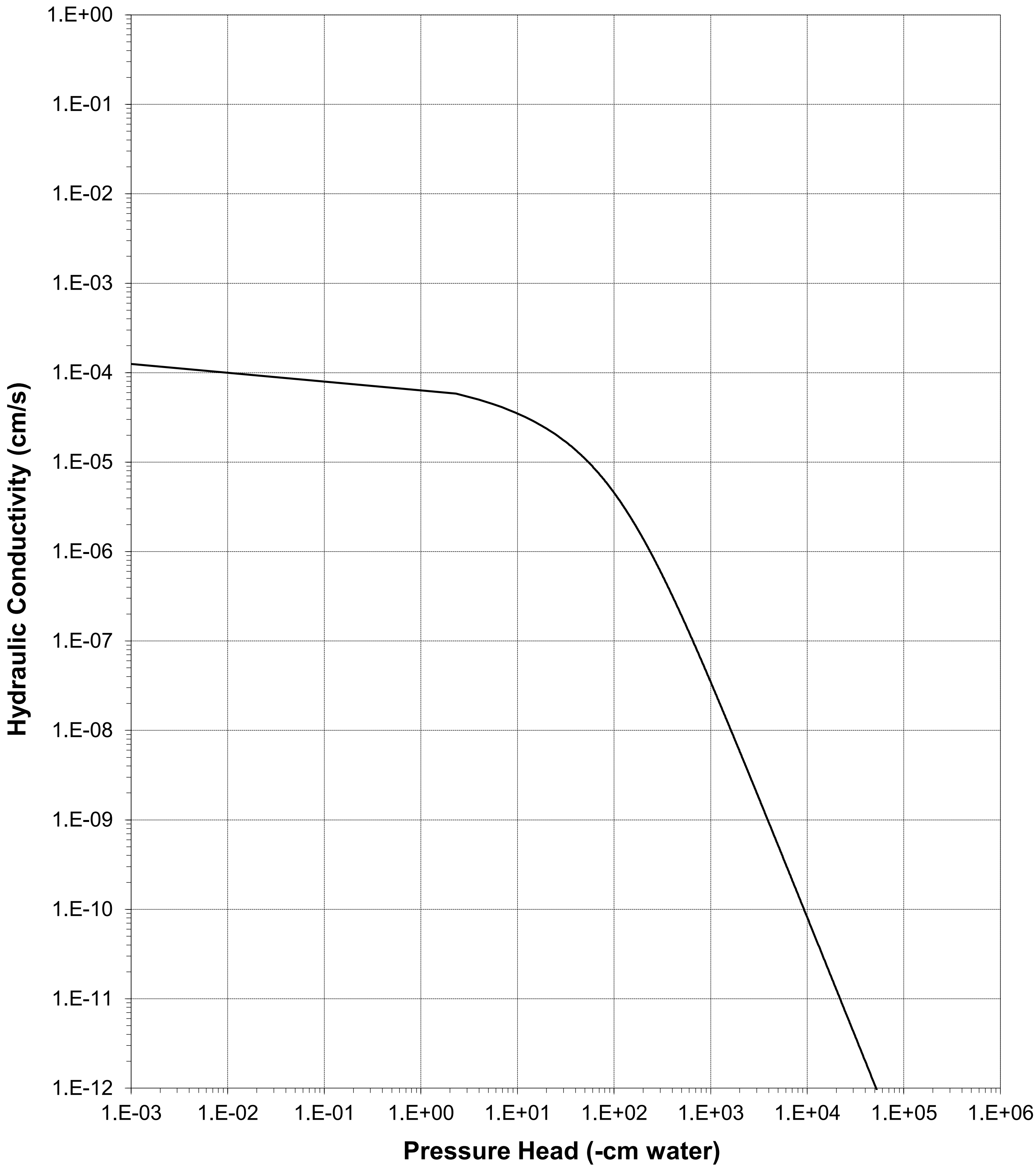
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: NRB-1 (2.5-3) (1.65 g/cc)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: NRB-1 (2.5-3) (1.65 g/cc)



Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	Intera (12-19)	*Dry wt. of sample* (g):	358.16
Job Number:	DB19.1451.01	*Tare wt., ring* (g):	137.01
Sample Number:	NRB-1 (10.5-11) (1.62 g/cc)	*Tare wt., screen & clamp* (g):	26.55
Project Name:	Lisbon Site	*Initial sample volume* (cm^3):	221.45
Depth:	10.5-11'	*Initial dry bulk density* (g/cm^3):	1.62
		Assumed particle density (g/cm^3):	2.75
		Initial calculated total porosity (%):	41.19

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)	
Hanging column:	13-Dec-19	14:00	613.14	0	41.28	
	20-Dec-19	14:30	613.48	13.0	41.28	‡‡
	26-Dec-19	14:30	613.76	34.0	41.28	‡‡
	3-Jan-20	16:00	607.03	102.0	38.52	
Pressure plate:	13-Jan-20	8:00	580.57	337	26.57	

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	---	---	---	---
	13.0	222.27	+0.37%	1.61	41.41
	34.0	222.95	+0.68%	1.61	41.58
	102.0	---	---	---	---
Pressure plate:	337	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing.

[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 for this sample

Technician Notes:

Laboratory analysis by: D. O'Dowd
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: NRB-1 (10.5-11) (1.62 g/cc)

Initial sample bulk density (g/cm^3): 1.62
Fraction of bulk sample used (<2.00mm fraction) (%): 100.00

Dry weight of dew point potentiometer sample* (g): 160.63
Tare weight, jar (g): 111.99

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	30-Dec-19	13:07	164.55	17337	13.03
	23-Dec-19	14:45	163.59	69244	9.84
	19-Dec-19	12:06	162.72	279833	6.95

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:	17337	---	---	---	---
	69244	---	---	---	---
	279833	---	---	---	---

Dry weight of relative humidity box sample* (g): 74.42
Tare weight (g): 41.90

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	6-Jan-20	8:20	75.59	841261	5.84

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:	841261	---	---	---	---

Comments:

[1] Applicable if the sample experienced volume changes during testing.

[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

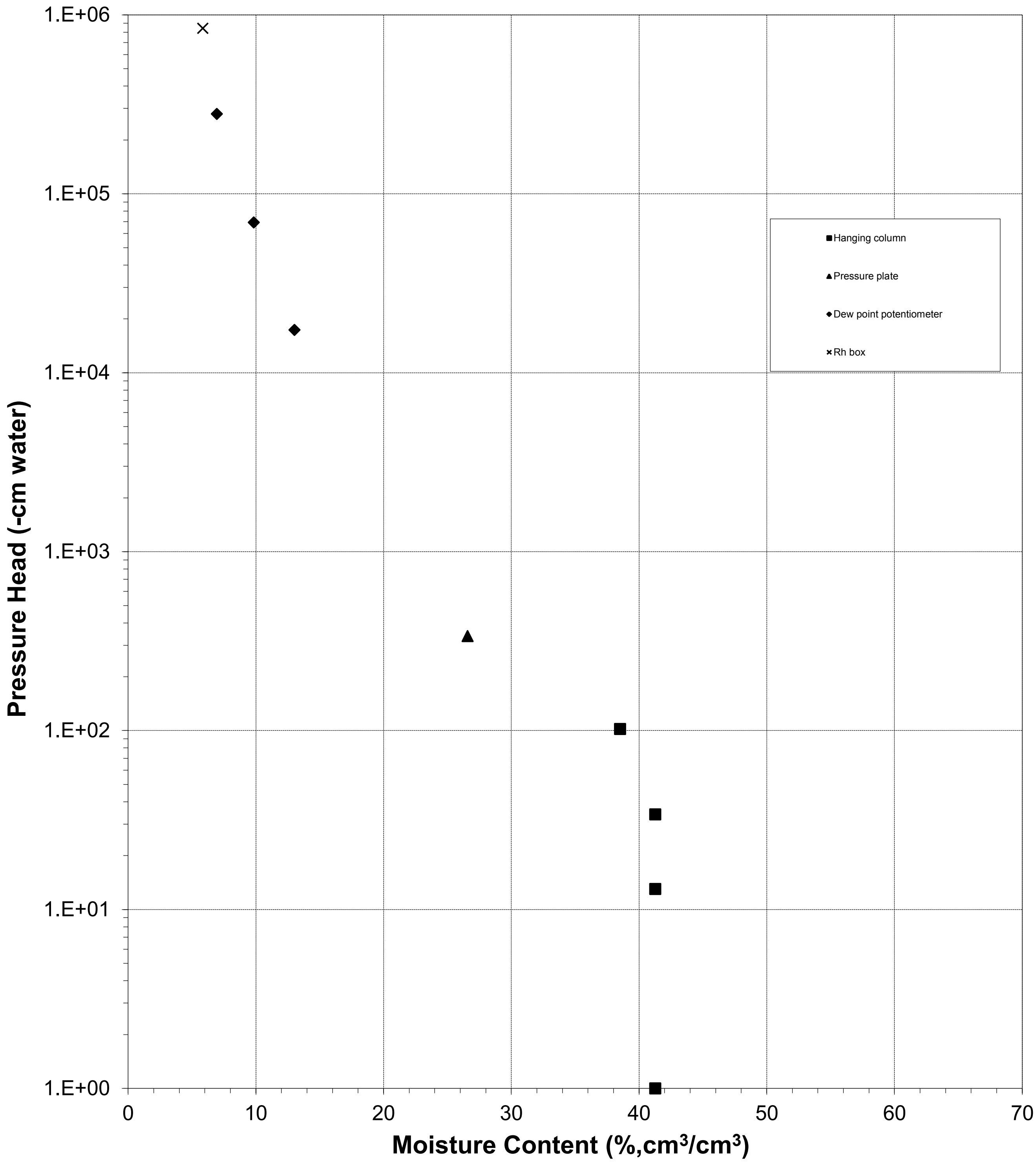
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm^3.

‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated for this sample

Laboratory analysis by: D. O'Dowd
Data entered by: A. Albay-Yenney
Checked by: J. Hines

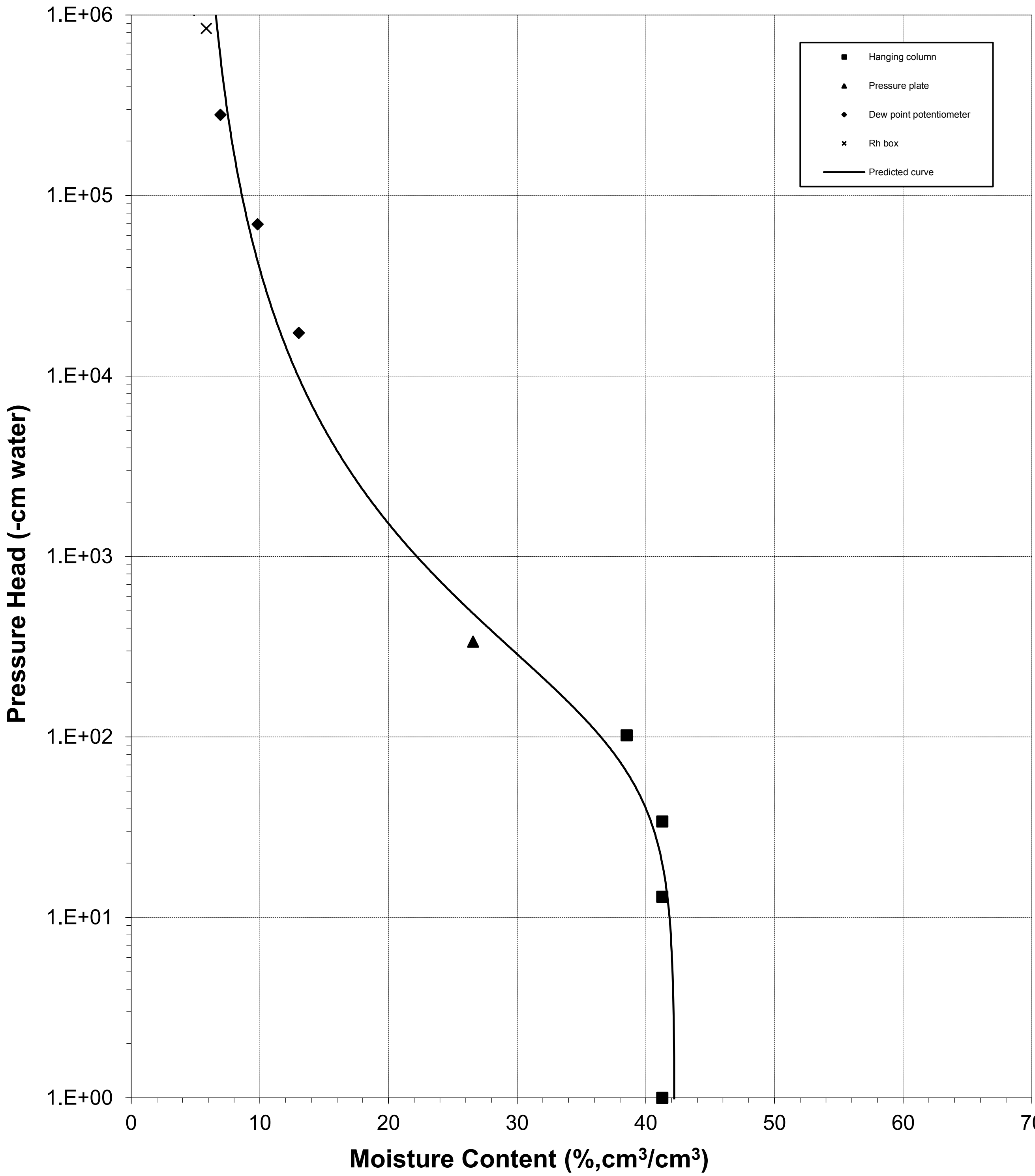
Water Retention Data Points

Sample Number: NRB-1 (10.5-11) (1.62 g/cc)



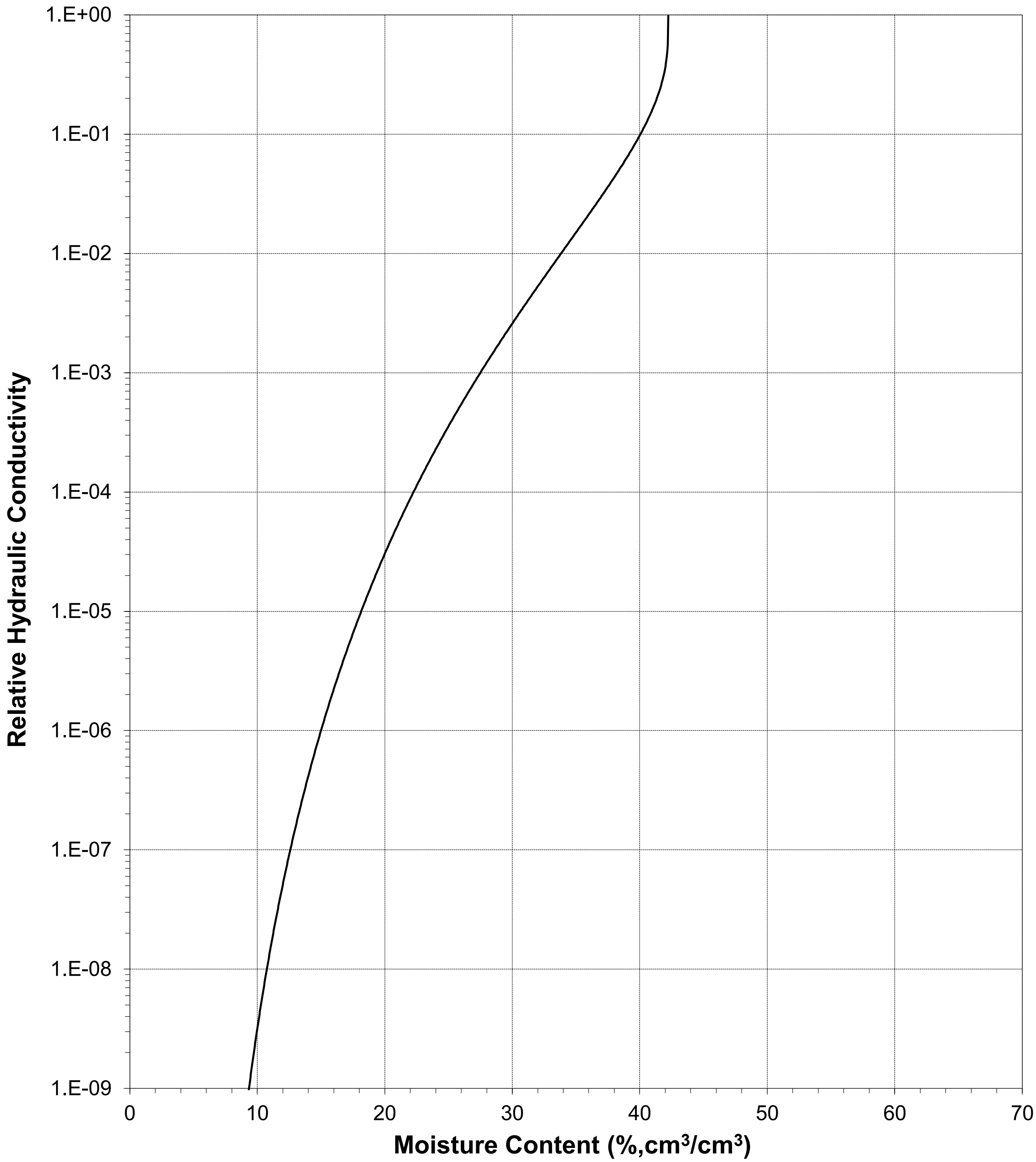
Predicted Calibration Curve and Data Points

Sample Number: NRB-1 (10.5-11) (1.62 g/cc)



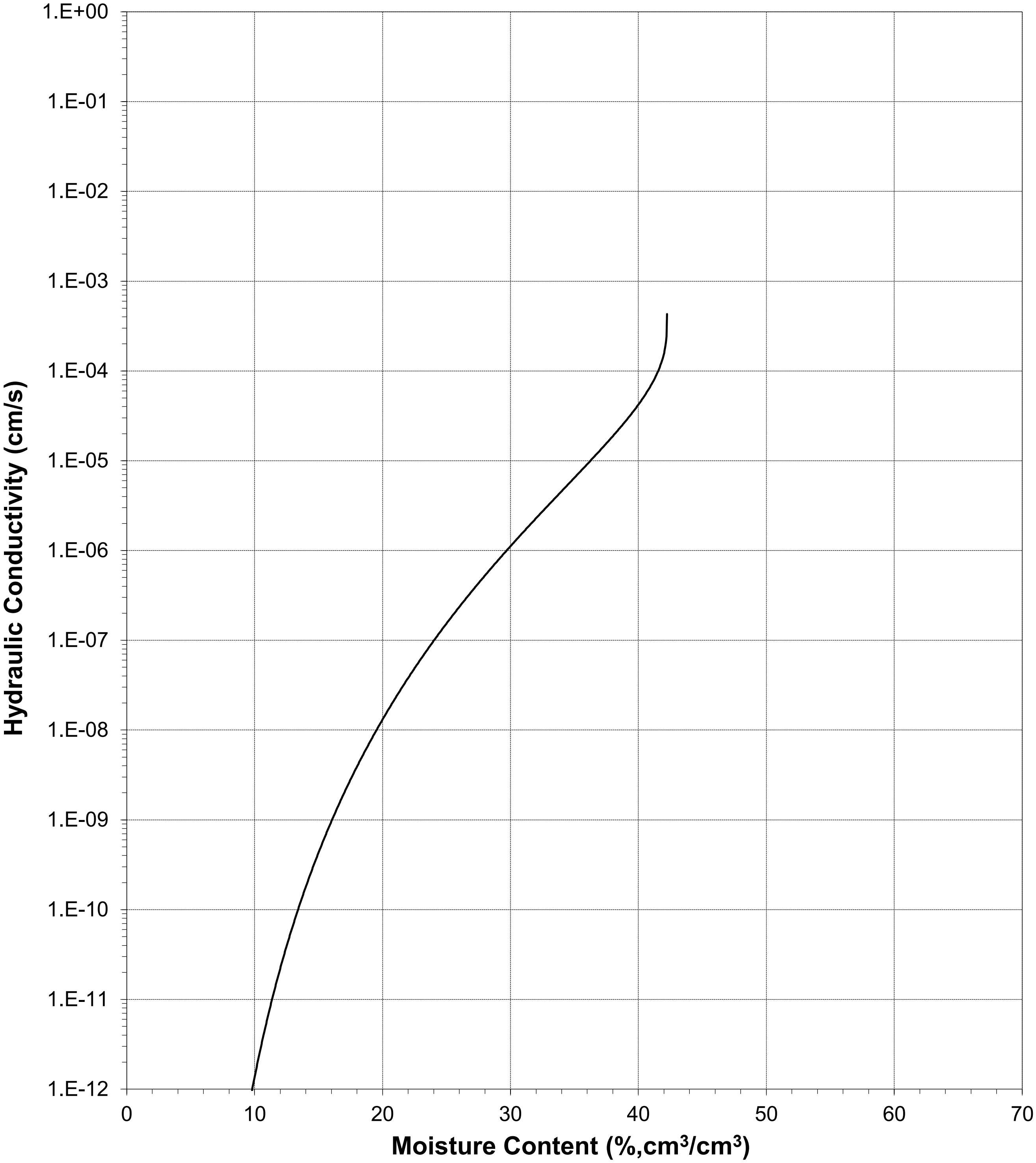
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: NRB-1 (10.5-11) (1.62 g/cc)



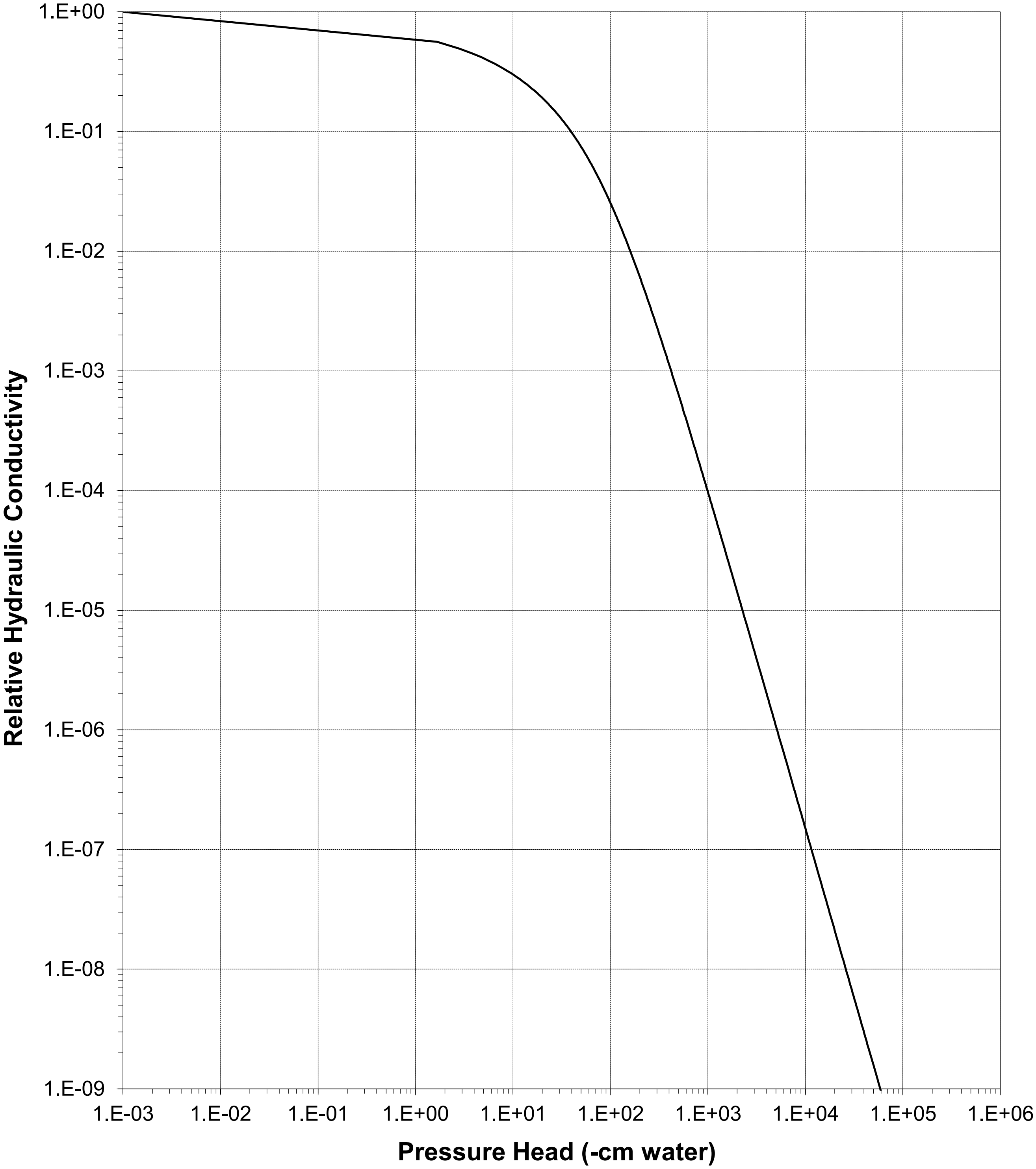
Plot of Hydraulic Conductivity vs Moisture Content

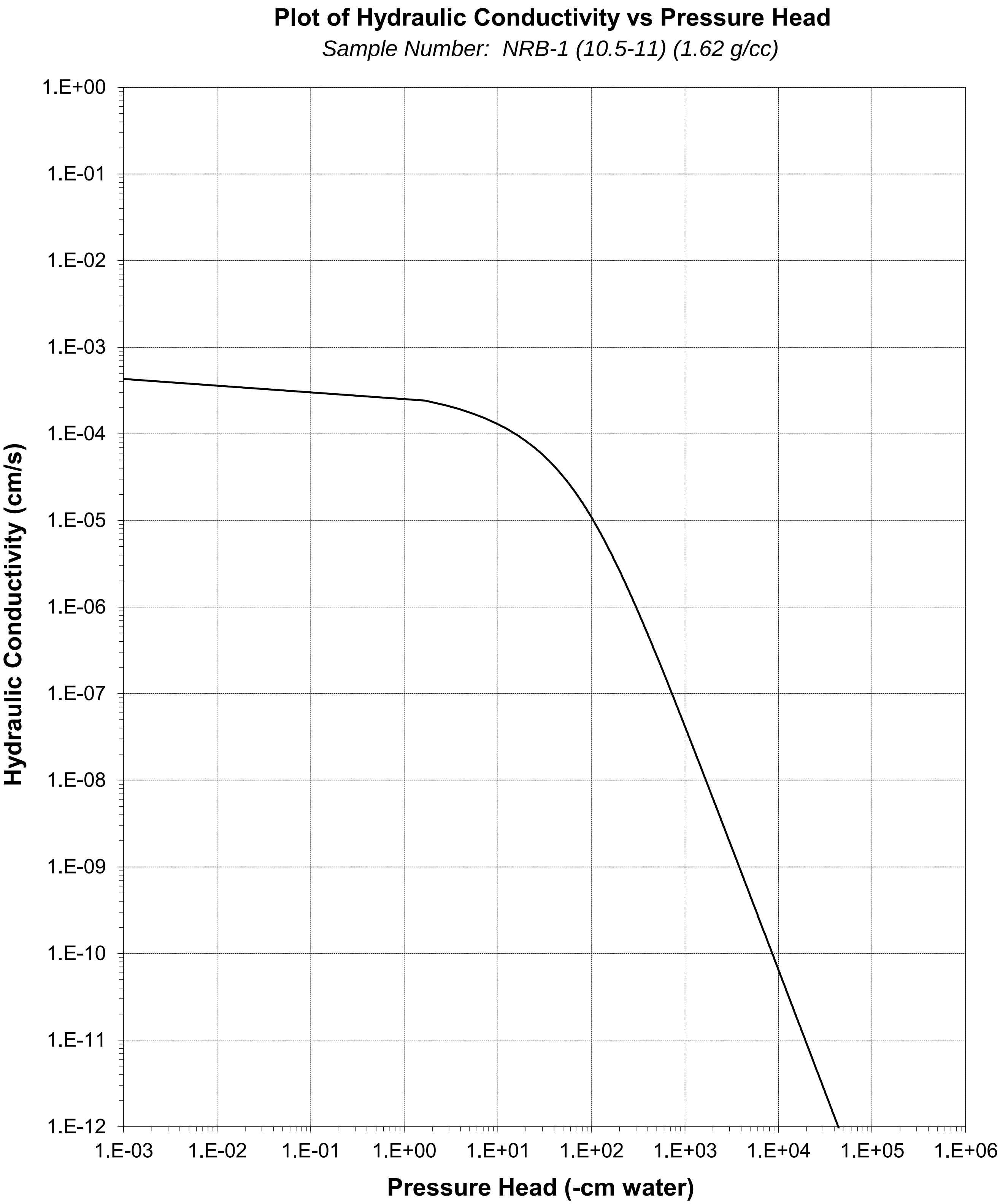
Sample Number: NRB-1 (10.5-11) (1.62 g/cc)



Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: NRB-1 (10.5-11) (1.62 g/cc)




Plot of Hydraulic Conductivity vs Pressure Head
Sample Number: NRB-1 (10.5-11) (1.62 g/cc)
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)

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name: Intera (12-19)
Job Number: DB19.1451.02
Sample Number: NRB-2 (2.5-3) (1.71 g/cc)
Project Name: Lisbon Site
Depth: 2.5-3'

Dry wt. of sample (g): 380.41
Tare wt., ring (g): 138.38
Tare wt., screen & clamp (g): 28.24
Initial sample volume (cm^3): 222.27
Initial dry bulk density (g/cm^3): 1.71
Assumed particle density (g/cm^3): 2.75
Initial calculated total porosity (%): 37.76

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content† (% vol)
Hanging column:	13-Dec-19	14:00	632.18	0	38.31
	20-Dec-19	14:30	632.10	13.0	38.27
	26-Dec-19	14:30	631.94	34.0	38.20
	3-Jan-20	16:00	628.97	102.0	36.87
Pressure plate:	13-Jan-20	8:00	620.10	337	32.87

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	---	---	---	---
	13.0	---	---	---	---
	34.0	---	---	---	---
	102.0	---	---	---	---
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: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: NRB-2 (2.5-3) (1.71 g/cc)

Initial sample bulk density (g/cm³): 1.71
Fraction of bulk sample used (<2.00mm fraction) (%): 100.00

Dry weight of dew point potentiometer sample* (g): 160.66
Tare weight, jar (g): 116.43

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	31-Dec-19	9:45	164.89	7852	16.37
	23-Dec-19	14:36	163.43	68123	10.72
	19-Dec-19	11:56	162.63	269533	7.62

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Dew point potentiometer:	7852	---	---	---	---
	68123	---	---	---	---
	269533	---	---	---	---

Dry weight of relative humidity box sample* (g): 72.92
Tare weight (g): 40.78

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	6-Jan-20	8:20	74.07	841261	6.14

Volume Adjusted Data [1]

	Water Potential (-cm water)	Adjusted Volume (cm³)	% Volume Change [2] (%)	Adjusted Density (g/cm³)	Adjusted Calc. Porosity (%)
Relative humidity box:	841261	---	---	---	---

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

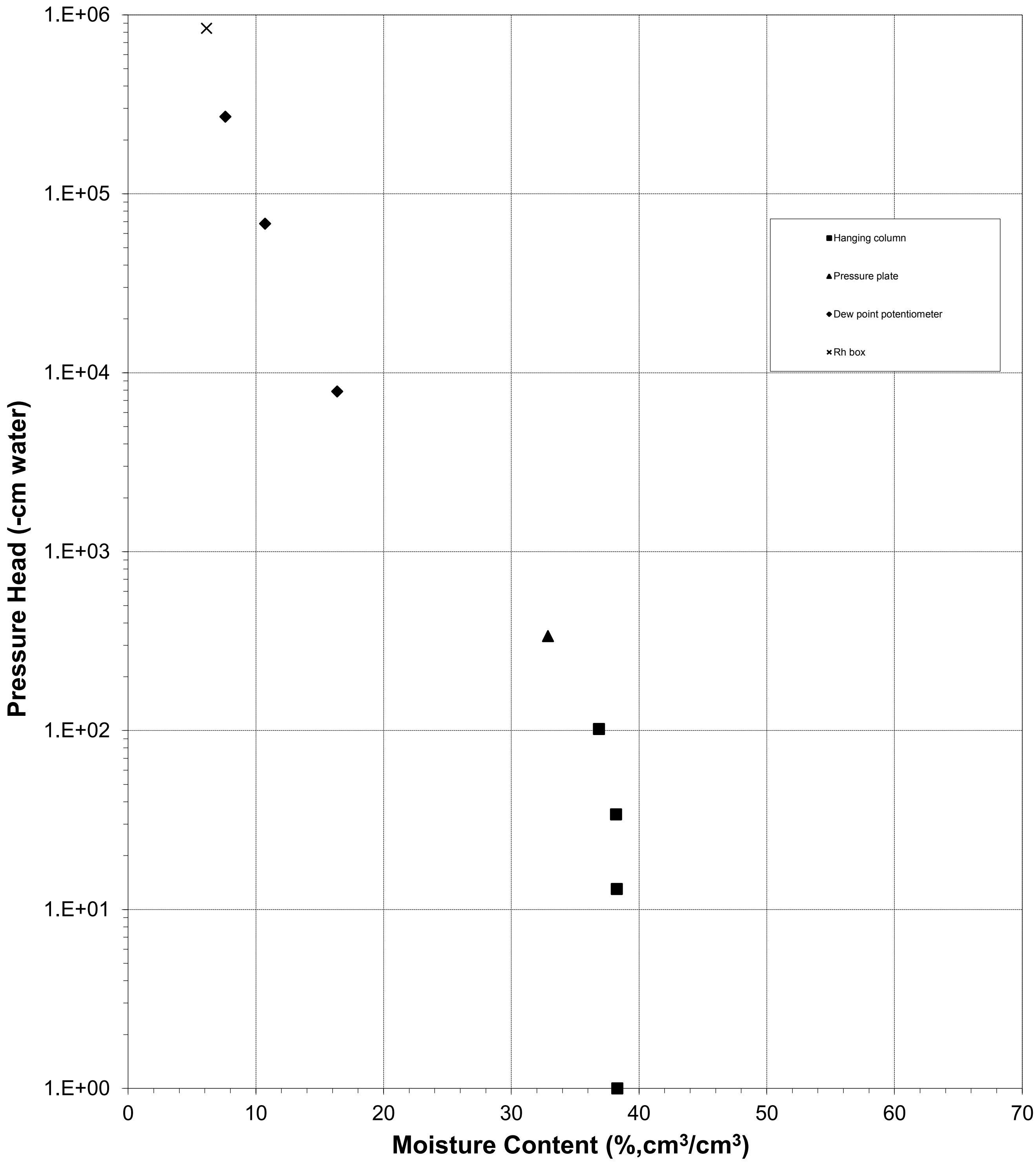
† Adjusted for >2.00mm (#10 sieve) material not used in DPP/RH testing. Assumed moisture content of material >2.00mm is zero, and assumed density of water is 1.0 g/cm³.

‡‡ 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: A. Albay-Yenney
Checked by: J. Hines

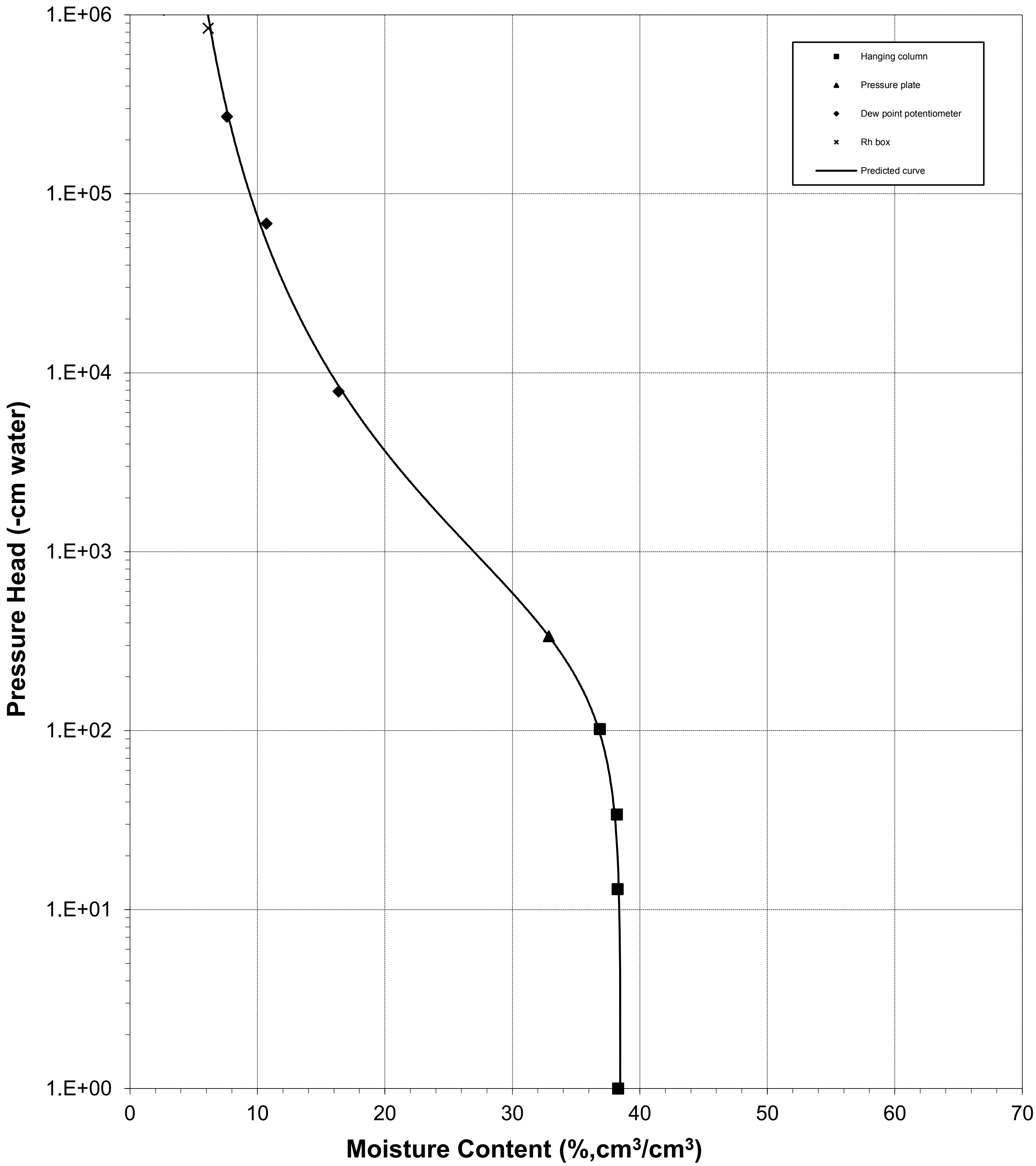
Water Retention Data Points

Sample Number: NRB-2 (2.5-3) (1.71 g/cc)



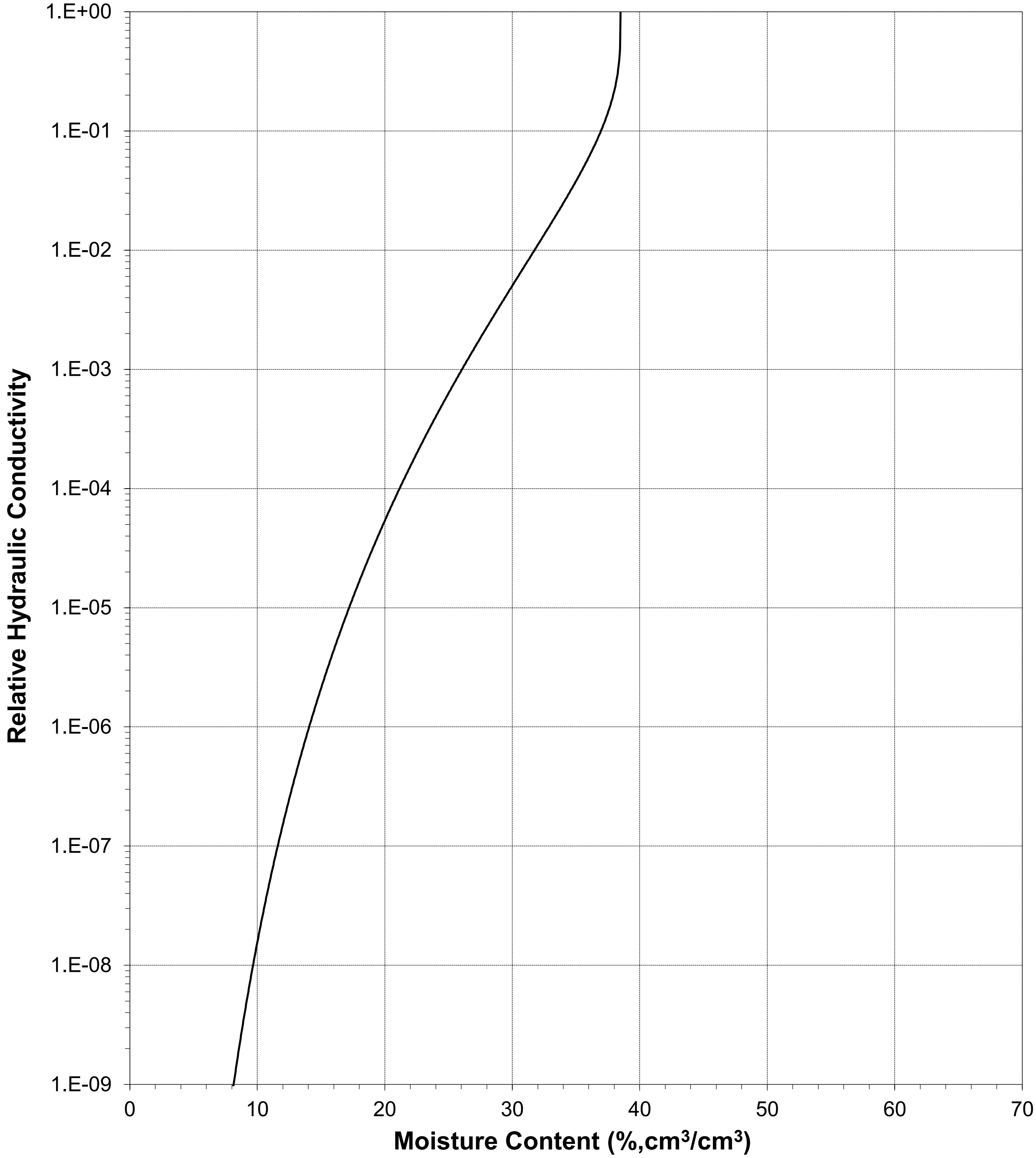
Predicted Calibration Curve and Data Points

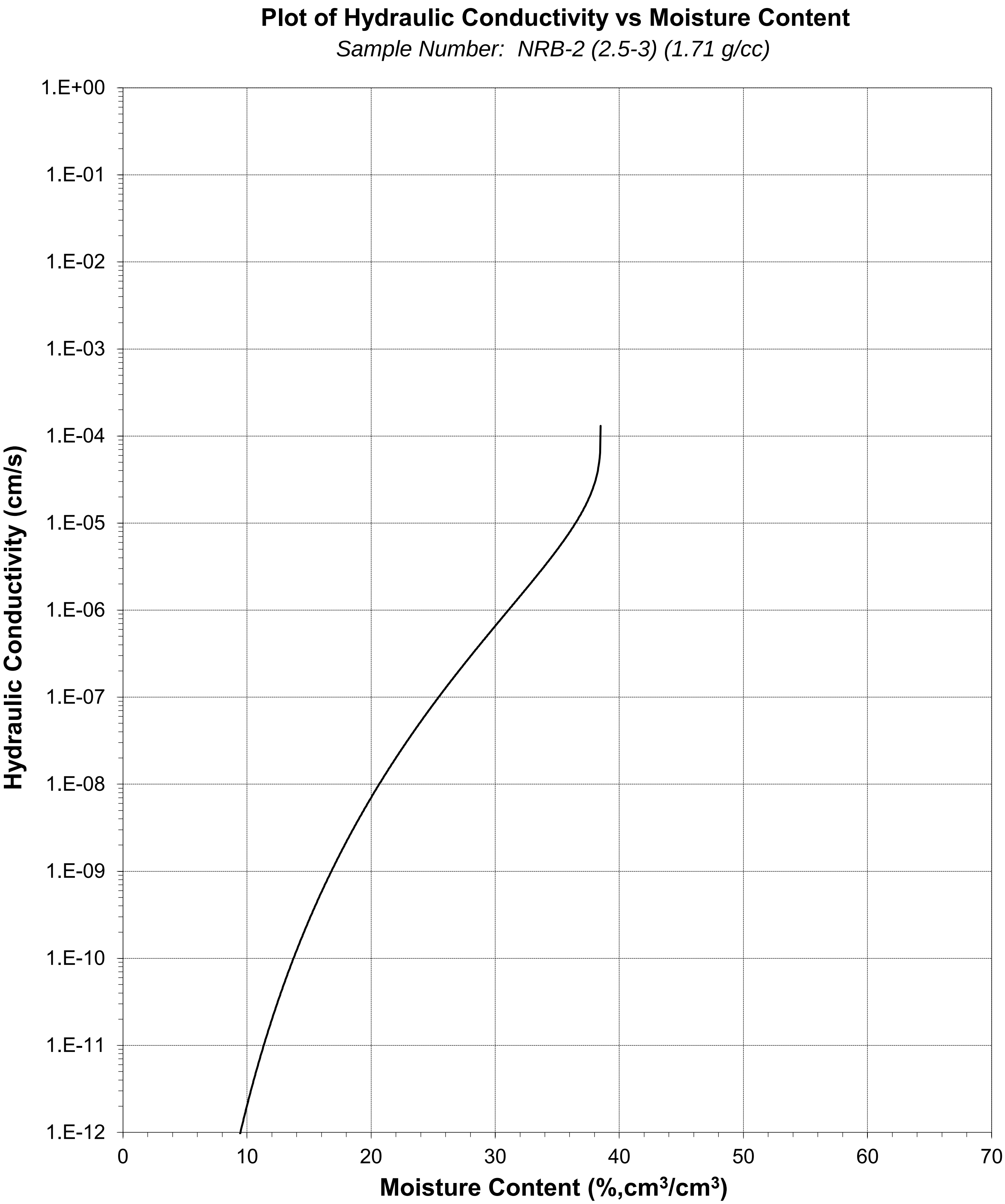
Sample Number: NRB-2 (2.5-3) (1.71 g/cc)



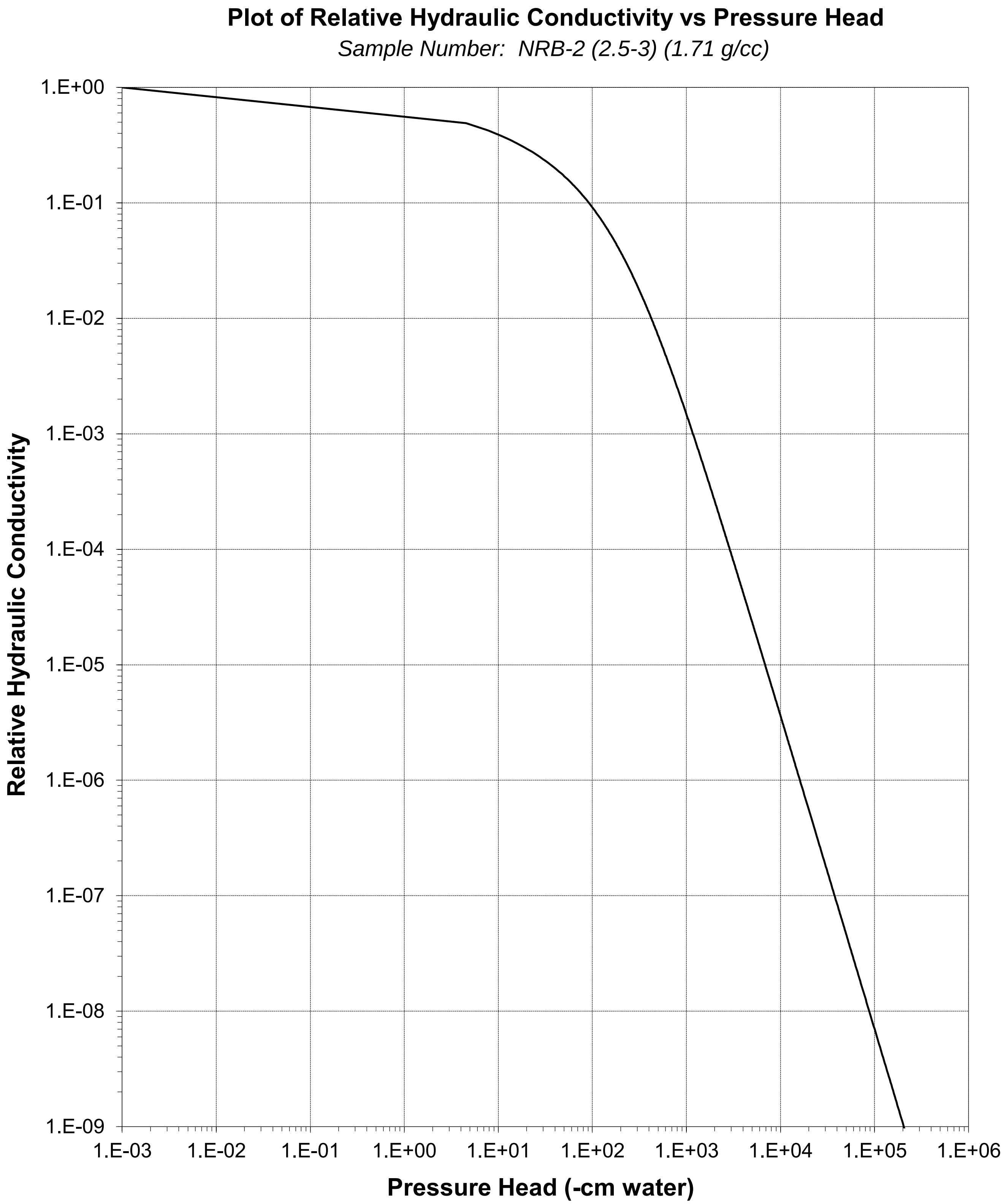
Plot of Relative Hydraulic Conductivity vs Moisture Content

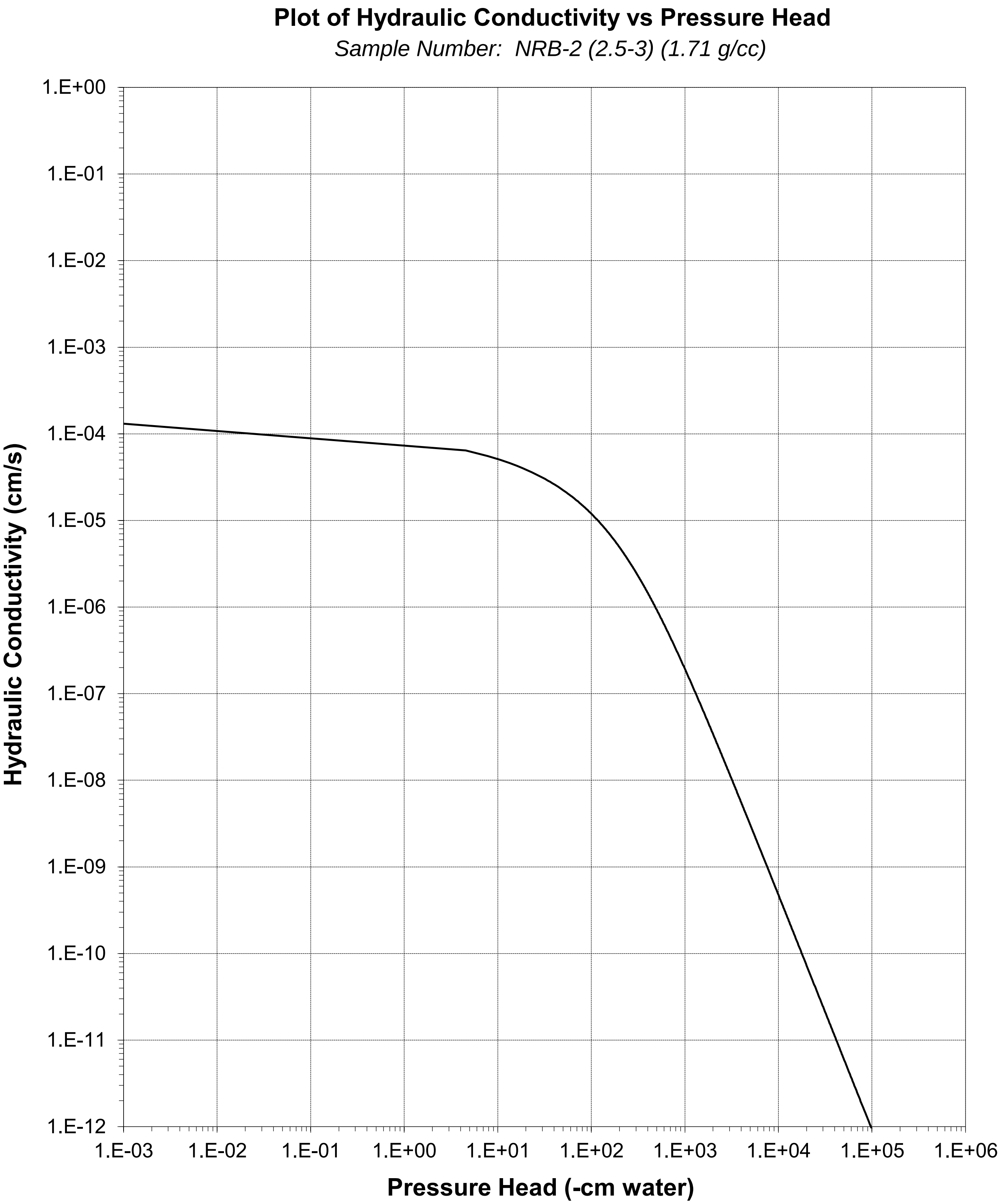
Sample Number: NRB-2 (2.5-3) (1.71 g/cc)





Plot of Hydraulic Conductivity vs Moisture Content
Sample Number: NRB-2 (2.5-3) (1.71 g/cc)
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: NRB-2 (2.5-3) (1.71 g/cc)
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: NRB-2 (2.5-3) (1.71 g/cc)
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)

Moisture Retention Data

Hanging Column / Pressure Plate

(Soil-Water Characteristic Curve)

Job Name:	INTERA Inc.	*Dry wt. of sample* (g):	359.70
Job Number:	DB19.1451.00	*Tare wt., ring* (g):	136.19
Sample Number:	NRB-2 (10-10.5) (1.63 g/cc)	*Tare wt., screen & clamp* (g):	27.48
Project Name:	Lisbon Site	*Initial sample volume* (cm^3):	220.28
Depth:	10-10.5'	*Initial dry bulk density* (g/cm^3):	1.63
		Assumed particle density (g/cm^3):	2.75
		Initial calculated total porosity (%):	40.62

	Date	Time	Weight* (g)	Matric Potential (-cm water)	Moisture Content † (% vol)
Hanging column:	13-Dec-19	14:00	613.65	0	40.98
	20-Dec-19	14:30	612.18	13.0	40.32
	26-Dec-19	14:30	605.96	34.0	37.49
	3-Jan-20	16:00	595.73	102.0	32.85
Pressure plate:	13-Jan-20	8:00	587.48	337	29.10

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	---	---	---	---
	13.0	---	---	---	---
	34.0	---	---	---	---
	102.0	---	---	---	---
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: A. Albay-Yenney
Checked by: J. Hines

Moisture Retention Data

Dew Point Potentiometer / Relative Humidity Box

(Soil-Water Characteristic Curve)

Sample Number: NRB-2 (10-10.5) (1.63 g/cc)

Initial sample bulk density (g/cm^3)*:* 1.63
Fraction of bulk sample used (<2.00mm fraction) (%): 98.39

Dry weight of dew point potentiometer sample* (g)*:* 162.70
Tare weight, jar (g)*:* 114.20

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Dew point potentiometer:	31-Dec-19	9:57	167.96	12849	17.42
	26-Dec-19	14:02	166.20	43342	11.59
	19-Dec-19	12:03	164.52	241591	6.03

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:	12849	---	---	---	---
	43342	---	---	---	---
	241591	---	---	---	---

Dry weight of relative humidity box sample* (g)*:* 88.05
Tare weight (g)*:* 40.70

	Date	Time	Weight* (g)	Water Potential (-cm water)	Moisture Content † (% vol)
Relative humidity box:	6-Jan-20	8:20	89.21	841261	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:	841261	---	---	---	---

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.

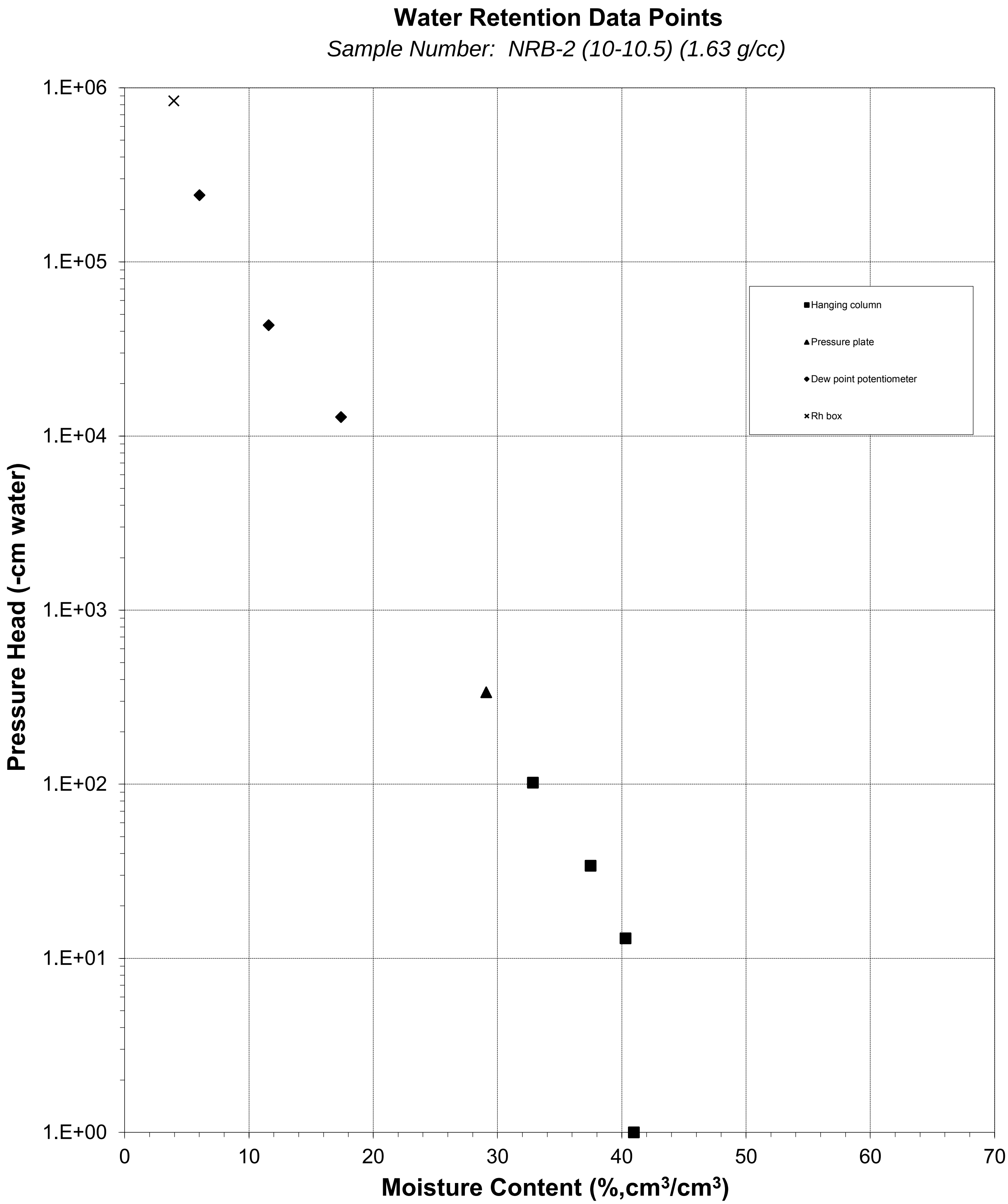
[2] Represents percent volume change from original sample volume. A '+' denotes measured sample swelling, a '-' denotes measured sample settling, and '---' denotes no volume change occurred.

* 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.

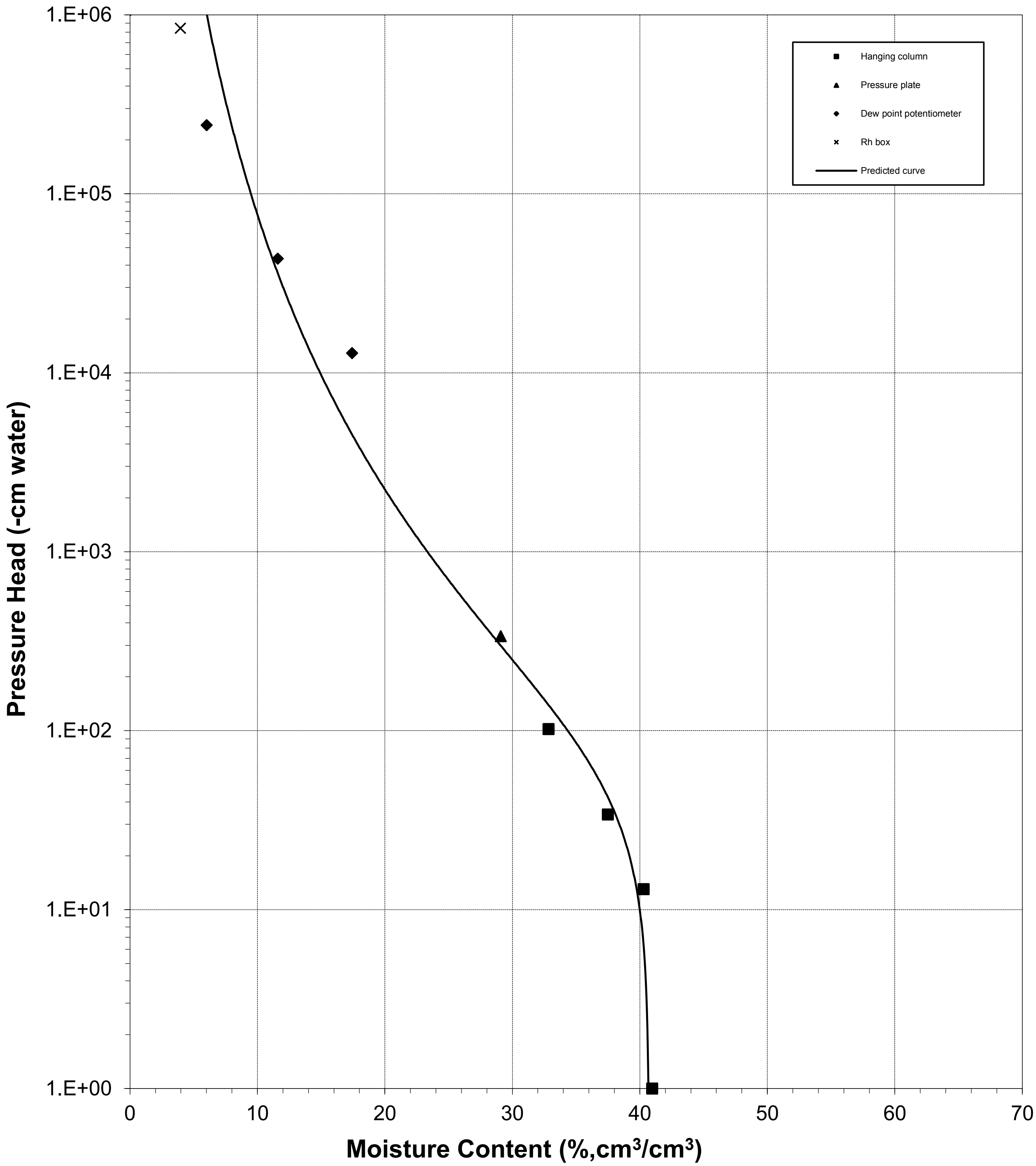
‡‡ Volume adjustments are applicable at this matric potential (see comment #1). Changes in volume, if applicable, are estimated based on obtainable measurements of changes in sample length and diameter.

Laboratory analysis by: D. O'Dowd
Data entered by: A. Albay-Yenney
Checked by: J. Hines


Water Retention Data Points
Sample Number: NRB-2 (10-10.5) (1.63 g/cc)
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

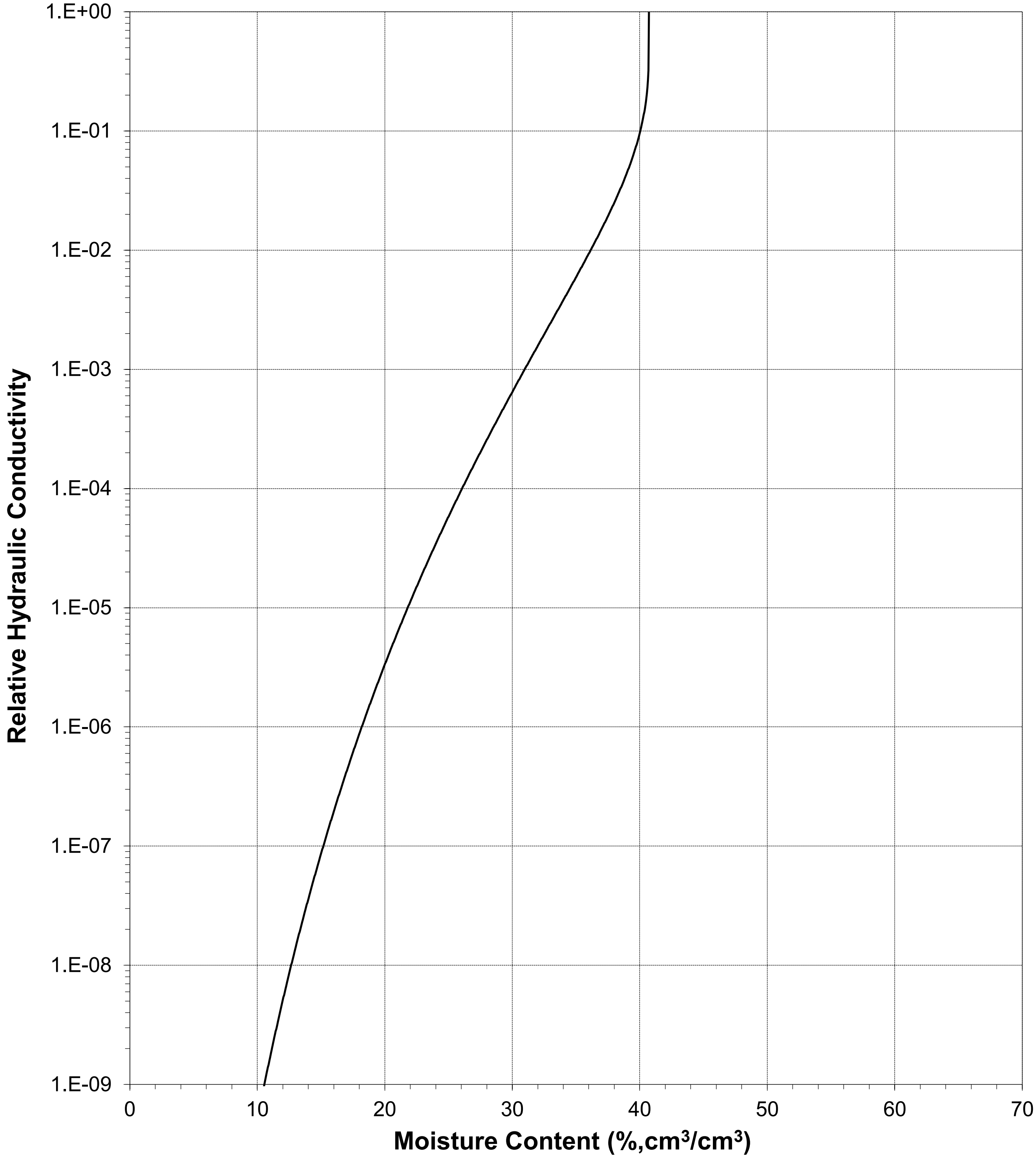
Predicted Calibration Curve and Data Points

Sample Number: NRB-2 (10-10.5) (1.63 g/cc)



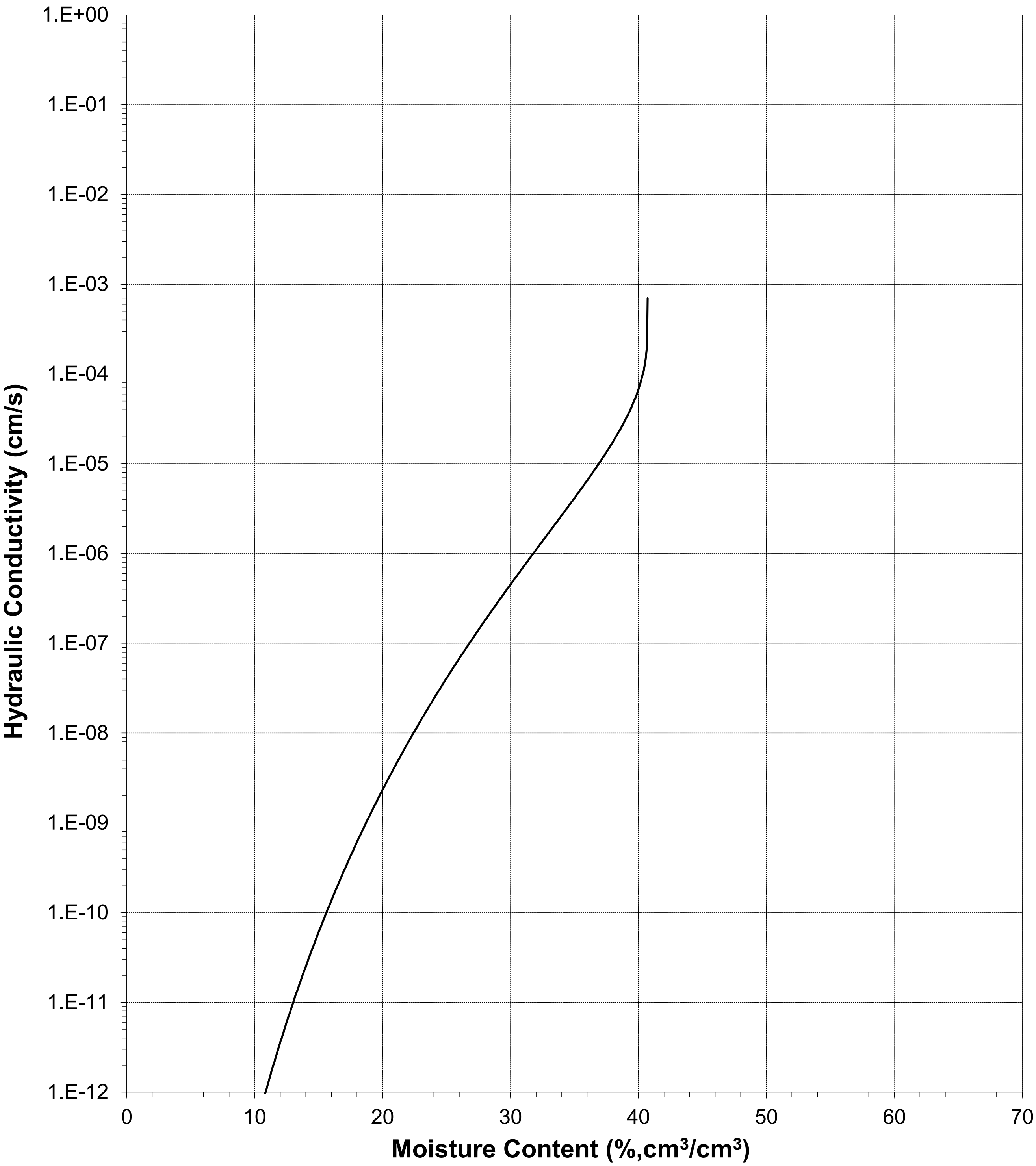
Plot of Relative Hydraulic Conductivity vs Moisture Content

Sample Number: NRB-2 (10-10.5) (1.63 g/cc)



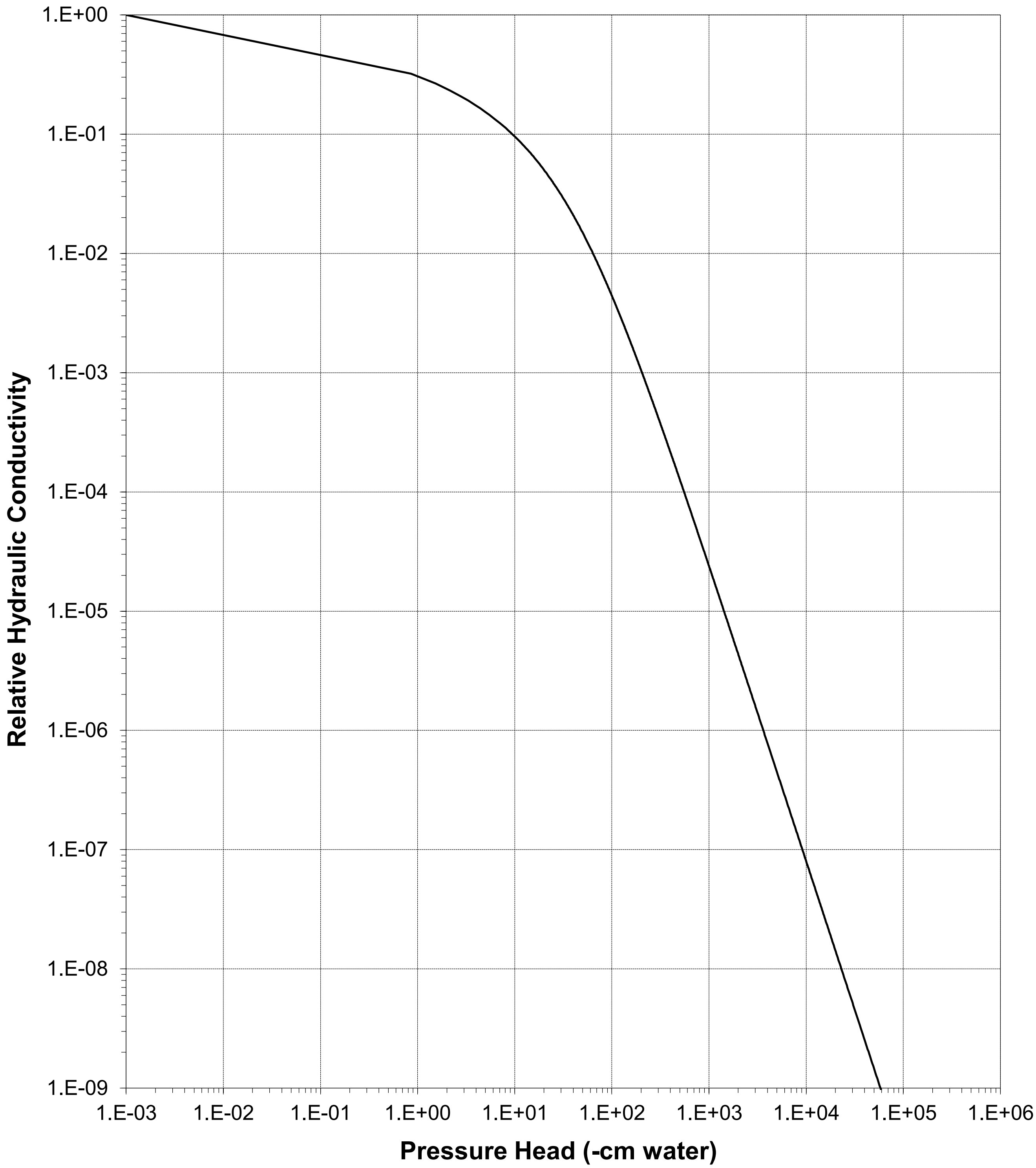
Plot of Hydraulic Conductivity vs Moisture Content

Sample Number: NRB-2 (10-10.5) (1.63 g/cc)



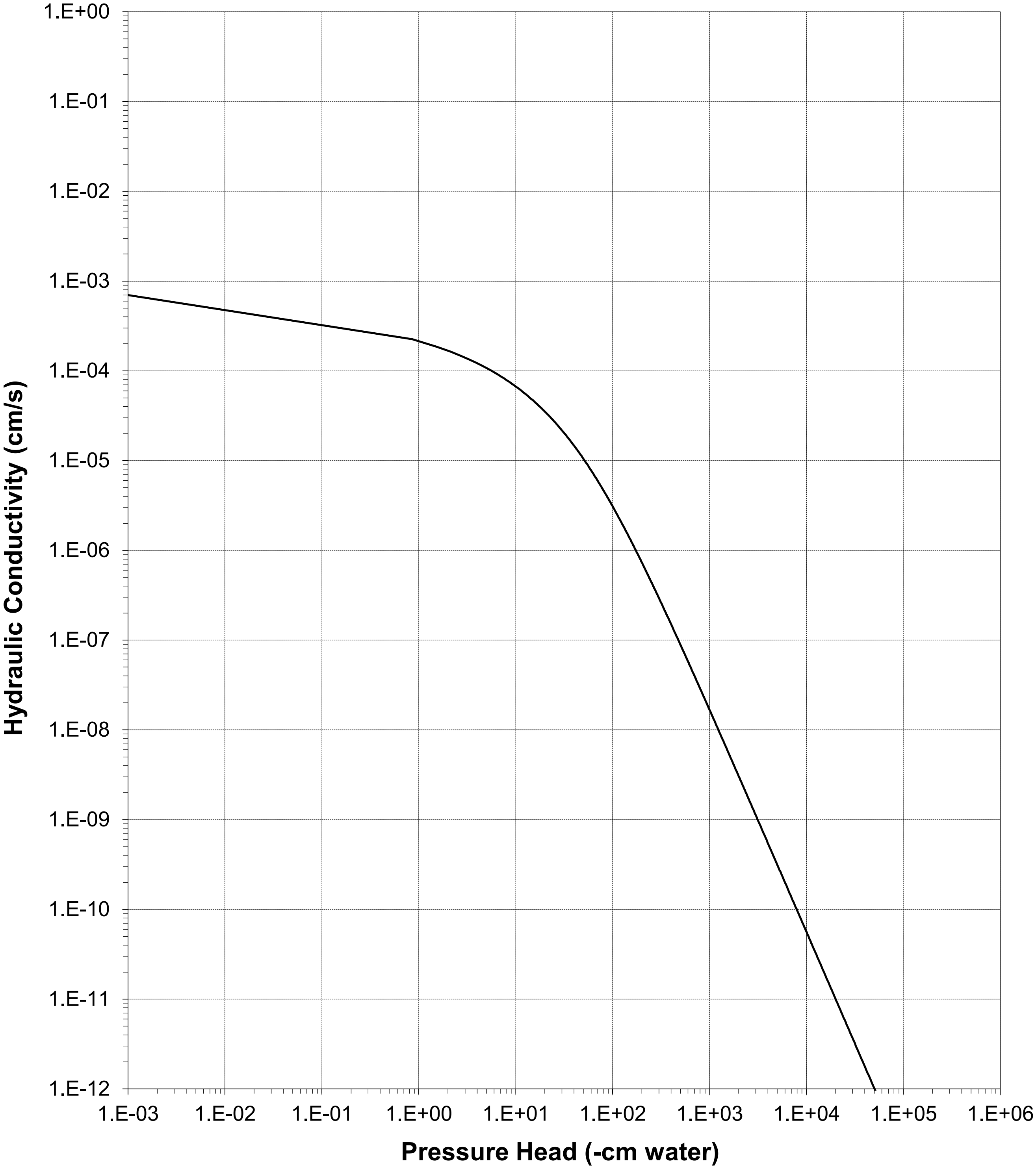
Plot of Relative Hydraulic Conductivity vs Pressure Head

Sample Number: NRB-2 (10-10.5) (1.63 g/cc)



Plot of Hydraulic Conductivity vs Pressure Head

Sample Number: NRB-2 (10-10.5) (1.63 g/cc)



Particle Size Analysis

Summary of Particle Size Characteristics

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
NRB-1 (0.5-1)	0.00051	0.054	0.065	127	35	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (1.5-2)	0.00016	0.057	0.068	425	126	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (2.5-3)	0.00075	0.053	0.064	85	20	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (3-3.5)	0.00053	0.049	0.058	109	27	WS/H	Silt with sand (ML)s	Loam	(Est)
NRB-1 (5.5-6)	0.0024	0.049	0.059	25	5.5	WS/H	Silt with sand (ML)s	Loam	
NRB-1 (10.5-11)	0.00014	0.059	0.068	486	203	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-1 (15.5-16)	0.00056	0.035	0.046	82	21	WS/H	Silt with sand (ML)s	Loam	(Est)
NRB-1 (21-21.5)	0.00064	0.016	0.042	66	0.084	WS/H	Fat clay with sand (CH)s	Clay Loam	(Est)
NRB-2 (0.5-1)	0.00031	0.044	0.055	177	31	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-2 (1.5-2)	0.00021	0.037	0.047	224	23	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-2 (2.5-3)	0.00067	0.042	0.052	78	11	WS/H	Lean clay with sand (CL)s	Loam	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
NRB-2 (3-3.5)	0.00011	0.038	0.048	436	27	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-2 (5.5-6)	0.00034	0.049	0.066	194	26	WS/H	Sandy lean clay s(CL)	Loam	(Est)
NRB-2 (10-10.5)	0.00075	0.030	0.041	55	1.1	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-3 (0.5-1)	0.00054	0.053	0.068	126	14	WS/H	Sandy lean clay s(CL)	Loam	(Est)
NRB-3 (1.5-2)	0.0081	0.24	0.37	46	1.6	WS/H	Silty sand (SM)	Sandy Loam †	
NRB-3 (2.5-3.5)	0.0074	0.24	0.31	42	3.5	WS/H	Silty sand (SM)	Loamy Sand	
NRB-5 (1-1.5)	0.0017	0.058	0.072	42	11	WS/H	Sandy silt s(ML)	Sandy Loam	
NRB-5 (2.5-3)	0.017	0.24	0.40	24	1.2	WS/H	Silty sand with gravel (SM)g	Sandy Loam †	
NRB-5 (3-3.5)	0.049	0.77	1.5	31	1.3	WS/H	Silty sand with gravel (SM)g	Loamy Sand †	
NRB-5 (5-5.5)	0.0011	0.055	0.068	62	15	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-6 (0.5-1)	0.0011	0.055	0.066	60	17	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Summary of Particle Size Characteristics (Continued)

Sample Number	d_{10} (mm)	d_{50} (mm)	d_{60} (mm)	C_u	C_c	Method	ASTM Classification	USDA Classification	
NRB-6 (1.5-2)	0.00031	0.049	0.059	190	43	WS/H	Silt with sand (ML)s	Loam	(Est)
NRB-6 (2.5-3)	0.0010	0.033	0.041	41	6.2	WS/H	Silt (ML)	Silt Loam	(Est)
NRB-6 (3-3.5)	0.00094	0.035	0.043	46	4.2	WS/H	Silt (ML)	Loam	(Est)
NRB-6 (5.5-6)	0.00016	0.042	0.053	331	14	WS/H	Lean clay with sand (CL)s	Loam	(Est)
NRB-6 (10.5-11)	0.00082	0.056	0.070	85	15	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-6 (15.5-16)	0.00061	0.060	0.072	118	35	WS/H	Sandy silt s(ML)	Sandy Loam	(Est)
NRB-6 (20-21.5)	0.0074	0.87	2.1	284	4.0	WS/H	Silty sand with gravel (SM)g	Sandy Loam †	

d_{50} = Median particle diameter

Est = Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

DS = Dry sieve

H = Hydrometer

WS = Wet sieve

† Greater than 10% of sample is coarse material

Percent Gravel, Sand, Silt and Clay*

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
NRB-1 (0.5-1)	0.0	31.7	53.9	14.3
NRB-1 (1.5-2)	0.0	34.7	51.9	13.4
NRB-1 (2.5-3)	0.0	32.0	53.0	15.0
NRB-1 (3-3.5)	0.0	24.6	61.8	13.5
NRB-1 (5.5-6)	0.0	26.1	64.4	9.5
NRB-1 (10.5-11)	0.0	32.7	50.7	16.7
NRB-1 (15.5-16)	0.0	22.3	64.2	13.4
NRB-1 (21-21.5)	0.0	27.1	36.3	36.6
NRB-2 (0.5-1)	0.0	25.0	58.2	16.8
NRB-2 (1.5-2)	0.0	18.7	62.9	18.4
NRB-2 (2.5-3)	0.0	22.5	59.5	18.0
NRB-2 (3-3.5)	0.1	21.1	56.7	22.2
NRB-2 (5.5-6)	0.0	35.8	48.4	15.7
NRB-2 (10-10.5)	0.6	18.8	59.0	21.6
NRB-3 (0.5-1)	0.2	35.9	45.1	18.8
NRB-3 (1.5-2)	8.4	60.0	25.2	6.4

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Percent Gravel, Sand, Silt and Clay* (Continued)

Sample Number	% Gravel (>4.75mm)	% Sand (<4.75mm, >0.075mm)	% Silt (<0.075mm, >0.002mm)	% Clay (<0.002mm)
NRB-3 (2.5-3.5)	3.0	68.8	23.1	5.1
NRB-5 (1-1.5)	1.2	36.7	51.8	10.4
NRB-5 (2.5-3)	17.0	56.4	20.4	6.2
NRB-5 (3-3.5)	29.6	57.0	10.3	3.1
NRB-5 (5-5.5)	1.2	34.2	52.3	12.3
NRB-6 (0.5-1)	1.0	32.3	55.0	11.7
NRB-6 (1.5-2)	0.1	26.4	58.7	14.9
NRB-6 (2.5-3)	0.0	14.5	69.4	16.1
NRB-6 (3-3.5)	0.0	12.6	69.2	18.2
NRB-6 (5.5-6)	0.0	23.9	55.3	20.7
NRB-6 (10.5-11)	2.6	34.0	50.7	12.6
NRB-6 (15.5-16)	0.3	37.6	48.6	13.5
NRB-6 (20-21.5)	26.3	54.0	16.0	3.7

*USCS classification does not classify clay fraction based on particle size. USDA definition of clay (<0.002mm) used in this table.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (0.5-1)
Project Name: Lisbon Site
Depth: 0.5-1'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 432.52
Weight Passing #10 (g): 432.52
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 55.97
Calculated Weight of Sieve Sample (g): 55.97

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	432.52	100.00
	2"	50	0.00	0.00	432.52	100.00
	1.5"	38.1	0.00	0.00	432.52	100.00
	1"	25	0.00	0.00	432.52	100.00
	3/4"	19.0	0.00	0.00	432.52	100.00
	3/8"	9.5	0.00	0.00	432.52	100.00
	4	4.75	0.00	0.00	432.52	100.00
	10	2.00	0.00	0.00	432.52	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.00	0.00	55.97	100.00
	40	0.425	0.09	0.09	55.88	99.84
	60	0.250	0.31	0.40	55.57	99.29
	100	0.150	1.92	2.32	53.65	95.85
	140	0.106	5.69	8.01	47.96	85.69
	200	0.075	9.76	17.77	38.20	68.25
	dry pan		2.85	20.62	35.35	
	wet pan			35.35	0.00	

d_{10} (mm): 0.00051 d_{50} (mm): 0.054
d_{16} (mm): 0.0040 d_{60} (mm): 0.065
d_{30} (mm): 0.034 d_{84} (mm): 0.10

Median Particle Diameter --d_{50} (mm): 0.054
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 127
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 35
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.053

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (0.5-1)
Project Name: Lisbon Site
Depth: 0.5-1'

Test Date: 12-Dec-19
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

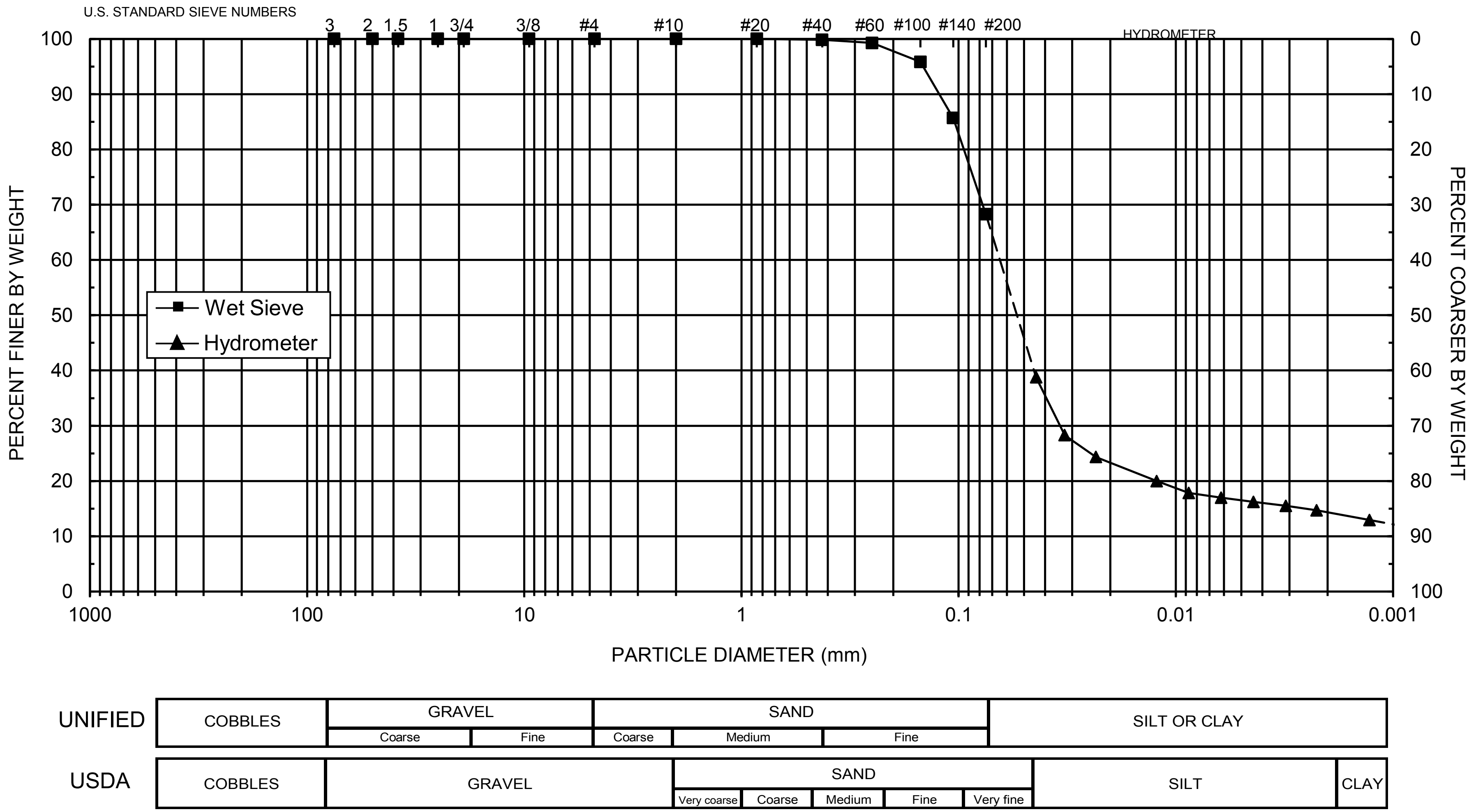
Initial Wt. (g)*:* 55.97
Total Sample Wt. (g)*:* 432.52
Wt. Passing #10 (g)*:* 432.52

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.2	29.00	6.83	22.2	11	0.0439	39	38.8
	2	19.2	23.00	6.83	16.2	12	0.0324	28	28.3
	4	19.2	20.75	6.83	13.9	12	0.0233	24	24.3
	15	19.2	18.25	6.83	11.4	13	0.0122	20	20.0
	30	19.3	17.00	6.80	10.2	13	0.0087	18	17.8
	60	19.3	16.50	6.80	9.7	13	0.0062	17	17.0
	120	19.5	16.00	6.73	9.3	13	0.0044	16	16.2
	240	19.8	15.50	6.64	8.9	13	0.0031	15	15.5
	463	19.9	15.00	6.60	8.4	13	0.0022	15	14.7
13-Dec-19	1436	19.1	14.25	6.86	7.4	13	0.0013	13	12.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00051**	d_{30} = **0.034**	d_{50} = **0.054**	d_{60} = **0.065**	C_u = **127**	C_c = **35**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (0.5-1)	**0.5-1'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 746.58
Weight Passing #10 (g): 746.58
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 62.21
Calculated Weight of Sieve Sample (g): 62.21

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	746.58	100.00
	2"	50	0.00	0.00	746.58	100.00
	1.5"	38.1	0.00	0.00	746.58	100.00
	1"	25	0.00	0.00	746.58	100.00
	3/4"	19.0	0.00	0.00	746.58	100.00
	3/8"	9.5	0.00	0.00	746.58	100.00
	4	4.75	0.00	0.00	746.58	100.00
	10	2.00	0.00	0.00	746.58	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.00	0.00	62.21	100.00
	40	0.425	0.04	0.04	62.17	99.94
	60	0.250	0.33	0.37	61.84	99.41
	100	0.150	2.65	3.02	59.19	95.15
	140	0.106	7.00	10.02	52.19	83.89
	200	0.075	11.59	21.61	40.60	65.26
	dry pan		5.06	26.67	35.54	
	wet pan			35.54	0.00	

d_{10} (mm): 0.00016
d_{16} (mm): 0.0041
d_{30} (mm): 0.037
d_{50} (mm): 0.057
d_{60} (mm): 0.068
d_{84} (mm): 0.11

Median Particle Diameter --d_{50} (mm): 0.057
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 425
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 126
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.057

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

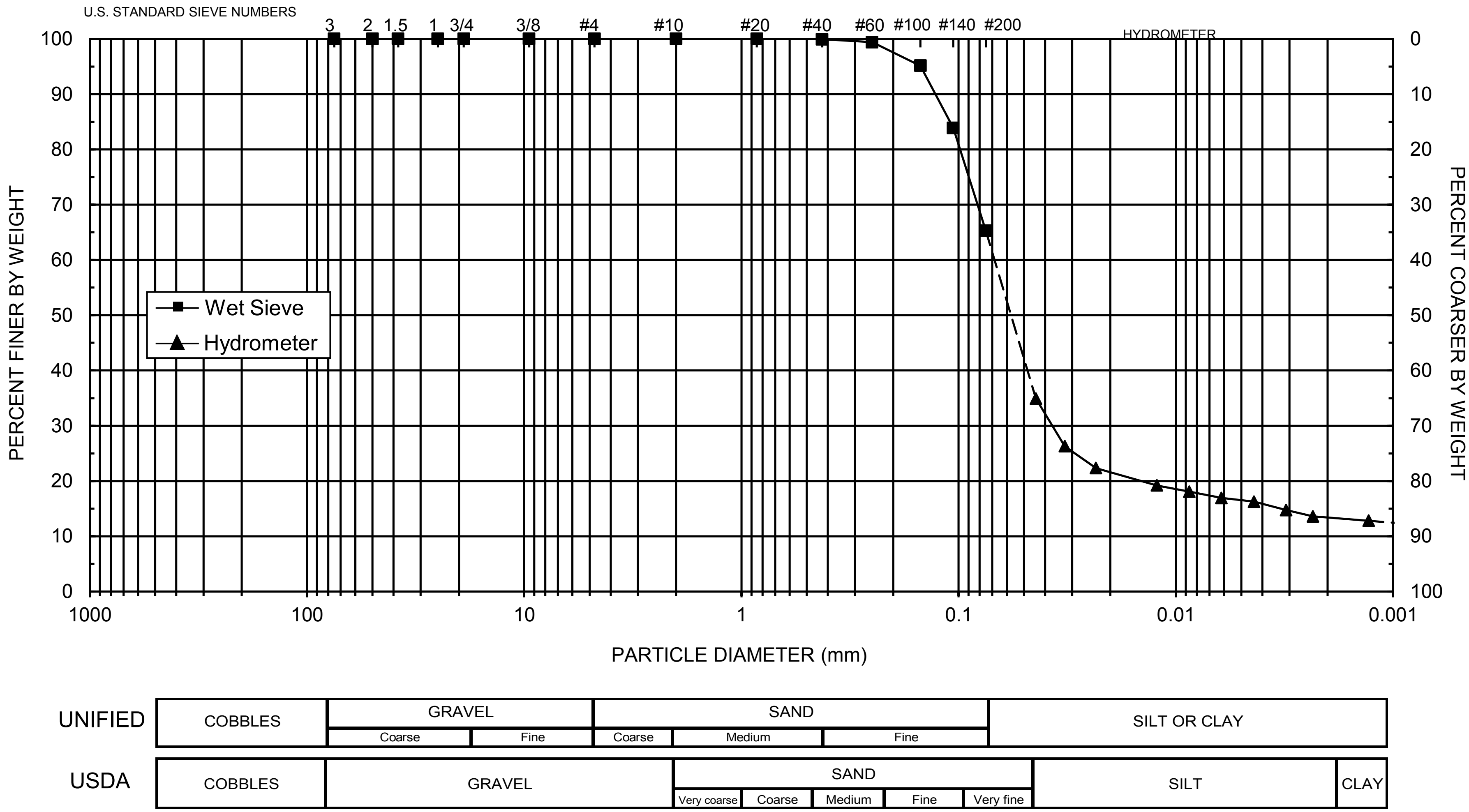
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-1 (1.5-2)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	1.5-2'	*Initial Wt.* (g)*:*	62.21
Test Date:	12-Dec-19	*Total Sample Wt.* (g)*:*	746.58
Start Time:	9:42	*Wt. Passing #10* (g)*:*	746.58

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.3	29.00	6.80	22.2	11	0.0440	35	34.9
	2	19.3	23.50	6.80	16.7	12	0.0324	26	26.3
	4	19.3	21.00	6.80	14.2	12	0.0233	22	22.3
	15	19.3	19.00	6.80	12.2	13	0.0122	19	19.2
	30	19.4	18.25	6.77	11.5	13	0.0087	18	18.1
	60	19.5	17.50	6.73	10.8	13	0.0062	17	16.9
	120	19.7	17.00	6.67	10.3	13	0.0044	16	16.2
	240	19.8	16.00	6.64	9.4	13	0.0031	15	14.7
	428	19.9	15.25	6.60	8.6	13	0.0023	14	13.6
13-Dec-19	1401	19.1	15.00	6.86	8.1	13	0.0013	13	12.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00016**	d_{30} = **0.037**	d_{50} = **0.057**	d_{60} = **0.068**	C_u = **425**	C_c = **126**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (1.5-2)	**1.5-2'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name:	INTERA Inc.	*Initial Dry Weight of Sample (g):*	363.70
Job Number:	DB19.1451.00	*Weight Passing #10 (g):*	363.70
Sample Number:	NRB-1 (2.5-3)	*Weight Retained #10 (g):*	0.00
Project Name:	Lisbon Site	*Weight of Hydrometer Sample (g):*	76.74
Depth:	2.5-3'	*Calculated Weight of Sieve Sample (g):*	76.74
Test Date:	17-Jan-20	*Shape:*	Rounded
		Hardness:	Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	363.70	100.00
	2"	50	0.00	0.00	363.70	100.00
	1.5"	38.1	0.00	0.00	363.70	100.00
	1"	25	0.00	0.00	363.70	100.00
	3/4"	19.0	0.00	0.00	363.70	100.00
	3/8"	9.5	0.00	0.00	363.70	100.00
	4	4.75	0.00	0.00	363.70	100.00
	10	2.00	0.00	0.00	363.70	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.00	0.00	76.74	100.00
	40	0.425	0.04	0.04	76.70	99.95
	60	0.250	0.32	0.36	76.38	99.53
	100	0.150	2.62	2.98	73.76	96.12
	140	0.106	7.68	10.66	66.08	86.11
	200	0.075	13.89	24.55	52.19	68.01
	dry pan		5.86	30.41	46.33	
	wet pan			46.33	0.00	

d_{10} (mm):	0.00075	d_{50} (mm):	0.053
d_{16} (mm):	0.0033	d_{60} (mm):	0.064
d_{30} (mm):	0.031	d_{84} (mm):	0.10

Median Particle Diameter --d_{50} (mm): 0.053

Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 85

Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 20

Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.052

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 15-Jan-20
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

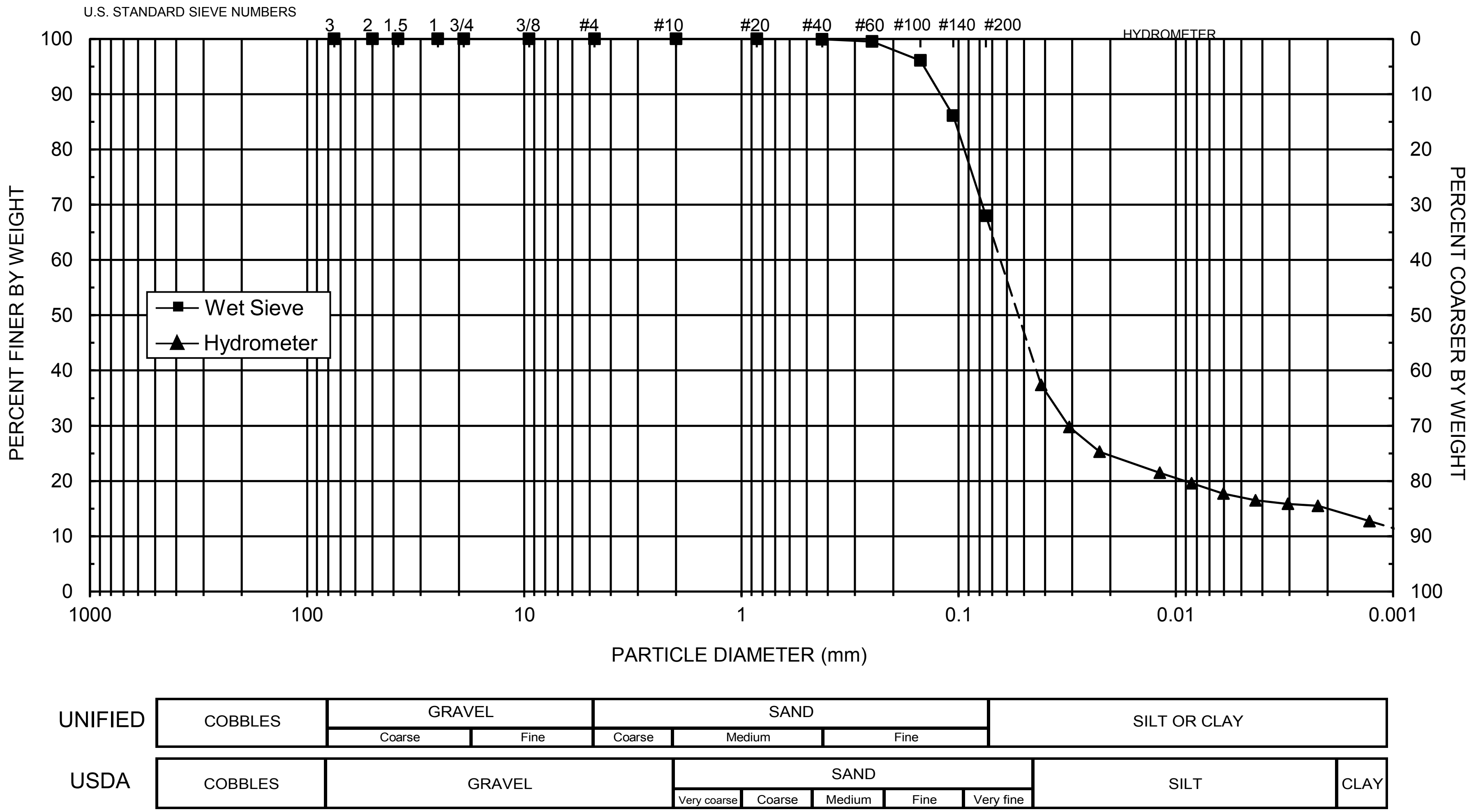
Initial Wt. (g)*:* 76.74
Total Sample Wt. (g)*:* 363.70
Wt. Passing #10 (g)*:* 363.70

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
15-Jan-20	1	19.7	36.00	6.67	29.3	10	0.0417	37	37.4
	2	19.7	30.00	6.67	23.3	11	0.0309	30	29.7
	4	19.7	26.50	6.67	19.8	11	0.0224	25	25.3
	15	19.7	23.50	6.67	16.8	12	0.0118	21	21.5
	30	19.8	22.00	6.64	15.4	12	0.0084	20	19.6
	60	19.9	20.50	6.60	13.9	12	0.0060	18	17.7
	120	20.0	19.50	6.57	12.9	13	0.0043	16	16.5
	240	20.0	19.00	6.57	12.4	13	0.0030	16	15.8
	457	19.9	18.75	6.60	12.1	13	0.0022	15	15.5
16-Jan-20	1389	18.6	17.00	7.02	10.0	13	0.0013	13	12.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines



d_{10} = **0.00075**	d_{30} = **0.031**	d_{50} = **0.053**	d_{60} = **0.064**	C_u = **85**	C_c = **20**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (2.5-3)	**2.5-3'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 747.66
Weight Passing #10 (g): 747.66
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 62.29
Calculated Weight of Sieve Sample (g): 62.29

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	747.66	100.00
	2"	50	0.00	0.00	747.66	100.00
	1.5"	38.1	0.00	0.00	747.66	100.00
	1"	25	0.00	0.00	747.66	100.00
	3/4"	19.0	0.00	0.00	747.66	100.00
	3/8"	9.5	0.00	0.00	747.66	100.00
	4	4.75	0.00	0.00	747.66	100.00
	10	2.00	0.00	0.00	747.66	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.10	0.10	62.19	99.84
	40	0.425	0.27	0.37	61.92	99.41
	60	0.250	0.46	0.83	61.46	98.67
	100	0.150	1.63	2.46	59.83	96.05
	140	0.106	4.30	6.76	55.53	89.15
	200	0.075	8.58	15.34	46.95	75.37
	dry pan		6.92	22.26	40.03	
	wet pan			40.03	0.00	

d_{10} (mm): 0.00053 d_{50} (mm): 0.049
d_{16} (mm): 0.0041 d_{60} (mm): 0.058
d_{30} (mm): 0.029 d_{84} (mm): 0.093

Median Particle Diameter --d_{50} (mm): 0.049
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 109
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 27
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.049

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Silt with sand (ML)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 12-Dec-19
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

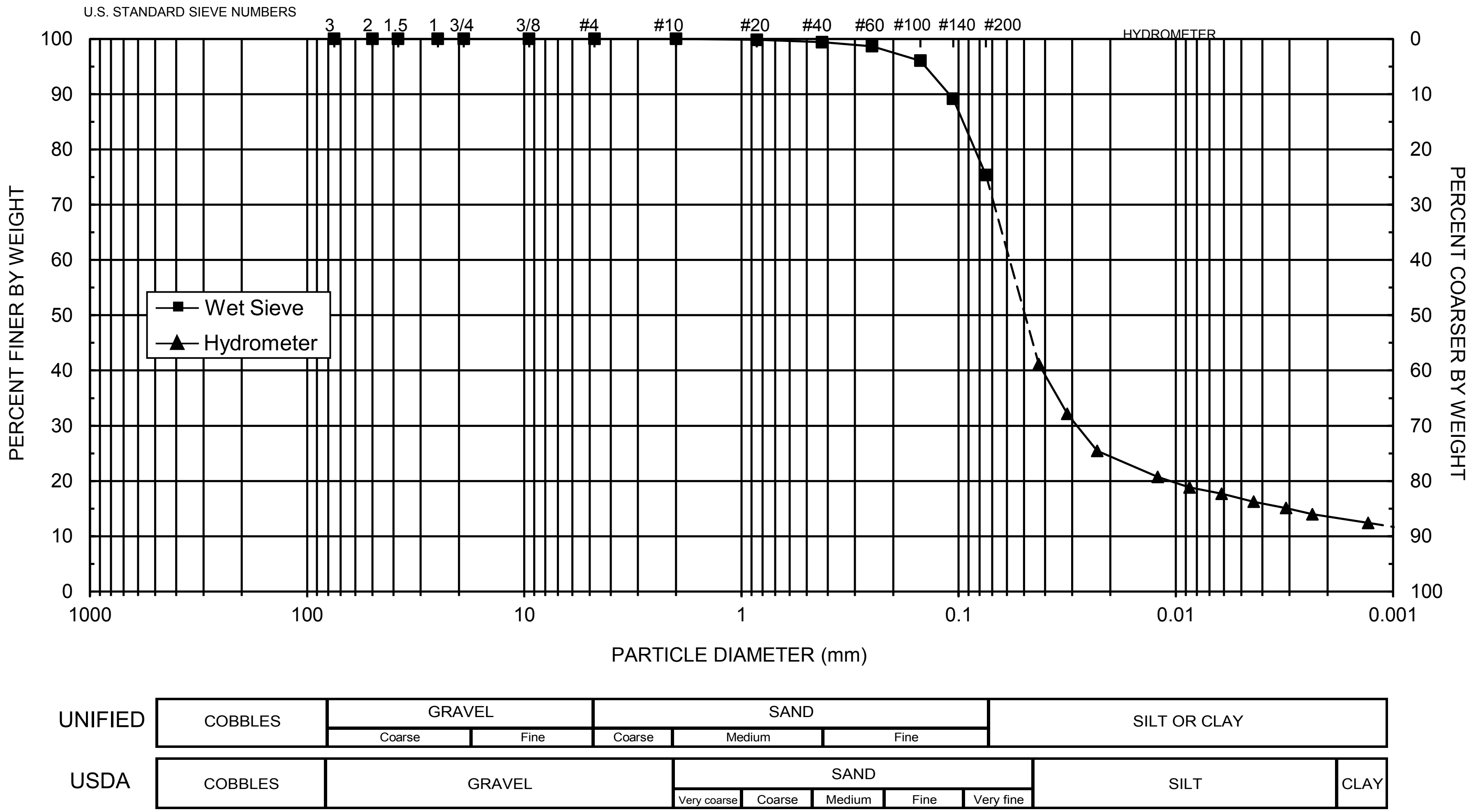
Initial Wt. (g)*:* 62.29
Total Sample Wt. (g)*:* 747.66
Wt. Passing #10 (g)*:* 747.66

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.3	33.00	6.80	26.2	10	0.0427	41	41.2
	2	19.3	27.25	6.80	20.5	11	0.0316	32	32.1
	4	19.3	23.00	6.80	16.2	12	0.0230	25	25.4
	15	19.3	20.00	6.80	13.2	13	0.0121	21	20.7
	30	19.4	18.75	6.77	12.0	13	0.0086	19	18.8
	60	19.5	18.00	6.73	11.3	13	0.0061	18	17.7
	120	19.7	17.00	6.67	10.3	13	0.0044	16	16.2
	240	19.8	16.25	6.64	9.6	13	0.0031	15	15.1
	424	19.9	15.50	6.60	8.9	13	0.0023	14	14.0
13-Dec-19	1396	19.1	14.75	6.86	7.9	13	0.0013	12	12.4

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00053**	d_{30} = **0.029**	d_{50} = **0.049**	d_{60} = **0.058**	C_u = **109**	C_c = **27**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (3-3.5)	**3-3.5'**	**Silt with sand (ML)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (5.5-6)
Project Name: Lisbon Site
Depth: 5.5-6'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 741.54
Weight Passing #10 (g): 741.54
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 67.22
Calculated Weight of Sieve Sample (g): 67.22

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	741.54	100.00
	2"	50	0.00	0.00	741.54	100.00
	1.5"	38.1	0.00	0.00	741.54	100.00
	1"	25	0.00	0.00	741.54	100.00
	3/4"	19.0	0.00	0.00	741.54	100.00
	3/8"	9.5	0.00	0.00	741.54	100.00
	4	4.75	0.00	0.00	741.54	100.00
	10	2.00	0.00	0.00	741.54	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.17	0.17	67.05	99.75
	40	0.425	0.50	0.67	66.55	99.00
	60	0.250	0.63	1.30	65.92	98.07
	100	0.150	1.86	3.16	64.06	95.30
	140	0.106	4.41	7.57	59.65	88.74
	200	0.075	9.98	17.55	49.67	73.89
	dry pan		4.34	21.89	45.33	
	wet pan			45.33	0.00	

d_{10} (mm): 0.0024
d_{16} (mm): 0.0076
d_{30} (mm): 0.028
d_{50} (mm): 0.049
d_{60} (mm): 0.059
d_{84} (mm): 0.095

Median Particle Diameter --d_{50} (mm): 0.049
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 25
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 5.5
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.051

Classification of fines (visual method): ML

ASTM Soil Classification: Silt with sand (ML)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (5.5-6)
Project Name: Lisbon Site
Depth: 5.5-6'

Test Date: 12-Dec-19
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

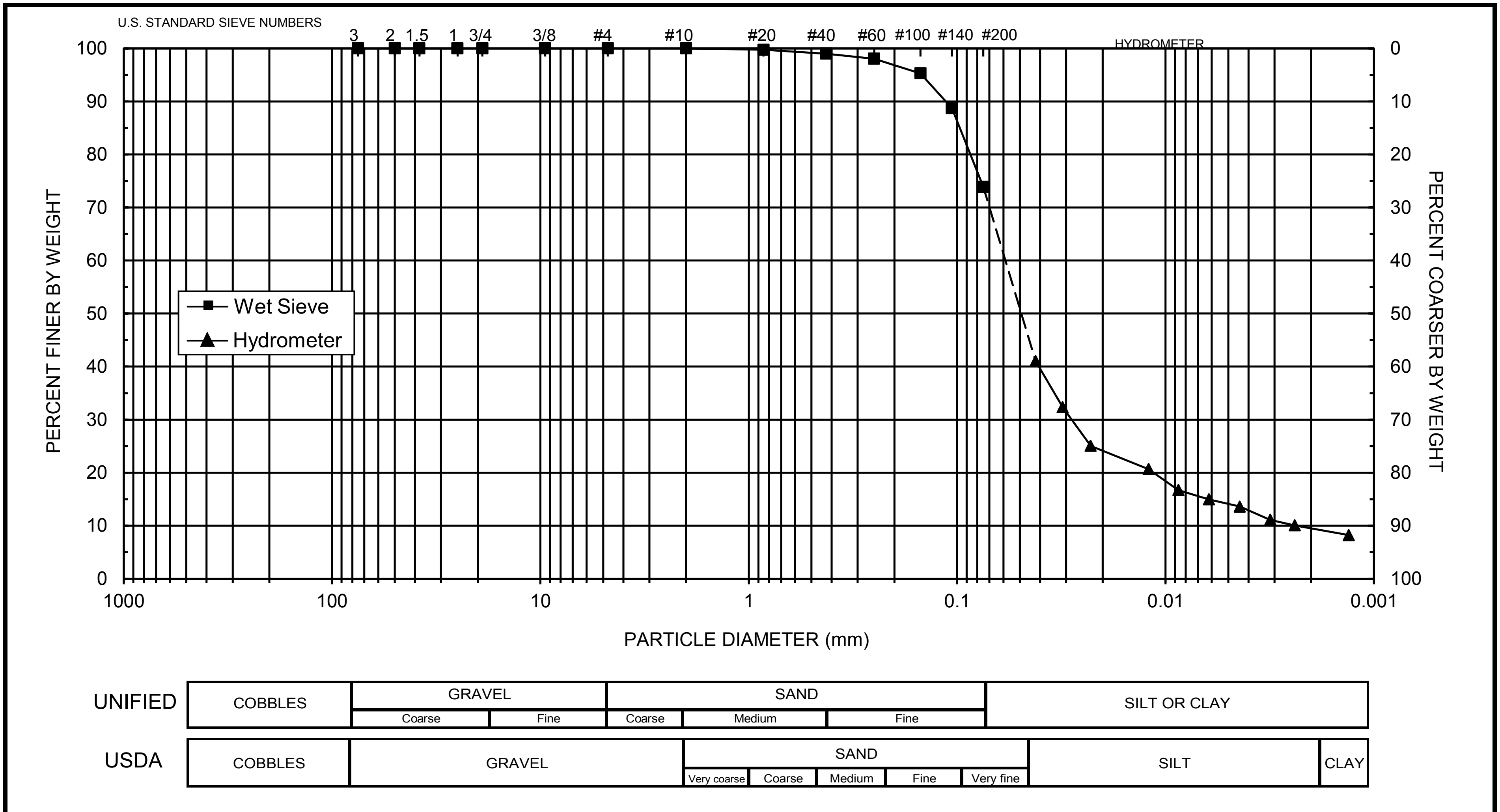
Initial Wt. (g)*:* 67.22
Total Sample Wt. (g)*:* 741.54
Wt. Passing #10 (g)*:* 741.54

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.3	35.00	6.80	28.2	10	0.0420	41	41.0
	2	19.3	29.00	6.80	22.2	11	0.0312	32	32.3
	4	19.3	24.00	6.80	17.2	12	0.0228	25	25.0
	15	19.3	21.00	6.80	14.2	12	0.0120	21	20.7
	30	19.4	18.25	6.77	11.5	13	0.0087	17	16.7
	60	19.5	17.00	6.73	10.3	13	0.0062	15	14.9
	120	19.7	16.00	6.67	9.3	13	0.0044	14	13.6
	240	19.8	14.25	6.64	7.6	14	0.0031	11	11.1
	418	19.9	13.50	6.60	6.9	14	0.0024	10	10.0
13-Dec-19	1391	19.1	12.50	6.86	5.6	14	0.0013	8	8.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} =	d_{30} =	d_{50} =	d_{60} =	C_u =	C_c =
0.0024	**0.028**	**0.049**	**0.059**	**25**	**5.5**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (5.5-6)	**5.5-6'**	**Silt with sand (ML)s**	**Loam**

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (10.5-11)
Project Name: Lisbon Site
Depth: 10.5-11'

Test Date: 17-Jan-20

Initial Dry Weight of Sample (g): 358.16
Weight Passing #10 (g): 358.16
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 82.01
Calculated Weight of Sieve Sample (g): 82.01

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	358.16	100.00
	2"	50	0.00	0.00	358.16	100.00
	1.5"	38.1	0.00	0.00	358.16	100.00
	1"	25	0.00	0.00	358.16	100.00
	3/4"	19.0	0.00	0.00	358.16	100.00
	3/8"	9.5	0.00	0.00	358.16	100.00
	4	4.75	0.00	0.00	358.16	100.00
	10	2.00	0.00	0.00	358.16	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.17	0.17	81.84	99.79
	40	0.425	0.62	0.79	81.22	99.04
	60	0.250	0.50	1.29	80.72	98.43
	100	0.150	1.76	3.05	78.96	96.28
	140	0.106	5.98	9.03	72.98	88.99
	200	0.075	17.76	26.79	55.22	67.33
	dry pan		10.56	37.35	44.66	
	wet pan			44.66	0.00	

d_{10} (mm): 0.00014
d_{16} (mm): 0.0015
d_{30} (mm): 0.044
d_{50} (mm): 0.059
d_{60} (mm): 0.068
d_{84} (mm): 0.098

Median Particle Diameter --d_{50} (mm): 0.059
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 486
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 203
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.053

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (10.5-11)
Project Name: Lisbon Site
Depth: 10.5-11'

Test Date: 15-Jan-20
Start Time: 9:06

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

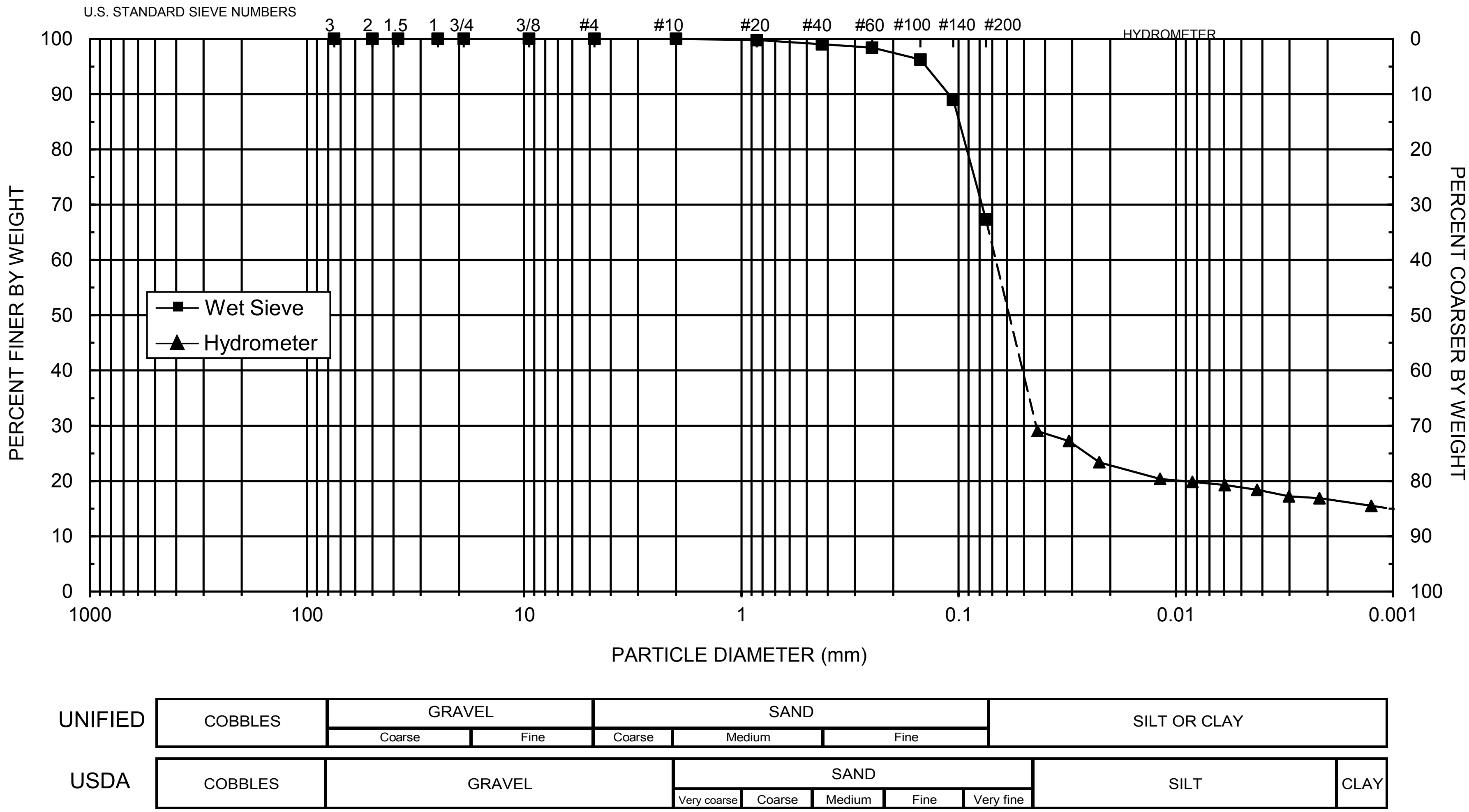
Initial Wt. (g): 82.01
Total Sample Wt. (g): 358.16
Wt. Passing #10 (g): 358.16

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
15-Jan-20	1	19.7	31.00	6.67	24.3	11	0.0433	29	29.0
	2	19.7	29.50	6.67	22.8	11	0.0310	27	27.2
	4	19.7	26.25	6.67	19.6	12	0.0225	23	23.4
	15	19.7	23.75	6.67	17.1	12	0.0118	20	20.4
	30	19.8	23.25	6.64	16.6	12	0.0084	20	19.8
	60	19.9	22.75	6.60	16.1	12	0.0059	19	19.3
	120	20.0	22.00	6.57	15.4	12	0.0042	18	18.4
	240	20.0	21.00	6.57	14.4	12	0.0030	17	17.2
	459	19.9	20.75	6.60	14.1	12	0.0022	17	16.9
16-Jan-20	1394	18.6	20.00	7.02	13.0	13	0.0013	15	15.5

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines



d_{10} = **0.00014**	d_{30} = **0.044**	d_{50} = **0.059**	d_{60} = **0.068**	C_u = **486**	C_c = **203**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (10.5-11)	**10.5-11'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (15.5-16)
Project Name: Lisbon Site
Depth: 15.5-16'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 761.80
Weight Passing #10 (g): 761.70
Weight Retained #10 (g): 0.10
Weight of Hydrometer Sample (g): 81.25
Calculated Weight of Sieve Sample (g): 81.26

Shape: Angular
Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	761.80	100.00
	2"	50	0.00	0.00	761.80	100.00
	1.5"	38.1	0.00	0.00	761.80	100.00
	1"	25	0.00	0.00	761.80	100.00
	3/4"	19.0	0.00	0.00	761.80	100.00
	3/8"	9.5	0.00	0.00	761.80	100.00
	4	4.75	0.00	0.00	761.80	100.00
	10	2.00	0.10	0.10	761.70	99.99
-10			(Based on calculated sieve wt.)			
	20	0.85	0.28	0.29	80.97	99.64
	40	0.425	0.82	1.11	80.15	98.63
	60	0.250	0.76	1.87	79.39	97.70
	100	0.150	1.32	3.19	78.07	96.07
	140	0.106	4.00	7.19	74.07	91.15
	200	0.075	10.97	18.16	63.10	77.65
	dry pan		2.68	20.84	60.42	
	wet pan			60.42	0.00	

d_{10} (mm): 0.00056
d_{16} (mm): 0.0048
d_{30} (mm): 0.023
d_{50} (mm): 0.035
d_{60} (mm): 0.046
d_{84} (mm): 0.088

Median Particle Diameter --d_{50} (mm): 0.035
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 82
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 21
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.043

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Silt with sand (ML)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

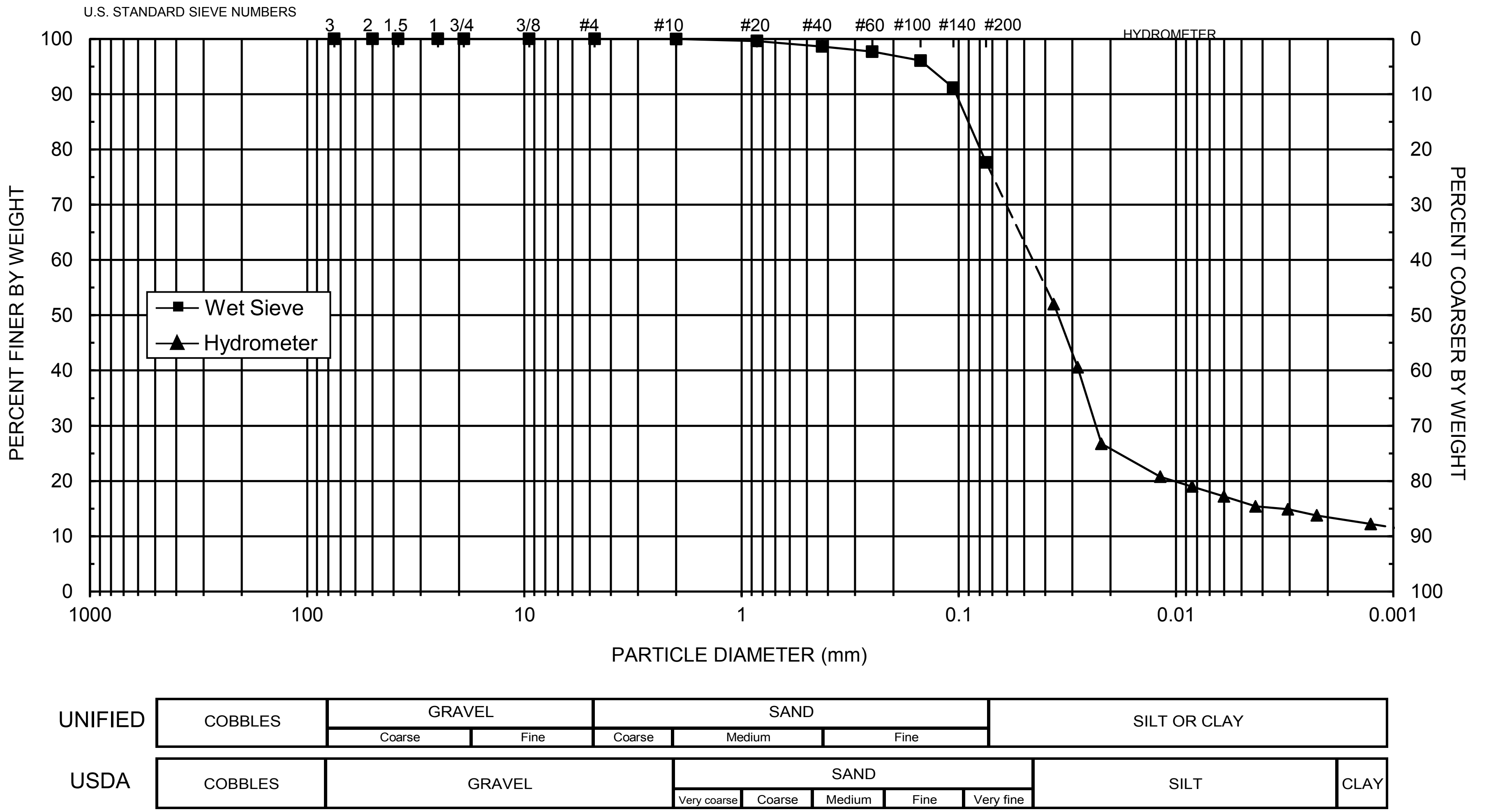
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-1 (15.5-16)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	15.5-16'	*Initial Wt.* (g)*:*	81.25
Test Date:	16-Dec-19	*Total Sample Wt.* (g)*:*	761.80
Start Time:	9:00	*Wt. Passing #10* (g)*:*	761.70

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.3	50.00	6.80	43.2	8	0.0365	52	52.0
	2	19.3	40.50	6.80	33.7	9	0.0284	41	40.6
	4	19.3	29.00	6.80	22.2	11	0.0220	27	26.7
	15	19.4	24.00	6.77	17.2	12	0.0118	21	20.7
	30	19.5	22.50	6.73	15.8	12	0.0084	19	19.0
	60	19.6	21.00	6.70	14.3	12	0.0060	17	17.2
	120	19.6	19.50	6.70	12.8	13	0.0043	15	15.4
	240	19.8	19.00	6.64	12.4	13	0.0030	15	14.9
	448	20.0	18.00	6.57	11.4	13	0.0022	14	13.8
17-Dec-19	1424	19.1	17.00	6.86	10.1	13	0.0013	12	12.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00056**	d_{30} = **0.023**	d_{50} = **0.035**	d_{60} = **0.046**	C_u = **82**	C_c = **21**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (15.5-16)	**15.5-16'**	**Silt with sand (ML)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (21-21.5)
Project Name: Lisbon Site
Depth: 21-21.5'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 692.14
Weight Passing #10 (g): 691.58
Weight Retained #10 (g): 0.56
Weight of Hydrometer Sample (g): 75.98
Calculated Weight of Sieve Sample (g): 76.04

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	692.14	100.00
	2"	50	0.00	0.00	692.14	100.00
	1.5"	38.1	0.00	0.00	692.14	100.00
	1"	25	0.00	0.00	692.14	100.00
	3/4"	19.0	0.00	0.00	692.14	100.00
	3/8"	9.5	0.00	0.00	692.14	100.00
	4	4.75	0.00	0.00	692.14	100.00
	10	2.00	0.56	0.56	691.58	99.92
-10			(Based on calculated sieve wt.)			
	20	0.85	0.70	0.76	75.28	99.00
	40	0.425	2.26	3.02	73.02	96.03
	60	0.250	3.52	6.54	69.50	91.40
	100	0.150	5.31	11.85	64.19	84.41
	140	0.106	4.89	16.74	59.30	77.98
	200	0.075	3.86	20.60	55.44	72.91
	dry pan		1.00	21.60	54.44	
	wet pan			54.44	0.00	

d_{10} (mm): 0.00064 d_{50} (mm): 0.016
d_{16} (mm): 0.00082 d_{60} (mm): 0.042
d_{30} (mm): 0.0015 d_{84} (mm): 0.15

Median Particle Diameter --d_{50} (mm): 0.016
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 66
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 0.084
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.056

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CH

ASTM Soil Classification: Fat clay with sand (CH)s
USDA Soil Classification: Clay Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

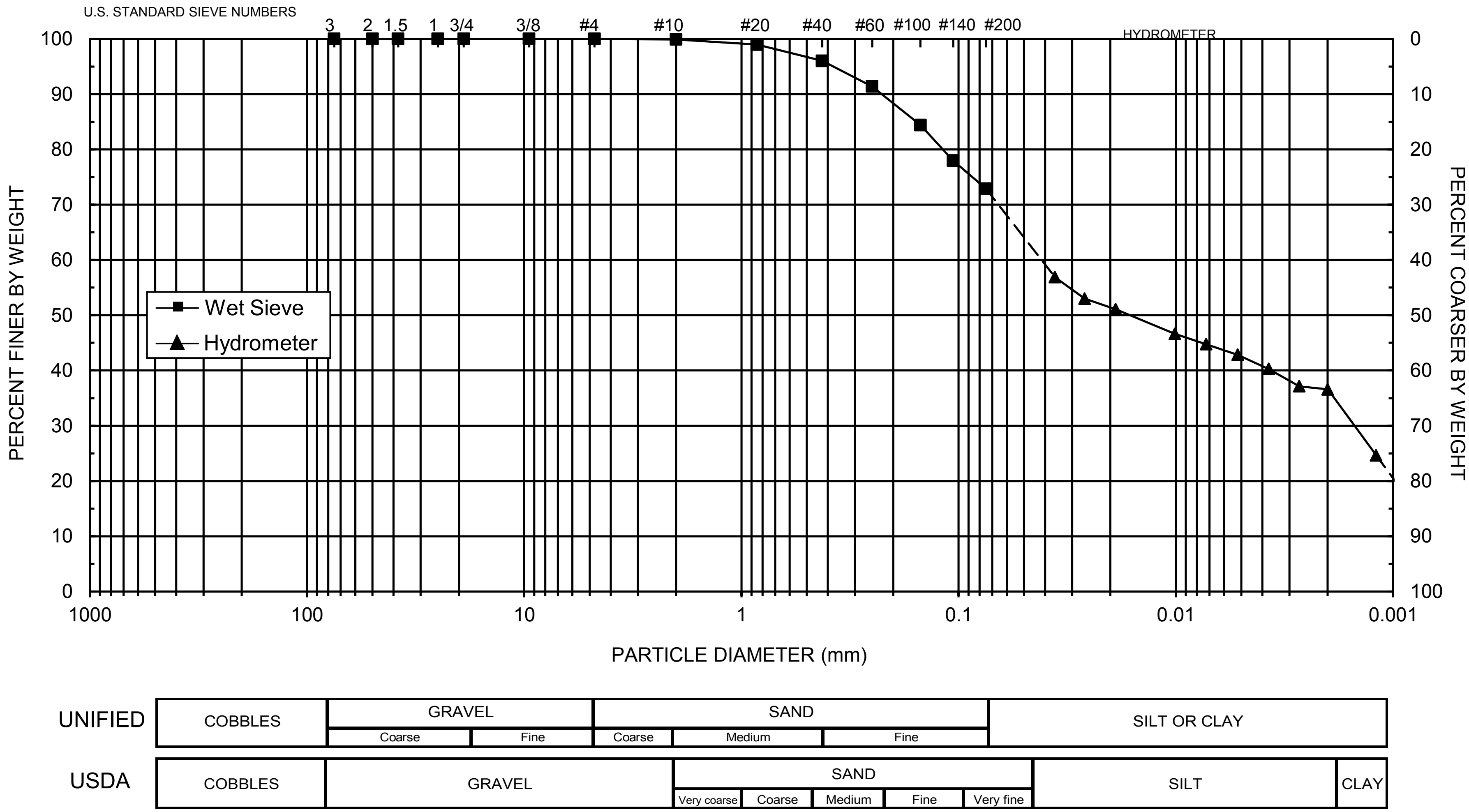
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-1 (21-21.5)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	21-21.5'	*Initial Wt.* (g)*:*	75.98
Test Date:	16-Dec-19	*Total Sample Wt.* (g)*:*	692.14
Start Time:	9:06	*Wt. Passing #10* (g)*:*	691.58

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.3	51.00	6.80	44.2	7	0.0360	57	56.9
	2	19.3	48.00	6.80	41.2	8	0.0263	53	53.0
	4	19.3	46.50	6.80	39.7	8	0.0189	51	51.1
	15	19.4	43.00	6.77	36.2	9	0.0101	47	46.6
	30	19.5	41.50	6.73	34.8	9	0.0072	45	44.7
	60	19.6	40.00	6.70	33.3	9	0.0052	43	42.8
	120	19.6	38.00	6.70	31.3	10	0.0037	40	40.3
	240	19.8	35.50	6.64	28.9	10	0.0027	37	37.1
	442	20.0	35.00	6.57	28.4	10	0.0020	37	36.6
17-Dec-19	1419	19.1	26.00	6.86	19.1	12	0.0012	25	24.6

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00064**	d_{30} = **0.0015**	d_{50} = **0.016**	d_{60} = **0.042**	C_u = **66**	C_c = **0.084**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-1 (21-21.5)	**21-21.5'**	**Fat clay with sand (CH)s**	**Clay Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (0.5-1)
Project Name: Lisbon Site
Depth: 0.5-1'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 456.49
Weight Passing #10 (g): 456.49
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 60.76
Calculated Weight of Sieve Sample (g): 60.76

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	456.49	100.00
	2"	50	0.00	0.00	456.49	100.00
	1.5"	38.1	0.00	0.00	456.49	100.00
	1"	25	0.00	0.00	456.49	100.00
	3/4"	19.0	0.00	0.00	456.49	100.00
	3/8"	9.5	0.00	0.00	456.49	100.00
	4	4.75	0.00	0.00	456.49	100.00
	10	2.00	0.00	0.00	456.49	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.00	0.00	60.76	100.00
	40	0.425	0.12	0.12	60.64	99.80
	60	0.250	1.03	1.15	59.61	98.11
	100	0.150	2.76	3.91	56.85	93.56
	140	0.106	3.50	7.41	53.35	87.80
	200	0.075	7.79	15.20	45.56	74.98
	dry pan		2.54	17.74	43.02	
	wet pan			43.02	0.00	

d_{10} (mm): 0.00031
d_{16} (mm): 0.0016
d_{30} (mm): 0.023
d_{50} (mm): 0.044
d_{60} (mm): 0.055
d_{84} (mm): 0.096

Median Particle Diameter --d_{50} (mm): 0.044
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 177
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 31
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.047

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay with sand (CL)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

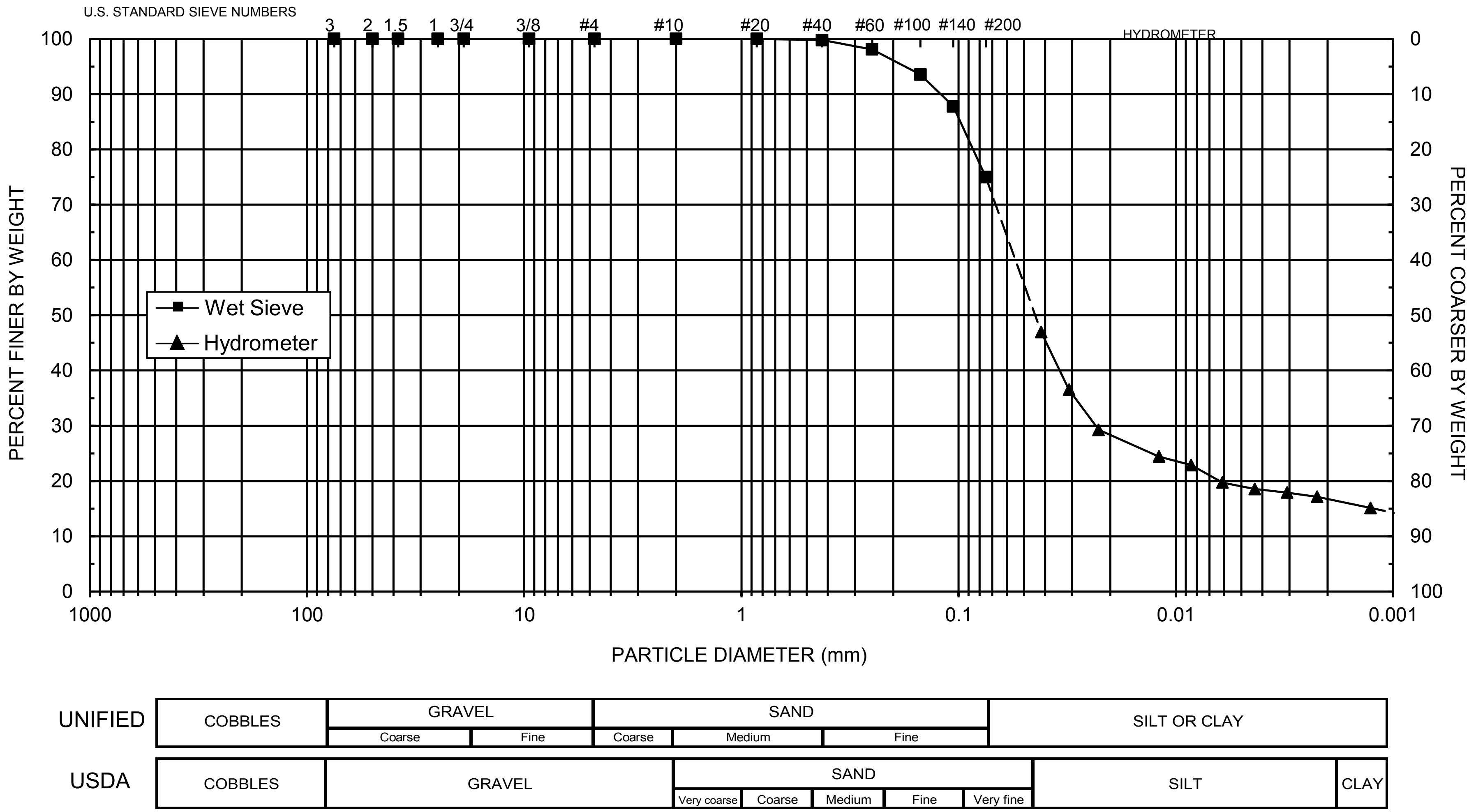
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2:	NA
Sample Number:	NRB-2 (0.5-1)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	0.5-1'	*Initial Wt.* (g):	60.76
Test Date:	12-Dec-19	*Total Sample Wt.* (g):	456.49
Start Time:	9:06	*Wt. Passing #10* (g):	456.49

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.2	36.00	6.83	29.2	10	0.0417	47	47.0
	2	19.2	29.50	6.83	22.7	11	0.0310	37	36.5
	4	19.2	25.00	6.83	18.2	12	0.0227	29	29.3
	15	19.2	22.00	6.83	15.2	12	0.0119	24	24.4
	30	19.3	21.00	6.80	14.2	12	0.0085	23	22.9
	60	19.4	19.00	6.77	12.2	13	0.0061	20	19.7
	120	19.5	18.25	6.73	11.5	13	0.0043	19	18.5
	240	19.8	17.75	6.64	11.1	13	0.0031	18	17.9
	458	19.9	17.25	6.60	10.6	13	0.0022	17	17.1
13-Dec-19	1432	19.1	16.25	6.86	9.4	13	0.0013	15	15.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00031**	d_{30} = **0.023**	d_{50} = **0.044**	d_{60} = **0.055**	C_u = **177**	C_c = **31**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-2 (0.5-1)	**0.5-1'**	**Lean clay with sand (CL)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 694.20
Weight Passing #10 (g): 694.20
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 69.64
Calculated Weight of Sieve Sample (g): 69.64

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	694.20	100.00
	2"	50	0.00	0.00	694.20	100.00
	1.5"	38.1	0.00	0.00	694.20	100.00
	1"	25	0.00	0.00	694.20	100.00
	3/4"	19.0	0.00	0.00	694.20	100.00
	3/8"	9.5	0.00	0.00	694.20	100.00
	4	4.75	0.00	0.00	694.20	100.00
	10	2.00	0.00	0.00	694.20	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.00	0.00	69.64	100.00
	40	0.425	0.06	0.06	69.58	99.91
	60	0.250	0.51	0.57	69.07	99.18
	100	0.150	1.44	2.01	67.63	97.11
	140	0.106	3.00	5.01	64.63	92.81
	200	0.075	8.00	13.01	56.63	81.32
	dry pan		1.86	14.87	54.77	
	wet pan			54.77	0.00	

d_{10} (mm): 0.00021
d_{16} (mm): 0.0010
d_{30} (mm): 0.015
d_{50} (mm): 0.037
d_{60} (mm): 0.047
d_{84} (mm): 0.081

Median Particle Diameter --d_{50} (mm): 0.037
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 224
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 23
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.040

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay with sand (CL)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

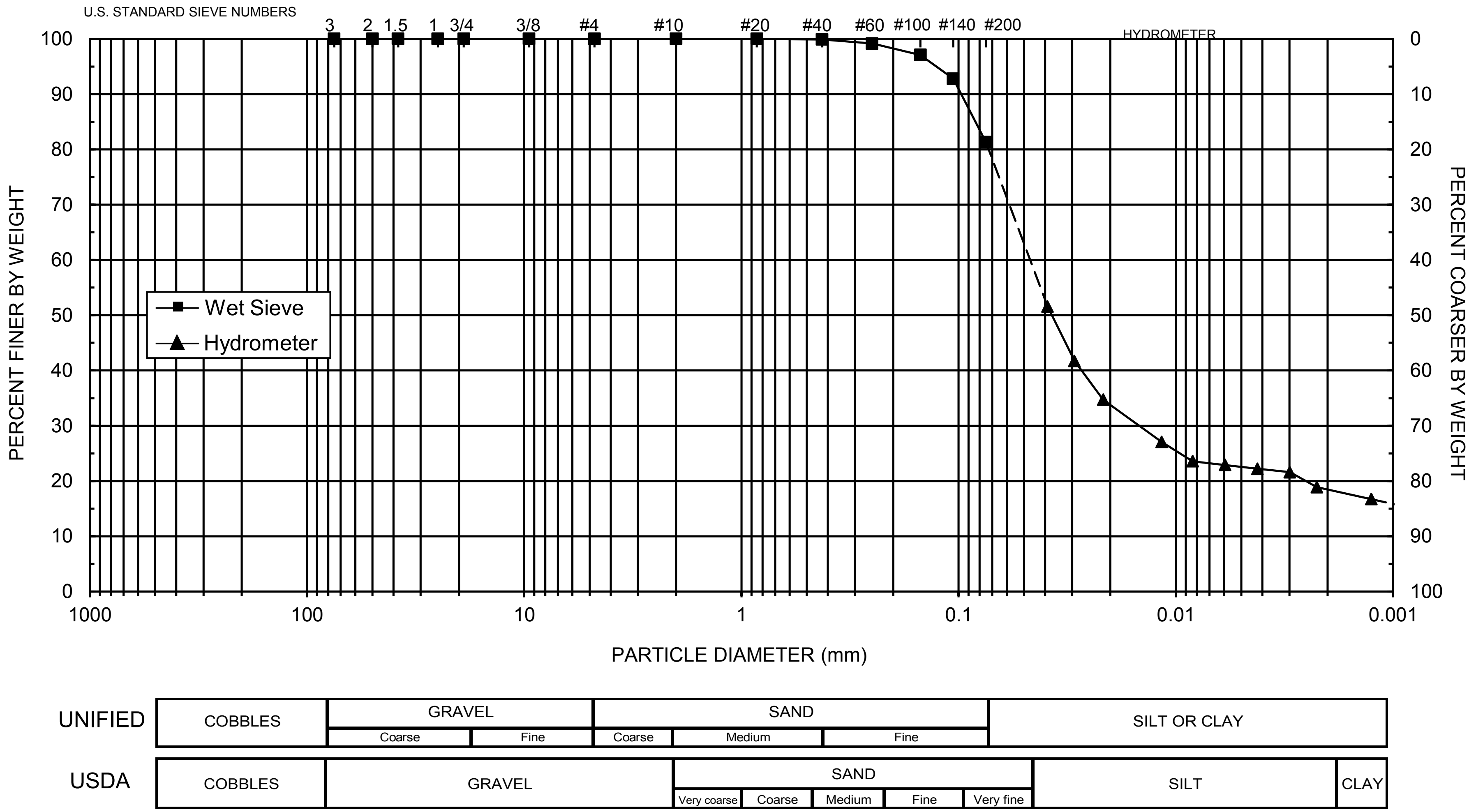
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with H_2O_2:*	NA
Sample Number:	NRB-2 (1.5-2)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	1.5-2'	*Initial Wt. (g):*	69.64
Test Date:	16-Dec-19	*Total Sample Wt. (g):*	694.20
Start Time:	9:12	*Wt. Passing #10 (g):*	694.20

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.3	43.50	6.80	36.7	9	0.0389	52	51.6
	2	19.3	36.50	6.80	29.7	10	0.0293	42	41.7
	4	19.3	31.50	6.80	24.7	11	0.0216	35	34.7
	15	19.5	26.00	6.73	19.3	12	0.0116	27	27.1
	30	19.5	23.50	6.73	16.8	12	0.0084	24	23.6
	60	19.6	23.00	6.70	16.3	12	0.0059	23	22.9
	120	19.6	22.50	6.70	15.8	12	0.0042	22	22.2
	240	19.8	22.00	6.64	15.4	12	0.0030	22	21.6
	437	20.0	20.00	6.57	13.4	13	0.0022	19	18.9
17-Dec-19	1414	19.1	18.75	6.86	11.9	13	0.0013	17	16.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00021**	d_{30} = **0.015**	d_{50} = **0.037**	d_{60} = **0.047**	C_u = **224**	C_c = **23**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-2 (1.5-2)	**1.5-2'**	**Lean clay with sand (CL)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 17-Jan-20

Initial Dry Weight of Sample (g): 380.41
Weight Passing #10 (g): 380.41
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 85.16
Calculated Weight of Sieve Sample (g): 85.16

Shape: Rounded
Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	380.41	100.00
	2"	50	0.00	0.00	380.41	100.00
	1.5"	38.1	0.00	0.00	380.41	100.00
	1"	25	0.00	0.00	380.41	100.00
	3/4"	19.0	0.00	0.00	380.41	100.00
	3/8"	9.5	0.00	0.00	380.41	100.00
	4	4.75	0.00	0.00	380.41	100.00
	10	2.00	0.00	0.00	380.41	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.01	0.01	85.15	99.99
	40	0.425	0.12	0.13	85.03	99.85
	60	0.250	0.87	1.00	84.16	98.83
	100	0.150	2.72	3.72	81.44	95.63
	140	0.106	4.30	8.02	77.14	90.58
	200	0.075	11.13	19.15	66.01	77.51
	dry pan		3.65	22.80	62.36	
	wet pan			62.36	0.00	

d_{10} (mm): 0.00067
d_{16} (mm): 0.0015
d_{30} (mm): 0.020
d_{50} (mm): 0.042
d_{60} (mm): 0.052
d_{84} (mm): 0.089

Median Particle Diameter --d_{50} (mm): 0.042
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 78
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 11
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.044

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay with sand (CL)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 15-Jan-20
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

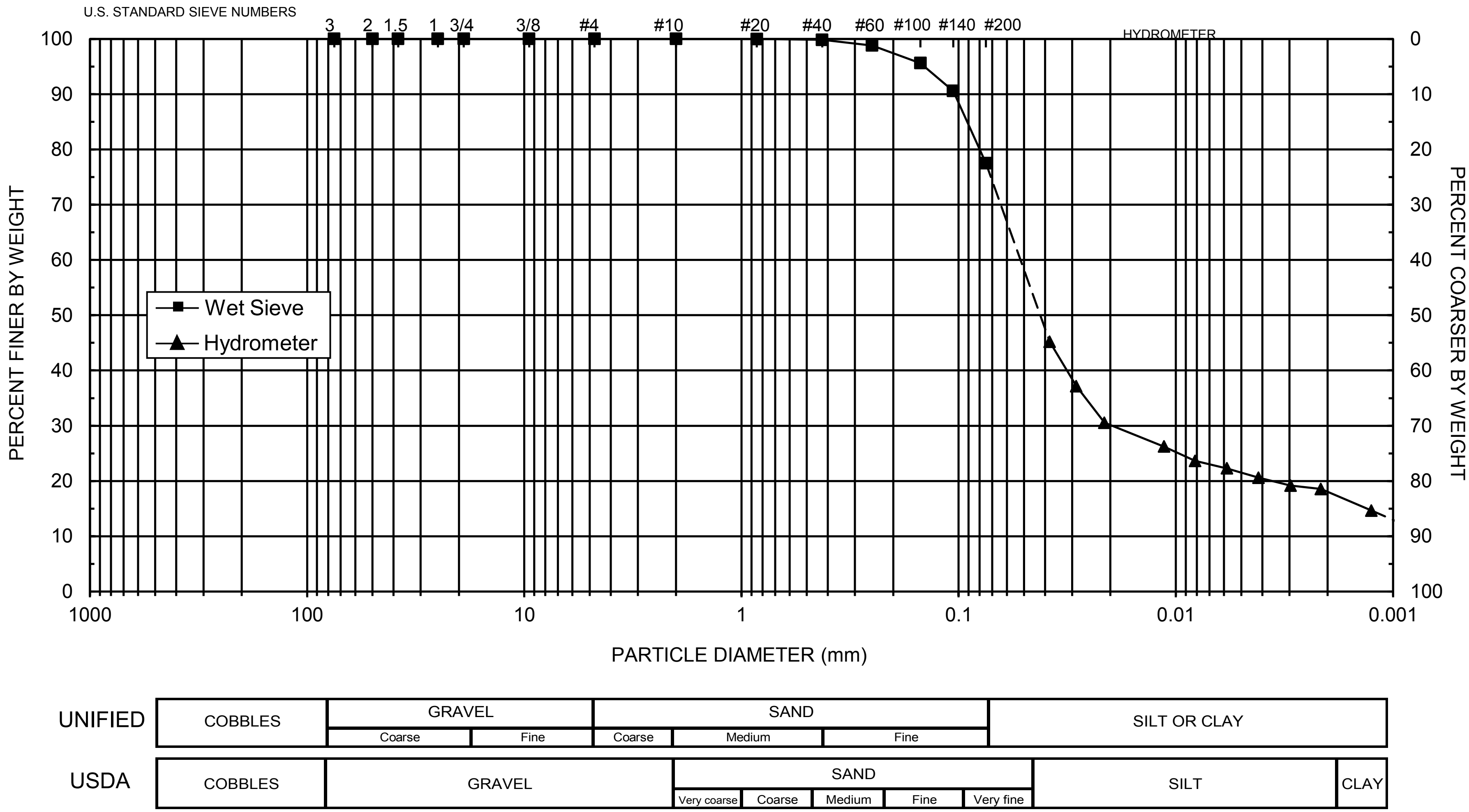
Initial Wt. (g)*:* 85.16
Total Sample Wt. (g)*:* 380.41
Wt. Passing #10 (g)*:* 380.41

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
15-Jan-20	1	19.7	46.00	6.67	39.3	8	0.0380	45	45.2
	2	19.7	39.00	6.67	32.3	9	0.0287	37	37.1
	4	19.7	33.25	6.67	26.6	10	0.0213	31	30.5
	15	19.7	29.50	6.67	22.8	11	0.0113	26	26.2
	30	19.7	27.25	6.67	20.6	11	0.0082	24	23.6
	60	19.9	26.00	6.60	19.4	12	0.0058	22	22.3
	120	20.0	24.50	6.57	17.9	12	0.0042	21	20.6
	240	20.0	23.25	6.57	16.7	12	0.0030	19	19.2
	461	19.9	22.75	6.60	16.1	12	0.0021	19	18.6
16-Jan-20	1399	18.6	19.75	7.02	12.7	13	0.0013	15	14.6

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines



d_{10} = **0.00067**	d_{30} = **0.020**	d_{50} = **0.042**	d_{60} = **0.052**	C_u = **78**	C_c = **11**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-2 (2.5-3)	**2.5-3'**	**Lean clay with sand (CL)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 743.41
Weight Passing #10 (g): 742.22
Weight Retained #10 (g): 1.19
Weight of Hydrometer Sample (g): 82.04
Calculated Weight of Sieve Sample (g): 82.17

Shape: Angular
Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	743.41	100.00
	2"	50	0.00	0.00	743.41	100.00
	1.5"	38.1	0.00	0.00	743.41	100.00
	1"	25	0.00	0.00	743.41	100.00
	3/4"	19.0	0.00	0.00	743.41	100.00
	3/8"	9.5	0.00	0.00	743.41	100.00
	4	4.75	0.58	0.58	742.83	99.92
	10	2.00	0.61	1.19	742.22	99.84
-10			(Based on calculated sieve wt.)			
	20	0.85	0.12	0.25	81.92	99.69
	40	0.425	0.26	0.51	81.66	99.38
	60	0.250	0.88	1.39	80.78	98.31
	100	0.150	2.56	3.95	78.22	95.19
	140	0.106	4.13	8.08	74.09	90.17
	200	0.075	9.29	17.37	64.80	78.86
	dry pan		3.08	20.45	61.72	
	wet pan			61.72	0.00	

d_{10} (mm): 0.00011
d_{16} (mm): 0.00046
d_{30} (mm): 0.012
d_{50} (mm): 0.038
d_{60} (mm): 0.048
d_{84} (mm): 0.088

Median Particle Diameter --d_{50} (mm): 0.038
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 436
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 27
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.042

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay with sand (CL)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 16-Dec-19
Start Time: 9:18

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

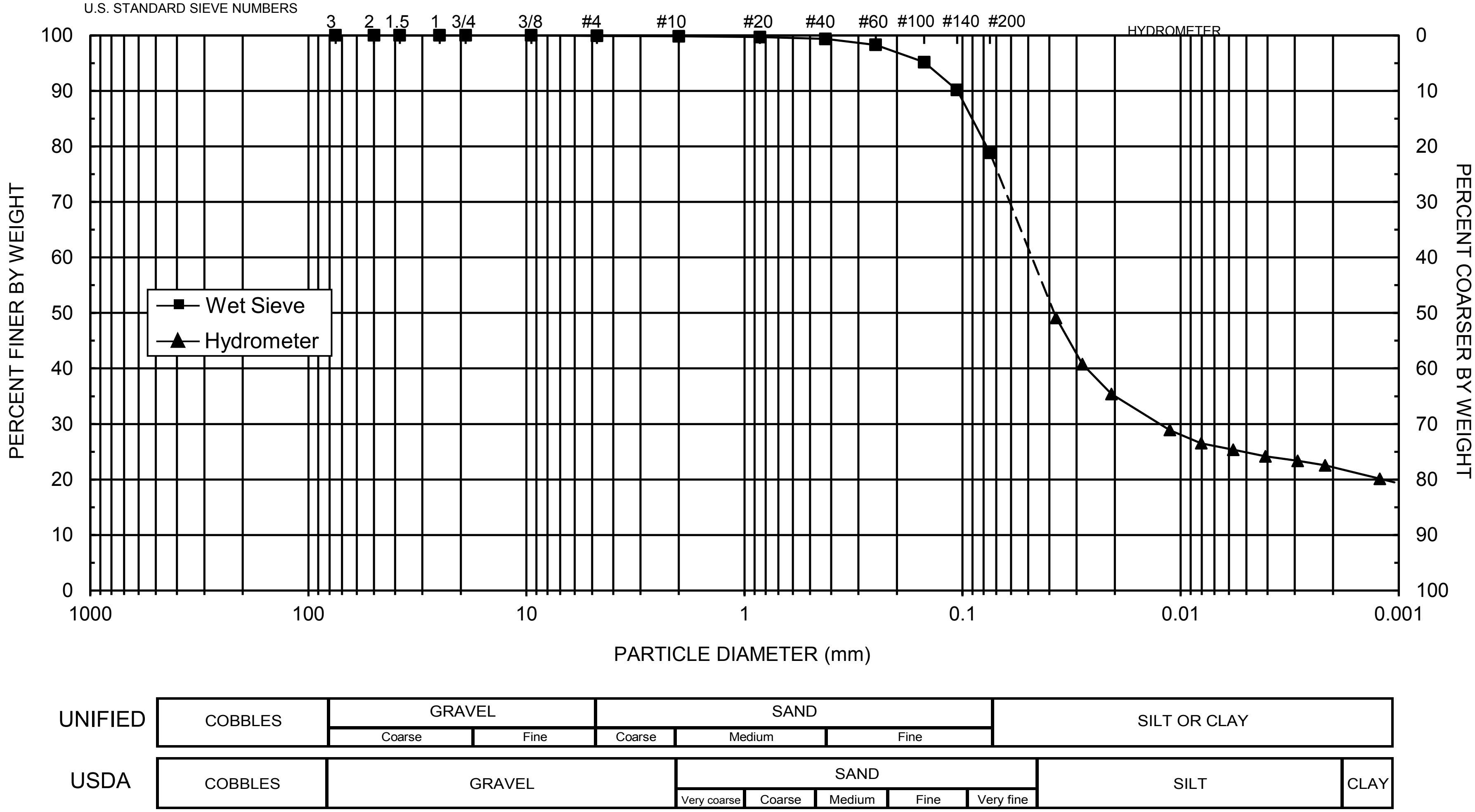
Initial Wt. (g)*:* 82.04
Total Sample Wt. (g)*:* 743.41
Wt. Passing #10 (g)*:* 742.22

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.4	48.00	6.77	41.2	8	0.0372	49	49.1
	2	19.4	41.00	6.77	34.2	9	0.0282	41	40.8
	4	19.4	36.50	6.77	29.7	10	0.0207	35	35.4
	15	19.5	31.00	6.73	24.3	11	0.0112	29	28.9
	30	19.5	29.00	6.73	22.3	11	0.0080	27	26.5
	60	19.6	28.00	6.70	21.3	11	0.0057	25	25.4
	120	19.6	27.00	6.70	20.3	11	0.0041	24	24.2
	240	19.8	26.25	6.64	19.6	12	0.0029	23	23.4
	432	20.0	25.50	6.57	18.9	12	0.0022	23	22.5
17-Dec-19	1409	19.1	23.75	6.86	16.9	12	0.0012	20	20.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00011**	d_{30} = **0.012**	d_{50} = **0.038**	d_{60} = **0.048**	C_u = **436**	C_c = **27**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-2 (3-3.5)	**3-3.5'**	**Lean clay with sand (CL)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (5.5-6)
Project Name: Lisbon Site
Depth: 5.5-6'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 702.99
Weight Passing #10 (g): 699.66
Weight Retained #10 (g): 3.33
Weight of Hydrometer Sample (g): 79.39
Calculated Weight of Sieve Sample (g): 79.77

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	702.99	100.00
	2"	50	0.00	0.00	702.99	100.00
	1.5"	38.1	0.00	0.00	702.99	100.00
	1"	25	0.00	0.00	702.99	100.00
	3/4"	19.0	0.00	0.00	702.99	100.00
	3/8"	9.5	0.00	0.00	702.99	100.00
	4	4.75	0.18	0.18	702.81	99.97
	10	2.00	3.15	3.33	699.66	99.53
-10			(Based on calculated sieve wt.)			
	20	0.85	0.72	1.10	78.67	98.62
	40	0.425	3.64	4.74	75.03	94.06
	60	0.250	3.91	8.65	71.12	89.16
	100	0.150	5.32	13.97	65.80	82.49
	140	0.106	5.45	19.42	60.35	75.66
	200	0.075	9.17	28.59	51.18	64.16
	dry pan		1.69	30.28	49.49	
	wet pan			49.49	0.00	

d_{10} (mm): 0.00034
d_{16} (mm): 0.0022
d_{30} (mm): 0.024
d_{50} (mm): 0.049
d_{60} (mm): 0.066
d_{84} (mm): 0.17

Median Particle Diameter --d_{50} (mm): 0.049
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 194
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 26
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.074

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Sandy lean clay s(CL)
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

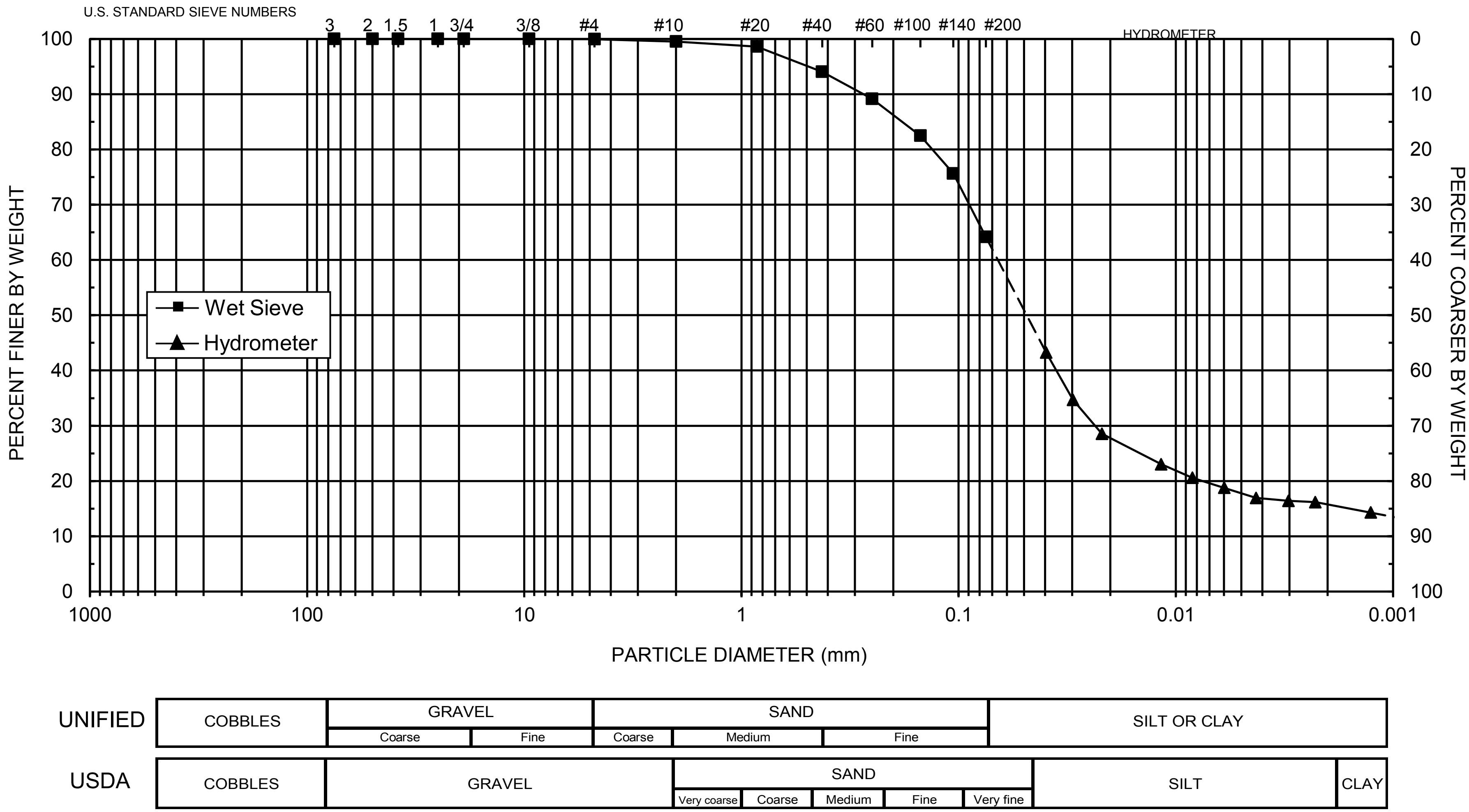
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-2 (5.5-6)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	5.5-6'	*Initial Wt. (g):*	79.39
Test Date:	16-Dec-19	*Total Sample Wt. (g):*	702.99
Start Time:	9:24	*Wt. Passing #10 (g):*	699.66

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.5	42.00	6.73	35.3	9	0.0395	43	43.3
	2	19.5	35.00	6.73	28.3	10	0.0297	35	34.7
	4	19.5	30.00	6.73	23.3	11	0.0219	29	28.5
	15	19.5	25.50	6.73	18.8	12	0.0117	23	23.0
	30	19.5	23.50	6.73	16.8	12	0.0084	21	20.6
	60	19.6	22.00	6.70	15.3	12	0.0060	19	18.8
	120	19.6	20.50	6.70	13.8	13	0.0043	17	16.9
	240	19.8	20.00	6.64	13.4	13	0.0030	16	16.4
	427	20.0	19.75	6.57	13.2	13	0.0023	16	16.2
17-Dec-19	1403	19.1	18.50	6.86	11.6	13	0.0013	14	14.3

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00034**	d_{30} = **0.024**	d_{50} = **0.049**	d_{60} = **0.066**	C_u = **194**	C_c = **26**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-2 (5.5-6)	**5.5-6'**	**Sandy lean clay s(CL)**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-2 (10-10.5)
Project Name: Lisbon Site
Depth: 10-10.5'
Test Date: 17-Jan-20

Initial Dry Weight of Sample (g): 359.70
Weight Passing #10 (g): 353.90
Weight Retained #10 (g): 5.80
Weight of Hydrometer Sample (g): 99.11
Calculated Weight of Sieve Sample (g): 100.73

Shape: Angular
Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	359.70	100.00
	2"	50	0.00	0.00	359.70	100.00
	1.5"	38.1	0.00	0.00	359.70	100.00
	1"	25	0.00	0.00	359.70	100.00
	3/4"	19.0	0.00	0.00	359.70	100.00
	3/8"	9.5	0.00	0.00	359.70	100.00
	4	4.75	2.28	2.28	357.42	99.37
	10	2.00	3.52	5.80	353.90	98.39
-10			(Based on calculated sieve wt.)			
	20	0.85	1.97	3.59	97.14	96.43
	40	0.425	2.94	6.53	94.20	93.51
	60	0.250	2.43	8.96	91.77	91.10
	100	0.150	2.39	11.35	89.38	88.73
	140	0.106	2.01	13.36	87.37	86.73
	200	0.075	6.23	19.59	81.14	80.55
	dry pan		4.62	24.21	76.52	
	wet pan			76.52	0.00	

d_{10} (mm): 0.00075
d_{16} (mm): 0.0013
d_{30} (mm): 0.0057
d_{50} (mm): 0.030
d_{60} (mm): 0.041
d_{84} (mm): 0.091

Median Particle Diameter --d_{50} (mm): 0.030
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 55
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.1
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.041

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay with sand (CL)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

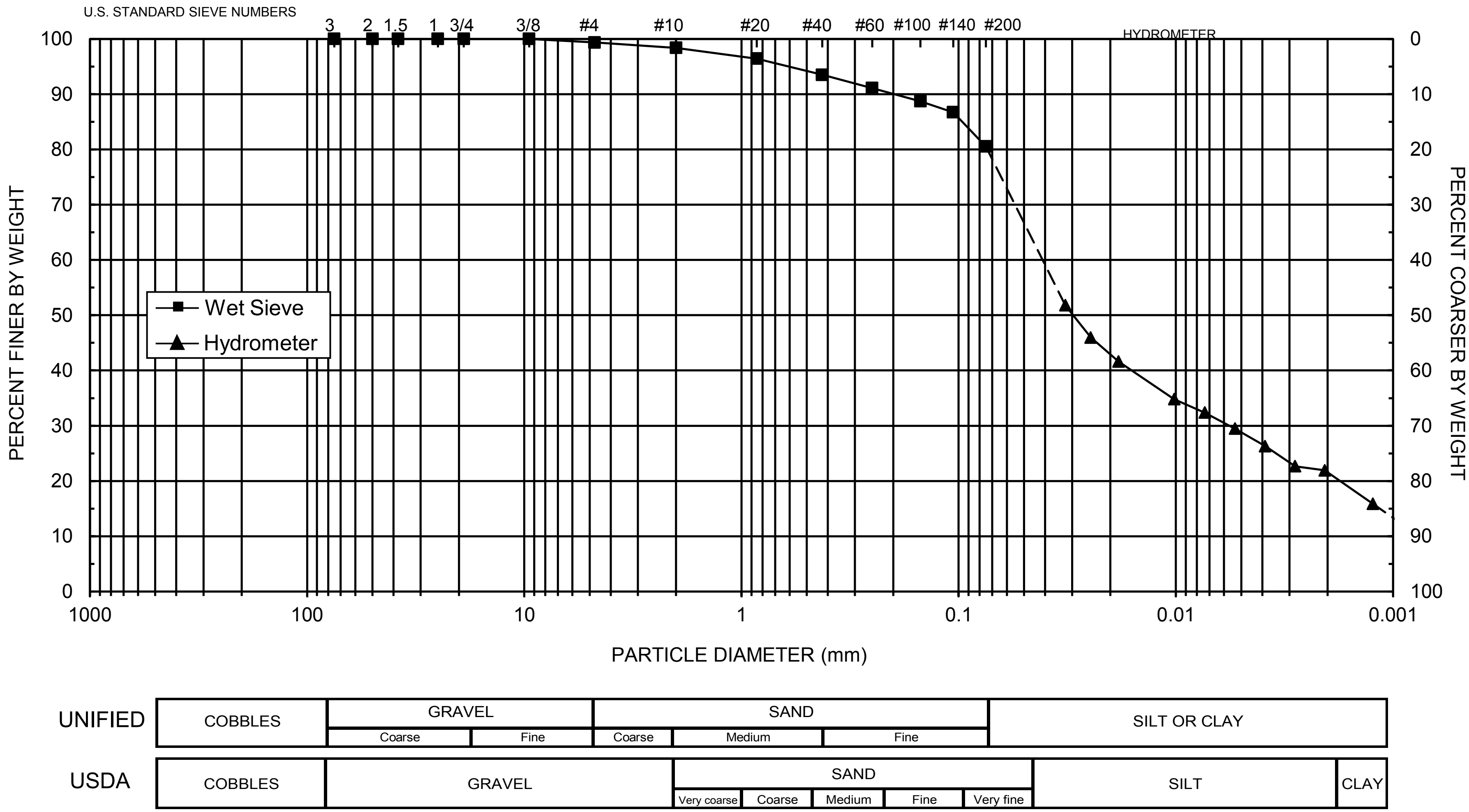
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-2 (10-10.5)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	10-10.5'	*Initial Wt.* (g)*:*	99.11
Test Date:	15-Jan-20	*Total Sample Wt.* (g)*:*	359.70
Start Time:	9:18	*Wt. Passing #10* (g)*:*	353.90

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
15-Jan-20	1	19.7	60.00	6.67	53.3	6	0.0322	53	51.8
	2	19.7	54.00	6.67	47.3	7	0.0246	47	46.0
	4	19.7	49.50	6.67	42.8	8	0.0183	42	41.6
	15	19.7	42.50	6.67	35.8	9	0.0102	35	34.8
	30	19.7	40.00	6.67	33.3	9	0.0073	33	32.4
	60	19.7	37.00	6.67	30.3	10	0.0053	30	29.5
	120	19.7	33.75	6.67	27.1	10	0.0039	27	26.3
	240	19.7	30.00	6.67	23.3	11	0.0028	23	22.7
	455	19.7	29.25	6.67	22.6	11	0.0021	22	21.9
16-Jan-20	1384	19.7	23.00	6.67	16.3	12	0.0012	16	15.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: A. Bland
Data entered by: A. Bland
Checked by: J. Hines



d_{10} = **0.00075**	d_{30} = **0.0057**	d_{50} = **0.030**	d_{60} = **0.041**	C_u = **55**	C_c = **1.1**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-2 (10-10.5)	**10-10.5'**	**Lean clay with sand (CL)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (0.5-1)
Project Name: Lisbon Site
Depth: 0.5-1'

Test Date: 13-Dec-19

Initial Dry Weight of Sample (g): 509.37
Weight Passing #10 (g): 500.49
Weight Retained #10 (g): 8.88
Weight of Hydrometer Sample (g): 71.47
Calculated Weight of Sieve Sample (g): 72.74

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	509.37	100.00
	2"	50	0.00	0.00	509.37	100.00
	1.5"	38.1	0.00	0.00	509.37	100.00
	1"	25	0.00	0.00	509.37	100.00
	3/4"	19.0	0.00	0.00	509.37	100.00
	3/8"	9.5	0.00	0.00	509.37	100.00
	4	4.75	0.94	0.94	508.43	99.82
	10	2.00	7.94	8.88	500.49	98.26
-10			(Based on calculated sieve wt.)			
	20	0.85	1.62	2.89	69.85	96.03
	40	0.425	2.40	5.29	67.45	92.73
	60	0.250	4.22	9.51	63.23	86.93
	100	0.150	4.68	14.19	58.55	80.49
	140	0.106	3.96	18.15	54.59	75.05
	200	0.075	8.11	26.26	46.48	63.90
	dry pan		3.06	29.32	43.42	
	wet pan			43.42	0.00	

d_{10} (mm): 0.00054
d_{16} (mm): 0.0013
d_{30} (mm): 0.023
d_{50} (mm): 0.053
d_{60} (mm): 0.068
d_{84} (mm): 0.20

Median Particle Diameter --d_{50} (mm): 0.053
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 126
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 14
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.085

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Sandy lean clay s(CL)
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

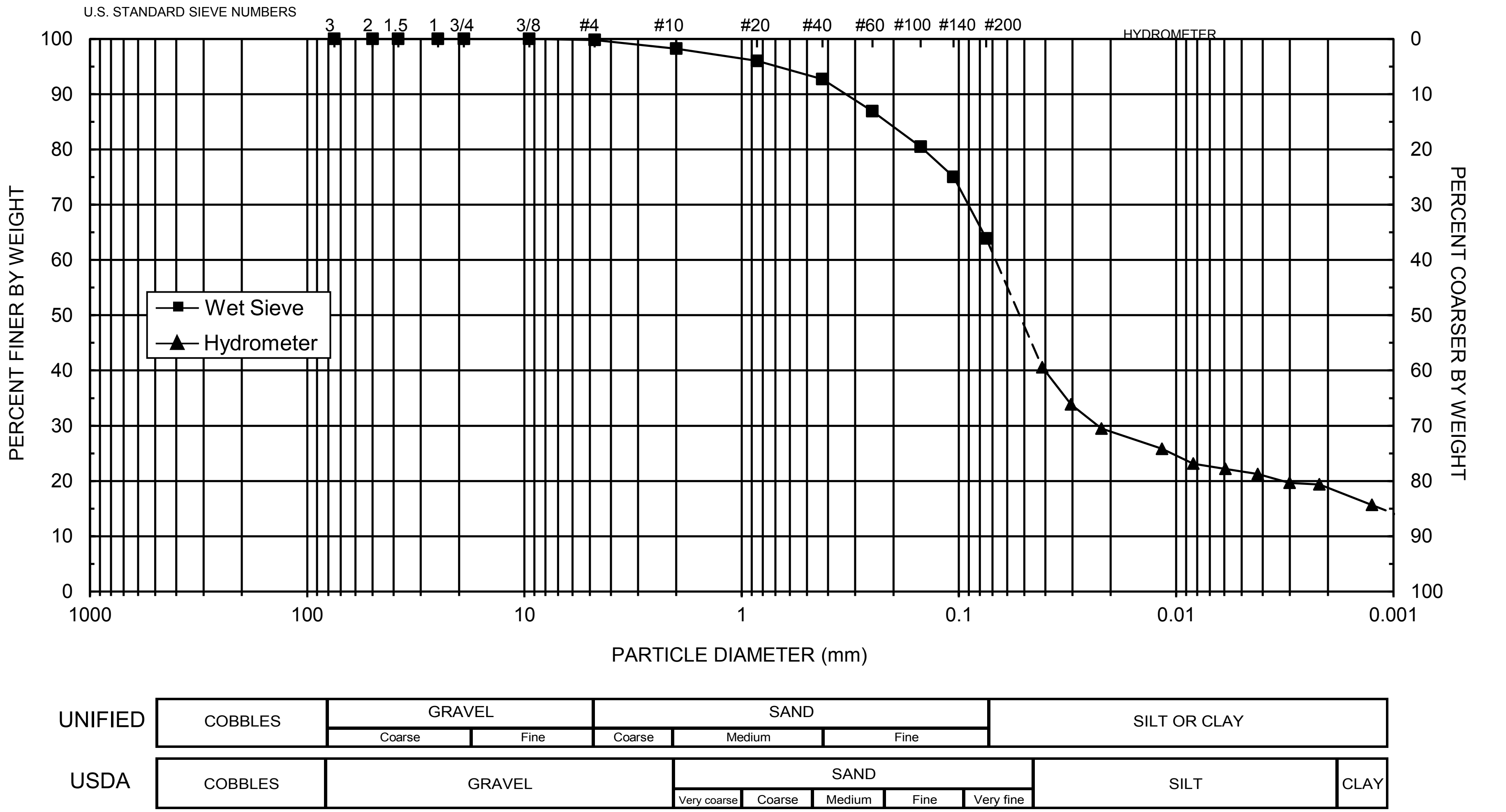
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with H_2O_2:*	NA
Sample Number:	NRB-3 (0.5-1)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	0.5-1'	*Initial Wt. (g):*	71.47
Test Date:	12-Dec-19	*Total Sample Wt. (g):*	509.37
Start Time:	9:12	*Wt. Passing #10 (g):*	500.49

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.2	37.00	6.83	30.2	10	0.0413	41	40.6
	2	19.2	32.00	6.83	25.2	11	0.0304	34	33.9
	4	19.2	28.75	6.83	21.9	11	0.0221	30	29.5
	15	19.3	26.00	6.80	19.2	12	0.0116	26	25.8
	30	19.3	24.00	6.80	17.2	12	0.0083	24	23.1
	60	19.4	23.25	6.77	16.5	12	0.0059	23	22.2
	120	19.6	22.50	6.70	15.8	12	0.0042	22	21.3
	240	19.8	21.25	6.64	14.6	12	0.0030	20	19.7
	453	19.9	21.00	6.60	14.4	12	0.0022	20	19.4
13-Dec-19	1427	19.1	18.50	6.86	11.6	13	0.0013	16	15.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00054**	d_{30} = **0.023**	d_{50} = **0.053**	d_{60} = **0.068**	C_u = **126**	C_c = **14**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-3 (0.5-1)	**0.5-1'**	**Sandy lean clay s(CL)**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'
Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 622.30
Weight Passing #10 (g): 516.97
Weight Retained #10 (g): 105.33
Weight of Hydrometer Sample (g): 70.80
Calculated Weight of Sieve Sample (g): 85.23

Shape: Angular
Hardness: Weathered and friable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	622.30	100.00
	2"	50	0.00	0.00	622.30	100.00
	1.5"	38.1	0.00	0.00	622.30	100.00
	1"	25	0.00	0.00	622.30	100.00
	3/4"	19.0	0.00	0.00	622.30	100.00
	3/8"	9.5	9.21	9.21	613.09	98.52
	4	4.75	43.10	52.31	569.99	91.59
	10	2.00	53.02	105.33	516.97	83.07
-10			(Based on calculated sieve wt.)			
	20	0.85	7.99	22.42	62.81	73.70
	40	0.425	9.19	31.61	53.62	62.92
	60	0.250	10.52	42.13	43.10	50.57
	100	0.150	7.65	49.78	35.45	41.60
	140	0.106	4.64	54.42	30.81	36.15
	200	0.075	3.90	58.32	26.91	31.58
	dry pan		0.75	59.07	26.16	
	wet pan			26.16	0.00	

d_{10} (mm): 0.0081 d_{50} (mm): 0.24
d_{16} (mm): 0.024 d_{60} (mm): 0.37
d_{30} (mm): 0.069 d_{84} (mm): 2.2

Median Particle Diameter --d_{50} (mm): 0.24
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 46
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.6
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.82

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand (SM)
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'

Test Date: 16-Dec-19
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

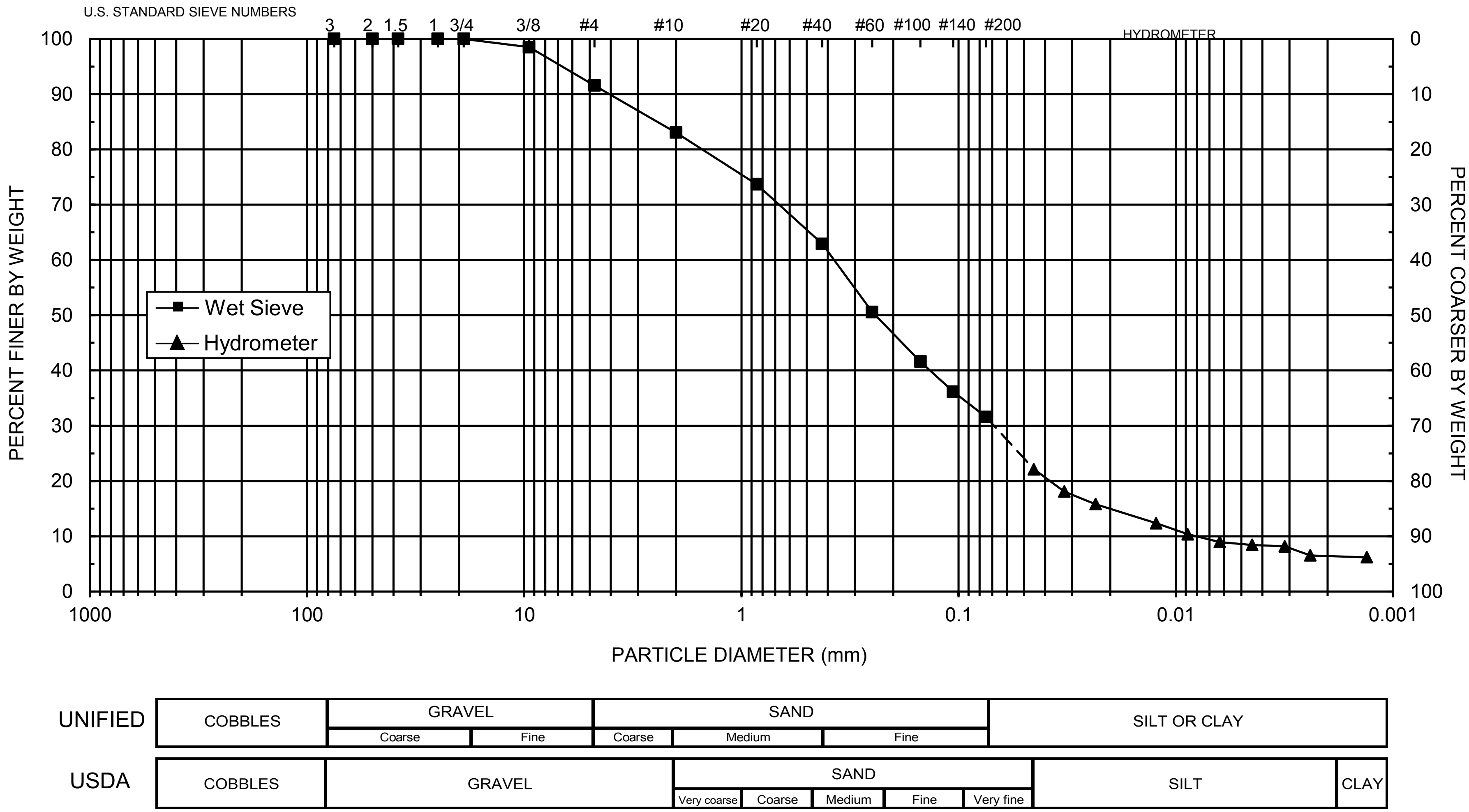
Initial Wt. (g)*:* 70.80
Total Sample Wt. (g)*:* 622.30
Wt. Passing #10 (g)*:* 516.97

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.5	26.00	6.73	19.3	12	0.0450	27	22.1
	2	19.5	22.50	6.73	15.8	12	0.0326	22	18.1
	4	19.5	20.50	6.73	13.8	12	0.0234	19	15.8
	15	19.5	17.50	6.73	10.8	13	0.0123	15	12.4
	30	19.5	15.75	6.73	9.0	13	0.0088	12	10.4
	60	19.6	14.50	6.70	7.8	13	0.0063	11	9.0
	120	19.7	14.00	6.67	7.3	14	0.0044	10	8.4
	240	19.8	13.75	6.64	7.1	14	0.0032	10	8.2
	421	20.0	12.25	6.57	5.7	14	0.0024	8	6.5
17-Dec-19	1398	19.1	12.25	6.86	5.4	14	0.0013	7	6.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.0081**	d_{30} = **0.069**	d_{50} = **0.24**	d_{60} = **0.37**	C_u = **46**	C_c = **1.6**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-3 (1.5-2)	**1.5-2'**	**Silty sand (SM)**	**Sandy Loam** †

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (2.5-3.5)
Project Name: Lisbon Site
Depth: 2.5-3.5'

Test Date: 13-Dec-19

Initial Dry Weight of Sample (g): 437.61
Weight Passing #10 (g): 395.24
Weight Retained #10 (g): 42.37
Weight of Hydrometer Sample (g): 70.33
Calculated Weight of Sieve Sample (g): 77.87

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	437.61	100.00
	2"	50	0.00	0.00	437.61	100.00
	1.5"	38.1	0.00	0.00	437.61	100.00
	1"	25	0.00	0.00	437.61	100.00
	3/4"	19.0	0.00	0.00	437.61	100.00
	3/8"	9.5	1.63	1.63	435.98	99.63
	4	4.75	11.55	13.18	424.43	96.99
	10	2.00	29.19	42.37	395.24	90.32
-10			(Based on calculated sieve wt.)			
	20	0.85	5.54	13.08	64.79	83.20
	40	0.425	8.47	21.55	56.32	72.33
	60	0.250	16.02	37.57	40.30	51.75
	100	0.150	11.61	49.18	28.69	36.84
	140	0.106	3.97	53.15	24.72	31.75
	200	0.075	2.76	55.91	21.96	28.20
	dry pan		1.14	57.05	20.82	
	wet pan			20.82	0.00	

d_{10} (mm): 0.0074 d_{50} (mm): 0.24
d_{16} (mm): 0.020 d_{60} (mm): 0.31
d_{30} (mm): 0.089 d_{84} (mm): 0.94

Median Particle Diameter --d_{50} (mm): 0.24
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 42
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 3.5
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.40

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand (SM)
USDA Soil Classification: Loamy Sand

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

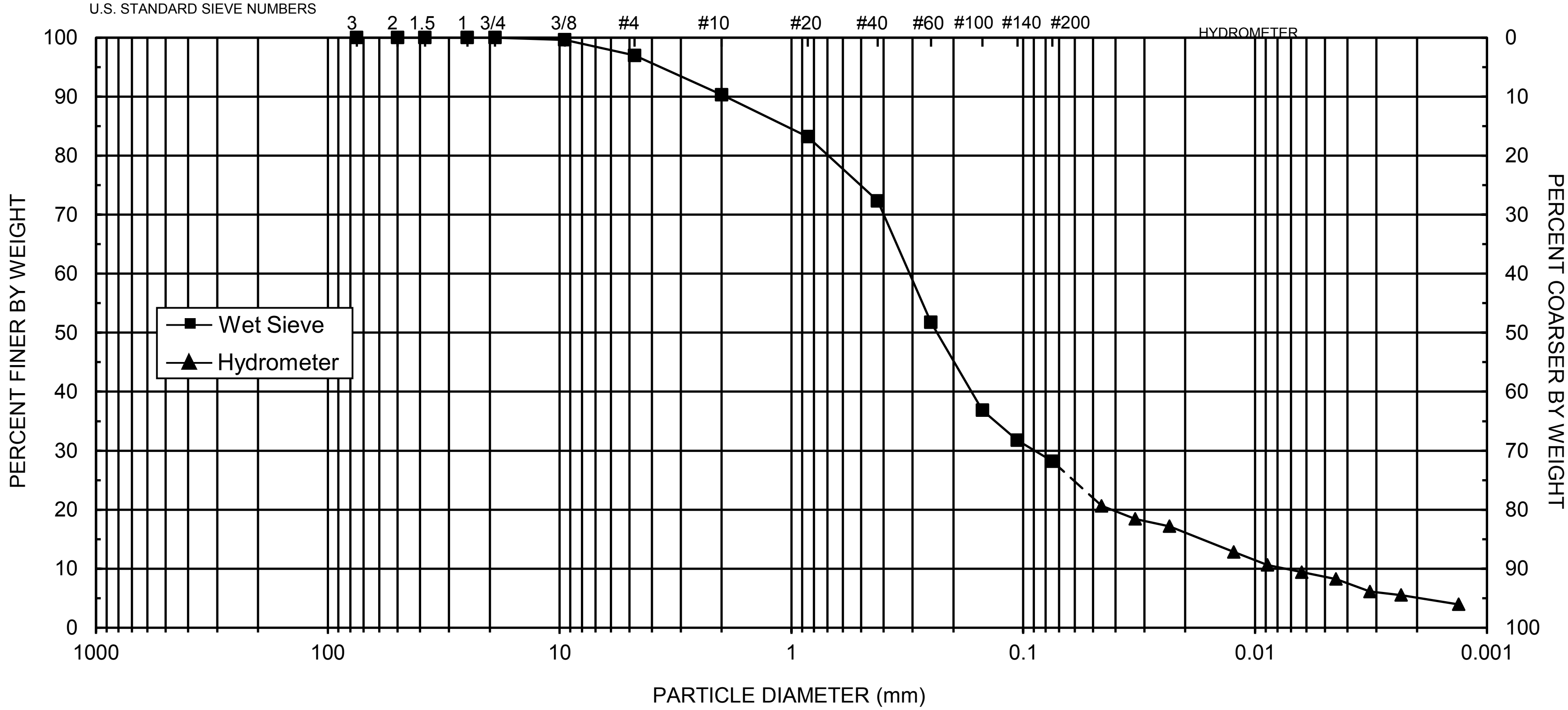
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-3 (2.5-3.5)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	2.5-3.5'	*Initial Wt. (g):*	70.33
Test Date:	12-Dec-19	*Total Sample Wt. (g):*	437.61
Start Time:	9:18	*Wt. Passing #10 (g):*	395.24

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.2	23.25	6.83	16.4	12	0.0459	23	20.6
	2	19.2	21.50	6.83	14.7	12	0.0329	20	18.4
	4	19.2	20.50	6.83	13.7	12	0.0234	19	17.2
	15	19.3	17.00	6.80	10.2	13	0.0124	14	12.8
	30	19.3	15.25	6.80	8.5	13	0.0088	12	10.6
	60	19.4	14.25	6.77	7.5	14	0.0063	10	9.4
	120	19.6	13.25	6.70	6.5	14	0.0045	9	8.2
	240	19.8	11.50	6.64	4.9	14	0.0032	7	6.1
	448	19.9	11.00	6.60	4.4	14	0.0023	6	5.5
13-Dec-19	1422	19.1	10.00	6.86	3.1	14	0.0013	4	3.9

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY	
		Coarse	Fine	Coarse	Medium	Fine		
USDA	COBBLES	GRAVEL	SAND				SILT	CLAY
			Very coarse, Coarse, Medium, Fine, Very fine					

d_{10} = **0.0074**	d_{30} = **0.089**	d_{50} = **0.24**	d_{60} = **0.31**	C_u = **42**	C_c = **3.5**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-3 (2.5-3.5)	**2.5-3.5'**	**Silty sand (SM)**	**Loamy Sand**

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (1-1.5)
Project Name: Lisbon Site
Depth: 1-1.5'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 619.75
Weight Passing #10 (g): 611.47
Weight Retained #10 (g): 8.28
Weight of Hydrometer Sample (g): 74.69
Calculated Weight of Sieve Sample (g): 75.70

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	619.75	100.00
	2"	50	0.00	0.00	619.75	100.00
	1.5"	38.1	0.00	0.00	619.75	100.00
	1"	25	0.00	0.00	619.75	100.00
	3/4"	19.0	0.00	0.00	619.75	100.00
	3/8"	9.5	3.77	3.77	615.98	99.39
	4	4.75	3.37	7.14	612.61	98.85
	10	2.00	1.14	8.28	611.47	98.66
-10			(Based on calculated sieve wt.)			
	20	0.85	0.34	1.35	74.35	98.21
	40	0.425	1.55	2.90	72.80	96.17
	60	0.250	3.31	6.21	69.49	91.79
	100	0.150	5.10	11.31	64.39	85.06
	140	0.106	6.08	17.39	58.31	77.03
	200	0.075	11.23	28.62	47.08	62.19
	dry pan		2.27	30.89	44.81	
	wet pan			44.81	0.00	

d_{10} (mm): 0.0017
d_{16} (mm): 0.0094
d_{30} (mm): 0.036
d_{50} (mm): 0.058
d_{60} (mm): 0.072
d_{84} (mm): 0.14

Median Particle Diameter --d_{50} (mm): 0.058
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 42
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 11
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.069

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

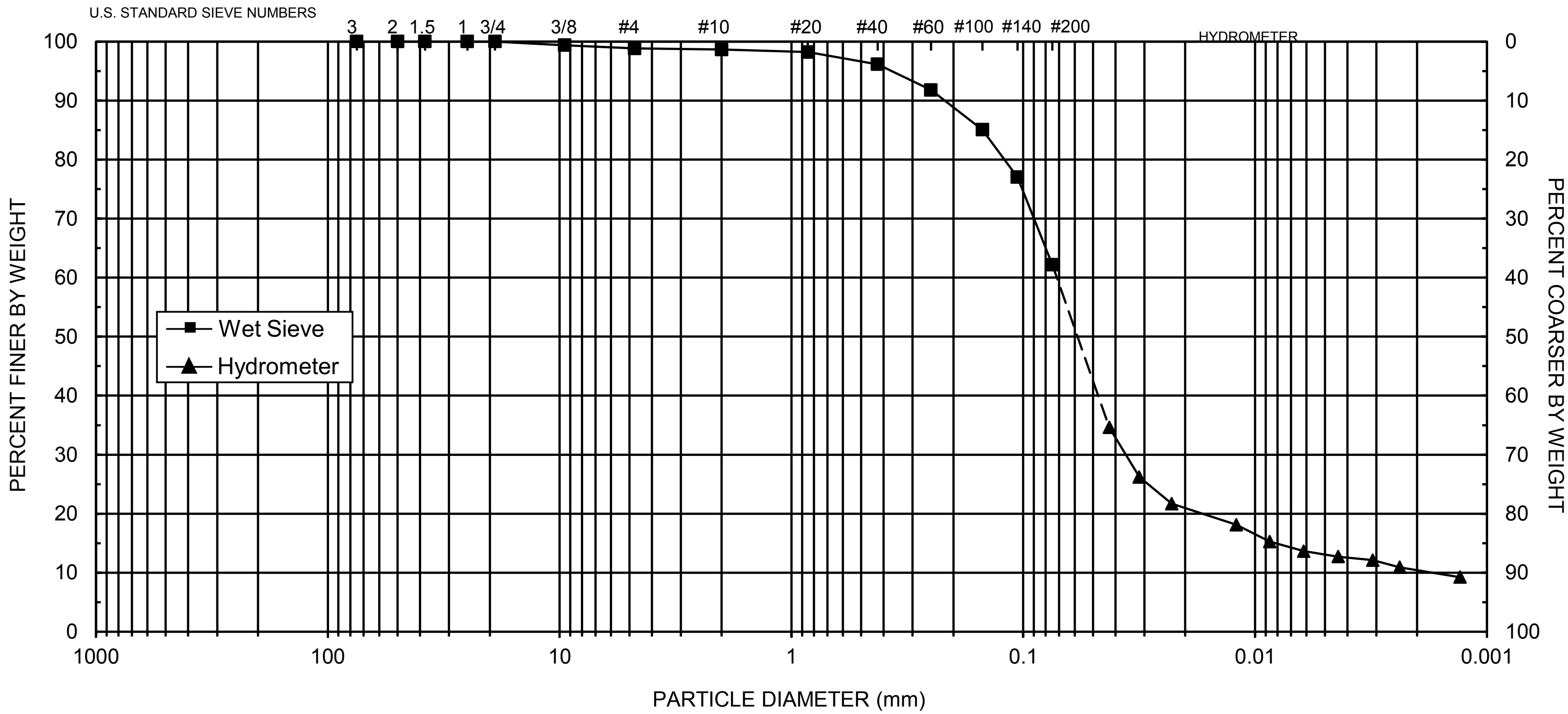
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2:	NA
Sample Number:	NRB-5 (1-1.5)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	1-1.5'	*Initial Wt.* (g):	74.69
Test Date:	16-Dec-19	*Total Sample Wt.* (g):	619.75
Start Time:	9:36	*Wt. Passing #10* (g):	611.47

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.5	33.50	6.73	26.8	10	0.0425	35	34.6
	2	19.5	27.00	6.73	20.3	11	0.0316	27	26.2
	4	19.5	23.50	6.73	16.8	12	0.0229	22	21.7
	15	19.5	20.75	6.73	14.0	12	0.0120	18	18.1
	30	19.6	18.50	6.70	11.8	13	0.0086	15	15.3
	60	19.6	17.25	6.70	10.5	13	0.0062	14	13.6
	120	19.7	16.50	6.67	9.8	13	0.0044	13	12.7
	240	19.8	16.00	6.64	9.4	13	0.0031	12	12.1
	416	20.0	15.00	6.57	8.4	13	0.0024	11	10.9
17-Dec-19	1393	19.1	14.00	6.86	7.1	14	0.0013	9	9.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.0017**	d_{30} = **0.036**	d_{50} = **0.058**	d_{60} = **0.072**	C_u = **42**	C_c = **11**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-5 (1-1.5)	**1-1.5'**	**Sandy silt s(ML)**	**Sandy Loam**

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 777.95
Weight Passing #10 (g): 614.76
Weight Retained #10 (g): 163.19
Weight of Hydrometer Sample (g): 74.82
Calculated Weight of Sieve Sample (g): 94.68

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	777.95	100.00
	2"	50	0.00	0.00	777.95	100.00
	1.5"	38.1	0.00	0.00	777.95	100.00
	1"	25	0.00	0.00	777.95	100.00
	3/4"	19.0	16.71	16.71	761.24	97.85
	3/8"	9.5	82.88	99.59	678.36	87.20
	4	4.75	32.75	132.34	645.61	82.99
	10	2.00	30.85	163.19	614.76	79.02
-10			(Based on calculated sieve wt.)			
	20	0.85	6.59	26.45	68.23	72.06
	40	0.425	10.02	36.47	58.21	61.48
	60	0.250	10.37	46.84	47.84	50.53
	100	0.150	10.06	56.90	37.78	39.90
	140	0.106	6.20	63.10	31.58	33.35
	200	0.075	6.36	69.46	25.22	26.64
	dry pan		1.91	71.37	23.31	
	wet pan			23.31	0.00	

d_{10} (mm): 0.017
d_{16} (mm): 0.044
d_{30} (mm): 0.089
d_{50} (mm): 0.24
d_{60} (mm): 0.40
d_{84} (mm): 5.6

Median Particle Diameter --d_{50} (mm): 0.24
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 24
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.2
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 2.0

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand with gravel (SM)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

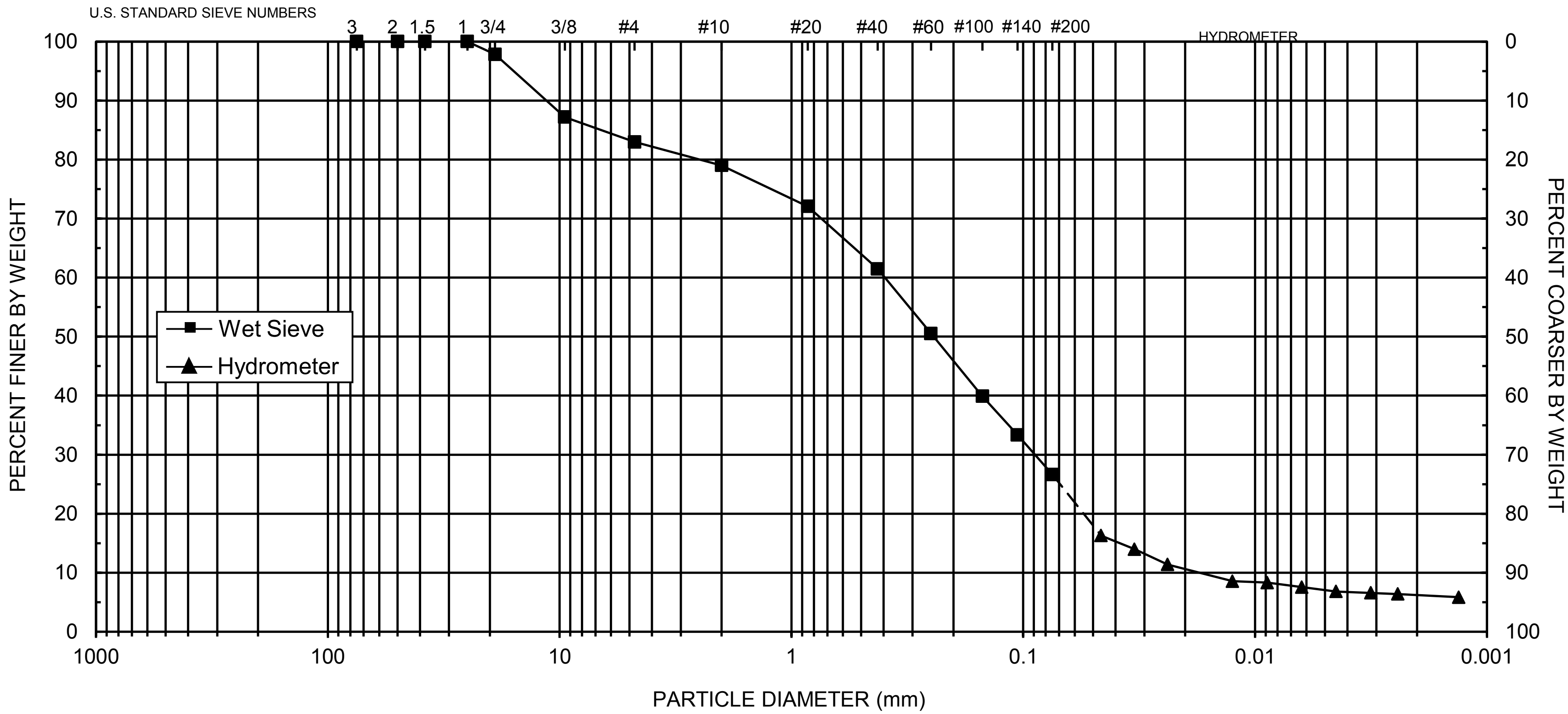
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-5 (2.5-3)	*Dispersant**:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	2.5-3'	*Initial Wt.* (g)*:*	74.82
Test Date:	16-Dec-19	*Total Sample Wt.* (g)*:*	777.95
Start Time:	9:42	*Wt. Passing #10* (g)*:*	614.76

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.5	22.50	6.73	15.8	12	0.0461	21	16.3
	2	19.5	20.25	6.73	13.5	13	0.0331	18	14.0
	4	19.5	17.75	6.73	11.0	13	0.0238	14	11.4
	15	19.5	15.00	6.73	8.3	13	0.0125	11	8.5
	30	19.6	14.75	6.70	8.0	13	0.0089	11	8.3
	60	19.6	14.00	6.70	7.3	14	0.0063	10	7.5
	120	19.7	13.25	6.67	6.6	14	0.0045	9	6.8
	240	19.8	13.00	6.64	6.4	14	0.0032	8	6.6
	411	20.0	12.75	6.57	6.2	14	0.0024	8	6.4
17-Dec-19	1388	19.1	12.50	6.86	5.6	14	0.0013	7	5.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY
		Coarse	Fine	Coarse	Medium	Fine	

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.017**	d_{30} = **0.089**	d_{50} = **0.24**	d_{60} = **0.40**	C_u = **24**	C_c = **1.2**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-5 (2.5-3)	**2.5-3'**	**Silty sand with gravel (SM)g**	**Sandy Loam †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 732.95
Weight Passing #10 (g): 470.64
Weight Retained #10 (g): 262.31
Weight of Hydrometer Sample (g): 77.30
Calculated Weight of Sieve Sample (g): 120.38

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	732.95	100.00
	2"	50	0.00	0.00	732.95	100.00
	1.5"	38.1	0.00	0.00	732.95	100.00
	1"	25	73.00	73.00	659.95	90.04
	3/4"	19.0	11.23	84.23	648.72	88.51
	3/8"	9.5	84.42	168.65	564.30	76.99
	4	4.75	48.16	216.81	516.14	70.42
	10	2.00	45.50	262.31	470.64	64.21
-10			(Based on calculated sieve wt.)			
	20	0.85	14.06	57.14	63.24	52.53
	40	0.425	20.70	77.84	42.54	35.34
	60	0.250	11.08	88.92	31.46	26.13
	100	0.150	7.74	96.66	23.72	19.70
	140	0.106	4.66	101.32	19.06	15.83
	200	0.075	2.93	104.25	16.13	13.40
	dry pan		0.58	104.83	15.55	
	wet pan			15.55	0.00	

d_{10} (mm): 0.049 d_{50} (mm): 0.77
d_{16} (mm): 0.11 d_{60} (mm): 1.5
d_{30} (mm): 0.31 d_{84} (mm): 14

Median Particle Diameter --d_{50} (mm): 0.77
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 31
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 1.3
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 5.0

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand with gravel (SM)g
USDA Soil Classification: Loamy Sand †

† Greater than 10% of sample is coarse material

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 16-Dec-19
Start Time: 9:48

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

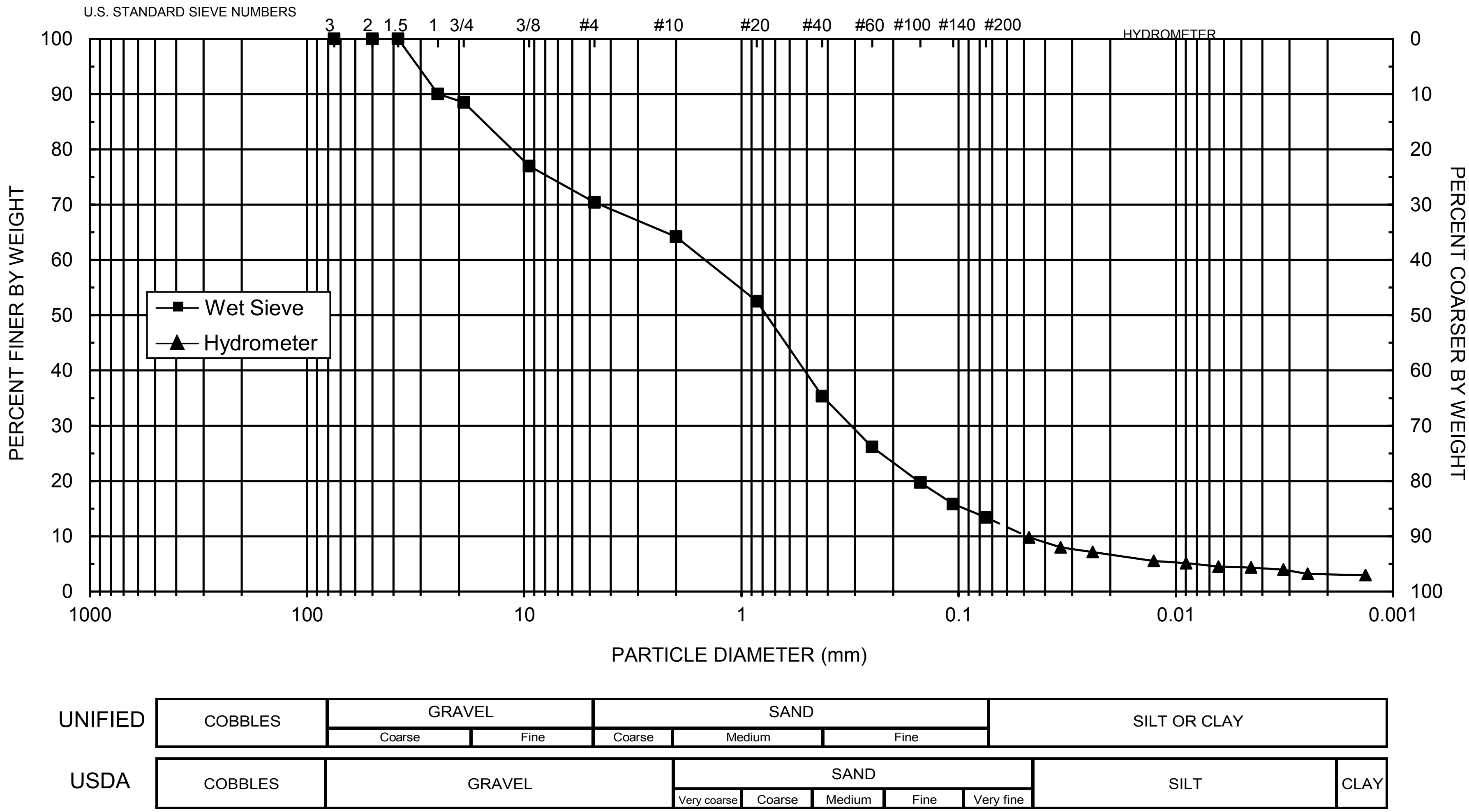
Initial Wt. (g): 77.30
Total Sample Wt. (g): 732.95
Wt. Passing #10 (g): 470.64

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.6	18.75	6.70	12.0	13	0.0473	15	9.8
	2	19.6	16.50	6.70	9.8	13	0.0339	12	8.0
	4	19.6	15.50	6.70	8.8	13	0.0241	11	7.2
	15	19.6	13.50	6.70	6.8	14	0.0126	9	5.5
	30	19.6	13.00	6.70	6.3	14	0.0090	8	5.1
	60	19.6	12.25	6.70	5.5	14	0.0064	7	4.5
	120	19.7	12.00	6.67	5.3	14	0.0045	7	4.3
	240	19.8	11.50	6.64	4.9	14	0.0032	6	4.0
	406	20.0	10.50	6.57	3.9	14	0.0025	5	3.2
17-Dec-19	1383	19.1	10.50	6.86	3.6	14	0.0013	5	3.0

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.049**	d_{30} = **0.31**	d_{50} = **0.77**	d_{60} = **1.5**	C_u = **31**	C_c = **1.3**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-5 (3-3.5)	**3-3.5'**	**Silty sand with gravel (SM)g**	**Loamy Sand †**

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (5-5.5)
Project Name: Lisbon Site
Depth: 5-5.5'
Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 232.76
Weight Passing #10 (g): 229.64
Weight Retained #10 (g): 3.12
Weight of Hydrometer Sample (g): 76.72
Calculated Weight of Sieve Sample (g): 77.76

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	232.76	100.00
	2"	50	0.00	0.00	232.76	100.00
	1.5"	38.1	0.00	0.00	232.76	100.00
	1"	25	0.00	0.00	232.76	100.00
	3/4"	19.0	0.00	0.00	232.76	100.00
	3/8"	9.5	0.00	0.00	232.76	100.00
	4	4.75	2.85	2.85	229.91	98.78
	10	2.00	0.27	3.12	229.64	98.66
-10			(Based on calculated sieve wt.)			
	20	0.85	0.31	1.35	76.41	98.26
	40	0.425	1.50	2.85	74.91	96.33
	60	0.250	2.89	5.74	72.02	92.62
	100	0.150	4.36	10.10	67.66	87.01
	140	0.106	5.71	15.81	61.95	79.67
	200	0.075	11.74	27.55	50.21	64.57
	dry pan		4.23	31.78	45.98	
	wet pan			45.98	0.00	

d_{10} (mm): 0.0011 d_{50} (mm): 0.055
d_{16} (mm): 0.0072 d_{60} (mm): 0.068
d_{30} (mm): 0.033 d_{84} (mm): 0.13

Median Particle Diameter --d_{50} (mm): 0.055
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 62
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 15
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.064

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (5-5.5)
Project Name: Lisbon Site
Depth: 5-5.5'

Test Date: 12-Dec-19
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

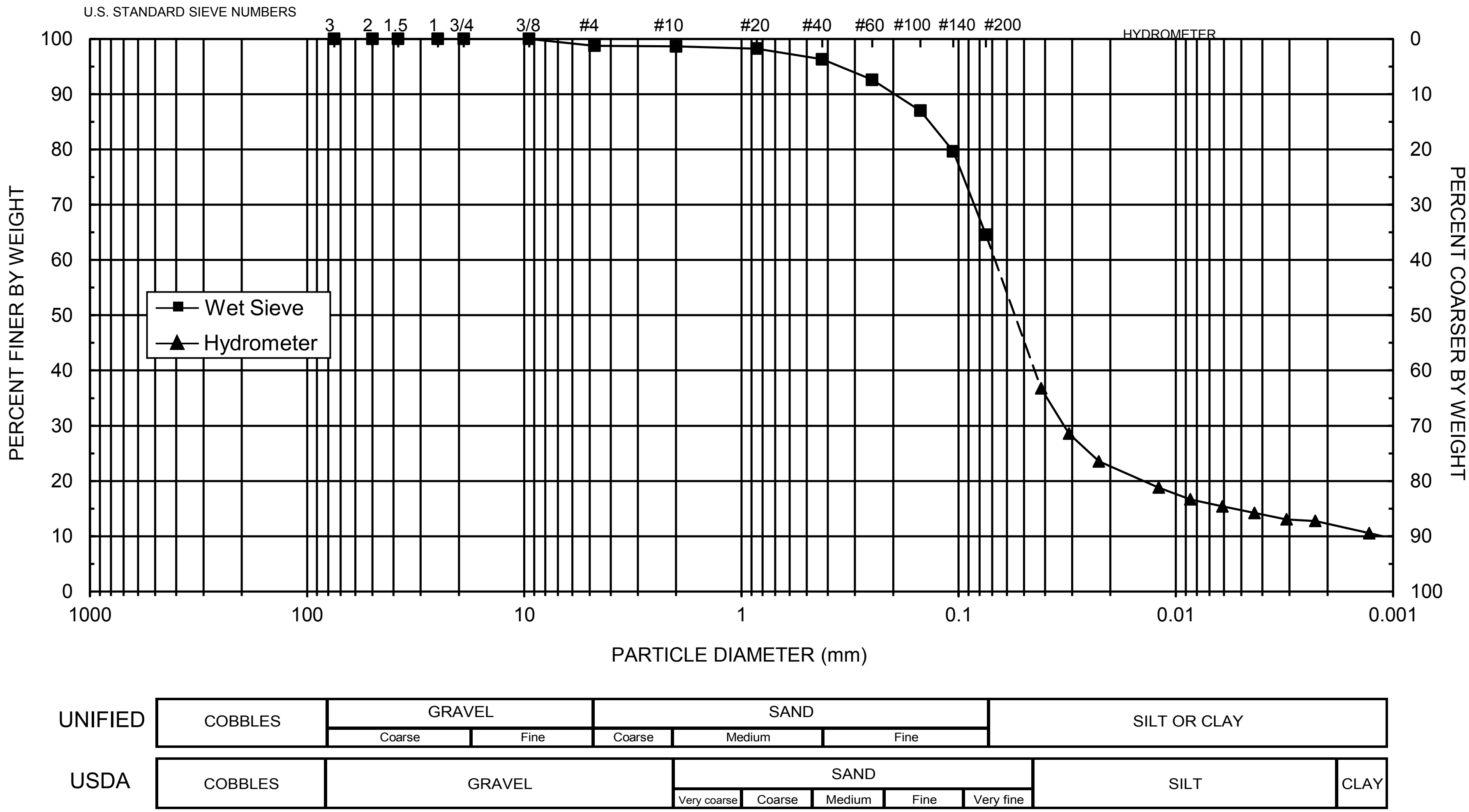
Initial Wt. (g): 76.72
Total Sample Wt. (g): 232.76
Wt. Passing #10 (g): 229.64

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.3	36.00	6.80	29.2	10	0.0417	37	36.7
	2	19.3	29.50	6.80	22.7	11	0.0310	29	28.6
	4	19.3	25.50	6.80	18.7	12	0.0226	24	23.5
	15	19.3	21.75	6.80	15.0	12	0.0120	19	18.8
	30	19.4	20.00	6.77	13.2	13	0.0086	17	16.7
	60	19.4	19.00	6.77	12.2	13	0.0061	16	15.4
	120	19.6	18.00	6.70	11.3	13	0.0043	14	14.2
	240	19.8	17.00	6.64	10.4	13	0.0031	13	13.0
	443	19.9	16.75	6.60	10.1	13	0.0023	13	12.8
13-Dec-19	1416	19.1	15.25	6.86	8.4	13	0.0013	11	10.6

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.0011**	d_{30} = **0.033**	d_{50} = **0.055**	d_{60} = **0.068**	C_u = **62**	C_c = **15**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-5 (5-5.5)	**5-5.5'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (0.5-1)
Project Name: Lisbon Site
Depth: 0.5-1'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 367.50
Weight Passing #10 (g): 363.80
Weight Retained #10 (g): 3.70
Weight of Hydrometer Sample (g): 71.31
Calculated Weight of Sieve Sample (g): 72.04

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	367.50	100.00
	2"	50	0.00	0.00	367.50	100.00
	1.5"	38.1	0.00	0.00	367.50	100.00
	1"	25	0.00	0.00	367.50	100.00
	3/4"	19.0	0.00	0.00	367.50	100.00
	3/8"	9.5	3.70	3.70	363.80	98.99
	4	4.75	0.00	3.70	363.80	98.99
	10	2.00	0.00	3.70	363.80	98.99
-10			(Based on calculated sieve wt.)			
	20	0.85	0.04	0.77	71.27	98.94
	40	0.425	0.24	1.01	71.03	98.60
	60	0.250	0.69	1.70	70.34	97.65
	100	0.150	2.26	3.96	68.08	94.51
	140	0.106	5.87	9.83	62.21	86.36
	200	0.075	14.20	24.03	48.01	66.65
	dry pan		5.51	29.54	42.50	
	wet pan			42.50	0.00	

d_{10} (mm): 0.0011
d_{16} (mm): 0.0087
d_{30} (mm): 0.035
d_{50} (mm): 0.055
d_{60} (mm): 0.066
d_{84} (mm): 0.10

Median Particle Diameter --d_{50} (mm): 0.055
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 60
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 17
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.055

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (0.5-1)
Project Name: Lisbon Site
Depth: 0.5-1'

Test Date: 12-Dec-19
Start Time: 9:30

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

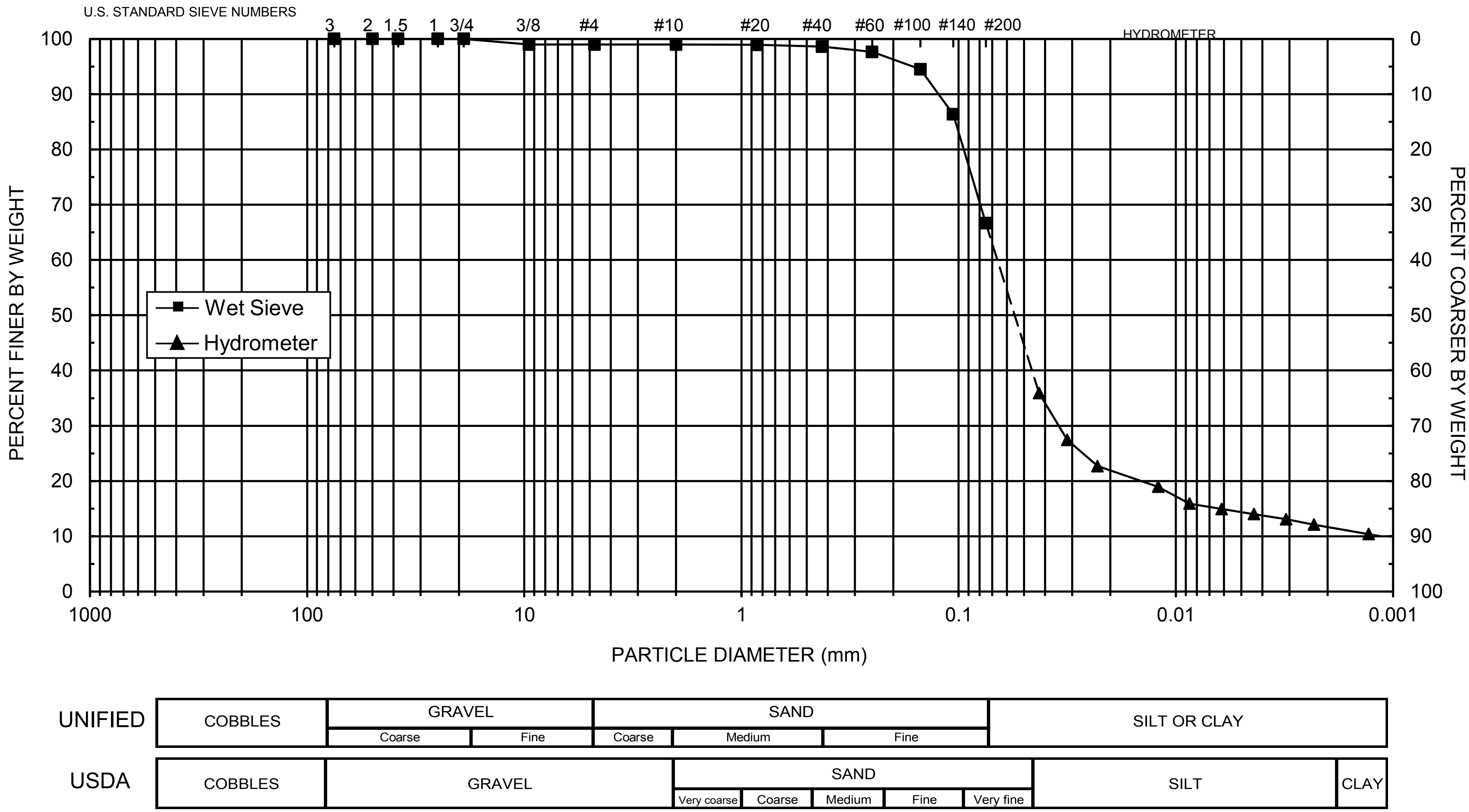
Initial Wt. (g)*:* 71.31
Total Sample Wt. (g)*:* 367.50
Wt. Passing #10 (g)*:* 363.80

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.3	33.25	6.80	26.5	10	0.0426	36	35.9
	2	19.3	27.00	6.80	20.2	11	0.0316	28	27.4
	4	19.3	23.50	6.80	16.7	12	0.0229	23	22.7
	15	19.3	20.75	6.80	14.0	12	0.0121	19	18.9
	30	19.3	18.50	6.80	11.7	13	0.0086	16	15.9
	60	19.4	17.75	6.77	11.0	13	0.0061	15	14.9
	120	19.6	17.00	6.70	10.3	13	0.0044	14	14.0
	240	19.8	16.25	6.64	9.6	13	0.0031	13	13.1
	438	19.9	15.50	6.60	8.9	13	0.0023	12	12.1
13-Dec-19	1412	19.1	14.50	6.86	7.6	13	0.0013	10	10.4

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.0011**	d_{30} = **0.035**	d_{50} = **0.055**	d_{60} = **0.066**	C_u = **60**	C_c = **17**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (0.5-1)	**0.5-1'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 672.13
Weight Passing #10 (g): 671.73
Weight Retained #10 (g): 0.40
Weight of Hydrometer Sample (g): 79.33
Calculated Weight of Sieve Sample (g): 79.38

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	672.13	100.00
	2"	50	0.00	0.00	672.13	100.00
	1.5"	38.1	0.00	0.00	672.13	100.00
	1"	25	0.00	0.00	672.13	100.00
	3/4"	19.0	0.00	0.00	672.13	100.00
	3/8"	9.5	0.00	0.00	672.13	100.00
	4	4.75	0.37	0.37	671.76	99.94
	10	2.00	0.03	0.40	671.73	99.94
-10			(Based on calculated sieve wt.)			
	20	0.85	0.04	0.09	79.29	99.89
	40	0.425	0.16	0.25	79.13	99.69
	60	0.250	0.32	0.57	78.81	99.29
	100	0.150	1.23	1.80	77.58	97.74
	140	0.106	5.33	7.13	72.25	91.02
	200	0.075	13.86	20.99	58.39	73.56
	dry pan		3.53	24.52	54.86	
	wet pan			54.86	0.00	

d_{10} (mm): 0.00031
d_{16} (mm): 0.0027
d_{30} (mm): 0.028
d_{50} (mm): 0.049
d_{60} (mm): 0.059
d_{84} (mm): 0.092

Median Particle Diameter --d_{50} (mm): 0.049
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 190
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 43
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.048

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Silt with sand (ML)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'

Test Date: 16-Dec-19
Start Time: 9:54

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

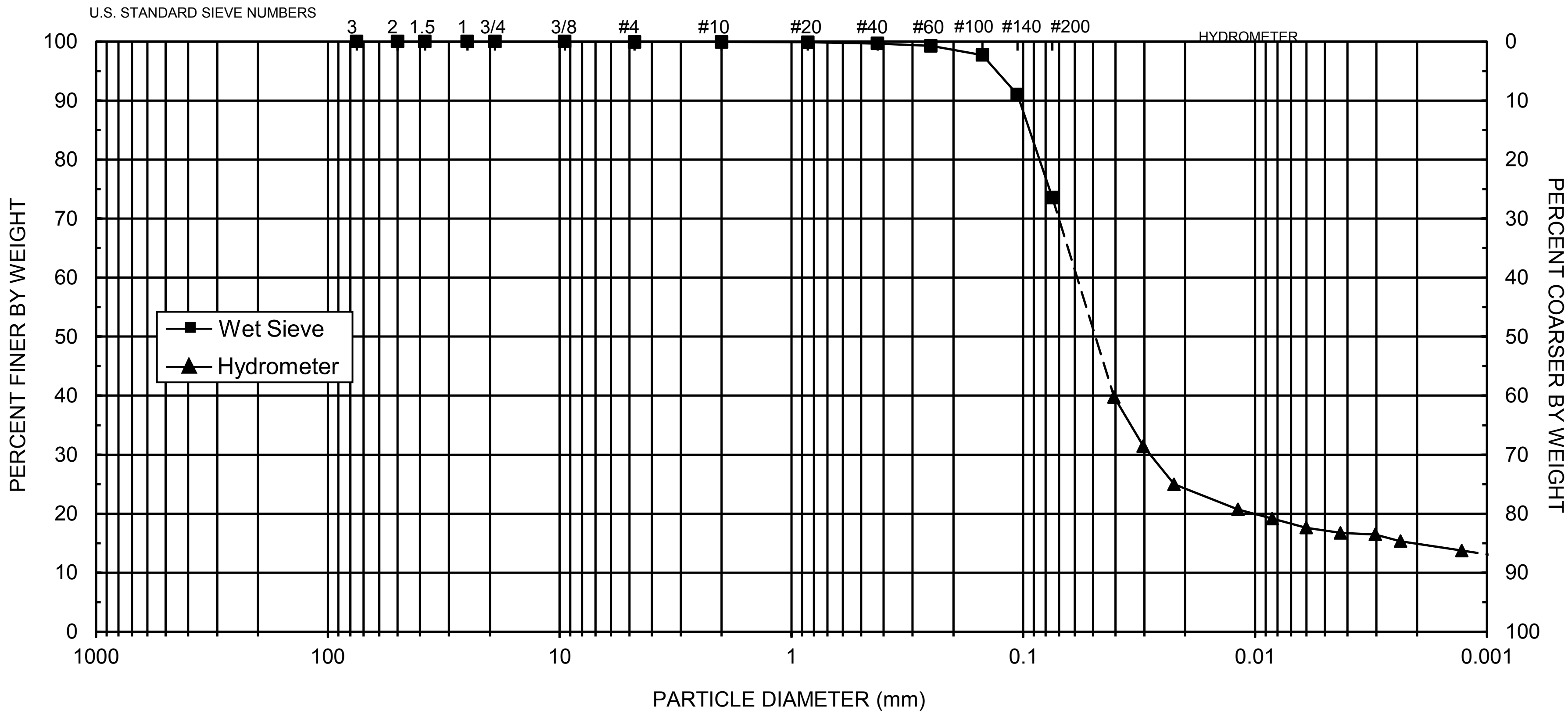
Initial Wt. (g)*:* 79.33
Total Sample Wt. (g)*:* 672.13
Wt. Passing #10 (g)*:* 671.73

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
16-Dec-19	1	19.5	39.00	6.73	32.3	9	0.0406	40	39.8
	2	19.5	32.25	6.73	25.5	11	0.0304	31	31.5
	4	19.5	27.00	6.73	20.3	11	0.0223	25	25.0
	15	19.6	23.50	6.70	16.8	12	0.0118	21	20.7
	30	19.6	22.25	6.70	15.5	12	0.0084	19	19.2
	60	19.6	21.00	6.70	14.3	12	0.0060	18	17.6
	120	19.7	20.25	6.67	13.6	13	0.0043	17	16.7
	240	19.8	20.00	6.64	13.4	13	0.0030	16	16.5
	401	20.0	19.00	6.57	12.4	13	0.0024	15	15.3
17-Dec-19	1377	19.1	18.00	6.86	11.1	13	0.0013	14	13.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY			
		Coarse	Fine	Coarse	Medium	Fine				
USDA	COBBLES	GRAVEL		SAND					SILT	CLAY
				Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.00031**	d_{30} = **0.028**	d_{50} = **0.049**	d_{60} = **0.059**	C_u = **190**	C_c = **43**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (1.5-2)	**1.5-2'**	**Silt with sand (ML)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 712.03
Weight Passing #10 (g): 712.03
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 78.56
Calculated Weight of Sieve Sample (g): 78.56

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	712.03	100.00
	2"	50	0.00	0.00	712.03	100.00
	1.5"	38.1	0.00	0.00	712.03	100.00
	1"	25	0.00	0.00	712.03	100.00
	3/4"	19.0	0.00	0.00	712.03	100.00
	3/8"	9.5	0.00	0.00	712.03	100.00
	4	4.75	0.00	0.00	712.03	100.00
	10	2.00	0.00	0.00	712.03	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.05	0.05	78.51	99.94
	40	0.425	0.33	0.38	78.18	99.52
	60	0.250	0.57	0.95	77.61	98.79
	100	0.150	0.86	1.81	76.75	97.70
	140	0.106	2.00	3.81	74.75	95.15
	200	0.075	7.60	11.41	67.15	85.48
	dry pan		2.31	13.72	64.84	
	wet pan			64.84	0.00	

d_{10} (mm): 0.0010
d_{16} (mm): 0.0020
d_{30} (mm): 0.016
d_{50} (mm): 0.033
d_{60} (mm): 0.041
d_{84} (mm): 0.072

Median Particle Diameter --d_{50} (mm): 0.033
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 41
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 6.2
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.036

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Silt (ML)
USDA Soil Classification: Silt Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 17-Dec-19
Start Time: 9:00

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

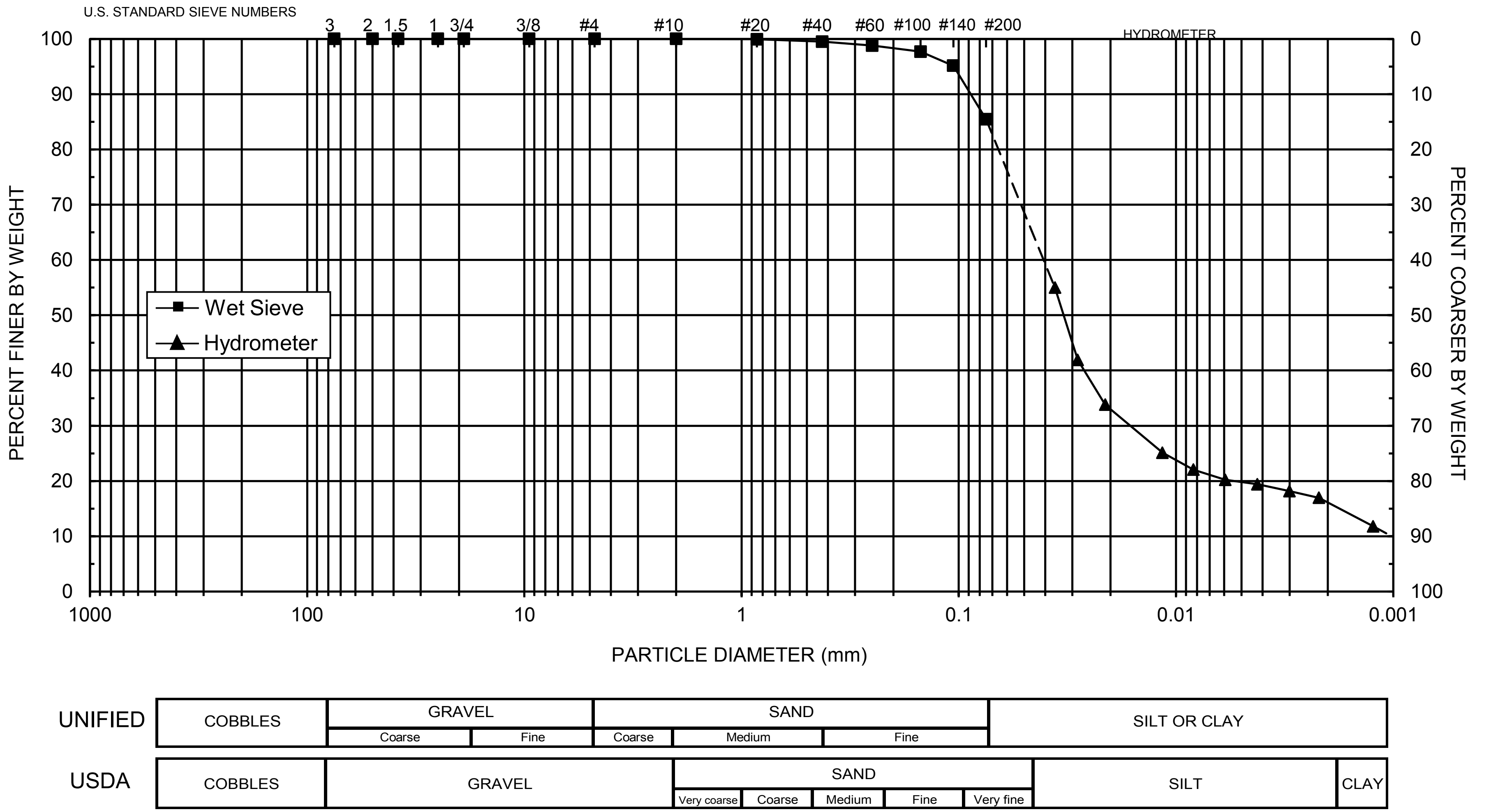
Initial Wt. (g)*:* 78.56
Total Sample Wt. (g)*:* 712.03
Wt. Passing #10 (g)*:* 712.03

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
17-Dec-19	1	19.1	51.00	6.86	44.1	7	0.0360	55	55.0
	2	19.1	40.50	6.86	33.6	9	0.0283	42	41.9
	4	19.1	34.00	6.86	27.1	10	0.0212	34	33.8
	15	19.2	27.00	6.83	20.2	11	0.0115	25	25.1
	30	19.3	24.50	6.80	17.7	12	0.0083	22	22.0
	60	19.4	23.00	6.77	16.2	12	0.0059	20	20.2
	120	19.7	22.25	6.67	15.6	12	0.0042	19	19.4
	240	19.7	21.25	6.67	14.6	12	0.0030	18	18.2
	455	19.8	20.25	6.64	13.6	13	0.0022	17	17.0
18-Dec-19	1513	19.3	16.25	6.80	9.5	13	0.0012	12	11.8

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.0010**	d_{30} = **0.016**	d_{50} = **0.033**	d_{60} = **0.041**	C_u = **41**	C_c = **6.2**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (2.5-3)	**2.5-3'**	**Silt (ML)**	**Silt Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (3-3.5)
Project Name: Lisbon Site
Depth: 3-3.5'

Test Date: 19-Dec-19

Initial Dry Weight of Sample (g): 734.24
Weight Passing #10 (g): 734.17
Weight Retained #10 (g): 0.07
Weight of Hydrometer Sample (g): 69.22
Calculated Weight of Sieve Sample (g): 69.23

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	734.24	100.00
	2"	50	0.00	0.00	734.24	100.00
	1.5"	38.1	0.00	0.00	734.24	100.00
	1"	25	0.00	0.00	734.24	100.00
	3/4"	19.0	0.00	0.00	734.24	100.00
	3/8"	9.5	0.00	0.00	734.24	100.00
	4	4.75	0.00	0.00	734.24	100.00
	10	2.00	0.07	0.07	734.17	99.99
-10			(Based on calculated sieve wt.)			
	20	0.85	0.02	0.03	69.20	99.96
	40	0.425	0.10	0.13	69.10	99.82
	60	0.250	0.25	0.38	68.85	99.46
	100	0.150	0.63	1.01	68.22	98.55
	140	0.106	1.75	2.76	66.47	96.02
	200	0.075	6.00	8.76	60.47	87.35
	dry pan		1.93	10.69	58.54	
	wet pan			58.54	0.00	

d_{10} (mm): 0.00094
d_{16} (mm): 0.0016
d_{30} (mm): 0.013
d_{50} (mm): 0.035
d_{60} (mm): 0.043
d_{84} (mm): 0.070

Median Particle Diameter --d_{50} (mm): 0.035
Uniformity Coefficient, Cu --$[d_{60}/d_{10}]$ (mm): 46
Coefficient of Curvature, Cc --$[(d_{30})^2/(d_{10}*d_{60})]$ (mm): 4.2
Mean Particle Diameter --$[(d_{16}+d_{50}+d_{84})/3]$ (mm): 0.036

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Silt (ML)
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

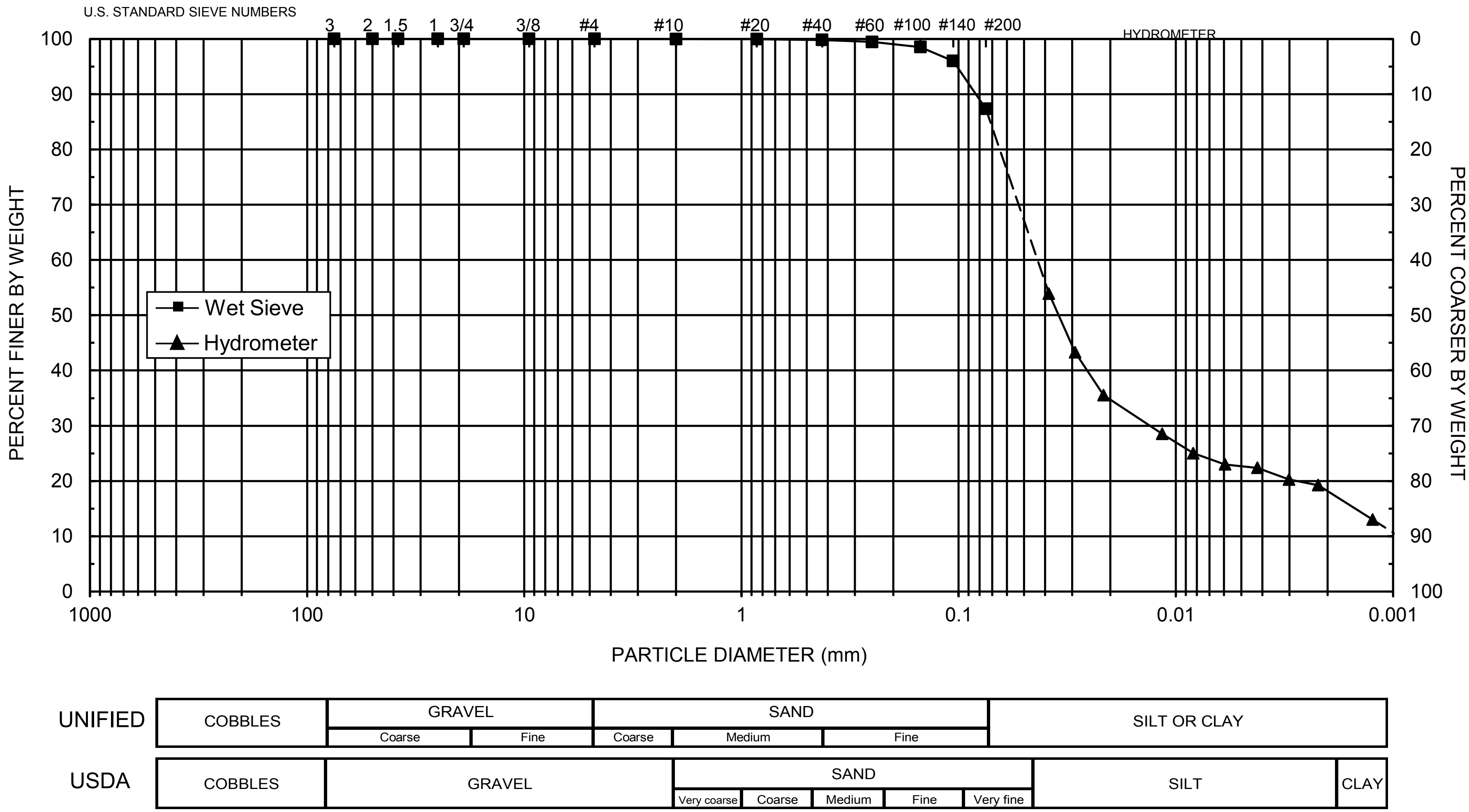
Job Name:	INTERA Inc.	*Type of Water Used:*	DISTILLED
Job Number:	DB19.1451.00	*Reaction with* H_2O_2*:*	NA
Sample Number:	NRB-6 (3-3.5)	*Dispersant*:*	$(NaPO_3)_6$
Project Name:	Lisbon Site	*Assumed particle density:*	2.75
Depth:	3-3.5'	*Initial Wt. (g):*	69.22
Test Date:	17-Dec-19	*Total Sample Wt. (g):*	734.24
Start Time:	9:06	*Wt. Passing #10 (g):*	734.17

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
17-Dec-19	1	19.1	45.00	6.86	38.1	8	0.0384	54	53.9
	2	19.1	37.50	6.86	30.6	10	0.0291	43	43.3
	4	19.1	32.00	6.86	25.1	11	0.0215	36	35.5
	15	19.2	27.00	6.83	20.2	11	0.0115	29	28.5
	30	19.3	24.50	6.80	17.7	12	0.0083	25	25.0
	60	19.5	23.00	6.73	16.3	12	0.0059	23	23.0
	120	19.7	22.50	6.67	15.8	12	0.0042	22	22.4
	240	19.7	21.00	6.67	14.3	12	0.0030	20	20.3
	450	19.8	20.25	6.64	13.6	13	0.0022	19	19.2
18-Dec-19	1508	19.3	16.00	6.80	9.2	13	0.0012	13	13.0

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00094**	d_{30} = **0.013**	d_{50} = **0.035**	d_{60} = **0.043**	C_u = **46**	C_c = **4.2**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (3-3.5)	**3-3.5'**	**Silt (ML)**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (5.5-6)
Project Name: Lisbon Site
Depth: 5.5-6'

Test Date: 19-Dec-19

Initial Dry Weight of Sample (g): 618.36
Weight Passing #10 (g): 618.36
Weight Retained #10 (g): 0.00
Weight of Hydrometer Sample (g): 73.50
Calculated Weight of Sieve Sample (g): 73.50

Shape: Rounded
Hardness: Soft

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	618.36	100.00
	2"	50	0.00	0.00	618.36	100.00
	1.5"	38.1	0.00	0.00	618.36	100.00
	1"	25	0.00	0.00	618.36	100.00
	3/4"	19.0	0.00	0.00	618.36	100.00
	3/8"	9.5	0.00	0.00	618.36	100.00
	4	4.75	0.00	0.00	618.36	100.00
	10	2.00	0.00	0.00	618.36	100.00
-10			(Based on calculated sieve wt.)			
	20	0.85	0.07	0.07	73.43	99.90
	40	0.425	0.21	0.28	73.22	99.62
	60	0.250	0.58	0.86	72.64	98.83
	100	0.150	1.71	2.57	70.93	96.50
	140	0.106	4.58	7.15	66.35	90.27
	200	0.075	10.45	17.60	55.90	76.05
	dry pan		2.81	20.41	53.09	
	wet pan			53.09	0.00	

d_{10} (mm): 0.00016
d_{16} (mm): 0.00066
d_{30} (mm): 0.011
d_{50} (mm): 0.042
d_{60} (mm): 0.053
d_{84} (mm): 0.091

Median Particle Diameter --d_{50} (mm): 0.042
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 331
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 14
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.045

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines: CL

ASTM Soil Classification: Lean clay with sand (CL)s
USDA Soil Classification: Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (5.5-6)
Project Name: Lisbon Site
Depth: 5.5-6'

Test Date: 17-Dec-19
Start Time: 9:12

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

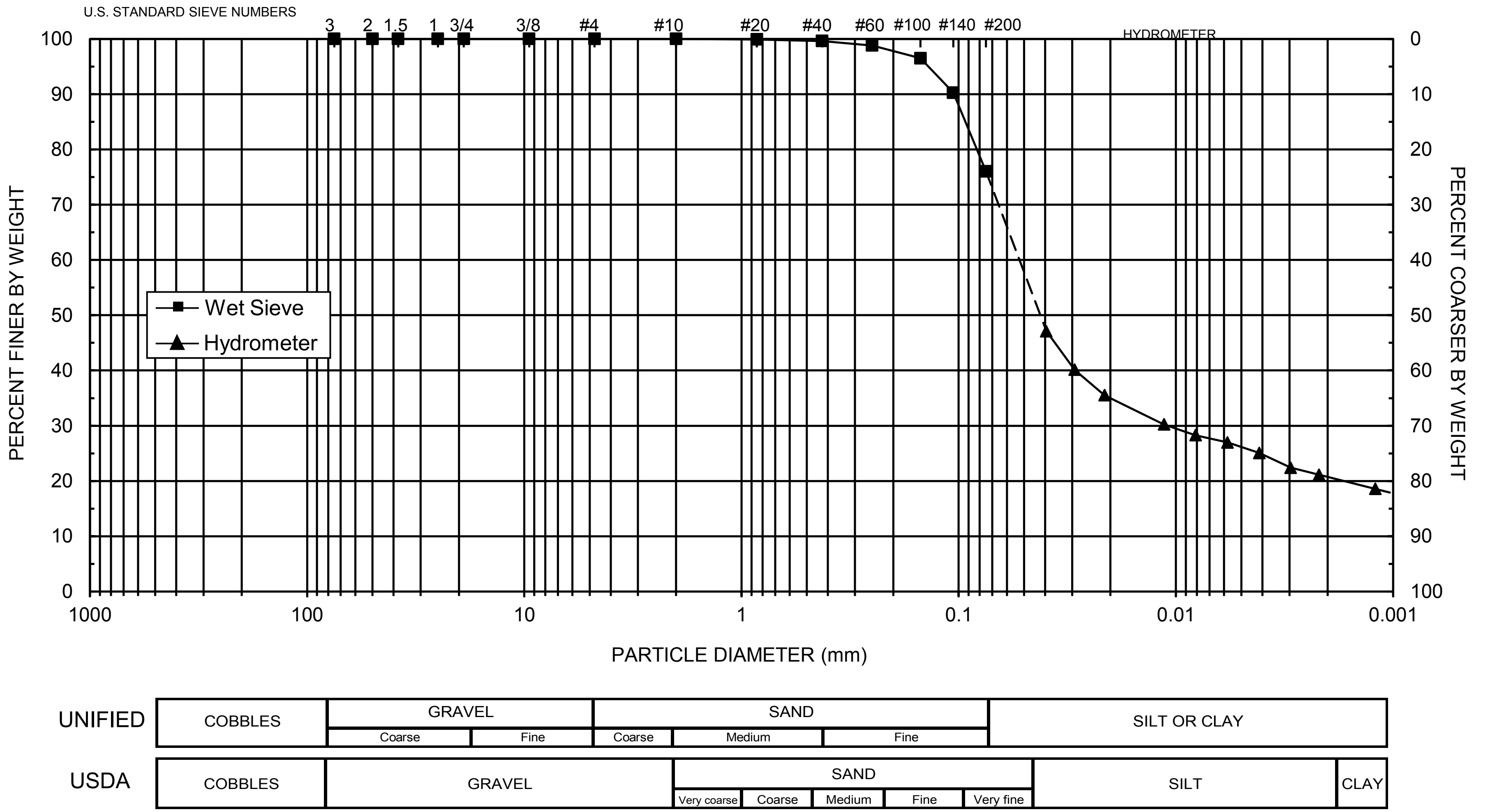
Initial Wt. (g)*:* 73.50
Total Sample Wt. (g)*:* 618.36
Wt. Passing #10 (g)*:* 618.36

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
17-Dec-19	1	19.1	42.25	6.86	35.4	9	0.0395	47	47.1
	2	19.1	37.00	6.86	30.1	10	0.0292	40	40.1
	4	19.2	33.50	6.83	26.7	10	0.0213	36	35.5
	15	19.3	29.50	6.80	22.7	11	0.0113	30	30.2
	30	19.4	28.00	6.77	21.2	11	0.0081	28	28.3
	60	19.5	27.00	6.73	20.3	11	0.0058	27	27.0
	120	19.7	25.50	6.67	18.8	12	0.0041	25	25.1
	240	19.7	23.50	6.67	16.8	12	0.0030	22	22.4
	445	19.8	22.50	6.64	15.9	12	0.0022	21	21.1
18-Dec-19	1503	19.3	20.75	6.80	14.0	12	0.0012	19	18.6

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00016**	d_{30} = **0.011**	d_{50} = **0.042**	d_{60} = **0.053**	C_u = **331**	C_c = **14**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (5.5-6)	**5.5-6'**	**Lean clay with sand (CL)s**	**Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (10.5-11)
Project Name: Lisbon Site
Depth: 10.5-11'

Test Date: 18-Dec-19

Initial Dry Weight of Sample (g): 691.99
Weight Passing #10 (g): 665.25
Weight Retained #10 (g): 26.74
Weight of Hydrometer Sample (g): 74.97
Calculated Weight of Sieve Sample (g): 77.98

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	691.99	100.00
	2"	50	0.00	0.00	691.99	100.00
	1.5"	38.1	0.00	0.00	691.99	100.00
	1"	25	0.00	0.00	691.99	100.00
	3/4"	19.0	0.00	0.00	691.99	100.00
	3/8"	9.5	8.90	8.90	683.09	98.71
	4	4.75	9.24	18.14	673.85	97.38
	10	2.00	8.60	26.74	665.25	96.14
-10			(Based on calculated sieve wt.)			
	20	0.85	0.82	3.83	74.15	95.08
	40	0.425	1.30	5.13	72.85	93.42
	60	0.250	2.20	7.33	70.65	90.60
	100	0.150	3.65	10.98	67.00	85.92
	140	0.106	6.82	17.80	60.18	77.17
	200	0.075	10.77	28.57	49.41	63.36
	dry pan		2.97	31.54	46.44	
	wet pan			46.44	0.00	

d_{10} (mm): 0.00082
d_{16} (mm): 0.0051
d_{30} (mm): 0.029
d_{50} (mm): 0.056
d_{60} (mm): 0.070
d_{84} (mm): 0.14

Median Particle Diameter --d_{50} (mm): 0.056
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 85
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 15
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.067

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (10.5-11)
Project Name: Lisbon Site
Depth: 10.5-11'

Test Date: 17-Dec-19
Start Time: 9:18

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

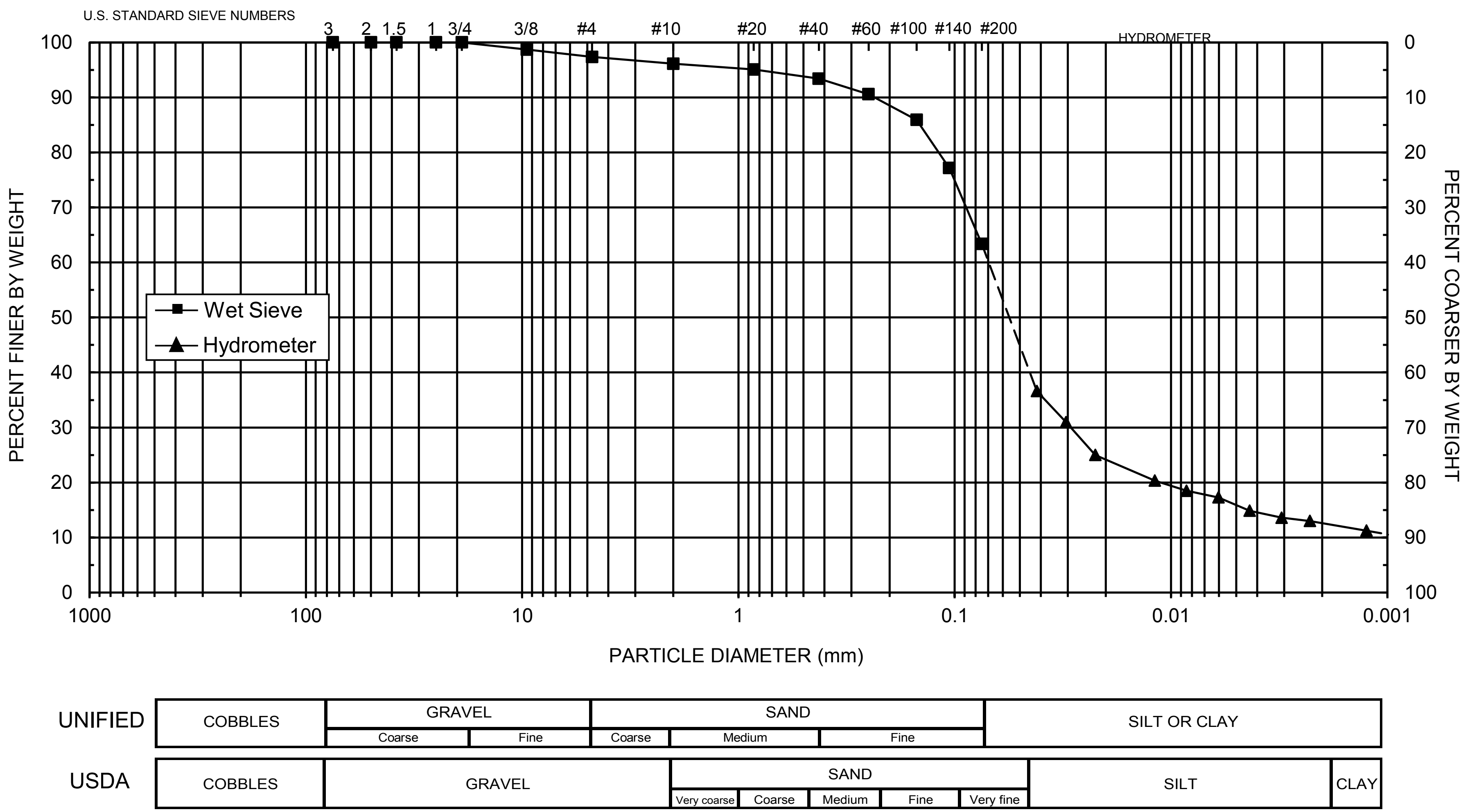
Initial Wt. (g)*:* 74.97
Total Sample Wt. (g)*:* 691.99
Wt. Passing #10 (g)*:* 665.25

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
17-Dec-19	1	19.2	36.00	6.83	29.2	10	0.0417	38	36.6
	2	19.2	31.50	6.83	24.7	11	0.0306	32	31.0
	4	19.2	26.75	6.83	19.9	11	0.0224	26	25.0
	15	19.3	23.00	6.80	16.2	12	0.0119	21	20.3
	30	19.4	21.50	6.77	14.7	12	0.0085	19	18.5
	60	19.5	20.50	6.73	13.8	12	0.0060	18	17.3
	120	19.7	18.50	6.67	11.8	13	0.0043	15	14.8
	240	19.7	17.50	6.67	10.8	13	0.0031	14	13.6
	440	19.8	17.00	6.64	10.4	13	0.0023	14	13.0
18-Dec-19	1497	19.3	15.75	6.80	9.0	13	0.0012	12	11.2

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.00082**	d_{30} = **0.029**	d_{50} = **0.056**	d_{60} = **0.070**	C_u = **85**	C_c = **15**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (10.5-11)	**10.5-11'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (15.5-16)
Project Name: Lisbon Site
Depth: 15.5-16'

Test Date: 19-Dec-19

Initial Dry Weight of Sample (g): 776.30
Weight Passing #10 (g): 773.15
Weight Retained #10 (g): 3.15
Weight of Hydrometer Sample (g): 76.05
Calculated Weight of Sieve Sample (g): 76.36

Shape: Rounded
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	776.30	100.00
	2"	50	0.00	0.00	776.30	100.00
	1.5"	38.1	0.00	0.00	776.30	100.00
	1"	25	0.00	0.00	776.30	100.00
	3/4"	19.0	0.00	0.00	776.30	100.00
	3/8"	9.5	0.00	0.00	776.30	100.00
	4	4.75	1.96	1.96	774.34	99.75
	10	2.00	1.19	3.15	773.15	99.59
-10			(Based on calculated sieve wt.)			
	20	0.85	0.69	1.00	75.36	98.69
	40	0.425	1.54	2.54	73.82	96.67
	60	0.250	2.44	4.98	71.38	93.48
	100	0.150	4.71	9.69	66.67	87.31
	140	0.106	7.59	17.28	59.08	77.37
	200	0.075	11.62	28.90	47.46	62.15
	dry pan		4.72	33.62	42.74	
	wet pan			42.74	0.00	

d_{10} (mm): 0.00061
d_{16} (mm): 0.0045
d_{30} (mm): 0.039
d_{50} (mm): 0.060
d_{60} (mm): 0.072
d_{84} (mm): 0.13

Median Particle Diameter --d_{50} (mm): 0.060
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 118
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 35
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 0.065

Note: Reported values for d_{10}, C_u, C_c, and soil classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Classification of fines (visual method): ML

ASTM Soil Classification: Sandy silt s(ML)
USDA Soil Classification: Sandy Loam

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (15.5-16)
Project Name: Lisbon Site
Depth: 15.5-16'

Test Date: 17-Dec-19
Start Time: 9:24

Type of Water Used: DISTILLED
Reaction with H_2O_2*:* NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

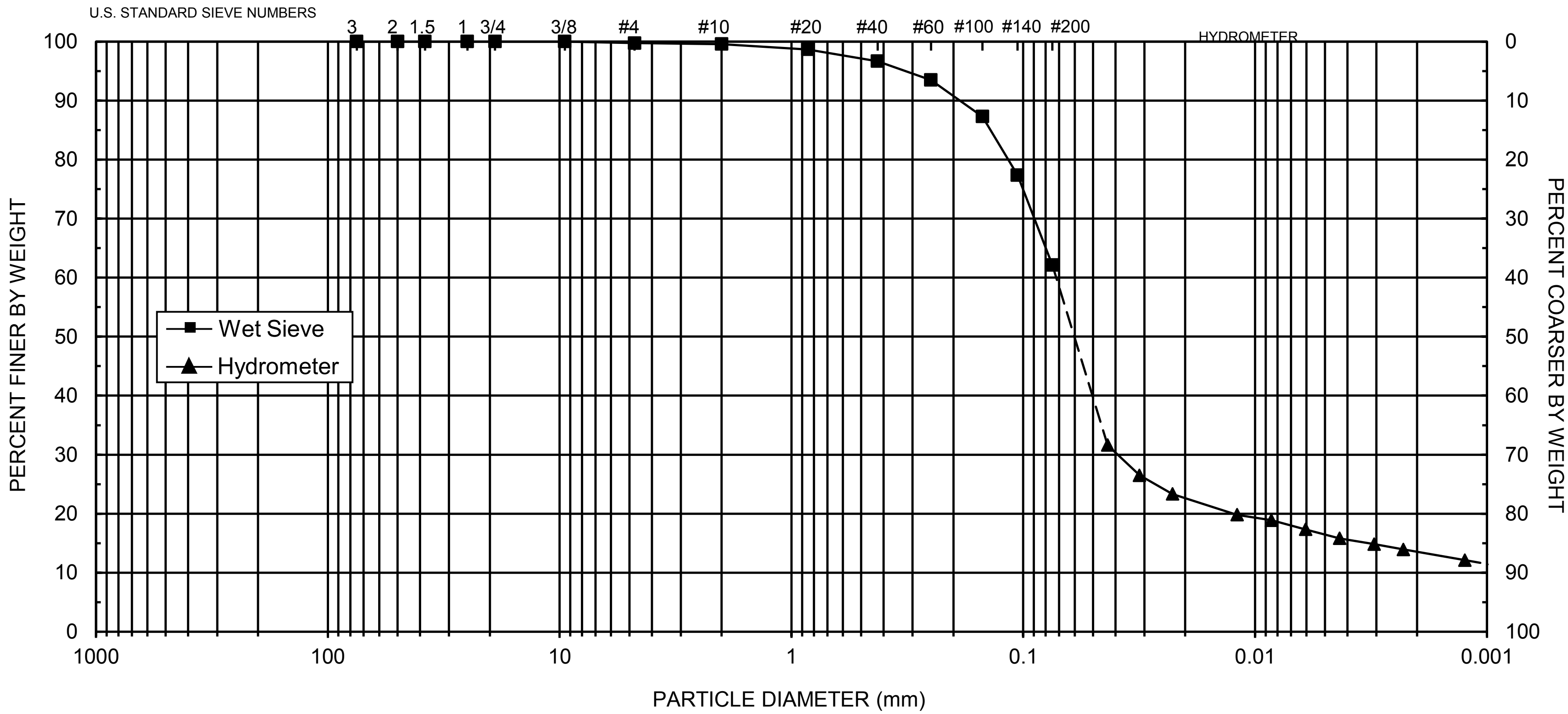
Initial Wt. (g)*:* 76.05
Total Sample Wt. (g)*:* 776.30
Wt. Passing #10 (g)*:* 773.15

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
17-Dec-19	1	19.2	31.50	6.83	24.7	11	0.0432	32	31.6
	2	19.2	27.50	6.83	20.7	11	0.0315	27	26.5
	4	19.3	25.00	6.80	18.2	12	0.0227	23	23.3
	15	19.3	22.25	6.80	15.5	12	0.0119	20	19.8
	30	19.4	21.50	6.77	14.7	12	0.0085	19	18.9
	60	19.5	20.25	6.73	13.5	13	0.0061	17	17.3
	120	19.7	19.00	6.67	12.3	13	0.0043	16	15.8
	240	19.7	18.25	6.67	11.6	13	0.0031	15	14.8
	434	19.8	17.50	6.64	10.9	13	0.0023	14	13.9
18-Dec-19	1492	19.3	16.25	6.80	9.5	13	0.0012	12	12.1

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



UNIFIED	COBBLES	GRAVEL		SAND			SILT OR CLAY	
		Coarse	Fine	Coarse	Medium	Fine		

USDA	COBBLES	GRAVEL	SAND					SILT	CLAY
			Very coarse	Coarse	Medium	Fine	Very fine		

d_{10} = **0.00061**	d_{30} = **0.039**	d_{50} = **0.060**	d_{60} = **0.072**	C_u = **118**	C_c = **35**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (15.5-16)	**15.5-16'**	**Sandy silt s(ML)**	**Sandy Loam**

Note: Reported values for d_{10}, C_u, C_c, and ASTM classification are estimates, since extrapolation was required to obtain the d_{10} diameter

Daniel B. Stephens & Associates, Inc.

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Wet Sieve Data (#10 Split)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (20-21.5)
Project Name: Lisbon Site
Depth: 20-21.5'

Test Date: 16-Dec-19

Initial Dry Weight of Sample (g): 239.96
Weight Passing #10 (g): 142.74
Weight Retained #10 (g): 97.22
Weight of Hydrometer Sample (g): 66.62
Calculated Weight of Sieve Sample (g): 111.99

Shape: Angular
Hardness: Hard and durable

Test Fraction	Sieve Number	Diameter (mm)	Wt. Retained	Cum Wt. Retained	Wt. Passing	% Passing
+10						
	3"	75	0.00	0.00	239.96	100.00
	2"	50	0.00	0.00	239.96	100.00
	1.5"	38.1	0.00	0.00	239.96	100.00
	1"	25	0.00	0.00	239.96	100.00
	3/4"	19.0	16.05	16.05	223.91	93.31
	3/8"	9.5	18.48	34.53	205.43	85.61
	4	4.75	28.58	63.11	176.85	73.70
	10	2.00	34.11	97.22	142.74	59.48
-10			(Based on calculated sieve wt.)			
	20	0.85	10.96	56.33	55.66	49.70
	40	0.425	10.93	67.26	44.73	39.94
	60	0.250	10.95	78.21	33.78	30.16
	100	0.150	6.27	84.48	27.51	24.56
	140	0.106	3.08	87.56	24.43	21.81
	200	0.075	2.42	89.98	22.01	19.65
	dry pan		0.74	90.72	21.27	
	wet pan			21.27	0.00	

d_{10} (mm): 0.0074
d_{16} (mm): 0.051
d_{30} (mm): 0.25
d_{50} (mm): 0.87
d_{60} (mm): 2.1
d_{84} (mm): 8.7

Median Particle Diameter --d_{50} (mm): 0.87
Uniformity Coefficient, Cu --[d_{60}/d_{10}] (mm): 284
Coefficient of Curvature, Cc --[$(d_{30})^2/(d_{10}*d_{60})$] (mm): 4.0
Mean Particle Diameter --[$(d_{16}+d_{50}+d_{84})/3$] (mm): 3.2

Classification of fines (visual method): ML

ASTM Soil Classification: Silty sand with gravel (SM)g
USDA Soil Classification: Sandy Loam †

† Greater than 10% of sample is coarse material

Laboratory analysis by: A. Bland
Data entered by: A. Albay-Yenney
Checked by: J. Hines

Daniel B. Stephens & Associates, Inc.

Particle Size Analysis
Hydrometer Data

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (20-21.5)
Project Name: Lisbon Site
Depth: 20-21.5'

Test Date: 12-Dec-19
Start Time: 9:36

Type of Water Used: DISTILLED
Reaction with H_2O_2: NA
Dispersant:* $(NaPO_3)_6$
Assumed particle density: 2.75

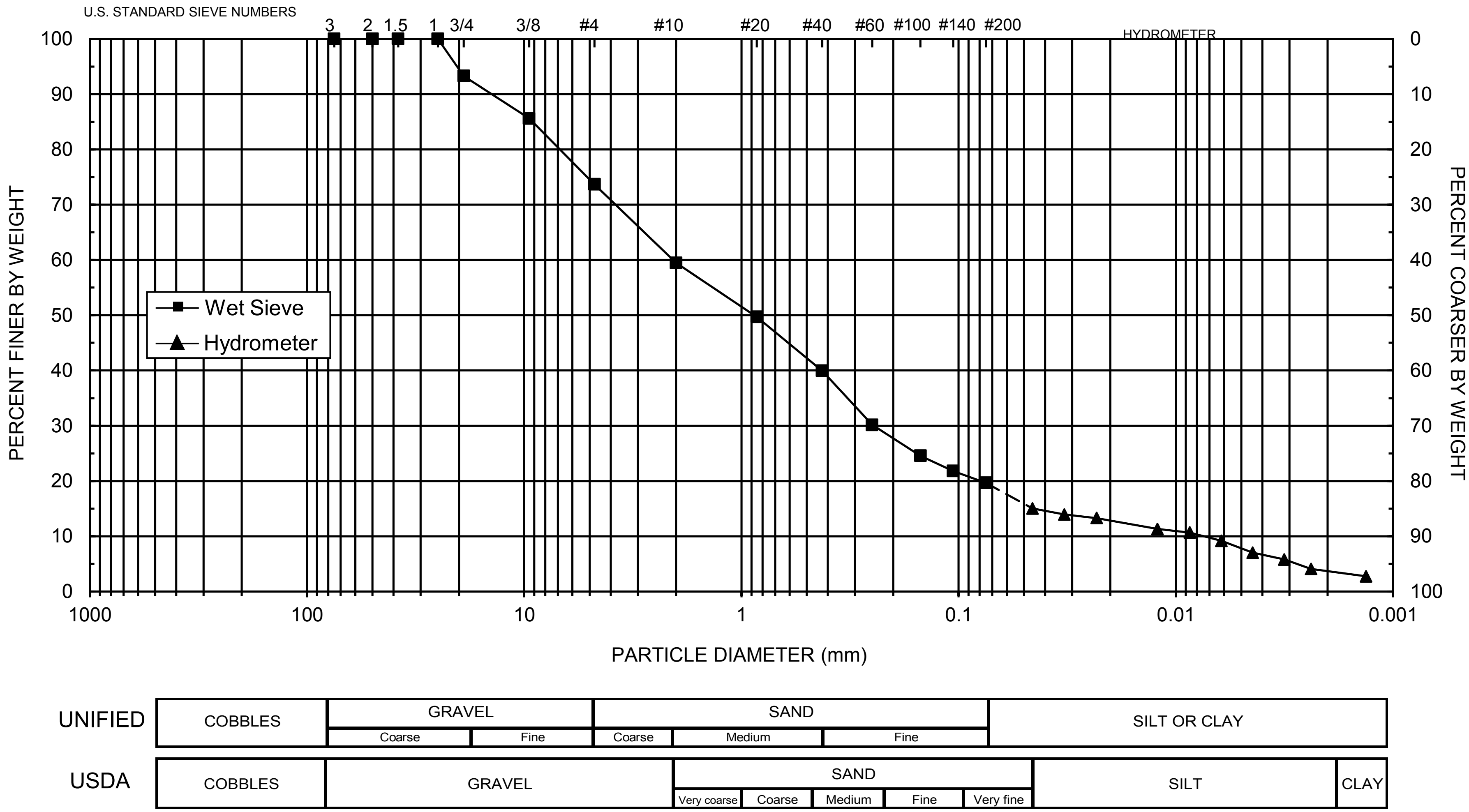
Initial Wt. (g): 66.62
Total Sample Wt. (g): 239.96
Wt. Passing #10 (g): 142.74

Date	Time (min)	Temp (°C)	R (g/L)	R_L (g/L)	R_{corr} (g/L)	H_m (cm)	D (mm)	P (%)	% Finer
12-Dec-19	1	19.3	24.00	6.80	17.2	12	0.0457	25	15.0
	2	19.3	22.75	6.80	16.0	12	0.0326	23	13.9
	4	19.3	22.00	6.80	15.2	12	0.0231	22	13.3
	15	19.3	19.75	6.80	13.0	13	0.0121	19	11.3
	30	19.3	19.00	6.80	12.2	13	0.0086	18	10.7
	60	19.4	17.25	6.77	10.5	13	0.0062	15	9.2
	120	19.6	14.75	6.70	8.0	13	0.0044	12	7.0
	240	19.8	13.25	6.64	6.6	14	0.0032	10	5.8
	433	19.9	11.25	6.60	4.6	14	0.0024	7	4.1
13-Dec-19	1406	19.1	10.00	6.86	3.1	14	0.0013	5	2.7

Comments:

* Dispersion device: mechanically operated stirring device

Laboratory analysis by: J. Niedbala
Data entered by: A. Albay-Yenney
Checked by: J. Hines



d_{10} = **0.0074**	d_{30} = **0.25**	d_{50} = **0.87**	d_{60} = **2.1**	C_u = **284**	C_c = **4.0**

SAMPLE NUMBER	DEPTH	ASTM CLASSIFICATION	USDA CLASSIFICATION
NRB-6 (20-21.5)	**20-21.5'**	**Silty sand with gravel (SM)g**	**Sandy Loam** †

† Greater than 10% of sample is coarse material

Daniel B. Stephens & Associates, Inc.

Atterberg Limits/ Identification of Fines

Summary of Atterberg Tests

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
NRB-1 (0.5-1)	---	---	---	ML
NRB-1 (1.5-2)	---	---	---	ML
NRB-1 (2.5-3)	---	---	---	ML
NRB-1 (3-3.5)	---	---	---	ML
NRB-1 (5.5-6)	---	---	---	ML
NRB-1 (10.5-11)	---	---	---	ML
NRB-1 (15.5-16)	---	---	---	ML
NRB-1 (21-21.5)	50	26	24	CH
NRB-2 (0.5-1)	26	16	10	CL
NRB-2 (2.5-3)	28	17	11	CL
NRB-2 (3-3.5)	31	17	14	CL
NRB-2 (5.5-6)	30	21	9	CL
NRB-2 (10-10.5)	32	19	13	CL
NRB-3 (0.5-1)	28	18	10	CL
NRB-3 (1.5-2)	---	---	---	ML
NRB-3 (2.5-3.5)	---	---	---	ML
NRB-5 (1-1.5)	---	---	---	ML
NRB-5 (2.5-3)	---	---	---	ML
NRB-5 (5-5.5)	---	---	---	ML
NRB-6 (0.5-1)	---	---	---	ML

--- = Soil requires visual-manual classification due to non-plasticity

Summary of Atterberg Tests (Continued)

Sample Number	Liquid Limit	Plastic Limit	Plasticity Index	Classification
NRB-6 (1.5-2)	---	---	---	ML
NRB-6 (3-3.5)	---	---	---	ML
NRB-6 (5.5-6)	28	17	11	CL
NRB-6 (10.5-11)	---	---	---	ML
NRB-6 (15.5-16)	---	---	---	ML
NRB-6 (20-21.5)	---	---	---	ML

--- = Soil requires visual-manual classification due to non-plasticity

Daniel B. Stephens & Associates, Inc.

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (0.5-1)
Project Name:	Lisbon Site
Depth:	0.5-1'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (0.5-1)
Project Name	Lisbon Site
Depth:	0.5-1'
Test Date:	17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample:	Dark Yellowish Brown (10YR 3/6)
Odor:	None
Moisture Condition:	Moist
HCl Reaction:	Strong

Preliminary Identification:

Dry Strength:	Low
Dilatency:	Rapid
Toughness:	Low
Plasticity:	Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (1.5-2)
Project Name: Lisbon Site
Depth: 1.5-2'

Test Date: 17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---

Liquid Limit: ---

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---

Plastic Limit: ---

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (1.5-2)
Project Name Lisbon Site
Depth: 1.5-2'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Brown (7.5YR 4/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (2.5-3)
Project Name:	Lisbon Site
Depth:	2.5-3'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (2.5-3)
Project Name Lisbon Site
Depth: 2.5-3'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Strong Brown (7.5YR 4/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (3-3.5)
Project Name Lisbon Site
Depth: 3-3.5'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Strong Brown (7.5YR 4/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (5.5-6)
Project Name: Lisbon Site
Depth: 5.5-6'

Test Date: 17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---

Liquid Limit: ---

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---

Plastic Limit: ---

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (5.5-6)
Project Name Lisbon Site
Depth: 5.5-6'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Brown (7.5YR 4/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (10.5-11)
Project Name:	Lisbon Site
Depth:	10.5-11'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (10.5-11)
Project Name	Lisbon Site
Depth:	10.5-11'
Test Date:	17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample:	Strong Brown (7.5YR 4/6)
Odor:	None
Moisture Condition:	Moist
HCl Reaction:	Strong

Preliminary Identification:

Dry Strength:	Low
Dilatency:	Rapid
Toughness:	Low
Plasticity:	Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (15.5-16)
Project Name:	Lisbon Site
Depth:	15.5-16'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-1 (15.5-16)
Project Name	Lisbon Site
Depth:	15.5-16'
Test Date:	17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample:	Strong Brown (7.5YR 4/6)
Odor:	None
Moisture Condition:	Moist
HCl Reaction:	Strong

Preliminary Identification:

Dry Strength:	Low
Dilatency:	Rapid
Toughness:	Low
Plasticity:	Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-1 (21-21.5)
Project Name: Lisbon Site
Depth: 21-21.5'

Test Date: 16-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	30	24	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	125.38	131.64	132.85
Weight of pan plus dry soil (g)	121.34	125.81	127.62
Weight of pan (g):	113.11	114.38	117.72
Gravimetric moisture content (% g/g):	49.09	51.01	52.83
Liquid Limit:	50		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	119.39	121.34
Weight of pan plus dry soil (g)	117.80	119.91
Weight of pan (g):	111.80	114.41
Gravimetric moisture content (% g/g):	26.50	26.00
Plastic Limit:	26	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: 50
Plastic Limit: 26
Plasticity Index: 24

Classification: CH

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (0.5-1)
Project Name:	Lisbon Site
Depth:	0.5-1'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	28	21
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	128.39	125.30	128.50
Weight of pan plus dry soil (g)	125.75	122.68	125.11
Weight of pan (g):	114.83	112.36	112.25
Gravimetric moisture content (% g/g):	24.18	25.39	26.36
Liquid Limit:	26		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	123.33	120.82
Weight of pan plus dry soil (g)	122.21	119.72
Weight of pan (g):	115.30	112.89
Gravimetric moisture content (% g/g):	16.21	16.11
Plastic Limit:	16	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	26
Plastic Limit:	16
Plasticity Index:	10
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (1.5-2)
Project Name:	Lisbon Site
Depth:	1.5-2'
Test Date:	26-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	33	25	19
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	129.60	129.97	125.28
Weight of pan plus dry soil (g)	126.43	126.42	122.34
Weight of pan (g):	115.69	114.78	113.15
Gravimetric moisture content (% g/g):	29.52	30.50	31.99
Liquid Limit:	31		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	126.47	125.56
Weight of pan plus dry soil (g)	124.98	123.84
Weight of pan (g):	116.64	114.24
Gravimetric moisture content (% g/g):	17.87	17.92
Plastic Limit:	18	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	31
Plastic Limit:	18
Plasticity Index:	13
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (2.5-3)
Project Name:	Lisbon Site
Depth:	2.5-3'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	32	25	18
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	132.76	130.60	132.55
Weight of pan plus dry soil (g)	129.49	127.14	129.02
Weight of pan (g):	117.21	114.74	116.97
Gravimetric moisture content (% g/g):	26.63	27.90	29.29
Liquid Limit:	28		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	122.50	124.94
Weight of pan plus dry soil (g)	121.59	123.86
Weight of pan (g):	116.23	117.59
Gravimetric moisture content (% g/g):	16.98	17.22
Plastic Limit:	17	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	28
Plastic Limit:	17
Plasticity Index:	11
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'
Test Date:	16-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	34	26	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	133.00	127.26	133.50
Weight of pan plus dry soil (g)	129.34	124.27	129.39
Weight of pan (g):	117.21	114.74	116.97
Gravimetric moisture content (% g/g):	30.17	31.37	33.09
Liquid Limit:	31		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	125.42	127.03
Weight of pan plus dry soil (g)	124.08	125.64
Weight of pan (g):	116.23	117.59
Gravimetric moisture content (% g/g):	17.07	17.27
Plastic Limit:	17	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	31
Plastic Limit:	17
Plasticity Index:	14
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (5.5-6)
Project Name:	Lisbon Site
Depth:	5.5-6'
Test Date:	16-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	25	15
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	130.53	127.45	131.04
Weight of pan plus dry soil (g)	126.41	123.86	127.32
Weight of pan (g):	112.04	111.92	115.56
Gravimetric moisture content (% g/g):	28.67	30.07	31.63
Liquid Limit:	30		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	124.13	125.81
Weight of pan plus dry soil (g)	122.04	123.93
Weight of pan (g):	111.87	114.81
Gravimetric moisture content (% g/g):	20.55	20.61
Plastic Limit:	21	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	30
Plastic Limit:	21
Plasticity Index:	9
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-2 (10-10.5)
Project Name:	Lisbon Site
Depth:	10-10.5'
Test Date:	16-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	33	25	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	127.48	127.11	131.34
Weight of pan plus dry soil (g)	124.58	123.50	126.45
Weight of pan (g):	114.83	112.36	112.25
Gravimetric moisture content (% g/g):	29.74	32.41	34.44
Liquid Limit:	32		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	124.71	122.06
Weight of pan plus dry soil (g)	123.23	120.62
Weight of pan (g):	115.30	112.89
Gravimetric moisture content (% g/g):	18.66	18.63
Plastic Limit:	19	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	32
Plastic Limit:	19
Plasticity Index:	13
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-3 (0.5-1)
Project Name:	Lisbon Site
Depth:	0.5-1'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	29	22	16
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	126.57	128.07	130.39
Weight of pan plus dry soil (g)	123.72	125.04	127.46
Weight of pan (g):	113.11	114.38	117.72
Gravimetric moisture content (% g/g):	26.86	28.42	30.08
Liquid Limit:	28		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	120.59	124.08
Weight of pan plus dry soil (g)	119.24	122.60
Weight of pan (g):	111.80	114.41
Gravimetric moisture content (% g/g):	18.15	18.07
Plastic Limit:	18	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	28
Plastic Limit:	18
Plasticity Index:	10
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-3 (1.5-2)
Project Name:	Lisbon Site
Depth:	1.5-2'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (1.5-2)
Project Name Lisbon Site
Depth: 1.5-2'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Very Pale Brown (10YR 7/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: None
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

<u>Identification of Inorganic Fine Grained Soils:</u>

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-3 (2.5-3.5)
Project Name:	Lisbon Site
Depth:	2.5-3.5'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-3 (2.5-3.5)
Project Name Lisbon Site
Depth: 2.5-3.5'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Yellowish Brown (10YR 5/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: None
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (1-1.5)
Project Name: Lisbon Site
Depth: 1-1.5'

Test Date: 17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---

Liquid Limit: ---

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---

Plastic Limit: ---

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (1-1.5)
Project Name Lisbon Site
Depth: 1-1.5'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Brown (10YR 3/3)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (2.5-3)
Project Name: Lisbon Site
Depth: 2.5-3'

Test Date: 17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve: See Sieve

Liquid Limit: ---
Plastic Limit: ---
Plasticity Index: ---

Classification (Visual Method): ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-5 (2.5-3)
Project Name	Lisbon Site
Depth:	2.5-3'
Test Date:	17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample:	Dark Yellowish Brown (10YR 4/4)
Odor:	None
Moisture Condition:	Moist
HCl Reaction:	Strong

Preliminary Identification:

Dry Strength:	None
Dilatency:	Rapid
Toughness:	Low
Plasticity:	Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-5 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'
Test Date:	26-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-5 (3-3.5)
Project Name	Lisbon Site
Depth:	3-3.5'
Test Date:	17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample:	Dark Yellowish Brown (10YR 4/6)
Odor:	None
Moisture Condition:	Moist
HCl Reaction:	Strong

Preliminary Identification:

Dry Strength:	None
Dilatency:	Rapid
Toughness:	Low
Plasticity:	Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-5 (5-5.5)
Project Name:	Lisbon Site
Depth:	5-5.5'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-5 (5-5.5)
Project Name Lisbon Site
Depth: 5-5.5'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Yellowish Brown (10YR 3/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (0.5-1)
Project Name:	Lisbon Site
Depth:	0.5-1'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (0.5-1)
Project Name Lisbon Site
Depth: 0.5-1'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Dark Yellowish Brown (10YR 3/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (1.5-2)
Project Name:	Lisbon Site
Depth:	1.5-2'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (1.5-2)
Project Name Lisbon Site
Depth: 1.5-2'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Brown (7.5YR 4/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (2.5-3)
Project Name:	Lisbon Site
Depth:	2.5-3'
Test Date:	26-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (2.5-3)
Project Name Lisbon Site
Depth: 2.5-3

Test Date: 26-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Brown (7.5YR 5/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (3-3.5)
Project Name:	Lisbon Site
Depth:	3-3.5'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (3-3.5)
Project Name Lisbon Site
Depth: 3-3.5'

Test Date: 26-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Strong Brown (7.5YR 4/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

<u>Identification of Inorganic Fine Grained Soils:</u>

Silt (ML)

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (5.5-6)
Project Name:	Lisbon Site
Depth:	5.5-6'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:	35	25	17
Pan number:	LL1	LL2	LL3
Weight of pan plus moist soil (g):	123.37	123.36	131.58
Weight of pan plus dry soil (g)	121.01	120.86	127.97
Weight of pan (g):	112.04	111.92	115.56
Gravimetric moisture content (% g/g):	26.31	27.96	29.09
Liquid Limit:	28		

Plastic Limit

	Trial 1	Trial 2
Pan number:	PL1	PL2
Weight of pan plus moist soil (g):	120.98	124.60
Weight of pan plus dry soil (g)	119.65	123.21
Weight of pan (g):	111.87	114.81
Gravimetric moisture content (% g/g):	17.10	16.55
Plastic Limit:	17	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	28
Plastic Limit:	17
Plasticity Index:	11
Classification:	CL

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (10.5-11)
Project Name:	Lisbon Site
Depth:	10.5-11'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (10.5-11)
Project Name Lisbon Site
Depth: 10.5-11'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Strong Brown (7.5YR 4/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Daniel B. Stephens & Associates, Inc.

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (15.5-16)
Project Name:	Lisbon Site
Depth:	15.5-16'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (15.5-16)
Project Name Lisbon Site
Depth: 15.5-16'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Brown (7.5YR 5/4)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: Low
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Daniel B. Stephens & Associates, Inc.

Atterberg Limits

Job Name:	INTERA Inc.
Job Number:	DB19.1451.00
Sample Number:	NRB-6 (20-21.5)
Project Name:	Lisbon Site
Depth:	20-21.5'
Test Date:	17-Dec-19

Liquid Limit

	Trial 1	Trial 2	Trial 3
Number of drops:			
Pan number:			
Weight of pan plus moist soil (g):			
Weight of pan plus dry soil (g)			
Weight of pan (g):			
Gravimetric moisture content (% g/g):	---	---	---
Liquid Limit:	---		

Plastic Limit

	Trial 1	Trial 2
Pan number:		
Weight of pan plus moist soil (g):		
Weight of pan plus dry soil (g)		
Weight of pan (g):		
Gravimetric moisture content (% g/g):	---	---
Plastic Limit:	---	

Results

Percent of Sample Retained on #40 Sieve:	See Sieve
Liquid Limit:	---
Plastic Limit:	---
Plasticity Index:	---
Classification (Visual Method):	ML

Comments:

--- = Soil requires visual-manual classification due to non-plasticity
* = 1-point method requested by client

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

Data for Description and Identification of Fines
(Visual-Manual Procedure)

Job Name: INTERA Inc.
Job Number: DB19.1451.00
Sample Number: NRB-6 (20-21.5)
Project Name Lisbon Site
Depth: 20-21.5'

Test Date: 17-Dec-19

Visual-manual classification of material passing the #40 sieve in lieu of Atterberg analysis due to non-plasticity:

Descriptive Information:

Color of Moist Sample: Yellowish Brown (10YR 5/6)
Odor: None
Moisture Condition: Moist
HCl Reaction: Strong

Preliminary Identification:

Dry Strength: None
Dilatency: Rapid
Toughness: Low
Plasticity: Non-plastic

Identification of Inorganic Fine Grained Soils:

Silt (ML)

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

Chemical Analysis

Summary of Chloride Analysis

Sample Number	Chloride (mg/kg)	Reporting Limit (mg/kg)
NRB-1 (0.5-1)	ND	60
NRB-1 (1.5-2)	ND	60
NRB-1 (2.5-3)	ND	61
NRB-1 (3-3.5)	ND	60
NRB-1 (5.5-6)	ND	60
NRB-1 (10.5-11)	85	60
NRB-1 (15.5-16)	ND	60
NRB-1 (21-21.5)	76	59
NRB-2 (0.5-1)	ND	60
NRB-2 (1.5-2)	ND	60
NRB-2 (2.5-3)	ND	60
NRB-2 (3-3.5)	ND	60
NRB-2 (5.5-6)	ND	60
NRB-2 (10-10.5)	130	60
NRB-3 (0.5-1)	ND	61
NRB-3 (1.5-2)	ND	59
NRB-3 (2.5-3.5)	ND	60
NRB-5 (1-1.5)	ND	60
NRB-5 (2.5-3)	ND	60
NRB-5 (3-3.5)	ND	60
NRB-5 (5-5.5)	ND	60
NRB-6 (0.5-1)	ND	60

Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, New Mexico

ND= Not detected at the specified reporting limit

Summary of Chloride Analysis (continued)

Sample Number	Chloride (mg/kg)	Reporting Limit (mg/kg)
NRB-6 (1.5-2)	ND	61
NRB-6 (2.5-3)	71	60
NRB-6 (3-3.5)	140	60
NRB-6 (5.5-6)	69	60
NRB-6 (10.5-11)	140	60
NRB-6 (15.5-16)	100	60
NRB-6 (20-21.5)	ND	60

Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, New Mexico

ND= Not detected at the specified reporting limit

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 1912724
Project: DBSA

Lab ID: 1912724-001 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(0.5-1) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	60		mg/Kg	20	12/17/2019 9:23:28 PM	49399

Lab ID: 1912724-002 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(1.5-2) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	60		mg/Kg	20	12/17/2019 9:35:49 PM	49399

Lab ID: 1912724-003 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(2.5-3) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	61		mg/Kg	20	12/17/2019 9:48:10 PM	49399

Lab ID: 1912724-004 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(3-3.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	60		mg/Kg	20	12/17/2019 10:00:31 PM	49399

Lab ID: 1912724-005 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(5.5-6) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	60		mg/Kg	20	12/17/2019 10:12:51 PM	49399

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 1912724
Project: DBSA

Lab ID: 1912724-006 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(10.5-11) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	85	60		mg/Kg	20	12/17/2019 10:25:13 PM	49399

Lab ID: 1912724-007 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(15.5-16) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/17/2019 10:37:34 PM	49399

Lab ID: 1912724-008 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-1(21-21.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	76	59		mg/Kg	20	12/17/2019 10:49:55 PM	49399

Lab ID: 1912724-009 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-2(0.5-1) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/17/2019 11:26:58 PM	49399

Lab ID: 1912724-010 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-2(1.5-2) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/17/2019 11:39:19 PM	49399

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 1912724
Project: DBSA

Lab ID: 1912724-011 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-2(2.5-3) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/17/2019 11:51:41 PM	49399

Lab ID: 1912724-012 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-2(3-3.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/18/2019 12:04:01 AM	49399

Lab ID: 1912724-013 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-2(5.5-6) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/18/2019 11:03:57 PM	49418

Lab ID: 1912724-014 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-2(10-10.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	130	60		mg/Kg	20	12/18/2019 11:40:59 PM	49418

Lab ID: 1912724-015 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-3(0.5-1) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	61		mg/Kg	20	12/18/2019 11:53:19 PM	49418

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 1912724
Project: DBSA

Lab ID: 1912724-016 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-3(1.5-2) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	59		mg/Kg	20	12/19/2019 12:05:40 AM	49418

Lab ID: 1912724-017 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-3(2.5-3.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/19/2019 12:18:01 AM	49418

Lab ID: 1912724-018 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-5(1-1.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/19/2019 12:30:22 AM	49418

Lab ID: 1912724-019 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-5(2.5-3) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/19/2019 12:42:43 AM	49418

Lab ID: 1912724-020 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-5(3-3.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/19/2019 12:55:05 AM	49418

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 1912724
Project: DBSA

Lab ID: 1912724-021 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-5(5-5.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	60		mg/Kg	20	12/19/2019 1:32:08 AM	49418

Lab ID: 1912724-022 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(0.5-1) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	60		mg/Kg	20	12/19/2019 1:44:28 AM	49418

Lab ID: 1912724-023 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(1.5-2) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	ND	61		mg/Kg	20	12/19/2019 1:56:50 AM	49418

Lab ID: 1912724-024 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(2.5-3) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	71	60		mg/Kg	20	12/19/2019 2:09:11 AM	49418

Lab ID: 1912724-025 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(3-3.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS							Analyst: **CJS**
Chloride	140	60		mg/Kg	20	12/19/2019 2:21:32 AM	49418

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quanitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Daniel B. Stephens & Assoc. **Lab Order:** 1912724
Project: DBSA

Lab ID: 1912724-026 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(5.5-6) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	69	60		mg/Kg	20	12/19/2019 2:33:52 AM	49418

Lab ID: 1912724-027 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(10.5-11) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	140	60		mg/Kg	20	12/19/2019 2:46:14 AM	49418

Lab ID: 1912724-028 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NRB-6(15.5-16) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	100	60		mg/Kg	20	12/19/2019 2:58:35 AM	49418

Lab ID: 1912724-029 **Collection Date:** 12/13/2019 9:00:00 AM
Client Sample ID: NBR-6(20-21.5) **Matrix:** SOIL

Analyses	Result	RL	Qual	Units	DF	Date Analyzed	Batch ID
EPA METHOD 300.0: ANIONS						Analyst: **CJS**	
Chloride	ND	60		mg/Kg	20	12/19/2019 3:10:56 AM	49418

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1912724**

20-Dec-19

Client: Daniel B. Stephens & Assoc.

Project: DBSA

Sample ID: **MB-49399** SampType: **mblk** TestCode: **EPA Method 300.0: Anions**
Client ID: **PBS** Batch ID: **49399** RunNo: **65234**
Prep Date: **12/17/2019** Analysis Date: **12/17/2019** SeqNo: **2240756** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	ND	1.5								

Sample ID: **LCS-49399** SampType: **lcs** TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSS** Batch ID: **49399** RunNo: **65234**
Prep Date: **12/17/2019** Analysis Date: **12/17/2019** SeqNo: **2240757** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	14	1.5	15.00	0	92.9	90	110			

Sample ID: **MB-49418** SampType: **mblk** TestCode: **EPA Method 300.0: Anions**
Client ID: **PBS** Batch ID: **49418** RunNo: **65273**
Prep Date: **12/18/2019** Analysis Date: **12/18/2019** SeqNo: **2241732** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	ND	1.5								

Sample ID: **LCS-49418** SampType: **lcs** TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSS** Batch ID: **49418** RunNo: **65273**
Prep Date: **12/18/2019** Analysis Date: **12/18/2019** SeqNo: **2241733** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	14	1.5	15.00	0	94.9	90	110			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
PQL	Practical Quantitative Limit	RL	Reporting Limit
S	% Recovery outside of range due to dilution or matrix		

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 or Constant Head: (Rigid Wall)	ASTM D5856M
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
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
Particle Size Analysis:	ASTM D7928, ASTM D6913
USCS (ASTM) Classification:	ASTM D6913, ASTM D4318, ASTM D2487
USDA Classification:	ASTM D7928, ASTM D6913, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Visual-Manual Description:	ASTM D2488
Soil Chloride	EPA 300.0

APPENDIX G

Chloride Mass Balance Calculation RIOAL.M001.LIS-NRWB-01CMB

GEOSCIENCE & ENGINEERING SOLUTIONS

1. Purpose

The purpose of this calculation (Calculation) is to estimate long-term historical deep percolation (recharge) to groundwater in the vicinity of the Lisbon Valley RAML Site (Site) using the chloride mass balance (CMB) method [REF001; REF002].

2. Background

Estimating recharge to groundwater at the Site is important to understanding the overall Site water balance as it relates to both the long-term performance of the reclaimed Tailing Storage Facilities (TSFs) at the Site (Upper Tailing Impoundment – UTI; and Lower Tailing Impoundment – LTI) and fate and transport modeling in groundwater.

The CMB method recognizes that the principal source of chloride ions in soil water (the vadose zone) is from chloride precipitation [REF001; REF002]. As water infiltrates, chloride accumulates in the soil profile and is concentrated by evapotranspiration (ET) in the root zone. At equilibrium, mass rate of chloride in equals mass rate out percolating below the root zone.

Figure 1 illustrates the Site and locations of six boreholes (NRB-1 through NRB-6) considered for collecting data to support the estimation of CMB. All boreholes were drilled except NRB-4.

Attachment A to this Calculation includes the boring logs for NRB-1 through 3, and NRB-5 and 6. As explained in greater detail in **Section 3** of this Calculation, the CMB calculation requires, in part, determination of chloride in soil water with depth. The boring logs include chloride in soil water together with a substantial amount of other information. Determination of chloride in soil water is explained in greater detail in **Section 3** of this Calculation.

3. Procedures

This section details the procedures used to estimate long-term historical deep percolation (recharge) to groundwater, including the CMB equation, input parameters, and calculations.

3.1 CMB Equation

The CMB equation is as follows [REF001, 002]:

$R = (Cl_p / Cl_{sw}) \times P$

- R = long-term average annual recharge (cm/s)
- Cl_p = Chloride in precipitation (mg/l)
- Cl_{sw} = Chloride in soil water (mg/l)
- P = long-term average annual precipitation (cm/sec)

3.2 Input Parameters

Chloride in precipitation (Cl_p) was estimated from data for Grand Junction, Colorado, located approximately 70 miles northeast of the Site. A value of 0.86 mg/L was used for this Calculation

[REF003 in REF004].

Chloride in soil water Cl_{sw} was determined in the laboratory from samples collected during the drilling of the borings, and is summarized as follows:

- Soil samples from the NRB boreholes were submitted by INTERA to DBS&A Laboratory in Albuquerque, NM, for testing of soil physical properties and chloride in soil moisture
- The DBS&A Laboratory submitted samples for chloride analyses to Hall Environmental Analysis Laboratory (HEAL) in Albuquerque, NM
- HEAL used the following protocol for determination of chloride in moisture from the soil samples [REF005]:
  - 30ml of deionized (DI) water is added to 10g of soil sample (at in-situ moisture content) in centrifuge tube
  - Sample is agitated vigorously for 15 minutes, then centrifuged for 10 minutes
  - Aliquot is pipette off top for analysis in instrument that has a particulate filter
  - Result is parts per million (ppm) and converted to mg/kg by multiplying by 3 (**Attachment B** to the calculation includes selected laboratory data for the soil samples from the NRB boreholes, including HEAL lab results reported in mg/kg)
- To determine the concentration of chloride in the dry soil (mg/l), the following conversion was done:
  - Determine equivalent dry mass (10mg (wet) / 1 + gravimetric water content)
  - Multiply the mg/kg result in the report by (calculated dry mass/30)
- The *Chloride in Soil Moisture* values plotted on the borehole logs (**Attachment A**) are the resultant dry soil moisture values; with a laboratory Reporting Limit of 60 mg/kg, it has been assumed that the lower bound of reporting for chloride in dry soil is 20 mg/l ("ND" on the borehole logs)

The range of measured (adjusted) **Cl_{sw}** is narrow, ranging from a low value of 20 mg/l (ND) to a high of 44 mg/l.

The **long-term average annual precipitation, P**, was estimated at 14.1 inches/year (1.152E-06 cm/sec) [REF006].

3.3 Assumptions

The following are important assumptions in understanding the calculations provided herein, and their validity in relying on the results to estimate R at the Site:

- Precipitation, chloride in precipitation, and ET represent long-term averages
- Moisture percolating below the root zone becomes recharge to groundwater

- Chloride concentration increases with depth; the value is constant below ET depth
- Data collected from the NRB borings are representative of the Site and historical conditions

3.4 Calculations

Considering the range of Cl_{sw} presented in Section 3.2 of this Calculation, but without consideration of other input parameter sensitivity; R is calculated as follows using the input values provided in **Section 3.2** of this Calculation:

$R = (Cl_p / Cl_{sw}) \times P$

- $Cl_p = 0.86$ mg/l
- $Cl_{sw} = 20$ mg/l
- P = 1.152E-06 cm/sec

R = (0.86/20) x 1.152E-06 = 5E-08 cm/s

- $Cl_p = 0.86$ mg/l
- $Cl_{sw} = 44$ mg/l
- P = 1.152E-06 cm/sec

R = (0.86/44) x 1.152E-06 = 2.3E-08 cm/s

The relationship between R and the input parameters Cl_p, Cl_{sw}, and P is simple and linear. As such, variation of the input parameters yields proportional variation of R. The calculations provided above demonstrate the range of estimated R for the observed range of measured (adjusted) Cl_{sw} values while holding both Cl_p and P constant.

To investigate the variability of R with variability of P and Cl_p, the following values for P and Cl_p were considered:

- P: vary P by 10% (12.7 to 15.5 in/yr; 1.037E-06 to 1.267E-06 cm/s)
- Cl_p: data regarding Cl_p in [REF004] indicates that Cl_p may vary more significantly than P; as such, vary Cl_p by 25% (0.65 to 1.08 mg/l)

Calculate R using the combination of input variables yielding the lowest value (R_l) and the highest value (R_h) given the range of P and Cl_p determined above, and range of Cl_{sw} described in **Section 3.2** of this Calculation:

Highest R (R_h):

- $Cl_p = 1.08$ mg/l
- $Cl_{sw} = 20$ mg/l
- P = 1.267E-06 cm/sec

R_h = (1.08/20) x 1.267E-06 = 6.8E-08 cm/s

Lowest R (R_l):

- Cl_p = 0.65 mg/l
- Cl_{sw} = 44 mg/l
- P = 1.037E-06 cm/sec

R_l = (0.65/44) x 1.037E-06 = 1.5E-08 cm/s

4. Summary

Long-term average annual recharge at the Site (R) was estimated using the chloride mass balance (CMB) method. Calculations were made with data collected from borings at the Site and using literature values where appropriate. In consideration of the site-specific data and range of possible variability of input parameters used to determine R, the following summarizes estimation of R at the Site:

- **R** is likely within the range of **2.3E-08 cm/s to 5E-08 cm/s**
- A lower-bound value (**R_l**) is estimated to be **1.5E-08 cm/s**
- An upper-bound value (**R_h**) is estimated to be **6.8E-08 cm/s**

7. References

[REF001]: Allison, G.B. and M.W. Hughes "The Use of Environmental Chloride and Tritium to Estimate Total Recharge to an Unconfined Aquifer". Aus. J. Soil Res., 1978, 16, 181-195

[REF002]: Allison, G.B., Gee, G.W., and Tyler, S.W. "Vadose-Zone Techniques for Estimating Groundwater Recharge in Arid and Semiarid Regions". Soil Sci. Soc. Am. J., 1994, 58:6-14

[REF003]: Lodge, J.P.Jr., Pate, J.B., Basbergill, W., Swanson, G.S., Hill, K.C., Lorange, E., and Lazurus, A.L. "Chemistry of United States Precipitation – Final Report on the National Precipitation Sampling Network". Laboratory of Atmospheric Sciences, National Center for Atmospheric Research, Boulder, CO, 1968, 66 p.

[REF004]: Stone, W.J. "Preliminary Estimates of Recharge at the Navajo Mine Based on Chloride in the Unsaturated Zone". New Mexico Bureau of Mines and Mineral Resources Open File Report 213, August 1984

[REF 005]: Email correspondence from Joleen Hines (Geo-Logic) to Larry Coons and Emily Woolsey (INTERA) RE: CMB/HELP Stephens-Coons Paper, March 18, 2020

[REF006]: U.S. Climate Data, 2018; La Sal weather station (LA SAL 1 SW)

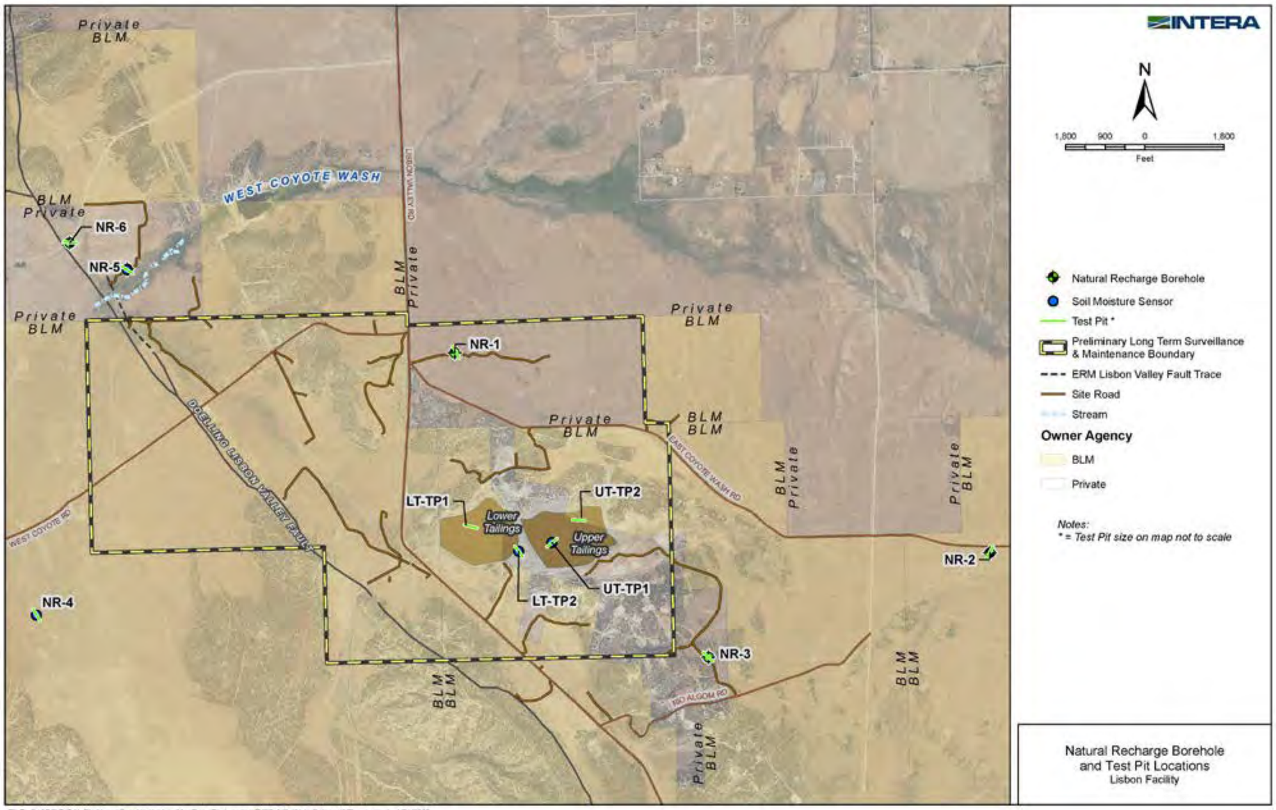
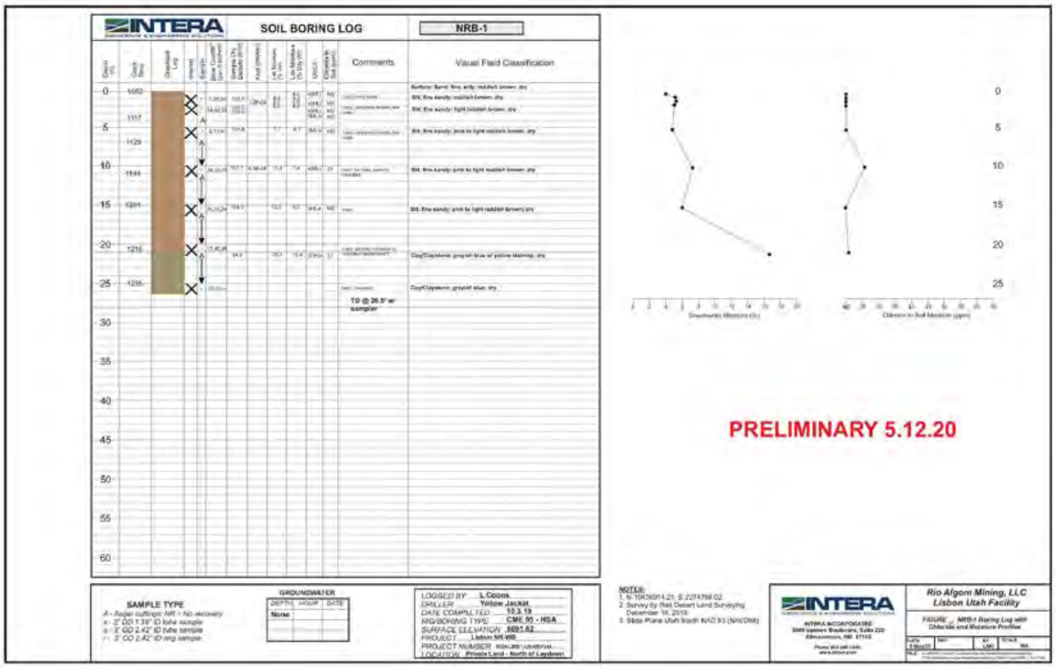
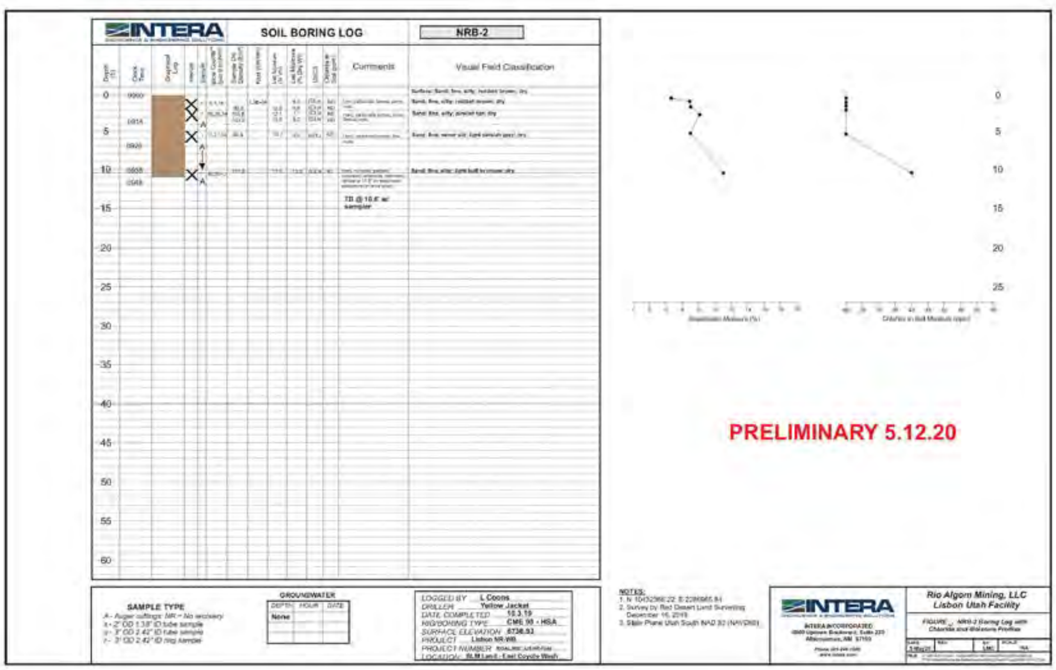


Figure 1

Appendix A

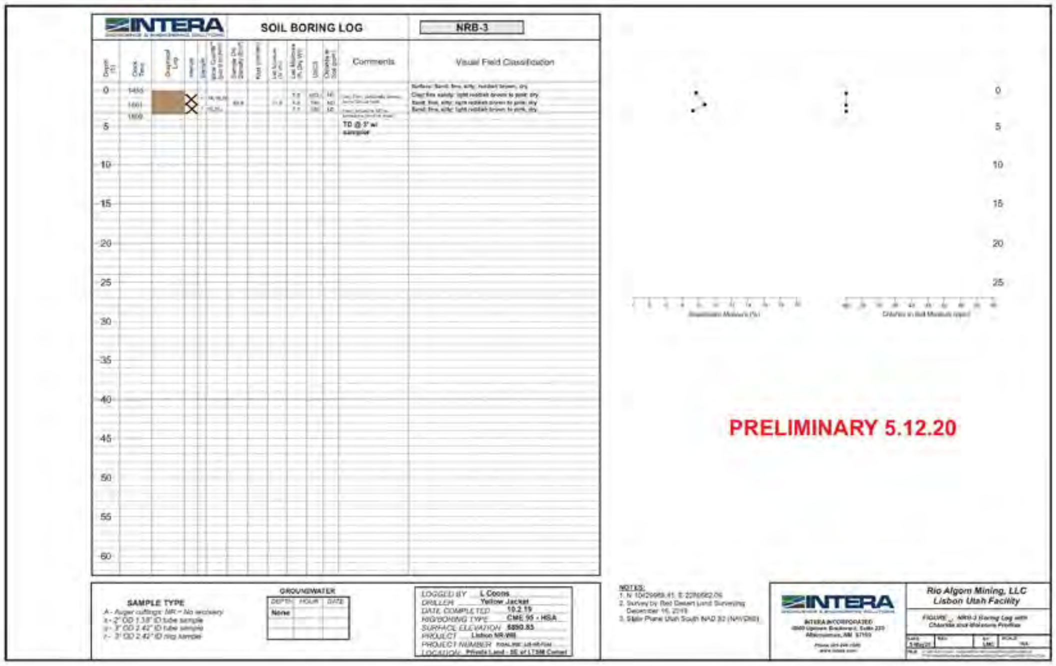
Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			**Subject:**	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 5 of 19	

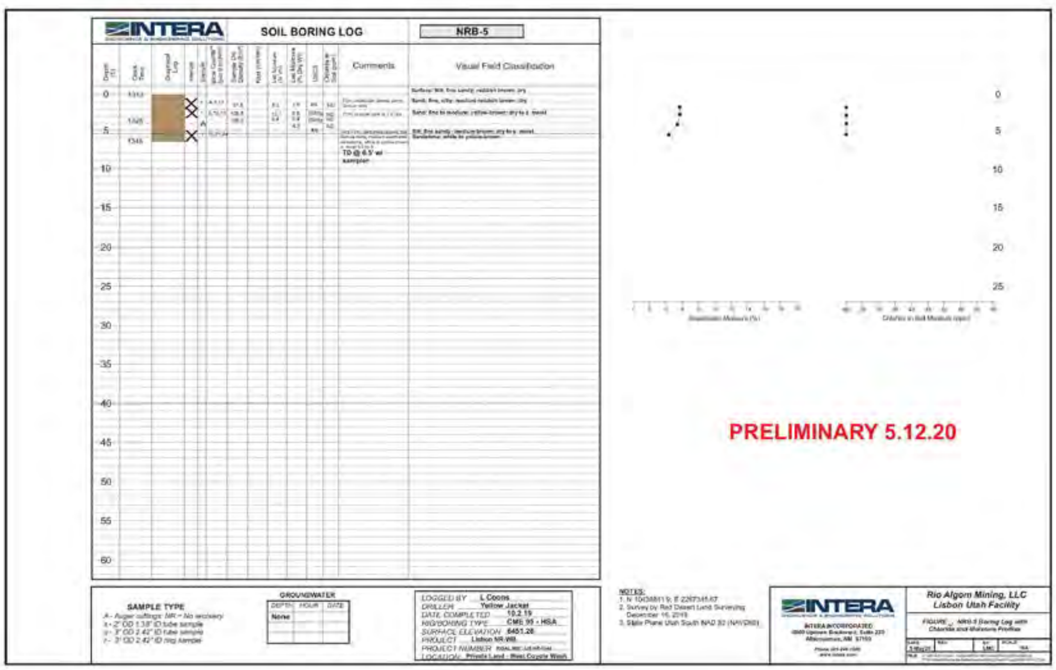




Appendix A

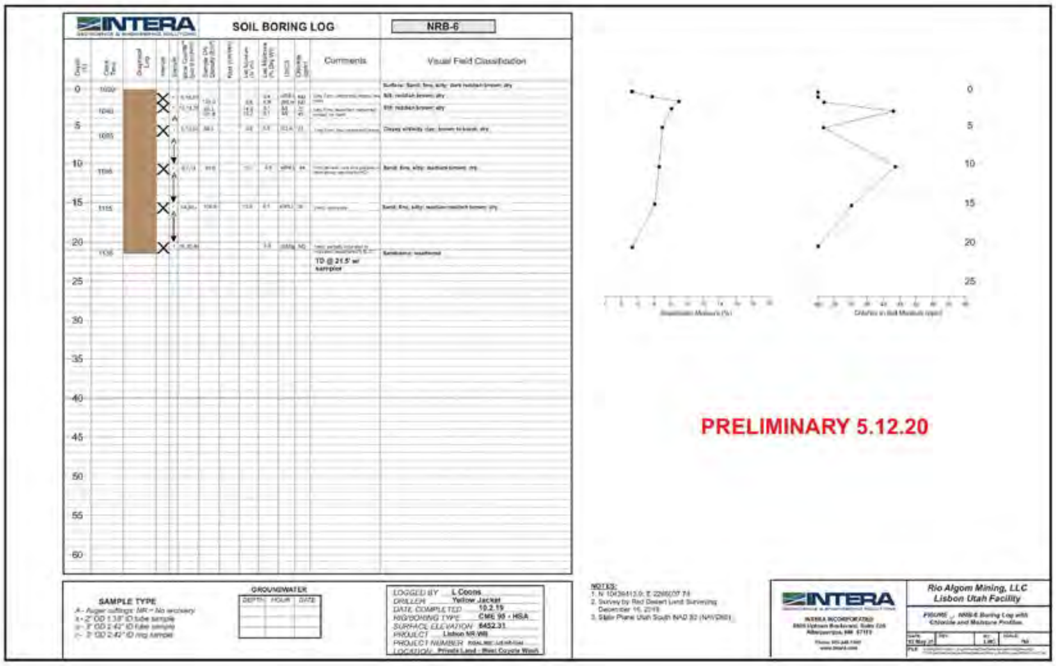
Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 6 of 19	





Appendix A

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 7 of 19	



Appendix B

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 8 of 19	

GEOSCIENCE & ENGINEERING SOLUTIONS

Note: this appendix contains only selected pages from the full Report

Laboratory Report for

INTERA Inc.

Lisbon Site - Natural Recharge Borings

RIOAL.M001.LIS-NR FIELD

January 20, 2020

Daniel B. Stephens & Associates, Inc.

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

Appendix B

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 9 of 19	

January 20, 2020

Larry Coons
INTERA Inc.
6000 Uptown Blvd NE Suite 220
Albuquerque, NM 87110
(505) 246-1600

Re: DBS&A Laboratory Report for the INTERA Inc. Lisbon Site - Natural Recharge Borings RIOAL.M001.LIS-NR FIELD Project

Dear Mr. Coons:

Enclosed is the report for the INTERA Inc. Lisbon Site - Natural Recharge Borings RIOAL.M001.LIS-NR FIELD 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 INTERA Inc. 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

Adam Bland
Laboratory Operations 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

Appendix B

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 10 of 19	

Summaries

3

Appendix B

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 11 of 19	

Daniel B. Stephens & Associates, Inc.

Notes

Sample Receipt:
A total of twenty nine samples were hand-delivered on December 6, 2019. Seven samples were received as loose material in a 1-gallon Ziploc bag. Nineteen samples were received as 6" x 2.5" stainless steel sleeves sealed with end caps and duct tape. The remaining three samples were received as stacked 2.5" x 6" brass rings.

Sample Preparation and Testing Notes:
Each of the samples was subjected to as-received gravimetric moisture content determination, particle size analysis, Atterberg limits testing and soil chloride analysis.

Each of the sleeve samples was subjected to initial properties analysis.

Four of the sleeve samples were subjected to moisture retention testing. An intact sample from each of the sleeves was obtained by extruding a portion of each sample into a sleeve of the same diameter. Each of these sub-samples was subjected to saturated hydraulic conductivity via the rigid wall method, and the hanging column and pressure chamber portions of the moisture retention testing. Adjacent sample material was used for the dewpoint potentiometer and relative humidity chamber portions of the moisture retention testing.

Porosity calculations, and the particle diameter calculations in the hydrometer portion of the particle size analysis testing, are based on the use of an assumed specific gravity value of 2.75.

Volumetric water contents were adjusted for changes in volume, where applicable. Due to the irregularities formed on the sample surfaces during settling or swelling, volume measurements obtained after the initial reading should be considered estimates.

Appendix B

Daniel B. Stephens & Associates, Inc.

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 (%)
NRB-1 (0.5-1)	4.0	NA	—	—	NA	NA	NA
NRB-1 (1.5-2)	5.2	8.6	—	—	1.66	1.75	39.5
NRB-1 (2.5-3)	5.1	NA	—	—	NA	NA	NA
NRB-1 (2.5-3) (1.65 g/cc)	5.3	8.7	—	—	1.65	1.73	40.1
NRB-1 (3-3.5)	4.9	8.0	—	—	1.65	1.73	40.2
NRB-1 (5.5-6)	4.7	7.7	—	—	1.63	1.70	40.9
NRB-1 (10.5-11)	6.7	NA	—	—	NA	NA	NA
NRB-1 (10.5-11) (1.62 g/cc)	7.4	11.9	—	—	1.62	1.74	41.2
NRB-1 (15.5-16)	6.0	10.0	—	—	1.67	1.77	39.1
NRB-1 (21-21.5)	16.4	25.0	—	—	1.52	1.77	44.6
NRB-2 (0.5-1)	4.6	NA	—	—	NA	NA	NA
NRB-2 (1.5-2)	6.8	10.9	—	—	1.60	1.70	42.0

NA = Not analyzed
— = This sample was not remolded

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 13 of 19	

Appendix B

Daniel B. Stephens & Associates, Inc.

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

	Moisture Content						
	As Received		Remolded				
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
NRB-2 (2.5-3)	6.5	NA	---	---	NA	NA	NA
NRB-2 (2.5-3) (1.71 g/cc)	7.1	12.1	---	---	1.71	1.83	37.8
NRB-2 (3-3.5)	8.2	13.6	---	---	1.66	1.80	39.6
NRB-2 (5.5-6)	6.9	10.7	---	---	1.55	1.66	43.5
NRB-2 (10-10.5)	7.5	NA	---	---	NA	NA	NA
NRB-2 (10-10.5) (1.63 g/cc)	10.9	17.9	---	---	1.63	1.81	40.6
NRB-3 (0.5-1)	7.9	NA	---	---	NA	NA	NA
NRB-3 (1.5-2)	8.5	11.8	---	---	1.39	1.51	49.3
NRB-3 (2.5-3.5)	7.3	NA	---	---	NA	NA	NA
NRB-5 (1-1.5)	5.8	8.6	---	---	1.47	1.56	46.5
NRB-5 (2.5-3)	5.8	10.1	---	---	1.74	1.84	36.7
NRB-5 (3-3.5)	5.4	9.4	---	---	1.73	1.82	37.1

NA = Not analyzed
--- = This sample was not remolded

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 14 of 19	

Appendix B

Daniel B. Stephens & Associates, Inc.

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

	Moisture Content						
	As Received		Remolded				
Sample Number	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Gravimetric (%, g/g)	Volumetric (%, cm^3/cm^3)	Dry Bulk Density (g/cm^3)	Wet Bulk Density (g/cm^3)	Calculated Porosity (%)
NRB-5 (5-5.5)	4.2	NA	---	---	NA	NA	NA
NRB-6 (0.5-1)	3.4	NA	---	---	NA	NA	NA
NRB-6 (1.5-2)	5.9	9.8	---	---	1.65	1.75	39.9
NRB-6 (2.5-3)	9.1	14.6	---	---	1.59	1.74	42.0
NRB-6 (3-3.5)	8.1	13.2	---	---	1.63	1.77	40.6
NRB-6 (5.5-6)	6.8	9.8	---	---	1.44	1.54	47.6
NRB-6 (10.5-11)	6.5	10.1	---	---	1.55	1.65	43.5
NRB-6 (15.5-16)	6.1	10.5	---	---	1.74	1.84	36.8
NRB-6 (20-21.5)	3.3	NA	---	---	NA	NA	NA

NA = Not analyzed
--- = This sample was not remolded

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 15 of 19	

INTERA
GEOSCIENCE & ENGINEERING SOLUTIONS

Appendix B

Daniel B. Stephens & Associates, Inc.

Summary of Chloride Analysis

Sample Number	Chloride (mg/kg)	Reporting Limit (mg/kg)
NRB-1 (0.5-1)	ND	60
NRB-1 (1.5-2)	ND	60
NRB-1 (2.5-3)	ND	61
NRB-1 (3-3.5)	ND	60
NRB-1 (5.5-6)	ND	60
NRB-1 (10.5-11)	85	60
NRB-1 (15.5-16)	ND	60
NRB-1 (21-21.5)	76	59
NRB-2 (0.5-1)	ND	60
NRB-2 (1.5-2)	ND	60
NRB-2 (2.5-3)	ND	60
NRB-2 (3-3.5)	ND	60
NRB-2 (5.5-6)	ND	60
NRB-2 (10-10.5)	130	60
NRB-3 (0.5-1)	ND	61
NRB-3 (1.5-2)	ND	59
NRB-3 (2.5-3.5)	ND	60
NRB-5 (1-1.5)	ND	60
NRB-5 (2.5-3)	ND	60
NRB-5 (3-3.5)	ND	60
NRB-5 (5-5.5)	ND	60
NRB-6 (0.5-1)	ND	60

Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, New Mexico

ND= Not detected at the specified reporting limit

Appendix B

Daniel B. Stephens & Associates, Inc.

Summary of Chloride Analysis (continued)

Sample Number	Chloride (mg/kg)	Reporting Limit (mg/kg)
NRB-6 (1.5-2)	ND	61
NRB-6 (2.5-3)	71	60
NRB-6 (3-3.5)	140	60
NRB-6 (5.5-6)	69	60
NRB-6 (10.5-11)	140	60
NRB-6 (15.5-16)	100	60
NRB-6 (20-21.5)	ND	60

Analysis performed by Hall Environmental Analysis Laboratory in Albuquerque, New Mexico

ND= Not detected at the specified reporting limit

24

Appendix B

Laboratory Tests and Methods

259

Rev.	Orig.	Date	Chkd.	Date	Client/Project:	RIOAL.M001.LIS-NRWB
0	LMC	12.1.20			Subject:	Estimated Long-Term Historical Recharge Using Chloride Mass Balance Method
					Calc. No.	RIOAL.M001.LIS-NRWB-01CMB
					Sheet 18 of 19	

Appendix B

Daniel B. Stephens & Associates, Inc.

Tests and Methods

Dry Bulk Density:	ASTM D7263
Moisture Content:	ASTM D7263, ASTM D2216
Calculated Porosity:	ASTM D7263
Saturated Hydraulic Conductivity: Falling or Constant Head: (Rigid Wall)	ASTM D5856M
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
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
Particle Size Analysis:	ASTM D7928, ASTM D6913
USCS (ASTM) Classification:	ASTM D6913, ASTM D4318, ASTM D2487
USDA Classification:	ASTM D7928, ASTM D6913, USDA Soil Textural Triangle
Atterberg Limits:	ASTM D4318
Visual-Manual Description:	ASTM D2488
Soil Chloride	EPA 300.0

APPENDIX H
HYDRUS Modeling

Appendix H
HYDRUS Model

CONTENTS

LIST OF FIGURES

LIST OF TABLES

H.1 HYDRUS Model

H.1.1 Introduction

A detailed quantification of infiltration through the tailings cover system requires a mathematical description of the water flow in the unsaturated zone, a characterization of the soil hydraulic properties of the cover materials, and adequate representation of vegetation and climatic conditions of the upper boundary condition. Unsaturated flow modeling was used to complement the simulations done in Hydrologic Evaluation of Landfill Performance (HELP) and evaluate Site-specific soil hydraulic data, climate and other data collected during the field program. HYDRUS (2D/3D) is a finite element (FE) model used to simulate water flow through two- and three-dimensional variably saturated soil columns by numerically solving the Richards equation while simultaneously incorporating a sink term to account for water removal by root water uptake. The Richards function is a nonlinear partial differential equation, as shown below (Šimůnek et al., 2018):

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial x_i}\left[K\left(K_{ij}^{A}\frac{\partial h}{\partial x_j} + K_{iz}^{A}\right)\right] - S$$

where θ is the volumetric water content [L3 L^{-3}]; h is the pressure head [L]; S is a sink term [T^{-1}], x_i (i=1,2,3) are the spatial coordinates [L]; t is time [T], K_{ij}^{A} are components of a dimensionless anisotropy tensor K^A; K is the unsaturated hydraulic conductivity function [LT^{-1}].

For this assessment, the HYDRUS 2D-general geometry type was used to define cross sections with a unitary width (equal to 1 cm) to simulate infiltration into one-dimensional representations of the lower and upper tailings using a daily time step. Two generic models were prepared to represent the OUTCAPP and INCAPP conditions on the impoundments (explained in detail in Section 6.1 of the NR-WB Report). These models were prepared with two different simulation lengths. The 4-year simulation models utilized the hydroclimatic data collected at the Site's weather station (2016-2020), the soil moisture sensor (SMS) data (2019-2021), and the moisture content data from the 2016 geotechnical investigation (INTERA, 2017) to define the initial conditions. These models used daily output between November 1, 2019, and June 30, 2021, to overlap with SMS data collected at lower tailing impoundment (LTI) and upper tailing impoundment (UTI) test pits and focused on evaluating cover parameterization. A second set of 246-year simulation models were prepared with the same parametrization by cycling the 41-year climate timeseries from La Sal SW 1 (Section 2.1 and 5.1) six times to evaluate infiltration after pseudo steady-state conditions were reached. Annual model output was used to evaluate the temporal dynamics of the model and calculate the average infiltration throughout the cover and tailing system.

The characterization of the soil hydraulic properties HYDRUS was done using the van Genuchten-Mualem hydraulic model (van Genuchten, 1980), which provides a parametric relationship between θ, h, and K based on retention curves obtained from hollow-stem auger (HSA) samples collected on the impoundments (INTERA, 2017). Profile geometry and soil hydraulic properties are consistent with the enhanced HELP model profiles (Section 6.2) and the 2016 geotechnical investigation data (INTERA, 2017). The upper boundary condition is defined using precipitation and potential evapotranspiration (PET) daily time series derived from a nearby station (La Sal SW 1). Vegetation was simulated using several combinations of leaf area index (LAI) and root distribution based on vegetation transects and vertical profiles observed at the LT-TP2 and UT-TP1 test pits (**Figures 4.2** and **4.3**) and a literature review of LAI values for similar environments (Section 5.2). The free drainage boundary condition was used at the bottom to represent a condition where the water table is far below tailings, as explained in the conceptual model for the Site (INTERA, 2021b). Sections H.1.2 through H.1.5 provide a detailed description of the FE mesh, hydraulic properties, boundary conditions, and initial conditions.

H.1.2 Model Layer Geometry and Finite Element Mesh

Information provided by the 2016 borings and 2019 test pit logs were integrated to generate two generic tailings profiles for the enhanced HELP models, known as OUTCAPP and INCAPP. The HYDRUS models have same number of layers and layer geometry with six layers for the OUTCAPP model and five layers for the INCAPP model.

Figure H.1 and **Figure H.2** show geometric objects used to define the cover layers in HYDRUS 2D/3D and **Figure H.3** shows a detailed view of the type of FE mesh geometry used in the models. These objects were used by the software to generate the FE mesh refinements and populate the parameter properties for each node. Considerable effort was placed refining the FE mesh given the contrast of hydraulic properties and non-linear effects caused by the atmospheric boundary conditions and root zone (Šimůnek and Šejna, 2009).

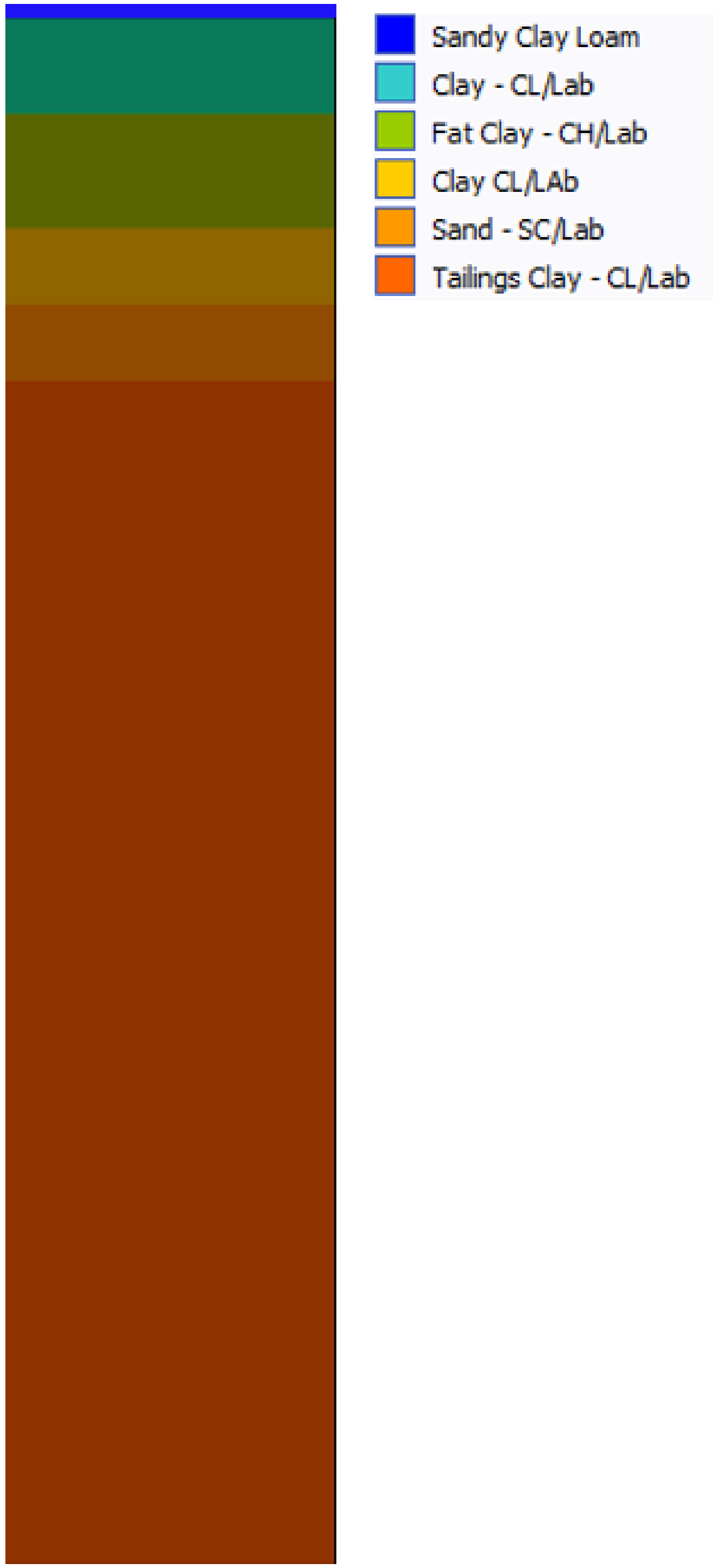


Figure H.1 Geometric Objects Used in OUTCAPP Model.

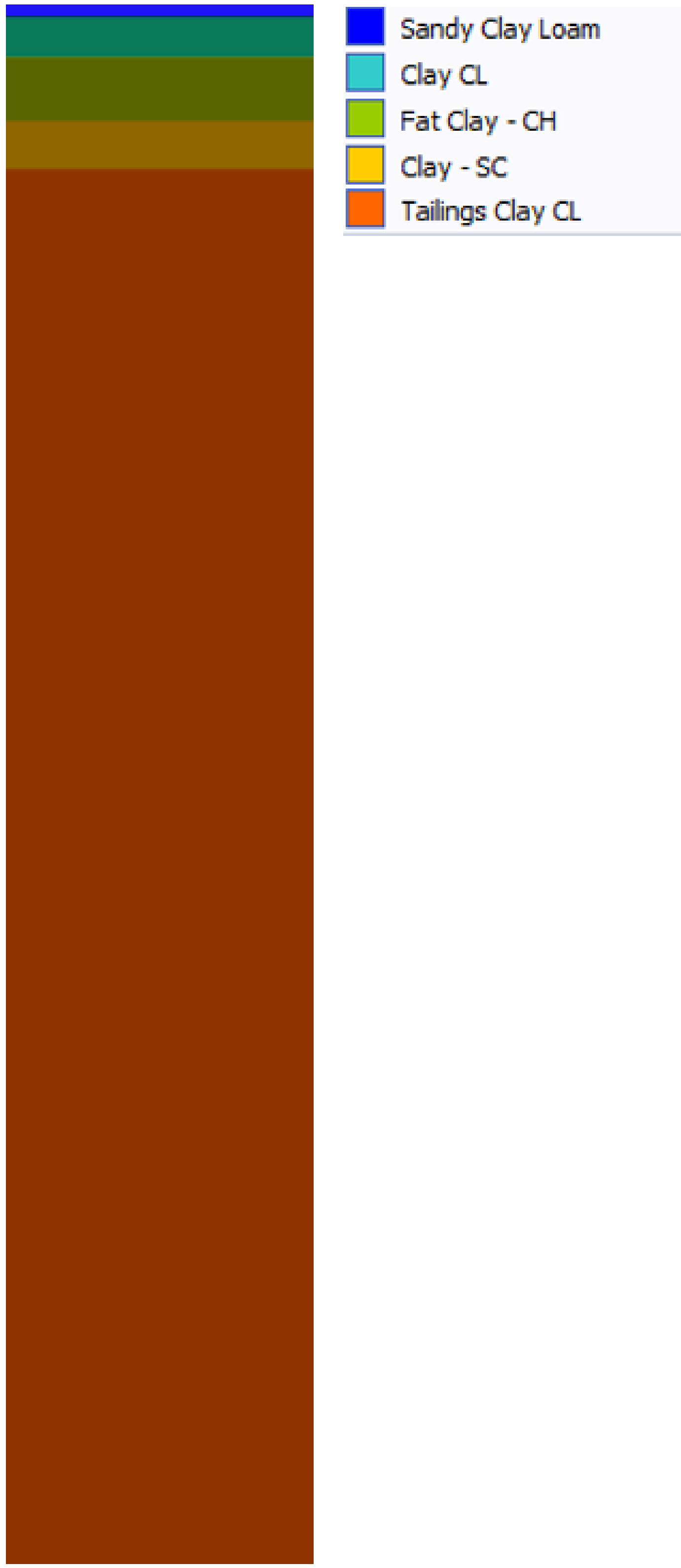


Figure H.2 Geometric Objects Used in INCAPP Model.

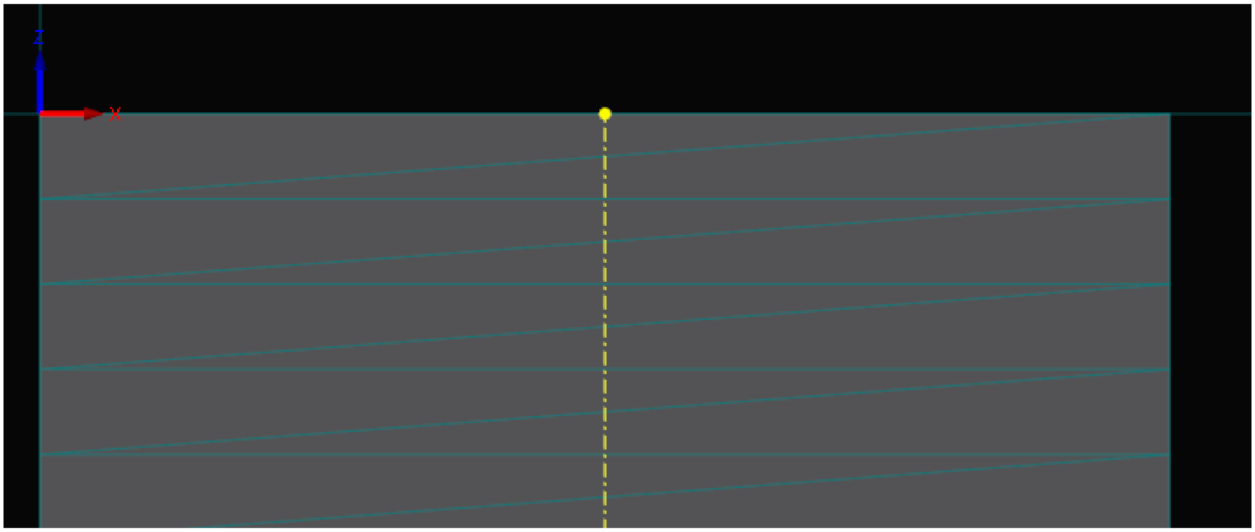


Figure H.3 Example of the Discretization Used in the Gravel Cover Layer of OUTCAPP.

Table H.1 and **Table H.2** provide a summary of the model geometry including the layer thickness, the total number of nodes for each layer, and the average vertical spacing between nodes at the center of each layer. For both models, the finest discretization is applied at layer 1 as it contains the nodes used for the highly variable atmospheric boundary condition. The average spacing continues to be very small for the upper 36 inches where root water uptake nodes were also included for several scenarios and where the largest change in hydraulic properties exist for the layers above and below the fat clay layer. Discretization was increased at these layers to avoid issues in numerical convergence. The spacing gradually increases towards the bottom of the model with the highest spacing in the layers representing the tailings clay. The FE mesh generated in the OUTCAPP model consisted of 2,514 nodes, while the INCAPP model consisted of 4,814. The higher number of nodes in the INCAPP model was due to problems with numerical convergence caused by greater contrast in terms of hydraulic properties between the top layer used to represent the gravel and the rest of the materials.

Table H.1 Geometry Properties by Layer for the INCAPP (UTB-TP-1) Model.

Layer	Material Type	Thickness (in)	Number of nodes	Average spacing of nodes at the center of the layer (in)
1	Gravel/Sandy Clay Loam	3	402	0.007
2	Clay	15	1602	0.009
3	Fat Clay	24	1002	0.024
4	Clay	18	204	0.088
5	Tailings Clay	546	1604	0.340

Table H.2 Geometry Properties by Layer for the OUTCAPP (LTB-TP-2) Model.

Layer	Material Type	Thickness (in)	Number of nodes	Average spacing of nodes at the center of the layer (in)
1	Gravel/Sandy Clay Loam	3	202	0.015
2	Clayey Sand	15	802	0.019
3	Fat Clay	18	502	0.036
4	Sandy Lean Clay	12	102	0.118
5	Clayey Sand	12	102	0.118
6	Tailings Clay	186	804	0.231

H.1.3 Hydraulic Properties

H.1.3.1 Selected parameters

The van Genuchten-Mualem hydraulic model (van Genuchten, 1980) was selected to define the hydraulic properties of the materials. The parameters required to define each layer include saturated hydraulic conductivity (K_{sat}), residual soil water content (θ_r), saturated soil water content (θ_s), van Genuchten model fitting parameters (α and n), and pore-connectivity parameter (l). Values used to represent each of the HYDRUS layers were obtained from the 2016 soil testing (INTERA, 2018) and soil properties database Rosetta V1.0 embedded in HYDRUS. (Schaap et al. 2001) after careful comparison of the retention curves with available observations and literature values for soils with similar United States department of Agriculture (USDA) soil classification. All the parameters for the OUTCAPP soil layers were obtained from retention curves developed from samples at the Lisbon Site except for the top coarse gravel layer, which was selected after numerical testing of several coarse materials in the Rosetta database. To provide numerical stability when larger pressure head gradients exist at the gravel and finer material interface, the coarser gravel layer was represented as the USDA class sandy clay loam from Rosetta (Carsel and Parrish, 1988). The sandy clay loam contained parameters representative of a coarser material with a high K_{sat}, but more similar to the underlying clay/silt layers.

Table H.3 presents the soil hydraulic parameters and corresponding sources used in OUTCAPP profile. This table contains a description of the assumed layer geometry, textural description based on INTERA (2018) characterization, and soil classification using field observations, the corresponding HELP material classification, and the associated USDA classification to the HELP material (Table 4, Schroeder et al., 1994) used as reference for evaluation of hydraulic properties.

Table H.3 Unsaturated Hydraulic Properties and Hydraulic Conductivity (Ks) for OUTCAPP.

No.	Thickness	Depth	Textural description	Soil Classification			θ_r (-)	θ_s (-)	α (cm^{-1})	n (-)	K_{sat} (cm/day)	K_{sat} (cm/s)	l (-)	Source
				USCS	HELP	USDA								
1	3 in (0.25')	+ 0.25'	Surface Gravel	NA	Gravel (21)	G	0.1	0.39	0.0590	1.48	31.44	3.64E-04	0.5	Rosetta Database Sandy Clay Loam (Carsel and Parrish, 1988)
2	18 in (1.5')	0-18" (0 - 1.5')	cover fill - Silt w/ clay and fine sand; dry	Lean Clay w Sand/Lean Clay	Moderately Compacted Clay - CL (25)	CL	0	0.37	0.0066	1.21	10.37	1.20E-04	0.5	LTB-02 Lab Retention Data with Porosity (Qs) (INTERA, 2018)
3	18 in (1.5')	18 -36" (1.5' - 3')	cover fill - fat clay w/ fine sand; dry to s. moist	Fat Clay	Moderately Compacted Fat Clay - CH (28)	SiC	0	0.37	0.0005	1.26	4.49E-03	5.20E-08	0.5	UTB-01 Fat Clay Layer Retention Data with Porosity (Qs) from LTB-02 Fat Clay Layer (30-36") (INTERA, 2018)
4	12 in (1')	36 -48" (3 -4')	cover fill - clay w/ fine sand; dry to s. moist	Sandy Lean Clay	Moderately Compacted Clay - CL (25)	CL	0	0.31	0.0023	1.23	2.76	3.20E-05	0.5	LTB-01 Sandy Lean Clay Layer (12-18") Retention Parameters with Ksat and Porosity (Qs) from LTB-02 Layer (42-48") (INTERA, 2018)
5	12 in (1')	48 - 60" (4-5')	cover fill - sand w/ clay and silt; dry to s. moist	Sandy Lean Clay/Clayey Sand	Moderately Compacted Clayey Sand - SC (24)	SCL	0	0.49	0.0023	1.23	6.57	7.60E-05	0.5	LTB-01 Sandy Lean Clay Layer (12-18") Retention Parameters with Average Ksat of LTB-02 Cover, and Porosity (Qs) from LTB-02 Layer (54-60") (INTERA, 2018)
6	174 in (14.5')	6-20.5'	Tailings Fill, clay and sand; moist	Tailings Average	Moderately Compacted Clay - CL (25)	CL	0	0.42	0.0016	1.25	0.04	4.90E-07	0.5	Average Retention Parameters from All Tailings Samples (INTERA, 2018)

Due to limited water retention data, several assumptions were made wherever necessary data was absent, generally based on the 2016 soil description and corresponding boring log. For example, retention data for the tailings clay layer was not available in the LTI; however, based on similar depths and soil classification was assumed to have the same unsaturated hydraulic properties as the tailings clay in INCAPP (UTB-01). The coarser gravel layer of the cover was represented as a sandy clay loam. In layer 2, retention data from LTB-02 was used; and for layers 4 and 5, retention data from LTB-01 were used. Retention data for the LTB-02 tailings were unavailable; thus an average of the tailing's retention data was used from LTB-01, UTB-01, and UTB-02. Porosity from 2016 soil testing was used in place of θ_s for each layer. Hydraulic properties are summarized in **Figure H.4** using K vs θ curves calculated from the van Genuchten hydraulic model. In addition to the curves representing the layers, observed K vs θ laboratory data pairs, and θ measurements collected at the Site are also shown with thin horizonal or vertical blue (LTB borings) or magenta (UTB borings) lines. **Figure H.4** was used to verify the parameter selection, and guide assumptions on the FE mesh discretization as a greater distance between these curves for contiguous layers and the same moisture content can indicate the need of additional FE nodes. Similarly, the comparison of these curves against literature values helped to confirm the appropriateness of the parameter selection and the general characteristics of each layer with sandier materials in the upper left and layers with more clay in the lower right.

The parameters for the INCAPP soil layers were derived using the same approach as in the OUTCAPP profile. **Table H.4** presents the soil hydraulic parameters and corresponding sources used in the INCAPP profile. The coarser gravel layer 1 of the cover was represented as a USDA sandy clay loam. For layer 2, retention data from UTB-02 (30-36") was used with K_{sat} from UTB-01 (6-12") and porosity averaged from soil samples taken at UTB-01 (6-12") and (18-24"). In layer 4, UTB-02 Cover Retention Parameters for Lean Clay with Sand Layer (30-36") with average K_{sat} for UTB-02 cover samples (Silt with Sand/Lean Clay with Sand/Sandy Lean Clay) was used. An average of the tailing's retention data was used from LTB-01, UTB-01, and UTB-02 tailings samples to represent the tailings. **Figure H.5** summarizes the information for INCAPP using the same elements as in **Figure H.4**. Note in this case the distance between the curve used to represent layer 1 and the rest of model materials is larger, indicating the need of the additional FE mesh refinements.

Table H.4 Unsaturated Hydraulic Properties and Hydraulic Conductivity (Ks) for INCAPP.

No.	Thickness	Depth	Textural description	Soil Classification			θ_r (-)	θ_s (-)	α (cm^{-1})	n (-)	K_{sat} (cm/day)	K_{ssat} (cm/s)	l (-)	Source
				USCS	HELP	USDA								
1	3 in (0.25')	+ 0.25'	original surface gravel filled w/ soil	NA	Gravel (21)	G	0.1	0.39	0.0590	1.48	31.44	3.64E-04	0.5	Rosetta Database Sandy Clay Loam (Carsel and Parrish, 1988)
2	18 in (1.5')	0-18" (0 - 1.5')	cover fill - clay w/ fine sand; moist	Sandy Lean Clay/Lean Clay w sand	Moderately Compacted Clay - CL (25)	CL	0.00	0.3700	0.0046	1.20	0.031968	3.70E-07	0.5	UTB-02 Cover Retention Parameters for Lean Clay with Sand Layer (30-36") with Ksat from UTB-01 Lab Parameters for Layer (6-12") and Porosity (Qs) averaged over UTB-01 Layer (6-12") and (18-24") (INTERA, 2018)
3	24 in (0.5')	18-42" (1.5' - 3.5')	cover fill - fat clay w/ silt and v. fine sand; moist	Fat Clay	Moderately Compacted Fat Clay - CH (28)	SiC	0.00	0.3852	0.0005	1.2638	0.0044928	5.20E-08	0.5	UTB-01 Lab Retention Data (INTERA, 2018)
4	18 in (1.5')	42 -60" (3.5 -5')	cover fill - Sand w/ clay and silt; s. moist	Clayey Gravel/Clayey Sand	Moderately Compacted Silty Sand-SC (24)	SCL	0.00	0.3440	0.0046	1.20	0.66816	7.73E-06	0.5	UTB-02 Cover Retention Parameters for Lean Clay with Sand Layer (30-36") with Average Ksat over UTB-02 Cover Samples (Silt with Sand/Lean Clay with Sand/Sandy Lean Clay) and Porosity (Qs) from UTB-01 (42-48") (INTERA, 2018)
5	546 in (45.5')	60 - 606" (5' - 50.5')	Tailings Fill-Clay w/ f. sand and silt; v. moist to wet	Tailings Average	Moderately Compacted Clay - CL (25)	CL	0.00	0.4200	0.0016	1.25	0.042336	4.90E-07	0.5	Average Retention Parameters from All Tailings Samples (INTERA, 2018)

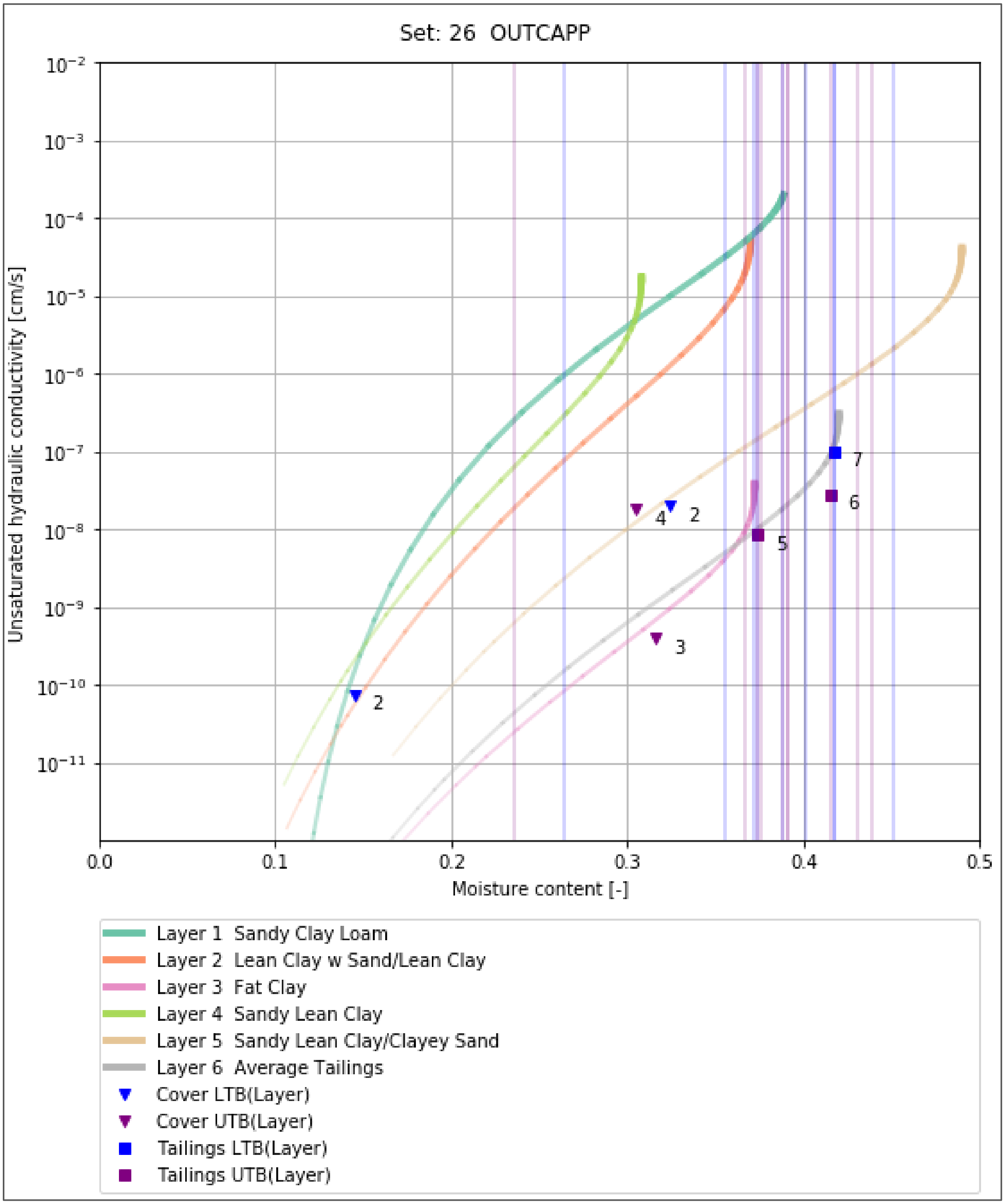


Figure H.4 Hydraulic Head versus Moisture Content using van Genuchten Soil Hydraulic Parameters for OUTCAPP.

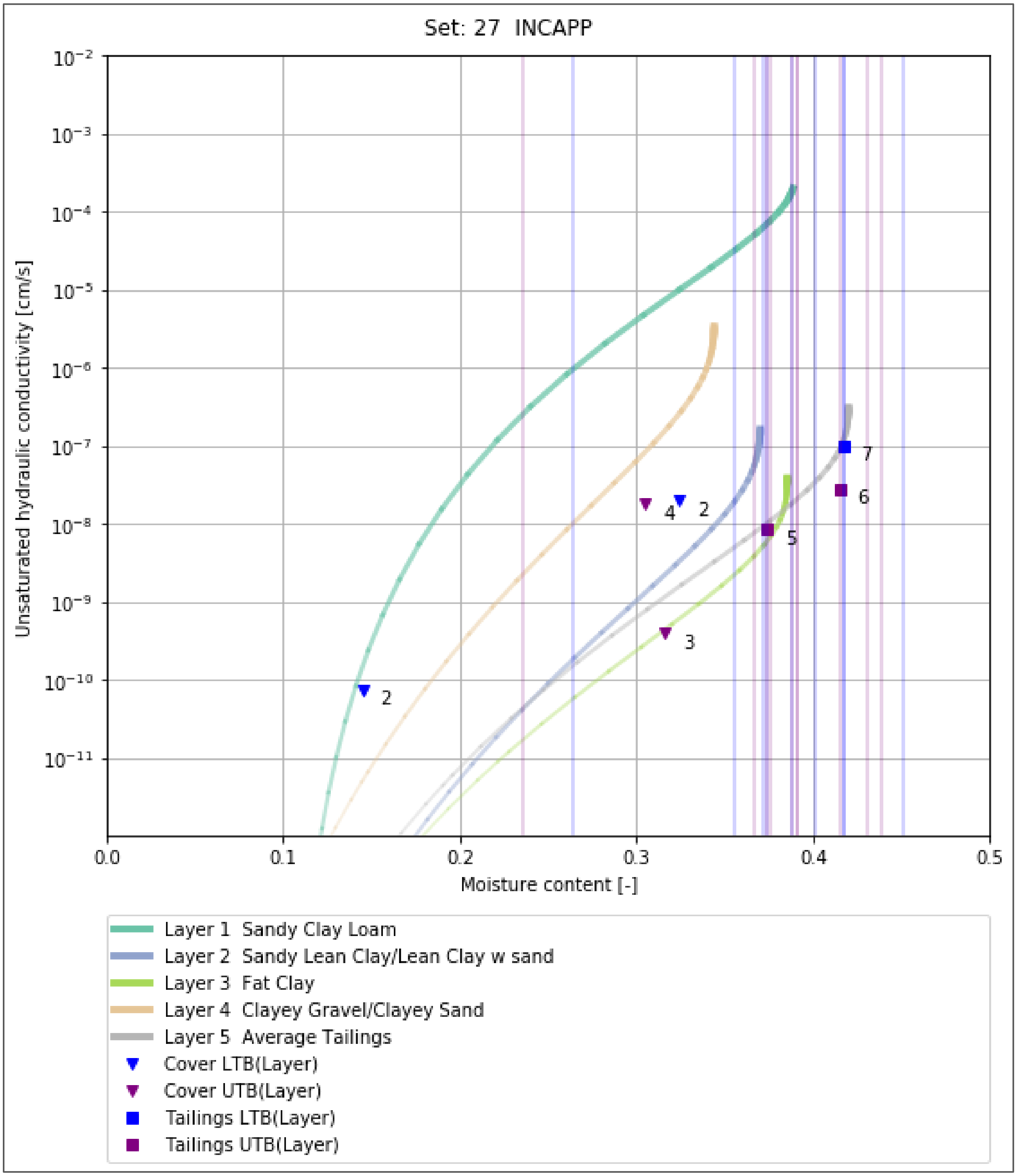


Figure H.5 Hydraulic Head Versus Moisture Content using van Genuchten Soil Hydraulic Parameters for INCAPP.

H.1.4 Boundary Conditions

Boundary conditions were defined with an atmospheric boundary condition at the surface and free drainage at the bottom of the tailings. The atmospheric boundary condition is defined by a time series of precipitation and PET that represent current climate conditions based on the available 41-year hydrologic record in the area around the Site and root water uptake parametrization consistent with vegetation observed in the field. The free drainage boundary condition selected for the bottom boundary condition is consistent with the depth to water measurements in the area of the tailing impoundments. This assumption is also supported by the higher hydraulic conductivity in the underlaying Quaternary alluvium formation (INTERA, 2021b). The following subsections present in a description of the atmospheric boundary conditions and selected parameters for the root water uptake function.

H.1.4.1 Atmospheric Boundary condition

The atmospheric boundary condition requires a time series of precipitation and potential evaporation, and potential transpiration as well as the specification of the hCritA parameter which indicates the absolute value of the minimum allowed pressure head at the soil surface (Šimůnek et al., 2018). This section explains the development of the daily precipitation and PET used to generate the model input time series based on nearby information. Multiple stations were reviewed to obtain a 41-year continuous precipitation and temperature dataset representative of Site conditions. The following sources were reviewed based on proximity to the Site and/or at the Site (Site Station) as well as elevation: La Sal Station (2351692), 4 miles from Site with a period of record (POR) from 1901 to 1978; La Sal SW 1 (2351697), 3 miles from Site with a POR from 1978 to 2020; Grand Junction (2353104), approximately 144 miles from Site with a POR from 1900 to 2020; Paradox (2353130), approximately 23 miles from Site with POR from 2005 to 2020; 30-year Climate Normals from the PRISM dataset (Daly et al., 2008), and the Site station with a POR from 2016 to 2020 calculated from 5- to 10-minute interval data. These stations contained several to many data gaps due to data not being reported or "trace" value recorded.

As a continuous daily dataset is necessary for input into the HYDRUS models, monthly and annual totals of precipitation and average maximum and minimum temperatures from 2016-2020 were compared across stations to develop a correlation for gap-filling the La Sal SW 1 data. The Paradox station was eliminated from review, being significantly lower in elevation, farther away in location, as well as having a poor correlation between monthly precipitation and temperature with Site precipitation and temperature. The two stations used to obtain complete datasets from 1980 to 2016 were Grand Junction and La Sal SW 1, due to proximity, stronger correlation of monthly data from 2016-2020, and more complete PORs. A correlation between La Sal SW 1 and Site data was also developed to fill gaps existing in the 2016-2020 dataset. The La Sal SW 1 station had approximately 400 empty or blank values, indicating data was not recorded or measured as "trace" in daily precipitation, and approximately 350 dates missing altogether, with some gaps spanning months. The Grand Junction-La Sal SW 1 correlations applied to filling La Sal SW 1 1980-2020 gaps are shown in **Figure H.6**. Additional data gaps (< 10 days) in the 2016-2020 Site weather station data were filled using La Sal SW 1-Site correlations as shown in **Figure H.7**.

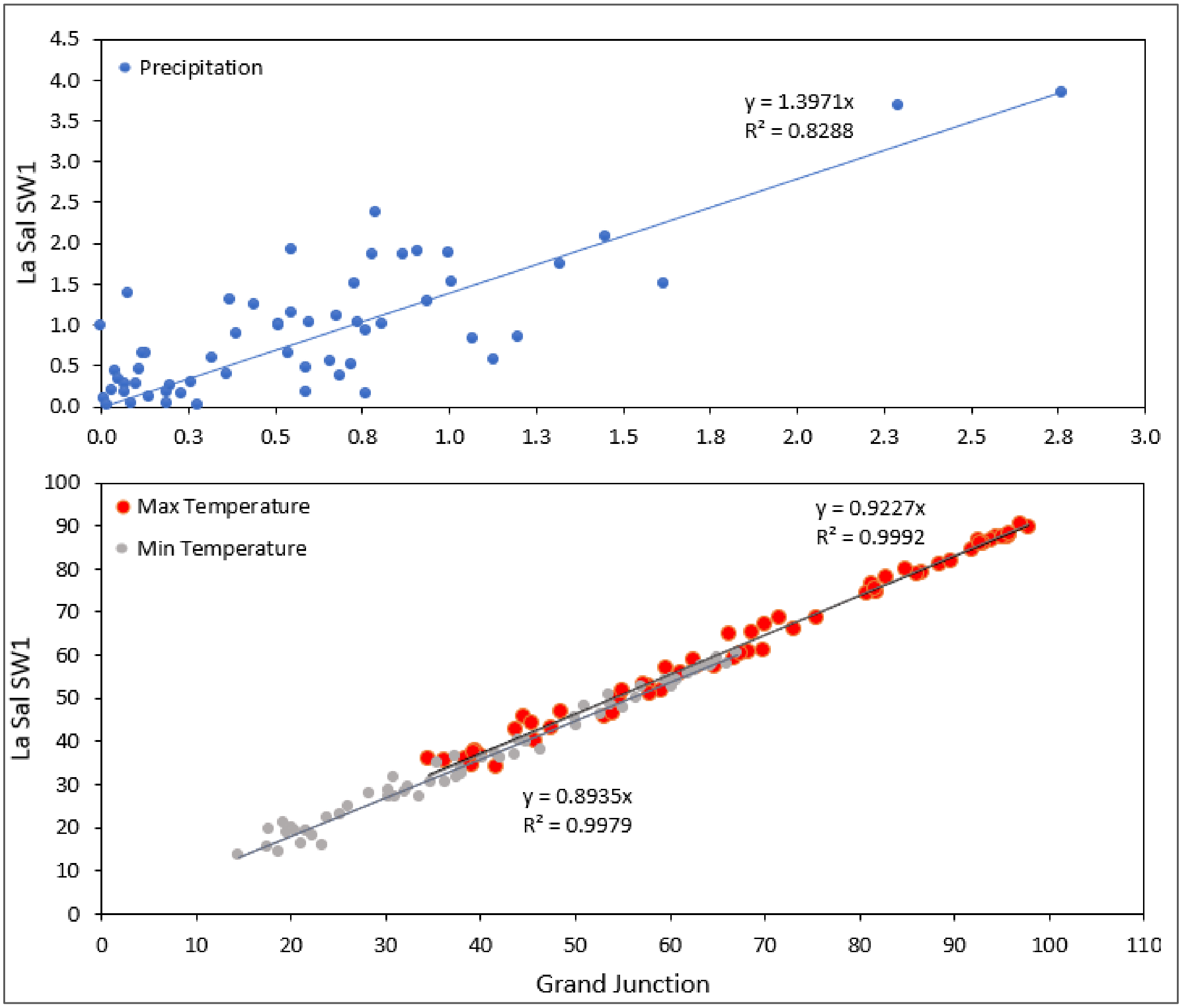


Figure H.6 Linear Correlations of Monthly Grand Junction and La Sal SW1 Precipitation and Temperature Data from 2016 to 2020.

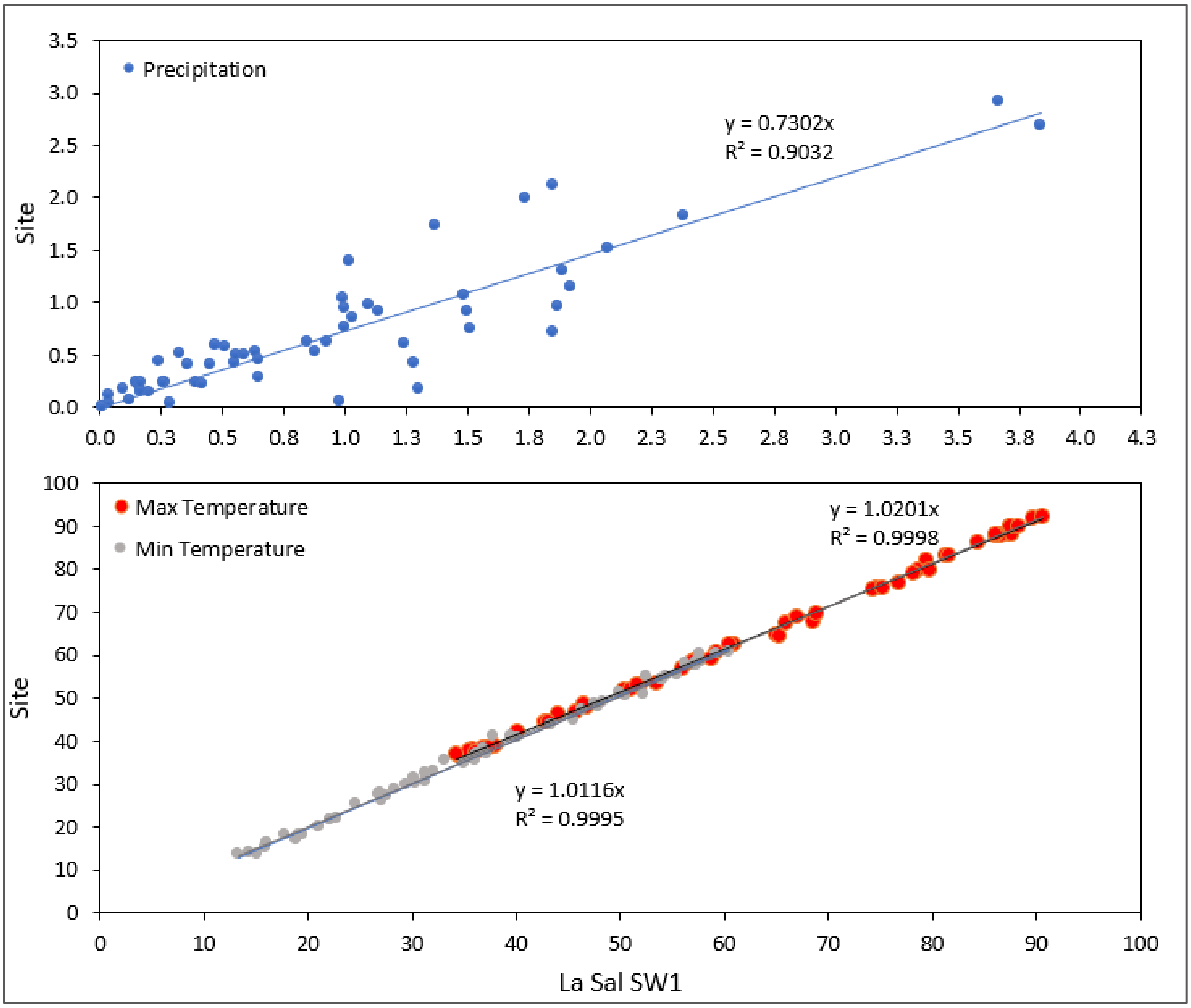


Figure H.7 Linear Correlations of Monthly La Sal SW1 and Site Precipitation and Temperature Data from 2016 to 2020.

To avoid calculating negative values of PET using the Hargreaves formula, raw temperature data was checked to determine whether any days contained a minimum temperature greater than the maximum temperature. If the minimum were greater than the maximum, the appropriate temperature was adjusted so the maximum temperature would be at least 2 degrees higher than the minimum. Finally, the Site weather station data was appended to the La Sal SW 1 gap-filled dataset for the final 41-year dataset as shown in **Figure H.8**.

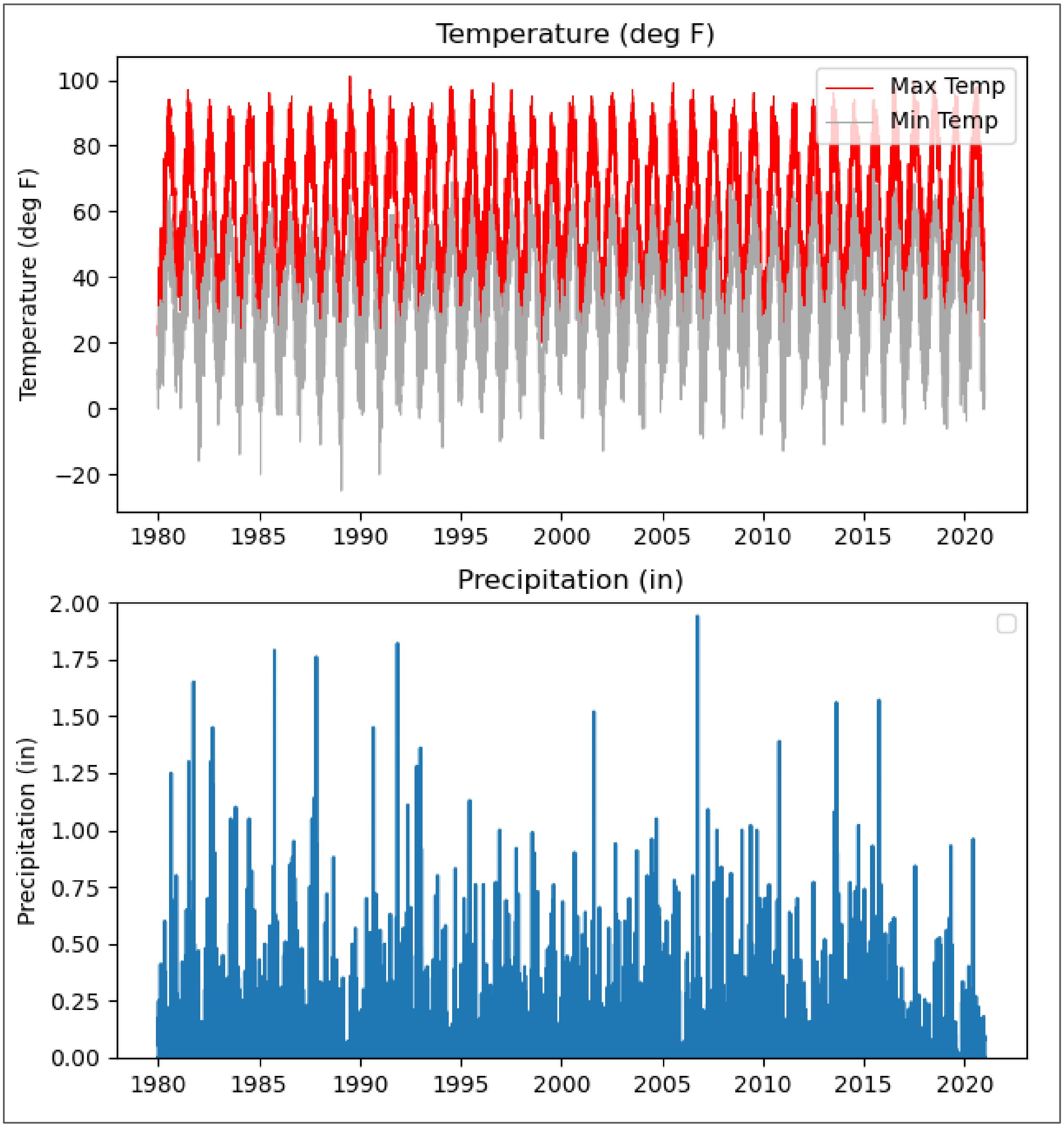


Figure H.8 1980-2020 Final Daily Precipitation and Temperature Timeseries after Gap Filling.

H.1.4.2 Potential Evapotranspiration

Daily PET was calculated in HYDRUS-1D using the Hargreaves equation below with daily maximum and minimum temperatures as input parameters (Šimůnek et al., 2013):

$$ET_p = 0.0023R_a\left(T_m + 17.8\right)\sqrt{TR}$$

R_a is the extraterrestrial radiation [mm/d], Tm is the daily mean air temperature [C], and TR is the temperature range between the mean daily maximum and minimum air temperatures [C] (Šimůnek et al., 2013). PET was then partitioned into potential transpiration (Tp) and potential evaporation (Ep) using the Beer-Lambert Law based on LAI for HYDRUS 2D/3D:

$$Tp = PET(1 - e^{(-r*LAI)})$$

$$Ep = PET(e^{(-r*LAI)})$$

where r is an extinction depth of 0.5 based on literature values and LAI included several estimates based on vegetation transects at the Site, literature values, and default values used in HELP simulations (Section 3.2.3).

A 4-year model was constructed for the purpose of sensitivity testing and calibrating the shallow root and soil properties. The 4-year model inputs consisted of the Site weather station precipitation and temperature from January 1, 2017, to December 31, 2020, providing four full years of data. The average precipitation across this time period is 7.85 in/yr with potential evaporation at 8.21 in/yr and potential transpiration at 39.04 in/yr (**Figure H.9**).

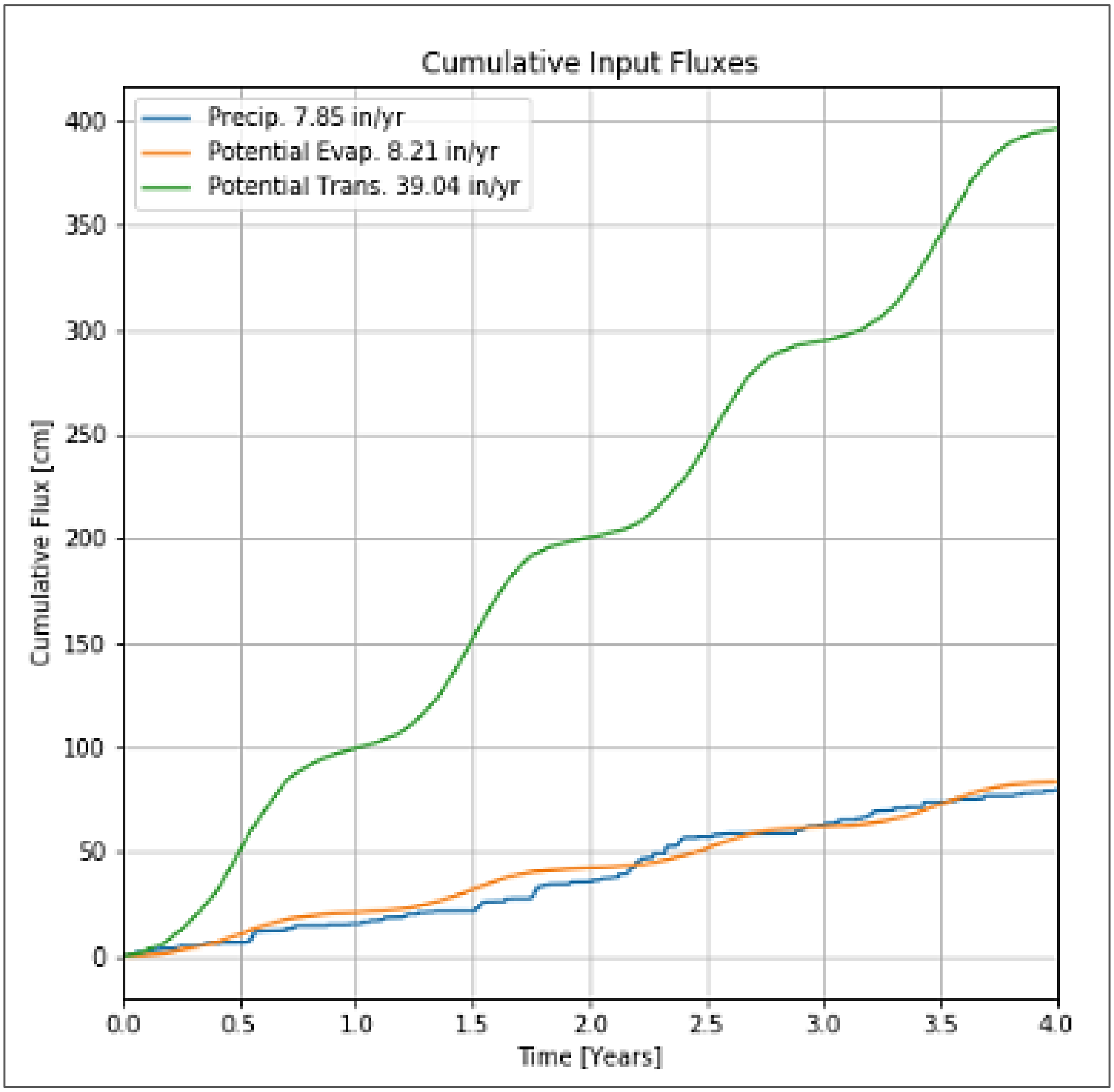


Figure H.9 Summary of Precipitation and Potential Atmospheric Fluxes in 4-year Model (2017-2020).

A 41-year model was built using the long-term precipitation and temperature timeseries and was cycled six times for flow through the soil column to reach pseudo-steady state. The 41-year model was constructed with the gap-filled 41-year timeseries mentioned earlier from January 1, 1980, to December 31, 2020. The average precipitation across the longer POR was approximately 40% higher than measured on-site at 13.16 in/yr with average potential evaporation of 7.83 in/yr and average potential transpiration 37.23 in/yr (**Figure H.10**). The 30-year normal from the PRISM data, being a gridded spatial dataset that combines available precipitation stations and terrain elevations, compared well in terms of average precipitation around the Site (13.15 in/yr) and showed the chosen value represent the conditions of the Lisbon Valley (**Figure H.11**).

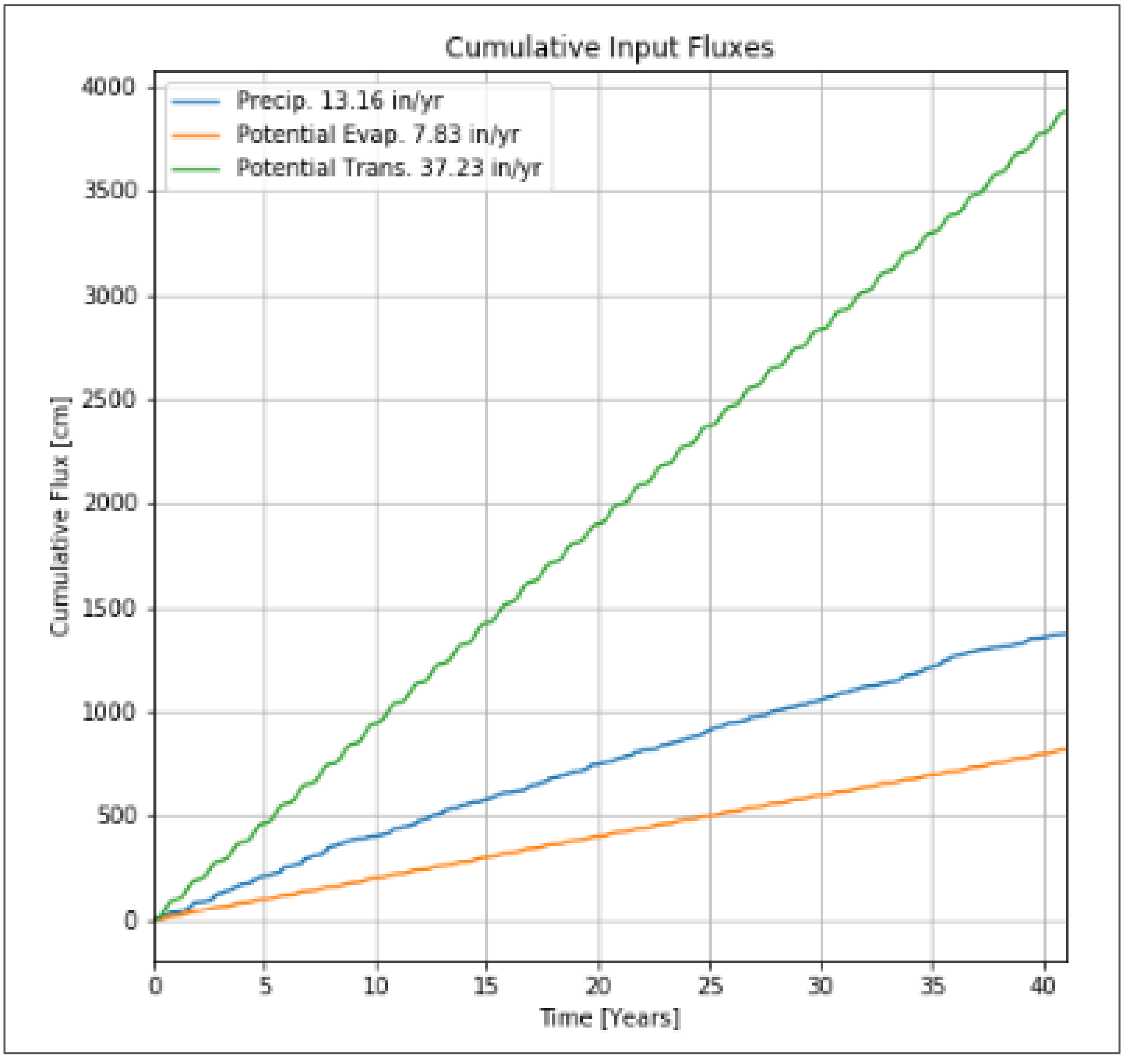


Figure H.10 Summary of Precipitation and Potential Atmospheric Fluxes in 41-year Model (1980-2020).

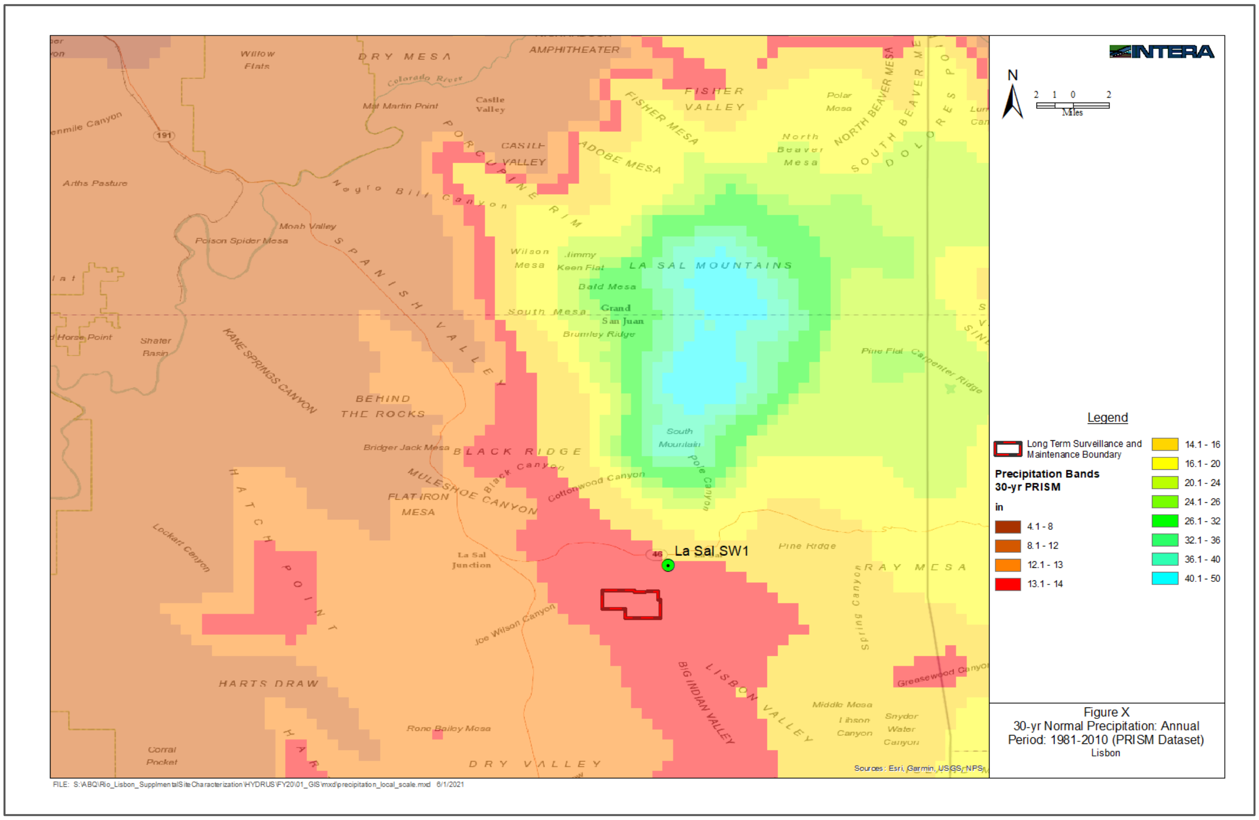


Figure H.11 30-year Normal Precipitation (1981-20210) Around the Lisbon Site.

H.1.4.3 Root Water Uptake

Root water uptake without compensation was selected to represent sink term, S, according to formulations described in Šimůnek et al. (2018). This parameterization requires the specification of the water uptake stress function and the spatial root distribution function. The S-Shaped water uptake reduction model suggested by van Genuchten (1987) with a critical stress of 1 was chosen to represent the tailings vegetation, predominantly rubber rabbitbrush and desert grasses. The S-Shaped reduction model uses the following parameters: P50 [cm] value of the pressure head at which the root water uptake is reduced by 50%.; P3 [-]: exponent p in the S-shaped root water uptake stress response function with the HYDRUS default value of 3; PW [cm]: Wilting point, i.e., the pressure head below which the root water uptake ceases (Šimůnek et al., 2018).

As an approximation of P50 [cm], laboratory water retention curves were used to determine at which pressure head, water content was reduced by nearly half (INTERA**,** 2018). The water content at this reduced pressure was then correlated with a pressure head using the LTB-02 6-12" water retention curves of approximately -5000 [cm]. This was further supported by comparing the equivalent water reduction parameters for grasses, alfalfa, and grapes from default parameters contained in the Feddes water reduction model providing bounding P50 values of 4,400 and 12,500

[cm]. P3 was kept as the HYDRUS default value of 3. The permanent wilting point below which transpiration ceases was taken from the literature value of -15 [bar] equivalent to approximately to -15,300 [cm] (Radcliffe and Simunek, 2018).

Root distributions were defined using the non-linear function proposed by Vrugt et al. (2001ab). Root distribution parameters were varied to reflect the LT-TP-2 test pit logs with maximum rooting depth varied from 18 to 36 in with depth of maximum intensity ranging from to 3 to 6 in root water uptake decreasing from 1 to 0, as well as remaining uniform across the root zone (**Appendix B).** Root distribution parameters were varied to reflect the UT-TP-2 test pit logs with maximum rooting depth varied from 8 to 18 in with depth of maximum intensity of 6 in and root water uptake decreasing from 1 to 0, as well as remaining uniform across the root zone (**Appendix B**). As roots are not present in the gravel layer, additional models with roots starting below the 3 in of surface gravel also better represent behavior of root water uptake.

H.1.5 Initial Conditions

H.1.5.1 Moisture content data profiles

Models were run using 4-year atmospheric dataset and a 41-year atmospheric dataset cycled 6 times with initial conditions similar to 2016 conditions. Initial conditions were set for both the OUTCAPP and INCAPP as a linearly decreasing head from -25 cm at the top of the column to -1 cm at the bottom of the column corresponding to the profile increasing in moisture gradually to the bottom of the tailings. The initial conditions were comparable to the 2016 volumetric water content measurements collected along the profiles, shown in **Figure H.12** and **Figure H.13** for OUTCAPP (circle markers) and INCAPP (diamond markers) models, respectively. These figures also include modeled moisture content at an annual time step using a color scale, with color guides at 0, 123, and 246 years. The range of the daily SMS data collected from 2019-2020 is also indicated on each figure at the corresponding depth. Overall, the models show a decreasing moisture trend over time, especially in deeper sections of the column, as the cover inhibits infiltration beyond the root zone and the tailings dry out. The range of simulated soil moisture is comparable with SMS data at the OUTCAPP with increasing values for the three shallowest sensors and lower range for the fourth sensor. In contrast, SMS data at the INCAPP is clearly out of range, with some values higher than porosity, due to issues with the calibration of the SMS sensor. No attempt was made at matching the exact measured soil moisture values as some discrepancy between the soil moisture measurements and average hydraulic properties parametrization is expected due to measurement error and small discrepancies between the van Genuchten hydraulic model and measured values. The selected initial conditions for both INCAPP and OUTCAPP represent conditions near saturation consistent with most of the water content measurements, while providing numerical stability for the simulations.

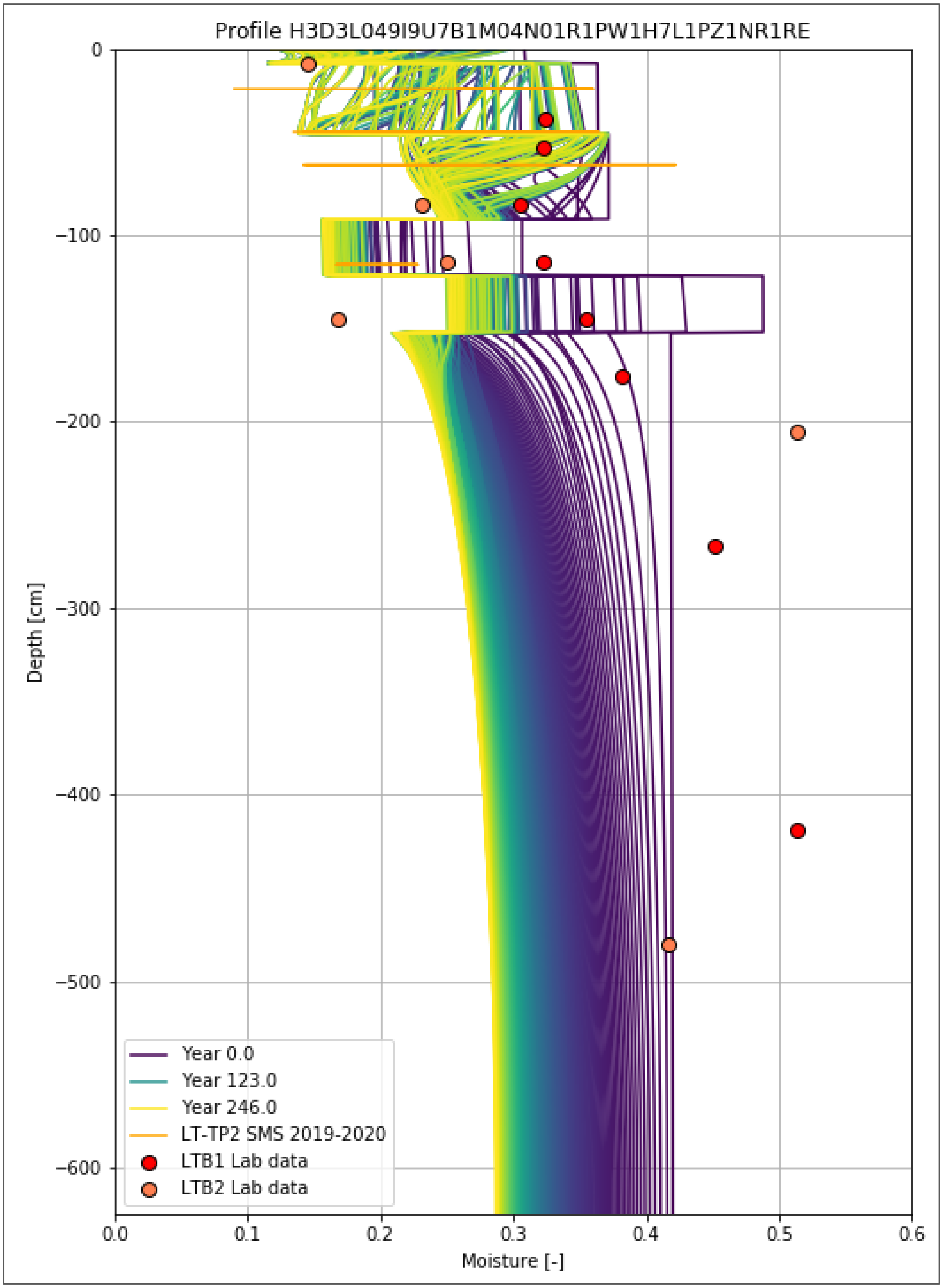


Figure H.12 Example of Moisture Content Varying with Profile over Depth and Time at OUTCAPP.

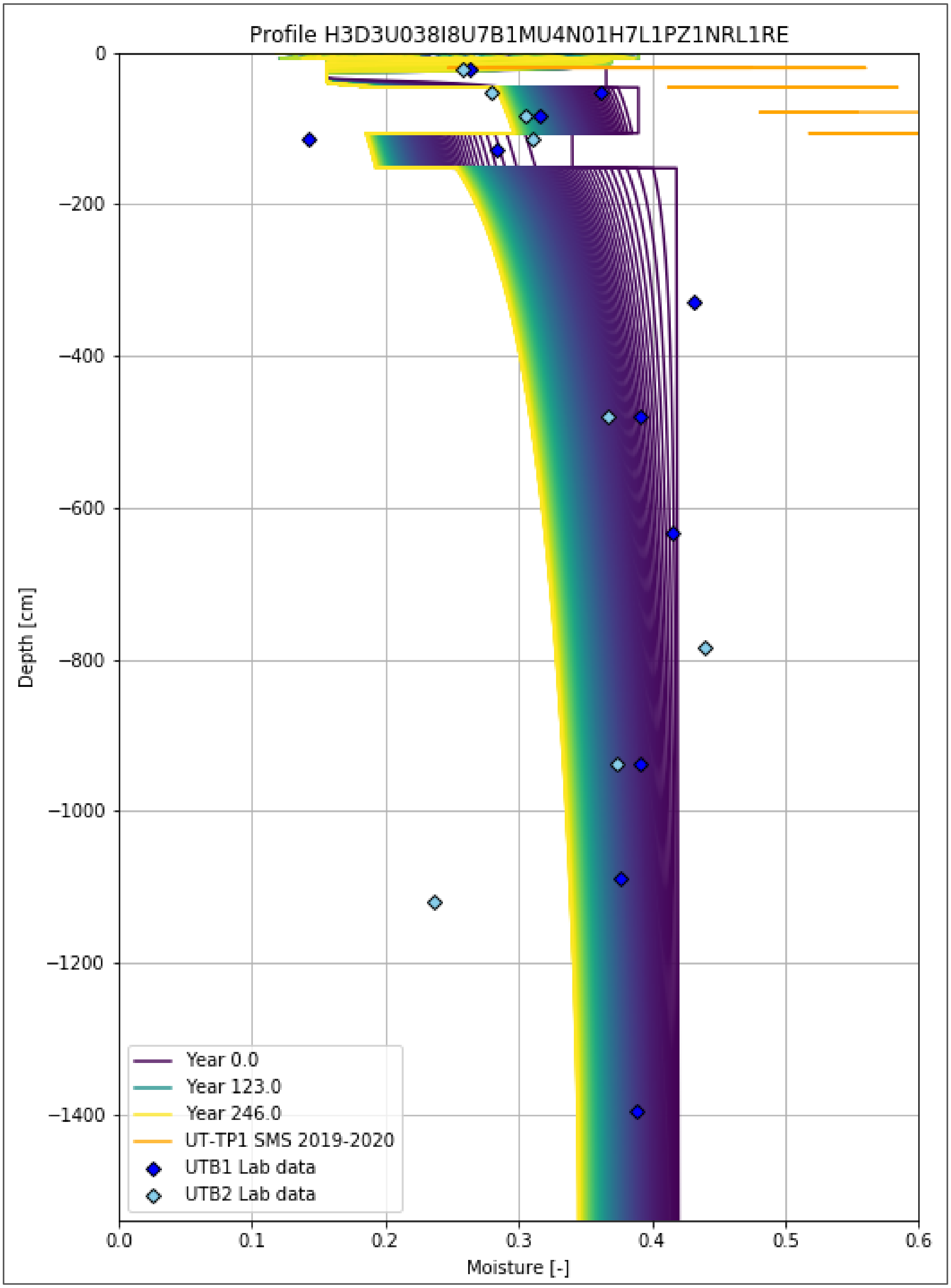


Figure H.13 Examples of Moisture Content Varying with Profile over Depth and Time at INCAPP.

APPENDIX I
HYDRUS Modeling Results

Appendix I
HYDRUS Modeling Results

CONTENTS

LIST OF FIGURES

LIST OF TABLES

I.1 HYDRUS Model

The HYDRUS models presented in this appendix were tested under a wide range of parameters and conditions using multiple iterations of finite element (FE) mesh discretization. One of the main limitations was the high contrast between hydraulic properties and the need of representing the atmospheric boundary condition at a daily time step, which requires very fine mesh discretization and long simulation times, respectively. Given the numerical stability limitations to solve the Richards equations under a wide range of conditions using HYDRUS 2D/3D, infiltration modeling presented in this appendix was done to represent a baseline condition using current climate and materials that can be compared against the more flexible modeling approach provided in the Hydrologic Evaluation of Landfill Performance (HELP) model. This appendix presents an evaluation of the 4-year models using available soil moisture sensor (SMS) data, the reasoning and methods used to evaluate pseudo steady-state fluxes at the bottom of the cover and tailings, a sensitivity analysis on the atmospheric boundary parameters, and a summary of the baseline simulations.

I.1.1 Model Evaluation Using Site Soil Moisture Sensor Data

The models were evaluated using several diagnostics, including the comparison of cover material response with and without roots to SMS data collected in 2019 and 2020 at LT-TP2 and UT-TP1, as well as feasibility of the water balance (infiltration versus evapotranspiration). The 4-year models were used to evaluate the top cover response to atmospheric conditions. Model estimates are not expected to match observations, as the HYDRUS models represent a simplification of the conditions using a one-dimesioal approach, and the SMS sensors were placed to obtain a relative response between cover layers rather than absolute values that can be compared against model results. History matching of the SMS data was not considered as the observations are based on a correlation between electrical conductivity and moisture content that requires calibration for each model layer. The initial conditions were based on moisture conditions observed during the 2016 investigation (INTERA, 2017) with a 3-year initialization period to avoid effects caused by discrepancies in the initial conditions. HYDRUS 2D/3D observation nodes were included in the OUTCAPP profile (described in detail in Section 6.2) coinciding with the SMS depths installed in LT-TP-2 at 8.5, 17.5, 24.5 and 45.5 inches. Water content was extracted at daily time step between November 2019 and June 2020 to be compared against the daily averages obtained from the SMS data. A visual comparison of soil moisture content observed in field data with soil moisture content calculated in the OUTCAPP model with roots between 3 and 36 inches can be seen in **Figure I.1**. Precipitation time series were included at the top of each column to aid evaluation of the moisture response of the model to precipitation pulses. The model captures important features in the observations such as the decreasing soil moisture variability with depth, response to precipitation pulses, and overall seasonal increases of moisture during the winter period. For this assessment, it was assumed that the effect of snow storage and melt during the winter are secondary compared to the effect of high potential evapotranspiration and the infiltration capacity of the soil. Model testing considering all the reported precipitation as liquid rain did not show significant amounts of runoff during the winter period that would suggest the need of a method to model snow accumulation and melt based on precipitation and temperature.

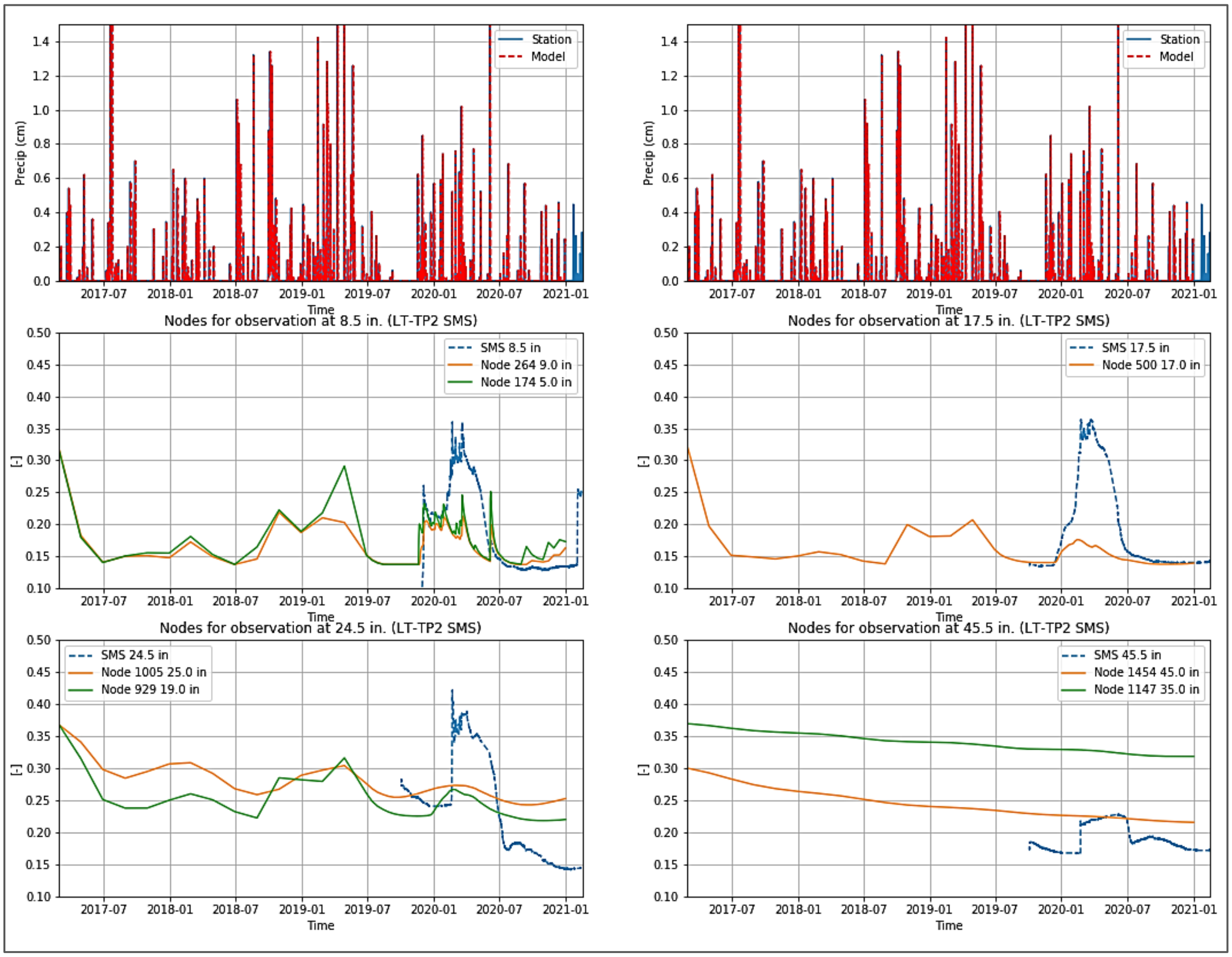


Figure I.1 Comparison of Model Soil Moisture Content with Field Observations at LT-TP-2.

Observation nodes were included in the INCAPP profile coinciding with the SMS depths installed in UT-TP1. A visual comparison of soil moisture content observed in the field with soil moisture content calculated in the INCAPP model without vegetation can be seen in **Figure I.2**. The conditions in the INCAPP model are much wetter than in the OUTCAPP model due to higher clay content in the model layers and less evapotranspiration. SMS data at UT-TP1 was not useful for evaluation as the moisture content out of the typical range and much higher than porosity. These high SMS readings indicate highly saturated conditions and the need for additional calibration of the sensor due to the soil chemistry induced by the evaporative cell operations.

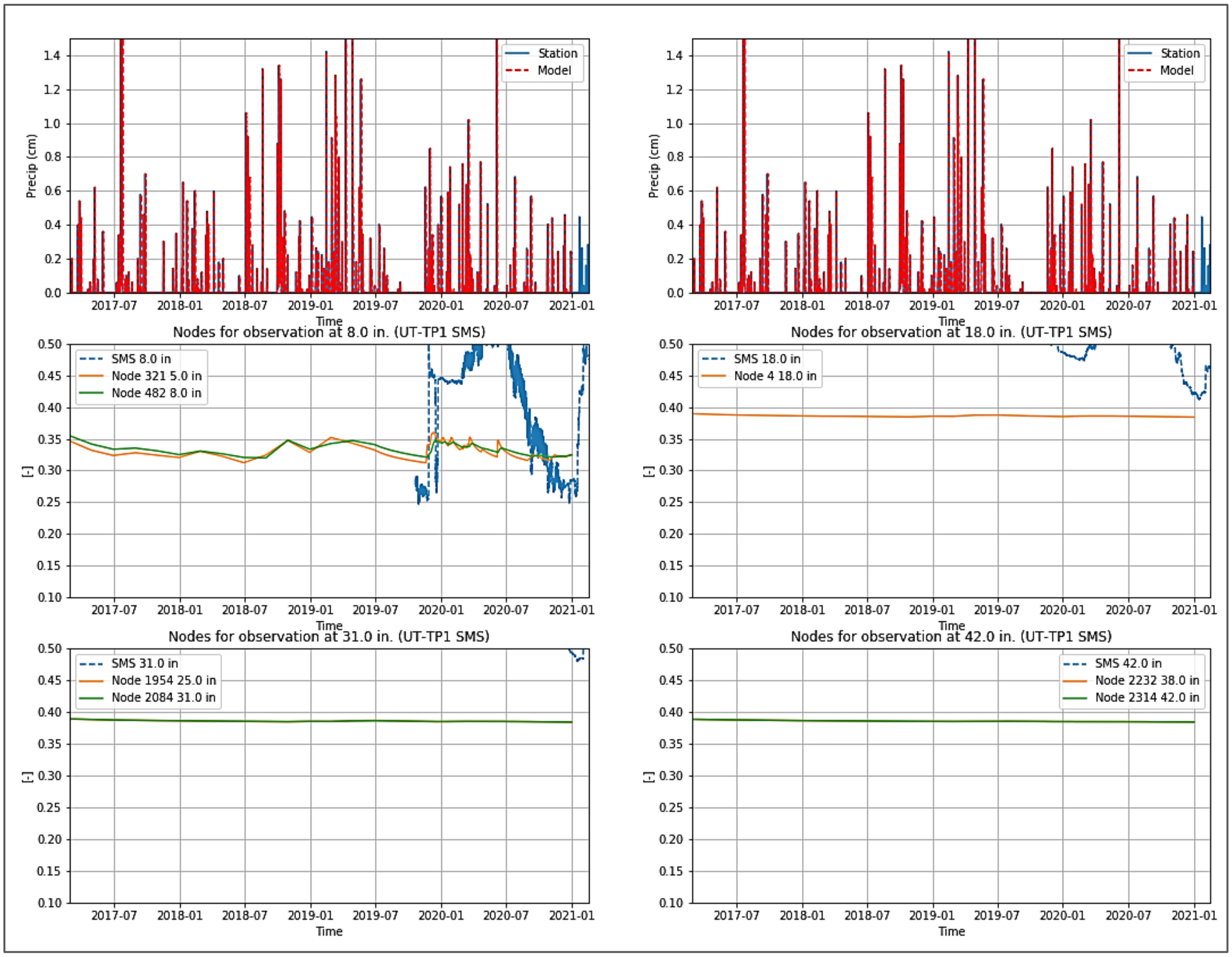


Figure I.2 Comparison of Model Soil Moisture Content with Field Observations at UT-TP-1.

I.1.2 Pseudo Steady-State Fluxes at the Bottom of Cover and Tailings

Current climate conditions are based on a 41-year record and model parametrization presented in **Appendix H.** Given the relatively shorth length of the time series available when compared to the average travel time though the model, a synthetic time series was developed by cycling the 41-year record until pseudo steady-state conditions were reached. Model fluxes were exported from a vertical HYDRUS 2D/3D cross section defined along the center line of the domain and from the output files summarizing the free drainage boundary cumulative flux. In general, models with relatively wet conditions and downward flux in the root zone reach pseudo steady state faster than models with upward flux in the root zone as the associated low hydraulic conductivity induces a much lower flux that takes longer to equilibrate. Pseudo steady-state conditions were evaluated by visualizing fluxes at the top and bottom of the tailings and identifying the number of cycles required for infiltration to fluctuate in a regular fashion or reach a condition where fluxes are only expected to decrease very slowly as K continues to decrease given reductions in θ. After evaluation of the infiltration fluxes for pseudo steady-state conditions in OUTCAPP and INCAPP models, simulations with six (6) cycles of climate (246 years) were selected to obtain average fluxes using the last two (2) cycles as they provided an acceptable compromise between model runtime and pseudo steady-state conditions for most of the scenarios.

Figures I.3 and **I.4** summarize fluxes for the OUTCAPP 18-inch root baseline and INCAPP baseline model without vegetation, respectively. These figures include fluxes at the bottom of the cover and tailings (top subplot) and the cumulative free drainage boundary conditions (bottom subplot). Average fluxes for the last two (2) cycles of climate are indicated by an horizonal line and included in the legends. Cumulative free drainage flux is slightly higher than the average bottom tailings flux as these values include the effect of the initial conditions. Pseudo steady-state conditions can be reached more easily when the net flow across the column is downward; for the OUTCAPP 18-inch root baseline model, the atmospheric boundary condition imposes a net upward flux that results in a very slow drainage of the soil column with average fluxes that differ by half order of magnitude after 246 years (5.29E-09 centimeters per second [cm/s] versus 1.12E-09 cm/s). In the case of the INCAPP, with a net downward flux, the average flux rates for the bottom of the cover and tailings are much closer in value (2.21E-08 cm/s versus 2.46 E-08 cm/s). In this case the small numerical differences are due to small asymmetries in the FE mesh and the averaging of the results. Given the small differences in the top and bottom fluxes, average percolation at the top and bottom of each tailings layer was used for analysis.

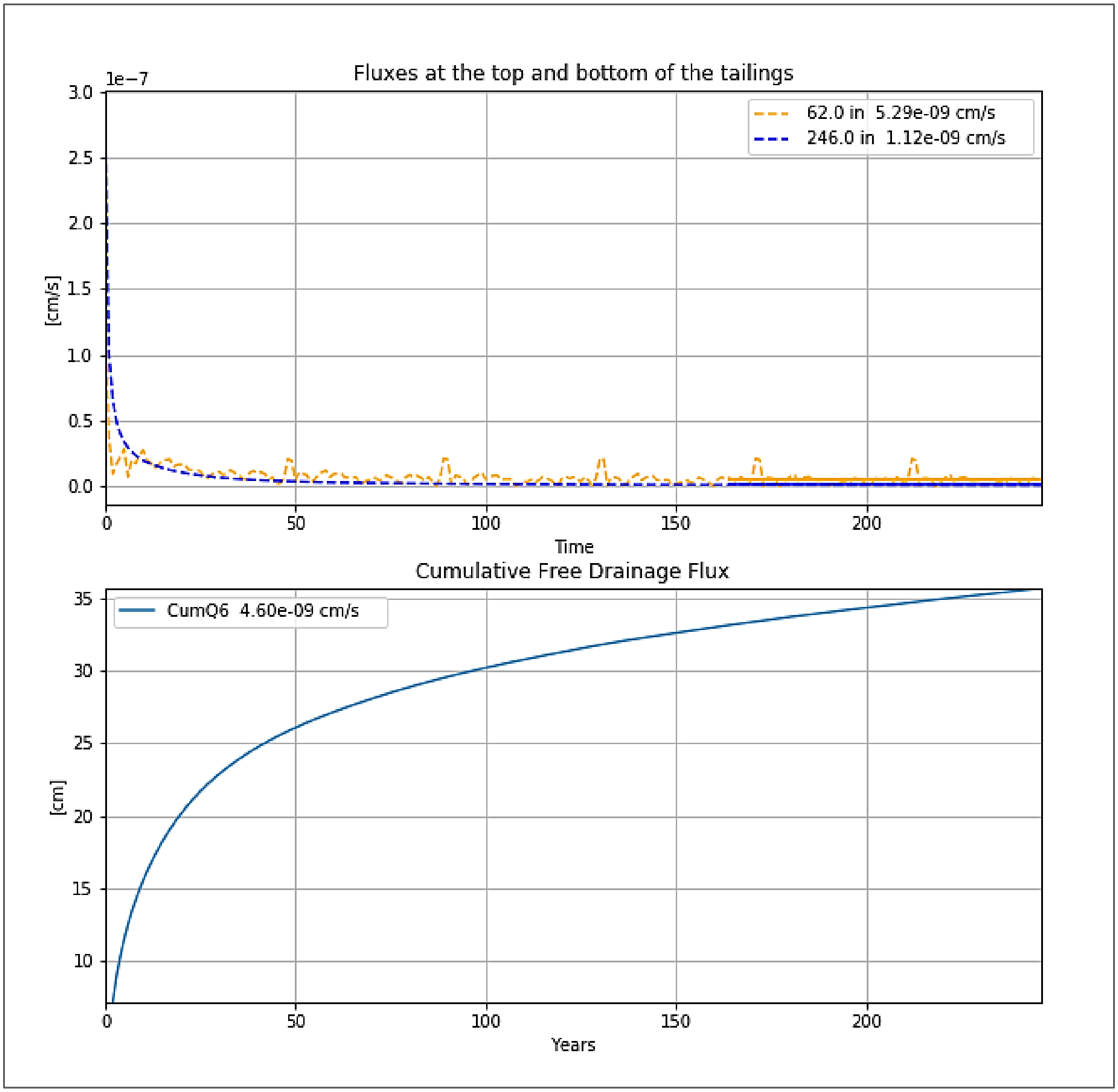


Figure I.3 Fluxes at the Top and Bottom of the Tailings at OUTCAPP 18-inch Root Baseline Model.

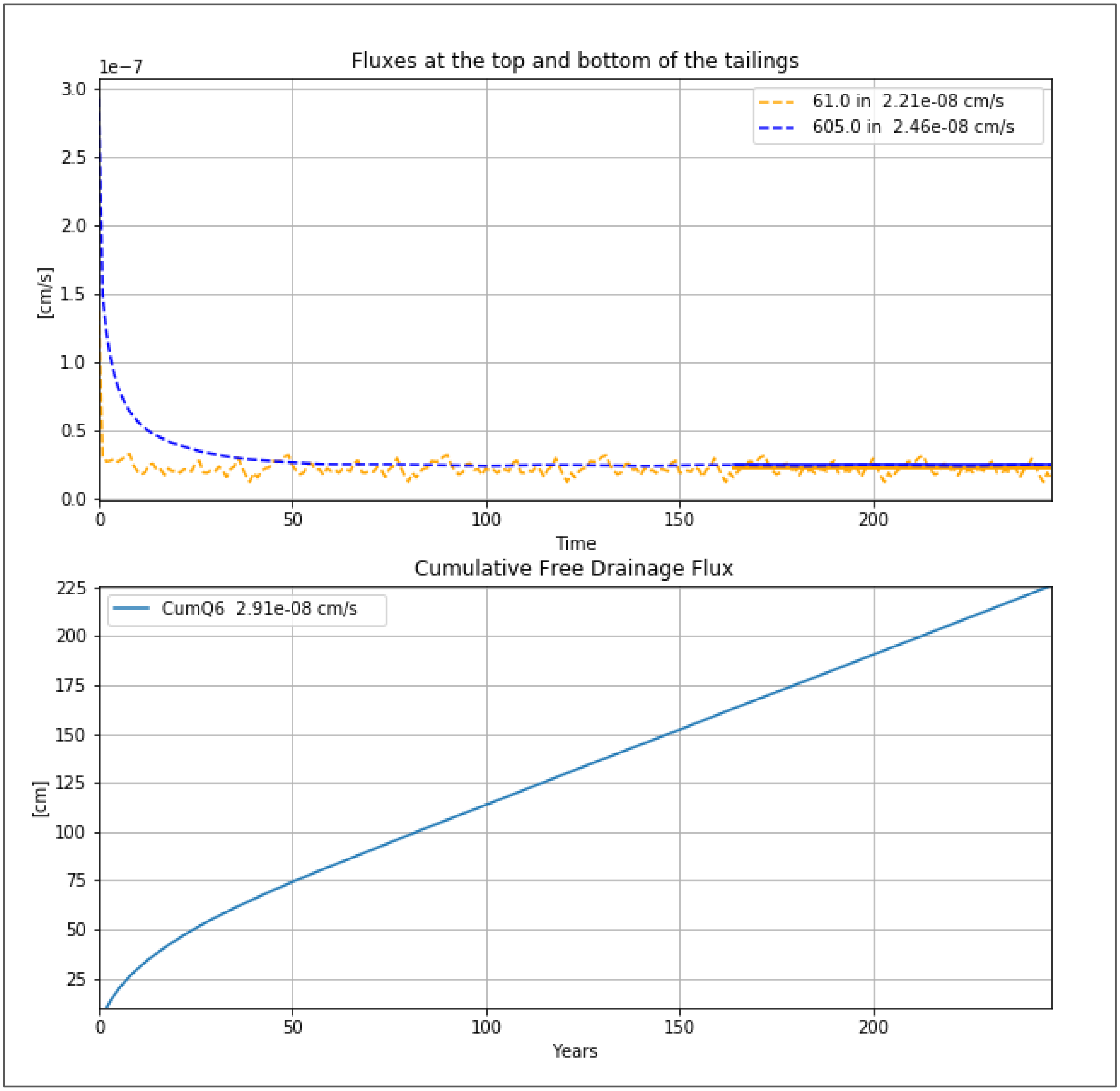


Figure I.4 Fluxes at the Top and Bottom of the Tailings at INCAPP Baseline Model without Vegetation.

I.1.3 Sensitivity Analysis

A one-at-a-time sensitivity analysis was done to evaluate the parameterization of the atmospheric boundary condition as it was shown to control the overall fluxes at the bottom of the cover and tailings. Variables affecting the atmospheric boundary are more uncertain due to the inability of directly measuring these parameters from laboratory or field data and their impact on numerical convergence. Leaf Area Index (LAI), root water uptake (root geometry and parametrization), hCritA, and P50 were tested over a range of conditions to determine how significant the variation of these parameters could affect final percolation rates. The primary method for evaluating the differences between the sensitivity models was a comparison of the net atmospheric flux (difference between infiltration and evapotranspiration), percolation rates leaving the cover, and percolation rates leaving the tailings after 246 years.

I.1.3.1 Leaf Area Index (LAI)

To represent the more abundant vegetative state of the lower tailings, greater LAI values of 0 and 1 were tested. Models with no vegetation (LAI equal to 0) had the largest fluxes at the bottom of the cover and tailings. In general, models with higher LAI resulted in slightly less average percolation rates, as most of the scenarios with vegetation show combined transpiration and evaporation surpassing infiltration and resulting in dry conditions at the top of the soil columns with a net upward atmospheric flux. In these cases, the downward flux throughout the bottom of the cover and tailings is driven by gravity and the initial water content with a very slow drainage as the tailings become drier and the hydraulic conductivity decreases. **Table I.1.** summarizes the results of the LAI sensitivity testing showing larger LAI resulting in lower percolation rates.

Table I.1 Average Percolation Rates (in/yr) with Changing Leaf Area Index.

<table>
<tr><th colspan="3">Percolation Rates (in/yr) with Changing LAI (0 and 1)</th></tr>
<tr><td>Model</td><td>1</td><td>0</td></tr>
<tr><td>INCAPP 18-inch Roots; 6-inch Max intensity with no roots in gravel layer</td><td>0.041</td><td rowspan="2">0.291</td></tr>
<tr><td>INCAPP 8-inch Roots; 6-inch Max intensity with no roots in gravel layer</td><td>0.035</td></tr>
<tr><td>OUTCAPP 36-inch Roots; 6-inch Max intensity with no roots in gravel layer</td><td>0.017</td><td>0.593</td></tr>
</table>

I.1.3.2 Root Water Uptake (RWU)

Root water uptake was varied by changing the maximum rooting depth and intensity, using both uniform and decreasing root water uptake reduction, and removing roots from the top gravel layer. Roots in OUTCAPP varied from 36 inches to 18 inches with maximum root intensity from 18 inches to 6 inches. Roots in INCAPP varied from 18 inches to 8 inches with maximum root intensity at 6 inches. Root distribution functions following the parametrization by Vrugt et al. (2001ab) and associated with these varied root configurations can be seen in **Figure I.5**. To determine the greatest amount of percolation possible at OUTCAPP and INCAPP, simulations were run without vegetation. **Table I.2** summarizes the results of the root water uptake sensitivity testing showing less percolation with uniform and decreasing root water uptake. In general, increasing maximum rooting intensity lowered percolation rates; however, the impact was not substantial. To further evaluate the performance of the roots in the system, a net atmospheric flux defined as the difference between cumulative evapotranspiration (positive values) and cumulative infiltration (negative values) fluxes, was estimated for each of the models. Most root configurations caused a net atmospheric upward flux with rooting absent in the gravel layer configuration providing a more reasonable balance between infiltration and evapotranspiration (values closer to zero) and uniform root water uptake and decreasing root water uptake configurations resulting in very high net upward atmospheric flux, as shown by **Table I.3.** A net downward flux using roots (negative net atmospheric flux) was only obtained for the INCAPP with maximum depth at 8 inches and maximum intensity at 6 inches.

Table I.2 Average Percolation Rates (in/yr) with Changing Root Water Uptake Configuration.

Percolation Rates (in/yr) with Changing RWU Configuration				
Model	Uniform RWU	Decreasing RWU	No Roots in Gravel[1]	No Roots
INCAPP 18-inch Roots; 6-inch Max Intensity	0.047	0.053	0.041	0.291
INCAPP 8-inch Roots; 6-inch Max Intensity	--	0.047	0.035	
OUTCAPP 36-inch Roots; 6-inch Max Intensity	0.017	0.020	0.017	0.593
OUTCAPP 36-inch Roots; 18-inch Max Intensity	0.017	0.018	0.016	
OUTCAPP 18-inch Roots; 6-inch Max Intensity	--	0.048	0.040	

[1.] Decreasing RWU below gravel layer
-- Not tested
RWU = root water uptake

Table I.3 Net Atmospheric Flux (in/yr) with Changing Root Water Uptake Configuration.

Net Atmospheric Flux (in/yr) with Changing RWU Configuration				
Model	Uniform RWU	Decreasing RWU	No Roots in Gravel[1]	No Roots[2]
INCAPP 18-inch Roots; 6-inch Max Intensity	10.860	13.440	0.060	-0.300
INCAPP 8-inch Roots; 6-inch Max Intensity	--	16.150	-0.020	
OUTCAPP 36-inch Roots; 6-inch Max Intensity	8.340	12.260	0.060	-0.550
OUTCAPP 18-inch Roots; 6-inch Max Intensity	--	15.510	0.020	

1. Decreasing RWU below gravel layer
2. Negative values (-) indicate net infiltration into the system
-- Not tested
RWU = root water uptake

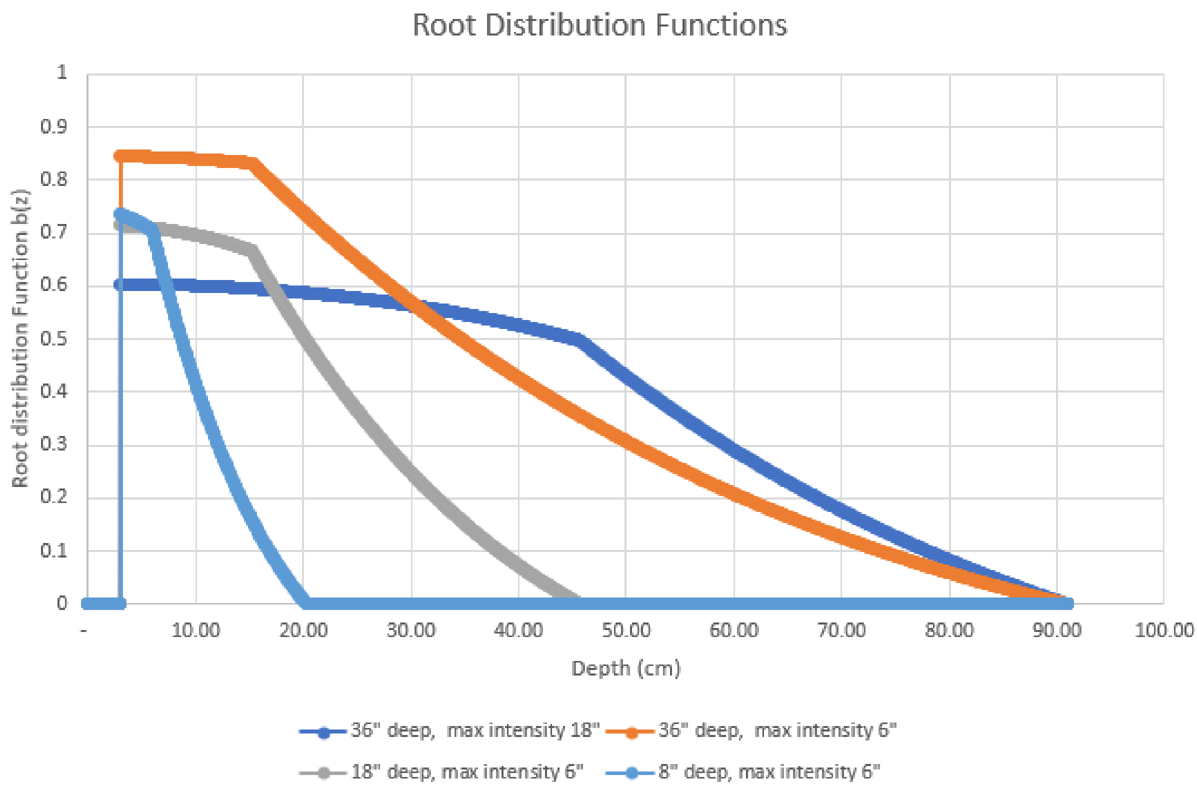


Figure I.5 Associated Root Distribution Functions used to Describe Root Water Uptake for Varied Root Configurations.

I.1.3.3 hCritA

The parameter hCritA is applied to the atmospheric boundary as the minimum allowed pressure head at the soil surface. For fine soils, this value is usually selected based on the Kelvin equation using average relative humidity and temperature for the Site. In this case, this calculation resulted in a very small value below the equivalent residual water content of the coarse materials tested to represent the upper coarse gravel layer. Consequently, a range of values between 500 cm and 10,000 cm was evaluated. hCritA did not have a significant impact on final percolation rates at OUTCAPP with no roots included in the gravel as shown in **Figure I.6**. Varying hCritA for INCAPP models did not have a significant impact on the final percolation rates at INCAPP with no roots included in the gravel, as shown in **Figure I.6**. For the INCAPP model with no vegetation, increasing hCritA decreased the bottom percolation rates slightly. **Table I.4.** summarizes the results of the hCritA sensitivity testing.

Although not having a large impact on final percolation rates, hCritA did have an impact on the net atmospheric flux with lower hCritA values resulting in unreasonably high upward fluxes (cumulative evapotranspiration considerably higher than cumulative infiltration), as shown in

Table I.5. The hCritA value of 5250 cm was selected for the baseline simulations as it was found to avoid numerical instabilities and provide a reasonable net atmospheric flux.

Table I.4 Average Percolation Rates (in/yr) with Changing hCritA.

Percolation Rates (in/yr) with hCritA				
Model	10,000	5,250	1,000	500
INCAPP No Roots	0.289	0.291	0.294	0.303
INCAPP 18" Roots; No roots in gravel	0.041	0.041	0.042	0.032
OUTCAPP 36" Roots; No roots in gravel	0.017	0.017	0.017	0.018

-- Not applicable to conceptual model

Table I.5 Net Atmospheric Flux (in/yr) with Changing hCritA.

Net Atmospheric (in/yr) with hCritA				
Model	10,000	5,250	1,000	500
INCAPP No Roots	-0.300	-0.300	-0.310	-0.320
INCAPP 18" Roots; No roots in gravel	0.050	0.060	1.440	8.100
OUTCAPP 36" Roots; No roots in gravel	0.060	0.060	2.270	10.850

1. Negative values (-) indicate net infiltration into the system
-- Not applicable to conceptual model

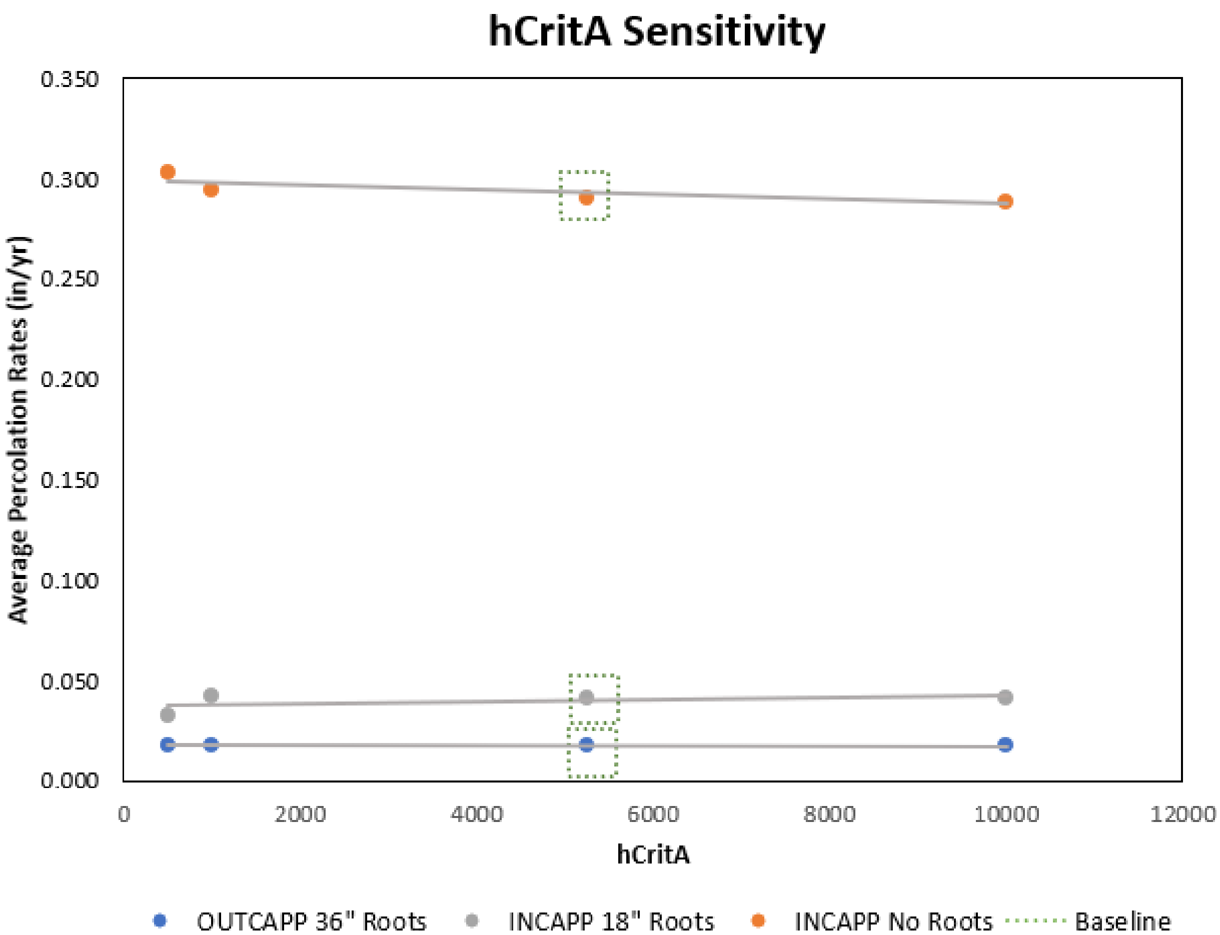


Figure I.6 Average Percolation Rates Resulting from Varied hCritA for Both INCAPP and OUTCAPP.

I.1.3.4 P50

The parameter P50 is used to define the root water uptake reduction curve and is the pressure head at which root water uptake is reduced by 50%. P50 was varied from 4,400 cm; 5,000 cm; and 10,000 cm at OUTCAPP based on a range of values derived from reference vegetation using the Feddes water reduction model. **Table I.6.** summarizes the results of the P50 sensitivity testing. P50 did not appear to have a significant impact on the water balance or fluxes at OUTCAPP for 36" roots with no roots included in the gravel as shown in **Figure I.7**. Generally, increasing P50 in OUTCAPP resulted in lower average tailings fluxes.

P50 was varied from 4,400 cm; 5,000 cm; and 12,500 cm at INCAPP. P50 did not appear to have a significant impact on the water balance or fluxes at INCAPP with 18-inch roots with no roots included in the gravel as shown in **Figure I.7**. Increasing P50 resulted in higher average percolation rates. P50 equal to value of 5,000 cm was selected for the baseline simulations in both models to represent an intermediate value.

Table I.6 Average Percolation Rates (in/yr) with Changing P50.

Percolation Rates (in/yr) with P50				
Model	12,500	10,000	5,000	4,400
INCAPP 18" Roots; No roots in gravel	0.042	--	0.041	0.041
OUTCAPP 36" Roots; No roots in gravel	--	0.016	0.017	0.018

-- Not applicable to conceptual model

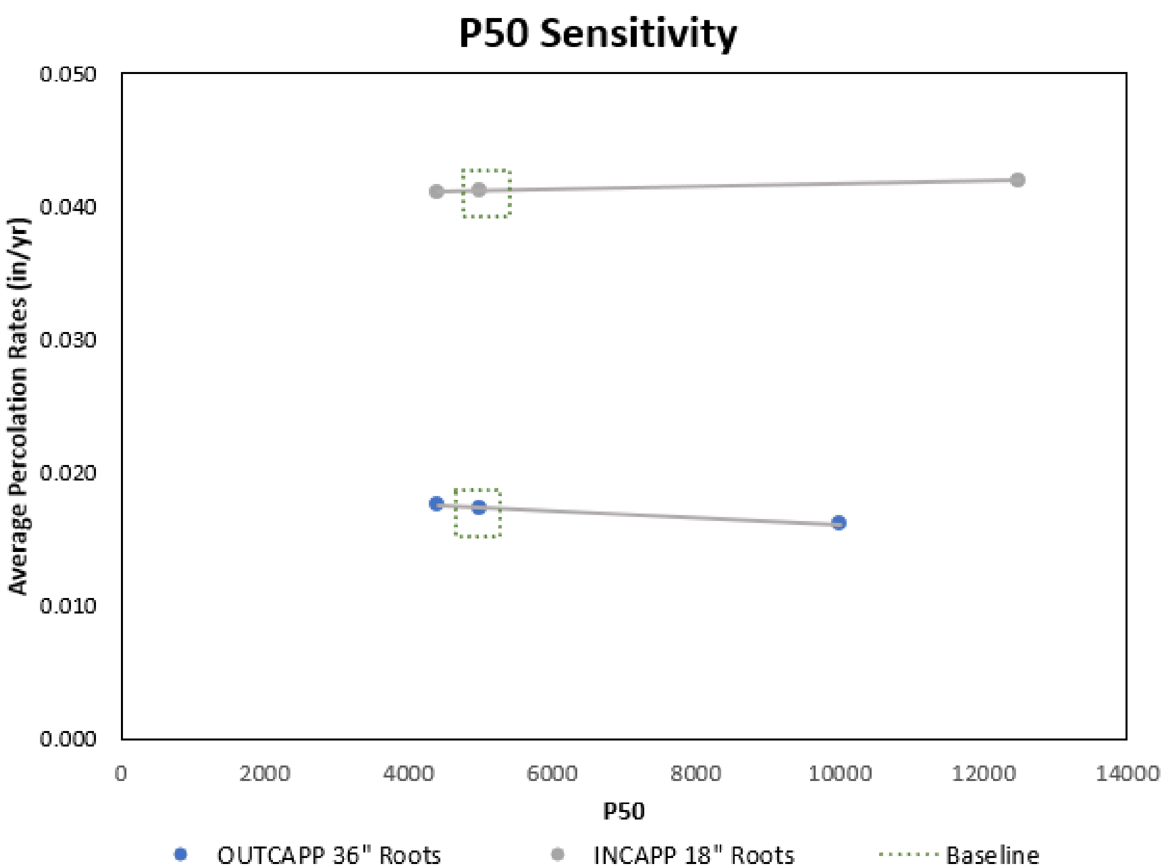


Figure I.7 Average Percolation Rates Resulting from Varied P50 for both OUTCAPP 36-inch Root Model and OUTCAPP 18-inch Root Models.

I.1.4 Baseline selection

Material properties, vegetation coverage, and LAI had the greatest effect on percolation rates through both tailing impoundments. Sensitivity analyses concluded additional parameters influencing evapotranspiration, such as hCritA and P50 did not have a large impact on tailings percolation rates in the 246-year cycled model. Values for hCritA of 5,250 cm and P50 of -5,000 cm were chosen to provide reasonable net atmospheric fluxes and numerical stability. Through comparison of the net atmospheric fluxes, it was also determined that roots should be absent in the gravel layer as this provided lower evapotranspiration rates more representative of the Site. The baseline conditions of LAI = 0 and LAI = 1 were selected to bound percolation rates through the OUTCAPP and a LAI = 0 was selected to represent the baseline conditions of the INCAPP, as presented in Section 7.2.