Report 052007/3

PROGRESS REPORT: QUESTA MINE ROCK PILE MONITORING AND CHARACTERIZATION STUDY

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Report 052007/3

PROGRESS REPORT: QUESTA MINE ROCK PILE MONITORING AND CHARACTERIZATION STUDY

1.0 INTRODUCTION AND TERMS OF REFERENCE

The Questa molybdenum mine, owned and operated by Molycorp Inc., is located approximately 5 miles east of the town of Questa in Taos County in north central New Mexico. The mine property lies within the Sangre de Cristo mountain range and is bounded on the south by the Red River and on the north by the Cabresto Creek drainage. The property location and main mine facilities are illustrated in Figure 1.

In September, 1999, Molycorp Inc. filed an application with the Mining and Minerals Division (MMD) of the Energy, Minerals, and Resources Department of New Mexico for extension of time for approval of a closeout plan for their Questa Mine, under Permit No. TA001RE. Robertson GeoConsultants Inc. (RGC) prepared a schedule for milestones and deliverables covering the period December 1999 until December 2001, the date of anticipated approval of the Closeout Plan. Molycorp submitted this schedule to the MMD in support of its time extension application on November 15, 1999. This schedule outlines the supporting studies and reports as well as the public review program required for preparation and submission of a Closeout Plan for the Questa Mine by January 31, 2001. Molycorp's application for the time extension for approval of a Closeout Plan for the Questa Mine was approved by the MMD on December 30, 1999.

The submitted schedule provides for a Phase 1 mine rock characterization and monitoring analyses and report to be submitted to the MMD by March 17th, 2000. This report is submitted to satisfy this requirement. Specifically, this report includes a description of the results achieved to date for Tasks 1.3, 1.4 and Task 1.5a (i.e. static testing) of Task 1.5 of this program in the following sections:

Section 2.0 Review of Work Tasks Completed To Date;
Section 3.0 Review of Field Data Monitoring
Section 4.0 Update on the Geochemical Characterization Program;
Section 5.0 Preliminary Interpretations; and
Section 6.0 Summary.

2.0 WORK TASKS COMPLETED AND ON-GOING

The following work tasks have been completed to date (for a description of the individual work tasks of the Phase 1 program, see Molycorp. 1998):

2.1 Task 1.1 Review of Mining History and Rock Pile Composition

The geometry of the various mine rock dumps was determined by comparing topographic maps for pre-mining and current conditions. The estimated depths of mine rock agreed fairly well with those encountered at the nine borehole locations.

A preliminary review of mining history and rock pile development was completed prior to the Phase 1 drilling program. The results of the drilling program will be compared with the mining records to determine the location and distribution of the various mine rock types. A more comprehensive mining history review is currently underway and will be summarized as part of the supporting material for the work plan for Phase 2.

2.2 Task 1.3 Phase 1 Drilling and Sampling Program

Following discussions with the NMED and internal review the drilling and instrumentation program was finalized and approved by the NMED in a letter dated July 7, 1999. The final work plan stipulated drilling and instrumentation of nine boreholes in three mine rock piles (2 in Spring Gulch, 3 in Sugar Shack South, 2 in Sugar Shack West and 2 in Capulin/Goathill).

The drilling and instrumentation of the nine boreholes in the mine rock piles started on July 29th and was completed on August 4th 1999. Nine drill holes were drilled in four waste piles at the locations shown on Figure 2. The drilling and sampling methods are described in the as-built report submitted to Molycorp (SRK, 1999b). A preliminary review and interpretation of the initial characterization of borehole samples (logs of lithology; paste pH and paste conductivity; moisture content) were provided in RGC Report 052007/1 entitled “Interim Report: Questa Waste Rock Pile Drilling, Instrumentation and Characterization Study” (RGC, 1999a). The drill logs are also reproduced in this report (Appendix A).

The drilling and sampling of two additional boreholes in natural scar material has also been completed. The drilling and sampling methods were identical to those in the mine rock piles. As outlined in the work plan, these boreholes were not instrumented. The drill logs for these two drill holes are provided in Appendix A and their locations shown on Figure 2.

2.3 Task 1.4 Instrumentation & Monitoring

The field instrumentation was completed as outlined in the work plan and is summarized in the as-built report (SRK 1999). Soil suction/moisture sensors were not installed in the boreholes (as originally proposed) due to anticipated difficulties in achieving a good contact with the rock matrix.

Field monitoring of dump temperature was initiated shortly after installation was completed. Field monitoring of pore gas constituents (oxygen and carbon dioxide) began in mid-September. An updated review of these monitoring data available to date is provided in Section 3 of this report.

2.4 Task 1.5 Phase 1 Static and Kinetic Laboratory Geochemical Testing Program

Task 1.5 was divided into to sub-tasks, namely 1.5a, the static testing program and 1.5b, the kinetic testing program. Task 1.5a has been completed and the results are provided in section 4.0 of this report.

2.5 Task 1.6 Phase 1 Geotechnical/Geohydrological Testing Program

Task 1.6 is currently on-going. Preliminary results for the physical characterization program were included in RGC Report No. 052008/4 “Work Plan for Questa Waste Rock Water Balance Study, Questa Mine Site, NM” (RGC, 2000) and additional data and interpretations of this program will be submitted under separate cover.

3.0 REVIEW OF FIELD MONITORING

A total of nine boreholes were drilled and instrumented at various locations of the Questa mine rock piles (2 in Spring Gulch, 3 in Sugar Shack South, 2 in Sugar Shack West and 2 in Capulin/Goathill). The locations of these boreholes are shown in Figure 2. The drilling and instrumentation was carried out from July 29th to August 4th 1999 and is summarized in an as-built report (SRK, 1999).

Samples were taken at five foot intervals during drilling of the nine boreholes (SRK, 1999). Drill logs are provided in Appendix A. These borehole samples were characterized in the field (lithology, paste pH and paste conductivity (EC)) and sub-samples were taken to the lab for determination of the moisture content (SRK, 1999). Figures 3-11 show the depth profiles of various physical and geochemical results (gravimetric water content, paste pH & EC, temperature and gas concentrations) in the nine boreholes determined on the samples recovered during drilling. The results of this field characterization program are discussed in the “Interim Report on the Waste Rock Drilling Program” (RGC Report 052007/1) and “Progress Report on Questa Waste Rock Investigation: Workplans for Routine Monitoring, Geochemical and Physical Characterization” (RGC Report 052007/1). More recent results have also been included in the “Workplan for Waste Rock Water Balance Study, Questa Mine Site, New Mexico” (RGC Report 052008/4). Table 1 provides a summary of these observations and a preliminary assessment of these data. The assessment is discussed in greater detail in section 6.0 below.

All nine boreholes were instrumented to measure in-situ temperature and to monitor O_2 and CO_2 in pore gas (SRK, 1999). Monitoring has been carried out monthly since the first complete round of monitoring was performed on September 16th and 17th 1999. Figures 12-15 show the results of the monthly in-situ monitoring for the period September to December 1999 at four selected locations (WRD-2, 5, 6 and 8). The depth profiles of temperature, O_2 and CO_2 are also shown in Figures 3-11 (data from December 28th 1999) to allow direct comparison with the physical and geochemical characteristics of the mine rock. The following sections provide a brief review and preliminary assessment of the monitoring data available to date

3.1 Monitoring Program

The current monitoring program consists of monitoring dump temperature, oxygen and carbon dioxide (in pore gas) at various depths of the nine boreholes (Molycorp, 1998). The in-situ dump temperatures are monitored using dedicated thermistors and the pore gas constituents (O_2 and CO_2) are monitored using a Nova 309BCWP portable gas analyzer. The analyzer is equipped with a small air pump, which delivers pore gas from the sampling port to surface.

An expanded work plan for the borehole monitoring has been submitted to include the following:

- Measuring relative humidity in the pore gas at various boreholes;
- measuring air (barometric) pressure at selected depths of the instrumented rock piles using the access tubing for pore gas monitoring and a differential pressure transducer;
- measuring local weather conditions at each borehole when monitoring is done, including air temperature, relative humidity, precipitation and snow depth/water equivalent; and
- detailed monitoring following “extreme events”.

3.1.1 Temperature Monitoring

The temperature monitoring data can be summarized as follows:

- seven of the nine instrumented mine rock pile locations show internal temperatures significantly higher than long-term average air temperature (55-60°F); “background” temperatures (< 60°F) were only observed in WRD-1 & 6; the highest temperatures (> 100°F) were observed at WRD-2, 4 & 5;
- temperatures within the rock piles typically increase monotonically with depth showing maximum temperatures at or near the base of the pile (or bottom of the borehole);
- within a given pile, a temperature gradient tends to develop parallel to the slope with lower temperatures at lower elevations and elevated temperatures at higher elevations (e.g. WRD-3 versus WRD-4 in Sugar Shack South and WRD-6 versus WRD-7 in Sugar Shack West);
- observed temperature profiles in the mine rock are much more uniform than the depth profiles of pore gas concentrations (O_2 and CO_2) and the depth profiles of physical and geochemical characteristics (moisture content, paste pH & EC). As a result there is no clear correlation of temperature with lithology and/or paste pH/conductivity at the local scale; and
- seasonal variations in ambient air temperature influence only the upper 10-20 ft of the mine rock piles (based on 5 months of monitoring); at greater depths the temperature remains virtually constant.

Ultimately, all heat generated within a pile is caused by the oxidation of sulfide minerals (predominantly pyrite) present within the rock. However, this does not necessarily imply that the most reactive material (with the highest oxidation rates) is located in areas of the pile with the highest temperatures. In order to understand the temperature at a given point one has to assess not only the oxidation rates of the local material (local heat source), but also the pattern of air movement, the oxidation rates of the mine rock material along the air flow path (upstream heat source), and heat conduction through the mine rock material.

The temperature gradients observed at Questa in most locations are sufficiently strong to create significant advective air movement (“thermal venting”) within a coarse rock pile. The fact that local pile temperatures appear to be more influenced by pile topography and geometry (depth, distance from toe, etc.) than by local geochemical conditions (lithology, paste pH etc.) supports the hypothesis that advection is a significant transport mechanism. This conclusion is also supported by the observation that there has been a steady increase in the oxygen concentrations and decrease in the carbon dioxide concentrations during the winter months as the thermal contrast, hence convective air flow, through the rock piles increase. This indicates that the oxidation rate in the Questa rock piles are not limited by air entry but by reaction kinetics.

3.1.2 Oxygen Monitoring

The oxygen data can be summarized as follows:

- oxygen concentrations do not show a consistent relationship with depth; some boreholes show a decrease with depth (WRD-5, 6, 8 & 9) while others show an increase with depth (WRD-2 & 7) or no change at all (WRD-1, 3 & 4);
- several boreholes showed no depletion of oxygen (i.e. ambient oxygen concentrations of about ~21%) throughout the pile profile (WRD-1 and WRD-3) or near the base of the mine rock pile (WRD-2 and WRD-9);
- very strong oxygen depletion (<5%) throughout the profile was only observed at WRD-7; some local depletion of oxygen was observed at WRD-2, 5 & 6; and
- oxygen concentrations show a seasonal trend with generally higher concentrations during the colder winter months compared to the warmer summer months (based on the 5 month monitoring period).

The monitoring data clearly suggest that the Questa mine rock piles are not "oxygen-limited", i.e. the supply of oxygen does not appear to be a rate-limiting step in the oxidation of sulfide minerals except in a few locations where oxygen approaches zero (e.g. WRD-6).

Furthermore, the oxygen data strongly suggest that advection is the dominant mechanism for transporting oxygen within the Questa mine rock piles. A review of the spatial distribution of oxygen suggests that "fresh air" may enter the pile either along the exposed slope faces (potentially driven into the upper profile by wind action and/or barometric pumping, see for example WRD-8 & 9) or along the coarse basal layer of the pile ("sucked" into the pile by thermal convection, see for example WRD-2 or WRD-9).

The oxygen data collected at the three stations in Sugar Shack South (WRD-3, 4 & 5) indicate a gradual decrease in oxygen content in the pore gas with distance from the toe of the pile. Large-scale thermal convection within this pile could explain this spatial distribution of oxygen (progressive consumption of oxygen in pore gas along the air flow path). The data collected from the three stations in Sugar Shack South provide an excellent opportunity to study the influence of large-scale convection on oxidation of the mine rock material.

None of the oxygen profiles show a uniform decrease with depth, which is commonly observed in mine rock piles that exhibit diffusion-controlled air transport (with the possible exception of WRD-6). The contribution of diffusion to oxygen transport is likely very small at Questa and restricted to the near-surface zone.

The seasonal increase in oxygen concentrations during the winter months (or more accurately the decrease in oxygen depletion) is likely a result of increased advective airflow during the much colder winter months due to the stronger temperature gradients (air temperatures dropped to less than 0° F in December 1999).

3.1.3 Carbon Dioxide Monitoring

The carbon dioxide monitoring data can be summarized as follows:

- carbon dioxide concentrations in pore gas vary from as low as 0.1% (ambient CO_2 concentrations in air, e.g. WRD-1 & 3) to as high as 11% (WRD-6) (note, that the quoted upper limit of the instrument is only 10%; thus it is likely that the CO_2 readings recorded in the lower portion of WRD-6 are in fact greater than 11%.
- in the majority of locations (WRD-1, 3, 4, 5, 6 & 7) carbon dioxide concentrations are inversely proportional to the oxygen concentration (with an increase in CO_2 of about 2.5% for every 10% decrease in O_2);
- at three locations (WRD-2, 8 & 9) carbon dioxide concentrations are very low despite significant oxygen depletion; and
- carbon dioxide concentrations also show a seasonal trend with generally lower concentrations during the colder winter months relative to the warm summer months (based on 5 months of monitoring).

Elevated levels of carbon dioxide in pore gas are likely indicative of carbonate buffering within the pile. The CO_2 data concur with the preliminary conclusions from the paste pH and conductivity survey that the mine rock material at WRD-2 (upper Spring Gulch), WRD-8 (Capulin Canyon) and WRD-9 (Capulin/Goathill) has very little, if any, neutralizing capacity (at least in the form of carbonates).

The fact that most other rock piles show a consistent inverse correlation between CO_2 and O_2 suggest that calcite, or other carbonates, are the dominant neutralizing agent and is common throughout the majority of the piles.

As outlined earlier in the discussion of pile temperature and oxygen concentrations, the observed carbon dioxide concentrations will need to be interpreted in the context of air flow through the piles (i.e. CO_2 concentrations may be influenced by the buffering reactions occurring upstream of the monitoring point).

The seasonal decrease in carbon dioxide concentrations during the winter months is consistent with the increase in oxygen in suggesting increased advective airflow during the much colder winter months due to the stronger temperature gradients.

4.0 GEOCHEMICAL CHARACTERIZATION

The geochemical testing program discussed here comprises the Phase 1 static testing of the Questa mine rock samples collected from the borehole drilling program (Task 1.5a). The purpose of the geochemical testing program is to characterize the Questa mine rock with respect to its acid generation and acid consuming potential, metal leaching and mobility characteristics and likely water quality conditions in both the near and long term. Some of these objectives are met with the data obtained from the static testing program while others require kinetic tests (Task 1.5b)

4.1 Previous Work

A preliminary characterization study of the Questa mine rock material was done in 1995 and is summarized in the SRK Report entitled “Questa Molybdenum Mine: Geochemical Assessment” SRK, 1995). This earlier study was of limited scope with respect to geochemical characterization of the mine rock material. The geochemical assessment included Acid Base Accounting (ABA) testing, multi-element ICP analyses and shake flask leaching analyses on selected mine rock samples collected at surface. Table 2 summarizes the number of samples submitted for each test with respect to rock type.

This initial work indicated that “the black andesite and aplite/granite rock types had negligible to low potential to generate acid and limited potential for leaching sulfate and metals. The mixed volcanic rock type, which comprises the majority of the mine rock dumps, was determined to have a significant potential to generate acid and leach contaminants such as sulfate, copper, manganese and zinc (SRK, 1995).

4.2 Current Geochemical Characterization Program

The current sampling and geochemical testing program was designed to augment the results from the preliminary geochemical testing (SRK, 1995), the on-going field monitoring program and the physical characterization studies currently underway. The overall scope of work for the geochemical testing of the mine rock samples collected during the mine rock drilling program has been outlined in the Waste Rock DP-1055 Work Plan (Molycorp, 1998).

The geochemical testing program has been subdivided into a static testing program (Task 1.5a) and kinetic testing program (Task 1.5b). The results discussed herein are for Task 1.5a, the static testing and included the following tests:

- Paste pH on ‘as received’ fines;
- Acid Base Accounting (ABA) analyses;
- Acid titration testing;
- Multi-element ICP analyses; and,
- Meteoric water leach extraction tests.

The test protocols for the various geochemical tests were provided in the letter submission to the NMED dated June 17 1999 (Molycorp, 1999). A staged approach to the testing program has been adopted whereby samples were first submitted for ABA and forward acid titration testing. Once the results were reviewed, a subset of samples was selected for the remaining tests of the static testing program, i.e. multi-element ICP and leach extraction testing. Proposed sample selection for the kinetic testing program in Task 1.5b is included in this report following discussion of the static testing results (see Section 4.3).

The samples selected for the specific test methods are indicated on the drill hole logs provided in Appendix A and summarized in Table 3. Sample selection was based partially on geochemical/lithological classifications. The Questa mine rock samples were categorized into 5 general ‘geochemical units’, namely:

- Predominantly aplite samples;
- Predominantly unaltered volcanics (including ‘black’ andesite);
- Predominantly propylitically altered andesite;
- Predominantly hydrothermally altered mixed volcanics; and
- Rhyolites/tuffs.

The term “altered” used here for classification purposes refers to alteration that occurred pre-mining (i.e. hydrothermal alteration of some type) and does not imply alteration due to weathering post disposal (such as sulfide oxidation).

Samples were selected at various depths in each of the drill holes in order to obtain a representative range of waste material types from each borehole (see Appendix A). An attempt was made to select samples which are representative of the range of rock types, alteration (i.e. hydrothermal, propylitic etc.), degree of weathering, paste pH and paste conductivity values, as well as temperature, oxygen and carbon dioxide content characteristics.

Additional samples were selected in those locations where:

- an 'acid front' is suspected at a specific depth within a drill hole (e.g. WRD-5),
- significant depletion in oxygen and/or increase in carbon dioxide was observed (e.g. WRD-6),
- unexpected paste pH and/or paste conductivities were seen for a certain rock type (e.g. low paste pH and very high paste conductivity for aplite in WRD-2), and
- advection/convection is anticipated to be a large factor in air transport (e.g. WRD-2).

It should also be noted that an intentional sampling bias with respect to potentially acid generating material is inherent in the program, as the majority of drill holes were located in areas believed to be of a more potentially acid generating nature. These locations were specifically selected to investigate the processes controlling ARD production and evolution in the mine rock piles.

The sample selection is believed to reflect the range of material characteristics present in the Questa mine rock dumps. Approximately 6% of the samples selected are aplite samples, 25% are unaltered volcanics (including the 'black' andesite), 6% are propylitcally altered andesites, 33% are hydrothermally altered mixed volcanics and 30% are rhyolite/tuff samples.

Hydrothermal scar material was also submitted for static testing. Samples were selected using the same rationale as was used for mine rock sample selection. Namely, samples were chosen at various depths in each of the drill holes that were believed to be representative of the range of paste pH and paste conductivity values. Nine samples of the hydrothermal scar material were submitted for ABA testing and sub-sets of these samples were also tested using the other test methods (see Appendix A). The results for the scar material are also discussed in this report.

4.2.1 Acid Base Accounting

In conjunction with the acid base accounting (ABA) tests, paste pH measurements were completed on the 'as received fines' of all the samples submitted for ABA testing. This pH is called the 'rinse pH' and uses a 1:1 solid to distilled water ratio to mimic as close as possible the methodology used in the field. These results serve in part as a QA/QC program for the field paste measurements and a comparison is provided in Figure 16.

It is standard practice with ABA testing to measure the paste pH of the crushed sample. The act of crushing the sample however liberates minerals that, in the field, are locked in the rock matrix. The liberated minerals are typically the neutralizing minerals, or 'alkalis'. As a result the ABA paste pH measurements are often biased towards more neutral pH values. Figure 17 is a comparison of the paste pH on the crushed ABA sample and the ‘rinse’ paste pH taken on the as received fines. The bias is quite notable and as a result the ‘rinse’ paste pH values are believed to be more representative of field conditions than the ABA paste pH values. The tendency for pH values to be higher on crushed samples reinforces the practice of obtaining samples using a sampling method that minimizes sample crushing (such as the Bekker Hammer type drill rig).

The modified acid base accounting (ABA) test is used to determine the balance between the acid producing (sulfides) and the acid consuming (predominantly carbonate) components of a sample. The results provide an initial classification of samples as to their potential for acid generation or acid consumption. The results for the Questa mine rock and hydrothermal scar samples are included in Table 4. A plot of neutralization potential (NP) versus acid potential (AP) is shown in Figure 18. Those samples that fall below the 1:1 line (i.e. have greater AP than NP) are considered potentially acid generating and those that lie above the 1:1 line and below the 3:1 line are considered ‘uncertain’ with respect to acid generation (note no samples lie above the 3:1 line). Of those samples that lie above the 1:1 cut-off line, the majority are from drillhole WRD-1.

Figure 19 is a plot of the NP:AP ratio versus the rinse paste pH. This graph shows that those samples that are currently acidic have NP:AP ratios of less than approximately 0.3. Theoretically, based only on the ‘quantity’ of sulfides and alkalis, any sample with an NP:AP ratio less than 1.0 could potentially also turn acidic over time. In practice the potential for acid generation also depends on the ‘reactivity’ and ‘availability’ of both the alkalis and the sulfides. The true acid generation potential can occur at values less than or greater than this first estimate of 1.0. Those samples with a ratio greater than 1.0 may or may not become acidic. Note, a significant number of samples have essentially zero neutralization potential (NP) and lie along the Y-axis. Figure 20 is a graph of AP versus rinse paste pH, a great deal of scatter is seen in this plot whereas Figure 21, a plot of NP versus rinse paste pH, shows a positive correlation and a trend similar to that seen in Figure 19. This suggests that it is the neutralization potential, or NP, rather than the acid potential, or AP, in the samples that controls the pH of that sample.

Depth profiles of NP, AP and rinse paste pH for each of the boreholes are provided in Figures 22 to 32. The results can be summarized as follows:

- With the exception of certain intervals in the WRD-1 and WRD-3 boreholes, AP consistently exceeds NP.
- There are no definitive trends with respect to depth in terms of AP or NP.
- There is very little NP remaining in the scar material, however certain intervals within the mine rock (WRD-1 to WRD-7) have appreciable NP values of 20 to 30 kg

$CaCO_3$/ton equivalent. In these zones buffering of the acid generation caused by oxidation is occurring, preventing or delaying the onset of acidic conditions
- The ABA results suggest that with the possible exception of WRD-1, all the profiles represented in the boreholes are considered potentially acid generating.

4.2.2 Acid Titration Tests

The forward acid titration test is used to determine, qualitatively, the acid neutralizing capacity of a sample by adding a measured amount of acid to the sample to lower the pH. The amount of acid required to reach each pH interval is dependent on the amount of neutralizing material available. The results for the Questa samples are shown in Figures 33 to 36. As the pH decreases, different minerals react to neutralize (or buffer) the added acid. Within the pH range of 5.5 to 7.0 carbonate minerals in the sample dissolve and neutralize the acidity. If there are significant carbonates present, a 'step' or flattening out of the curve will occur within that pH range (i.e. 5.5 to 7.0). Between the pH range of 3.0 to 3.7, limonite (FeOOH) will buffer acid. At even lower pH values (i.e. below ~3), aluminosilicate minerals such as the feldspars in the sample will dissolve and buffer added acid.

The results of the forward acid titration tests can be summarized as follows:
- The WRD-1 samples below ~ 20 ft, show some flattening of the curve in the pH range where carbonate buffering occurs.
- The surficial sample from WRD-1 does not show this same flattening, this would suggest that either carbonates were not present near surface (in the aplite) or that if present, the carbonates have been depleted at the surface.
- The WRD-2 sample (taken from 55 to 60' below surface) does not appear to have any buffering until the pH is below 3 (i.e. at the pH where aluminosilicates will dissolve).
- WRD-3 and WRD-4 show similar trends to each other, however WRD-3 in general requires more acid to drop to the same pH level (i.e. has greater buffering potential). Both samples show some flattening in the pH ranges where carbonates and Fe-OOH will dissolve and neutralize acid, as well as at lower pH values where aluminosilicates begin to buffer.
- WRD-5, WRD-6 and a sample from depth in WRD-7 contain significantly more buffering than WRD-2, WRD-3 or WRD-4 likely due to the presence of carbonates and FeOOH.
- WRD-8 contains no significant buffering minerals except aluminosilicates at very low pH values.
- Neither scar sample contains any buffering until the pH is below 2 (i.e. when aluminosilicates begin to dissolve).

- Titration curves do not appear to correlate with sample lithology descriptions from the drill logs. However those samples where calcite was noted have a longer, flatter titration curve.

4.2.3 Multi-element ICP

Multi-element ICP analyses were completed on 29 samples. The results are provided in Table 5. In general, the major elements are aluminum, calcium, iron, potassium, magnesium, sodium and titanium. Samples were not analyzed for silica, but it is assumed that silica is also a major element. Minor elements include barium, cobalt, chromium, copper, manganese, molybdenum, nickel, phosphorus, lead, strontium, vanadium and zinc. Trace amounts of silver, arsenic, beryllium, bismuth, cadmium, scandium, yttrium and zircon were also detected. The samples are currently being analyzed for fluoride content, however the results are not currently available and will be included in subsequent reports. The solids chemistry of the scar samples does not differ materially from that of the mine rock samples.

4.2.4 Leach Extraction Tests

The objective of the leach extraction tests is to characterize and quantify the soluble contaminant content of a sample. The procedure used was the EPA 1312 leach extraction test with a leachate reagent of de-ionized water acidified to pH 5.5 (Meteoric Water Mobility Test reagent) to represent rainwater. The results are provided in Table 6. The concentrations in the leachate however are not necessarily representative of what concentrations would be expected in the field. Rather, they are representative of the quantity of leach water compared with solid sample. Field conditions have much higher solid:liquid ratios than what is tested in the lab. Thus field concentrations are typically much higher, particularly for extraction tests with low concentrations, and often limited by solubility constraints. In order to predict pore water qualities representative of field conditions, calculations and geochemical speciation modeling (using MINTEQA2) will be completed once fluoride analyses are available and results will be presented in a subsequent report.

Table 7 provides the leach extraction results on a calculated per weight basis (i.e. in units of mg/kg) and depth profiles for some of the key parameters for each of the boreholes are provided in Figures 37 to 47. The results are summarized as follows:

- WRD-1 shows significantly larger amounts of soluble alkalinity than acidity (and therefore leachate pH values in the near neutral range), soluble sulfate and calcium concentrations are in the range of gypsum solubility suggesting on-going sulfide oxidation and acid neutralization. Magnesium (likely from magnesium rich carbonates or magnesium sulfates) is the only major cation that shows any degree of solubility and molybdenum is the only minor cation showing dissolution in the near neutral pH range.

- The WRD-2 samples tested have no soluble alkalinity, acidic pH, significant amounts of soluble acidity and sulfate. Aluminum and iron are soluble in significant quantities, as are the minor elements copper, zinc, nickel and cobalt.
- WRD-3 has some residual alkalinity in the top 60 ft, however the sample from depth (105 ft) is deplete in alkalinity and shows a slightly depressed pH and increase in both acidity and sulfate. Correspondingly, the amount of major and minor cations (except Mo) increase near the bottom of the borehole where alkalinity is low.
- Only one leach extraction sample was completed from WRD-4. It contains negligible soluble alkalinity, moderate amounts of acidity, sulfate and calcium concentrations and significant amounts of soluble magnesium and zinc.
- The interval in WRD-5 between approximately 20 and 25 ft has negligible soluble alkalinity and significant amounts of soluble sulfate, calcium, manganese, aluminum, magnesium, copper and zinc. Samples tested above and below that interval have greater amounts of soluble alkalinity and therefore higher pH values and relatively lower amounts of soluble sulfate and cations.
- The top 25 to 30 ft in WRD-6 has negligible soluble alkalinity and low pH values. Correspondingly, this interval has higher soluble amounts of sulfate, aluminum, zinc, copper etc. Below approximately 30 ft, the amount of soluble alkalinity increases and (with the exception of magnesium) the relative amounts of soluble components decrease. This profile shows trends typical of material in which an ‘acid front’ has developed (i.e. low to no alkalinity, low pH and relatively high levels of contaminants in the upper portions, a relatively abrupt zone or boundary where the inverse occurs as depth increases and oxygen becomes limiting).
- Three leach extraction samples were tested from the WRD-7 borehole. A similar correlation as is shown in previous samples is apparent in this borehole whereby the sample with sufficient amount of soluble alkalinity (at ~ 50 ft) shows lesser amounts of soluble constituents (with the exception of magnesium) than the samples with little to no soluble alkalinity (at ~ 10 ft and 75 ft).
- The two samples tested in WRD-8 were acidic with no soluble alkalinity and significant amounts of calcium, sulfate, aluminum, manganese, magnesium, zinc and copper.
- Similarly, WRD-9 has no soluble alkalinity, acidic pH values and significant amounts of soluble components, primarily sulfate, aluminum, manganese, magnesium and zinc. The amount of these components in this borehole seems to increase with depth perhaps as a result of a leached surficial zone or an accumulation of secondary precipitates due to evaporation near the base.

Leach extraction tests were also carried out on selected scar material samples. The scar material can be divided into the upper zone of sulfide and metal depleted oxidized (oxide) zone and a lower metal rich (sulfide) zone. Samples of scar material from only the oxide zone have been tested to date. Additional samples from the interface zone and the sulfide zone have been selected and submitted for testing. Results will be presented in a subsequent report. The results for the oxide zone are summarized below.

- SSB-1 and SSB-2 both have no soluble alkalinity and acidic pH values
- Moderate amounts of soluble sulfate, calcium, aluminum and magnesium were detected and are comparable to the results for the WRD-1 borehole.
- The scar materials have significantly less soluble metals than the acidic mine rock samples.

There are two geochemical reasons that can account for the relative difference in soluble metal content in the scar material compared to the acidic mine rock. (1) The time for which the upper layers of scar material have been exposed to natural weathering and leaching processes is much greater than for the mine rock, resulting in the production of an 'oxide' or partially oxidized upper zone. (2) The original metal content, for some metals, in the unoxidized (sulfide zone) scars may not have been at levels as high as is seen in the mine rock. There are geochemical halos that surround the orebody, in general the further from the orebody you get, the lower the concentrations of some associated metals. At Questa these associated metals are Mo, Mn, Pb and Zn. At the same time, there may be increases in other elements such as Fe as the pyrite content may increase in the pyrite halo. The mine rock is essentially taken immediately adjacent to the orebody whereas the scars vary in distance from the orebody.

There is also a physical reason for increased metal and 'salt' concentrations in the pore waster of the mine rock piles. Such an increase would be expected if there were evaporative drying in the piles with entry of cold, dry air and the exit of warmer moist air.

Comparison of the ICP and leach extraction results (Table 8) provides an estimate of the soluble percentage of each element in the samples from the mine rock and the oxide zone of the scars. The percentages are variable from sample to sample, however significant amounts (~10 to 25%) of soluble calcium, cadmium, copper, manganese and zinc are seen in many samples.

4.3 Additional Testing

The assessment of future ARD drainage potential and associated water qualities requires the completion of the characterization work, particularly outstanding fluoride test results, the testing on the ‘sulfide’ scar materials and the kinetic testing of Task 1.5b as well as the modeling and prediction work that follows in Task 1.8.

Based on the results of the static testing program, the samples provided in Table 9 have been selected for the kinetic testing program. Justification for this sample selection is discussed in section 5.0 below.

5.0 INTERPRETATION

The monitoring program, static geochemical testing and physical characterization programs provide a comprehensive assessment of the current conditions of the mine rock and scar materials. It is anticipated that there will be changes in the material over time. The following interpretation however is primarily for current conditions with only preliminary estimations of likely or potential changes. A thorough assessment of future ARD drainage potential requires the completion of the kinetic testing (Task 1.5b) as well as the modeling and prediction work that follows in Task 1.8.

5.1 Spring Gulch

Based on the surface characterization studies (SRK, 1996; Wagner & Harrington, 1995) it was anticipated that WRD-1 would be principally in aplite and black andesite waste and non-acid generating (Zones 151 to 154). WRD-2 would be expected to be in mixed volcanics and aplite (Zones 187 to 189) and acid generating. The results from WRD-1 and 2 (locations shown on Figure 2) confirm this.

WRD-1 was completed in aplite and black andesite that has undergone propylitic alteration (see SRK 1999). The andesite cuttings locally contain pyrite, chalcopyrite and molybdenite. Calcite was consistently present in the andesite. None of the mixed volcanic material was observed.

The paste pH results were consistently above 7 and conductivity values less than 2,500 μS/cm. The temperature in the drillhole ranges from 60^{o} to 55^{o} F suggesting that there is negligible heat of oxidation. Temperature difference, particularly in winter provide thermal convective transport of oxygen through the rock pile and, with the low rate of oxidation, only very small reductions in oxygen content are observed in the profile. However, the ABA results suggest uncertain potential with respect to acid generation and oxygen is not limiting. Currently there is a significant amount of soluble alkalinity throughout the profile and it is possible that this drillhole will remain non-acid generating (with localized acid generation and neutralization). Two samples have been proposed for further testing from this drillhole, one in the aplite material and another in the black andesite mine rock in order to better understand the kinetics of these materials and likely future geochemical characteristics.

WRD-2 was completed in mixed volcanics, characterized by altered rock fragments in a yellow-brown clay rich matrix. Locally pyrite could be observed.

The paste pH results were consistently low (generally less than 4) and high conductivity values were recorded, particularly near the base of the pile. Leach extraction results also indicate substantial accumulation of secondary minerals near the base of this drillhole. Relatively low moisture contents and the high temperatures (~90^{o} F) at the base suggest that the relative increase in secondary mineral accumulation at the bottom of the drillhole may in part be due to evaporative processes.

There is no residual soluble alkalinity in WRD-2 and therefore no effective buffering capacity, a result supported by negligible concentrations of CO_2. All the results obtained to date indicate substantial oxidation in WRD-2. One WRD-2 sample is suggested for further test work to assess the rate of sulfide oxidation (where no buffering is occurring) and the likely long term water qualities from this rock pile and to characterize the secondary mineral content attributed to the very high paste conductivities seen in this drillhole.

5.2 Sugar Shack South

WRD-3 to 5 were drilled in this pile at the locations shown in Figure 2. From the surface characterization studies it was anticipated that the upper part of WRD-3 would be in non-acid generating aplite (Zone 88, in the aplite wrap-round berm) and the lower part in potentially acid generating mixed volcanics (Zone 66 and 87) resulting in low (or no) ARD potential in the top and high ARD potential at depth. WRD-4 was expected to be mainly in mixed volcanics (Zone 66) with high ARD potential, and WRD-5 in mixed volcanics and andesite resulting in high ARD potential. These expectations were substantially confirmed in these drill holes.

WRD-3 was drilled near the toe of the pile, primarily in fresh aplite and andesite for the upper 55 ft with hydrothermally altered mixed volcanic material near the base of the hole.

The paste pH and conductivities appear to correlate with lithology, with higher pH and lower conductivities in the upper aplite/andesite rocks and lower pH, higher conductivities in the lower portion. It should be noted that the pH in the lower section is not nearly as low, or the conductivity as high as is observed in WRD-2, indicating that the current acidity and oxidation conditions are much milder than the conditions pertaining in WRD-2 (leach extraction results also confirm this comparison).

The temperature profile reflects some increase in temperature over that observed in WRD-1 but is considerably less than that in WRD-2. ABA results suggest that although the upper portion of the drillhole is not currently acidic, sulfate concentrations suggest sulfides are oxidizing and that if the alkalinity becomes consumed this material may become acid generating. Currently there is substantial soluble alkalinity in the upper 55 ft, but none in the lower profile where secondary mineral accumulation is apparent. The geochemical characteristics appear to correlate with lithology and indicate that the upper aplite/andesite material is currently buffering any acid produced but has the potential to become acidic and the lower mixed volcancis are currently acidic with no residual buffering capacity.

A sample in the upper profile (i.e. aplite/andesite material) from this drillhole has been selected for further kinetic test work to ascertain the sustainability of near neutral conditions (acid production and consumption rates) and likely long term water qualities associated with this rock type.

WRD-4 is located at the pile mid height, and intercepted hydrothermally altered mixed volcanics and lesser amounts of fresh aplite. Despite the apparent potential for acid generation the pH values are generally quite high (above 4.5 and often above 7). The ABA results suggest that WRD-4 be classified as potentially acid generating.

The temperature profile indicates a rapid increase in temperature with depth to over 100^{o} F at the base. This indicates that there is oxidation and heat generation occurring in the airflow pathway between drill hole WRD-3 and 4. During drilling and prior to removal of the drill stem, hot air was observed to discharge from the drill pipe (SRK, 1999). Because the drill stem was closed and continuous from the surface to the bottom of the hole, the airflow originated at the base of the mine rock pile. This illustrates the relatively high air permeability that exists in the coarse rock zone at the base of the rock pile and the freedom with which air can move through the rock pile under the pressure gradients that develop naturally as a result of differences in air density due to temperature differences (chimney effect).

All the monitoring and testing results obtained to date suggest that the material in WRD-4 is currently oxidizing and generating acid, and, with the exception of a few intervals (surface and between 45 to 55 ft), contains enough neutralization to buffer the acid produced. The ABA balance suggests this is a temporary condition.

WRD-5, located near the top of the pile, intercepted clay altered material near the surface and fresh porpylitic andesite with calcite at depth. From the paste pH and conductivity profiles it is apparent that oxidation and acid generation is occurring near the top of the pile but that it is being controlled by the calcite (calcium carbonate) buffering at certain intervals. The temperature profile reflects a steady increase with depth to temperatures over 110 ^{o}F at the base. This indicates that oxidation is ongoing in the airflow pathway between WRD-4 and 5. Gas concentrations also suggest active sulfide oxidation and carbonate neutralization (lower O_2 and higher CO_2 concentrations). Leach extraction testing suggests that certain intervals contain soluble alkalinity while others (20 to 25 ft) do not. The ABA results indicate all the samples should be classified as potentially acid generating. One sample from the WRD-5 drillhole has been selected for additional kinetic testwork to confirm the static test results and provide information about the dynamic processes occurring in the mine rock.

5.3 Sugar Shack West

WRD-6 and 7. From the surface characterization studies it was anticipated that WRD-6 and WRD-7 would be completed in rhyolite/andesite (Zone 40). The material was therefore expected to have moderate acid generation potential.

In both holes, clay altered mixed volcanic materials were encountered to a depth of about 30 ft. At depth the rock appeared to be fresher mixed volcanic material. Both holes show similar paste pH and conductivity profiles, reflecting that both profiles were developed from the same materials piled from the same platform at the same time.

The temperature profiles are quite different; with the temperature in WRD-6 being slightly elevated (compared with WRD-1) while that for WRD-7 is considerably elevated. The gas concentration profiles in WRD-6 show an abrupt boundary between 20 and 30 ft from the surface at which oxygen concentrations drop to near zero and carbon dioxide concentrations jump to over 10%. Samples taken above and below this boundary for leach extraction testing show negligible soluble alkalinity and acidic leachate pH values above the boundary and significant amounts of soluble alkalinity and near neutral pH conditions immediately below the boundary. ABA results classify WRD-6 as potentially acid generating above and below this apparent boundary. It is anticipated that the boundary is a result of oxidation (hence low O_2) and neutralization (hence high CO_2) at depth. A sample from below the evident boundary has been selected for additional testwork.

The gas profiles in WRD-7 do not show the same trends. Carbon dioxide is constant throughout the profile (~2%) and oxygen concentrations generally increase with depth indicating entry of air near the base of the pile. The amount of soluble alkalinity at the surface and the base of WRD-7 is negligible, however some alkalinity is still available at about mid height in the drillhole. Similar to WRD-6 however, the samples in WRD-7 have ABA characteristics that classify the entire profile as potentially acid generating.

5.4 Capulin

WRD-8. From the surface characterization, the mine rock in Capulin pile at WRD-8 was expected to be rhyloite - andesite with ARD potential (Zone 3B). The material encountered was a crystal rich tuff with altered, clay rich matrix. Sulfide mineralization was more common at this location (SRK, 1999). Paste pH was uniformly low (below 4), but conductivity was moderate. The temperature increased with depth to temperatures in excess of 90^{o} F at 100 ft. Oxygen is not limited and carbon dioxide is not elevated above ambient levels. This suggests that sulfide oxidation without buffering is occurring throughout the depth of the profile. The results of the geochemical testing program confirm the monitoring results. ABA tests show no neutralization potential and sufficient acid potential. Leach extraction results indicate no soluble alkalinity and significant accumulation of secondary minerals throughout the depth.

WRD-9. From the surface characterization, the mine rock was expected to be acidic andesite of variable color (Zone 7). Lithologies encountered were mixed volcanics, tuff and black andesite. Cuttings from the upper 25 ft contained altered clay. Fresher materials were encountered at depth.

Moderate increases in temperatures with depth were seen and as in WRD-8, oxygen is not limited the entire length of the drillhole and no significant increases in carbon dioxide have been detected. ABA results classify WRD-9 as acid generating and the leach extraction results show no soluble alkalinity remaining. Secondary mineral accumulation is evident and appears to increase at the base of the drillhole. This increase may be a reflection of sulfide content (which also increases with depth), but may also be due in part to drying out or evaporative processes at the base (note relatively low moisture content in basal samples). A sample from the base of WRD-9 has been selected for detailed mineralogical characterization.

5.5 Hydrothermal Scar Material

The boreholes in the scar material were not instrumented, however drill cuttings were collected and submitted for characterization testing. **SSB-1** and **SSB-2** were relatively shallow boreholes (to depths of ~30 and 70 ft respectively) located near the open pit (see Figure 2). Both holes show similar geochemical results. All samples tested via ABA testing indicate acid generating conditions with no neutralization potential. The relatively low sulfide and metals content at shallower depths indicate depletion of sulfide and metals due to oxidation and leaching. The leach extraction results confirm this (i.e. no soluble alkalinity) and only moderate secondary mineral accumulation is seen, i.e. the leached 'oxide' zone. One representative 'leached' scar sample has been selected for detailed mineralogical characterization. Additional samples have also been selected for further static testing of material from greater depths in these boreholes to evaluate the sulfide and metal contents at depth (i.e. the 'transition' and 'sulfide' zones).

6.0 SUMMARY

Table 1 provides a summary of the characterization results for the various boreholes. In general, WRD-1 is the only drillhole which is currently completely non-acid generating throughout its profile. ABA results however indicate uncertain potential for acid generation and kinetic testing is proposed. WRD-3 through WRD-7 show some variability with respect to current acid conditions and buffering capacities with significant intervals of currently non-acid generating material, however all are classified as potentially acid generating. WRD-2, WRD-8, WRD-9 and both drillholes in scar material (SSB-1 and SSB-2) are currently acid generating from top to bottom with no buffering capacities.

With the exception of WRD-6, sulfide oxidation and acid generation does not appear to be strictly related to depth in the mine rock pile and oxygen is not limited. In intervals where there is some residual soluble alkalinity (carbonates), pH values remain near neutral and the corresponding metal and cation amounts are relatively low (i.e. secondary minerals containing metals and other cations are pH dependent). Samples containing carbonate alkalinity show some correlation to lithology. Aplite and unaltered andesite have higher neutralization potential than mixed volcanics or other altered rock types. However, samples typically consist of more than one rock type and distinct lithological zones are difficult to determine in certain piles.

In general, there is significant secondary mineral accumulation in the mine rock and exceptional amounts at the base of WRD-2 and WRD-9. Mineralogical characterization studies on samples proposed in section 4.3 above will identify these minerals, and their sources, and would be used for calibration in geochemical speciation modeling. Understanding the secondary mineral development, in relation to all the physical and geochemical characteristics, is critical to understanding solution migration and potential evaporation processes that may or may not be occurring within the piles.

Water movement within the pile is of critical importance in determining the load of oxidation products that may be released into the environment. It is evident that there are soluble amounts of ‘contaminants’ present in the mine rock piles. It is not evident that these ‘contaminants’ are leaching out of the rock piles, in fact many of the temperature profiles suggest that evaporation is likely occurring. Most instrumented mine rock piles appear to be relatively “dry” near the base, i.e. showing (gravimetric) moisture contents typically less than 5%. No free water was observed during drilling or during subsequent monitoring of the standpipe slotted piezometers installed at the base of each pile.

The data collected to date strongly suggest that water movement in the mine rock piles is slow and occurs as unsaturated flow. Due to the inherent difficulty in measuring very low seepage rates at the base of the piles the seepage will likely have to be estimated indirectly by measuring the net infiltration through the upper-most layers of the mine rock piles.

Advective air flow has been identified as the likely dominant transport mechanism for oxygen within the piles. Air flow modeling will be carried out to assess the relative importance of (i) thermal convection (ii) wind-induced advection and (iii) barometric pumping. Thermal convection is clearly evident in several “hot piles” (e.g. WRD-2, 4 & 5). Thermal convection does not only influence the supply of oxygen for sulfide oxidation (by “sucking” fresh air potentially deep into the pile), but may also significantly influence the moisture distribution within a pile. The hot air near the base of the pile can potentially result in significant internal drying of the mine rock piles. The water vapour may be carried upward during convection. As the air cools on its way up to the pile surface the water vapour will condense releasing some of the moisture back to the mine rock matrix. In areas with very permeable mine rock, the air may have little opportunity to cool down and hot moist air may leave the pile producing the observable steaming vents.

Air flow modeling has been included as a new task in this work plan (Task 1.7) to evaluate the influence of air drying on the water balance of the various rock piles. The routine monitoring program in the rock piles (temperatures and pore gas constituents) has been designed to obtain the data required to calibrate the air flow model.

The kinetic test program currently on-going, the speciation modeling and the Phase 2 investigation and monitoring program have been designed to further our current understanding and, where information ‘gaps’ exist, to provide the data required to achieve a thorough and comprehensive understanding of the current and likely future geochemical and physical characteristics of the mine rock piles.

7.0 REFERENCES

Robertson GeoConsultants Inc. (1999a), Interim Report: Questa Waste Rock Pile Drilling, Instrumentation and Characterization Study. Report No. 052007/1 prepared for Molycorp Inc., September 6, 1999.

Robertson GeoConsultants Inc. (1999b), Progress Report: Questa Waste Rock Investigation: Workplans for Routine Monitoring, Geochemical and Physical Characterization. Report No. 052007/2 prepared for Molycorp Inc., November 1999.

Robertson GeoConsultants Inc. (2000), Work Plan for Questa Waste Rock Water Balance Study, Questa Mine Site, NM. Report No. 052008/4 prepared for Molycorp Inc., February 2000.

Stephen, Robertson and Kirsten (1999a), Preliminary Observations of Mine Waste Rock Piles at Questa New Mexico. Report prepared for Molycorp Inc., August 29, 1999.

Stephen, Robertson and Kirsten (1999b), Questa Waste Rock Investigation Waste Pile Instrumentation As-Built Report. Report No. 09215 prepared for Molycorp, Inc., and September 1999.

Molycorp, 1998. “Questa Mine Waste Rock Discharge Plan – Molycorp’s Response to Comments by NMED on Discharge Plan Application for Waste Rock, DP-1055”. Letter report submitted to NMED, July 31, 1998.

Molycorp, 1999. “Questa Mine Waste Rock Discharge Plan – Response to Comments and Requests by the Groundwater Water Quality Bureau in Letter dated April 29, 1999”. Letter report submitted to NMED, June 17, 1999.

Table 1. Summary of Field Characterization in Various Boreholes in Waste Rock.

Borehole	Location	Bench Level	Lithology[1]	Field Characterization	Geochemical Characterization	Preliminary Interpretation[2]
WRD-1	Spring Gulch	9100'	aplite in upper 25'; black andesite (w/ calcite) in lower portion	high paste pH & moderately low paste cond	Ave. NP/AP=1.2 [0.6-2.2]; Ave. $S_{(T)}$ = 0.77%; Ave. $S_{(SO4)}$=0.11%; soluble alkalinity throughout depth, moderate amounts of soluble SO_4, Ca (greater at surface), Mg, Mo.	Currently non-acid generating; considered 'uncertain' with respect to future potential acid generation; some sulfide oxidation (SO_4 production) and significant calcite buffering
WRD-2	Spring Gulch	9250'	hydrothermally altered mixed volcanics, some aplite at base	very low paste pH & high/very high paste cond	Ave. NP/AP <0.1 [<0.1-0.1]; Ave. $S_{(T)}$ = 3.52%; Ave. $S_{(SO4)}$=1.18%; no soluble alkalinity, moderate to significant amounts of soluble SO_4, Ca, Mg, Al, Cu, Zn +/- Co, Ni.	predominantly acid generating material; significant accumulation of secondary minerals near base (potentially due in part to evaporation - low MC, high T near base); no residual buffering capacity.
WRD-3	Sugar Shack South	8700'	unaltered andesite & aplite in upper 55'; hydrothermally altered andesite and mixed volcanics in lower portion	high paste pH & moderate paste cond in upper portion; moderate/low paste pH & high paste cond in lower portion	Ave. NP/AP=0.5 [0.1-1.5]; Ave. $S_{(T)}$ = 2.03%; Ave. $S_{(SO4)}$=0.63%; some soluble alkalinity (decreases with depth), moderate amounts of soluble SO_4, Ca, Mg, Al, Mn, Cu, Zn +/- Co, Ni (at depth) and Mo (near surface).	majority of material throughout depth considered potentially acid generating; alkalinity currently available in upper profile; negligible alkalinity available in lower profile (possibly related to lithology); accumulation of secondary minerals near base
WRD-4	Sugar Shack South	9150'	mix of hydrothermally altered mixed volcanics, aplite/granite, and unaltered grey volcanics	moderate paste pH and moderate/high paste cond	Ave. NP/AP=0.3 [0.2-0.6]; Ave. $S_{(T)}$ = 2.3%; Ave. $S_{(SO4)}$=0.83%; no soluble alkalinity in upper profile, moderate amounts of soluble SO_4, Ca, Mg, Mn, Zn.	mix of acid generating and currently non-acid generating material; majority considered potentially acid generating; calcite buffering in lower profile, some secondary mineral accumulation near surface.
WRD-5	Sugar Shack South	9250'	hydrothermally altered mixed volcanics in upper 25'; grey-green andesite (propylitic) in lower portion	low paste pH and moderate paste cond in upper portion; high paste pH and moderate paste cond in lower portion	Ave. NP/AP=0.3 [<0.1-0.6]; Ave. $S_{(T)}$ = 1.78%; Ave. $S_{(SO4)}$=0.43%; variable amounts of soluble alkalinity, SO_4, Ca, Mg, Al, Mn, Zn, Cu (pH dependent).	mix of acid generating and currently non-acid generating material; majority considered potentially acid generating; calcite buffering in certain intervals, some secondary mineral accumulation where acidic pH conditions prevail.
WRD-6	Sugar Shack West	9000'	hydrothermally altered mixed volcanics in upper 30'; unaltered tuff in grey-brown matrix at depth	low paste pH and moderate/ high paste cond in upper portion; high paste pH and moderate/ high paste cond in lower portion	Ave. NP/AP=0.2 [0.1-0.2]; Ave. $S_{(T)}$ = 2.21%; Ave. $S_{(SO4)}$=0.68%; no soluble alkalinity in upper ~25ft, some soluble alkalinity below 25ft; significant amounts of soluble SO_4, Ca, variable amounts of soluble Mg, Al, Mn, Zn, Cu +/- Co, Ni (pH dependent).	potentially acid-generating material throughout; secondary mineral accumulation in upper ~25ft (potentially related to lithology); predicted "acid front" at a depth of ~30ft; profiles typical of a diffusion-controlled air transport system.
WRD-7	Sugar Shack West	9400'	hydrothermally altered mixed volcanics (w/ aplite) in upper 30'; hydrothermally altered mixed volcanics (w/ rhyolite) in grey-brown matrix at depth	low paste pH and moderate high paste cond in upper portion; high paste pH and moderate/ low paste cond in lower portion	Ave. NP/AP=0.2 [<0.1-0.2]; Ave. $S_{(T)}$ =2.41%; Ave. $S_{(SO4)}$=0.53%; interval mid section with some soluble alkalinity, moderate amounts of soluble SO_4, Ca, Mg, and variable amounts of soluble Al, Mn, Zn +/- Cu (pH dependent).	potentially acid-generating material throughout; possible "acid front" at a depth of ~30ft; significant secondary mineral accumulation near surface; no residual buffering capacity at surface or base
WRD-8	Capulin	9810'	crystal rich grey tuff with altered (grey/light brown) clay matrix	low paste pH and moderate/ high paste cond	Ave. NP/AP <0.1; Ave. $S_{(T)}$ =1.68%; Ave. $S_{(SO4)}$=0.85%; no soluble alkalinity, significant amounts of soluble SO_4, Ca, Mg, Al, Mn, Zn +/- Cu.	acid-generating material throughout; significant secondary mineral accumulation throughout; no residual buffering capacity.
WRD-9	Capulin	9800'	mixed volcanics, tuff and black andesite	low paste pH and moderate/ high paste cond	Ave. NP/AP <0.1 [<0.1-0.1]; Ave. $S_{(T)}$ =1.23%; Ave. $S_{(SO4)}$=0.48%; no soluble alkalinity, moderate to significant amounts of soluble SO_4, Ca, Mg, Al, Mn, Zn (increasing with depth).	acid-generating material throughout; significant accumulation of secondary minerals near base (correlates with sulfide content); no residual buffering capacity.

Note:
(1) emphasis placed on weathered matrix (e.g. "hydrothermally altered mixed volcanics" characterized by yellow-brown matrix in field descriptions)
(2) based on preliminary data (needs to be confirmed by further geochemical testing and monitoring)

Table 2. Summary of rock types tested in previous study (after SRK, 1995)

Rock Type	No. of Samples Collected	ABA Analyses	Whole Rock Analyses	Shake Flask Extraction Test
Hydrothermal Scar	9	2	4	7
Aplite/Granite	8	7	5	1
Black Andesite	10	7	2	3
Mixed Volcanics	21	15	8	15

Table 3. Summary of number of samples tested using various test methods.

Test Method	Number of Samples Tested
Field Paste pH	182
Field Paste Conductivity	182
Field Moisture Content	160
Lab Paste pH	51
Lab Paste Conductivity	51
ABA	60
Acid Titration	13
Multi-Element ICP	29
Leach Extraction	29

Table 4. Acid Base Accounting (ABA) Results.

SAMPLE	RINSE pH	PASTE pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
WRD - 1 5 - 10	7.7	7.9	0.94	0.47	14.7	8.8	-5.9	0.6
WRD - 1 15 - 20	6.4	7.9	0.36	0.05	9.7	14.3	4.6	1.5
WRD - 1 20 - 25	7.7	8.0	0.41	0.04	11.6	9.9	-1.7	0.9
WRD - 1 20 - 25 DUPL.	7.1	7.8	0.46	0.08	11.9	10.2	-1.7	0.9
WRD - 1 30 - 35	7.0	8.0	1.81	0.07	54.4	31.5	-22.9	0.6
WRD - 1 50 - 55	7.8	8.2	0.92	0.06	26.9	30.4	3.5	1.1
WRD - 1 70 - 75	7.0	8.1	0.67	0.03	20.0	29.9	9.9	1.5
WRD - 1 85 - 90	7.9	8.1	0.57	0.08	15.3	34.3	18.9	2.2
MIN	6.4	7.8	0.36	0.03	9.7	8.8	-22.9	0.6
MAX	7.9	8.2	1.81	0.47	54.4	34.3	18.9	2.2
MEAN			0.77	0.11	20.5	21.1	0.6	1.2
STD DEV			0.47	0.15	14.7	11.3	12.3	0.6
WRD - 2 5 - 10	4.2	6.4	2.99	0.68	72.2	7.5	-64.7	0.1
WRD - 2 20 - 25	3.6	4.8	3.98	1.14	88.8	-0.4	-89.1	<0.1
WRD - 2 40 - 45	2.5	4.0	3.67	1.75	60.0	-4.5	-64.5	<0.1
WRD - 2 55 - 60	3.2	4.0	3.42	1.14	71.3	-5.1	-76.4	<0.1
MIN	2.5	4.0	2.99	0.68	60.0	-5.1	-89.1	<0.1
MAX	4.2	6.4	3.98	1.75	88.8	7.5	-64.5	0.1
MEAN			3.52	1.18	73.0	-0.6	-73.7	<0.1
STD DEV			0.42	0.44	11.8	5.8	11.7	
WRD - 3 0 - 5	5.9	7.2	1.40	0.43	30.3	17.8	-12.6	0.6
WRD - 3 20 - 25	6.5	7.6	1.02	0.25	24.1	35.8	11.7	1.5
WRD - 3 50 - 55	6.8	7.7	1.97	0.16	56.6	22.0	-34.6	0.4
WRD - 3 50 - 55 DUPL.	7.3	7.7	1.97	0.17	56.3	25.1	-31.1	0.4
WRD - 3 70 - 75	4.0	5.8	2.25	1.13	35.0	3.5	-31.5	0.1
WRD - 3 85 - 90	5.5	7.2	2.40	0.85	48.4	17.0	-31.4	0.4
WRD - 3 100 - 105	4.3	6.4	3.23	1.45	55.6	5.1	-50.5	0.1
MIN	4.0	5.8	1.02	0.16	24.1	3.5	-50.5	0.1
MAX	7.3	7.7	3.23	1.45	56.6	35.8	11.7	1.5
MEAN			2.03	0.63	43.8	18.0	-25.7	0.5
STD DEV			0.71	0.51	13.7	11.2	19.8	0.5
WRD - 4 5 - 10	5.0	6.5	2.29	0.91	43.1	10.3	-32.9	0.2
WRD - 4 25 - 30	7.2	7.9	2.10	0.39	53.4	31.5	-21.9	0.6
WRD - 4 40 - 45	4.7	6.8	2.34	1.01	41.6	10.9	-30.7	0.3
WRD - 4 50 - 55	4.9	6.5	2.45	1.44	31.6	7.5	-24.1	0.2
MIN	4.7	6.5	2.10	0.39	31.6	7.5	-32.9	0.2
MAX	7.2	7.9	2.45	1.44	53.4	31.5	-21.9	0.6
MEAN			2.30	0.94	42.4	15.0	-27.4	0.3
STD DEV			0.15	0.43	9.0	11.1	5.2	0.2
WRD - 5 5 - 10	6.9	7.9	2.75	0.14	81.6	24.5	-57.1	0.3
WRD - 5 20 - 25	4.1	4.7	1.87	1.04	25.9	-1.0	-26.9	0.0
WRD - 5 25 - 30	4.9	6.3	1.80	0.76	32.5	6.1	-26.4	0.2
WRD - 5 35 - 40	7.0	8.0	1.52	0.22	40.6	23.5	-17.1	0.6
WRD - 5 40 - 45	7.3	8.0	2.28	0.30	61.9	20.5	-41.4	0.3
WRD - 5 40 - 45 DUPL.	7.6	7.9	2.33	0.38	60.9	17.4	-43.6	0.3
WRD - 5 60 - 65	6.4	7.0	0.43	0.14	9.1	4.4	-4.7	0.5
MIN	4.1	4.7	0.43	0.14	9.1	-1.0	-57.1	0.0
MAX	7.6	8.0	2.75	1.04	81.6	24.5	-4.7	0.6
MEAN			1.85	0.43	44.6	13.6	-31.0	0.3
STD DEV			0.75	0.34	24.8	10.3	17.6	0.2
WRD - 6 0 - 5	2.7	7.2	1.62	0.80	25.6	-0.8	-26.4	<0.1
WRD - 6 10 - 15	3.4	4.1	1.69	1.02	20.9	-2.0	-22.9	<0.1
WRD - 6 20 - 25	3.6	4.2	2.42	0.96	45.6	-2.4	-48.0	<0.1
WRD - 6 25 - 30	4.6	6.1	2.18	0.76	44.4	4.4	-40.0	0.1
WRD - 6 30 - 35	7.2	7.6	2.88	0.29	80.9	19.5	-61.4	0.2
WRD - 6 45 - 50	6.8	7.8	2.16	0.35	56.6	12.5	-44.1	0.2
WRD - 6 50 - 55	7.4	7.7	2.53	0.56	61.6	8.3	-53.3	0.1
MIN	2.7	4.1	1.62	0.29	20.9	-2.4	-61.4	<0.1
MAX	7.4	7.8	2.88	1.02	80.9	19.5	-22.9	0.2
MEAN			2.21	0.68	47.9	5.6	-42.3	0.2
STD DEV			0.45	0.29	20.8	8.3	13.9	0.1

Table 4. Acid Base Accounting (ABA) Results.

SAMPLE		RINSE pH	PASTE pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
WRD - 7	5 - 10	3.7	4.7	2.95	0.49	76.9	0.2	-76.6	<0.1
WRD - 7	20 - 25	3.3	4.5	2.18	1.13	32.8	-0.8	-33.6	<0.1
WRD - 7	30 - 35	6.2	7.4	2.65	0.40	70.3	12.8	-57.6	0.2
WRD - 7	45 - 50	7.0	7.6	2.93	0.34	80.9	19.4	-61.6	0.2
WRD - 7	55 - 60	6.8	7.6	2.06	0.24	56.9	13.6	-43.3	0.2
WRD - 7	70 - 75	2.2	5.7	1.68	0.57	34.7	1.6	-33.1	<0.1
	MIN	2.2	4.5	1.68	0.24	32.8	-0.8	-76.6	<0.1
	MAX	7.0	7.6	2.95	1.13	80.9	19.4	-33.1	0.2
	MEAN			2.41	0.53	58.8	7.8	-50.9	0.2
	STD DEV			0.52	0.32	21.0	8.5	17.3	0.0
WRD - 8	10 - 15	3.8	3.7	1.29	0.80	15.3	-4.6	-19.9	<0.1
WRD - 8	25 - 30	3.0	4.3	1.30	0.86	13.8	-2.8	-16.5	<0.1
WRD - 8	40 - 45	4.0	4.5	1.68	1.09	18.4	-3.0	-21.4	<0.1
WRD - 8	55 - 60	2.8	4.3	2.45	0.75	53.1	-2.9	-56.0	<0.1
WRD - 8	70 - 75	4.1	4.0	1.69	0.75	29.4	-3.6	-33.0	<0.1
	MIN	2.8	3.7	1.29	0.75	13.8	-4.6	-56.0	<0.1
	MAX	4.1	4.5	2.45	1.09	53.1	-2.8	-16.5	<0.1
	MEAN			1.68	0.85	26.0	-3.4	-29.4	
	STD DEV			0.47	0.14	16.3	0.8	16.1	
WRD - 9	10 - 15	2.7	4.4	0.47	0.32	4.7	-0.9	-5.6	<0.1
WRD - 9	20 - 25	4.5	4.5	0.55	0.29	8.1	-1.1	-9.3	<0.1
WRD - 9	45 - 50	4.0	3.9	0.58	0.41	5.3	-2.2	-7.5	<0.1
WRD - 9	75 - 80	3.9	5.6	1.42	0.60	25.6	3.5	-22.1	0.1
WRD - 9	95 - 100	4.1	4.3	1.54	0.62	28.8	-2.4	-31.1	<0.1
WRD - 9	95 - 100 DUPL.	4.0	4.3	1.52	0.59	29.1	-1.4	-30.4	<0.1
WRD - 9	110 - 115	4.1	4.7	2.53	0.53	62.5	1.3	-61.3	<0.1
	MIN	2.7	3.9	0.47	0.29	4.7	-2.4	-61.3	<0.1
	MAX	4.5	5.6	2.53	0.62	62.5	3.5	-5.6	0.1
	MEAN			1.23	0.48	23.4	-0.5	-23.9	<0.1
	STD DEV			0.75	0.14	20.4	2.1	19.6	
SSB - 1	0-5	3.8	4.8	0.94	0.55	12.2	0.9	-11.3	0.1
SSB - 1	9-14	3.1	4.1	1.04	0.60	13.8	0.0	-16.0	<0.1
SSB - 1	24-29	5.2	6.5	2.95	0.34	81.6	8.1	-73.4	0.1
	MIN	3.1	4.1	0.9	0.3	12.2	0.0	-73.4	<0.1
	MAX	5.2	6.5	3.0	0.6	81.6	8.1	-11.3	0.1
	MEAN			1.64	0.50	35.83	3.00	-33.58	0.09
	STD DEV			1.13	0.14	39.61	4.46	34.59	0.02
SSB - 2	9-14	2.9	3.8	1.98	1.83	4.7	0.0	-10.4	<0.1
SSB - 2	24-29	3.3	3.9	1.94	1.54	12.5	0.0	-20.4	<0.1
SSB - 2	39-44	3.5	4.2	1.55	1.32	7.2	0.0	-14.6	<0.1
SSB - 2	49-54	3.8	4.7	0.95	0.60	10.9	2.4	-8.6	0.2
SSB - 2	64-69	4.5	6.1	1.25	0.31	29.4	6.1	-23.3	0.2
	MIN	2.9	3.8	1.0	0.3	4.7	0.0	-23.3	<0.1
	MAX	4.5	6.1	2.0	1.8	29.4	6.1	-8.6	0.2
	MEAN			1.53	1.12	12.94	1.70	-15.44	0.10
	STD DEV			0.44	0.64	9.69	2.68	6.29	0.01

AP = ACID POTENTIAL IN TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.
NP = NEUTRALIZATION POTENTIAL IN TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.
NET NP = NET NEUTRALIZATION POTENTIAL = TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.
NOTE: WHEN S(T) AND/OR S(SO4) IS REPORTED AS <0.01, IT IS ASSUMED TO BE ZERO FOR THE AP CALCULATION.
*RINSE pH ON "AS-RECEIVED" MATERIAL, 50 GRAMS OF SAMPLE IN 50 MLS DISTILLED WATER.
DUPL. = DUPLICATE.

Table 5. Multi-Element ICP Results.

SAMPLE:		WRD - 1 5-10	WRD - 1 20-25	WRD - 1 50-55	WRD - 1 85-90	WRD - 2 40-45	WRD - 2 55-60	WRD - 3 20-25	WRD - 3 50-55	WRD - 3 100-105	WRD - 4 5-10	WRD - 5 5-10	WRD - 5 20-25	WRD - 5 40-45	WRD - 6 0-5	WRD - 6 20-25	WRD - 6 30-35	WRD - 7 5-10	WRD - 7 45-50	WRD - 7 70-75	WRD - 8 25-30	WRD - 8 55-60
Ag	ppm	<0.2	<0.2	<0.2	<0.2	0.2	0.2	0.6	<0.2	<0.2	<0.2	<0.2	0.4	0.4	0.2	0.4	0.4	0.6	<0.2	0.2	0.4	<0.2
Al	%	0.56	0.52	2.78	1.27	0.94	1.14	1.91	1.32	1.25	1.63	1.32	1.39	1.61	1.11	1.31	1.29	0.95	1.01	0.76	0.36	0.64
As	ppm	5	<5	<5	<5	<5	<5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	<5	5
Ba	ppm	120	20	440	150	90	80	100	100	100	130	80	100	90	100	50	60	70	70	80	20	50
Be	ppm	0.5	0.5	<0.5	0.5	0.5	0.5	1.5	1	0.5	0.5	1	1	1	0.5	1	1	0.5	1	0.5	1	1
Bi	ppm	<5	<5	<5	<5	5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	5	5	5	5
Ca	%	1.25	0.76	1.40	1.90	1.24	0.92	2.82	1.43	2.03	1.50	1.34	1.17	1.28	0.81	1.19	1.21	0.66	1.35	0.75	0.83	0.74
Cd	ppm	<1	<1	1	<1	1	<1	3	1	1	1	1	1	1	<1	1	1	2	<1	<1	1	1
Co	ppm	6	3	27	9	9	12	16	15	16	19	15	9	14	8	12	21	11	13	6	1	5
Cr	ppm	153	165	217	175	86	110	177	130	170	146	141	124	113	115	96	118	90	109	130	152	123
Cu	ppm	120	89	242	146	123	98	126	162	97	154	144	188	371	118	211	235	93	211	129	50	27
Fe	%	1.16	0.98	5.32	3.35	4.92	3.74	3.99	3.40	3.71	4.16	3.97	3.90	4.15	3.44	4.17	4.33	4.09	3.94	2.98	1.62	2.41
K	%	0.28	0.21	2.08	0.48	0.67	0.58	0.71	0.77	0.78	0.86	0.54	0.39	0.50	0.42	0.32	0.40	0.29	0.37	0.29	0.24	0.25
Mg	%	0.16	0.16	3.71	0.72	0.43	0.59	1.65	1.08	0.92	1.43	0.99	0.96	1.48	0.82	0.91	1.03	0.58	0.50	0.43	0.03	0.15
Mn	ppm	370	390	565	840	125	195	1690	550	385	570	550	635	1455	410	450	1285	650	520	420	540	405
Mo	ppm	150	154	60	202	22	26	550	216	188	146	12	12	8	10	10	12	38	16	10	14	12
Na	%	0.03	0.03	0.07	0.04	0.05	0.03	0.05	0.03	0.03	0.05	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0.01	0.01
Ni	ppm	14	7	67	23	24	30	57	44	54	57	44	30	43	29	35	42	29	34	16	7	18
P	ppm	430	230	2330	1530	1240	1230	1560	1190	1520	1730	1190	1250	1280	1000	1030	1030	1000	1160	810	100	470
Pb	ppm	64	32	8	14	70	104	56	24	20	44	42	58	68	54	90	72	268	46	50	264	68
Sb	ppm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Sc	ppm	1	1	13	4	1	1	6	4	3	5	2	2	2	2	2	2	1	1	1	<1	1
Sn	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sr	ppm	171	26	195	455	214	93	181	93	433	299	218	105	223	157	152	120	112	196	90	32	823
Ti	%	0.01	0.01	0.43	0.06	0.02	0.01	0.20	0.07	0.06	0.11	0.03	0.04	0.03	0.03	0.05	0.03	0.01	0.01	0.01	<0.01	<0.01
V	ppm	11	8	171	67	20	18	83	51	46	65	32	36	39	33	40	34	17	21	17	2	7
W	ppm	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Y	ppm	6	7	15	10	3	3	12	8	7	8	10	4	6	4	7	10	4	7	4	10	8
Zn	ppm	71	45	48	28	36	67	341	38	39	122	75	88	126	65	98	166	320	61	43	274	257
Zr	ppm	2	2	8	5	5	5	6	4	4	4	6	4	4	4	4	5	5	5	5	4	6

Table 5. Multi-Element ICP Results.

SAMPLE:		WRD - 9 20-25	WRD - 9 45-50	WRD - 9 95-100	WRD - 9 110-115	SSB-1 0-5'	SSB-1 9-14'	SSB-2 24-29'	SSB-2 39-44'
Ag	ppm	0.4	0.2	0.2	0.4	0.2	0.2	0.6	<0.2
Al	%	0.55	0.23	1.38	1.21	1.47	1.07	1.22	1.17
As	ppm	10	<5	5	<5	<5	<5	<5	<5
Ba	ppm	40	30	130	70	200	140	110	50
Be	ppm	0.5	<0.5	1	1.5	0.5	0.5	0.5	0.5
Bi	ppm	5	5	<5	<5	<5	<5	5	<5
Ca	%	0.12	0.01	0.45	0.60	0.50	0.28	1.06	1.18
Cd	ppm	<1	<1	1	3	1	1	1	1
Co	ppm	2	<1	8	14	5	6	5	8
Cr	ppm	192	89	109	116	217	120	160	159
Cu	ppm	32	12	47	34	48	46	78	46
Fe	%	1.79	1.36	3.54	3.70	4.08	4.05	5.73	7.01
K	%	0.28	0.36	0.34	0.28	0.64	0.59	0.36	0.13
Mg	%	0.13	0.02	0.68	0.83	0.91	0.63	0.98	1.02
Mn	ppm	230	55	815	1345	245	230	340	310
Mo	ppm	16	28	14	16	12	14	10	2
Na	%	0.04	0.01	0.01	0.02	0.06	0.04	0.06	0.08
Ni	ppm	9	5	30	43	34	30	30	32
P	ppm	250	90	1200	1190	1300	1200	1490	1420
Pb	ppm	54	42	164	78	58	54	46	44
Sb	ppm	<5	<5	<5	<5	<5	<5	5	<5
Sc	ppm	<1	<1	2	2	3	2	2	2
Sn	ppm	<10	<10	<10	<10	<10	<10	<10	<10
Sr	ppm	16	7	24	29	111	68	95	103
Ti	%	<0.01	<0.01	<0.01	<0.01	0.04	0.04	0.01	0.01
V	ppm	6	2	25	23	44	39	59	66
W	ppm	<10	<10	<10	<10	<10	<10	<10	<10
Y	ppm	7	3	10	14	3	3	1	2
Zn	ppm	70	21	222	354	47	33	42	52
Zr	ppm	4	5	4	5	4	4	4	5

Table 6. Leach Extraction Results

SAMPLE	FROM	TO	DISTILLED WATER VOLUME (mL)	SAMPLE WEIGHT (g)	pH	REDOX (mV)	CONDUCTIVITY (uS/cm)	Alkalinity (mg CaCO3/L)	ACIDITY (pH 4.5) (mg CaCO3/L)	Acidity (pH 8.3) (mg CaCO3/L)	SULPHATE (mg/L)	Al mg/L	Sb mg/L	As mg/L	Ba mg/L
WRD - 1 5-10	5	10	400	200	7.37	286	2020	28.5	0.0	4.0	1460	<0.2	<0.2	<0.2	0.05
WRD - 1 20-25	20	25	400	200	7.55	282	1305	32.0	0.0	8.5	797	<0.2	<0.2	<0.2	<0.01
WRD - 1 50-55	50	55	400	200	7.60	286	1410	32.0	0.0	6.5	868	<0.2	<0.2	<0.2	0.09
WRD - 1 85-90	85	90	400	200	7.72	280	860	37.0	0.0	4.5	452	<0.2	<0.2	<0.2	0.06
WRD - 2 40-45	40	45	400	200	3.09	472	3370	0.0	330.0	890.0	2760	169	<0.2	<0.2	<0.01
WRD - 2 55-60	55	60	400	200	3.48	456	4010	0.0	600.0	1610.0	4060	296	<0.2	<0.2	<0.01
WRD - 3 20-25	20	25	400	200	7.55	311	1955	33.0	0.0	4.0	1350	<0.2	<0.2	<0.2	0.01
WRD - 3 50-55	50	55	400	200	7.47	309	1916	26.0	0.0	4.0	1320	<0.2	<0.2	<0.2	0.02
WRD - 3 100-105	100	105	400	200	4.39	404	2530	0.0	2.0	222.0	2140	32.4	<0.2	<0.2	0.02
WRD - 4 5-10	5	10	400	200	5.01	409	2400	4.0	0.0	106.0	1880	11.4	<0.2	<0.2	0.01
WRD - 5 5-10	5	10	400	200	7.50	320	2010	30.0	0.0	4.0	1430	<0.2	<0.2	<0.2	0.02
WRD - 5 20-25	20	25	400	200	3.83	473	2660	0.0	156.0	522.0	2220	72.7	<0.2	<0.2	0.01
WRD - 5 40-45	40	45	400	200	7.52	313	2470	28.0	0.0	5.5	2040	<0.2	<0.2	<0.2	0.04
WRD - 6 0-5	0	5	400	200	3.04	473	2720	0.0	205.0	565.0	2150	82.0	<0.2	<0.2	0.01
WRD - 6 20-25	20	25	400	200	3.64	455	2790	0.0	395.0	945.0	2520	179	<0.2	<0.2	0.02
WRD - 6 30-35	30	35	400	200	7.37	351	2050	30.0	0.0	7.0	1630	<0.2	<0.2	<0.2	0.04
WRD - 7 5-10	5	10	400	200	4.00	420	2116	0.0	11.0	216.0	1710	36.1	<0.2	<0.2	0.01
WRD - 7 45-50	45	50	400	200	7.49	341	2070	26.0	0.0	8.0	1530	<0.2	<0.2	<0.2	0.02
WRD - 7 70-75	70	75	400	200	4.52	408	1978	0.0	0.0	53.0	1470	7.1	<0.2	<0.2	0.02
WRD - 8 25-30	25	30	400	200	3.58	442	2670	0.0	161.0	630.0	2280	82.7	<0.2	<0.2	<0.01
WRD - 8 55-60	55	60	400	200	3.85	452	2630	0.0	237.5	772.5	2450	122	<0.4	<0.4	<0.02
WRD - 9 20-25	20	25	400	200	3.81	431	1245	0.0	10.0	160.0	738	20.7	<0.2	<0.2	<0.01
WRD - 9 45-50	45	50	400	200	2.87	500	1253	0.0	247.5	492.5	672	61.1	<0.2	<0.2	<0.01
WRD - 9 95-100	95	100	400	200	3.79	458	2320	0.0	45.0	387.5	1900	48.6	<0.2	<0.2	<0.01
WRD - 9 110-115	110	115	400	200	3.96	456	3280	0.0	137.5	740.0	3060	112	<0.2	<0.2	<0.01
SSB-1 0-5'	0	5	400	200	4.02	462	1361	0.0	5.0	50.0	883	6.2	<0.2	<0.2	<0.01
SSB-1 9-14'	9	14	400	200	3.33	497	1403	0.0	42.5	162.5	798	16.0	<0.2	<0.2	<0.01
SSB-2 24-29'	24	29	400	200	3.48	491	2670	0.0	155.0	630.0	2250	92.7	<0.2	<0.2	<0.01
SSB-2 39-44'	39	44	400	200	3.65	486	2590	0.0	50.0	380.0	2080	51.1	<0.2	<0.2	<0.01

Table 6. Leach Extraction Results

SAMPLE	DISSOLVED METALS														
	Be	Bi	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Li	Mg	Mn	Mo	Ni
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
WRD - 1 5-10	<0.005	<0.1	<0.1	<0.01	561	<0.01	<0.01	0.02	<0.03	<0.05	<0.01	14.4	1.44	0.55	<0.05
WRD - 1 20-25	<0.005	<0.1	<0.1	<0.01	298	<0.01	<0.01	<0.01	<0.03	<0.05	<0.01	11.1	0.249	1.89	<0.05
WRD - 1 50-55	<0.005	<0.1	<0.1	<0.01	301	<0.01	<0.01	<0.01	<0.03	<0.05	0.02	18.8	0.065	1.67	<0.05
WRD - 1 85-90	<0.005	<0.1	<0.1	<0.01	153	<0.01	<0.01	<0.01	<0.03	<0.05	0.01	9.4	0.178	0.97	<0.05
WRD - 2 40-45	0.020	<0.1	<0.1	<0.01	503	0.13	0.37	5.07	17.3	<0.05	0.47	187	10.2	<0.03	0.76
WRD - 2 55-60	0.043	<0.1	<0.1	0.02	514	0.07	0.72	8.57	18.1	<0.1	1.11	405	18.0	<0.03	1.41
WRD - 3 20-25	<0.005	<0.1	<0.1	<0.01	498	<0.01	<0.01	0.01	<0.03	<0.05	0.03	23.6	0.618	1.00	<0.05
WRD - 3 50-55	<0.005	<0.1	<0.1	<0.01	466	<0.01	<0.01	0.02	<0.03	<0.05	0.02	57.5	0.726	0.56	<0.05
WRD - 3 100-105	0.014	<0.1	<0.1	<0.01	515	<0.01	0.58	2.69	0.81	0.08	0.28	156	19.6	<0.03	1.15
WRD - 4 5-10	<0.005	<0.1	<0.1	0.10	500	<0.01	0.51	0.53	<0.03	<0.05	0.14	134	20.9	<0.03	0.58
WRD - 5 5-10	<0.005	<0.1	<0.1	<0.01	399	<0.01	<0.01	<0.01	<0.03	<0.05	<0.01	73.4	1.82	0.05	<0.05
WRD - 5 20-25	0.030	0.2	<0.1	0.03	519	0.03	0.59	3.92	2.95	0.11	0.35	159	24.6	<0.03	0.88
WRD - 5 40-45	<0.005	<0.1	<0.1	<0.01	343	<0.01	<0.01	<0.01	<0.03	<0.05	0.02	235	0.376	0.03	<0.05
WRD - 6 0-5	0.045	<0.1	<0.1	0.01	419	0.09	0.53	5.41	10.9	<0.05	0.29	98.8	20.0	<0.03	0.80
WRD - 6 20-25	0.070	<0.1	<0.1	0.02	490	<0.01	0.66	12.5	1.02	<0.05	0.85	76.4	14.1	<0.03	1.33
WRD - 6 30-35	<0.005	<0.1	<0.1	<0.01	409	<0.01	<0.01	<0.01	<0.03	<0.05	<0.01	138	9.77	<0.03	<0.05
WRD - 7 5-10	0.029	<0.1	<0.1	0.10	577	<0.01	0.24	4.29	4.05	<0.05	0.20	43.7	28.5	<0.03	0.36
WRD - 7 45-50	<0.005	<0.1	<0.1	<0.01	426	<0.01	<0.01	<0.01	<0.03	<0.05	<0.01	108	0.462	<0.03	<0.05
WRD - 7 70-75	0.005	<0.1	<0.1	<0.01	484	<0.01	0.09	1.20	0.60	<0.05	0.04	37.8	14.7	<0.03	0.10
WRD - 8 25-30	0.129	<0.1	<0.1	0.10	441	<0.01	0.16	3.47	0.68	0.15	0.11	29.6	139	<0.03	0.50
WRD - 8 55-60	0.14	<0.2	<0.2	0.21	564	<0.02	0.27	1.88	5.09	<0.2	0.24	60.1	107	<0.06	0.9
WRD - 9 20-25	0.018	<0.1	<0.1	0.02	173	<0.01	0.08	0.70	0.58	<0.05	0.05	25.5	20.0	<0.03	0.36
WRD - 9 45-50	0.010	<0.1	<0.1	0.01	22.0	0.06	0.09	1.26	14.2	<0.05	0.05	18.1	12.9	<0.03	0.28
WRD - 9 95-100	0.047	<0.1	<0.1	0.09	324	<0.01	0.40	1.12	1.57	<0.05	0.28	151	45.2	<0.03	0.73
WRD - 9 110-115	0.112	<0.1	<0.1	0.39	441	<0.01	1.66	1.68	1.90	<0.1	0.27	266	185	<0.03	2.52
SSB-1 0-5'	<0.005	<0.1	<0.1	<0.01	263	<0.01	0.05	0.15	0.06	<0.05	0.02	9.0	1.34	<0.03	0.07
SSB-1 9-14'	<0.005	<0.1	<0.1	<0.01	222	<0.01	0.13	0.59	1.20	<0.05	0.04	16.2	3.07	<0.03	0.13
SSB-2 24-29'	0.020	<0.1	<0.1	<0.01	412	0.02	0.26	1.13	2.42	<0.05	0.12	96.7	5.83	<0.03	0.71
SSB-2 39-44'	0.009	<0.1	<0.1	<0.01	394	<0.01	0.19	0.37	0.47	<0.05	0.10	86.1	5.85	<0.03	0.51

Table 6. Leach Extraction Results

SAMPLE	P mg/L	K mg/L	Se mg/L	Si mg/L	Ag mg/L	Na mg/L	Sr mg/L	Tl mg/L	Sn mg/L	Ti mg/L	V mg/L	Zn mg/L
WRD - 1 5-10	<0.3	9	<0.2	1.60	<0.01	5	4.34	<0.2	<0.03	<0.01	<0.03	0.044
WRD - 1 20-25	<0.3	8	<0.2	1.74	<0.01	2	1.23	<0.2	<0.03	<0.01	<0.03	0.008
WRD - 1 50-55	<0.3	20	<0.2	1.31	<0.01	7	5.24	<0.2	<0.03	<0.01	<0.03	<0.005
WRD - 1 85-90	<0.3	7	<0.2	1.24	<0.01	13	7.60	<0.2	<0.03	<0.01	<0.03	<0.005
WRD - 2 40-45	<0.3	<2	<0.2	3.75	<0.02	<2	0.656	<0.2	<0.03	<0.01	<0.03	1.95
WRD - 2 55-60	0.6	<2	<0.2	1.40	<0.01	<2	0.648	<0.2	<0.03	<0.01	<0.03	3.99
WRD - 3 20-25	<0.3	6	<0.2	1.15	<0.01	5	3.64	<0.2	<0.03	<0.01	<0.03	0.072
WRD - 3 50-55	<0.3	13	<0.2	1.27	<0.01	6	5.79	<0.2	<0.03	<0.01	<0.03	0.005
WRD - 3 100-105	<0.3	2	<0.2	1.39	<0.01	<2	3.62	<0.2	<0.03	<0.01	<0.03	1.48
WRD - 4 5-10	<0.3	7	<0.2	3.49	<0.01	3	2.94	<0.2	<0.03	<0.01	<0.03	5.25
WRD - 5 5-10	<0.3	10	<0.2	1.27	<0.01	2	8.25	<0.2	<0.03	<0.01	<0.03	<0.005
WRD - 5 20-25	<0.3	<2	<0.2	4.07	0.09	2	2.58	<0.2	<0.03	0.01	0.08	5.44
WRD - 5 40-45	<0.3	11	<0.2	1.01	<0.01	4	5.35	<0.2	<0.03	<0.01	<0.03	0.005
WRD - 6 0-5	<0.3	<2	<0.2	3.85	<0.01	<2	1.37	<0.2	<0.03	<0.01	<0.03	3.89
WRD - 6 20-25	n/a	<2	<0.2	3.83	<0.01	<2	5.79	<0.2	<0.03	<0.01	<0.03	5.60
WRD - 6 30-35	<0.3	9	<0.2	0.95	<0.01	3	5.93	<0.2	<0.03	<0.01	<0.03	0.029
WRD - 7 5-10	<0.3	3	<0.2	3.10	<0.01	<2	4.42	<0.2	<0.03	<0.01	<0.03	17.2
WRD - 7 45-50	<0.3	11	<0.2	1.66	<0.01	4	5.38	<0.2	<0.03	<0.01	<0.03	<0.005
WRD - 7 70-75	<0.3	7	<0.2	2.34	<0.01	4	3.37	<0.2	<0.03	<0.01	<0.03	0.725
WRD - 8 25-30	<0.3	<2	<0.2	1.95	<0.01	5	1.15	<0.2	<0.03	<0.01	<0.03	42.7
WRD - 8 55-60	<0.6	<4	<0.4	2.4	<0.03	<4	3.27	<0.4	<0.06	<0.02	<0.06	42.3
WRD - 9 20-25	<0.3	2	<0.2	3.16	<0.01	3	0.275	<0.2	<0.03	<0.01	<0.03	4.14
WRD - 9 45-50	<0.3	<2	<0.2	1.25	<0.01	<2	0.054	<0.2	<0.03	<0.01	<0.03	3.26
WRD - 9 95-100	<0.3	2	<0.2	3.50	<0.01	<2	0.142	<0.2	<0.03	<0.01	<0.03	14.0
WRD - 9 110-115	<0.3	3	<0.2	2.13	<0.03	<2	0.488	<0.2	<0.03	<0.01	<0.03	51.5
SSB-1 0-5'	<0.3	3	<0.2	3.42	<0.01	<2	0.242	<0.2	<0.03	<0.01	<0.03	0.231
SSB-1 9-14'	<0.3	<2	<0.2	4.14	<0.02	3	0.069	<0.2	<0.03	<0.01	<0.03	0.611
SSB-2 24-29'	<0.3	<2	<0.2	2.36	<0.01	<2	0.459	<0.2	<0.03	<0.01	<0.03	0.779
SSB-2 39-44'	<0.3	<2	<0.2	3.84	<0.01	<2	0.428	<0.2	<0.03	<0.01	<0.03	0.678

Table 7. Calculated Leachate Chemistry (on per weight basis).

SAMPLE	FROM	TO	DISTILLED WATER VOLUME (mL)	SAMPLE WEIGHT (g)	pH	REDOX. (mV)	CONDUCTIVITY (uS/cm)	Alkalinity (mg CaCO3/L)	ACIDITY (pH 4.5) (mg CaCO3/L)	Acidity (pH 8.3) (mg CaCO3/L)	Sulphate mg/kg	Al mg/kg	Sb mg/kg	As mg/kg	Ba mg/kg	Be mg/kg
WRD - 1 5-10	5	10	400	200	7.37	286	2020	28.5	0.0	4.0	2920				0.1	
WRD - 1 20-25	20	25	400	200	7.55	282	1305	32.0	0.0	8.5	1594					
WRD - 1 50-55	50	55	400	200	7.60	286	1410	32.0	0.0	6.5	1736				0.18	
WRD - 1 85-90	85	90	400	200	7.72	280	860	37.0	0.0	4.5	904				0.12	
WRD - 2 40-45	40	45	400	200	3.09	472	3370	0.0	330.0	890.0	5520	338				0.04
WRD - 2 55-60	55	60	400	200	3.48	456	4010	0.0	600.0	1610.0	8120	592				0.086
WRD - 3 20-25	20	25	400	200	7.55	311	1955	33.0	0.0	4.0	2700				0.02	
WRD - 3 50-55	50	55	400	200	7.47	309	1916	26.0	0.0	4.0	2640				0.04	
WRD - 3 100-105	100	105	400	200	4.39	404	2530	0.0	2.0	222.0	4280	64.8			0.04	0.028
WRD - 4 5-10	5	10	400	200	5.01	409	2400	4.0	0.0	106.0	3760	22.8			0.02	
WRD - 5 5-10	5	10	400	200	7.50	320	2010	30.0	0.0	4.0	2860				0.04	
WRD - 5 20-25	20	25	400	200	3.83	473	2660	0.0	156.0	522.0	4440	145.4			0.02	0.06
WRD - 5 40-45	40	45	400	200	7.52	313	2470	28.0	0.0	5.5	4080				0.08	
WRD - 6 0-5	0	5	400	200	3.04	473	2720	0.0	205.0	565.0	4300	164			0.02	0.09
WRD - 6 20-25	20	25	400	200	3.64	455	2790	0.0	395.0	945.0	5040	358			0.04	0.14
WRD - 6 30-35	30	35	400	200	7.37	351	2050	30.0	0.0	7.0	3260				0.08	
WRD - 7 5-10	5	10	400	200	4.00	420	2116	0.0	11.0	216.0	3420	72.2			0.02	0.058
WRD - 7 45-50	45	50	400	200	7.49	341	2070	26.0	0.0	8.0	3060				0.04	
WRD - 7 70-75	70	75	400	200	4.52	408	1978	0.0	0.0	53.0	2940	14.2			0.04	0.01
WRD - 8 25-30	25	30	400	200	3.58	442	2670	0.0	161.0	630.0	4560	165.4				0.258
WRD - 8 55-60	55	60	400	200	3.85	452	2630	0.0	237.5	772.5	4900	244				0.28
WRD - 9 20-25	20	25	400	200	3.81	431	1245	0.0	10.0	160.0	1476	41.4				0.036
WRD - 9 45-50	45	50	400	200	2.87	500	1253	0.0	247.5	492.5	1344	122.2				0.02
WRD - 9 95-100	95	100	400	200	3.79	458	2320	0.0	45.0	387.5	3800	97.2				0.094
WRD - 9 110-115	110	115	400	200	3.96	456	3280	0.0	137.5	740.0	6120	224				0.224
SSB-1 0-5'	0	5	400	200	4.02	462	1361	0.0	5.0	50.0	1766	12.4				
SSB-1 9-14'	9	14	400	200	3.33	497	1403	0.0	42.5	162.5	1596	32				
SSB-2 24-29'	24	29	400	200	3.48	491	2670	0.0	155.0	630.0	4500	185.4				0.04
SSB-2 39-44'	39	44	400	200	3.65	486	2590	0.0	50.0	380.0	4160	102.2				0.018

Table 7. Calculated Leachate Chemistry (on per weight basis).

SAMPLE	CALCULATED METALS (PER WEIGHT BASIS)																
	Bi mg/kg	B mg/kg	Cd mg/kg	Ca mg/kg	Cr mg/kg	Co mg/kg	Cu mg/kg	Fe mg/kg	Pb mg/kg	Li mg/kg	Mg mg/kg	Mn mg/kg	Mo mg/kg	Ni mg/kg	P mg/kg	K mg/kg	Se mg/kg
WRD - 1 5-10				1122			0.04				28.8	2.88	1.1			18	
WRD - 1 20-25				596							22.2	0.498	3.78			16	
WRD - 1 50-55				602						0.04	37.6	0.13	3.34			40	
WRD - 1 85-90				306						0.02	18.8	0.356	1.94			14	
WRD - 2 40-45				1006	0.26	0.74	10.14	34.6		0.94	374	20.4		1.52			
WRD - 2 55-60			0.04	1028	0.14	1.44	17.14	36.2		2.22	810	36		2.82	1.2		
WRD - 3 20-25				996			0.02			0.06	47.2	1.236	2			12	
WRD - 3 50-55				932			0.04			0.04	115	1.452	1.12			26	
WRD - 3 100-105				1030		1.16	5.38	1.62	0.16	0.56	312	39.2		2.3		4	
WRD - 4 5-10			0.2	1000		1.02	1.06			0.28	268	41.8		1.16		14	
WRD - 5 5-10				798							146.8	3.64	0.1			20	
WRD - 5 20-25	0.4		0.06	1038	0.06	1.18	7.84	5.9	0.22	0.7	318	49.2		1.76			
WRD - 5 40-45				686						0.04	470	0.752	0.06			22	
WRD - 6 0-5			0.02	838	0.18	1.06	10.82	21.8		0.58	197.6	40		1.6			
WRD - 6 20-25			0.04	980		1.32	25	2.04		1.7	152.8	28.2		2.66			
WRD - 6 30-35				818							276	19.54				18	
WRD - 7 5-10			0.2	1154		0.48	8.58	8.1		0.4	87.4	57		0.72		6	
WRD - 7 45-50				852							216	0.924				22	
WRD - 7 70-75				968		0.18	2.4	1.2		0.08	75.6	29.4		0.2		14	
WRD - 8 25-30			0.2	882		0.32	6.94	1.36	0.3	0.22	59.2	278		1			
WRD - 8 55-60			0.42	1128		0.54	3.76	10.18		0.48	120.2	214		1.8			
WRD - 9 20-25			0.04	346		0.16	1.4	1.16		0.1	51	40		0.72		4	
WRD - 9 45-50			0.02	44	0.12	0.18	2.52	28.4		0.1	36.2	25.8		0.56			
WRD - 9 95-100			0.18	648		0.8	2.24	3.14		0.56	302	90.4		1.46		4	
WRD - 9 110-115			0.78	882		3.32	3.36	3.8		0.54	532	370		5.04		6	
SSB-1 0-5'				526		0.1	0.3	0.12		0.04	18	2.68		0.14		6	
SSB-1 9-14'				444		0.26	1.18	2.4		0.08	32.4	6.14		0.26			
SSB-2 24-29'				824	0.04	0.52	2.26	4.84		0.24	193.4	11.66		1.42			
SSB-2 39-44'				788		0.38	0.74	0.94		0.2	172.2	11.7		1.02			

Table 7. Calculated Leachate Chemistry (on per weight basis).

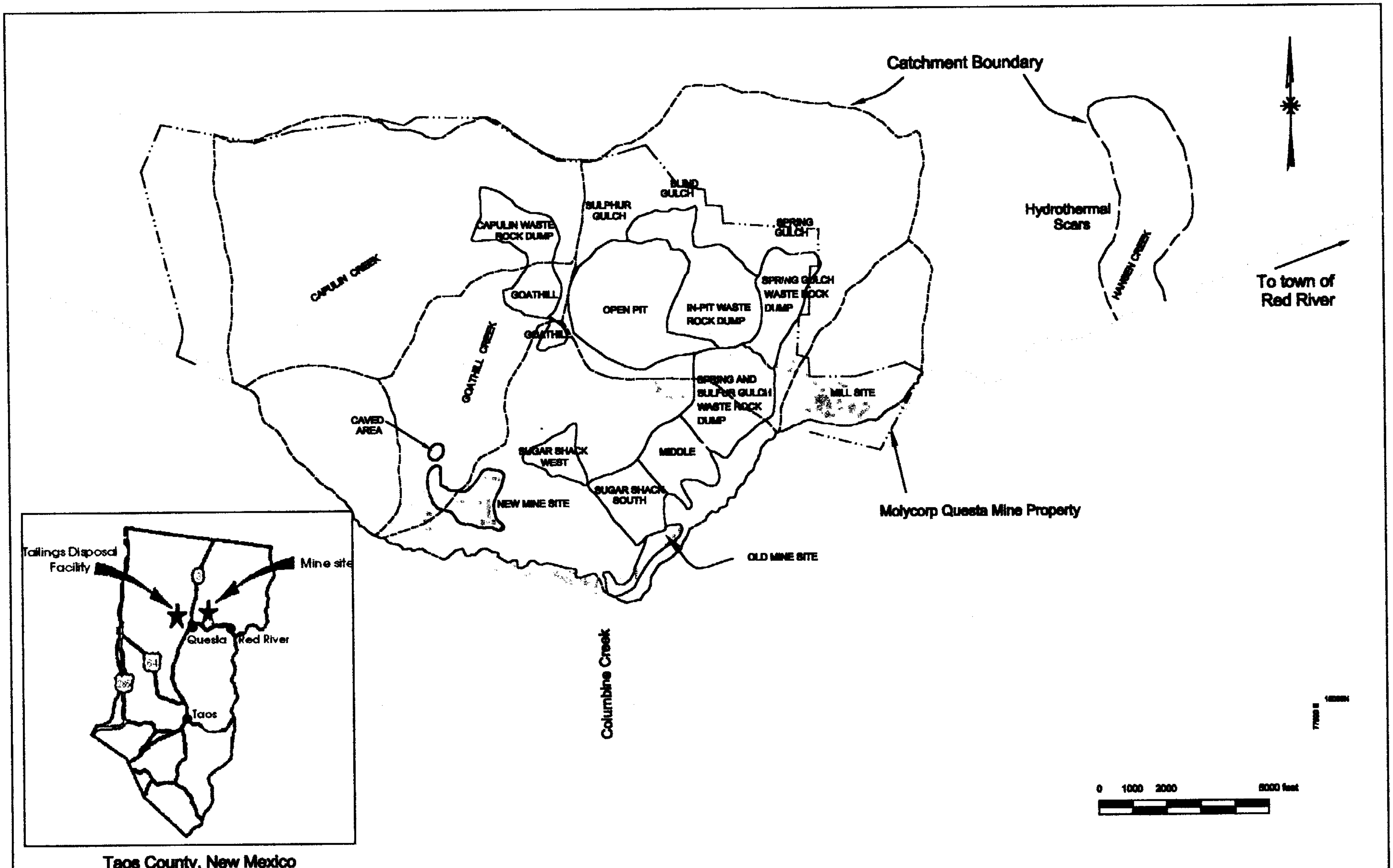
SAMPLE	Si mg/kg	Ag mg/kg	Na mg/kg	Sr mg/kg	Tl mg/kg	Sn mg/kg	Ti mg/kg	V mg/kg	Zn mg/kg
WRD - 1 5-10	3.2		10	8.68					0.088
WRD - 1 20-25	3.48		4	2.46					0.016
WRD - 1 50-55	2.62		14	10.48					
WRD - 1 85-90	2.48		26	15.2					
WRD - 2 40-45	7.5			1.312					3.9
WRD - 2 55-60	2.8			1.296					7.98
WRD - 3 20-25	2.3		10	7.28					0.144
WRD - 3 50-55	2.54		12	11.58					0.01
WRD - 3 100-105	2.78			7.24					2.96
WRD - 4 5-10	6.98		6	5.88					10.5
WRD - 5 5-10	2.54		4	16.5					
WRD - 5 20-25	8.14	0.18	4	5.16			0.02	0.16	10.88
WRD - 5 40-45	2.02		8	10.7					0.01
WRD - 6 0-5	7.7			2.74					7.78
WRD - 6 20-25	7.66			11.58					11.2
WRD - 6 30-35	1.9		6	11.86					0.058
WRD - 7 5-10	6.2			8.84					34.4
WRD - 7 45-50	3.32		8	10.76					
WRD - 7 70-75	4.68		8	6.74					1.45
WRD - 8 25-30	3.9		10	2.3					85.4
WRD - 8 55-60	4.8			6.54					84.6
WRD - 9 20-25	6.32		6	0.55					8.28
WRD - 9 45-50	2.5			0.108					6.52
WRD - 9 95-100	7			0.284					28
WRD - 9 110-115	4.26			0.976					103
SSB-1 0-5'	6.84			0.484					0.462
SSB-1 9-14'	8.28		6	0.138					1.222
SSB-2 24-29'	4.72			0.918					1.558
SSB-2 39-44'	7.68			0.856					1.356

Table 8. Percentage of Each Element Present In Soluble Form.

SAMPLE:		WRD - 1 5-10	WRD - 1 20-25	WRD - 1 50-55	WRD - 1 85-90	WRD - 2 40-45	WRD - 2 55-60	WRD - 3 20-25	WRD - 3 50-55	WRD - 3 100-105	WRD - 4 5-10	WRD - 5 5-10	WRD - 5 20-25	WRD - 5 40-45	WRD - 6 0-5	WRD - 6 20-25	WRD - 6 30-35	WRD - 7 5-10	WRD - 7 45-50	WRD - 7 70-75	WRD - 8 25-30	WRD - 8 55-60	WRD - 9 20-25	WRD - 9 45-50	WRD - 9 95-100	WRD - 9 110-115	SSB-1 0-5'	SSB-1 9-14'	SSB-2 24-29'	SSB-2 39-44'
Ag	ppm	-	-	-	-		-	-	-	-	-	-	22.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Al	%	-	-	-	-	1.8	2.6	-	-	0.3	0.1	-	0.5	-	0.7	1.4	-	0.4	-	0.1	2.3	1.9	0.4	2.7	0.4	0.9	0.0	0.1	0.8	0.4
As	ppm	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ba	ppm	0.0	-	0.0	0.0	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	-	-	-	-	-	-	-	-	-	-
Be	ppm	-	-	-	-	4.0	8.6	-	-	2.8	-	-	3.0	-	9.0	7.0	-	5.8	-	1.0	12.9	14.0	3.6	-	4.7	7.5	-	-	4.0	1.8
Bi	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ca	%	4.5	3.9	2.2	0.8	4.1	5.6	1.8	3.3	2.5	3.3	3.0	4.4	2.7	5.2	4.1	3.4	8.7	3.2	6.5	5.3	7.6	14.4	22.0	7.2	7.4	5.3	7.9	3.9	3.3
Cd	ppm	-	-	-	-	-	-	-	-	-	10.0	-	3.0	-	-	2.0	-	5.0	-	-	10.0	21.0	-	-	9.0	13.0	-	-	-	-
Co	ppm	-	-	-	-	4.1	6.0	-	-	3.6	2.7	-	6.6	-	6.6	5.5	-	2.2	-	1.5	16.0	5.4	4.0	-	5.0	11.9	1.0	2.2	5.2	2.4
Cr	ppm	-	-	-	-	0.2	0.1	-	-	-	-	-	0.0	-	0.1	-	-	-	-	-	-	-	-	0.1	-	-	-	-	0.0	-
Cu	ppm	0.0	-	-	-	4.1	8.7	0.0	0.0	2.8	0.3	-	2.1	-	4.6	5.9	-	4.6	-	0.9	6.9	7.0	2.2	10.5	2.4	4.9	0.3	1.3	1.4	0.8
Fe	%	-	-	-	-	0.0	0.0	-	-	0.0	-	-	0.0	-	0.0	0.0	-	0.0	-	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
K	%	0.3	0.4	0.1	0.1	-	-	0.1	0.2	0.0	0.1	0.2	-	0.2	-	-	0.2	0.1	0.3	0.2	-	-	0.1	-	0.1	0.1	0.0	-	-	-
Mg	%	0.9	0.7	0.1	0.1	4.3	6.9	0.1	0.5	1.7	0.9	0.7	1.7	1.6	1.2	0.8	1.3	0.8	2.2	0.9	9.9	4.0	2.0	9.1	2.2	3.2	0.1	0.3	1.0	0.8
Mn	ppm	0.4	0.1	0.0	0.0	8.2	9.2	0.0	0.1	5.1	3.7	0.3	3.9	0.0	4.9	3.1	0.8	4.4	0.1	3.5	25.7	26.4	8.7	23.5	5.5	13.8	0.5	1.3	1.7	1.9
Mo	ppm	0.4	1.2	2.8	0.5	-	-	0.2	0.3	-	-	0.4	-	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Na	%	1.7	0.7	1.0	3.3	-	-	1.0	2.0	-	0.6	0.7	0.7	2.0	-	-	1.5	-	2.0	1.3	5.0	-	0.8	-	-	-	-	0.8	-	-
Ni	ppm	-	-	-	-	3.2	4.7	-	-	2.1	1.0	-	2.9	-	2.8	3.8	-	1.2	-	0.6	7.1	5.0	4.0	5.6	2.4	5.9	0.2	0.4	2.4	1.6
P	ppm	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	ppm	-	-	-	-	-	-	-	-	0.4	-	-	0.2	-	-	-	-	-	-	-	0.1	-	-	-	-	-	-	-	-	-
Sb	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sn	ppm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sr	ppm	2.5	4.7	2.7	1.7	0.3	0.7	2.0	6.2	0.8	1.0	3.8	2.5	2.4	0.9	3.8	4.9	3.9	2.7	3.7	3.6	0.4	1.7	0.8	0.6	1.7	0.2	0.1	0.5	0.4
Ti	%	-	-	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
V	ppm	-	-	-	-	-	-	-	-	-	-	-	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn	ppm	0.1	0.0	-	-	5.4	6.0	0.0	0.0	3.8	4.3	-	6.2	0.0	6.0	5.7	0.0	5.4	-	1.7	15.6	16.5	5.9	15.5	6.3	14.5	0.5	1.9	1.9	1.3

Table 9. Summary of suggested samples for kinetic testing

Sample	Lithology	Comments	Recommended for:	
			Humidity Cell Testing	Mineralogical Characterization
WRD-1 5-10'	Aplite	Paste pH=7.7; cond=1040 µS; NP/AP=0.6	X	X
WRD-1 50-55'	Black Andesite	Paste pH=7.8; cond=2250µS; NP/AP=1.1	X	X
WRD 2 55-60'	Mixed Volcanics	Paste pH=3.3; cond=6370 µS; NP/AP<0.1	X	X
WRD-3 20-25'	Andesite/Aplite	Paste pH=8.1; cond=2370 µS; NP/AP=1.5	X	X
WRD-4 5-10'	Mixed Volcanics	Paste pH=5.11; cond=2930 µS; NP/AP=0.2		X
WRD-5 5-10'	Rhyolite	Paste pH=7.8; cond=1880 µS; NP/AP=0.3	X	X
WRD-6 20-25'	Rhyolite/Volcanics	Paste pH=3.9; cond=2970 µS; NP/AP<0.1		X
WRD-6 30-35'	Tuff	Paste pH=7.4; cond=2860 µS; NP/AP=0.2	X	X
WRD-9 110-115'	Tuff	Paste pH=3.8; cond=4660 µS; NP/AP<0.1		X
SSB-2 24-29'	Hydrothermal Scar	Paste pH=3.3; cond=4300 µS; NP/AP<0.1		X

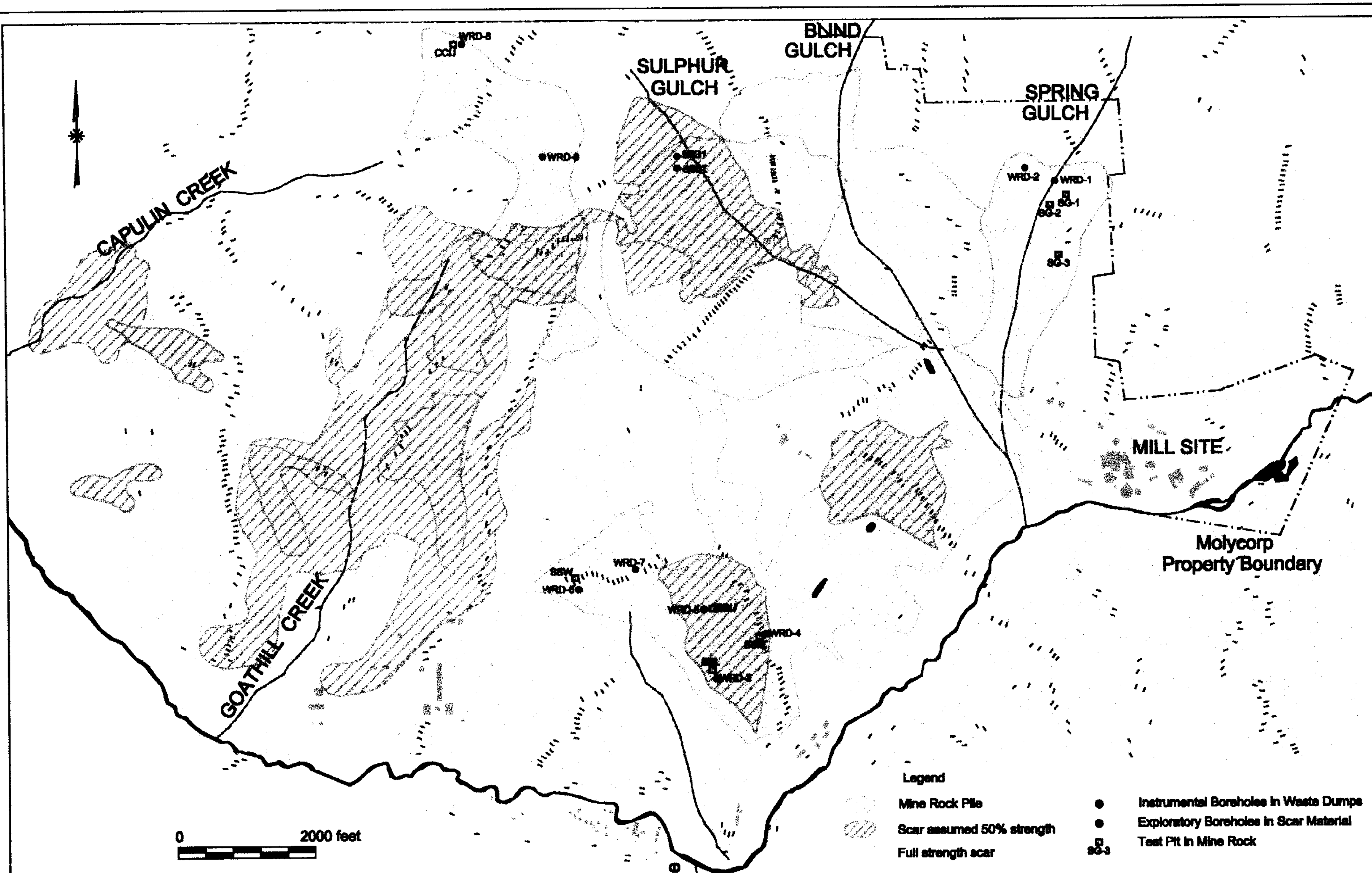


CLIENT:	MOLYCORP, INC.
PROJECT No:	052007/3
PROJECT:	QUESTA CLOSEOUT PLAN
LOCATION:	QUESTA MINE NEW MEXICO, USA

ROBERTSON GEOCONSULTANTS INC.
Consulting Geotechnical and Environmental Engineers

Property Location and Main Mine Facility

DATE:	DRAWN BY:	FIGURE:
Mar. 2000	JG	1



CLIENT:	MOLYCORP, INC.
PROJECT No:	052008
PROJECT:	QUESTA CLOSEOUT PLAN
LOCATION:	QUESTA MINE NEW MEXICO, USA

ROBERTSON GEOCONSULTANTS INC.
Consulting Geotechnical and Environmental Engineers

Location of Boreholes and Test Pits

DATE:	DRAWN BY:	FIGURE:
March 2000	JG	2

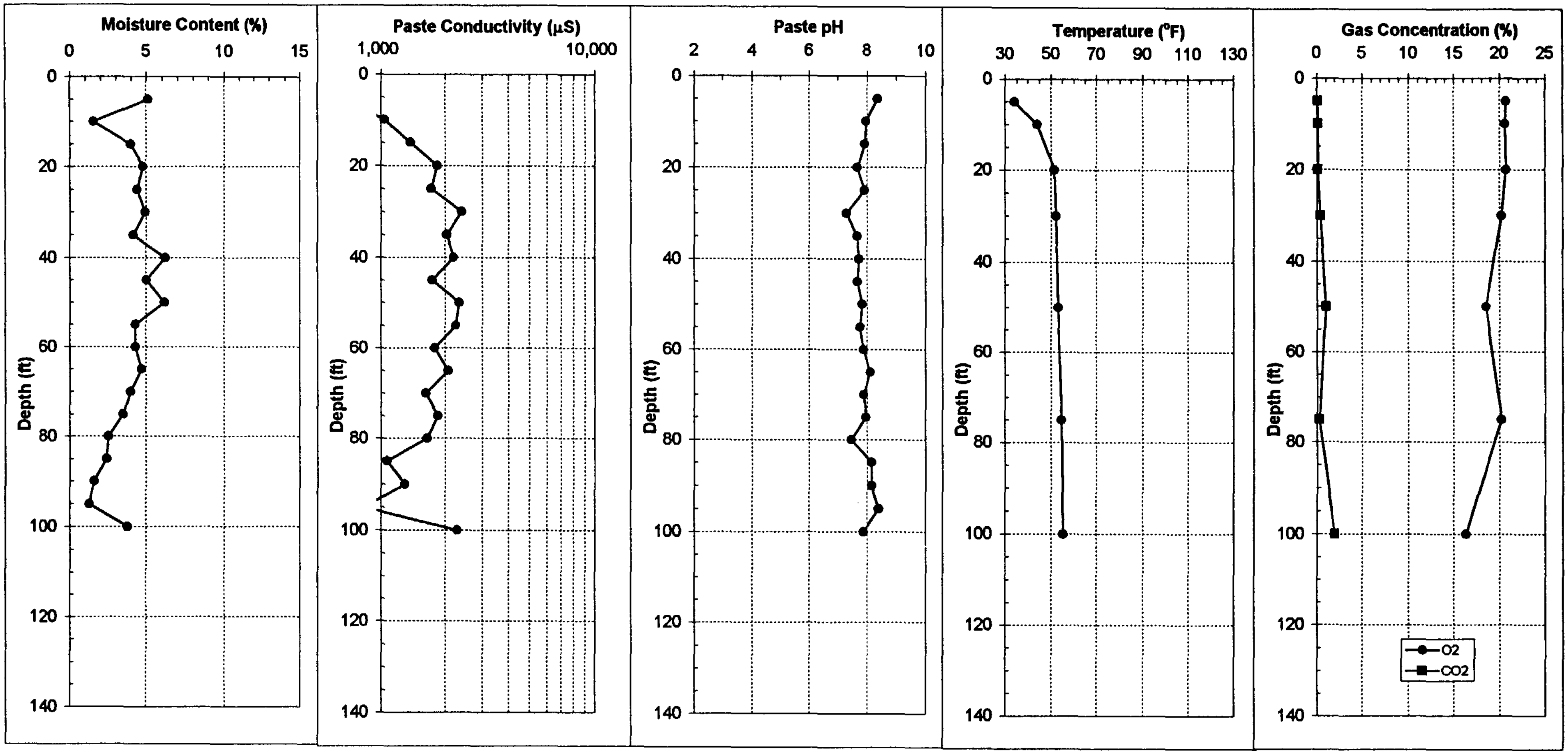


Figure 3. Summary of Characterization Monitoring Data for WRD-1

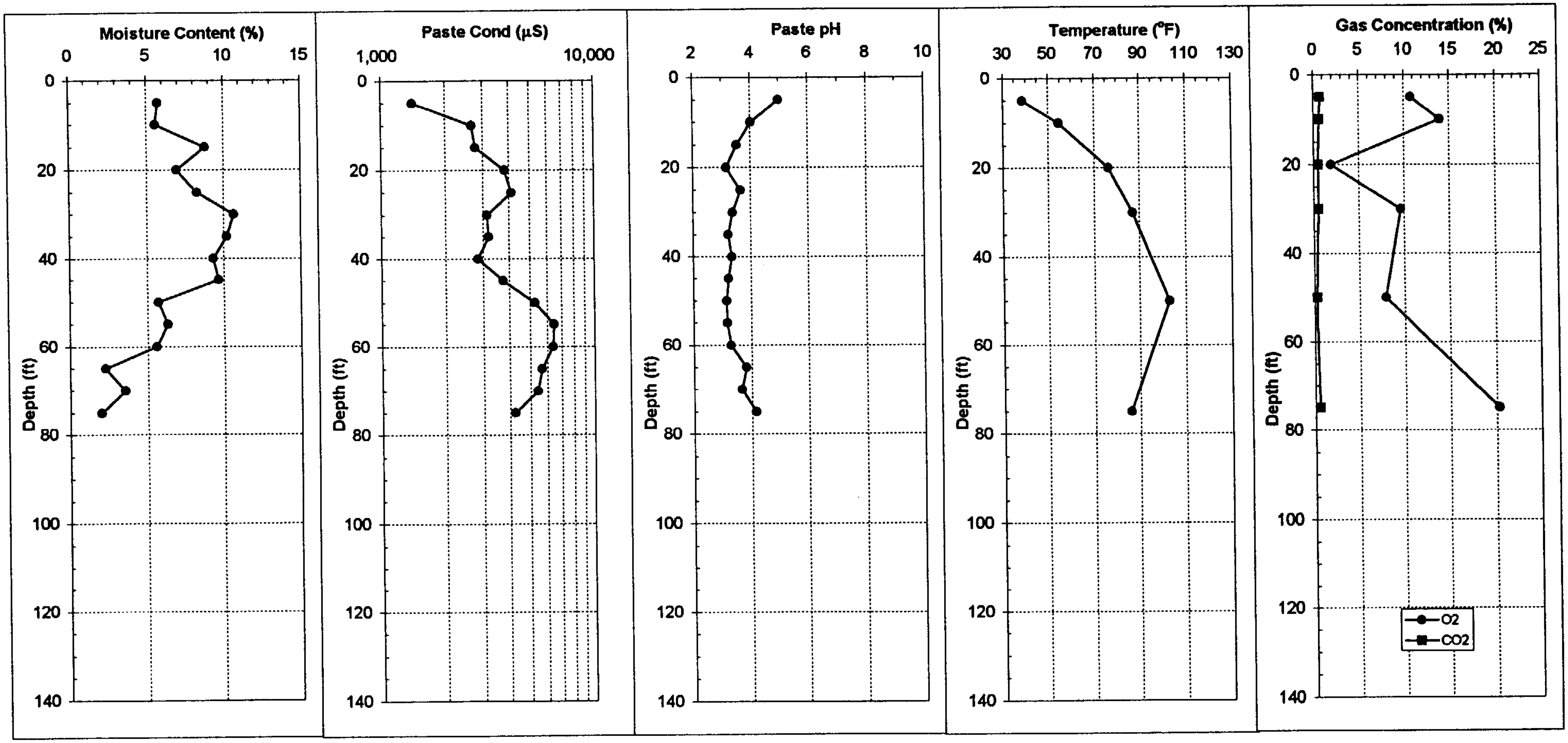


Figure 4. Summary of Characterization Monitoring Data for WRD-2.

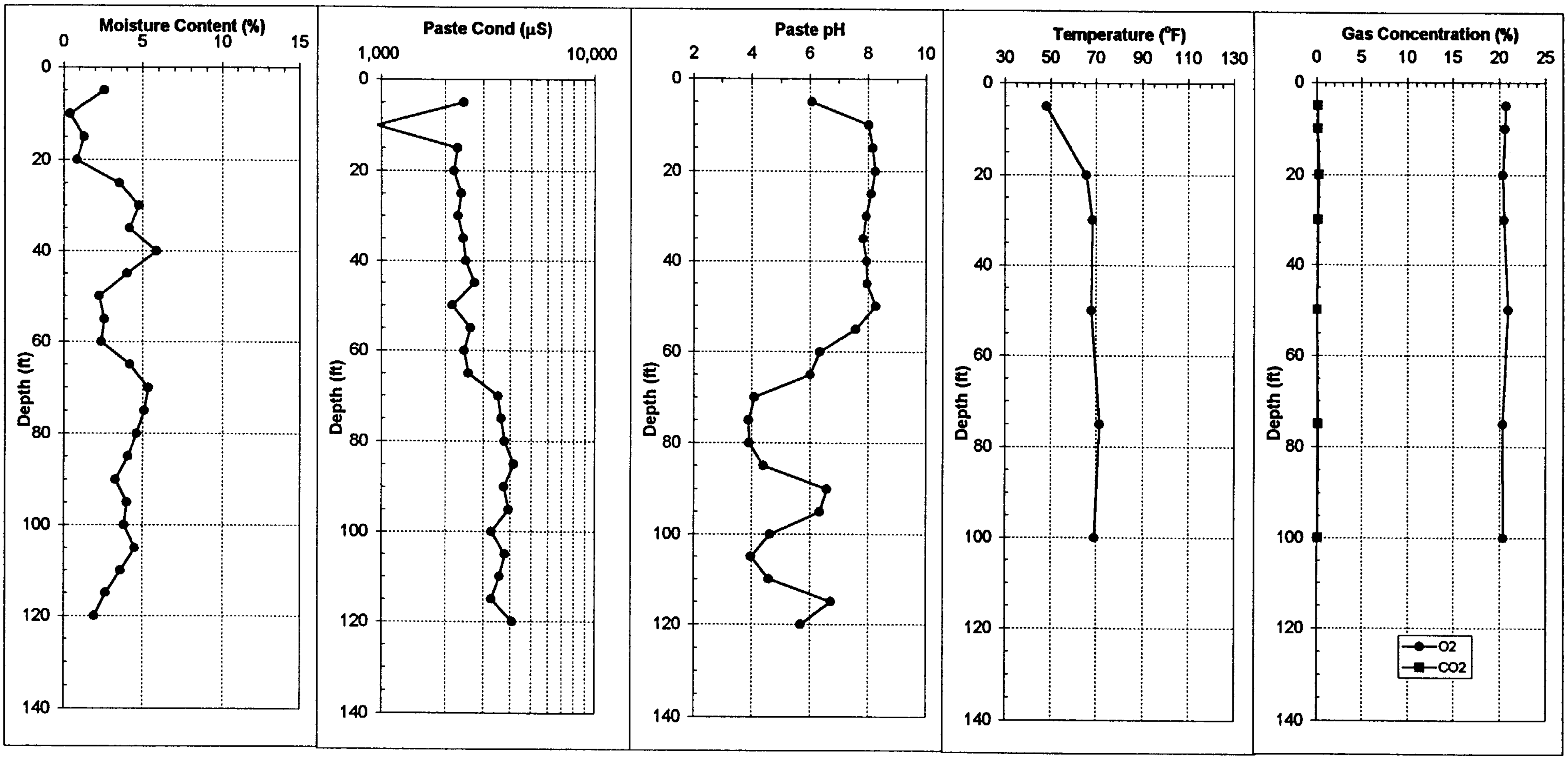


Figure 5. Summary of Characterization Monitoring Data for WRD-3

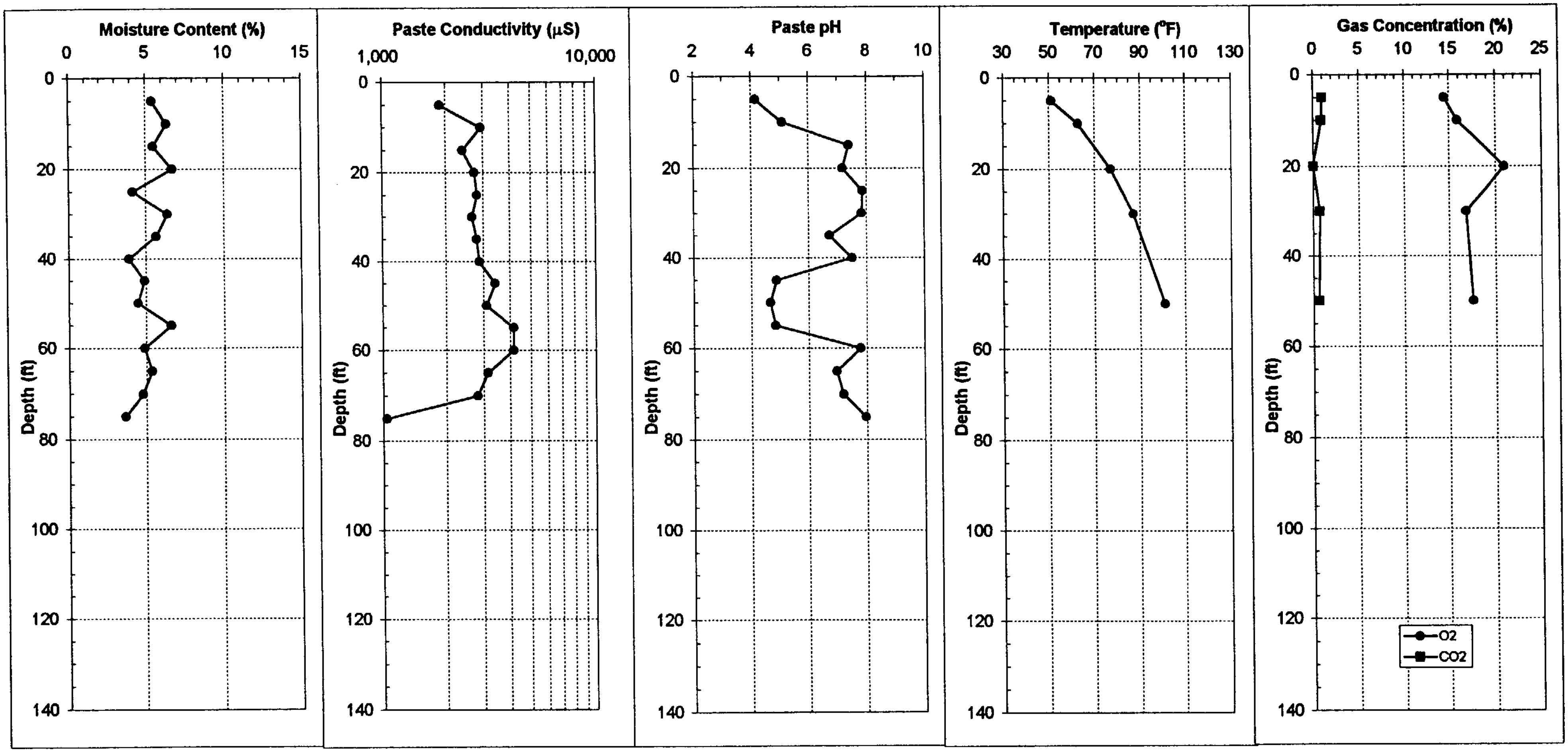


Figure 6. Summary of Characterization Monitoring Data for WRD-4.

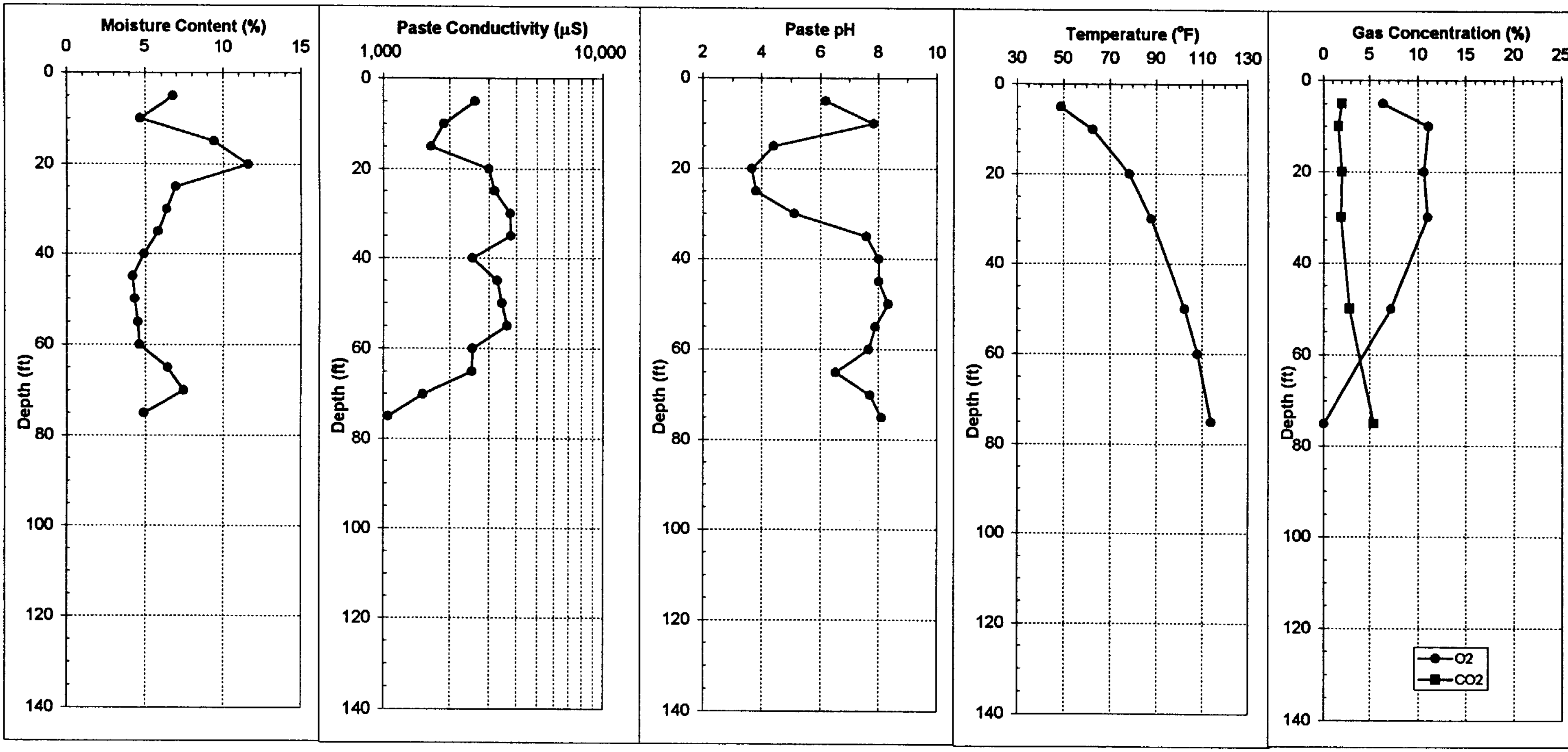


Figure 7. Summary of Characterization Monitoring Data for WRD-5.

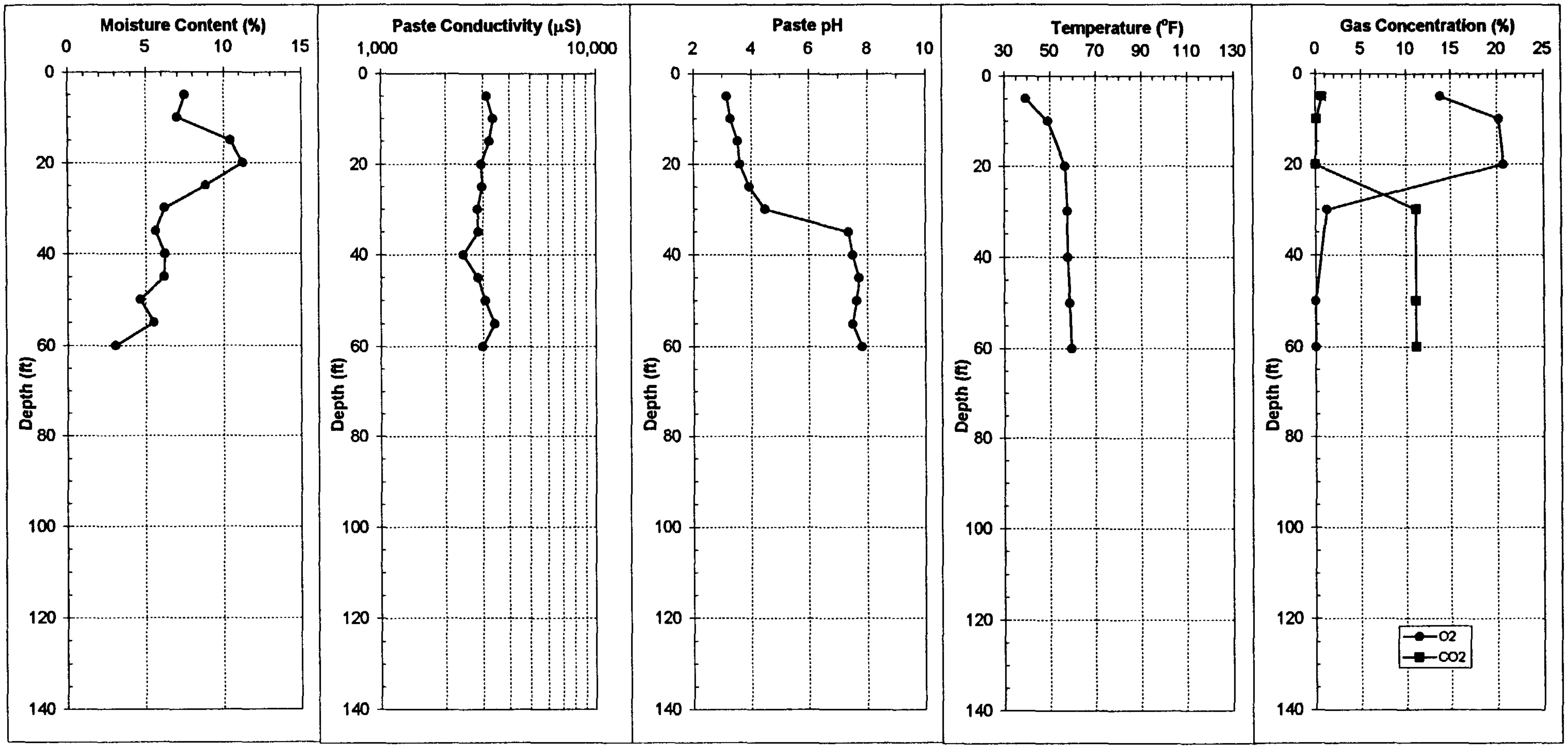


Figure 8. Summary of Characterization Monitoring Data for WRD-6.

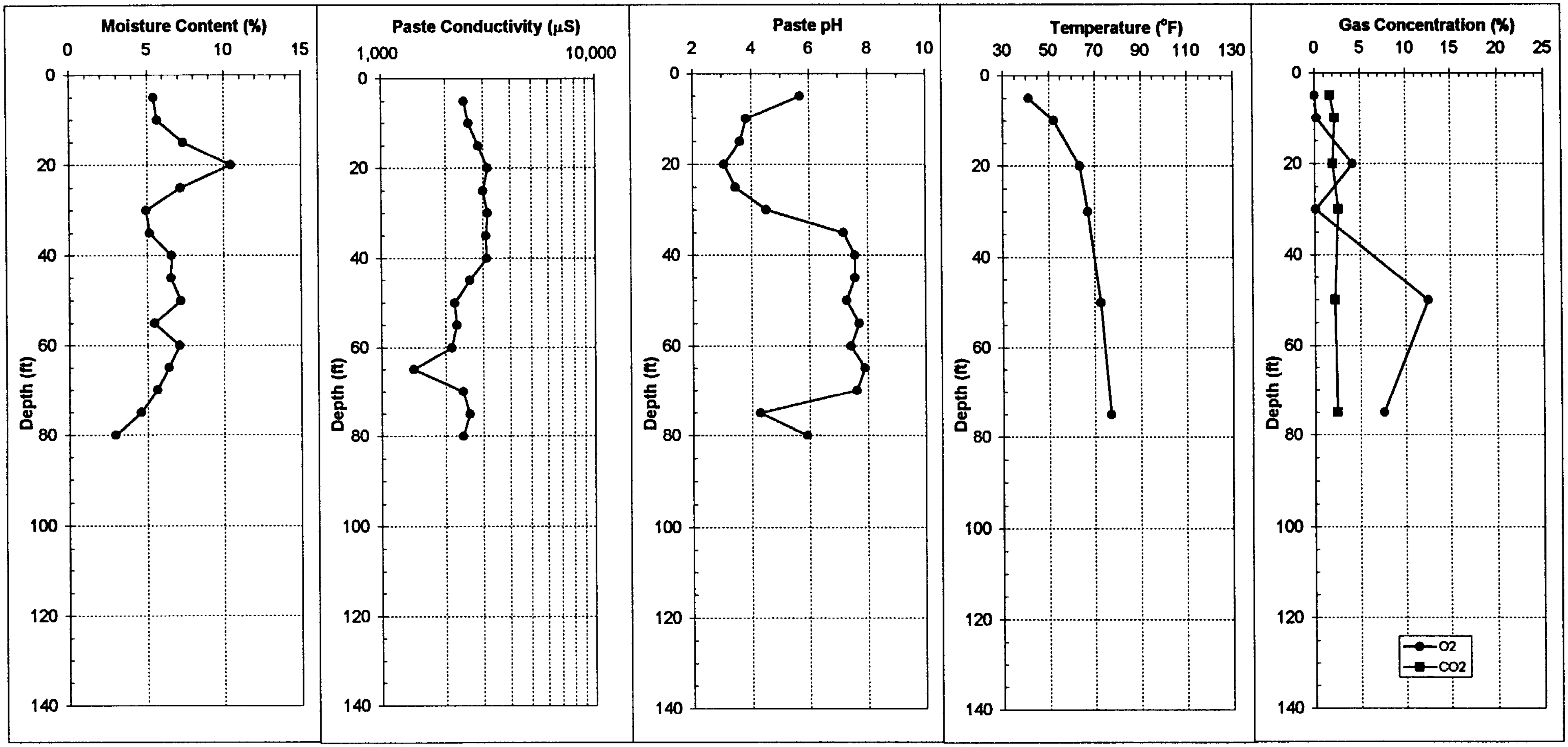


Figure 9. Summary of Characterization Monitoring Data for WRD-7.

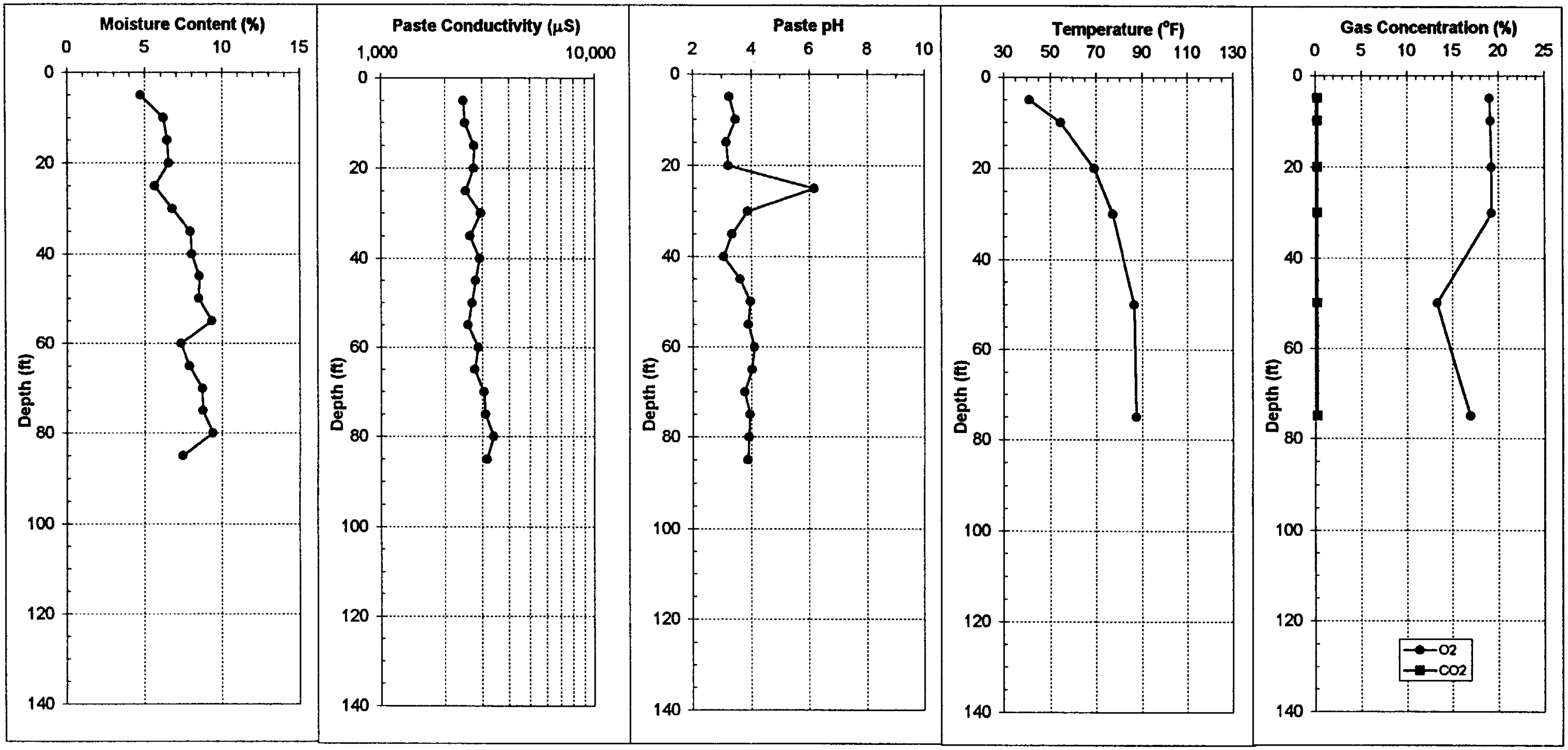


Figure 10. Summary of Characterization Monitoring Data for WRD-8.

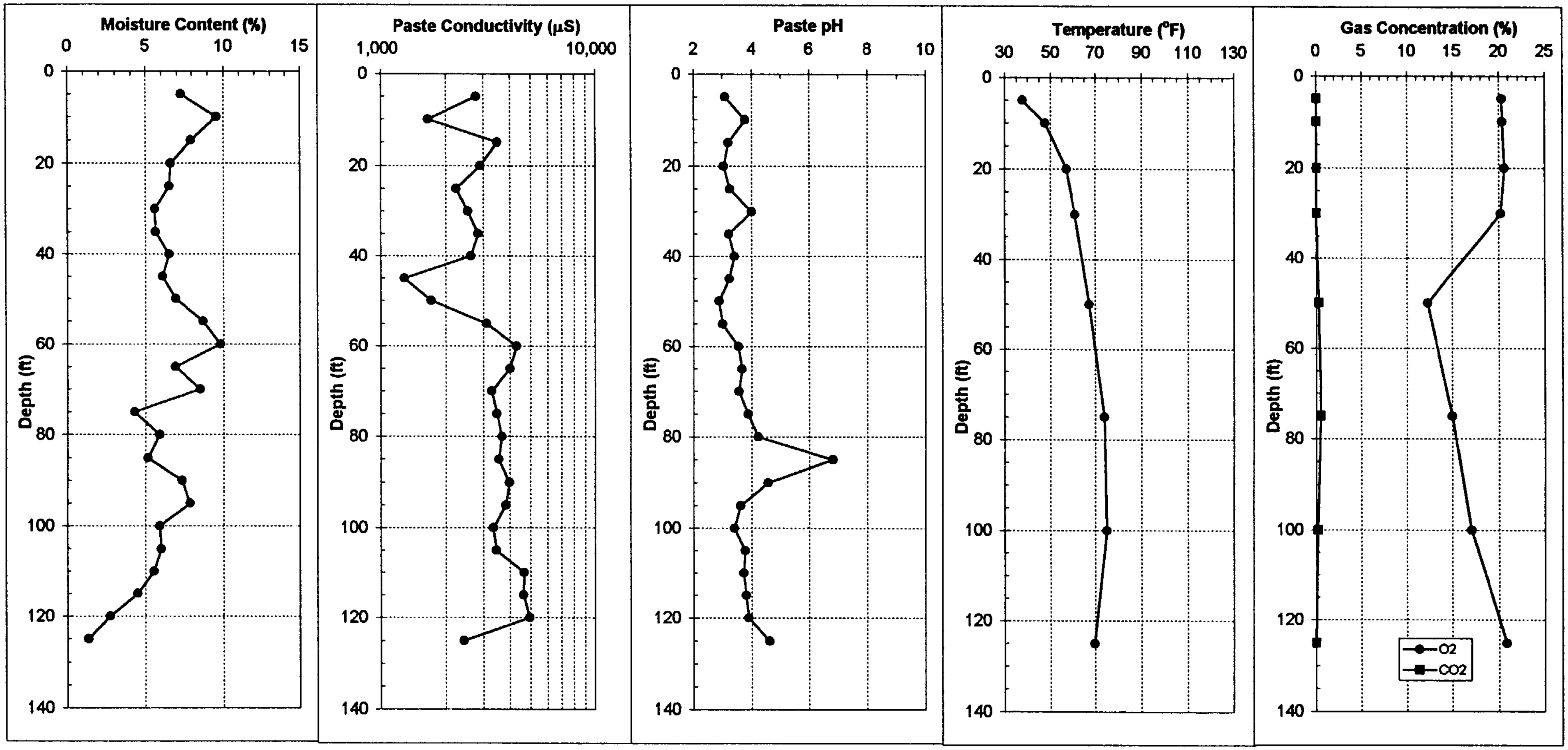


Figure 11. Summary of Characterization Monitoring Data for WRD-9.

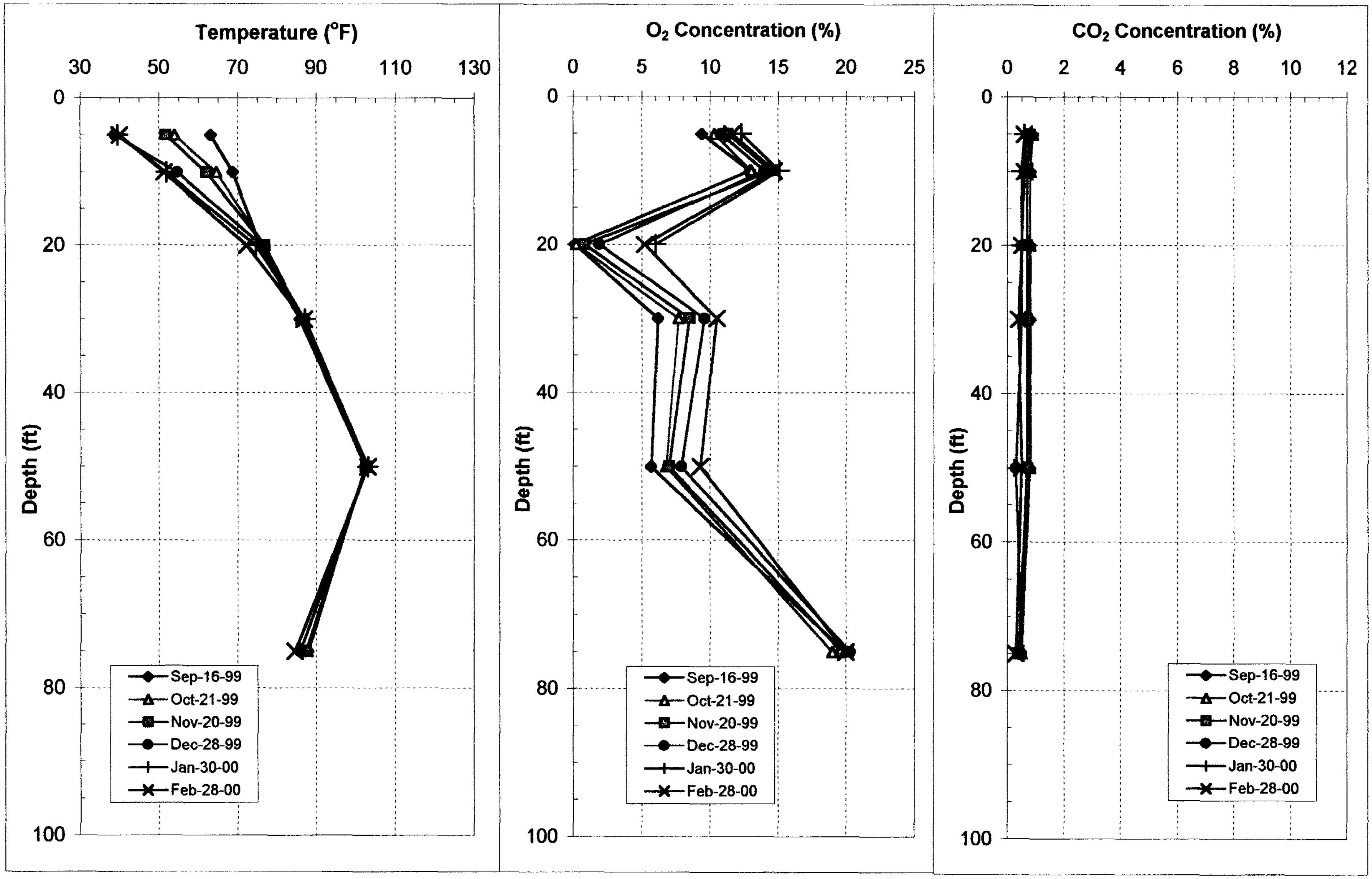


Figure 12. Time trends of temperature, O2 and CO2 at WRD-2.

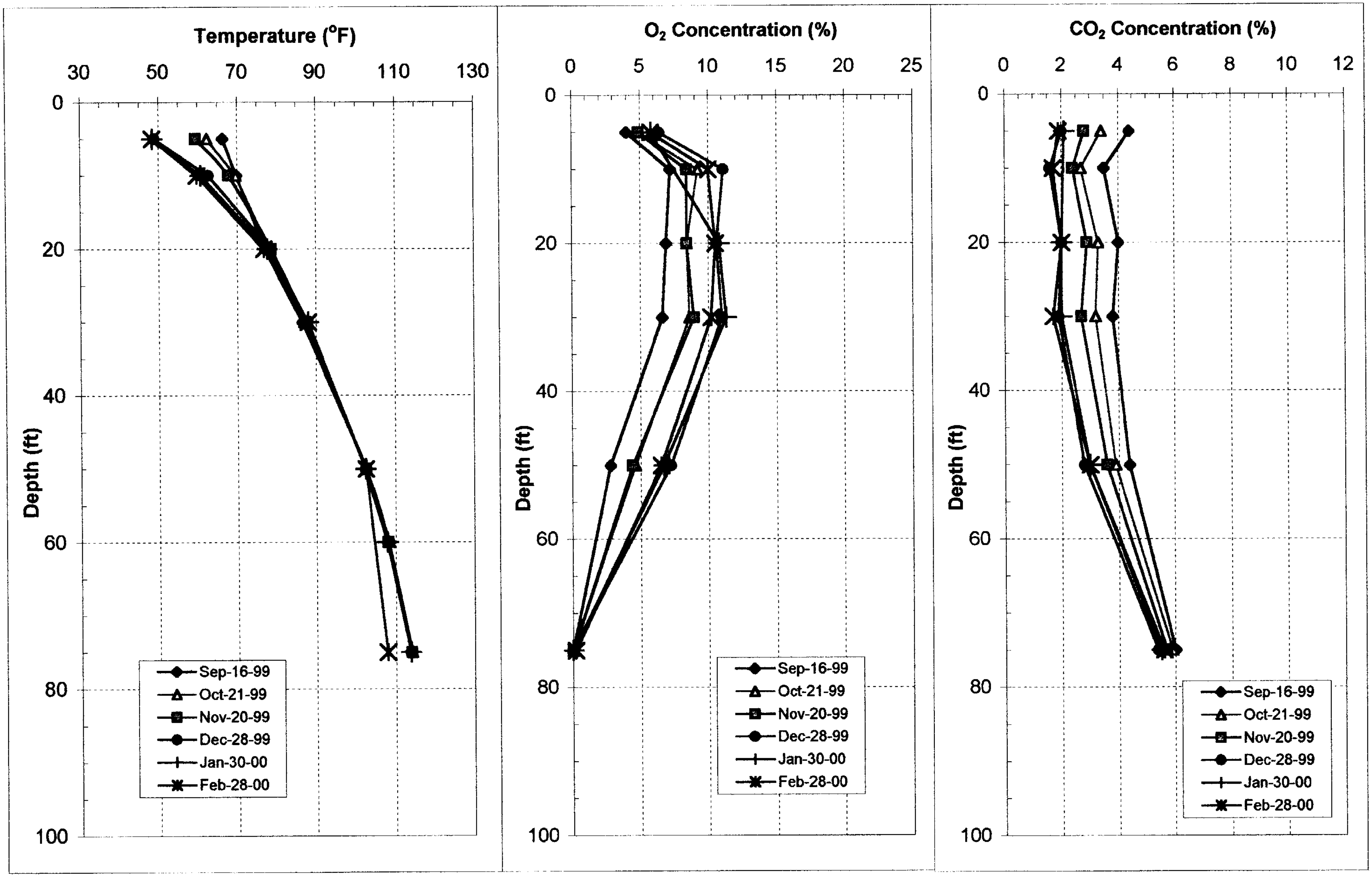


Figure 13. Time trends of temperature, O2 and CO2 at WRD-5.

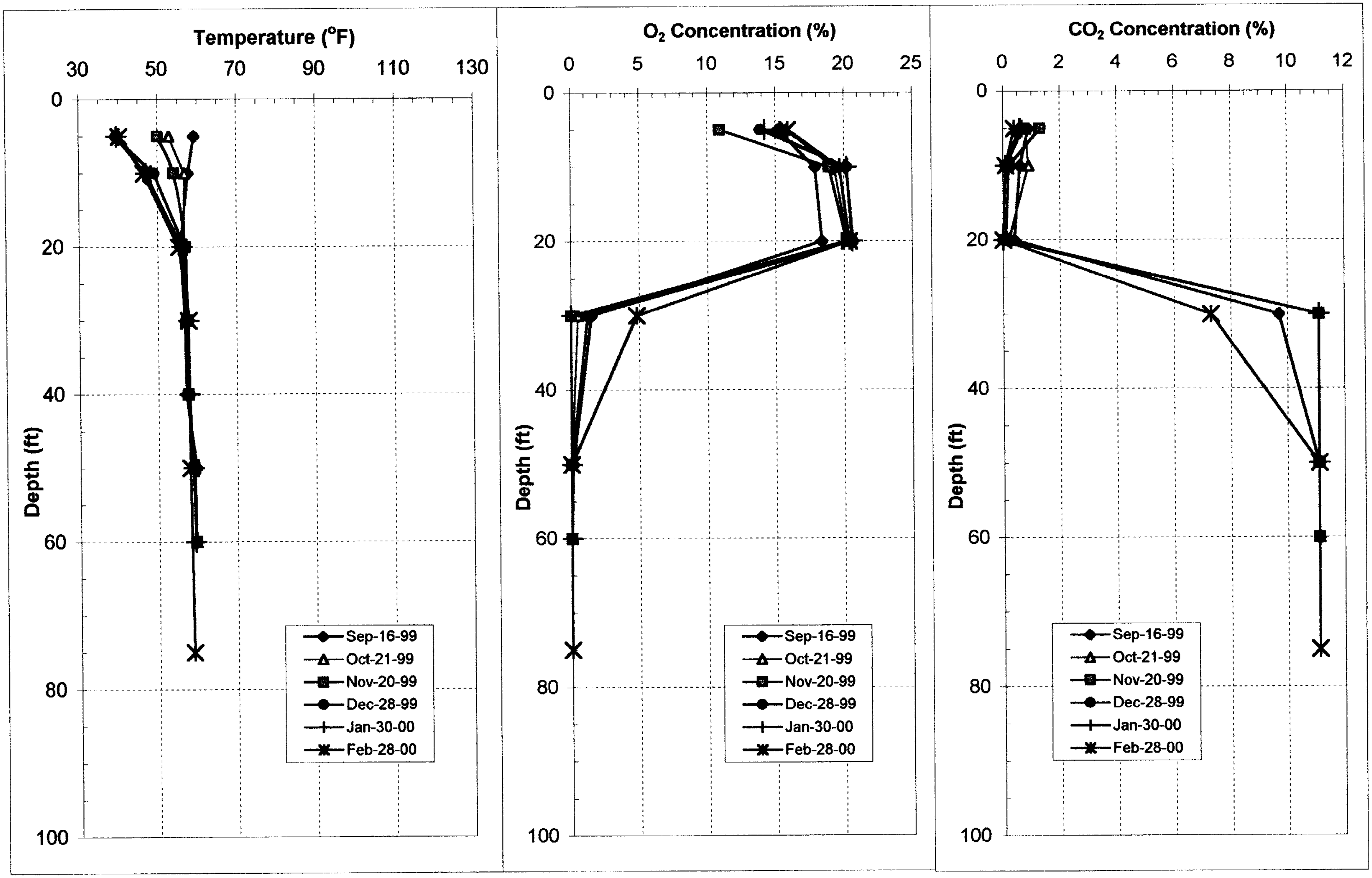


Figure 14. Time trends of temperature, O2 and CO2 at WRD-6.

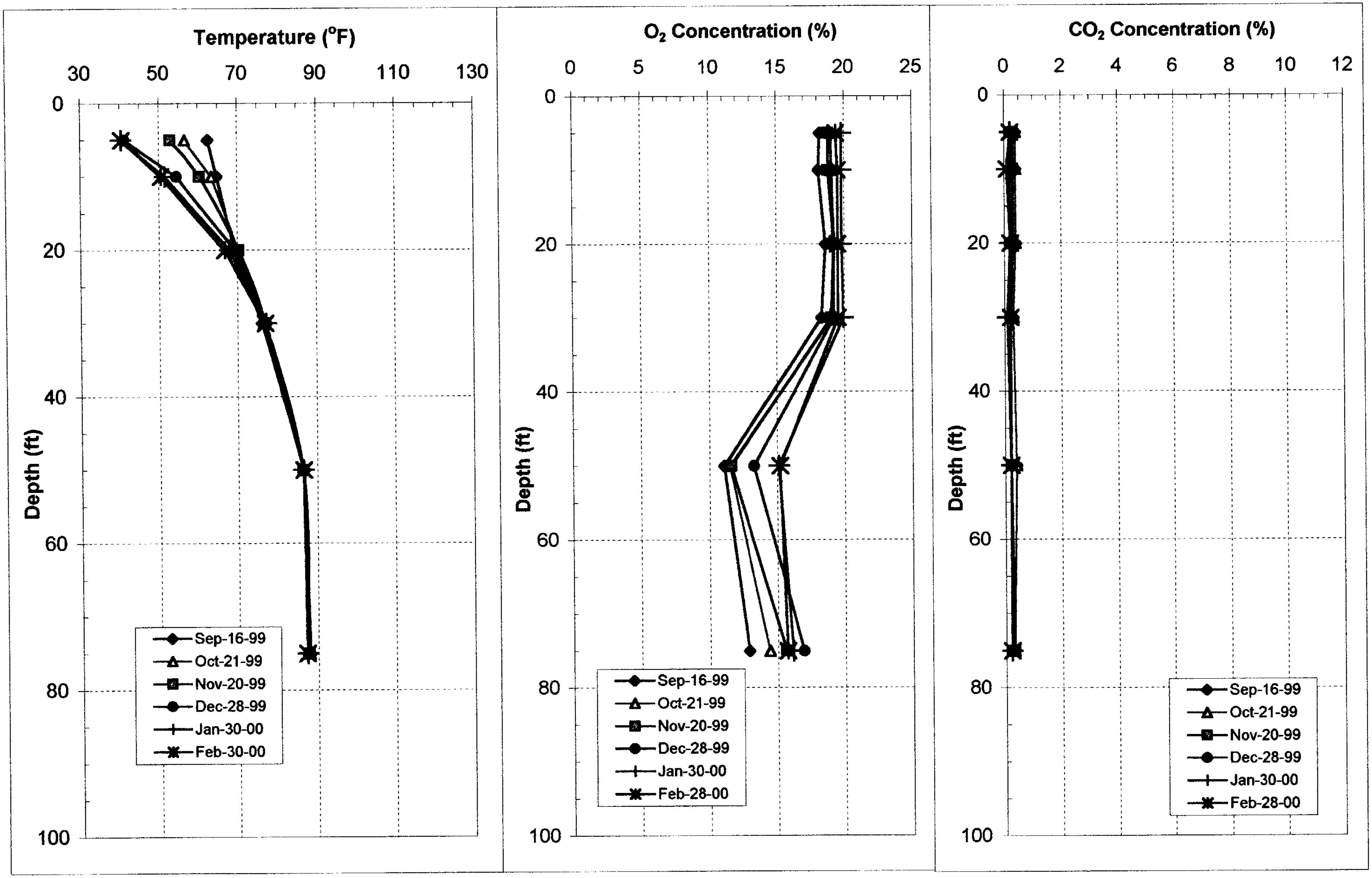


Figure 15. Time trends of temperature, O2 and CO2 at WRD-8.

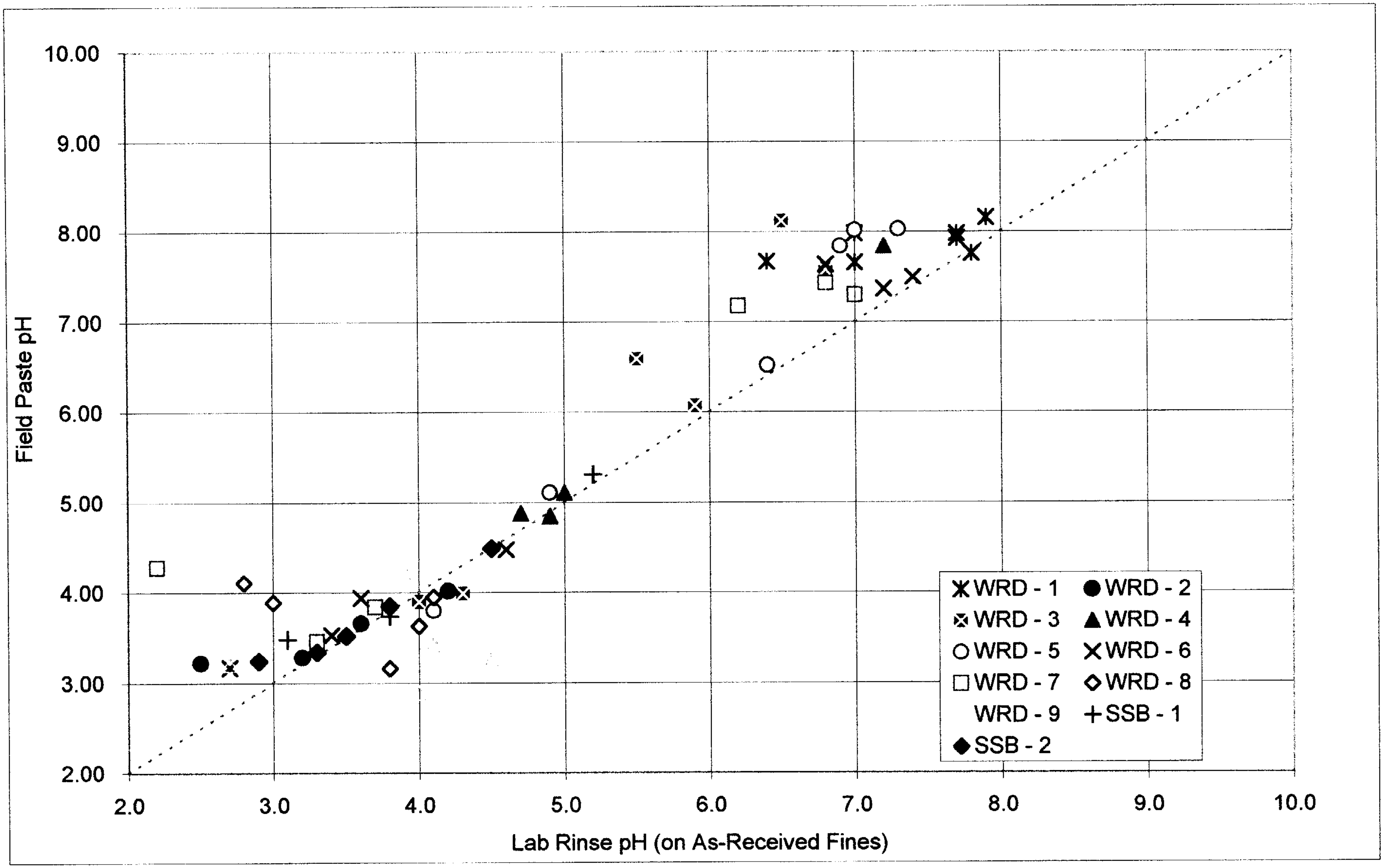


Figure 16: Comparison of Field and Laboratory Paste pH Values.

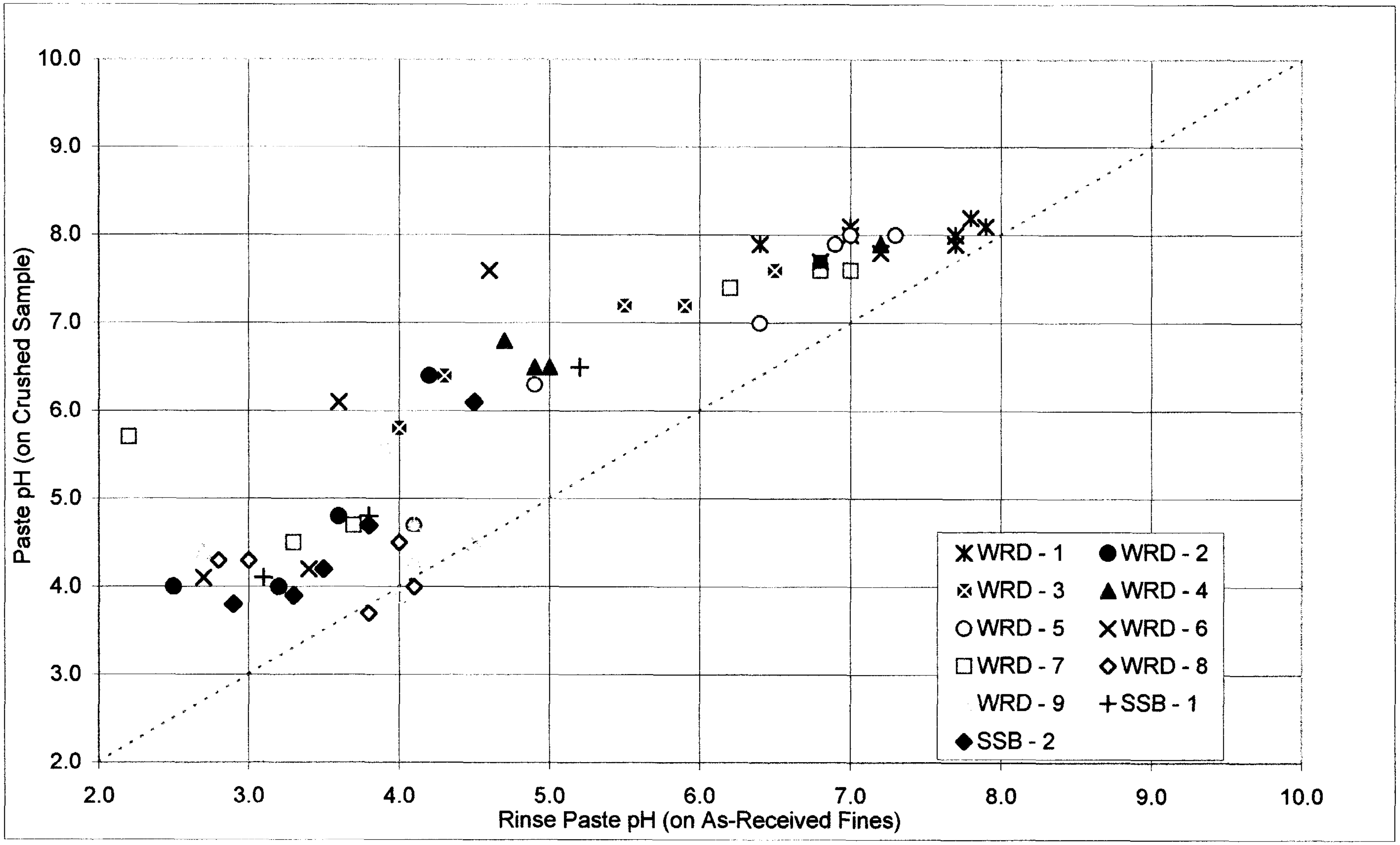


Figure 17: Comparison of 'Rinse pH' and 'Crushed pH' Values.

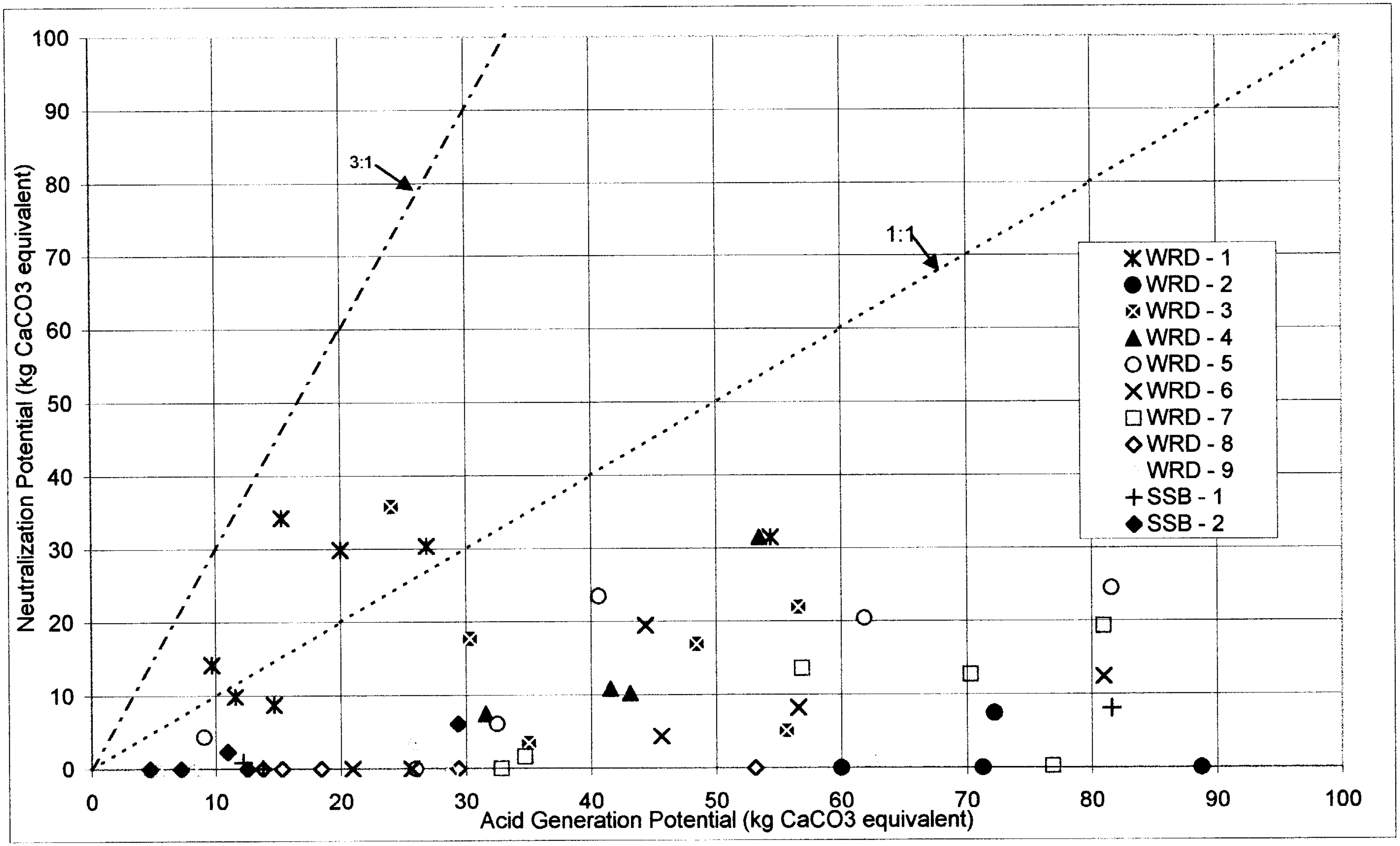


Figure 18: Neutralization Potential Versus Acid Generating Potential.

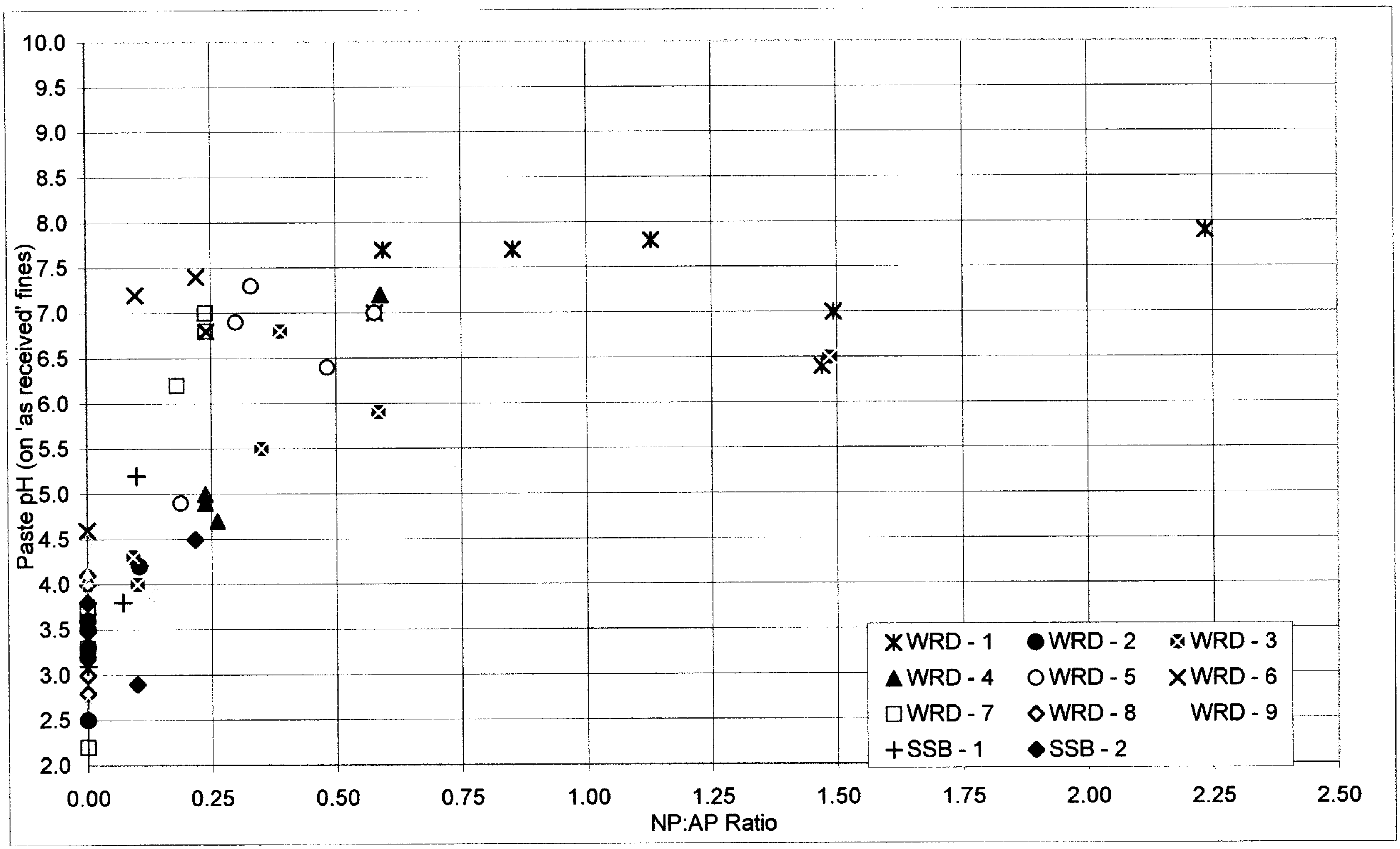


Figure 19: Rinse Paste pH versus NP:AP Ratio.

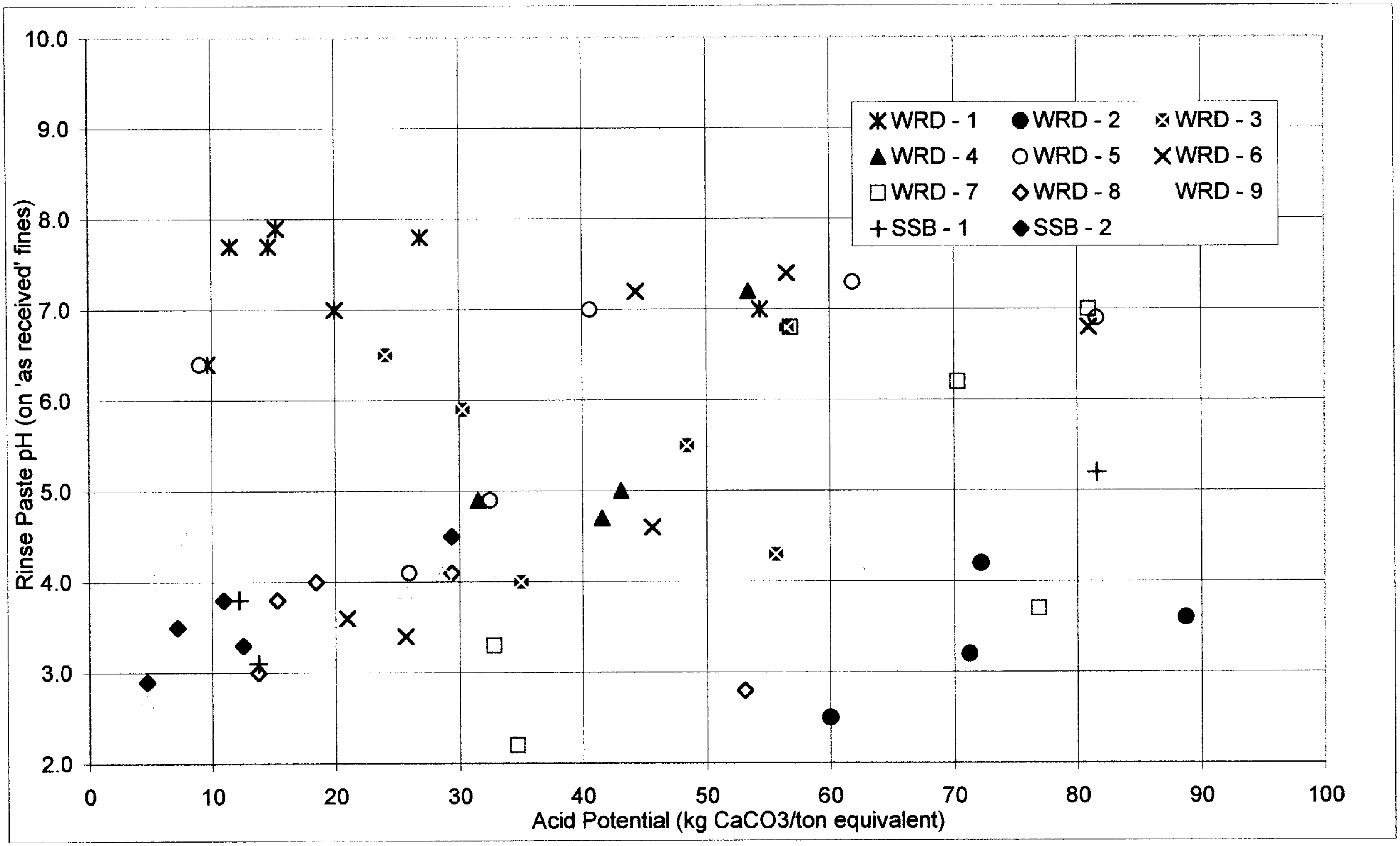


Figure 20: Acid Potential Versus Rinse Paste pH.

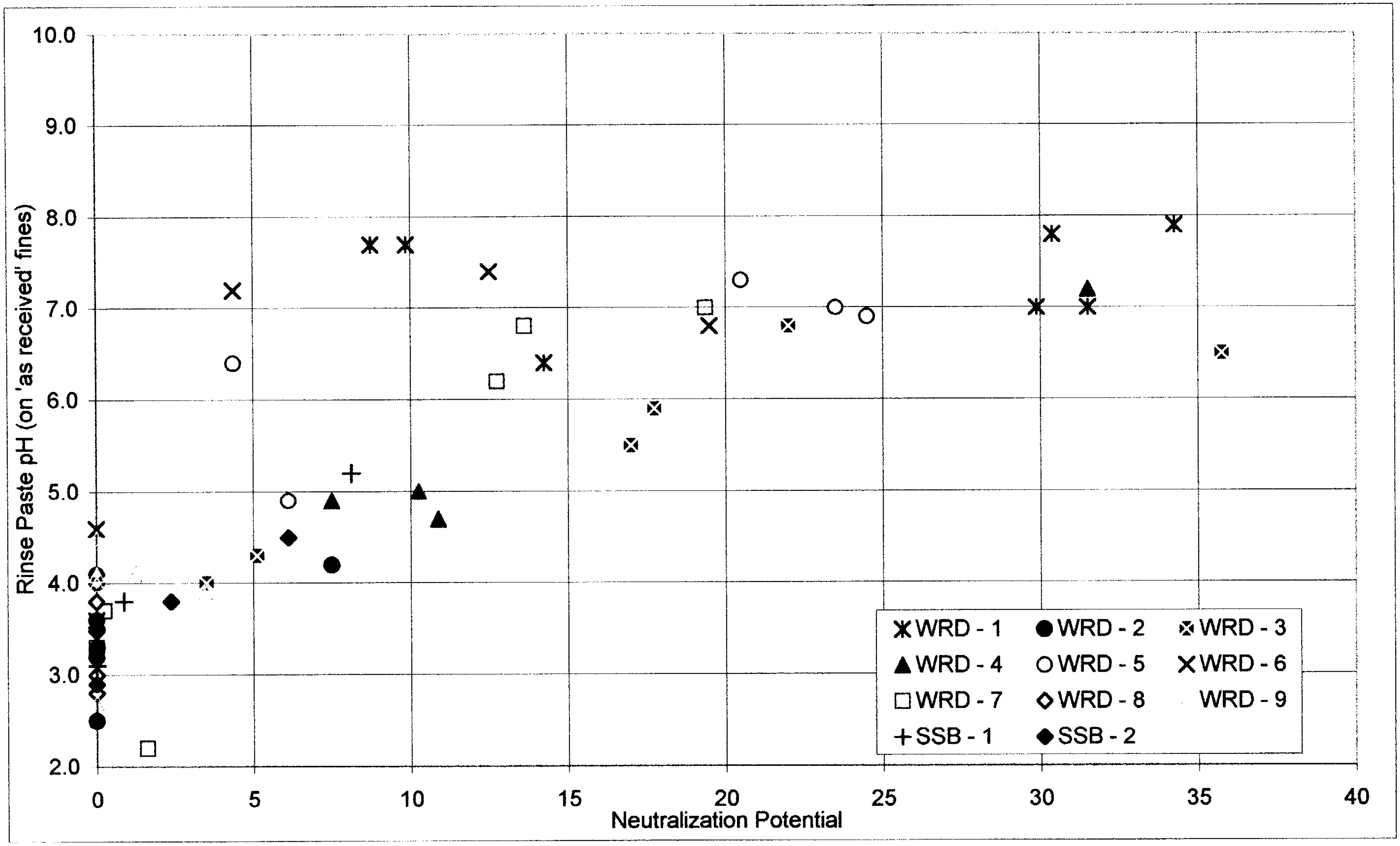


Figure 21: Rinse Paste pH Versus Neutralization Potential.

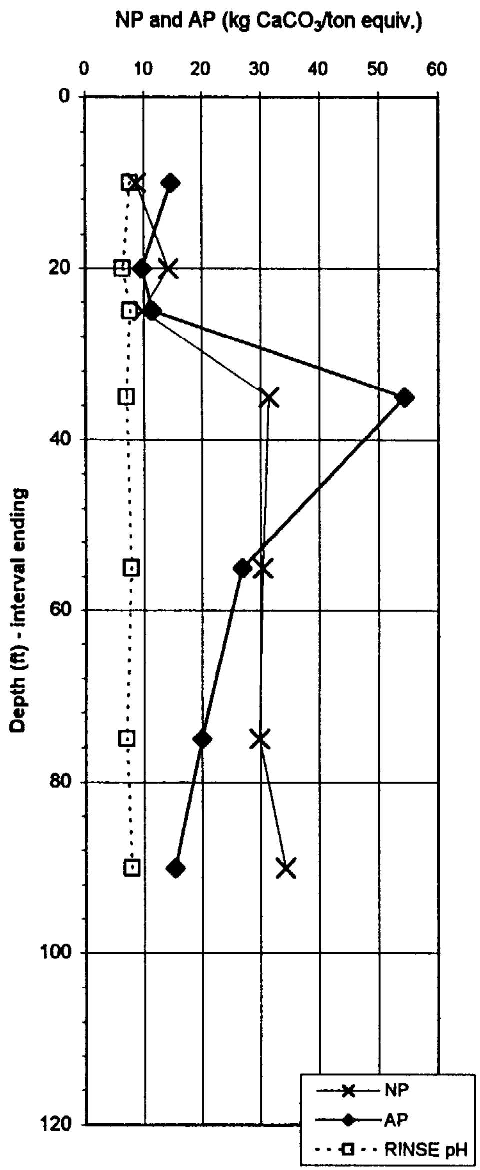


Figure 22. WRD-1

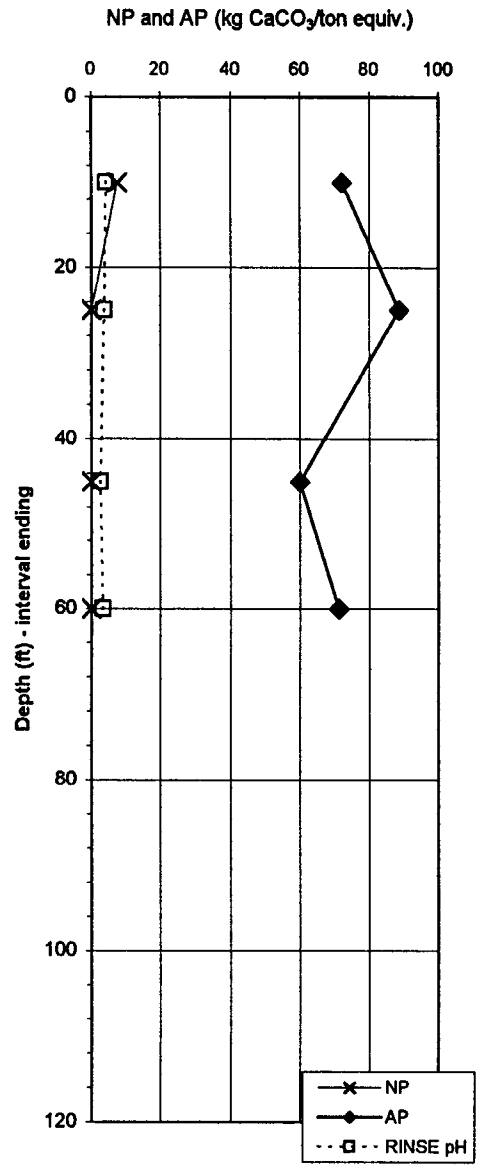


Figure 23. WRD-2

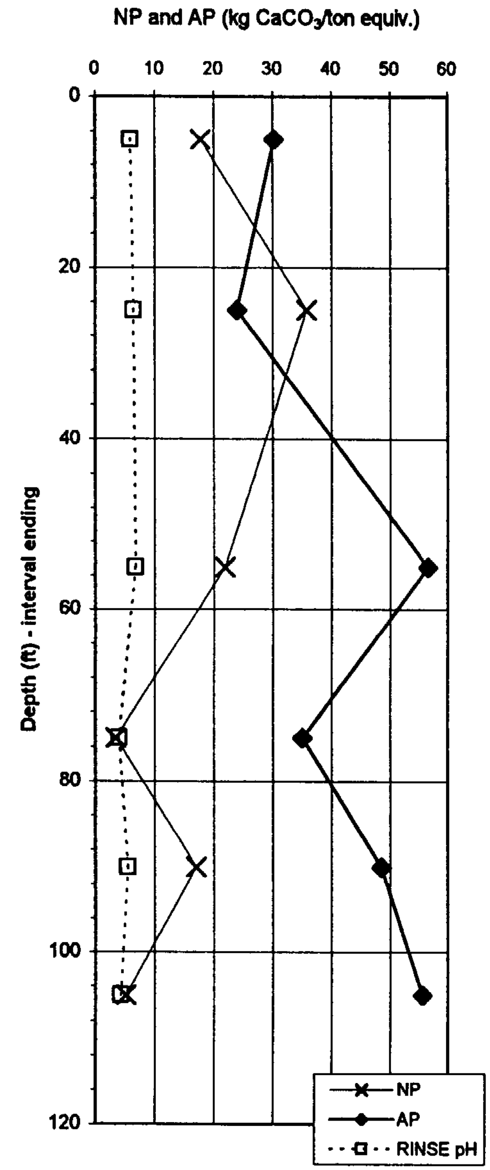


Figure 24. WRD-3

Depth Profiles of Acid Base Accounting Results.

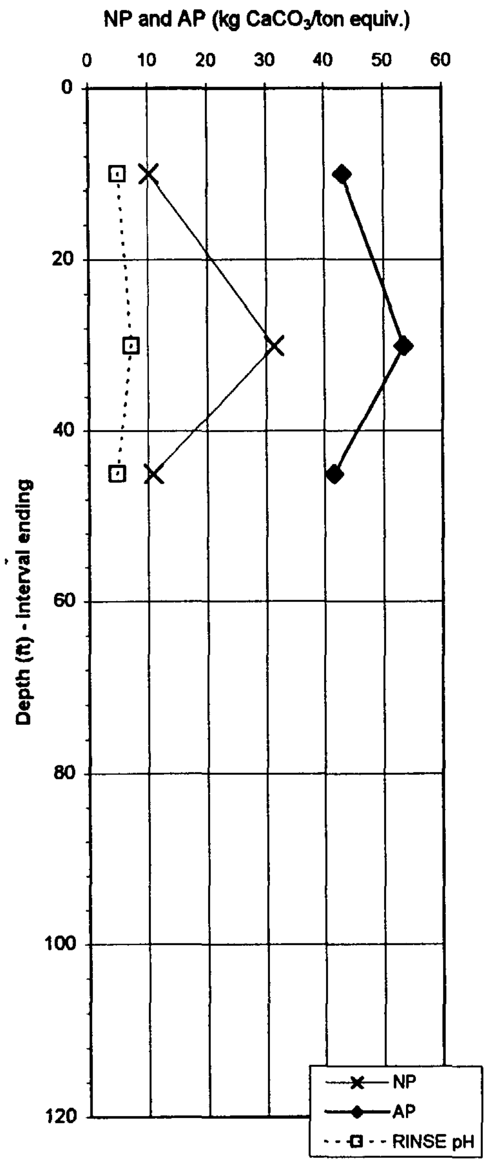


Figure 25. WRD-4

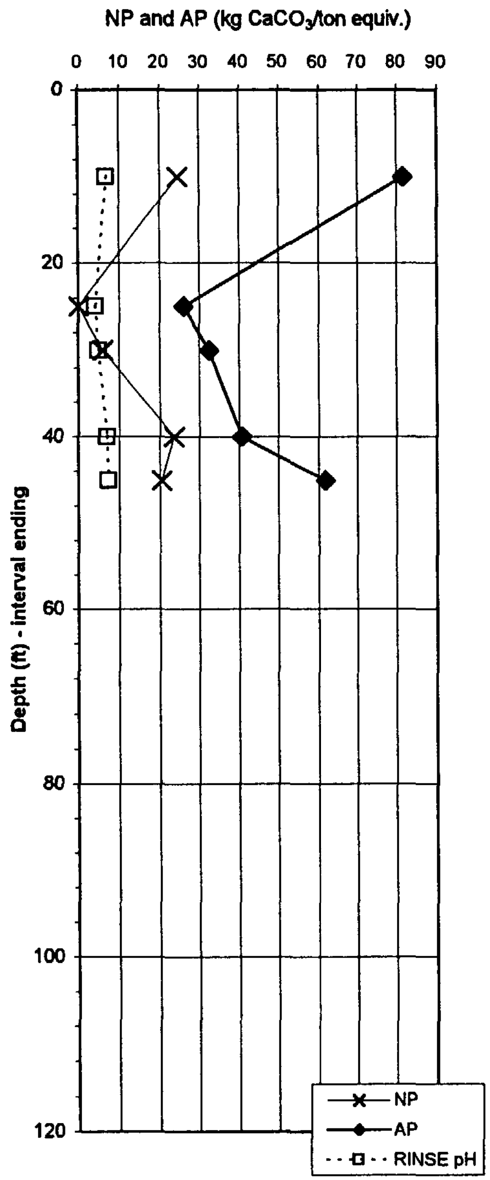


Figure 26. WRD-5

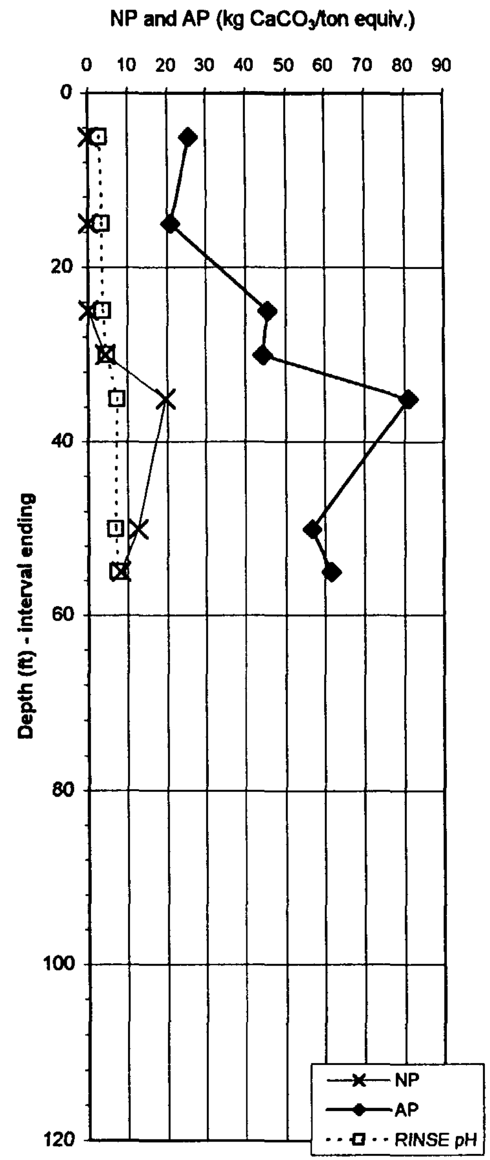


Figure 27. WRD-6

Depth Profiles of Acid Base Accounting Results.

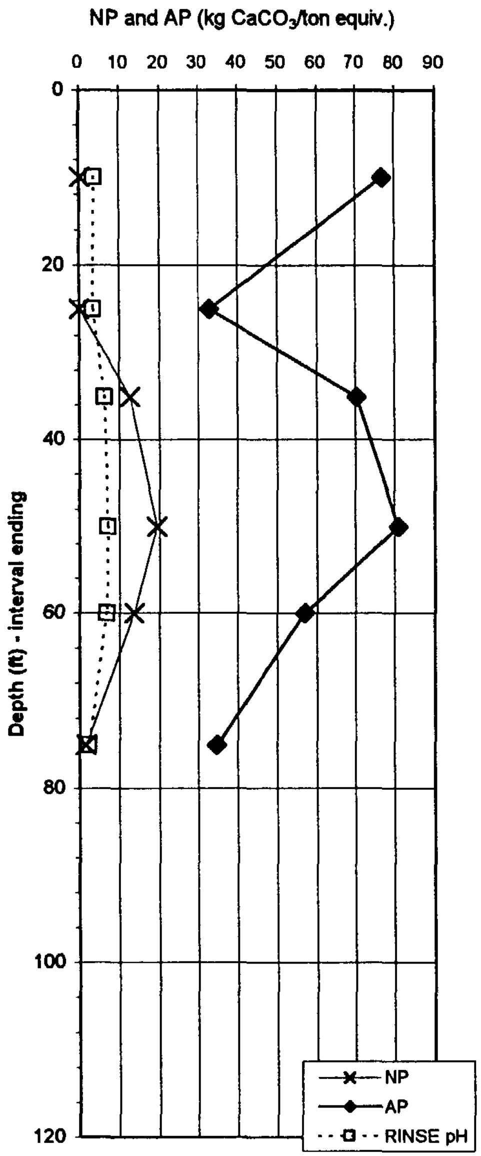


Figure 28. WRD-7

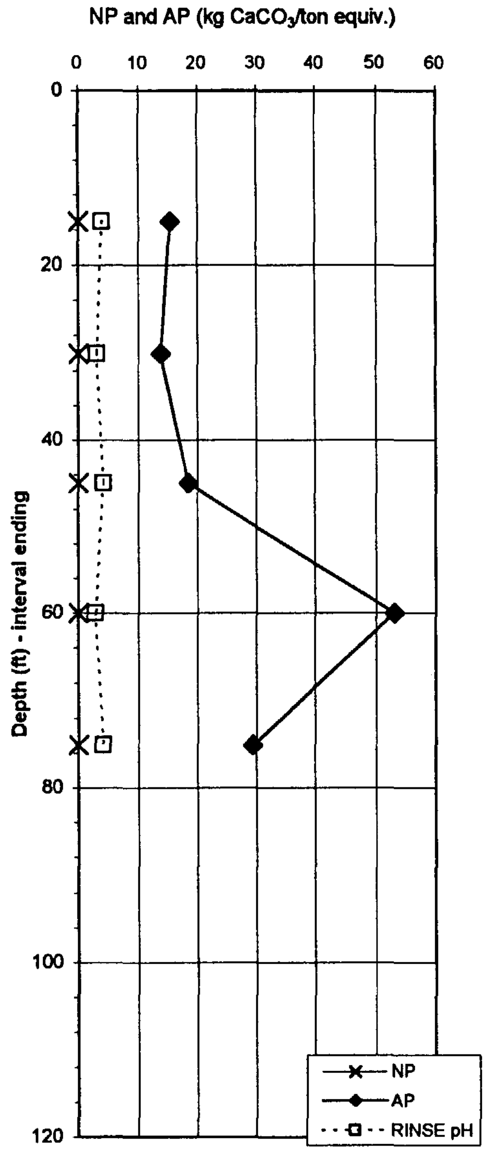


Figure 29. WRD-8

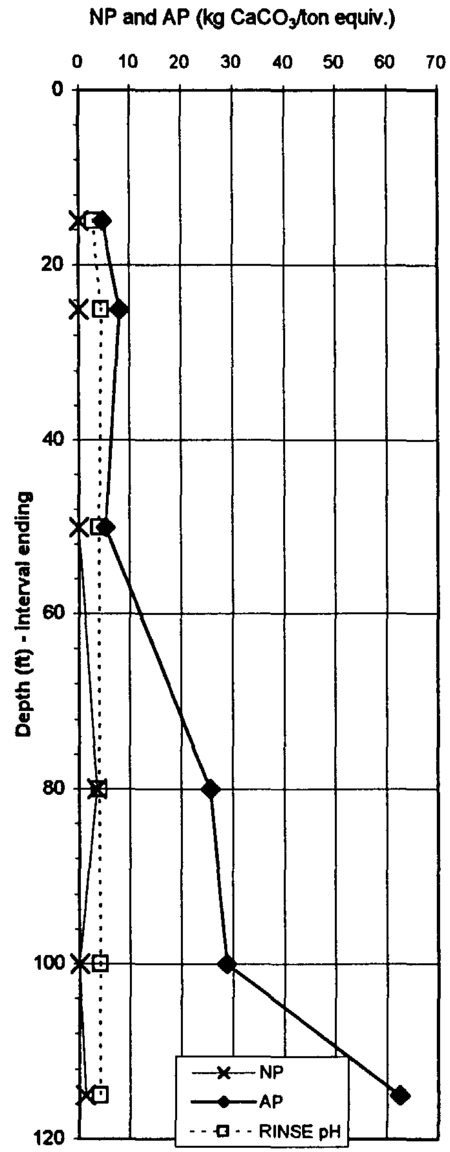


Figure 30. WRD-9

Depth Profiles of Acid Base Accounting Results.

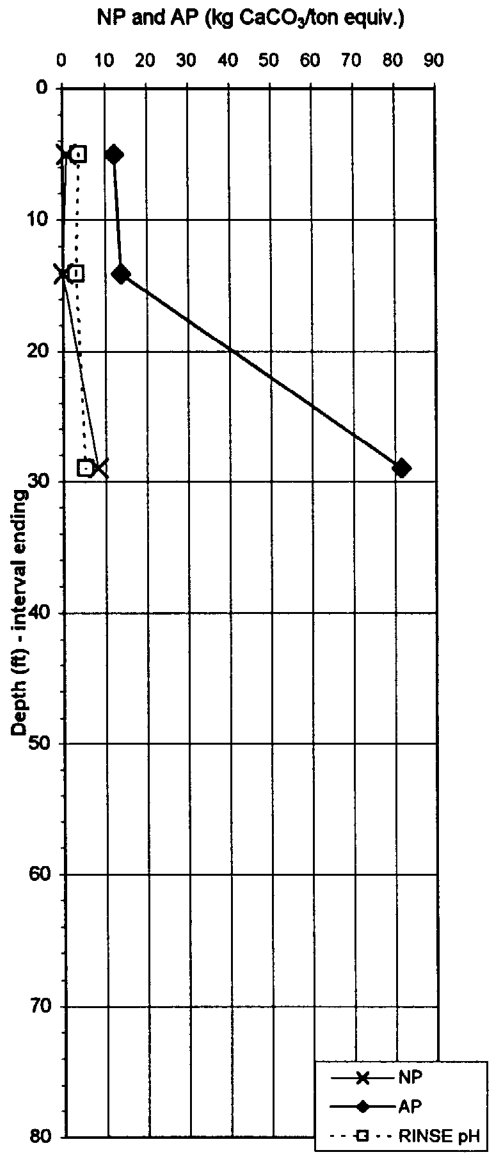


Figure 31. SSB-1

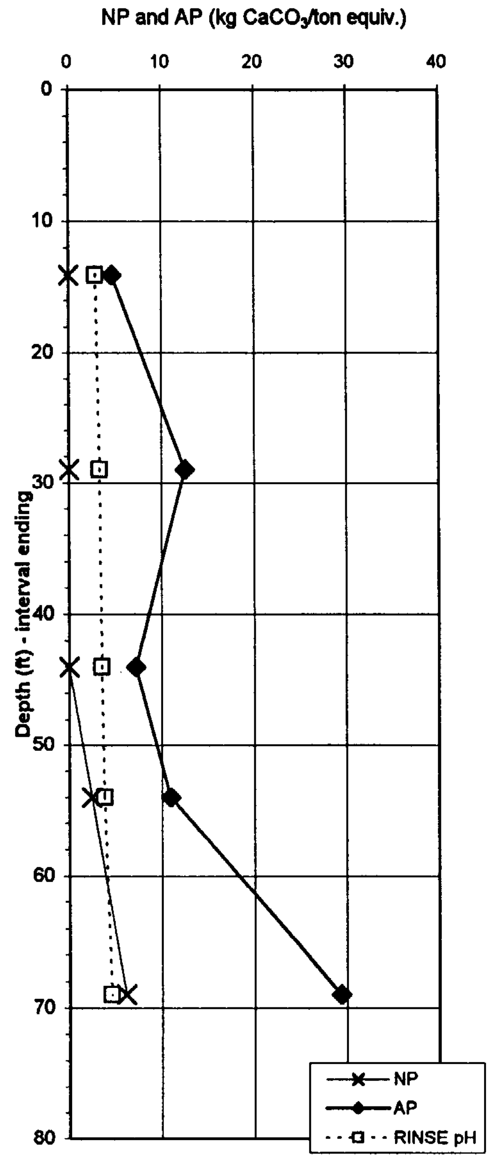


Figure 32. SSB-2

Depth Profiles of Acid Base Accounting Results.

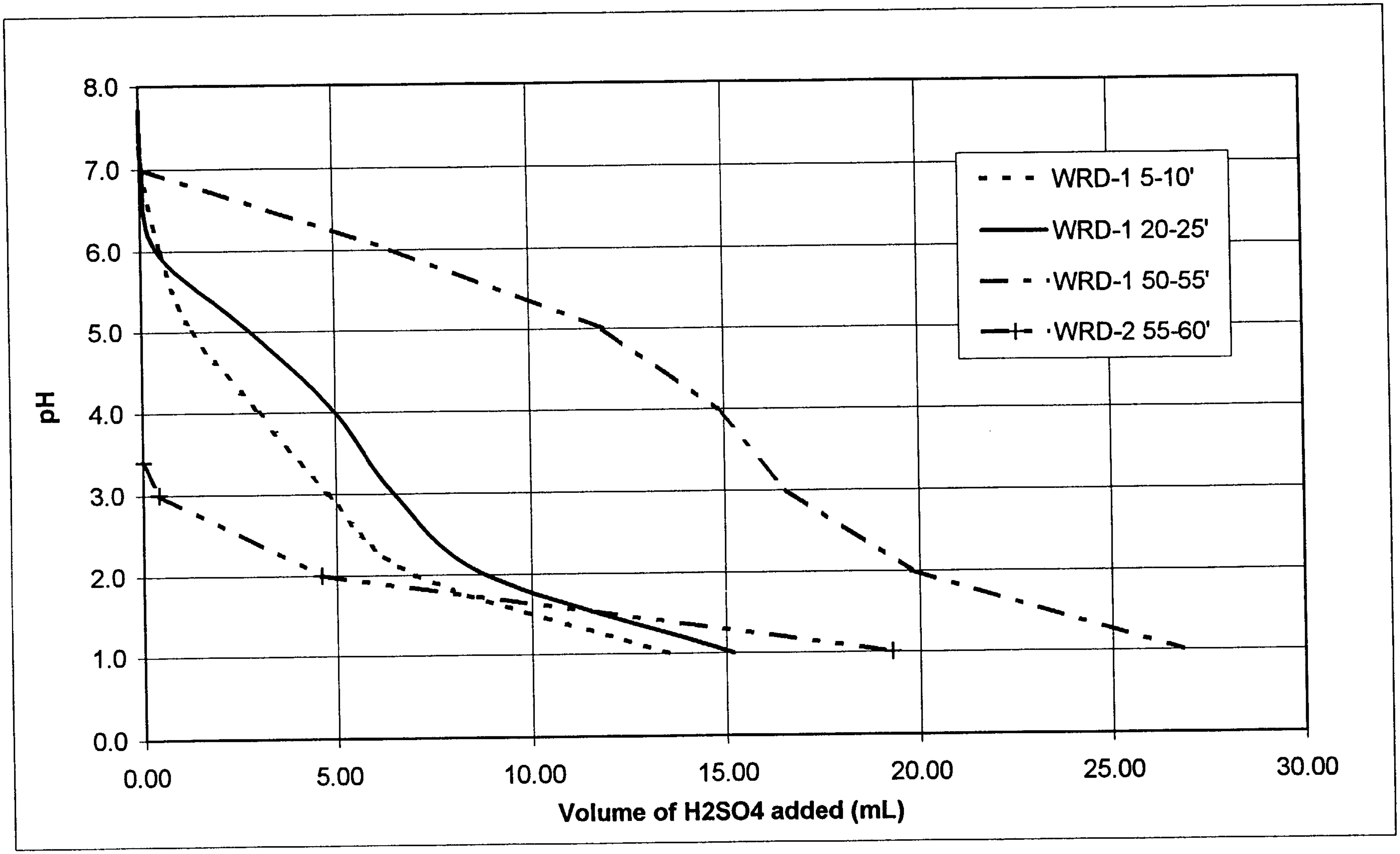


Figure 33: Forward Acid Titration Results for WRD-1 WRD-2 Samples.

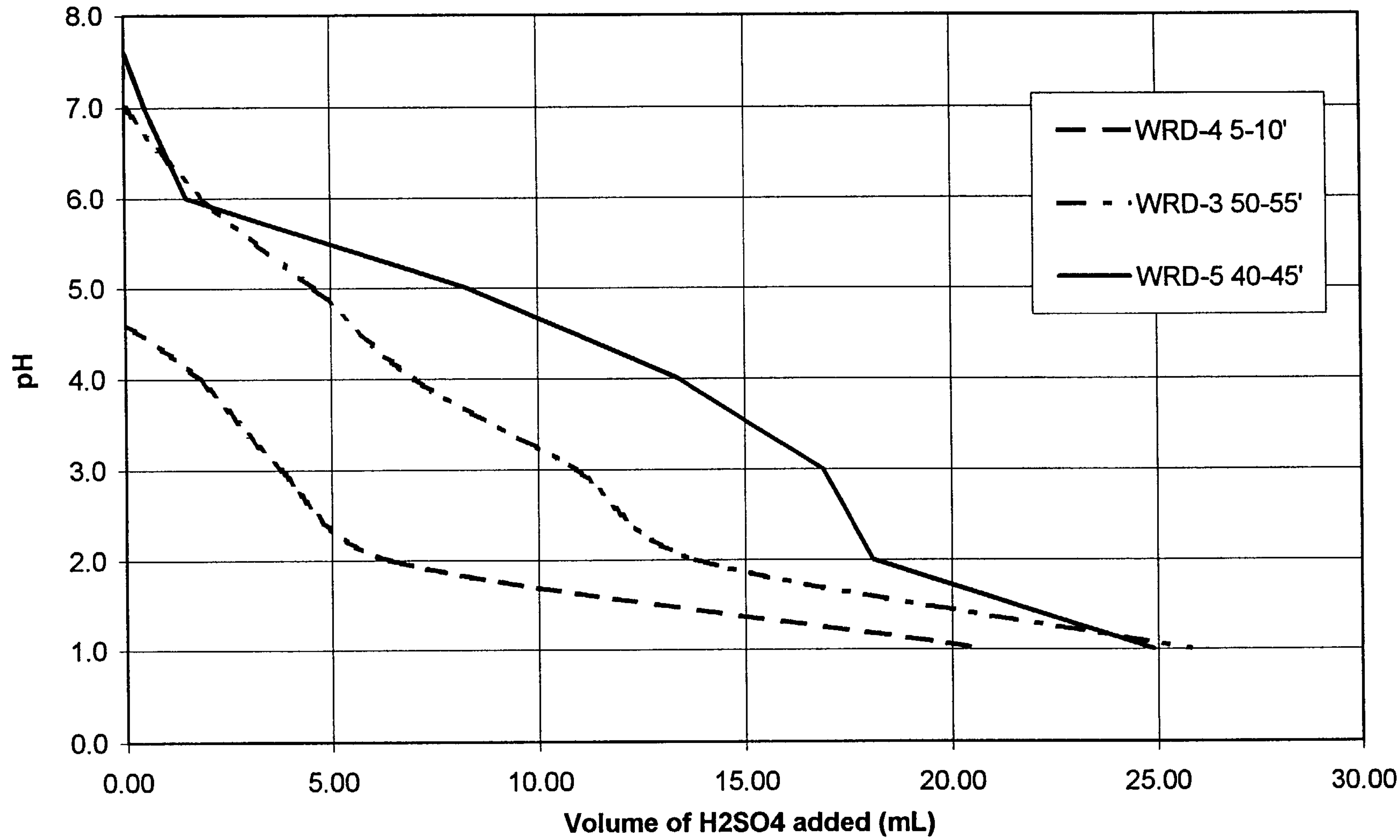


Figure 34: Forward Acid Titration Results for WRD-3, WRD-4 WRD-5 Samples.

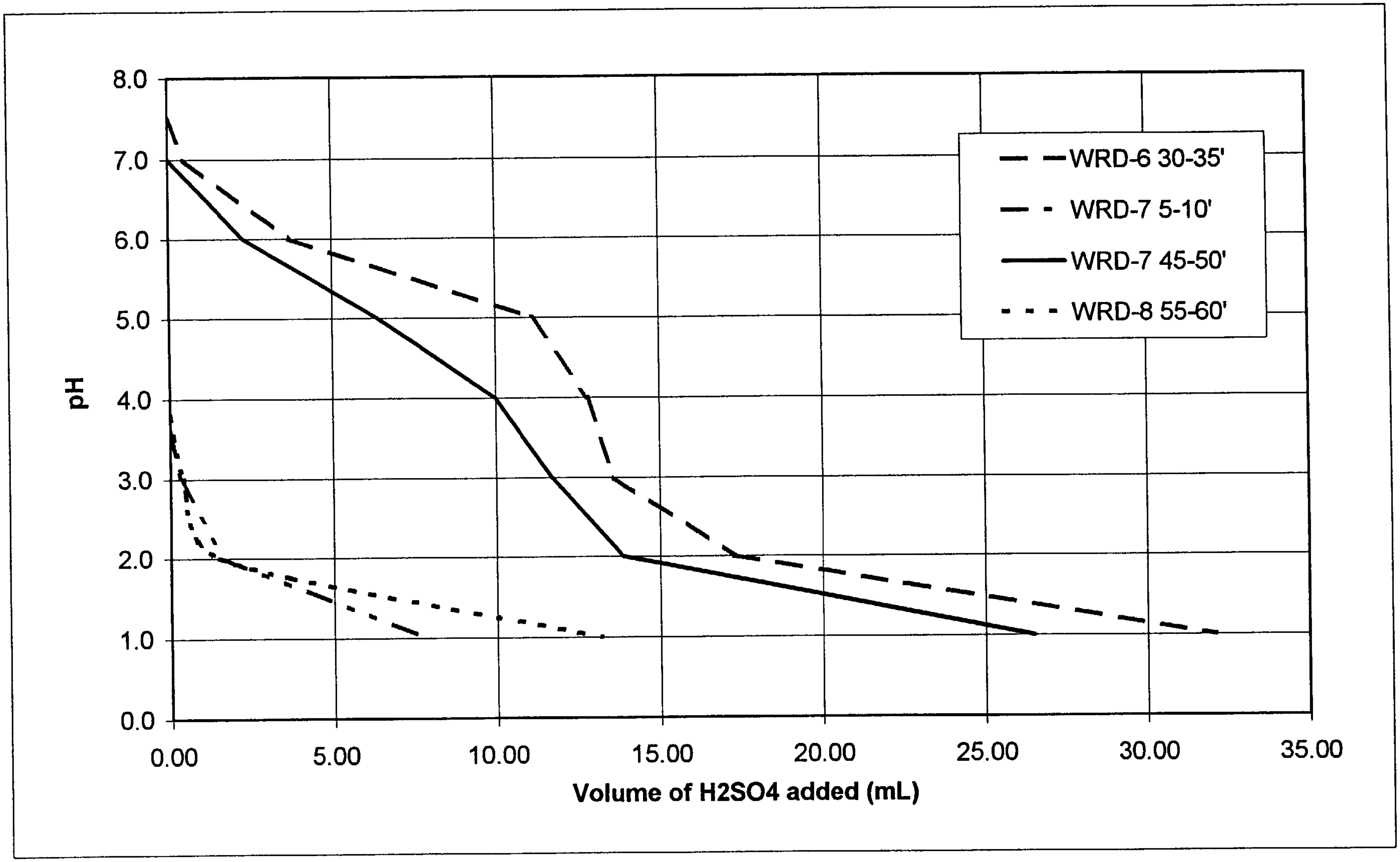


Figure 35: Forward Acid Titration Results for WRD-6, WRD-7 WRD-8 Samples.

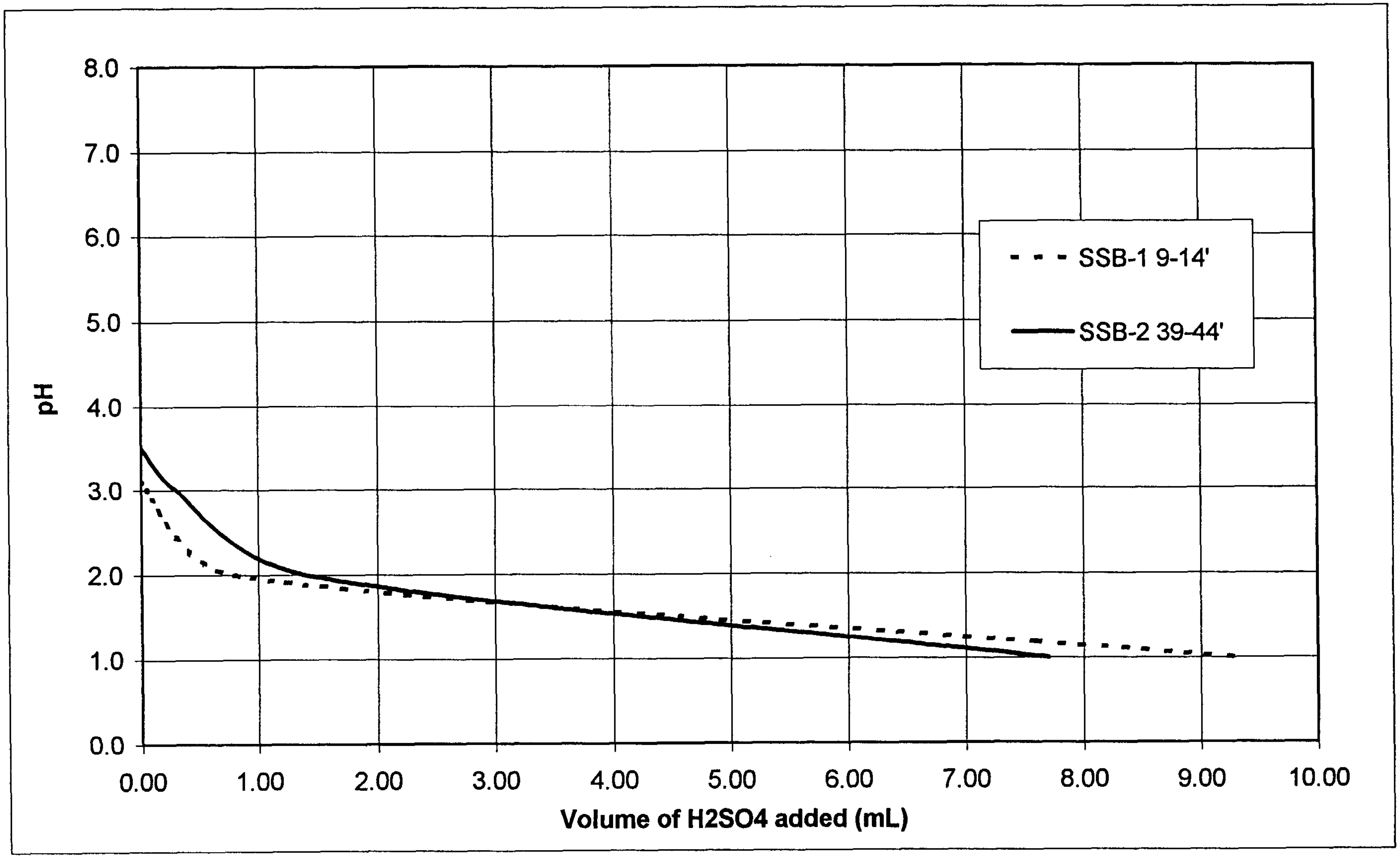


Figure 36: Forward Acid Titration Results for Scar Samples.

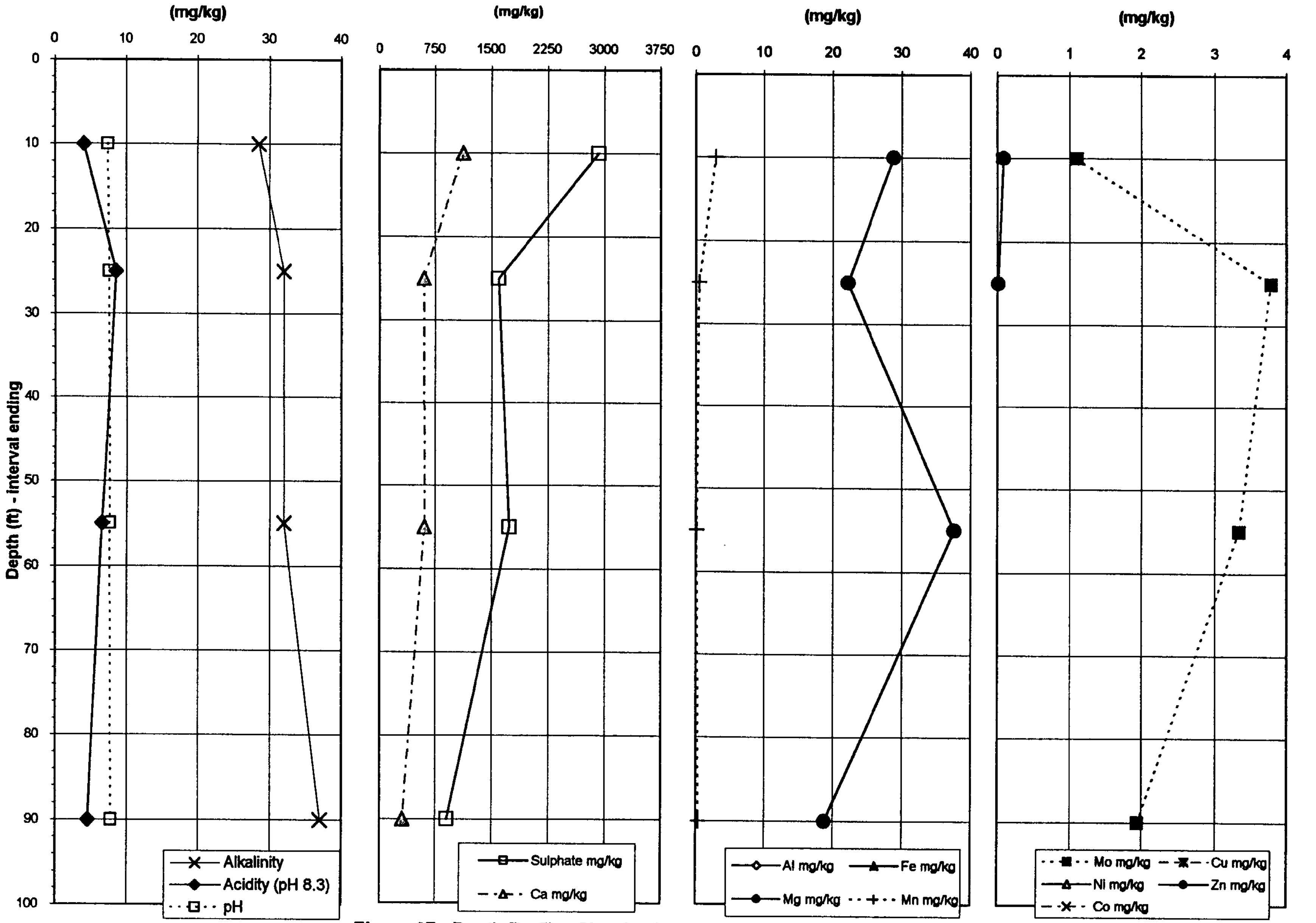


Figure 37. Depth Profiles Showing Leach Extraction Results for WRD-1.

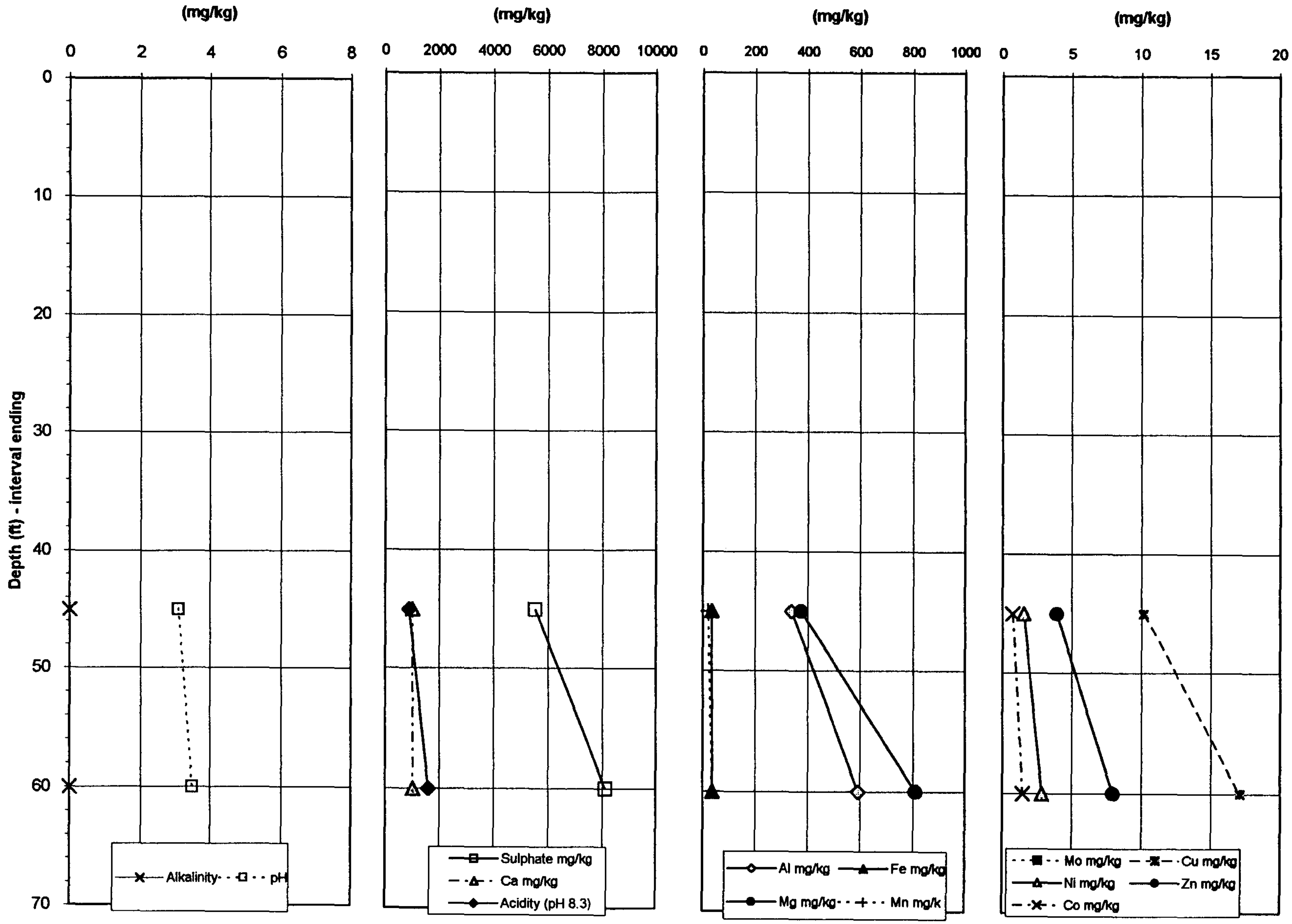


Figure 38. Depth Profiles Showing Leach Extraction Results for WRD-2.

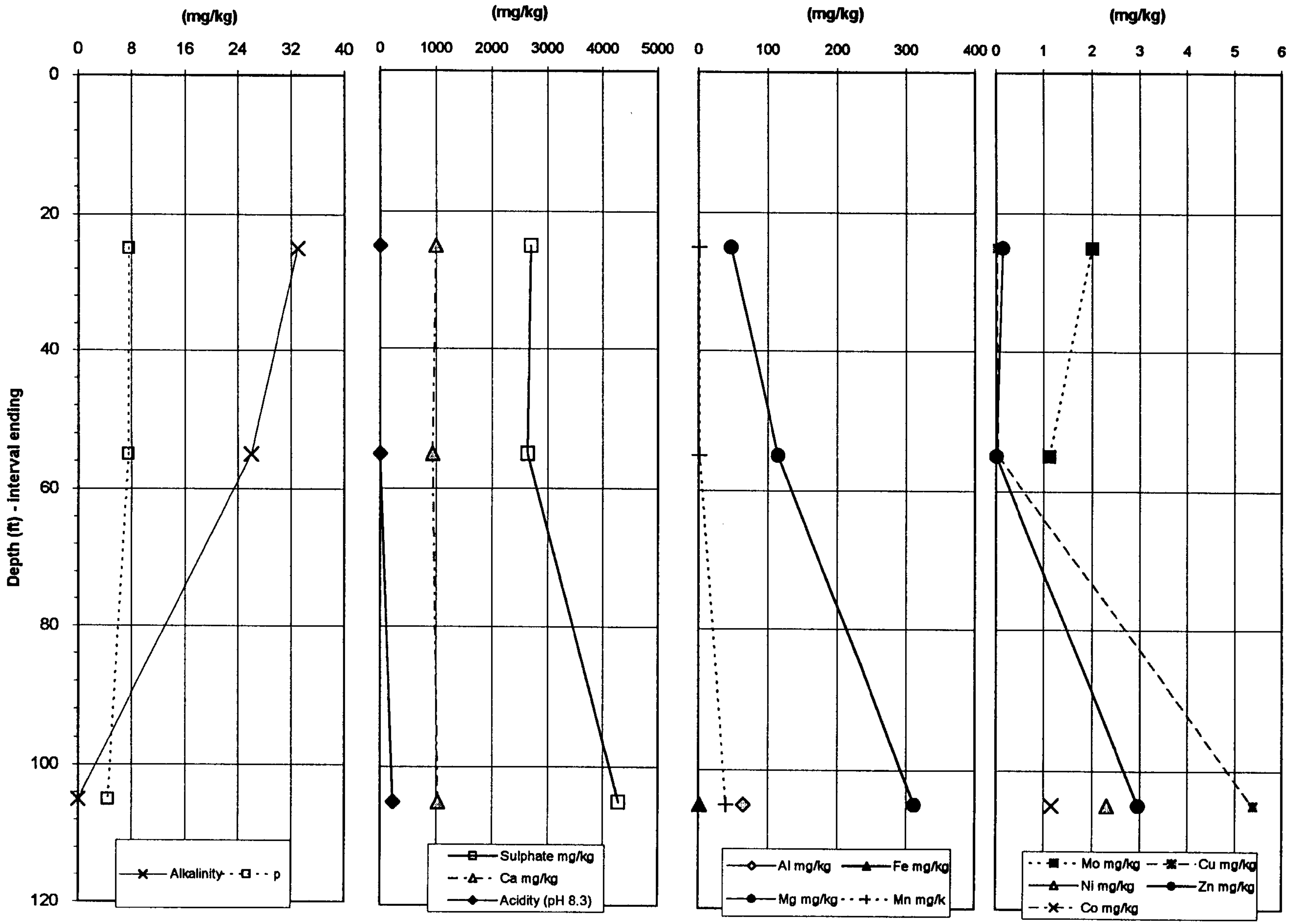


Figure 39. Depth Profiles Showing Leach Extraction Results for WRD-3.

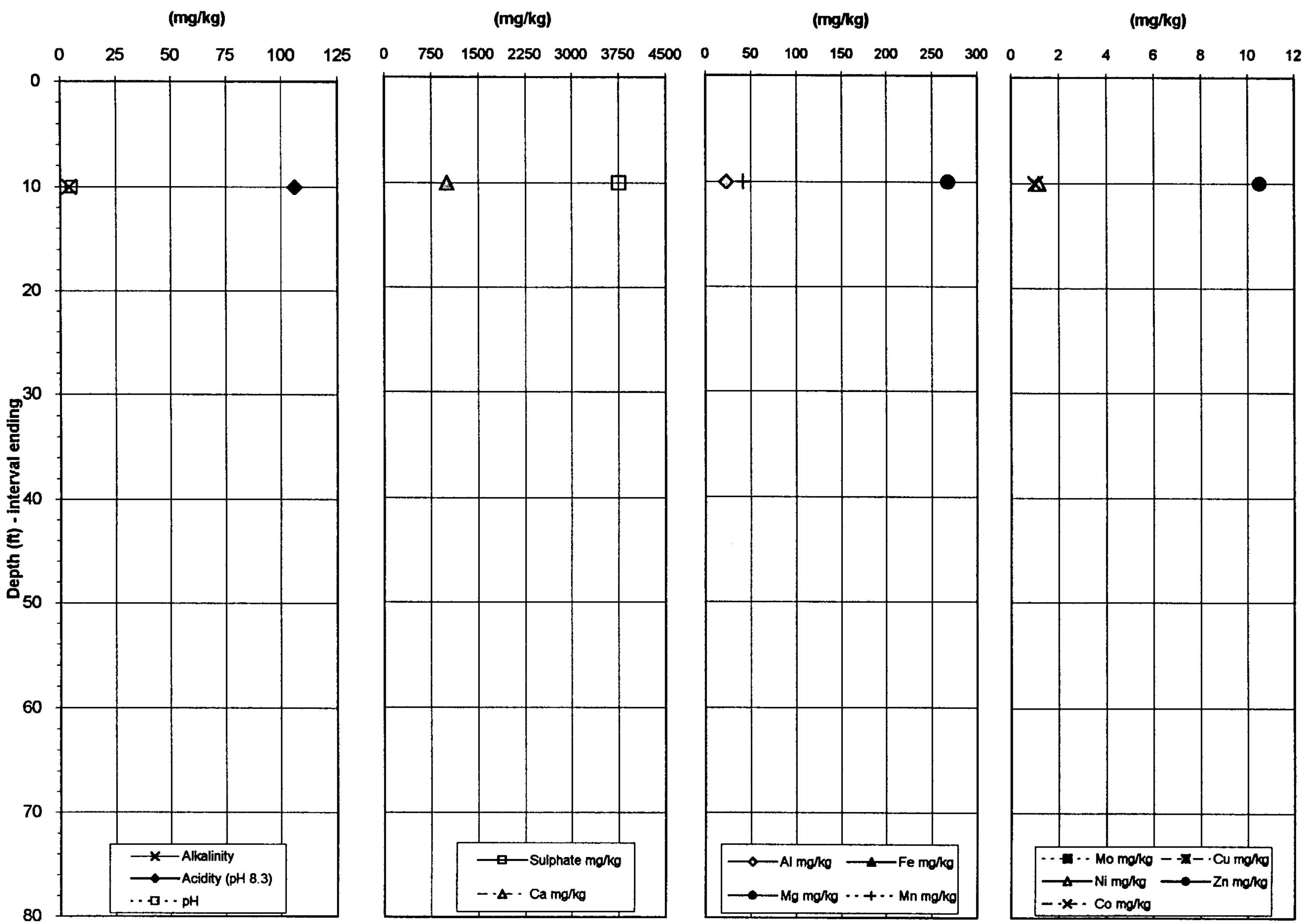


Figure 40. Depth Profiles Showing Leach Extraction Results for WRD-4.

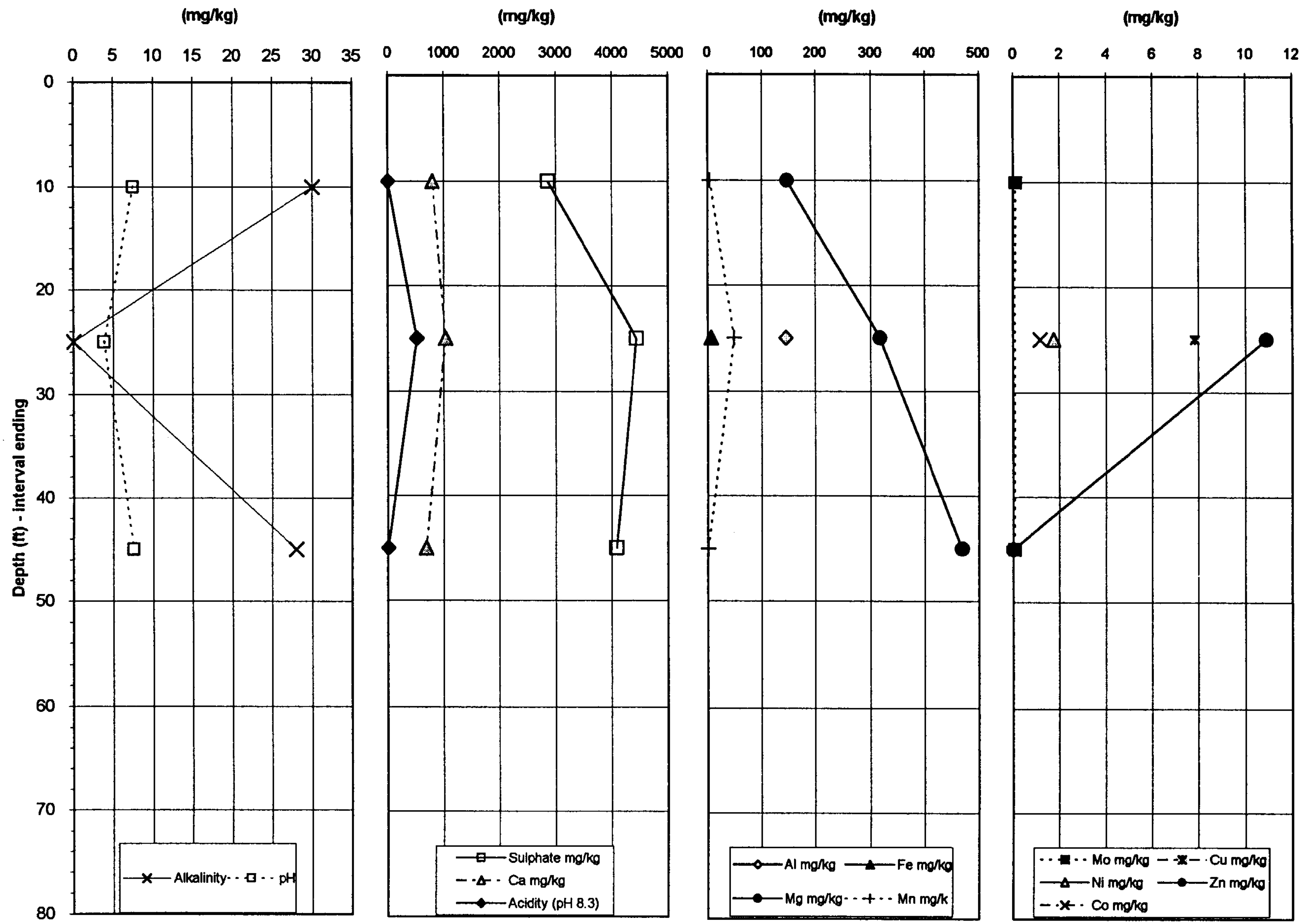


Figure 41. Depth Profiles Showing Leach Extraction Results for WRD-5.

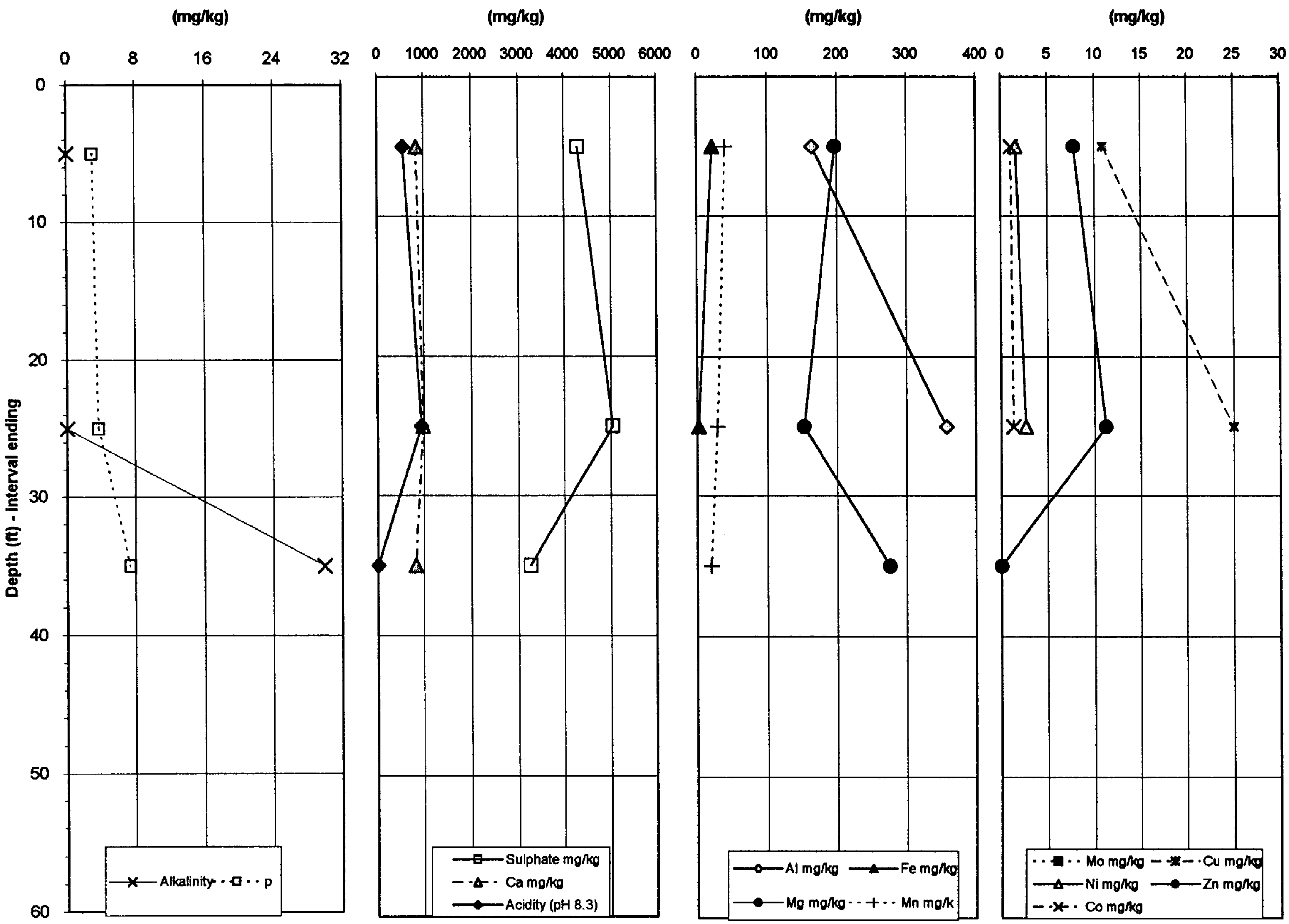


Figure 42. Depth Profiles Showing Leach Extraction Results for WRD-6.

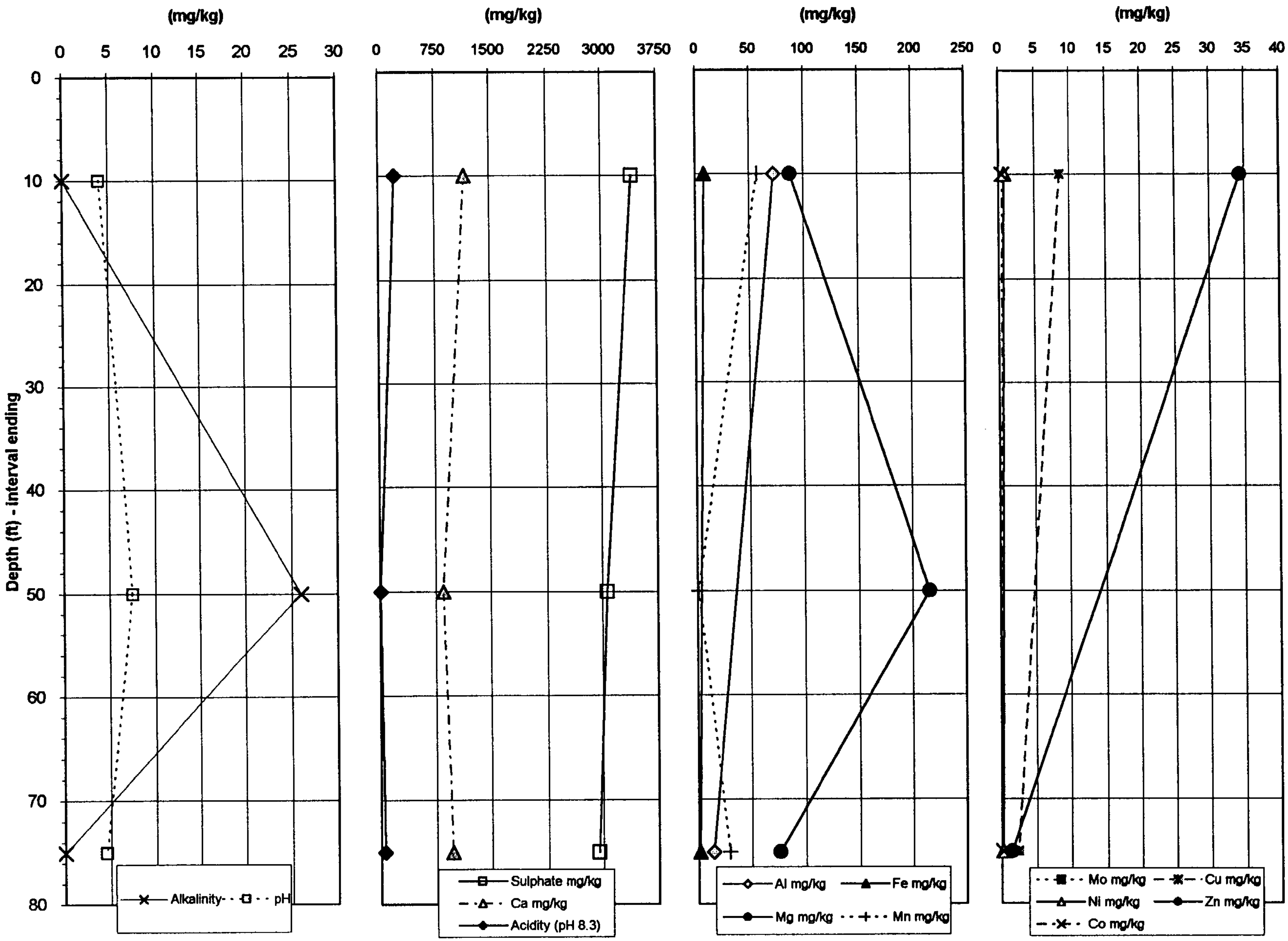


Figure 43. Depth Profiles Showing Leach Extraction Results for WRD-7.

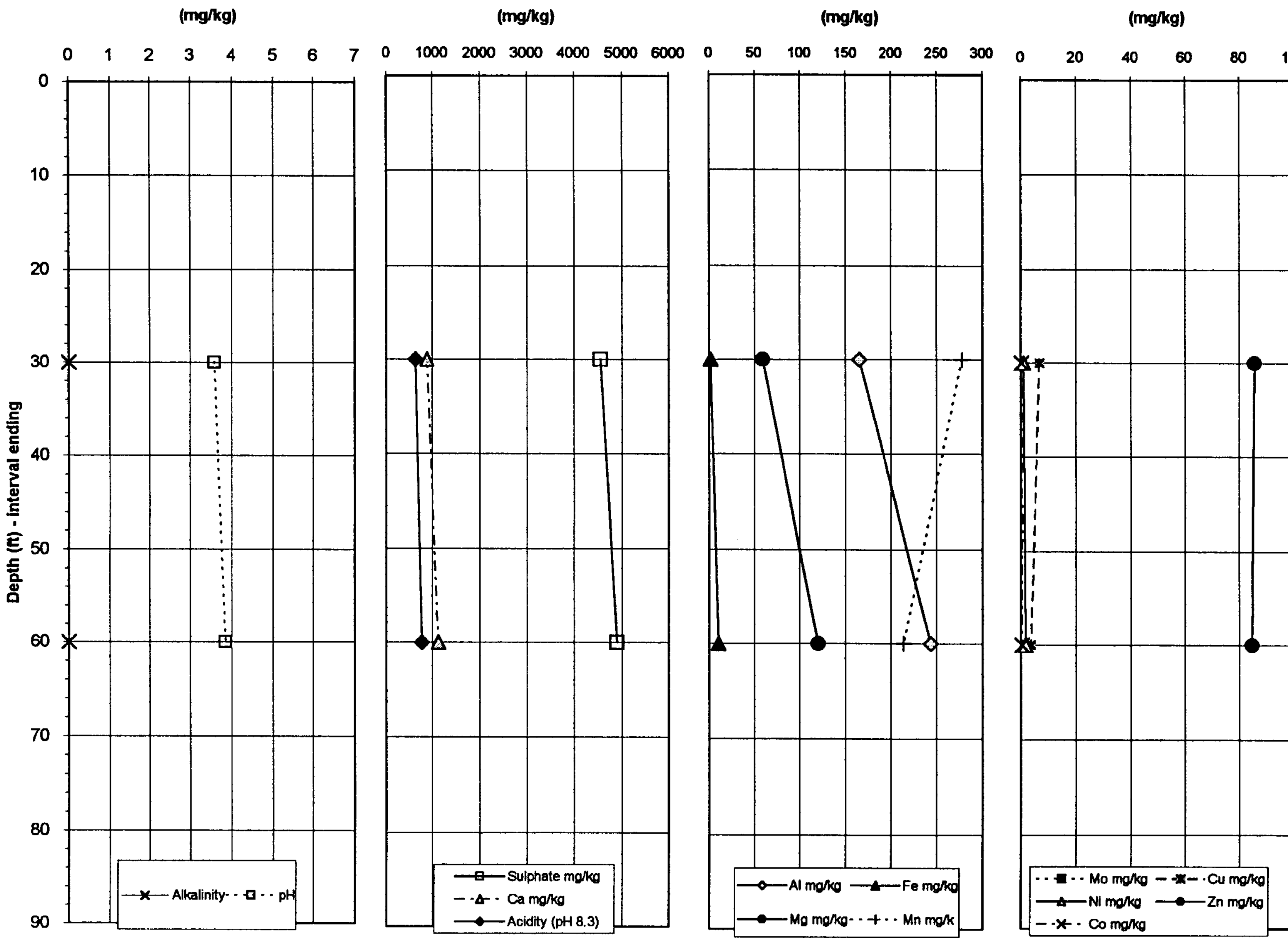


Figure 44. Depth Profiles Showing Leach Extraction Results for WRD-8.

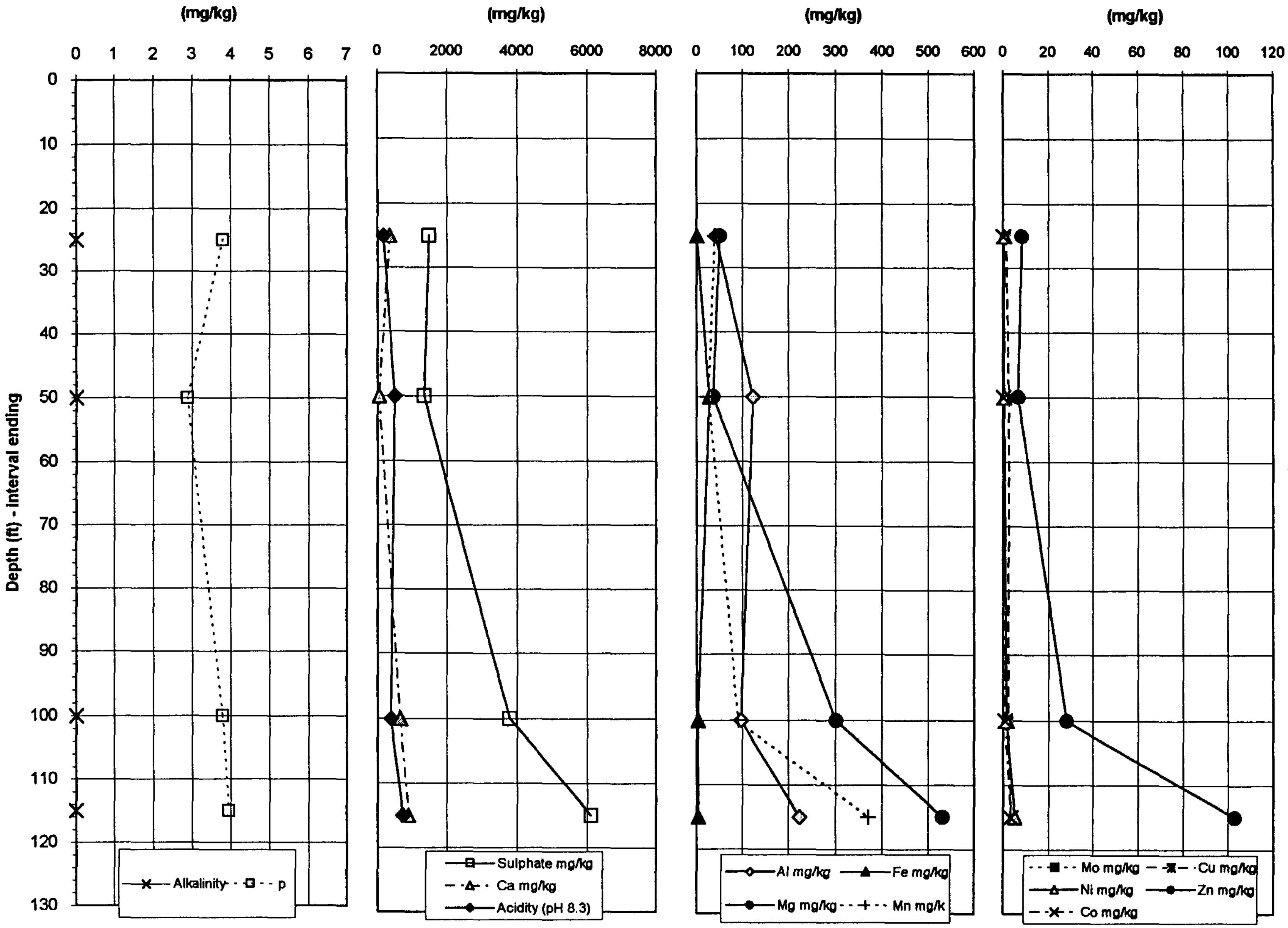


Figure 45. Depth Profiles Showing Leach Extraction Results for WRD-9.

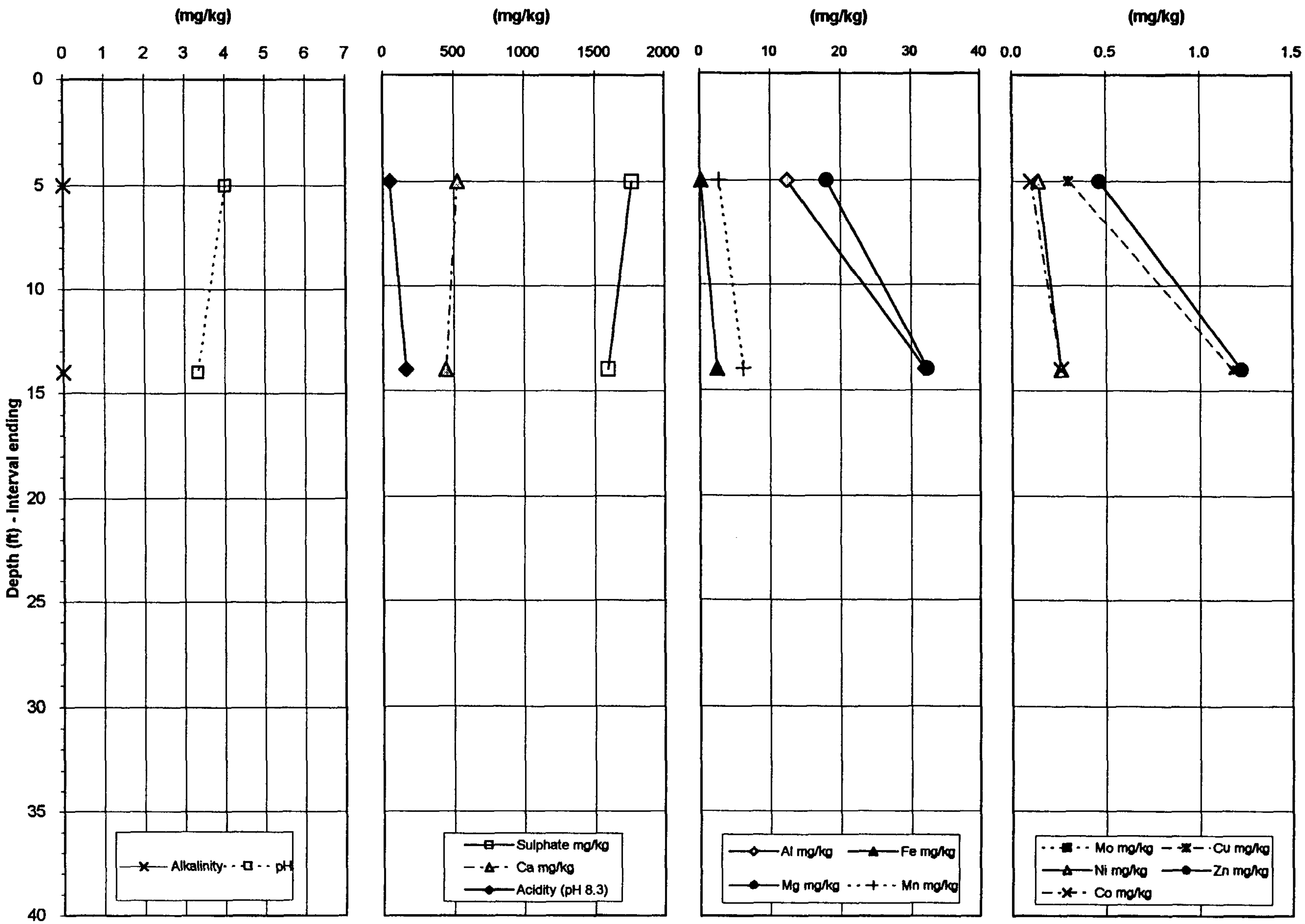


Figure 46. Depth Profiles Showing Leach Extraction Results for SSB-1.

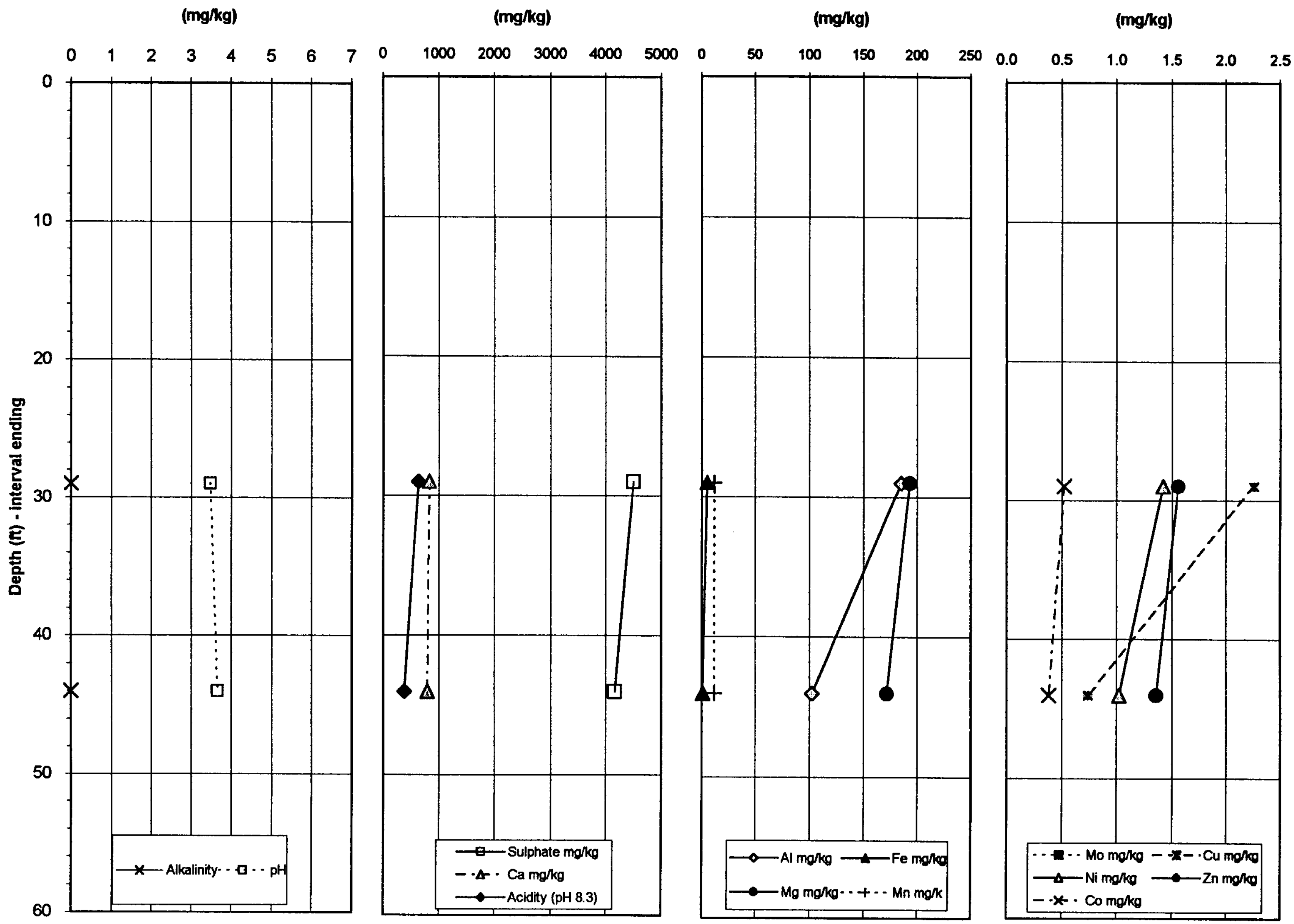


Figure 47. Depth Profiles Showing Leach Extraction Results for SSB-2.

Table A1. Drill Hole Log for WRD 1 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 1
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Aplite, light grey, minor Pyrite, tan matrix	dry	8.37	634	5.1						
5	10	Aplite, minor Pyrite, w/ Andestite, tan matrix	dry	7.98	1,040	1.6		X		X	X	X
10	15	Aplite, trace Pyrite, tan matrix	dry, poor recovery	7.93	1,380	4.0						
15	20	Aplite, minor Andesite, light grey, tan matrix	dry	7.67	1,850	4.8		X				
20	25	Aplite, light grey, tan matrix	dry	7.93	1,730	4.4		X	X	X	X	X
25	30	Andesite, >1% Pyrite, trace Molydenum, mineralized, brown matrix	dry ,color change to brown at ~27'	7.29	2,400	4.9						
30	35	Andesite, >1% Pyrite, Aplite, minor Rhyolite, Fluorite, Calcite, Trace Molydenum	dry	7.66	2,040	4.1		X				
35	40	Andesite, trace Pyrite, minor Aplite, Calcite, dark brown matrix	dry	7.73	2,200	6.2						
40	45	fresh Andesite, Calcite, dark grey to black, dark brown matrix	dry	7.68	1,750	5.0	C1A					
45	50	Andesite, trace Chalcopyrite, abundant Calcite, dark grey, dark brown matrix	dry	7.84	2,340	6.2						
50	55	Andesite, trace Pyrite, Calcite, dark brown matrix	dry	7.76	2,250	4.3		X		X	X	X
55	60	Andesite, porphyry, 1% Pyrite, minor calcite, dark brown matrix	dry	7.88	1,800	4.3						
60	65	Andesite, abundant Calcite, dark green-grey, propylitically altered, dark brown	dry	8.11	2,070	4.7						
65	70	Andesite, trace Pyrite, abundant calcite, dark grey, dark brown-grey matrix		7.89	1,630	4.0						
70	75	Andesite, fresh trace Pyrite, dark grey, dark grey-brown matrix	dry	7.98	1,852	3.5		X				
75	80	Andesite, trace Pyrite, minor Calcite, dark grey-green, dark grey matrix	dry	7.46	1,650	2.5	C1B					
80	85	Andesite, minor Calcite, black, minor propylitic alteration, grey matrix	dry	8.16	1,065	2.4						
85	90	Andesite, trace Calcite, black, minor propylitic alteration, grey matrix	dry	8.16	1,296	1.6		X			X	X
90	95	Andesite, black, fresh, grey matrix	dry	8.41	836	1.3	C1B					
95	100	Andesite, black, large blocks, fresh	dry	7.89	2,290	3.8						

Code:		
	C1A	Composite sample for grain size analysis
		Sample for geochemical testing
		Bedrock as inferred from drill action and borehole samples

Table A2. Drill Hole Log for WRD 2 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 2
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	mixed volcanics, mostly oxidized, yellow-brown clay rich matrix	dry	4.99	1,410	5.7	C2A					
5	10	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	dry	4.02	2,670	5.6		X				
10	15	mixed volcanics, oxidized, yellow-brown clay rich matrix	dry	3.53	2,780	8.8	C2A					
15	20	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	dry	3.17	3,820	6.9						
20	25	mixed volcanics, yellow-brown clay rich matrix	dry	3.66	4,110	8.3		X				
25	30	mixed volcanics, yellow-brown clay rich matrix	dry	3.38	3,140	10.7	C2B					
30	35	mixed volcanics, oxidized, yellow-brown clay rich matrix	dry	3.21	3,190	10.2						
35	40	mixed volcanics, trace Pyrite, oxidized, yellow-brown matrix	moist	3.34	2,840	9.3	C2C					
40	45	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	moist	3.22	3,730	9.6		X			X	X
45	50	mixed volcanics, trace Pyrite, oxidized, yellow-brown clay rich matrix	moist	3.14	5,240	5.7	C2C					
50	55	mixed volcanics trace Pyrite, yellow-brown clay rich matrix	moist	3.17	6,440	6.3						
55	60	mixed volcanics, yellow-brown clay rich matrix	moist	3.28	6,370	5.6		X		X	X	X
60	65	Aplite, trace Pyrite, fresh blocks	dry	3.82	5,630	2.3						
65	70	Aplite, trace Pyrite, fresh blocks	dry, poor recovery	3.66	5,390	3.5						
70	75	Aplite, >1% Pyrite, fresh blocks	dry	4.15	4,220	2.0						

Code:

C2A	Composite sample for grain size analysis
	Sample for geochemical testing
	Bedrock as inferred from drill action and borehole samples

Table A3. Drill Hole Log for WRD 3 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 3
Start Date ########
End Date

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth		Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing				
From	To							ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Andesite, minor Aplite, trace Pyrite, gravel in tan sand, silt size matrix	dry, split sample	6.07	2,430	2.6		X				
5	10	Aplite, minor Andesite, fresh blocks	dry, split sample	8.02	948	0.4						
10	15	Andesite, minor Aplite, trace Pyrite, large fragments	dry, split sample, poor recovery	8.16	2,280	1.3	C3A					
15	20	Andesite, trace Pyrite, fresh blocks	dry, split sample, poor recovery	8.25	2,190	0.8						
20	25	Andesite, trace Pyrite, fresh blocks	dry, split sample	8.12	2,370	3.5		X			X	X
25	30	Andesite, trace Pyrite, blocks, brown matrix	dry, split sample	7.94	2,290	4.8						
30	35	Andesite, blocks	dry, split sample	7.84	2,420	4.1						
35	40	Andesite, Aplite, blocks	dry, split sample	7.96	2,480	5.9						
40	45	Andesite, Aplite, Rhyolite fragments, trace to minor Pyrite,	dry, split sample	7.97	2,730	4.0	C3B					
45	50	Andesite, Rhyolite fragments, trace Pyrite	dry, split sample	8.27	2,150	2.3						
50	55	Rhyolite, minor Pyrite, fresh hydrothermally altered volcanics	dry, split sample	7.58	2,610	2.6		X	X	X	X	X
55	60	Andesite, trace pyrite, minor hydrothermally altered volcanic Pyrite	dry, split sample	6.35	2,450	2.4						
60	65	Andesite, minor Pyrite, hydrothermical alteration	dry, split sample	6.01	2,560	4.2						
65	70	few Andesite, fragments, yellow-brown matrix	dry, split sample	4.10	3,510	5.4	C3C					
70	75	Andesite, minor Pyrite, moderately hydrothermally altered, yellow-brown matrix	dry, split sample	3.90	3,630	5.1		X				
75	80	Andesite, minor Pyrite, minor Aplite, hydrothermally altered, yellow-brown matrix	dry, split sample	3.93	3,760	4.6	C3C					
80	85	Andesite, trace Pyrite, hydrothermally altered, yellow-brown matrix	dry, split sample	4.41	4,150	4.1						
85	90	Andesite, minor Pyrite, minor telsic volcanic Chalcopyrite, Rhyolite, hydrothermally altered, yellow-brown matrix	dry, split sample	6.59	3,740	3.3		X				
90	95	Andesite, trace Pyrite, minor Rhyolite, yellow-brown matrix	dry, large fragment:	6.35	3,930	4.0						
95	100	Andesite, Rhyolite, mixed volcanics, fresh and hydrothermally altered, yellow-brown matrix	dry, split sample	4.64	3,270	3.8						
100	105	Andesite, Rhyolite mixed volcanics, yellow-brown matrix	dry, split sample	3.99	3,780	4.5		X			X	X
105	110	Andesite, minor Rhyolite, mixed volcanics, fresh and hydrothermally altered, yellow-brown matrix	dry, split sample	4.61	3,560	3.6						
110	115	Andesite, minor Pyrite, slightly altered	dry, split sample	6.73	3,270	2.7						
115	120	Andesite, minor Pyrite, slightly altered	dry, split sample	5.68	4,090	2.0						

Code:

C3A	Composite sample for grain size analysis
	Sample for geochemical testing
	Bedrock as inferred from drill action and borehole samples

Table A4. Drill Hole Log for WRD 4 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 4
Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill
Start Date ########
End Date
Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth		Lithology	Comments	Paste pH	Paste Cond	Moisture Content	Grain Size	Phase 1a Geochemical Testing				
From	To			(su)	(μS)	(%)	Analysis	ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	mixed volcanics, hydrothermally altered, coarse gravel, tan fines	dry, whole bucket sample	4.17	1,880	5.4						
5	10	volcanics, dark brown, hydrothermally altered, mostly clay-sand sized	dry, split sample	5.11	2,930	6.3		X		X	X	X
10	15	Andesite, Granite, angular gravel, light brown silt-clay matrix,	dry, split sample	7.40	2,400	5.5	C4A					
15	20	mixed volcanics, hydrothermally altered, dark brown fines	dry, split sample	7.19	2,720	6.7						
20	25	Aplite, Granite, Andesite, gravel	dry, split sample	7.87	2,810	4.2						
25	30	mixed volcanics, hydrothermally altered, drak brown matrix	dry, split sample	7.84	2,660	6.4		X				
30	35	volcanic, light grey, gravel, hydrothermally altered, tan matrix	dry, split sample	6.74	2,790	5.6	C4B					
35	40	volcanics, light grey, hydrothermally altered	dry, split sample	7.51	2,870	3.9						
40	45	mixed volcanics, grey, coarse blocks,tan matrix	dry, split sample	4.88	3,400	4.9		X				
45	50	volcanics, grey, coarse blocks,tan matrix	dry, split sample	4.68	3,100	4.5	C4C					
50	55	volcanics, grey, gravel <1" dia., tan matrix	slightly moist, split sample	4.85	4,160	6.6		X				
55	60	volcanics, grey, coarse gravel, tan matrix	slightly moist, split sample	7.78	4,170	4.9	C4C					
60	65	Andesite, dark grey, volcanic, angular, one lithology	moist, split sample	6.96	3,130	5.4						
65	70	Andesite, dark grey, volcanic,minor brown matrix, one lithology	moist, split sample	7.18	2,810	4.8						
70	75	Andesite, dark grey, volcanic, angular large fragments, slightly brown matrix	moist, more red hue than others	7.95	1,040	3.6						

Code:

Code	
C4A	Composite sample for grain size analysis
	Sample for geochemical testing
	Bedrock as inferred from drill action and borehole samples

Table A5. Drill Hole Log for WRD 5 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 5
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth		Lithology	Comments	Paste pH	Paste Cond	Moisture Content	Grain Size	Phase 1a Geochemical Testing				
From	To			(su)	(µS)	(%)	Analysis	ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Andesite, Rhyolite, mixed vocanics, yellow-brown matrix	moist	6.18	2,590	6.8						
5	10	Rhyolite, minor Andesite, brown matrix	moist	7.84	1,880	4.7		X			X	X
10	15	minor Aplite, mixed volcanics, yellow-brown clay rich matrix	moist	4.40	1,650	9.4	C5A					
15	20	Andesite, trace Pyrite, highly altered Rhyolite, black, mixed volcanics, yellow-brown (clay-rich) matrix	moist	3.66	3,000	11.6						
20	25	Andesite, minor Pyrite, highly altered Rhyolite, easily crumbled, yellow-brown clay rich matrix	moist	3.80	3,190	6.9		X			X	X
25	30	Andesite, trace Pyrite, minor Rhyolite, dark grey, slightly oxidized, brown matrix	dry	5.11	3,750	6.4		X				
30	35	Andesite, Rhyolite, trace Pyrite, dark grey-brown matrix	dry	7.60	3,770	5.8	sample missing					
35	40	Andesite, dark grey-green, large blocks, propylitic alteration, grey matrix	dry	8.02	2,530	4.9		X				
40	45	Andesite, trace Pyrite, Calcite, dark grey-green, propylitic alteration, grey matrix	dry	8.03	3,280	4.2		X	X	X	X	X
45	50	Andesite, minor Pyrite, dark green-grey, grey matrix	dry	8.34	3,430	4.3	C5B					
50	55	Andesite, trace Pyrite, Calcite, dark grey-green, grey matrix	dry	7.89	3,640	4.5						
55	60	Andesite, drak grey, brown matrix	dry	7.67	2,530	4.6						
60	65	Andesite, Rhyolite, mixed volcanics, fresh and altered, dark brown matrix	dry	6.52	2,510	6.4		X				
65	70	trace Pyrite, mixed volcanics, large blocks oxidized, brown matrix	dry	7.73	1,510	7.4						
70	75	Andesite, trace Pyrite, Epidote, minor Rhyolite,dark grey-green, grey matrix	dry	8.11	1,050	4.9						
75	80	Andesite, minor Pyrite, dark grey, large blocks, uniform, grey matrix	dry									

Code:

C5A	Composite sample for grain size analysis
	Sample for geochemical testing
(shaded)	Bedrock as inferred from drill action and borehole samples

Table A6. Drill Hole Log for WRD 6 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 6
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth		Lithology	Comments	Paste pH	Paste Cond	Moisture Content	Grain Size	Phase 1a Geochemical Testing				
From	To			(su)	(µS)	(%)	Analysis	ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	mixed volcanics, yellow-brown clay rich matrx	moist	3.17	3,130	7.49		X			X	X
5	10	mixed volcanics,dominant Tuff, trace Pyrite, grey, light brown clay rich	moist	3.29	3,350	7.02	C6A					
10	15	mixed volcanics, fresh, highly altered varients (bleached, oxidized), light brown clay rich matrix	moist	3.53	3,200	10.45		X				
15	20	black Andesite,light grey Rhyolite/Tuff, mixed volcanics, light brown clay rich matrix	moist	3.62	2,960	11.25	C6A					
20	25	grey Rhyolite, minor highly altered volcanics (Rhyolite, trace Pyrite) light brown clay rich matrix	moist	3.94	2,970	8.84		X			X	X
25	30	grey Rhyolite, trace Pyrite, (Tuff?), grey-brown matrix	moist, drier than above	4.48	2,830	6.20		X				
30	35	Tuff, trace Pyrite, grey, crystal, grey matrix	moist	7.37	2,860	5.66		X		X	X	X
35	40	Tuff, massive Pyrite, dark grey, very little banding, grey matrix	moist	7.50	2,430	6.24	C6B					
40	45	Tuff, >1% Pyrite, Epidote, dark grey, crystal, grey matrix	slightly moist	7.71	2,850	6.16						
45	50	mixed volcanics, grey Tuff, trace Pyrite, light grey Rhyolite, oxidized Rhyolite (?), grey-brown matrix	dry	7.64	3,090	4.66		X				
50	55	mixed volcanics, dominate Tuff, >1% Pyrite, dark grey, crystal, grey-brown matrix	dry	7.50	3,410	5.52		X				
55	60	Tuff, minor Pyrite, light grey, crystal, grey rock powder matrix	dry, competent rock-bedrock	7.81	2,980	3.08						

Code:

Code	
C6A	Composite sample for grain size analysis
	Sample for geochemical testing
	Bedrock as inferred from drill action and borehole samples

Table A7. Drill Hole Log for WRD 7 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 7
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth		Lithology	Comments	Paste pH	Paste Cond	Moisture Content	Grain Size	Phase 1a Geochemical Testing				
From	To			(su)	(μS)	(%)	Analysis	ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Andesite, trace Pyrite, Aplite, yellow-brown matrix	dry	5.68	2,450	5.4						
5	10	mixed volcanics, Aplite, yellow-brown matrix	dry	3.84	2,570	5.7		X		X	X	X
10	15	Aplite, mixed volcanics, yellow-brown clayey matrix	moist (raining)	3.63	2,850	7.4	C7A					
15	20	mixed volcanics, Aplite, yellow-brown matrix	moist (raining)	3.09	3,140	10.4						
20	25	mixed volcanics, Aplite, yellow-brown matrix	dry	3.46	3,000	7.2		X				
25	30	mixed volcanics, dominate Andesite, brown matrix	dry	4.52	3,140	4.9						
30	35	mixed volcanics, brown matrix	dry	7.18	3,100	5.2		X				
35	40	mixed volcanics, dominant Rhyolite, rh prophyry, grey-brown matrix	dry	7.57	3,110	6.6						
40	45	mixed volcanics, Aplite, grey-brown matrix	moist (lightly raining)	7.57	2,600	6.6	C7B					
45	50	mixed volcanics, Aplite, brown matrix	dry	7.30	2,200	7.2		X		X	X	X
50	55	mixed volcanics, dominant grey Rhyolite, grey-brown matrix	dry	7.71	2,250	5.5						
55	60	mixed volcanics, dominate Rhyolite, grey matrix	moist	7.43	2,130	7.1		X				
60	65	grey Rhyolite, minor Andesite, grey matrix	moist	7.91	1,410	6.4						
65	70	mixed volcanics, dominate Rhyolite, grey-brown matrix	moist (lightly raining)	7.63	2,400	5.6	C7C					
70	75	light grey Rhyolite (partialy oxidized), minor Pyrite, minor black Andesite, trace Pyrite, yellow-brown matrix	dry	4.28	2,580	4.6		X			X	X
75	80	Andesite, dark grey, fresh, prophyry, large blocks	dry bedrock	5.92	2,410	2.9						

Code:

C7A	Composite sample for grain size analysis
(unshaded box)	Sample for geochemical testing
(grey-shaded box)	Bedrock as inferred from drill action and borehole samples

Table A8. Drill Hole Log for WRD 8 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 8
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Grey welded tuff, volcanic brecia, dark brown matrix	moist	3.25	2,440	4.7						
5	10	Grey tuff, dark brown matrix	moist	3.47	2,480	6.2						
10	15	Grey tuff, crystal rich and crystal poor varieties, dark brown clay rich matrix	moist	3.16	2,740	6.4		X				
15	20	Dark grey tuff, trace pyrite, dark brown clay rich matrix	moist	3.23	2,730	6.5	C8A					
20	25	Dark grey tuff, minor pyrite, silicified, dark grey-brown matrix	moist	6.17	2,500	5.6						
25	30	Grey tuff, minor pyrite, silicified, dark grey-brown clay rich matrix	moist	3.89	2,950	6.7		X			X	X
30	35	Grey tuff, trace pyrite, silicified, dark brown-orange clay rich matrix	moist	3.35	2,620	7.9						
35	40	Grey tuff, trace pyrite, crystal rich, brown-orange clay rich matrix	moist	3.07	2,910	8.0						
40	45	Grey tuff, trace pyrite, crystal rich, brown-orange clay rich matrix	moist	3.63	2,790	8.5		X				
45	50	Grey tuff, minor pyrite, crystal rich, grey-brown matrix	moist	3.98	2,680	8.5	C8B					
50	55	Grey tuff, minor Pyrite, grey-tan clay rich matrix	moist	3.91	2,570	9.3						
55	60	dark grey Tuff, trace Pyrite, crystal rich and crystal poor varieties, grey	moist	4.11	2,870	7.3		X		X	X	X
60	65	dark grey Tuff, trace Pyrite, brown clay rich matrix	moist	4.02	2,760	7.8	C8C					
65	70	dark grey Tuff, crystal poor, light brown clay rich matrix	moist	3.79	3,050	8.7						
70	75	dark grey Tuff, trace Pyrite, light brown matrix	moist	3.95	3,100	8.7		X				
75	80	dark grey Tuff, trace Pyrite, light brown clay rich matrix	moist, drier than above	3.93	3,380	9.4						
80	85	Tuff, light grey, fresh, light brown matrix	dry	3.88	3,150	7.4						

Code:

C8A	Composite sample for grain size analysis
	Sample for geochemical testing
	Bedrock as inferred from drill action and borehole samples

Table A9. Drill Hole Log for WRD 9 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: WRD 9
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By: A. Eschenbacher, SMA
G. Muller, SRK Consulting Inc.

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (μS)	Moisture Content (%)	Grain Size Analysis	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Mixed volcanics, trace pyrite, oxidized clasts, light brown matrix	dry	3.10	2,780	7.3	C9A					
5	10	Mixed volcanics, brown clay rich matrix	moist	3.79	1,660	9.6						
10	15	Mixed volcanics, dominate andesite, black, brown clay-rich matrix	moist	3.21	3,480	7.9		X				
15	20	black Andesite, trace Pyrite, brown clay rich matrix	moist	3.05	2,910	6.6	C9A					
20	25	Black andesite, trace pyrite, minor grey rhyolite, brown matrix	moist	3.26	2,250	6.5		X			X	X
25	30	Tuff, dark grey, welded, brown matrix	dry, poor recovery	4.01	2,550	5.6						
30	35	Mixed volcanics, andesite, trace pyrite, rhyolite, tuff, brown matrix	dry, poor recovery	3.23	2,840	5.6						
35	40	Grey rhyolite, dark grey tuff, welded, light brown matrix	dry, poor recovery	3.41	2,630	6.5						
40	45	Rhyolite, light grey, fresh, large blocks, light brown-grey matrix	dry	3.24	1,290	6.1						
45	50	Rhyolite, light grey, fresh, large blocks, light brown-grey clay rich matrix	dry	2.89	1,720	6.9		X			X	X
50	55	Grey rhyolite,tuff, welded, light brown clay rich matrix	moist	3.01	3,110	8.7						
55	60	Tuff, grey, welded, light brown clay rich matrix	moist	3.56	4,280	9.8	C9B					
60	65	grey welded Tuff, minor oxidized Tuff with trace Pyrite, light brown clay rich	dry	3.67	3,980	6.9						
65	70	Tuff, >1% Pyrite, grey, crystal rich, brown clay rich matrix	moist	3.57	3,270	8.5						
70	75	grey welded Tuff, Tuff breccia, boulder +/- 3' dia., minor Pyrite	dry	3.88	3,460	4.3						
75	80	Reddish grey tuff, >1% pyrite, epidote, large blocks, light brown matrix	dry	4.23	3,660	5.9		X				
80	85	Red-grey tuff, >1% pyrite, epidote, large blocks, light brown matrix	dry	6.82	3,530	5.1						
85	90	Mixed volcanics, red-grey tuff, strong pyrite, oxidized and bleached crystal	dry	4.59	3,960	7.3	C9C					
90	95	Mixed volcanics, mostly rhyolite, red-grey, crystal rich, minor pyrite, light	dry	3.62	3,810	7.9						
95	100	Mixed volcanics, minor pyrite, light brown matrix	dry	3.42	3,330	5.9		X	X		X	X
100	105	Mixed volcanics, mostly various tuffs, fresh, oxidized, light broen clay rich	dry	3.78	3,450	6.0						
105	110	Mixed volcanics, light brown-grey matrix	dry	3.73	4,660	5.6						
110	115	Tuff, light grey, crystal rich, boulder, light brown-grey matrix	dry	3.82	4,630	4.5		X			X	X
115	120	Mixed volcanics, dominate tuff, light grey, boulder, grey matrix	dry	3.90	4,940	2.7						
120	125	Tuff, light grey, fresh, grey rock powder matrix	dry, bedrock	4.64	2,440	1.3						

Code:

C9A	Composite sample for grain size analysis
	Sample for geochemical testing
	Bedrock as inferred from drill action and borehole samples

Table A10. Drill Hole Log for SSB 1 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: SSB-1
Start Date ########
End Date ########

Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill

Logged By:

Depth From	Depth To	Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Phase 1a Geochemical Testing: ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Altered Rock - Hydrothermal Scar Material, yellowish-brown	moist	3.74	2,180		X			X	X
5	10	Altered Rock - Hydrothermal Scar Material, yellowish-brown	dry from 9' -total de	3.55	2,180						
10	15	Altered Rock - Hydrothermal Scar Material, yellowish-brown	dry from 9' -total de	3.48	1,930		X				
15	20	Altered Rock - Hydrothermal Scar Material, yellowish-brown	dry	3.78	1,740						
20	25	Bedrock - Andesite Porphyry with pyrite	dry	4.20	2,410						
25	30	Bedrock - Andesite Porphyry with pyrite	dry	5.31	2,460		X		X	X	X
30	35	Bedrock - Andesite Porphyry with pyrite	dry	5.24	2,660						

Code: [shaded box] *Sample for geochemical testing*

Table A11. Drill Hole Log for SSB 2 with Sample Selection for Phase 1a of the Geochemical Characterization Program

Drill Hole: SSB-2
Driller: Layne Western Drilling
Equipment: AP-1000 Hammer Drill
Start Date ########
End Date ########
Logged By:

Depth		Lithology	Comments	Paste pH (su)	Paste Cond (µS)	Moisture Content (%)	Phase 1a Geochemical Testing				
From	To						ABA	ABA Duplicate	Titration Testing	ICP	Leach Extraction
0	5	Altered rock - scar material, yellowish-brown from 0' to 3' Andesite with pyrite		5.23	2,020						
5	10	Andesite with pyrite Altered rock - scar material, yellowish-brown		4.96	2,050		X				
10	15	Altered rock - scar material, yellowish-brown		3.24	2,710						
15	20	Altered rock - dark yellowish-brown		3.36	2,060		X				
20	25	Altered rock - light yellowish-brown		3.24	2,870						
25	30	Altered rock - andesite clasts dark red from 24' to 34'		3.34	4,300		X			X	X
30	35	Altered rock - dark red and increasing andesite		3.63	3,320						
35	40	Altered rock - increasing andesite		3.50	3,970						
40	45	Altered rock - no andesite		3.52	3,190		X		X	X	X
45	50	Altered rock - increasing andesite		3.84	2,550						
50	55	Altered rock - increasing andesite		3.85	2,340		X				
55	60	Andesite with pyrite and dark red oxidation on fracture surfaces		3.66	2,840						
60	65	Altered rock - hydrothermal scar material with andesite clasts yellow		4.51	2,480						
65	70	Bedrock - andesite with pyrite and red oxidation on fracture surfaces, gray, dry		4.49	2,480		X				

Code: [shaded box] Sample for geochemical testing