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Memorandum

Date:	28 April 2009
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From:	Greg Corcoran, Geosyntec Rebecca Flynn, Geosyntec Ron Johnson, Geosyntec
Subject:	Leachate and Vadose Zone Sump Evaluation Basic Remediation Company Corrective Action Management Unit Geosyntec Project: SC0313

INTRODUCTION

The Basic Remediation Company (BRC) Corrective Action Management Unit (CAMU) (Site) has been designed with a single composite liner system consisting of, from top to bottom, a geocomposite, a textured 60-mil high density polyethylene (HDPE) geomembrane, and a geosynthetic clay liner (GCL). The CAMU design incorporates four leachate collection and removal system (LCRS) sumps with an underlying 4 foot (ft) by 4 ft (bottom area) vadose zone monitoring sump. The vadose zone sumps consist of, from top to bottom, 1.5 ft of drainage aggregate, a geocomposite, a textured 60-mil HDPE geomembrane, and a GCL.

OBJECTIVE

The CAMU has been designed as a "dry landfill," meaning that the waste to be placed in the CAMU will not generate leachate. This was demonstrated in the Waste Processing and Placement Plan (WPPP) (Geosyntec 2008a). The WPPP has established, through laboratory and field testing, minimum placement requirements for the material such that leachate will not be generated from the waste materials being placed in the CAMU.

Following rain events in February 2009, leachate was discovered in the Phase I and II LCRS sumps and liquid was detected in the Phase I vadose zone sump. The Phase II vadose zone sump did not have any detectable liquid present. Table 1 presents the documented sump monitoring events and pumping volumes for the CAMU through 28 April 2009 and Table 2 presents a summary of the detected liquid depths in the sumps through 28 April 2009.

Questions have been raised regarding potential source(s) of the leachate. The following sections present a number of evaluations performed in an effort to understand the potential source(s) of LCRS leachate and vadose zone sump liquid.

BACKGROUND

The following sections summarize the timeline of events and pertinent information documented during CAMU construction that was considered in the evaluation.

Rain Events

Four significant precipitation events have occurred at the Site since construction began. The first event occurred 25 August 2008 when approximately 0.44 inches (in.) of rainfall was recorded at the nearest meteorological monitoring station (Station 4769 Pioneer Detention Pond) operated by Clark County Flood Control District (CCFCD, 2009) (Attachment 1). At the time of this rain event, Phase I liner installation had been completed and ENTACT was placing and spreading operations layer material.

On 26 through 27 November 2008, 0.48 in. of rainfall was recorded (CCFCD, 2009) (Attachment 1). At this time, Phase I waste placement was on-going and Phase II liner installation and operation layer placement was on-going.

On 18 December 2008, a snow event generated 0.76 in. of precipitation (CCFCD, 2009) (Attachment 1). At this time, Phase I waste placement was on-going and Phase II liner installation was complete with 2 ft of operations layer.

On 7 through 9 February 2009, 0.72 in. of rainfall was recorded (CCFCD, 2009) (Attachment 1). At the time of the rain event, waste placement interim elevations had been reached in Phase I, waste placement was continuing in Phase II, and geomembrane installation had recently concluded, but geocomposite installation had not begun, in Phase IIIA.

Pumping Volumes and Liquid Levels

The volumes of leachate pumped from the Phase I and II sumps were not documented until 18 February 2009. Prior to that date, pumping events were documented but the volumes were not recorded. Between 18 February 2009 and 3 April 2009, volumes of leachate and liquids removed from the sumps were calculated from the pumping times and recorded flow measurements. Flow measurements were made by recording the time to fill a 5 gallon (gal) bucket. Subsequent to 3 April 2009, volumes of leachate and liquids removed from the sumps were recorded using a flow meter. Liquid removed from the leachate and vadose zone sumps is used for dust control within the current limits of the lined area of the CAMU. Excluding pumping events prior to 18 February 2009 and through 27 April 2009, the following approximate total volume of liquid have been removed from the sumps:

Sump	Estimated Total Volume Removed (Gallons)
Phase I LCRS	5,399
Phase I Vadose	248
Phase II LCRS	100,003
Phase II Vadose	0

Table 1 depicts the detailed information related to sump pumping volumes.

Beginning 9 March 2009, liquid levels in the LCRS and vadose zone sumps were recorded. Prior to 9 March 2009, liquid was monitored but levels were not recorded. Liquid levels after 9 March 2009 were measured by sliding a 2 inch diameter polyvinyl chloride (PVC) pipe into the side slope riser pipe and then lowering a water level meter probe into the sump through the PVC pipe. The use of the PVC pipe reduces a false positive due to condensation in the pipe as well as eliminating the potential for the probe to catch on the HDPE welds and generate a false negative. The water level in the sump is calculated from the sump and riser geometry and recorded. Table 2 presents the depths of detected liquid in the sumps.

Dust Control

Dust control operations occur continuously around the Site. Water trucks reportedly control dust adjacent to the CAMU with rear facing spray bars and side facing side cannons. Water trucks also control dust within the CAMU by spraying into the cell from the surrounding haul road or by driving above waste within the cell and spraying across the waste surface. Dust control may be more or less frequent depending on the ambient temperatures, wind speeds, humidity, and construction operations; however, according to water truck operators, dust control occurs, on average, 7 times per day within the CAMU with approximately 4,000 gals sprayed each time to suppress dust. Given this flow and frequency, on average, approximately 28,000 gals of dust control leachate or water a day are applied across the CAMU a large portion of which is likely lost to evaporation from the surface of the emplaced waste in the CAMU.

Groundwater

Daniel B. Stephens & Associates (DBS&A) reported groundwater elevations in 2005 varying from approximately 1723 ft above mean sea level (MSL) at the southern property line to 1705 ft MSL at the northern edge of Phase IIIB, and approximate gradient of 0.015 ft/ft across the site (DBS&A, 2006). However, as a result of dust control operations during initial Phase I and II cell excavation, a temporary perched water surface has developed in areas of the site on material with reportedly low permeability. The presence of these temporary perched surfaces results in highly variable groundwater conditions. For example, during Phase II excavation, groundwater was encountered at an elevation of 1731 ft MSL, significantly higher than the 1723 ft MSL anticipated based on previous measurements. Figure 1 presents the groundwater elevations at the wells in the vicinity of the CAMU.

CAMU HYDROLOGY EVALUATION

A hydraulic evaluation was performed on the CAMU to better understand the source, quantity, and depth of leachate in the Phase I and II LCRS sumps (Attachment 2). This evaluation was performed for the 7 to 9 February rain event, and assumes that prior to this event, previously accumulated liquids were removed via pumping and the sumps were essentially dry.

The rain fall amounts discussed in the previous section were measured at the Pioneer Detention Basin Gauge No. 4769 located approximately 3,000 feet southwest of the CAMU (CCFCD, 2009). A total of 0.72 in. of rainfall was recorded during the 3 days evaluated and it is assumed that the same rainfall occurred uniformly over the CAMU (Table 1). A second rain gauge was consulted, Timet Gauge No. 4774, which is located approximately 5,000 feet east of the CAMU (CCFCD, 2009). Data from this gauge is not available from September 2008 through January 2009; however, during the February rain event, a significant difference in the measured rain amounts from these two rain gauges is evident. As the Pioneer Detention Basin Gauge No. 4769 has a complete data set and measured larger rain fall amounts, it was used in this evaluation to be conservative.

Phases I, II, and IIIA make up approximately 22.6 acres of the site. Portions of the Phase II and IIIA cells are graded to drain to each of the Phase I and Phase II sumps. For this evaluation, the 31 January 2009 as-built data was used to determine that approximately 6.0 acres of side slope and base liner system were not covered with waste and would allow rain water directly into the LCRS system. Of the 6.0 acres, approximately 0.6 and 5.4 acres of exposed side slope and base liner system area contributed to the Phase I and Phase II sump, respectively. Waste area was not considered in this evaluation as it is assumed that precipitation falling on the waste surface evaporated shortly after the rain event, was pumped off by Entact, or evaporated during surficial waste processing (disking of the waste) prior to placement of additional waste materials in accordance with the WPPP. Using these areas and a rainfall total of 0.72 inches, a maximum of approximately 11,730 and 105,569 gal was estimated to have collected in the Phase I and II LCRS systems, respectively (Attachment 2).

As a result of rain entering the LCRS system on the side slopes and Phase IIIA adjoining Phase II at the southeast slope, it is assumed runoff was conveyed to the LCRS sumps through the LCRS piping at the toe of the side slopes or at the low area at the west end of Phase IIIA at the Phase II tie-in where a LCRS pipe collects the water from Phase IIIA. Using an assumed porosity of 0.40 for the gravel in the sump and 0.35 for the waste (average value based on laboratory testing presented in the WPPP), it was estimated that a maximum of 3.45 ft of head could have been overlying the Phase I LCRS sump liner system and 4.1 ft of head could have been overlying the Phase II LCRS sump liner system (Attachment 1).

Between 18 February 2009 and 27 April 2009, approximately 5,399 and 100,003 gal have been pumped from the Phases I and II LCRS sumps, respectively (Table 1). As previously stated, these volumes were provided by ENTACT. As presented in Table 1, recently, smaller volumes have been pumped from the Phase II LCRS sump and pumping from the Phase I LCRS has ceased. In our judgment, the majority of leachate generated from this rainfall event has been removed from both phases and the decreasing amount of leachate removed from the LCRS sumps is generated from the continued drainage of the operations layer material which had become saturated as the LCRS sumps filled beyond the top of the drainage aggregate and the geocomposite over the liner system outside of the sumps.

VADOSE ZONE SUMP EVALUATION

As presented in Table 1, approximately 248 gal of liquid were pumped from the Phase I vadose zone sump and as presented in Table 2, approximately 0.64 ft, or 59 gal, remain in the vadose zone sump for a total of approximately 307 gal. The investigations and evaluations into the vadose zone sump liquid source are discussed in the following sections.

Chemical Makeup

Liquid samples were collected from both the LCRS and vadose zone sump and tested for metals, semi volatile organic compounds (SVOCs), and pesticides (Attachment 2). The appearance of the liquids collected from the LCRS and vadose zone sumps was different as the LCRS leachate is murky and brown/tan in color while vadose zone liquid is clear (Attachment 3). Results of testing indicated the vadose zone liquid was impacted with constituents similar to the LCRS leachate, but at diluted concentrations from the LCRS leachate, with the exception that several of the organo-chlorine pesticides that were found in the LCRS sump leachate were not found in the vadose zone sump liquid. In addition, the vadose zone liquid analytical data is impacted with similar chemicals and concentrations as the site groundwater.

Potential Sources of Impacts

Storage of LCRS and vadose zone sump pipe and drainage aggregate materials for Phase I occurred above the Western Ditch. As a result, the LCRS and vadose zone materials may have become impacted prior to installation in the sumps. These potentially impacted materials may have impacted liquids collected in the vadose zone sump.

Decontamination and sampling procedures used during the initial sump investigations are not well documented. It is possible that the vadose zone sump liquid may have become impacted by pumps or water level meters that were used within the LCRS sump.

It has been suggested that liquid in the vadose zone sump originated in the LCRS sump. The smaller concentrations of similar constituents may be the result of dilution or filtration through the GCL.

Subsurface Investigation

Due to the variability of groundwater across the site previously discussed and the leachate constituents similar to groundwater constituents, a groundwater piezometer was proposed in the vicinity of the Phase I vadose zone sump. Geotechnical and Environmental Services, Inc (GES) drilled 51 ft below ground surface (bgs) and installed a monitoring well approximately 5 ft south of the sump side slope riser pipe. Their report is included as Attachment 4.

Groundwater Elevation

GES reported groundwater at approximately 1712 ft MSL during drilling and the vadose zone sump liner is at an elevation of 1720.65 ft MSL, based on as-built survey (Geosyntec 2008b). This indicates the groundwater elevation is not above the vadose zone sump liner elevation. The approximate groundwater elevation reported 8 April 2009 is 1711.8 ft MSL as measured by Mike Carlson of ENTACT (Figure 1). Therefore, the groundwater is not a likely source of water in the vadose zone sump.

Soil Moisture, Grain Size, and Capillary Rise

GES recorded subsurface conditions and collected geotechnical samples during drilling operations. Their exploration log indicates silty sands and gravels above a clay layer at an approximate elevation of 1708 ft MSL. In addition, the moisture content on samples collected above the groundwater table ranged from 2.0% to 6.4%. Based on the type of soil and the low moisture content, the capillary rise from the groundwater surface is not likely high enough to impact the vadose zone sump. Furthermore, moisture forming the capillary rise would not likely create free liquids that could provide a source for the vadose zone sump liquids.

Results of the subsurface investigation indicate groundwater is not a source of liquid in the vadose zone sump.

Geomembrane Defect Evaluation

Defect in LCRS Geomembrane

Due to the similar, but diluted, concentrations of constituents in the vadose zone sump liquid, an evaluation of flow through a defect in the composite liner system was performed (Attachment 5). The evaluation establishes a flow through the GCL and back calculates a geomembrane defect size based on the wetted area of GCL and transmissivity, from literature, along the interface between the GCL nonwoven geotextile component and overlying geomembrane.

Given the permeability through the GCL in a hydrated state, based on hydraulic conductivity testing performed on the site specific Phase I GCL at a normal stress of 5 psi, 304 gallons of leachate collecting in the vadose zone sump would occur over an area of approximately 457 ft^2 (42.5 m^2) in 51 days (7 February to 31 March 2009) and an area of approximately 124 ft^2 (11.5 m^2) in 217 days (25 August 2008 to 31 March 2009).

Using the transmissivity of the GCL-geomembrane interface, a travel distance of 0.0019 inches (4.7E-05 m) and 0.0075 inches (1.9E-04 m) would occur along the GCL in 51 and 217 days, respectively; therefore, in order to create enough wetted GCL area to percolate a total of 304 gallons in the known time period, the geomembrane defect is calculated as 457 ft^2 (42.5 m^2) and 124 ft^2 (11.5 m^2) for 51 and 217 days, respectively.

This evaluation assumes that the GCL has achieved a hydrated state by pulling moisture from the underlying soil subgrade materials (i.e. bentonite component of the GCL, which is hydroscopic, has a higher soil suction than the adjacent soil subgrade and therefore removes moisture from the adjacent soil) from time of installation and covering with the geomembrane to approximately 1 week after installation. This hydraulic conductivity, which was performed using de-ionized water, will be impacted by leachate containing large concentrations of divalent compounds such as magnesium and calcium. Given the presence of both of these compounds in the Phase I leachate, the permeability of the bentonite could increase. Conservatively assuming a four order of magnitude increase in permeability to 1 x 10^{-5} cm/sec, the geomembrane defect diameter size would need to be approximately 5.2 inches and 2.5 inches for the 51 day and 217 day case, respectively.

Field observations by construction quality assurance (CQA) personnel did not indicate defects in the GCL or geomembrane which were not repaired or defects with an area exceeding 2.6 inches in diameter. In addition, on 3 September 2008, representatives from McGinley, Geosyntec, Applied Soil Water (ASW), Nevada Division of Environmental Protection (NDEP), ENTACT, and Weston investigated the sump condition following the 25 August 2008 rain event, after removing sediment, and found it to be acceptable. As a result, this evaluation indicates the liquid in the Phase I vadose zone sump is not likely caused by a defect in the geomembrane. However, there is a possibility that a small portion of the liquid did originate from the LCRS sump leachate.

EPA Assumed Defect in LCRS Geomembrane

In addition to the above scenario, the flow caused by a 2 mm diameter defect was evaluated. This diameter was selected based on the EPA recommended defect size. The result of this analysis indicates a total volume of approximately 2.4 x 10^{-5} gal in 51 days and 1.2 x 10^{-4} gal in 217 days (Attachment 4). Therefore, it is unlikely the source of the leachate is a small defect resulting from installation, manufacturing, or other damage.

Defect in Geomembrane caused by Generator

After the 25 August 2008 rain event, a generator used to power the pump to remove the leachate from the LCRS sump burned a hole through the geomembrane and scorched the top geotextile component of the underlying GCL at an approximate elevation of 1726 ft MSL. The hole was temporarily closed with a patch and duct taped. The liner installer, ESI, arrived onsite 6 September 2008 to make the repair (repair number R-177). The repair was cut open and a small portion of the top geotextile of the GCL was witnessed to be "degraded" by the heat but not hydrated (Attachment 6). A new piece of GCL was installed, as per the specification, over the affected area. The repair to the geomembrane was completed and vacuum tested and passed. The geocomposite was also repaired per the specifications.

This event raised two possible sources of liquid in the Phase I vadose zone sump: leachate draining into the vadose zone through the hole in the geomembrane during pumping to remove the leachate from the LCRS sump or leachate flow through an incomplete repair of this hole when leachate head accumulated above the Phase I LCRS sump liner system. Photographs taken of the hole appear to indicate that the GCL was not hydrated prior to making the repair (Attachment 6). Therefore, it does not appear leachate drained through the hole during pumping. As documented in the Phase I as-built drawings (Geosyntec, 2008b), based on the elevation of the repair, 1726 ft MSL, the elevation of the LCRS sump liner, 1720.65ft MSL, and the maximum estimated depth of leachate, 3.45 ft, the maximum elevation of the leachate was approximately 1724.1 ft MSL. Therefore, it is unlikely leachate entered the vadose zone sump through the hole caused by the generator.

Six (6) other geomembrane repairs were conducted, tested, and passed within the area of the top of the LCRS sump. It is unlikely that these repairs allowed a contribution of liquid to the vadose zone sump.

Geomembrane Wrinkles

The 25 August 2008 rain event occurred during operations layer placement in Phase I. As a result of the lack of overburden on the liner system, wrinkles were still present in the geomembrane along the floor and side slopes. The presence of wrinkles in the geomembrane allows a channel, or pathway, between the GCL and geomembrane for liquid to travel. As noted during the Phase II liner tie-in to Phase I, rain was able to travel between these layers and hydrate the GCL for a distance of approximately 15 feet under the Phase I liner system. The hydrated GCL was subsequently removed during Phase II liner system tie-in construction. The Phase IIIB liner tie-in to Phase I was recently exposed and the GCL was found to be hydrated along the edges from free water (rain or condensation water); however, the GCL was not hydrated beyond the edges. There is however the possibility that rain water that accumulated in the northwest corner of the tie-in between Phase I and Phase IIIB may have infiltrated into the thin veneer of sand (1-inch minus soil) used on the side slopes of Phase I prior to installation of the liner system. This water may have migrated down the side slopes within this veneer of sand, never impacting the overlying GCL, and into the vadose zone sump at the toe of the slope.

The Phase I vadose zone sump was measured for liquid on 31 August 2008 and found to be dry. As stated previously, the liquid prior to 9 March 2009 was measured by lowering a water level meter into the side slope riser pipe without a guide tube; therefore, a false negative may have been detected during this monitoring event if the water level meter became caught on the lip created on the inside of polyethylene pipe when it is butt fusion welded.

Vadose Zone Sump Side Slope Riser

The application of dust control water to the dirt access roadway along the western perimeter of Phase I occurred nearly daily since the completion of the Phase I liner system. It has been theorized that the end caps on the vadose zone side slope risers may have been off of the pipe, thus allowing small amounts of dust control water to enter the pipe when the water truck passes the open pipe multiple times per day. However, the pipes were installed with end caps and it is unlikely that the end caps were removed for a period of time long enough to contribute substantially to the quantity of liquid in the vadose zone sump.

PROPOSED INVESTIGATIONS

The following investigations have been proposed to further evaluate the vadose zone sump liquid source.

GCL Filtration Test

A GCL filtration test has been suggested with CAMU leachate for the purpose of understanding the potential change in concentrations of the liquid as it permeates through the GCL. As the hydraulic conductivity of the GCL is in the range of 10^{-11} m/s, conducting a test of the flow, under hydraulic gradient conditions representing field conditions, would take a very long time to perform. Furthermore, performing analytical testing on the permeant exiting the GCL may not provide useful information as the potential for leakage discussed above is very small and the fact that the permeant would likely dilute or otherwise be affected by construction water or other materials within the vadose zone sump. Therefore, it is not recommended to perform filtration testing on the GCL using the leachate.

Tracer Test

A tracer test may be performed to evaluate if leachate in the LCRS sump has a pathway to the vadose zone sump. The most common tracers used in pathway analysis are fluorescent dyes such as fluorescein and rhodamine-WT and halides such as chloride, bromide, and iodide. The tracer may be injected into the LCRS sump at a known concentration. Samples are collected from the vadose zone sump and tested for detectable levels of the tracer dye or halide. If the vadose zone sample indicates the presence of the tracer, than there is a pathway for leachate from the LCRS sump into the vadose zone sump.

While tracer tests may give a definitive answer to whether or not the sumps are linked hydraulically, the GCL in the liner system will significantly slow the migration of tracer to the vadose zone sump. As evident by the lack of significant recharge since the 27 March 2009 pumping event, the leachate source has slowed significantly. Therefore, a tracer test may take a significant amount of time to complete (tens of years). In addition, the LCRS sump may not be pumped while the tracer test is being conducted as leachate removal will alter the concentration and quantity of tracer in the sump. Furthermore, if additional leachate collects in the LCRS sump during the tracer study, it will dilute the tracer.

Electrical Leak Location

The electrical leak location method detects electrical paths through the geomembrane component of the liner system. A voltage source is connected to one electrode in the material under the geomembrane, which in this case would be the GCL, while a diode is placed above the geomembrane, which in this case would be within the waste or LCRS sump riser pipe. Detection of an electrical current (amperage) indicates a potential hole in the geomembrane. This method generally relies on multiple measurements conducted in sweeps in an attempt to pin-point the location of the current and thus the potential hole in the geomembrane. This method is susceptible to false positives and false negatives related to electrical connectivity between the materials on both sides of the geomembrane, nature of materials relied on to conduct electrical currents, size of hole, and distance from monitoring equipment to the hole.

Given the nature of the waste (salt and metal containing materials), depth of the waste (greater than 30 feet), limited ability to access multiple points for testing within the sump, and potential for false positives and false negatives, this testing is not recommended at this time.

CONCLUSION

This sump evaluation has presented several potential sources of water in the vadose zone sump. However, there is no clear source of the water in the vadose zone sump. The most probable source would appear to be construction water or water originating from the 25 August 2008 rain event that traveled along the base of the liner system from either Phase I/II or Phase I/IIIB tie-in locations.

RECOMMENDATIONS

Recent monitoring events have indicated liquid is not recharging in the vadose zone sump (Table 2). In addition, pumping from the Phase I LCRS sump has decreased substantially and the volume is virtually stable, indicating a significant volume of the leachate generated from the February rain event has been removed, reducing a possible source of leachate into the vadose zone sump.

As a result of the apparent steady state condition of recharge and liquid head in the sumps, continued monitoring of liquid levels is recommended for the Phase I vadose zone sump. Permanent pumps and transducers will be installed within the sumps to provide more accurate head measurements and reduce the potential for cross-contamination in pumping events. Following the next precipitation event, the sumps may be reevaluated if leachate levels change. In addition, additional leachate and vadose zone liquid analytical testing results will be submitted to NDEP as they become available.

REFERENCES

Clark County Flood Control District (CCFCD), 2009, Sensor Data available at: http://www.ccrfcd.org/sensordata.htm.

DBS&A, 2006, "Conceptual Site Model: Proposed CAMU Site, Henderson, Nevada," October.

Geosyntec, 2008a "Revised Waste Placement and Processing Plan," October.

Geosyntec, 2008b "Phase I Construction Quality Assurance Report, Basic Remediation Company, Corrective Action Management Unit, Henderson, Nevada." September, 2008.

ATTACHMENTS

<u>Figures</u>

Figure 1 – Groundwater Contour Map

<u>Tables</u>

Table 1 – Sump Pumping Volumes

Table 2 – Measured Liquid Depths

<u>Attachments</u>

Attachment 1 – CAMU Hydrology Evaluation

Attachment 2 – Leachate Analytical Test Results

Attachment 3 – Photo - LCRS Leachate vs. Vadose Zone liquid

Attachment 4 – GES Phase I Piezometer CAMU-VS1-AA Installation Report

Attachment 5 – Leak Evaluation for a Composite Liner System

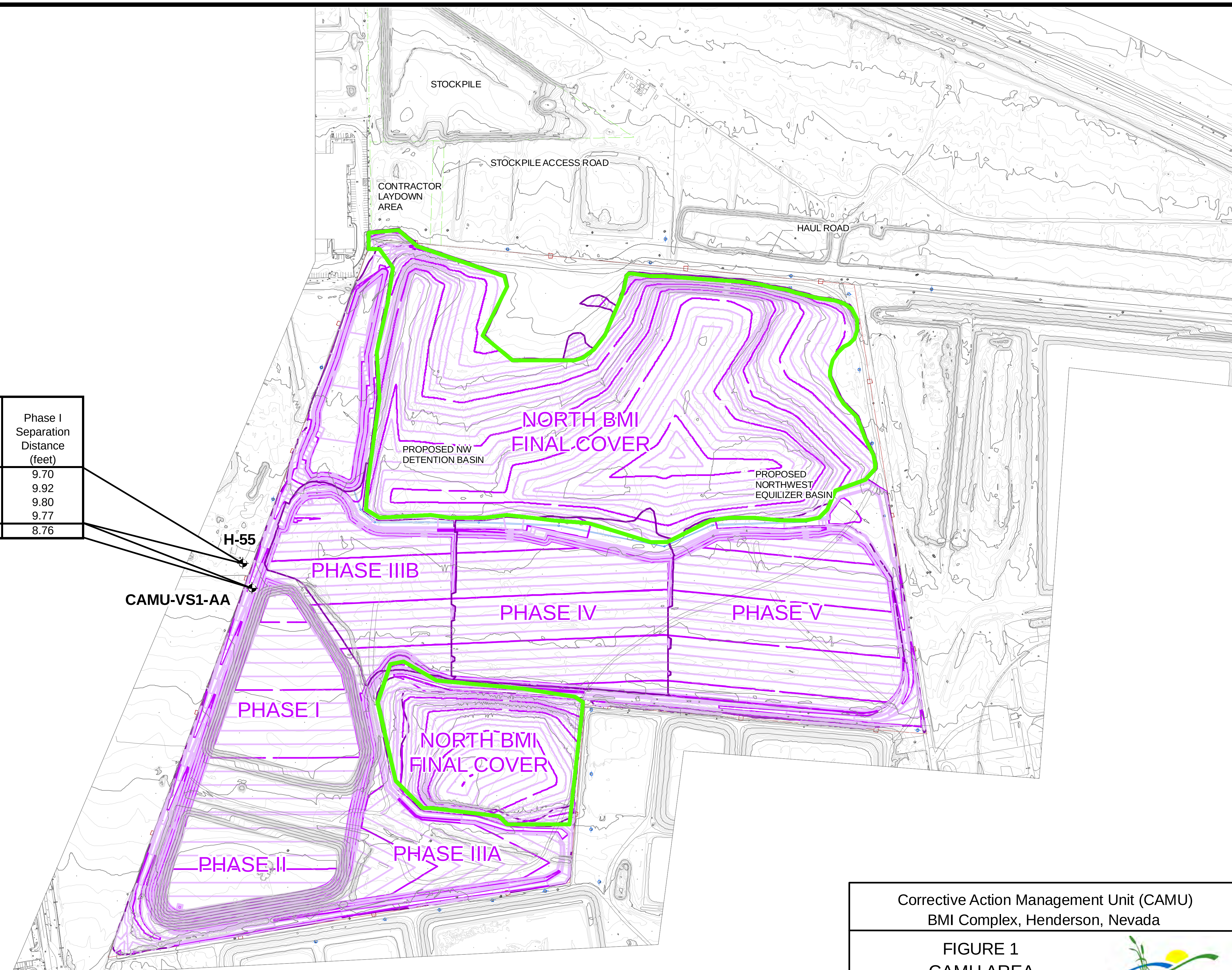
Attachment 6 – Photo Log – Generator Hole Repairs

* * * * *

Figures

Well	Date	Depth to-Water (feet below casing)	Ground Water Elevation (MSL)	Lowest Phase I Liner Elevation (MSL)	Phase I Separation Distance (feet)
H-55	10-30-07	41.20	1710.95	1720.653	9.70
	04-02-08	41.42	1710.73	1720.653	9.92
	10-22-08	41.30	1710.85	1720.653	9.80
	01-28-09	41.27	1710.88	1720.653	9.77
CAMU-VS1-AA	4-8-09	40.17	1711.89	1720.653	8.76

Note: No other wells are located in the Phase I area.



N

0 200 400 Feet

Explanation

- Well
- Existing major fill elevation contour
- Existing minor fill elevation contour
- Approximate limits of existing BMI landfill
- Proposed minor fill elevation contour
- Proposed major fill elevation contour
- BRC landfill site boundary

Base Map Source: Geosyntic Consultants , October 2007, Overall Phasing Plan

Corrective Action Management Unit (CAMU)
BMI Complex, Henderson, Nevada

FIGURE 1
CAMU AREA
OVERALL PHASING PLAN

Basic Remediation COMPANY

Prepared by: DBS&A CRS Date 09/19/08

S:/PROJECTS/BRC/ES05.0067_BRC_CAMU/GIS/MXDS/CAMU_CRSWORKING.MXD 807280

S:/PROJECTS/BRC/ES08.0154_BRC_CAMU_GWM_WORK_PLAN/GIS/MXD/CAMU_PHASING_PLAN2.MXD 902240

Daniel B. Stephens & Associates, Inc
JN ES08.0154

Tables

Table 1
Sumps Pumping Volumes
BRC CAMU
Henderson, Nevada

Date Pumped	Approximate Volume Pumped (gallons)										Rainfall Quantity*	
	Phase I		Phase II		Phase IIIB		Phase V		Total		Timet[1]	Pioneer[2]
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	Inches	Inches
25-Aug-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.24	0.44
31-Aug-08	PQU	Dry	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
2-Sep-08	Dry	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
8-Sep-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.04
9-Nov-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.04
25-Nov-08	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
26-Nov-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.40
27-Nov-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.08
1-Dec-08	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
15-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.12
17-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.20
18-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.76
22-Dec-08	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
23-Dec-08	Dry	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
24-Dec-08	Dry	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
25-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.12
23-Jan-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.04
24-Jan-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.08
7-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.39	0.60
8-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.04	0.04
9-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.12	0.08
11-Feb-09	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
13-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.04
15-Feb-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
16-Feb-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.04
18-Feb-09	Dry	N/A	2,000	N/A	N/A	N/A	N/A	N/A	2,000	0	0.0	0.0
19-Feb-09	Dry	N/A	11,000	N/A	N/A	N/A	N/A	N/A	11,000	0	0.0	0.0
20-Feb-09	Dry	N/A	17,000	N/A	N/A	N/A	N/A	N/A	17,000	0	0.0	0.0
23-Feb-09	Dry	N/A	8,000	N/A	N/A	N/A	N/A	N/A	8,000	0	0.0	0.0
24-Feb-09	Dry	N/A	8,000	N/A	N/A	N/A	N/A	N/A	8,000	0	0.0	0.0
26-Feb-09	Dry	N/A	6,000	N/A	N/A	N/A	N/A	N/A	6,000	0	0.0	0.0
5-Mar-09	4,000	N/A	2,000	N/A	N/A	N/A	N/A	N/A	6,000	0	0.0	0.0
6-Mar-09	Dry	N/A	10,000	N/A	N/A	N/A	N/A	N/A	10,000	0	0.0	0.0
7-Mar-09	Dry	N/A	6,000	N/A	N/A	N/A	N/A	N/A	6,000	0	0.0	0.0
10-Mar-09	Wet	N/A	N/A	Dry	N/A	N/A	N/A	N/A	0	0	0.0	0.0

Table 1
Sumps Pumping Volumes
BRC CAMU
Henderson, Nevada

Date Pumped	Approximate Volume Pumped (gallons)										Rainfall Quantity*	
	Phase I		Phase II		Phase IIIB		Phase V		Total		Timet[1]	Pioneer[2]
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	Inches	Inches
19-Mar-09	N/A	100	N/A	N/A	N/A	N/A	N/A	N/A	0	100	0.0	0.0
25-Mar-09	N/A	N/A	4,000	Dry	N/A	N/A	N/A	N/A	4,000	0	0.0	0.0
26-Mar-09	1,000	N/A	3,100	Dry	N/A	N/A	N/A	N/A	4,100	0	0.0	0.0
27-Mar-09	N/A	140	1,900	Dry	N/A	N/A	N/A	N/A	1,900	140	0.0	0.0
28-Mar-09	N/A	N/A	1,800	Dry	N/A	N/A	N/A	N/A	1,800	0	0.0	0.0
30-Mar-09	N/A	4	1,800	Dry	N/A	N/A	N/A	N/A	1,800	4	0.0	0.0
31-Mar-09	N/A	N/A	1,500	Dry	N/A	N/A	N/A	N/A	1,500	0	0.0	0.0
1-Apr-09	N/A	N/A	3,000	Dry	N/A	N/A	N/A	N/A	3,000	0	0.0	0.0
2-Apr-09	N/A	N/A	1,150	Dry	N/A	N/A	N/A	N/A	1,150	0	0.0	0.0
3-Apr-09	N/A	2	550	Dry	N/A	N/A	N/A	N/A	550	2	0.0	0.0
4-Apr-09	N/A	N/A	688	Dry	N/A	N/A	N/A	N/A	688	0	0.0	0.0
6-Apr-09	N/A	1	1,100	Dry	N/A	N/A	N/A	N/A	1,100	1	0.0	0.0
7-Apr-09	N/A	N/A	769	Dry	N/A	N/A	N/A	N/A	769	0	0.0	0.0
8-Apr-09	N/A	N/A	650	Dry	N/A	N/A	N/A	N/A	650	0	0.0	0.0
9-Apr-09	N/A	N/A	592	Dry	N/A	N/A	N/A	N/A	592	0	0.0	0.0
10-Apr-09	N/A	N/A	600	Dry	N/A	N/A	N/A	N/A	600	0	0.0	0.0
11-Apr-09	N/A	N/A	491	Dry	N/A	N/A	N/A	N/A	491	0	0.0	0.0
12-Apr-09	N/A	N/A	407	Dry	N/A	N/A	N/A	N/A	407	0	0.0	0.0
13-Apr-09	N/A	N/A	499	Dry	N/A	N/A	N/A	N/A	499	0	0.0	0.0
14-Apr-09	N/A	N/A	500	Dry	N/A	N/A	N/A	N/A	500	0	0.0	0.0
15-Apr-09	N/A	N/A	1,064	Dry	N/A	N/A	N/A	N/A	1,064	0	0.0	0.0
16-Apr-09	N/A	N/A	390	Dry	N/A	N/A	N/A	N/A	390	0	0.0	0.0
17-Apr-09	N/A	N/A	351	Dry	N/A	N/A	N/A	N/A	351	0	0.0	0.0
20-Apr-09	399	1	698	Dry	N/A	N/A	N/A	N/A	1,097	1	0.0	0.0
22-Apr-09	N/A	N/A	628	Dry	N/A	N/A	N/A	N/A	628	0	0.0	0.0
24-Apr-09	N/A	N/A	773	Dry	N/A	N/A	N/A	N/A	773	0	0.0	0.0
27-Apr-09	N/A	N/A	1,003	DRY	N/A	N/A	N/A	N/A	1,003	0	0.0	0.0
Total:	5,399	248	100,003	0	0	0	0	0	105,402	248	0.79	3.16

N/A - Not measured and not pumped, or not existing at time of event PQU-Sump pumped quantity unknown

1- Rainfall from Rainfall Station 4774 Timet. There is no daily data prior to Feb. 2009, There was significant rainfall events on August 25, September 8, and November 26,2008 and a major Snow/Rain event happened on December 17 & 18.

2- Rainfall from Rainfall Station 4769 Pioneer Detention Pond.

Table 2
Measured Liquid Depths
BRC CAMU
Henderson, Nevada

Date Measured	Approximate Depth of Water in Sump (feet)							
	Phase I		Phase II		Phase IIIB		Phase V	
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose
3/9/2009	2.50	1.30	0.80	Dry	N/A	N/A	N/A	N/A
3/21/2009	2.80	1.40	1.00	Dry	N/A	N/A	N/A	N/A
3/22/2009	2.80	1.50	1.90	Dry	N/A	N/A	N/A	N/A
3/23/2009	N/A	1.20	N/A	Dry	N/A	N/A	N/A	N/A
3/24/2009	2.80	1.50	2.00	Dry	N/A	N/A	N/A	N/A
3/25/2009	2.80	N/A[1]	1.20	Dry	N/A	N/A	N/A	N/A
3/26/2009 AM	2.80	1.50	2.90	Dry	N/A	N/A	N/A	N/A
3/26/2009 PM	0.90	1.50	2.30	Dry	N/A	N/A	N/A	N/A
3/26/2009 (2130)	N/A	N/A	2.00	Dry	N/A	N/A	N/A	N/A
3/27/2009 (0030)	N/A	N/A	1.20	Dry	N/A	N/A	N/A	N/A
3/27/2009 AM	1.12	1.50	2.60	Dry	N/A	N/A	N/A	N/A
3/27/2009 (1130)	N/A	0.63[2]	N/A	N/A	N/A	N/A	N/A	N/A
3/27/2009 PM	1.19	0.69	1.73	Dry	N/A	N/A	N/A	N/A
3/28/2009 AM	1.30	0.70	2.80	Dry	N/A	N/A	N/A	N/A
3/28/2009 (1406)	N/A	N/A	2.10	N/A	N/A	N/A	N/A	N/A
3/28/2009 (1645)	N/A	N/A	1.70	N/A	N/A	N/A	N/A	N/A
3/29/2009	1.50	0.70	2.80	Dry	N/A	N/A	N/A	N/A
3/30/2009	1.60	0.70	3.0[3]	Dry	N/A	N/A	N/A	N/A
3/31/2009	1.70	0.68	2.90	Dry	N/A	N/A	N/A	N/A
4/1/2009	1.80	0.68	3.0[3]	Dry	N/A	N/A	N/A	N/A
4/2/2009	1.80	0.68	2.60	Dry	N/A	N/A	N/A	N/A
4/3/2009	1.90	0.68	2.60	Dry	N/A	N/A	N/A	N/A
4/4/2009	2.00	0.67	2.70	Dry	N/A	N/A	N/A	N/A
4/5/2009	2.10	0.67	2.80	Dry	N/A	N/A	N/A	N/A
4/6/2009	2.10	0.67	3.0[3]	Dry	N/A	N/A	N/A	N/A
4/7/2009	2.20	0.67	2.80	Dry	N/A	N/A	N/A	N/A
4/8/2009	2.20	0.67	2.70	Dry	N/A	N/A	N/A	N/A
4/9/2009	2.30	0.67	2.70	Dry	N/A	N/A	N/A	N/A
4/10/2009	2.30	0.67	2.60	Dry	N/A	N/A	N/A	N/A

Table 2
Measured Liquid Depths
BRC CAMU
Henderson, Nevada

Date Measured	Approximate Depth of Water in Sump (feet)							
	Phase I		Phase II		Phase IIIB		Phase V	
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose
4/11/2009	2.30	0.67	2.50	Dry	N/A	N/A	N/A	N/A
4/12/2009	2.40	0.67	2.40	Dry	N/A	N/A	N/A	N/A
4/13/2009	2.40	0.67	2.50	Dry	N/A	N/A	N/A	N/A
4/14/2009	2.50	0.67	2.60	Dry	N/A	N/A	N/A	N/A
4/15/2009	2.50	0.67	2.60	Dry	N/A	N/A	N/A	N/A
4/17/2009	2.50	0.67	1.20	Dry	N/A	N/A	N/A	N/A
4/20/2009	2.60	0.67*	2.60	Dry	N/A	N/A	N/A	N/A
4/22/2009	2.20	0.64	2.70	Dry	N/A	N/A	N/A	N/A
4/24/2009	2.30	0.64	1.5**	Dry	N/A	N/A	N/A	N/A
4/27/2009	2.40	0.64	2.9*	Dry	N/A	N/A	N/A	N/A

[1] Not measured due to new pump installation
[2] Measured after Phase 1 Vadose Sump pumped
[3] Started pumping after GES Sampling
* Pre-Sample/Pump measurement
** Post-Sample/Pump measurement

Attachment 1

Geosyntec consultants

COMPUTATION COVER SHEET

Client: **BRC** Project: **BRC Corrective Action Management Unit** Project/ Proposal No.: **SC0313** Task No.

Title of Computations **HYDROLOGIC EVALUATION**

Computations by:	Signature	Sang Yeo	4/15/09 Date
	Printed Name	Sang Yeo	
	Title	Senior Staff Engineer	
Assumptions and Procedures Checked by: (peer reviewer)	Signature	Rebecca Flynn	4/15/09 Date
	Printed Name	Rebecca Flynn	
	Title	Senior Staff Engineer	
Computations Checked by:	Signature	Rebecca Flynn	4/15/09 Date
	Printed Name	Rebecca Flynn	
	Title	Senior Staff Engineer	
Computations backchecked by: (originator)	Signature	Sang Yeo	4/15/09 Date
	Printed Name	Sang Yeo	
	Title	Senior Staff Engineer	
Approved by: (pm or designate)	Signature	G. Corcoran	4/15/09 Date
	Printed Name	Greg Corcoran	
	Title	Principal	

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	S. Yeo	Date:	04/14/08	Reviewed by:	R. Flynn	Date:	4/15/09
Client:	BRC	Project:	BRC CAMU	Project/ Proposal No.:	SC0313	Task No.:	

EVALUATION OF SURFACE WATER HYDROLOGY
BRC – CORRECTIVE ACTION MANAGEMENT UNIT
HENDERSON, NEVADA

OBJECTIVE

The objective of this hydrology analysis is to estimate the volume of leachate in the Phase I and II leachate collection and removal system (LCRS) sumps caused by the rainfall event 7-9 February 2009 at the Basic Remediation Company (BRC) Corrective Action Management Unit (CAMU) in Henderson, Nevada. The volume of leachate calculated in this evaluation is used to approximate the maximum head of leachate above the liner system in the LCRS sumps.

BACKGROUND AND PURPOSE

The BRC CAMU consists of a base liner with a LCRS and vadose zone monitoring sump. The components of the base liner are (from bottom to top): prepared subgrade; geosynthetic clay liner (GCL); 60-mil high-density polyethylene (HDPE) geomembrane; geocomposite drainage layer; and 2-ft operations layer. The LCRS sump consists of the base liner system overlain by 2.0 feet of drainage aggregate. Vadose zone sumps were constructed at Phases I and II of the BRC CAMU, as shown on Figures 1 and 2. The composite liner system in the vadose zone sumps is composed of (from bottom to top) a GCL, 60-mil HDPE geomembrane, and a geocomposite overlain by 1.5 feet of drainage aggregate.

A significant precipitation event occurred at the site for three days in February 2009. Precipitation entered into the Phase I LCRS through the exposed liner system on the side slopes of Phase II that drain to the Phase I sump. Precipitation entered into the Phase II LCRS sump through the exposed liner system on the side slopes of Phase II that drain to the Phase II sump. In addition, the phase IIIA geomembrane installation had just been completed, thereby allowing precipitation falling on the exposed geomembrane to be conveyed directly to the Phase II side slope where the LCRS piping collected and transferred the water directly to the Phase I and II LCRS sumps. Water entering the exposed side slope liner system (permeable woven geotextile overlying the geocomposite) flowed down slope along the top of the side slope geomembrane to the LCRS piping at the toe of the slope, which conveyed the liquid directly to the LCRS sumps and began to build up head on the LCRS sump liner system. Precipitation quantities, as reported by Clark County Flood Control Rainfall Station 4769 Pioneer Pond, for this precipitation event are summarized in Table 1.

Table 1. Precipitation for 3 days in February 2009

Date	Rainfall (in.)	Accumulated Rainfall (in.)
2/7/09	0.60	0.60
2/8/09	0.04	0.64
2/9/09	0.08	0.72

WATERSHED AREAS

Water collected in the LCRS was directed to either the LCRS sump in Phase I (Sump I) or Phase II (Sump II), as shown on Figures 1 and 2, respectively. Figures 3 and 4 show the watershed areas contributing to each of the sumps. Note the only areas of Phase I and II which are considered in this evaluation are the exposed side-slopes as calculated from the January 2009 interim waste survey. The watershed areas associated with each LCRS sump are summarized in Table 2.

Table 2. Watershed Areas Associated with LCRS Sumps

Sump	Sump I @ Phase I		Sump II @ Phase II	
Watershed	Phase II	Phase IIIA-I	Phase II	Phase IIIA-II
Area (acres)	0.3	0.3	1.0	4.4
Total	0.6 acres		5.4 acres	

VOLUME OF WATER AT SUMP

Using the precipitation data and watershed sub-area, water volumes are calculated for each sump, as summarized on Table 3.

Written by:	S. Yeo	Date:	04/14/08	Reviewed by:	R. Flynn	Date:	4/15/09
Client:	BRC	Project:	BRC CAMU	Project/ Proposal No.:	SC0313	Task No.:	

For example, Sump 1:

V = A x P

V = (26,136 ft^2) x (0.05 ft) = 1306.8 ft^3
= 9,775 gallons

where:
V = volume accumulated, ft^3

A = contributing area, 0.6 acre x $\frac{43560\,ft^2}{1acre}$ = 26136 ft^2

P = Precipitation total, 0.60 inches x $\frac{1\,ft}{12inches}$ = 0.05 ft

The water volumes are summarized in Table 3. After the precipitation event, it was estimated that an approximate maximum of 11,730 gallons and 105,570 gallons of water could accumulate within and around Sump I and Sump II, respectively.

Table 3. Maximum Water Volume

Date	Rainfall (in.)	Phase I + Phase IIIA-I		Phase II + Phase IIIA-II	
		Water Volume (gallons)	Accumulated Water Volume (gallons)	Water Volume (gallons)	Accumulated Water Volume (gallons)
2/7/09	0.60	9,775	9,775	87,974	87,974
2/8/09	0.04	652	10,427	5,865	93,839
2/9/09	0.08	1,303	11,730	11,730	105,569

WATER HEIGHT AT SUMPS

Based on the volume of water accumulated within and around the LCRS sumps, the maximum water head is estimated from the bottom of each sump and evaluated over 1 vertical foot intervals. For example, Sump I:

Capacity of LCRS Sump:

V = (Elev2 – Elev1) x A x η

V = (1722.76-1720.65 ft) x 220 SF x 0.4 = 186 ft^3
= 1,391 gallons

where:

Elev2 = Top elevation of LCRS Sump, 1722.76 ft msl

Elev1 = Bottom elevation of LCRS Sump, 1720.65 ft msl

A = average area = $\frac{(A_T + A_B)}{2} = \frac{(340 + 100)}{2}$ = 220 SF

A_T = Top area of LCRS Sump, ((1722.76-1720.65) x 2 x 2) + 10)^2 = 340 SF

A_B = Bottom area of LCRS Sump, 10 ft x 10 ft = 100 SF

η = porosity of gravel, 0.4

Capacity of Area at elevation 1723 ft msl:

V = d x A x η

V = 1 ft x 463 ft^2 x 0.35 = 162 ft^3
= 1,212 gallons

where:

D = depth of material, 1 ft

A = average area = $\frac{(A_T + A_B)}{2} = \frac{(340 + 585)}{2}$ = 463 SF

A_T = Top area, 585 ft^2 (Figure 1)

A_B = Bottom area, 340 ft^2 (from above)

η = porosity of operations layer, 0.35 (average waste porosity, see page 10 of Waste Processing and Placement Plan dated 14 October 2008) – note, conservatively does not include geocomposite porosity

Capacity of Area at elevation 1724 ft msl:

V = d x A x η

V = 1 ft x 3002 ft^2 x 0.35 = 1,051 ft^3
= 7,858 gallons

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where:

D = depth of material, 1 ft

A = average area $= \dfrac{(A_T + A_B)}{2} = \dfrac{(5418 + 585)}{2}$ = 3002 ft^2

A_T = Top area, 5418 ft^2 (Figure 1)

A_B = Bottom area, 585 ft^2 (Figure 1)

η = porosity of operations layer, 0.35

Capacity of Area at 1725 ft msl

V = d x A x η

V = 1 ft x 9299 ft^2 x 0.35 = 3,254 ft^3

= 24,343 gallons

where:

D = depth of material, 1 ft

A = average area $= \dfrac{(A_T + A_B)}{2} = \dfrac{(5418 + 13179)}{2}$ = 9299 ft^2

A_T = Top area, 13,179 ft^2 (Figure 1)

A_B = Bottom area, 5,418 ft^2 (Figure 1)

η = porosity of operations layer, 0.35

Total Capacity of Sump and 3 ft above:

$V_T = \sum V$ = 34,872 gallons

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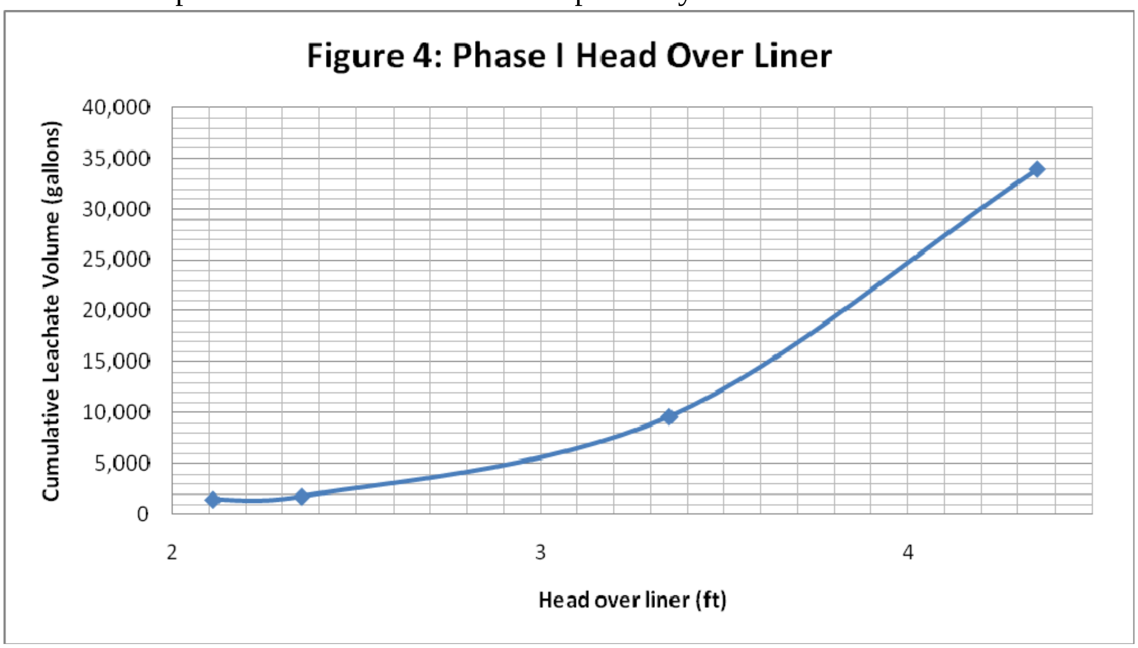
Client:	BRC	Project:	BRC CAMU	Project/ Proposal No.:	SC0313	Task No.:	

Table 4 – Water Quantities at Sump I

Elevation	Head	Cumm. Head	Top Area	Botto m Area	Average Area:	Total Volume	Porosity	Water Volume	Water Volume Cumulative
ft msl	ft	ft	sf	sf	sf	gallons		gallons	gallons
Sump (1720.65-1722.76)	2.11	2.11	356	100	228	3,597	0.4	1,439	1,439
1723	0.24	2.35	585	356	470	845	0.35	296	1,734
1724	1	3.35	5,418	585	3,002	22,453	0.35	7,859	9,593
1725	1	4.35	13,179	5,418	9,299	69,554	0.35	24,344	33,937

Figure 4 below displays the total volume of leachate in the vicinity of the Phase I sump and the anticipated head over the LCRS sump liner system as a result.



Based on this estimate, the amount of head over the Sump I liner system, given the leachate volume of 11,730 gallons, is approximately 3.45 ft or approximately 1.34 ft over the Phase I liner system (3.45 – 2.11 foot deep sump).

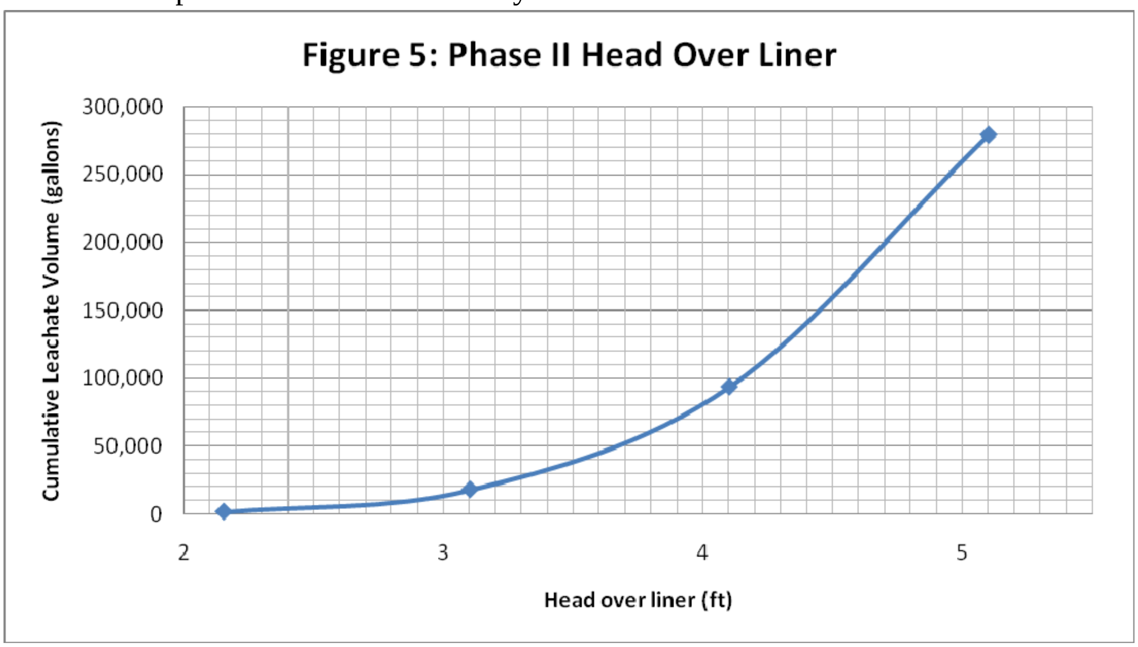
Written by: **S. Yeo** Date: **04/14/08** Reviewed by: **R. Flynn** Date: **4/15/09**

Client: **BRC** Project: **BRC CAMU** Project/ Proposal No.: **SC0313** Task No.:

Table 5 – Water Quantities at Sump II

Elev.	Head	Cumm. Head	Top Area	Bottom Area	Average Area:	Total Volume	Porosity	Water Volume	Water Volume Cumulative
ft msl	ft	ft	sf	sf	sf	gallons		gallons	gallons
Sump (1733.9-1736.05)	2.15	2.15	362	100	231	3,716	0.4	1,486	1,486
1737	0.95	3.1	12,811	362	6,587	46,804	0.35	16,381	17,868
1738	1	4.1	45,050	12,811	28,931	216,402	0.35	75,741	93,609
1739	1	5.1	96,998	45,050	71,024	531,259	0.35	185,941	279,549

Figure 5 below displays the total volume of leachate in the vicinity of the Phase II sump and the anticipated head over the liner system as a result.



Based on this estimate, the amount of head over the Phase II liner system, given the leachate volume of 105,569 gallons, is approximately 4.17 ft or approximately 2.02 ft over the Phase I liner system (4.17 – 2.15 foot deep sump).

Written by:	S. Yeo	Date:	04/14/08	Reviewed by:	R. Flynn	Date:	4/15/09
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Note the porosity of the drainage aggregate is assumed to be 0.4. It is also assumed that there is no evaporation or adsorption of the water.

PUMPING AT SUMPS

On 11 February 2009, Sumps I and II were pumped, thereby reducing the head over the liner system. Therefore, the maximum water head value that was estimated above was likely not fully achieved or was achieved for a short duration of time. As summarized on Table 6, the pump for Sump I was operated on 3/5/09 and 3/26/09 and pumped out approximately 5,000 gallons of water. An estimated total of 94,097 gallons of water has been pumped out since 2/18/09 from the Sump II.

Table 6. Pumping Data

Date Pumped	Approximate Volume Pumped (gallons)	
	Phase I	Phase II
	LCRS	LCRS
11-Feb-09	PQU	PQU
18-Feb-09	Dry	2,000
19-Feb-09	Dry	11,000
20-Feb-09	Dry	17,000
23-Feb-09	Dry	8,000
24-Feb-09	Dry	8,000
26-Feb-09	Dry	6,000
5-Mar-09	4,000	2,000
6-Mar-09	Dry	10,000
7-Mar-09	Dry	6,000
10-Mar-09	Wet	N/A
19-Mar-09	N/A	N/A
25-Mar-09	N/A	4,000
26-Mar-09	1,000	3,100
27-Mar-09	N/A	1,900

Written by: S. Yeo Date: 04/14/08 Reviewed by: R. Flynn Date: 4/15/09

Client: BRC Project: BRC CAMU Project/ Proposal No.: SC0313 Task No.:

Date Pumped	Approximate Volume Pumped (gallons)	
	Phase I	Phase II
	LCRS	LCRS
28-Mar-09	N/A	1,800
30-Mar-09	N/A	1,800
31-Mar-09	N/A	1,500
1-Apr-09	N/A	3,000
2-Apr-09	N/A	1,150
3-Apr-09	N/A	550
4-Apr-09	N/A	688
6-Apr-09	N/A	1,100
7-Apr-09	N/A	769
8-Apr-09	N/A	650
9-Apr-09	N/A	592
10-Apr-09	N/A	600
11-Apr-09	N/A	491
12-Apr-09	N/A	407
Total:	5,000	94,097

Note: PQU = pumped quantity unknown

Based on the volumes of accumulated and removed water from the LCRS sumps, the remaining water volume, as of 12 April 2009, if estimated in Table 7. The remaining volume in Sump I, assuming all the water reached the sump, would be less than approximately 3,700 gallons and there would be no more remaining surface water on Sump II.

Written by:	S. Yeo	Date:	04/14/08	Reviewed by:	R. Flynn	Date:	4/15/09
Client:	BRC	Project:	BRC CAMU	Project/ Proposal No.:	SC0313	Task No.:	

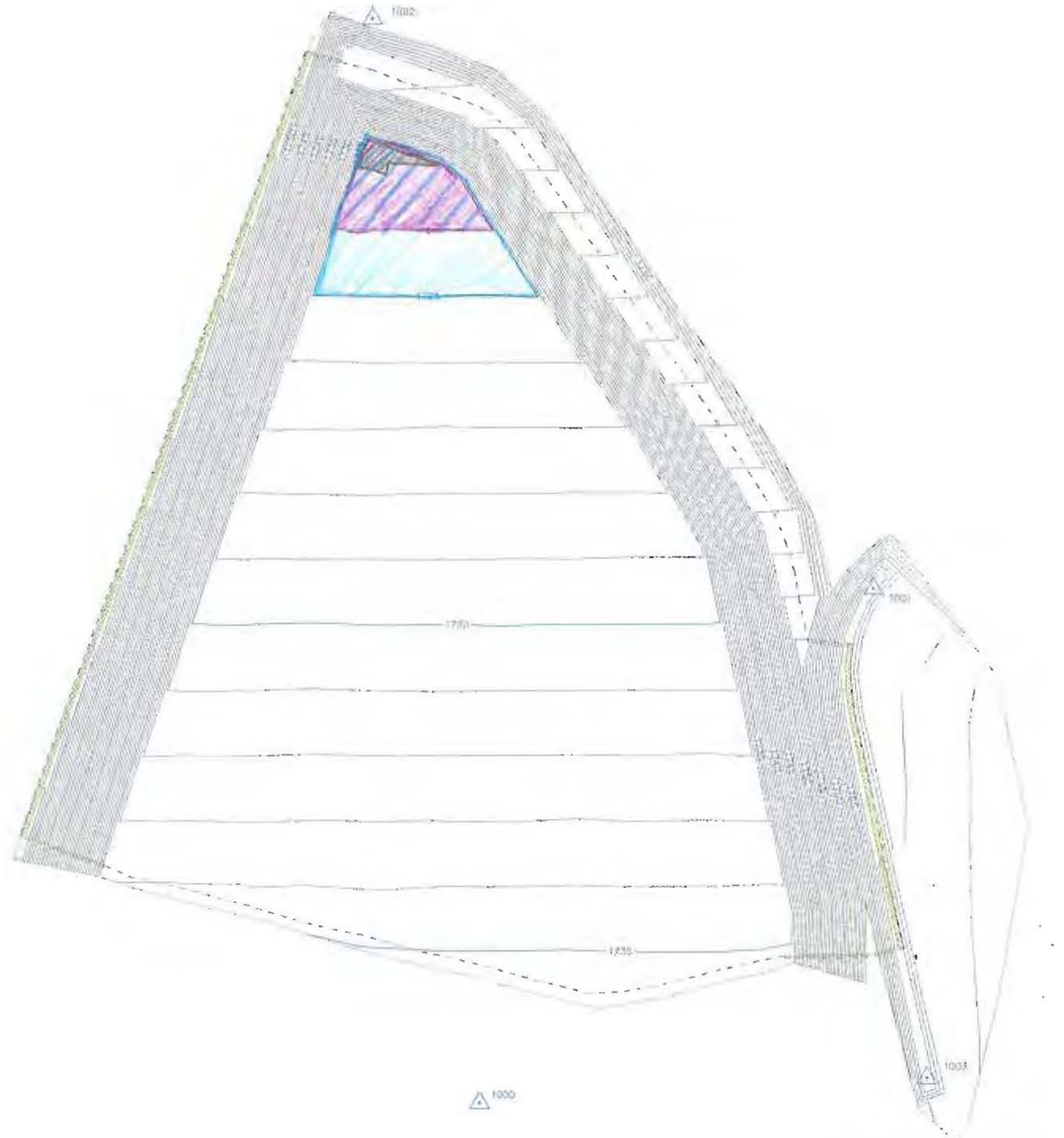
Table 7. Expected Remaining Surface Water in Sump

Summary	Water Volume at Sump I (gallon)	Water Volume at Sump II (gallon)
Maximum estimated water volume by 2/10/09	11,730	105,569
Pumping out by 3/19/09	5,000	94,097
Total	6,730	11,472

CONCLUSIONS

The conclusions are as follows:

- Two sumps accumulated the precipitation water contacting the exposed liner system in Phase I, Phase II, and Phase IIIA.
- 11,730 and 105,569 gallons of surface water could have accumulated in Sump I and Sump II, respectively, from the three-day rain event on 7-9 February 2009
- Maximum water heads on the liner system were estimated to be 1.34 ft and 2.02 feet for Sump I and II, respectively, not accounting for pumping, evaporation, adsoption, or other potential water losses prior to reaching the sumps.
- Pumping operations were performed to reduce the water head. The estimated remaining water, as of 12 April 2009, is less than approximately 6,730 gallons in Sump I and 11,472 gallons in Sump II.



TOTAL STATION CONTROL POINTS			
PT #	NORTHING	EASTING	ELEVATION
1000	17129.62	13927.01	1765.06
1001	17522.06	14229.85	1768.04
1002	17956.75	13846.95	1749.28
1003	17148.53	14269.26	1769.59

COORDINATE SYSTEM

HORIZONTAL COORDINATE SYSTEM WAS ESTABLISHED BY [illegible]

BASIS OF BEARING

SOUTH [illegible] WEST - BEING THE BEARING BETWEEN CLARK COUNTY [illegible] CONTROL POINTS "[illegible]" AND "[illegible]" AS SHOWN ON THE MAP IN FILE [illegible] OF SURVEYS, PAGE [illegible], OFFICIAL RECORDS, CLARK COUNTY, NEVADA.

BENCHMARK

CLARK COUNTY BENCHMARK NO. [illegible] - RIVET AND SQUARE ALUMINUM PLATE IN A CONCRETE CENTERLINE ISLAND, [illegible] WEST OF THE NOSE IN THE MIDDLE OF SUNSET RD. WEST SIDE OF INTERSECTION OF BOULDER HWY. AND SUNSET RD.
NAVD 1988 DATUM
ELEVATION = [illegible] METERS
[illegible] FEET
(REVISED 2001)

GRAPHIC SCALE

120 0 60 120 240

(IN FEET)

1 inch = 120 ft.

Area @ elev. 1723 ft msl

Area @ elev 1724 ft msl

Area @ elev 1725 ft msl

HDPE GEOMEMBRANE LIMITS
ANCHOR TRENCH
TEMPORARY ANCHOR TRENCH ON SIDE SLOPE
1725 MAJOR CONTOURS(AS-BUILT)
MINOR CONTOURS(AS-BUILT)
CONTROL POINTS

N

CAMU PHASE I SUBGRADE AS-BUILT

REVISIONS

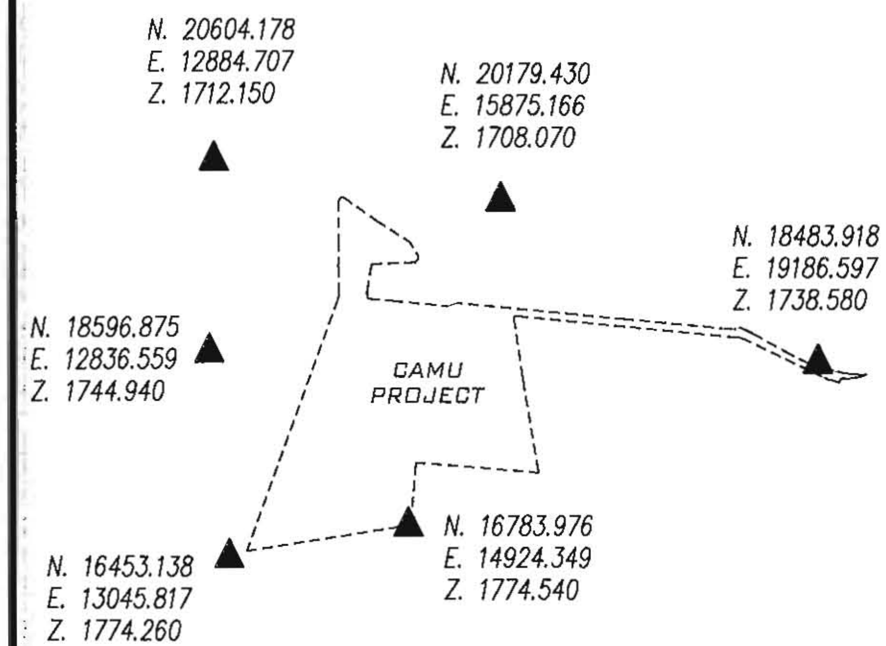
NO.	BY	DATE	DESCRIPTION

FIGURE 1

Contact: KENNEY LAND SURVEYING (MIKE KENNEY)
Phone: 702-263-0505
Email: MIKEK.KLS@LVCOXMAIL.COM

PROJECT CONTROL

1" = 2000'



BENCHMARK

CLARK COUNTY BENCHMARK (6C22 2E4), BEING A RIVET AND SQUARE ALUMINUM PLATE IN A CONCRETE CENTERLINE ISLAND, 4' WEST OF THE NOSE IN THE MIDDLE OF SUNSET ROAD, WEST SIDE OF THE INTERSECTION OF BOULDER HIGHWAY AND SUNSET ROAD.

PUBLISHED ELEVATION - 505.816 METERS = 1659.50 FEET
NAVD 1988 DATUM - PUBLISHED (2003)

BASIS OF BEARINGS

SOUTH 85°36'52" WEST, BEING THE BEARING BETWEEN CLARK COUNTY GIS CONTROL POINTS "CC-GIS 848" AND CC-GIS W51", AS SHOWN ON THE MAP IN FILE 88 OF SURVEYS, PAGE 53, OFFICIAL RECORDS, CLARK COUNTY, NEVADA.

COORDINATE SYSTEM

THE COORDINATE SYSTEM AND ASSOCIATED BEARING ROTATION INFORMATION WAS ESTABLISHED AND PROVIDED BY PBS&J.

LINE LEGEND

GEOSYNTHETIC LINER LIMIT
PHASE I - MAJOR CONTOUR
PHASE I - MINOR CONTOUR
PHASE II - MAJOR CONTOUR
PHASE II - MINOR CONTOUR

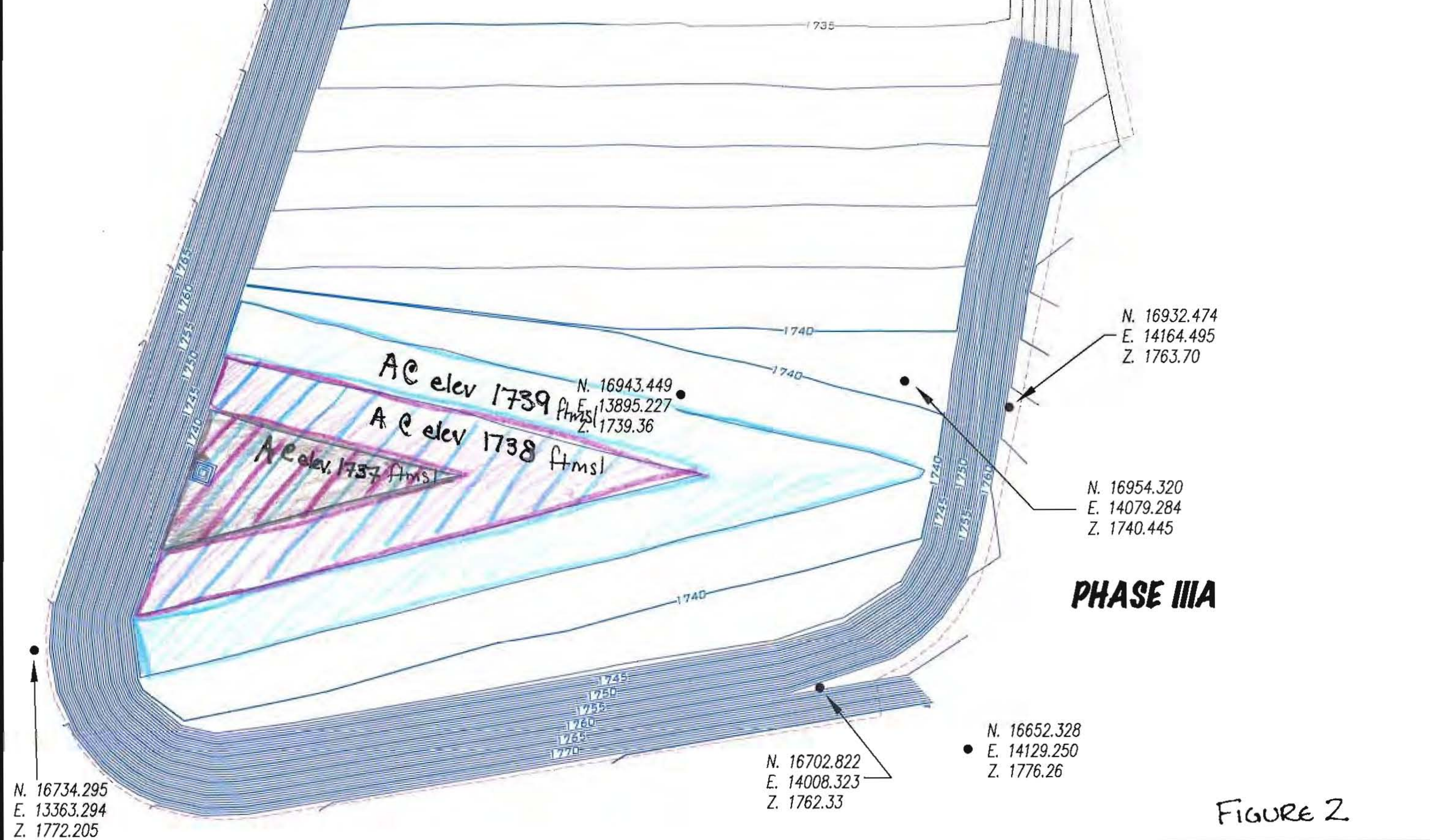
SYMBOL LEGEND

▲ FOUND AERIAL PHOTO CONTROL POINT

• ESTABLISHED CONTROL POINT FOR CONVENTIONAL SURVEYING ACTIVITIES

NOTES:

1) PHASE I AS-BUILT INFORMATION PROVIDED BY KENNEY LAND SURVEYING



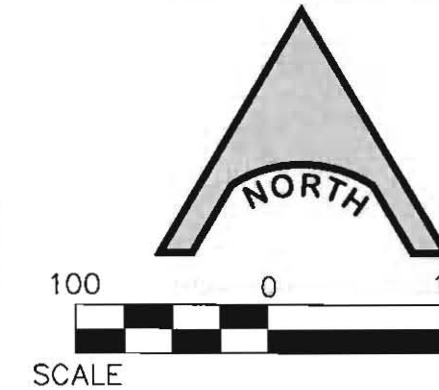


FIGURE 2

NO.	REVISION	DATE
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AS-BUILT
CORRECTIVE ACTION MANAGEMENT UNIT - (CAMU)
PHASE II - SUBGRADE

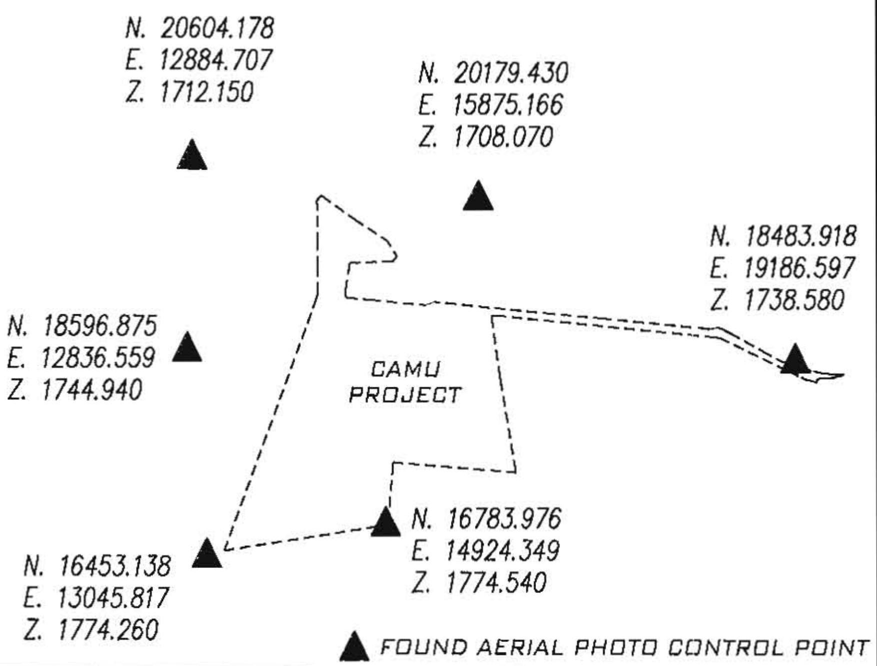
FIELD SURVEY DATE: NOVEMBER 2008
FIELD CREW: C.G.

ABSOLUTE BOUNDARY & CONTROL SOLUTIONS
6440 SKY POINT DRIVE
SUITE 140 - PMB 321
LAS VEGAS, NV. 89131
(702) 953-7452
(702) 987-5943 FAX
WWW.AB-CS.COM

Date:	December 10, 2008
Drawn:	C. Givant
Checked:	C. Givant
Job Number:	2008-06-23-01-02
Sheet No.	1 of 1

PROJECT CONTROL

1" = 2000'



BENCHMARK

CLARK COUNTY BENCHMARK (6C22 2E4), BEING A RIVET AND SQUARE ALUMINUM PLATE IN A CONCRETE CENTERLINE ISLAND, 4' WEST OF THE NOSE IN THE MIDDLE OF SUNSET ROAD, WEST SIDE OF THE INTERSECTION OF BOULDER HIGHWAY AND SUNSET ROAD.

PUBLISHED ELEVATION - 505.816 METERS = 1659.50 FEET NAVD 1988 DATUM - PUBLISHED (2003)

BASIS OF BEARINGS

SOUTH 85°36'52" WEST, BEING THE BEARING BETWEEN CLARK COUNTY GIS CONTROL POINTS "CC-GIS 848" AND CC-GIS W51", AS SHOWN ON THE MAP IN FILE 88 OF SURVEYS, PAGE 53, OFFICIAL RECORDS, CLARK COUNTY, NEVADA.

COORDINATE SYSTEM

THE COORDINATE SYSTEM AND ASSOCIATED BEARING ROTATION INFORMATION WAS ESTABLISHED AND PROVIDED BY PBS&J.

LINE LEGEND

SURFACE 1 - MAJOR CONTOUR
SURFACE 1 - MINOR CONTOUR
SURFACE 2 - MAJOR CONTOUR
SURFACE 2- MINOR CONTOUR
1/31/2009 SURVEY LIMITS

SURFACE 1

THE SURFACE SHOWN HEREON AS "SURFACE 1" REPRESENTS THE PHASE I & II SUBGRADE SURFACES + 0.0625' WHICH ACCOUNTS FOR THE THICKNESS OF THE GEOSYNTHETIC MATERIALS. THE PHASE I SUBGRADE SURFACE DATA WAS PROVIDED BY KENNEY LAND SURVEYING (KLS) AND THE PHASE II SUBGRADE SURFACE WAS SURVEYED BY ABSOLUTE BOUNDARY & CONTROL SOLUTIONS (ABCS) AS DEPICTED ON PREVIOUSLY GENERATED PHASE II REPORTS.

SURFACE 2 - SEE NOTE 1

THE SURFACE SHOWN HEREON AS "SURFACE 2" REPRESENTS THE CONDITIONS OF THE AREA AS THEY EXISTED ON 1/31/2009 AT APPROXIMATELY 5:00PM LOCAL TIME AS SURVEYED BY ABSOLUTE BOUNDARY AND CONTROL SOLUTIONS (ABCS).

SURFACE VOLUME COMPARISON

A COMPARISON FROM SURFACE 1 TO SURFACE 2 (SEE ABOVE) WAS PERFORMED VIA COMPUTER METHODS IN AUTOCAD CIVIL 3D VERSION 2009. THIS COMPARISON RESULTED IN A QUANTITY OF:

FILL: 435,774 CUBIC YARDS (GROSS)

THIS GROSS QUANTITY NEEDED TO BE REVISED TO EXCLUDE THE AREA FOR THE HDPE LCRS PIPE AND THE DRAINAGE AGGREGATE. USING SURVEY DATA PROVIDED BY KENNEY LAND SURVEYING,

435,774 CUBIC YARDS
- 131 CUBIC YARDS FOR PHASE I PIPE/AGGREGATE
- 130 CUBIC YARDS FOR PHASE II PIPE/AGGREGATE

435,513 CUBIC YARDS (NET)

MONTH TO MONTH COMPARISON

THE NET FILL REPORTED ABOVE IS THE TOTAL WASTE VOLUME PLACED SINCE THE INSTALLATION OF THE GEOSYNTHETIC LINER MATERIALS. THE FOLLOWING CALCULATIONS REFLECT THE MONTHLY VOLUMES.

435,513 CUBIC YARDS OF WASTE (INCLUDES OPERATION LAYER)
-130,799 CUBIC YARDS PLACED AS REPORTED 10/31/2008
- 62,944 CUBIC YARDS PLACED AS REPORTED 11/30/2008
- 58,686 CUBIC YARDS PLACED AS REPORTED 12/31/2008

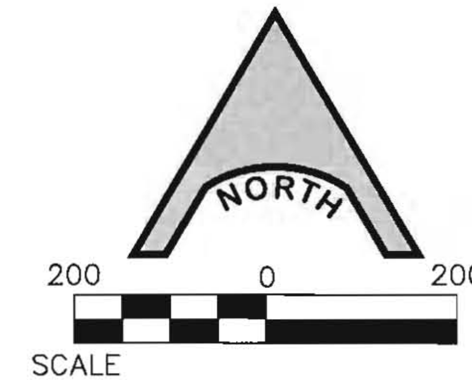
183,084 CUBIC YARDS (NET) - PLACED IN JANUARY 2009

NOTES:

1) PREVIOUSLY REPORTED SURFACE INFORMATION WAS EXTRACTED AND UTILIZED IN LIEU OF REPEATING FIELD COLLECTION ACTIVITIES OVER THOSE AREAS WHICH HAVE REMAINED UNDISTURBED SINCE PRIOR REPORTS WERE GENERATED. THIS EXTRACTED INFORMATION WAS MERGED WITH THE THE DATA COLLECTED ON THE DATE SPECIFIED TO CREATE THE FINAL SURFACE REPRESENTED HEREIN.

Exposed AREA DRAINING TO SUMP I

EXPOSED AREA DRAINING TO SUMP II



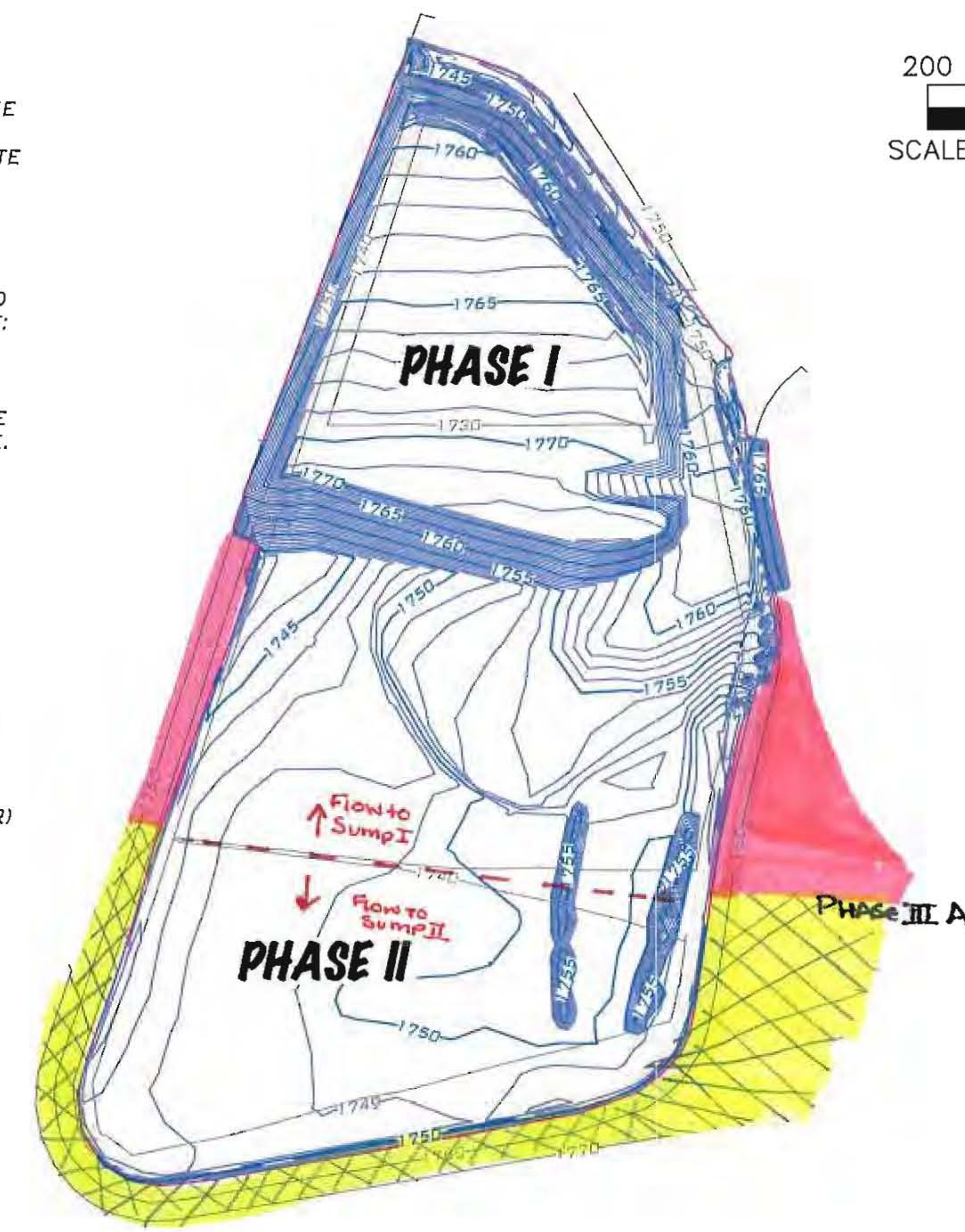


FIGURE 3

NO.	REVISION	DATE
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△		

CORRECTIVE ACTION MANAGEMENT UNIT - (CAMU)

PHASE I & II WASTE PLACEMENT
AS OF 1/31/2009

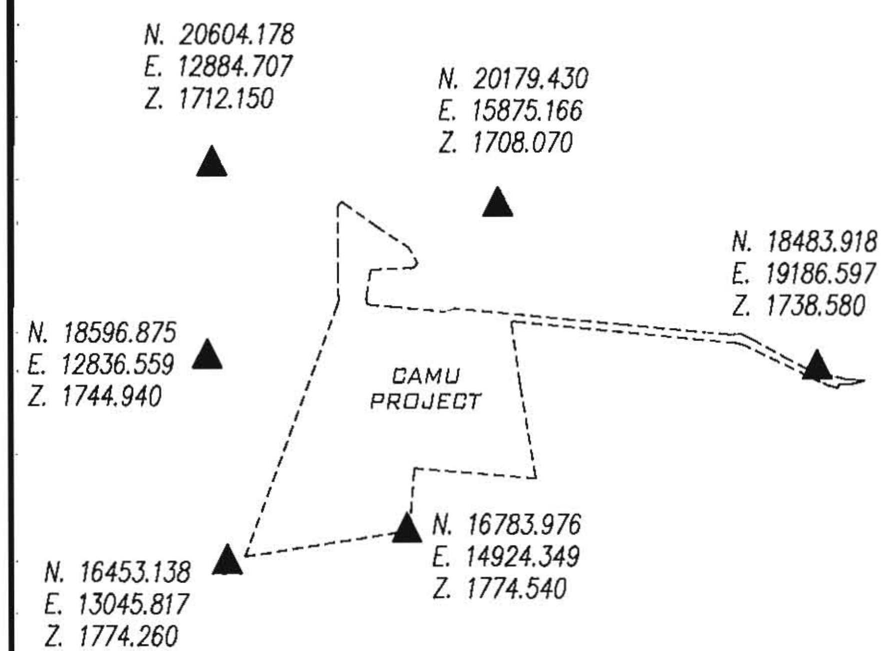
FIELD SURVEY DATE: 1-31-2009
FIELD CREW: M.C. / T.G.

ABSOLUTE BOUNDARY & CONTROL SOLUTIONS
6440 SKY POINT DRIVE
SUITE 140 - PMB 321
LAS VEGAS, NV. 89131
(702) 953-7452
(702) 987-5943 FAX
WWW.AB-CS.COM

Date:	February 5, 2009
Drawn:	C. Hendrickson
Checked:	C. Givant
Job Number:	2008-06-23-01-02
Sheet No.	1 of 1

PROJECT CONTROL

1" = 2000'



BENCHMARK

CLARK COUNTY BENCHMARK (6C22 2E4), BEING A RIVET AND SQUARE ALUMINUM PLATE IN A CONCRETE CENTERLINE ISLAND, 4' WEST OF THE NOSE IN THE MIDDLE OF SUNSET ROAD, WEST SIDE OF THE INTERSECTION OF BOULDER HIGHWAY AND SUNSET ROAD.

PUBLISHED ELEVATION - 505.816 METERS = 1659.50 FEET
NAVD 1988 DATUM - PUBLISHED (2003)

BASIS OF BEARINGS

SOUTH 85°36'52" WEST, BEING THE BEARING BETWEEN CLARK COUNTY GIS CONTROL POINTS "CC-GIS 848" AND CC-GIS W51", AS SHOWN ON THE MAP IN FILE 88 OF SURVEYS, PAGE 53, OFFICIAL RECORDS, CLARK COUNTY, NEVADA.

COORDINATE SYSTEM

THE COORDINATE SYSTEM AND ASSOCIATED BEARING ROTATION INFORMATION WAS ESTABLISHED AND PROVIDED BY PBS&J.

LINE LEGEND

PHASE II - MAJOR CONTOUR
PHASE II - MINOR CONTOUR
PHASE IIIA - MAJOR CONTOUR
PHASE IIIA - MINOR CONTOUR
GEOSYNTHETIC LINER LIMIT

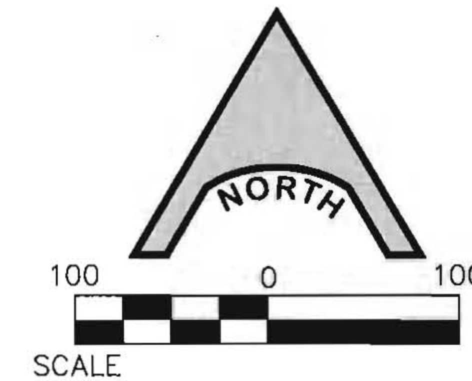
SYMBOL LEGEND

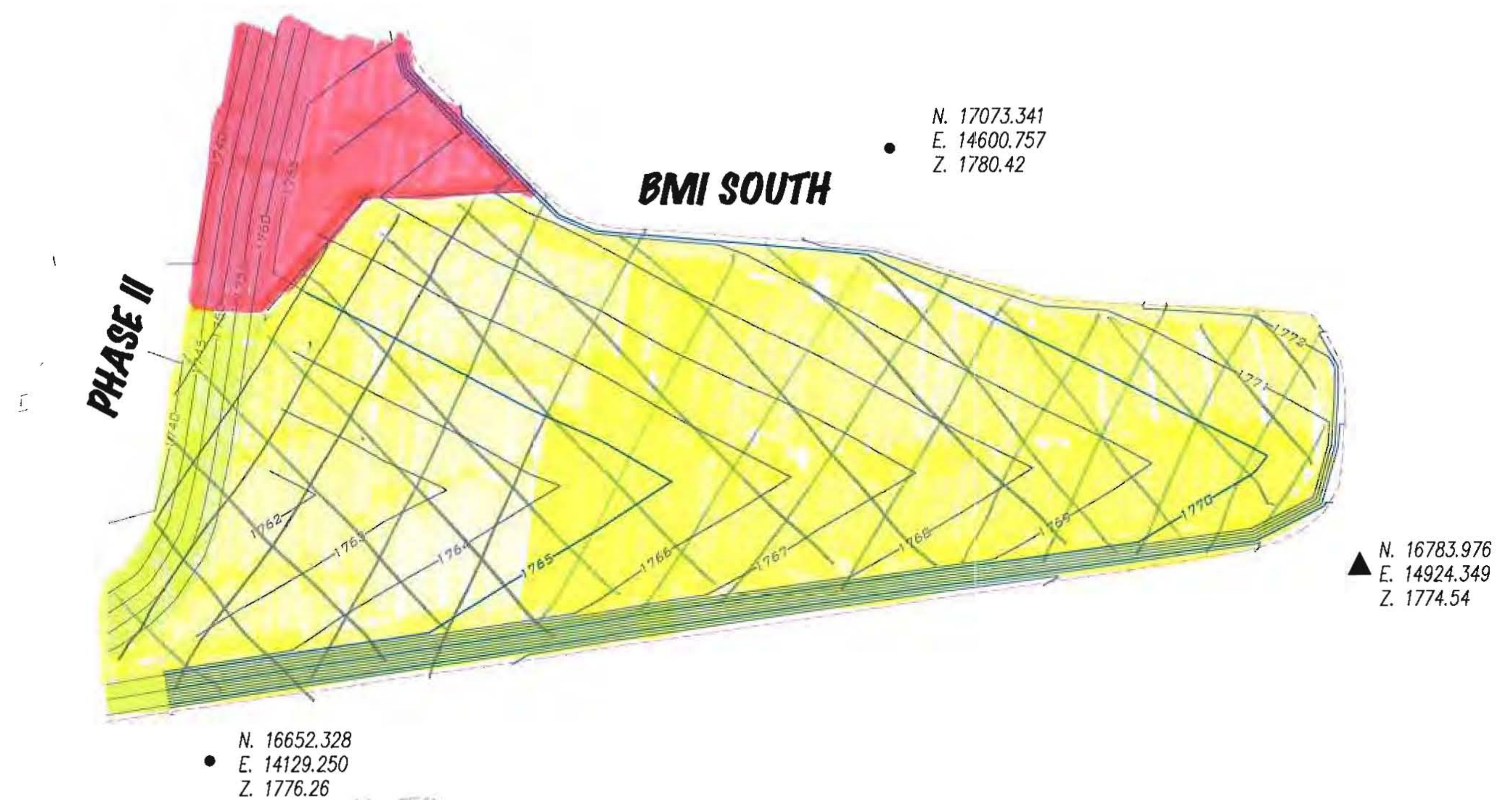
▲ FOUND AERIAL PHOTO CONTROL POINT

● ESTABLISHED CONTROL POINT FOR CONVENTIONAL SURVEYING ACTIVITIES

NOTES:

PH II ASBUILT INFORMATION WAS SURVEYED BY ABCS AND REPORTED IN THE DECEMBER 10, 2008 SUBGRADE ASBUILT REPORT.





EXPOSED AREA DRAINING TO SUMP I

EXPOSED AREA DRAINING TO SUMP II

FIGURE 4

NO.	REVISION	DATE
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CORRECTIVE ACTION MANAGEMENT UNIT - (CAMU)

PHASE IIIA
SUBGRADE ASBUILT

FIELD SURVEY DATE: 1-31-2009
FIELD CREW: C.G.
JOB # 2008-06-23-01

ABSOLUTE BOUNDARY & CONTROL SOLUTIONS
6440 SKY POINT DRIVE
SUITE 140 - PMB 321
LAS VEGAS, NV. 89131
(702) 953-7452
(702) 987-5943 FAX
WWW.AB-CS.COM

Date:	February 13, 2009
Drawn:	C. Hendrickson
Checked:	C. Givant
Task:	2009.01.31.01
Sheet No.	1 of 1

Attachment 2

Attachment 2
Summary of Analytical Results
BRC CAMU
Henderson, Nevada

Class	Chemical	Units	MCL	NDEP Water BCL	CAMUI-S-N	CAMUI-S-S	CAMUI-V-N
Metals	Aluminum	µg/L	50	36500	**9910**	**125**	**455**
	Antimony	µg/L	6	14.6	2.6	**9.2**	1.6
	Arsenic	µg/L	10	0.045	**29**	**50.9**	**6.2**
	Barium	µg/L	2,000	7300	867	862	74.3
	Beryllium	µg/L	4	73	ND	ND	ND
	Boron	µg/L	--	7300	1350	688	310
	Cadmium	µg/L	5	18.3	**15**	**84**	0.31
	Calcium	µg/L	--	--	3880000	349000	207000
	Chromium (Total)	µg/L	100	--	**304**	**550**	6.1
	Cobalt	µg/L	--	730	14	19.7	0.62
	Copper	µg/L	1,300	1356	23.1	23.6	10.9
	Iron	µg/L	300	25600	**14400**	**22400**	**966**
	Lead	µg/L	15	15	**105**	**590**	13.6
	Lithium	µg/L	--	73	**286**	**89.5**	**106**
	Magnesium	µg/L	--	--	1980000	33200	62600
	Manganese	µg/L	50	1703	**2030**	**6160**	**168**
	Mercury	µg/L	2	--	0.19	0.21	0.041
	Molybdenum	µg/L	--	183	139	**226**	34.6
	Nickel	µg/L	--	730	43	100	5.2
	Potassium	µg/L	--	--	334000	40600	21600
	Selenium	µg/L	50	183	7.2	23.9	3
	Silver	µg/L	100	183	6.1	72.1	ND
	Sodium	µg/L	--	--	5750000	358000	615000
	Strontium	µg/L	--	21900	**53500**	4700	3480
	Thallium	µg/L	2	2.6	**10.5**	**254**	0.27
	Tin	µg/L	--	21900	ND	ND	0.6
	Titanium	µg/L	--	146000	162	41.1	24.6
	Tungsten	µg/L	--	274	6.2	10.4	0.3
	Uranium	µg/L	30	110	11.7	**49.6**	20.1
	Vanadium	µg/L	--	183	124	29	11.2
	Zinc	µg/L	500	10950	60.6	394	12.1

Attachment 2
Summary of Analytical Results
BRC CAMU
Henderson, Nevada

Class	Chemical	Units	MCL	NDEP Water BCL	CAMUI-S-N	CAMUI-S-S	CAMUI-V-N
Organo-chlorine Pesticides	2,4-DDD	µg/L	--	--	0.057	ND	ND
	2,4-DDE	µg/L	--	--	0.12	0.15	ND
	4,4-DDD	µg/L	--	0.28	0.087	ND	ND
	4,4-DDE	µg/L	--	0.2	0.16	ND	ND
	4,4-DDT	µg/L	--	0.2	**0.86**	**0.21**	**0.34**
	Aldrin	µg/L	--	0.004	ND	ND	ND
	alpha-BHC	µg/L	--	0.011	**7.5**	**0.5**	**0.1**
	alpha-Chlordane	µg/L	2	--	ND	ND	ND
	beta-BHC	µg/L	--	0.037	**8.8**	**2.7**	**0.57**
	Chlordane	µg/L	2	0.19	ND	ND	ND
	delta-BHC	µg/L	--	--	0.84	ND	ND
	Dieldrin	µg/L	--	0.0042	ND	ND	ND
	Endosulfan I	µg/L	--	--	ND	ND	ND
	Endosulfan II	µg/L	--	--	ND	ND	ND
	Endosulfan sulfate	µg/L	--	--	ND	ND	ND
	Endrin	µg/L	2	11	ND	ND	ND
	Endrin aldehyde	µg/L	--	--	0.2	ND	ND
	Endrin ketone	µg/L	--	--	ND	ND	ND
	gamma-Chlordane	µg/L	2	--	ND	ND	ND
	Heptachlor	µg/L	0.4	0.015	**5.9**	**0.055**	**0.064**
	Heptachlor epoxide	µg/L	0.2	0.0074	ND	ND	ND
	Lindane	µg/L	0.2	0.052	ND	ND	ND
	Methoxychlor	µg/L	40	183	ND	0.36	ND
	Toxaphene	µg/L	3	0.061	ND	ND	ND
Water Quality Parameters	Hardness, Total	mg/L	--	--	17800000	1010000	775000
	Total Dissolved Solids	mg/L	500	--	**28700**	**96600**	**1920**

Bold values indicate value exceeds lowest comparison level.

Attachment 3

Vadose Zone Liquid versus LCRS Leachate

Vadose Zone Liquid (left): clear, some solids

LCRS Leachate (right): murky, yellow, unknown solids

Attachment 4

GES
GEOTECHNICAL &
ENVIRONMENTAL
SERVICES, INC.

PROVIDING
- Geotechnical Engineering
- Construction Materials Engineering
- Environmental Engineering
- Drilling Services

April 1, 2009
Project No. 20092523V1

Dr. Ranajit Sahu, Ph.D, C.E.M.
Basic Remediation Company
875 West Warm Springs Road
Henderson, Nevada 89011

RE: Phase 1 Piezometer CAMU-VS1-AA Installation

Dear Dr. Sahu:

On March 29, 2009 Geotechnical and Environmental Services, Inc. (GES) installed a piezometer identified as CAMU-VS1-AA adjacent to the Corrective Action Management Area (CAMU) Phase 1 Sumps per direction of Basic Remediation Company (BRC). This activity report details the scope of services performed, which consisted of the following:

- March 29, 2009: Drill and collect soil samples from a borehole (B-1) located adjacent to the Phase 1 Sumps. The soil samples were submitted to the GES soils laboratory for analyses of the physical properties. Following completion of the drilling and soil sampling, the borehole was converted to a piezometer (CAMU-VS1-AA). Please refer to Figures 1, 2 and 3 for approximate sample locations and photographs.

GES's scope of services was to collect samples so that others may evaluate the data resulting from our sampling efforts and install a piezometer. Therefore, this report does not provide the analytical results.

Field Investigation Methodology

<u>Soil Characterization</u> – GES collected soil samples on March 29, 2009 from one (1) borehole located in the CAMU facility approximately one half-mile south of Warm Springs Road and approximately one quarter-mile east of Highway 95 in Henderson, Nevada. The location was determined by others and marked with white spray paint prior to drilling. The location is approximately 10-feet south and 5-feet west of the Phase 1 Sumps. Entact Environmental Services surveyed the location prior to drilling and after installation of the piezometer using Global Positioning System (GPS) techniques.

Upon arrival GES documented the existing site conditions with photographs and field notes. A tail gate safety meeting was performed prior to setting up the drill rig. Eagle Drilling, LLC performed the drilling, soil sampling and well construction. The borehole was advanced using a Diedrich D-50 track rig with 6 inch outside diameter Hollow stem augers. The borehole was advanced to approximately 50-feet below the general ground surface (bgs), as instructed by BRC. Following the drilling and soil sampling, the borehole was converted to a piezometer.

Soil sampling was conducted at depth intervals per direction of Geosyntec Consultants. Soil samples were collected from 15-feet bgs, 20-feet bgs, 25-feet bgs and every 2.5-feet below 25-feet until the bottom of the boring at 50-feet bgs. The analytical parameters were also determined by Geosyntec Consultants. The depth intervals and analytical parameters are summarized in Table 1. Each sample was provided a unique designation with the following information: sample location, depth interval, GES project number date and samplers initials. The samples were named for the borehole designation (B-1). For example, the first sample depth was identified as B-1, 15.3 – 15.8, 20092523V1, 03-16-09, RC.

Piezometer Costruction

The depth to the bottom of the borehole was measured prior to starting installation of the piezometer. The depth to the bottom was measured at 51-feet bgs. Sand (Number 3 Monterey Sand) was added initially to bring the bottom of the boring up to 50-feet bgs. The well was installed following the sand placement. The well consisted of Schedule 40 PVC well screen (25-feet long) and blank casing (25-feet long) with a PVC end cap at the bottom. Upon completion of the PVC well materials, the sand pack was constructed in the annular space outside the screen interval. The sand pack extends to approximately 23-feet bgs. Bentonite was added and hydrated to form the seal above the sand pack. The bentonite seal was then built to 2-feet bgs. The surface completion consisted of a 12-inch diameter well box with a flush mounted lid. A concrete pad was built around the well box and sloped on the surface to allow drainage.

The depth to ground water below the top of the well casing (BTOC) and the depth to the bottom of the well (DTB) was measured using a Solinst water level meter. The initial depth to ground water was 39.50 feet and the depth to the bottom of well was 50.5 feet.

The piezometer was developed by hand bailing and surging. Using the industry standard method of five (5) water column volumes, approximately 35 gallons were purged from the well. The piezometer was purged using a clean stainless steel bailer.

Investigative Derived Waste (IDW)

Investigative Derived Waste (IDW) consisted of purged ground water and drill cuttings (soil). All IDW was disposed of in the CAMU landfill adjacent to the Phase 1 sumps per direction from Entact Environmental Services.

Changes to Original Planned Work

During this work there were no modifications to the original scope of services.

We appreciate this opportunity to provide our professional services. If you have questions or comments, feel free to contact our office at (702) 365-1001.

Sincerely,
Geotechnical & Environmental Services, Inc.

Richard A. Cooke

Richard A. Cooke, CEM
Project Geologist
C.E.M. #1820

RAC:ACS:as
Enc.: Vicinity Map
Site Map
Photographs
Table 1

Dist: 1 original mailed to addressee
1 copy emailed to Sahuron@earthlink.net
1 cc to project file

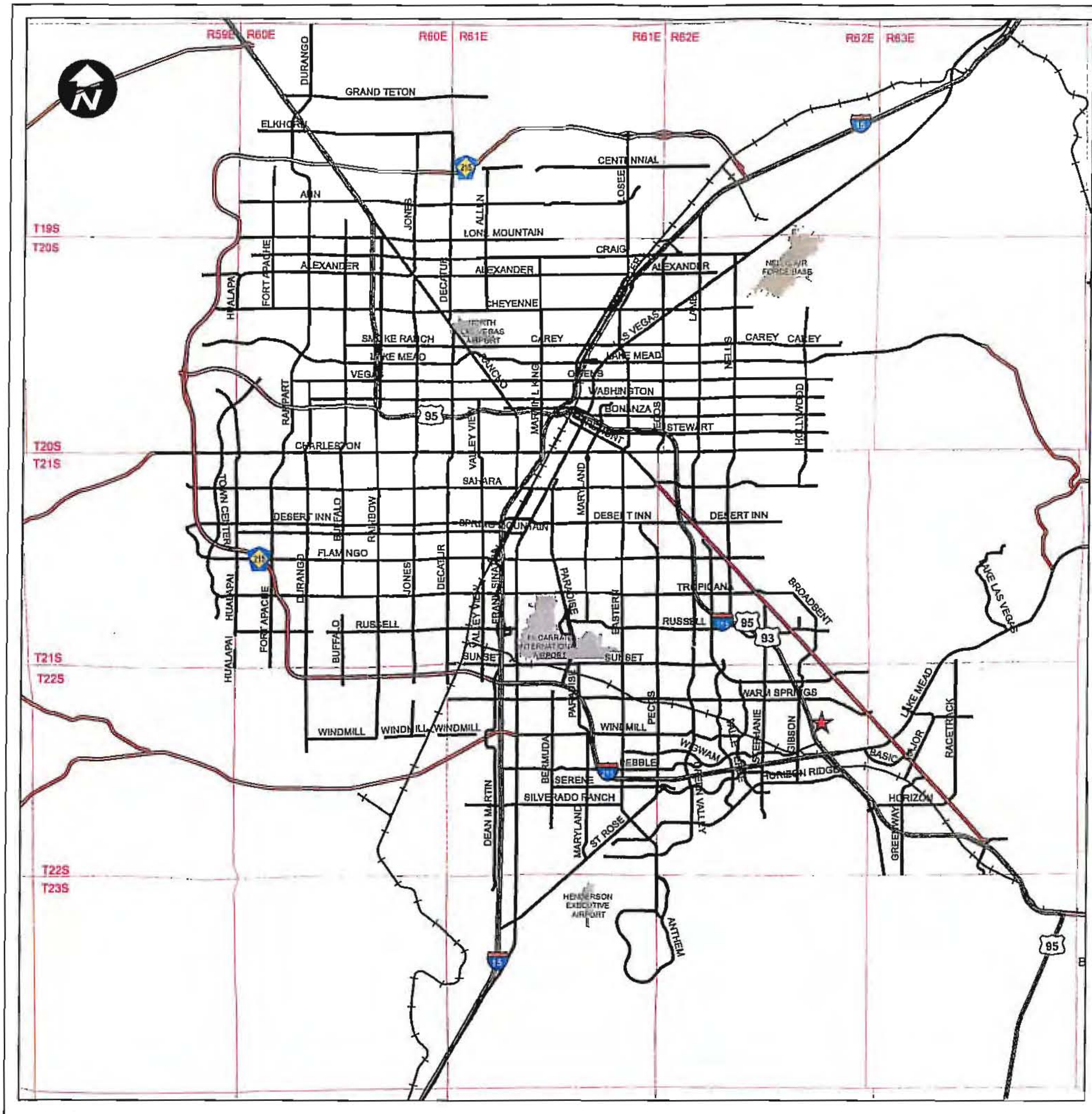
FIGURES

VICINITY MAP

SITE MAP

PHOTOGRAPHS

BORING LOGS



Legend

- ★ Approximate Project Location
- Airports
- Interstate
- Major Streets
- Railroad
- State Highway
- Township & Range

NOTE: Data presented on this map is a compilation of GIS Metadata extracted from a variety of sources. Major Streets, Airports, and Railroads is data obtained from the Southern Nevada GIS Management Office. This data is downloaded by GES for incorporation into drawings generated by GES. Data contained within this page is to be used for informational purposes only. GES has not modified the data contained herein and uses it as it is acquired from the respective agency.

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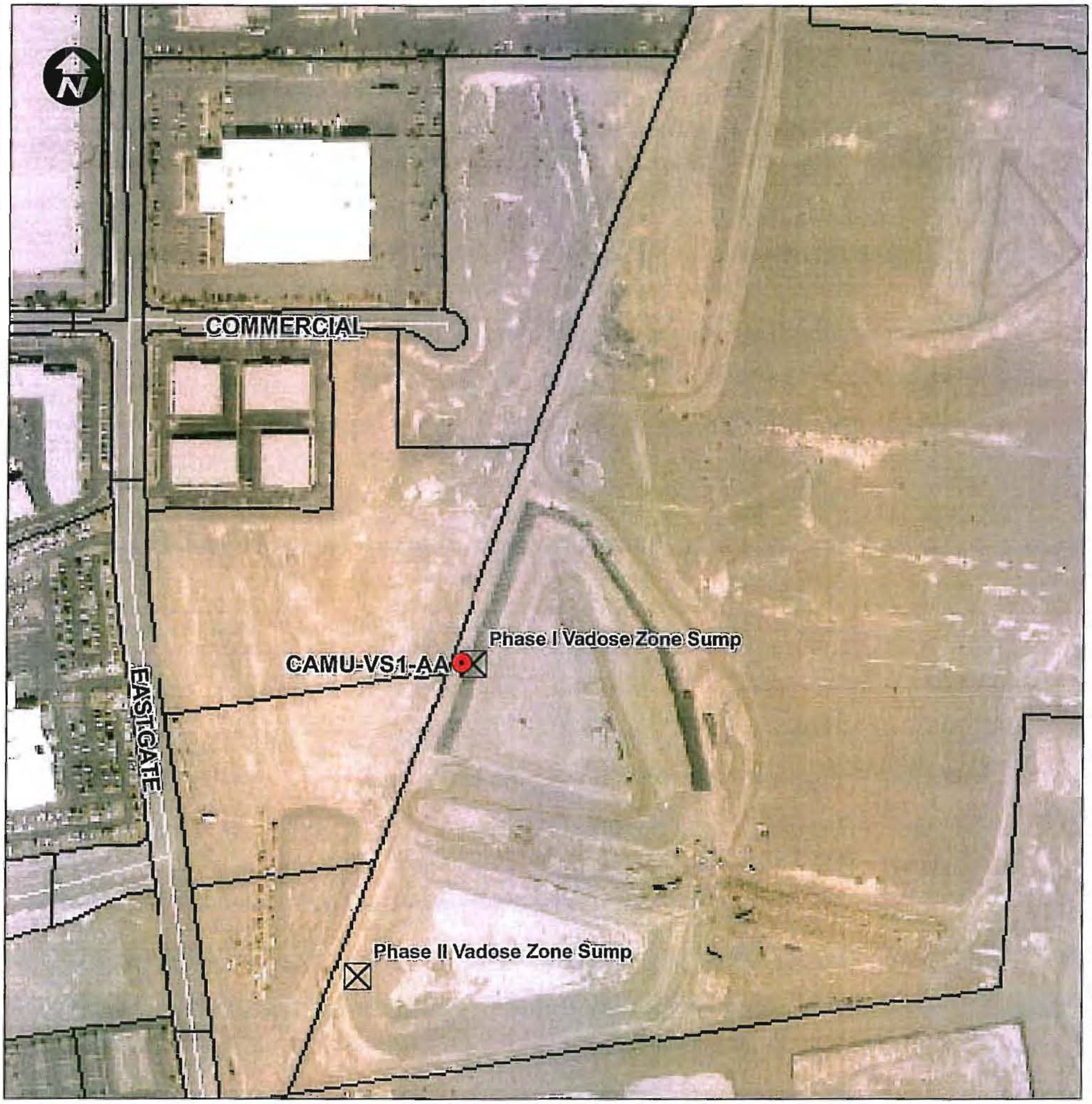
Las Vegas, NV 89119
GES
702-365-1001
www.gesnevada.com

SAMPLE LOCATION MAP CAMU-VS1-AA PIEZOMETER & SUMPS BASIC REMEDIATION COMPANY	Drawn By: MMD	Date Drawn: 04/01/2009
	Project No. 20092523V1	Figure No. 1

J:\Jobs\2009_Jobs\20092523\V1\GIS\Maps\Figure 2.mxd\Figure 1.mxd



Legend

- Well Location
- CAMU Vadose Zone Sump Sample Locations

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SAMPLE LOCATION MAP CAMU-VS1-AA PIEZOMETER & SUMPS BASIC REMEDIATION COMPANY	Drawn By: MMD	Date Drawn: 04/01/2009
	Project No. 20092523V1	Figure No. 2

J:\Jobs\2000_Jobs\20092523\V1\GIS\Maps\Figure 2.mxd

1. Site prior to setting up to drill.

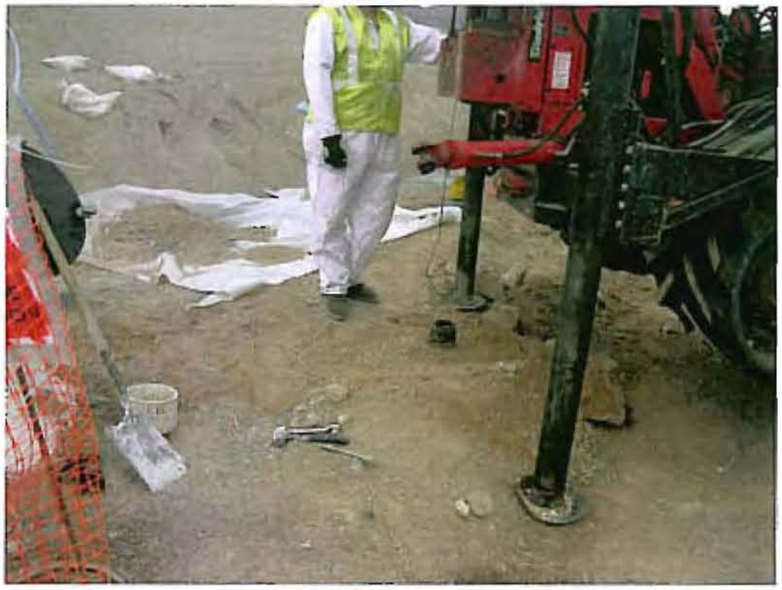
2. Close up of drilling location.

3. Drilling at 15'.

GES

PROJECT:
Phase I Piezometer

FIGURE 3
Site Photographs



4. Drilling at 15'.

5. Sample from 15'.

6. Transition to wet MCF: Dark gray and moist, gray and wet, brown and moist.

GES

PROJECT:
Phase I Piezometer

FIGURE 3a
Site Photographs

7. Transition to wet MCF: Dark gray and moist, gray and wet, brown and moist.

8. Close-up of screen with scale.

9. Installing the well screen.

GES

PROJECT:
Phase I Piezometer

FIGURE 3b
Site Photographs

10. Installing the well screen.

11. Installing the well screen.

12. #3 sand used for sand pack.

GES

PROJECT:
Phase I Piezometer

FIGURE 3c
Site Photographs

13. 3/8" bentonite used for seal.

14. Close up view of finished well.

15. View showing the location of the well with respect to the Phase 1 Sumps.

GES

PROJECT:
Phase I Piezometer

FIGURE 3d
Site Photographs

16. View showing traffic area set up to protect the well from vehicles.

PROJECT:
Phase I Piezometer

FIGURE 3e
Site Photographs

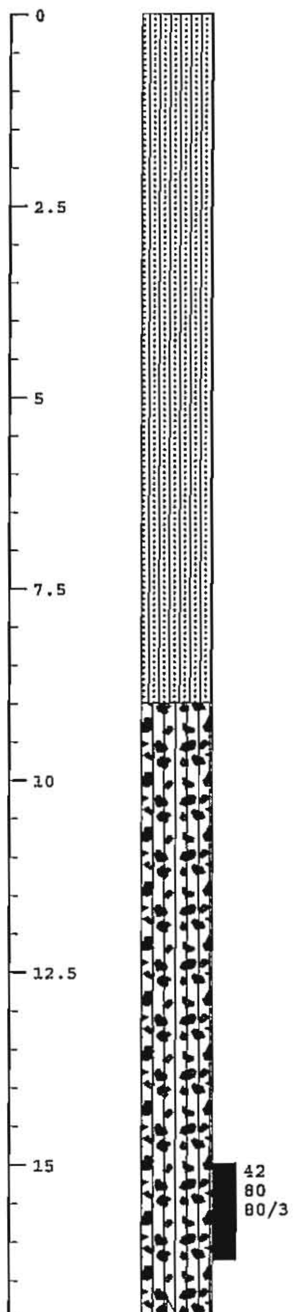
EXPLORATION LOG
CAMU-VS1-AA

PROJECT: PHASE I SUMP PIEZOMETER
EXPLORATION LOCATION:
EXPLORATION SIZE (dia.): 6" O.D. H.S. AUGERS
ELEVATION:

PROJECT NO.: 20092523V1
EXPLORATION DATE: 03/29/2009
EQUIPMENT: DIEDRICH D-50 TRACK RIG
LOGGED BY: WIKTOR/COOKE

INITIAL DEPTH TO WATER: 39.5'
FINAL DEPTH TO WATER: 39.5'

DATE MEASURED: 03/29/2009
DATE MEASURED: 03/29/2009



ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	% SWELL	WELL CONSTRUCTION
		SM	Very pale brown silty SAND with gravel, dry and medium dense.						
			...strong, brown, dense.						
			...large cobble or boulder.						
			...light brown.						
			...cobbles present to 10 feet deep.						
		GM	Light brown silty GRAVEL with sand, dry and very dense.						
			...weakly cemented and very dense.						
			...moderately cemented and hard to 20 feet.						

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC. Figure No. 4

EXPLORATION LOG
CAMU-VS1-AA

PROJECT: PHASE I SUMP PIEZOMETER
EXPLORATION LOCATION:
EXPLORATION SIZE (dia.): 6" O.D. H.S. AUGERS
ELEVATION:

PROJECT NO.: 20092523V1
EXPLORATION DATE: 03/29/2009
EQUIPMENT: DIEDRICH D-50 TRACK RIG
LOGGED BY: WIKTOR/COOKE

INITIAL DEPTH TO WATER: 39.5'
FINAL DEPTH TO WATER: 39.5'

DATE MEASURED: 03/29/2009
DATE MEASURED: 03/29/2009

ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	% SWELL	WELL CONSTRUCTION
17.5									
20	55 50/2 50/0	GW	Brown well graded GRAVEL with sand, dry, moderately cemented and hard. ...moderately cemented to 27 1/2 feet.						
22.5									
25	64 100								
27.5	22 30 30		...uncemented to 29.5 feet.						
		SP	Brown poorly graded SAND, little gravel, dry and very dense. ...moderately cemented.						
30	100 69 50	GW	Brown well graded GRAVEL with sand, dry, moderately cemented and hard. ...weakly cemented.						
		SP	Brown poorly graded SAND, little gravel, dry, weakly cemented and very dense.						
32.5	22 32 40								

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

EXPLORATION LOG
CAMU-VS1-AA

PROJECT: PHASE I SUMP PIEZOMETER
EXPLORATION LOCATION:
EXPLORATION SIZE (dia.): 6" O.D. H.S. AUGERS
ELEVATION:

PROJECT NO.: 20092523V1
EXPLORATION DATE: 03/29/2009
EQUIPMENT: DIEDRICH D-50 TRACK RIG
LOGGED BY: WIKTOR/COOKE

INITIAL DEPTH TO WATER: 39.5'
FINAL DEPTH TO WATER: 39.5'

DATE MEASURED: 03/29/2009
DATE MEASURED: 03/29/2009

ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	% SWELL	WELL CONSTRUCTION
35	107 107 89	GW	Brown well graded GRAVEL with sand, dry, moderately cemented and hard.						
37.5	62 78		...moist, weakly cemented. ...very dark gray.						
40	50/1 100/0 90/6		...strongly cemented and very hard. ...gray, sampler refusal. Drill to 41 feet & resample. ...wet at 40 feet.						
42.5	27 33		...trace clay.						
		CL	Brown lean CLAY with sand, moist and very stiff. Muddy Creek Formation Contact.						
45	38 28 20		...with gravel. ...stiff.						
47.5	6 8 10		...firm. ...strong brown. ...stiff.						
50	22 110		Light brown clayey SAND, wet and very dense.						

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

EXPLORATION LOG
CAMU-VS1-AA

PROJECT: PHASE I SUMP PIEZOMETER
EXPLORATION LOCATION:
EXPLORATION SIZE (dia.): 6" O.D. H.S. AUGERS
ELEVATION:

PROJECT NO.: 20092523V1
EXPLORATION DATE: 03/29/2009
EQUIPMENT: DIEDRICH D-50 TRACK RIG
LOGGED BY: WIKTOR/COOKE

INITIAL DEPTH TO WATER: 39.5'
FINAL DEPTH TO WATER: 39.5'

DATE MEASURED: 03/29/2009
DATE MEASURED: 03/29/2009

ELEVATION/ DEPTH	SOIL & SAMPLE SYMBOLS	USCS	DESCRIPTION	PI	LL	MOISTURE CONTENT (%)	DRY DENSITY (pcf)	% SWELL	WELL CONSTRUCTION
			END OF BORING AT 51.0 FEET						
52.5									
55									
57.5									
60									
62.5									
65									
67.5									

The descriptions contained within this exploration log apply only at the specific exploration location and at the time the exploration was made. It is not intended to be representative of subsurface conditions at other locations or times.

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

TABLE 1

Boring B-1(CAMU-VS1-AA)
Soil Type Analyses Summary

Sample Interval	USCS Soil Type	Moisture Content & Dry Density	Sieve analysis	Atterberg Limits	Hydrometer
15' - 16.3'	Silty Gravel (GM)	Yes			
20' - 21'	Well Graded Gravel (GW)	Yes			
25' - 26'	Well Graded Gravel (GW)	Yes	Yes		Yes
27.5' - 28.5'	Well Graded Gravel (GW)	Yes			
30.5' - 31.5'	Poorly Graded Sand (SP)	Yes	Yes		Yes
33' - 34'	Poorly Graded Sand (SP)	Yes			
35.5' - 36.5'	Well Graded Gravel (GW)	Yes	Yes		Yes
37.5' - 38.5'	Well Graded Gravel (GW)	Yes			
40.0' - 41.0'	Well Graded Gravel (GW)	Yes	Yes		Yes
42.5' - 43.5'	Lean Clay (CL)	Yes		Yes	
45.7' - 46.5'	Lean Clay (CL)	Yes	Yes	Yes	Yes
48.0' - 49.0'	Lean Clay (CL)	Yes		Yes	
50.0' - 51.0"	Clayey Sand (SC)	Yes	Yes		Yes

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Las Vegas, NV 89119
(702) 365-1001

Moisture/Density Log - Sample Rings

Project Name: BRC PHASE 1 PIEZOMETER **Project No.:** 20092523V1 **Lab No.:** 09-0008
Date Sampled: 3/29/2009 **Tested By:** AS **Date:** 4/7/2009

Sample	B-1	B-1	B-1	B-1	B-1	B-1	
Depth	37.5'-38.0'	40.0'-40.54'	42.5'-43.0'	45.7'-46.0'	48.0'-48.5'	50.0'-50.5'	
Soil Description: Remarks/Condition:		DISTURBED					
Length	5.00		4.00	3.00	4.00	5.00	
Tube + Wet Soil	890.22		670.30	518.27	654.60	769.72	
Tube	202.83		171.60	122.68	171.70	202.81	
Wet Soil	687.39		498.70	395.59	482.90	566.91	
Volume	0.0131		0.0105	0.0079	0.0105	0.0131	
Wet Density	115.8		105.0	111.0	101.7	95.5	
Tare + Wet Soil	358.62	659.74	836.00	497.69	823.50	769.14	
Tare + Dry Soil	343.50	605.63	568.45	368.50	566.87	464.08	
Water Loss	15.12	54.11	267.55	129.19	256.63	305.06	
Tare Weight	105.58	109.98	108.60	108.40	110.50	109.92	
Wt. Dry Soil	237.92	495.65	459.85	260.10	456.37	354.16	
Moisture Content	6.4	10.9	58.2	49.7	56.2	86.1	
Dry Density	108.9		66.4	74.2	65.1	51.3	

GEOTECHNICAL &
ENVIRONMENTAL
SERVICES, INC.

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Las Vegas, NV 89119
(702) 365-1001

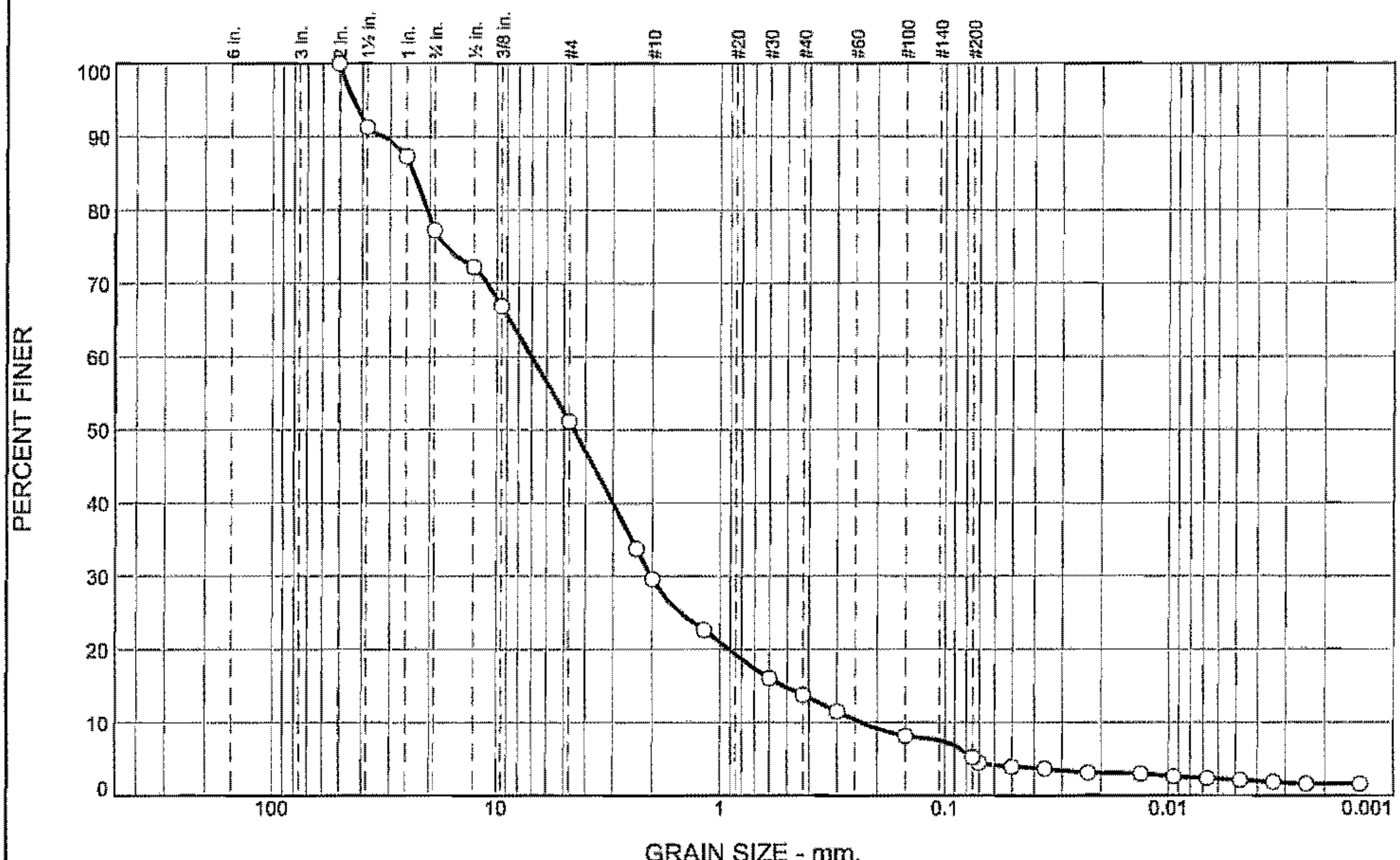
Moisture/Density Log - Sample Rings

Project Name: BRC PHASE 1 PIEZOMETER **Project No.:** 20092523V1 **Lab No.:** 09-0008

Date Sampled: 3/29/2009 **Tested By:** AS **Date:** 4/7/2009

Sample	B-1	B-1	B-1	B-1	B-1	B-1	B-1
Depth	15.3'-15.8'	20.2'-20.7'	25.0-'25.5'	27.5'-28.0'	30.5'-31.0'	33.0'-33.5'	35.5'-36.0'
Soil Description: Remarks/Condition:							
Length	3.00	3.00	6.00	4.00	3.00	4.00	5.00
Tube + Wet Soil	555.20	573.89	1134.67	726.03	598.71	724.80	914.76
Tube	128.70	128.82	248.38	168.33	122.81	172.46	202.86
Wet Soil	426.50	445.07	886.29	557.70	475.90	552.34	711.90
Volume	0.0079	0.0079	0.0157	0.0105	0.0079	0.0105	0.0131
Wet Density	119.7	124.9	124.4	117.4	133.6	116.3	119.9
Tare + Wet Soil	307.17	267.23	523.54	359.98	939.71	360.12	970.03
Tare + Dry Soil	300.10	264.10	507.26	349.60	912.39	349.40	921.05
Water Loss	7.07	3.13	16.28	10.38	27.32	10.72	48.98
Tare Weight	108.31	108.82	108.35	108.05	108.04	110.25	108.38
Wt. Dry Soil	191.79	155.28	398.91	241.55	804.35	239.15	812.67
Moisture Content	3.7	2.0	4.1	4.3	3.4	4.5	6.0
Dry Density	115.5	122.5	119.5	112.6	129.2	111.3	113.1

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	22.7	26.2	21.5	15.8	8.5	3.2	2.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100.0		
1.5	91.3		
1	87.4		
.75	77.3		
.5	72.2		
.375	66.9		
#4	51.1		
#8	33.7		
#10	29.6		
#16	22.7		
#30	16.0		
#40	13.8		
#50	11.5		
#100	8.1		
#200	5.3		
0.0703 mm.	4.4		
0.0505 mm.	3.9		
0.0358 mm.	3.7		
0.0229 mm.	3.1		
0.0133 mm.	3.0		
0.0095 mm.	2.6		
0.0067 mm.	2.3		
0.0048 mm.	2.1		
0.0034 mm.	1.8		
0.0024 mm.	1.6		
0.0014 mm.	1.6		

* (no specification provided)

Soil Description

WELL-GRADED GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 23.5277 D_{60}= 6.9964 D_{50}= 4.5241
D_{30}= 2.0385 D_{15}= 0.5181 D_{10}= 0.2347
C_u= 29.81 C_c= 2.53

Classification

USCS= GW-GM AASHTO=

Remarks

ENTERED BY:AS

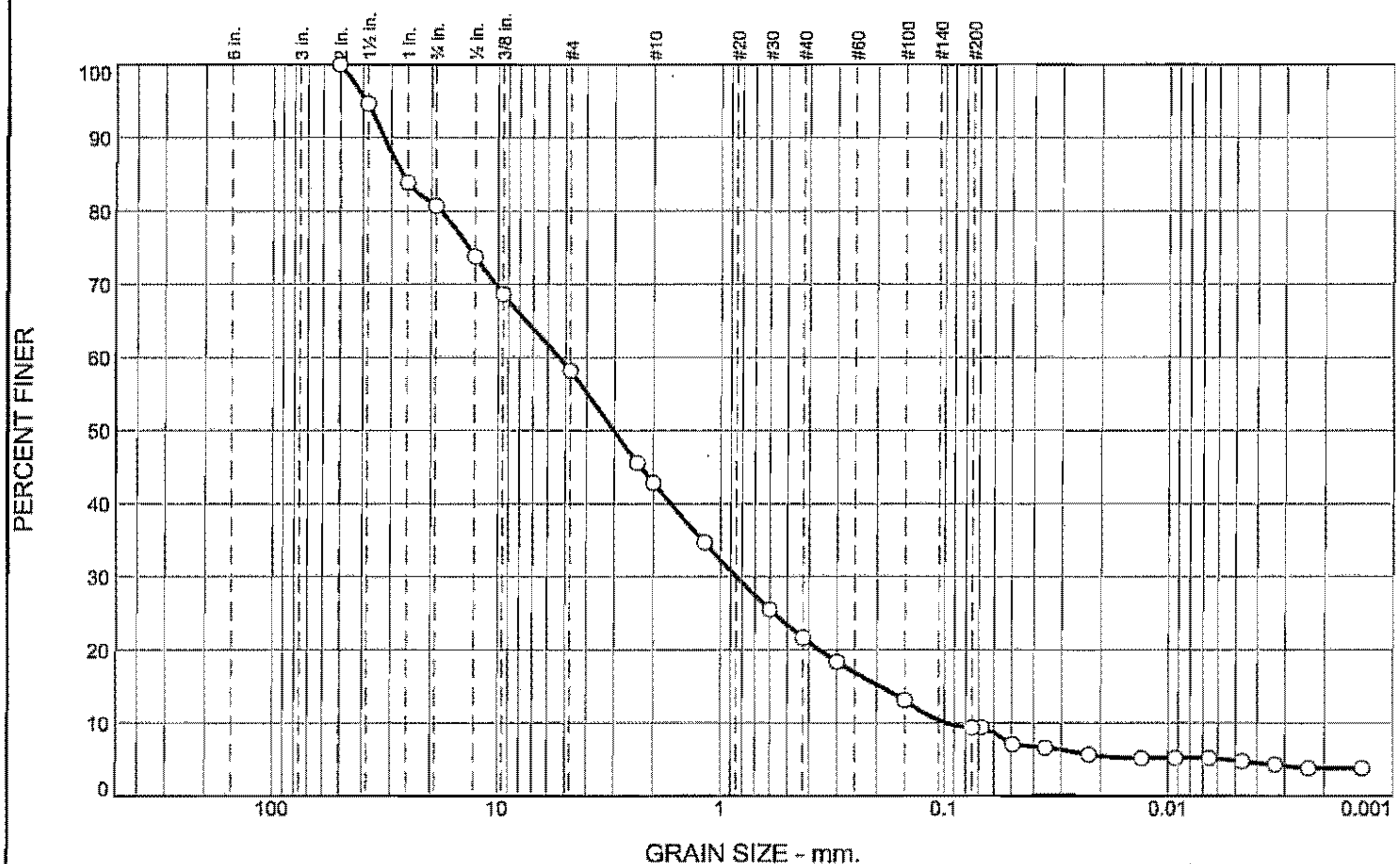
Sample No.: B-1 **Source of Sample:** LAB#09-0008 **Date:** 04/07/09
Location: BORING B-1 @ 25.0'-26.0' **Elev./Depth:** 25.0'-26.0'

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: BRC
Project: BRC PHASE 1 PIEZOMETER
Project No: 20092523V1 **Figure** 1

Tested By: AS **Checked By:** AS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	19.3	22.5	15.3	21.2	12.3	4.6	4.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100.0		
1.5	94.7		
1	83.9		
.75	80.7		
.5	73.8		
.375	68.6		
#4	58.2		
#8	45.6		
#10	42.9		
#16	34.7		
#30	25.5		
#40	21.7		
#50	18.4		
#100	13.1		
#200	9.4		
0.0681 mm.	9.4		
0.0497 mm.	7.1		
0.0353 mm.	6.6		
0.0226 mm.	5.7		
0.0131 mm.	5.2		
0.0093 mm.	5.2		
0.0066 mm.	5.2		
0.0047 mm.	4.7		
0.0033 mm.	4.3		
0.0024 mm.	3.8		
0.0014 mm.	3.8		

* (no specification provided)

Soil Description

WELL-GRADED SAND WITH SILT AMD GRAVEL

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 26.7929 D_{60}= 5.3205 D_{50}= 3.0243
D_{30}= 0.8502 D_{15}= 0.1925 D_{10}= 0.0987
C_u= 53.90 C_c= 1.38

Classification

USCS= SW-SM AASHTO=

Remarks

ENTERED BY:AS

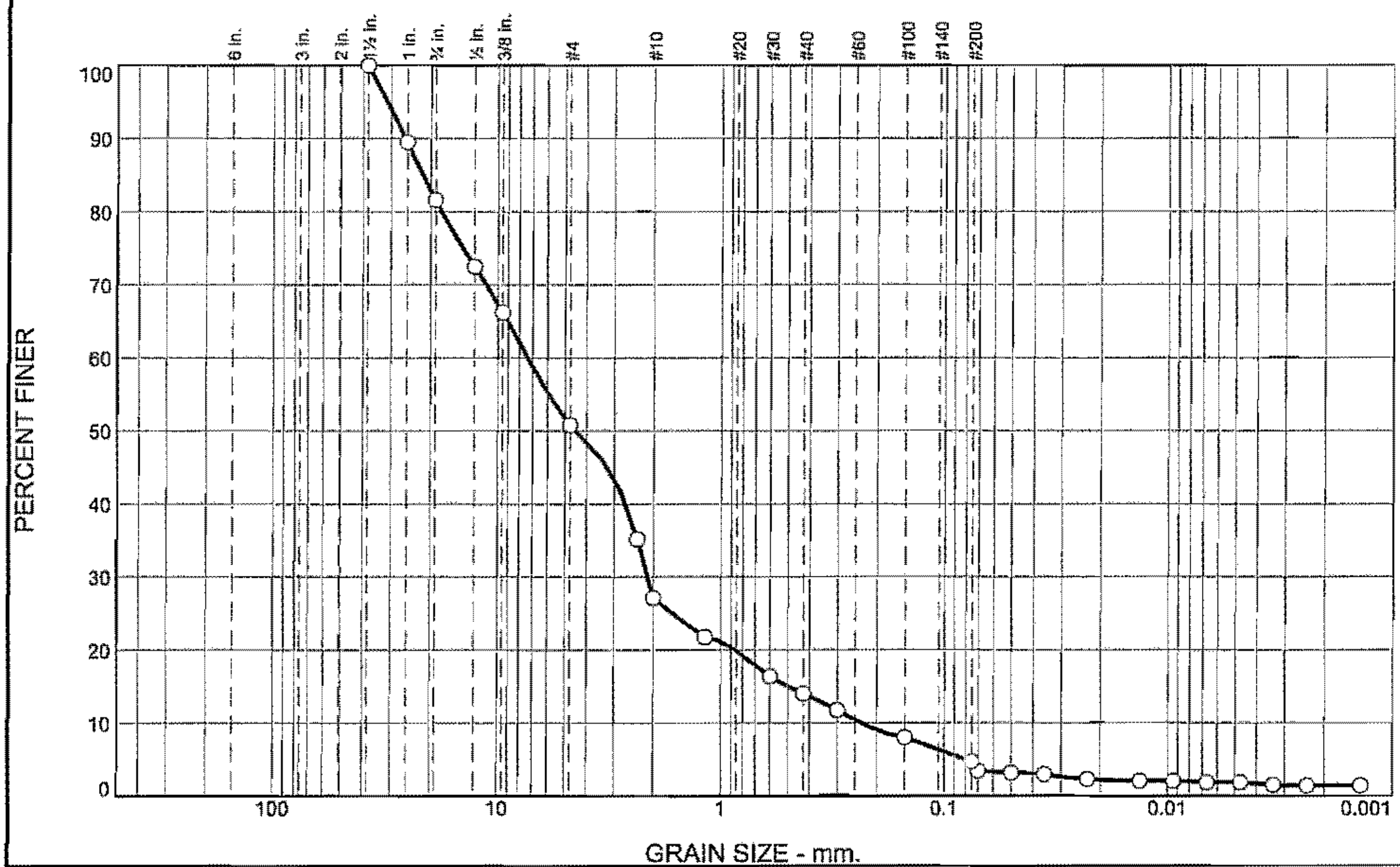
Sample No.: B-1 **Source of Sample:** LAB#09-0008 **Date:** 04/07/09
Location: BORING B-1 @ 30.5'-31.5' **Elev./Depth:** 30.5'-31.5'

GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

Client: BRC
Project: BRC PHASE 1 PIEZOMETER
Project No: 20092523V1 **Figure** 2

Tested By: AS **Checked By:** AS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	18.4	30.8	23.7	13.0	9.4	2.9	1.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5	100.0		
1	89.5		
.75	81.6		
.5	72.5		
.375	66.2		
#4	50.8		
#8	35.2		
#10	27.1		
#16	21.8		
#30	16.4		
#40	14.1		
#50	11.8		
#100	8.0		
#200	4.7		
0.0702 mm.	3.4		
0.0500 mm.	3.2		
0.0355 mm.	3.0		
0.0229 mm.	2.3		
0.0133 mm.	2.1		
0.0094 mm.	2.1		
0.0067 mm.	1.8		
0.0047 mm.	1.8		
0.0034 mm.	1.5		
0.0024 mm.	1.4		
0.0014 mm.	1.4		

* (no specification provided)

Soil Description

WELL-GRADED GRAVEL WITH SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 21.6136 D_{60}= 7.3453 D_{50}= 4.5050
D_{30}= 2.1288 D_{15}= 0.4958 D_{10}= 0.2337
C_u= 31.43 C_c= 2.64

Classification

USCS= GW AASHTO=

Remarks

ENTERED BY:AS

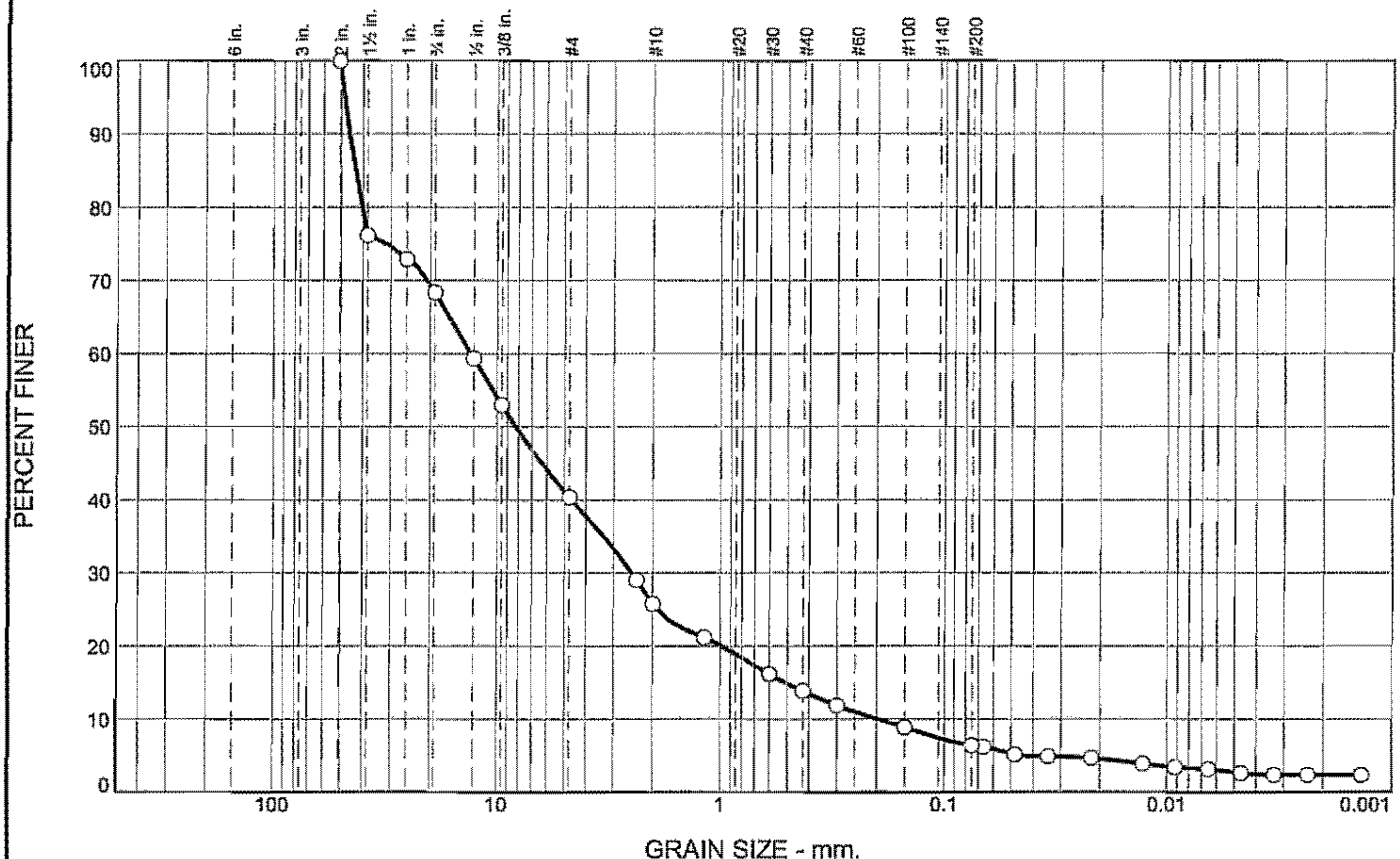
Sample No.: B-1 **Source of Sample:** LAB#09-0008 **Date:** 03/06/09
Location: BORING B-1 @ 35.5'-36.5' **Elev./Depth:** 35.5'-36.5'

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: BRC
Project: BRC PHASE 1 PIEZOMETER
Project No: 20092523V1 **Figure** 3

Tested By: AS **Checked By:** AS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	31.7	27.9	14.6	11.9	7.5	3.7	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100.0		
1.5	76.1		
1	72.9		
.75	68.3		
.5	59.3		
.375	53.0		
#4	40.4		
#8	29.8		
#10	25.8		
#16	21.2		
#30	16.2		
#40	13.9		
#50	11.9		
#100	8.8		
#200	6.4		
0.0663 mm.	6.2		
0.0481 mm.	5.2		
0.0343 mm.	4.9		
0.0218 mm.	4.7		
0.0128 mm.	3.9		
0.0092 mm.	3.4		
0.0065 mm.	3.1		
0.0047 mm.	2.6		
0.0033 mm.	2.4		
0.0023 mm.	2.4		
0.0014 mm.	2.4		

* (no specification provided)

Soil Description

WELL-GRADED GRAVEL WITH SILT AND SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 43.3924 D_{60}= 13.0911 D_{50}= 8.2449
D_{30}= 2.4775 D_{15}= 0.5070 D_{10}= 0.1985
C_u= 65.94 C_c= 2.36

Classification

USCS= GW-GM AASHTO=

Remarks

ENTERED BY:AS

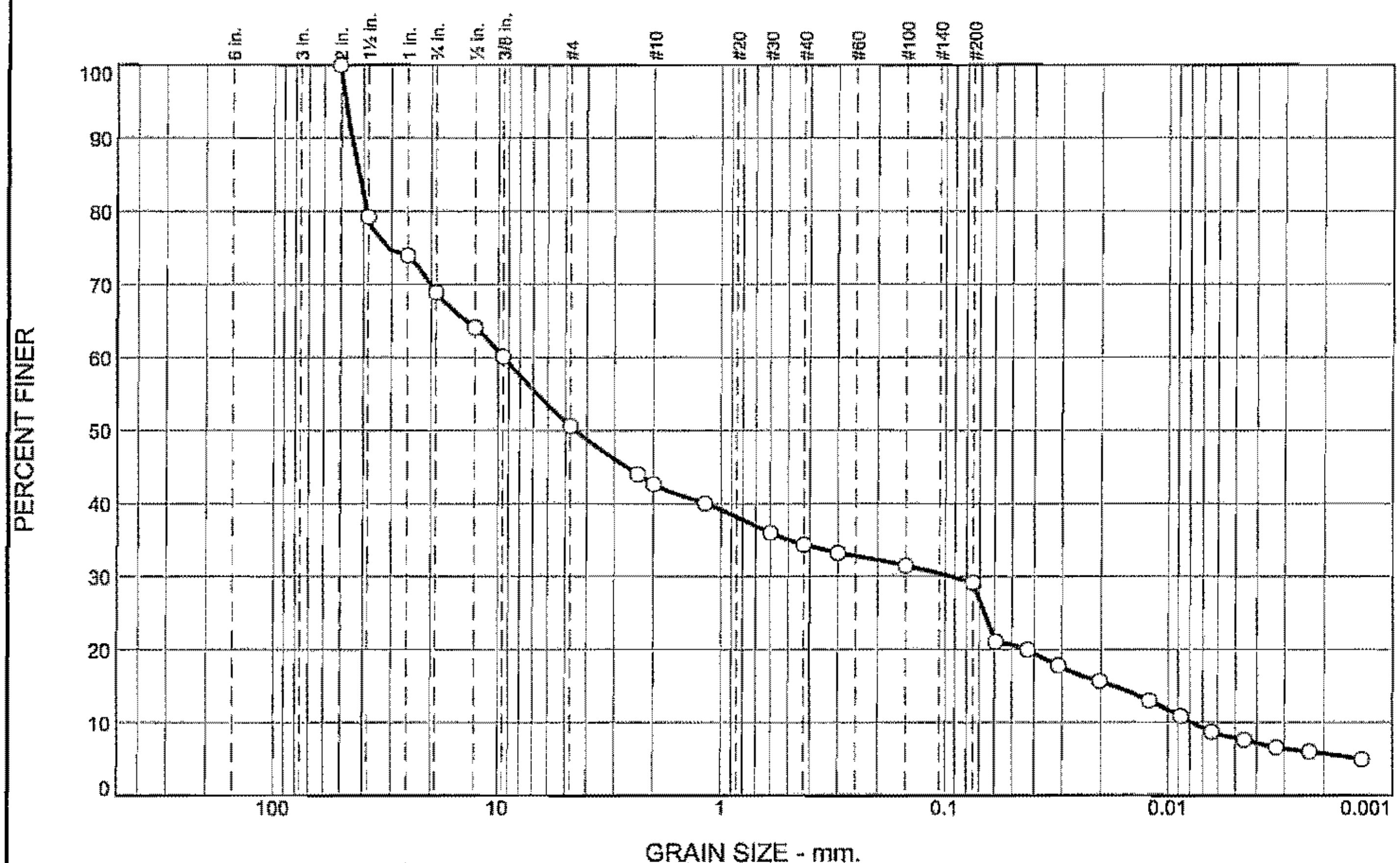
Sample No.: B-1 **Source of Sample:** LAB#09-0008 **Date:** 04/07/09
Location: BORING B-1 @ 40.0'-41.0' **Elev./Depth:** 40.0'-41.0'

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: BRC
Project: BRC PHASE 1 PIEZOMETER
Project No: 20092523V1 **Figure** 4

Tested By: AS **Checked By:** AS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	31.1	18.3	8.0	8.2	5.2	21.3	7.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2	100.0		
1.5	79.2		
1	74.0		
.75	68.9		
.5	64.1		
.375	60.1		
#4	50.6		
#8	44.0		
#10	42.6		
#16	40.0		
#30	36.0		
#40	34.4		
#50	33.2		
#100	31.5		
#200	29.2		
0.0592 mm.	21.1		
0.0426 mm.	20.0		
0.0311 mm.	17.8		
0.0203 mm.	15.7		
0.0121 mm.	13.0		
0.0088 mm.	10.8		
0.0064 mm.	8.7		
0.0046 mm.	7.6		
0.0032 mm.	6.5		
0.0023 mm.	6.0		
0.0014 mm.	4.9		

* (no specification provided)

Soil Description

Clayey gravel with sand

Atterberg Limits

PL= 27 LL= 56 PI= 29

Coefficients

D_{85}= 42.1381 D_{60}= 9.4476 D_{50}= 4.5010
D_{30}= 0.0941 D_{15}= 0.0173 D_{10}= 0.0078
C_u= 1206.15 C_c= 0.12

Classification

USCS= GC AASHTO= A-2-7(3)

Remarks

ENTERED BY:AS

Sample No.: B-1 **Source of Sample:** LAB#09-0008 **Date:** 04/07/09
Location: BORING B-1 @ 45.7'-46.5' **Elev./Depth:** 45.7'-46.5'

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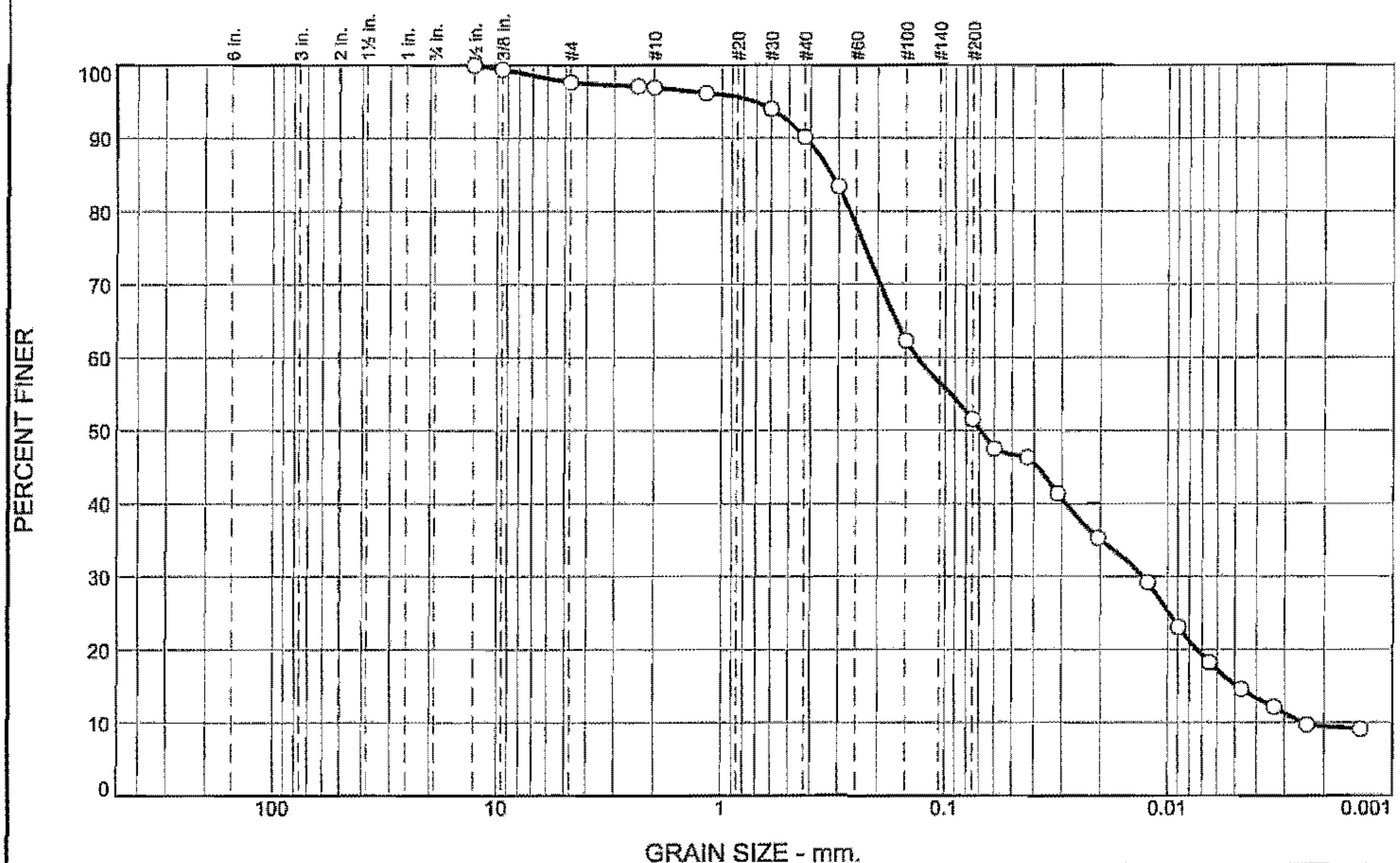
Client: BRC
Project: BRC PHASE 1 PIEZOMETER
Project No: 20092523V1 **Figure** 5

Tested By: AS **Checked By:** AS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.3	0.8	6.7	38.7	36.3	15.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5	100.0		
.375	99.4		
#4	97.7		
#8	97.1		
#10	96.9		
#16	96.2		
#30	94.0		
#40	90.2		
#50	83.5		
#100	62.3		
#200	51.5		
0.0600 mm.	47.5		
0.0428 mm.	46.3		
0.0312 mm.	41.4		
0.0205 mm.	35.3		
0.0123 mm.	29.2		
0.0090 mm.	23.1		
0.0065 mm.	18.2		
0.0047 mm.	14.6		
0.0033 mm.	12.1		
0.0024 mm.	9.7		
0.0014 mm.	9.1		

* (no specification provided)

Soil Description

LEAN CLAY

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.3195 D_{60}= 0.1339 D_{50}= 0.0694
D_{30}= 0.0129 D_{15}= 0.0049 D_{10}= 0.0025
C_u= 53.22 C_c= 0.49

Classification

USCS= CL AASHTO=

Remarks

ENTERED BY:AS

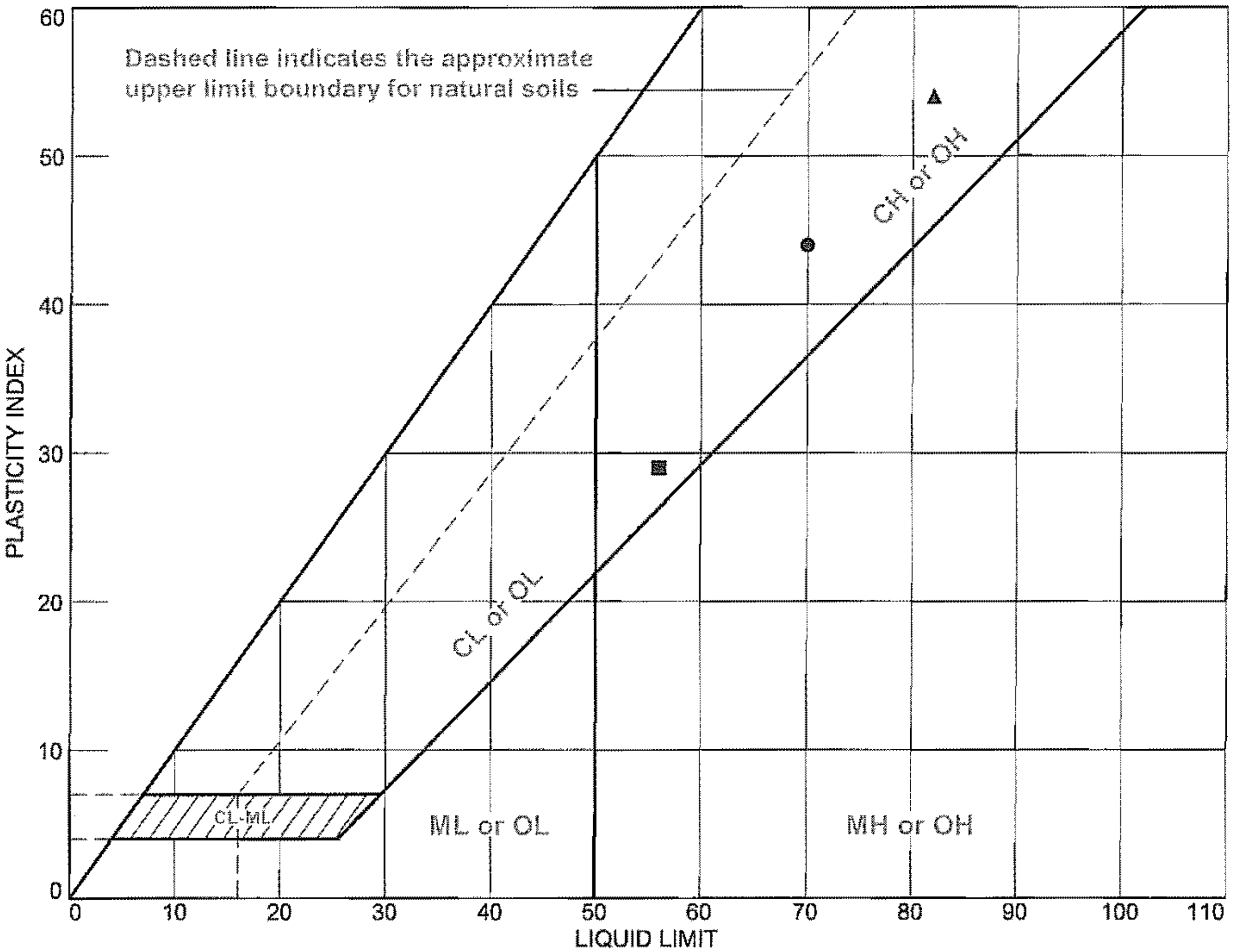
Sample No.: B-1 **Source of Sample:** LAB#09-0008 **Date:** 04/07/09
Location: BORING B-1 @ 50.0'-51.0' **Elev./Depth:** 50.0'-51.0'

GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

Client: BRC
Project: BRC PHASE 1 PIEZOMETER
Project No: 20092523V1 **Figure** 6

Tested By: AS **Checked By:** AS

LIQUID AND PLASTIC LIMITS TEST REPORT



SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	LAB#09-0008	B-1	42.5'-43.0'		26	70	44	CH
■	LAB#09-0008	B-1	45.7'-46.5'		27	56	29	GC
▲	LAB#09-0008	B-1	48.0'-48.5'		28	82	54	CH

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Client: BRC
Project: BRC PHASE I PIEZOMETER

Project No.: 20092523V1 **Figure** 7

Tested By: AS **Checked By:** AS

Attachment 5

Geosyntec
consultants

COMPUTATION COVER SHEET

Client: **BRC**	Project: **BRC CAMU**	Project/ Proposal No.:	**SC0313**
		Task No.	**10-01**

Title of Computations **LEAK EVALUATION FOR A COMPOSITE LINER SYSTEM**

Computations by:	Signature		Date 4/06/09
	Printed Name	Rebecca Flynn	
	Title	Senior Staff Engineer	
Assumptions and Procedures Checked by: (peer reviewer)	Signature		Date 4/06/09
	Printed Name	Meghan Lithgow	
	Title	Senior Staff Engineer	
Computations Checked by:	Signature		Date 4/06/09
	Printed Name	Meghan Lithgow	
	Title	Senior Staff Engineer	
Computations backchecked by: (originator)	Signature		Date 4/14/09
	Printed Name	Rebecca Flynn	
	Title	Senior Staff Engineer	
Approved by: (pm or designate)	Signature		Date 4/15/09
	Printed Name	Gregory T. Corcoran, PE	
	Title	Principal Engineer	

Approval notes:

Revisions (number and initial all revisions)

No.	Sheet	Date	By	Checked by	Approval

Written by:	**R. Flynn**	Date:	**04/06/09**	Reviewed by:	**G. Corcoran**	Date:	**4/15/09**
Client:	**BRC**	Project:	**BRC CAMU**	Project/ Proposal No.:	**SC0313**	Task No.:	**10/1**

LEAK EVALUATION FOR A COMPOSITE LINER SYSTEM

BACKGROUND AND PURPOSE

Phase I of the Basic Remediation Company (BRC) Corrective Action Management Unit (CAMU) is constructed with a leachate collection and removal system (LCRS) sump overlying a vadose zone sump. Two significant rain storms occurred at the site and after approximately 217 days following the first rain event and 51 days following the second rain event, leachate was discovered in the LCRS sump. In addition, liquid was discovered in the vadose zone sump.

This calculation package evaluates the area of flow through a geosynthetic clay liner (GCL) which would produce the volume of liquid discovered in the vadose zone sump assuming a defect in the LCRS sump geomembrane. Following determination of the size of defect necessary to generate the quantity of liquid discovered within the vadose zone sump, a leakage rate calculation is performed to determine the potential quantity of liquid that may have passed through a defect in the LCRS geomembrane and GCL based on an EPA accepted hole size in the LCRS geomembrane.

PROCEDURE

The composite liner system in the LCRS sump is composed of (from bottom to top) a GCL, 60-mil HDPE geomembrane, and a geocomposite. Because the geocomposite does not inhibit vertical flow through the liner system, it is ignored in this evaluation. In order for leachate found in the vadose zone monitoring sump to have originated from the LCRS sump, a defect in the geomembrane permitting flow through the GCL would be required.

Flow through the GCL is driven by the hydraulic conductivity of the GCL at the boundary conditions present at the time of flow through the GCL. Additionally, the leachate can flow between the GCL and geomembrane, creating a larger wetted surface than the initial geomembrane defect. Using the transmissivity of the GCL-geomembrane interface, the distance of leachate travel can be calculated. The calculated distance can then be used to evaluate the size of the geomembrane defect.

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According to the EPA, common practice is to assume a 2 mm diameter defect in the geomembrane; therefore, this calculation will also evaluate the flow through a 0.002 m defect (Attachment A). Typically, the flow through the defect is reviewed with no more than 1 foot of head on the primary liner system; however, in this evaluation, 3.45 feet of head will be used as this is the maximum head calculated for the Phase I LCRS sump.

ASSUMPTIONS AND APPROACH

The approach to this calculation is conservative because it utilizes the following assumptions:

1. February 2009 rain event water flowed nearly instantaneously to the sump and immediately created head on the LCRS sump liner system.
2. CASE I - Maximum head on the LCRS sump liner system (3.45 feet, Attachment B), as calculated based on assumed maximum rain volumes and areas allowing rain water into LCRS, was present for the entire 51 day duration considered in this analysis (Case I). This is conservative as pumping from the LCRS sump continuously reduced the head over time and this maximum head value was likely not achieved or was a very short duration event.
3. CASE II - Maximum head on the LCRS sump liner system (3.00 feet) was present for the entire 217 day duration considered in this analysis (Case II) from the completion of the Phase I liner system to the removal of the vadose sump liquids. This is conservative as pumping from the LCRS sump continuously reduced the head over time and this maximum head value was likely not achieved or was a very short duration event.
4. The GCL hydraulic conductivity was tested on Phase I GCL at 5 psi normal stress (Attachment C), which is less than the estimated >20 psi (>30 feet of waste thickness) normal stress over the Phase I sump at the time of the second rain event. Additional normal stress would result in a lower hydraulic conductivity. Normal stress that was present at the time of the first rain event would have been approximately 3 psi (2 feet of drainage aggregate and 3 feet of standing water). As the lower normal stress condition was evident for a short time period prior to the placement of the 2 foot thick operations layer that would

increase the normal stress to approximately 5 psi, the 5 psi derived GCL hydraulic conductivity is considered to be conservative.

5. Vadose sump pumped volumes, which were measured by timing a pump and filling a 5 gallon bucket, are likely not very accurate. However, pumped volume of 244 gallons plus an estimated 60 gallons (0.70 feet [ft] reported remaining in sump) remaining in the bottom of the sump upon completion of pumping will be used (Attachment D).

Following an evaluation of the required GCL wetted area, the transmissivity at the geotextile-geomembrane interface will be used to estimate the radius of the wetted front of the GCL. Using the estimated wetted surface area of GCL, the geomembrane defect size required to generate that wetted surface area will be calculated.

INPUT PARAMETERS AND ANALYSIS

Calculation of GCL Wetted Area

Test results on GCL for the Phase I liner system were used as the GCL parameters (Attachment C). The flow through the GCL was evaluated using Darcy's Law as follows:

q = kiA

where:

$$q_I = \frac{v}{T_I} = \frac{1.15m^3}{4{,}406{,}400s} = 2.61\text{E-07 cubic meters per second } (m^3/s)$$

$$i_I = \frac{(H_I + t_{GCL})}{t_{GCL}} = \frac{(1.052m + 0.0055m)}{0.0055m} = 192$$

$$q_{II} = \frac{v}{T_{II}} = \frac{1.15m^3}{18{,}748{,}800} = 6.13\text{E-08 cubic meters per second } (m^3/s)$$

$$i_{II} = \frac{(H_{II} + t_{GCL})}{t_{GCL}} = \frac{(0.9144m + 0.0055m)}{0.0055m} = 167$$

Where:

v = 304 gallons (1.15 cubic meters [m^3]) (Attachment D)

$t_I = 51 days \times \frac{24 hrs}{1 day} \times \frac{60 \min}{1 hr} \times \frac{60 s}{1 \min}$ = 4,406,400s

[7 February 2009 – 30 March 2009]

$t_{II} = 217 days \times \frac{24 hrs}{1 day} \times \frac{60 \min}{1 hr} \times \frac{60 s}{1 \min}$ = 18,748,800s

[25 August 2008 – 30 March 2009]

H_I = 3.45 ft (1.052 meters [m]) (Attachment B)

H_{II} = 3.00 ft (0.9144 m)

t_{GCL} = 0.0055 m (Attachment E)

Note: Interim waste elevation 36 ft above bottom of LCRS sump with approximate unit weight of waste of 110 pcf equates to approximately 190 kPa of pressure on the LCRS GCL. This is conservative for Case II as waste was not at interim elevation; however, Attachment E demonstrates the lower the overlying pressure, the greater hydrated GCL thickness.

$$A_I = \frac{q}{ik} = \frac{2.61E-07 \frac{m^3}{s}}{(192 \frac{m}{m})(3.2E-11 \frac{m}{s})} = \mathbf{42.5\ m^2}$$

$$A_{II} = \frac{q}{ik} = \frac{6.13E-08 \frac{m^3}{s}}{(167 \frac{m}{m})(3.2E-11 \frac{m}{s})} = \mathbf{11.5\ m^2}$$

Where:

A = area over which flow is occurring, square meters (m^2), *to be determined*

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k = 3.2E-11 m/s (Attachment C)

Assuming the liquid flows outward from the geomembrane defect in a radial manner, the distance away from the geomembrane defect wetted by the leachate is determined using the following formula:

$A = \pi r^2$

$r = \sqrt{\frac{A}{\pi}}$

$r_I = \sqrt{\frac{42.5m^2}{\pi}} = 3.69$ m

$r_{II} = \sqrt{\frac{11.5m^2}{\pi}} = 1.91$ m

Calculation of Leachate Travel within GCL Geotextile

The interface between the upper nonwoven geotextile portion of the GCL and geomembrane was tested for transmissivity (Harpur, et. al., 1993, Attachment F). Harpur notes the rapid decrease in transmissivity, T, as the bentonite in the GCL is hydrated. Therefore, in this evaluation, two transmissivities are used:

$0 < t \leq 10$ hours (hrs):

T = 1E-10 m^2/s

t > 10 hrs:

T= 1E-11 m^2/s.

Note: These transmissivities were evaluated at a normal stress of 10 psi with a head of 330 millimeters (mm) and 320 mm over a period of 2 weeks.

The distance traveled per unit width, W, in 40 days by transmissivity is calculated as follows:

For $t \leq 10$ hr

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$$D_{10} = \frac{(T)(t)}{W} = \frac{(1E-10\frac{m^2}{s})(36{,}000s)}{1m} = 3.6\text{E-06 m}$$

where:

D_{10} = Distance of travel in 10 hours

$$t = 10hr \times \frac{60\min}{1hr} \times \frac{60s}{1\min} = 36{,}000 \text{ s}$$

W = 1 m

For t > 10 hr

$$D_{T\text{-}I} = \frac{D_{10} + (T \times (t_I - 36{,}000))}{W} = \frac{(3.6E-06m) + (1E-11\frac{m^2}{s} \times (4{,}406{,}400s - 36{,}000s)}{1m}$$

$D_{T\text{-}I}$ = 4.7E-05 m

$D_{T\text{-}I}$

$$= \frac{D_{10} + (T \times (t_{II} - 36{,}000))}{W} = \frac{(3.6E-06m) + (1E-11\frac{m^2}{s} \times (18{,}748{,}800s - 36{,}000s)}{1m}$$

$D_{T\text{-}II}$ = 1.9E-04 m

Where:

$D_{T\text{-}I}$ = Total distance traveled in 51 days

$D_{T\text{-}II}$ = Total distance traveled in 217 days

T = 1E-11 m^2/s

$$t_I = 51days \times \frac{24hrs}{1day} \times \frac{60\min}{1hr} \times \frac{60s}{1\min} = 4{,}406{,}400 \text{ s}$$

$$t_{II} = 217days \times \frac{24hrs}{1day} \times \frac{60\min}{1hr} \times \frac{60s}{1\min} = 18{,}748{,}800 \text{ s}$$

W = 1 m

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Calculation of Geomembrane Defect Size

The transmissivity and geomembrane defect together must be large enough to create the wetted front of the GCL calculated earlier. Therefore, the size of the geomembrane defect is evaluated as follows:

<u>Case I</u>

Area of wetted GCL, $A_{GCL\text{-}I} = 42.5\ m^2$, $r_{GCL} = 3.68$ m

Distance traveled along interface, $D_{T\text{-}I} = 4.7E\text{-}05$ m

Area of Geomembrane Defect, $\mathbf{A_{Geo\text{-}I} = \pi r^2 = \pi (3.68 - 0.000047)^2 = 42.5\ m^2}$

<u>Case II</u>

Area of wetted GCL, $A_{GCL\text{-}II} = 11.5\ m^2$, $r_{GCL} = 1.91$ m

Distance traveled along interface, $D_{T\text{-}II} = 1.9E\text{-}04$ m

Area of Geomembrane Defect, $\mathbf{A_{Geo\text{-}II} = \pi r^2 = \pi (1.91 - 0.00019)^2 = 11.5\ m^2}$

Liquid flow through defect in LCRS sump geomembrane

Assuming the defect diameter is 2 mm based on US EPA guidance, the evaluation above will be repeated in reverse to estimate the flow through the GCL.

Area of wetted GCL

<u>Case I</u>

Area of Geomembrane Defect, $A_{Geo\text{-}I} = \pi r^2 = \pi (0.001\ m)^2 = 3.14E\text{-}06\ m^2$

Distance traveled along interface, $D_{T\text{-}I} = 4.7E\text{-}05$ m, from above

Area of wetted GCL, $\mathbf{A_{GCL\text{-}I} = \pi (0.001 + 4.7E\text{-}05)^2 = 3.44E\text{-}06\ m^2}$

<u>Case II</u>

Area of Geomembrane Defect, $A_{Geo\text{-}II} = \pi r^2 = \pi (0.001\ m)^2 = 3.14E\text{-}06\ m^2$

Distance traveled along interface, $D_{T\text{-}II} = 1.9E\text{-}04$ m, from above

Area of wetted GCL, $\mathbf{A_{GCL\text{-}II} = \pi (0.001 + 1.9E\text{-}04)^2 = 4.45E\text{-}06 m^2}$

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Flow through GCL

$q = kiA$

Case I

$q_I = ki_IA_I = (3.2E\text{-}11 \text{ m/s}) \times (192 \text{ m/m}) \times (3.44E\text{-}06 \text{ m}^2)$ $= 2.11E\text{-}14 \text{ m}^3\text{/s}$
$= 1.83E\text{-}09 \text{ m}^3\text{/day}$
$= 4.76E\text{-}07 \text{ gal/day}$

$V_I = q_I$ x 51 days = 4.76E-07 gal/day x 51 days = **2.43E-05 gal << 304 gal**

Case II

$q_{II} = ki_{II}A_{II} = (3.2E\text{-}11 \text{ m/s}) \times (167 \text{ m/m}) \times (4.45E\text{-}06 \text{ m}^2)$ $= 2.38E\text{-}14 \text{ m}^3\text{/s}$
$= 2.06E\text{-}09 \text{ m}^3\text{/day}$
$= 5.44E\text{-}07 \text{ gal/day}$

$V_{II} = q_{II}$ x 217 days = 5.44E-07 gal/day x 217 days = **1.18E-04 gal << 304 gal**

where:

V_I = Leachate volume accumulated in 51 days

V_{II} = Leachate volume accumulated in 217 days

i_I = 192 m/m, from above

i_{II} = 167 m/m, from above

k = 3.2E-11 m/s, permeability of GCL (Attachment C)

RESULTS

Given the permeability through the GCL, 304 gallons of leachate collecting in the vadose zone sump would occur over an area of approximately 42.5 m^2 in 51 days and an area of approximately 11.5 m^2 in 217 days.

Using the transmissivity of the GCL-geomembrane interface, a travel distance of 4.7E-05 m and 1.9E-04 m would occur along the GCL in 51 and 217 days, respectively; therefore, in order to create enough of wetted GCL area, the initial geomembrane defect is calculated as 42.5 m^2 and 11.5 m^3 for 51 and 217 days, respectively.

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Field observations by construction quality assurance (CQA) personnel did not indicate defects in the GCL or geomembrane which were not repaired or defects over an area of 11.5 m^2 or larger. As a result, this calculation indicates the majority of the water in the Phase I vadose zone sump is not likely caused by a defect in the geomembrane.

Alternatively, using the EPA recommended, commonly used defect diameter of 2 mm, the volume of leachate estimated from this method is significantly less than the approximately 304 gal pumped from the vadose zone sump. Therefore, it is unlikely the source of the liquid in the vadose sump is a defect resulting from installation, manufacturing, or other damage.

REFERENCES

Harpur, W.A., Wilson-Fahmy, R.F., and Koerner, R.M., 1993, "Evaluation of the Contact between Geosynthetic Clay Liners and Geomembranes in Terms of Transmissivity," *Proceedings of the 7th GRI Seminar*, December.

Petrov, Robert, Rowe, Kerry, and Quigley, Robert, 1997, "Selected Factors Influencing GCL Hydraulic Conductivity," *Journal of Geotechnical and Geoenvironmental Engineering*, August.

ATTACHMENTS

Attachment A – EPA Recommended Geomembrane Defect

Attachment B – Sump Hydrology Evaluation

Attachment C – GCL Test Data

Attachment D – Sump Pumping Data

Attachment E – Confining Stress Verse Final GCL Height

Attachment F – Evaluation of the Contact between Geosynthetic Clay Liners and Geomembranes in Terms of Transmissivity liners are unlikely to exhibit LDCRS flows that exceed 100 gpad (1,000 lphd).

Surface Impoundments with Composite Top Liners

There is insufficient data to present observations on the performance of this category of facilities. However, it is anticipated that the performance of these facilities would be the same as the performance of landfills with composite top liners.

2.4. Theoretical Analysis of Top Liner Performance

A theoretical analysis of top liner performance was also performed. This analysis further supports the conclusion from the above data that 20 gpad is not a practical action leakage rate.

Available Information

In recent years, various investigators have developed analytical techniques for estimating leakage rates through liners. These investigations include: Bonaparte et al. [1989]; Brown et al. [1987]; EPA [1987]; Giroud and Bonaparte [1989a,b]; Giroud et al. [1991]; and Jayawickrama et al. [1987]. The reference presented by Bonaparte et al. [1989] presents equations to estimate leakage rates through both geomembrane liners and composite liners; these equations are used in the analysis below to estimate leakage rates through top liners.

To estimate the anticipated leakage rate through a top liner at a waste management unit, a frequency of defect and size of defect in the geomembrane component of the top liner must be assumed. Available information on the frequency and size of defects in properly-installed geomembrane liners had been reported by EPA [1987], Giroud and Bonaparte [1989a], Giroud and Fluent [1987], and Laine [1991]. This information is also used below to estimate leakage rates through top liners.

Results of Analysis

Frequency and Size of Geomembrane Defects. Giroud and Bonaparte [1989a] presented limited case study data, including CQA records, records of foresnic investigations, and LDCRS flow rate data, from which they drew "tentative" conclusions regarding the frequency and size of defects in geomembrane liners installed using rigorous CQA procedures. From their data, they recommended that for the purpose of estimating leakage rates through geomembranes, a geomembrane defect (hole) frequency of one to two per acre (two to five per hectare) be considered along with a defect size of 0.005 in^2 (3.2 mm^2). Recently Laine [1991] presented data from two leak location surveys in which geomembrane seam defects were identified at a frequency of two to five per acre (five to twelve per hectare). Thus, the frequency of defects found by Laine is twice as high as the frequency recommended by Giroud and Bonaparte for estimating leakage rates. However, the size of the defect found by Laine was typically very

US EPA, 1992 "Action Leakage Rates for Leak Detection Systems," January.

Attachment A (1/2)

small, i.e., pinhole sized with areas on the order of 0.001 in^2 (0.6 mm^2) or less. The defect size is about five times smaller than the defect size recommended by Giroud and Bonaparte for estimating leakage rates. Since the calculated leakage rate for a given installed area of geomembrane is proportional to the product of the size of the defect and the frequency of defects, the findings of both of the above-described investigations lead to comparable top liner leakage rates when used.

For the analysis of top liner leakage rates presented below, a defect frequency of one per acre (two per hectare) and a defect size of 0.005 in^2 (3.2 mm^2) is assumed.

Analysis Results. The results of calculations using the equations from Bonaparte et al. [1989] for steady-state leakage through geomembrane holes are presented below. For the calculations, it was assumed that the top liner consists of a geomembrane alone, and the hydraulic conductivity of the material overlying the geomembrane is 1×10^{-2} cm/s (1×10^{-4} m/s) which is appropriate for a landfill with a granular leachate collection and removal system (LCRS). The calculated top liner leakage rates, given the above-described conditions, are presented in Table 3.

Table 3. Calculated leakage rates through a geomembrane top liner.

Liquid head on top liner (ft)	Steady-State leakage rate (gpad)
0.1	10
1.0	60
10.0	220

Calculated top liner leakage rates would be much lower than those given in Table 3 if the top liner was a composite liner rather than a geomembrane alone. Conversely, the calculated top liner leakage rate would be somewhat higher if the material above the top liner had a higher permeability, or if the liner was exposed (as might be the case for a surface impoundment).

The calculation results presented above must be interpreted separately with respect to landfills and surface impoundments. For landfills, the design maximum liquid head in the LCRS is 1 ft (0.3 m). However, the average liquid head under normal operating conditions should be only on the order of 0.1 ft (0.03 m); in many instances, the average head may be only on the order of 0.1 ft (0.03 m), or even less. In this case the calculated results support a conclusion that under normal operating conditions (i.e., when there is an average hydraulic head in the LCRS of 0.1 ft (0.03 m), or less), the leakage rate through a properly designed geomembrane top liner, constructed using proper procedures and rigorous CQA, will frequently be less than 20 gpad

Attachment A (2/2)

Sump Hydrology Evaluation

BRC – CAMU (SC0313)

Purpose: Evaluation of Hydrologic Volumes - 2/7/09 to 2/9/09

Rainfall Data from 2/9/09 to 2/13/09

Date	Rainfall (in.)	Accumulated Rainfall (in.)
2/6/09	0.00	0.00
2/7/09	0.60	0.60
2/8/09	0.04	0.64
2/9/09	0.08	0.72
2/10/09	0.00	0.72

Notes: 1. Rainfall data obtained from Clark County Regional Flood Control District at Pioneer Detention Basin (Gauge No. 4769).

Area of Watersheds for Phases I, II, and IIIA

Sump	Sump I @ Phase I		Sump II @ Phase II	
Watershed	Phase II-I	Phase IIIA-I	Phase II	Phase IIIA-II
Area (acres)	0.3	0.3	1.0	4.4
Estimated Total	0.6 acres		5.4 acres	

Notes: 1. Phase I, II and IIIA areas presented are based on exposed liner system (no operations layer), as obtained from as-built drawing dated 1/31/09. Contribution to Phase I or II sump determined based on as-built drawing base grade contours.

2. Phase I contained over 35 feet of waste, as obtained from as-built drawing dated 1/31/09.
3. Phase II contained over 10 feet of waste, as obtained from as-built drawing dated 1/31/09.
4. Based on contractor pumping, evaporation, previous waste hydraulic conductivity testing and waste thicknesses at time of rain events; rainfall on waste areas neglected in calculations.

Rainfall Total Estimated Quantities

Date	Rainfall (in.)	Phase I + Phase IIIA-I		Phase II + Phase IIIA-II	
		Rainfall quantities (gallons)	Accumulated Rainfall quantities (gallons)	Rainfall quantities (gallons)	Accumulated Rainfall quantities (gallons)
2/6/09	0.00	0	0	0	0
2/7/09	0.60	9,775	9,775	87,974	87,974
2/8/09	0.04	652	10,427	5,865	93,839
2/9/09	0.08	1,303	11,730	11,730	105,569
2/10/09	0.00	0	11,730	0	105,569

Note: 1. Accumulated rainfall does not account for evaporation.

Reported Pumping Volumes

Date	Phase I (gallon)	Phase II (gallon)
2/18/09	0	2,000
2/19/09	0	11,000
2/20/09	0	17,000
2/23/09	0	8,000
2/24/09	0	8,000
2/26/09	0	6,000
3/5/09	4,000	2,000
3/6/09	0	10,000
3/7/09	0	6,000
3/10/09	4,000	0
3/19/09	0	0
Total	8,000	70,000

Note: 1. Pumping volumes reported by Entact, estimated based on recording time to fill 5-gallon bucket and time duration of pumping.
2. Removal of water from sumps governed by transmissivity of geocomposite and hydraulic conductivity of operations layer soil.

Attachment B (2/4)

Water Height Analysis – Sump I

Elevation (ft)	Accumulated water volume (gallons)	Fill	Approximate rainfall quantity (gallon)
Sump I (1720.65 to 1722.76)	1,237	Gravel for sump	
1723	2,427	Waste	
1724	10,286	Waste	11,730
1725	34,630	Waste	
Approximate maximum water elevation estimated at 1724.1 ft., which equates to approximately **3.45 ft. of head in LCRS sump**			

Notes: 1. Volumes calculated based on assumed porosity of 0.4 for sump gravel and 0.35 for waste (based on previous waste testing). Geocomposite, pipe, and pipe gravel backfill are not accounted for in this analysis.
2. Water collected on Phase II side slopes and small area of Phase IIIA base liner system surface water migrates down 2.1H:1V slope to toe of slope into LCRS piping, which conveys water to sump in less than one day.
3. Phase IIIA geomembrane complete during rain event. Geocomposite installation not started until after rain event.
4. Does not account for evaporation, adsorption, and rainfall variability.

Water Height Analysis – Sump II

Elevation (ft)	Accumulated water volume (gallons)	Fill	Approximate rainfall quantity (gallon)
Sump II (1734 to 1736)	1,173	Gravel for sump	
1737	18,367	Waste	
1738	94,107	Waste	105,569
1739	280,048	Waste	
Approximate maximum water elevation estimated at 1738.1 ft., which equates to approximately **4.1 ft. of head in LCRS sump**			

Notes: 1. Volumes calculated based on assumed porosity of 0.4 for sump gravel and 0.35 for waste (based on previous waste testing). Geocomposite, pipe, and pipe gravel backfill are not accounted for in this analysis.
2. Water collected on Phase II side slopes and majority of Phase IIIA base liner system surface water migrates down 2.1H:1V slope to toe of slope into LCRS piping, which conveys water to sump in less than one day.
3. Phase IIIA geomembrane complete during rain event. Geocomposite installation not started until after rain event.
4. Does not account for evaporation, adsorption, and rainfall variability.

Attachment B (3/4)

Summary

Summary	Phase I Sump	Phase II Sump
	gallons	gallons
Rainfall total quantity by 2/10/09	11,730	105,569
Pumping total by 3/19/09	8,000	70,000
Total	3,730	35,569

Attachment B (4/4)

GCL TEST RESULTS

TRI Client: Geosyntec Consultants
Project: BRC CAMU

Material: Bentomat DN GCL
Sample Identification: 6533
TRI Log #: E2308-40-06

PARAMETER	TEST REPLICATE NUMBER 1	2	3	4	5	6	7	8	9	10	MEAN	STD. DEV.	PROJ. SPEC.
Bentonite - Mass/Unit Area (ASTM D 5993, result @ 0% M.C.)													
Bentonite mass/unit area (lbs/ft^2)	0.89	0.97	0.93	0.87	0.89						0.91	0.04	0.75 min
Moisture Content (%)	22.4	21.4	23.7	23.6	24.8						23.2	1.3	25 max
Index Flux (ASTM D 5887)													
Index Flux ($m^3/m^2/sec$)	3.4E-09										3.4E-09		1.0E-8 max
Hydraulic Conductivity (cm/sec)	3.2E-09										3.2E-09		

GeosyntheticTesting.com
9063 Bee Caves Road / Austin, TX 78733 / 512 263 2101 / fax: 512 263 2558

Attachment C (1/1)

Sumps Pumping Volumes
BRC CAMU
Henderson, Nevada

Date Pumped	Approximate Volume Pumped (gallons)										Rainfall Quantity*	
	Phase I		Phase II		Phase IIIB		Phase V		Total		Timet[1]	Pioneer[2]
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	Inches	Inches
25-Aug-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.24	0.44
31-Aug-08	PQU	NLD	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
2-Sep-08	NLD	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
8-Sep-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.04
9-Nov-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.04
25-Nov-08	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
26-Nov-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.40
27-Nov-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.08
1-Dec-08	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
15-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.12
17-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.20
18-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.76
22-Dec-08	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
23-Dec-08	NLD	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
24-Dec-08	NLD	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	-	0.0
25-Dec-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.12
23-Jan-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.04
24-Jan-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	-	0.08
7-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.39	0.60
8-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.04	0.04
9-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.12	0.08
11-Feb-09	PQU	N/A	PQU	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
13-Feb-09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.04
15-Feb-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.0
16-Feb-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0	0	0.0	0.04
18-Feb-09	NLD	N/A	2,000	N/A	N/A	N/A	N/A	N/A	2,000	0	0.0	0.0

Attachment D (1/3)

Sumps Pumping Volumes
BRC CAMU
Henderson, Nevada

Date Pumped	Approximate Volume Pumped (gallons)										Rainfall Quantity*	
	Phase I		Phase II		Phase IIIB		Phase V		Total		Timet[1]	Pioneer[2]
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	Inches	Inches
19-Feb-09	NLD	N/A	11,000	N/A	N/A	N/A	N/A	N/A	11,000	0	0.0	0.0
20-Feb-09	NLD	N/A	17,000	N/A	N/A	N/A	N/A	N/A	17,000	0	0.0	0.0
23-Feb-09	NLD	N/A	8,000	N/A	N/A	N/A	N/A	N/A	8,000	0	0.0	0.0
24-Feb-09	NLD	N/A	8,000	N/A	N/A	N/A	N/A	N/A	8,000	0	0.0	0.0
26-Feb-09	NLD	N/A	6,000	N/A	N/A	N/A	N/A	N/A	6,000	0	0.0	0.0
5-Mar-09	4,000	N/A	2,000	N/A	N/A	N/A	N/A	N/A	6,000	0	0.0	0.0
6-Mar-09	NLD	N/A	10,000	N/A	N/A	N/A	N/A	N/A	10,000	0	0.0	0.0
7-Mar-09	NLD	N/A	6,000	N/A	N/A	N/A	N/A	N/A	6,000	0	0.0	0.0
10-Mar-09	Wet	N/A	N/A	NLD	N/A	N/A	N/A	N/A	0	0	0.0	0.0
19-Mar-09	N/A	100	N/A	N/A	N/A	N/A	N/A	N/A	0	100	0.0	0.0
25-Mar-09	N/A	N/A	4,000	NLD	N/A	N/A	N/A	N/A	4,000	0	0.0	0.0
26-Mar-09	1,000	N/A	3,100	NLD	N/A	N/A	N/A	N/A	4,100	0	0.0	0.0
27-Mar-09	N/A	140	1,900	NLD	N/A	N/A	N/A	N/A	1,900	140	0.0	0.0
28-Mar-09	N/A	N/A	1,800	NLD	N/A	N/A	N/A	N/A	1,800	0	0.0	0.0
30-Mar-09	N/A	4	1,800	NLD	N/A	N/A	N/A	N/A	1,800	4	0.0	0.0
31-Mar-09	N/A	N/A	1,500	NLD	N/A	N/A	N/A	N/A	1,500	0	0.0	0.0
1-Apr-09	N/A	N/A	3,000	NLD	N/A	N/A	N/A	N/A	3,000	0	0.0	0.0
2-Apr-09	N/A	N/A	1,150	NLD	N/A	N/A	N/A	N/A	1,150	0	0.0	0.0
3-Apr-09	N/A	2	550	NLD	N/A	N/A	N/A	N/A	550	2	0.0	0.0
4-Apr-09	N/A	N/A	688	NLD	N/A	N/A	N/A	N/A	688	0	0.0	0.0
6-Apr-09	N/A	1	1,100	NLD	N/A	N/A	N/A	N/A	1,100	1	0.0	0.0
Total:	4,000	100	70,000	0	0	0	0	0	74,000	100	0.79	3.16

N/A - Not measured and not pumped, or not existing at time of event

PQU-Sump pumped quantity unknown

NLD - No liquid detected

1- Rainfall from Rainfall Station 4774 Timet. There is no daily between Sept. 2008 and Feb. 2009.

2- Rainfall from Rainfall Station 4769 Pioneer Detention Pond.

Attachment D (2/3)

Zone Sumps Depths
BRC CAMU
Henderson, Nevada

Date Measured	Approximate Depth of Water in Sump (feet)							
	Phase I		Phase II		Phase IIIB		Phase V	
	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose	LCRS	Vadose
9-Mar-09	2.50	1.30	0.80	Dry	N/A	N/A	N/A	N/A
21-Mar-09	2.80	1.40	1.00	Dry	N/A	N/A	N/A	N/A
22-Mar-09	2.80	1.50	1.90	Dry	N/A	N/A	N/A	N/A
23-Mar-09	N/A	1.20	N/A	Dry	N/A	N/A	N/A	N/A
24-Mar-09	2.80	1.50	2.00	Dry	N/A	N/A	N/A	N/A
25-Mar-09	2.80	N/A[1]	1.20	Dry	N/A	N/A	N/A	N/A
26-Mar-09 AM	2.80	1.50	2.90	Dry	N/A	N/A	N/A	N/A
26-Mar-09 PM	0.90	1.50	2.30	Dry	N/A	N/A	N/A	N/A
26-Mar-09 2130	N/A	N/A	2.00	Dry	N/A	N/A	N/A	N/A
27-Mar-09 0030	N/A	N/A	1.20	Dry	N/A	N/A	N/A	N/A
27-Mar-09 AM	1.12	1.50	2.60	Dry	N/A	N/A	N/A	N/A
27-Mar-09 1130	N/A	0.63[2]	N/A	N/A	N/A	N/A	N/A	N/A
27-Mar-09 PM	1.19	0.69	1.73	Dry	N/A	N/A	N/A	N/A
28-Mar-09 AM	1.30	0.70	2.80	Dry	N/A	N/A	N/A	N/A
28-Mar-09 1406	N/A	N/A	2.10	N/A	N/A	N/A	N/A	N/A
28-Mar-09 1645	N/A	N/A	1.70	N/A	N/A	N/A	N/A	N/A
29-Mar-09	1.50	0.70	2.80	Dry	N/A	N/A	N/A	N/A
30-Mar-09	1.60	0.70	3.0[3]	Dry	N/A	N/A	N/A	N/A
31-Mar-09	1.70	0.68	2.90	Dry	N/A	N/A	N/A	N/A
1-Apr-09	1.80	0.68	3.0[3]	Dry	N/A	N/A	N/A	N/A
2-Apr-09	1.80	0.68	2.60	Dry	N/A	N/A	N/A	N/A
3-Apr-09	1.90	0.68	2.60	Dry	N/A	N/A	N/A	N/A
4-Apr-09	2.00	0.67	2.70	Dry	N/A	N/A	N/A	N/A
5-Apr-09	2.10	0.67	2.80	Dry	N/A	N/A	N/A	N/A
6-Apr-09	2.10	0.67	3.0[3]	Dry	N/A	N/A	N/A	N/A

[1] Not measured due to new pump installation
[2] Measured after Phase 1 Vadose Sump pumped
[3] Started pumping after GES Sampling

Attachment D (3/3)

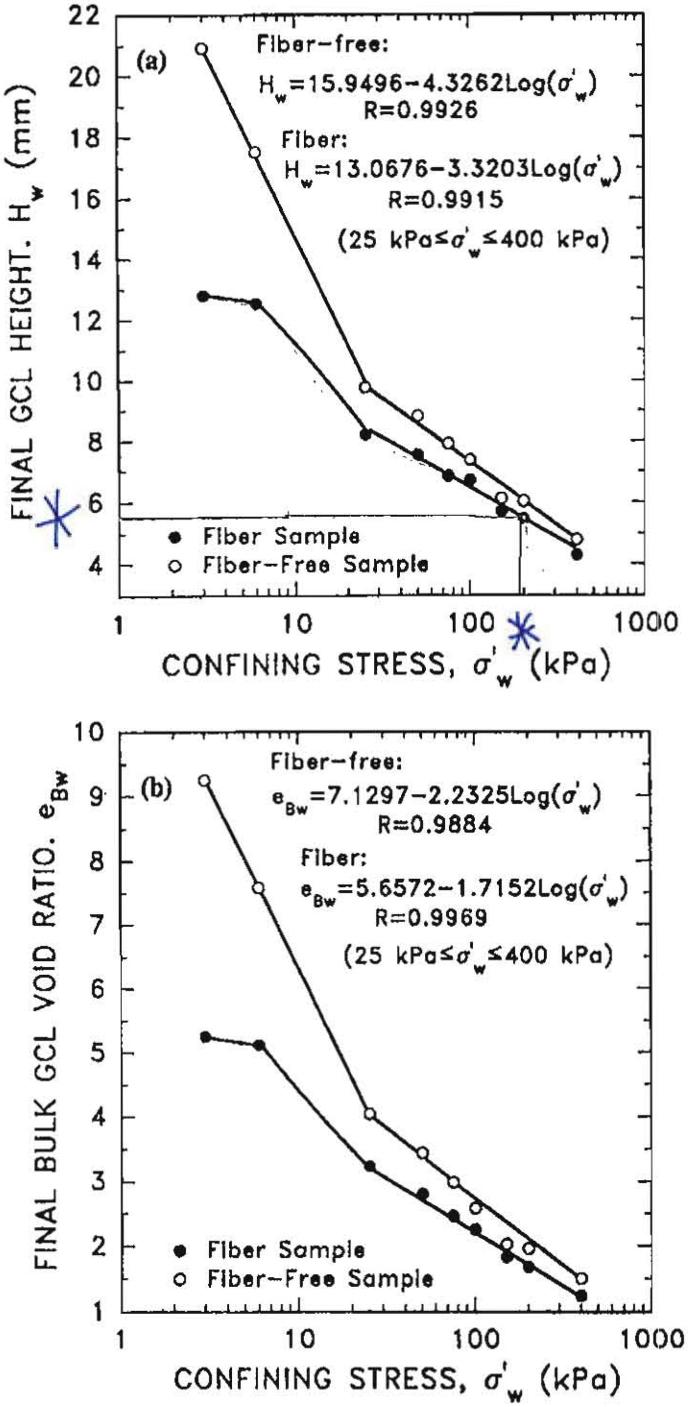

FIG. 3. Confining Stress for both Fiber and Fiber-Free Samples versus: (a) Final GCL Height; (b) Final Bulk GCL Void Ratio

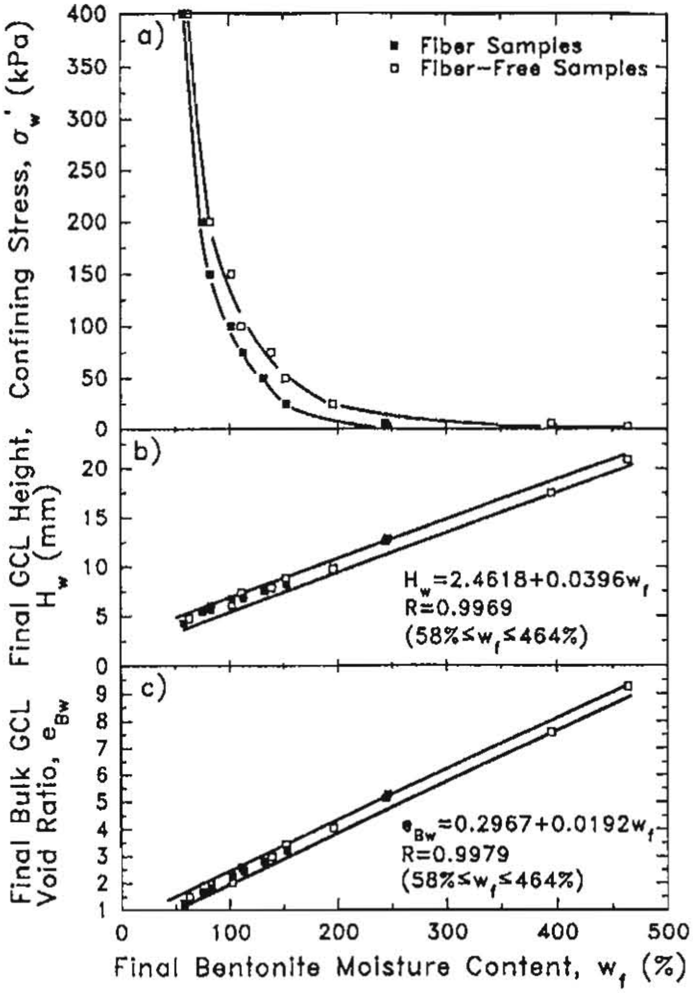

FIG. 4. GCL Properties Obtained from Confined Swell Tests

and GCL heights were constant, and after at least one pore volume of flow. Relatively large flow rates (with resulting large hydraulic gradients) were used so several pore volumes could be passed through the GCLs and constant hydraulic conductivity values could be obtained within reasonable time limits. This enabled a sufficient number of values required for a preliminary examination of the amount of scatter resulting from similar tests conducted in the fixed-ring permeameter and hence, an estimation of potential reproducibility of test results. Also, because of the small thickness of GCLs, it is not uncommon for GCLs to be subjected to large gradients, which may be representative of field conditions in certain applications (e.g., man-made lakes, reservoirs, canals, etc.). Nevertheless, the large hydraulic gradients used in this investigation were not considered to produce significant differences in k-values relative to values obtained at traditionally lower gradients because (1) as will be illustrated later, k-values obtained fell within the range of previously published values for GCLs at a given effective stress; (2) Petrov et al. (1997) showed that similar hydraulic conductivity results were obtained for both small and large gradients by comparing results from the fixed-ring permeameter used to obtain values presented herein, with the results obtained from a double-ring and a flexible-wall permeameter; and (3) Petrov (1995) demonstrated that subsequently increasing the hydraulic gradient by a factor ranging from 1.7 to 7.1 had a negligible impact on the hydraulic properties as seepage induced consolidation was relatively small compared to the initial sample thickness.

In the next few subsections, the effects of water type, static confining stress, bulk GCL void ratio, and needle-punching on GCL hydraulic conductivity will be discussed followed by a brief section on test reproducibility in the fixed-ring apparatus. The last section in this paper examines the compatibility characteristics of a well water-hydrated GCL sequentially permeated with a range of ethanol/water mixtures.

Effect of Distilled/Tap Water

The type of water has previously been shown to impact the hydraulic conductivity of some clayey soils. For example, Dunn and Mitchell (1984) found that a silty clay soil underwent an increase in permeability when tap water was used versus distilled water. Questions have been raised pertaining to the effect, if any, of the nature of the water type on GCL hydraulic conductivity. Tests conducted by Shan and Daniel

PETROV, ROBERT, Et Al., (1997) "Selected Factors Influencing GCL Hydraulic Conductivity," Journal of GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING, AUGUST

Attachment E (1/1)

EVALUATION OF THE CONTACT BETWEEN GEOSYNTHETIC CLAY LINERS AND GEOMEMBRANES IN TERMS OF TRANSMISSIVITY

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ABSTRACT

An apparatus is described which measures the flow beneath a geomembrane with a hole at its contact with a geosynthetic clay liner. The hole in the geomembrane is circular and the flow regime beneath it is radial. The testing technique allows for the application of various normal stresses to the contact between the geosynthetic clay liner and the geomembrane. The head on the geomembrane hole can be varied to represent field conditions. The flow is quantified in terms of transmissivity which can be calculated using either constant head or falling head conditions. Test results are presented for five commercially available geosynthetic clay liners under the two normal stresses of 7 and 70 kPa (1 and 10 psi). Values are compared to transmissivity between a geomembrane and a compacted clay liner and seem to be significantly lower for all geosynthetic clay liner products.

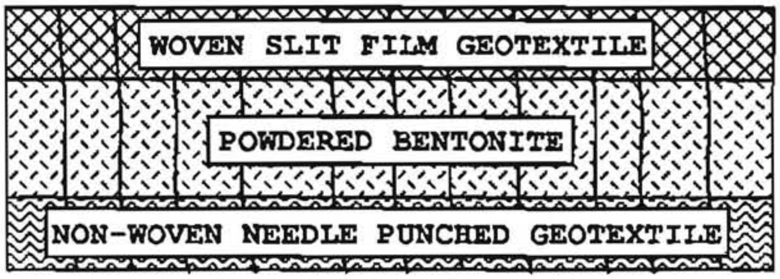
INTRODUCTION

For both hazardous waste and municipal solid waste containment, the required strategy of the U.S. Environmental Protection Agency is a composite liner. This liner is considered to be a geomembrane placed directly over a compacted clay liner (CCL). The essential reason behind this concept can be shown by the illustrations of Figure 1. With a CCL by itself, the entire area is available for flow by the leachate. With a composite liner, flow through a hole in the geomembrane is forced in a radial configuration which greatly reduces the net amount through the composite. Of course, lateral flow at the contact between the geomembrane and the compacted clay liner should be minimized. Quantification of the water flow at the contact has been evaluated in the laboratory in terms of transmissivity (Fukuoka, 1986, Brown et al, 1987 and Giroud and Bonaparte, 1989). These values will be used for comparative purposes later in the paper.

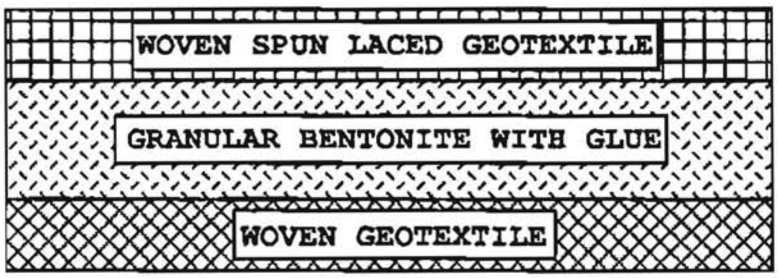
In recent years, geosynthetic clay liners "GCLs" are increasingly being chosen to replace compacted clay liners in various cases such as in the primary liner in double lining systems, as the lower component in single lining systems and in landfill caps. However, because most available GCLs consist of bentonite sandwiched between two geotextiles, their equivalency to CCLs with respect to intimate contact with the geomembrane is often questioned due to the presence of the upper geotextile. Clearly, there is a lack of transmissivity data for the geotextile used in the various products when bentonite is the

Attachment F (1/3)

GCL "A"



GCL "B"



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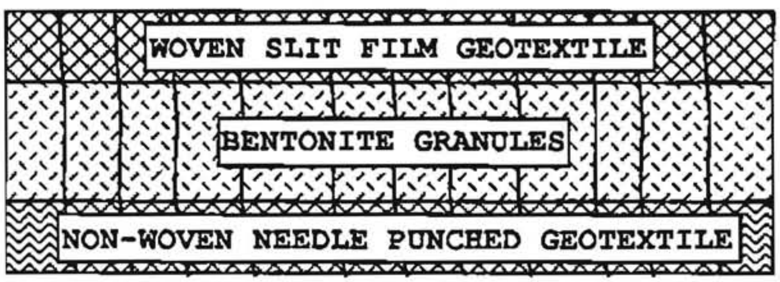
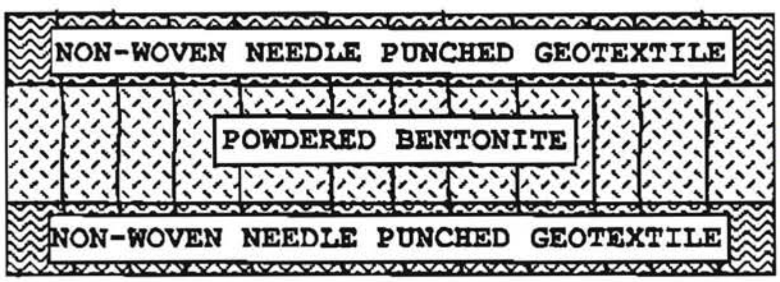


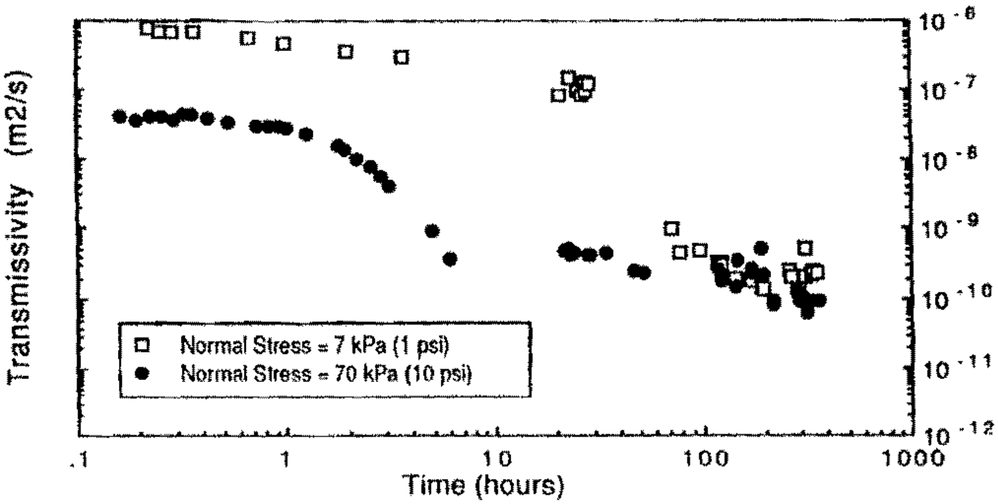
GCL "D"



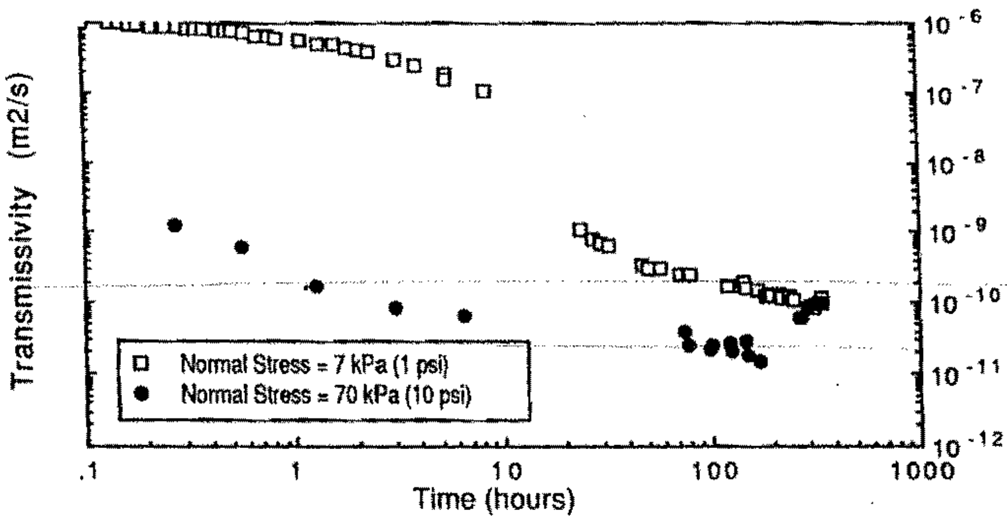
GCL "E"

Fig. 3 GCLs Evaluated in this Study

Attachment F (2/3)



(d) GCL "D"



(e) GCL "E"

Fig.4 (cont.) Variation of Apparent Transmissivity with Time for the Five GCLs Evaluated in This Study

Attachment F (3/3)

Attachment 6

Date: 9/6/2009 Direction: N/A Description: Burn hole on Phase I side slope from generator. Damaged geocomposite and geomembrane shown.	
Date: 9/6/2009 Direction: N/A Description: Burn hole on Phase I side slope from generator. Damaged GCL shown. Note granular bentonite indicating GCL is non-hydrated.	

Date: 9/6/2009 Direction: N/A Description: Repair to GCL in accordance with Technical Specifications