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APPROVED
DIVISION OF SOLID WASTE MANAGEMENT
DATE 11/7/95 BY [illegible]

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Mr. Bobby Lutfy
North Carolina Department of Environment, Health,
and Natural Resources
Solid Waste Section
Post Office Box 27687
Raleigh, North Carolina 27611-7687

Re: Response to Comments - Buncombe County MSWLF Landfill Design Hydrogeologic Report

Dear Mr. Lutfy,

The purpose of this letter is to respond to the Solid Waste Section's (SWS) memo dated April 27, 1995 which presented comments regarding the technical review of the Design Hydrogeologic Report prepared by Camp Dresser &McKee (CDM) for the proposed Buncombe County MSWLF Landfill. The response to each of the SWS's comments are presented directly below each comment for your convenience. In some cases, the SWS comments have been summarized. We feel that the comments have been addressed completely, however if any questions should arise during your review, do not hesitate to call for clarification. We appreciate your input and help in reviewing this report.

SOLID WASTE SECTION COMMENTS

- **.1623(b)(1)(A) Clarification is needed on the information necessary to demonstrate compliance with the vertical separation requirements of .1624(b)(4). A 1" = 100' scale plan view drawing of the subbase grades for Cells 1-3 should be submitted that accurately shows the location of the borings. A summary table should be submitted that shows the following information for each boring in or near the Cells 1-3 area: boring number, ground surface elevation, proposed subbase grade elevation (for the bottom of the clay liner), top of bedrock elevation, and seasonal high water table elevation.**

  The requested plan view drawing is attached as Sheet 1. Table 1, which includes the above elevations, and the distance between the base grade and the current ground surface, top of bedrock, and seasonal high water level elevation, is attached following this letter.

- **.1623(b)(2)(A) The information required in Subparagraphs (a)(4) through (a)(12):**

  (a)(4)(E) A summary table and brief discussion should be submitted that provides the required information for each lithologic unit (Hydrogeologic unit). This information should be provided for saturated and unsaturated units (vadose zone) as required by .1631(c)(2).

  A summary of lithological data was provided in Table 3-1 of the Design Hydrogeologic Report, and a detailed discussion of hydrogeologic units was found in Section 3.2 of that report, and in Section 3.3.4, the Hydrogeologic Conceptual Model. To provide further clarification, a table has been generated (Table 2, attached) which lists the ranges for the characteristics of site lithologies including thickness, stratigraphy, hydraulic conductivities, and porosities, and the Site lithologies are summarized below.

  The Site lithologies consist of saprolite, partially weathered rock (PWR), and bedrock. These lithologies are a gradational sequence, formed by the in-place weathering of the granite gneiss bedrock found at the Site. The saprolite consists of unconsolidated silty clay to silty sand that represents the complete weathering of the gneiss. The saprolite is of greatest thickness in the upland areas between the secondary drainage features (hollows) within the Site. The PWR is defined as the unconsolidated materials with a blow count of greater than 50 blows for 6 inches. Like the saprolite, the thickness of the PWR is greatest in the upland areas between the hollows. The exception to this is a large thickness of saprolite/PWR in the upper part of Hollow A. Both the saprolite and PWR are characterized by a relatively low hydraulic conductivity, and both are saturated only locally in low areas (at the bottom of secondary drainage features). The base of the PWR (top of bedrock) is defined by hollow stem auger refusal. The bedrock lithology is the primary hydrogeologic unit for the Site, since most of the saturation is within this unit. The degree of fracturing of the bedrock determines the hydraulic characteristics. The hydraulic conductivity has been shown to be highly variable, locally ranging from relatively low to relatively high.

- **(a)(7)(C) Normally more detailed information regarding the estimated long-term seasonal high water table would be required. Since the limiting factor for excavation at this site is bedrock rather than the water table, further discussion of the seasonal high water table will not be necessary.**

  No response is required for this comment.

- **(a)(7)(D) Further discussion is needed of any natural and man-made activities that have the potential for causing water table fluctuations. The present discussion is confined mostly to seasonal variations in the water table.**

  As discussed in Section 4.1 of the Design Hydrogeologic Report, construction of the landfill is expected to cause a lowering in the water table due to reduced infiltration. In addition, removal of the current vegetative cover at the site would be expected to cause a lowering of the water table due to an expected increase in surface water runoff and thus, reduced infiltration. At present, only seasonal precipitation variation is expected to cause water table fluctuations, since no groundwater pumping or other groundwater stresses have been identified that would affect the site.

- **(2)(B) As previously referenced, a summary table is needed that presents the required information in .1631(c)(2) for each unsaturated and saturated geologic unit.**

  See response to Comment (2)(A) above.

- **(2)(C) Additional information is necessary on the proximity and withdrawal rate of the groundwater users and the availability of alternative drinking water supplies, as required by .1631(a)(2)(E)(iv) and (v). As referenced in my May 3, 1994, memo of review for the Site Study, additional information is needed for all water supply wells in the facility and within 500 feet of the facility. Which wells are to be abandoned and which will be continued to be used? Have any of the wells within 500 feet been sampled for the Appendix I constituents?**

  Sheet SD-2 of the Facility Plan drawings in the Permit To Construct Application shows the location of residences both within the landfill property boundary and surrounding the property boundary. Eight water supply wells have been identified within landfill property boundaries. All water supply wells located within the landfill property boundary will be abandoned. Three water supply wells have been located within 500 feet of the waste boundary of Cells 1-3. Two are located south of the cells and are located within the landfill property and will be abandoned. The third well is located north of the cells on the opposite side of Blevin Branch. This well is not located on the landfill property as shown on Sheet SD-2, however it is scheduled to be abandoned. Sheet SD-2 also identifies which water supply wells located outside the buffer zone are to be abandoned.

It is assumed that none of the wells shown on Sheet SD-2 have been sampled for Appendix I constituents, since neither CDM or Buncombe County has collected samples from these wells. Since there will be no active wells within 500 feet of Cells 1-3 and the future cells, water supply wells will not be included in the routine monitoring.

- **(2)(G) There are no flow nets or hydrogeologic cross sections that characterize the vertical groundwater flow regime. Since the saturated zone is virtually all in the fractured bedrock, which is an environment where the potentiometric head is influenced by a number of variables, it is probably not useful to attempt to construct flow nets for the vertical dimension of groundwater flow. The Design Hydrogeologic Report should clearly establish the reason that this information has not been provided.**

Plates 3-1a through 3-1c of the Design Hydrogeologic Report are geologic cross sections. These cross sections do provide vertical characterization of the groundwater flow regime by showing the water level depths at nested well completion. The vertical gradients at different locations can be assessed by comparing the distance between nested well water levels. As discussed in Section 3.3.1.1 of the Design Hydrogeologic Report, "Due to the complexity of the Site, this presentation format is considered preferable to flow net diagrams". The vertical gradients throughout the Site vary with the heterogeneities of the fracture flow system, thus the system cannot be precisely represented by a flow net diagram. Vertical gradients are dependent on the completion depth of the piezometers and the varying head pressures that are found with depth. An idealized flow net diagram for the Site was presented in the Design Hydrogeologic Report as Figure 3-7. This figure represents the conceptual model for average groundwater flow lines beneath the Site.

- **(2)(I) The certification by a Licensed Geologist that all borings will be properly abandoned has not been provided.**

A letter from Buncombe County stating their intention to provide the required certification on piezometer abandonment is provided in Appendix A.

- **(3)(A)(i)(II) The SWS requested additional discussion on detection monitoring by alternative methods other than groundwater monitoring wells alone.**

  CDM and Buncombe County are currently evaluating alternative monitoring options and will provide a response to this comment once the evaluation is completed.

- **(3)(C) A certification of the effectiveness of the water quality monitoring plan has not been provided.**

  An addendum to the Water Quality Monitoring Plan that addresses this requirement, is included in Appendix B.

- **Volume One, Section 1, Facility Plan. Sheet SD-2, Proposed Site Development, indicates a change in the proposed location for the construction and demolition (C&D) landfill. Portions of this newly proposed C&D area were not proposed for landfill disposal in the Facility Plan submitted as part of the Site Plan application. Additional hydrogeologic subsurface characterization would be required for this area in order to consider permitting a C&D landfill.**

  The final location of the C&D landfill had not been determined at the time the field investigation was ongoing. Therefore, this area was not characterized. It is recognized that additional subsurface characterization will be necessary before issuance of a permit for the C&D landfill.

- **Section 2, Engineering Plan:**

  2.4.5 Seismic Impact Zones: This section is misleading, since the site is located in a seismic impact zone as defined by Rule .1622(5). The language should be changed to be consistent with the rules.

  The first sentence of Section 2.4.5 should be revised to read "The proposed MSW unit is located within a seismic impact zone with at maximum horizontal acceleration value of 0.20g . . . ".

Appendix F Geotechnical Analysis: Mark Landis needs to seal this report with his Professional Geologist seal in order to meet the requirements of Rule .0202(a)(3).

Appendix F, on Page 2 states that "quartz veins and alumino-silicate pegmatites are common in such metamorphic environments". A Professional Geologist must evaluate the subgrade prior to liner construction to determine if quartz veins or pegmatites are present that could provide preferential groundwater flow paths that may affect the design of the monitoring system.

Appendix F, Laboratory Test Results: SInce the liquid limit for B-313, bag 2 (20' - 30') is greater that 50, the USCS classification should be MH rather than CL.

The above comments were addressed by GEI Consultants, Inc. Their response is included in Appendix C.

The following comments are regarding Volume 2, Engineering Plan, Appendix G Design Hydrogeologic Report:

- **Section 2.2.2 Monitoring wells and piezometers should be constructed so that the sand filter pack extends a maximum of two feet above the top of the screen, rather than a minimum of two feet above the top of the screen, as referenced in the report.**

  Table 2-1 of the Design Hydrogeologic Report provides a summary of construction data for all site piezometers. In some cases, the sand pack did extend more than two feet above the top of screen. Sand pack placement will be carefully monitored during construction of the groundwater monitor wells to ensure that the sand pack does not extend more than two feet.

- **Table 3-1, Summary of lithologic Data: The depth to PWR listed in Table 3-1 differs from the depth referenced in the boring logs for the following borings: B-359, B-360H, B-361, B-362H, B-363, B-365, B-366A, B-367, B-368, and B-369. There are similar discrepancies for the depth to bedrock data for borings B-362H and B-372.**

Table 3-1 has been modified to contain the depths of PWR and bedrock from the boring logs, as attached. It should be noted that these discrepancies were generally on the order of one or two feet (within the error of the estimation of the PWR depth), and no results or conclusions within the Design Hydrogeologic Report are affected by these discrepancies.

- **3.3.1.1 The method of calculating the vertical gradient is different from the standard method normally used. Unless a reference can be provided to support the method used, the vertical gradients must be recalculated using the following formula: the difference in the water table elevation between two nested piezometers, divided by the vertical distance from the midpoint of the two piezometer screens of the nest. As previously referenced, the sand packs should not extend significantly above (or below) the screens.**

  The vertical gradients have been recalculated using the midpoint of the well sensing zones as provided in Table 3-6, attached. The midpoint of the well sensing zone (the distance between the bottom of the borehole and the top of the sand pack or the water table, which ever is deeper) is considered more appropriate then the midpoint of the well screen, since the head in the well is a function of the sensing zone interval rather than the well screen interval. The recalculated vertical gradients do not affect any conclusions drawn in the Design Hydrogeologic Report.

- **3.3.3 Pumping Test Results Why were extended interval open borehole wells used for the pumping wells? While the wells do indicate some degree of interconnectedness of fractures, use of the open borehole wells makes the data more difficult to interpret. It is especially difficult to know how to design an effective monitoring system using limited screen intervals.**

  Why were methods for "confined aquifers used"? Normally an unconfined or semi-confined aquifer would be expected for shallow fractured bedrock. If the conditions are indeed confined, then this calls into question the degree of interconnectedness of the fractures and further complicates designing an effective monitoring system with monitoring wells.

  Were efforts made to perform aquifer analysis using assumptions that more realistically fit the heterogeneous anisotropic conditions and significant gradients that actually exist at the site?

Extended interval open borehole wells were used for conducting the pumping tests in order to target fractured intervals in bedrock and to maximize the potential yield from the bedrock aquifer. By pumping from an extended interval open borehole, the degree of interconnectedness of the aquifer as a whole could be evaluated, rather than evaluating one or several fracture systems. Using an extended interval on the pumping wells minimizes the effect of partial penetration on the data analysis. An effective monitoring system should be based on the Site data, and include the targeting of fracture systems during drilling in order to optimize the connectedness of the monitoring wells and the bedrock aquifer system. Fracture systems can be identified during drilling by observations such as drill rod drops, drill bit chatter, and air lift yield (blow tests). Fracture zones can also be identified by performing packer tests within the boreholes. By targeting the most conductive fracture zones for monitoring well screened intervals, an optimal monitoring system can be developed.

Both confined and unconfined aquifer test analyses were performed as included in Appendices D and E of the Design Hydrogeologic Report. The results of confined and unconfined analyses were considered sufficiently close to make the use of confined analyses appropriate and defensible. Given the heterogeneity of the fracture flow system, groundwater conditions beneath the Site may vary from unconfined to confined. Drilling observations and pumping test Storativity values suggest that the fracture flow system is largely semi-confined to confined (Storativity values of less than 10^{-3} indicate confined conditions).

Aquifer test analysis methods deviating from the Theis assumptions (i.e. heterogeneous, anisotropic conditions) were evaluated for the Site, however, these alternative methods require data on the nature of the heterogeneity and anisotropy that are not available for the Site. For example, Moench's method for a dual-porosity fracture flow system requires specific data on fracture geometries and bedrock secondary porosities. The Site bedrock fracture system cannot be defined to the extent required to use this aquifer test analysis method. Type curves for a leaky artesian aquifer assume a dual aquifer system not found at the Site, and the shape of Site curves more closely corresponded with the Theis type curve than with the leaky artesian aquifer type curve.

- **Plate 3-3, Top of Bedrock Elevation Map, Cell 1-3 Area: There appear to be some minor errors in the contours in several areas.**

The plate has been reviewed and the errors have been corrected. A revised Plate 3-3 is included following this response.

- **Plate 3-5, Potentiometric Surface Map, February 1995, Cell 1-3 Area: There appear to be some minor anomalies and possible errors in the contours in several areas.**

  The plate has been reviewed and some errors were noted and corrected. A revised Plate 3-5 is included following this letter. The potentiometric surface map, as discussed in Section 3.3.1.1 of the Design Hydrogeologic Report, represents an idealized shallow bedrock system. There are indeed several anomalies which relate to the complex third dimension of the Site. Plate 3-5 represents a best approximation of the Site groundwater system. Some wells which have water levels which appear to be too low for the contours (for example, B-312 in Hollow A, B-368, and B-357) represent a deep well completion in which water levels are deeper than those expected for the shallow bedrock system.

- **Appendix B, Geotechnical Laboratory Data: What is the source of the natural water content and porosity values on Page 1 of Appendix B? Some of the values do not correlate to the data in the test reports.**

  This comment was addressed by GEI. Refer to Appendix C for the response.

- **Appendix F, Piezometer Water Level Hydrographs: The scale and hydrograph for Piezometer B-227 is incorrect.**

  The hydrograph for Piezometer B-227 inadvertently had the Y-axis labels rounded to no decimal places. The corrected hydrograph is included in Appendix D.

SECTION SIX, WATER QUALITY MONITORING PLAN

- **3.1 The plan proposes that "Shallow bedrock monitoring wells will target the shallowest water-bearing fracture zones encountered". Is this irrespective of the yield and interconnectedness of the fracture(s) in the proposed monitoring interval? The previous efforts to target more conductive zones for the Phase III study appear to have been to some extent successful and similar efforts should be used to target monitoring zones for the detection monitoring wells.**

At nested locations, the shallow bedrock monitoring well will target the shallowest water-bearing fracture zone since this zone is where the water table will be first encountered, particularly if this is a drop in the water table elevation due to landfill construction as was previously discussed. The water quality monitoring plan does provide for the installation of a deeper bedrock monitoring well which would be completed below the shallowest water-bearing fracture zone. This monitoring well will will target the more conductive fracture zones encountered at depth. During monitoring well construction, packer testing could be used to identify the more conductive fracture zones so that the well screen intervals can be properly placed.

- **3.2 In determining if saturation conditions are evident upon refusal of hollow stem auger drilling, are seasonal variations in the water table and responses to precipitation events going to be considered? In light of the relief and the depth to water at the site, putting a 100 foot limit on the depth of the deeper wells may be too restrictive.**

Flucuations in the water table will be considered during well construction and screen placement. If the water table is encountered within the saprolitic soils and the saturated thickness is sufficient, then a monitoring well will be installed. If the saturated thickness encountered in the saprolite is not sufficent, then the boring will be advanced into the bedrock to so that the proper screen interval can be installed to ensure that the well will have a sufficient column of water so that it can be sampled year round. The screen interval could include both the upper portion of the bedrock and the saprolite. Monitoring wells installed in the saprolite will be constructed as a nested pair, with the other well installed in the upper portion of the bedrock. If the water table elevation does drop in respones to construction of the landfill and the well completed within the saprolite goes dry, then the deeper montoring well will provide monitoring for the upper portion of the water table.

Since the monitoring wells will be located between the landfill and the groundwater discharge features, it is anticipated that most wells will be completed within 100 feet of ground surface. Also, based on the observed subsurface conditions, it appears that the more conductive fracture zones would be encountered within 100 feet of ground surface. However, if subsurface conditions dictate that a deeper completion is required, then the wells will installed at the depth required. All the deeper monitoring wells will target the most conductive fracture zones, regardless of depth.

- **Figure 3-1. The location of the upgradient monitoring wells and surface monitoring locations need to be depicted more accurately on a larger scale map.**

  Sheet 2 shows the entire site with the location of the upgradient monitoring wells and the surface water sampling locations.

- **Figure 3-2. The grout in the annular space of the monitoring well should come up to the ground surface. The top of the concrete slab should be slope to shed water away from the well and should be thick enough to firmly anchor the outer well casing and protect the well from frost damage.**

  Figure 3-2 has been revised to reflect these changes and is included in Appendix E. Six inches of concrete shown on the schematic is sufficent to both anchor the casing and protect the well from frost damage.

- **As referenced previously, the sand filter pack should extend a maximum of two feet above the screen.**

  The sand pack for the groundwater monitoring wells will be placed so that it extends no more than two feet above the top of the screen. Deeper monitoring wells may require the use tremie pipe to place the sand pack and prevent bridging.

- **3.4 The exact locations of the surface water sampling locations need to be identified. Are the streams to be sampled from the near bank, or mid-stream, or composite samples? The spring capture systems must be designed in such a way as to provide sampling locations above the sedimentation basins.**

  Surface water sampling locations SW-1 and SW-2, are shown on Sheet 2. Stream samples will be grab samples collected from the near bank. An additional surface water sampling location, SW-3, has been located at the outfall for the spring capture system, located west of Cell 1. This outfall will daylight above the pond surface and provide a suitable location for sample collection. Final construction detail of the outfall can be provided to the SWS when completed. SW-2 and SW-3 locations are shown on the revised Plate 3-1 of the Water Quality Monitoring Plan.

SAMPLING AND ANALYSIS PLAN (SAP)

- **4.2 The baseline sampling event constitutes the initial semi-annual sampling event. Subsequent sampling is required at least semi-annually. Therefore the phase "After the initial year" should be deleted from the text.**

  This sentence in Section 4.2 has been revised to the following "Groundwater samples from each of the monitoring wells will be collected on a semi-annual basis."

- **If disposable basiler are used they must be Teflon bailers certified to have been cleaned according to the approved decontamination protocol.**

  If disposable bailers are used, they will be constructed of teflon and certification of decontamination will be provided. Disposable bailer will only be used if laboratory decontaminated standard teflon bailers or dedicated sampling systems are not available.

- **The sampling equipment decontamination protocol referenced on page 4-5 is incorrect. The acid rinse cleaning step has been omitted.**

  The sampling equipment decontamination protocal has been revised as follows:

  1. Clean item with tap water and phosphate-free laborator detergent (Liquinox or equivalent), using a brush if necessary to remove particulate matter and surface film.
  2. Rinse thoroughly with tap water.
  3. Rinse with 10% nitric or 10% hydrochloric acid.
  4. Rinse thoroughly with deionized or distilled water and allow to air dry.
  5. Rinse with deionized or distilled water and allow to air dry.
  6. Wrap with aluminum foil, if necessary, to prevent contamination of equipment during storage and transport.

- **5.3 Statistical comparisons are required for each compliance well. Comparisons of differences in the average concentrations among wells, as referenced in the SAP, is not appropriate.**

  This statement was intended to indicate that the average concentration of each well will be used for statistical comparisons, not the average concentration of all wells. A statistical analysis will be done for each compliance well.

- **5.6 In item four (4) it is not clear what frame of reference is for the phrase "within 30 days". The rules require that assessment monitoring be establised within 90 days of the determination of a statistical increase or exceedence of the N.C. Groundwater Standards for any Appendix I constituent in any compliance well.**

  The assessment monitoring program shall be establish within 90 days of determination of a statistical increase or exceedance of the N.C. Groundwater Standards.

We trust all the comments have been addressed. Please do not hesitate to call if you need assistance in clarifying any of the responses. Buncombe County and CDM appreciate the SWS assistance with expediting the review process.

Sincerely yours,

CAMP DRESSER & McKEE

Timothy Grant

Timothy D. Grant

cc: Bob Hunter, Buncombe County
Joe Wiseman, Camp Dresser & McKee

Table 1

Summary of Base Grade, Ground Surface, Bedrock, and Water Level Elevations
Buncombe County Solid Waste Management Facility

Boring/ Well	Ground Surface Elevation (feet msl)	Base Grade Elevation (feet msl)	Excavation /Fill Depth * (feet)	Top of Bedrock Elevation (feet msl)	Height above Bedrock (feet)	Water Level Elevation ** (feet msl)	Height above Water (feet)
BC-108	2019.9	2012	-8	1971.4	41	DRY	ND
B-308	2017.1	2012	-5	1971.4	41	1954.83	57
BC-110	2032.2	NA	NA	< 1983.7	NA	DRY	NA
B-310	2033.7	NA	NA	< 1983.7	NA	1959.75	NA
BC-111	2004.0	2012	8	1961.0	51	ND	ND
B-311C	2002.9	2012	9	1948.4	64	DRY	ND
B-311	2006.2	2013	7	1948.4	65	1940.05	73
B-311A	2003.1	2009	6	1948.4	61	1914.00	95
BC-112	1975.5	1990	15	< 1941.0	> 49	DRY	ND
B-312	1977.8	1992	14	1940.3	52	1913.33	79
BC-113	2060.7	2046		< 2012.0	34	ND	ND
B-313	2058.6	2042	-17	< 2012.0	30	1988.81	53
B-313A	2058.2	2042	-16	< 2012.0	30	1988.73	53
BC-114	2034.8	2010		2004.5	6	ND	ND
B-314	2037.0	2010	-27	2004.5	6	1981.63	28
BC-115	2044.6	2021	-24	2012.1	9	DRY	ND
B-315	2044.8	2019	-26	2012.1	7	1983.11	36
BC-124	1934.9	NA	NA	1929.0	NA	ND	NA
BC-125	2031.6	2010	-22	1965.6	44	ND	ND
BC-126	1957.0	1950	-7	1940.0	10	ND	ND
B-326	1963.9	1968	4	1947.0	21	1944.24	24
BC-135	2071.6	NA	NA	2054.5	NA	ND	NA
B-335	2071.6	NA	NA	2054.5	NA	2017.76	NA
BC-136	2050.0			2029.5	NA	ND	NA
B-236	2050.0	NA	NA	2029.5	NA	2008.40	NA
BC-137	1922.0	NA	NA	1913.0	NA	1911.22	NA
B-239	1986.9	1982	-5	1963.7	18	1948.58	33
B-240	1939.8	1974	34	1934.8	39	1935.42	39
B-340A	1942.7	1981	38	1934.8	46	1920.54	60
B-242	1988.4	NA	NA	1980.9	NA	1958.42	NA
B-245	1985.8	NA	NA	1973.3	NA	1956.48	NA
B-246	2027.1	2020	-7	1984.1	36	1975.04	45
B-247	2018.2	2006	-12	2012.7	-7	1954.76	51
B-248	2002.3	NA	NA	1997.3	NA	1958.84	NA

Table 1

Summary of Base Grade, Ground Surface, Bedrock, and Water Level Elevations
Buncombe County Solid Waste Management Facility

Boring/ Well	Ground Surface Elevation (feet msl)	Base Grade Elevation (feet msl)	Excavation /Fill Depth * (feet)	Top of Bedrock Elevation (feet msl)	Height above Bedrock (feet)	Water Level Elevation ** (feet msl)	Height above Water (feet)
B-250	2074.9	NA	NA	< 2023.4	NA	1939.96	NA
B-356H	1952.3	1986	34	1937.3	49	1947.97	38
B-357	2013.6	2015	1	1957.6	57	1947.29	68
B-358	1956.6	NA	NA	1946.6	NA	1961.01	NA
B-359	2045.5	NA	NA	2000.5	NA	1981.23	NA
B-360H	1974.4	2000	26	1960.4	40	1974.80	25
B-360	1977.5	2000	22	1960.4	40	1975.74	24
B-360A	1977.1	2000	23	1960.4	40	1967.07	33
B-361	2015.3	NA	NA	1988.3	NA	1956.19	NA
B-362H	1956.7	1986	29	1935.7	50	1953.14	33
B-362	1959.0	1985	26	1935.7	49	1953.74	31
B-363	2028.8	2028	-1	1994.3	34	1987.50	41
B-364	2008.4	NA	NA	1992.9	NA	1923.77	NA
B-365	1870.3	NA	NA	1865.3	NA	1866.08	NA
B-366	1929.9	NA	NA	1925.3	NA	1920.55	NA
B-366A	1930.8	NA	NA	1925.3	NA	1920.66	NA
B-367	1943.9	1991	47	1932.4	59	1934.10	57
B-367A	1944.6	1989	44	1932.4	57	1924.63	64
B-368	1977.9	NA	NA	1958.9	NA	1913.95	NA
B-369	1960.1	NA	NA	1941.6	NA	1929.04	NA
B-370	1934.0	NA	NA	1913.0	NA	1910.77	NA
B-371	1989.2	NA	NA	1973.7	NA	1940.95	NA
B-372	2025.4	2013	-12	1981.4	34	1985.20	28
B-374H	1914.9	NA	NA	1898.4	NA	1911.90	NA
B-374	1921.7	NA	NA	1898.4	NA	1911.38	NA
B-375	1954.3	1993	39	1947.8	45	1936.55	56
B-375A	1953.5	1991	38	1947.8	43	1931.91	59
Minimum			-27		-7		24
Maximum			47		65		95
Average			NA		37		48

NA = Not Applicable (outside landfill area).
ND = Not Determined (borehole not completed as piezometer).
* Positive number indicates fill, negative number indicates cut.
** The seasonal high water level elevation data are from February 1995.

Table 2

Summary of Saturated Zone and Vadose Zone Lithologies
Buncombe County Solid Waste Management Facility

Lithology	Composition	Thickness Range	Slug Test Hydraulic Conductivity Range (cm/sec)	Laboratory Undisturbed Hydraulic Conductivity Range (cm/sec)	Laboratory Remolded Hydraulic Conductivity Range (cm/sec)	Laboratory Porosity Range (percent)
Saprolite	Silty Sand to Silty Clay, soft	0-55'	8.4e-6 - 3.2e-5	5.3e-7 - 2.7e-4	1.5e-8 - 2.2e-6	18-45
PWR *	Weathered Gneiss - Silty Sand to Silty Clay, soft to mod hard	0-44'	4.4e-5 - 6.4e-5 **	2.9e7 **	--	30-44 **
Bedrock	Fractured Gneiss, mod hard to very hard.	NA	7.1e-6 - 1.7e-2	NA	NA	1-5***

NA = Not Applicable.

* - PWR = Partially weathered rock, as determined by a blow count of greater than 50 for 6".

** - PWR samples may include regolith (PWR and saprolite).

*** - Estimated porosity value. Reference Sections 3.2.3 and 3.3.4.2 of Design Hydrogeologic Report for discussion of bedrock porosity.

Table 3-1

Summary of Lithogical Data
Buncombe County Solid Waste Management Facility

Borehole	Surveyed Ground Surface Elevation (feet msl)	Depth to PWR (feet bgs)	PWR Elevation (feet msl)	Depth to Bedrock (feet bgs)	Bedrock Elevation (feet msl)
B-1 *	2090.0	19.0	2071.0	19.0	2071.0
B-1A *	2070.0	16.0	2054.0	> 25.0	< 2045.0
B-2 *	2065.0	28.0	2037.0	> 33.6	< 2031.4
B-3 *	2025.0	5.0	2020.0	> 13.9	< 2011.1
B-3A *	2005.0	27.0	1978.0	> 39.1	< 1965.9
B-4 *	2040.0	12.0	2028.0	> 18.7	< 2021.3
B-5 *	1895.0	3.0	1892.0	8.0	1887.0
B-5A *	1900.0	6.0	1894.0	10.0	1890.0
B-6 *	2020.0	28.0	1992.0	> 33.6	< 1986.4
B-7 *	2000.0	3.0	1997.0	6.0	1994.0
B-7A *	2010.0	3.0	2007.0	6.0	2004.0
B-8	ND	12.0	2037.0	25.0	2024.0
B-8A	ND	8.0	2033.0	21.0	2020.0
B-12	ND	> 45.0	< 1979.0	> 45.0	< 1979.0
BC-101 *	2023.3	15.0	2008.3	18.5	2004.8
BC-102 *	1975.8	9.0	1966.8	15.5	1960.3
BC-103 *	2069.1	> 50.0	< 2019.1	> 50.0	< 2019.1
BC-103A *	2069.1	54.5	2014.6	> 79.0	< 1990.1
BC-104 *	2059.7	38.5	2021.2	38.5	2021.2
B-204 *	-	-	-	-	-
BC-105 *	2096.2	> 48.5	< 2047.7	> 48.5	< 2047.7
BC-106 *	2074.2	29.5	2044.7	29.5	2044.7
BC-107 *	2051.2	39.5	2011.7	> 48.0	< 2003.2
BC-107A *	2052.1	40.0	2012.1	56.5	1995.6
BC-108	2019.9	28.5	1991.4	48.5	1971.4
B-308	2017.1	-	-	-	-
BC-109 *	2017.2	35.0	1982.2	> 49.0	< 1968.2
BC-109A *	2017.2	35.0	1982.2	> 75.0	< 1942.2
BC-110	2032.2	33.0	1999.2	> 48.5	< 1983.7
B-310	2033.7	-	-	-	-
B-111	2004.0	30.0	1975.0	44.0	1961.0
B-311C	2002.9	~ 50.0	1952.9	54.5	1948.4
B-311	2006.2	-	-	-	-
B-311A	2003.1	-	-	-	-
BC-112	1975.5	> 34.5	< 1941.0	> 34.5	< 1941.0
B-312	1977.8	~ 35.0	1942.8	37.5	1940.3
BC-113	2060.7	44.0	2017.0	> 49.0	< 2012.0
B-313	2058.6	-	-	-	-
B-313A	2058.2	-	-	-	-
BC-114	2034.8	20.0	2013.0	28.5	2004.5
B-314	2037.0	-	-	-	-
BC-115	2044.6	13.5	2031.1	32.5	2012.1
B-315	2044.8	-	-	-	-
BC-116 *	2086.0	40.0	2046.0	> 49.0	2037.0
BC-117 *	2048.3	> 49.0	< 1999.3	> 49.0	1999.3
BC-118 *	1979.0	9.0	1970.0	> 18.5	< 1960.5
BC-119 *	1915.6	13.5	1902.1	14.0	1901.6
BC-120 *	1850.6	7.0	1843.6	7.0	1843.6
BC-121 *	2034.7	24.0	2010.7	30.0	2004.7
BC-122 *	1873.5	5.0	1868.5	5.0	1868.5

Table 3-1

Summary of Lithogical Data
Buncombe County Solid Waste Management Facility

Borehole	Surveyed Ground Surface Elevation (feet msl)	Depth to PWR (feet bgs)	PWR Elevation (feet msl)	Depth to Bedrock (feet bgs)	Bedrock Elevation (feet msl)
BC-123 *	1846.3	8.5	1837.8	8.5	1837.8
BC-124	1934.9	3.0	1930.0	4.0	1930.9
BC-125	2031.6	39.5	1992.1	66.0	1965.6
BC-126	1957.0	9.5	1947.5	17.0	1940.0
B-326	1963.9	-	-	-	-
BC-127 *	1851.8	10	1841.8	12.0	1839.8
B-227 *	-	-	-	-	-
BC-128 *	1942.2	10	1932.2	16.5	1925.7
BC-129 *	2013.3	15	1998.3	22.0	1991.3
BC-130 *	1978.3	5	1973.3	11.0	1967.3
BC-131 *	1994.4	4	1990.4	7.0	1987.4
B-231 *	-	-	-	-	-
BC-132 *	2054.8	14	2040.8	> 26.5	< 2028.3
B-232 *	-	-	-	-	-
BC-133 *	2092.5	9	2083.5	22.5	2070.0
BC-134 *	2092.7	> 35	< 2057.7	38.0	2054.7
B-234 *	-	-	-	-	-
BC-135	ND	> 15.0	< 2057.0	17.5	2054.5
B-335	2071.6	-	-	-	-
BC-136	ND	10.0	2040.0	20.5	2029.5
B-236	2050.0	-	-	-	-
BC-137	1922.0	3.0	1919.0	9.0	1913.0
BC-138 *	2041.4	25.0	2016.4	> 69.0	< 1972.4
B-238 *	-	-	-	-	-
B-239	1986.7	9.0	1977.7	23.0	1963.7
B-240	1939.8	4.0	1935.8	5.0	1934.8
B-340A	1942.7	-	-	-	-
B-241A *	2041.1	17.0	2024.1	17.0	2024.1
B-241B *	1975.7	17.0	1958.7	19.0	1956.7
B-242	1988.4	7.0	1981.4	7.5	1980.9
B-243 *	2023.3	29.0	1994.3	53.0	1970.3
B-244 *	2003.3	16.0	1987.3	30.0	1973.3
B-245	1985.8	12.0	1973.8	12.5	1973.3
B-246	2027.1	9.0	2018.1	43.0	1984.1
B-247	2018.2	4.0	2014.2	5.5	2012.7
B-248	2002.3	1.5	2000.8	5.0	1997.3
B-249 *	2076.0	26.0	2050.0	26.0	2050.0
B-250	2074.9	> 51.5	< 2023.4	> 51.5	< 2023.4
B-251 *	2059.3	40.5	2018.8	> 51.0	< 2008.3
B-252 *	2032.7	10.8	2021.9	20.5	2012.2
B-253 *	1772.0	4	1768.0	4.5	1767.5
B-254 *	1855.9	0.8	1855.1	0.8	1855.1
B-255 *	1980.1	7.5	1972.6	7.5	1972.6
B-356H	1952.3	10.0	1942.3	15.0	1937.3
B-357	2013.6	40.0	1973.6	56.0	1957.6
B-358	1956.6	5.0	1951.6	10.0	1946.6
B-359	2045.5	36.0	2009.5	45.0	2000.5
B-360H	1974.4	11.0	1963.4	14.0	1960.4
B-360	1977.5	-	-	-	-
B-360A	1977.1	-	-	-	-

Table 3-1

Summary of Lithogical Data
Buncombe County Solid Waste Management Facility

Borehole	Surveyed Ground Surface Elevation (feet msl)	Depth to PWR (feet bgs)	PWR Elevation (feet msl)	Depth to Bedrock (feet bgs)	Bedrock Elevation (feet msl)
B-361	2015.3	13.0	2002.3	27.0	1988.3
B-362H	1956.7	11.0	1945.7	** 21.0	** 1935.7
B-362	1959.0	-	-	-	-
B-363	2028.8	8.0	2020.8	34.5	1994.3
B-364	2008.4	3.0	2005.4	15.5	1992.9
B-365	1870.3	4.0	1866.3	5.0	1865.3
B-366	1929.9	-	-	-	-
B-366A	1930.8	3.0	1927.8	5.5	1925.3
B-367	1943.9	9.0	1934.9	11.5	1932.4
B-367A	1944.6	-	-	-	-
B-368	1977.9	13.0	1964.9	19.0	1958.9
B-369	1960.1	6.0	1954.1	18.5	1941.6
B-370	1934.0	15.0	1919.0	21.0	1913.0
B-371	1989.2	11.5	1977.7	15.5	1973.7
B-372	2025.4	37.0	1988.4	44.0	1981.4
B-374H	1914.9	15.0	1899.9	16.5	1898.4
B-374	1921.7	ND	ND	ND	ND
B-375	1954.3	5.0	1949.3	6.5	1947.8
B-375A	1953.5	-	-	-	-
B-376 *	1884.8	3.0	1881.8	4.0	1880.8
B-377 *	1821.6	1.0	1820.6	1.5	1820.1

* Outside the Cell 1-3 Area
** Refusal in offset holes reached at 10,10,15, and 17 feet bgs.
ND = Not Determined
Depth to bedrock defined by auger refusal.
PWR = Partially weathered rock, determined by a blow count of 50 for 6 inches.

Table 3-6

Summary of Vertical Gradient Data
Buncombe County Solid Waste Management Facility

Nest (Shallower/ Deeper)	Completion Date (Shallower Completion)	Completion Date (Deeper Completion)	Measurement Date	Water Level Elevation Shallow (feet bmp)	Water Level Elevation Deep (feet bmp)	Water Level Difference (feet)	Center of Sensing Zone Shallow (feet bgs)	Center of Sensing Zone Deep (feet bgs)	Sensing Zone Difference ** (feet)	Vertical Gradient (ft/ft)	Comments
B-311/311A	12/14/94	10/25/94	12/15/94	1937.92	1913.53	-24.39	80.6	128.5	48.0	-0.51	24 hrs after B-311 Completion
			12/16/94	1937.92	1913.53	-24.39	80.6	128.5	48.0	-0.51	Post step test #2
			12/19/94	1940.22	1911.04	-29.18	80.6	128.5	48.0	-0.61	Post pumping test #2
			12/20/94	1940.21	1912.22	-27.99	80.6	128.5	48.0	-0.58	Post pumping test #2
			2/16/95	1940.05	1914.00	-26.05	80.6	128.5	48.0	-0.54	
			Average			-26.4				-0.6	
B-313/313A	10/15/94	10/15/94	11/29/94	1988.89	1988.83	-0.06	82.4	116.5	34.1	-0.002	
			12/7/94	1989.01	1988.92	-0.09	82.4	116.5	34.1	-0.003	
			12/15/94	1988.92	1988.87	-0.05	82.4	116.5	34.1	-0.001	Post step test #2
			12/16/94	1988.89	1988.86	-0.03	82.4	116.5	34.1	-0.001	
			12/19/94	1988.95	1988.90	-0.05	82.4	116.5	34.1	-0.001	After pumping test #2
			2/16/95	1988.81	1988.73	-0.08	82.4	116.5	34.1	-0.002	
			Average			-0.06				-0.002	
B-240/340A	11/23/93	12/13/94	12/15/94	1924.59	1920.85	-3.74	13.0	80.3	67.3	-0.06	48 hrs after B-340A completion
			12/20/94	1925.33	1919.17	-6.16	13.0	80.3	67.3	-0.09	Post pumping test #2
			2/16/95	1935.42 *	1920.54	-14.88	13.0	80.3	67.3	-0.22	
			Average			-4.9				-0.07	
B-360H/360	10/24/94	10/16/94	11/29/94	1972.00	1971.94	-0.06	6.0	21.5	15.5	-0.004	
			12/7/94	1971.92	1971.91	-0.01	6.0	21.5	15.5	-0.001	Post step test #1
			12/15/94	1971.83	1971.78	-0.05	6.0	21.5	15.5	-0.003	Post pumping test #1
			2/16/95	1974.80 *	1975.74 *	0.94	6.0	21.5	15.5	0.061	
			Average			-0.04				-0.003	
B-360/360A	10/16/94	10/16/94	11/29/94	1971.94	1966.14	-5.80	21.5	52.5	31.0	-0.19	
			12/7/94	1971.91	1966.24	-5.67	21.5	52.5	31.0	-0.18	Post step test #1
			12/15/94	1971.78	1966.16	-5.62	21.5	52.5	31.0	-0.18	Post pumping test #1
			2/16/95	1975.74 *	1967.07	-8.67	21.5	52.5	31.0	-0.28	
			Average			-5.70				-0.18	
B-362H/362	10/19/94	10/17/94	11/29/94	1952.31	1952.07	-0.24	11.3	33.5	22.3	-0.011	
			12/7/94	1952.27	1951.94	-0.33	11.3	33.5	22.3	-0.015	Post step test #1
			12/15/94	1952.23	1951.29	-0.94	11.3	33.5	22.3	-0.042	Post pumping test #1
			2/16/95	1953.14 *	1953.74 *	0.6	11.3	33.5	22.3	0.027	
			Average			-0.50				-0.023	
B-366/366A	12/2/94	10/17/94	12/6/94	1918.74	1917.81	-0.93	24.3	54.0	29.8	-0.031	Pre-step test #1
			12/7/94	1918.78	1918.15	-0.63	24.3	54.0	29.8	-0.021	Post step test #1
			12/8/94	1918.93	1918.30	-0.63	24.3	54.0	29.8	-0.021	
			2/16/95	1920.55 *	1920.66 *	0.11	24.3	54.0	29.8	0.004	
			Average			-0.73				-0.025	
B-367/367A	10/17/94	10/17/94	10/30/94	1934.08	1919.04	-15.04	51.8	84.3	32.5	-0.46	
			11/29/94	1934.10	1919.13	-14.97	51.8	84.3	32.5	-0.46	
			12/7/94	1932.41	1920.36	-12.05	51.8	84.3	32.5	-0.37	Post step test #1
			12/8/94	1932.46	1920.96	-11.50	51.8	84.3	32.5	-0.35	
			12/15/94	1930.00	1917.96	-12.04	51.8	84.3	32.5	-0.37	Post pumping test #1
			2/16/95	1934.10	1924.63	-9.47	51.8	84.3	32.5	-0.29	
			Average			-12.51				-0.36	

Table 3-6

Summary of Vertical Gradient Data
Buncombe County Solid Waste Management Facility

Nest (Shallower/ Deeper)	Completion Date (Shallower Completion)	Completion Date (Deeper Completion)	Measurement Date	Water Level Elevation Shallow (feet bmp)	Water Level Elevation Deep (feet bmp)	Water Level Difference (feet)	Center of Sensing Zone Shallow (feet bgs)	Center of Sensing Zone Deep (feet bgs)	Sensing Zone Difference ** (feet)	Vertical Gradient (ft/ft)	Comments
B-374H/374	10/18/94	10/22/94	10/30/94	1911.07	1910.97	-0.10	10.3	40.0	29.8	-0.003	
			11/29/94	1911.47	1911.03	-0.44	10.3	40.0	29.8	-0.015	
			12/15/94	1911.25	1910.97	-0.28	10.3	40.0	29.8	-0.009	
			12/20/94	1910.98	1910.86	-0.12	10.3	40.0	29.8	-0.004	Post pumping test #2
			2/16/95	1911.90	1911.38	-0.52	10.3	40.0	29.8	-0.017	
			Average			-0.29				-0.010	
B-375/375A	10/22/94	10/22/94	11/2/94	1932.03	1930.11	-1.92	55.5	84.3	28.8	-0.07	
			11/29/94	1933.04	1930.30	-2.74	55.5	84.3	28.8	-0.10	
			12/15/94	1932.51	1930.26	-2.25	55.5	84.3	28.8	-0.08	
			12/20/94	1932.25	1929.90	-2.35	55.5	84.3	28.8	-0.08	Post pumping test #2
			2/16/95	1936.55 *	1931.91	-4.64	55.5	84.3	28.8	-0.16	
			Average			-2.32				-0.08	

* = Anomolous value, not used in calculating average.

** Sensing zone difference is the distance between the center of the shallow well sensing zone and the center of the deep well sensing zone.
The sensing zone is defined as the interval between the bottom of the borehole and the top of the sand pack or the water level, which ever is deeper.

County of Buncombe

SOLID WASTE
30 VALLEY STREET
ASHEVILLE, NC 28801

Bob Hunter, Director

DIVISIONS

Office:	704-255-5066
Recycling:	704-255-5066
Landfill:	704-658-0137
Transfer Station:	704-253-6826
Fax:	704-255-5722

June 12, 1995

Mr. Bobby Lutfy
N. C. Dept. of Environment, Health & Nat. Resources
Solid Waste Section
P O Box 27687
Raleigh, NC 27611-7687

Re: Response to Comments - Buncombe County MSWLF Landfill Design Hydrogeologic Report

Dear Mr. Lutfy:

In accordance with Rule .1623(b)(2)(I), Buncombe County will provide the required certification by a Licensed Geologist that all boring and piezometers at the site, not converted to monitoring wells, will be properly abandoned in accordance with 15A NCAC 2C Rule .0113(a)(2).

Sincerely,

Bob Hunter
Director of Solid Waste

BH/cl

ADDENDUM TO THE WATER QUALITY MONITORING PLAN

The following statement is based on existing site conditions as of March 31, 1995 and data currently available on subsurface conditions and groundwater flow at the proposed Buncombe County Solid Waste Management Facility site. Additionally, it is our professional opinion that construction of a lined landfill may alter subsurface conditions.

In accordance with North Carolina Solid Waste Management Rule .1631(d)(1), I hereby state to the best of my knowledge, information and belief and in my professional opinion as an engineering professional, that the water quality monitoring system will be effective in providing detection of a release of hazardous constituents from the Buncombe County Solid Waste Management Facility to the uppermost aquifer, provided that the system is operated and maintained properly.

NORTH CAROLINA LICENSED SEAL 950 GEOLOGIST JOHN T. DRAKE

7/7/95

GEI Consultants, Inc.

7721 Six Forks Road
Suite 136
Raleigh, NC 27615-5014
919·676·0665

May 15, 1995
Project 94290

Mr. Tim Grant
Carolina Corporate Center
Camp Dresser & McKee
5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612

Re: Buncombe County Landfill
Geotechnical Review Comments

Dear Mr. Grant:

In response to a copy of a letter you received from Bobby Lutfy to Bill Sessoms of the North Carolina Department of Health and Natural Resources, Division of Solid Waste, dated May , 1995, GEI Consultants, Inc. (GEI) provides the following response to the geotechnical related issues:

Volume One, Section 2, Engineering Plan

(1) 2.4.5 Seismic Impact Zones: The site is located in a seismic impact zone as defined by rule .1622 (5). This comment was not referencing GEI's portion of the report.

(2) Appendix F, Geotechnical Analysis, PG seal: The report provided by GEI is a "Geotechnical Site Evaluation", and is not intended to be construed as the geological/hydrogeological portion of the design geological study. The issues covered in the geotechnical evaluation are engineering evaluations and recommendations and have been sealed by a Professional Engineer in accordance with Rule .0202 (a) (3).

(3) Appendix F, Page 2, "quartz veins and alumino-silicate pegmatites...": GEI intends to be present during the construction of the proposed first phase of the landfill and would assist CDM in locating quartz veins and pegmatites uncovered from the construction excavation. GEI would be available to assist CDM in further evaluating the presence of such features with respect to the groundwater monitoring plan.

(4) Appendix F, Lab Tests Results, B-313, bag 2: The USCS classification for this sample is MH. We have attached a modified soil description of this sample.

Volume Two, Section 2, Engineering Plan

(4) Appendix B, Laboratory Data: The natural water contents used in the porosity calculations are taken before undisturbed permeability tests. The water contents reported on the undisturbed permeability tests are taken after the tests, hence the discrepancy.

If you have any questions concerning these remarks, please feel free to contact this office.

Sincerely,

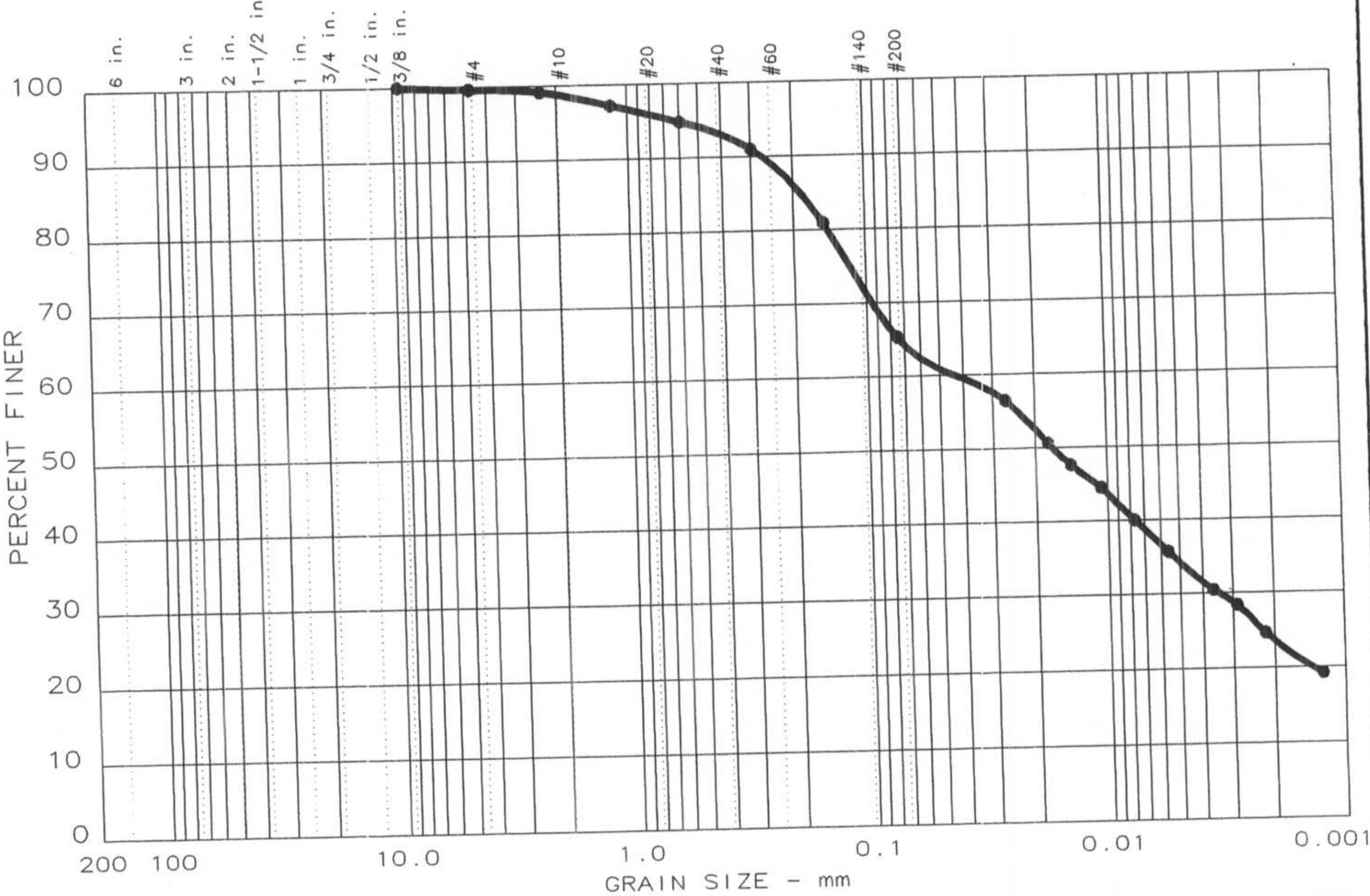
GEI CONSULTANTS, INC.

James R. Talbot

James R. Talbot, P.E.
Project Manager

Attachment

GRAIN SIZE DISTRIBUTION TEST REPORT



	Test	% +3"	% GRAVEL	% SAND	% SILT	% CLAY
●	2	0.0	0.4	34.3	31.1	34.2

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
●	51	18	0.184		0.0168	0.0034				

MATERIAL DESCRIPTION	USCS	AASHTO
● Sandy elastic silt	MH	

Project No.: 94290

Project: Buncombe County Landfill

● Location: B-313 bag 2 (20'-30')

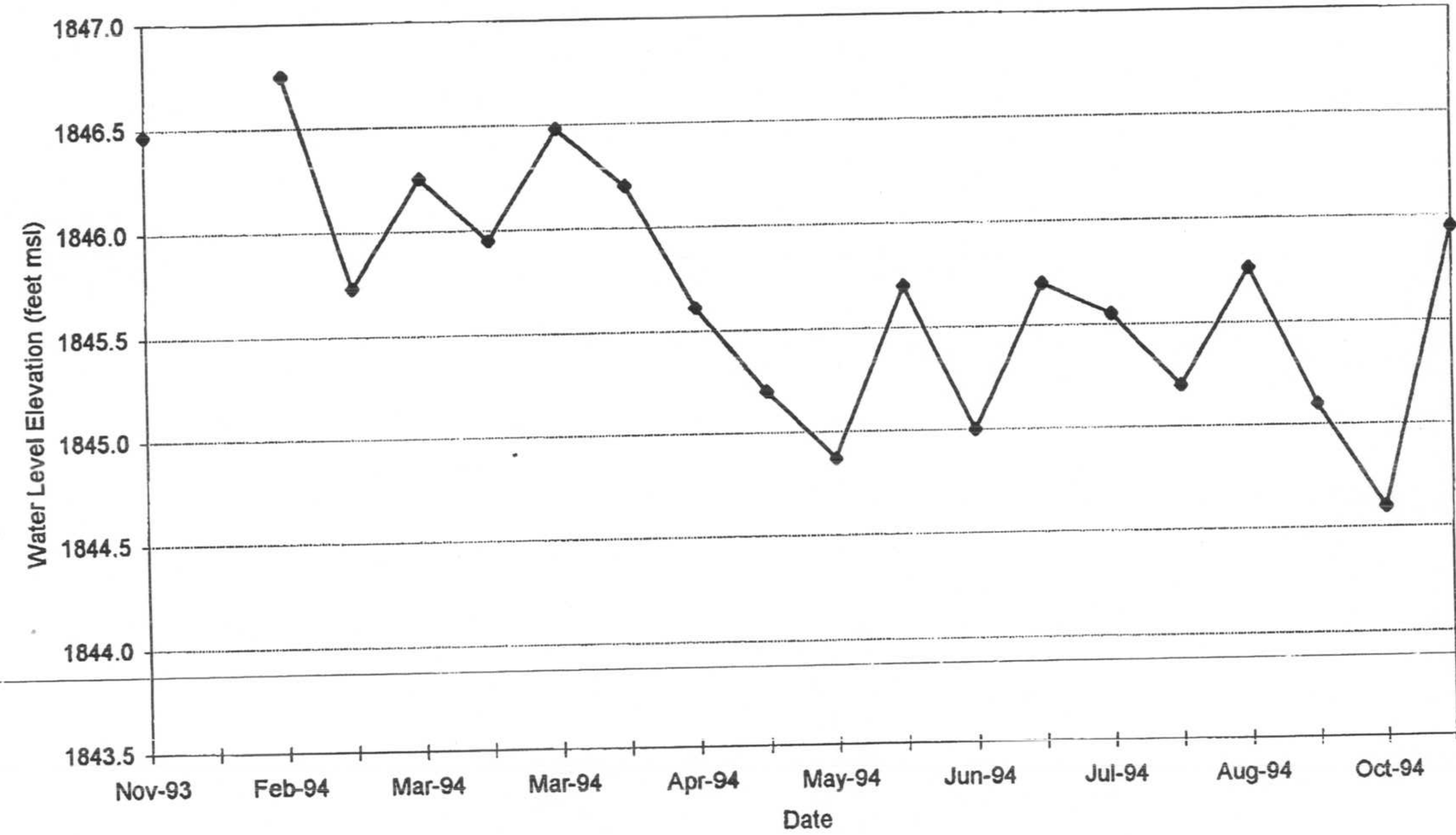
Date: November 14, 1994

Φ GEI Consultants, Inc.

Remarks:

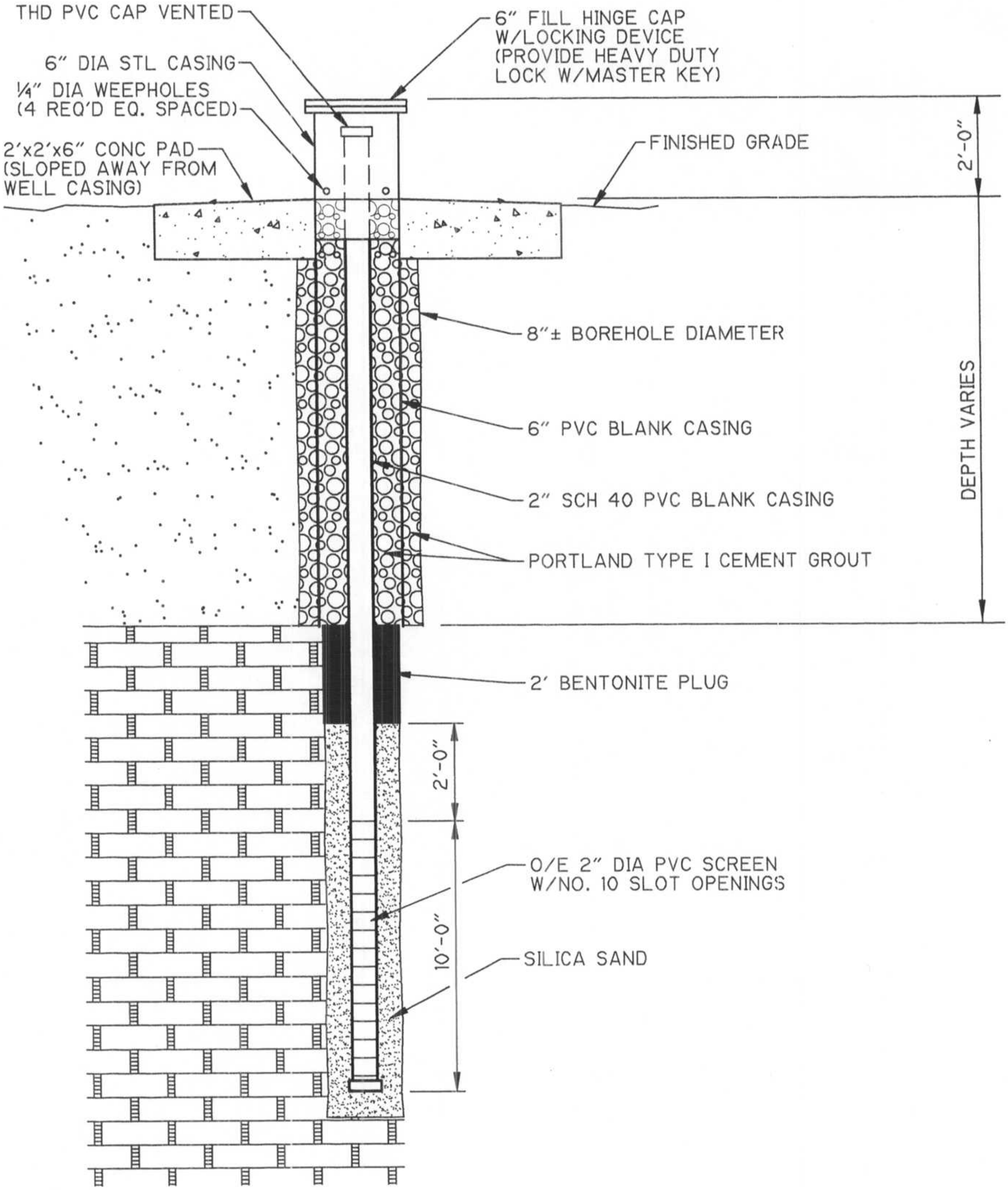
B-313

Figure No. ______



Well Hydrograph
B-227

CDM Camp Dresser & McKee



CDM Camp Dresser & McKee

Figure No. 3-2
TYPE III GROUNDWATER MONITORING WELL

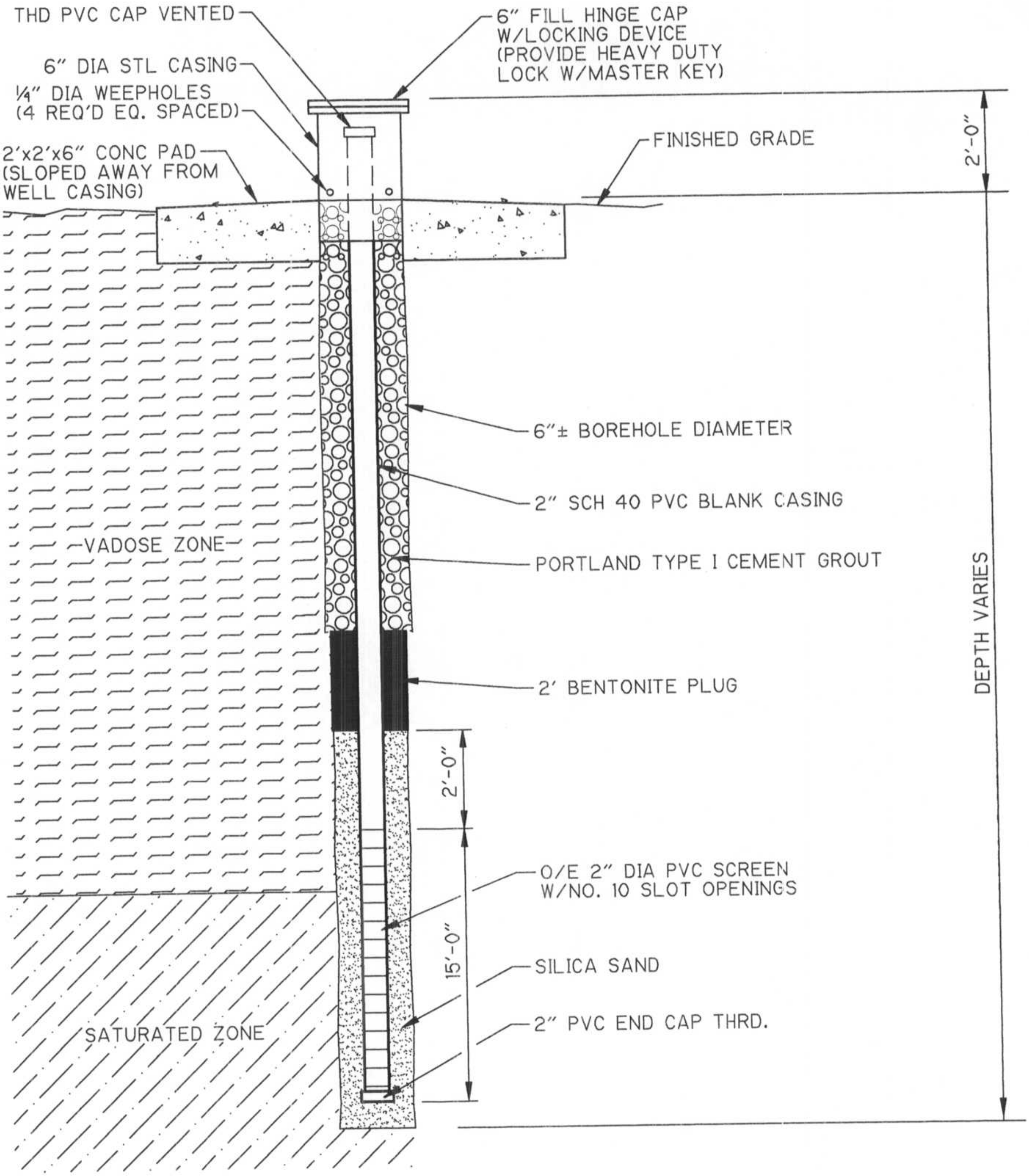


Figure No. 3-2
TYPE II GROUNDWATER MONITORING WELL