NCDENR
North Carolina Department of Environment and Natural Resources

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September 30, 2010

Ms. Carolyn Callihan
Superfund Site Evaluation Section
US EPA Region IV Waste Division
61 Forsyth Street, 11th Floor
Atlanta, GA 30303-3104

Subject: Site Inspection (SI)
Singer Co Furniture Div Plts 3 4 & MH (NCD 000 604 322)
904 Virginia Street Southwest
Lenoir, Caldwell County, NC 28645

Dear Ms. Callihan:

Enclosed is the Site Inspection Report for the Singer Co Furniture Div Plts 3 4 & MH site. Based on the findings of the Site Inspection, the NC Superfund Section recommends the site be assigned a "No Further Remedial Action Planned" (NFRAP) status under CERCLA. A copy of this report is being furnished to the Inactive Hazardous Sites Branch (IHSB) of the North Carolina Superfund Section for their review, and any further necessary action under State authority.

HRS score sheets will follow under separate cover. Please contact Jim Bateson at (919) 508-8449 if you have any questions.

Sincerely,

James M. Gamble, P.G.
Hydrogeologist
Site Evaluation and Removal Branch
NC Superfund Section

cc: Scott Ross, file

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Site Inspection (SI) Report

Singer Co Furniture Div Plts 3 4 & MH
NCD 000 604 322
904 Virginia Street Southwest
Lenoir, Caldwell County, NC 28645

September 30, 2010

Superfund Section
Division of Waste Management
North Carolina Department of Environment
And Natural Resources

Prepared by:

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EXECUTIVE SUMMARY

The North Carolina Superfund Section has completed a Site Inspection (SI) for the Singer Company Furniture Div Plts 3 4 & MH facility, NCD 000 604 322, 904 Virginia Street Southwest, Lenoir, Caldwell County, NC 28645. The SI included two site visits (one for reconnaissance and one for sampling) review of extensive historic information, and limited new sampling. The facility is currently idle and is presumably slated for demolition. The land encompassing most of the facility has been sold and is proposed for redevelopment. Land encompassing the old landfill remains titled to Singer.

The facility is composed of two manufacturing buildings, two relatively large lumber sheds, several small storage structures, about 3 acres of paved drive and parking areas, and an on-site landfill.

For more than 30 years the landfill was operated by various owners as the disposal site for all wastes generated during the manufacture of furniture, maintenance of the factories, and daily operations of the offices. Waste wood, metal, solvents, glues, paints, oils, office trash etc. were placed in the landfill. Before the construction of the furniture plant (1963) the landfill was owned and operated by the City of Lenoir and was open to the public. The total volume of waste is estimated at 243,000 yd^3 spread over and area of 10 acres. The footprint extends over two parcels, one owned by the City of Lenoir the other by Singer. In 1981 the landfill was closed: leveled and covered with a thin layer of soil. Currently the cover supports a more or less complete vegetative cover of trees, brush, grass, and weeds.

No records have ever been kept regarding what, where, or how much waste was placed in the landfill. In the 1950's waste would have been anything and everything from the surrounding community. From 1963 to 1976 the wastes would have been typical furniture manufacturing wastes such as finishing residues (both solid and liquid), glue wastes, solvents, paints, scrap wood, scrap metal, any trash generated at the facility. This material entered the landfill in bulk and/or in drums some of which was burned in open pits.

There is a dilute plume of metals and organics migrating away from the landfill via ground water. Ground water moves through flood plain sediments, residual soils/rock, and bedrock from the landfill to discharge into Lower Creek and its flood plain immediately north. There are no ground water users in this direction. The area is served by city water and no residents were located that use groundwater for drinking. Two wells are known or suspected to exist that could potentially be used for drinking. However, one of these is located about 1,100 ft. lateral from the landfill and the other is about 2,000 ft. up-gradient.

Metals and some organics are moving away from the landfill via surface water. These contaminants are likely entering Lower Creek immediately north of the landfill and flowing with it toward Lake Rhodhiss. Lake Rhodhiss is a water supply lake and is used for recreational

boating and fishing. There are environmental targets along the surface water migration pathway beginning about 1.5 miles downstream from the facility. Due to the dilution impact of Lower Creek at these targets, and the relatively low freshwater ecosystem toxicity / persistence / bioaccumulation factor values of groundwater contaminants these targets are not suspected to be exposed to actual contamination from the Singer facility. The surface water intakes on Lake Rhodhiss are beyond the 15 mile target distance limit.

Five metals; barium, chromium, copper, iron, and vanadium were detected in the surface water migration pathway at concentrations greater that three times background. No concentrations detected in sediment exceeded the NC Inactive Hazardous Sites Branch concentrations for those compounds in Industrial soil. Similarly, no surface water concentrations exceeded the NCAC 2B Surface Water standard.

The NC Superfund Section recommends the site be assigned a "No Further Remedial Action Planned" (NFRAP) status under CERCLA. A copy of this report is being furnished to the Inactive Hazardous Sites Branch (IHSB) of the North Carolina Superfund Section for their review, and any further necessary action under state authority.

1.0 INTRODUCTION

Under authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA), the North Carolina Superfund Section conducted a Site Inspection (SI) at the Singer Co Furniture Div Plts 3 4 & MH (CERCLIS id. NCD 000 604 322) in Lenoir, Caldwell Count, NC. The purpose of this investigation was to collect information concerning conditions of the on-site landfill sufficient to assess the threat posed to human health and the environment and to determine the need for additional CERCLA/SARA or other appropriate action.

The investigation included; reviewing previous investigations at the site, sampling environmental media, and making observations about the surrounding community. This information was collected for evaluating and documenting HRS factors. (1)

2.0 SITE DESCRIPTION, OPERATIONAL HISTORY AND WASTE CHARACTERISTICS

2.1 Site Location and Climate

The site is spread across two parcels with different addresses. The property with the manufacturing plants is identified in Caldwell County property records at 914 Virginia Street, Lenoir, Caldwell County, NC 28645. The parcel with the landfill has an address of 714 Virginia Street, Lenoir, Caldwell County, NC 28645. CERCLIS lists the site at 904 Virginia Street Southwest, Lenoir, NC 28645. The site reference point is the approximate center of the southern edge of the main manufacturing building, Plant 33, located at 35.8929^{o} north latitude and 81.5546^{o} west longitude, Figure 1.

Caldwell County lies in west central North Carolina approximately 25 miles northwest of Hickory, NC. The county lies near the western edge of the piedmont physiographic province. (2) This area is characterized by moderately steep hills with long narrow valleys. Elevations there range from 930 ft. above mean sea level (msl) to 5,921 ft. msl. (3)

Caldwell is a medium size county with 472 square miles of land area. This makes it the 52nd largest by land area of North Carolina's 100 counties. According to the US Census Bureau, Caldwell Count had a population of 77,415 in 2000 with average household size of 2.48. It had a population density of 163 people per square mile. The county is North Carolina's 29th largest by population density. (4) The Caldwell County code is 14.

Western North Carolina has a mild climate with hot humid summers and mild winters. In Caldwell County the average high temperatures reach the mid to upper 80's in July and August and the upper 40's in January. The two year, 24 hour rainfall intensity is estimated at 0.15 inches. The mean annual lake evaporation is about 36 inches, and the average annual precipitation is 49.2 inches resulting in a net annual precipitation of 13.2 inches. (5) (6)

2.2 Site Description

The facility lies within the city limits of Lenoir in an industrial area along the city's main western thoroughfare, Morganton Boulevard (NC Hwy 18, US Hwy 64). The site is bordered by Virginia Street to the east and south, Fairview Drive to the west and City of Lenoir property and Lower Creek to the north. Residences lie southwest of the site across Fairview Drive. The nearest residence is more than 700 ft. from the site and the landfill, Figure 2.

When the Kent Coffey Furniture Company first developed the facility it identified the larger manufacturing building as Plant 3 and a smaller wood laminating building as Plant 4. Subsequently a different owner renamed the buildings Plants 33 and Plants 54. Collectively, the manufacturing buildings and ancillary facilities have been referred to as the Miller Hill Complex.

The Miller Hill Complex sits on a relatively flat man-made bench near the base and northern end of an elongate hill. The hill trends NE-SW and rises to a maximum height of about 1,236 ft.. above sea level about 1/2 mile southwest from the facility. The bench was created by cutting into the hill and filling in the flood plain. South of Plant 54, the remaining hill rises steeply about 75 ft. then drops steeply to Virginia Street.

Virginia Street, which borders the property on the east, runs north-south past the facility then turns southwest behind and passes along the south side of the ridge. There are currently no residences along Virginia Street in the vicinity of the facility. Five former residences on the east side of Virginia Street directly across from the Singer parking lot are now vacant and the parcels have been recombined into a single tract, which is now owned by Tapaha Dynamics, LLC. Similarly, former residential properties along the east side of Fairview Road are now owned by Tapaha Dynamics, LLC. They have been recombined with one of the Singer Tracts into a single parcel. The west side of Fairview Road is residential.

The two land parcels that historically encompassed the facility totaled about 59 acres. There is a northern parcel that is approximately 22 acre in size, which encompasses the landfill, a lumber shed, and the flood plain to the north. There is a southern parcel, approximately 37 acres in size, which contains the remaining significant infrastructure and buildings. After recombination with the above-referenced residential parcels, the southern parcel size is now about 56 acres.

The complex is composed of Plant 33 (an approximately 175,000 sq. ft. building), Plant 54 (an approximately 41,000 sq. ft. building), a lumber shed (approximately 13,000 sq. ft.), and a storage building (about 4,140 sq. ft.). There is an apron of asphalt (about 100 ft. wide) around the main plant on the west south and east sides and a large (2.3 acre) paved parking area on the east side, which extends from the Plant 33 to Virginia Street. On the northern parcel is a lumber shed (approximately 16,000 sq. ft.) and another storage building (about 4,750 sq. ft.). Site and area layout are shown on Figure 2 and Figure 3.

2.3 Site Operational History and Waste Characteristics

Activities at the site began in the 1950's, when the edge of the floodplain was used as a public landfill operated by the City of Lenoir. Portions of the land were bought in 1963 by the Kent Coffey Furniture Company, which built Plant 33 and continued to use the landfill. The wood laminating facility (Plant 54) was built in 1966. The Magnavox Company bought the facility in 1969 and continued to operate it until 1973.

The Singer Company bought the facility in 1973. They operated the facility including the landfill much as it had always operated until 1976. In 1976, Singer began sending its finish residue and other trash to the Caldwell County Landfill and Incinerator. In 1980, Singer began operating its own hazardous waste incinerator and closed the landfill entirely in 1981. Use of the lumber yard ended in 1989. In October 1995, furniture manufacturing was stopped at Plant 33. Manufacturing equipment was removed and the space was converted into storage. A wood drying kiln and the wood laminating operations continued briefly. All operations ceased in 1997.

The facility currently stands idle. The landfill remains grassed over with many trees growing through it. The parcel that includes Plant 33 and Plant 54 has been sold. Tapaha Dynamics LLC currently owns a nearby data center and has consolidated many pieces of property between the current data center and the former Singer facility. The presumption when talking to local citizens and government officials is that the former Singer facility will be razed for an expansion of the data center. (7) The parcel that includes the landfill remains titled to Singer. The landfill is the focus of this SI.

No records have ever been kept regarding what, where, or how much waste was placed in the landfill. In the 1950's waste would have been anything and everything from the surrounding community. From 1963 to 1976 the wastes would have been typical furniture manufacturing wastes such as finishing residues (both solid and liquid), glue wastes, solvents, paints, scrap wood, scrap metal, and any trash generated at the facility. This material entered the landfill in bulk and/or in drums, some of which was burned in open pits. (8) (9)

Among the glue wastes placed in the landfill would have been the dried residuals and soil from the glue wash evaporation pond. Dilute mixtures of glue and water were poured into a depression behind Plant 54 where the volatile liquids were allowed to evaporate. The remaining dried residue was periodically scrapped up and placed in the landfill. (8) (9)

After 1976, when Singer began sending finishing wastes off site, the wastes going into the landfill were limited to wood and metal wastes. The landfill was closed in 1981 and no additional waste is believed to have been placed. The above history was compiled from the site histories presented in several previous investigations. (9) (10) (8)

2.4 Previous Environmental Investigations

Known previous environmental investigations are as follows:

1978 – Report of Preliminary Subsurface Investigation, Law Engineering Testing Company: This is a report of geotechnical borings advanced to evaluate the suitability of soils to support building foundations. One of the areas investigated was on the landfill north of the limber shed. The borings encountered too many rock fragments to allow a reliable geotechnical evaluation. No mention is made of waste materials. (11)

1980 – Report of Preliminary Geotechnical Exploration, Law Engineering Testing Company: This is a report of additional geotechnical investigations for construction purposes and does not address landfill conditions. (12)

1982 – Landfill Investigation Report; Phase I, Sirrine Company: This is the report of a limited investigation (4 monitoring wells) to determine whether contaminants were migrating from the landfill via groundwater. It was concluded that organic compounds and metals present immediately down gradient were migrating from the landfill. Arsenic, lead, chromium, and barium in groundwater were greater than the Maximum Contaminant Level (MCL) at that time. (13)

1983 – Landfill Investigation Report; Phase II, Sirrine Company: This is the report of additional investigation to learn the down gradient extent of contamination identified in Phase I and to estimate the hydraulic conductivity of the floodplain sediments. Three additional wells were installed. The report concluded that the contaminants had not migrated significantly. Monitoring wells located about 300 ft. down gradient did not show contamination. (10)

1988 – RCRA Facility Assessment, US EPA: This is a summary of field work conducted by the EPA in November 1987. It identified nine solid waste management units (SWMUs) and included the following recommendations: (8)

- SWMU No. 1 Old Landfill – groundwater monitoring plan needed
- SWMU No. 2 Abandoned Drums by Lower Creek – a formal investigation needed to determine the contents and impact followed by removal as appropriate
- SWMU No. 3 Glue Wash Evaporation Pond – soil and groundwater testing needed
- SWMU No. 4 Incinerator – no further action required, managed under state RCRA permit
- SWMU No. 5 Water Wash Storage Tank – no further action required
- SWMU No. 6 Hazardous Waste Storage Area – soil sampling recommended
- SWMU No. 7 Waste Satellite Storage Area – no further action required
- SWMU No. 8 Floor Area Lumber Yard Building – no further action required
- SWMU No. 9 Spill at Oil Tank, Lumber Yard Bldg. – soil and ground water sampling needed.

1989 – Preliminary Assessment. No further action under CERCLA was recommended and this site was archived from CERCLIS.

1995 – Geophysical Investigation Report; Phase II: Seismic Refraction Survey, Pyramid Environmental. – This is the report of a seismic refraction survey conducted across the landfill

and adjacent area. Results of this survey identify several layers in the subsurface that support discernibly different wave velocities. The different velocities are in turn interpreted as representing layers of the subsurface. The top layer is interpreted to include the wastes placed in the landfill. Note: it is these depths combined with estimates of the lateral extent that were used by the NC Superfund Section to estimate the volume of the landfill. (14)

1997 - RCRA Facility Investigation (RFI) Report; Environmental Quality Management, Inc. – The RFI was completed in accordance with the requirements of Singer's permit (NCD 000 604 322) to operate a hazardous waste incinerator and container storage facility. The report documented environmental investigations at five SWMU's. It included the following conclusions: (9)

- "No quantifiable offsite releases of hazardous constituents have been emitted from the Singer property."
- "Hazardous constituents, at concentrations below those which cause exceedances [sic] of commonly accepted health-based risk levels, have been detected in soils and/or groundwater located near SWMU No. 1, SWMU No. 3, and SWMU No. 9."
- "SWMU No. 6 was closed under the provisions of the RCRA Permit and it has been demonstrated that there is no statistically significant difference between the soil of SWMU No. 6 and the background soils."
- "The historical source of contamination at SWMU Nos. 2, 3, and 9 has been removed."
- "The landfill (SWMU No. 1) has been in existence for more than 57 years and it has not been active for more than 17 years."
- There is a dilute plume of metals and organics migrating away from the landfill via ground water. Recommendations include annual monitoring at five groundwater wells, surface water and swamp sediments located downgradient [sic] of SWMU No. 1. If the concentration of any hazardous constituent exceeds levels specified herein, Singer and /or its successors will notify the government and implement an investigation plan designed to verify the changed conditions and to determine if abatement or other corrective actions are warranted."

The NC Superfund Section is not aware of any monitoring of the landfill after the 1997 RFI.

3.0 WASTE / SOURCE SAMPLING AND RESULTS

Although no records about landfill operations were maintained, the footprint of the landfill is apparent from elevation data. Using this data, the location and volume of wastes can be estimated. No source samples were collected for this SI due to the number of previous studies. The source, the landfill, is an approximately 243,000 cubic yard mass of mixed waste from the manufacture of furniture, facility maintenance, and the community. It is spread over about 10 acres and is about 15-20 ft. thick (on average). The landfill is covered with a thin layer of soil and sawdust which supports a more or less complete vegetative cover. The landfill's

leading edge is made up of large boulders; through which trees are growing. The flat portion of the landfill is overgrown with brush and grass. Pieces of metal and concrete are visible at irregular intervals across the landfill. The landfill is not maintained. Precipitation readily infiltrates the wastes and can leach chemicals from the waste.

4.0 GROUNDWATER PATHWAY

4.1 HYDROGEOLOGIC SETTING

The site lies within the Piedmont Physiographic Provence, near its western limit. The Brevard Fault Zone, which is the boundary between the Piedmont and Blue Ridge Physiographic regions, is about five miles northwest from the site. The Brevard Fault Zone is a major structural feature, geologically speaking, that passes through the entire state. It crosses into North Carolina in the south about where the South Carolina – North Carolina – Georgia boarders meet and runs northeast and out of the state to the west of Danville, Virginia. The surface trace is mapped as a northeast-southwest trending arc of about 200 miles long. (15) Beneath the surface, the fault zone dips southeast and flattens out as it extends beneath much of central North Carolina. Near that surface the dynamics of the rock sliding along this surface have pressed a fabric into the region that is visible in the topography as high relief elongate hills oriented parallel (NE-SW) to the fault zone's surface trace. At the surface, bedrock types too appear as elongate irregular bands that are roughly parallel to the fault zone's surface trace.

Bedrock beneath the site is mapped as a foliated to massive migmatic granitic gneiss. This rock is composed generally of quartz, feldspars, and mica minerals in various arrangements. The bedrock surface is irregular. (14) No conductivity testing was completed on the bedrock.

Atop the un-weathered bedrock sits a mantle of residual material that is derived from the weathering in-place of the underlying bedrock. This partially weathered rock retains some of the fabric of its parent material as well as remnant rock fragments. The residual material varies in thickness over the site but is about 5 – 20 ft. thick beneath the flood plain. (10) It was described in one report as "…layered bands of highly weathered feldspathic rock fragments, coarse quartz grains, biotite, and clay." (10) Hydraulic conductivity estimates for the residuum (saprolite) were on the order of 10^{-5} cm/s to 10^{-4} cm/s. (9)

In the floodplain the residual material is overlain by sediments deposited by water (alluvium). The alluvial sediments vary in thickness from 0 ft. where they pinch out against the hillsides to about 35 ft. adjacent to the creek. The alluvium is described as "…brown to grayish-black silty clay and clayey silt." in the upper part to "…blue-grey to yellow brown fine to coarse sand with basal gravel." in the lower part. (10) Some investigators subdivided the alluvial unit into upper and lower units based on the greater coarseness near the bottom. However, other testing: slug tests, grain size analyses, and borehole permeability tests did not suggest very different hydraulic properties from the top to the bottom of the alluvium. Hydraulic conductivity estimates range from 10^{-5} cm/s to 10^{-3}cm/s throughout the alluvium. (9) (10)

Precipitation infiltrates the subsurface and moves through the sediments and rocks from the hill tops and slopes to the floodplain and creek where it emerges into the surface water. In general, the highest velocities occur in the bedrock where water moves along fractures and/or the fabric of the rock. The bedrock has essentially no storage capacity and is recharged by water infiltrating from overlying layers. The partially weathered rock and the alluvial sediments act as both conduits for water movement to the streams and as reservoirs for recharging lower layers. The entire system constitutes a single aquifer.

4.2 Ground Water Targets

The site and the community immediately surrounding it lay entirely within the city limits of Lenoir. City water lines run along the streets that surround the facility; Virginia Street, Morganton Blvd, and Fairview Drive, Figure 4.

The 1983 Landfill Investigation identified eight wells along Virginia Street. (10) The well locations were estimated from the maps provided in the report and are reproduced here in Figure 4. Of the eight wells identified then only one, WW-1, remains in use today. NC Superfund Staff observed in December 2009 and January 2010 that all of the houses served by the remaining wells are vacant and dilapidated. The parcels all along Virginia Street have been purchased by Tapaha Dynamics, LLC and recombined into a single parcel. It seems clear that these houses will be demolished for the expansion of the nearby data center. (7)

Additionally, one other well was observed by NC Superfund Section Staff. There is a well house on the property located at 1102 Fairview Rd., about 1,600 ft. southwest from the site. No one was home at the time of the survey, so staff could not ask whether there was a well or, if so, is it still in use. However, there is a water meter in the front yard. The remaining surrounding residents were all connected to city water and no other wells were observed.

There are no potable wells down gradient between the landfill and the ground water discharge at Lower Creek. It does not appear that there are any viable groundwater targets. No ground water samples were collected during this Site Inspection.

Groundwater-to-surface water interactions were not evaluated for this SI. Documenting a groundwater-to-surface water release to Lower Creek would not change the recommendation for no further action under CERCLA for several reasons: the lack of nearby surface water targets, the dilution impact of Lower Creek at these targets, and the relatively low freshwater ecosystem toxicity / persistence / bioaccumulation factor values of groundwater contaminants.

5.0 SURFACE WATER PATHWAY

5.1 HYDROLOGIC SETTING

Water that runs off the site flows north across impermeable surfaces to man-made and natural ditches and underground conduits. During the early development of the site an unnamed tributary to Lower Creek that flowed across the eastern edge of the property was piped. A storm

drain catches the water behind Plant 54 and carries it 900 ft. via a culvert beneath the parking area to a discharge point adjacent to the landfill, Figure 5. Beyond this discharge point the drainage is open.

Surface run-off continues in open drainages along the east side of the landfill across the flood plain to Lower Creek. Lower Creek flows southwest approximately twelve miles to Lake Rhodhiss, Figure 6. The 15 mile surface water pathway ends in Lake Rhodhiss.

5.1.1 Overland Segments

The landfill is immediately adjacent to an unnamed tributary to Lower Creek. There is no separation between the landfill and the tributary so there is no overland segment. The PPE is estimated as where the toe of the landfill abuts the tributary.

5.1.2 In-Water Segments

Below the PPE, the unnamed tributary flows about 400 ft. north to its confluence with Lower Creek. Lower Creek is a moderate size stream with average daily flow on the order of tens of cubic ft. per second (cfs) up to about 100 cfs. Peak flows range up to around 1000 cfs. (16) In the area near and downstream from the Singer Furniture site, the stream has a floodplain that varies from about 100 ft. wide to about 1,000 feet wide. The Singer Furniture facility does not lie within the flood zone. The limit of the flood zone, Zone A (100 yr), along the creek follows the contour of the landfill. (16) The wastes were placed in the flood plain and likely become saturated during high water events. The bulk of waste however do not appear to impede flow except on the city owned property where wastes extend to near the creek.

5.2 Surface Water Targets

5.2.1 Drinking Water

The area is served by the municipal water system. Contaminants in the surface water move in sediment and water along Lower Creek some twelve miles to Lake Rhodhiss. The countryside along the surface water migration pathway is mostly rural and agricultural with some residential development. Agriculture along the way is both crops and grazing.

There are two surface water intakes on Lake Rhodhiss; beyond the 15 mile target distance limit. The nearest, about 1.5 miles beyond the target distance limit, serves a 12 million gallon per day filtration plant for the Town of Valdese, in Burke County, NC and the second, which lies about 6 miles beyond the target distance limit, serves a 12 million gallon per day filtration plant for the City of Lenoir.

5.2.2 Human Food Chain

No fishing or recreational activity was observed along Lower Creek near the site and up to about 5 miles below the PPE. Lake Rhodhiss is a recreational lake which is used for boating and fishing. Lower Creek is classified by the NC Division of Water Quality as a Class C surface water body. (17) Class C water bodies are defined as: "Waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life including propagation, survival and maintenance of biological integrity, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner." (17)

5.2.3 Environmental

There are about 3 miles of mapped wetlands through which Lower Creek flows before it enter Lake Rhodhiss (18) The nearest mapped wetland to the Singer facility is about 6.5 miles downstream from the PPE. The three remaining miles of the surface water migration pathway that extend into Lake Rhodhiss do not encounter other environmental targets.

Beginning about 1.5 miles downstream from the site, the NC Natural Heritage Program has identified the Sticky Bog Asphodel. This plant is not listed but is proposed for listing as "significantly rare". At about 3.5 miles downstream from the PPE, the NC Clean Water Management Trust Fund maintains a 2.05 acre easement. (19)

At about 8 miles downstream from the PPE and continuing to Lake Rhodhiss, Lower Creek flows through the Johns River Game Lands, a managed natural area owned by the NC Wildlife Resources Commission. (19)

5.3 SURFACE WATER PATHWAY SAMPLING

As detailed earlier, there have been several environmental investigations at the site. The 1997 RFI was completed under RCRA sampling protocols with robust quality control measures. Taken together these investigations give a reasonably good picture of the type and volume of waste, the condition of the landfill, and what chemicals are migrating from it. Background surface soil and surface water results for the RFI were used as background for this SI. See Table 2a and 1b for background sample details.

Sediment and surface water samples were collected from three locations to determine current conditions at the site. All sampling for the SI sampling event was conducted by NC Superfund Section staff in accordance with the NC Superfund Section Quality Assurance Program Plan (QAPP) (App. B) and Quality Assurance Standard Operating Procedures (QASOP). The QASOP adopts by reference the Field Branches Quality System and Technical Procedures, U. S. Environmental Protection Agency, Region 4. The Program Plan is derived directly from the EPA-Approved NC Department of Environmental and Natural Resources QA Plan for Data, 2004.

Sample SFC-01 was collected from the small tributary that passes along the east side of the landfill just before its discharge to Lower Creek. SFC-01 was collected from the middle of the stream bed. Sample SFC-02 was collected in that same tributary adjacent to the toe of the terminal edge of the landfill, at the PPE. SFC-02 was collected from sediments deposited in a small pocket in the bank at the stream's edge.

Sample SFC-03 was collected from the toe of the slope along the face of the landfill, where water was flowing from beneath the rip-rap that made up the slope. This was, as near as could be determined, the location of a leachate seep noted in RFI Report. The sediment at SFC-03 was iron-stained material deposited just where the water flowed from beneath a large boulder. The flow from this seep entered standing water in the flood plain where it seeped into sediments.

5.4 SURFACE WATER PATHWAY RESULTS

Six metals: barium, chromium, copper, iron, lead, and vanadium were detected at concentrations greater that three times background. No concentrations detected in sediment exceeded the NC Inactive Hazardous Sites Branch concentrations for those compounds in Industrial soil. Based on a comparison to background surface water sample (SW-3) there was a release of copper, iron, lead, and vanadium to surface water in the surface water pathway; however, no levels exceeded their NCAC 2B surface water standards.

In general, sediment at SFC-03 location had the highest concentrations of contaminants. Vanadium and Chromium were highest at location SFC-02. The highest concentrations detected in surface water were generally at the location of SFC-01. Copper was highest at SFC-02 and Barium was highest at SFC-03. Results are summarized in Table 3. Sample locations area shown on Figure 5.

5.5 SURFACE WATER PATHWAY CONCLUSIONS

There has been an observed release of barium, chromium, copper, iron, and vanadium to sediments in the unnamed tributary to Lower Creek that flows adjacent to the landfill. There has been an observed release of copper, iron, and vanadium to surface water in the unnamed tributary to Lower Creek that flows adjacent to the landfill. While no samples were collected in Lower Creek, the nearest fishery is not closer than five miles below the tributary's confluence with Lower Creek and the nearest surface water pathway target other than a fishery is 3.5 miles below the PPE.

6.0 SOIL EXPOSURE AND AIR PATHWAY

The landfill is relatively inaccessible to would-be trespassers. There is not a fence enclosure around the landfill. However, adjacent portions of the facility are fenced, which limits

access to the landfill. The former lumber yard to the east is surrounded on three sides by a 6-8 foot high chain link fence. This fence runs the entire length of the landfill on the east. A similar fence encloses the plant buildings on all sides except across the landfill. The city owned property on the west is wooded and overgrown as is much of the landfill property. Access is available via a power line/sewer line maintenance lane. This un-kept narrow lane is passable by vehicle (4 wheel drive would be needed) or by foot. It begins along Fairview Road just south of its bridge over Lower Creek. It runs along the south side of the creek and along the east side of the landfill. Section staff observed beer cans and evidence of occasional access near the bridge immediately after turning off Fairview Road onto the maintenance lane. No evidence of recreational access was observed beyond that point. The remaining portions appeared to be used strictly for maintenance of the power and sewer lines.

Because of the relatively difficult access and the forest/grass covering, casual exposure to landfill soils is unlikely. For that reason, the section did not evaluate the soil exposure pathway.

Due to the remoteness alluded to above and the low volatility of the contaminants detected (metals) the Section judged that the air migration pathway is incomplete and did not evaluate it.

7.0 SI SUMMARY AND CONCLUSIONS

The North Carolina Superfund Section has completed a Site Inspection for the Singer Company Furniture Div Plts 3 4 & MH facility. The SI included two site visits (one for reconnaissance and one for sampling), review of extensive historic information, and limited new sampling. The facility is currently idle and is presumably slated for demolition. The land encompassing most of the facility has been sold and is proposed for redevelopment. Land encompassing the old landfill remains titled the Singer, which was the focus of this SI.

For more than 30 years the landfill was operated by various owners as the disposal site for all wastes generated during the manufacture of furniture, maintenance of the factories, and daily operations of the offices. Waste wood, metal, solvents, glues, paints, oils, office trash etc. were placed in the landfill. Before the construction of the furniture plant (1963) the landfill was owned and operated by the City of Lenoir and was open to the public. The total volume of waste is estimated at 243,000 yd^3 spread over an area of about 10 acres. The footprint extends over two parcels, one owned by the City of Lenoir the other by Singer.

No records were kept about landfill operations, so there is no precise information about waste type, volume, or placement. The wastes were placed north of the facility where the land surface dropped down to the flood plain of Lower Creek. Upon its final closure in 1981, the

landfill was covered with a thin layer of soil and sawdust and left alone. Currently the area is partially forested and partially grassed.

There is a dilute plume of metals and organics migrating away from the landfill via ground water. Ground water moves through flood plain sediments, residual soils/rock, and bedrock from the landfill to discharge into Lower Creek and its flood plain immediately north. There are no ground water users in this direction. The area is served by city water and no residents were located that use groundwater for drinking. Two wells are known or suspected to exits that could potentially be used for drinking, see Figure 4. However, one of these is located about 1,100 ft. lateral from the landfill and the other is about 2,000 ft. up-gradient.

Metals are moving away from the landfill via overland surface water. These contaminants are likely entering Lower Creek immediately north of the landfill and flowing with it toward Lake Rhodhiss. Lake Rhodhiss is a water supply lake and is used for recreational boating and fishing. There are environmental targets along the surface water migration pathway beginning about 3.5 miles downstream from the facility. These targets are not known nor suspected to be exposed to actual contamination from the Singer facility. The surface water intakes on Lake Rhodhiss are beyond the 15 mile target distance limit.

The functional remoteness and low volatility of the contaminants detection indicates that exposure via the soil or air migration pathway is unlikely.

The North Carolina Superfund Section recommends that the site be assigned a “No Further Remedial Action Planned” (NFRAP) status under CERCLA. A copy of this report is being furnished to the Inactive Hazardous Sites Branch (IHSB) of the North Carolina Superfund Section for their review, and any further necessary action under state authority.

Singer Co Furniture Div Plts 3 4 & MH
NCD 000 604 322
SI References:

1. **United State Environmental Protection Agency.** 40 CFR Part 300, Hazard Ranking System, Final Rule. *Federal Register.* Washington, D.C. , 1990. Vol. 22, 241.

2. **Prowell, David C. and Obermeier, Stephen F.** Evidence of Cenozoic Tectonism. [book auth.] J. Wright, Jr. and Zullo, Victor A. Horton. *The Geology of the Carolinas.* Knoxville : The University of Tennessee Press, 1991.

3. **NC Department of Transportation.** NCDOT GIS Data Distribution, 2007 LiDar data. *North Carolina Department of Transportation.* [Online] NC Department of Transportation, 2007. [Cited: June 29, 2010.] http://www.ncdot.org.

4. **US Census Bureau.** Census 2000 Data for the State of North Carolina. *U.S. Census Bureau.* [Online] 2000. [Cited: May 24, 2010.] http://www.census.gov/census2000/states/nc.html.

5. **North Carolina State University.** 1971 - 2000 Climate Normals. *State Climate Office of North Carolina.* [Online] 2000. [Cited: May 24, 2010.] http://www.nc-climate.ncsu.edu/cronos/normals.php.

6. **United States Department of Commerce.** Climatic Atlas of the United States. Asheville : National Climatic Center, 1979.

7. **North Carolina Superfund Section.** Record of Conversation with Planning Director. Raleigh : North Carolina Division of Waste Management, 2010.

8. **United States Environmental Protection Agency.** *RCRA Facility Assessment for the site of Singer Furniture Company Plant No 33.* Atlanta : USEPA Region IV, 1988.

9. **Environmental Quality Mangement, Inc.** *Findings, Conclusions, and Recommendations of the RCRA Facility Investigation Singer Furniture Company Miller Hill Complex.* Durham : Environmental Quality Management, Inc., 1997.

10. **J.E. Sirrine Company Engineers.** *Landfill Investigation Report; Phase II Singer Furniture Plant No. 3.* Greenville : Sirrine Company, 1983.

11. **Law Engineering Testing Company.** *Report of Preliminary Subsurface Investigation Singer Furniture Plant Nos. 3 and 4 Additions.* Charlotte : Law Engineering, 1978.

12. **Law Engineering Testing Company**. *Report of Preliminary Geotechnical Exploration.* Charlotte : Law Engineering, 1980.

13. **J.E. Sirrine Company.** *Landfill Investigation Report (Phase I).* Greenville : Sirrine Company, 1982. Environmental Investigation.

14. **Pyramid Environmental, Inc.** *Geophysical Investigation Report, Phase II: Seismic Refraction Survey.* Greensboro : Pyramid Environmental, Inc., 1995. Geophysical Survey.

15. **North Carolina Geological Survey.** *Geologic map of North Carolina, 1:500,000 scale.* Raleigh : North Carolina Geological Survey, 1985.

16. **State of North Carolina.** Floodplain Maping Information System [FMIS]. *North Carolina Floodplain Mapping Program.* [Online] 2009. [Cited: May 1, 2009.] http://www.ncfloodmaps.com/.

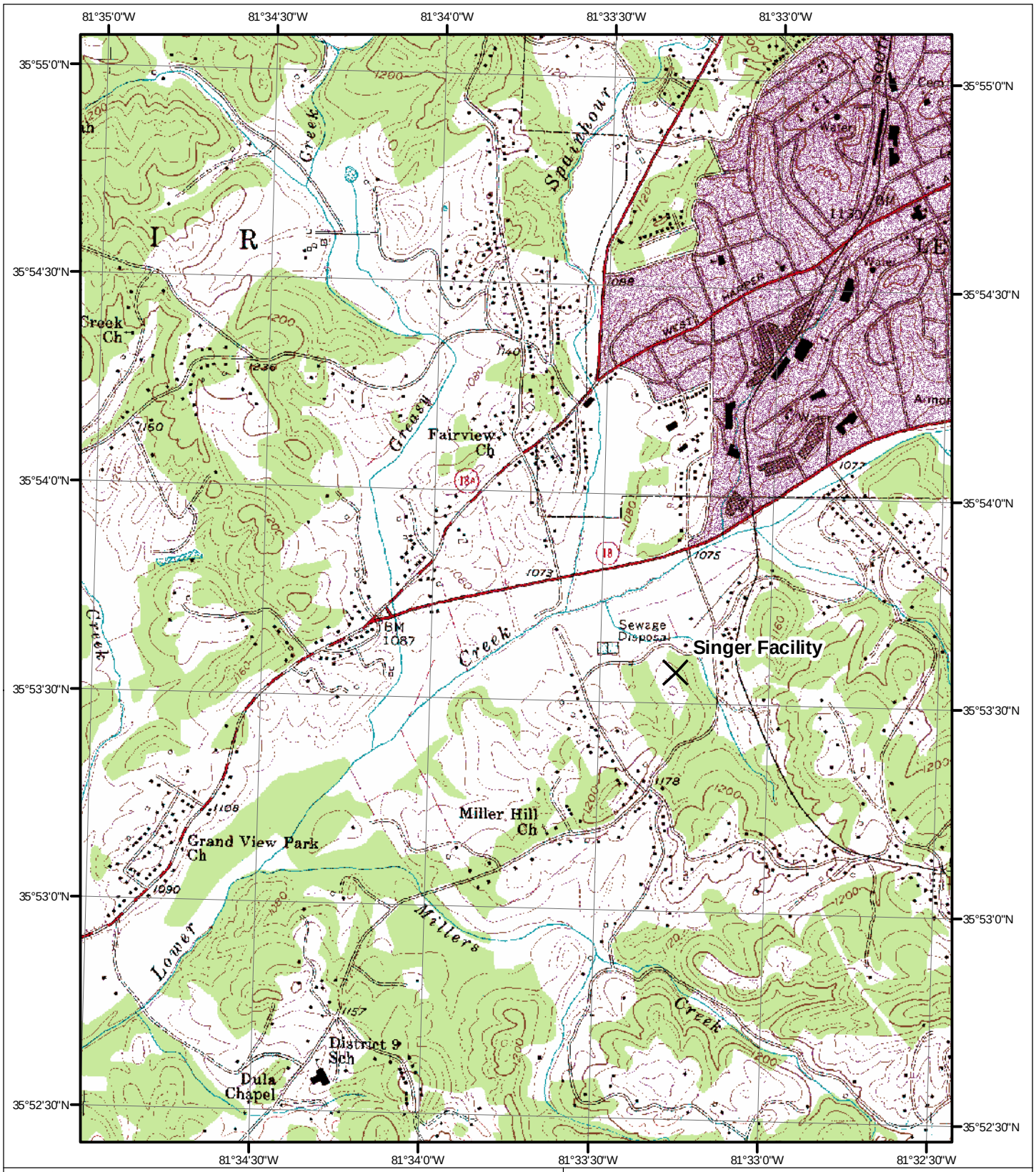
17. **North Carolina Division of Water Quality.** Surface Water Classifications. *N.C. Division of Water Quality.* [Online] North Carolina Department of Environment and Natural Resources. [Cited: May 1, 2009.] http://portal.ncdenr.org/web/wq/ps/csu/classifications.

18. **U.S. Fish & Wildlife Service.** National Wetlands Inventory. *U.S. Fish & Wildlife Service.* [Online] United State Department of the Interior. [Cited: May 1, 2009.] http://www.fws.gov/wetlands/data/WMSLayerInfo.html.

19. **North Carolina Department of Environment and Natural Resources.** North Carolina Natural Heritage Program. *The North Carolina Natural Heritage Program.* [Online] 2010. [Cited: January 1, 2010.] www.ncnhp.org.

20. **North Carolina Division of Water Resources.** Water Resources Information, Storage, Analysis, and Retrieval System (WRISARS). *Divison of Water Resources.* [Online] [Cited: May 20, 2009.] http://www.ncwater.org/wrisars/index.php.

Figures



County Location

Map Extent:
Caldwell County

USGS 7.5 Minute Topographic Quadrangle: ***Lenoir***

Coordinates of approximate center of ***Singer - Miller Hill Complex***:

Longitude:	81° 33' 16.57"	Latitude:	35° 53' 34.51"
	81.5546°		35.8929°

Facility Location Map

Site Name:	Singer Co Furniture Div Plts 3 4 & MH
Site Number:	NCD000604322
Scale:	1:24,000
Date:	December 28, 2009
Figure	1
Prepared by:	JMG

Est. extent of landfill on Singer Property

Est. total extent of landfill.

Parcels

0 250 500 1,000 Feet

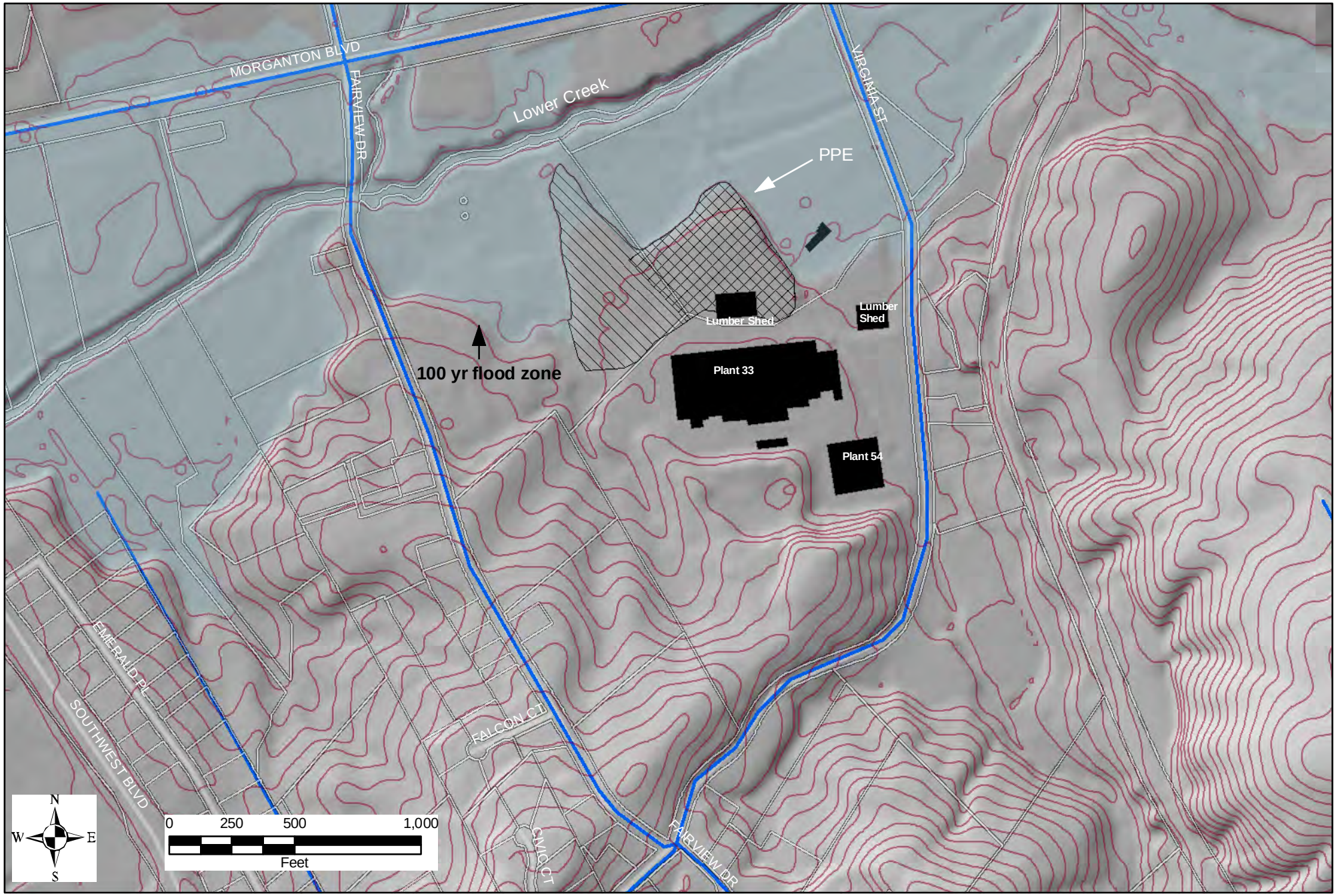
Absolute Scale 1:6,000

County location:

Base map is 2008 aerial imagery available at www.nconemap.com.
Parcels and roads provided by Caldwell County.

Facility Layout on Aerial Imagery

Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	September 22, 2010
Figure:	2	Prepared by:	NCDWM



Est. extetn of landfill on Singer property.

Est. total extent of landfill.

Parcels

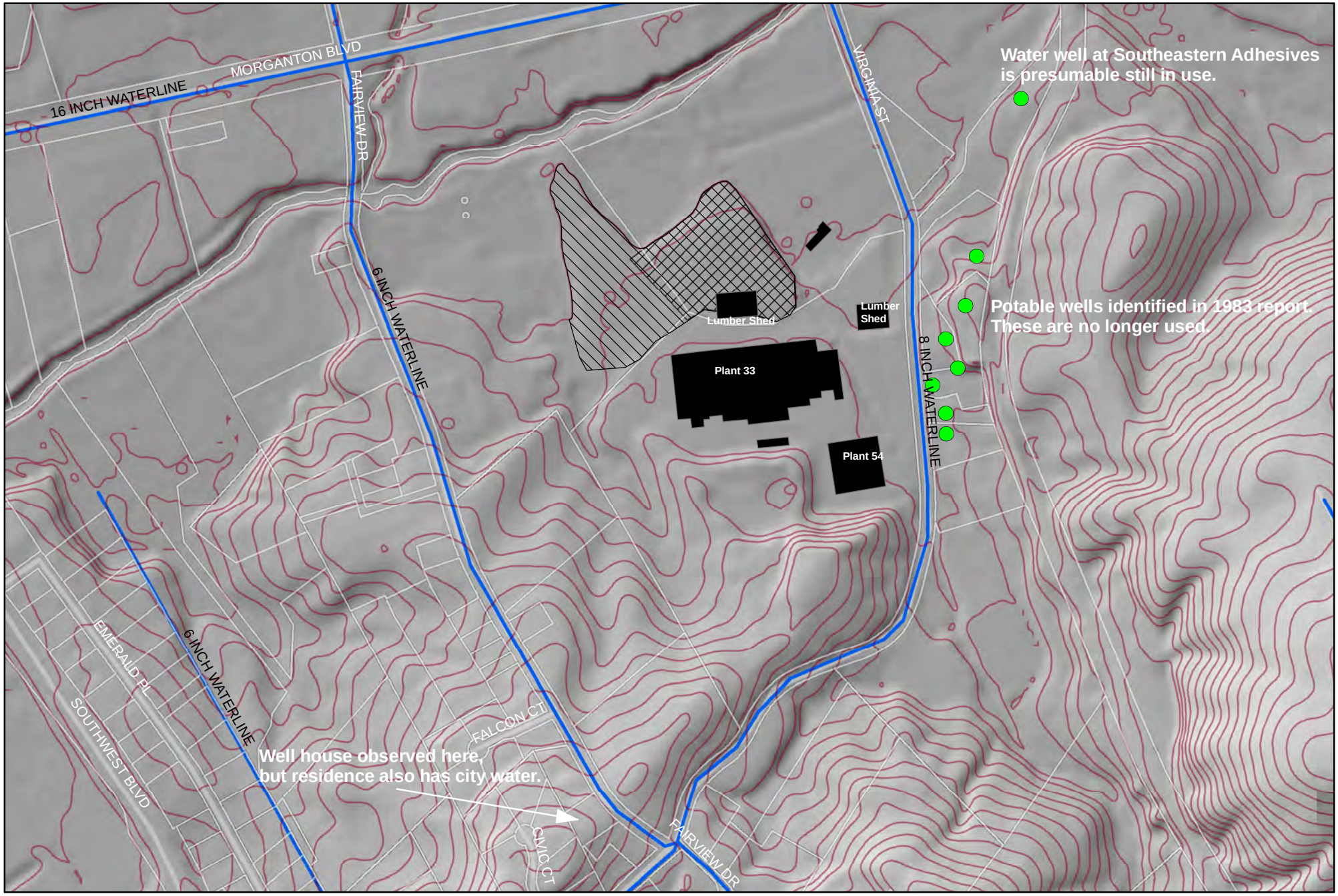
Absolute Scale 1:6,108

County location:

Base map is hillshade from 2007 Lidar imagery available from NC Department of Transportation. Contour interval is 10 feet and is based on 2007 Lidar elevation measurements. Parcels, roads, and water lines provided by Caldwell County. Building footprints traced by NC Superfund Staff from 2008 aerial imagery.

Facility Layout on Topography

Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	September 22, 2010
Figure:	3	Prepared by:	NCDWM



N
W E
S

0 250 500 1,000 Feet

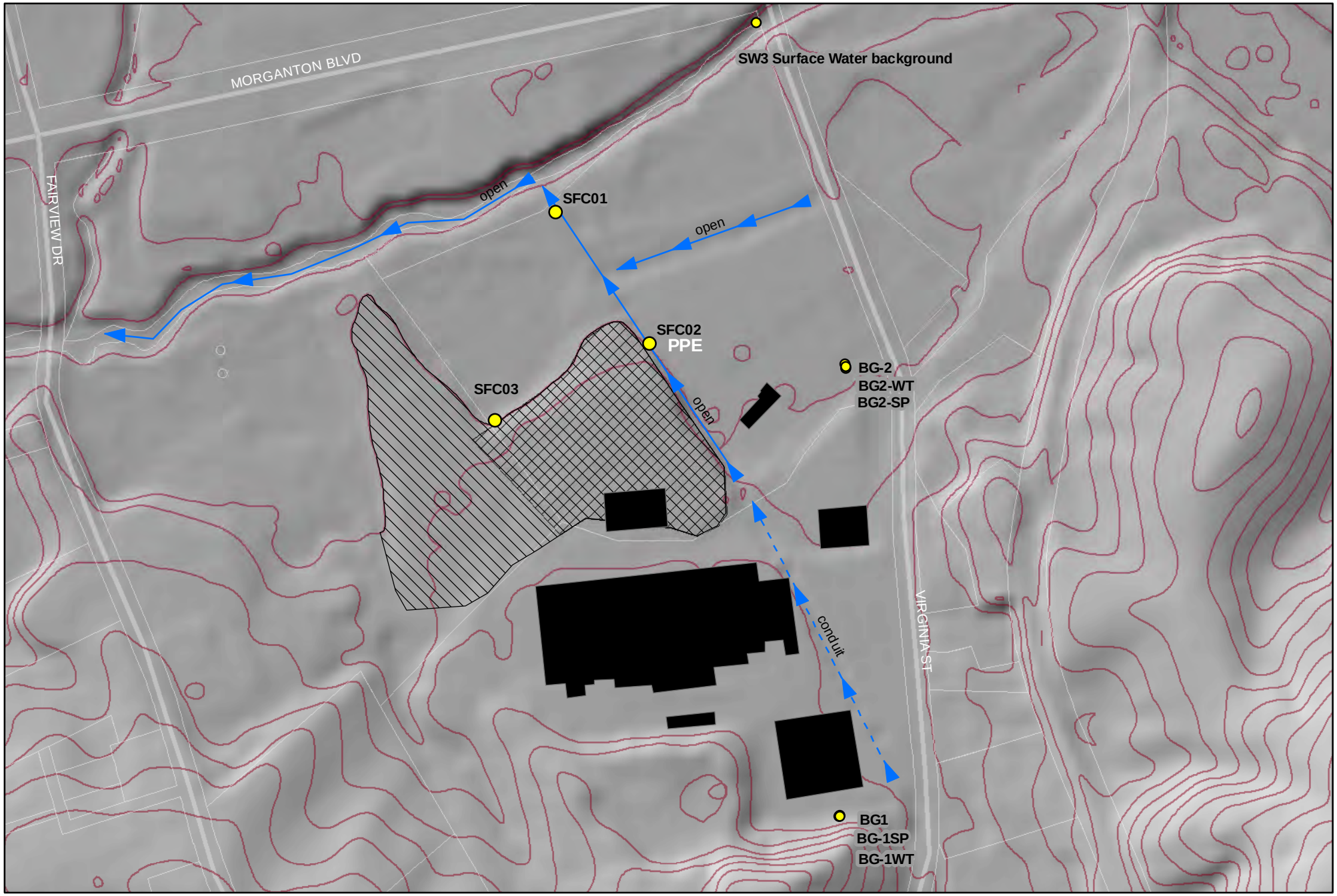
Absolute Scale 1:6,108

Base map is hillshade from 2007 Lidar imagery available from NC Department of Transportation. Contour interval is 10 feet and is based on 2007 Lidar elevation measurements. Parcels, roads, and water lines provided by Caldwell County. Building footprints traced by NC Superfund Staff from 2008 aerial imagery.

County location:

Area Ground Water Usage

Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	September 22, 2010
Figure:	4	Prepared by:	NCDWM



N
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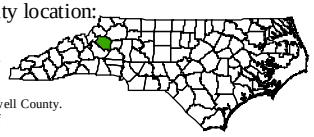
0 250 500 1,000
Feet

Absolute Scale 1:4,000

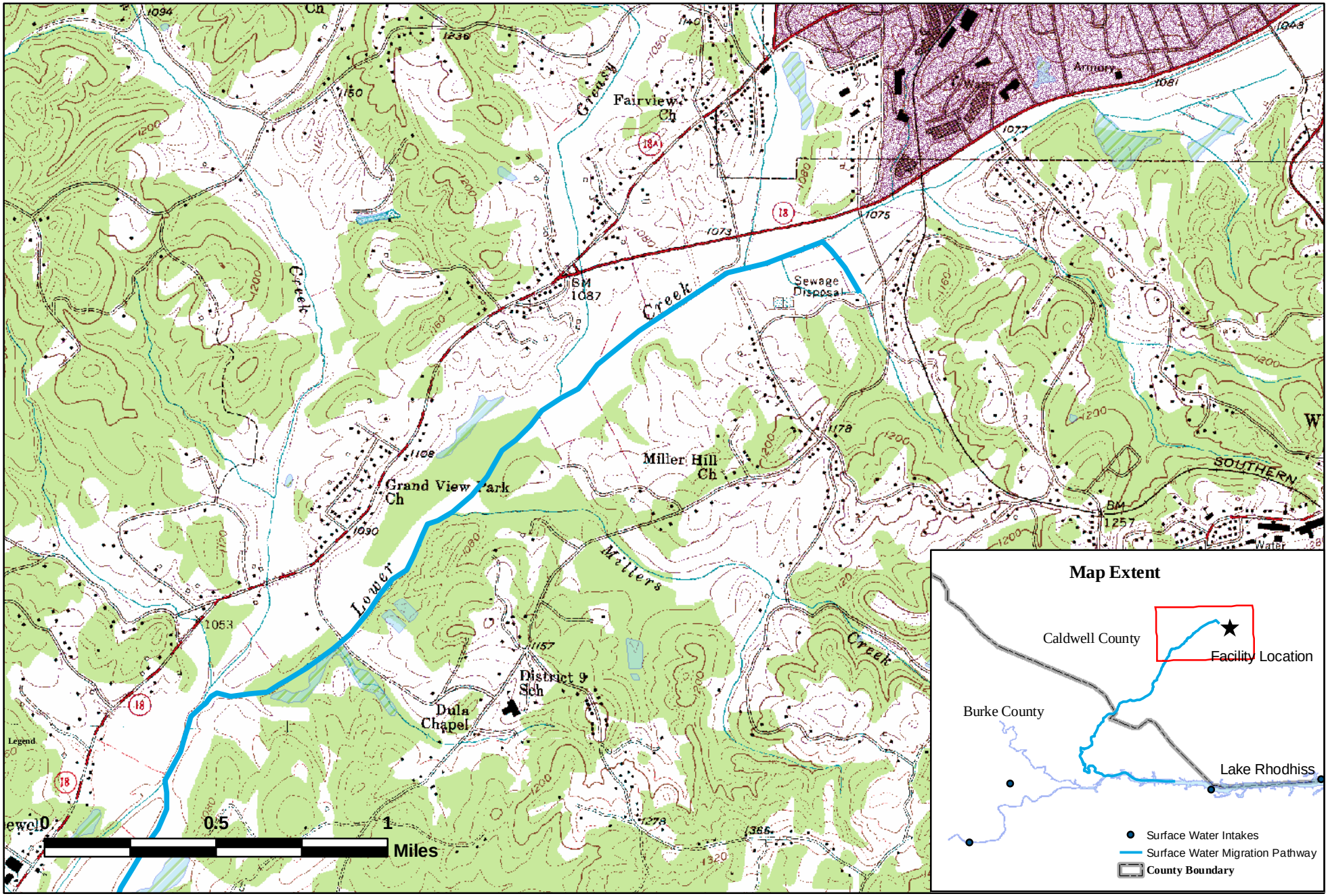
Base map is hillshade from 2007 Lidar imagery available from NC Department of Transportation. Contour interval is 10 feet and is based on 2007 Lidar elevation measurements. Parcels, roads, and water lines provided by Caldwell County. Building footprints traced by NC Superfund Staff from 2008 aerial imagery.

County location:



Sample Locations

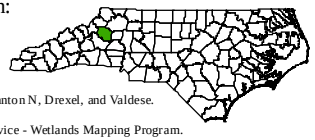
Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	September 22, 2010
Figure:	5	Prepared by:	NCDWM



Surface Water Migration Pathway
Wetlands
Pond, Lake, or River

N
W E
S

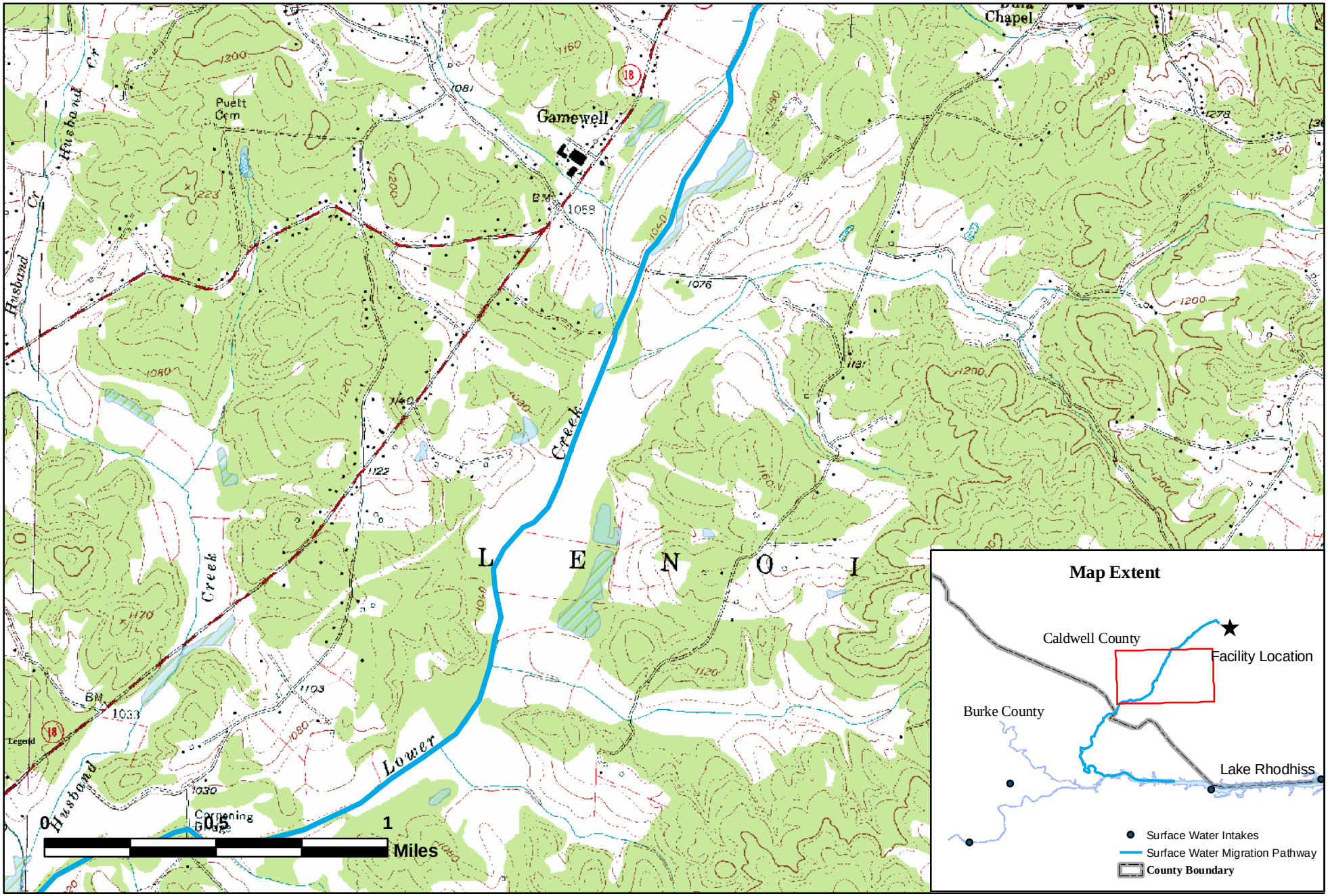
County location:



Base Map is USGS Topograhic Quadrangles: Lenoir, Morganton N, Drexel, and Valdese.

Wetlands polygons obtained from US Fish and Wildlife Service - Wetlands Mapping Program.

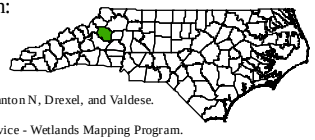
Surface Water Pathway (Tile 1 of 5)			
Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	August 27, 2010
Figure: 6	Prepared by: NCDWM	Scale:	1:24,000



Surface Water Migration Pathway
Wetlands
Pond, Lake, or River

N W E S

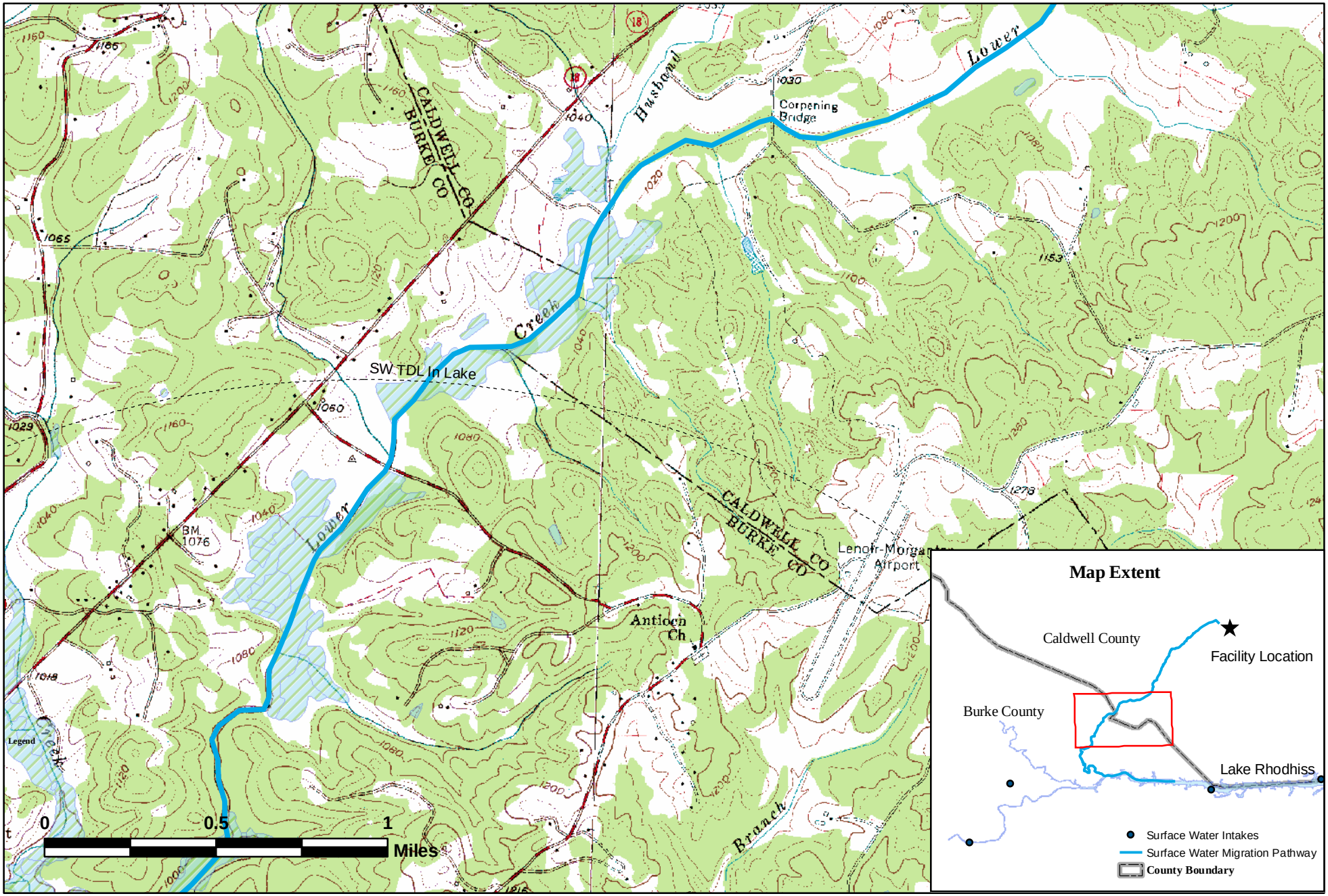
County location:



Base Map is USGS Topograhic Quadrangles: Lenoir, Morganton N, Drexel, and Valdese.

Wetlands polygons obtained from US Fish and Wildlife Service - Wetlands Mapping Program.

Surface Water Pathway (Tile 2 of 5)			
Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	August 27, 2010
Figure: 6	Prepared by: NCDWM	Scale:	1:24,000



Surface Water Migration Pathway
Wetlands
Pond, Lake, or River

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W E
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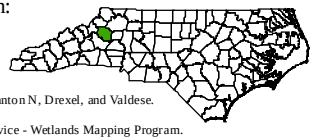
County location:

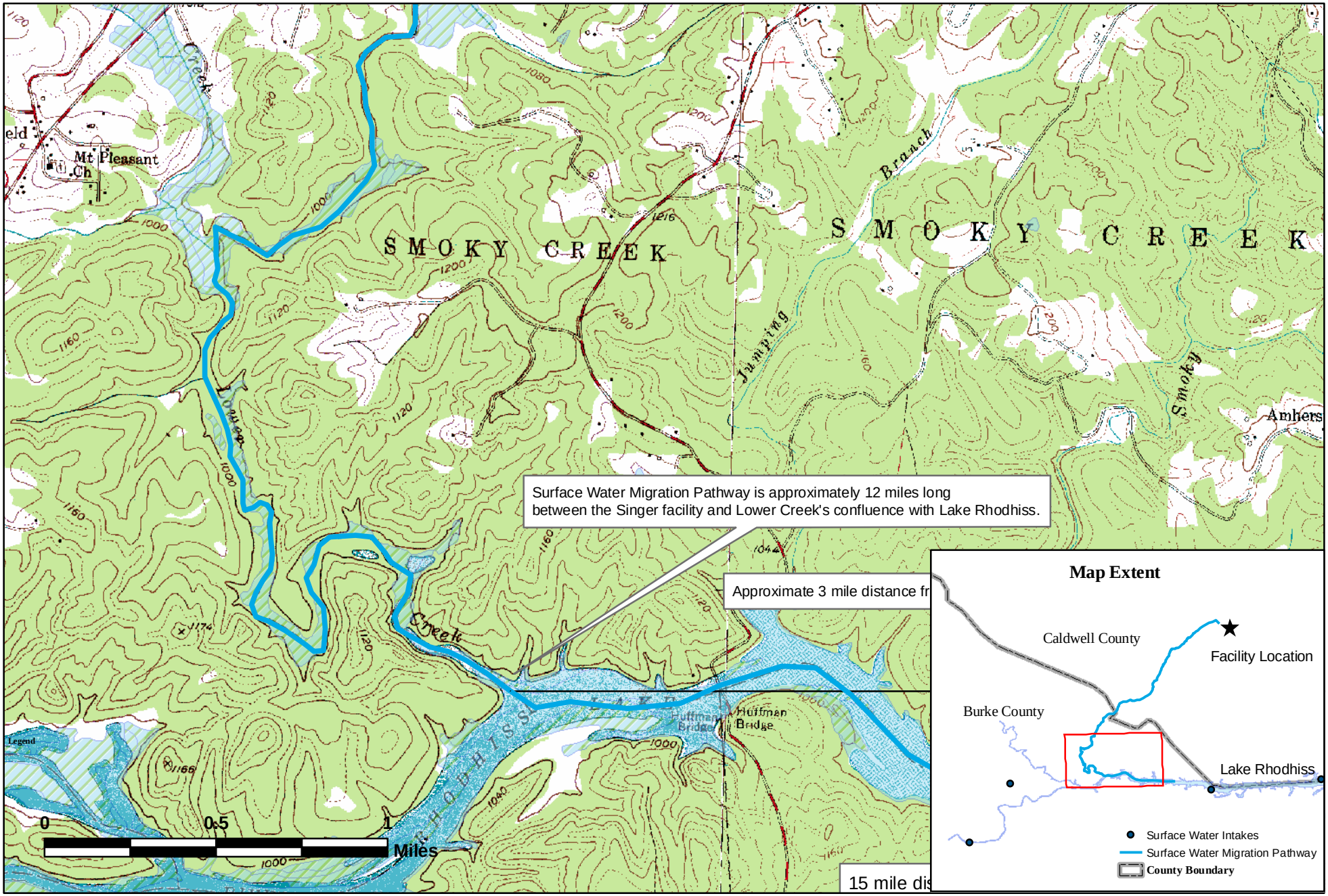


Base Map is USGS Topograhic Quadrangles: Lenoir, Morganton N, Drexel, and Valdese.

Wetlands polygons obtained from US Fish and Wildlife Service - Wetlands Mapping Program.

Surface Water Pathway (Tile 3 of 5)

Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	August 27, 2010
Figure: 6	Prepared by: NCDWM	Scale:	1:24,000



Surface Water Migration Pathway
Wetlands
Pond, Lake, or River

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W E
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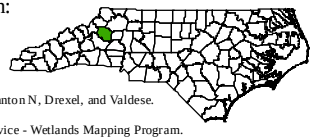
County location:

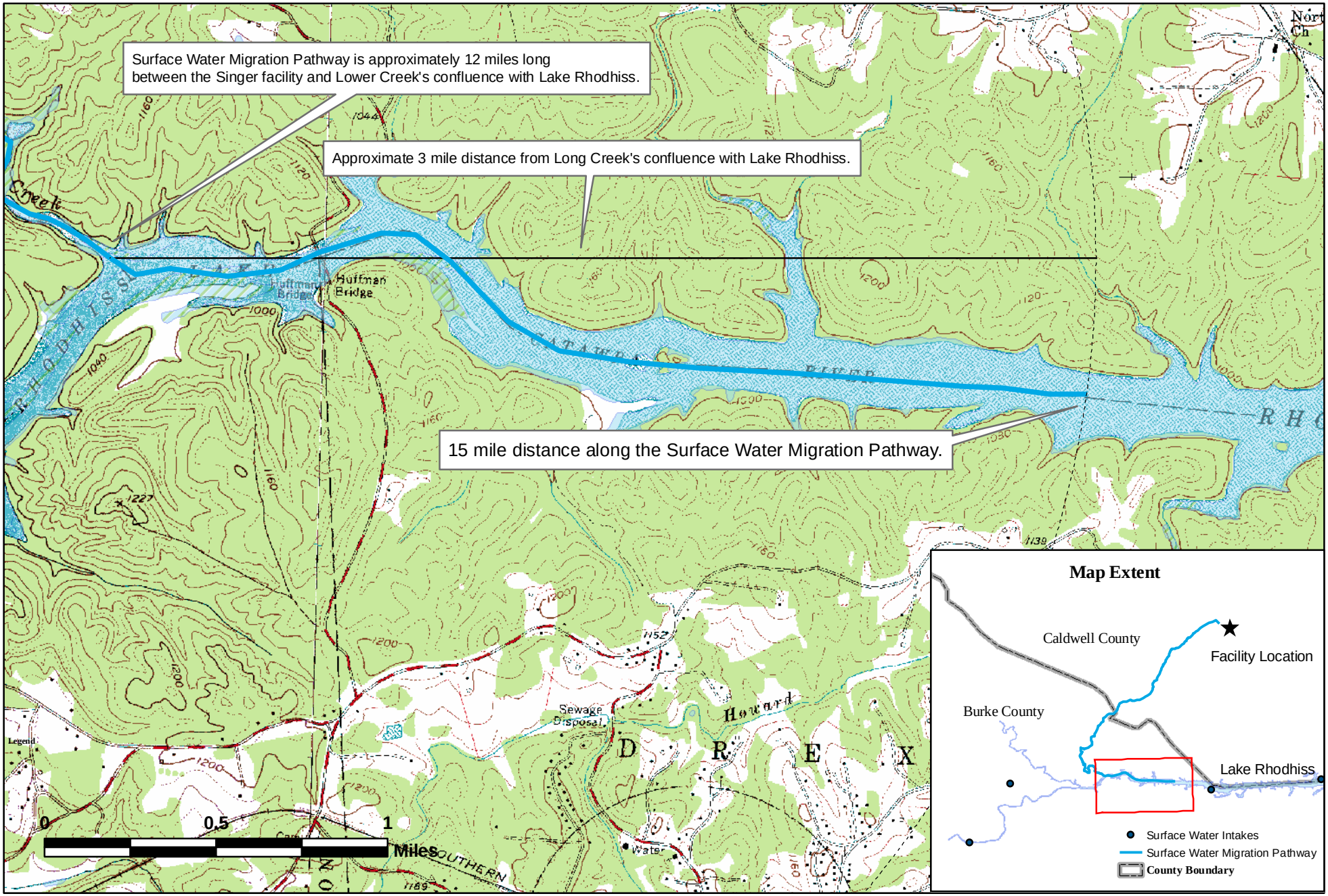


Base Map is USGS Topograhic Quadrangles: Lenoir, Morganton N, Drexel, and Valdese.

Wetlands polygons obtained from US Fish and Wildlife Service - Wetlands Mapping Program.

Surface Water Pathway (Tile 4 of 5)

Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	August 27, 2010
Figure: 6	Prepared by: NCDWM	Scale:	1:24,000



Surface Water Migration Pathway
Wetlands
Pond, Lake, or River

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W E
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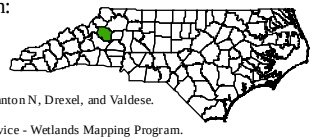
County location:



Base Map is USGS Topograhic Quadrangles: Lenoir, Morganton N, Drexel, and Valdese.

Wetlands polygons obtained from US Fish and Wildlife Service - Wetlands Mapping Program.

Surface Water Pathway (Tile 5 of 5)			
Site Name:	Singer Co Furniture Div Plts 3 4 & MH		
Site Number:	NCD 000 604 322	Date:	August 27, 2010
Figure: 6	Prepared by: NCDWM	Scale:	1:24,000

TABLES

Table 1a Background Sample Details, Organics

Sample ID	Sample Date	depth interval in inches	Formaldehyde	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Pyrene	Bis(2-ethylhexyl)phthalate	Butylbenzylphthalate	2-Methylnaphalene	Naphthalene	Phenanthrene	Di-n-Butylphthalate	Diethlphthalate	Fluoranthene
BG-1WT	11/7/1995	6-12	1.3					280 J							
BG-1SP	11/7/1995	6-12	0.67					440							
BG1	2/29/1996	6-12	0.92					0.27 J							
BG1Dup	2/29/1992	6-12	0.11					0.34 J							
BG2	2/29/1996	6-12	0.33				0.062 J	0.12 J		0.055 J	0.052 J	0.03 J	0.057 J	0.042 J	0.056 J
BG2Dup	2/29/1996	6-12	0.31				0.061 J	0.12 J		0.054 J	0.051 J	0.03 J	0.055 J	0.043 J	0.056 J
BG2-SP	9/26/1995	6-12		0.019 J	0.094 J	0.1 J	0.012 J	0.087 J							
BG2-WT	9/26/1995	6-12					0.0095 J	0.046 J	0.014 J						
Highest concentration detected			1.3	0.019	0.094	0.1	0.062	440	0.014	0.055	0.052	0.03	0.057	0.043	0.056

All concentrations in mg/kg

All information from RCRA Facility Investigation report,1997, Appendix 3.1 Background Soils

B - denotes a compound that was also detected in the trip blank.

J - denote an estimated concentration.

Table 1b Background Sample Details, Metals

Sample ID	Sample Date	depth interval in inches	Selenium		Zinc	Vanadium	Copper	Cobalt	Chromium	Cadmium		Berylium	Barium	Arsenic		Antimony		Tin		Thallium		Silver		Nickel	Mercury		Lead		Iron
BG-1WT	11/7/1995	6-12	0.53	B	45	57.9	29.6	11.7	22.2	13	B	0.89	163	0.84	B	0.37	B	1.2	B					14.2			5.8	B	22800
BG-1SP	11/7/1995	6-12	0.66	B	39.2	51.6	23.5	9.3	15.7	1.1	B	0.96	133	0.87	B	0.36	B	1	B					8.8			5.8	B	19300
BG1	2/29/1996	6-12			63.5	31	27.8	7.1	15.4			0.76	107	1.3	B			0.61	B					12.8	12.8		2.8	B	11500
BG1Dup	2/29/1992	6-12			110	30.9	29.9	8.8	12.3			0.78	111	1.4	B			0.71	B					10.2			2.8	B	11600
BG2	2/29/1996	6-12			91	48.8	32.2	8.4	27			0.25	128	2.9	B			2.1	B			0.34	B	14.7	0.02	B	5.9		19800
BG2Dup	2/29/1996	6-12			34.2	44	19.3	6.9	19.7			0.22	121	0.92	B	0.37	B	2.3	B			0.26	B	10	0.03	B	4.5	B	17600
BG2-SP	9/26/1995	6-12	5.2	B	36.6	42.2	20.7	7.2	22.6	1.5		0.21	B 133	5.7	B					21.7	B			11.9			6.1		18400
BG2-WT	9/26/1995	6-12	3	B	27.2	39.4	13.9	6.9	14.1	1		0.33	103	3.7	B	2.5	B							6.6			5.8		15700
Highest concentration detected			5.2		110	57.9	32.2	11.7	27	13		0.96	163	5.7		2.5		2.3		21.7		0.34		14.7	12.8		6.1		22800

All concentrations in mg/kg

All information from RCRA Facility Investigation report,1997, Appendix 3.1 Background Soils

Table 2 Landfill Area Sample Analytical Results

Analyte	SFC-01-SD	SFC-01-SW	SFC-02-SD	SFC-02-SDD	SFC-02-SW	SFC-02-SWD	SFC-03-SD	SFC-03-SW	soil background	SW background
Acenaphthylene	0.0049 u	0.11 u	0.0056 u	0.011	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Aluminum	9700	7100	12000	15000	2100	2400	9300	760	--	--
Anthracene	0.011	0.11 u	0.011	0.0084 J,QM-3	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Arsenic, Inorganic	0.23	1 u	0.27	0.27	1 u	1 u	1.6	1 u	5.7	--
Barium	120	**89**	150	180	34	33	**490**	**79**	163	22.9
Benz[a]anthracene	0.05	0.11 u	0.039	0.04 J,QM-2	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Benzo(g,h,I,)perylene	0.019	0.11 u,J,QM-3	0.013	0.028 J,QM-1,QM-2,QM-3	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Benzo[a]pyrene	0.066	0.11 u	0.036	0.052	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Benzo[b]fluoranthene	0.096	0.11 u	0.058	0.075	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Benzo[k]fluoranthene	0.033	0.11 u	0.021	0.026 J,QM-2,QM-3	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Beryllium and compounds	0.53	3 u	0.68	0.85	3 u	3 u	0.9 u	3 u	0.96	--
Bis(2-ethylhexyl)phthalate	2	11 u	1.6	1.7	10 u	11 u	6.9	11 u	440	--
Cadmium (Water)	0.1 u	0.5 u	0.099 u	0.1 u	0.5 u	0.5 u	0.63	0.5 u	--	--
Calcium	1000	6300	1100	1200	5300	5400	11000	18000	--	--
Chromium, Total	20	**8.4**	26	29	5 u	5 u	22	5 u	27	1.5
Chrysene	0.056	0.11 u	0.039	0.046	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Cobalt	9.1	5.1	11	13	5 u	5 u	9.1	5 u	11.7	--
Copper	19	**28**	26	30	**26**	**28**	**100**	**12**	32.2	1.9
Dibenz[a,h]anthracene	0.0079	0.11 u	0.0056 u	0.0069 J,QM-3	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Fluoranthene	0.094	0.11 u	0.057	0.092	0.1 u	0.11 u	0.031	0.11 u	--	--
Indeno[1,2,3-cd]pyrene	0.04	0.11 u	0.019	0.04	0.1 u	0.11 u	0.023 u	0.11 u	--	--
Iron	19000	**10000**	23000	26000	**3000**	**3200**	**110000**	1500	22800	843
Lead and Compounds	9.5	8.7	12	13	2.2	2	**28**	1 u	6.1	--
Magnesium	5500	3100	7300	8800	1700	1800	4000	5400	--	--
Manganese (Water)	390	300	430	480	110	120	600	85	--	--
Mercury (elemental)	0.02 u	0.1 u	0.02 u	0.02 u	0.1 u	0.1 u	0.098	0.1 u	--	--
Methylnaphthalene, 2-	0.0079	0.11 u	0.0073	0.0064	0.1 u	0.11 u	0.026	0.11 u	--	--
Naphthalene	0.0074	0.11 u	0.0073	0.0074	0.1 u	0.11 u	0.049	0.11 u	--	--
Nickel Soluble Salts	8.5	10 u	10	12	10 u	10 u	15	10 u	14.7	--
Phenanthrene	0.036	0.11 u	0.021	0.042 J,QM-1,QM-3	0.1 u	0.11 u	0.028	0.11 u	--	--
Potassium	5100 J,QM-1	3600	6500	8100	2500	2600	2600	5600	--	--
Pyrene	0.094	0.11 u,J,QM-3	0.056	0.078	0.1 u	0.11 u	0.031	0.11 u	--	--
Selenium	0.4 u	2 u	0.4 u	0.4 u	2 u	2 u	0.81	2 u	--	--
Sodium	100 u	2400	99 u	100 u	2300	2300	300 u	4100	--	--
Strontium, Stable	4.8	28	6.4	7.4	23	23	65	80	--	--
Thallium (Soluble Salts)	0.31	1 u	0.4	0.44	1 u	1 u	0.2 u	1 u	--	--
Titanium	1300	460	1500	1800	86	94	730	33	--	--
Vanadium, Metallic	46	**25**	57	67	**7.1**	**7.5**	48	5 u	57.9	1.6
Yttrium	9.5	7.8	13	17	3 u	3 u	15	3 u	--	--
Zinc (Metallic)	71	48	91	95	25	25	300	25	110	36.4

Bold - indicates a value greater than 3 times the value in the background sample (if present).

-- indicates that no background concentration is available for that compound.

Where results were non-detect (u flagged) the numbers are shown in light grey.

Background surface water concentrations were taken from the 1997 RFI (sample SW-3).

U - The analyte was not detected at or above the reporting limit.

J - The identification of the analyte is acceptable; the reported value is an estimate.

QM-1 - Matrix Spike Recovery less than method control limits.

QM-2 - Matrix Spike Recovery greater than method control limits.

Attachments

(selected references)

Reference (7)

Reference (8)

RCRA FACILITY ASSESSMENT
for the site of
Singer Furniture Company
Plant No. 33
Lenoir, North Carolina

RECEIVED
MAY 11 1988
SOLID WASTE MANAGEMENT SECTION

Prepared by Robert Reimer, WES, EPA IV

I. Preliminary Review

A. Facility Waste Generation and Manufacturing Process

Description

1. History

In the 1950's the City of Lenoir operated a public landfill on the northern portion of this site. (See RFA-Appendix No. 1 for a map.)

In 1963, the Kent Coffey Furniture Company purchased the site and built the main building of the current facility (the current Building No. 3). In 1969, the facility was purchased and operated by the Magnavox Company. Finally, in 1973, the site was purchased by the Singer Furniture Company. During this active industrial life, the facility has been used for the manufacture of home, electronic and occasional furniture. Hazardous wastes are generated during the manufacturing process in the form of finishing residues, contaminated rubbish (rags, etc.) and off-spec solvent materials. Singer built a hazardous waste incinerator on the site in 1980 for the destruction of its finishing residues.

2. Operations

The public landfill operated by the City of Lenoir was open to all and no records were kept as the the quantities or types of waste disposed of therein.

During the Kent Coffey period (1963 - 1969), the disposal site continued to be used privately, but now for only the basic types of waste typical to furniture manufacturing. This includes solid and liquid finishing residue, wood and metal scrap, solid glue waste and ordinary trash.

Magnavox continued to use the landfill in this manner during its ownership (1969 - 1973), as did Singer during its early years (1973 - 1976). In 1976, Singer began to send all finish residues and most other trash to the Caldwell County Landfill and Incinerator. Some wood and metal scrap continued to be put into the landfill until 1981 when it was closed, leveled and grassed over.

Since 1982, Singer has employed a consultant to investigate and monitor the status of the landfill and the local groundwater.

B. General Background on Environmental Setting

Refer to the Singer Furniture Part B application, Section B for more detailed information.

Surrounding property is all zoned "industrial." The site is bounded on the north by Lower Creek and an unnamed tributary to Lower Creek. While the facility's RCRA-regulated units are not within the 100-year floodplain, Lower Creek and its tributary are 100-year flood zones. Since the onsite landfill is adjacent to the two streams, portions of the landfill are affected by flooding. As recently as 1978, significant flooding has occurred in this area.

C. Locations and Characteristics of Solid Waste Management Units and Other Potential Areas of Concern

1. Facility Map Identifying Solid Waste Management Units

See RFA-Appendix No. 1 and No. 2 for maps of the SWMUs on site.

2. Solid Waste Management Unit Information

Old Landfill (SWMU No. 1)

a. Size and Location:
The landfill is roughly "L" shaped, but it has no clearly defined boundaries. It measures approximately 800' x 1000'. It is bounded by the Plant fence on the south and Lower Creek on the north. Wooded areas limit its expansion to the east and west.

b. Waste Characteristics:
The landfill operated as a public dump prior to 1963. After that time it received primarily furniture manufacturing residues and wastes. Liquids and solids were both disposed of in the landfill, including residues probably containing Appendix 8 contaminated wastes. No records, however, were kept on the placement of wastes in the landfill, nor can such data be generated by interviews, etc.

c. Migration Pathways:
Any leachate generated in the landfill could flow away in either the groundwater or via Lower Creek. The creek itself does not rise above the "wall" of the landfill in a 100 year flood, so leachate is generated only by rainfall and run-on from the adjacent plant area. No "leachate streams" were observed at the toe of the landfill, but it was not possible to examine the toe completely due to forest and vegetative overgrowth.

d. Evidence of a Release:
No evidence of a release was observed.

e. Potential of Exposure:
The potential of release and exposure is high. The landfill was not constructed according to modern hazardous waste standards, yet it contains unknown quantities of hazardous wastes. Only minimal monitoring for releases has been done to date.

Abandoned Drums by Lower Creek (SWMU No. 2)

a. Size and Location:
Between twelve (12) and twenty (20) fifty-five gallon drums were observed between the banks of Lower Creek and the north side of the landfill. These metal drums were rusted and their labels were worn off, apparently from years of weather exposure. They were scattered widely (rather than in any immediate proximity to each other). The Singer Company representative said that the drums floated onto the site during a prior flood event (probably in 1978).

b. Waste Characteristics:
The characteristics of the materials within the drums are unknown. For the most part the drums are rusted through and empty, although some contain liquid (possibly rain water). Labels are similarly illegible. If in fact the drums did "float" onto the facility, then they were probably only partially full.

c. Migration Pathways:
Any release from the drums would leave the facility boundaries via either the groundwater or Lower Creek. If the drums were mostly empty, then residues would leak slowly and enter the groundwater; the contents of full containers would either flow into or be washed into Lower Creek.

d. Evidence of a Release:
No evidence of a release was observed, in that no vegetation was visibly harmed and the contents of the drums was unknown. Clearly, however, if the drums contained any hazardous wastes at all then these wastes were released into the environment, since the drums can no longer contain waste.

e. Potential of Exposure:
Based on the low number of drums and the apparent age of them as well, there is a very low potential of exposure from the drums today. It is possible, however, that a plume of contamination exists in the groundwater as a result of a prior release.

Glue Wash Evaporation Pond (SWMU No. 3)

a. Size and Location:
Glue wash water from laminating operations is collected in drums and then poured into a depressed area behind Building No. 4, where it evaporates. The resulting "intermittent" pond is roughly circular and about twenty (20) feet across.

b. Waste Characteristics:
The liquid is mostly water. In the past, its glue component has contained one-half percent formaldehyde, and other Appendix 8 constituents could have been present. When the water and glue-volatiles evaporate, a thin crust of brownish white plastic-like material is left in place. This is periodically collected and disposed of as non-hazardous waste.

c. Migration Pathways:
It is unlikely that any significant air emissions occur from this pond. It is possible that any hazardous constituents (if present) could migrate away from the unit via the groundwater.

d. Evidence of a Release:
There is no evidence of a release of hazardous constituents from this unit.

e. Potential of Exposure:
The potential of exposure to hazardous constituents from this unit is minimal, given the small quantities involved. However, based on the historical composition of the glue and the length of time this practice has been occurring, there is a clear possibility of an non-sudden, uncontrolled release having occurred.

Incinerator (SWMU No. 4)

a. Size and Location:
The incinerator is described more completely in the RCRA Part B application for this facility. It is a single hearth, controlled combustion unit of relatively small size.

b. Waste Characteristics:
Finishing residues contaminated with solvents and paints (containing a very low level of hazardous constituents) are combusted along with stain wash water. The primary hazard associated with the finishing residues is their flammability.

c. Migration Pathways:
The only potential pathway is via air emissions and this release is controlled by the North Carolina RCRA permit.

d. Evidence of a Release:
No evidence of a release was observed.

e. Potential of Exposure:
Considering the very low levels of hazardous constituents present in the residues along with the efficiency of incineration in general, there is no significant potential of exposure from incinerator operations.

Water Wash Storage Tank (SWMU No. 5)

a. Size and Location:
The water wash storage tank is a vertical tank with a capacity of roughly 5,000 gallons. It feeds into the incinerator via a short pipeline.

b. Waste Characteristics:
The wash water contains stain and finishing rinses. These rinses may or may not contain hazardous constituents. A review of the historical data available would yield an answer.

c. Migration Pathways:
Possible releases from the tank would result from spills associated with either the tank itself or the tank-filling operations. Substantial spills could travel overland to the landfill area, but would not reach Lower Creek or its tributary directly. Therefore any actual releases would enter the environment via groundwater transport.

d. Evidence of a Release:
There is no evidence of a release from this unit.

e. Potential of Exposure:
The potential of exposure to hazardous constituents from this unit is very low.

Hazardous Waste Storage Area (SWMU No. 6)

a. Size and Location:
This is the area where drums of finishing residues are stored prior to incineration. It is located adjacent to the incinerator and measures about fifty (50) feet by fifty (50) feet.

b. Waste Characteristics:
The finishing residues are described under "Incinerator (SWMU No. 4)" above, and are much more extensively characterized in the facility's Part B application.

c. Migration Pathways:
The only route for migration at this unit would be for air-blown residues after a spill. The material is generally non-flowing and is easily contained (but for wind entrainment).

d. Evidence of a Release:
There was no evidence of a release visible, but the areas to the side and behind the storage pad were not inspected due to the difficulty of gaining access to those areas.

e. Potential of Exposure:
The potential for exposure exists due to the volume of material managed and the regular loading and unloading operations at this unit. (Residues are shipped onto this site by other Singer facilities.) Since the waste would be airborne, it could both travel far and be easily ingested or inhaled.

Waste Satellite Storage Area (SWMU No. 7)

a. Size and Location:
Finishing residues are stored at this unit prior to being relocated to the storage area near the incinerator. It is located inside the south fence near the maintenance building. It is about fifty (50) feet by twenty (20) feet.

b. Waste Characteristics:
The finishing residues are described under "Incinerator (SWMU No. 4)" above, and are much more extensively characterized in the facility's Part B application.

c. Migration Pathways:
The only route for migration at this unit would be for air-blown residues after a spill. The material is generally non-flowing and is easily contained (but for wind entrainment).

d. Evidence of a Release:
There was no evidence of a release visible, but the area behind the storage pad was not inspected due to the difficulty of gaining access to that area.

e. Potential of Exposure:
The potential for exposure is very low since wastes are not kept at this location very long prior to being moved to the regular storage area. Also since much of the total waste at this facility comes from offsite, the amount of waste managed at this unit is significantly less than at the regular storage area.

Floor Area, Lumber Yard Building (SWMU No. 8)

a. Size and Location:
The location of the Lumber Yard Building is given on the map in RFA-Appendix No.1. The building is open to the environment and is currently used for the storage of unused industrial equipment. The floor of the building is dirt and the dirt is discolored. The building measures roughly 150 feet by 30 feet.

b. Waste Characteristics:
There is no clear waste management taking place at this unit. However, the discolored soil floor suggests that spills of unknown material have occurred.

c. Migration Pathways:
If the dirt were contaminated, then constituents could leach out from rain water that collects inside and flow into the groundwater.

d. Evidence of a Release:
The is no clear evidence of a release of hazardous wastes or hazardous constituents.

e. Potential of Exposure:
Given the uncharacterized nature of the soil discoloration, it is not possible to conclude that any potential for exposure exists. This is an area of other concern, however.

Spill at Oil Tank, Lumber Yard Bldg. (SWMU No. 9)

a. Size and Location:
The oil tank holds roughly 500 gallons of an uncertain petroleum product. The ground around the blackened tank is black as well, for an area of approximately fifteen feet by thirty feet. The unit is within forty feet of an unnamed tributary to Lower Creek.

b. Waste Characteristics:
The exact nature of the waste (spilled material) is not known. It is a petroleum product; whether it was "fresh" new fuel or recycled "spent" fuel is uncertain.

c. Migration Pathways:
Migration (if any) from this unit is via the groundwater.

d. Evidence of a Release:
The areal extent of the spill is visible on the ground's surface. Given the nature of the operations at the Lumber Yard, it is likely that this has been a regular, non-sudden release.

e. Potential of Exposure:
The potential of exposure as a result of this spill is significant. The tank's proximity to the tributary to Lower Creek adds to the concern.

II. Visual Site Inspection

A. Visual Site Inspection Activities and Observations

The Visual Site Inspection (VSI) was attended by:

Bob Reimer	US EPA
Jill McCabe	NC DHR
Larry Fox	NC DHR
Richard McDonald	Singer

The VSI was conducted on November 30, 1987 at the Singer Furniture Company site in Lenoir, North Carolina. Mr. Jack Tripletts, the RCRA incinerator operator, was also interviewed during the site visit.

B. Update on Solid Waste Management Units Identified Above

The information collected during the VSI was used in preparing the summaries in Part I (c)(2) above.

C. Conclusions and Recommendations for Further Action

Old Landfill (SWMU No. 1)

A groundwater monitoring program is necessary to fully determine and assess the existence of any releases from the landfill. Corrective action would follow, as needed.

Abandoned Drums by Lower Creek (SWMU No. 2)

A formal investigation as to the source and the contents of the drums is needed. If it cannot be determined that the drums' contents posed no risk, then soil sampling and/or shallow groundwater monitoring is in order to determine if a release has occurred. Corrective action would follow, as needed.

Glue Wash Evaporation Pond (SWMU No. 3)

Surface soil sampling should be conducted in order to determine if any release has occurred. Corrective action would follow, as needed.Also, if the current, or any future, glues contain hazardous constituents, then this practice should be discontinued immediately.

Incinerator (SWMU No. 4)

No further action is required. The State RCRA permit will manage this unit.

Water Wash Storage Tank (SWMU No. 5)

No further investigation is required.

Hazardous Waste Storage Area (SWMU No. 6)

The surface soils adjacent to the storage area pad should be sampled for the same constituents historically present in the finishing residues. Corrective action would follow, as needed.

Waste Satellite Storage Area (SWMU No. 7)

No further investigation is required.

Floor Area, Lumber Yard Building (SWMU No. 8)

No further investigation is required.

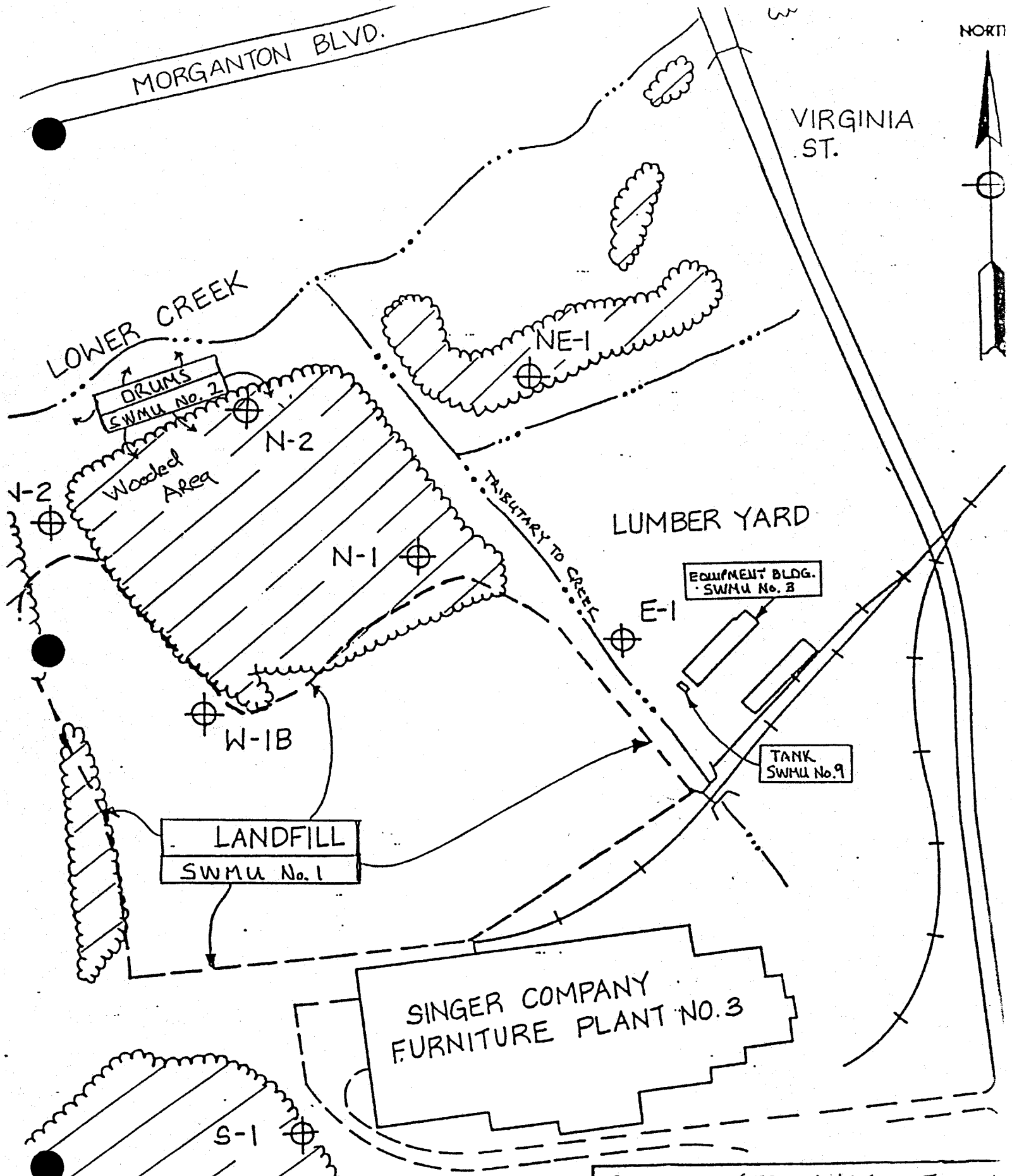
Spill at Oil Tank, Lumber Yard Bldg. (SWMU No. 9)

Local soil sampling and/or shallow groundwater monitoring is in order to determine if a release has occurred. If a release is confirmed, the nearby portions of the tributary to Lower Creek should be soil-sampled. Corrective action would follow, as needed.

III. Appendices (attached)

RFA-Appendix No. 1

Map of Singer Furniture Company Solid Waste Management Units No.s 1,2,8 and 9

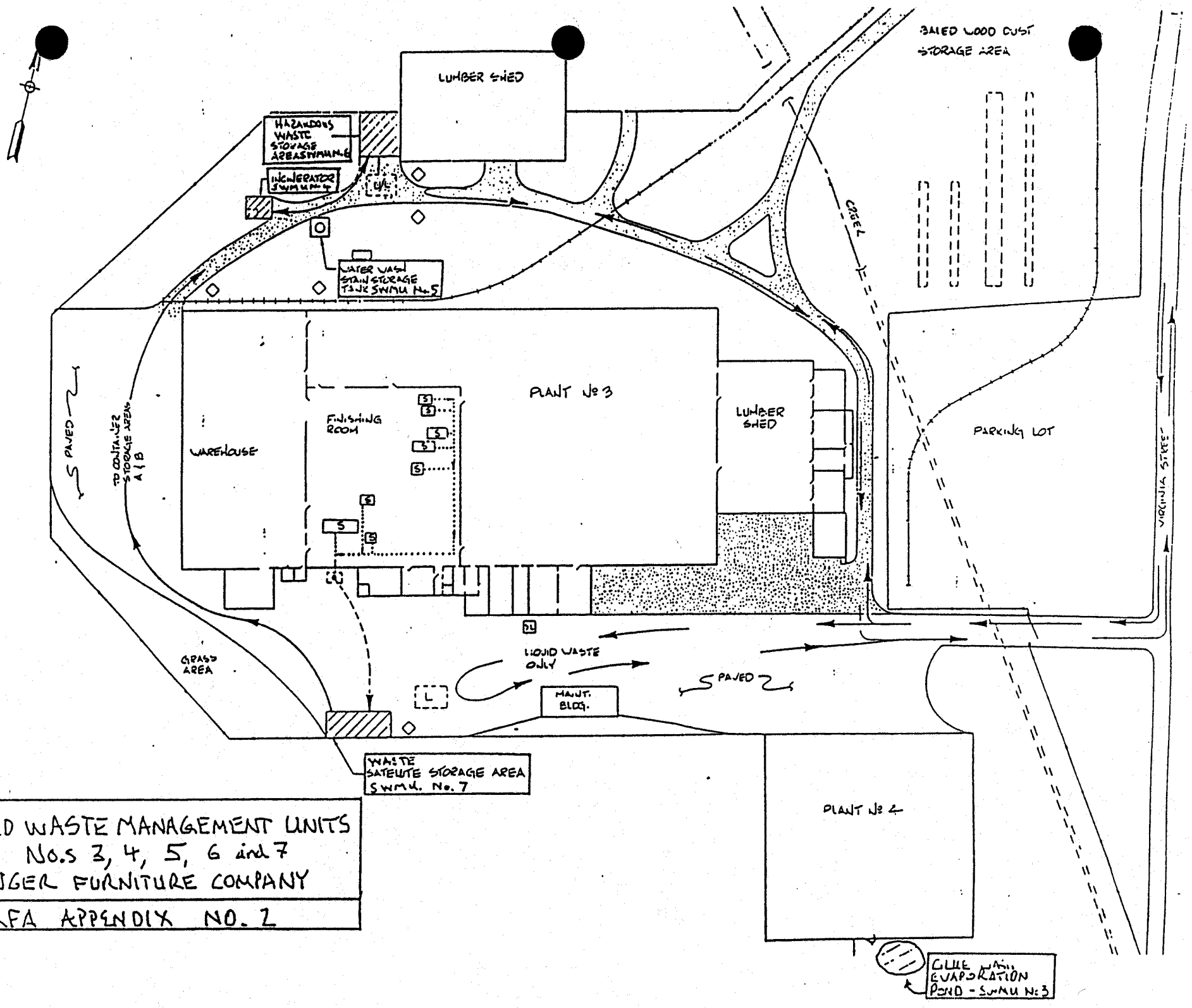


SOLID WASTE MANAGEMENT UN
No.s 1, 2, 8, 9
SINGER FURNITURE COMPAN

RFA. APPENDIX NO. 1

RFA-Appendix No. 2

Map of Singer Furniture Company Solid Waste Management Units No.s 3, 4, 5, 6 and 7



SOLID WASTE MANAGEMENT UNITS
No.s 3, 4, 5, 6 and 7
SINGER FURNITURE COMPANY

RFA APPENDIX NO. 2

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Reference (9)

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DRAFT

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS OF THE RCRA FACILITY INVESTIGATION SINGER FURNITURE COMPANY MILLER HILL COMPLEX 904 VIRGINIA STREET LENOIR, NORTH CAROLINA HSWA PERMIT NUMBER NCD 000604322

by

Environmental Quality Management, Inc.
Cedar Terrace Office Park, Suite 250
3325 Durham-Chapel Hill Boulevard
Durham, North Carolina 27707-2646

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APR 16 1997
HAZARDOUS WASTE

PN 7043-3

Singer Furniture Company
1912 East Chester Drive
High Point, North Carolina 28265

Revision 0, April 16, 1997

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CERTIFICATIONS

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to be the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for failure to report any known violations.

Rahat Alam, Acting President
Singer Furniture Company
William L. Foster
Vice President Administration

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for failure to report known violations.

Thomas Robertson, Project Manager
Environmental Quality Management, Inc.

EXECUTIVE SUMMARY

On November 9, 1994, the U.S. Environmental Protection Agency (EPA) and the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR) approved the Resource Conservation and Recovery Act (RCRA) facility investigation work plan. The work plan had previously been developed by Singer Furniture Company (Singer) in accordance with hazardous waste treatment, storage, and disposal facility (TSDF) permit number NCD000604322. The permit had been issued to Singer for the incinerator and container storage operations formerly located at the Miller Hill Furniture Manufacturing Complex. The Miller Hill Complex is located at 904 Virginia Street, Lenoir, North Carolina.

Between November 9, 1994 and March 14, 1997, Singer and its contractors have implemented the work plan by conducting field investigations, data analysis and evaluation, and report preparation. The purpose of the work plan was to guide the efforts necessary to measure the extent, magnitude, and impact of hazardous constituents potentially released into the environment by four solid waste management units (SWMU) located at the Miller Hill Complex. The SWMUs that were included in the work plan are identified as:

SWMU No. 1 - Landfill
SWMU No. 2 - Abandoned Drums at Lower Creek
SWMU No. 3 - Glue Wash Evaporation Pond
SWMU No. 6 - Hazardous Waste Storage Area
SWMU No. 9 - Spill at Fuel Oil Tank in Lumber Yard

The findings, conclusions, and recommendations are summarized as follows:

- No quantifiable offsite releases of hazardous constituents have been *emitted* from the Singer property.
- Hazardous constituents, at concentrations below those which cause exceedances of commonly accepted health-based risk levels, have been detected in soils and/or groundwater located near SWMU No. 1, SWMU No. 3, and SWMU No. 9.
- SWMU No. 6 was closed under the provisions of the RCRA Permit and it has been demonstrated that there is no statistically significant difference between the soils of SWMU No. 6 and the background soils.
- The historical source of contamination at SWMU Nos. 2, 3, and 9 has been removed.

- The landfill (SWMU No. 1) has been in existence for more than 57 years and it has not been active for more than 17 years.

- Recommendations include annual monitoring at five groundwater wells, surface water and swamp sediments located downgradient of SWMU No. 1. If the concentration of any hazardous constituent exceeds levels specified herein, Singer and/or its successors will notify the government and implement an investigation plan designed to verify the changed conditions and to determine if abatement or other corrective actions are warranted.

SECTION 1

INTRODUCTION

1.1 PURPOSE AND OBJECTIVES

On March 23, 1987, Singer Furniture Company (Singer) submitted an application for a Resource Conservation and Recovery Act (RCRA) permit to operate an incinerator and a container storage area at its Miller Hill Complex in Lenoir, North Carolina. The incinerator unit was operated for the disposal of hazardous wastes generated at the Plant No. 33 facility (Miller Hill Complex) and three other Singer facilities in Lenoir, North Carolina; Roanoke, Virginia; and Chocowinitty, North Carolina. The hazardous wastes consisted of ignitable solid wastes in the form of liquid finishing waste, wood filler scrapings, lacquer dust, and discarded rags. The wastes from the offsite Singer facilities were transported by the U.S. Environmental Protection Agency (EPA) registered waste transporters to the Plant No. 33 facility. Permits for the operation of the incinerator were issued by the North Carolina Department of Environment, Health and Natural Resources (NCDEHNR) and EPA on June 30, 1988. Copies of the separately issued Federal and State permits are included in Appendix 1.1.

This document has been prepared to fulfill the requirements of the RCRA permits. It incorporates all of the information required by Sections II and VI of the respective Federal and State permits as well as the comments received on previously submitted work plans.

The 1984 Hazardous and Solid Waste Act (HSWA) amendments to RCRA state that the regulatory agency "... Shall require corrective action for all releases of hazardous constituents or waste from any solid waste management unit (SWMU) located at a treatment, storage, and disposal facility (TSDF) seeking a permit... regardless of the time at which waste was placed in such unit...."

The EPA guidance for conducting a corrective action program (CAP) to evaluate past and continuing releases suggests the use of a process that contains five main phases. The five main phases are:

- RCRA Facility Assessment (RFA)
- RCRA Facility Investigation (RFI)
- Corrective Measure Study (CMS)
- Corrective Measure Implementation (CMI)
- Implementation of Interim Measures (IIM).

In accordance with the five-phase process, an RFA was completed by EPA and documented in a report dated May 11, 1988. A copy of the RFA is included in Appendix 1.2. The RFA identified nine SWMUs at the Singer facility. The RFA recommended that remedial investigations be performed for five of the SWMUs. These five SWMUs were:

SWMU No. 1	Landfill
SWMU No. 2	Abandoned Drums at Lower Creek
SWMU No. 3	Glue Wash Evaporation Pond
SWMU No. 6	Hazardous Waste Storage Area
SWMU No. 9	Spill at Fuel Tank in Lumber Yard.

Based on the results of the RFA, Singer was required by a permit condition to implement an RFI. The purpose of an RFI is to determine the nature and extent of releases from regulated hazardous waste units (HWUs), SWMUs, and other areas of concern (AOC) at the facility and to gather all necessary data to support a CMS.

Corrective action is an umbrella term for a wide range of technical and institutional actions designed to identify and remedy actual or potential dangers to human health and the environment. The following discusses the terminology in the CAP.

- Facility: 1) All contiguous land and structures, other appurtenances, and improvements on the land used for treating, storing, or disposing of hazardous waste; a facility may consist of several TSDF operational units [e.g., one or more landfills, surface impoundments, or combination of land-based units, incinerator(s), tanks, and containers]; and 2) for the purposes of implementing corrective action under 40 CFR 264.101, all of the

contiguous property under control of the owner or operator seeking a permit under Subtitle C of RCRA.

- Release: Spilling, leaking, pouring, emitting, emptying, discharging, injecting, pumping, escaping, leaching, dumping, or disposing of hazardous waste (including hazardous constituents) into the environment. This includes the abandonment or discarding of barrels, containers, drums, and other closed receptacles containing hazardous waste or constituents.

- SWMU: Any discernable unit in which solid wastes have been placed, irrespective of whether the unit was intended for the management of solid or hazardous waste or when the solid waste was placed in the unit. Such units include any areas at a facility where solid wastes have been routinely and systematically placed.

- Corrective Action Management Area (CAMA) - An area within a facility designating common boundaries or properties of adjacent or overlapping SWMUs. CAMAs function solely for the purpose of facility investigative efforts.

- Corrective Action Management Unit (CAMU) - An area within a facility or coextensive with the boundaries of the facility designated for the purposes of carrying out corrective action requirements. Within the boundaries of a CAMU there may exist landfills, surface impoundments, waste piles, and land treatment units that received waste prior to July 26, 1992. CAMUs function solely for the purpose of facilitating the management of remediation waste. Permitted units must be closed or be in the process of closing in order to be included in a CAMU.

- Temporary Unit - May consist of a tank or container storage unit located within the boundaries of a facility that is used to store and/or treat waste generated from a CAP. Temporary units may be used for up to 2 years with EPA approval.

- Action Levels - Human-health-based levels of hazardous constituents that are indicators for the protection of human health. If concentrations above the action levels are discovered during an RFI, a CMS may be required.

- Cleanup Levels - Technically achievable goals for contaminated media. Cleanup levels are determined on a case-by-case basis. Generally cleanup levels for carcinogens must be equal to or below an upper bound excess life-time cancer risk in the 1×10^{-4} to 1×10^{-6} range. For noncarcinogens the cleanup level is set at the concentrations where no adverse effects are

expected. Typically, the aggregate hazard index is set not to exceed one for any common target organs or adverse effects.

- RFA - A preliminary evaluation of existing information to determine if there is reasonable evidence to indicate that a release has or may occur. An RFA is limited in scope, qualitative in nature, and is generally designed to identify SWMU(s).

- RFI - A study to gather information on the source of releases and physical information on the area around an SWMU that may affect the migration and disposition of released contaminants. The goal of an RFI is to develop a model of any release on all impacted environmental media and to determine if corrective actions are needed.

- CMS - A study designed to evaluate remedial alternatives and to set out specific methodologies and criteria for corrective action implementation.

- Interim Measures (IM) - Actions taken to contain, remove, or treat contamination resulting from ongoing releases of hazardous constituents from SWMUs.

The purpose of the RFI is to measure and evaluate the potential extent, magnitude, and impact of onsite chemical constituents. The specific objectives of an RFI are to:

- Determine the extent and magnitude of chemical constituents in the environmental media.

- Determine whether chemical constituents pose immediate and/or long-term threats to public health and the environment.

- Define physical features at the facility that may affect chemical constituent migration to any offsite receptors.

- Estimate the health risks that result from exposure to the contaminants.

- Define preliminary remedial action goals.

- Identify potential corrective measures.

- Define the scope of any CMS, if one is required.

Historically, site-specific geologic information has been collected and presented in two geotechnical investigations and a separate two-phased landfill investigation as follows:

- Landfill Investigation Report (Phase I), J. E. Sirrine Company (Sirrine), January 1983 (Appendix 1.3)
- Landfill Investigation Report (Phase II), J. E. Sirrine Company, December 1983 (Appendix 1.4)
- Report of Preliminary Subsurface Investigation, Law Engineering Testing Company (Law), October 17, 1978 (Appendix 1.5)
- Report of Preliminary Geotechnical Exploration, Law Engineering Testing Company, August 23, 1980 (Appendix 1.6).

The information gathered during these investigations provided a significant basis for an assessment of the hydrogeologic condition at the facility.

1.2 FACILITY DESCRIPTION

Singer is a manufacturer of dining room, bedroom, wall units, and occasional furniture. Singer's Plant Nos. 33 and 54 are located on a 60.97-acre parcel known as the Miller Hill Complex at 904 Virginia Street, NW, in Lenoir, Caldwell County, North Carolina. Historical reports identify Singer Plant Nos. 33 and 54 as Plant Nos. 3 and 4, respectively. The plant ID numbers were changed in the early 1980's in order to uniquely identify multiple sites that had the same plant number. Historical reports also note that the plants are on Miller Hill Road. The name of Miller Hill Road has been changed to Virginia Street by the City of Lenoir. Figure 1-1 is a plan map showing the approximate location of the facility from a large-scale perspective.

The subject property is bounded on the northeast by Lower Creek, on the northwest by privately held property, on the east by Virginia Street, on the west by City of Lenoir property, and on the south by privately-held property. Plant No. 33 is located approximately in the center of the Singer property on the side of a hill cut.

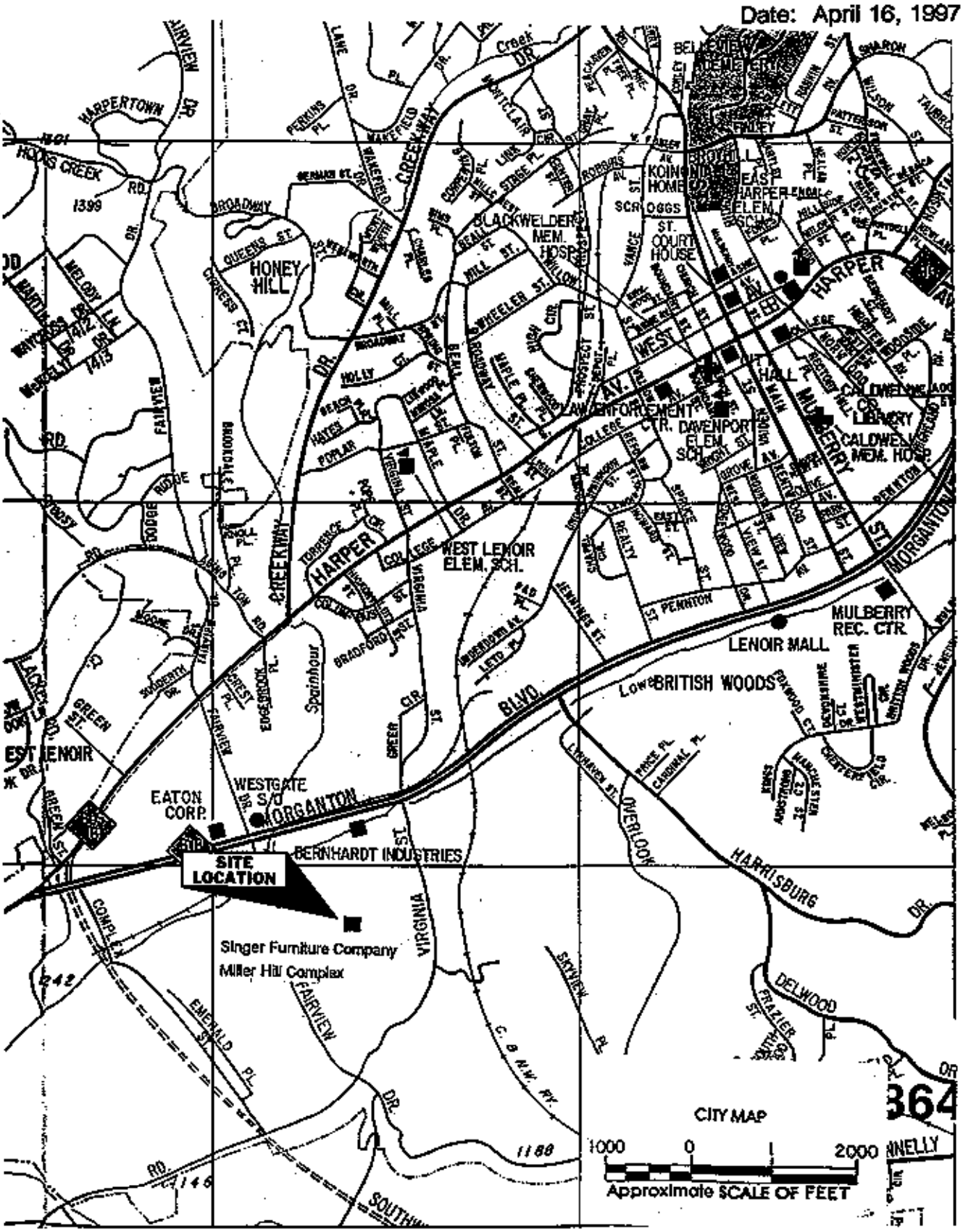

Figure 1-1. Facility location map.

Figure 1-2 is a facility topographic map and site plan that shows plant buildings, property boundaries, parking lots, internal roads, sewer waste lines, hazardous waste facilities, and SWMUs. The topography is shown at 2-foot contour intervals for an area extending approximately 1000 feet in all directions from the perimeter of the hazardous waste management facilities.

Figure 1-3 is a City of Lenoir zoning map that shows surrounding land-use areas. All contiguous properties are zoned for industrial uses. Singer is bounded on the north and northeast by industrial properties. Low-density, nonconforming-use residential properties are located directly east of the property along Virginia Street. Low-density residential properties located to the west and southwest along Fairview Drive are buffered from Singer property by undeveloped forest and pasture land. A former wastewater treatment plant and landfill, owned by the City of Lenoir, is located west of and adjacent to the Singer property. The city property is now used for the composting of leaves and as an animal shelter. The property line between Singer and the City of Lenoir bisects the landfill identified as SWMU No. 1. Figure 1-4 identifies adjacent properties within 1000 feet of the facility. Figure 1-5 identifies property boundaries and known utilities.

The operations at the Singer site were similar to most all furniture manufacturing--the principal difference from year-to-year being the patterns, styles, and colors. Significant materials commonly found at furniture and fixture manufacturing facilities include wood, saw dust, fuel oil, petroleum-based varnish, lacquer, paint and pigment products, paint/finishing stripper, solvents, cleaning detergents, and waste materials.

Manufacturers of furniture and fixtures are separated by the primary raw materials (i.e., wood and metal). The primary raw materials, industrial processes, waste and by-products, and final products differ for the production of wood and metal furniture. The following brief descriptions present the industrial activities and significant materials associated with the manufacture of wood furniture. Industrial activities and significant materials are fairly uniform across this sector.

The process of manufacturing wood furniture begins with the delivery and storage of wood. There are three different raw wood materials: lumber, veneer, and particle board.

Once delivered, raw lumber is allowed to air dry up to 1 year. After the lumber is sufficiently air dried, it is then transported to a dry kiln for further drying. The lumber is kiln dried from 7 to 150 days. Once the lumber has been dried to a desired moisture content, the dried lumber is taken to the processing area (Plant 33). The remaining furniture manufacturing processes are all completed indoors. Singer also receives lumber that is already dried. Therefore, not all lumber needs to be air or kiln dried.

The dried lumber is run through planners, to create a smooth, preliminary working surface, and then cut to specified dimensions depending on the end use. The sized lumber is then taken through sanding and machining operations. Sanding produces a smooth, fine working surface. Machining can include boring, routing, lathe operations, mitre cutting, and finish cuts. From this point, each piece of wood is dedicated to a specific product.

Veneer is another raw material used in the production of furniture. In this process logs are placed in a steam vat to increase the moisture content of a log. The logs are turned on a lathe to peel off the veneer. The resulting veneer sheets are layered into stacks or "hacks." Moisture is removed from the hacks by kiln drying. After a desired moisture content has been achieved, the hacks are disassembled. Veneer is then pressed onto particle board or solid wood by using urea formaldehyde adhesives (Plant 54).

Particle board is the third raw material incorporated into the manufacture of wood furniture. The board is received, cut to size, and banded on all four edges with solid wood. The banding is accomplished in continuous, steam-heated units using adhesives. The panels are allowed to cool and then they are sanded. Particle board is frequently coated with veneer.

The products from the three raw materials may be combined during the machining and sanding step or during the final assembly of a furniture piece. The machining and

sanding step may include initial sizing of particle board, veneer, and lumber; laminating operations; and surface printing. Once all the pieces of a particular furniture item are manufactured and sized, assembly can begin. This process generally involves an assembly line with many different individuals and machines working together to build the unit.

The final step in creating an unupholstered piece of furniture involves surface finishing. This process may involve many separate coats of stains, lacquers, sealers, and finishes applied to a single unit. This is the step where a uniform wood color and texture are given to each piece of furniture or furniture grouping. After the final inspection of a furniture piece, the unit is packaged and either stored temporarily on site or immediately shipped to an offsite location.

The Miller Hill Complex is described by subdividing the property into northern, central, and southern sections. The southern section consists of a high hill, dense woods, and an abandoned soil borrow pit. This area has not been disturbed for several years and there has never been any manufacturing activities on this portion of the property.

The central third of the property includes Plant 33, Plant 54, and related structures and buildings used to support maintenance personnel, supplies, and equipment. In October 1995, Singer removed the furniture manufacturing equipment (planners, shapers, saws, conveyors, finish booths, etc.) and stopped making furniture at Plant 33. The central and western portions of Plant 33 were remodeled and converted into a finished goods storage warehouse. The warehouse is used to store sewing machines and case goods that have been manufactured at other locations and are awaiting shipment to retailers and/or other distribution locations. The east end of Plant 33 includes the lumber drying kiln. In December 1996, Singer decided to close all operations at the Miller Hill Complex and the lumber drying kiln previously used to prepare raw lumber for furniture-making purposes has been evacuated. Except for the improved wastewater management procedures used to control the disposal of the glue being washed off of the press rollers,

Plant 54 activities did not change since the plant was constructed in 1966. Plant 54 ceased operations in March 1997.

The structures and portions of the property commonly referred to as the lumber yard (central northeastern) have not been actively used to support furniture making since 1989. All manufacturing related equipment and inventory were removed from the Lumber Yard structures prior to the start of the RFI activities. The buildings and structures have been recently used to store saw dust, wood scraps, tractors, trucks, and spare parts for the manufacturing operations formerly conducted on and offsite. The northeastern one-sixth of the property is used as a softball/baseball field for Singer employees and Lenoir community teams. The northwestern one-sixth portion includes the closed landfill (SWMU No. 1) and the floodplain of Lower Creek. Except for grass cutting, there have not been any activities or use of the northwestern portions of the property since the landfill was closed.

1.3 WORK PLAN HISTORY

A brief synopsis and chronology of the CAP at the Singer Miller Hill Complex is provided below:

11-19-80	Singer obtained interim status and operated hazardous waste storage facilities.
3-23-84	Singer submitted a permit application and sought permission to operate as a hazardous waste management facility.
5-11-88	EPA completed an RFA and determined that CAP requirements are applicable to the Singer facility.
6-30-88	EPA and the NCDEHNR concurrently issued permits for Singer to operate as a hazardous waste management facility.
5-27-89	Singer submitted an RFI work plan.
4-6-90	EPA transmitted comments and a notice of technical inadequacy for the RFI work plan.

4-24-90	Singer submitted an amended RFI work plan.
4-23-91	EPA identified additional deficiencies in the revised RFI work plan.
7-12-91	Singer submitted a revised RFI work plan in response to EPA's April 23, 1991, comments.
6-15-93	EPA identified additional deficiencies in the revised RFI work plan.
10-1-93	Singer submitted a second revised RFI work plan in response to EPA's June 15, 1993, comments.
3-24-94	EPA issued notice of violation and opportunity to show cause letter. This notice identified additional deficiencies in the second revised RFI work plan that were in need of correction and clarification.
5-11-94	The show cause meeting between EPA and Singer determined that a completely revised work plan would be submitted.
8-9-94	Singer submitted the revised work plan to EPA.
11-9-94	EPA approved the work plan contingent upon incorporation of corrections and clarifications by December 14, 1994.
12-14-94	On December 14, 1994, Singer provided the required corrections and clarifications to EPA.
1-17-95	Kickoff Meeting was conducted for implementing RFI work plan.
2-20-95 to 2-24-95	Grid survey was conducted by Western Carolina Surveyors. Also, magnetometer and seismic survey was completed by Pyramid Environmental.
3-1-95	Community Relations Plan and complete Work Plan were submitted to Caldwell County Library. Information was given to the local newspapers and County Board, etc.

4-24-95 to 4-27-95	Soil sampling was conducted at old drum locations (SWMU No. 2); also initial sampling was conducted on SWMU No. 9 area soils.
8-18-95	Wetlands construction permit application was submitted to US Army Corp of Engineers (USACOE) (Asheville Field Office) for two access roads in SWMU No. 2 area.
9-7-95 to 9-8-95	Water filtration system was set up and initial sampling of system was conducted to verify water was "organic-free." Also, road clearing was coordinated with Danny Swanson of Swanson Construction Co.
9-18-95 to 9-22-95	Two paths were cleared with heavy equipment (Swanson Construction Co.) in the "flood plain" area. Also a large dirt pile was moved from behind Plant 54 to allow access for background wells at BG-1 location.
9-26-95 to 9-28-95	Monitoring Wells BG-2WT, BG-2SP, and SWMU9-13WT were installed.
10-2-95 to 10-11-95	Monitoring Wells SWMU3-9WT and SWMU3-10WT were installed.
10-12-95 to 10-17-95	Soil hydraulic characteristics were tested at six locations on the landfill (S&EC, Inc.). Newly installed wells were developed (BG-2WT, 2SP; CAMA1-7WT, CAMA1-7SP; CAMA1-8WT, CAMA1-8SP).
10-18-95	Wetlands permit to construct two access roads in the SWMU No. 2 area was issued by the USACOE.
10-18-95 to 10-20-95	Monitoring wells were installed using "Mud-Buggy" (CAMA1-3WT and CAMA1-3SP). Also, approximately 10 truckloads of gravel were spread on path south of Plant 54 to allow access for rock drilling rig.
10-23-95 to 10-26-95	Monitoring wells were installed using "Mud-Buggy" (CAMA1-5WT and CAMA1-5SP). Also, Installation of Monitoring Wells using "Air-Rig": (BG-1WT, 1SP). Continued development and sampling of new wells.

10-30-95 to 11-7-95	Monitoring well development activities continued (BG-1WT, 1SP; CAMA1-5WT, 5SP; CAMA1-3WT, 3SP). Initial sampling of wells CAMA1-4WT, CAMA1-4SP, BG-2WT and BG-2SP were performed. Also, soil sampling was conducted at well locations using drill rig (split-spoon sampling).
11-8-95 to 11-10-95	Initial water sampling was conducted of newly installed wells (CAMA1-3WT, CAMA1-3SP, CAMA1-5WT, 5SP; BG-1WT, 1SP; BG-2WT, 2SP). Also, Western Carolina Surveyors were on site to obtain well casing elevations and as built locations.
12-12-95 to 12-14-95	Selected groundwater monitoring locations were resampled for Quality Assurance (QA)/Quality Control (QC) purposes (BG-1WT, 1SP; BG-2WT, 2SP; CAMA1-3WT, 3SP; CAMA1-5WT, 5SP; SW-1, SW-3, SW-5).
12-18-95 to 12-20-95	Soil samples were taken using trailer-mounted drill-rig (CAMA1-4WT, 4SP; 7WT, 7SP; BG-1WT, 1SP, 2WT, 2SP, SWMU9-13WT). Creek and sediment samples were taken at SW-1, SW-3, and SW-5 stream locations.
2-12-96 to 2-15-96	First Quarterly Groundwater Sampling Activity was performed (Winter 1996).
2-29-96	Additional soil sampling was conducted at SWMU No. 3 and SWMU No. 9.
3-25-96 to 3-27-96	Monitoring wells were installed using tracked drill rig (CAMA1-6WT, 6SP). Also, slug tests were conducted at selected monitoring wells.
4-1-96 to 4-4-96	Monitoring wells were developed (CAMA1-6WT, 6SP). Also, slug tests of selected wells were continued. Initial groundwater sampling of CAMA1-6WT, 6SP was conducted.
5-7-96 to 5-9-96	Second quarterly groundwater sampling activity (Spring 1996) was performed.
6-7-96	Selected wells were resampled for "alcohols" for QA/QC purposes.
8-12-96 to 8-15-96	Third quarterly groundwater sampling activity (Summer 1996) was performed.

11-5-96 to 11-7-96	Fourth quarterly groundwater sampling Activity (Fall 1996) was performed.
11-19-96 to 11-21-96	Selected wells were resampled for "herbicides" for QA/QC purposes.
12-3-96 to 12-4-96	Monitoring well CAMA1-5WT was resampled for "semivolatiles" for QA/QC purposes.

1.4 PREVIOUS INVESTIGATIONS

The methodologies used to derive the historical site profiles include extraction of information from three basic resources: 1) interviews with key personnel, including those possessing an extensive knowledge of facility operations and site development; 2) aerial photographs covering 1940 to 1995; and 3) review of historical files including title abstracts.

Seven onsite groundwater monitoring wells were installed during the two phases of the landfill investigation performed in 1982 and 1983 by Simrine and S&ME. The wells were screened within different portions of the hydrogeologic regime of the site. The report for the first phase of the landfill investigation indicates the wells were not installed in accordance with North Carolina Division of Environmental Management (NCDEM) requirements. S&ME obtained a variance from the NCDEM requirements, but the report and correspondence from the NCDEM do not provide an explanation of the variances from the requirements. Some of the well boreholes were extended below the bottom of the installed well screens. It is not known how these boreholes were backfilled before the installation of the wells. The wells are constructed of 2-inch-diameter polyvinyl chloride (PVC) risers and screens. The four wells installed during the first phase of the investigation were constructed of schedule 80 PVC with screens having 0.025-inch slots. The three wells installed during the second phase were constructed of schedule 40 PVC with 0.015-inch slotted screens. The PVC sections were glued together, which is inconsistent with EPA procedures. All of the wells have 5-foot lengths of screens, except

for wells N-1 and N-2 which have 10-foot lengths of screen. Soil boring and well record forms for all the wells are located in Appendix 1.7.

The background well (S-1) is installed upgradient of the southwestern portion of the landfill and is screened within the Saprolite of the site. The borehole for the well was extended into the Saprolite 6.5 feet.

The remaining six wells installed by S&ME are screened in the Alluvial Aquifer, but the screens were not located consistently within this aquifer. Monitoring wells W-1B and W-2 are located on City of Lenoir property, within landfilled material. These wells are screened within the lower Alluvial Aquifer. The depth to the top of the groundwater at W-1B is approximately 18 feet below ground surface and the well was screened from 40 to 45 feet below ground surface. Monitoring well W-2 is screened from 23 to 28 feet below ground surface and the depth to the top of groundwater is approximately 11 feet. Well W-1B has been damaged by differential settling and tree roots. Neither a bailer nor a water level indicator probe can be passed through the opening of well W-1B. The borehole of W-2 extended 7 feet below the bottom of the well screen.

Monitoring well E-1 is located along the eastern perimeter of the landfill, within the lumber yard. The unnamed tributary to Lower Creek is located between the landfill and E-1. E-1 is screened within the lower Alluvial Aquifer, with the borehole extending 3 feet below the bottom of the screen. The top of the groundwater at E-1 is approximately 7 feet below the ground surface, and the well is screened from 27 to 32 feet below ground surface.

N-1 is located at the bottom of the northeastern toe of the landfill and downgradient of the area that is believed to contain most of the disposed industrial wastes. N-1 is screened across the interface of the upper and lower portion of the Alluvial Aquifer, with the screen located 9.7 to 19.7 feet below the ground surface. The top of the groundwater at N-1 is approximately 7 feet below the ground surface.

Monitoring well NE-1 is located within the floodplain of Lower Creek, approximately 290 feet northeast of the northeast corner of the Singer portion of the landfill. The unnamed tributary to Lower Creek and the drainage ditch for the lumber yard are located

between the landfill and NE-1. NE-1 is screened within the lower portion of the Alluvial Aquifer, with the screen located 25.5 to 30.5 feet below the ground surface. The top of the groundwater at NE-1 is located approximately 5 feet below the ground surface. The borehole for NE-1 extended 4.5 feet below the bottom of the well screen, approximately 1 foot into the Saprolite underlying the alluvial soils.

Monitoring well N-2 is located approximately 350 feet north of the northern edge of the landfill and is screened within the upper portion of the Alluvial Aquifer. The depth to the top of the groundwater at N-2 is approximately 7 feet, and the well is screened from 10 to 20 feet below the ground surface. The borehole for N-2 extended to a depth of 35 feet below the ground surface, approximately 1 foot into the Saprolite underlying Alluvial Aquifer. The casing for well N-2 was damaged February 1995 when a city truck ran over the riser pipe. The city was using the Singer access road to reach a sewer manhole that is located northwest of Singer and on private property. The riser has been repaired and resurveyed so that water table and chemical concentration information can be retrieved from this location.

Prior to initiating the RFI, groundwater samples had been collected from some of the wells on seven occasions. The analyses performed on the groundwater samples were not conducted by the same laboratory, and the laboratories did not include comparable QA/QC procedures.

The collection of the samples for volatile organic analyses does not appear to have been performed in accordance with EPA-approved protocol. The report for Phase I of the investigation indicates that the groundwater from a well was placed in a compositing container until a sufficient volume was collected to fill all the sample containers for that well sample. The water from the compositing container was then transferred to the sample containers. The collected groundwater samples were analyzed for volatile and semivolatile organic priority pollutants by Spectrix Laboratory of Houston, Texas, and for metals, cyanide, phenols, total organic carbon (TOC), chloride, nitrate, and sulfate by Enwright Laboratories of Greenville, South Carolina. The volatile and semivolatile priority pollutant analyses were performed by EPA Methods 624 and 625, respectively. The EPA

Method 624 semivolatile analyses included 11 acid compounds, 47 base neutral compounds, and 26 pesticide compounds. The EPA Method 625 analyses included 31 volatile compounds.

No volatile or semivolatile compounds were detected in the groundwater samples collected from monitoring wells W-1B or S-1. One semivolatile compound, bis(2-ethylhexyl) phthalate, and two volatile compounds, ethylbenzene and toluene, were detected in the sample from N-1. The ethylbenzene was detected in the N-1 sample at a concentration of 55 micrograms per liter (μg/L) and the toluene concentration was 166 μg/L. The bis(2-ethylhexyl) phthalate was detected at a concentration of 100 μg/L. The only organic compound detected in the sample from monitoring well E-1 was the volatile compound methylene chloride at 30 μg/L. Methylene chloride and phthalate are common laboratory contaminants.

The methods used for the metals, cyanide, phenols, TOC, chloride, nitrate, and sulfate analyses were not specified in the laboratory data provided in the Phase I investigation report. The laboratory data indicate that the analytical methods were those approved for National Pollution Discharge Elimination System (NPDES) monitoring at the time of the investigation.

The groundwater sample from the background well, S-1, had seven metals with concentrations above the detection level. These seven metals were arsenic, beryllium, cadmium, chromium, lead, zinc, and barium.

All of these metals were detected in the groundwater samples from monitoring wells N-1 and W-1B. Arsenic and nickel were also detected in the sample from monitoring well N-1. No metals were detected in the sample from monitoring well E-1. The concentrations of the metals in the sample from well N-1 ranged from approximately 6 to 174 times as great as the concentration detected in the sample from S-1. The primary drinking water standards for arsenic, chromium, lead, and barium were exceeded in the sample from monitoring well N-1. The primary drinking water standard for arsenic, chromium, and lead is 50 μg/L, and the standard for barium is 1,000 μg/L. The concentrations of these compounds detected in the S-1 sample were 93, 400, 600, and

6,100 μg/L, respectively. The concentration of barium detected in the groundwater sample from monitoring well S-1, 1,100 μg/L, also exceeded the drinking water standard. A table of all of the analytical results for each well is provided in Appendix 1.8. Also included in Appendix 1.8 are concentration-versus-time graphs for the constituents that have been detected prior to implementation of the RFI work plan.

The three monitoring wells installed during the second phase of the landfill investigation were sampled by Sirrine personnel on August 8, 1983. The four wells installed during the first phase of the investigation were not sampled again during the second-phase sampling event. The groundwater samples were analyzed for organic priority pollutants, metals, cyanide, and phenols by Environmental Testing and Certification Corporation (ETC) of Edison, New Jersey, and for specific ions, total dissolved solids, TOC, pH, and specific conductivity by the Sirrine Laboratory. The volatile and semivolatile organic priority pollutant analysis was performed by EPA Methods 624 and 625, respectively. The metal analyses were performed according to the methods published by EPA in Methods for Chemical Analysis of Water and Wastes.

The only organic compound detected above the minimum detection level in any of the samples from the three monitoring wells was methylene chloride. Methylene chloride was detected at a concentration of 16 μg/L in the sample from monitoring well NE-1. Organic compounds were present at concentrations below the minimum quantitation limits in the samples from monitoring wells W-2 and N-2. None of the groundwater samples had metal concentrations above primary drinking water standards. The minimum detection level for lead of 100 μg/L was above the drinking water standard of 50 μg/L.

Sirrine issued a report in September 1984 regarding the analytical results for groundwater samples collected on June 20, 1984, from six of the onsite monitoring wells. A sample was not collected from well S-1 during this sampling event. The report does not provide information on who collected the samples, the sampling procedures, or the laboratory that performed the analyses. The samples were analyzed for priority pollutants (volatile and semivolatile organics, cyanide, and metals). The analytical methods and

detection limits for the analyses are not specified in the report. Methylene chloride was detected in the sample from monitoring well W-2 at a concentration of 23 μg/L. Other organic compounds were present at concentrations below the minimum quantitation level in the samples from all six wells. Barium, which was previously detected at high concentrations in samples from N-1, W-1B, and S-1, was not included in the analyses. Chromium was detected at a concentration of 30 μg/L in the samples for E-1 and NE-1. Zinc was detected in all six samples, with concentrations ranging from 30 to 290 μg/L. The concentration of zinc in the samples from monitoring wells W-1B (120 μg/L) and E-1 (290 μg/L) increased from the concentrations detected in previously collected samples from these wells. The zinc concentration decreased from previous samples in the samples from wells W-2, N-2, and N-1 and remained the same in the sample from NE-1. The zinc concentrations detected in these four samples were 30, 60, 110, and 180 μg/L, respectively.

Samples were collected from the groundwater monitoring wells by Singer personnel on a yearly basis from 1985 to 1987. The procedures used to collect the samples are unknown. The samples collected by Singer were analyzed by Chemical Environmental Technology Inc. (CET) of Cary, North Carolina. The actual laboratory sheets are not available for review; only summary sheets are available.

The first round of sampling by Singer personnel was performed in May 1985. Samples were collected from all seven of the existing groundwater monitoring wells. The samples were analyzed for volatile and semivolatile organic compounds, and metals. The samples were also analyzed for water quality indicators such as chloride, conductivity, pH, cyanide, nitrate, total dissolved solvents (TDS), and TOC.

Methylene chloride was detected in the samples from wells NE-1, E-1, W-2, N-1, N-2, and S-1 at concentrations of 17.2, 8.2, 3, 6.4, 6, and 11.6 μg/L, respectively. Trichloroethylene was also detected in the sample from NE-1 at a concentration of 5.4 μg/L. Other organic compounds were detected at concentrations below the minimum quantitation level in the samples from E-1, W-2, and N-1.

Zinc and copper were detected in the sample from NE-1 at concentrations of 50 and 40 μg/L, respectively. Zinc was detected in the samples from wells E-1, W-2, N-1, and S-1 at concentrations of 10, 10, 10, and 20 μg/L, respectively. Barium, which had previously been detected in wells N-1 and S-1 at concentrations exceeding the primary drinking water standard, was not included in the metal analyses.

Singer personnel performed their second round of sampling on the wells in July 1986. The samples were collected from all seven wells and were analyzed by CET for volatile organic compounds (VOCs), metals, and the water quality indicators. The minimum quantitative levels used in the metal analyses were lower than those used in the 1985 sample analyses. The list of water quality indicators was expanded to include total organic halogen (TOX). Trichloroethylene was detected in the samples from wells W-2 and W-1B at concentrations of 1.8 and 15.4 μg/L, respectively. The sample from W-1B also had a detectable concentration of 1,1-dichloroethane of 6.9 μg/L. The compounds bromodichloromethane, bromoform, 1,1-dichloroethane, 1,1,2,2-tetrachloroethane, toluene, and xylene were detected in the sample from well N-1 at concentrations of 402, 42.5, 20.5, 64.0, 2.1, and 3.1 μg/L, respectively. The metals with primary drinking water standards (barium, cadmium, chromium, mercury, selenium, and silver) were present in the groundwater samples from NE-1, E-1, W-2, and W1-B. Chromium, mercury, and cadmium were detected at concentrations of 124, 5, and 12 μg/L, respectively, in the sample from well N-2. The primary drinking water standards for these metals are 50, 2, and 10 μg/L, respectively. A cadmium concentration of 10 μg/L was detected in the sample from well N-1. The concentrations of iron and sodium in the downgradient wells are 30 to 200 times higher than the concentrations in the upgradient well (S-1). The barium concentration in well S-1 was 10 μg/L, which was over 100 times less than the concentration of the first sample taken from this well in 1982. The concentration of barium in well N-2 was 280 μg/L, which was approximately 22 times less than the concentration detected in the initial 1982 sample. The primary drinking water standard for barium is 1000 μg/L.

Singer personnel conducted their third sampling of the wells in July 1987. Samples were collected from all seven wells and were analyzed by CET for the same parameters as the samples collected in 1986, except manganese was replaced in the metal analyses by magnesium. The sample from well NE-1 contained a concentration of 16.5 μg/L of 1,2-dichloroethane. A concentration of 16.2 μg/L of 1,1,2-trichoroethane was detected in the sample from well W-1B. The sample from well N-1 had detected concentrations of 222.5 μg/L chloroform, 9.3 μg/L 1,2-dichloroethane, and 8.0 μg/L toluene. The barium levels detected in the samples from wells N-1 and N-2 showed increases of approximately 5 and 10 times, respectively, compared to levels detected in the 1986 samples. The concentrations detected in these samples were 1460 and 670 μg/L, respectively. The 1460 μg/L concentration is above the primary drinking water standard of 1000 μg/L. The barium concentration in the background well S-1 increased from 10 to 60 μg/L. The barium concentrations in the remaining four wells decreased from the concentrations detected in the 1985 samples. Chromium was detected at or above the primary drinking water standard of 50 μg/L in samples from wells NE-1, N-2, and N-1. The concentrations of chromium in these samples were 50, 230, and 200 μg/L, respectively. The concentration of cadmium in the sample from well N-2 was 11 μg/L, which is above the primary drinking water standard of 10 μg/L.

Environmental Quality Management, Inc. (EQ) personnel collected groundwater samples on March 10, 1994. A surface water sample was collected on March 11, 1994, from the small wetland area located at the northwest edge of the toe of the Singer portion of the landfill. The monitoring wells were purged of approximately five standing well volumes of groundwater before the samples were collected. The purging and sampling were performed with disposable, precleaned PVC bailers. An equipment blank was collected from a bailer that was subsequently used for purging and sampling monitoring well NE-1. The samples were analyzed for the compounds on EPA's Appendix IX (Appendix 1.9) list by 1-800-9-Analysis Inc. in Research Triangle Park, North Carolina. Carbon disulfide was detected in the samples from monitoring wells N-1 and NE-1 at concentrations of 8.45 and 7.48 μg/L, respectively. Carbon disulfide had not previously

been included in the analytical parameters for the samples from the wells. The sample from well NE-1 also had a detected concentration of 87,830 μg/L of bis(2-ethylhexyl) phthalate. None of the metals with primary drinking standards were detected at or above the standards in the groundwater samples. The concentrations of metals in the samples remained in the range of previously detected concentrations, except for barium, iron, and chromium which decreased. No detectable concentrations of any Appendix IX compounds were detected in the equipment blank. High concentrations of calcium, magnesium, potassium, and sodium were detected in the wetland surface water sample. The concentrations of these metals were 7,633, 2949, 1363, and 5507 μg/L, respectively. Barium, iron, manganese, silver, and zinc were also detected in the surface water sample at concentrations of 11, 87, 6, 6, and 26 μg/L, respectively.

The analytical results of the seven groundwater sampling events do not reveal a trend in the types and concentration of compounds detected in the samples. The variability in compounds detected in successive samples from individual monitoring wells could be caused by laboratory contamination, changes in analytical quantitation limits, and/or actual variations in groundwater quality. Methylene chloride has been detected inconsistently in seven of the groundwater monitoring wells. The detected concentrations have ranged from 30 μg/L to below the minimum quantitation level. The concentrations of methylene chloride detected in the samples are consistent with laboratory contamination problems. Samples from monitoring Well N-1 would be expected to show the greatest consistency, if an ongoing release was occurring from the landfill. Only two compounds, however, were detected in successive samples collected from N-1. Trichlorofluoromethane was detected at concentrations below the minimum quantitation limit in the samples collected from N-1 in June 1984 and May 1985. Toluene was detected in the samples collected in July 1986 and July 1987 at concentrations of 2.1 and 8.9 μg/L, respectively. None of the previously detected compounds were detected in the sample collected from N-1 in March 1994.

The historical information just discussed has been presented in order to fully disclose the information available to the regulatory agencies and Singer when the RFI

work plan was developed. The historical information was devolved by using techniques and procedures in common use during the late 1970's and early 1980's. A significant amount of uncertainty is associated with the comparison of historical investigative results with current investigative results. Hence, whenever a conflict between the old information and the new information is presented herein, Singer and its contractors have discounted the historical information. Historical information is herein defined to mean information that was generated before the RFI work plan was approved in December 1994. The QA and QC practices used during the RFI were specifically designed to assure comparability and to minimize uncertainty.

1.5 REPORT ORGANIZATION

Section 2 describes methodology, procedures, and results of the specific investigations and data collection efforts completed as part of this study effort. Section 3 presents the environmental setting and background conditions of the site and surrounding community. Section 4 describes the nature and extent of any contamination discovered during the investigations. Section 5 presents information on the toxicity of the contaminants, and applicable protection standards for each environmental media. Section 6 describes the methodology and results of the risk evaluation and characterizes the risk for the maximum exposed individual. Section 7 identifies the preliminary remedial action goals for each SWMU or CAMU, as appropriate and describes the potential corrective action measures that will achieve the preliminary remedial action goals. Finally, Section 8 presents the conclusions and recommendations.

This document contains historical reports, figures, and other data items that have been incorporated using the best available copy. The document is formatted so as to allow future revisions to be tracked on a page-by-page basis. The baseline document is dated April 16, 1997 and marked revision zero.

SECTION 2

INVESTIGATIVE TASKS

2.1 LOCATION SURVEYING

The proposed locations for the monitoring wells, soil borings, and surface water samples outlined in the approved RFI Work Plan were located and surveyed by using the following procedures and methodology.

The surveying activities needed to identify the proposed locations for the monitoring wells, soil-borings, and surface water sample points were performed by Western Carolina Surveyors (Surveyors) in February of 1995. In addition, the Surveyors marked a 40 foot x 40 foot grid with numbered lines running north-south, and lettered lines running east-west. The grid size was established to allow for a line of sight traverse between stakes and to achieve coverage of the abandoned drum area (SWMU No. 2) and the old landfill area (SWMU No. 1). The grid was installed to guide the magnetometer and seismic teams as they conducted their investigations in February and March of 1995.

The monitoring wells were installed between September of 1995 and March of 1996 by Geologic Exploration, Inc. (Geologic) under the supervision of EQ. The final location of the installed wells were determined by the Surveyors in May of 1996. These final locations were all within 1 to 30 feet of the locations described in the approved Work Plan. Variances were attributed to the location of trees, standing water, or proximity to buildings and/or other structures. In addition to the final locations, the Surveyors determined the "top of casing" elevations for each of the monitoring wells. The final locations of the monitoring wells, soil borings, and surface water samples are shown on the site map (Figure 1-2).

The soil boring locations for the Oil Spill area (SWMU No. 9) were originally surveyed in February of 1995. However, as a result of soil vapor surveys, hand

auguring, and visual observations, the field team determined that the boring/sample locations for SWMU 9 -SB1 through SWMU 9 -SB5 should be moved 20 feet east. Soil boring and sample locations SWMU 9 -SB6, -SB7, -SB8 and -SB9 were added in February of 1996 to better define the extent of contamination in this area. The locations for these borings were determined by measuring from the known location of SWMU 9 -13WT via tape measure and compass. These additional borings were located as follows:

SWMU 9 -SB6	100 ft North of SWMU 9 - 13WT
SWMU 9 -SB7	100 ft Northeast of SWMU 9 - 13WT
SWMU 9 -SB8	100 ft Northwest of SWMU 9 - 13WT
SWMU 9 -SB9	100 ft Southwest of SWMU 9 - 13WT.

Based on interviews with Singer employees, soil vapor analysis, and visual observations, the field team determined the center of the Glue Wash Evaporation Pond (SWMU No. 3) was 20 feet east of the location presented in the work plan. The location presented in the work plan was determined from historical aerial photographs that include oblique angles. These oblique angles prevented a more accurate determination during the planning effort. Hence, the sampling grid for SWMU No. 3 was shifted 20 feet east for locations SWMU 3 -SB1 through SWMU 3 -SB5. Additional soil borings (SWMU 3 -SB6, -SB7, -SB8) were installed to determine the extent of contamination in this area. These additional borings were located 40 feet west by measuring from the known locations of the previously installed borings via a tape measure and by aligning the axis between the borings to be parallel with the Plant 54 building.

2.2 MAGNETOMETER SURVEY

In February 1995, Pyramid Environmental, Inc. (Pyramid) conducted a magnetometer survey over approximately 14 acres of the landfill and floodplain. The

survey was conducted using an EG&G Geometrics G-856 proton-precession magnetometer and consisted of measuring the total magnetic field intensity on a grid system. The grid was used so that data could be gathered in a systematic manner and properly located geographically. The grid had a 40 foot by 40 foot spacing with numbered lines running north-south and lettered lines running east-west. The layout of the grid is shown in Figure 2-1. A copy of the report prepared by Pyramid for the magnetometer survey is located in Appendix 2.1.

A proton precision magnetometer uses the precession of spinning protons of hydrogen nuclei to measure the total magnetic field intensity at a given point. The magnetic field at a given point goes through daily or diurnal variations. The local magnetic field is also affected by nearby magnetic and/or iron-bearing materials. The effect is dependent on the size of the object, the distance from the object, and the magnetic susceptibility of the object. Local anomalies of hundreds or even thousands of gammas can be produced by buried metal objects such as underground storage tanks or buried drums. Interpretation of magnetic data is nonunique in that an anomaly can often be produced by either a large, deeply buried object, or a distribution of many small, shallow objects.

A map of the total magnetic field intensity for the site, as derived from the magnetometer survey, is shown in Figure 2-2. The total magnetic field intensity ranged from a low value of 50784 gammas to a high of 58158 gammas; however, both extreme values were located next to the lumber shed metal building located south of Plant 33. Analysis of the magnetic field intensity data indicates large magnetic anomalies along the northern edge of the landfill area (Figure 2-2). These anomalies are probably due to large amounts of metal debris that can be visually observed along this part of the landfill. With the exception of two small negatives anomalies at grid locations (230,X) and (30,K), all other anomalies could be explained by observed features in the vicinity (e.g., buildings, fences, etc.). These two undocumented anomalies are consistent with buried metal objects of 100 to 400 pounds (lb) and 70 to 300 lb, respectively, in the

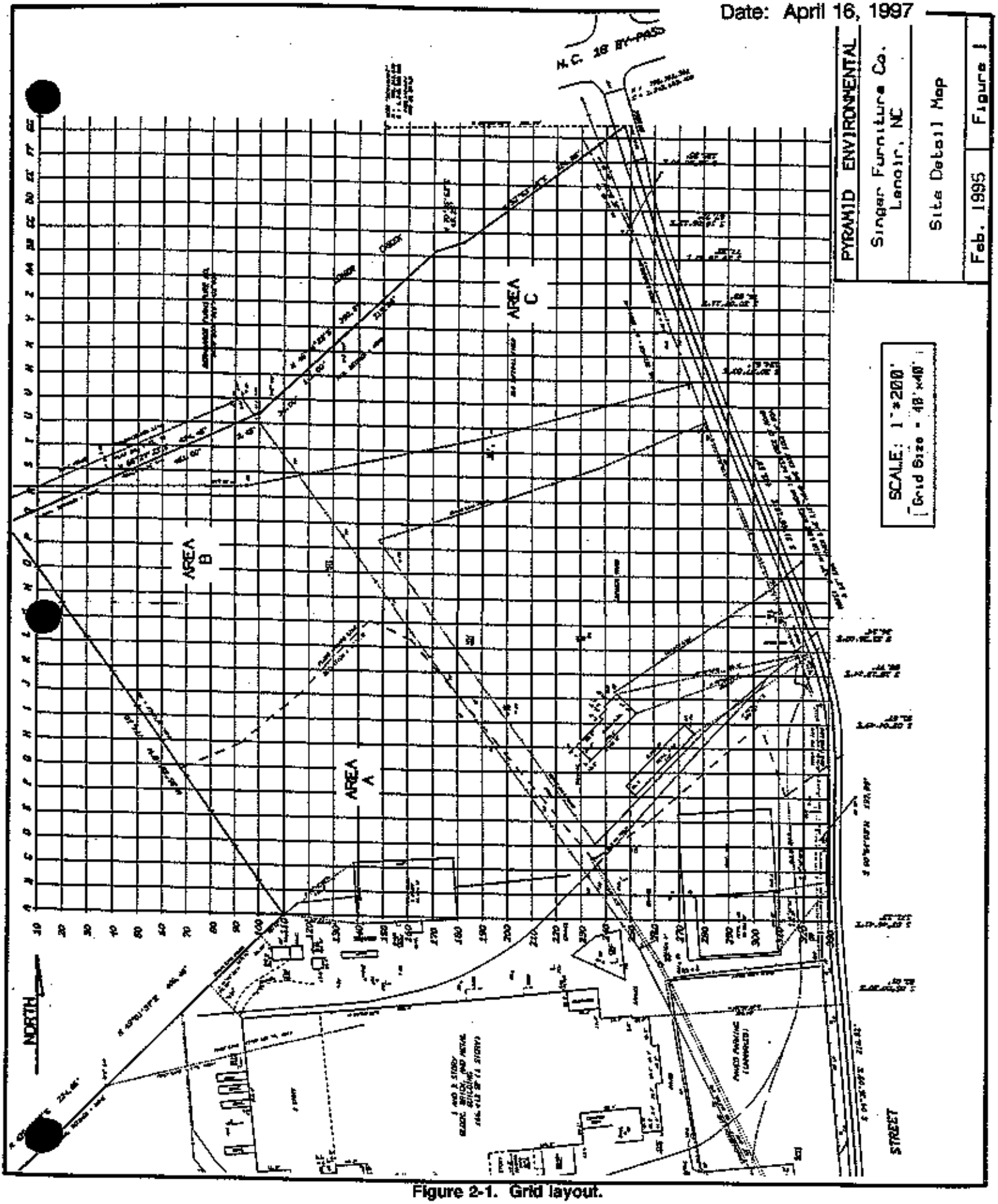

Figure 2-1. Grid layout.

Figure 2-2. Total magnetic field intensity map.

near surface (0 to 2 feet deep). Long time employees report that worn out planners, routers, and equipment were disposed in the landfill.

Because of the large range of magnetic intensities observed in the magnetometer survey, the magnetic intensities were plotted in Figure 2-2 with a contour interval of 200 gammas, making small amplitude anomalies and/or lineations difficult to discern. The magnetometer data were also examined using smaller contour intervals to look for lower amplitude anomalies than those visible in Figure 2-2. This approach was only useful in areas located away from large anomalies. Using the smaller contour intervals, two lineations of positive and negative anomalies with amplitudes between 20 and 50 gammas were noted in the softball field area. These lineations are shown in Figure 2-3. As isolated anomalies, these amplitudes would be consistent with 1 to 2 lb of iron located 4 to 6 feet from the magnetometer, or 20 to 30 lb of iron 15 to 20 from the magnetometer. The fact that they form a clear linear trend indicates that they may represent a buried pipeline. One of these lineations is located and oriented with the approximate location of a water line that runs through the Singer property (Figure 1-5). The second lineation does not correspond with any known pipelines on the Singer property.

The anomalie at grid location (80,K) is located within the portion of the landfill that is owned by the City of Lenoir. There were discarded appliances, such as hot water heaters, dishwashers, kitchen stoves, and clothes washers that were visible on this portion of the landfill. The anomalie could easily be attributed to being another household appliance. The city removed much of the debris during 1995 as part of the animal shelter construction.

The other undocumented anomalie is located in the softball field along the lineation that runs southeast to northwest (Figure 2-3). No known disposal activities have ever been performed in the softball field and, as previously stated, no pipelines with the orientation of the lineation are known to exist in the softball field. On April 27, 1995, EQ used a hand-held Schonstedt Model MAC-51B magnetic locator to attempt to further delineate the anomalie in the softball field. The magnetic locator provides

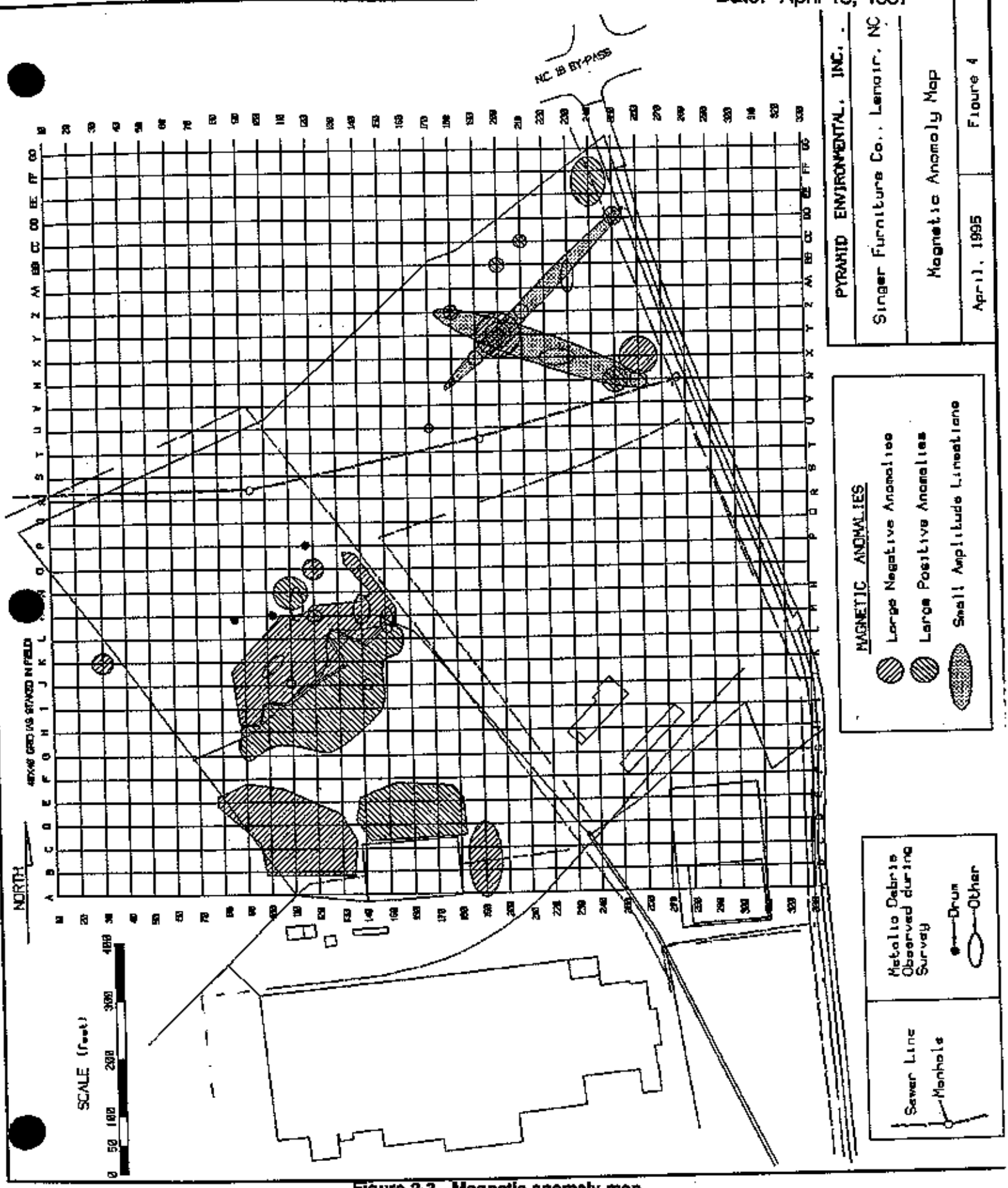

Figure 2-3. Magnetic anomaly map.

qualitative readings, allowing only a comparison of an area to its surroundings. The magnetic locator displayed elevated readings around grid location (X,220) in an elliptical shape that was oriented along the unexplained lineation. The anomalie had a width of approximately 8 feet and height of approximately 15 feet. The highest readings were obtained within the bottom third of the anomalie. No physical evidence of a buried object was observed in the area of anomalie. Orientation of the lineation may be explained as a small pipeline (gas, water, sewer) passing through the ballfield.

2.3 SEISMIC SURVEY

In March 1995, Pyramid conducted a seismic refraction survey on the same portions of the Singer site where they had conducted the magnetometer survey. The seismic refraction method uses the fact that seismic (sound) waves travel at different velocities through different types of rock and soil. Seismic waves are generated by a small source, such as a sledge hammer striking the ground or small explosive charges. Receivers called geophones are placed in a line at varying distances from the source. The amount of time the seismic waves take to travel from the source to geophones located nearby reveals the seismic velocity of the rear surface layer. With increasing distance from the source, seismic waves traveling through the faster, deeper layers begin to arrive first, revealing the velocities and depths of those layers. The seismic refraction method assumes increasing velocity with depth and relatively flat lying layers. The method cannot easily distinguish velocity inversions, layers with very large dips, or lateral changes within a layer.

The seismic survey at the Singer property used an EG&G Geometrics Strategies signal enhancement seisprometer with a 24 channel geophone spread using 8 hertz geophones. The survey consisted of five seismic refraction lines with two spreads per line (Figure 2-4). The geophone spacing for all the lines, except spread 2 of line 1, was 20 feet. This spread had a geophone spacing of 15 feet. The seismic source was a 12-pound sledge hammer striking a steel plate placed on the ground surface. An

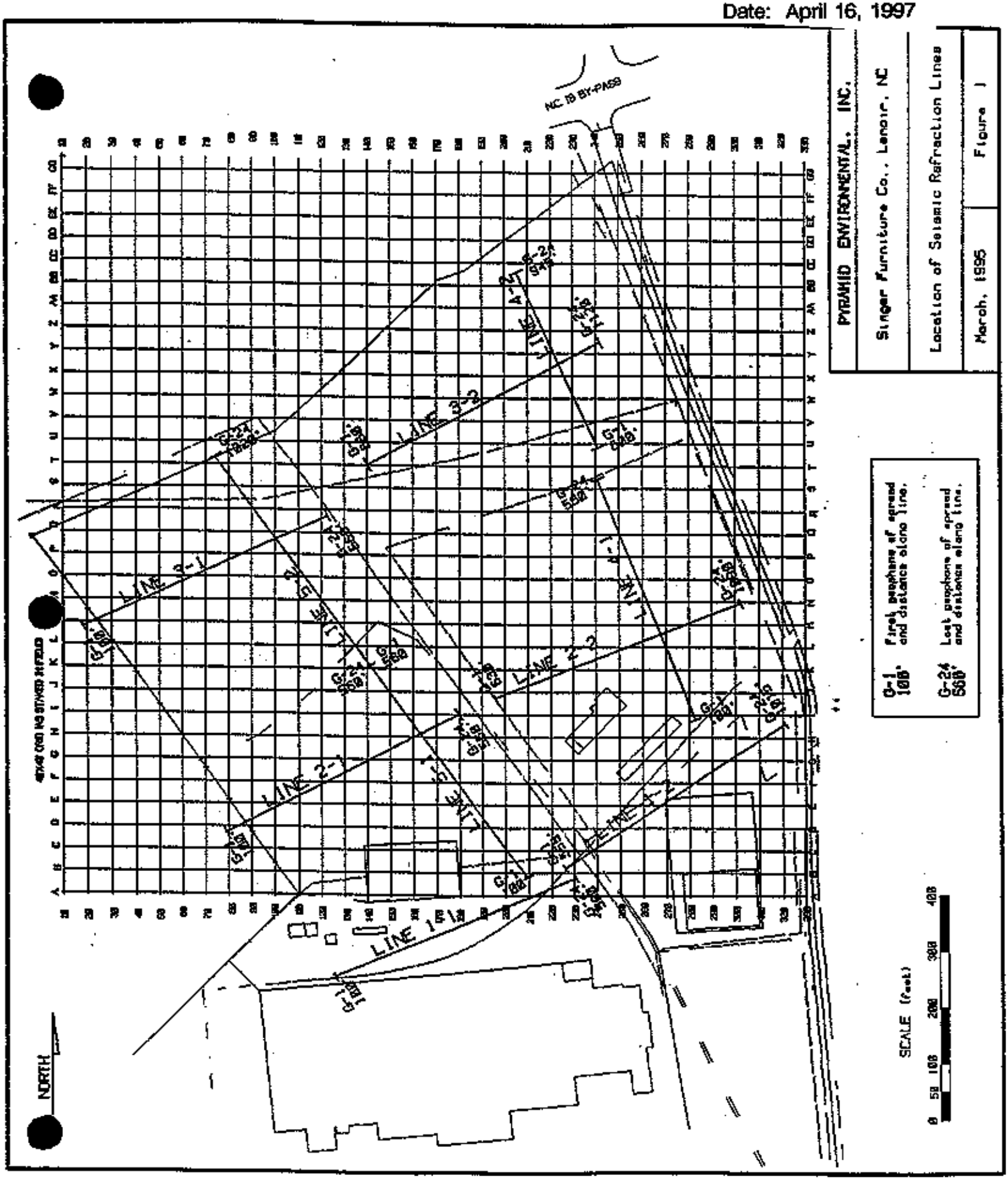

Figure 2-4. Location of seismic refraction lines.

electronic trigger mechanism attached to the sledge hammer signaled the start time to the seismograph.

Interpretation of the seismic refraction survey data shows three identifiable subsurface layers. Layer 1 is the near surface material with a seismic velocity of between 1,200 and 2,100 feet per second (ft/s). The thickness of this layer ranged from less than 10 feet to almost 40 feet. Layer 1 is interpreted as unconsolidated to moderately consolidated soil and/or fill material. Layer 1 is also referred to as alluvial site. Layer 2 has a seismic velocity of 5,000 to 7,100 ft/s and a thickness that varies from less than 10 feet to over 100 feet. Layer 2 is interpreted as water saturated, clay rich soil and/or weathered bedrock. Layer 2 is also referred to as Saprolitic soil. Layer 3 has a seismic velocity of 16,500 to 27,000 ft/s. Layer 3 is interpreted as unweathered metamorphic basement rock.

The seismic data did not provide any evidence of hidden low velocity layers or other local anomalies which would indicate the presence of clay lenses, a perched water table, or similar complex features. Some of the local variations in seismic velocity within Layers 1 and 2 may reflect more complex structures than the seismic refraction method can easily resolve. A copy of the seismic survey report prepared by Pyramid is provided in Appendix 2.2.

Figures 9 and 10 in Appendix 2.2 show the elevations of the tops of Layers 2 and 3, respectively, based on the interpretation of the seismic refraction data. Based on these elevations, groundwater traveling laterally through Layer 1 would generally flow from southeast to northwest, with localized flow to drainage features such as ditches and streams. Groundwater traveling laterally through Layer 2 would generally flow south to north, with much more localized flow occurring throughout the site. Within the landfill, there is an area that could serve as a preferential flow path through both Layers 2 and 3. This area is located near the western edge of the landfill. Two sets of the wells placed downgradient of the landfill by EQ during the RFI activities are located within this preferential flow area. These wells CAMA1-5WT, CAMA1-5SP,

CAMA1-6WT, and CAMA1-6SP, would serve to detect any compounds moving through this preferential flow path.

2.4 SOIL BORINGS AND SAMPLING

In order to obtain information about the geology and subsurface contaminant distribution, 49 soil borings were installed during the RFI. Nineteen soil borings were performed for the installation of monitoring wells, 8 soil borings were installed at SWMU No. 3, 9 soil borings were installed at SWMU No. 9, and 13 soil borings were installed as part of the General Landfill Assessment. The installation of the borings was performed using hand trowels, hand augers, and drill rigs. Borings performed with drill rigs used hollow stem augers in conjunction with split spoon samplers. The installation of the soil borings were performed in accordance with the RFI sampling and analysis plan (SAP). Appendix 2.3 contains the SAP.

During the installation of all soil borings, the soils were examined for the presence of overt evidence of contamination and the soils were visually logged and classified in accordance with the Standard Soil Classification System. The classifications of the soils were recorded on boring logs and are presented in Appendix 2.4.

Soil samples were also collected from selected monitoring well borings for laboratory analyses of density, moisture content, anion and cation exchange capacity, and grain size distribution. These parameters were collected to assist in the design and operation of remedial measures if the RFI had shown the soils and/or the groundwater to be impacted from releases from the SWMUs.

The samples submitted for these laboratory analyses were selected based on observations of different soil types and/or to provide information on the spacial variation of these parameters within the floodplain and background locations. The samples submitted for the analyses were from the boreholes of wells BG-1WT, BG-2WT, CAMA1-4WT, CAMA1-5WT, CAMA1-7WT, CAMA1-8WT, SWMU9-13WT, and

SWMU3-9WT. A more complete description of the installation procedures for monitoring wells is provided in Section 2.5.

The type of borings performed varied at each SWMU. The analyses performed on samples collected from the borings also varied by SWMU. The types of boring and the sample analyses are discussed for each SWMU below.

2.4.1 SWMU No. 1 - Landfill

The 13 soil borings performed at SWMU No. 1 were part of the General Landfill Assessment (Section 2.8). The borings were performed using stainless steel hand augers. The borings were performed to assess the composition and thickness of the landfill cover. A portion of each auger's contents was placed in a sealed container and screened using an organic vapor analyzer (OVA). The hand augers were decontaminated between boring locations by following the procedures specified in the SAP.

2.4.2 SWMU No. 2 - Abandoned Drums

A 5 foot by 5 foot square grid was established at each drum location and the surface vegetation and detritus were removed from each location. A boring was performed at the center and each of the grid corners from the surface to one foot below grade using a stainless steel trowel. The soil from each of the borings within a grid were then composited. The composite sample from each drum location was submitted for TOC analysis. Samples from the background well locations and a flood plain soil located near the ball field were also submitted for TOC analysis. The equipment used for the collection and compositing of the soil samples were decontaminated between drum locations in accordance with the SAP. The compositing of the samples was also performed in accordance with the SAP. The results of this sampling is discussed in Section 4.

2.4.3 SWMU No. 3 - Glue Pond

Nine soil borings were installed at the glue pond to define the lateral and vertical extent of contamination. All of the borings were performed using properly decontaminated stainless steel hand augers. An initial soil boring was installed at the center of the Glue Pond and representative soil samples were collected from the boring at one foot intervals until bedrock was encountered. A portion of each auger's contents were placed in a sealed container for OVA analyses. One sample was collected from the surface and another sample was collected at the termination of the boring at the bedrock. The two samples were submitted to the laboratory for 40 CFR 264 Appendix IX compounds, plus formaldehyde analyses. When the laboratory analyses revealed the presence of formaldehyde in the samples collected from the initial boring, additional borings were performed around the perimeter of the glue pond. Samples were collected from each of the borings and OVA analyses were performed on portions of the samples. None of the OVA analyses revealed the presence of volatile compounds. Samples from the termination depth of each boring were submitted for laboratory analyses. The samples were analyzed for the same compounds as the initial center boring. The termination sample was selected for submittal since this sample from the initial center boring had the highest concentrations of detected compounds. Following receipt of the laboratory results for the perimeter samples, three additional borings were performed to the west of the Glue Pond to define the lateral extent of contamination. Three additional samples were collected at the termination of the borings at bedrock. The samples were collected from this depth because the OVA and laboratory results of the previously collected sample had shown this depth to be the highest impacted zone of the soil as one moved away from the center of the SWMU. The samples were submitted for the same analyses as the perimeter samples. The results of the sampling for the Glue Pond are discussed in Section 4.

2.4.4 SWMU No. 9 - Fuel Oil Spill

Five initial soil borings were installed at SWMU No. 9. These five borings were located within and around the perimeter of the surface staining caused by the fuel oil spill. The borings were advanced with a stainless steel hand auger. Soil samples were collected at one foot intervals until groundwater was encountered. A portion of each sample was placed in a sealed container for OVA analysis. The sample from each boring with the highest OVA was submitted for laboratory analysis. Another sample from each boring was collected for laboratory analyses from the unsaturated soil immediately above the groundwater. The samples submitted for laboratory analyses were analyzed for the detection of volatile and semivolatile hydrocarbons by EPA Methods 8240 and 8270.

Four additional borings were installed at SWMU No. 9 to delineate the lateral extent of contamination. Samples were collected at a depth of 4 feet below land surface (BLS) from these borings for laboratory analyses of volatile and semivolatile hydrocarbons. The samples were selected from this depth because of the previous OVA and laboratory analyses had shown the soil from this depth to be the most impacted as one moved away from the center of the SWMU.

2.5 MONITORING WELL INSTALLATION AND SAMPLING

Nineteen groundwater monitoring wells were installed as part of the RFI. The installation of 17 of the wells was performed from September 21, 1995 to November 7, 1995. The remaining two wells were installed from March 25, 1996 to April 14, 1996. Drilling services for the installation of all of the wells were provided by Geologic.

The wells installed during the RFI assess the groundwaters of Alluvial Aquifer and the Saprolite unit. The wells to assess the Alluvial Aquifer were screened across the top of the water table. The wells installed to assess the Saprolite unit were screened at the top of the Saprolite unit.

The monitoring wells installed within all hydrogeological units were constructed of Type 304 stainless steel and were installed in accordance with the SAP. The wells constructed at the top of the water table used 10 foot lengths of screen. The distance between the top of the well screen and the groundwater was dependent on the depth to water below the land surface. The wells installed at the top of the Saprolite unit used 5 foot lengths of screen.

The well screens placed in the Alluvial and Saprolite Aquifer units have 0.010 inch wide slots. The filter pack for the wells consists of sand with a grain size distribution of 0.2 to 0.8 millimeters. The screen slot width and filter pack were selected based on the grain-size analyses performed for eight soil samples collected from five boreholes of the monitoring wells installed during the investigation of the landfill performed in 1982 and 1983.

The well installation procedures outlined in the SAP were followed to the extent feasible. Deviations from the SAP were required during the installation of five wells. Copies of the well construction logs are located in Appendix 2.5. During the installation of the Alluvial Aquifer wells CAMA1-5WT, CAMA1-6WT, and CAMA1-8WT groundwater was encountered at a depth of 2.5 feet BLS. For alluvial wells the SAP called for 1) the filter pack to be extended to two feet above the top of the well screen, 2) a minimum of two feet of bentonite be placed on top of the filter pack, and 3) grout placed on top of the bentonite to within two feet BLS. With the groundwater so close to the ground surface, these procedures could not be followed. These wells were constructed by placing the top of the well screen to 0.5 feet above the water table, placing one foot of filter pack above the top of the screen, and placing one foot of bentonite on top of the filter pack and bringing it even with the ground surface. The pad built for the well serves as the grout for the borehole.

For the installation of background wells BG-1WT, an attempt was made to install the borehole using hollow stem augers, but the borehole could only be extended to a depth of 8 feet BLS before refusal occurred. The area where background wells BG-1WT and BG-1SP were installed consists of Saprolitic material overlain with gravel and

silty sand that serves as a road bed. No groundwater was encountered in the borehole before refusal occurred. The installation of the boreholes for these two background wells required the use of an air rotary hammer equipped drill rig. The boreholes had to be extended to 12 feet BLS before groundwater was encountered. The consistency of the Saprolite material prevented the use of split spoon samplers for the collection of samples for OVA analyses. Although background well BG-1WT was labeled in accordance with pre-established nomenclature, it actually monitors the groundwater within the Saprolite of the Singer property. The borehole for background well BG-1SP was extended to the bottom of the Saprolite material and into the top of fractured bedrock, which underlies the Saprolite. It was not intended to extend the borehole into the bedrock, but no significant difference in the response of the air rotary hammer was noted before bedrock cuttings came to the surface. The borehole, which extended 5 feet into the bedrock, was backfilled with 2 feet of sand. Five feet of well screen was used for the well. Well BG-1SP, therefore, monitors the groundwater moving along the bedrock/Saprolite interface.

The installation of two sets of paired wells located downgradient of the landfill, CAMA1-3WT, CAMA1-3SP, and CAMA1-5WT and CAMA1-5SP, required the use of a drill rig mounted on an all terrain vehicle (ATV) commonly used in oil exploration. The ATV, even with high flotation tires, could not gain access to the location of the paired wells CAMA1-6WT (6WT) and CAMA1-6SP (6SP). Attempts to access this location resulted in the vehicle getting stuck.

Singer applied for a USACOE 401/404 wetland permit for the construction of a road to the location of 6WT and 6SP. Although the permit was issued by the USACOE, the limitations imposed on the volume and depth of fill material that could be used in the road made its construction impractical. Singer appealed to the NCDEHNR for relief from the requirement to install these two wells, based on their practically and necessity for the wells. Singer offered to perform quarterly sampling of the wetland marsh located between the northwest edge of the landfill and the location of 6WT and 6SP. Given the observed presence of water in the marsh at all times, including during low

rainfall periods, this marsh is in direct contact with the groundwater of the Alluvial Aquifer. The requested relief was not granted and in March of 1996, a drill rig mounted on a tracked vehicle was obtained and the installation of 6WT and 6SP was completed.

The boreholes for the wells installed in the Alluvial Aquifer had total depths ranging from 12 to 15 feet. The boreholes for the wells installed in the Saprolite Aquifer had total depths ranging from 30 to 35 feet. Table 2-1 summarizes the construction of all of the wells installed during the RFI.

The majority of the newly installed monitoring wells were developed by surging and pumping with a submersible pump. Three wells (CAMA1-3WT, CAMA1-5WT, and CAMA1-6SP) were developed by surging and bailing with TEFLON bailers. Three wells (BG-2WT, BG-2SP, and CAMA1-6WT) were developed by surging with organic-free water. Development of the wells was not performed within 48 hours of the installation. The following procedure was used to complete development activities at a majority of the wells:

1. The static water level and total well depth were measured.

2. The pH, temperature, and specific conductance of a groundwater sample from the well were measured.

3. The pump was placed in the well, pumping began, and the pumping rate was recorded. The pH, temperature, turbidity, and specific conductance of the groundwater removed from the well were measured periodically during the pumping.

4. The pumping was continued until the turbidity of the groundwater removed from the well reached a value of 5 Nephelometric Turbidity Units (NTUs) or less, as measured with a turbidity meter. The pumping was then discontinued and surging of the well using a surge block was then performed.

5. Steps 2 through 4 were then repeated until the turbidity of the groundwater at the beginning of a pumping cycle was 5 NTUs or less and the temperature, pH, and specific conductance of the groundwater stabilized.

TABLE 2-1. SUMMARY OF CONSTRUCTION OF WELLS INSTALLED DURING SINGER RFI

Well No.	Total depth of borehole, ft BLS[a]	Screen depth, ft BLS	Filter pack depth, ft BLS	Bentonite depth, ft BLS	Aquifer monitored
BG-1WT	25	10 to 20	8 to 25	8 to 10	Saprolite
BG-1SP	35	28 to 33	27 to 35	25 to 27	Saprolite
BG-2WT	14	3 to 13	2 to 13	1 to 2	Alluvial
BG-2SP	38	32 to 37	30 to 38	28 to 30	Saprolite
CAMA1-3WT	14	3 to 13	1 to 14	0 to 1	Alluvial
CAMA1-3SP	36	30 to 35	28 to 36	26 to 28	Saprolite
CAMA1-4WT	12.5	2 to 12	1.5 to 12.5	0.5 to 1.5	Alluvial
CAMA1-4SP	36	30 to 35	28 to 35	26 to 28	Saprolite
CAMA1-5WT	12.5	2 to 12	1 to 12.5	0 to 1	Alluvial
CAMA1-5SP	35	29.5 to 34.5	28.5 to 35	25.5 to 28.5	Saprolite
CAMA1-6WT	12.5	2 to 12	1 to 12.5	0 to 1	Alluvial
CAMA1-6SP	34.5	29.25 to 33.25	27.25 to 34.25	25.25 to 27.25	Saprolite
CAMAS1-7WT	12.5	2 to 12	1 to 12.5	0 to 1	Alluvial
CAMAW1-7SP	38	32 to 37	30 to 38	28 to 30	Saprolite
CAMA1-8WT	12.5	2 to 12	1 to 12.5	0 to 1	Alluvial
CAMA1-8SP	37.5	31 to 36	29 to 37.5	27 to 29	Saprolite
SWMU3-9WT	16.5	5 to 15	3 to 16	2 to 3	Alluvial
SWMU3-10WT	15.5	5 to 10	3 to 15	1 to 3	Alluvial
SWMU9-13WT	12.5	2 to 12	1 to 12.5	0 to 1	Alluvial

[a]BLS = Below land surface.

The same basic procedures were used for the wells developed by bailers, except the water removal rate was not recorded. Three wells at the site required an alternative development procedure. These wells were BG-2WT, BG-2SP, and CAMA1-6WT. Attempts were made to develop these wells using the standard procedure, but the wells

continuously went dry after the removal of small volumes of water (less than 5 gallons); even at low pumping rates. In order to facilitate the development of these wells, organic-free water was introduced into the wells and the wells were then surged for approximately 5 minutes in order to flush soil materials from the filter pack of the wells. The volume of water introduced into the wells was tracked. The wells were then pumped at a low flow rate until they went dry again. The well was allowed to recover and was then pumped dry again. This process was continued until the same volume of water introduced into the well was removed. The turbidity, pH, temperature, and specific conductance of the water removed during this procedure were not monitored. The well was then twice allowed to recover and pumped dry. After allowing the well to recover again, a sample of the groundwater was collected and the turbidity was measured. The pumping dry and recovery procedure was continued until the groundwater entering the well had a turbidity of 5 NTUs or less and the pH, temperature, and conductivity stabilized.

The total amount of groundwater removed during the development of each well was recorded in the logbook. The groundwater removed during well development was placed in 55-gallon drums. The drums were labeled with the well number, date of filling, and contents. The drums were placed in the Singer's temporary storage area until the results of groundwater sampling indicated if the water was hazardous. The analyses showed the water to be within acceptable limits of the Lenoir sewer use ordinance and the water was sent to the City of Lenoir wastewater treatment plant.

The newly installed monitoring wells at the Singer property were sampled after the development had been completed. A well was not sampled within 24 hours after development of the well had been completed. Sampling was performed in accordance with the SAP.

The first batch of wells installed, developed, and sampled included wells BG-2WT, BG-2SP, CAMA1-4WT, CAMA1-4SP, CAMA1-7WT, CAMA1-7SP, CAMA1-8WT, CAMA1-8SP, BG-2WT, BG-2SP, SWMU9-13WT, SWMU3-9WT, and SWMU3-10WT. These wells were sampled on October 25 and 26, 1995. The second batch of wells

installed, developed, and sampled included wells BG-1WT, BG-1SP, CAMA1-3WT, CAMA1-3SP, CAMA1-4WT, and CAMA1-4SP. In addition to these six wells, background wells BG-2WT and BG-2SP were sampled again in order to provide more data for statistical analysis. The initial groundwater samples were analyzed for Appendix IX compounds, excluding dioxins, plus formaldehyde, TOC, TOX, pH, and conductivity.

On February 12 through 15, 1996, another round of sampling was performed for the initial 17 wells installed during the RFI. In addition to the wells installed as part of the RFI, samples were also collected from four of the wells (S-1, N-1, NE-1, and E-1) installed during the landfill study performed in 1985 and 1986. The samples were analyzed for the same analytes as the newly installed wells. Duplicate samples were collected from all four of the background wells in order to increase the amount of data available for statistical analyses as part of the QC program.

The first round of samples was collected from the final two wells to be installed, CAMA1-6WT and CAMA1-6SP, on April 5, 1996. These initial samples were analyzed for Appendix IX compounds, excluding dioxins, plus formaldehyde, TOC, TOX, pH, and conductance.

Three additional rounds of sampling of all 19 RFI wells plus the four landfill study wells were performed from May 6 through 10, 1996, August 12 through 15, 1996, and November 4 through 7, 1996. The samples from each round were analyzed for the same analytes as the previously collected samples. Table 2-2 provides a summary of the number of times each well at the Singer site was sampled.

Evaluations and analyses were performed after each groundwater sampling event to determine whether the concentrations of compounds had changed significantly within a well and whether the concentrations within the downgradient wells differed significantly from those in the background wells. The groundwater in a hydrogeological unit was considered to have been impacted if the sample concentration of a hazardous constituent was at least three times higher than background concentration and the sample concentration is above the groundwater quality standard. The evaluation of the

TABLE 2-2. SAMPLING EVENT SUMMARY FOR GROUNDWATER MONITORING WELLS INSTALLED DURING SINGER RFI

Well No.	Number of sampling events	Sample dates
BG-1WT	7[a]	11/8/95[a], 2/15/96[a], 5/7/96, 8/14/96, 11/17/96
BG-1SP	7[a]	11/8/95[a], 2/15/96[a], 5/7/96, 8/14/96, 11/17/96
BG-2WT	7[b]	10/26/95, 11/9/95, 2/14/96[b], 5/7/96, 8/13/96, 11/6/96
BG-2SP	9[b,c]	10/26/95, 11/9/95, 2/14/96[b], 5/7/96, 8/13/96[c], 11/6/96[c]
CAMA1-3WT	6	11/9/95[c], 2/13/96, 5/8/96, 8/15/96, 11/5/96
CAMA1-3SP	6	11/9/95[c], 2/13/96, 5/8/96, 8/15/96, 11/5/96
CAMA1-4WT	5	10/26/95, 2/13/96, 5/8/96, 8/15/96, 11/5/96
CAMA1-4SP	5	10/26/95, 2/13/96, 5/8/96, 8/15/96, 11/5/96
CAMA1-5WT	5	11/8/95, 2/14/96, 5/8/96, 8/15/96, 11/5/96
CAMA1-5SP	5	11/8/95, 2/14/96, 5/8/96, 8/15/96, 11/5/96
CAMA1-6WT	4	4/5/96, 5/9/96, 8/14/96, 11/17/96
CAMA1-6SP	4	4/5/96, 5/9/96, 8/14/96, 11/17/96
CAMA1-7WT	6	10/25/95, 2/15/96, 5/7/96, 8/18/96, 11/15/96
CAMA1-7SP	5	10/25/95, 2/15/96, 5/7/96, 8/18/96, 11/15/96
CAMA1-8WT	5	10/25/95, 2/15/96, 5/7/96, 8/18/96, 11/15/96
CAMA1-8SP	6	10/26/95, 2/15/96, 5/7/96, 8/18/96, 11/15/96

(continued)

TABLE 2-2 (continued)

Well No.	Number of sampling events	Sample dates
SWMU3-9WT	6[c]	10/26/95, 2/14/96, 5/9/96[c], 8/14/96, 11/16/96
SWMU3-10WT	7[c]	10/26/95[c], 2/14/96[c], 5/9/96[c], 8/14/96, 11/16/96[c]
SWMU-13WT	6[c]	10/25/95, 2/14/96, 5/8/96[c], 8/13/96, 11/16/96

[a] Duplicate samples were collected from this well the first two times it was sampled in order to increase data available for statistical analysis.
[b] Duplicate samples were collected from this well the third time it was sampled in order to increase data available for statistical analysis.
[c] Includes duplicate samples collected for QA/QC purposes.

results of the RFI Phase I landfill groundwater assessment have determined that no additional monitoring wells are required to define the extent of the contamination, determine the assess potential receptors, or evaluate potential corrective measures.

Surface Water and Sediment Contamination--

With regard to surface water and surface sediment contamination, three areas of concern were identified: the marsh identified on the topographic base map, leachate seeps emanating from the toe of the landfill, and discharges from the Alluvial and Saprolitic Aquifers into Lower Creek and the Lower Creek Valley floor.

In order to assess these areas of concern, Phase I of the work plan included the collection of the following samples:

- Three samples were collected from the marsh located near monitoring well W-1B. Two samples were collected from the surface water contained in the marsh. The third sample consisted of sediments from the bottom of the marsh. The sample locations are shown in Figure 1-2.

- A reconnaissance survey along the toe of the Old Landfill was completed to identify potential landfill leachate seeps. Several reconnaissance events were performed to account for seasonal changes in groundwater

elevation and evaluate the potential correlation of flow (leachate seepage) with precipitation event. Reconnaissances of the landfill borders revealed the presence of only one identifiable leachate seepage. This seepage is located at the northwest edge of the landfill located on the Singer property. The seepage emits from the rocks that have been placed on the border of the landfill. The seepage has been examined during all climatic conditions and the flow has never been concentrated enough to accurately measure or sample it. The seepage flows in a thin layer over the rocks and eventually discharges to the marsh area located adjacently to the rocks. Samples of sediment and surface water were collected from the marsh area concurrently with the collection of groundwater samples from the monitoring wells on two occasions.

- Two stream sediment and two stream surface water samples from Lower Creek, one set from above SWMU No. 1 and one set from below SWMU No. 1, were collected for analysis. The sediment and surface water samples from Lower Creek were collected from the Singer property side of the stream. The samples allowed for the determination of whether surface and/or groundwater flow from the landfill area was affecting the water quality of Lower Creek. The sampling locations are shown in Figure 1-2.

All samples collected were analyzed for 40 CFR 264, Appendix IX compounds, excluding dioxins, in accordance with the procedures and requirements outlined in the SAP.

2.6 WATER TABLE ELEVATIONS

Groundwater movement is often related to topography, lithology, elevation of recharge and discharge areas, man made influences, and climatic rainfall variations. Water table elevations were collected from 26 locations during the field investigation.

Referenced groundwater elevations were determined by measuring the distance from the top of the well casing to the top of the water table. The elevation of the top of the well casing had been previously determined by the survey crews. The field investigation team used an electronic water level indicator to determine the depth to groundwater. The indicator was capable of measuring the distance to within 0.1 inches.

Groundwater table elevations were recorded on 18 different days during the field investigation effort. Because some of the wells were installed at a later date and the field investigation team did not always have time to collect water table data from every well on a given sampling day, there are data gaps in the information used to determine the groundwater flow direction. Direction of groundwater flow between wells is inferred by comparing the water table elevations at each location and date, and by considering the factors listed above. The amount of information for determining groundwater flow directions is robust and the data gaps are believed to be insignificant.

The data points (groundwater table elevations in monitoring wells) used to determine the groundwater flow direction are displayed in Table 2-3. Figure 2-5 graphically displays the groundwater table fluctuations for all monitoring location and by date. Figures 2-6 through 2-11 display water table fluctuation and trend data for each SMWU, the background (BG) wells, the water table (WT) wells and the Saprolite (SP) wells. Figure 2-12 presents water table information along a north to south axis with background well BG-1SP being the most southern location and having the highest topographic ground elevation and Lower Creek at the bridge crossing on Virginia Street being the most northern location being monitored. Appendix 2.6 contains the potentiometric maps for each of days that water table information was collected. This information clearly indicates that the groundwater flows in a northwesterly direction.

The field team was also onsite and taking measurements during two intense rain storm events (October 4, 1995 and August 13, 1996). During these rain storm events Lower Creek had risen significantly above its normal/typical water table elevation and the groundwater table also rose to the highest elevations measured during the investigation. Lower Creek is 80 to 200 feet north of the CAMA-1 monitoring well locations and direct communication between Lower Creek and the monitoring wells is demonstrated. The data also indicate that the groundwater table fluctuated less than 4 feet during the study period and that the newly installed water table wells were screened at a depth that would identify if nonaqueous low density floating contaminants existed.

TABLE 2-3. TABULAR DISPLAY OF GROUNDWATER TABLE ELEVATIONS BY LOCATION AND DATE

Well Identification Number	Location by Western Carolina Surveyors		Total Depth (ft)	Top of Casing (Elevation)	Date: 09/25/95		Date: 10/04/95		Date: 10/05/95	
	North	East			Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)
Lower Creek	791455.00000	1243235.00000	N.A.	N.A.						
CAMA1-8SP	790872.98703	1243314.24091	41.00	1068.74			5.79	1062.95	4.17	1064.57
CAMA1-8WT	790855.60523	1243316.10042	15.24	1069.48			10.85	1058.63	9.58	1059.90
NE-1	790830.00000	1243460.00000	32.39	1070.65	8.35	1062.30	7.62	1063.03	6.25	1064.40
CAMA1-7WT	790792.91161	1243483.77746	15.71	1069.07			5.44	1063.63	4.67	1064.40
CAMA1-7SP	790787.20466	1243471.76550	39.66	1069.08			6.80	1062.28	5.46	1063.62
N-2	790776.07513	1242949.08158		1070.77						
CAMA1-4WT	790770.89957	1243019.33296	15.02	1068.47			9.72	1058.75	5.63	1062.84
CAMA1-4SP	790766.23258	1243005.81697	39.09	1068.45			7.62	1060.83	6.77	1061.68
CAMA1-5SP	790660.90776	1242801.79651	37.21	1068.13						
CAMA1-5WT	790648.50285	1242800.12737	14.62	1068.10						
W-2	790640.00000	1242570.00000	31.01	1072.47	14.35	1058.12	13.66	1058.81	11.25	1061.22
CAMA1-3WT	790629.89591	1243115.73505	16.49	1068.99						
CAMA1-3SP	790623.23270	1243107.60969	38.99	1068.50						
N-1	790608.00000	1243195.00000	22.77	1072.59	11.47	1061.12	10.60	1061.99	8.32	1064.27
E-1	790495.00000	1243420.00000	33.56	1073.82	9.96	1063.86	9.67	1064.15	8.52	1065.30
BG-2SP	790464.57592	1243858.25469	39.41	1074.12			8.15	1065.97	7.96	1066.16
BG-2WT	790453.58735	1243860.80183	16.36	1074.03			6.84	1067.19	6.76	1067.27
CAMA1-6WT	790423.44348	1242954.82503	14.98	1067.77						
CAMA1-6SP	790417.44553	1242954.07719	37.2	1068.53						
SWMU9-13WT	790349.91426	1243542.95698	15.71	1074.21			7.63	1066.58	7.14	1067.07
S-1	789610.00000	1242960.00000	30.85	1098.32	19.00	1079.32	19.03	1079.29	18.89	1079.43
SWMU3-9WT	789568.51930	1243739.32219	15.30	1093.21						
SWMU3-10WT	789384.87839	1243683.88013	14.79	1094.59						
BG-1WT	789271.57417	1243851.29165	23.36	1101.54						
BG-1SP	789266.24612	1243843.43144	37.20	1101.53						

(continued)

TABLE 2-3 (continued)

Well Identification Number	Location by Western Carolina Surveyors		Date: 10/06/95		Date: 10/09/95		Date: 10/23/95		Date: 11/08-09/95	
	North	East	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)
Lower Creek	791455.00000	1243235.00000								
CAMA1-8SP	790872.98703	1243314.24091	4.82	1063.92	6.66	1062.08	7.11	1061.63		
CAMA1-8WT	790855.60523	1243316.10042	8.68	1060.80	9.03	1060.45	9.81	1059.67		
NE-1	790830.00000	1243460.00000	6.58	1064.07	7.43	1063.22				
CAMA1-7WT	790792.91161	1243483.77746	5.01	1064.06	5.95	1063.12	5.96	1063.11		
CAMA1-7SP	790787.20466	1243471.76550	5.51	1063.57	6.02	1063.06	6.41	1062.67		
N-2	790776.07513	1242949.08156								
CAMA1-4WT	790770.89957	1243019.33296	8.59	1059.88	9.54	1058.93	9.56	1058.91		
CAMA1-4SP	790766.23258	1243005.81697	6.49	1061.96	6.00	1062.45	6.88	1061.57		
CAMA1-5SP	790660.90776	1242801.79651							7.11	1061.02
CAMA1-5WT	790648.50285	1242800.12737							4.89	1063.21
W-2	790640.00000	1242570.00000	11.83	1060.64	12.90	1059.57				
CAMA1-3WT	790629.89591	1243115.73505							5.25	1063.74
CAMA1-3SP	790623.23270	1243107.60969							5.84	1062.66
N-1	790608.00000	1243195.00000	8.19	1064.40	8.31	1064.28				
E-1	790495.00000	1243420.00000	8.20	1065.62	8.95	1064.87		0.00		
BG-2SP	790464.57592	1243858.25469	7.46	1066.66	7.25	1066.87	7.57	1066.55	7.37	1066.75
BG-2WT	790453.58735	1243860.80183	6.80	1067.23	6.73	1067.30	6.64	1067.39	5.96	1068.07
CAMA1-6WT	790423.44348	1242954.82503								
CAMA1-6SP	790417.44553	1242954.07719								
SWMU9-13WT	790349.91426	1243542.95698	6.81	1067.40	6.98	1067.23	6.93	1067.28		
S-1	789610.00000	1242960.00000	18.75	1079.57	18.64	1079.68				
SWMU3-9WT	789568.51930	1243739.32219					7.97	1085.24		
SWMU3-10WT	789384.87839	1243683.88013					6.21	1086.38		
BG-1WT	789271.57417	1243851.29165							14.65	1086.89
BG-1SP	789266.24612	1243843.43144							14.47	1087.06

(continued)

TABLE 2-3 (continued)

Well Identification Number	Location by Western Carolina Surveyors		Date: 11/16/95		Date: 02/13/96		Date: 03/01/96		Date: 03/14/96	
	North	East	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)
Lower Creek	791455.00000	1243235.00000								1059.75
CAMA1-8SP	790872.98703	1243314.24091	7.04	1061.70	6.31	1062.43	6.96	1061.78	7.05	1061.69
CAMA1-8WT	790855.60523	1243316.10042	9.82	1059.66	8.64	1060.84	9.80	1059.68	10.02	1059.46
NE-1	790830.00000	1243460.00000	7.76	1062.89	7.16	1063.49	7.62	1063.03	7.72	1062.93
CAMA1-7WT	790792.91161	1243483.77746	5.72	1063.35	5.79	1063.28	5.87	1063.20	5.88	1063.19
CAMA1-7SP	790767.20466	1243471.76550	6.28	1062.80	5.61	1063.47	6.15	1062.93	6.25	1062.83
N-2	790776.07513	1242949.08158								
CAMA1-4WT	790770.89957	1243019.33296	9.65	1058.82	8.55	1059.92	9.46	1059.01	9.77	1058.70
CAMA1-4SP	790766.23258	1243005.81697	6.81	1061.64	6.02	1062.43	6.72	1061.73	6.87	1061.58
CAMA1-5SP	790660.90776	1242801.79651	6.81	1061.32	5.91	1062.22	6.67	1061.46	6.86	1061.27
CAMA1-5WT	790648.50285	1242800.12737	5.43	1062.67	3.73	1064.37	5.25	1062.85	5.48	1062.62
W-2	790640.00000	1242570.00000	13.50	1058.97	12.61	1059.86	13.40	1059.07	13.59	1058.88
CAMA1-3WT	790629.89591	1243115.73505	5.51	1063.48	4.42	1064.57	5.11	1063.88	5.65	1063.34
CAMA1-3SP	790623.23270	1243107.60969	5.87	1062.63	5.15	1063.35	5.72	1062.78	5.46	1063.04
N-1	790606.00000	1243195.00000	9.10	1063.49	8.17	1064.42	9.11	1063.48	9.39	1063.20
E-1	790495.00000	1243420.00000	9.24	1064.58	8.52	1065.30	9.00	1064.82	9.12	1064.70
BG-2SP	790464.57592	1243858.25469	7.32	1066.80	6.65	1067.47	7.02	1067.10	7.13	1066.99
BG-2WT	790453.58735	1243860.80183	5.73	1068.30	4.85	1069.18	4.58	1069.45	4.87	1069.16
CAMA1-6WT	790423.44348	1242954.82503								
CAMA1-6SP	790417.44553	1242954.07719								
SWMU9-13WT	790349.91426	1243542.95698	6.23	1067.98	5.44	1068.77	5.72	1068.49	5.80	1068.41
S-1	789610.00000	1242960.00000	18.29	1080.03	17.32	1081.00	17.27	1081.05	17.44	1080.88
SWMU3-9WT	789568.51930	1243739.32219	8.04	1085.17			7.66	1085.55	7.88	1085.33
SWMU3-10WT	789384.87639	1243683.88013	6.06	1088.53			5.62	1088.97	5.77	1088.82
BG-1WT	789271.57417	1243851.29165	14.56	1086.98	14.05	1087.49	14.26	1087.28	14.42	1087.12
BG-1SP	789266.24612	1243843.43144	14.40	1087.13	13.87	1087.66	14.10	1087.43	14.24	1087.29

(continued)

TABLE 2-3 (continued)

Well Identification Number	Location by Western Carolina Surveyors		Date: 04/04/96		Date: 05/06/96		Date: 06/07/96		Date: 08/13,14/96	
	North	East	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)
Lower Creek	791455.00000	1243235.00000				1059.65		1059.72		
CAMA1-8SP	790872.98703	1243314.24091	6.81	1061.93	7.18	1061.56	7.35	1061.39	5.92	1062.82
CAMA1-8WT	790855.60523	1243316.10042	9.55	1059.93	11.64	1057.84	10.39	1059.09	10.58	1058.90
NE-1	790830.00000	1243460.00000	7.49	1063.16	7.90	1062.75	8.03	1062.62	8.23	1062.42
CAMA1-7WT	790792.91161	1243483.77746	5.78	1063.29	6.04	1063.03	6.19	1062.88	4.76	1064.31
CAMA1-7SP	790787.20466	1243471.76550	6.02	1063.06	6.43	1062.65	6.55	1062.53	5.48	1063.60
N-2	790776.07513	1242949.08158			11.81	1058.96	12.09	1058.68	10.95	1059.82
CAMA1-4WT	790770.89957	1243019.33296	9.59	1058.88	9.97	1058.50	10.19	1058.28	5.52	1062.95
CAMA1-4SP	790766.23258	1243005.81697	6.73	1061.72	7.11	1061.34	7.29	1061.16	6.45	1062.00
CAMA1-5SP	790660.90776	1242801.79651	6.68	1061.45	7.13	1061.00	7.34	1060.79	6.3	1061.83
CAMA1-5WT	790648.50285	1242800.12737	5.30	1062.80	5.82	1062.28	7.35	1060.75	3.54	1064.56
W-2	790640.00000	1242570.00000	13.42	1059.05	13.89	1058.58	14.05	1058.42	13	1059.47
CAMA1-3WT	790629.89591	1243115.73505	5.41	1063.58	6.16	1062.83	7.03	1061.96	4.1	1064.89
CAMA1-3SP	790623.23270	1243107.60969	5.46	1063.04	6.46	1062.04	6.34	1062.16	5.22	1063.28
N-1	790608.00000	1243195.00000	9.21	1063.38	9.78	1062.81	10.48	1062.11	8.9	1063.69
E-1	790495.00000	1243420.00000	8.99	1064.83	9.37	1064.45	9.56	1064.26	9.21	1064.61
BG-2SP	790464.57592	1243858.25469	6.99	1067.13	7.34	1066.78	7.54	1066.58	7.4	1066.72
BG-2WT	790453.58735	1243860.80183	4.43	1069.60	4.93	1069.10	5.85	1068.18	6.92	1067.11
CAMA1-6WT	790423.44348	1242954.82503	4.39	1063.38	3.25	1064.52	3.78	1063.99	3.73	1064.04
CAMA1-6SP	790417.44553	1242954.07719	5.06	1063.47	5.89	1062.64	6.05	1062.48	5.11	1063.42
SWMU9-13WT	790349.91426	1243542.95698	5.57	1068.64	6.09	1068.12	6.46	1067.75	7.61	1066.60
S-1	789610.00000	1242960.00000	17.57	1080.75	19.48	1078.84	18.28	1080.04	18.74	1079.58
SWMU3-9WT	789568.51930	1243739.32219	7.72	1085.49	8.88	1084.33	8.39	1084.82	8.7	1084.51
SWMU3-10WT	789364.87639	1243683.88013	5.87	1088.72	6.66	1087.93	8.13	1086.46	7.79	1086.80
BG-1WT	789271.57417	1243651.29165	14.35	1087.19	16.21	1085.33	14.98	1086.56	14.93	1086.61
BG-1SP	789266.24612	1243843.43144	14.22	1087.31	14.59	1086.94	14.80	1086.73	14.73	1086.80

(continued)

TABLE 2-3 (continued)

Well Identification Number	Location by Western Carolina Surveyors		Date: 11/04/96		Date: 11/19/96		Date: 12/03/96	
	North	East	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)	Depth to Water (ft)	Groundwater Elev. (ft)
Lower Creek	791455.00000	1243235.00000						
CAMA1-8SP	790872.98703	1243314.24091	7.2	1061.54	7.21	1061.53	6	1062.74
CAMA1-8WT	790855.60523	1243316.10042	9.94	1059.54	10.15	1059.33	7.87	1061.61
NE-1	790830.00000	1243460.00000			7.92	1062.73	6.75	1063.90
CAMA1-7WT	790792.91161	1243483.77746	5.75	1063.32	5.99	1063.08	5.4	1063.67
CAMA1-7SP	790787.20466	1243471.76550	6.35	1062.73	6.46	1062.62	5.29	1063.79
N-2	790776.07513	1242949.08158			11.61	1059.16	9.22	1061.55
CAMA1-4WT	790770.89957	1243019.33296	9.83	1058.64	9.78	1058.69	8.32	1060.15
CAMA1-4SP	790766.23258	1243005.81697	6.96	1061.49	7.05	1061.40	7.16	1061.29
CAMA1-5SP	790660.90776	1242801.79651	6.9	1061.23	7.02	1061.11	5.81	1062.32
CAMA1-5WT	790648.50285	1242800.12737	5.52	1062.58	5.17	1062.93	2.68	1065.42
W-2	790640.00000	1242570.00000			13.74	1058.73	12.22	1060.25
CAMA1-3WT	790629.89591	1243115.73505	5.6	1063.39	5.42	1063.57	3.66	1065.33
CAMA1-3SP	790623.23270	1243107.60969	5.91	1062.59	6.05	1062.45	2.16	1066.34
N-1	790608.00000	1243195.00000			9.25	1063.34	8.11	1064.48
E-1	790495.00000	1243420.00000	9.3	1064.52			8.37	1065.45
BG-2SP	790464.57592	1243858.25469	7.8	1066.32	9.64	1064.48	6.69	1067.43
BG-2WT	790453.58735	1243860.80183	5.9	1068.13	7.73	1066.30	5.46	1068.57
CAMA1-6WT	790423.44348	1242954.82503			3.14	1064.63	3.05	1064.72
CAMA1-6SP	790417.44553	1242954.07719			5.79	1062.74	4.71	1063.82
SWMU9-13WT	790349.91426	1243542.95698	6.3	1067.91	8.04	1066.17	5.03	1069.18
S-1	789610.00000	1242960.00000			18.2	1080.12	18	1080.32
SWMU3-9WT	789568.51930	1243739.32219	8.25	1084.96	10.01	1083.20	8.25	1084.96
SWMU3-10WT	789384.87839	1243683.88013	6.2	1088.39	7.61	1086.98	5.95	1088.64
BG-1WT	789271.57417	1243851.29165			18.64	1082.90	14.46	1087.08
BG-1SP	789266.24612	1243843.43144			16.94	1084.59	14.26	1087.27

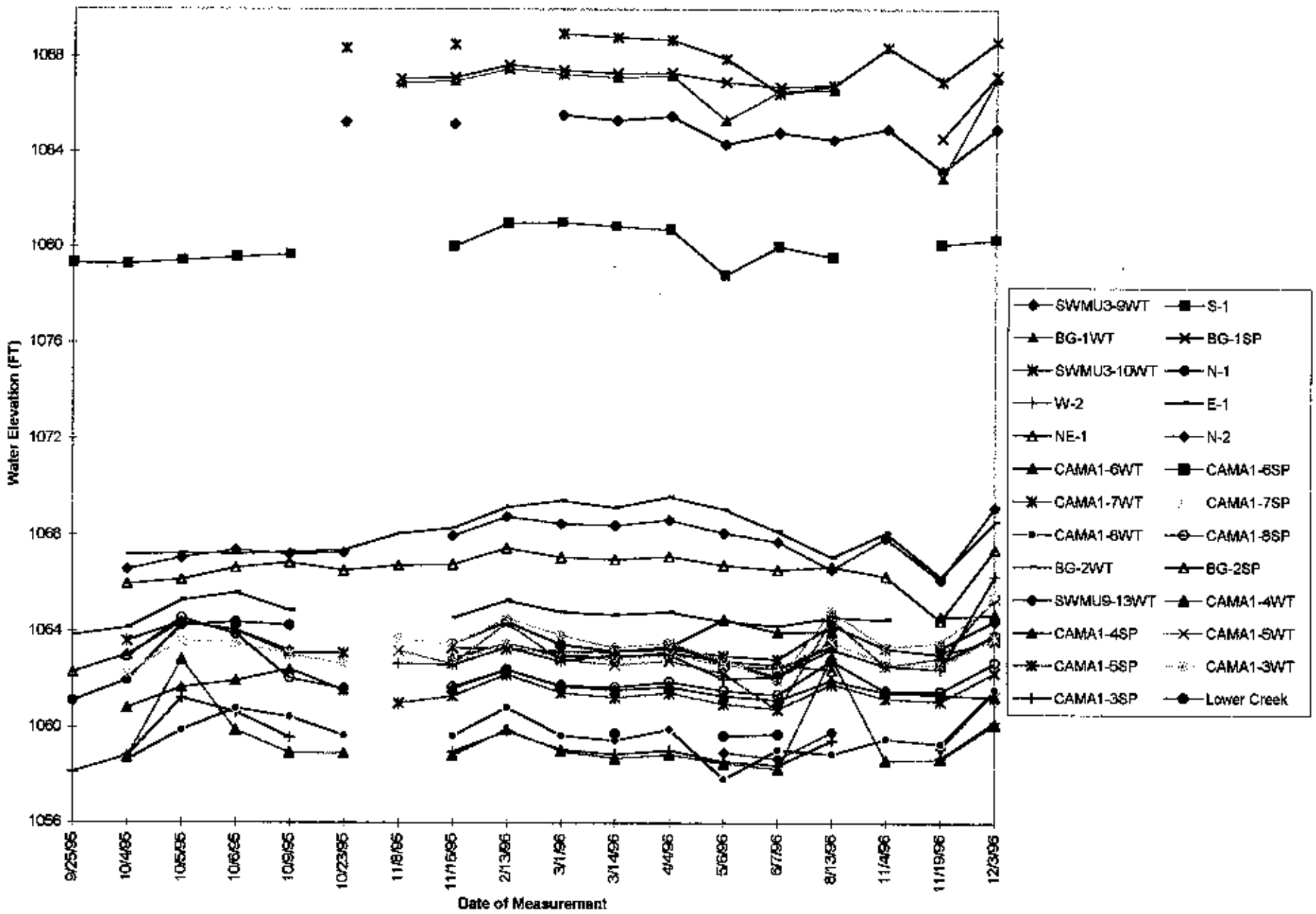

Figure 2-5. Graphical display of groundwater table fluctuations by location and date.

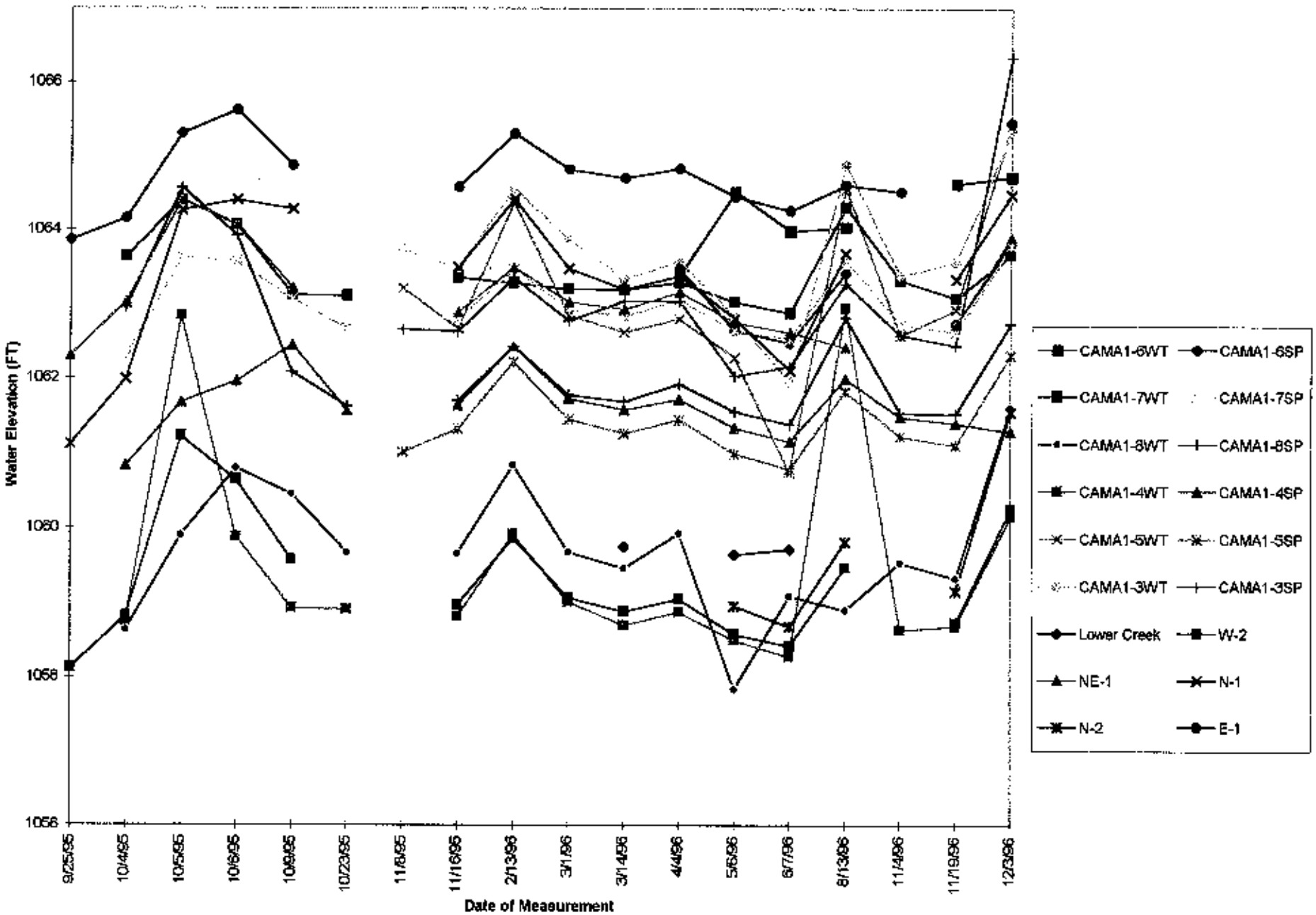

Figure 2-6. Groundwater fluctuations for wells at CAMA 1.

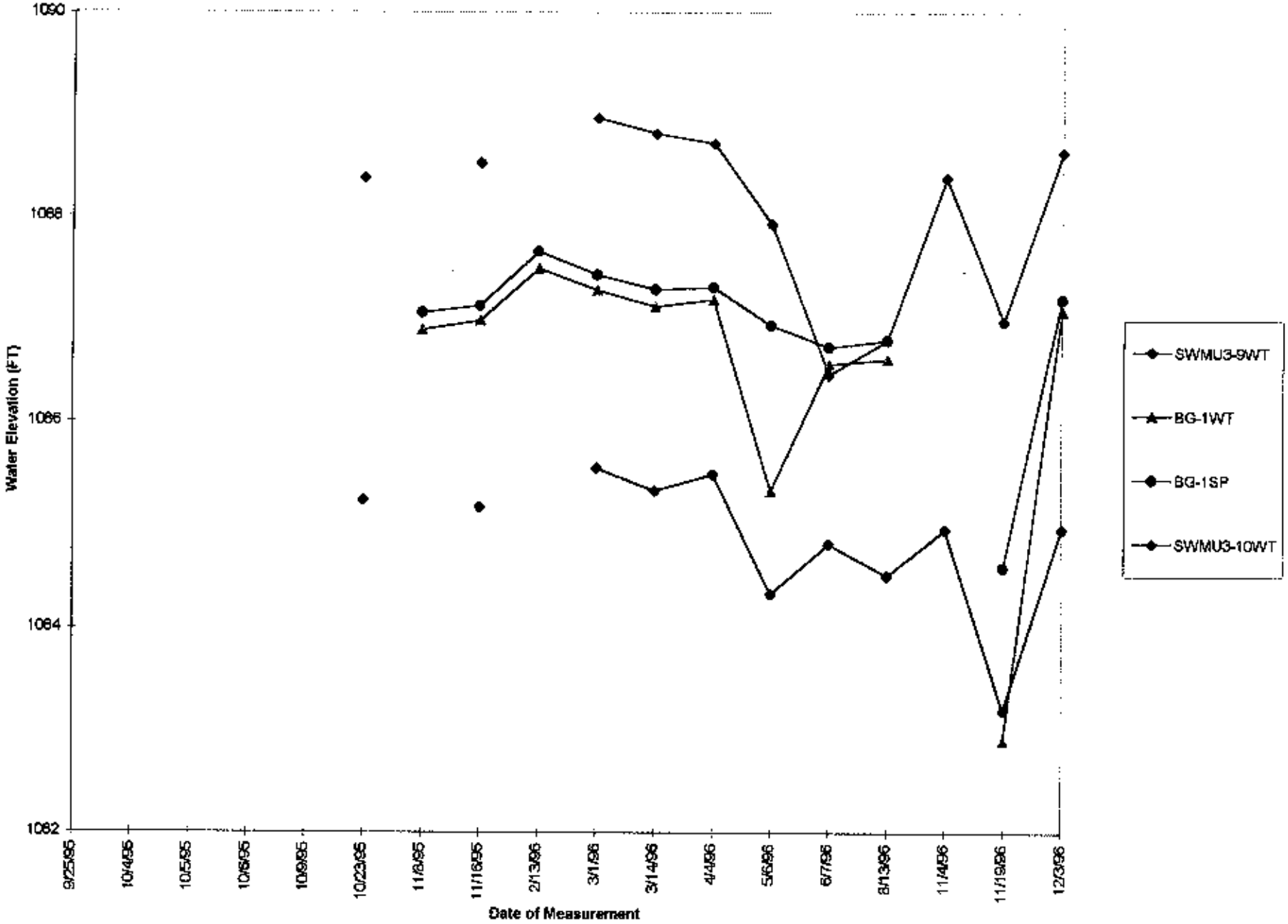

Figure 2-7. Graphical display of groundwater fluctuations at SWMU No. 3.

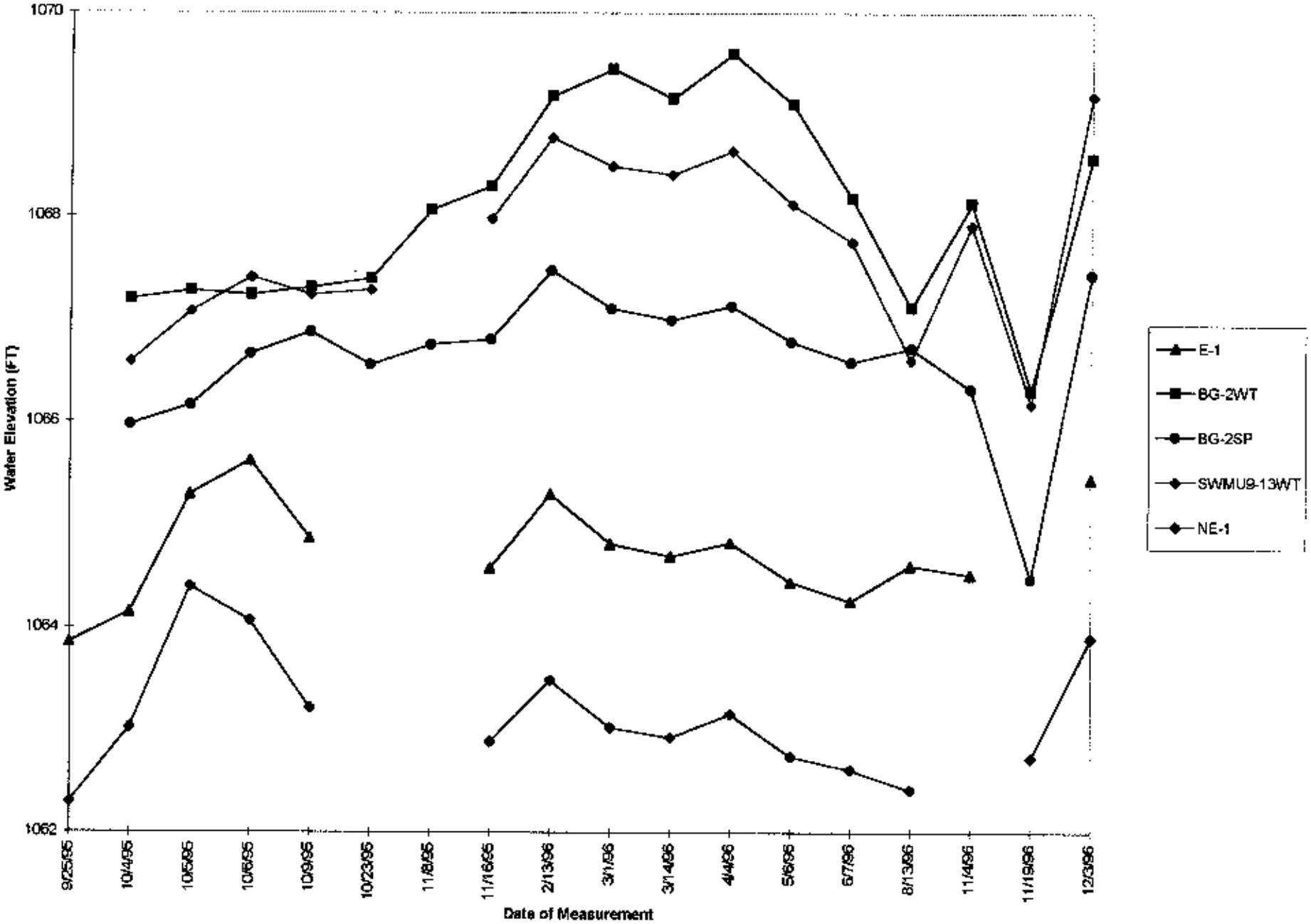

Figure 2-8. Graphical display of groundwater table fluctuations at SWMU No. 9.

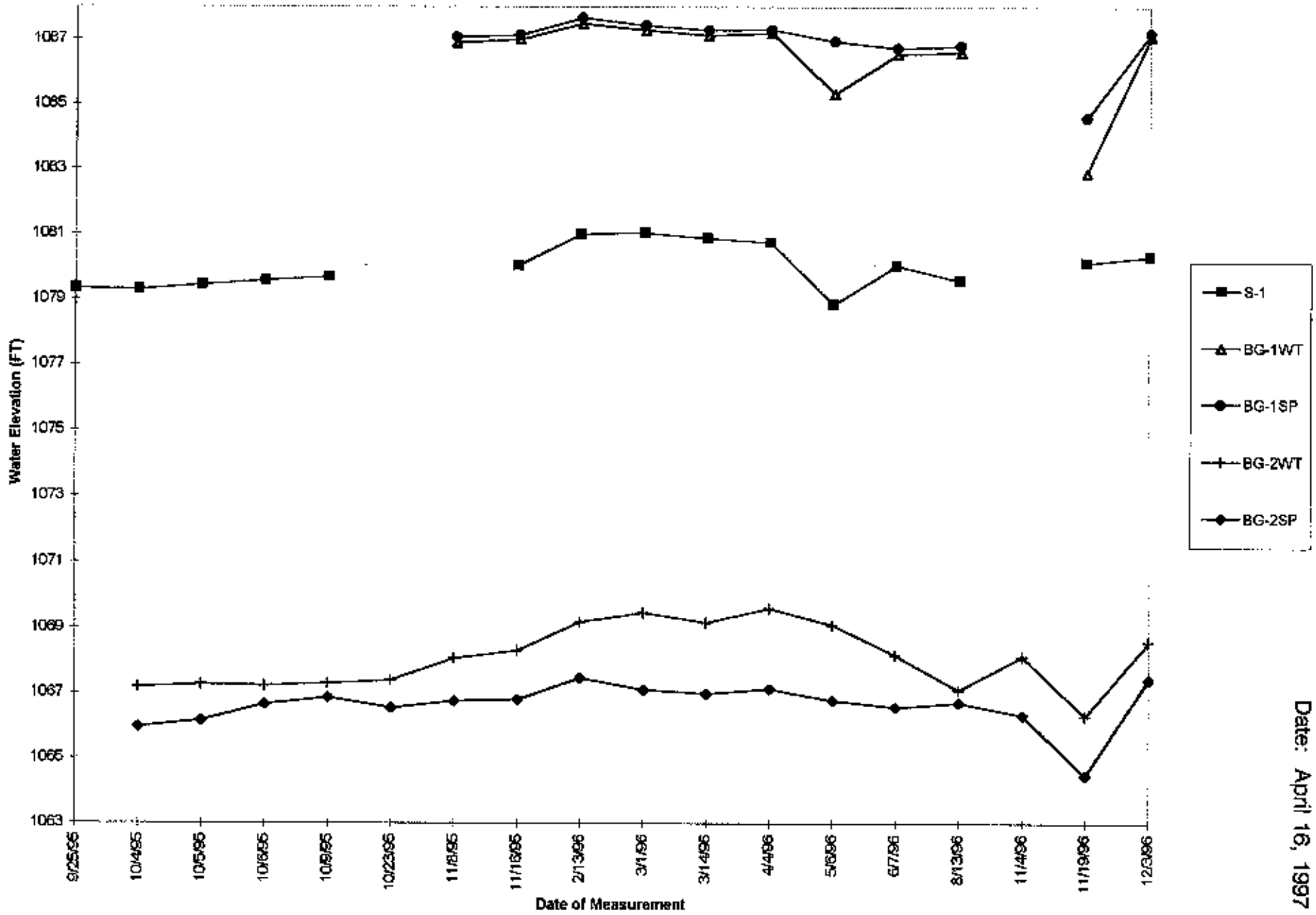

Figure 2-9. Graphical display of groundwater table fluctuations for the background wells.

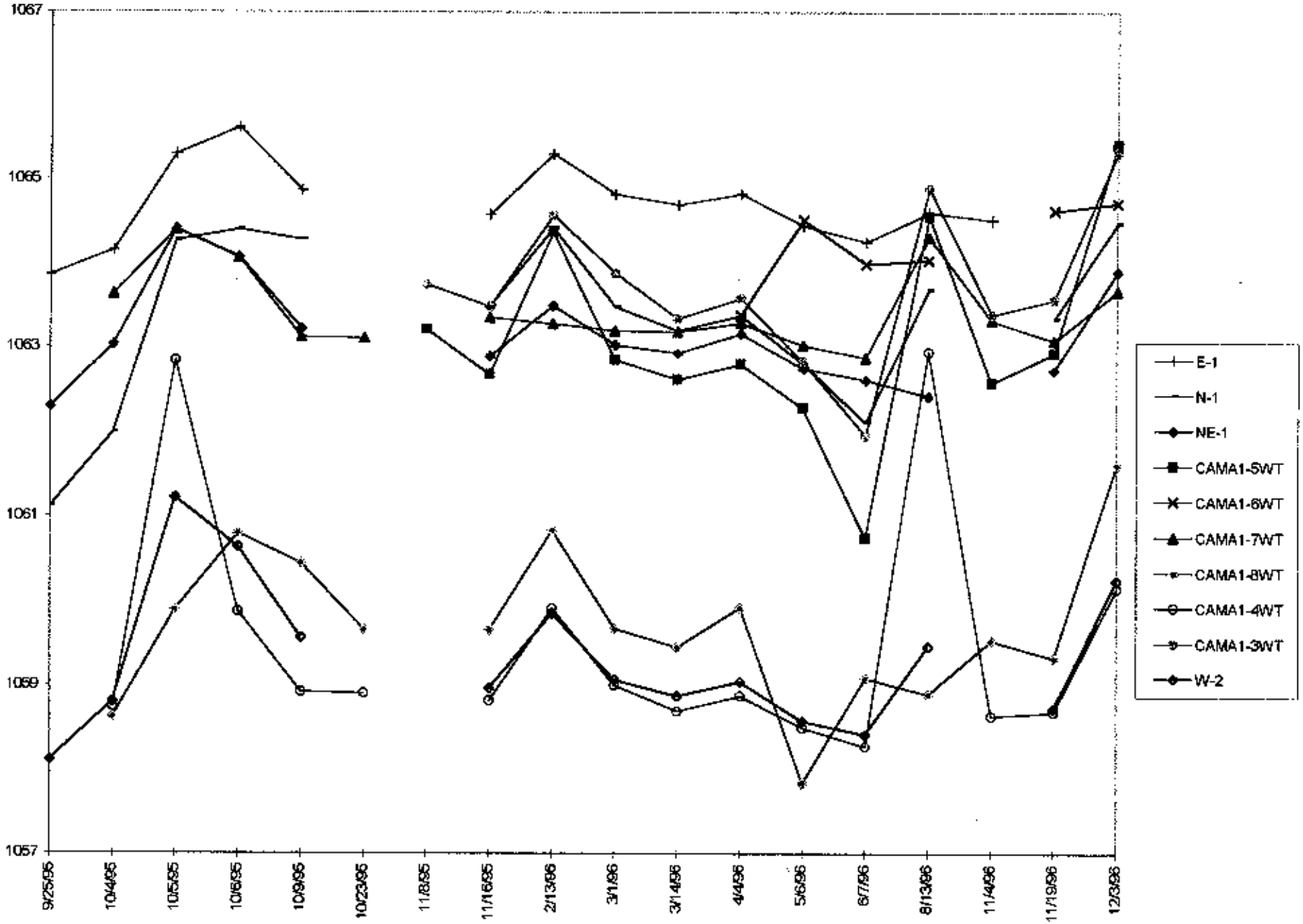

Figure 2-10. Graphical display of groundwater table fluctuations in water table (WT) wells.

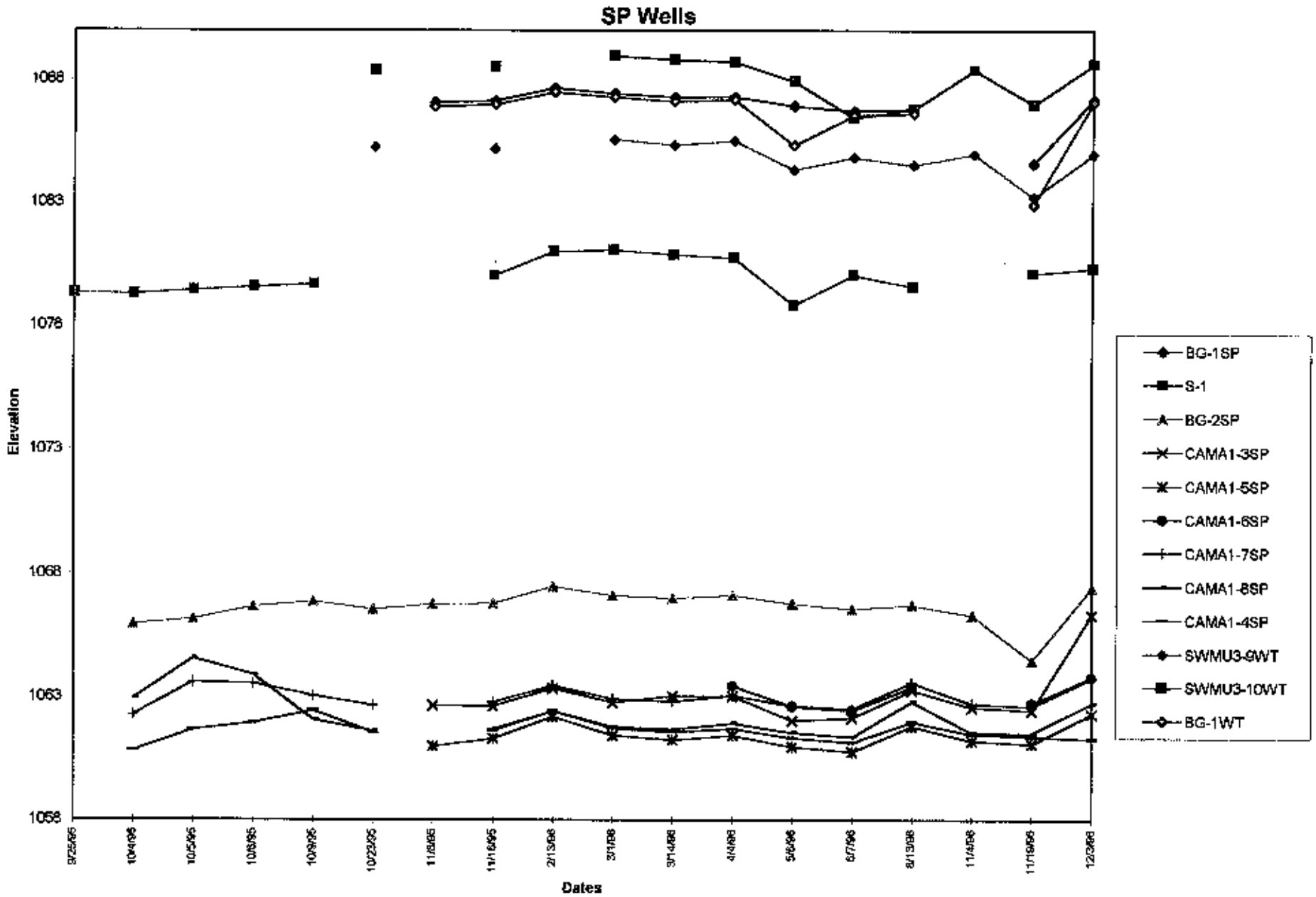

Figure 2-11. Graphical display of groundwater table fluctuations in Saprolite wells.

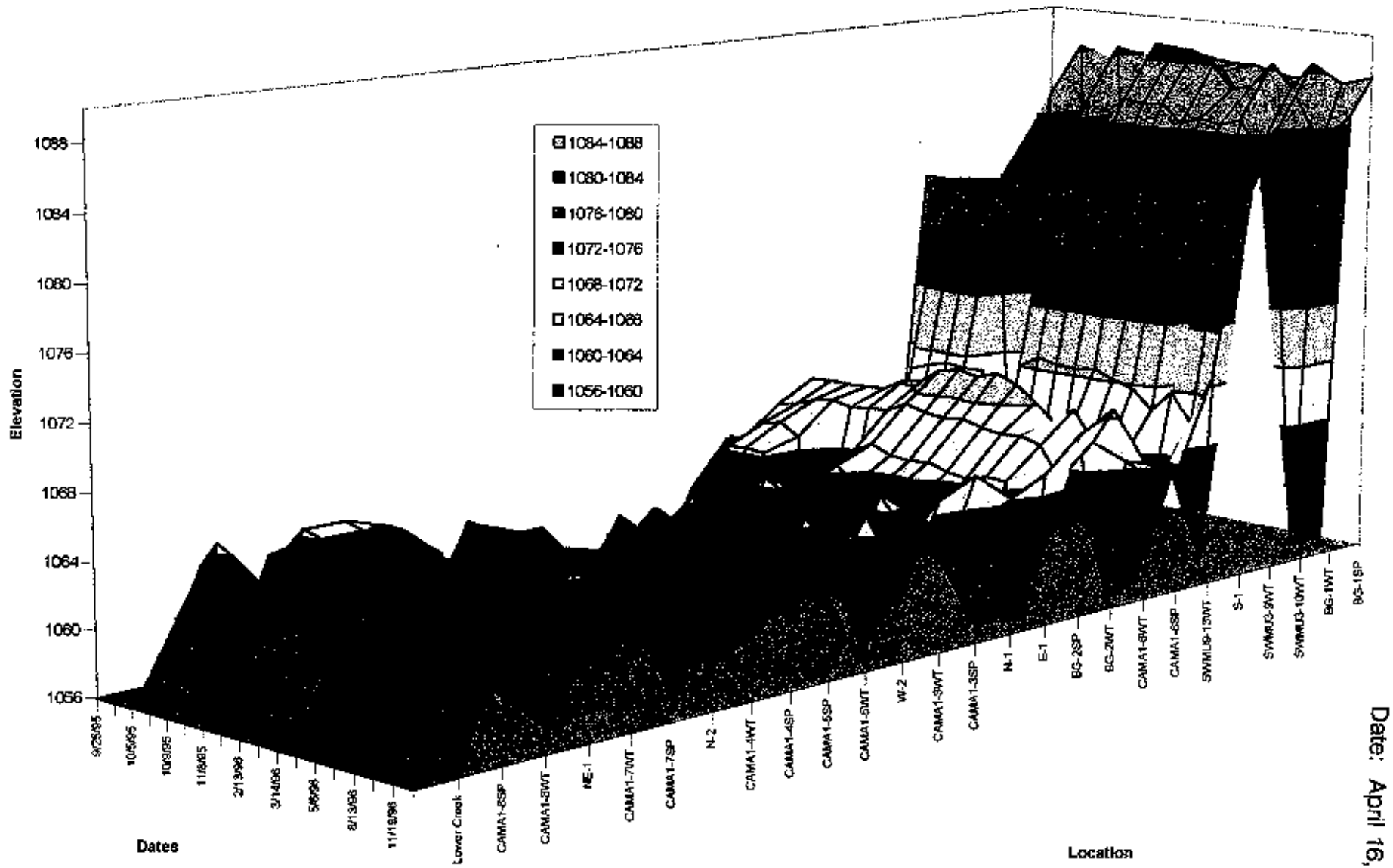

Figure 2-12. Graphical display of water table elevations along north to south axis.

2.7 AQUIFER TESTING AND HYDRAULIC CONDUCTIVITY

Rising head permeability (slug) tests were performed on seven wells to determine the characteristics of the Alluvial and Saprolite Aquifers. Four tests were performed on wells that penetrated the Alluvial Aquifer and the remaining three tests were performed on wells that penetrated the Saprolite Aquifer. When a slug test was performed on a Saprolite well, a slug test was performed on its paired alluvial well.

A slug test was performed by introducing a solid cylindrical piece of PVC (the slug) into the well to be tested. Before the slug was introduced into the well, the static water level of the well was measured. After introducing the slug into the well, the water level was allowed to return to its static level. The slug was then removed and the recording of the water levels within the well was measured at given time intervals. The time interval lengths were adjusted as the test progressed. The test continued until the water level in the well returned to the static water level or the water level returned to within 90 percent of the original static water level.

The data obtained during the slug tests were analyzed to determine the hydraulic conductivities using the methodologies outlined by Freeze and Cherry (1979). The methodologies were incorporated into an Excel spreadsheet for analysis of the data. Appendix 2.7 contains copies of the spreadsheets containing the analyses. The hydraulic conductives obtained from the slug test data are shown in Table 2-4.

The hydraulic conductivities in the Alluvial Aquifer varied from 0.0019 ft/h to 0.63 ft/h. The hydraulic conductivities obtained from the slug tests performed on the wells nearest the creek (CAMA1-4WT and CAMA1-8WT) had the highest values (0.63 ft/h and 0.43 ft/h, respectively). The soils surrounding these wells are predominately sands. The lowest hydraulic conductivity of the alluvial wells was obtained from BG-2WT. BG-2WT is located in the Lumber Yard and the soils associated with the well are silty clayey sands and sandy silty clays.

TABLE 2-4. HYDRAULIC CONDUCTIVITIES DETERMINED FROM SLUG TESTS PERFORMED ON RFI WELLS

Well number	Aquifer monitored	Hydraulic conductivity, ft/h
CAMA1-3WT	Alluvial	0.0085 0.07
CAMA1-3SP	Saprolite	0.0088 0.075
CAMA1-4WT	Alluvial	0.63 5.04
CAMA1-8WT	Alluvial	0.44 3.52
CAMA1-8SP	Saprolite	0.0082 0.066
BG-1WT	Saprolite	0.17 1.36
BG-2WT	Alluvial	0.0019 0.015

The other alluvial well that has a low hydraulic conductivity is CAMA1-3WT which is located near the northeast toe of the landfill. The soils surrounding this well are predominantly silty clays and silts.

The hydraulic conductivities of the Saprolite Aquifer varied from 0.17 ft/h at the southern portion of the Singer property (BG-1WT) to 0.0082 ft/h near Lower Creek (CAMA1-8SP). The hydraulic conductivity of the Alluvial Aquifer at CAMA1-8SP (0.43 ft/h) was approximately 50 times higher than the Saprolite Aquifer hydraulic conductivity at the same area. The Saprolite and Alluvial Aquifers at the northeast toe of the landfill have approximately the same hydraulic conductivity (0.0085 for CAMA1-3WT and 0.0088 ft/h for CAMA1-3SP).

2.8 GENERAL LANDFILL ASSESSMENT

On October 21, 1996, a general inspection of the Old Landfill was conducted by a geologist and an environmental engineer. The inspection addressed the entire landfill cover, including but not limited to, an assessment of the soil cover materials and vegetation; identification of vegetation that are either beneficial and/or detrimental to the

cover; identification of areas of erosion; and reconnaissance to identify areas of actual or potential landfill leachate seepage.

The inspection of the landfill cover revealed the presence of vegetation on 80 percent of the surface area. Most of the vegetation would generally be considered beneficial or nondetrimental to the cover. The majority of the vegetation is grass with some low growing weeds and ground covers such as vinca. The majority of the weeds are growing along the north central lip of the landfill cover. The area where little grass exists is due to the predominance of sawdust on the surface. The sawdust covers the northwestern portion of the landfill. The grasses protect the cover from the effects of wind and water erosion. Singer performs mowing of the landfill cover on a regular basis which keeps the vegetation healthy and generally prevents the establishment of trees and brush on the cover. The northern face of the landfill on Singer property is covered with stone and cement blocks. Some trees and brushes are growing along this northern face, but they are not threatening the integrity of the landfill. The portion of the landfill on the City of Lenoir property has trees and brushes growing on the cover and face of the landfill.

Reconnaissances of the landfill borders revealed the presence of only one identifiable leachate seepage. This seepage is located at the northwest edge of the landfill located on Singer property. The seepage emits from the rocks that have been placed on the border of the landfill. The seepage has been examined during all climatic conditions and the flow has never been concentrated enough to accurately measure or sample. The seepage flows in a thin layer over the rocks and eventually discharges to the marsh area located adjacent to the rocks. Samples of sediment and surface water were collected from the marsh area on two occasions concurrently with the collection of groundwater samples from the monitoring wells. The results of the sediment and surface water analyses indicate the presence of contaminants at concentrations that are below those which cause exceedances of commonly accepted risk levels. The results are fully discussed in Section 4.

On September 21, 1995, soil borings were performed at seven locations on the landfill cover. The borings were performed to assess the composition and thickness of the cover. The locations of the soil borings were selected after a visual inspection of the soil cover, vegetation, and land surface elevation were performed. The inspection revealed one area of the landfill where the cover composition was visually different from the remainder of the cover. This area was along the northwest lip of the cover where sawdust had been placed. The vegetation in this area is also different; i.e., the grasses are less dense and low growing weeds are prominent. One of the soil borings was performed in this area. Another soil boring was performed adjacent to the sawdust area to evaluate the difference in cover composition. The remaining five boring locations were selected randomly across the surface of the landfill cover to provide an adequate assessment of any variation in the cover composition. The locations of the seven borings are shown on Figure 2-13. All of the soil borings were performed using decontaminated stainless steel hand augers. The borings were advanced until refusal of the auger occurred. None of the borings were advanced greater than three feet below the surface of the cover before refusal occurred due to encountering large rocks. At each of the boring locations, two separate borings were performed approximately five feet apart to determine the variability in the composition of the cover and the depth to refusal. For each of the paired borings, the cover composition and depth to refusal were not found to have tangible variations. The soils removed from each boring were visually logged and characterized in accordance with the Standard Soil Classification System. A log for each set of paired borings is provided in Appendix 2.4. The soils from the borings were visually inspected for evidence of contamination and a portion of each auger's contents was placed in a sealed container and screened using an OVA. Neither the OVA analyses nor the visual inspections of the boring soils revealed the presence of volatile compounds or other overt evidence of contamination. The soils encountered at the surface of the cover varied from silty clays to clayey silts and graded to sandy silts and silty sands at the termination of the borings.

On October 12, 1995, a geologist and an environmental engineer completed the installation of six additional soil borings into the landfill cover. The six additional borings were performed to provide a more complete assessment of the materials used for the construction of the cover. As with the seven original borings, the materials from the borings were visually classified and OVA analyses of the soils were performed. The OVA analyses did not indicate the presence of any volatile organic compounds and no overt evidence of contamination was detected. The soils from the six additional borings were of the same classifications as the original borings installed in the cover.

Underlying the soils of the cover were large rocks. Singer personnel have previously stated that rock removed during excavation activities at the south end of Plants 33 and 54 was placed on the landfill and subsequently covered by soil. The boring performed in the area where the sawdust had been placed indicated that the sawdust was deposited over the rocks that had been previously placed on the landfill.

2.9 PERMEABILITY TESTING OF LANDFILL COVER

During the General Landfill Assessment, the silty clays and clayey silts at the surface of the cover were identified as the least permeable horizon of the cover. Six of the General Landfill Assessment boring locations were selected for the performance of saturated vertical hydraulic conductivity tests of the landfill cover surface. The locations for the hydraulic conductivity tests were selected to ensure that both the silty clays and clayey silts encountered at the surface were evaluated. The assessments of each soil type were distributed over the surface of the landfill in a manner so that a conductivity assessment was performed over each portion of the cover.

The vertical hydraulic conductivity tests were performed by Soil and Environmental Consultants, Inc. (SEC) on October 12 and 13, 1995. The hydraulic conductivities were measured using a constant head permeametor and double ring infiltrometer. Two replicate measurements were performed at each of the six locations. The replicate measurements were performed at each location simultaneously and were

intended to determine the variability in the conductivities within an approximate 15 foot spacing.

The results of the measurements revealed the saturated vertical hydraulic conductivities to vary greatly over the landfill cover and even at each test location. The measured conductivities varied from a low of 0.05 centimeters per hour (cm/h) to a high of 14.5 cm/h. The difference in conductivities for replicate measurements were as great as 400 percent to as little as 7 percent. The results of the measurements are shown in Table 2-5. Based on the measured vertical hydraulic conductivities, rainfall falling on the landfill cover would be expected to infiltrate and be available to generate leachate within the landfill. The locations of the vertical hydraulic conductivity measurements are shown on Figure 2-14.

TABLE 2-5. RESULTS OF DOUBLE RING INFILTROMETER TEST
SINGER FURNITURE COMPANY, LENOIR, NC

Site	Rep	cm^3/min	cm/h
LFSB-8	1	6.9	0.59
	2	19.8	1.70
LFSB-3	1	50	4.30
	2	194	16.6
LFSB-9	1	78	6.7
	2	115.5	9.9
LFSB-5	1	34	2.9
	2	31.25	2.7
LFSB-10	1	3.05	0.26
	2	0.57	0.05
LFSB-12	1	169	14.5
	2	67.6	5.8

Figure 2-14. Locations of vertical hydraulic conductivity measurements.

2.10 SAMPLE ANALYSIS AND QUALITY ASSURANCE

Sampling and analysis of the materials at the Singer facility was conducted to determine the presence or absence, general extent, concentration, and chemical nature of residual contamination that may be present at the facility. The results of this effort are being used to evaluate the necessity of further remedial actions at this site and assess the potential public health impacts related to this facility. The SAP provides a detailed description of field and laboratory procedures for data gathering at the Singer site.

Soil, groundwater, and surface water have been identified as being potentially contaminated media at the Singer facility. Table 2-6 compares the projected type and number of sample points to be used in this investigation with the actual number and type performed.

TABLE 2-6. COMPARISON OF THE PROJECTED TYPE AND NUMBER OF SAMPLE POINTS TO THE ACTUAL NUMBER OF SAMPLE POINTS

Type of sample point	Proposed	Actual
Existing groundwater monitoring wells	5	6
New groundwater table monitoring wells	8	11
New Saprolite groundwater monitoring wells	8	8
Soil samples	40	77
Lower Creek surface water samples	2	2
Marsh surface water samples	1	2
Seep surface water samples	a	0
Subsurface soil samples	40	52
Drum samples	0-20[b]	0

[a]Will be dependent on the existence seeps.
[b]Will be dependent on number of drums discovered during characterization activities for SWMU No. 2.

The sampling and monitoring locations are shown in Figure 2-15. Chemical analyses of samples was conducted by Ross Analytical Services, Inc. (RASI), a member of the EPA Contract Laboratory Program. Sample collection procedures were in accordance with the EPA Region IV Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual. The Laboratory QC/QA Plan is included in Appendix 2.8. This QC/QA plan provides detailed information with respect to laboratory QC/QA and sample control procedures. Table 2-7 summarizes the data quality objectives of the sampling program. Table 2-8 compares the proposed overall sampling effort with that actually accomplished. Analytical methods, practical quantitation limits (PQL), estimated quantitation limits (EQL), and QA objectives for each constituent are summarized in Tables 2-9 and 2-10. Sample container specifications are summarized in Table 2-11.

Field measurements of topographic features, water levels, time of travel, geophysical parameters, and physical dimensions were recorded during the comprehensive field investigations. All sampling locations used during field investigations were accurately established and depicted on the site topographic map.

Each field measurement made is traceable to the actual person making the measurement and to the field equipment used to make that measurement. All equipment maintenance and calibration records are kept in log books and field records so that all such procedures are traceable. All time records are kept in local time.
The specific objectives of this section are to:

- Describe the standard practices used to make physical field measurements
- List the field equipment used to make such measurements
- Present specific QC procedures to insure that such measurements are accurate.

Field measurements were taken in conjunction with the groundwater monitoring, surface water sampling, sediment sampling, and soil sampling described herein. All

Figure 2-15. Water and soil sampling locations.

TABLE 2-7. DATA QUALITY OBJECTIVES SUMMARY

Primary data quality control factors								
Media	Task	Data collection activity	Data type	Data use	Analytical level	Primary contaminants	Required detection limit	Critical samples
SOURCE	(solids) Sampling	Analysis by RASI	Analysis "A"	SC, EA	III	Appendix IX Compounds (except dioxin/furans), hazardous waste characteristic	See Tables 2.10-4 and 2.10-5	Yes
SOIL/SEDIMENT	Soil/sediment sampling	Analysis by RASI	Analysis "A"	SC, EA	III	Appendix IX compounds (except dioxin/furans)	See Tables 2.10-4 and 2.10-5	Yes
		Analysis by RASI	Analysis "C"	SC, EA	III	TOC, TOX, CEC	See Tables 2.10-4 and 2.10-5	No
		Particle size analysis by Geo Technologies	Analysis "B"	SC, EA	III			No
		Bulk density and moisture content by Geo Technologies	Analysis "B"	SC, EA	III			No
		Analytical analysis by Savannah Laboratories	Analysis "A"	SC, EA	III	Formaldehyde	See Tables 2.10-4 and 2.10-5	Yes
SURFACE WATER	Surface water sampling	Analysis by RASI	Analysis "A"	SC, EA	III	Appendix IX compounds (except dioxin/furans)	See Tables 2.10-4 and 2.10-5	Yes
GROUND-WATER	Groundwater sampling	Analysis by RASI	Analysis "A" Analysis "C"	SC, EA	III	Appendix IX compounds (except dioxin/furans)	See Tables 2.10-4 and 2.10-5	Yes
		Analysis by Savanna Laboratory	Analysis "A"	SC, EA	III	Formaldehyde	See Tables 2.10-4 and 2.10-5	Yes
AIR	Air sampling	Analysis by EQ	Analysis "A"	SC, EA	I	Appendix IX compounds (except dioxin/furans)	See Tables 2.10-4 and 2.10-5	No

Note: Organization base on "Data Quality Objectives for Remedial Response Activities: "Example Scenario" (EPA/54-/G-87/004).

Analysis A: Appendix IX compounds 40 CFR 264
Analysis B: Physical tests
Analysis C: Indicator parameters
Data Use Symbols: SC - Site characterization
EA - Engineering Evaluation
RASI - Ross Analytical Services, Inc.

Analytical Levels: I - Qualitative screening with field instruments
II - Field analysis with sophisticated instruments
III - Offsite analysis by analytical laboratory
---- Not applicable

TABLE 2-8. COMPARISON OF PROPOSED VERSUS ACTUAL SAMPLING EFFORTS

Sample matrix	Laboratory parameters	Investigative						Field duplicate						Field blank						MS/MSD						Matrix total	
		No.		Freq.		Total		No.		Freq.		Total		No.		Freq.		Total		No.		Freq.		Total			
		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b		
Source sampling[a] (solids)	Hazardous waste constituents	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	2	0
	Hazardous waste characteristics	1	0	1	0	1	0	1	0	1	0	1	0													2	0
Soil[b]	Hazardous constituents	40	77	2	1	80	77	4	11	2	1	8	11	2	6	1	1	2	6	4	1	2	6	8	6	98	94
	Particle size distribution	6	8	1	1	6	8																			6	8
	Permeability, CEC, TOX, TOC	6	7	1	1	6	7																			6	7
	Formaldehyde	2	35	1	1	2	35	1	7	1	1	1	7	1	0	1	0	1	0	1	2	1	2	1	2	5	44
Sediments	Hazardous constituents	2	3	1	1	2	3	1	0	1	0	1	0	0	6	1	0	0	0	1	0	1	0	1	0	4	3
Surface water	Hazardous constituents	2	3	1	1	2	3	1	0	1		1	0	1	0	1	0	1	0	1	0	1	0	1	0	5	3
Groundwater[c,d]	Hazardous constituents	37	128	1.4	1	37	128	4	151	4	1	16	15	5	18	1	1	5	18	5	1	1	16	5	18	63	161
	TOC, TOX pH, conductivity, temperature	29	128	5	1	145	128	5	15	5	1	25	15	5	0	1	0	5	0	5	5	1	0	5	0	180	142
Air	VOC	0	0	1	0	0	0	0	0	1	0	0	0													0	0

[a]Proposed.
[b]Actual.
[c]New SWMUs were not discovered.
[d]Less than six quarters of data was collected from some of the wells.

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
VOLATILES	8240 (1)	
1,1,1,2-Tetrachloroethane		5
1,1,1-Trichloroethane		5
1,1,2,2-Tetrachloroethane		5
1,1,2-Trichloroethane		5
1,1-Dichloroethane		5
1,1-Dichloroethene (1,1-Dichloroethylene)		5
1,2,3-Trichloropropane		5
1,2-Dibromo-d-chloropropane (DBCP)		5
1,2-Dibromoethane (Ethylene dibromide)		5
1,2-Dichloroethane		5
1,2-Dichloroethene (Total)		5
1,2-Dichloropropane		5
2-Butanone (Methyl ethyl ketone)		10
2-Hexanone		10
4-Methyl-2-pentanone		10
Acetone		10
Acetonitrile		50
Acrolein		10
Acrylonitrile		10
Allyl chloride		5
Benzene		5
Bromodichloromethane		5
Bromoform		5
Bromomethane (Methyl bromide)		10
Carbon disulfide		5
Carbon tetrachloride		5
Chlorobenzene		5
Chloroethane		10
Chloroform		5
Chloromethane (Methyl chloride)		10
Chloroprene		5
Cis-1,3-Dichloropropene		5
Dibromochloromethane (Chlorodibromomethane)		5
Dichlorodifluoromethane		10
Ethyl cyanide (Propionitdle)		20
Ethyl methacrylate		5
Ethylbenzene		5
Iodomethane		5
Methacrylonitrile		10
Methyl methacrylate		5
Methylene Chloride		5
Styrene		5

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
Tetrachloroethene (Tetrachloroethylene)		5
Toluene		5
Trans-1,3-Dichloropropene		5
trans-1,4-Dichloro-2-butene		5
Trichloroethene (Trichloroethylene)		5
Trichlorofluoromethane		5
Vinyl acetate		20
Vinyl Chloride		10
Xylenes (Total)		5
(1) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
1,2-Dichloroethane-d4	76-114	
Toluene-dB	88-110	
4-Bromofluorobenzene	86-115	
WATER SOLUBLE VOLATILES	8015 (2)	
1,4-Dioxane		500
Isobutyl alcohol		600
(2) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
tert-Butyl alcohol	60-150	
SEMI-VOLATILES	8270 (3)	
1,2,4,5-Tetrachlorobenzene		20
1,2,4-Tdchlorobenzene		10
1,2-Dichlorobenzene		10
1,3,5-Trinitrobenzene		50
1,3-Dichlorobenzene		10
1,3-Dinitrobenzene		50
1,4-Dichlorobenzene (p-Dichlorobenzene)		15
1,4-Naphthoquinone		200
1-Naphthylamine		10
2,3,4,6-Tetrachlorophenol		50
2,4,5-Trichlorophenol		20
2,4,6-Trichlorophenol		10
2,4-Dichlorophenol		10
2,4-Dimethylphenol		20
2,4-Dinitrophenol		50
2,4-Dinitrotoluene		10
2,6-Dinitrotoluene		10
2-6-Dichlorophenol		50

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
2-Acetylaminofluorene		30
2-Chloronaphthalene		10
2-Chlorophenol		10
2-Methylnaphthalene		10
2-Naphthylamine		20
2-Nitroaniline		50
2-Nitrophenol		10
2-Picoline		10
3-3'-Dichlorobenzidine		25
3-3'-Dimethylbenzidine		10
3-Methylcholanthrene		10
3-Nitroaniline		50
4,6-Dintro-o-cresol		50
4-Aminobiphenyl		20
4-Bromophenyl phenyl ether		10
4-Chloroaniline		10
4-Chlorophenyl phenyl ether		10
4-Nitroaniline		50
4-Nitrophenol		50
4-Nitroquinoline 1-oxide		20
5-Nitro-o-toluidine		10
7,12-Dimethylbenz[a]anthracene		20
Acenaphthene		10
Acenaphthylene		10
Acetophenone		10
Alpha, alpha dimethylphenethylamine		(4)
Aniline		10
Anthracene		10
Aramite		20
Benzo (a) pyrene		10
Benzo (b) fluoranthene		10
Benzo (k) fluoranthene		10
Benzo(a)anthracene		10
Benzo(g,h,i)perylene		10
Benzyl alcohol		20
bis(2-Chloroethoxy)methane		10
bis(2-chloroethyl)ether		10
bis(2-chloroisopropyl)ether		10
bis(2-Ethylhexl)phthalate		10
Butyl benzyl phthalate		10
Chlorobenzilate		30
Chrysene		10
Di-n-butyl phthalate		10

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
Di-n-octyl phthalate		10
Diallate (Total)		10
Dibenz(a,h)anthracene		10
Dibenzofuran		10
Diethyl phthalate		10
Dimethyl phthalate		10
Dinoseb		20
Diphenylamine		10
Ethyl methanesulfonate		10
Fluoranthene		10
Fluorene		10
Hexachlorobenzene		10
Hexachlorobutadiene		10
Hexachlorocyclopentadiene		(4)
Hexachloroethane		10
Hexachlorophene		(4)
Hexaxchloropropene		50
Indeno(1,2,3-cd)pyrene		10
Isophorone		10
Isosafrole		10
m- and p-Cresol (coeluate)		10
Methapyrilene		100
Methyl methanesulfonate		10
N-Nitrosodi-n-butylamine		10
N-Nitrosodi-n-propylamine		10
N-Nitrosodiethylamine		10
N-Nitrosodimethylamine		10
N-Nit osodiphenylami'ne		10
N-Nitrosomethylethylamine		20
N-Nit osomorphorine		10
N-Nitrosopiperidine		10
N-Nitrosopyrrolidine		10
Naphthalene		10
Nitrobenzene		10
o-Creosol		10
o-Toluidine		10
p-(Dimethylamino)azobenzene		20
p-Phenylenediamine		(4)
Pentachlorobenzene		10
Pentachloroethane		200
Pentachloronitrobenzene		10
Pentachlorophenol		50
Phenacetin		20

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
Phenanthrene		10
Phenol		10
Pronamide		20
Pyrene		10
Pyridine		50
Safrole		10
(3) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
Nitrobenzene-d5	35-114	
2-Fluorobiphenyl	43-116	
Terphenyl-dl4	33-141	
Phenol-d5	10-110	
2-Fluorophenof	21-110	
2,4,6-Tribromophenol	10-123	
(4) These compounds are unstable in the standards or not recovered from the samples		
PESTICIDES/PCBs	8080 (5)	
4,4'DDD		0.1
4,4'DDE		0.05
14,4'DDT		0.1
Aldrin		0.05
Alpha-BHC		0.05
Beta-BHC		0.05
Chlordane		0.1
Delta-BHC		0.05
Dieldrin		0.05
Endosulfan I		0.1
Endosulfan 11		0.05
Endosulfan sulfate		0.5
Endrin		0.1
Endrin aldehyde		0.2
Gamma-BHC (Lindane)		0.05
Heptachlor		0.05
Heptachlor epoxide		0.05
Isodrin		0.1
Kepone		0.5
p,p'-Methoxychlor		2
PCB-1016		1
PCB-1 221		2
PCB-1232		1

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
PCB-1242		1
PCB-1248		1
PCB-1254		1
PCB-1260		1
Toxaphene		2
(5) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
Tetrachloro-m-xylene	60-150	
Decachlorobiphenyl	60-150	
OP-PESTICIDES	8140 (6)	
Dimethoate		2
Disulfoton		2
Famphur		2
Methyl parathion		0.5
O,O,O-Triethyl phosphorothioate		2
Parathion		2
Phorate		2
Sulfotepp		2
Thionazin		2
(6) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
Malathion	40-50	
HERBICIDES	8150 (7)	
2,4'-D		2
2,4,5-T		2
2,4,5-TP (Silvex)		2
(7) Surrogates used for quality assurance objectives		
Surrogates	% Recovery	
2,4-DE	48-131	
METALS		
Antimony	7041 (8)	100
Arsenic	6010 (8)	100
Barium	6010 (8)	10
Beryllium	6010 (8)	2

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
Cadmium	6010 (8)	5
Chromium	6010 (8)	20
Cobalt	6010 (8)	10
Copper	6010 (8)	10
Iron	6010 (8)	200
Lead	6010(8)	50
Mercury	7470 (8)	0.2
Nickel	6010 (8)	20
Selenium	6010 (8)	100
Silver	6010 (8)	50
Thallium	6010 (8)	400
Tin	6010 (8)	100
Vanadium	6010 (8)	10
Zinc	6010 (8)	50
(8) Quality Assurance Objectives		
% Recovery Limits	% RPD	
75-125	0-20	
DIOXINS/FURANS	8280 (9)	
2,3,7,8 TCDD		0.005
PCDDs		
PCDFs		
(9) Quality Assurance Objectives		
% Recovery Limits	% RPD	
TCDD 63-137	0-40	
PCDDs 37-163	0-40	
PCDFs 52-148	0-40	
OTHER ANALYSES		
Carbon, total organic	9060 (10)	1000
Cyanide (Total)	9010 (11)	10
Halogens, total organic	9020 (12)	10
Hydrogen ion (pH)	9040 (13)	NA
Ignitability	1010	NA
Radioactivity, alpha	703 (14)	2 pCi/l
Radioactivity, beta	703 (14)	2 pCi/l
Specific conductance	9050 (15)	1 umho/cm
Formaldehyde	8315 (16)	20
(10) Quality Assurance Objectives		
% Recovery Limits	% RPD	

TABLE 2-9. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR WATER AND OTHER LIQUIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/l)
60-140	0-40	
(11) Quality Assurance Objectives		
% Recovery Limits	% RPD	
75-125	0-30	
(12) Quality Assurance Objectives		
% Recovery Limits	% RPD	
60-140	0-40	
(13) Quality Assurance Objectives		
% Recovery Limits	% RPD	
90-110	0-10	
(14) Quality Assurance Objectives		
% Recovery Limits	% RPD	
48-162	0-25	
(15) Quality Assurance Objectives		
% Recovery Limits	% RPD	
90-110	0-10	
(16) Quality Assurance Objectives		
% Recovery Limits	% RPD	
50-155	0-30	

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
VOLATILES	8240 (1)	
1,1,1,2-Tetrachloroethane		5
1,1,1-Trichloroethane		5
1,1,2,2-Tetrachloroethane		5
1,1,2-Tdchloroethane		5
1,1-Dichloroethane		5
1,1-Dichloroethene (1,1-Dichloroethylene)		5
1,2,3-Trichloropropane		5
1,2-Dibromo-d-chloropropane (DBCP)		5
1,2-Dibromoethane (Ethylene dibromide)		5
1,2-Dichloroethane		5
1,2-Dichloroethene (Total)		5
1,2-Dichloropropane		5
2-Butanone (Methyl ethyl ketone)		10
2-Hexanone		10
4-Methyl-2-pentanone		10
Acetone		10
Acetonitrile		50
Acrolein		10
Acrylonitrile		10
Allyl chloride		5
Benzene		5
Bromodichloromethane		5
Bromoform		5
Bromomethane (Methyl bromide)		10
Carbon disulfide		5
Carbon tetrachloride		5
Chlorobenzene		5
Chloroethane		10
Chloroform		5
Chloromethane (Methyl chloride)		10
Chloroprene		5
Cis-1,3-Dichloropropene		5
Dibromochloromethane (Chlorodibromomethane)		5
Dichlorodifluoromethane		10
Ethyl cyanide (Propionitrile)		20
Ethyl methacrylate		5
Ethylbenzene		5
Iodomethane		5
Methacrylonitrile		10
Methyl methaerylate		5
Methylene Chloride		5
Styrene		5

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
Tetrachloroethene (Tetrachloroethylene)		5
Toluene		5
Trans-1,3-Dichloropropene		5
trans-1,4-Dichloro-2-butene		51
Trichloroethene (Trichloroethylene)		5
Trichlorofluoromethane		5
Vinyl acetate		20
Vinyl Chloride		10
Xylenes (Total)		5
(1) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
1,2-Dichloroethane-d4	76-114	
Toluene-d8	88-110	
4-Bromofluorobenzene	86-115	
WATER SOLUBLE VOLATILES	8015 (2)	
1,4-Dioxane		1000
Isobutyl alcohol		1200
(2) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
tert-Butyl alcohol	60-150	
SEMI-VOLATILES	8270 (3)	
1,2,4,5-Tetrachlorobenzene		670
1,2,4-Trichlorobenzene		330
1,2-Dichlorobenzene		330
1,3,5-Tdnitrobenzene		1700
1,3-Dichlorobenzene		330
1,3-Dinitrobenzene		1700
1,4-Dichlorobenzene (p-Dichlorobenzene)		500
1,4-Naphthoquinone		6700
1-Naphthylamine		330
2,3,4,6-Tetrachlorophenol		1700
2,4,5-Trichlorophenof		670
2,4,6-Trichlorophenol		330
2,4-Dichlorophenol		330
2,4-Dimethylphenol		670
2,4-Dinitrophenol		1700
2,4-Dinitrotoluene		330

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
2,6-Dinitrotoluene		330
2-6-Dichlorophenol		1700
2-Acetylaminofluorene		1000
2-Chloronaphthalene		330
2-Chlorophenol		330
2-Methylnaphthalene		330
2-Naphthylamine		670
2-Nitroaniline		1700
2-Nitrophenol		330
2-Picoline		330
3-3'-Dichlorobenzidine		830
3-3'-Dimethylbenzidine		330
3-Methylcholanthrene		330
3-Nitroaniline		1700
4,6-Dintro-o-cresol		1700
4-Aminobiphenyl		670
4-Bromophenyl phenyl ether		330
4-Chloroaniline		330
4-Chlorophenyl phenyl ether		330
4-Nitroaniline		1700
4-Nitrophenol		1700
4-Nitroquinoline 1-oxide		670
5-Nitro-o-toluidine		330
7,12-Dimethylbenz[a]anthracene		670
Acenaphthene		330
Acenaphthylene		330
Acetophenone		330
Alpha, alpha dimethylphenethylamine		(4)
Aniline		330
Anthracene		330
Aramite		670
Benzo (a) pyrene		330
Benzo (b) fluoranthene		330
Benzo (k) fluoranthene		330
Benzo(a)anthracene		330
Benzo(g,h,i)perylene		330
Benzyl alcohol		670
bis(2-Chloroethoxy)methane		330
bis(2-chloroethyl)ether		330
bis(2-chloroisopropyl)ether		330
bis(2-Ethylhexl)phthalate		330
Butyl benzyl phthalate		330
Chlorobenzilate		1000

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
Chrysene		330
Di-n-butyl phthalate		330
Di-n-octyl phthalate		330
Diallate (Total)		330
Dibenz(a,h)anthracene		330
Dibenzofuran		330
Diethyl phthalate		330
Dimethyl phthalate		330
Dinoseb		670
Diphenylamine		330
Ethyl methanesulfonate		330
Flourene		330
Fluoranthene		300
Hexachlorobenzene		330
Hexachlorobutadiene		330
Hexachlorocyclopentadiene		(4)
Hexachloroethane		330
Hexachlorophene		(4)
Hexaxchloropropene		1700
Indeno(1,2,3-cd)pyrene		330
Isophorone		330
Isosafrole		330
m- and p-Cresol (coeluate)		330
Methapyrilene		3300
Methyl methanesulfonate		330
N-Nitrosodi-n-butylamine		330
N-Nitrosodi-n-propylamine		330
N-Nitrosodiethylamine		330
N-Nitrosodimethylamine		330
N-Nitrosodiphenylamine		330
N-Nitrosomethylethylamine		670
N-Nitrosomorpholine		330
N-Nitrosopiperidine		330
N-Nitrosopyrrolidine		330
Naphthalene		330
Nitrobenzene		330
o-Creosol		330
o-Toluidine		330
p-(Dimethylamino)azobenzene		670
p-Phenylenediamine		(4)
Pentachlorobenzene		330
Pentachloroethane		6700
Pentachloronitrobenzene		330

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
Pentachlorophenol		1700
Phenacetin		670
Phenanthrene		330
Phenol		330
Pronamide		670
Pyrene		330
Pyridine		1700
Safrole		330
(3) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
Nitrobenzene-d5	35-114	
2-Fluorobiphenyl	43-116	
Terphenyl-d14	33-141	
Phenol-d5	10-110	
2-Fluorophenol	21-110	
2,4,6-Tribromophenol	10-123	
(4) These compounds are unstable in the standards or not recovered from the samples		
PESTICIDES/PCBs	8080 (5)	
4,4'DDD		3.3
4,4'DDE		1.7
4,4'DDT		3.3
Aldrin		1.7
Alpha-BHC		1.7
Beta-BHC		1.7
Chlordane		3.3
Delta-BHC		1.7
Dieldrin		1.7
Endosulfan I		3.3
Endosulfan II		1.7
Endosulfan sulfate		17
Endrin		3.3
Endrin aldehyde		6.7
Gamma-BHC (Lindane)		1.7
Heptachlor		1.7
Heptachlor epoxide		1.7
Isodrin		3.3
Kepone		17
p,p'-Methoxychlor		67
PCB-1016		33

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
PCB-1 221		67
PCB-1232		33
PCB-1242		33
PCB-1248		33
PCB-1254		33
PCB-1260		33
Toxaphene		67
(5) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
Tetrachloro-m-xylene	60-150	
Decachlorobiphenyl	60-150	
OP-PESTICIDES	8140 (6)	
Dimethoate		67
Disulfoton		67
Famphur		67
Methyl parathion		17
O,O,O-Triethyl phosphorothioate		67
Parathion		67
Phorate		67
Silfotepp		67
Thionazin		67
(6) Surrogates used for quality assurance objectives		
Surrogates	% Recovery Limits	
Malathion	60-125	
HERBICIDES	8150 (7)	
2,4'-D		20
2,4,5-T		20
2,4,5-TP (Silvex)		20
(7) Surrogates used for quality assurance objectives		
Surrogates	% Recovery	
2,4-DE	48-1	
METALS		
Antimony	7041 (8)	5
Arsenic	6010 (8)	10
Barium	6010 (8)	0.2

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
Beryllium	6010 (8)	0.2
Cadmium	6010 (8)	0.5
Chromium	6010 (8)	2
Cobalt	6010 (8)	1
Copper	6010 (8)	1
Iron	6010 (8)	20
Lead	6010 (8)	5
Mercury	7470 (8)	0.02
Nickel	6010 (8)	2
Selenium	6010 (8)	50
Silver	6010 (8)	20
Thallium	6010 (8)	40
Tin	6010 (8)	10
Vanadium	6010 (8)	1
Zinc	6010 (8)	5
(8) Quality Assurance Objectives		
% Recovery Limits	% RPD	
70-130	0-30	
DIOXINS/FURANS	8280 (9)	
2,3,7,8 TCDD		0.5
PCDDs		0.5
PCDFs		0.5
(9) Quality Assurance Objectives		
% Recovery Limits	% RPD	
TCDD 69-145	0-40	
PCDDs 71-203	0-40	
PCDFs 55-146	0-40	
OTHER ANALYSES		
Carbon, total organic	9060 (10)	50
Cyanide (Total)	9010 (11)	1
Halogens, total	9056 (12)	200
Paint filter liquids	9095 (13)	NA
Toxic compound leaching procedure (TCLP)	1311	NA
Formaldehyde	8315 (14)	100
(10) Quality Assurance Objectives		
% Recovery Limits	% RPD	

TABLE 2-10. LABORATORY ANALYTICAL METHODS AND ESTIMATED QUANTITATION LIMITS FOR SOLIDS AND SEMISOLIDS

PARAMETER	ANALYTICAL METHOD	EQL (ug/kg)
60-140	0-40	
(11) Quality Assurance Objectives		
% Recovery Limits	% RPD	
75-125	0-30	
(12) Quality Assurance Objectives		
% Recovery Limits	% RPD	
70-130	0-40	
(13) Quality Assurance Objectives		
% Recovery Limits	% RPD	
NA	0-40	
(14) Quality Assurance Objectives		
% Recovery Limits	% RPD	
50-155	0-40	

TABLE 2-11. SAMPLE VOLUMES, BOTTLES, PRESERVATIVES AND HOLDING TIMES

Analysis	No. of bottles	Volume	Bottle material	Preservative	Holding time
Water:					
Volatiles	2	40 mL	Glass	4°C, HCl to pH < 2	7 days
Semivolatiles (2)					
Base neutral	2	1 L	Glass	4°C	7/40 days
Acid	1	1 L	Glass	4°C	7/40 days
Dioxin	1	1 L	Glass	4°C	7/40 days
PCB	1	1 L	Glass	4°C	7/40 days
Pesticides	1	1 L	Glass	4°C	7/40 days
Herbicides	1	1 L	Glass	4°C	7/40 days
Metals (1)	1	1 L	Polyethylene	1:1 Nitric to pH < 2.0	6 months
Cyanide	1	1 L	Polyethylene	NaOH to pH > 12	14 days
Sulfide	1	1 L	Polyethylene	Zn CH_3COO NaOH to pH > 9	7 days
Soil:					
VOA	1	100 g	Glass	N/A	14 days
LL semivolatiles	3	500 g	Glass	N/A	7/40 days
Metals (1)	1	500 g	Glass	N/A	6 months

Notes:

(1) Mercury analysis were completed within 28 days.
Reference: User's Guide to the Contract Laboratory Program, EPA, 12/86.

(2) 7/40 - 7 days holding time prior to extraction, 40 days holding time prior to analysis.

*All waste samples will be solid and as such will be analyzed per the handling requirements of soil. Leachate samples will be liquid and treated as water samples.

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(2) 7/40 - 7 days holding time prior to extraction, 40 days holding time prior to analysis.

*All waste samples will be solid and as such will be analyzed per the handling requirements of soil. Leachate samples will be liquid and treated as water samples.

field measurements were conducted in accordance with EPA Region IV Standard Operating Procedures and Quality Assurance Manual (ISOPQM, February 1991). Subsurface geophysical investigative methods were used to determine subsurface drum locations or other subsurface characteristics of the site prior to any drilling or sampling. Air monitoring for health and safety purposes was conducted as described in the Site Health and Safety Plan during site investigations.

Samples were collected at each SWMU in proper order, i.e., from areas of least suspected contamination to the most contaminated whenever this strategy was possible. Field measurements were taken at the time of sampling. Geophysical measurements to determine the location of buried drums were made prior to drilling in the landfill area, the Lower Creek area where drums were found, and in any additional areas where subsurface items are suspected.

The method used for selecting the appropriate location for conducting field measurements on soil relied heavily on visual observations and preliminary assessments of the hydrogeologic regimes. The most common field measurement for soil was to compile information on the stratigraphic profile by completing a physical description of the soil. The physical description was compared to the stratigraphic data already available to refine the understanding of the site conditions. The stratigraphic profile assisted in the interpretation of the site's hydrogeologic regime. The pertinent assessment components included both the saturated and vadose (or unsaturated) zones. A physical description was completed for each soil boring that was more than 1.5 feet deep and groundwater well installed. The physical descriptions followed the unified soil classification system and were recorded on soil boring logs.

Engineering, physical, and chemical soil properties were measured to determine relative permeability, porosity (total and effective), hydraulic conductivity, moisture content, organic carbon content, cation and anion exchange capacity, and grain size distribution. Samples and measurements were collected for each significant soil zone (i.e., soil types having similar characteristics) underlying the site. The resulting data have been presented elsewhere in this report.

2.10.1 Groundwater

The remedial investigation for the Singer site included a program for precise groundwater monitoring of the area, including temporal variation in groundwater levels. This program involved the measurement of water level monitoring wells installed for the purpose of monitoring and investigating the saturated zone(s) at the site. These data are used to define groundwater flow direction and chemical indicator characteristics. The field measurements for groundwater included:

- Depth to groundwater
- pH
- Conductivity
- Temperature
- Total depth of well.

Each parameter was measured and recorded at least quarterly. Potentiometric contours and flow nets were prepared.

SWMU No. 1 - Landfill has been characterized as a large volume, low toxicity codisposal (industrial/municipal) landfill. This type of SWMU is capable of generating leachate plumes of dilute organic and inorganic compounds. These types of SWMUs are customarily remediated through the use of containment (cover and cut off areas of discharge), and pump and treat techniques. The degree of site characterization necessary to design an effective groundwater extraction system depends on the objective of the remediation. If well head containment and treatment is the objective, simple characterization of the contaminants and conventional design of the treatment system, using volume requirements and water quality (discharge) parameters, is all that is necessary. If, however, aquifer restoration is needed, because the contaminants are wide spread or affecting groundwater use, it is necessary to characterize:

1. Hydrogeologic properties of the geologic layer
2. Types and distribution of contaminants
3. Location of sources and their potential for continuing contamination

4. Contaminant migration properties

5. The consumption uses of the groundwater.

Whatever the remedial objective of a groundwater extractive system, its functional purpose is to establish control of groundwater flows near the facility.

The field monitoring aspects of the initial groundwater investigation included the systematic use of "slug tests" and the recording of water table elevations. Aquifer characteristics were determined for each significant stratigraphic unit identified at the site by conducting slug tests.

2.10.2 Surface Water

The purpose of surface water hydrology studies is to describe the drainage system, flow characteristics, and water quality of streams and water bodies at or near the facility. Additionally, determining surface to subsurface water relationships forms the basis of assessing any future environmental impacts of the facility on surface water bodies. The site investigation included procedures to collect surface water quality indicator parameters and characterize hydrologic and stream flow characteristics. Precipitation data have been correlated with stream flow data. It is apparent that the CAMA1 series rise and fall as a function of rainfall much more rapidly than the SWMU No. 3 and SWMU No. 9 wells.

Lower Creek field measurements were taken from a location near the Virginia Street bridge and down stream of the Singer property where the sewer line crosses the creek.

At each surface water sampling location the following field measurements were recorded once:

- Dissolved oxygen
- pH
- Temperature
- Specific conductance
- Flow velocity
- Depth of water.

These field measurements were noted in the field log book.

2.10.3 Air Monitoring

The air monitoring system design consisted of three monitoring strategies. The existing data indicate that the probability of the residents at the receptor sites being exposed to VOC concentration levels of concern is very small because there are no open pools of liquid waste and the SWMUs have been closed for several years. Therefore, the primary air containment sources have been removed and a primary screening strategy has been designed to provide real-time information on total VOC concentrations near and downwind of the work site to allow timely initiation of emission control procedures when necessary. Neither the refined screening strategy nor the quantitative assessment strategy as described in the work plan were implemented during the investigation.

2.10.4 Ancillary Field Data

Ancillary field data that were collected including climatic data, subsurface gas monitoring, site traffic, visible noticeable activities on adjacent properties, and information concerning Lower Creek.

In order to correlate fluctuations in groundwater and surface water levels climatological data were collected. Impacts of rainfall was divided into three categories: 1) surface water dilution potential; 2) runoff potential; and 3) infiltration potential. Surface water dilution potential affects the ability of surface water to assimilate discharges and consequently reduce concentrations. Runoff potentially affects the rate of transport of contaminated materials to surface waters and surrounding land. Infiltration potential determines the rate at which precipitation can enter the soil and transport contaminants to groundwater or surrounding land. Precipitation data were collected each day and the monthly mean and range of these data have been compiled and presented in Section 3.

At least once per quarter ancillary anecdotal information concerning the conditions of Lower Creek were recorded. This information included newsworthy events concerning offsite spills, fishing conditions, dredge and fill work, nearby construction, etc. This information was gathered by Singer employees and included in the project files to help assist in the interpretation of the data being collected.

2.10.5 Field Measurement QA/QC

Collection of Replicate Measurements--

QA procedures for field analysis, and field analytical and test instrumentation calibration are an essential part of these field measurement procedures. All field analytical procedures were conducted in duplicate at least 10 percent of the time. A record of these duplicate analyses was maintained in field logbooks. A significant difference in the replicate analyses resulted in recalibration of the instruments being used, re-examination of the analytical methodology being used, or re-examination of the sampling location.

All field analyses are traceable to the specific individual performing the analyses. Time records were kept in local time and were recorded to the minute. This information was entered into the field logbooks for all field analyses.

Field Blanks, Equipment Blanks, and Trip Blanks--

Field blanks were obtained to determine if any contaminants that may be present in the sampling area (i.e., dust, volatile organic contamination) may have originated from a source other than the source being sampled. Field blanks were collected by pouring deionized water from one clean sample jar to another at the sampling site. One field blank was collected per sampling event. Field blanks were labeled and marked on the chain of custody form and analyzed as necessary.

Equipment field blanks are defined as samples that are obtained by running reagent grade water over/through sample collection equipment after it has been cleaned. These samples were used to determine if cleaning procedures were

adequate. One equipment blank was collected during each groundwater sampling event. Equipment blanks were labeled and identified on the chain-of-custody documentation.

Trip blanks were used to check for container contamination or contamination from exposure to airborne or ambient contaminants during travel. Trip blanks consisted of volatile organic analyses (VOA) vials filled with organic-free water at the laboratory and shipped with the empty sample containers to the site. One trip blank was prepared per shipment. One trip blank remained with the VOA vials in the field during sampling procedures and was submitted with the samples collected that day. The trip blank vial was not opened at the site. Trip blanks were analyzed by EPA Method 8240 for volatile organics. Trip blanks will be labeled and identified on the chain-of-custody form.

Duplicate Samples--

Duplicate samples are two samples collected simultaneously in separate containers from the same source under identical conditions. Duplicate samples allow for the evaluation of field collection and laboratory analytical methodologies. One duplicate sample was obtained for every 10 samples collected from the sample media (i.e., soil or water). The duplicate sample was given a unique identifier and was included on the chain-of-custody documentation. The collection of the duplicate sample(s) was noted in the field log book.

Clean equipment was taken to the site. The drilling rig and heavy equipment was cleaned prior to arrival onsite. Clean sample containers, provided by the laboratory chosen for sample analysis, were delivered or taken to the site. Some field equipment was cleaned and reused. Decontamination of sampling equipment was necessary to ensure that contamination from one area of the site was not spread throughout the site.

All equipment that was cleaned was placed in the designated area for clean equipment. This area was free of any contamination. Rinseate from cleaning

procedures using solvents, spent nitric acid, or isopropanol was collected and properly disposed by Singer.

Equipment blanks were obtained to determine whether cleaning and decontamination techniques have effectively cleaned the sampling equipment. All sampling equipment was decontaminated according to the procedures described in the work plan. An equipment blank was collected prior to beginning work on the project and at least one equipment sample bank was collected during each sampling event. Equipment chosen for sampling was chosen randomly with different equipment sampled on different days.

Disposable sampling equipment was bagged and containerized for proper offsite disposal. Safety procedures followed the site Health and Safety Plan.

All sampling was performed in accordance with procedures outlined in the USEPA Region IV Environmental Services Division SOPQAM, February 1, 1991.

- Water level and total well depth measurements was performed prior to purging to determine the standing water volumes in the wells.

- Groundwater monitoring wells were purged, prior to sampling, until three (3) to five (5) times the volume of standing water in the well had been removed. If a well was purged dry, the well was allowed to recover and it was sampled within 24 hours.

- Well purging was performed using either submersible pumps or Teflon bailers. The pumps and bailers were cleaned in accordance with the procedures outlined in the work plan.

- Groundwater samples from a well were collected using either dedicated Teflon bailers or the same Teflon bailer used for purging the well.

- Purge water was containerized for storage until analyses results provided a determination of the proper disposal method.

- A clean pair of new, disposable gloves was worn each time a different location was sampled and gloves were donned immediately prior to sampling.

- Containers for samples suspected of containing high concentrations of contaminants were placed in separate plastic bags immediately after collecting, preserving, labeling, etc.

- All background and ambient samples were collected first and placed in separate ice chests or shipping containers. Highly contaminated samples were never placed in the same ice chest as background samples. Highly contaminated samples were placed in a plastic bag before placing them in ice chests. Ice chests or shipping containers for samples suspected to contain high concentrations of contaminants were lined with new, clean, plastic bags.

- Generally one member of the field team took all the notes, filled out labels, etc., while the other members collected all of the samples.

- The water sample was always collected before the sediment sample was collected from Lower Creek.

The volume of sample obtained was sufficient to perform all required analyses with an additional amount collected to provide for QC needs, split samples, or repeat examinations. The sample volume required for each analysis was the volume of the standard container less ullage (empty space) required for sample mixing by laboratory personnel and safe shipment of samples to the laboratory. A minimum of 10 percent ullage except for VOA in every sample container was used during sampling events at the Singer site.

The type of sample container was dictated by the analyses required. Table 2-11 presented the information on the containers used for each sample analysis.

Samples for some analyses were preserved in order to maintain their integrity. Preservation requirements for routine analyses of samples were also presented in Table 2-11. All chemical preservatives used were supplied by RASI. All samples requiring preservation were preserved immediately upon collection in the field. Samples that were not preserved in the field are:

- Samples collected that were suspected of being highly contaminated with toxic materials.

All samples preserved with chemicals were clearly identified by indicating on the sample label that the sample was preserved.

The elapsed time between sample collection and initiation of laboratory analyses was within the prescribed time frame for each individual analysis to be performed.

After collection, all sample handling was minimized. When samples were placed in an ice chest, personnel ensured that the melted ice could cause sample containers to become submerged, as this may result in sample cross-contamination. Plastic bags, such as Zip-Lock® bags, were used when small sample containers (e.g., VOA's) were placed in ice chests to prevent cross-contamination.

All soil samples, except for samples collected for VOC analyses, were mixed as thoroughly as possible to ensure that the sample was representative. Mixing was performed by the quartering method. The soil was placed in a stainless steel sample pan and divided into quarters. Each quarter was mixed, then all quarters were mixed into the center of the pan. This procedure was followed until the sample was adequately mixed. Soil and sediment samples collected for purgeable organic compounds analyses were not mixed. The 100 ml sample containers used for purgeable organic compound analyses for soils were filled completely and no head space was allowed to remain in the sample containers.

Water samples to be analyzed for purgeable organic compounds were collected in 40-ml septum vials with screw cap and Teflon®-silicone disk in the cap to prevent contamination of the sample by the cap. Three 40-ml vials containing four drops of concentrated HCl were filled with the sample.

The vials (40-ml) were completely filled to prevent volatilization, and extreme caution was exercised when filling a vial to avoid any turbulence that could also produce volatilization. The sample was carefully poured down the side of the vial to minimize turbulence. After capping, the bottle was turned over and tapped to check for bubbles. If any bubbles were present, the procedure was repeated. Because the VOA

- Samples for purgeable organic compounds analyses were shipped by air.

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vials were pre-preserved, extreme caution was exercised in order to prevent the loss of the preservative.

All samples were fully documented in the field records, on the field sample Chain-Of-Custody Record, and on the sample labels. Any sample either known or thought to be hazardous was identified on both the sample label and the field sample Chain-Of-Custody Record. Information explaining the hazard, i.e., corrosive, flammable, poison, etc., was listed.

All auxiliary data such as flow measurements, photographs of sampling sites, meteorological conditions, and other observations were entered onto the field records when the auxiliary data were collected. Auxiliary data relative to a particular sampling location were collected as close to the sample collection time as possible.

Sampling team personnel maintained sample chain-of-custody during all field investigations for all samples collected.

The field investigation of the SWMUs required the collection of additional samples for various QC purposes. These included samples for the evaluation of field/laboratory methodology (trip blanks and duplicate samples), or to assess sampling equipment (equipment rinse blanks). In addition, it was necessary to provide split or duplicate samples to assess field sampling procedures. A detailed discussion of each of these types of QC samples is provided below:

- Split Sample: A sample that was portioned into two or more containers from a single sample container or sample mixing container.

- Duplicate Sample: Two or more samples collected simultaneously into separate containers from the same source under identical conditions.

- Trip Blanks: Trip blanks were prepared prior to the sampling event in the actual sample container and kept with the investigative samples throughout the sampling event. They were packaged for shipment with the other samples and sent for analysis. At no time after their preparation were the sample containers opened before they reached the laboratory. Volatile organic trip blanks were used to determine if samples were contaminated during storage and transportation back to the laboratory. Trip blanks were provided per shipment but not per cooler.

- Equipment Blanks: Equipment field blanks are defined as samples that were obtained by running organic-free water over/through sample collection equipment after it had been cleaned. These samples were used to determine if cleaning procedures were adequate. (The equipment may have been cleaned in the field or prior to the field operation.)

- Pre and Post Preservative Blanks: To determine if the preservative used during field operations were contaminated, post preservative blanks were prepared. These samples were prepared by putting analyte-free/organic-free water in the container and then preserving the sample with the appropriate preservative.

- Field Blanks: Organic-free water was taken to the field in sealed containers or was generated onsite and poured into the appropriate sample containers. Field blanks were collected in dusty environments and/or from areas where volatile organic contamination was present in the atmosphere and originating from a source other than the source being sampled.

Investigation derived waste (soil cuttings, well purge water, and equipment decontamination fluids) were locally drummed and stored in the accumulation area maintained by Singer. Once the laboratory report confirmed the materials did not have the characteristics of a hazardous waste, arrangement were made by Singer to despose of the water with the City of Lenoir and the soils with STAT, Inc. Appendix 8.2 includes the correspondence and documentation concerning disposal of investigation related waste.

2.11 DATA MANAGEMENT AND QUALITY ASSURANCE

The main objective of the Data Management Plan was to establish procedures for tracking, documenting, and presenting investigative data collected during the RFI. Data generated for the RFI as well as existing data, were used to form the basis for conclusions and recommendations. Therefore, these data must be properly organized for review and manipulation. Organization of the data was planned prior to actual data collection to ensure appropriate and useable information. Procedures were established for the efficient validation and transfer of information to a system from which data were

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During field activities, the principle investigators were responsible for the day-to-day recording of data and providing appropriate information to the data coordinator. The data coordinator was responsible for ensuring that the information collected for the various technical areas were properly coded and entered into the data management system. The data coordinator has the authority to enforce proper procedures as

evaluated with minimal effort. This section describes the operating practices followed by Singer and EQ personnel during the collection and reporting of data.

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outlined in the plan and to implement corrective procedures to ensure the accurate and timely flow and transfer of information. Data were generated from a variety of sources such as geotechnical, sampling, field notes, screening measurements, and laboratory analyses. The generators of data (engineers, scientists, samplers, and chemical analysts) were responsible for accurate and complete documentation of data required under any stated task and to ensure that these data were presented to the data coordinator in a timely manner.

An alpha-numeric coding system was developed to identify each boring location, monitoring well, and environmental sample taken during water, soil, and sediment sampling. This number tracking system permits the reviewer to immediately determine the location, sample type, and date of sample collection. A listing of the identification numbers is maintained by the data coordinator and other project team personnel.

Presentation and measurement of field observations such as field data sheets, sampling sheets, notebooks, and records were marked with the project number to allow all data generated during the RFI to be traced back to the project number.

Each investigative location, installation, and sample was identified using a combination of letters and numbers. The components of the identifiers are described below.

- Location/Sample Identifier: A 4 to 12 character alpha-numeric designation was used to identify the location and sample type. The alpha characters used were as follows (if applicable):

  SW - surface water
  BG - background
  WT - groundwater at top of upper most aquifer
  SP - groundwater at top of Saprolite layer
  CAMA - corrective action waste management area
  SWMU - solid waste management unit
  SB - soil boring
  SS - surface seep
  MW - monitoring well.

The remaining characters were either digits or a combination of letters and numbers. These digits designate the unique location or sample number. Soil boring samples were assigned additional identifiers after the location/sample identifier. The additional identifier referred to the sample depth. Examples of identifiers for typical samples are presented below:

> BG-1WT: Background well number 1 screened at the top of the upper most aquifer (SWMU9-4SB-0: Soil sample collected at the surface of Station 4 from the oil spill SWMU.

A two or three letter identifier was used to identify QC samples collected. The QC identifier code will be added to the end of sample identifiers. The QC identifiers are as follows:

TA - trip blank
DUP - duplicate
MS - matrix spike
MSD - matrix spike duplicate
FB - field blank.

Data entries on data collection sheets were referenced to the collection locations or sample using the codes described above.

All data collection activities performed at Singer were documented either in a bound field logbook or on appropriate data collection sheets. Entries on data collection sheets were cross-referenced to a field logbook. The entries are as detailed and descriptive as necessary to assure that the project goals and objectives were met. The goal was to document a particular situation so that it can be recalled without reliance on memory. All field logbook entries have been dated.

Items included in the field logbook are personnel on site, dates, weather conditions, times, sample intervals, field decisions and discussions, daily activities, problems encountered, and all other relevant information concerning ongoing field activities.

All drilling information was recorded on a separate drilling log form. A unique log sheet was maintained for each individual soil boring.

A sampling sheet was completed for each unique sample collected. A sampling event was also cross-referenced in the field logbook and noted on the chain-of-custody record.

All samples collected in the field were documented on a chain-of-custody record. The chain-of-custody record serves as a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory. A chain-of-custody record was completed for each sample at each sampling location and include the following information.

- Project name
- Collection date and time
- Sample identification (location-specific) number
- Sample analyses
- Name(s) of sampler(s)
- Name of person relinquishing samples
- Name of person or entity delivering samples
- Airbill number if applicable to be placed under special instructions sections
- Name of laboratory and sample custodian accepting samples
- Date and time samples were accepted by laboratory.

Data reduction was performed on the raw data. The complexity of the data reduction depended on the specific analytical method and the number of discrete operations (extractions, dilutions, and concentrations) involved in obtaining a sample that can be measured.

Data validation was performed at all levels to insure accuracy and consistency of analytical data. The data validation process starts with the laboratory analyst. Pertinent data and the method used were recorded in the analyst's notebook or on the bench sheet. Any modifications of the operating parameters were recorded in the analyst's notebook or bench sheet.

The generation of sample data by an analyst included the generation of QC data, as appropriate for each sample set. The monitoring of sample blanks, sample spikes,

and sample duplicate analysis was accomplished via laboratory QC management software. The analyst computed the data precision and accuracy and compared the computed value to the acceptance intervals identified for that parameter, method, and matrix. The computed value was deemed to be in control if it was within the acceptance interval. Out of control data values were brought to the attention of the laboratory supervisor and QA supervisor. A joint review was conducted to determine the cause and institute corrective action. The data set was rerun once the corrective actions were taken, and the new data were reviewed as stated above.

The laboratory QC data coordinator received all the completed precision and accuracy data summary forms and entered the data into the laboratory QC computer system. QC charts were generated and maintained by the laboratory. The laboratory supervisor reviewed data for consistency and reasonableness with other data and determined if requirements were satisfied. Selected hard copy output was reviewed to ensure that results were interpreted correctly. Unusual or unexpected results were reviewed and a decision was made as to whether the analysis should be repeated.

Laboratory analytical results required statistical analysis in order to develop statistical means and standard deviation values for ambient levels of Appendix IX constituents. Concentrations of constituents in the samples collected downgradient of the SWMUs were then be compared to the background concentrations.

The statistical analysis of the sample data began with the calculation of descriptive statistics. These descriptive statistics provided summary information and allowed for a preliminary and subjective evaluation of the data. The descriptive statistics included the arithmetic mean and standard deviation, minimum and maximum concentration, sample size, and the 95 percent upper confidence limit (UCL) of the mean.

Contaminant concentrations in the downgradient sample were compared to background levels by using the maximum values and the 95 percent UCL. All statistical comparisons were performed at the 0.05 level of significance.

Data collected during the RFI were tabulated in spreadsheet form in a manner that permitted the reviewer to easily summarize the data, identify analytical results, and the sample type and location. The data tables summarize the final results (uncorrected for blanks and recoveries), methods of analysis, levels of quantitation, and QA/QC blanks. The analytical results have been reported with no more than two significant figures (consistent with the limits of uncertainty). Data have been reported in units commonly used for the analyses performed. Concentrations in liquids have been expressed in terms of weight per unit volume (e.g., micrograms per liter). Concentrations in solid or semisolid matrices have been expressed in terms of weight per unit weight of sample (e.g., micrograms per kilogram).

Analytical results for each media were also presented in tabular form for summary purposes. Analytical results for each media were compared to background concentration levels for organics and inorganics determined during the RFI.

Whenever possible, graphical displays of data were prepared in order to permit the reviewer to observe the analytical results with respect to their spatial distribution. A site map exists showing the features of the site and the area immediately surrounding it. The site map served as a base figure for the generation of other graphical figures for purposes of data display. Other graphical figures include investigative locations, SWMU boundaries, chemical constituent contour maps, and various cross-sections.

The following types of data presentation were used:

- All sampling and measurement locations
- Contours illustrating groundwater flow patterns and concentrations of representative chemical constituents in groundwater and soils
- Cross sections presenting geologic data, as well as selected groundwater flow and chemistry data
- Appropriate graphical displays generated to display relevant site features such as net groundwater flow, potentiometric surface, and stratigraphy

- Appropriate graphical displays generated to include hydraulic conductivity data measurements and associated calculations

- A map indicating features affecting the migration of contaminants and the location of potentially affected receptors of contamination.

Data collected from field investigations and laboratory analyses of samples were electronically stored and presented in tabular or spreadsheet form in a manner that permits the reviewer to easily summarize the data, identify analytical methods and results, and recognize the sample type, date of analysis, and location. The analytical results were stored and managed using Microsoft Excel 5.0.

The analytical data and the associated data screening and reduction algorithms were electronically stored in unique workbooks for each SWMU by sampling location (e.g., CAMA1-3SP, BG-2WT, SWMU9-13WT, etc.). The large volume of groundwater analytical data, has necessitated the grouping of the laboratory results for each well or paired well set. The summary information for each well has been compiled and is presented on a well by well and SWMU by SWMU basis. The soil analytical results are compiled in workbooks for each total SWMU (i.e., CAMA No. 1, SWMU No. 3, etc.).

The laboratory reported analytical results were compiled in a work sheet for each sample sent to the laboratory for analysis. For example, a soil sample at 2 to 4 feet below the surface at background location number 1 during the installation of the Saprolite well will have a work sheet entitled BG-1SP 2 to 4 ft. Groundwater samples have work sheet names that include the well number and sampling event number. For example, BG-1SP (2) translates into the second groundwater sample collected from background well BG-1SP.

QC and assured laboratory data were provided by RASI on computer diskette(s) for each sampling event. EQ placed the data in the appropriate workbook by creating a unique work sheet for that sample and by importing the laboratory information. The importation was accomplished by using a standardized protocol and format. Each analysis type (e.g., volatiles, semivolatiles, metals, etc.) was sorted in descending order by chemical abstract services (CAS) number for the analyte. This standard procedure

assures consistency and continuity in the data handling. The standardized procedure also provides a QC check for the formulas used to calculate the descriptive statistics (i.e., minimum value, maximum value, sample population standard deviation, and 95 percent upper confidence limit of the sample population mean value).

The summary work sheets for each sampling group are identical in format and calculation and presentation. The main goal of the summary sheets is to provide an audit trail to the laboratory data and summarize pertinent information in a manner that allows easy identification of important results, statistical analyses, and comparative analyses. A summary sheet displays all of the related results on a side by side basis and allows one to determine if there are outliers, trends, QC issues, and/or confirmed contamination for the SWMU.

In order to manage the data in a consistent manner from location to location, the summary work sheets were designed to allow for the analysis of additional samples. The first four columns always show the compound, CAS number, analysis type, and EPA analytical method. The summary sheet then provides a synopsis of the laboratory results by including the following information for each sample: 1) sample date, 2) method results, 3) flag code, and 4) quantitation limit.

The concentration of each compound detected within a SWMU has been compiled and grouped to display the results and allow a convenient platform for additional data reduction and interpretation efforts. The data reduction effort included a comparison of individual sample results and the associated data qualifier "flag" codes to those already included in the data base. Newly quantified and QC accepted results were added to the data base and included the extent of contamination evaluation. Qualified analytical results were used in the extent of contamination evaluation only if the sample data meet the project acceptance criteria. Logical statements and comparative functions were used to review reported sample results and provide the appropriate input for the statistical work up, and the comparative and interpretation section. The acceptance criteria for qualified compounds is described below in Table 2-12.

TABLE 2-12. LABORATORY RESULTS DATA QUALIFIER CODES[a]

ORGANICS	
U	This flag indicates the compound was analyzed for but not detected.
J	This flag indicates an estimated value. This flag is used 1) when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, 2) when the mass spectral and retention time data indicate the presence of a compound that meets the volatile and semivolatile GC/MS identification criteria, and the result is less than the Project Quantitation Limit but greater than zero, and 3) when the retention time data indicate the presence of a compound that meets the pesticide/Aroclor identification criteria, and the result is less than the Practical Quantitation Limit but greater than zero. For example, if the sample quantitation limit is 10 μg/L, but a concentration of 3 μg/L is calculated; the report value is 3J. Note: The J flag is not used and the compound is not reported as being identified for pesticide/Aroclor results less than the Practical Quantitation Limit if the pesticide residue analysis expert determines that the peaks used for compound identification resulted from instrument noise or other interferences (column bleed, solvent contamination, etc.).
N	This flag indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds (TICs), where the identification is based on a mass spectral library search. It is applied to all TIC results. For generic characterization of a TIC, such as chlorinated hydrocarbon, the N flag is not used.
P	This flag is used for a pesticide/Aroclor target analyte when there is greater than 25 percent difference for detected concentrations between the two GC columns. The lower of the two values is reported and flagged with a P.
C	This flag applies to pesticide results where the identification has been confirmed by GC/MS. If GC/MS confirmation was attempted but was unsuccessful, use a laboratory-defined flag instead (see the X qualifier).

(continued)

TABLE 2-12 (continued)

B	This flag is used when the analyte is found in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user to take appropriate action. This flag shall be used for a tentatively identified compound as well as for a positively identified target compound. The combination of flags BU or UB is expressly prohibited. Blank contaminants are flagged B only when they are detected in the sample.
E	This flag identifies compounds whose concentrations exceed the upper level of the calibration range of the instrument for that specific analysis. If one or more compounds have a response greater than the upper level of the calibration range, the sample or extract was diluted and reanalyzed. All such compounds with a response greater than the upper level of the calibration range shall have the concentration flagged with an E. Note: For total xylenes, where three isomers are quantified as two peaks, the calibration range of each peak shall be considered separately. For example, a diluted analysis is not required for total xylenes unless the concentration of the peak representing the single isomer exceeds 200 μg/L or the peak representing the two co-eluting isomers on that GC column exceeds 400 μg/L. Similarly, if the two 1,2-Dichloroethene isomers coelute, a diluted analysis is not required unless the concentration exceeds 400 μg/L.
D	If a sample or extract is reanalyzed at a higher dilution factor, for example when the concentration of an analyte exceeds the upper calibration range, the DL suffix is appended to the sample number for the more diluted sample, and all reported concentrations on that Form I are flagged with the D flag. This flag alerts data uses that any discrepancies between the reported concentrations may be due to dilution of the sample or extract. Note: The D flag is not applied to compounds which are not detected in the sample analysis, i.e., compounds reported with the Project Quantitation Limit and the U flag.
A	This flag indicates that a tentatively identified compound is a suspected aldol-condensation product.

(continued)

TABLE 2-12 (continued)

X	Other specific flags may be required to properly define the results. If used, the flags shall be fully described, with the description attached to the sample data summary package and the SDG Narrative. Begin b using X. If more than one flag is required, use Y and Z as needed. If more than five qualifiers are required for a sample result, use the X flag to represent a combination of several flags. For instance, the X flag might combine the A, B, and D flags for some samples. The laboratory-defined flags are limited to X, Y, and Z.
INORGANICS	
B	This flag is used when the analyte concentration was less than the project quantitation limit but greater than the instrument detection limit.
U	This flag indicates the compound was analyzed for but not detected.
E	The reported value is estimated because of the presence of interference.
M	Duplicate injection precision not met.
N	Spiked sample recovery not within control limits.
S	The reported value was determined by the Method of Standard Additions (MSA).
W	Post-digestion spike for Furnace AA analysis is out of control limits (85 to 115%), while sample absorbance is less than 50 percent of spike absorbance.
*	Duplicate analysis not within control limits.
+	Correlation coefficient for the MSA is less than 0.995.
Entering "S," "W," or "+" is mutually exclusive. No combination of these qualifiers can appear in the same field for an analyte.	

[a]Statement of work for EPA Contract Laboratory Program (CLP) - guidelines and Standard Operating Procedures low concentration water December 1994.

"J" and "B" flag qualified laboratory results were retained for inclusion in the extent of contamination evaluation, only if the reported sample result was at least ten (10) times higher than the value reported for the associated method blank and the sample result was also at least three (3) times higher than the applicable quantitation limit for the sample matrix. If the sample results did not meet this criteria, the result was not used in the extent of contamination evaluation. A note has been provided at the bottom of each spreadsheet if the sample results were eliminated because of method blank contamination. The note displays the reported concentration for the sample and the concentration for the associated method blank. It should be noted that only common laboratory contaminants (e.g., Acetone, Methylene Chlorine, and Phthalates) were found in the method blanks. "P" flag qualified data did not meet the plus or minus 20 percent QA criteria for duplicate/confirmation analyses, hence Pesticides and PCB's analyses that were flagged with "P" codes were excluded from the extent of contamination evaluation. Additionally, if a compound was only detected one time and it was qualified with a "J" flag, the results were excluded from the extent of contamination evaluation.

Screening the data for qualified detects and nondetects was used to establish a data base for the statistical analysis. The data screening protocol assigned a value of zero (0) to all "U" flagged analytical results, if every sample in the group was reported as a nondetect for the compound being reviewed. For example, suppose for a particular compound you have 13 samples, and all except one were reported as nondetect and the one detected value was below the quantitation limit. It is common practice to use half of the quantitation limit for each nondetect value in the statistical workup, if there was one or more positive identifications for the compound of interest. Hence, the following criteria and protocol were used to determine if the data should be used in the extent of contamination evaluation: 1) if the laboratory reported values exceeded the quantification limit, then half of the quantification limit was used for all "U" flagged values and the reported value was used for all "J" flagged data; 2) if the laboratory reported only "U" flag codes, then a value of zero is assigned; 3) if the

laboratory reported more than 2 values with "J" flags and all other values are "U" flagged, then half the quantification limit was used for the "U" flagged nondetect values; and 4) if the laboratory reported a single "J" flag and all other results were nondetect, then the "J" flagged data was treated as an outlier and assigned a value equal to the quantification limit.

The statistical analysis portion of the work sheet evaluated the accepted data and reported the results of the statistical analysis in the data summary section: The statistical work up includes: 1) the sample population size within the group; 2) the minimum concentration, maximum concentration, average concentration, standard deviation of the sample population, and the 95 percent UCL concentration for the mean concentration. The maximum value and the 95 percent UCL for each applicable compound was then compared to the background 95 percent UCL concentration for the applicable compound. If the 95 percent UCL sample concentration was lower than the 95 percent UCL concentration of the same compound in the background, no further analysis was completed. If the 95 percent UCL for the compound was higher than the background <u>or</u> there were no positive hits at the background location for that compound, then both the 95 percent UCL concentration and the maximum concentration value were compared to the applicable action level. For any comparison of the maximum value or the 95 percent UCL to an action level, a ratio calculation was performed to provide the reviewer with an indication of the significance.

REFERENCES

1. Cherry, J. A., and R. A. Freeze. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

SECTION 3

ENVIRONMENTAL SETTING AND BACKGROUND CONDITIONS

The following subsections describe the environmental setting of the Miller Hill Complex.

3.1 TOPOGRAPHY

The Miller Hill Complex strides a west to east trending ridge of modest peaks and valleys. Miller Hill peaks 1/3 mile southwest of the most southern property line of Singer at an elevation of 1214 feet above mean sea level (MSL). An unnamed hill peaks 1/4 mile southeast of the southern property line at an elevation of 1290 feet above MSL. The southern most portion of the Singer property line runs in a southeasterly direction along a naturally occurring gap between these two hills. Virginia Street (formerly called Miller Hill Street) is constructed in the gap and provides local egress for the surrounding community. The Singer property drops in elevation from a high point of 1186 feet to a low of 1066 feet above MSL along a transect that runs from south to north. The topographic relief on the southern most portions of the property is classified as steep with a drop rate of approximately 1400 vertical feet per 1000 horizontal feet.

Lower Creek runs in a southwesterly direction in an alluvial valley floor that is located between the Miller Hill ridge line located to the south of the Singer property and the unnamed ridge line that also trends from west to east on the north side of Lower Creek. The north side ridge peaks at an elevation of 1240 feet above MSL. Approximately 2/3 of the Singer property is located on land that is part of the alluvial valley floor through which Lower Creek flows. The topographic relief on this portion of the property is classified as gentle with a drop rate of approximately 5 vertical feet per 1000 horizontal feet.

The topographic map (Figure 1-2) is based on an aerial photography dated April 4, 1994. The map displays the local topography (i.e., within 1000 feet of the Singer property lines) at a scale of 1 inch to 100 feet and the contour intervals are resolved to the two foot level.

3.2 GEOLOGY AND SOILS

3.2.1 Local Soil Characteristics

General Soil Descriptions--

The USDA, "Soil Survey of Caldwell County, North Carolina," shows five soil series having been mapped in and surrounding the subject site. The mapped units include the Cecil Series, Pacolet Series, Urban land-Masada complex, Urban land-Arents complex, and the Wehadkee loam. The following presents a summary of the available soil series data for the units mapped at the Singer site by the USDA and discussed in the "Soil Survey of Caldwell County, North Carolina."

The Cecil series consists of well drained soils. These soils were derived from metamorphic and igneous rocks on the Piedmont Uplands, with a typical pedon of fine sandy loam to sandy loam. The series occurs on slopes ranging from 2 to 15 percent, with the Cecil soils of the site being mapped as having 8 to 15 percent slopes and being eroded. The series was mapped in the southern portion of the Singer property which is wooded, undeveloped, and topographically upland.

The Pacolet soil series consists of well drained soils that formed in residue from metamorphic and igneous rock on Piedmont Uplands. The pedon typically consists of loamy soils with a clayey subhorizon 1 to 2 feet thick located at an approximate depth of 0.5 feet below the ground surface. The series occurs on slopes ranging from 15 to 40 percent, with the Pacolet soils of the Singer site being mapped with slopes of 15 to 20 percent. The series was mapped in the southern portion of the site which is wooded and undeveloped.

Wehadkee loam is mapped at the Singer site along Lower Creek in the Soil Survey of Caldwell County, North Carolina. Nearly level, poorly drained soils which occur on flood plains along streams are typical of the Wehadkee loam. Surface runoff is generally very slow to ponding, with the seasonal high water table at or near the surface. The permeability is moderate, and shrink-swell potential is low.

The areas of Plant Nos. 33 and 54 and the landfill are mapped as the Urban land Arents complex. The Urban land-Arents complex map unit consists of nearly level soils on flood plains and low terraces. Industrial and urban development have altered or covered the soil to such an extent that specific soil identification is not considered practical. The Urban land consists of areas that have been filled, leveled, and covered with asphalt, concrete, buildings, or other impervious cover. The Arents are areas that have had fill material placed over the original soil surfaces.

The area of the borrow pit, located south of Plant No. 33, is mapped as a urban land - Masuda complex with slopes of 2 to 15 percent. The Masuda soil series makes up approximately 25 percent of this map unit. The Masuda soil series consists of well drained soils that formed in alluvium on stream terraces. Masuda soils typically have loamy soils. The Urban land portion of the map unit consists of soils that have been changed topographically by cutting, filling, grading, and shaping. Historical records indicate that the soils identified as urban land were excavated from the Pacolet soils identified as being located on the southern portion of the site.

The engineering, physical, and chemical properties of the five mapped soil units are shown in Table 3-1. These properties include the bulk density, permeability, available water capacity, the percent of organic matter in the soil, and the particle size distribution. The values for the soil properties were obtained from the Caldwell County Soil Survey and represent the properties of typical pedons of the mapped units within Caldwell County. The properties shown for the urban land - Masuda complex represent the Masuda portion of the unit. These properties were not available for the Urban land - Arents complex.

TABLE 3-1. PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS MAPPED IN THE SOIL SURVEY OF CALDWELL COUNTY AS BEING ON THE SINGER FURNITURE COMPANY PROPERTY[a]

Map symbol and soil name	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Erosion factors		Organic matter	Fragments > 3 in.	Percentage passing sieve number--			
							K	T			4	10	40	200
	In	Pct	G/cc	In/h	In/h	pH			Pct	Pct				
CeD2 Cecil	0-4 4-40 40-62	5-20 4-60	1.00-1.50 1.30-1.50	2.0-6.0 0.6-2.0	0.12-0.14 0.13-0.15	4.5-6.0 4.5-5.5	0.26	4	0.5-2	0 0	84-100 97-100	80-100 92-100	67-90 72-99	26-42 55-95
PaE Pacolet	0-7 7-40 40-60	8-20 35-65 10-25	1.00-1.50 1.30-1.50 1.20-1.50	2.0-6.0 0.6-2.0 0.6-2.0	0.08-0.12 0.12-0.15 0.08-0.15	4.5-6.5 4.5-6.0 4.5-6.0	0.20 0.26 0.26	3	0.5-2	0-2 0-1 0-2	85-100 80-100 80-100	80-100 80-100 70-100	42-80 60-95 60-80	16-35 51-75 30-50
Urban land - Arents.														
Urban land - Masada	0-10 10-58 58-72	10-27 27-65 25-40	1.20-1.50 1.30-1.60 1.30-1.60	2.0-6.0 0.6-2.0 0.6-2.0	0.10-0.17 0.10-0.17 0.10-0.17	4.5-6.5 4.5-6.5 4.5-6.5	0.32 0.24 0.24	5	1-3	0-5 0-10 0-10	90-100 80-100 80-100	75-100 70-100 70-100	50-100 65-90 65-95	36-75 50-80 50-80
Wehadkee	0-10 10-37 37-80	5-20 16-35	1.35-1.80 1.30-1.60	2.0-6.0 0.6-2.0	0.10-0.15 0.16-0.20	4.5-6.5 4.5-6.5	0.24 0.32	5	2-5	0 0	100 100	95-100 99-100	60-80 85-100	30-80 51-90

[a]The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated.

3.2.2 Site-Specific Soil Characteristics

Site-specific information on the soils of the Singer property have been obtained during the RFI activities. This information has been supplemented by information obtained during two geotechnical investigations and a separate two-phased investigation of the landfill. These investigations were the following:

A. Landfill Investigation Report (Phase I), J. E. Sirrine Company (Sirrine), January 1983 (Appendix 1.4)
B. Landfill Investigation Report (Phase II), J. E. Sirrine Company, December 1983 (Appendix 1.4)
C. Report of Preliminary Subsurface Investigation, Law Engineering Testing Company, October 17, 1978 (Appendix 1.5)
D. Report of Preliminary Geotechnical Exploration, Law Engineering Testing Company, August 23, 1980 (Appendix 1.6).

The location of soil borings and groundwater monitoring wells installed during the landfill and geotechnical investigations at the site is indicated on Figure 2-15. The information gathered during the geotechnical and landfill investigations are provided below.

The geotechnical investigations were performed to evaluate the suitability of the soils of the site for plant expansion. The investigations, performed by Law Engineering Test Company, consisted of 18 soil borings in 1978 and 12 soil borings in 1980 (Figure 2-15). Sixteen soil borings were installed north of the maintenance warehouse during the 1978 geotechnical investigation. The boring logs for the 1978 geotechnical investigation are provided in Appendix 1.3. These 16 soil borings identified fill material underlain by rock fill placed over debris material. The fill material consisted of sandy clayey silt and silty sand, and varied in depth from 2.5 to 6 feet. Aerial photographs and employee interviews indicate that all of the fill material was excavated from the hill side located south of Plants 54 and 33.

Four borings were placed in the area between the maintenance warehouse and the Plant No. 33 building during the 1978 geotechnical investigation. The soils encountered consisted of fill material, ranging in depth from 3 to 13 feet, underlain by alluvium soils of 2 to 7 feet in thickness. The fill material was composed of clayey sandy silt and silty sand

and the alluvium soils consisted of firm to stiff sandy clayey silt and sandy silty clay with rounded gravel. The alluvium soils were underlain by residual soils, resulting from the inplace chemical weathering of parent rock material. The residual soils consisted of firm to dense micaceous silty sand. The thickness of the residual soils varied from 2 to greater than 12 feet. No residual soils were encountered in the fourth boring.

Two soil borings were installed south of the Plant No. 33 building during the 1978 geotechnical investigation. Residual soils of micaceous, silty, fine to coarse sands were encountered in these borings. The residual soils had thicknesses of approximately 30 feet and were underlain by Saprolite. The Saprolite crushed to silty fine to medium sand during testing.

The second geotechnical investigation consisted of the installation of seven soil borings within the present Singer property and two on property that Singer no longer owns. The two offsite locations were in the Lower Creek floodplain, approximately 200 and 400 feet east of the current property. The boring logs for the second geotechnical investigation are provided in Appendix 1.4. Five of the nine soil borings were installed within the floodplain of Lower Creek. The soil profiles revealed by the borings consisted of 1 to 4 feet of fill material underlain by 30 to 33 feet of alluvium soil and 6 to 7 feet of residual soil. The fill material consisted of silty sand. The alluvium soils encountered in the borings varied from 18 to 20 feet of silty clay and clayey silt underlain by approximately 12 to 30 feet of silty sand. The residual soil was composed of micaceous silty sand.

The remaining four borings were placed in the area south of Plant No. 33 building. Residual soils of micaceous sandy silt and silty sand with a thickness of 35 to 36 feet were encountered in the borings. The residual soils were underlain by Saprolite 4 to 6 feet deep. The Saprolite crushed to micaceous, silty, fine to coarse sand during testing.

The landfill investigation, performed by Sirrine and S&ME, in 1983 (Appendix 1.4) consisted of the installation of eight soil borings with the subsequent installation of groundwater monitoring wells in seven of the borings. The locations of the soil borings are shown in Figure 2-15 and are labeled as S-1, N-1, N-2, E-1, W-2, and W-1. Five of

the soil borings and four of the monitoring wells were installed during the first phase of the landfill investigation. Two of the borings were placed in the floodplain of Lower Creek, two were placed in the landfill, and the fifth was installed southwest of the Plant No. 33 building.

The borings installed in the floodplain revealed silt with debris to a depth of approximately five feet. The silt was underlain by clay of three to five feet thickness. The clay was underlain by silt and sand with the silt interbedded in the sand in the boring north of the landfill (N-1). The silt was located between the clay and sand in the boring east of the landfill (E-1).

A boring installed in the southwest portion of the landfill (W-1) showed fill material and debris to a depth of 10 feet. The fill material was composed of sandy sift and silty sand. This boring was abandoned at the 10 foot depth due to the presence of the debris and garbage. A second boring was installed (W-1 B) and silt fill material and debris were encountered to a depth of 15 feet. The fill materials was underlain by 10 feet of clay, 8 feet of silt, followed by sand to a depth of 45 feet. A two foot layer of sift was interbedded within the sand.

The boring southwest of the Plant No. 33 building (S-1) revealed fill material to a depth of approximately 9 feet underlain by 15 feet of sand. The fill material was composed of silt. The sand graded from silty sand to fine grain sand. The sand was underlain by Saprolite that graded from sift to clay.

The second phase of the landfill investigation consisted of the installation of three additional soil borings with subsequent installation of monitoring wells. Two of the borings were installed in the floodplain of Lower Creek and the third boring was placed within the landfill (Figure 2-15). The alluvium soil from the northeast most boring within the floodplain (NE-1) was composed of sands with interbedded clay horizons. The clay layers varied in thickness from 2 to 10 feet. The sand and clay was underlain by Saprolite composed of silt and clay.

The soil in the other boring installed in the floodplain (N-2) consisted of sands with a clay layer of 4 foot thickness located at a depth of 22 foot. The sand extends 8 feet

below the bottom of the clay layer and is underlain by Saprolite. The Saprolite is composed of silt and clay. The boring installed in the northeast portion landfill (W-2) revealed 7 feet of fill material underlain by 28 feet of interbedded layers of clay and sand.

The soils information gathered during the RFI was consistent with the information gathered during the previous investigations. The information gathered during the RFI provided additional information on the lithology of the sediments within the floodplain and the Lumber yard and the Saprolite in the southern portion of the site.

These were six sets of paired wells installed within the floodplain. One of each set of well borings was installed into the alluvial materials of the floodplain and extended a maximum of 15 feet into this material. The second well of the set was installed through the alluvial materials and into the top of underlying Saprolite materials.

One set of paired wells was installed in the Lumber Yard during the RFI. One of the paired wells was extended into the alluvial material and the second extended into underlying Saprolite.

A set of paired wells was installed into the Saprolite materials in the area south of Plant 54. One well boring was extended into the Saprolite deep enough to monitor the top of the water table within the Saprolite and the second well boring was extended down to the weathered bedrock below the Saprolite.

One well was installed to the west of Plant 54 and another well was installed to the north of Plant 54. Both well borings extended into the Saprolite deep enough to monitor the top of the water table within the Saprolite. An attempt was made to install a well (SWMU3-11WT) on the east side of Plant 54, but bedrock was encountered at a depth of 4 inches BLS.

The locations of the wells installed during the RFI are shown on Figure 1-2. A brief description of the soils encountered during the installation of the RFI wells is provided below.

The monitoring wells installed in the Saprolite south of Plant 54, BG-1WT and BG-1SP, serve as wells to determine the background conditions. The Saprolite material encountered in the two well borings broke down into silty, clayey sands with quartz,

feldspar and mica. Bands of iron staining was evident in the Saprolite at depths of below 4 BLS. The water table was encountered within the Saprolite at a depth of approximately 12 feet. The depth of the Saprolite was approximately 30 feet BLS. The weathered bedrock below the Saprolite consisted of hornblende, feldspar, mica, and quartz.

The Saprolite well installed to the west of Plant 54, SWMU3-10WT, had a total boring depth of 14 feet. The Saprolite material encountered in the boring broke down into silt and silty clay. The Saprolite was overlain by a clayey sand of approximately 2 foot depth. The clayey sand appears to be colluvium material from the upgradient area to the south.

The well installed into the Saprolite to the north of Plant 54, SWMU3-9WT, had a total boring depth of 16 feet. The Saprolite material encountered in the boring broke down into silt and silty clay. The Saprolite was overlain by a clayey sand of approximately 9 foot deep. The clayey sand appears to be colluvium material from the upgradient area to the south. Groundwater was encountered at an approximate depth of 9.5 feet BLS.

The set of paired wells installed in the Lumber yard (BG-2WT and BG-2SP) also serve as wells to monitor the background conditions. The alluvial material encountered in the boreholes consisted of approximately 2 feet of sand underlain by layers of silty clay sandy and sandy silt. A 5.5 foot layer of sand with rounded quartz pebbles existed immediately above the Saprolite, which was encountered at a depth of 33.5 feet BLS. The Saprolite broke to sandy clayey silt with quartz and feldspar fragments and iron banding. Groundwater was encountered in the boreholes at an approximate depth of 4 feet BLS.

The other well installed in the Lumber yard, SWMU9-13WT, had a total boring depth of 12 feet. The soils encountered in the boring were consistent with those encountered in the other borings performed in the Lumber Yard. Groundwater was encountered at approximately 4 feet BLS.

Two of the paired sets of monitoring wells installed in the floodplain of Lower Creek were located in the old softball field located north of the Lumber Yard. One pair of wells (CAMA1-7WT and 7SP) was installed near a drainage ditch that separates the Lumber Yard and the softball field. The other pair (CAMA1-8WT and CAMA1-8SP) was installed

north of the sewer line transecting the property and near the unnamed tributary to Lower Creek that runs south to north through the Singer property. The soils encountered in the CAMA1-7WT and -7SP borings consisted of 18 feet of silty clay underlain by coarse grain sands with gravel. Saprolite was encountered at a depth of 33 feet BLS. The Saprolite broke down into clayey, sandy silt. Groundwater was encountered in the borings at a depth of 4 feet BLS.

The soils encountered in the borings for CAMA1-8WT and -8SP consisted of approximately 2 feet of silt clay underlain by sands with lens of silty clay. The sands varied from fine grained to coarse grained. A 3.5 foot bed of coarse grain sand with pebbles overlays the Saprolite that was encountered at a depth of approximately 31.5 feet BLS. The Saprolite broke to sandy silty clay with hornblende, mica, and feldspar fragments. Groundwater was encountered in the borings at a depth of 5.5 feet BLS.

The remaining four sets of paired wells installed in the floodplain are located in the area between the toe of the landfill and Lower Creek. One set of wells (CAMA1-3WT and -3SP) are located near the northeast toe of the landfill and another set (CAMA1-6WT and -6SP) is located near the northwest toe of the landfill. A third pair of wells (CAMA1-4WT and -4SP) is located near the confluence of Lower Creek and its unnamed tributary. CAMA1-4WT and -4SP are located downgradient of CAMA1-3WT and -3SP. The fourth pair of wells (CAMA1-5WT and -5SP) are located near Lower Creek downgradient of CAMA1-6WT and -6SP.

The soils encountered in the borings for CAMA1-3WT and -3SP consisted of 18 feet of silty clay with layers of silty sand. The silty clay gave way to 7 feet of clayey silt with sand lens. The clayey silt was underlain by coarse grain sand with gravel that extended down to the Saprolite at 31 feet BLS. Groundwater was encountered in the borings at 6 feet BLS.

The soils encountered in the borings for CAMA1-4WT and -4SP consisted of 7 feet of silty clay underlain by 8 feet of slightly silty sand. Below the slightly silty sand, layers of clays and silt extended for 10 feet before the soil changed to coarse grain sand with pebbles. The coarse grain sand overlaid the Saprolite that was located at a depth of 30

feet BLS. The Saprolite broke down into silty sand. Groundwater was encountered in the boring at a depth of 7 feet BLS.

The soils encountered in the borings for CAMA1-5WT and -5SP consisted of 6.5 feet of clayey silt followed by sand. The sand had lens of sandy silts and the grain size of sand varied from fine to coarse. The bottom 11 feet of sand was coarse grained with quartz and feldspar fragments. The Saprolite was encountered at a depth of 34 feet BLS and it broke down into a sandy silt with a high mica content.

The soils encountered in the borings for CAMA1-6WT and -6SP consisted of 19 feet of stiff clay. The clay was underlain by sand that became coarser and had increasing amounts of mica and quartz fragment with depth. An approximate 1 foot layer of rounded gravel with sand was located above the Saprolite that was encountered at a depth of 33 feet BLS. The Saprolite broke down into a silty sand. Groundwater was encountered in the borehole at a depth of 2.5 feet BLS.

3.2.3 Soil Testing

Analytical Testing--

During the installation of the borings for the four background wells, soil samples were collected from the depths of 6 and 48 inches BLS. The eight samples were analyzed for Appendix IX compounds, excluding dioxins, plus formaldehyde, sulfide, and TOC. In addition to the borehole samples, an additional soil boring was performed at each well location to obtain confirmation samples. The confirmation samples were collected from the same depths as the borehole samples and duplicate samples were collected at each depth. The confirmation samples were analyzed for the same parameters as the borehole samples. The confirmation sample borings were designated as BG-1-SB1 and BG-2-SB1.

The analytical results for the 6 in. soil sample collected from the borehole for BG-1WT revealed the presence of 1 VOC, 1 semivolatile organic compounds (SVOC), 15 metals, TOC, and formaldehyde. The 48 in. sample from this borehole had detected concentrations of SVOCs, 15 metals, TOC, and formaldehyde. The detected compounds

for both samples are shown in Table 3-2. The analytical results for all samples are provided in Appendix 3.1.

The analytical results for the 6 inch soil sample collected from the borehole for BG-1SP revealed the presence of one VOC, one SVOC, 15 metals, TOC, and formaldehyde. The 48 in. sample from this borehole had detected concentrations of SVOCs, 15 metals, TOC, and formaldehyde.

The analytical results for the 6 inch soil sample collected from the confirmation soil boring BG-1-SB1 revealed the presence of one SVOC, 12 metals, and formaldehyde. The duplicate 6 in. sample had the same detected compounds. The 48 in. sample from BG-1-SB1 had detected concentrations of one SVOC and 13 metals. The duplicate 48 in. sample had the same detected compounds.

The analytical results for the 6 inch soil sample collected from the borehole for BG-2WT revealed the presence of 2 SVOCs, 14 metals, 1 pesticide, TOC, and sulfur. The 48 in. sample from this borehole had detected concentrations of 1 VOC, 4 SVOCs, 15 metals, sulfide, TOC, and formaldehyde.

The analytical results for the 6 inch soil sample collected from the borehole for BG-2SP revealed the presence of 5 SVOCs, 14 metals, sulfide, and TOC. The 48 in. sample from this borehole had detected concentrations of 1 VOC, 3 SVOCs, 14 metals, TOC, sulfide, and formaldehyde.

The analytical results for the 6 inch soil sample collected from the confirmation soil boring BG-2-2B1 revealed the presence of 1 VOC, 8 SVOCs, 14 metals, 1 pesticide, 1 PCB, and formaldehyde. The duplicate 6 inch sample had the same detected compounds, plus one additional VOC. The 48 in. sample from this boring had detected concentrations of 1 VOC, 2 SVOCs, 14 metals, and formaldehyde. The duplicate 48 in. sample had detectable concentrations of 2 VOCs, 3 SVOCs, 14 metals, and formaldehyde.

Acetone, methylene chloride, and all forms of phthalates are ubiquitous laboratory contaminants associated with the analytical procedures and no conclusions concerning environmental contamination should be attempted unless the reported concentrations are

TABLE 3-2. SUMMARY OF DETECTED COMPOUNDS IN BACKGROUND SOIL SAMPLES

Sample location	Sample depth, in.	Analytical results
BG-1WT	6	<u>VOCs</u> Acetone <u>SVOCs</u> Bis(2-ethylhexyl)phthalate <u>Metals</u> Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Antimony, Tin Nickel, Lead, Iron <u>Other</u> Formaldehyde TOC
BG-1WT	48	<u>VOCs</u> None <u>SVOCs</u> Benzo[a]pyrene Fluoranthene Benzo[b]fluoranthene Pyrene Bis(2-ethylhexyl)phthalate <u>Metals</u> Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Antimony, Tin Nickel, Lead, Iron <u>Other</u> Formaldehyde

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-1SP	6	**VOCs** Acetone **SVOCs** Phenanthrene Bis(2-ethylhexyl)phthalate **Metals** Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Antimony, Tin Nickel, Lead, Iron **Other** Formaldehyde TOC
BG-1SP	48	**VOCs** None **SVOCs** Butylbenzylphthalate Benzo[a]pyrene Fluoranthene Pyrene Di-n-butylphthalate Bis(2-ethylhexyl)phthalate **Metals** Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Antimony, Tin Nickel, Lead, Iron **Other** Formaldehyde

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-1-SB1	6	VOCs Methylene Chloride SVOCs Bis(2-ethylhexyl)phthalate Metals Zinc, Vanadium, Copper, Cobalt Chromium, Beryllium, Barium, Arsenic Tin, Nickel, Lead, Iron Other Formaldehyde
BG-1-SB1	6 Duplicate	VOCs Methylene Chloride Acetone SVOCs Bis(2-ethylhexyl)phthalate Metals Zinc, Vanadium, Copper, Cobalt Chromium, Beryllium, Barium, Arsenic Tin, Nickel, Lead, Iron Other Formaldehyde
BG-1-SB1	48	VOCs None SVOCs Bis(2-ethylhexyl)phthalate Metals Zinc, Vanadium, Copper, Cobalt Chromium, Beryllium, Barium, Arsenic Antimony, Tin, Nickel, Lead Iron Other None

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-1-SB1	48 Duplicate	VOCs None SVOCs Bis(2-ethylhexyl)phthalate Metals Zinc, Vanadium, Copper, Cobalt Chromium, Beryllium, Barium, Arsenic Tin, Nickel, Mercury, Lead Iron Other None
BG-2WT	6	VOCs None SVOCs Pyrene Bis(2-ethylhexyl)phthalate Pesticides - PCBs Endosulfan Metals Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Antimony, Nickel Lead, Iron Other Sulfide TOC

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-2WT	48	**VOCs** Acetone **SVOCs** Butylbenzylphthalate Benzo[g,h,i]perylene Pyrene **Metals** Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Antimony, Thallium Nickel, Lead, Iron **Other** Formaldehyde Sulfide TOC
BG-2SP	6	**VOCs** None **SVOCs** Benzo[a]pyrene Pyrene Benzo[b]fluoranthene Benzo[g,h,i]perylene Bis(2-ethylhexyl)phthalate **Metals** Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Thallium, Nickel Lead, Iron **Other** Sulfide TOC

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-2SP	48	**VOCs** Acetone **SVOCs** Benzo[a]pyrene Pyrene Bis(2-ethylhexyl)phthalate **Metals** Selenium, Zinc, Vanadium, Copper Cobalt, Chromium, Cadmium, Beryllium Barium, Arsenic, Thallium, Nickel Lead, Iron **Other** Formaldehyde Sulfide TOC
BG-2-SB1	6	**VOCs** Acetone **SVOCs** Di-n-butylphthalate 2-Methylnapthalene Naphthalene Phenanthrene Diethylphthalate Fluoranthere Pyrene Bis(2-ethylhexyl)phthalate **Pesticides - PCBs** Dieldren Aroclor 1260 **Metals** Zinc, Vanadium, Copper, Cobalt Chromium, Beryllium, Barium, Arsenic Tin, Silver, Nickel, Mercury Lead, Iron **Other** None

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-2-SB1	6 Duplicate	VOCs Methylene Chloride Acetone SVOCs Di-n-butylphthalate 2-Methylnapthalene Naphthalene Phenanthlene Diethylphthalate Fluoranthene Pyrene Bis(2-ethylhexyl)phthalate Pesticides - PCBs Dieldren Aroclor 1260 Metals Zinc, Chromium, Tin, Lead, Vanadium, Beryllium, Silver, Iron, Copper, Barium, Nickel, Cobalt, Arsenic, Mercury Other None
BG-2-SB1	48	VOCs Methylene Chloride Acetone SVOCs Diethylphthalate Di-n-butylphthalate Metals Zinc, Chromium, Tin, Lead, Vanadium, Beryllium, Silver, Iron, Copper, Barium, Nickel, Cobalt, Arsenic, Mercury Other Formaldehyde

(continued)

TABLE 3-2 (continued)

Sample location	Sample depth, in.	Analytical results
BG-2-SB1	48 Duplicate	VOCs Methylene Chloride Acetone SVOCs Pyrene Di-n-butylphthalate Bis(2-ethylhexyl)phthalate Metals Zinc, Vanadium, Copper, Cobalt Chromium, Beryllium, Barium, Arsenic Tin, Silver, Nickel, Mercury Lead, Iron Other Formaldehyde

10 times higher that the values reported in the method blanks associated with the analysis and the results are 3 times higher than the quantitation limits. All of the results obtained from the background locations are very near the quantitation limit and the locations are believed to be representative of background conditions at a furniture manufacturing facility.

Laboratory testing was performed on eight soil samples collected from the boreholes of five of the groundwater monitoring wells installed during the first phase of the landfill investigation performed in 1982. The laboratory testing consisted of performing grain-size analyses and developing estimated effective porosities of the samples. Two of the samples were collected from the upper alluvium unit with one of the samples classified as a slightly silty clay and the other sample classified as a slightly sandy, silty clay. The analyses showed the slightly silty clay to have 79.1 percent fines and the slightly sandy silty clay to have 97 percent fines.

Five of the six samples collected from the lower alluvium unit were classified as sands with varying amounts of clay and silts. The sixth sample was collected from clay lenses within the lower unit. The sand samples had percentages of fines ranging from

6 to 22 percent with a geometric mean of 9.2 percent. The clay sample from the lower unit contained 88 percent fines. Table 3-3 provides a summary of the physical laboratory tests of the soil samples.

TABLE 3-3. SUMMARY OF PHYSICAL LABORATORY TESTS OF SOIL SAMPLES COLLECTED DURING LANDFILL INVESTIGATION[a]

Well No.	Depth of sample, ft	Sample description	% silt and clay, 0.074 mm
W-1B	28.5 - 30	Slightly sandy Clay	79.1
E-1	18.5 - 20	Silty Sand	22.0
NE-1	13.5 - 15	Slightly sandy, silty Clay	97.0
NE-1	23.5 - 25	Fine to coarse Sand	6.0
N-2	23.5 - 25	Silty, sandy Clay	88.0
N-2	28.5 -30	Fine to coarse Sand	7.0
W-2	23.5 - 25	Clayey Sand	12.0
W-2	33.5 - 35	Clayey Sand	6.0

[a] Landfill investigation performed by J. E. Sirrine Co. and Soil and Material Engineers, Inc.

Physical Characteristic Testing--

During the RFI, soil samples were collected from the boreholes of eight wells for grain size, bulk density, and moisture analyses. The samples submitted for the analyses were collected from above the water table.

The wells from which the samples were collected from include:

BG-1WT	CAMA1-7WT
BG-2WT	CAMA1-8WT
CAMA1-4WT	SWMU3-9WT
CAMA1-5WT	SWMU9-13WT.

The samples from wells BG-1WT and SWMU3-9WT are representative of the Saprolite of the site. The remaining samples are representative of the alluvial materials of the site. A summary of results of the grain size, bulk density, and moisture analyses are given in Table 3-4. The full analytical results are provided in Appendix 3.2.

Samples were collected from 13 of the borings of the monitoring wells installed during the RFI for cation exchange capacity (CEC) analyses. The CEC analyses were performed to determine the total amount of metal cations that could be held by the soils of the site. A summary of the results of the CEC analyses are given in Table 3-5.

3.2.4 Regional Geology and Hydrogeology

The subject facility is located in the western portion of the Inner Piedmont Belt of the Piedmont geologic province. Bedrock within the Inner Piedmont typically consists of Paleozoic age crystalline rocks that occur in northeast-trending belts. The Singer property lies along the border of two major rock types as mapped by Sumsion (1967). These are the quartz-biotite and the granitic gneiss bedrock units. According to the 1985 Geologic Map of North Carolina, bedrock in the Lenoir area generally consists of a magmatic granitic gneiss, with no mappable structural features depicted in the vicinity of the subject site. Goldsmith and others (1978) describe the granitic gneiss bedrock unit as a medium to coarse-grained, thickly layered gneissic biotite granite to quartz diorite with biotite gneiss and schist, hornblende gneiss, amphibolite and metagabbro. Bedrock in the Inner Piedmont Belt is typically overlain by a Saprolite unit, developed through in-place chemical and physical weathering of underlying bedrock. The thickness of Saprolitic units can vary significantly.

The general topography of the Lenoir area is gentle to moderate relief, with relief increasing from southeast to northwest. The topography consists of hills separated by broad valleys. The Singer property lies within the Catawba River drainage basin. The streams of the drainage basin have developed as a result of the geologic features of the area. Joints and shears of the geologic system occur along most streams (Sumsion, 1967).

TABLE 3-4. GRAIN SIZE, BULK DENSITY, AND MOISTURE ANALYSES

Well Number	Sample Depth (feet BLS)	Soil Type	Percent Silt & Clay	Natural Mositure Content (%)	Optimum Mositure Content (%)	Maximum Dry Density (lb/cf)
BG-1WT	0-2	Micaceous Silty Fine To Medium Sand With Gravel	22%	14%	9%	127.0
BG-2WT	0-2	Micaceous Silty Fine To Medium Sand With Gravel	17%	8.2%	7.8%	131.8
CAMA1-4WT	0-2	Slightly Sandy Silt	53%	17.8%	16.2%	109.1
CAMA1-5WT	0-2	Slightly Clayey Slightly Sandy Silt	76%	41.4%	22.4%	101.2
CAMA1-7WT	0-2	Micaceous Slightly Clayey Silt	74%	26.2%	22.8%	102.0
CAMA1-8WT	0-2	Sandy Silt	65%	25.9%	16.0%	111.2
SWMU3-9WT	0-2	Micaceous Sandy Silt	42%	17.7%	12.2%	117.8
SWMU9-13WT	0-2	Micaceous Silty Fine To Medium Sand With Gravel	18%	10.0%	8.0%	132.3

TABLE 3-5. CATION EXCHANGE CAPACITY FOR SELECTED SOIL SAMPLES

Well No.	Sample Depth, ft	CEC
BG-2SP	4-4.5	3.02
BG-2SP	0.5-1	1.46
BG-2WT	4-4.5	4.54
BG-2WT	0.5-1	2.98
CAMA1-7WT	2-4	7.42
SWMU9-13WT	2-4	1.21
CAMA1-4SP	2-4	2.46
CAMA1-4WT	2-4	2.66
SWMU3-9WT	4	1.87
SWMU3-10WT	4	1.89
CAMA1-5WT	2-4	7.87
BG-1SP	0.5-1	3.80
BG-1SP	4-4.5	4.94
BG-1WT	0.5-1	4.16
BG-1WT	4-4.5	4.70
CAMA1-6SP	2-2.5	12.9
CAMA1-6WT	2.27	12.8

Consultation with Mr. Douglas Harned of the North Carolina office of the U.S. Geological Survey (February 1997) revealed that no hydrogeologic studies of the Lenoir area have been performed to date. A study of the groundwater resources of the Morganton, North Carolina area included Caldwell County (Sumison, 1967), but the information supplied is broad in scope. General hydrogeological studies have been performed for the Piedmont province. These studies are summarized herein and have been used to describe the general hydrogeological system of the Singer property.

Heath (1984) described the groundwater system for the Piedmont province as consisting of four components. These components are:

1. The unsaturated zone in the regolith
2. The saturated zone in the regolith
3. The transition zone between the regolith and bedrock
4. The fractured crystalline bedrock.

The regolith is composed of the soil and Saprolite. The soil zone is generally three to eight feet deep. The total porosity of the soil is commonly around 55 percent and the specific yield is approximately 40 percent (Heath, 1983). The average grain size usually decreases abruptly at the interface of the soil and Saprolite.

A study of Piedmont soils (Lutz, 1969) has shown the topsoil portion of the soils (7 to 10 inches below ground surface) to have a mean hydraulic conductivity of 5.7 inches per hour (0.0040 cm/s) and the subsoil (7 to 20 inches below ground surface) to have a mean hydraulic conductivity of 1.8 inches per hour (0.0013 cm/s). Heath (1984) reported hydraulic conductivities of 0.5 to 10 inches per hour (0.00035 to 0.0071 cm/s) for Saprolite.

The unsaturated zone of the regolith extends from the ground surface to the water table. The water table is the top of the saturated zone. The thickness of the unsaturated zone usually ranges from 5 to 50 feet. An examination of 2326 wells in the Piedmont province revealed a mean depth to the water table of 31.3 feet (Daniel, 1987).

The interval below the top of the water table and above the transition zone is the regolith saturated zone. The examination of the records for 1,749 water supply wells in the Piedmont province showed the medium saturated thickness to be a function of topography (Daniel, 1987). The median saturated thickness beneath valleys and draws was 28 feet; below slopes and flat areas was 15 feet; and beneath hills and ridges, was 9 feet.

Most of the water storage within the Piedmont groundwater system is provided by the saturated regolith zone. The porosity of the bedrock ranges from 0.01 to 2 percent (Heath, 1984), as compared to a range of porosity for the regolith of 35 to 55 percent. The regolith supplies water to the interconnected fractures within the bedrock. The fractures of the bedrock are planar features oriented along zones of lithologic and structural weakness. The hydraulic conductivity of fractured bedrock generally ranges from 0.001 to 3 feet per day (Heath, 1984).

Granite bedrock composed mostly of sodium and potassium feldspars normally have groundwater with high concentrations of sodium bicarbonate. Gabbro bedrock, composed largely of calcium feldspars and ferromagnetic minerals, can provide groundwater with high concentrations of calcium and magnesium bicarbonate. Groundwater from mica schists contains high concentrations of iron. The granitic gneiss bedrock unit of the Lenoir area would be expected to have a mixing of waters from adjacent rock types of different compositions.

3.2.5 Facility Hydrogeology

Based on information gathered during the RFI, the previous landfill investigation, and the two geotechnical investigations, the following geologic units have been identified for the Singer property:

Alluvial Aquifer (Unit I) - Consisting of as much as 39 feet of interbedded and/or alternating beds of fine to coarse sand, silt, and clay; and various admixtures of these lithologies.

Saprolite and Colluvium Aquifer (Unit II) - Consisting of decomposed bedrock (Saprolite) and Saprolite talus (colluvium).

Bedrock Aquifer (Unit III) - Crystalline (Metamorphic) rocks consisting primarily of gneiss.

The location of soil borings and groundwater monitoring wells installed during the RFI and landfill and geotechnical investigations at the site are indicated on Figure 2-15. The

stratigraphic relationships and lithology of these units beneath the plant site are illustrated in Appendix 3.3.

The following sections discuss the geologic and hydrogeologic properties of Units I, II, and III.

Hydrogeology of the Alluvial Aquifer--

Lithology and Thickness--The youngest geologic formation in the landfill area is the alluvium (Oal) presumably of Quaternary (Recent) age, which was deposited by Lower Creek. The alluvium is interpreted to underlie the entire landfill and the flood plain of Lower Creek.

The alluvium consists primarily of poorly sorted sediments, ranging from coarse sand and gravel to clay. The alluvium thickens from zero beneath the south part of the plant to as much as approximately 39 feet beneath the floodplain of Lower Creek at wells N-2 and NE-1. Most of the alluvium consists of water-bearing sands, and is herein referred to as the Alluvial Aquifer.

On the basis of lithology and texture, the alluvium can be divided into an upper unit (Unit IA) and a lower unit (Unit IB). The upper unit (Unit IA) consists primarily of alternating and interbedded thin layers of very fine to fine clayey sand; silty sand; sandy clay; sandy, silty clay; and clayey silt. Although thin beds of moderately sorted sand occur in this unit, the sediments of the upper unit are classified as poorly sorted.

The lower unit (IB) contains coarser-grained and better sorted sediments than those in the upper unit. Unit IB consists predominantly of medium to coarse sand with various admixtures of very-fine to fine sand. Thin gravel lenses occur near the base of the lower alluvium. Thin (2 to 4 feet thick) clays that are not continuous between monitoring well and soil boring locations occur in the lower unit.

The lower unit of the Alluvial Aquifer is generally more permeable than the upper unit. The rate of groundwater movement through the lower unit, therefore, would be higher than the upper unit.

The clay and silty clays of the upper unit of the Alluvial Aquifer serve to retard and attenuate the lateral and vertical movement of contaminants.

Hydrogeology of the Saprolite Aquifer–

The alluvial soils of the floodplain and landfill area are underlain by weathered decomposed bedrock (Saprolite). The Saprolite extends to the southern portion of the Singer property.

Between the area of the site where the alluvium soils tail out near the north site of Plant 33 and the steep upslope portions of the site south of Plant 54, the Saprolite is overlain by Colluvium. The Colluvium originates from the movement of highly decomposed bedrock and Saprolite from the steep slope south of Plant 54. The thickness of the Colluvium material varies from approximately 2 feet at Plant 54 to 15 foot at the southwest end of Plant 33. The soils of the Colluvium and Saprolite are lithologically similar, but the density of the Saprolite is higher.

The texture of the Saprolite is primarily silt and silty clays with quartz, weathered feldspars, hornblende, and mica. Some of the Saprolite within the floodplain has a texture of silty sands. The Saprolite soils are porous, but have low permeabilities and effective porosities. The rate of lateral movement of groundwater through the Saprolite is slow. The Saprolite would serve as a low permeability confining bed over the bedrock aquifer.

The thickness of the Saprolite varies from 17 to 109 feet in the area of the landfill and floodplain. These thicknesses are based on the results of the seismic survey performed in this area. Based on the soil borings performed in the upslope area south of Plant 54, the thickness of the Saprolite in this area varies from 30 to 45 feet.

In some areas of the site and surrounding area, the Saprolite is sufficiently permeable to supply small quantities of groundwater for wells. Seven large-diameter wells located east of Virginia Street probably tap the Saprolite. The composition of Saprolite, based on boring samples from the landfill area and exposures in the borrow pit located south and uphill of Plant No. 33 indicates that the bedrock is probably biotite-hornblende gneiss.

Hydrogeology of the Bedrock Aquifer--

Crystalline bedrock underlies the landfill area and the floodplain of Lower Creek. Similar bedrock is expected to underlie the remaining portions of the facility. The Bedrock Aquifer and Alluvial Aquifer are separated by the Saprolite. According to the U.S. Geological Survey (Harned, 1997), the hydrogeology of bedrock aquifers in the Lenoir area is poorly known. In general, the occurrence, movement, and availability of groundwater in the Bedrock Aquifer is probably typical of other crystalline-rock areas where the hydrogeology is known.

Groundwater in the Bedrock Aquifer occurs within and along water-bearing fractures caused by in situ weathering along joints and other planes of weakness. Fractures in the Bedrock Aquifer area are probably recharged by infiltration of rainfall into and through the Saprolite and weathered bedrock in the topographically high areas immediately south and southeast of the plant site. Presumably, groundwater movement through the Bedrock Aquifer is northward and northwestward toward the Lower Creek valley. Because the Bedrock Aquifer recharge areas are at comparatively high elevations (1100 to 1200 ft msl), groundwater in the Bedrock Aquifer beneath the landfill area probably exists under artesia pressure.

Apparently, the only utilization of the Bedrock Aquifer in the immediate area of the site is from one well (WW-1) at Southeastern Adhesives Co., located approximately 1100 feet northeast of the landfill. This 6-inch diameter well, reportedly 300 feet deep, is reportedly pumped at approximately 3000 to 4000 gal/day (2 to 4 gal/m).

3.3 GROUNDWATER

3.3.1 Groundwater Recharge and Lateral Movement

Groundwater elevation measurements were performed on nineteen occasions during the RFI activities. These measurements were collected during all times of the year and under all types of climatic conditions. These measurements were used to construct water table (potentiometric) maps (Appendix 2.6).

In general, the potentiontric maps indicate the following:

- The general groundwater flow direction through the Singer property is from the southeast to the northwest towards Lower Creek.
- Lower Creek is the discharge area for the Alluvial and Saprolitic Aquifer.
- The Alluvial Aquifer is recharged in the area southeast of the facility.
- The hydraulic gradient through the Alluvial Acquifer site averaged 0.018 ft/ft.
- The Saprolite Aquifer is recharged in the area south Plant 54.
- The hydraulic gradient through the Saprolite Acquifer of the site averaged 0.020 ft/ft.

Rising head permeability tests (slug tests) were performed during the RFI on four wells screened within the Alluvial Aquifer and three wells screened within the Saprolite Aquifer. The radial hydraulic conductivities obtained from the tests are shown in Table 3-6.

TABLE 3-6. HYDRAULIC CONDUCTIVITIES DETERMINED FROM SLUG TESTS PERFORMED ON RFI WELLS

Well number	Aquifer monitored	Hydraulic conductivity, ft/h
CAMA1-3WT	Alluvial	0.0085
CAMA1-3SP	Saprolite	0.0088
CAMA1-4WT	Alluvial	0.63
CAMA1-8WT	Alluvial	0.44
CAMA1-8SP	Saprolite	0.0082
BG-1WT	Saprolite	0.17
BG-2WT	Alluvial	0.0019

0.27
0.06

The hydraulic conductivities obtained from the slug tests performed on the wells nearest the creek (CAMA1-4WT and CAMA1-8WT) had the highest values (0.63 ft/h and 0.43 ft/h, respectively). The soils surrounding these wells are predominately sands. The lowest hydraulic conductivity of the alluvial wells was obtained from BG-2WT. BG-2WT is located in the Lumber Yard and the soils associated with the well are silty clayey sands and sandy silty clays. The other alluvial well that has a low hydraulic conductivity is CAMA1-3WT which is located at near the northeast toe of the landfill. The soils surrounding this well are predominantly silty clays and silts.

The hydraulic conductivities of the Saprolite Aquifer varied from 0.0019 ft/h at the southern portion of the Singer property (BG2-1WT) to 0.0082 near Lower Creek (CAMA1-8SP). The hydraulic conductivity of the Alluvial Aquifer at CAMA1-8SP (0.44 ft/h) was approximately 50 times higher than the Saprolite Aquifer hydraulic conductivity at the same area. The Saprolite and Alluvial Aquifers in the northeast toe of the landfill have approximately the same hydraulic conductivity (0.0085 for CAMA-1-3WT and 0.0088 ft/h for CAMA1-3SP).

The porosity (n) of sediments within the Alluvial Aquifer are estimated to be within the range of 20 percent for sands to approximately 30 percent for clays. The effective porosity (n_e), however, governs the movement of groundwater through the sediments. The effective porosity of the sands is estimated to range from 20 to 30 percent and the effective porosity of the clays is estimated to range from 5 to 10 percent.

The rate of groundwater movement through the soil is assumed to be laminar and governed by Darcy's equation for laminar flow:

$$v = \frac{K}{n_e} \cdot \frac{dh}{dL}$$

where v = Average linear groundwater velocity (ft/day)

K = Radial hydraulic conductivity (ft/day)

n_e = Effective porosity (decimal fraction)

dh/dL = hydraulic gradient (ft/ft).

Using the hydraulic conductivities obtained in the permeability test of the wells screened, the estimated effective porosities and the average hydraulic gradient of 0.018 ft/ft, groundwater movement through the alluvial aquifer would occur at the rates of 0.018 ft/day to 0.90 ft/day. Table 3-7 shows the range of groundwater velocities that could occur in the Alluvial and Saprolite Aquifers. The estimated effective porosities are estimated to be in the 15 to 25 percent range. Using the hydraulic conductivities obtained in the permeability tests of the wells screened in the Saprolite aquifer, the estimated porosities and the average hydraulic gradient of 0.02 ft/ft, groundwater movement would occur at the rates of 0.027 ft/day to 0.40 ft/day.

The shortest distance between the toe of the landfill and Lower Creek is approximately 350 feet. If groundwater moved through the floodplain at a rate equal to the calculated minimum groundwater velocity (0.018 ft/day) for the Alluvial Aquifer, a release from the landfill would require 53 years to reach Lower Creek, neglecting attenuation, absorption, etc. The minimum time for a release to reach Lower Creek would occur if the groundwater moved at the rate of the highest calculated velocity of 0.9 ft/day. The time for the release to travel the 350 feet would than be slightly longer than 1 year.

3.3.2 Vertical Groundwater Movement

The vertical movement of groundwater in the Alluvial Aquifer is governed by the same hydraulic principles that govern lateral groundwater movement. In horizontally bedded alluvial sediments, however, the vertical permeability (K) is often orders of magnitude lower than radial permeability. There are no laterally continuous, low-permeability confining beds separating the upper unit (1A) and lower unit (1B). Therefore, groundwater moves slowly downward from the upper unit into the lower unit.

The Alluvial Aquifer is separated from the Bedrock Aquifer by a thickness of low-permeability silts and clays (Saprolite) that ranges from 17 to 109 feet. This thickness is

TABLE 3-7. RATE OF GROUNDWATER MOVEMENT WITHIN ALLUVIAL AND SAPROLITE AQUIFERS

Number well	Radial hydraulic conductivity, ft/day	Soil type(s)	Estimated effective porosity, %	Ground-water velocity, ft/day[a]	Aquifer monitored
CAMA1-3WT	0.20	Silty clay with lens of silty sands	10	0.036	Alluvial
CAMA1-3SP	0.21	Saprolite grading to sandy clayey silt	10	0.042	Saprolite
CAMA1-4WT	15.05	Coarse grain sands with lens of silty clay	30	0.90	Alluvial
CAMA1-8WT	10.23	Fine to coarse grain sands with lens of silty clay	25	0.74	Alluvial
CAMA1-8SP	0.20	Saprolite grading to sandy clayey sands with feldspar, hornblende and mica	15	0.027	Saprolite
BG-1WT	4.00	Saprolite grinding to silty clayey sand with quarts and feldspar fragments	20	0.40	Saprolite
BG-2WT	0.05	Silty clays and clayey silts with lens of sands	5	0.018	Alluvial

[a]Based on average hydraulic gradient of 0.018 ft/ft for the Alluival Acquifer and 0.02 ft/ft for the Saprolite Acquifer.

based on the seismic report referenced in Section 2. This low permeability Saprolite is thought to function as a confining bed which retards the downward vertical movement of groundwater from the Alluvial Aquifer into the Bedrock Aquifer.

3.3.3 Groundwater Utilization

The area in the vicinity of the Singer plant is served by public water and sewer by the City of Lenoir. A public water distribution line is located along Virginia Street east of the plant. Reportedly some residents east of Virginia Street use both the public water and some use wells for drinking water and other domestic (household) uses. A well survey

(1994) was made in the area immediately adjacent to the facility. The survey identified nine wells in close proximity to the facility. All nine wells are hydraulically up of the SWMUs. There are no water withdrawal wells located on Singer property or in the downgradient area between the SWMUs and Lower Creek.

Information obtained from the survey indicates that eight of the water wells are located east of Virginia Street. A bedrock well (WW-1) located at the Southeastern Adhesive Company facility (WW-1) is used to supply water for manufacturing purposes. Two shallow dug wells (WW-6 and WW-7) are used for lawn irrigation, and other nonpotable domestic purposes only. Five wells (WW-2, WW-3, WW-4, WW-5, and WW-8) are currently unused, and the residents obtain water from the City of Lenoir public water system. The ninth well (WW-9) is located southwest of the Singer property. Well WW-9 has been used for livestock watering.

Because well construction records were incomplete or nonexistent, the depths of two dug wells (WW-2 and WW-3) were measured in 1983 and reported as 22 and 42 ft deep, respectively). The depths of three other large-diameter dug wells were reported to range between 17 to 22 feet. These wells are located at elevations above 1095 feet MSL and are above the flood plain. Therefore, they probably tap Saprolite soils rather than the Alluvial Aquifer.

3.3.4 Groundwater Quality

Two sets of paired background wells were installed during the RFI. The background wells installed during the RFI are identified as BG-1WT, BG-1SP, BG-2WT, and BG-2SP. One of the wells installed during the previous landfill investigation (S-1) also serves as a background well. The locations of these wells are shown on Figure 2-1.

Both BG-1WT and BG-1SP are screened within the Saprolite Aquifer. The Alluvial Aquifer is not present at the location of these wells. BG-1WT is screened across the top of the groundwater within the Saprolite Aquifer and BG-1SP is screened at the interface of the Saprolite and underlying weathered bedrock. BG-2WT is screened across the top

of the groundwater within the Alluvial Aquifer. BG-2SP is screened at the top of the Saprolite that underlies the Alluvial Aquifer.

Groundwater samples were collected from the background wells for comparison with groundwater samples collected from the wells installed at the SWMUs to determine if releases had occurred from the SWMUs. The comparison of the background samples with the SWMU well samples was performed using methodologies outlined in Section 4. The results of the comparisons for each SWMU are discussed in Section 4.

The samples collected from the background and SWMU wells were analyzed for Appendix IX compounds, excluding dioxins, plus formaldehyde, TOX, sulfide. hardness, and total cyanide. At least five quarters of sampling were performed for each of the background wells. Table 2-2 provides a detailed summary of the number of samples collected from all the monitoring wells installed during the RFI.

The analytical results for seven sets of samples collected from background well BG-1WT revealed detected concentrations of 2 VOCs, 1 SVOC, 15 metals, 1 pesticides, and TOX. The compounds detected were not present during each sampling event. The compounds detected in the samples for all background wells are presented in Table 3-8.

The analytical results for seven sets of samples collected from background well BG-1SP revealed detected concentrations of 2 VOCs, 4 SVOCs, 15 metals, 1 pesticide, and TOX. The compounds detected were not present in each set of samples.

The analytical results for seven set of samples collected from background well BG-2WT revealed detected concentrations of 3 VOCs, 3 SVOCs, metals, and TOX. The compounds detected were not present during each sampling event.

The analytical results for nine sets of samples collected from background well BG-2SP revealed detected concentrations of 4 VOCs, 3 SVOCs, and 12 metals. The compounds detected were not present in each set of samples.

The analytical results for five sets of samples collected from background well S-1 revealed detected concentrations of 2 VOCs, 3 SVOCs, 14 metals, and TOX. The compounds detected were not present in each set of samples.

Appendix 3.4 contains the groundwater sampling results.

TABLE 3-8. SUMMARY OF DETECTED COMPOUNDS IN BACKGROUND GROUNDWATER SAMPLES

Sample location	Analytical results				
BG-1WT	VOCs		SVOCs		
	Acetone Methylene Chloride		Butylbenzylphthalate		
	Metals				
	Selenium Chromium Antimony Mercury	Zinc Cadmium Tin	Vanadium Beryllium Nickel	Copper Barium Lead	Cobalt Arsenic Iron
	Other				
	TOX				
BG-1SP	VOCs		SVOCs		
	Methylene Chloride Acetone		Butylbenzylphthalate Di-n-butylphthalate Diethylphthalate Bis(2-ethylhexyl)phthalate		
	Metals				
	Selenium Chromium Nickel	Zinc Cadmium Mercury	Vanadium Beryllium Lead	Copper Barium Iron	Cobalt Antimony
	Other				
	TOX				

(continued)

TABLE 3-6 (continued)

Sample location	Analytical results				
BG-2WT	VOCs		SVOCs		
	Methylene Chloride		Butylbenzylphthalate		
	Acetone		Di-n-butylphthalate		
	Carbon Disulfide		Diethylphthalate		
	Pesticide				
	Heptachlor Epoxide				
	Metals				
	Selenium	Zinc	Vanadium	Copper	Cobalt
	Chromium	Cadmium	Beryllium	Barium	Antimony
	Nickel	Mercury	Lead	Iron	
	Other				
	Formaldehyde				
BG-2SP	VOCs		SVOCs		
	Methylene Chloride		Butylbenzylphthalate		
	Acetone		Di-n-butylphthalate		
	Benzene		Phenol		
	Carbon Disulfide				
	Metals				
	Zinc	Vanadium	Copper	Cobalt	Chromium
	Cadmium	Barium	Antimony	Nickel	Mercury
	Lead	Iron			

(continued)

TABLE 3-8 (continued)

Sample location	Analytical results				
S-1	VOCs		SVOCs		
	Methylene Chloride Acetone		Di-n-butylphthalate Diethylphthalate Bis(-2-ethythexyl)phthalate		
	Metals				
	Zinc Nickel Lead	Cadmium Copper Chromium	Silver Atimony Tin	Vanadium Mercury Iron	Barium Cobalt
	Other				
	TOX				

3.4 SURFACE WATER AND SEDIMENT

The Singer plant is located in the valley of Lower Creek which flows to the southwest and empties into the upper reaches of the Catawba River. Land-surface elevations at the site range from approximately 1186 feet MSL along the ridge located south of the facility to approximately 1066 feet MSL in the Lower Creek floodplain in the northern portion of the property (Figure 1-2). The southern portion of the facility is relatively rugged, exhibiting significant topographic relief. A borrow pit has been cut into the hill side behind Plant Nos. 33 and 54. The central portion of the property is relatively level, sloping gently toward the north, and covered by numerous buildings and parking areas. The former landfill forms a small plateau just south of Plant No. 33. The surface of the landfill slopes gently northward, and the northern edge of the landfill drops in elevation from approximately 1085 MSL to 1065 ft MSI at the Lower Creek floodplain. The northern portion of the facility is relatively level and is part of the Lower Creek flood plain. The most southern (upper) portion of the site is steeply sloped towards the two unnamed Lower Creek tributaries and is adequately drained. The flood plain area, from the landfill

northward to Lower Creek, is a poorly drained wooded area and is periodically flooded. In general, surface water flow is controlled by topographic contours of landforms and man-made features. Flow typically occurs perpendicular to the landform contours, from areas of higher to lower elevations.

A storm sewer inlet is located west of the glue wash evaporation pond (SWMU No. 3). Water collected in the inlet flows through a reinforced concrete pipe that runs beneath the glue pond and is discharged to an unnamed tributary of Lower Creek. The tributary originates offsite south of the Singer property and has perennial flow. The tributary has been routed through a storm sewer and channelized through the Singer property. The tributary runs through the storm sewer from the southern edge of the Singer property and emerges from the storm sewer at the southeast corner of the landfill and flows north-south along the eastern edge of the landfill and through the floodplain before junctioning with Lower Creek.

A ditch that originates at the eastern edge of the Singer property and north of the lumber yard collects storm water runoff from Virginia Street and the Singer property. The storm water ditch runs east-west and discharges into the unnamed tributary of Lower Creek, described above, near the northeast corner of the landfill.

Water from the Lumber Yard flows towards the Lower Creek tributary located adjacent to and west of the yard and towards the east-west ditch located adjacent to and north of the yard. Surface water from the landfill flows in multiple directions. Water from the eastern portion of the landfill flows toward the unnamed tributary of Lower Creek. Water from the central portion of the landfill sheet flows toward the flood plain of Lower Creek. Water from the western portion of the landfill flows toward a wetland marsh located on the northwestern portion of the property. Water from the non-Singer portion of the landfill flows to the wetland and to another unnamed tributary to Lower Creek that is located on city property and west of the landfill.

The daily stream flow of Lower Creek was monitored at Mulberry Street in Lenoir from October 1966 to September 1978. This monitoring station was located

approximately 1.5 miles upstream of the Singer property. The mean flow over the 12 years of monitoring was 42.5 cubic feet per second.

The water quality of Lower Creek was monitored at Highway 321 in Lenoir from July 1969 to February 1981, by the North Carolina Division of Environmental Management. Highway 321 is located approximately 1.7 miles upstream of the Singer property. During the period of monthly monitoring, manganese concentrations in the water varied from 1 00 to 330 micrograms per liter (μg/L) and iron levels ranged from 600 to 10,000 μg/L Detectable concentrations of lead (100 μg/L) were observed on two occasions and arsenic was detected twice (10 and 20 μg/L). A copy of the STORET data is provided in Appendix 3.5.

A taxonomy richness investigation of Lower Creek was performed at Harrisburg Street in September 1987 by a biologist from the NCDEHNR. Sixty-five species were observed and a fair bioclassification rating was provided for Lower Creek at this station. Harrisburg Street is located approximately 0.5 miles upstream of the Singer property. A copy of the taxonomy richness report is provided in Appendix 3.6.

Lower Creek has a North Carolina surface water quality classification of "C." Class C waters are suited for aquatic life propagation and survival, fishing, wildlife, secondary recreation, agriculture, and any other usage except primary recreation or as a source of water supply. The Class C designation is the minimum classification for surface waters. The water quality standards for Class C waters are provided in Table 3-9.

The City of Lenoir operates a wastewater treatment facility that discharges to Lower Creek approximately 1 mile downstream of the Singer property. Lower Creek receives storm water runoff from numerous manufacturing and industrial properties located adjacent to, upstream and downstream from the Singer property. The property located directly across the creek from the Singer property has pipes discharging storm water collected from public roads and parking lots directly to Lower Creek.

According to the 1987 Flood Insurance Study conducted for Caldwell County by the Federal Emergency Management Agency, the drainage area of Lower Creek at the Singer property is 28.4 square miles. The Flood Insurance Study evaluated the flood

TABLE 3-9. NORTH CAROLINA WATER QUALITY STANDARDS FOR CLASS C SURFACE WATERS[a]

Parameters	Aquatic life	Human health
Arsenic (µg/l)	50	
Benzene (µg/l)		71.4
Beryllium (ng/l)		117
Cadmium (µg/l)	2.0	
Carbon tetrachloride (µg/l)		4.42
Chloride (mg/l)	230 (AL)	
Chorline, total residual (µg/l)	17 (AL)	
Chlorophyll a, corrected (µg/l)	40	
Chromium, total (µg/l)	50	
Coliform, fecal (MFTCC/100 ml)		200
Copper (µg/l)	7 (AL)	
Cyanide (µg/l)	5.0	
Dioxin (ng/l)		0.000014
Dissolved gases	(A)	
Dissolved oxygen (mg/l)	5.0 (Sw)(1)	
Fluoride (mg/l)	1.8	
Hexachlorobutadiene (µg/l)		49.7
Iron (mg/l)	1.0 (AL)	
Lead (µg/l)	25	
MBAS (µg/l) (Methylene-Blue-Active Substances)	500	
Mercury (µg/l)	0.012	
Nickel (µg/l)	88	

(continued)

TABLE 3-9 (continued)

Parameters	Aquatic life	Human health
Pesticides		
Aldrin (ng/l)	2.0	0.136
Chlordane (ng/l)	4.0	0.588
DDT (ng/l)	1.0	0.591
Demeton (ng/l)	100	
Dieldrin (ng/l)	2.0	0.144
Endosulfan (ng/l)	50	
Endrin (ng/l)	2.0	
Guthion (ng/l)	10	
Heptachlor (ng/l)	4.0	0.214
Undane (ng/l)	10	
Methoxychlor (ng/l)	30	
Mirex (ng/l)	1.0	
Parathion (ng/l)	13	
Toxaphene(ng/l)	0.2	
pH (units)	6.0-9.0 (Sw)	
Phenolic compounds (μg/l)		(B)
Polychlorinated biphenyls (ng/l)	1.0	0.079
Polynuclear aromatic hydrocarbons (ng/l)		31.1
Radioactive substances (average annual activity)		
Combined radium-226 and radium-228 (pC/1)		5
Alpha emitters (pC/1)		15
Beta emitters		0.50
Gross (PC/1)		8
Strontium-95 (pC/1)		20,000
Tritium (pC/1)		
Selenium (μg/l)	5	
Silver (μg/l)	0.06 (AL)	
Solids, suspended	(N)	
Temperature		
Mountain and upper piedmont waters (°F)	≤ 84.2	
Lower piedmont and coastal plain waters (°F)	≤ 89.6	

(continued)

TABLE 3-9 (continued)

Parameters	Aquatic life	Human health
Tetrachloroethane (1,1,2,2)(μg/l)		10.8
Toluene (μg/l)	11	
Trialkyltin (μg/l)	0.008	
Trichloroethylene (μg/l)		92.4
Turbidity (NTU)	50; 25 (C)	
Vinyl chloride (μg/l)		525
Zinc (μg/l)	50 (AL)	

[a] 15A NC AC 2B-0.0200 classifications and water quality standards applicable to surface waters of North Carolina, February 1, 1993.

Note: (N) See 2B 0.0211 (b), (c), (d), or (e) for narrative description of limits.
(AL) Values represent action levels as specified in 0.0211 (b) (4).
(SW) Designated swamp waters may have a pH as low as 4.3 and dissolved oxygen less than 5.0 mg/l if due to natural conditions.
(1) An instantaneous reading may be as low as 4.0 μg/l but the daily average must be 5.0 μg/l or more.
(A) Not greater than 110 percent of saturation.
(B) Only such levels as will not result in fish-flesh tainting or impairment of other best usage.
(C) Streams and lakes, respectively.

events that have a recurrence interval of 10, 50, 100, and 500 years. These flood events have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded in any year. The peak discharges and surface elevations for these flood events at the Singer property are provided below.

Flood event, yr	Peak discharge, ft^3	Elevation, MSL
10	3,730	1070.1
50	7,400	1074.2
100	9,230	1075.9
500	15,060	1081.3

The 100-year flood event would have a mean velocity that is much less than 1.5 feet per second at the Singer property and the floodway width would be 480 feet. The actual mean velocity is calculated as follows:

$$V_{100}(ft/s) = Q_{100}/C_x = 0.02$$

Peak discharge (Q_{100}) = 9,230 ft^3/min = 154 ft^3/s

Critical width (W_{100}) = 480 ft at the narrowest point on the Singer property

Critical depth (D_{100}) = 15.9 ft = Flood elevation (1075.9 M.S.L.) - Nonflood elevation (1060 M.S.L.)

Cross-sectional area (C_x) = W_{100} * D_{100} = 7,632 ft^2.

It is generally agreed, that in open channel flow water velocities must be greater than 1.5 feet per second in order to prevent deposition of suspended solids and to allow soil erosion to occur. The floodway elevations and discharge rates for the other flood events are not provided in the Flood Insurance Study. Figure 3-1 is a copy of the Flood Insurance rate map depicting the 100 year flood in the vicinity of the Singer property.

The potential for transport of contaminated soil from the floodplain by flood waters from Lower Creek depends on many factors including the depth, velocity, and turbulence of the flood waters and the properties of the soil and its vegetative cover. The depth and velocity of the flood waters depend on the amount, intensity, frequency, and areal distribution of rainfall. The turbulence of the flood waters depends on the flow characteristics of the floodplain, which include shape, flow length, and vegetation. The western arm of the landfill extends almost to the bank of Lower Creek and is located downstream of SWMU No. 2. The landfill arm will restrict water flow within the floodplain of Lower Creek and soil and debris picked up by flood waters will tend to be deposited within the floodplain behind the flood way restriction. It should be noted that the arm of the landfill is owned by the City of Lenoir and not Singer Furniture.

The 100-year flood event would have a mean velocity of 1.5 feet per second at the Singer property and the floodway width would be 480 feet. The floodway widths and mean velocities for the other flood events are not provided in the Flood Insurance Study. Figure 3-1 is a copy of the Flood Insurance rate map depicting the 100 year flood in the vicinity of the Singer property.

The potential for transport of contaminated soil from the floodplain by flood waters from Lower Creek depends on many factors including the depth, velocity, and turbulence of the flood waters and the properties of the soil and its vegetative cover. The depth and velocity of the flood waters depend on the amount, intensity, frequency, and areal distribution of rainfall. The turbulence of the flood waters depends on the flow characteristics of the floodplain, which include shape, flow length, and vegetation. The western arm of the landfill extends almost to the bank of Lower Creek and is located downstream of SWMU No. 2. The landfill arm will restrict water flow within the floodplain of Lower Creek and soil and debris picked up by flood waters will tend to be deposited within the floodplain behind the flood way restriction. It should be noted that the arm of the landfill is owned by the City of Lenoir and not Singer Furniture.

The erosion of soil by water can be estimated by use of the Universal Soil Loss Equation (USLE). The rainfall factor, R, of the equation represents the influence of precipitation on erosion, and is derived from historical data on the frequency and intensity of storms in an area. The erodibility factor, K, represents the influence of soil properties on erosion. The cover factor, C, reflects how vegetative cover influences erosion. The length-slope factor, LS, represents the influence of slope steepness and length. The erosion control practice factor, P, reflects the use of methods to control runoff/erosion.

The USLE was used with factors selected to represent conditions within the floodplain of Lower Creek. Based on the USDA Soil Survey of Caldwell County, the flood plain consists of Wehadkee loam. The upper horizon of this soil has an erodibility factor of 0.24. The vegetative cover of the floodplain consists of woods with good quality coverage that would provide a cover factor of 0.001. The Lenoir area has a rainfall factor of 230 for the 10 year flood. The 10 year flood would inundate SWMU No. 2. A length-

The erosion of soil by water can be estimated by use of the Universal Soil Loss Equation (USLE). The rainfall factor, R, of the equation represents the influence of precipitation on erosion, and is derived from historical data on the frequency and intensity of storms in an area. The erodibility factor, K, represents the influence of soil properties on erosion. The cover factor, C, reflects how vegetative cover influences erosion. The length-slope factor, LS, represents the influence of slope steepness and length. The erosion control practice factor, P, reflects the use of methods to control runoff/erosion.

The USLE was used with factors selected to represent conditions within the floodplain of Lower Creek. Based on the USDA Soil Survey of Caldwell County, the flood plain consists of Wehadkee loam. The upper horizon of this soil has an erodibility factor of 0.24. The vegetative cover of the floodplain consists of woods with good quality coverage that would provide a cover factor of 0.001. The Lenoir area has a rainfall factor of 230 for the 10 year flood. The 10 year flood would inundate SWMU No. 2. A length-

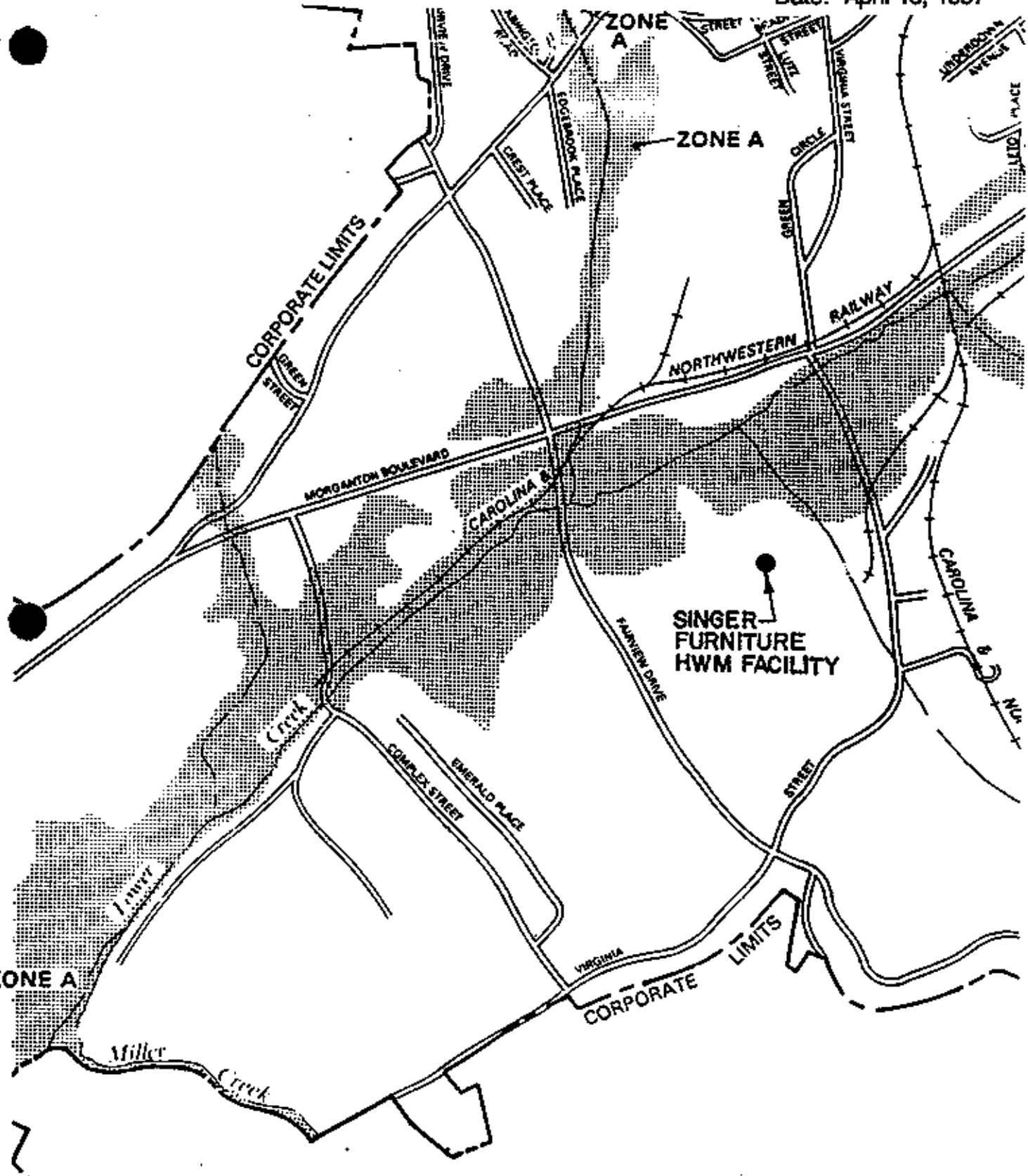

Figure 3-1. Flood insurance rate map.

slope factor of 0.15 was used in the USLE. This LS factor is representative of the slope of the floodplain from SWMU No. 2 to the western arm of the landfill. An erosion control practice factor of 1.0 was used because no control practices are in place. With these factors, an annual erosion rate of 0.01 tons per acre per year were estimated by the USLE. Based on this estimate, the potential for migration of contaminated soil from the floodplain is considered low.

Surface water and sediment samples were collected from Lower Creek at up and downstream locations during nonstorm conditions in December 1995. The upstream sample (SW-3) was collected at the Virginia Street Bridge and the downstream sample (SW-1) was collected just west of the northwest corner of the Singer property. The sediment and surface water samples were collected from the Singer side of the creek. The samples were collected to determine whether surface and/or groundwater flow from the landfill area were affecting the surface water quality of Lower Creek. The surface water and sediment samples were analyzed for Appendix IX compounds, excluding dioxins. The downstream analytical results were compared against the upstream analytical results to determine if the surface water quality had been affected.

The analysis of the background (upstream) surface water sample from Lower Creek revealed the presence of 1 VOC and 6 metals. The VOC detected in the background was methylene chloride at a concentration of 1 μg/L. The metals detected were zinc (36.4 μg/L), vanadium (1.60 μg/L), copper (1.90 μg/L), chromium (1.50 μg/L), barium (22.90 μg/L), and iron (843 μg/L).

The background sediment sample had detectable concentrations of VOCs, SVOCs, and 12 metals. The VOC detected in the sample was methylene chloride at a concentration of 6 μg/L. The SVOCs detected were acetophenone, phenanthrene, benzo[a]pyrene, chrysene, fluoranthene, benzo[b]fluoranthene, pyrene, and bis(2methylhexyl) phthalate. The acetophenone was detected at a concentration of 390 μg/L and the remaining VOCs were each detected at concentrations of 400 μg/L. The metals detected in the sample were zinc (21.1 mg/kg), vanadium (14.5 mg/kg), copper (4.2 mg/kg), cobalt (10.3 mg/kg), chromium (5.7 mg/kg), cadmium (0.11 mg/kg),

beryllium (0.24 mg/kg), barium (46.7 mg/kg), tin (2.3 mg/kg), nickel (2.7 mg/kg), lead (15.7 mg/kg), and iron (5800 mg/kg).

Surface water and sediment samples were collected from the marsh area located near the northwest corner of the landfill. The samples were analyzed for Appendix IX compounds, excluding dioxins. The analytical results for the marsh area samples were used in conjunction with the samples from Lower Creek to determine if releases from the landfill had affected surface water quality. Appendix 3.7 contains the results of the surface water sampling.

The comparison of the surface water samples was performed using the statistical analysis procedures discussed in Section 2. The results of the sediment and stream analyses indicate the presence of contaminants at concentrations that are below those which cause exceedances of commonly accepted risk levels discussed in Section 4.

3.5 AIR QUALITY

The ambient air quality has been studied by the NCDEHNR Air Quality Section to determine if emissions from the furniture manufacturing facilities (including Singer) collectively impact the air quality found in the Lower Creek Valley in Lenoir. The NCDEHNR concluded in its report that the concentrations of compounds emitted from the furniture manufacturing and finishing facilities measured in samplers designed to represent the highest concentrations citizens might be exposed to were far below the North Carolina Acceptable Ambient Levels for Air Toxic constituents. Appendix 3.8 includes the NCDEHNR report entitled Investigation of Toxic Air Pollutants Emitted by Wood Furniture Manufacturing Facilities in Caldwell County, North Carolina.

3.6 CLIMATIC CONDITIONS

Lenoir is located in the foothills of the western Piedmont of the North Carolina, a transitional area of rolling country and hills close to the mountains (approximately 40 miles

from Lenoir). The general elevation of the area around Lenoir is approximately 1120 feet above sea level. The Atlantic Ocean is approximately 185 miles southeast.

The mountains have a moderating effect on winter temperatures, causing appreciable warming of cold air from the northwest winds. Lenoir enjoys a moderate climate, characterized by relatively cool winters and quite warm summers. Winter weather is changeable, with occasional cold periods, but extreme cold for extended periods is rare. Snow is infrequent, and the first snowfall of the season usually comes in late November or December. Heavy snowfalls have occurred, but any appreciable accumulation of snow on the ground for more than a day or two is rare. The mean annual snowfall is approximately 8.7 inches.

Summers are long and quite warm, with afternoon temperatures frequently in the low 90's. On the average, the last occurrence in spring with a temperature of 32 degrees is mid-April. In the fall, the average first occurrence of 32 degrees is early November. The annual average maximum temperature is 70.6° F with an annual average minimum temperature of 45.8° F. The average annual temperature is 58.2° F.

Rainfall is evenly distributed throughout the year. The driest weather usually occurs in the fall. Summer rainfall comes principally from thunderstorms with occasional dry spells of one to two weeks duration. Average annual rainfall is approximately 49 inches. The rainfall duration intensity for the following conditions is noted:

24 hour - 25 year storm event is 0.3 inches per hour

1 hour - 100 year storm event is 3.1 inches per hour

5 minute - 2 year storm event is 5.0 inches per hour.

Appendix 3.9 includes the tabulated weather information for the period September 1995 to December 1996. As is evident from the weather data, groundwater samples have been collected during periods that were relatively wet (October 1995 and August of 1996) as well as during periods that were relatively dry May 1996. The climatic conditions

encountered during the site investigation are believed to be typical and representative of the area.

3.7 SOCIOECONOMIC CONDITIONS

This section presents information on the social and economic conditions of persons residing near the Singer facility. The information has been synthesized by compiling data that are in the public domain. As discussed in Section 1, the facility is surrounded mainly by industrial land use areas. Low density (< 1 person/acre) residential properties are found at various locations to the south, east, and west of the Singer property within 0.25 mile (1300 feet) of the property line. There are no residential properties closer than 0.25 mile on the north side of the facility. More dense residential population centers (1.28 persons/acre) are found to the southwest and north within a 0.8 mile radius of the Singer facility. The site is located within the city limits, and the City of Lenoir central business district is located approximately 1.7 miles to the northeast. Rural residential areas are located within one mile to the north west, west, southwest, and south. Because of the lack of published information on socioeconomic conditions in the irregularly-shaped area within 1000 feet of the Singer property line, the socioeconomic study area was chosen at a 0.8 mile radius from the center of the Singer property in order to take advantage of the published census data for the census tract block groups in Caldwell County.

The socioeconomic data representing conditions in the 0.8 mile radius surrounding the site are presented in Table 3-10. Socioeconomic data for the City of Lenoir are also presented for comparative purposes. The data were derived from the U.S. EPA/U.S. Department of Commerce LandView™II database and the 1990 Census of Population and Housing Database C90STF3A files. The 0.8 mile radius area includes the centroids of Census Tract 301 Block Group 6 and Census Tract 303 Block Group 2. Any changes in socioeconomic conditions since 1990 are not reflected in the data, however, no significant changes are expected. The economic data have not been adjusted for inflation.

TABLE 3-10. SOCIOECONOMIC DATA FOR 0.8 MILE RADIUS SURROUNDING THE SINGER MILLER COMPLEX

Data Parameter		0.8 Mile Radius	Percent of Total	City of Lenoir	Percent of Total
Number of Persons		1652		14192	
Number of Families		454		4082	
Number of Households		641		5936	
Sex	Male	734	44.4%	6618	46.6%
	Female	918	55.6%	7574	53.4%
Race	White	1499	90.7%	11805	83.2%
	Black	153	9.3%	2276	16.0%
	Indian	0	0.0%	65	0.5%
	Asian	0	0.0%	38	0.3%
	Other Race	0	0.0%	8	0.1%
	Hispanic	0	0.0%	38	0.3%
Age	0-6	127	7.7%	1321	9.3%
	7-17	276	16.7%	1975	13.9%
	18-39	588	35.6%	4519	31.8%
	40-64	371	22.5%	3891	27.4%
	65 & Over	290	17.6%	2486	17.5%
Ave. Persons Per Household		2.58		2.39	
Median Household Income		$20,476		$21,372	
Median Family Income		$26,375		$22,679	
Per Capita Income		$10,417		$9,075	
Housing Units	Total	820		6338	
	Occupied	744	90.7%	5929	93.5%
	Vacant	76	9.3%	409	6.5%
Housing Unit Type	Single Family	492	60.0%	4554	71.9%
	Multi-Family	237	28.9%	1413	22.3%
	Mobile Home	84	10.2%	350	5.5%
	Other	7	0.9%	21	0.3%
Occupancy Status	Owner	402	54.0%	3742	63.1%
	Renter	342	46.0%	2187	36.9%
Median Gross Value of Owner-Occupied Units		$34,200		$47,100	
Median Gross Rent for Renter-Occupied Units		$315		$317	

The data show that socioeconomic conditions in the area surrounding the site are generally similar to conditions in the entire City of Lenoir. The population in the City of Lenoir and the study area are characterized in the census data as residing outside of any urbanized area. The study area contains a residential population of 1,652 persons, which is equal to 11.6 percent of the population of the city. Conditions that varied by more than five percent between the area surrounding Singer and the City of Lenoir include:

- The percentage of white residents is higher by 7.5 percent
- The percentage of black residents is lower by 6.7 percent
- The median family income is higher by 14.0 percent
- The per capita income is higher by 12.9 percent
- The percentage of single family housing units is lower by 11.9 percent
- The percentage of multi-family housing units is higher by 6.6 percent
- The percentage of owner-occupants is lower by 9.1 percent
- The percentage of renter-occupants is higher by 9.1 percent
- The median gross value of owner-occupied housing units is lower by 37.7 percent.

REFERENCES

1. Sumison, C. T., and R. L. Laney. 1967. Geology and Ground Water Resources of the Morganton Area: North Carolina Department of Water Resources Ground Water Bulletin 12, 119 p.

2. Goldsmith, R., D. F. Milton, and F. A. Wilson. 1978. Preliminary Geologic Map, Geologic Map Index, and Annotated Bibliography, Charlotte 2° Sheet, North Carolina and South Carolina. Open-File Report No. 78-590. U.S. Geol. Survey, Reston, Virginia.

3. Telephone conversation Mr. Douglas Harned, North Carolina. Office of the U.S. Geological Survey, February 1997.

4. Heath, R. C. 1984. Ground Water Regions of the United States: U.S. Geological Survey Water-Supply Paper 2242, 78 p.

5. Heath, R. C. 1983. Basic Ground Water Hydrology: U.S. Geological Survey Water-Supply Paper 2220, 84 p.

6. Lutz, J. F. 1969. The Movement and Storage of Water in North Carolina Soils and the Role of Soil in Determining Water Quality: Water Resources Research Institute of the University of North Carolina, No. 24, 45 p.

7. Daniel, III, C. C. 1987. Statistical Analysis Relating Well Yield to Construction Practices and Siting of Wells in the Piedmont and Blue Ridge Provinces of North Carolina. U.S. Geological Survey Water-Resources Investigations Report 86-5132, 54 p.

8. Johnson, A. I. 1967. Specific Yield of Granular Sediments. U.S. Geol. Survey Water-Supply Paper 1662-D.

SECTION 4

NATURE AND EXTENT OF CONTAMINATION

This section provides a historical site profile, a summary of the volumes and types of waste handled, a chronology of the SWMUs, and a presentation of the spatial distribution of the contaminants.

4.1 METHODOLOGY AND OVERVIEW

The subject facility includes 61 acres located in Lenoir, Caldwell County, North Carolina on 904 Virginia Street, S.W. at latitude 350° 53' 45" north and longitude 81° 33' 00" west. Site maps were provided in Section 1. The subject site is located wholly within the city limits of Lenoir and is generally described as being in the southwestern gradient of the city.

Title searches and aerial photographs have been used to compile information concerning the site history and extent of operations. A total of 56 years of photographic history, covering the period 1940 to 1995 was available from the public records of the United States Department of Agriculture (USDA), U.S. Geological Survey (USGS), North Carolina Division of Land Resources, North Carolina Department of Transportation (NCDOT) and the NCDEHNR. Table 4-1 lists the available photographs.

Title records indicate the City of Lenoir obtained 11 acres of land from a Mr. James Dula et al. and 17 acres from a J. V. Lackey et al. for the purpose of building and operating a sewage treatment plant in 1939 and 1938, respectively. Additionally the 1939 deed granted a 20 foot road right-of-way leading from Miller Hill Road (currently Virginia Street) running across the ridge of the property to the sewage treatment plant. Operations of the sewage treatment plant, the adjacent landfill, and the borrow pit south of the bisecting roadway are clearly evidenced in the 1940 photograph. The southern extreme of the current property has had the trees harvested. The eastern and northern

TABLE 4-1. COMPENDIUM OF AVAILABLE HISTORICAL AERIAL PHOTOGRAPHS USED TO ASSIST IN LOCATING AND DESCRIBING SITE ACTIVITIES

Date	Scale	Source[a]
1940	1 inch equals 1200 feet	SCS
1954	1 inch equals 1667 feet	NCDLR
1960	1 inch equals 500 feet	NCDOT
1962	1 inch equals 1200 feet	SCS
1962	1 inch equals 500 feet	NCDOT
1967	1 inch equals 1200 feet	SCS
1971	1 inch equals 500 feet	NCDOT
1975	1 inch equals 500 feet	NCDOT
1976	1 inch equals 500 feet	NCDOT
1984	1 inch equals 2000 feet	USGS
1987	1 inch equals 500 feet	NCDOT
1994	1 inch equals 100 feet	Singer
1995	1 inch equals 1000 feet	NCDEHNR

[a]SCS - USDA Soil Conservation Service
NCDLR - North Carolina Division of Land Resources
USGS - United States Geological Survey
NCDOT - North Carolina Department of Transportation
Singer - Singer Furniture Company
NCDEHNR - North Carolina Department of Environment, health, and Natural Resources

portion of the current property is tilled for agricultural purposes. The unnamed tributary to Lower Creek has been channelized to provide drainage to the agricultural acreage.

In 1953 Kent Coffey Manufacturing Company purchased 82.48 acres from the Dula family (60.969 acres of current property and 21.51 acres located east of Virginia Street and no longer owned by Singer). The 1954 aerial photograph shows the city landfill area has been expanded to approximately 3 acres and the north and south portion of the current property have been allowed to revegetate with trees. The Lower Creek tributary

runs along the eastern boundary of the landfill. A building that appears to be residential in nature is apparent where Plant No. 33 is currently located. A one acre clearing of trees is apparent in the extreme northeast portion of the property but picture quality does not allow for any interpretation of the clearing.

A 1956 USGS topographic map shows a railroad spur had been laid to service the lumber yard, the existing stacker building, and lumber storage shed. The lumber storage was to support the furniture manufacturing operations located east of Virginia Street. By 1960 the lumber storage yard was at its maximum extent of operation and fill material from the onsite borrow pit had been used to elevate the yard above the natural floodplain. The unnamed tributary circumventing the landfill has been replaced with the existing north-south ditch and the east-west storm water collection ditch is visible for the first time. A recently constructed sewer line is visible in the northern portion of the property.

The 1960 photograph also shows the maximum extent of the city landfill to be approximately 6 acres. The city operated landfill extends from the bisecting road to just south of Lower Creek and from the sewage plant on the west to 200 feet into the current Singer property. The eastern edge of the landfill extends to where the RCRA permitted incinerator and container storage area were constructed in 1980. The landfill appears to have been leveled and covered with borrow material from the pit located on the current Singer property. The residential structure is still visible.

The 1962 photograph indicates that the landfill has risen in height, but the remainder of the property is largely unchanged from the 1960 photograph. Singer Plant 33 was constructed in 1962 but is not visible in the March photograph.

The 1967 photograph shows that Plant Nos. 33 and 54 have been constructed on land that was excavated out of the hillside and south of the road that had bisected the property. The bisecting road is no longer visible and the city portion of the landfill is no longer active. Borrow material and presumable landfill materials from the Plant Nos. 33 and 54 operations are being placed in the area southeast of the future container storage area and west of the north-south drainage ditch (Lower Creek tributary).

The 1971 aerial photograph shows the landfill activities to be occurring in approximately the same areas as shown in the 1967 photograph. the activities have been extended slightly to the north along the north-south ditch and the depth of the fill appears to have increased.

By 1975, the area of activity in the landfill has decreased. The majority of the activity is occurring along the eastern edge of the landfill. The landfill has been expanded northward adjacent to the north-south ditch. The inactive portion of the landfill is vegetated with what appears to be natural vegetation (bushes, trees, etc.). The degree of disturbance of the borrow area also appears to have decreased.

Virtually no change has occurred in the landfill between the 1975 and 1976 aerial photographs. There appears to be more material piled along the northern edge of the active portion of the landfill. The material along the edge appears to be large rocks or boulders.

The 1984 aerial photograph shows the landfill to be inactive. The entire landfill appears to be vegetated. The most recently active portion of the landfill appears to be vegetated with grass and the previously established natural vegetation is still in place. The maintenance building located north of Plant No. 33 had been constructed by 1984. The incinerator and its associated tank building are visible in the photograph. The scale and quality of the photograph do not allow for discernment of the hazardous waste container storage area. In the 1987 aerial photograph the landfill appears to have been reshaped and graded. The northern arm of the landfill, adjacent to the north-south ditch, does not extend as far northward as observed from the 1975, 1976, and 1984 aerial photographs.

The 1994 aerial photograph shows that the incinerator has been removed, the glue pond has been revegetated, and the lumber yard is inactive. The flood plain to the west of the north-south ditch is heavily wooded. The floodplain east of the north-south ditch and north of the east-west ditch is a softball field. Dense vegetation is covering the banks of Lower Creek and the unnamed tributaries and ditches located on the property.

The 1995 aerial photograph shows that the grass at the landfill and ballfield has been mowed. Other than the grass being mowed, there are no discernable onsite differences between the 1994 and 1995 photographs. It has been noted that the city/county have begun construction of the animal shelter that is located east of the former wastewater treatment plant and landfill on the city property adjacent to Singer.

EPA has required Singer to conduct RFI work at five SWMUs. The following sections describes the operational history and contents of the SWMUs. Figure 1-2 delineated all of the SWMU boundaries and identifies the sampling locations for each SWMU. Figure 1-5 delineates all known utilities and easements at the Singer site.

4.2 CHRONOLOGY AND CONTAMINANT DISTRIBUTION

SWMU No. 1 - Landfill--

The onsite portion of the landfill is approximately five acres and it is located immediately north of Plant 33 and west of the lumber yard. The landfill was constructed on the floodplain of Lower Creek and its upper most elevation is approximately 38 feet above the creek bed and its lowest most elevation is approximately 10 feet above the creek bed. The boundaries and elevations of the landfill have been determined by using seismic refractory techniques, planimetric surveying, and photogrametic methods and they are delineated on the topographic map (Figure 1-2). The landfill is bisected by the property line separating Singer and City of Lenoir. The landfill has been closed for more than 17 years and has been in existence for 59 years.

Initially, the city of Lenoir, used a road right-of-way crossing from Miller Road (current Virginia Street) to the sewage treatment plant located west of the current Singer property. Aerial imagery indicates that municipal landfilling was limited to portions of the current Singer property that are northwest of building 33 and approximately 125 feet north of the hazardous waste incinerator and container storage areas. Municipal disposal activities were conducted from 1938 until 1963. The landfill was primarily used to dispose of sludge from primary and secondary wastewater treatment operations, however, the city

accepted trash, industrial waste, and garbage at the site when it was delivered by private haulers or Individuals. The city has indicated that this landfill was not the destination for garbage and trash that was collected by city crews or city contractors. Long time Singer employees indicates that local industry and residents routinely used the landfill for disposal purposes.

Subsequent to the city's usage, Singer predecessors, Kent Coffey Manufacturing Company, Consolidated Furniture Industries, Magnovox Furniture Company, and Singer Corporation, used the site for disposal of empty drums, drums containing finishing waste, trash, heavy equipment, construction and demolition debris, and lumber waste. Long time Singer employees have indicated that the landfill was routinely used by Furniture plants in the local area between 1963 and 1976. General disposal activities were halted in 1976, however, nonchemical waste such as lumber and discarded manufacturing equipment continued to be landfilled until 1980. In 1981 the landfill was leveled to cover any exposed waste and equipment and a grass cover was established as erosion protection. The cover material was obtained from the onsite barrow area that had been used to elevate the manufacturing facilities above the floodplain.

There are no written records of the wastes types or quantity that have been disposed in the landfill. Long time employees indicate: 1) the central to northwestern portion is primarily trash and wood waste; 2) the southeastern portion is primarily rocks, construction debris, heavy equipment, and trash, and 3) the eastern and north eastern portion is primarily trash and finishing waste. Long time employees also indicate that open burning of finishing waste was a common practice during the 60's and 70's. The operations at the site were and are similar to most all furniture manufacturing. The principal difference from year-to-year being the patterns, styles, and colors. The estimated landfill volume is 110 acre feet (177,472 yd^3). Long time employees indicate that a vast majority of the landfilled material is wood waste and dirt.

The investigative effort included collecting soil and groundwater samples from the downgradient (north) side of the landfill. The samples were prefixed with CAMA-1 designations. During the actual installation of each well, soil samples were taken at

approximately 2 to 4 feet. These samples were taken directly from the 24 inch, stainless steel, split spoon sampler and placed in the appropriate containers.

During the well installation, some of the CAMA1 wells, (CAMA1-4WT, CAMA1-7WT, CAMA1-8WT), had approximately 50 lb of soil collected and stored in air-tight plastic bags for physical properties analysis. These soils were analyzed by Geo Technologies, Inc. for moisture, particle and grain size, and bulk density. The results from these soils physical properties tests are discussed in Section 3 of this report.

Sampling of the groundwater at each of the 12 CAMA1 wells was conducted after the installation and well development were complete. Prior to sampling, a minimum of three well volumes was purged from each of the respective wells. The groundwater from each of the wells was analyzed for: volatile organics (Method 8240), BNAs (Method 8270), extractable organics (Method 8270), herbicides (Method 8150), metals (Method 6010), total organic Halides (Method 9020), total cyanide (Method 9010/335.2), total sulfide (Method 9030). All of the above analyses were performed by RASI. In addition, the groundwater from each CAMA1 well was analyzed by Savannah Laboratories for formaldehyde (Method 8315).

The initial groundwater sampling was conducted during October through December of 1995 for all the CAMA1 wells except CAMA1-6WT and CAMA1-6SP, which were initially sampled in April of 1996.

In February of 1996, the first quarterly groundwater sampling was conducted for all the CAMA1 wells except CAMA1-6WT and CAMA1-6SP, which were not yet installed. The quarterly sampling consisted of the same analyses conducted during the initial sampling described above.

All of the groundwater analyses were performed on unfiltered samples obtained from dedicated, 2-inch, teflon bailers. All groundwater samples were transferred directly from the sampling device (teflon bailer) to the appropriate sample container. Sample bottles requiring chemical preservatives had been pre-preserved by the laboratory. After filling each sample container, the sample was immediately placed in an insulated, plastic, cooler and chilled with ice to 4°C prior to shipment to the laboratory for analysis.

The data for this SWMU has a CAMA-1 identification label. Table 4-2 lists the hazardous constituents that have been quantified in the soil or groundwater in the vicinity of the landfill.

The landfill cover was not engineered to provide an impermeable cap. Infiltrometer testing described earlier demonstrates that the cap is not homogenous and it is highly permeable in places. Hence, rainfall and snow melt have percolated through the landfill and leachate has been generated. Because the landfill has been closed for more than 17 years it is reasonable to assume that the landfill contents is in equilibrium with the environment and that the maximum extent of contamination has already occurred and that natural attenuation is occurring.

The figures in Appendices 4.1 and 4.2 present the analytical data for each compound that was quantified by the laboratory. It is evident that the contamination is confined to a localized area via groundwater.

Because the water table is near or within the base of the landfill, as indicated by the cross sectional lithographs discussed in Section 3, the receptors most likely to be affected are users of downgradient surface and groundwaters. The city, NCDEM, or EQ have not identified any users of the downgradient water systems within 1000 feet of the facility. The area is supplied potable water by the City of Lenoir and future use of the groundwater and/or the surface water of Lower Creek as a potable water supply is highly unlikely.

The landfill has been constructed in the Lower Creek floodplain. The 100 year flood event has been estimated to have a mean velocity of 1.5 feet per second at the Singer property. It is, however, generally recognized that velocities lower than 2.5 feet per second generally do not have the momentum to cause scouring and erosion of intact soils and plants.

SWMU No. 2 - Abandoned Drums at Lower Creek--

Fourteen 55-gallon drums of unconfirmed origin were located between the northern edge of the landfill and Lower Creek. These drums were scattered about and in the

TABLE 4-2. HAZARDOUS CONSTITUENTS DETECTED IN SOILS AND GROUNDWATER IN THE VICINITY OF THE LANDFILL

Groundwater	Soils	
Volatiles		
Trichloroethene	Formaldehyde	
1,1-Dichloroethane	Methylene Chloride	
Methylene chloride	Acetone	
Benzene		
Acetone		
Semivolatiles		
Butylbenzylphthalate	Phenanthrene	Phenathrene
Di-n-Butylphthalate	Di-n-Buytlphthalate	Benzo(b)Fluoranthene
Diethy Phthalate	Diethyphthalate	Benzo(g,h,i)Perylene
N-nitrosomorpholine	Benzo-(a)-Pyrene	1,4 Naphthoquinone
Bis(2-ethylhexyl) Phthalate	Chrysene	Pyrene
	Bis(2-ethylhexyl) Phthalate	
Metals		
Selenium	Selenium	
Zinc	Zinc	
Vanadium	Vanadium	
Copper	Copper	
Cobalt	Cobalt	
Chromium	Chromium	
Cadmium	Cadmium	
Beryllium	Beryllium	
Barium	Barium	
Arsenic	Arsenic	

(continued)

TABLE 4-2 (continued)

Antimony	Antimony
Tin	Tin
Silver	Silver
Nickel	Nickel
Mercury	Mercury
Lead	Lead
Iron	Iron
Pesticides and PCB's	
Endosulfan	Dieldrin
Heptachlor epoxide	Aroclor 1260
	Endosulfan Sulfate
Purgeables	
1,4 dioxane	
Herbicides	
None	2,4,5-T

Lower Creek flood plain. Figure 1-2 indicates the location of the 14 drums included in the RFA report. The drums were discovered in 1987 in a densely foliated area of approximately 300,000 square feet (6.9 acres). All of the drums were on the surface and partially buried in silt. The drums were in various stages of decay and 8 of the 14 were completely rusted out. The drum labels were either nonexistent or worn off from exposure to the weather.

The drums are suspected of having floated onto the property during a flood in 1977. Long time employees and city residents have indicated that a drum reconditioning company located 1.5 miles upstream of Singer lost its inventory of drums awaiting to be reconditioned during this storm event. Records of the loss, however, were not found in city archives nor newspaper accounts of the storm.

In July 1990 six drums with unknown contents and sound structural integrity were removed from the floodplain. Waste characterization of the drums indicated that five of the six contained waste that met the criteria to be classified as ignitable hazardous waste. The six drums were consolidated into three drums and were shipped offsite in December 1990 to a hazardous waste management facility for treatment and ultimate disposal. No other waste characterization was completed and speciated information is not available. Soil samples were collected from ground surface to a foot below grade at each of the 14 drum locations. The soil samples were analyzed for extraction toxicity characteristics, and PCB and pesticide content. The soil analysis were all below the detection limit and/or characteristic standard.

Site reconnaissance efforts completed in February and April 1994 indicated there was old debris and solid waste scattered about on the city side of the landfill. Included in the observed waste were: tires, glass bottles, steel fuel tank, refrigeration, hot water heaters, abandoned heavy equipment, cans, building materials, household trash, etc. Drum carcasses, wood waste, metal scrap, and concrete debris are visible on the Singer property near the northern edge of the landfill face. It is believed that all intact drums have been removed and there is no visual evidence of vegetation stress or releases to soils.

In accordance with the work plan, composite soil samples were collected at each of the 14 drum locations (D-1 to D-14). These samples were collected in April of 1995 at a depth of 6 inches to 1 foot. These samples were taken using a stainless steel, decontaminated hand trowel. The composite sample was obtained by mixing the soil from the trowel in a stainless steel, decontaminated mixing bowl. The sample locations (D-1 to D-14) had previously been marked by survey stakes. These drum locations are shown on Figure 1-2. The soils were analyzed for TOC (EPA Method 9060). A portion of each sample was screened in the field with a Photoionization Detector (PID) to detect the presence of VOCs. No VOCs were detected in any of the samples, hence, only samples immediately above the water table were collected.

The TOC concentration at the former drum locations ranged from a low of 7,370 mg/kg to a high 21,500 mg/kg. Soil samples were also collected from every bore hole used to install a groundwater monitoring well. The TOC values from the wells also located in the flood plain (CAMA-1 series) ranged from a low of 7,000 to a high of 15,996 mg/kg. The TOC concentration at the background locations (BG series) ranged from a low of 2,410 to a high of 8,760 mg/kg. The single TOC sample collected in the former lumber yard had a value of 6,300 mg/kg and a single sample collected in the ball field near Virginia Street had a TOC value of 18,000 mg/kg. The 95 UCL of the mean TOC value of the samples collected from the drum locations and the background TOC samples were calculated to be 14,617 and 8,452 mg/kg, respectively. TOC concentrations are naturally affected by soil type, moisture content, vegetation and root content, etc. It is not unusual for the concentration to be highly variable in an area that is as densely foliated as the flood plain of lower creek. Because the 95 percent UCL for TOC at the drum location is less than three times higher than the background locations, broad spectrum laboratory analyses were not completed for the individual drum locations. Broad spectrum analyses, however, were completed for the soils and groundwater collected from the CAMA-1 locations. It is believed that the wells and soil samples collected to assess the nature and extent of contamination via the CAMA-1 series is sufficient to characterize the affects that any of the drums may have had on the environment.

SWMU No. 3.- Glue Waste Evaporation Pond--

The Glue Wash Evaporation Pond was a small impoundment approximately 20 feet in diameter and 1 to 2 feet deep located south of Plant 54 as shown in Figure 1-2. This impoundment received wash water containing urea formaldehyde glue from 1979 to 1989. The wash water was allowed to evaporate, the glue solids were allowed to harden, and periodically the solids were removed and disposed as solid waste in either the onsite landfill prior to 1980 and in an offsite county landfill after 1980. Visible evidence of the pond was removed in 1990 and the area has been grassed and is routinely mowed as part of the facility's yard maintenance activities.

The glue pond was constructed overtop of a storm sewer. This sewer is a five foot corrugated metal pipe that discharges to the unnamed Lower Creek tributary that runs north-south under the parking lot and between the landfill and the lumber yard. In 1993, the area near the pond was disturbed when a roof drain was connected to the underlying storm sewer. Reportedly, the depth to bedrock is 4 to 5 feet below ground surface. The area where Plant 54 and glue pond were located has been excavated out of a hill side. Rock outcroppings are visible along the southern boundary of the manufacturing area. Surface water from this area is directed to a catch basin located 40 feet southwest of Plant 54.

In the process of making furniture, glue is used to laminate veneer onto base stock, assemble finished pieces, and fill holes and imperfections. The glue is applied by hand or by stainless steel rollers. At the end of each shift, the glue rollers are manually cleaned with water producing a dilute glue water mixture. Approximately 50 gallons of mixture are collected from the rollers in pans and buckets each day. The production of glue/water mixture is an integral part of furniture manufacturing. A single 1989 lab sample of the glue pond water indicates that the pond contained 1.2 percent formaldehyde. A single soil sample collected after the solid residues were removed in 1990 indicates the soil contained less than 1 ppm of free formaldehyde. A review of MSDS sheets indicates that formaldehyde content of the glue has varied from 0.5 percent to 3 percent. Urea formaldehyde is a highly polyermized material. Formaldehyde is a gaseous material that is soluble in water and readily decomposes when exposed to sunlight.

The potential exposure pathway is via soils, groundwater, and surface water. Initial soil borings were taken at depths of 1 foot and 2 feet at SB-1. SB-1 was the approximate center of the old evaporation pond area. These samples were collected using a 3 in. stainless steel, decontaminated, hand auger. These two samples were only analyzed for formaldehyde. The results from the analyses of these samples indicated the presence of formaldehyde at a concentration of 330 and 3,600 ppb, respectively. The extent and concentration were investigated with additional sampling as per the work plan.

Additional sampling of the evaporation pond was conducted in September of 1995. Soil samples were taken from locations SB-2, SB-3, SB-4, and SB-5. These samples were taken to better define the area and concentration of the contaminated soil in SWMU-3. The results from the analyses of SB-2, SB-3, SB-4, and SB-5 indicated the presence of formaldehyde and other hazardous constituents. Because the lateral extent of contamination had not been determined, additional sampling was conducted at soil boring locations: SB-6, SB-7, and SB-8. These samples were collected at depths of approximately 0.5 ft and 4 ft below ground level. These were the last soil samples collected to better define the contaminated area of SWMU-3. All sample locations SB-1 to SB-8 for SWMU-3 are shown on Figure 1-2.

In addition to the soil boring samples, soil samples were also collected during the installation of SWMU-3 monitoring wells. There were two monitoring wells installed in the SWMU-3 area:

SWMU3-9WT
SWMU3-10WT

The soil borings for the monitoring wells were made using a drill rig with a 6-inch, decontaminated, hollow stem auger. Soil samples were collected continuously using a stainless steel, decontaminated, 24 inch split-spoon sampler. Once the sampler was advanced to depth, it was removed and given to the onsite geologist/engineer for interval sampling and observation.

Also, during the well installation, SWMU3-9WT had approximately 50 lb of soil collected and stored in air-tight plastic bags for physical properties analysis. These soils were analyzed by Geo Technologies, Inc. for moisture, particle and grain size, and bulk density. Results from the soil physical tests are discussed in Section 3.

Sampling of the groundwater at both of the SWMU-3 monitoring wells was conducted after the installation and well development were completed in October 1995. Prior to sampling, a minimum of three well volumes was purged from each of the SWMU-3 wells. The groundwater from each of the wells was analyzed for: volatile organics

(Method 8240), BNAs (Method 8270), extractable organics (Method 8270), herbicides (Method 8150), metals (Method 6010), total organic halides (Method 9020), total cyanide (Method 9010/335.2), total sulfide (Method 9030). All of the above analyses were performed by RASI. In addition, the groundwater from each well was analyzed by Savannah Laboratories for formaldehyde (Method 8315).

The initial groundwater sampling was conducted during October 1995. In February of 1996, the first quarterly groundwater sampling was conducted for both of the SWMU-3 wells. The quarterly sampling consisted of the same analyses conducted during the initial sampling described above.

All of the groundwater analyses was performed on unfiltered samples obtained from dedicated, 2-inch, teflon bailers. All groundwater samples were transferred directly from the sampling device (teflon bailer) to the appropriate sample container. Sample bottles requiring chemical preservatives had been pre-preserved by the laboratory. After filling each sample container, the sample was immediately placed in an insulated, plastic, cooler and chilled with ice to 4°C. prior to shipment to the laboratory for analysis.

Table 4-3 identifies the contaminants that were detected in the soils and groundwater of the SWMU-3 area. Appendices 4.3 and 4.4 present the quantified compound isopleths for the Glue Pond area. The results indicate the presence of contaminant of concentrations that are below those which cause exceedances of commonly accepted risk levels. It is evident that the contamination is confined to a relatively small and localized area.

SWMU-6 - Hazardous Waste Container Storage Area--

The container storage area was located outdoors on the west side of the lumber shed immediately north of Plant 33. The maximum inventory of 55 gallon drums in storage at any given time during the operating life of the unit was 500 drums. The area was managed and permitted to store only wastes that did not contain free liquids. The area was approximately 50 by 76 feet. Drums of waste were stored at this location on

TABLE 4-3. HAZARDOUS CONSTITUENTS DETECTED IN SOILS AND GROUNDWATER IN THE VICINITY OF THE GLUE POND

Volatiles	
Groundwater	Soils
Formaldehyde	Acetone
Trichloroethene	
Methylene chloride	
Acetone	
Semivolatiles	
Butylbenzylphthalate	Di-n-Butyl phthalate
	Bis-(2-ethylhexl)phthalate
Metals	
Selenium	Selenium
Zinc	Zinc
Vanadium	Vanadium
Copper	Copper
Cobalt	Cobalt
Chromium	Chromium
Cadmium	Cadmium
Beryllium	Beryllium
Barium	Barium
Arsenic	Arsenic
Antimony	Antimony
Tin	Tin
Thallium	Thallium
Silver	Silver
Nickel	Nickel

(continued)

TABLE 4-3 (continued)

Mercury	Mercury
Lead	Lead
Iron	Iron
Pesticides	
Isodrin	4,4'-DDE
	Aldrin

wooden pallets to prevent ground contact. Only waste generated by Singer was stored at this location. Figure 1-2 is a plan site plan view showing the location of SWMU-6.

This SWMU was a permitted hazardous waste management unit under permit number NCDO00604322. This unit's closure was addressed in the facility's closure plan as described in the permit and an approved modified closure plan dated April 9, 1993. The unit has been clean closed in accordance with the approved closure plan and certified by an independent professional engineer on July 6, 1993 (John P. Carroll, Jr., P.E. No. 10951) as required by 40 CFR 264.115. A closure report and certification were submitted on July 16, 1993 to NCDEHNR for approval. NCDEHNR approval and acceptance of the closure certification was received on February 25, 1994. A summary of the closure activities is provided herein:

A site inspection was conducted to identify areas of visible evidence of spills or contamination and assure an adequate storage space in the 90-day accumulation area of drums generated during the closure activities. In addition, a site control plan was established, key contacts were identified, and it was confirmed that all utilities were disconnected.

These activities were conducted and no evidence of spills or contamination were identified in the Container Storage Area. The 90-day accumulation area appeared to have adequate storage space available for drums expected to be generated. Site control was established prior to demolition activities, and a list of key personnel was also established

and included in the field logbook. The site inspection and initiation of onsite closure activities were conducted on June 1, 1993.

Upon initiation of closure activities at the Container Storage Area, no containers of waste were present. Markers along the north side of the area identified where rows of drums had been stored. Because there was no visible evidence of spills or contamination on the surface no excavation or removal of surface materials was required.

The sampling locations/grids were preselected as identified and included in the closure plan. These locations were identified to demonstrate if statistical differences exist between the Container Storage Area and background conditions. At each of the identified grids (Nos. 1, 9, 10, 17, and 25), the surface gravel was removed using a pick and shovel. The soil was then collected using a metal sampling trowel and placed directly into the appropriate laboratory container, labeled, and sealed. The containers were then placed into a cooler with ice and prepared for shipment to RASI for analysis. Split samples were collected simultaneously at each of the sampling grids. These split samples were included with the other samples collected; however, they were identified with a unique sample identification number. These samples were collected in the event that a container was damaged or broken in shipment.

Samples collected were analyzed by the laboratory for the following parameters and by the method as specified:

- Methyl ethyl ketone by Method 8015
- Toluene by Method 8020
- Xylene by Method 8020
- Dimethyl phthalate by Method 8060
- bis(2-Ethylhexyl)phthalate by Method 8060.

Coolers containing the samples were shipped via Federal Express to the laboratory following proper chain-of-custody procedures.

An identical grid layout was also established in the background area. The sample grids were sampled following the same sampling strategies.

Equipment used during the sampling in both of these areas was decontaminated between each of the sampling grids by triple washing and final rinse. All decontamination fluids generated were contained, and upon completion of sampling, were placed into the drums of liquids generated during the washing of the incinerator floor and disposed of properly.

Table 4-4 presents a summary of analytical results of samples collected during the performance closure activities.

All sample results indicate that no contaminants were detected in any of the soil samples collected. All test results were below the PQL of the laboratory. This further indicates that the Container Storage Area has not been affected by the storage of waste materials prior to processing in the incinerator.

Based on the submission of the closure report, certification of closure to the appropriate regulatory agency, acceptance of the closure certification by the regulatory agency and by approval of the RFI work plan, no further investigation activities were completed for this unit.

SWMU-9 - Spill at Oil Tank, Lumber yard Stacker Building–

This SWMU was identified by an area of discolored soil approximately 30 feet by 15 feet. The discoloration was the result of overfills, spills, or leaks associated with an above-ground, 200 gallon storage tank containing virgin diesel fuel. The SWMU-9 is located on the west wall of the lumber yard stacker building as depicted in Figure 1-2.

Diesel fuel is a fraction of crude oil that primarily contains organic compounds with 15 to 18 carbon atoms. Typical constituents of concern in the diesel fuel fraction are as follows:

- Benzene
- Toluene
- Xylenes

TABLE 4-4. SUMMARY OF ANALYTICAL RESULTS

Sampled ID	Sample location	Methyl ethyl ketone	Toluene	Xylene	Dimethyl phthalate	bis(2-Ethylhexyl) phthalate
SFC-W1-1	Waste management area - grid 1	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-W2-9	Waste management area - grid 9	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-W3-10	Waste management area - grid 10	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-W4-17	Waste management area - grid 17	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-W5-25	Waste management area - grid 25	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-B1-1	Background area - grid 1	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-B2-9	Background area - grid 9	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-B3-10	Background area - grid 10	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-B4-17	Background area - grid 17	<PQL	<PQL	<PQL	<PQL	<PQL
SFC-B5-25	Background area - grid 25	<PQL	<PQL	<PQL	<PQL	<PQL
Water trip blank	Trip blank	<PQL	<PQL	<PQL	NA	NA

NOTES: Results are reported in ug/Kb for solids and ug/L for liquids.
PQL = Laboratory Practical Quantitation Limit.
NA = Not Analyzed.

- Ethylbenzene
- Polynuclear Aromatic Hydrocarbons (PAHs).

There are no records or other information concerning the volumes or dates upon which the oil spill occurred. The tank was in operation from 1963 until 1989. Based on interviews, the surface stains were caused when delivery hoses were drained onto the ground and releases were not routine, continuous, or systematic. The diesel fuel was used to operate fork lifts that operated in the lumber yard. The tank was removed from the facility in 1989.

SWMU-9 is located in a relatively flat area adjacent to the lumber yard building 150 feet east of the ditch that runs south to north through the plant to Lower Creek. Overland flow in this area is via sheet flow to the north towards Lower Creek.

A potential exists for release of petroleum products to ground water via contaminated soils as a secondary source. Surface water run-off during precipitation events may have contained petroleum products and migrated towards Lower Creek.

Soil samples were collected from five boring locations (SB1 through SB5) in April of 1995. The laboratory missed the holding time for these samples and the results have been qualativity used to identify new sampling locations because the presence of a contaminant was confirmed. The center boring was in the approximate location of the removed 500 gallon aboveground storage tank (AST). The outer four borings were approximately 20 ft out from the center boring in the four cardinal directions. The samples from the outer borings were taken to better define the contaminated area.

In November of 1995, a second set of soil samples were collected from five boring locations (SB1A-SB5A). The center boring for the second set of samples was the same as the center boring for the previous set of samples. The outer four borings were moved farther out (approximately 40 ft) to better define the extent of the soil contamination. In December of 1995, the second set of sample boring locations were re-analyzed for semi-volatile organics due to laboratory complications from the November 1995 sampling.

In order to evaluate the overall extent of contamination, an additional set of soil samples were collected in March of 1996 from soil borings SB-6 through SB-9 and the

decision to install monitoring well SWMU9-13WT was made. There was only one monitoring well installed in the SWMU-9 area. The soils were analyzed by RASI for volatile organics, extractable organics, and metals. In addition, soils were analyzed by Savannah Laboratories for formaldehyde.

Also, during the well installation, approximately 50 lb of soil from the SWMU9-13WT borehole cuttings was collected and stored in an air-tight plastic bag for physical analyses. This soil was tested by Geo Technologies, Inc. for moisture, particle and grain size, and bulk density. These physical properties were obtained to better define the physical properties of the SWMU-9 soils and are discussed in Section 3 of this report.

Sampling of the groundwater at the SWMU9-13WT well was conducted after the installation and well development were complete (October 1995). The groundwater from this well was analyzed for: volatile organics (Method 8240), BNAs (Method 8270), extractable organics (Method 8270), herbicides (Method 8150), metals (Method 6010), total organic halides (Method 9020), total cyanide (Method 9010/335-2), total sulfide (Method 9030). All of the above analyses were performed by RASI. In addition, the groundwater from SWMU9-13WT was analyzed by Savannah Laboratories for formaldehyde (Method 8315).

The initial groundwater sampling was conducted during October 1995. In February of 1996, the first quarterly groundwater sampling was conducted for the well SWMU9-13WT. The quarterly sampling consisted of the same analyses conducted during the initial sampling described above. All of the groundwater analyses were performed on unfiltered samples obtained from dedicated, 2-inch, teflon bailers. All groundwater samples were transferred directly from the sampling device (teflon bailer) to the appropriate sample container.

Table 4-5 lists the hazardous constituents that have been quantified in the groundwater and soils in the vicinity of the fuel oil spill. Appendices 4.5 and 4.6 present the quantified compound isopleths for SWMU-9. There are no isopleths for compounds that were only detected one time. The extent of contamination appears to be confined to a relatively localized area.

TABLE 4-5. HAZARDOUS CONSTITUENTS QUANTIFIED IN SOILS AND GROUNDWATER IN THE VICINITY OF SWMU NO. 9

Volatiles		
Groundwater	Soils	
1,1-Dichloroethene	2 Butanone	
Methylene chloride	Methylene chloride	
Acetone	Acetone	
	M,P xylene	
Semivolatiles		
Butybenzylphthalate	2 Methylnapthalene	Chrysene
Di-n-Butylbenzyl phthalate	Napthalene	Benzo(k)Fluoranthene
Diethyl phthalate	Fluorene	Fluoranthene
Acenaphthene	Butyl Benzlphthalate	Benzo(b)Fluoranthene
	Phenanthrene	Dibenzofuran
	Di-n-Butyphthalate	Pyrene
	Diethy Phthalate	Anthracene
	Acenaphthene	Di-n-octylphthalate
	Benzo-(a)-Pyrene	Bis(2-ethylhexl) phthalate
Metals		
Selenium	Selenium	
Zinc	Zinc	
Vanadium	Vanadium	
Copper	Copper	
Cobalt	Cobalt	
Chromium	Chromium	
Cadmium	Cadmium	
Beryllium	Beryllium	

(continued)

TABLE 4-5 (continued)

Barium	Barium
Arsenic	Arsenic
Antimony	Antimony
Tin	Tin
Thalllum	Thallium
Silver	Silver
Nickel	Nickel
Mercury	Mercury
Lead	Lead
Iron	Iron
Pesticides	
	Chlordane

SECTION 5

ACTION LEVELS

Action levels (ALs) are health- and/or regulatory-based levels of hazardous constituents that are used as indicators for protection of human health. Media-specific concentrations above the ALs indicate the need for further assessment of whether a release has occurred and the severity of the potential release.

ALs are expressed as media-specific concentrations (e.g., mg/kg of soil) that are deemed protective of one or more human exposure pathways (e.g., ingestion of soil). Therefore, ALs are typically determined for each medium that exhibits a potential for human exposure. The major media include soil, groundwater, surface water, and air.

A necessary step in determining the usefulness of ALs is the consideration of background contaminant concentrations. Background concentrations are divided into two types: naturally occurring and anthropogenic. Natural background is usually limited to metals whereas anthropogenic (i.e., human-made) background includes both organic and inorganic contaminants. Generally, a release is considered not to have occurred if media sampling results indicate contaminant levels at or near background levels. If, however, sampling results indicate concentrations significantly greater than background, health-based ALs for each contaminant are calculated. These ALs are then compared to sampling results to determine whether further action is required. The following sections describe the procedures used to determine media-specific ALs for the Singer site. Appendix 5.1 contains the detailed action level calculations.

5.1 EXPOSURE ASSUMPTIONS

The exposure models used to determine ALs are consistent with the U.S. EPA concept of "reasonable maximum exposure" (RME) in the commercial/industrial setting (U.S. EPA, 1990 and 1991). Because the Singer site and surrounding properties have

historically been zoned for commercial or industrial land-use, it was deemed appropriate that these properties would continue to be similarly zoned for the foreseeable future. Singer is willing to place deed restrictions to further assure that the property will continue to be used for commercial and industrial purposes. EPA's method for estimating RME for chronic exposures on a site-specific basis is to combine an average exposure point concentration with reasonably conservative values for intake and duration in the calculations (U.S. EPA, 1989 and 1991). Because the area is furnished with potable water by the City of Lenoir, neither the groundwater nor the surface water are used as potable water supplies. Hence, as an added level of assurance the deed restrictions may also prohibit future onsite uses of the groundwater downgradient of the SWMUs. The resulting estimate of RME is then compared with chemical-specific toxicity criteria to determine a site-specific estimate of risk.

Risk-based ALs differ from a site-specific estimate of risk in that the exposure equations and fate and transport models are run in reverse to back-calculate a risk-specific level of contaminant in the applicable media (e.g., soil, groundwater, surface water, etc.). This concept has been introduced by EPA in the Hazardous Waste Identification Project (U.S. EPA, 1994), the Risk Assessment Guidance for Superfund, Part B (U.S. EPA, 1991a), and the Technical Background Document for Soil Screening Guidance (U.S. EPA, 1996). North Carolina Risk Analysis Framework (NCDEHNR, 1996) has proposed to adopt the methodologies used by EPA. The approach taken for calculating action levels at the Singer site is consistent with these principles and uses the most recent EPA and NCDEHNR guidance and techniques.

5.2 RISK LEVEL

Acceptable risk levels used in calculating the ALs are consistent with the requirements of U.S. EPA RCRA and Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) risk assessment guidance (U.S. EPA, 1996 and 1996c). The acceptable risk level for Class A and B carcinogens was set at 1×10^{-6}, while

the acceptable risk level for Class C carcinogens was set at 1×10^{-5}. ALs for noncarcinogens were set at a Hazard Quotient (HQ) of 1, however, toxicity values equal to 20 percent of the oral reference dose (RfD) and/or 20 percent of the inhalation reference concentration (RfC) were used to be consistent with the provisions of NCDEHNR (1996).

5.3 EXPOSURE PATHWAYS

Exposure pathways pertinent to potential contaminant releases from the Singer SWMUs were determined from a wide range of potential pathways. In general, all exposure pathways may be derived from the following two general pathways given in U.S.EPA (1994):

- All direct exposure pathways (e.g., inhalation, direct ingestion of drinking water and soil, and dermal contact with soil and water)
- Major indirect exposure pathways demonstrated to be of concern for certain groups of contaminants (e.g., lipophilic compounds associated with fish, crops, and dairy food chain pathways).

Because of the assumption of commercial/industrial land-use at and in proximity to the Singer site, all pathways associated with crops, and beef and dairy products were eliminated from further consideration. Other indirect pathways, except for exposure due to recreational fishing, were also eliminated because: 1) the direct exposure pathways resulted in more restrictive (i.e., lower) ALs, and 2) Lower Creek is not suitable for recreational swimming. It was conservatively assumed, however, that the Lower Creek could be used for recreational fishing, and so this indirect exposure pathway was retained for analysis. Finally, all of the major direct exposure pathways, except for dermal contact and consumption of groundwater, were included for calculation of ALs.

Dermal contact was not included because recent EPA guidance (U.S. EPA, 1992) concluded that for a constituent to pose a greater risk via dermal absorption than through direct ingestion, the absorption through the dermal route must be greater than 10 percent.

At the present time, the only compound with an absorption rate greater than 10 percent is pentachlorophenol (U.S. EPA, 1996). Therefore, in the case of pentachlorophenol, the incidental soil ingestion AL was divided in half to account for the assumption that exposure via the dermal route is equivalent to the ingestion route (U.S. EPA, 1996).

Consumption of groundwater was also eliminated from consideration according to the criteria specified in NCDEHNR (1996). Because the groundwater gradient for all SWMUs is directed towards the Lower Creek and the surface elevations on the opposite side of the creek rise rapidly, the logical conclusion is that potentially affected groundwater is intercepted by the Lower Creek. This restricts the potential downgradient supply wells to onsite locations and to a 0.8 acre parcel that is in the regulatory floodway of Lower Creek and subject to multiple utility easements. Water supplies are provided by a public water supply system that is unaffected by potential contamination from the SWMUs. For these reasons, consumption of groundwater was eliminated from further consideration as a potential exposure pathway.

The following, therefore, represent the human exposure pathways used for calculation of health-based action levels at the Singer site:

- Outdoor inhalation of volatiles from soils (onsite)
- Indoor inhalation of volatiles from groundwater (onsite)
- Indoor inhalation of volatiles migrating from soil to groundwater (onsite)
- Inhalation of respirable particulates (PM_{10}) from wind-eroded soils (onsite)
- Incidental ingestion of soils (onsite)
- Ingestion of contaminated fish (offsite).

5.4 TOXICITY VALUES

Toxicity values for compound-specific ALs were taken from the following, in order of preference:

1. U.S. EPA Integrated Risk Information System (IRIS)
2. U.S. EPA Health Effects Assessment Summary Tables (HEAST)
3. U.S. EPA Region IV Provisional Values
4. U.S. EPA Region III Risk-Based Concentration Table (12/96)
5. U.S. EPA Region IX Preliminary Remediation Goal Table (8/96).

If no toxicity values were available from any of the sources referenced above, a surrogate chemical was chosen that is chemically related (i.e., structure-activity related) according to the provisions of U.S. EPA (1995). In the case of contaminants that have been assigned oral toxicity values but not inhalation values, the following route-to-route extrapolation was used according to the procedures given in U.S. EPA (1996) to determine either an inhalation RfC or an inhalation unit risk factor (URF):

$$Extrapolated\ RfC\ mg/m^3 = RfD\ mg/kg\text{-}day\ x\ \frac{70kg}{20m^3/day}$$

$$Extrapolated\ URF\ (\mu g/m^3)^{-1} = \frac{SF_{oral}\ \frac{kg\text{-}day}{mg}}{70\ kg}\ x\ 20\ m^3/day\ x\ 10^{-3}\ mg/\mu g$$

It should be noted that there is a considerable degree of uncertainty in the validity of extrapolated inhalation toxicity values. This is due to the implicit assumption that the route of administration is irrelevant to the delivered dose. Regardless of the uncertainty in the validity of the extrapolated inhalation toxicity values, it was considered more conservative to use such values than not to consider inhalation for these contaminants.

5.5 CHEMICAL/PHYSICAL PROPERTIES

Chemical and physical properties (e.g., Henry's law constant, solubility in water, etc.) for each constituent were taken from the U.S. EPA Superfund Chemical Data Matrix (U.S. EPA, 1996a). These properties are consistent with those of U.S. EPA (1996). If a specific constituent was not included in the Superfund Chemical Data Matrix, chemical properties were derived from other sources in the literature. Odor threshold values were obtained from Massachusetts DEP (1994). Values for diffusivity in air and diffusivity in water were taken from the U.S. EPA WATER8 model (U.S. EPA, 1994a). Appendix 5.2 includes a description of each contaminant detected at the site. The appendix also includes the physical and chemical properties used in the action level calculations.

5.6 CALCULATION OF DIRECT SOIL INGESTION ALs

The following represents the procedures used to calculate the ALs for the incidental ingestion of noncarcinogenic contaminants in commercial/industrial soils.

$$AL\ (mg/kg) = \frac{THQ \times BW \times AT \times 365\ days/yr}{1/RfD_o \times 10^{-6}\ kg/mg \times EF \times ED \times IR}$$

where

THQ = Target hazard quotient, 1

BW = Body weight, 70 kg

AT = Averaging time, 25 yr

RfD_o = Oral reference dose x 0.2, mg/kg-day (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

IR = Soil ingestion rate, 50 mg/day.

The following represents the procedures used to calculate the ALs for the incidental ingestion of carcinogenic contaminants in commercial/industrial soils:

$$AL\ (mg/kg) = \frac{TR \times AT \times 365\ days/yr}{SF_o \times 10^{-6}\ kg/mg \times EF \times ED \times IR}$$

where TR = Target risk (10^{-6} for Class A and B; 10^{-5} for Class C)

AT = Averaging time, 70 yr

SF_o = Oral slope factor, $(mg/kg\text{-}day)^{-1}$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

IR = Soil ingestion rate, 50 mg/day.

References: U.S. EPA (1996)

5.7 CALCULATION OF VOLATILE OUTDOOR INHALATION ALs

The following represents the procedures used to calculate the default outdoor inhalation ALs for volatile carcinogenic contaminants in commercial/industrial soils:

$$Volatile\ AL\ (mg/kg) = \frac{TR \times AT \times 365\ days/yr}{URF \times 1000\ \mu g/mg \times EF \times ED \times \left(\frac{1}{VF}\right)}$$

where TR = Target risk (10^{-6} for Class A and B; 10^{-5} for Class C)

AT = Averaging time, 70 yr

URF = Unit risk factor, $(\mu g/m^3)^{-1}$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

VF = Volatilization factor, m^3/kg (chemical-specific).

The following represents the procedure used to calculate the default outdoor inhalation ALs for volatile noncarcinogenic contaminants in commercial/industrial soils:

$$Volatile\ AL\ (mg/kg) = \frac{THQ \times AT \times 365\ days/yr}{EF \times ED \times \left(\frac{1}{RfC} \times \frac{1}{VF}\right)}$$

where THQ = Target hazard quotient, 1

AT = Averaging time, 25 yr

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfC = Reference concentration x 0.2, mg/m^3 (chemical-specific)

VF = Volatilization factor, m^3/kg (chemical-specific).

Calculation of the volatilization factor (VF):

$$VF\ (m^3/kg) = Q/C \times \frac{(3.14 \times D_A \times T)^{1/2}}{(2 \times \rho_b \times D_A)} \times 10^{-4}\ m^2/cm^2$$

and,

$$D_A = \frac{\left[\left(\theta_a^{10/3}\ D_i\ H' + \theta_w^{10/3}\ D_w\right)/n^2\right]}{\rho_b\ K_d + \theta_w + \theta_a\ H'}$$

where Q/C = Inverse of the mean ambient air concentration at the center of a 0.5 acre area source, 68.81 g/m^2-s per kg/m^3

D_A = Apparent diffusivity, cm^2/s

T = Exposure interval, 7.9×10^8 seconds

ρ_b = Soil dry bulk density, 1.5 g/cm^3

Θ_a = Soil air-filled porosity, 0.284

D_i = Diffusivity in air, cm^2/s (chemical-specific)

H' = Henry's law constant, unitless (chemical-specific)

Θ_w = Soil water-filled porosity, 0.150

D_w = Diffusivity in water, cm^2/s (chemical-specific)

n = Total soil porosity, 0.434

K_d = Soil/water partition coefficient, cm^3/g ($=K_{oc} \times f_{oc}$)

K_{oc} = Soil organic carbon partition coefficient, cm^3/g (chemical-specific)

f_{oc} = Organic carbon content of soil, 0.006 g/g.

Because the emission model used to calculate the VF operates under the assumption of an infinitely deep source of emissions, the model is subject to mass balance violations under certain conditions. For compounds with high Henry's law constants in combination with relatively shallow depths of contamination, the total mass emitted may exceed the total initial mass. To eliminate this possibility, a mass-limit volatilization factor (VF_m) is calculated as:

$$VF_m\,(m^3/kg) = Q/C \times \left[(T \times 3.15E{+}07\ s/yr)/(\rho_b \times d_s \times 10^6\ g/Mg)\right]$$

where Q/C = Inverse of the mean ambient air concentration at the center of a 0.5 acre area source, 68.81 g/m^2-s per kg/m^3

T = Exposure period, 25 yr

ρ_b = Soil dry bulk density, 1.5 kg/L

d_s = Average source depth, 2.7432 m (= average depth to groundwater).

If the value of the VF is less than the value of the VF_m, the final volatilization factor is set equal to VF_m.

Finally, the calculated value of the volatile AL is compared with the calculated value of the soil saturation concentration (C_{sat}). C_{sat} is the concentration in soil at or above which a residual phase is likely to be present (e.g., nonaqueous phase liquid or solid). If the calculated value of the volatile AL is greater than or equal to the value of C_{sat}, the volatile AL is set equal to C_{sat}. This means that the value of the volatile AL will always be less than or equal to that required to achieve a residual phase. C_{sat} is calculated as:

$$C_{sat} = \frac{S}{\rho_b}\left(K_d\,\rho_b + \theta_w + H'\,\theta_a\right)$$

where S = Solubility in water, mg/L (chemical-specific)

K_d = Soil/water partition coefficient, L/kg (chemical-specific)

ρ_b = Soil dry bulk density, 1.5 kg/L

Θ_w = Soil water-filled porosity, 0.150

H' = Henry's law constant, unitless (chemical-specific)

Θ_a = Soil air-filled porosity, 0.284.

References: U.S. EPA (1996)

5.8 CALCULATION OF PARTICULATE INHALATION ALs

The following represents the procedures used to calculate the default inhalation ALs for wind-eroded particulates from carcinogenic contaminants in commercial/industrial soils:

$$Particulate\ AL\ (mg/kg) = \frac{TR \times AT \times 365\ days/yr}{URF \times 1000\ \mu g/mg \times EF \times ED \times \left(\frac{1}{PEF}\right)}$$

where TR = Target risk (10^{-6} for Class A and B; 10^{-5} for Class C)

AT = Averaging time, 70 yr

URF = Unit risk factor, $(\mu g/m^3)^{-1}$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

PEF = Default particulate emission factor, $1.32 \times 10^9\ m^3/kg$.

The following represents the procedures used to calculate the default inhalation ALs for wind-eroded particulates from noncarcinogenic contaminants in commercial/industrial soils:

$$Particulate\ AL\ (mg/kg) = \frac{THQ \times AT \times 365\ days/yr}{EF \times ED \times \left(\frac{1}{RfC} \times \frac{1}{PEF}\right)}$$

where THQ = Target hazard quotient, 1

AT = Averaging time, 25 yr

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfC = Reference concentration x 0.2, mg/m^3 (chemical-specific)

PEF = Particulate emission factor, 1.32 x 10^9 m^3/kg.

References: U.S. EPA (1996)

5.9 CALCULATION OF SOIL-TO-GROUNDWATER ALs

Soil-to-groundwater ALs are reverse-calculated based on a target soil leachate concentration (C_w). The value of C_w for each constituent is based on the lowest of the following: 1) the risk-based groundwater concentration at the water table below the soil contamination which results in an acceptable risk due to indoor inhalation of volatiles within a hypothetical structure, 2) one-half of the pure component solubility in water, and 3) 1,000 times the NCAC 2L.0200 existing or interim groundwater standard. These criteria are consistent with the Ceiling Concentration Limits (CCLs) and G-2 groundwater category found in NCDEHNR (1996). CCLs are concentrations set by the NCDEHNR that are the upper limit on the amount of contamination that can remain in groundwater or soil at a site. Category G-2 groundwater is categorized as: contaminant groundwater that has the potential to cause exposure via the movement of vapor from the groundwater through the soil to a nearby building.

The G-2 groundwater target concentration is calculated as:

$$C_w = \frac{P_{air}}{a \; x \; d \; x \left(\frac{H}{R \; x \; T}\right) \; x \; C}$$

where C_w = Groundwater target concentration, mg/L

P_{air} = Target air concentration, mg/m^3

a = Default attenuation factor, unitless (= 0.0005)

d = Default modification factor, unitless (= 0.1)

H = Henry's law constant, atm-m^3/mol (chemical-specific)

R = Molar gas constant, atm-m^3/mol-°K (= 8.205E-05)

T = Temperature, °K (= 285)

C = Conversion factor, L/m^3 (= 1,000).

The target air concentration (P_{air}) is calculated as the lowest of Air_c, Air_{nc}, and 50 percent of the odor threshold. Such that:

$$Air_c = \frac{10^{-6}}{URF \times 1{,}000\ \mu g/mg}$$

where URF = Unit risk factor, (μg/m^3)$^{-1}$ (chemical-specific)

and,

$$Air_{nc} = 0.2 \times RfC$$

where RfC = Reference concentration, mg/m^3 (chemical-specific).

The following represents the procedures used to calculate the default soil migration to groundwater ALs for inorganic contaminants:

$$Soil\text{-}to\text{-}Ground\ Water\ AL\ (mg/kg) = C_w \left(K_d + \frac{\theta_w + \theta_a H'}{\rho_b} \right) df$$

where C_w = Target soil leachate concentration, mg/L

K_d = Inorganic soil/water partition coefficient, L/kg (U.S. EPA, 1996)

Θ_w = Soil water-filled porosity in the vadose zone, 0.30

Θ_a = Soil air-filled porosity in the vadose zone, 0.13

H' = Henry's law constant, unitless (chemical-specific)

ρ_b = Soil dry bulk density, 1.5 kg/L

df = Default dilution factor, unitless (= 20).

The following represents the procedures used to calculate the default soil migration to groundwater ALs for organic contaminants:

$$\textit{Soil-to-Groundwater AL (mg/kg)} = C_w \left((K_{oc}\, f_{oc}) + \frac{\theta_w + \theta_a\, H'}{\rho_b} \right) df$$

where C_w = Target soil leachate concentration, mg/L

K_{oc} = Organic carbon partition coefficient, L/kg (chemical-specific)

f_{oc} = Organic carbon content of vadose zone soil, 0.001 g/g

Θ_w = Soil water-filled porosity in the vadose zone, 0.30

Θ_a = Soil air-filled porosity in the vadose zone, 0.13

H' = Henry's law constant, unitless (chemical-specific)

ρ_b = Soil dry bulk density, 1.5 kg/L

df = Default dilution factor, unitless (= 20).

As with the volatile AL, calculation of the soil-to-groundwater AL is subject to mass balance violations because of the assumption of an infinite source. To avoid a mass balance violation, the total soil concentration (C_T^o) corresponding to the maximum possible leaching given a fixed source depth is calculated as:

$$C_T^o = (C_w \times I \times ED)/(\rho_b \times d_s)$$

where C_w = Target soil leachate concentration, mg/L

I = Infiltration rate, 0.22 m/yr (U.S. EPA, 1996)

ED = Exposure duration, 25 yr

ρ_b = Soil dry bulk density, 1.5 kg/L

d_s = Average source depth, 2.7432 m (= average depth to groundwater).

If the value of the calculated soil-to-groundwater AL is less than the value of C_T^o, the soil-to-groundwater AL is set equal to C_T^o.

References: U.S. EPA (1996) and NCDEHNR (1996)

5.10 CALCULATION OF GROUNDWATER ALs VIA THE INHALATION PATHWAY

Groundwater ALs are reverse-calculated based on a hypothetical structure being located above the underlying contamination and above the top of the water table. The groundwater AL is calculated as the lowest of the following: 1) the groundwater concentration which results in an acceptable risk due to indoor inhalation of volatiles, 2) one-half of the pure component solubility in water, and 3) 1,000 times the NCAC 2L.0200 groundwater standard. These criteria are consistent with the CCLs and G-2 groundwater category found in NCDEHNR (1996).

The G-2 groundwater target concentration is calculated as in Section 5.9. The final groundwater AL is then calculated as the lower of the target concentration and 1,000 times the NCAC 2L.0200 standards.

5.11 CALCULATION OF FISH INGESTION ALs

ALs for fish consumption were calculated for possible surface water contamination using the following procedures. Where values exist for both a Clean Water Act, Section 304(a) Ambient Water Quality Criteria for Fish Consumption (AWQC-F) and an NC 2B.0211 Class C Surface Water Quality Standard, the lower of the two values was used as the surface water AL. If only one standard exists for a specific chemical, it was used as the AL. If a standard does not exist, the following risk-based procedure was used to calculate the surface water ALs for recreational consumption of fish from the Lower Creek:

$$\text{Surface Water Fish Consumption AL } (mg/L) = \frac{C_{fish}}{BCF}$$

where C_{fish} = Concentration in fish, mg/kg

BCF = Bioconcentration factor, L/kg (chemical-specific)

and,

$$C_{fish} = \frac{I \times BW}{CR}$$

where I = Intake of contaminant, mg/kg-day

BW = Body weight, 70 kg

CR = Consumption rate of fish, 0.054 kg/day

and,

$$I = \frac{TR \times AT \times 365\ days/yr}{ED \times EF \times SF_o} \text{ for Carcinogens}$$

where TR = Target risk (10^{-6} for Class A and B; 10^{-5} for Class C)

AT = Averaging time, 70 yr

ED = Exposure duration, 30 yr

EF = Exposure frequency, 350 days/yr

SF_o = Oral slope factor, $(mg/kg\text{-}day)^{-1}$ (chemical-specific)

and,

$$I = HQ \times RfD_o \times 0.2 \text{ for Noncarcinogens}$$

where HQ = Hazard quotient, 1

RfD_o = Oral reference dose, mg/kg-day (chemical-specific).

The value of the BCF for each constituent was taken from U.S. EPA (1996b). If no referenced value of the BCF existed for a specific organic compound, the BCF was calculated using the Duluth equation from U.S. EPA (1994):

$$logBCF = 0.79\ logK_{ow} - 0.40 - \log(7.6/3.0)\ .$$

The BCFs for selected inorganics and organic compounds are taken directly from U.S. EPA (1994).

The ALs calculated for fish consumption were further refined to account for losses due to volatilization and burial in the benthic sediments between the point of surface water sampling adjacent to the Singer site and the nearest point of public access to the Lower

Creek (approximately one-half mile downstream from the Singer site). The downstream action level is calculated using a first-order exponential from U.S. EPA (1988):

$$C_{(x)} = C_{(o)} \left[\exp\left(-K_{wt}\left(\frac{x}{u}\right)\right)\right]^{-1}$$

where $C_{(x)}$ = Fish consumption AL at downstream distance x, mg/L

$C_{(o)}$ = Fish consumption AL at the Singer site, mg/L (chemical-specific)

K_{wt} = Overall water body dissipation rate constant, yr^{-1} (chemical-specific)

x = Distance downstream, 805 m

u = Average stream velocity, 1.45×10^{7} m/yr

and,

$$K_{wt} = (f_{water}\ k_v) + (f_{benth}\ k_d)$$

where f_{water} = Fraction of total water body concentration occurring in the water column (unfiltered stream water fraction = 1)

k_v = Water column volatilization rate constant, yr^{-1} (chemical-specific)

f_{benth} = Fraction of total water body concentration occurring in benthic sediments (sediment fraction = 0)

k_d = Benthic burial rate constant, yr^{-1} (chemical-specific)

and,

$$k_v = \frac{K_v}{d_z\,(1 + Kd_{sw}\ TSS\ 10^{-6}\ kg/mg)}$$

where K_v = Overall volatilization transfer rate, m/yr

d_z = Average water body depth, 0.61 m

Kd_{sw} = Suspended sediment/surface water partition coefficient, L/kg = K_{oc} x foc_{sw}; foc_{sw} = 0.075 (default)

TSS = Total suspended solids, mg/L (default = 10)

and,

$$K_v = \left[K_L^{-1} + \left(K_G \frac{H}{RT}\right)^{-1}\right]^{-1}$$

where K_L = Liquid-phase transfer coefficient, m/yr

K_G = Default gas-phase transfer coefficient, = 36,500 m/yr

H = Henry's law constant, atm-m^3/mol (chemical-specific)

R = 8.205 x 10^{-5} atm-m^3/mol-°K

T = Default water body temperature, = 298°K

and,

$$K_L = \left(\frac{10^{-4}\ m^2/cm^2\ D_w\ u}{d_z}\right)^{0.5}\ 3.15\ x\ 10^7\ s/yr$$

where D_w = Diffusivity of compound in water, cm^2/s (chemical-specific)

u = Average stream velocity, 0.46 m/s

d_z = Average water body depth, 0.61 m

and,

$$k_d = \left[\frac{(X_e\ WA_L\ SD\ 10^3\ g/kg) - (Vf_x\ TSS)}{WA_w\ TSS} \right] \left(\frac{TSS\ 10^{-6}\ kg/mg}{BS\ d_b} \right)$$

where X_e = Unit soil loss, kg/m^2 per year

WA_L = Watershed area, $7.36 \times 10^7\ m^2$

SD = Watershed sediment delivery ratio, unitless (= 0.12)

Vf_x = Average water body volumetric flow rate, $1.34 \times 10^7\ m^3/yr$

TSS = Total suspended solids, mg/L (default = 10)

WA_w = Water body surface area, $9.15 \times 10^4\ m^2$

BS = Benthic solids concentration, kg/L (default = 1)

d_b = Depth of upper benthic sediment layer, m (default = 0.03)

and,

$$X_e = RF\ K\ LS\ C\ P\ \frac{907.18}{4047}$$

where RF = USLE rainfall factor, yr^{-1} (default = 300)

K = USLE erodibility factor (default = 0.36 tons/acre)

LS = USLE length-slope factor (default = 1.5)

C = USLE cover management factor (default = 0.1)

P = USLE supporting practice factor (default = 1)

and,

$$SD = a\ (WA_L)^{-b}$$

where a = Empirical intercept coefficient (a = 1.2 for $WA_L \leq$ 100 sq miles)

WA_L = Watershed area, 7.36×10^7 m^2

b = 0.125.

Reference: U.S. EPA (1994)

5.12 SUMMARY OF ACTION LEVEL EVALUATIONS

The risk and regulatory-based action levels were compared to media-specific contaminant concentrations to determine which contaminants may require further investigation. The maximum contaminant concentration was compared to the action level. In addition, if the chemical-specific 95% UCL of the arithmetic mean concentration of a SWMU sample population was three times higher than the 95% UCL of the mean background concentration for the same chemical, the 95% UCL chemical-specific concentration was also compared to the action levels.

Table 5-1 shows the results of these comparisons. For the surface water pathway, only mercury was present at a 95% UCL concentration greater than the action level (within a factor of 1.2). For soils, the 95% UCL concentrations of arsenic and silver at CAMA-1 were greater than their respective action levels, generally within a factor of 2.0 to 2.3. In the case of groundwater, the 95% UCL of silver at SWMU-3 was greater than the action level, and this was within a factor of 1.2. It should be noted that the soil action level for arsenic is driven by incidental ingestion of soil, while the soil action level for silver is driven by leaching to groundwater with both metals having a target groundwater concentration equal to the CCL of one-half the solubility limit.

Additionally, all quantified contaminants were compared to applicable regulatory limits. These included the North Carolina Class C surface water standards and the Federal Clean Water Act Ambient Water Quality Criteria for Fish Consumption. A

TABLE 5-1. SUMMARY OF ACTION LEVEL EXCEEDANCES

Chemical	Medium	Location	Conc. Units	Action Level	Maximum Conc.	95% UCL Conc.	95% UCL Background Conc.	Maximum Conc. > Action Level	95% UCL > 3 X Background and > Action Level
Arsenic	Soil	CAMA1	mg/kg	3.82	18.60	8.90	2.57	yes	yes
Arsenic	Soil	SWMU3	mg/kg	3.82	12.20	4.36	2.57	yes	no
Arsenic	Soil	SWMU9	mg/kg	3.82	5.90	1.97	2.57	yes	no
Benzo(a)pyrene	Soil	SWMU9	µg/kg	784.00	1,650.00	608.65	173.97	yes	no
Beryllium	Soil	CAMA1	mg/kg	1.33	2.00	1.53	0.74	yes	no
Beryllium	Soil	SWMU3	mg/kg	1.33	1.90	1.48	0.74	yes	no
Beryllium	Soil	SWMU9	mg/kg	1.33	1.70	0.87	0.74	yes	no
Lead	Groundwater	SWMU3	µg/L	75.00	106.00	29.87	6.43	yes	no
Lead	Groundwater	SWMU9	µg/L	75.00	90.70	30.82	6.43	yes	no
Methylene chloride	Soil	SWMU9	µg/kg	1,994.53	2,500.00	1,011.88	3.99	yes	no
Mercury	Surface Water	Lower Creek	µg/L	0.01	0.02	0.01	0.00	yes	yes
Silver	Soil	CAMA1	mg/kg	0.59	6.30	1.14	0.18	yes	yes
Silver	Groundwater	CAMA1	µg/L	3.45	4.20	0.96	0.85	yes	no
Silver	Groundwater	SWMU3	µg/L	3.45	24.70	4.25	0.85	yes	yes

comparison was also made to the applicable 50 percent odor threshold, one-half the solubility limit, and 1,000 times the NCAC 2L.0200 standard as specified in NCDEHNR (1996). Table 5-2 gives the results of these comparisons. In only two cases were these standards surpassed. The first case is for mercury when compared to the Class C surface water standard; this exceedance was within a factor of 1.2. The second is for the case of silver with respect to one-half the solubility limit in groundwater. This occurred at SWMU-3 and again the exceedance was within a factor of 1.2.

TABLE 5-2. MEDIA CONCENTRATIONS COMPARED TO REGULATORY STANDARDS

Chemical	CAS No.	CAMA 1 indoor air conc. > 50% odor threshold (yes/no)	SWMU 3 indoor air conc. > 50% odor threshold (yes/no)	SWMU 9 indoor air conc. > 50% odor threshold (yes/no)	CAMA 1 groundwater conc. > 0.5 x solubility in water (yes/no)	CAMA 1 groundwater conc. > 1,000 x NCAC 2L.0200 GW standard (yes/no)	SWMU 3 groundwater conc. > 0.5 x solubility in water (yes/no)	SWMU 3 groundwater conc. > 1,000 x NCAC 2L.0200 GW standard (yes/no)	SWMU 9 groundwater conc. > 0.5 x solubility in water (yes/no)	SWMU 9 groundwater conc. > 1,000 x NCAC 2L.0200 GW standard (yes/no)	Downstream surface water conc. > NCAC 2B .0211 Class C Surface Water Quality Standards (mg/L)	Downstream surface water conc. > Federal Ambient Water Quality Criteria for Fish consumption, AWQC-F (mg/L)
1,1-Dichloroethene	75-34-3				no	no	no	no	no	no		
1,4-Dioxane	123-91-1				no	no	no	no	no	no		
1,4-Naphthoquinone (Naphthalene as surrogate)	130-15-4	no										
2,4,5-T	93-76-5											
2-Butanone (MEK)	78-93-3			no								
2-Methylnaphthalene (Naphthalene as surrogate)	91-57-6			no								
4,4' DDD	72-54-8											
Acenaphthene	83-32-9			no	no	no	no	no	no	no		
Acetone	67-64-1	no	no	no	no	no	no	no	no	no		
Aldrin	309-00-2		no									
alpha-Chlordane (Chlordane as surrogate)	5103-71-9			no								
Anthracene	120-12-7											
Antimony	7440-36-0				no	no	no	no	no	no		
Arsenic	7440-38-2				no	no	no	no	no	no		
Barium	7440-39-3				no	no	no	no	no	no		
Benzene	71-43-2				no	no	no	no	no	no		
Benzo(a)pyrene	50-32-8											
Benzo(b)fluoranthene	205-99-2											
Benzo(g,h,i)perylene (Pyrene as surrogate)	191-24-2											
Benzo(k)fluoranthene	207-08-9											
Beryllium	7440-41-7				no	no	no	no	no	no	no	no
Bis(2-ethylhexyl)phthalate	117-81-7				no	no	no	no	no	no		
Butylbenzylphthalate	85-68-7				no	no	no	no	no	no		
Cadmium	7440-43-9				no	no	no	no	no	no	no	no
Chromium	7440-47-3				no	no	no	no	no	no		
Chrysene	218-01-9											
Cobalt	7440-48-4				no	no	no	no	no	no		
Copper	7440-50-8				no	no	no	no	no	no		
Di-n-butylphthalate	84-74-2				no	no	no	no	no	no		
Di-n-octyl phthalate	117-84-0											
Dibenzofuran	132-64-9											
Diethylphthalate	84-66-2				no	no	no	no	no	no		
Endosulfan II	33213-65-9				no	no	no	no	no	no		
Fluoranthene	206-44-0											
Fluorene	86-73-7											
Formaldehyde	50-00-0				no	no	no	no	no	no		
Heptachlor epoxide	1024-57-3				no	no	no	no	no	no		
Iron	7439-89-6				no	no	no	no	no	no		
Isodrin (as Aldrin)	465-73-6				no	no	no	no	no	no		
Lead	7439-92-1				no	no	no	no	no	no	no	no
m,p-Xylene	1330-20-7			no								
Mercury	7439-97-6				no	no	no	no	no	no	yes	no
Methylene Chloride	75-09-2	no		no	no	no	no	no	no	no		
N-Nitrosomorpholine (N-Nitrosopyrrolidine as surrogate)	59-89-2				no	no	no	no	no	no		
Naphthalene	91-20-3			no								
Nickel	7440-02-0				no	no	no	no	no	no	no	no
Phenanthrene (Pyrene as surrogate)	85-01-8											
Pyrene	129-00-0											
Selenium	7782-49-2				no	no	no	no	no	no	no	no
Silver	7440-22-4				no	no	yes	no	no	no		
Thallium	7440-28-0				no	no	no	no	no	no		
Tin	7440-31-5				no	no	no	no	no	no		
Toluene	108-88-3										no	no
Trichloroethene	79-01-6				no	no	no	no	no	no		
Vanadium	7440-62-2				no	no	no	no	no	no		
Zinc	7440-66-6				no	no	no	no	no	no		

*A blank cell indicates that the contaminant was either not detected in the applicable medium, or that there is no standard.

References:

Land, C. E. 1971. Confidence intervals for linear functions of the normal mean and variance. *Annals of Mathematical Statistics*, 42:1187-1205.

Land, C. E. 1975. Tables of confidence limits for linear functions of the normal mean and variance, in Selected Tables in *Mathematical Statistics*, Vol. III. American Mathematical Society, Providence, Rhode Island, pp. 384-419.

Massachusetts DEP. 1994. Background Documentation for the Development of the MCP Numerical Standards. Massachusetts Department of Environmental Protection. April 1994.

NC DEHNR (North Carolina Department of Environment, Health, and Natural Resources). 1996. North Carolina Risk Analysis Framework, Methods for Determining Target Concentrations in Soil & Groundwater - Draft. Risk-based Protocol Working Group. November 1996.

U.S. EPA (Environmental Protection Agency). 1988. Superfund Exposure Assessment Manual. OSWER Directive 9285.5-1. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-88/001.

U.S. EPA (Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund (RAGS): Volume 1: Human Health Evaluation Manual (HHEM), Part A, Interim Final. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

U.S. EPA (Environmental Protection Agency). 1990. Exposure Factors Handbook - and Supplements. Office of Health and Environmental Assessment. EPA/600/8-89/043.

U.S. EPA (Environmental Protection Agency). 1991. Human Health Evaluation Manual (HHEM), Supplemental Guidance: Standard Default Exposure Factors. Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.6-03.

U.S. EPA (Environmental Protection Agency). 1991a. Risk Assessment Guidance for Superfund (RAGS): Volume 1: Human Health Evaluation Manual (HHEM), Part B, Development of Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.7-01B.

U.S. EPA (Environmental Protection Agency). 1992. Dermal Exposure Assessment: Principles and Applications - Interim Report. Office of Research and Development, Cincinnati, Ohio. EPA/600/8-91/011B.

U.S. EPA (Environmental Protection Agency). 1992a. Supplemental Guidance to RAGS: Calculating the Concentration Term. Publication 9285.7-081. Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. EPA (Environmental Protection Agency). 1994. Exit Criteria for the Hazardous Waste Identification Rule - Review Draft. Office of Solid Waste and Emergency Response, Washington, D.C., February 1994.

U.S. EPA (Environmental Protection Agency). 1994a. User's Guide for Wastewater Treatment Compound Property Processor and Air Emissions Estimator (WATER8). Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA-453/C-94-080C.

U.S. EPA (Environmental Protection Agency). 1995. Supplemental Guidance to RAGS, Human Health Risk Assessment Bulletin No. 2, Toxicity Assessment. U.S. Environmental Protection Agency Region IV, Atlanta, Georgia. November 1995.

U.S. EPA (Environmental Protection Agency). 1996. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-96/128.

U.S. EPA (Environmental Protection Agency). 1996a. Superfund Chemical Data Matrix. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-96/028.

U.S. EPA (Environmental Protection Agency). 1996b. Personal communication with Ms. Lydia K. Dow of the U.S. Environmental Protection Agency, Region IV, Water Quality Standards Section regarding updated Clean Water Act Section 304(a) criteria. By facsimile, December 11, 1996.

U.S. EPA (Environmental Protection Agency). 1996c. Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule, Part V. 40 CFR Ch. 1. 61 FR 19432. May 1, 1996.

SECTION 6

RISK EVALUATION

Media-specific concentrations at the Singer site were not only compared to risk based and regulatory action levels, but a risk evaluation was also performed. The risk evaluation included calculation of pathway-specific incremental risks and hazard quotients for each applicable contaminant; aggregate risks and hazard indices were also calculated across pathways to generate a total site risk and hazard index.

The following methodology was used to perform the risk evaluation. The methodology incorporates the use of media-specific concentrations representing the 95% UCL of the arithmetic mean concentration for the SWMU specific chemical assuming a lognormal distribution (Land, 1971 and 1975). Using these data, exposure point concentrations were calculated for each SWMU for each exposure pathway. With the applicable exposure point concentrations, the pathway-specific incremental risk was calculated for each carcinogenic contaminant; likewise, the pathway-specific hazard quotient for each noncarcinogenic contaminant was also calculated. As with the action levels, the incremental risks and hazard quotients were determined based on RME in the commercial/industrial setting.

As described in the supplemental guidance to RAGS (U.S. EPA, 1992a), chronic exposure to site contaminants is best represented by an average concentration. If an individual is assumed to move randomly across an exposure area overtime, spatially averaged exposure point concentrations are used to characterize risk, especially for the future land-use scenario. Therefore, the following procedure was used to estimate the total site aggregate risk and hazard index:

1. The incremental risk and/or hazard quotient was calculated for each applicable contaminant for each exposure pathway at each SWMU.

2. The aggregate risk and hazard index was calculated for each exposure pathway for each SWMU. It was conservatively assumed that each

noncarcinogenic contaminant has the same toxic endpoint and/or mechanism of action.

3. For each exposure pathway, an average aggregate risk and average hazard index were calculated using equally weighted (1/3 SWMU3, 1/3 SWMU9, and 1/3 CAMA1) values across all applicable SWMUs.

4. The total site aggregate risk and hazard index were calculated as the sum the average exposure pathway risks and hazard indices, respectively.

As with calculation of the action levels, the following represent the human exposure pathways used in the risk evaluation:

- Outdoor inhalation of volatiles from soils (onsite)
- Indoor inhalation of volatiles from groundwater (onsite)
- Indoor inhalation of volatiles migrating from soil to groundwater (onsite)
- Inhalation of respirable particulates (PM_{10}) from wind-eroded soils (onsite)
- Incidental ingestion of soil (onsite)
- Ingestion of contaminated fish (offsite).

Chemical/physical properties and toxicity values for each contaminant were derived from the same references and procedures as those used to determine the action levels (see page 5-25).

Fate and transport models used to derive exposure point concentrations were identical to those used to determine the action levels (see page 5-25). These models, however, were used to forward-calculate exposure point concentrations. These concentrations were then incorporated into standardized calculations to estimate incremental risks and hazard quotients.

6.1 CALCULATION OF RISKS FROM DIRECT SOIL INGESTION

The following represents the procedures used to calculate the incremental cancer risk for incidental direct ingestion of contaminated surface soils:

$$Risk = \frac{C_s \times 10^{-3}\ mg/\mu g \times IR_s \times 10^{-6}\ kg/mg \times EF \times ED \times SF_o}{BW \times AT_c \times 365\ days/yr}$$

where C_s = Surface soil concentration, μg/kg (chemical-specific)

IR_s = Soil ingestion rate, 50 mg/day

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

SF_o = Oral slope factor, $(mg/kg\text{-}day)^{-1}$ (chemical-specific)

BW = Body weight, 70 kg

AT_c = Averaging time for carcinogens, 70 yr.

The following represents the procedures used to calculate the hazard quotient (HQ) for incidental direct ingestion of contaminated surface soils:

$$HQ = \frac{C_s \times 10^{-3}\ mg/\mu g \times IR_s \times 10^{-6}\ kg/mg \times EF \times ED \times \frac{1}{RfD}}{BW \times AT_{nc} \times 365\ days/yr}$$

where C_s = Surface soil concentration, μg/kg (chemical-specific)

IR_s = Soil ingestion rate, 50 mg/day

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfD = Oral reference dose, mg/kg-day (chemical-specific)

BW = Body weight, 70 kg

AT_{nc} = Averaging time for noncarcinogens, 25 yr.

References: U.S. EPA (1996)

6.2 CALCULATION OF RISKS FROM INHALATION OF VOLATILES IN OUTDOOR AIR

The following represents the procedures used to calculate the incremental cancer risk from inhalation of volatile contaminants diffusing to outdoor air from contaminated subsurface soils.

Calculation of the outdoor ambient air exposure point concentration (C_{air}) in units of mg/m^3:

$$C_{air} = \frac{1}{Q/C} \times 10^6\ mg/kg \times 10^4\ cm^2/m^2 \times \frac{C_s \times 10^{-9}\ kg/\mu g \times 2 \times D_A \times \rho_b}{(3.14 \times D_A \times T)^{0.5}}$$

where Q/C = Inverse of the mean ambient air concentration at the center of a 0.5 acre area source, 68.81 g/m^2-s per kg/m^3

C_s = Subsurface soil concentration, μg/kg (chemical-specific)

D_A = Apparent diffusivity, cm^2/s

ρ_b = Soil dry bulk density, 1.5 g/cm^3

T = Exposure interval, 7.9 x 10^8 seconds

and,

$$D_A = \frac{\left[\left(\theta_a^{10/3} D_i H' + \theta_w^{10/3} D_w\right)/n^2\right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

where Θ_a = Soil air-filled porosity, 0.284

D_i = Diffusivity in air, cm^2/s (chemical-specific)

H' = Henry's law constant, unitless (chemical-specific)

Θ_w = Soil water-filled porosity, 0.150

D_w = Diffusivity in water, cm^2/s (chemical-specific)

n = Total soil porosity, 0.434

ρ_b = Soil dry bulk density, 1.5 g/cm^3

K_d = Soil/water partition coefficient, cm^3/g ($=K_{oc} \times f_{oc}$)

K_{oc} = Soil organic carbon partition coefficient, cm^3/g (chemical-specific)

f_{oc} = Organic carbon content of soil, 0.006 g/g.

Because the emission model used to calculate C_{air} operates under the assumption of an infinitely deep source of emissions, the model is subject to mass balance violations under certain conditions. To eliminate this possibility, a mass-limit outdoor air volatile concentration (C_{air-m}) in units of mg/m^3 is calculated as:

$$C_{air-m} = \frac{C_s \times 10^{-9}\ kg/\mu g \times \rho_b \times 10^6\ mg/kg \times d_s}{ED \times 3.15E{+}07\ s/yr} \times \frac{1}{Q/C} \times 10^6\ mg/kg$$

where C_s = Subsurface soil concentration, $\mu g/kg$ (chemical-specific)

ρ_b = Soil dry bulk density, 1.5 Mg/m^3

d_s = Average source depth, 2.7432 m (= average depth to groundwater)

ED = Exposure duration, 25 yr

Q/C = Inverse of the mean ambient air concentration at the center of a 0.5 acre area source, 68.81 g/m^2-s per kg/m^3.

If the value of C_{air-m} is less than the value of C_{air}, the final outdoor ambient air exposure point concentration is set equal to C_{air-m}. With the exposure point concentration in outdoor air, the incremental cancer risk from inhalation of volatiles in outdoor air is calculated as:

$$Risk = \frac{C_{air} \times 10^3\ \mu g/mg \times URF \times EF \times ED}{AT_c \times 365\ days/yr}$$

where C_{air} = Final air concentration, mg/m^3 (chemical-specific)

URF = Unit risk factor, $(\mu g/m^3)^{-1}$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

AT_c = Averaging time for carcinogens, 70 yr.

The hazard quotient from inhalation of volatiles in outdoor air is calculated as:

$$HQ = \frac{C_{air} \times EF \times ED \times \frac{1}{RfC}}{AT_{nc} \times 365\ days/yr}$$

where C_{air} = Final air concentration, mg/m^3 (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfC = Reference concentration, mg/m^3 (chemical-specific)

AT_{nc} = Averaging time for noncarcinogens, 25 yr.

References: U.S. EPA (1996)

6.3 CALCULATION OF RISKS FROM INHALATION OF OUTDOOR PARTICULATE MATTER

The following represents the procedures used to calculate the incremental cancer risk and hazard quotient from inhalation of contaminated particulate matter in outdoor air caused by wind erosion.

Calculation of the outdoor ambient air exposure point concentration (C_{air}) of contaminated particulate matter in units of mg/m^3:

$$C_{air} = \left[\frac{0.036 \ x \ (1-V) \ x \ (U_m/U_t)^3 \ x \ F(x) \ x \ C_s \ x \ 10^{-9} \ kg/\mu g}{3{,}600 \ s/h}\right] x \ \frac{1}{Q/C} \ x \ 10^6 \ mg/kg$$

where V = Fraction of vegetative cover (default = 0.5)

U_m = Mean annual windspeed (default = 4.69 m/s)

U_t = Equivalent threshold value of windspeed at 7 m (default = 11.32 m/s)

F(x) = Function of (x) (default = 0.194)

C_s = Surface soil concentration, μg/kg (chemical-specific)

Q/C = Inverse of the mean concentration at the center of a 0.5 acre area source, 90.80 g/m^2-s per kg/m^3.

With the exposure point concentration of particulate matter in outdoor air, the incremental cancer risk from inhalation is calculated as:

$$Risk = \frac{C_{air} \times 10^3\ \mu g/mg \times URF \times EF \times ED}{AT_c \times 365\ days/yr}$$

where C_{air} = Air concentration of particulate matter, mg/m^3 (chemical-specific)

URF = Unit risk factor, $(\mu g/m^3)^{-1}$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

AT_c = Averaging time for carcinogens, 70 yr.

The hazard quotient for inhalation of contaminated particulate matter in outdoor air is calculated as:

$$HQ = \frac{C_{air} \times EF \times ED \times \frac{1}{RfC}}{AT_{nc} \times 365\ days/yr}$$

where C_{air} = Air concentration of particulate matter, mg/m^3 (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfC = Reference concentration, mg/m^3 (chemical-specific)

AT_{nc} = Averaging time for noncarcinogens, 25 yr.

References: U.S. EPA (1996)

6.4 CALCULATION OF RISKS FROM INHALATION OF VOLATILES FROM SOIL-TO-GROUNDWATER-TO-INDOOR AIR

The following represents the procedures used to calculate the risks from inhalation of volatiles in indoor air caused by leaching of contamination from soil to groundwater and subsequent diffusion and advection of vapors into a hypothetical structure.

Calculation of the indoor air concentration (C_{air}) in units of mg/m^3:

$$C_{air} = \left[\frac{C_s \times 10^{-3}\ mg/\mu g}{\left(K_d + \frac{\theta_w + \theta_a H'}{\rho_b} \right) df} \right] \times \left[a \times d \times \left(\frac{H}{R \times T} \right) \times 10^3\ L/m^3 \right]$$

where

C_s	=	Subsurface soil concentration, μg/kg (chemical-specific)
K_d	=	Soil/water partition coefficient, L/kg (chemical-specific)
Θ_w	=	Vadose zone soil water-filled porosity, 0.30
Θ_a	=	Vadose zone soil air-filled porosity, 0.13
H'	=	Henry's law constant, unitless (chemical-specific)
ρ_b	=	Vadose zone soil dry bulk density, 1.5 Kg/L
df	=	Default dilution factor, unitless (=20)
a	=	Default attenuation factor, unitless (=0.0005)
d	=	Default modification factor, unitless (=0.1)
H	=	Henry's law constant, atm-m^3/mol (chemical-specific)
R	=	Molar gas constant, atm-m^3/mol-°K (=8.205E-05)
T	=	Temperature, °K (=285)

and for organics,

$$K_d = K_{oc} \times f_{oc}$$

where K_{oc} = Organic carbon partition coefficient, L/kg (chemical-specific)

f_{oc} = Default organic carbon content of vadose zone soil, 0.001 g/g

and for inorganics,

$$K_d = K_{d,i}$$

where $K_{d,i}$ = Inorganic soil/water partition coefficient, L/kg (chemical-specific).

As with the outdoor air concentration due to volatilization from soils, calculation of the indoor air concentration originating from contaminated soils is subject to mass balance violations because of the assumption of an infinite source. To avoid a mass balance violation, the indoor air concentration corresponding to leaching and subsequent volatilization of the entire mass of soil contamination over the exposure duration (C_{air-m}) is calculated in units of mg/m^3 as:

$$C_{air-m} = \left[\frac{\rho_b \times d_s \times C_s \times 10^{-3}\ mg/\mu g}{I \times ED}\right] \times \left[a \times d \times \left(\frac{H}{R \times T}\right) \times 10^3\ L/m^3\right]$$

where ρ_b = Vadose zone soil dry bulk density, 1.5 kg/L

d_s = Average depth to groundwater, m (=2.7432)

C_s = Subsurface soil concentration, mg/kg (chemical-specific)

I = Average infiltration rate, m/yr (=0.22)

ED = Exposure duration, 25 yr

a = Default attenuation factor, unitless (=0.0005)

d = Default modification factor, unitless (=0.1)

H = Henry's law constant, atm-m^3/mol (chemical-specific)

R = Molar gas constant, atm-m^3/mol-°K (=8.205E-05)

T = Default temperature, °K (=285).

If the value of C_{air-m} is less than the value of C_{air}, the final indoor air concentration is set equal to C_{air-m}.

With the final value of the indoor air exposure point concentration, the incremental cancer risk is calculated as:

$$Risk = \frac{C_{air} \times 10^3\ \mu g/mg \times EF \times ED \times URF}{AT_c \times 365\ day/yr}$$

where C_{air} = Final indoor air concentration, mg/m^3 (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

URF = Unit risk factor, $(\mu g/m^3)^{-1}$ (chemical-specific)

AT_c = Averaging time for carcinogens, 70 yr.

The hazard quotient for inhalation of volatiles in indoor air with contamination originating in subsurface soil is calculated as:

$$HQ = \frac{C_{air} \times EF \times ED \times \frac{1}{RfC}}{AT_{nc} \times 365\ days/yr}$$

where C_{air} = Final indoor air concentration, mg/m^3 (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfC = Reference concentrations, mg/m^3 (chemical-specific)

AT_{nc} = Averaging time for noncarcinogens, 25 yr.

References: U.S. EPA (1996) and NCDEHNR (1996)

6.5 CALCULATION OF RISKS FROM INHALATION OF VOLATILES FROM GROUNDWATER-TO-INDOOR AIR

The following represents the procedures used to calculate the risks from inhalation of volatiles in indoor air caused by diffusion and advection of vapors emanating from contaminated groundwater into a hypothetical structure.

Calculation of the indoor air concentration (C_{air}) in units of μg/m^3:

$$C_{air} = C_w \times a \times d \times \left(\frac{H}{R \times T}\right) \times 10^3\ L/m^3$$

where C_w = Groundwater concentration, μg/L (chemical-specific)

a = Default attenuation factor, unitless (=0.0005)

d = Default modification factor, unitless (=0.1)

H = Henry's law constant, atm-m^3/mol (chemical-specific)

R = Molar gas constant, atm-m^3/mol-°K (=8.205E-05)

T = Default temperature, °K(=285).

With the indoor air concentration, the incremental cancer risk is calculated as:

$$Risk = \frac{C_{air} \times EF \times ED \times URF}{AT_c \times 365\ days/yr}$$

where C_{air} = Indoor air concentration, $\mu g/m^3$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

URF = Unit risk factor, $(\mu g/m^3)^{-1}$ (chemical-specific)

AT_c = Averaging time for carcinogens, 70 yr.

The hazard quotient for inhalation of volatiles in indoor air with contamination originating in the groundwater is calculated as:

$$HQ = \frac{C_{air} \times 10^{-3}\ mg/\mu g \times EF \times ED \times \frac{1}{RfC}}{AT_{nc} \times 365\ days/yr}$$

where C_{air} = Indoor air concentration, $\mu g/m^3$ (chemical-specific)

EF = Exposure frequency, 250 days/yr

ED = Exposure duration, 25 yr

RfC = Reference concentration, mg/m^3 (chemical-specific)

AT_{nc} = Averaging time for noncarcinogens, 25 yr.

References: NCDEHNR (1996)

6.6 CALCULATION OF RISKS FROM RECREATIONAL FISHING IN THE LOWER CREEK

As discussed in Section 5.3 the recreational fishing indirect exposure pathway was considered for off-site exposure to possible surface water contamination. Three surface water sampling locations were used to determine background concentrations (upstream) and site-contributed surface water concentrations (downstream). Surface water samples SW-1 and SW-5 were used to determine downstream concentrations, while surface water sample SW-3 represented background concentrations.

SW-1 consisted of one sampling event from the Lower Creek below SWMU-1 and on the Singer property side of the stream. SW-5 consisted of two sampling events within the marsh area near monitoring wells W-1, CAMA1-6SP and CAMA1-6WT. SW-3 consisted of one sampling event above SWMU-1, again on the Singer property side of the stream.

Surface water within the marsh area represented by the SW-5 samples is segregated from the Lower Creek by a berm created to cover a sewage line that runs between the marsh and the stream. The elevation of the berm prevents intermixing of the two surface water bodies except during flood events. The available groundwater monitoring data from the wells closest to the marsh demonstrate that the contaminants found in the marsh are not migrating to Lower Creek via the groundwater pathway. Therefore, the marsh surface water concentrations represented by SW-5 were time-averaged to account for a total of three 10-year flood events over an exposure duration of 30 years. The time-averaged contribution of the SW-5 surface water concentrations to the Lower Creek concentration ($C_{wt}^{t\text{-}ave}$) in units of μg/L was calculated as:

$$C_{wt}^{t\text{-}ave} = \left[\frac{A_{sw} \times d_{sw} \times C_{wt} \times 10^3\ L/m^3}{Q_f^{10} \times \tau_f}\right] \times \left[\frac{(ED/10) \times \tau_f}{ED \times 24\ h/day \times 365\ days/yr}\right]$$

where A_{sw} = Average area of marsh represented by SW-5, m^2 (=966.16)

d_{sw} = Average depth of marsh surface water during a 10-year flood event, m (=1.707)

C_{wt} = Maximum concentration of the two SW-5 marsh surface water samples, μg/L (chemical-specific)

Q_f^{10} = 10-year floodway flow rate, L/h (=6,338,016)

τ_f = 10-year flood event duration, h (=24)

ED = Exposure duration, 30 yr.

The value of $C_{wt}^{t\text{-}ave}$ was then added to the concentration of SW-1 to derive a final downstream concentration (C_{wt}^{ave}). If the final downstream concentration of each contaminant was greater than three times the applicable upstream concentration, the contaminant was included in the risk evaluation.

The nearest downstream location at which public access allows for fishing was determined to be approximately one-half mile (805 meters). To account for loss of contaminants due to volatilization and/or burial within the benthic sediments across this distance, the overall water body dissipation rate constant (K_{wt}) is units of $(yr)^{-1}$ was calculated as:

$$K_{wt} = (f_{water}\ k_v) + (f_{benth}\ k_d)$$

where f_{water} = Fraction of total water body concentration occurring in the water column (unfiltered stream water fraction = 1) (chemical-specific)

k_v = Water column volatilization rate constant, yr^{-1} (chemical-specific)

f_{benth} = Fraction of total water body concentration occurring in benthic sediments (sediment fraction = 0) (chemical-specific)

k_d = Benthic burial rate constant, yr^{-1} (chemical-specific)

and,

$$k_v = \frac{K_v}{d_z\left(1 + Kd_{sw}\ TSS\ 10^{-6}\ kg/mg\right)}$$

where K_v = Overall volatilization transfer rate, m/yr

d_z = Average water body depth, 0.61 m

Kd_{sw} = Suspended sediment/surface water partition coefficient, L/kg = K_{oc} x foc_{sw}; foc_{sw} = 0.075 (default)

TSS = Total suspended solids, mg/L (default = 10)

and,

$$K_v = \left[K_L^{-1} + \left(K_G\ \frac{H}{RT}\right)^{-1}\right]^{-1}$$

where K_L = Liquid-phase transfer coefficient, m/yr

K_G = Default gas-phase transfer coefficient, = 36,500 m/yr

H = Henry's law constant, atm-m^3/mol (chemical-specific)

R = 8.205×10^{-5} atm-m^3/mol-°K

T = Default water body temperature, = 298°K

and,

$$K_L = \left(\frac{10^{-4}\ m^2/cm^2\ D_w\ u}{d_z}\right)^{0.5} 3.15 \times 10^7\ s/yr$$

where D_w = Diffusivity of compound in water, cm^2/s (chemical-specific)

u = Average stream velocity, 0.46 m/s

d_z = Average water body depth, 0.61 m

and,

$$k_d = \left[\frac{(X_e\ WA_L\ SD\ 10^3\ g/kg) - (Vf_x\ TSS)}{WA_w\ TSS}\right]\left(\frac{TSS\ 10^{-6}\ kg/mg}{BS\ d_b}\right)$$

where X_e = Unit soil loss, kg/m^2 per year

WA_L = Watershed area, $7.36 \times 10^7\ m^2$

SD = Watershed sediment delivery ratio, unitless (= 0.12)

Vf_x = Average water body volumetric flow rate 1.34×10^7, m^3/yr

TSS = Total suspended solids, mg/L (default = 10)

WA_w = Water body surface area, $9.15 \times 10^4\ m^2$

BS = Benthic solids concentration, kg/L (default = 1)

d_b = Depth of upper benthic sediment layer, m (default = 0.03)

and,

$$X_e = RF\ K\ LS\ C\ P\ \frac{907.18}{4047}$$

where RF = Universal Soil Loss Equation (USLE) rainfall factor, yr^{-1} (default = 300)

K = USLE erodibility factor (default = 0.36 tons/acre)

LS = USLE length-slope factor (default = 1.5)

C = USLE cover management factor (default = 0.1)

P = USLE supporting practice factor (default = 1)

and,

$$SD = a\ (WA_L)^{-b}$$

where a = Empirical intercept coefficient (a = 1.2 for $WA_L \leq$ 100 sq miles)

WA_L = Watershed area, 7.36×10^7 m^2

b = 0.125.

With a calculated value of the overall water body dissipation rate constant (K_{wt}), the downstream surface water concentration at the point of public access (C_{wt-x}) in units of mg/L was calculated as:

$$C_{wt-x} = \exp\left(-K_{wt}\left(\frac{x}{u}\right)\right) x\ C_{wt}^{ave}\ x\ 10^{-3}\ mg/\mu g$$

where K_{wt} = Overall water body dissipation rate constant, $(yr)^{-1}$ (chemical-specific)

x = Downstream distance to point of public access, m (=805)

u = Average stream velocity, 1.45×10^7 m/yr

C_{wt}^{ave} = Average surface water concentration at site, μg/L (chemical-specific).

References: U.S. EPA (1994)

With a surface water concentration at the point of public access, the concentration of contaminant present in the flesh of edible fish was calculated as:

$$C_{fish} = C_{wt\text{-}x} \times BCF$$

where C_{fish} = Concentration in fish, mg/kg_{fish}

$C_{wt\text{-}x}$ = Surface water concentration at the point of public access, mg/L (chemical-specific)

BCF = Bioconcentration factor (3% lipid weighted ave.) L/kg_{fish} (chemical-specific).

The incremental cancer risk from recreational fishing was calculated as:

$$Risk = \frac{C_{fish} \times CR \times EF \times ED \times SF_o}{BW \times AT_c \times 365\ days/yr}$$

where C_{fish} = Concentration in fish, mg/kg_{fish} (chemical-specific)

CR = Consumption rate of fish, kg/day (=0.054)

EF = Exposure frequency, 350 days/yr

ED = Exposure duration, 30 yr

SF_o = Oral slope factor $(mg/kg\text{-}day)^{-1}$ (chemical-specific)

BW = Body weight, 70 kg

AT_c = Averaging time for carcinogens, 70 yr.

The hazard quotient for recreational fishing was calculated as:

$$HQ = \frac{C_{fish} \times CR \times EF \times ED \times \frac{1}{RfD_o}}{BW \times AT_{nc} \times 365\ days/yr}$$

where C_{fish} = Concentration in fish, mg/kg_{fish} (chemical-specific)

CR = Consumption rate of fish, kg/day (=0.054)

EF = Exposure frequency, 350 days/yr

ED = Exposure duration, 30 yr

RfD_o = Oral reference dose, mg/kg-day (chemical-specific)

BW = Body weight, 70 kg

AT_{nc} = Averaging time for noncarcinogens, 30 yr.

References: U.S. EPA (1989)

6.6 SUMMARY OF RISK EVALUATION

Detailed calculations of incremental risks and hazard quotients relating to exposure to soils, groundwater, and surface water can be found in Appendices 6-1, 6-2, and 6-3, respectively.

Table 6-1 summarizes the results of the risk evaluation. As can be seen, the total site incremental caner risk was calculated to be 2.9×10^{-6}, while the total site hazard index was calculated to be 0.12. The preponderance of the potential site cancer risk and the hazard index can be attributed to incidental ingestion of soil. Much

TABLE 6-1. SUMMARY RISK CHARACTERIZATION USING 95% UCL MEDIA CONCENTRATIONS AND PROPORTIONAL EXPOSURE LOCATION ASSUMPTIONS

CAMA 1 aggregate risk from soil ingestion	SWMU 3 aggregate risk from soil ingestion	SWMU 9 aggregate risk from soil ingestion	Average site aggregate risk from soil ingestion	CAMA 1 aggregate risk from inhalation of volatiles in outdoor air	SWMU 3 aggregate risk from inhalation of volatiles in outdoor air	SWMU 9 aggregate risk from inhalation of volatiles in outdoor air	Average site aggregate risk from inhalation of volatiles in outdoor air	CAMA 1 aggregate risk from inhalation of outdoor particulate matter	SWMU 3 aggregate risk from inhalation of outdoor particulate matter	SWMU 9 aggregate risk from inhalation of outdoor particulate matter	Average site aggregate risk from inhalation of outdoor particulate matter
3.7E-06	2.3E-06	2.0E-06	2.7E-06	4.6E-08	7.3E-08	2.7E-08	4.8E-08	8.0E-08	4.3E-08	4.2E-08	5.5E-08
CAMA 1 hazard index from soil ingestion	SWMU 3 hazard index from soil ingestion	SWMU 9 hazard index from soil ingestion	Average site hazard index from soil ingestion	CAMA 1 hazard index from inhalation of volatiles in outdoor air	SWMU 3 hazard index from inhalation of volatiles in outdoor air	SWMU 9 hazard index from inhalation of volatiles in outdoor air	Average site hazard index from inhalation of volatiles in outdoor air	CAMA 1 hazard index from inhalation of outdoor particulate matter	SWMU 3 hazard index from inhalation of outdoor particulate matter	SWMU 9 hazard index from inhalation of outdoor particulate matter	Average site hazard index from inhalation of outdoor particulate matter
1.3E-01	9.4E-02	9.9E-02	1.1E-01	5.4E-03	1.6E-03	6.9E-03	5.0E-03	2.1E-04	2.9E-04	2.0E-04	2.3E-04

(continued)

TABLE 6-1 (continued)

CAMA 1 aggregate risk from soils-to groundwater-to-indoor air	SWMU 3 aggregate risk from soils-to groundwater-to-indoor air	SWMU 9 aggregate risk from soils-to groundwater-to-indoor air	Average site aggregate risk from soils-to groundwater-to-indoor air	CAMA 1 aggregate risk from groundwater-to-indoor air	SWMU 3 aggregate risk from groundwater-to-indoor air	SWMU 9 aggregate risk from groundwater-to-indoor air	Average site aggregate risk from groundwater-to-indoor air
6.5E-09	1.4E-09	1.2E-07	4.4E-08	9.1E-08	4.3E-08	3.8E-09	4.6E-08

CAMA 1 hazard index from soils-to groundwater-to-indoor air	SWMU 3 hazard index from soils-to groundwater-to-indoor air	SWMU 9 hazard index from soils-to groundwater-to-indoor air	Average site hazard index from soils-to groundwater-to-indoor air	CAMA 1 hazard index from groundwater-to-indoor air	SWMU 3 hazard index from groundwater-to-indoor air	SWMU 9 hazard index from groundwater-to-indoor air	Average site hazard index from groundwater-to-indoor air
2.3E-03	6.3E-04	3.4E-03	2.1E-03	8.3E-03	4.5E-03	3.4E-03	5.4E-03

Total site aggregate risk	Total site hazard index	Recreational fisherman aggregate risk	Recreational fisherman hazard index
2.9E-06	1.2E-01	3.9E-08	3.8E-01

of the potential cancer risk can be attributed to arsenic and beryllium, while most of the hazard index can be attributed to arsenic and lead.

Offsite risks were also calculated for the recreational fishing scenario. The total cancer risk was calculated to be 3.9×10^{-6} and is attributed solely to beryllium. The total offsite hazard index was calculated to be 0.38 with the majority of the risk attributable to lead and mercury.

References:

Land, C. E. 1971. Confidence intervals for linear functions of the normal mean and variance. *Annals of Mathematical Statistics*, 42:1187-1205.

Land, C. E. 1975. Tables of confidence limits for linear functions of the normal mean and variance, in Selected Tables in *Mathematical Statistics*, Vol. III. American Mathematical Society, Providence, Rhode Island, pp. 384-419.

Massachusetts DEP. 1994. Background Documentation for the Development of the MCP Numerical Standards. Massachusetts Department of Environmental Protection. April 1994.

NC DEHNR (North Carolina Department of Environment, Health, and Natural Resources). 1996. North Carolina Risk Analysis Framework, Methods for Determining Target Concentrations in Soil & Groundwater - Draft. Risk-based Protocol Working Group. November 1996.

U.S. EPA (Environmental Protection Agency). 1988. Superfund Exposure Assessment Manual. OSWER Directive 9285.5-1. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-88/001.

U.S. EPA (Environmental Protection Agency). 1989. Risk Assessment Guidance for Superfund (RAGS): Volume 1: Human Health Evaluation Manual (HHEM), Part A, Interim Final. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/1-89/002.

U.S. EPA (Environmental Protection Agency). 1990. Exposure Factors Handbook - and Supplements. Office of Health and Environmental Assessment. EPA/600/8-89/043.

U.S. EPA (Environmental Protection Agency). 1991. Human Health Evaluation Manual (HHEM), Supplemental Guidance: Standard Default Exposure Factors. Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.6-03.

U.S. EPA (Environmental Protection Agency). 1991a. Risk Assessment Guidance for Superfund (RAGS): Volume 1: Human Health Evaluation Manual (HHEM), Part B, Development of Preliminary Remediation Goals. Office of Emergency and Remedial Response, Washington, D.C. Publication 9285.7-01B.

U.S. EPA (Environmental Protection Agency). 1992. Dermal Exposure Assessment: Principles and Applications - Interim Report. Office of Research and Development, Cincinnati, Ohio. EPA/600/8-91/011B.

U.S. EPA (Environmental Protection Agency). 1992a. Supplemental Guidance to RAGS: Calculating the Concentration Term. Publication 9285.7-081. Office of Solid Waste and Emergency Response, Washington, D.C.

U.S. EPA (Environmental Protection Agency). 1994. Exit Criteria for the Hazardous Waste Identification Rule - Review Draft. Office of Solid Waste and Emergency Response, Washington, D.C., February 1994.

U.S. EPA (Environmental Protection Agency). 1994a. User's Guide for Wastewater Treatment Compound Property Processor and Air Emissions Estimator (WATER8). Office of Air Quality Planning and Standards. Research Triangle Park, North Carolina. EPA-453/C-94-080C.

U.S. EPA (Environmental Protection Agency). 1995. Supplemental Guidance to RAGS, Human Health Risk Assessment Bulletin No. 2, Toxicity Assessment. U.S. Environmental Protection Agency Region IV, Atlanta, Georgia. November 1995.

U.S. EPA (Environmental Protection Agency). 1996. Soil Screening Guidance: Technical Background Document. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-96/128.

U.S. EPA (Environmental Protection Agency). 1996a. Superfund Chemical Data Matrix. Office of Emergency and Remedial Response, Washington, D.C. EPA/540/R-96/028.

U.S. EPA (Environmental Protection Agency). 1996b. Personal communication with Ms. Lydia K. Dow of the U.S. Environmental Protection Agency, Region IV, Water Quality Standards Section regarding updated Clean Water Act Section 304(a) criteria. By facsimile, December 11, 1996.

U.S. EPA (Environmental Protection Agency). 1996c. Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities; Proposed Rule, Part V. 40 CFR Ch. 1. 61 FR 19432. May 1, 1996.

SECTION 7

CORRECTIVE ACTION OBJECTIVES

Initial evaluation of the proper corrective measures requires consideration of the physical characteristics and geography of the site, as well as the nature and extent of contamination. Once all necessary site characterization has been completed, several factors concerning the potential corrective measures should be evaluated before a commitment is made to a particular approach. The extent of the evaluation will depend on the magnitude of the impacted area and the location of potential receptors. The factors that should be considered when evaluating corrective measure options can be broken down in four categories: 1) technical, 2) institutional, 3) human health and the environment, and 4) costs. Figure 7-1 is a generic flow diagram showing the procedure for deciding the permanent corrective-action approach.

Two aspects of corrective actions determine their desirability from a performance standpoint: effectiveness and useful life. Effectiveness refers to how well the corrective action technology accomplishes its intended purpose, such as containment, diversion, removal, destruction, or treatment. The effectiveness of available alternatives should be determined either through design specifications or by performance evaluation. Useful life refers to the length of time a corrective action technology can maintain the desired level of effectiveness. Some corrective action technologies deteriorate with time. Such deterioration can sometimes be slowed down through proper system operation and maintenance, but the technology may eventually require replacement. Each corrective action alternative should be evaluated in terms of the projected service life of its component technologies.

Two aspects of corrective action technologies that provide information about reliability are operation and maintenance requirements (i.e., frequency and complexity) and demonstrated reliability at similar sites. Demonstrated and expected reliability is a way of measuring the risk and effect of failure. One should evaluate whether the

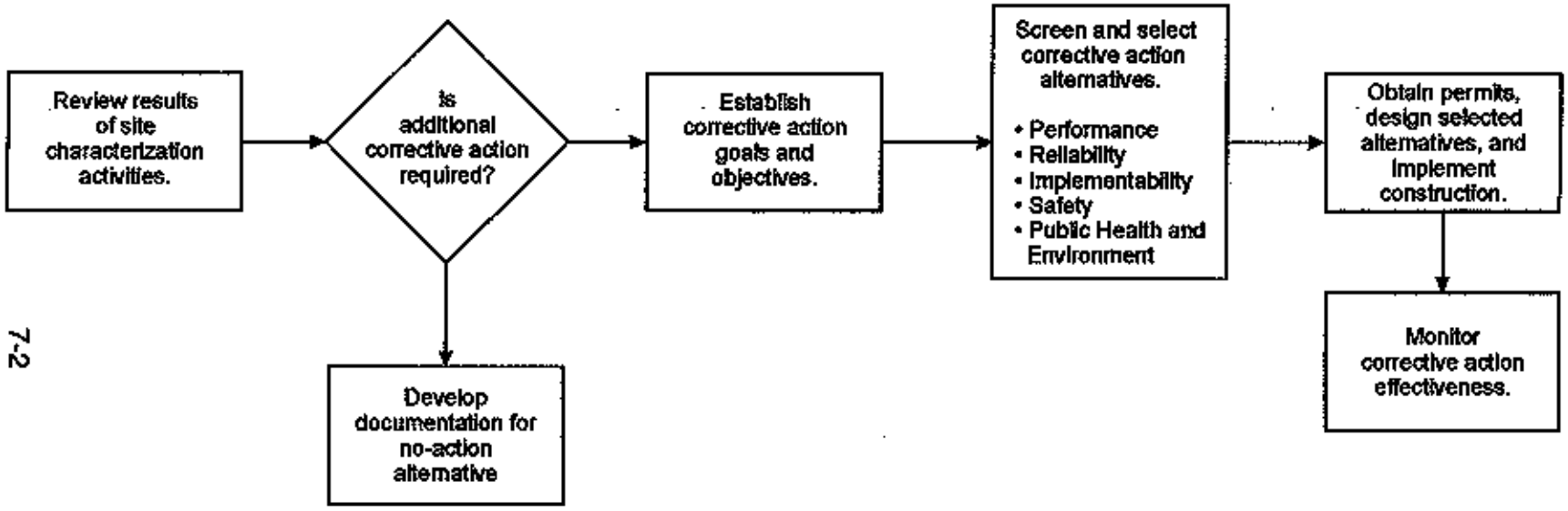

Figure 7-1. Permanent corrective action process.

considered technologies have been used effectively at similar sites; whether a combination of technologies has been used effectively; whether the failure of any one technology has an immediate impact on receptors; and whether the alternative has the flexibility to deal with uncontrollable changes at the site. Another important consideration in the selection process is whether the corrective action can be implemented with relative ease, i.e., whether it can be constructed or installed within the time frame required to achieve the desired results.

The effects of Federal, State, and local standards and other institutional considerations on the implementation and operational timing should be analyzed. In addition to the regulatory requirements in RCRA covering corrective action, regulatory programs under the Safe Drinking Water Act (SDWA), the Federal Water Pollution Control Act (Clean Water Act or CWA), the Toxic Substance Control Act (TSCA), and the CERCLA will often have some impact on corrective actions.

Each corrective action alternative should be evaluated with regard to safety. This evaluation should include threats to the safety of nearby communities and environment as well as those to workers during implementation. Safety factors to consider are fire, explosion, and exposure to hazardous substances. Consideration should be given to the effect on human health and any beneficial or adverse environmental impacts in the selection of corrective actions. The objective should be to improve public health and the environment to the extent that site-specific conditions permit.

Both capital and operation and maintenance costs should be estimated. The estimate should reflect the scale of the planned corrective actions. Estimates for large, long-term corrective action options will require more detail. Application of a particular option is determined by conditions both internal and external to the site, such as the location of underground utilities, depth of the water table, heterogeneity of subsurface materials, and the site itself (i.e., whether it lies in a remote or a congested urban area).

Before a commitment is made to a specific corrective action strategy, the levels of acceptable risk should be established to assist in the determination of criteria for meeting cleanup objectives. Data obtained during the RFI and technology performance

evaluations are used in this determination. An analysis could be made to forecast concentrations of the released substance in the media of concern. Based on toxicity data and regulatory and environmental standards, the relative human and environmental hazard posed by exposure to various concentration levels can be assessed. The combination of the likelihood of exposure to the released substance and the hazard posed by such exposure provides a measurement of the relative risk involved. This relative risk factor can then be used to establish cleanup goals and to assist in the selection and design of appropriate corrective-action technologies.

7.1 PRELIMINARY REMEDIAL ACTION GOALS (PRGs)

The risk- and regulatory-based action levels developed for the RFI are specific to the Singer site and encompass the exposure pathways, exposure assumptions, and fate and transport models that are appropriate given the site conceptual model. It is therefore proposed that the 95 percent upper confidence mean concentration for the quantified compounds serve as the PRGs. Otherwise the PRGs must be refined during a CMS. The CMS would include an analysis of: 1) uncertainties in the exposure assumptions, background concentration, and fate and transport modeling, 2) technical feasibility of potential remedies, 3) long-term effectiveness and permanence of potential remedies, and 4) costs.

Of particular interest is whether the PRGs may be achieved in a feasible manner. As the major purpose of any potential CMS, feasible achievement of the remediation goals necessarily must consider whether the media-specific and contaminant-specific goals (i.e., concentrations) can be met given the state of the current technology and the feasibility of applying a given technology on a site-specific basis. By necessity, these factors must be considered in a potential CMS and may ultimately effect any final remediation goals.

7.2 DESCRIPTION OF POTENTIAL CORRECTIVE MEASURES

This section provides descriptions of corrective measures that may be selected to contain, treat, remediate, and/or dispose of contamination that is identified during the RFI of Singer's Miller Hill Complex. The corrective measures described in this section have been selected based on the current knowledge of the site. As additional data become available, the technologies described herein may no longer be applicable and/or additional technologies may be evaluated as potential corrective measures. The final selection of corrective measures will be made after consulting with the public and the regulatory agencies.

The soil and groundwater could be remediated by several groups of general response actions, as listed in Table 7-1. Under each environmental media and general response action, the technologies that are potentially feasible to treat the site specific contaminants are evaluated based on four criteria: effectiveness, advantages, disadvantages, and cost. The development of these potentially applicable technologies into concept-level corrective measures is presented in Table 7-2. Figure 7-2 summarizes the potential corrective measure technologies evaluation process. Additional data requirements for the further evaluation of corrective measures technologies are also presented in the same figure. Bench scale testing generally involves conducting the treatment process in a reduced scale, simulated environment to determine the treatability of contaminants. Pilot scale testing generally involves reduced scale of operation under actual field conditions to determine the feasibility of the treatment technology applied at the site.

TABLE 7-1. GENERAL RESPONSE ACTION TO BE SCREENED

Environmental media	General response actions	Objectives	Description of action	Potentially applicable technologies
Soil	No Action	Establishes base level for comparison	No action is taken to address the contamination problem	None
	Institutional Controls and Periodic Groundwater monitoring	Prevents future land uses that are unacceptable and verifies contaminants have not exceeded a specified action level	Post closure RCRA permit deed restrictions, security provisions	Fencing/Permit issuance
	Containment	Prevents direct human contact and further groundwater contamination	Contains contaminated soil at original location	Capping
	In-situ treatment	Reduces the extent of contamination in soil	Treats contaminated soil with minimum disturbance of soil	Bioremediation Soil Flushing Soil Vapor Extraction Stabilization/Solidification Vitrification
	Excavation/Treatment	Reduces the extent of contamination in soil	Removes contaminated soil for on-site or off-site treatment	Bioremediation Soil Flushing Stabilization/Solidification Thermal Desorption Thermal Pyrolysis
	Excavation/Disposal	Prevents direct human contact and further groundwater contamination	Removes contaminated soil for off-site disposal	Off-site Landfilling
Groundwater	No Action	Establishes base line level for comparison	No action is taken to address the contamination problem	None
	Institutional Controls and Periodic Groundwater Monitoring	Prevents unacceptance land uses and verifies contaminants have not exceed predetermined action levels	Post closure permit deed restrictions, security provisions	Fencing/Permit issuance
	Containment	Prevent migration of contaminated groundwater	Restricts contaminated groundwater to original location and prevents groundwater flow through contamination	Physical Barrier Hydraulic Barrier
	Extraction/Discharge	Reduce the extent of contamination in groundwater	Extracts groundwater and discharge to an off-site treatment facility or surface water	Discharge to Surface Water Discharge to POTW
	In-situ Treatment	Reduce the extent of contamination in groundwater	Treats contaminated groundwater in place	Bioremediation Oxidation
	Extraction/Treatment/Discharge	Reduce the extent of contamination in groundwater	Extracts groundwater to surface for onsite treatment and discharge	Aeration or Air stripping Biological Treatment Carbon Adsorption Incineration Stream Stripping UV/Oxidation Chemical Treatment

(continued)

TABLE 7-1 (continued)

Environmental media	General response actions	Objectives	Description of action	Potentially applicable technologies
Landfill	No Action	Establishes base line level for comparison	No action is taken to address the contamination problem	None
	Containment	Prevents human contact	Contains Landfill material at original location	Capping, Levees, Floodwalls
	Groundwater control	Prevents further groundwater contamination	Lowers water table and/or diverts flow around contamination	Interceptor Trenches Well Points Sheet Piles Slurry Walls
	Excavation/Disposal	Prevent direct human contact and further groundwater contamination	Remove landfill material for off-site disposal	Excavation Solidification Disposal

TABLE 7-2. EVALUATION OF POTENTIAL APPLICABLE TECHNOLOGIES

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Soil	No Action	None	Monitoring the nature and extent of soil contamination without taking any actions to treat or dispose the contaminated soil	Does not remediate contaminants	Minimum operation and maintenance required Serves as a baseline against which the potential technologies can be measured	Potential release of contaminants to groundwater Potential exposure due to ingestion of soil	Low	Retained for further evaluation
Soil	Institutional Control	Monitoring Permitting	Sampling and Analysis	Does not remediate contaminants unless proven necessary	Easily implemented minimal operation near term status quo	Potential release of contaminants to groundwater and potential exposure due to soil ingestion	Low	Retained for further evaluation
Soil	Containment	Capping	Covering the contaminated soil with an impermeable cap to minimize the surface water contact and, as a result, reducing the amount of infiltration into groundwater	Does not remove or eliminate contaminants; effective to prevent potential release of contaminants form soil into groundwater	Easily implemented Minimum operation and maintenance required	A preventive measure, does not remediate contaminants Restrict future land use; may be unsuitable for site still in operation	Medium	Retained for further evaluation
Soil	In-situ Treatment	Bioremediation	Using naturally occuring microorganisms to decompose contaminants by adding oxygen and nutrients into subsurface to stimulate the growth of microorganisms	Effective in removing many organic and inorganic contaminants	Requires minimum site disruption No waste handling or transportation Permanent removal of certain contaminants from soil	Difficult to predict clean-up time Contamination of soil and groundwater may occur due to the addition of oxygen and nutrients into subsurface Difficult to obtain uniform clean-up Waste product can be degraded into unknown compounds Ineffective for metals	Low to Medium	Retained for further evaluation
Soil	In-situ Treatment	Soil flushing	Flooding the site with appropriate washing solution to elutriate contaminants from soil, and collecting the elutriate with a series of wells or subsurface drains for treatment	Effective in removing organic and inorganics depended upon the chosen of flushing solution	Permanent removal of contaminants from soil Easily apply to permeable soil	May introduce potential toxins into the soil system and alter the properties of the soil system Potential exists to transport contaminants into uncontaminated zone	Low to Medium	Not retained for further evaluation due to the disadvantages of the technology

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Soil	In-situ Treatment	Soil-vapor Extraction	Inducing air flow through the soil by pulling a vacuum on holes drilled into the subsurface, and carrying out volatilized contaminants	Effective in removing medium to high levels of volatile and semi-volatile organic contaminants in unsaturated soil	No solid waste handling or transportation	Difficult to remove low levels of contaminants Air treatment system may be required Difficult to obtain uniform clean-up Ineffective for metals	Low to Medium	Not retained for further evaluation due to low organic content and ineffectiveness on metals
Soil	In-situ Treatment	Stabilization/ Solidification	Mixing contaminated soil with agents that chemically and physically locks the contaminants in a solid matrix with high integrity and low permeability. Customized crane or rotary rig is commonly used to mix soil	Does not remove or eliminate contaminants; applied primarily to metals; mixed results when used to treat organic contaminant in unsaturated soil	No waste transportation costs and liability Improve the physical integrity of treated soil Short clean-up time	Increases the volume of treated soil Vapor capturing and treating system may be necessary Delivering reagents to the subsurface for uniform mixing may be difficult Operation is affected by the weather	Medium	Retained for further evaluation
Soil	In-situ Treatment	Vitrification	A thermal treatment technology which converts soil into an inert glass product by using electric current to pass through contaminated soil	Effective in destroying organic and inorganic wastes of soils containing significant levels of silicate	No waste handling or transportation Short clean-up time The products of this process are long lasting and highly durable	Requiring an adequate power supply Water in soils affects operational time and increases the total cost Special equipment and trained personnel are required	Very High	Not retained for further evaluation because of the high cost of operation and existence of hydric soils
Soil	Excavation/ Treatment	Bioremediation	Employing inherent or inoculated microorganisms to remediate the excavated soil in a reactor where nutrients and oxygen are maintained under optimum conditions	Effective in decomposing most organic contaminants in unsaturated soil	Permanent removal of certain contaminants from soil	Difficult to treat low level of contaminants Waste product can be degraded into unknown compounds Excavation may not be feasible under existing facilities Ineffective for metals	Low to medium	Not retained for further evaluation
Soil	Excavation/ Treatment	Incineration	Burning the contaminated soil at high temperature (1800 to 3000°F) to destroy organic	Effective in destroying organic contaminants; metals do not burn, but concentrate in ash	Permanently eliminate organic contaminants Short clean-up time May be able to utilize on-site blast furnace	Not a stand-alone solution; needs to treat air and dispose ash Excavation may not be feasible under existing facilities	Very High	Not retained for further evaluation because of Low VOC concentration, Ineffectiveness for metals and high costs

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Soil	Excavation/ Treatment	Soil Flushing	Flushing the excavated soil with water or other solvents to leach out contaminants, and then treating the liquid waste	Effective in removing organic and certain inorganic wastes	Appropriate for sandy soil with high permeability Treated soil could be replaced at original location	Not a stand-alone solution; needs to treat or dispose liquid waste Difficult to treat clay and clay-like soils Can only remove soluble contaminants Excavation may not be feasible under existing facilities	Low to Medium	Not retained due to increase volume of waste and ineffectiveness in hydric soils
Soil	Excavation/ Treatment	Stabilization/ Solidification	Mixing contaminated soil with agents that chemically and physically locks the contaminants in a solid matrix with high integrity and low permeability	Does not remove or eliminate contaminants; applied primarily to metals; mixed results when used to treat organic	Improve the physical integrity of treated soil Short clean-up time	Increases the volume of treated soil Need to dispose treated mass Excavation may not be feasible under existing facilities	Medium	Retained for further evaluation
Soil	Excavation/ Treatment	Thermal Desorption	Heating the contaminated soil to drive off volatile contaminants from the soil matrix	Effective in eliminating volatile and semi-volatile organic; certain volatilizable metals	Short clean-up time Treated soil could be replaced at original location	Need to treat emitted air High energy required Ineffective for metals	Very High	Not retained for further evaluation because of cost, ash liability and ineffective for metals
Soil	Excavation/ Treatment	Thermal Pyrolysis	Heating contaminated soil in an oxygen-starved system to separate volatile components from nonvolatile char and ash Infrared radiation is frequently used as the heat source	Effective in eliminating volatile and semi-volatile organic	Short clean-up time	Need to treat emitted air and dispose treated soil High energy required	Very High	Not retained for further evaluation because of the cost and potential liability for ash disposal
Soil	Excavation/ Disposal	Offsite Landfilling	Transporting and disposing contaminated soil in a remote landfill facility	Eliminate site receptor pathways	Removes source from site	Long-term liability Transportation expenses governing the overall cost Does not remediate contaminants	Medium to High	Retained for further evaluation
Ground-water	No Action	None	None	Does not remediate contaminants	Minimal operation and maintenance required Serves as a baseline against which the potential technologies can be measured	Extent of contamination may increase due to unknown contents of landfill	Low	Retained for further evaluation
Ground-water	Institutional control	Security Monitoring	Monitoring the nature and extent of groundwater contamination without taking actions to treat the contaminated groundwater	Does not remediate contaminants	Minimal operation and maintenance required Serves as a baseline against which the potential technologies can be measured	Extent of contamination may increase due to groundwater flow	Low	Retained for further evaluation

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Ground-water	Containment	Physical Barrier	Encapsulating contaminated region with an impermeable barrier to restrict the movement of contaminated groundwater Sheet piling, grouting, and slurry walls are the commonly applied methods	Does not remediate contaminants	Restrict contaminated groundwater in a controlled area	Additional groundwater modeling and monitoring is necessary	Medium to High	Retained for further evaluation
Ground-water	Containment	Hydraulic Barrier	Intercepting groundwater by wells, trenches or drains to halt the migration of contaminated groundwater	Does not remediate contaminants	Restrict contaminated groundwater in a controlled area	May be hindered by site conditions	Low	Retained for further evaluation
Ground-water	Extraction/ Discharge	Discharge to Surface water	Extracting contaminated groundwater and directly discharging into Lower Creek	Organic contaminants may be degraded by naturally occurring microorganisms in surface water	Minimal operation and maintenance required	Require continuously monitoring Need to apply a National Pollutants Discharge Elimination System (NPDES) permit May require treatment	Low	Retained for further evaluation
Ground-water	Extraction/ Discharge	Discharge to POTW	Extracting contaminated groundwater to a public owned treatment facility	Effective in removing most organic and inorganic contaminants	Minimal operation and maintenance required	May require pretreatment Require permitting POTW may not accept large volume of water	Low	Retained for further evaluation
Ground-water	In-situ Treatment	Bioremediation	Consisting of a system of injection and extraction wells to introduce nutrients and microorganisms Waste product can be degraded into unknown compounds	Effective to decompose most organic contaminants Not effective for metal removal	Minimal disturbance to existing site Cost-effective to treat groundwater in shallow aquifer Permanent removal of certain contaminants	Difficult to predict clean-up time May cause additional pollution problem by adding excess nutrients and microorganisms Waste product can be degraded into unknown compounds	Medium	Not retained for further evaluation
Ground-water	In-situ Treatment	Oxidation	Consisting of a system of injection and extraction wells to introduce oxidizing agents to degrade organic contaminants	Effective to decompose most organic contaminants	Minimal disturbance to existing site Cost-effective to treat groundwater in shallow aquifer	May cause additional pollution problem by adding chemicals May increase mobility of metals	Medium	Not retained for further evaluation due to low organic concentration and ineffectiveness on metals

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Ground-water	Extraction/ Treatment	Aeration or Air Stripping	Pumping contaminated groundwater to surface and mixing large volumes of air with the water in an reactor to promote volatilization of contaminants into air	Effective in removing relatively volatile organic	Easy operations Potential VOCs can be effectively removed	Difficult to achieve high level of semi-volatiles removal Emitted air needs to be treated May require pretreatment to remove iron Ineffective for metals	Low	Not retained for further evaluation due to low organic concentration
Ground-water	Extraction/ Treatment	Steam Stripping	Pumping contaminated groundwater to surface and mixing live steam with the water in a packed column to promote volatilization of contaminants into gas phase	Effective in removing volatile and semivolatile organic contaminants	High removal efficiency of volatiles and semivolatiles can be achieved	Treated steam needs to be condensated and treated Air treatment may be required for noncondensable gas contaminants Ineffective for metals	High.	Not retained for further evaluation due to cost factors
Ground-water	Extraction/ Treatment	Carbon Adsorption	Pumping contaminated groundwater to surface and passing the water through carbon column so that organic contaminants are separated from aqueous phase to the solid (carbon) phase	Effective in removing organic and certain inorganic contaminants	High removal efficiency of volatiles and semivolatiles can be achieved	Spent carbon needs to be regenerated or disposed Pretreatment of water to extend the life of carbon may be needed	Low	Retained for further evaluation
Ground-water	Extraction/ Treatment	Incineration	Extracting contaminated groundwater and burning the water at very high temperature to destroy organics	Effective in removing organic contaminants; metals do not burn, but concentrate in ash	Permanently eliminate organic contaminants No effluent discharge	Not a stand-alone solution; needs to treat emitted air and dispose ash	High	Not retained for further evaluation due to high costs
Ground-water	Extraction/ Treatment	Biological Treatment	Extracting contaminated groundwater and using microorganisms to degrade contaminants in the water in a controlled reactor	Effective to eliminate most organic contaminants	Permanent removal of certain contaminants	Difficult to eliminate low levels of organics Contaminants can be degraded into unknown compounds	Low	Retained for further evaluation
Ground-water	Extraction/Treat ment	Chemical Treatment	Extracting contaminated groundwater, adjusting the pH, adding a coagulant, then settling out the flocculant	Effective for removing heavy metals	Easy operation Demonstrated technology	Requires operator attention for sludge handling Sludge may be considered as hazardous waste Difficult to achieve high efficiency with low concentrations	Low	Retained for further evaluation

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Ground-water	Extraction/ Treatment	UV/Oxidation	Extracting contaminated groundwater, mixing the water with oxidants and enhancing the oxidation activity with UV light	Effective to eliminate organic and certain inorganic contaminants	High level of removal efficiency can be achieved	May require pretreatment High operation and maintenance required Not effective for metals	High	Not retained for further evaluation due to ineffectiveness on metals
Landfill	No Action	None	None	Does not remediate contaminants	Minimum operation and maintenance required Serves as a baseline against which the potential technologies can be measured	Potential release of contaminants to groundwater	Low	Retained for further evaluation
Landfill	Institutional Control	Security Fencing Monitoring	Monitoring the environmental conditions without taking any actions to treat or dispose the landfill material	Does not remediate contaminants	Low cost minimum operator and equipment	Potential release of contaminants	Low	Retained for further evaluation
Landfill	Containment	Capping	Covering the landfill material with an impermeable cap to minimize the surface water contact and, as a result, reducing the amount of infiltration into landfill	Does not remove or eliminate contaminants; effective to prevent potential release of contaminants from landfill into groundwater	Maybe implemented Minimum operation and maintenance required	A preventive measure, does not remediate contaminants Restrict further land use	Medium	Retained for further evaluation
Landfill	Groundwater . Collection and Treatment	Biological Treatment	Employing naturally occurring microorganisms to biodegrade organic constituents in water	Effective in eliminating many organic contaminants	Permanent removal of certain organic contaminants	Not a stand-alone solution; needs to discharge effluent and to dispose sludge May need large area to build the reactors Some contaminants may not be biodegradable	Low to Medium	Not retained because the metals are not likely to be biodegradable and low concentration of organics in soil and groundwater
Landfill	Groundwater Collection and Treatment	Incineration	Burning the contaminated soil at high temperature (1600 to 300° F) to destroy organic	Effective in destroying organic contaminants; metals do not burn, but concentrate in ash	Permanently eliminate organic contaminants May be able to sinter and utilize on-site blast furnace	Not a stand-alone solution; needs to treat air and dispose ash	Very High	Not retained for further evaluation due to the high cost
Landfill	Groundwater Collection and Treatment	UV/Oxidation	Application UV light and oxidants to oxidize organic contaminants	Effective in eliminating many organic and inorganic contaminants	Permanently eliminate many contaminants	May require pretreatment Easy foul High power requirements and high O&M	High	Not retained due to listed disadvantages

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Landfill	Groundwater Collection and Treatment	Chemical Treatment	Extracting contaminated groundwater, adjusting the pH to 8, adding a coagulant, then settling out the floc	Effective for removing heavy metals	High level of removal efficiency Fast operation	Requires operator attention for sludge handling Sludge may be considered as hazardous waste	Low	Retained for further evaluation
Landfill	In-situ Treatment	Bioremediation	Using soils naturally occurring microorganisms to decompose contaminants by adding water, oxygen and nutrients into subsurface to stimulate the growth of microorganisms	Effective in removing many organic and inorganic contaminants	Requires minimum site disruption No waste handling or transportation Permanent removal of certain contaminants	Contamination of soil and groundwater may occur due to the addition of oxygen nutrients, and water into surface Difficult to obtain uniform clean-up Biological activities may unstabilize metal contents Not a stand-alone solution; needs to control leachate	Low to Medium	Not retained for further evaluation due to listed disadvantages
Landfill	In-situ Treatment	Soil Flushing	Flooding the site with appropriate washing solution to elutriate contaminants from soil, and collecting the elutriate with a series of wells or subsurface drains for treatment	Effective in removing organic and inorganic depended upon the chosen of flushing solution	Permanent removal of contaminants from soil Easily apply to permeable soil	Potential exists to transport contaminants into surrounding soil and groundwater	Low to Medium	Not retained for further evaluation due to the disadvantages of the technology
Landfill	In-situ Treatment	Soil-vapor Extraction	Inducing air flow through the soil by pulling a vacuum on holes drilled into the subsurface, and carrying out volatilized contaminants	Effective in removing medium to high levels of volatile and semi-volatile organic contaminants in unsaturated soil	No solid waste handling or transportation	Difficult to apply low porosity material Air treatment system may be required Difficult to obtain uniform clean-up Not a stand-alone solution; needs to control leachate	Low to Medium	Not retained for further evaluation due to the disadvantages of the technology
Landfill	In-situ Treatment	Stabilization/ Solidification	Mixing contaminated soil with agents that chemically and physically locks the contaminants in a solid matrix with high integrity and low permeability. Customized crane or rotary rig is commonly used to mix soil	Does not remove or eliminate contaminants; applied primarily to metals; mixed results when used to treat organic	No waste transportation costs and liability Improve the physical integrity of treated soil Short clean-up time	Increases the volume of treated soil Operation is affected by the weather Only effective to treat wastes with low level or organic contents	Medium	Retained for further evaluation

(continued)

TABLE 7-2 (continued)

Cleanup media	General response action	Potential applicable technology	Technology description	Effectiveness	Advantage	Disadvantage	Cost	Comment
Landfill	In-situ Treatment	Vitrification	A thermal treatment technology which converts soil into an inert glass product by using electric current to pass through contaminated soil	Effective in destroying organic and inorganic wastes of soils containing significant levels of silicate	No waste handling or transportation Short clean-up time The products of this process are long lasting and highly durable	Requiring an adequate power supply Water in soils affects operational time and increases the total cost Special equipment and trained personnel required	High	Not retained for further evaluation because of the high cost of operation and low organic content
Landfill	Excavation/ Disposal	Off-site Landfilling	Excavating landfill material and disposing in a remote landfill facility	Eliminate site receptor passways	Remove source from site	Long-term liability Transportation cost governing the overall cost Does not remediate contaminants	Medium to High	Not retained for further evaluation because it is not practical to move the amount of material involved

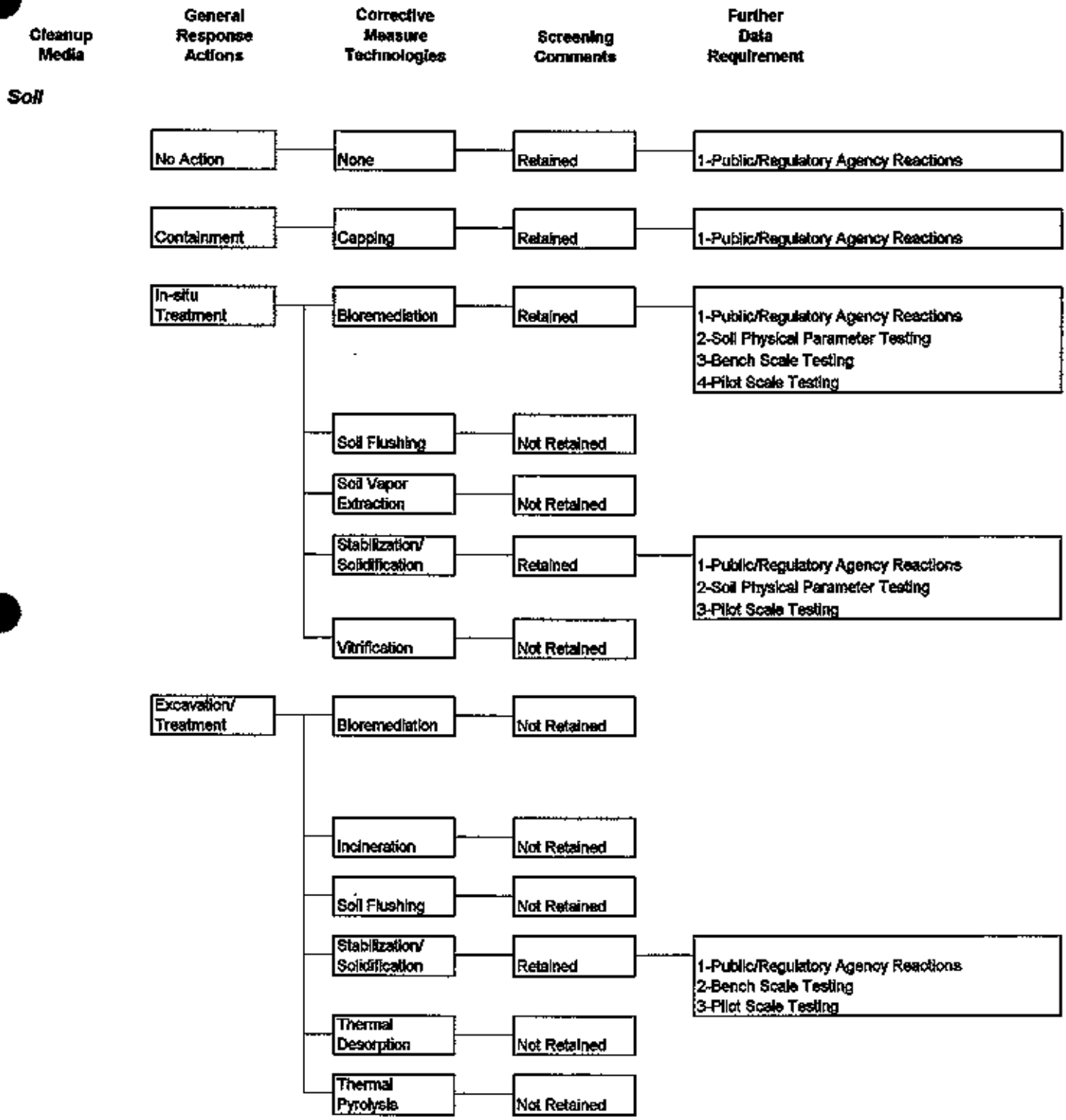

Figure 7-2. Summary of potential corrective measure technologies. (continued)

Cleanup Media	General Response Actions	Corrective Measure Technologies	Screening Comments	Further Data Requirement
Soil				
	Excavation/ Disposal	Off-Site Landfilling	Retained	1-Public/Regulatory Agency Reactions 2-Field Sampling to Determine Excavation Limits 3-Waste Characteristic Testing of Excavated Material
Ground Water				
	No Action	None	Retained	1-Public/Regulatory Agency Reactions 2-Field Sampling to Monitor Contaminated Plume
Ground Water				
	Containment	Physical Barrier	Retained	1-Public/Regulatory Agency Reactions 2-Continued Sampling to Monitor Contaminated Plume 3-Additional Geologic Information 4-Modeling of Ground Water Flow
		Hydraulic Barrier	Retained	1-Public/Regulatory Agency Reactions 2-Continued Sampling to Monitor Contaminated Plume 3-Additional Geologic Information 4-Modeling of Ground Water Flow
	Extraction/ Discharge	Discharge to Surface Water	Retained	1-Public/Regulatory Agency Reactions 2-Permit Application for Surface Discharge
		Discharge to POTW	Retained	1-Public/Regulatory Agency Reactions 2-Contact Local POTW
	In-situ Treatment	Bioremediation	Retained	1-Public/Regulatory Agency Reactions 2-Soil Physical Parameter Testing 3-Bench Scale Testing 4-Pilot Scale Testing
		Oxidation	Not Retained	

Figure 7-2. Summary of potential corrective measure technologies. (continued)

Cleanup Media	General Response Actions	Corrective Measure Technologies	Screening Comments	Further Data Requirement
Ground Water				
	Excavation/ Treatment	Aeration or Air Stripping	Retained	1-Public/Regulatory Agency Reactions 2-Ground Water Quality Testing
		Steam Stripping	Not Retained	
		Carbon Adsorption	Retained	1-Public/Regulatory Agency Reactions 2-Isotherms for Each Contaminant 3-Bench Scale Testing
		Incineration	Not Retained	
		Biological Treatment	Retained	1-Public/Regulatory Agency Reactions 2-Bench Scale Testing
		UV/ Oxidation	Not Retained	
		Chemical Treatment	Retained	1-Public/Regulatory Agency Reactions 2-Bench Scale Testing
Landfill				
	No Action	None	Retained	1-Public/Regulatory Agency Reactions 2-Field Sampling to Monitor Nature and Extent of Contaminate
	Containment	Capping	Retained	1-Public/Regulatory Agency Reactions 2-Field Sampling to Verify the Existence of Leachate

Figure 7-2. Summary of potential corrective measure technologies. (continued)

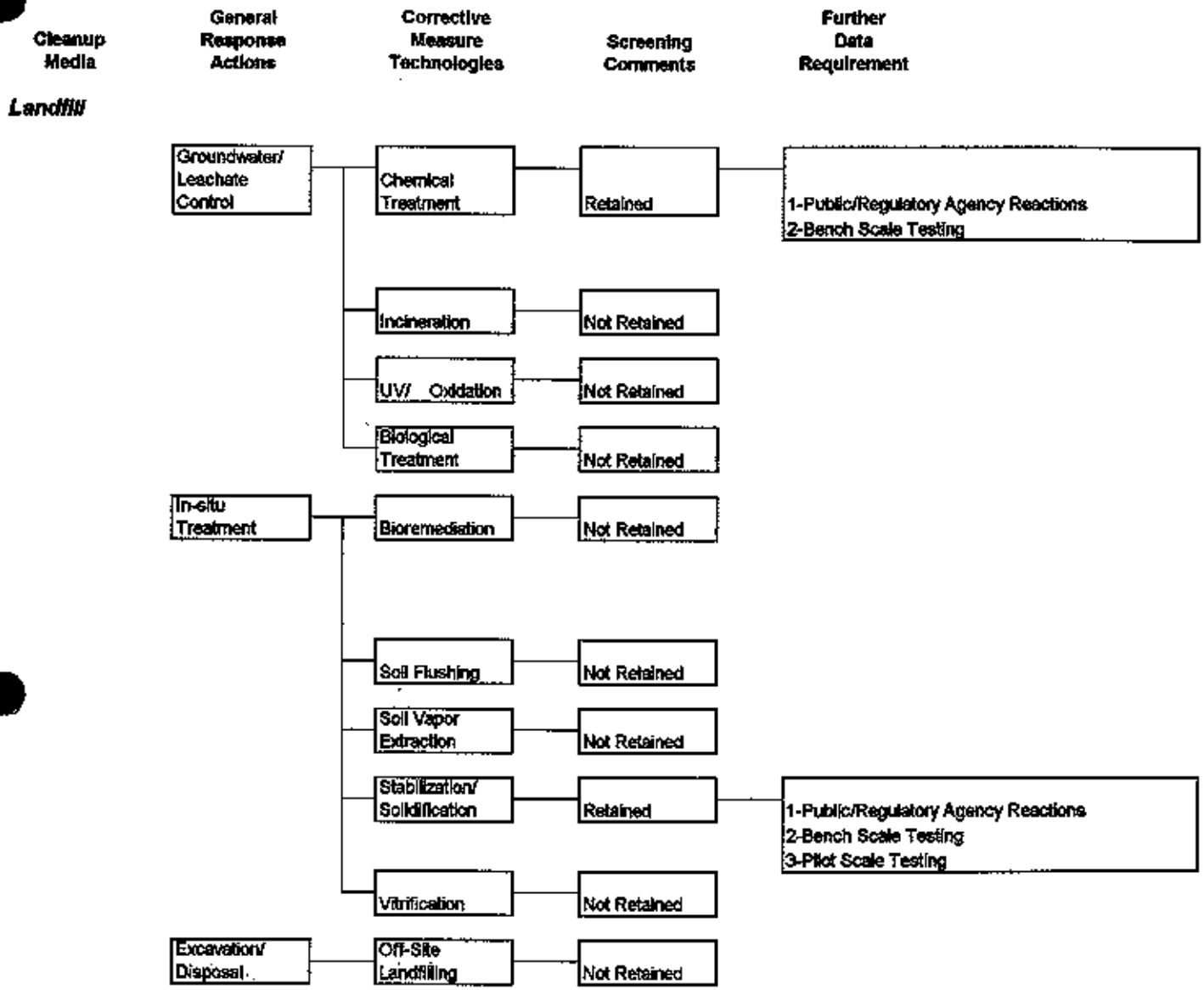

Figure 7-2. Summary of potential corrective measure technologies.

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

The objectives of this investigation were to identify and characterize waste sources at the Singer Miller Hill Complex, evaluate contaminant mitigation pathways, evaluate the potential environmental impacts, and determine if a corrective measure study or remedial actions are necessary.

The investigation indicates that there are low concentrations of contaminants in the soils and groundwater near and/or adjacent to the SWMUs. The risks associated with the site are believed to be within the acceptable range and the corrective actions should be limited to periodic groundwater monitoring and the implementation of institutional controls. A corrective measure study is not recommended. Table 8-1 summarizes the risks and hazards associated with the commercial/industrial worker. Appendix 8-1 contains the public meeting minutes.

Recommendations include: 1) annual monitoring of groundwater for a period of five years following well locations N-1, CAMA1-3WT, CAMA1-6WT, CAMA1-4WT, and CAMA1-5WT and 2) surface water and sediment at the swamp area near CAMA1-6WT. The target list of analytes includes arsenic, beryllium, lead, iron, mercury, silver, trichloroethene, and benzene. If the target analyte concentration exceeds the 95 percent UCL of the mean and the action levels specified herein, Singer will notify the government and implement an investigation plan designed to verify the changed conditions and determine if abatement or other corrective actions are warranted. Soil monitoring is not recommended because the metals are relatively immobile, and the groundwater is a more sensitive ecosystem.

TABLE 8-1. SUMMARY OF RISK AND HAZARDS

EXCESS CANCER RISKS	
National Contingency Plan Acceptance Range	1:10,000 to 1:1,000,000
Aggregate Risk for a Onsite Commercial/Industrial Worker	2.9:1,000,000
Aggregate Risk for a Recreational Fisherman	3.9:1,000,000
Risk drivers for the site:	
Arsenic at CAMA-1 via soil ingestion	2.33:1,000,000
Arsenic at SWMU-3 via soil ingestion	1.14:1,000,000
Beryllium at CAMA-1 via soil ingestion	1.15:1,000,000
Beryllium at SWMU-3 via soil ingestion	1.11:1,000,000
Beryllium at surface water via fish consumption	3.89:1,000,000

COMPARISON OF THE 95% UCL MEAN CONCENTRATION (mg/kg) (ppm)			
	Soil background	Soil SWMU	Ratio
Arsenic	2.57	CAMA-1 8.9	3.46
Silver	0.18	CAMA-1 1.14	6.33
Beryllium	0.74	CAMA-1 1.53	2.06

HAZARD QUOTIENTS	
National Contingency Plan Acceptance Value	< 1
Total Site Hazard Index for Commercial/Industrial Worker	0.12
Total Hazard Index for Recreational Fisherman	0.38

COMPOUNDS WITH HIGHEST HAZARD QUOTIENTS FOR THE SITE	
Iron via Soil Ingestion at SWMU 9	0.052
Lead via Soil Ingestion at CAMA-1	0.049

(continued)

TABLE 8-1 (continued)

Arsenic via Soil Ingestion at CAMA-1			0.015		
Benzene via Inhalation at CAMA-1			0.0036		
Trichloroethylene via Inhalation at SWMU-3			0.0022		
CHEMICALS THAT EXCEED REGULATORY GUIDANCE					
Chemical	Medium	Standard	Threshold concen-tration	Medium 95% UCL concen-tration	Ratio
Mercury	Surface water	NC Class C	0.012 μg/l	0.02 μg/l	1.7
Silver	G.W (SWMU3)	0.5 * Solubility	3.45 μg/l	4.25 μg/l	1.2

Reference (10)

(text only)

SIRRINE

LANDFILL INVESTIGATION

REPORT

PHASE II

SINGER FURNITURE

PLANT NO. 3

LENOIR,

NORTH CAROLINA

DECEMBER 19, 1983

SIRRINE ENVIRONMENTAL CONSULTANTS

JOB NO. F-1003

J. E. SIRRINE COMPANY
ENGINEERS
SOUTH CAROLINA DIVISION
GREENVILLE, SOUTH CAROLINA

SIRRINE

Phase II
Landfill Investigation
Singer Furniture

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SIRRINE

Phase II
Landfill Investigation
Singer Furniture

A. INTRODUCTION

J. E. Sirrine Company was retained by Singer Furniture to conduct a Phase II Landfill Investigation at Plant No. 3 in Lenoir, North Carolina.

The Phase I Landfill Investigation was conducted in October, 1982. This study revealed that certain chemicals, known to have been disposed in the landfill, have migrated into the groundwater in the immediate vicinity of the landfill. The purpose of the Phase II Landfill Investigation was: to determine the down-gradient extent of contamination in the alluvial floodplain of Lower Creek; and to evaluate the hydrogeologic properties of the alluvial floodplain, i.e., the direction and rate of groundwater movement.

To accomplish the above described project scope, three monitoring wells were installed during the Phase II study to complement four wells installed during Phase I. Only one of the Phase I wells was found to contain organic or metal priority pollutants in measurable quantities. Well N-1, located within 100 feet of the north slope of the landfill, contained ethylbenzene (55 ug/l), toluene (166 ug/l), and Bis (2-ethlyhexyl) phthalate (100 ug/l). In addition, the metals arsenic, chromium, lead, and barium were detected in concentrations exceeding the primary drinking water standards.

The Phase II monitoring wells were installed at greater distances from the landfill to determine if a contaminant plume exists and, its horizontal and vertical extent (Figure 1). The additional three Phase II wells also enabled a more precise groundwater flow rate and direction to be calculated.

A. INTRODUCTION - continued

This Phase II investigation represents a refinement of the data and conclusions reached during Phase I. This report contains recommendations for the continued evaluation of groundwater quality down-grade of the landfill utilizing the existing monitoring network of seven wells. The Phase I report should be used as a reference for background material. The Soil & Material Engineers' Phase II Hydrogeologic Investigation is included as Appendix 1.

B. SUMMARY

The landfill site had been used by the City of Lenoir for municipal/industrial refuse disposal and subsequently by Magnavox and Singer Furniture. There is no record of the types and quantities of chemicals buried at the site, but it is known that Singer Furniture disposed of organic solvents, varnish, lacquers, paints, and other chemicals associated with the production and finishing of furniture. A portion of the material was buried in drums and the remainder disposed in bulk or burned in pits.

The Phase I investigation revealed that leachate, containing some of the materials described above, has migrated a short distance from the landfill. Certain solvents and metals were detected in Well N-1 located just less than 100 feet from the north slope of the fill. The wells installed to the east and west of the landfill were essentially free of priority pollutant organics and metals.

Phase II involved the installation of three additional wells at greater distances east, north, and west of the landfill. The Phase II wells were installed closer to Lower Creek, which is the major drainage feature of the area. All three Phase II wells were found to be essentially free of priority pollutant solvents and metals. This information indicates that the source of the chemicals detected in Well N-1 may not be large enough for significant quantities of organics or metals to be found several hundred feet downgrade of the landfill. Dispersion of a relatively small contaminant source could dilute the concentration of organics and metals found in Well N-1 to below the detection limit in a short distance.

B. SUMMARY - continued

An area well survey was conducted to determine if any residences or businesses are currently utilizing groundwater as a potable source. It was determine that several residences along Virginia Street, bordering the lumber yard on the east side of Plant No. 3, currently use groundwater as a drinking water source. The residential wells are all shallow and tap the saprolite zone.

The landfill is located 600-1000 feet from the Virginia Street residences in the down-grade direction. In addition, water level measurements taken in these residential wells and the seven groundwater monitoring wells conclusively show the area groundwater movement to be toward Lower Creek. Therefore, any leachate from the landfill would move away from the Virginia Street residences north and west toward Lower Creek.

C. ANALYTICAL SUMMARY

Groundwater samples were taken from the three Phase II monitoring wells on August 8, 1983. Environmental Testing and Certification Corporation (ETC), of Edison, New Jersey, performed the organic priority pollutant analysis and the J. E. Sirrine Company laboratory performed additional analysis for specific ions, solids, TOC, pH, and specific conductivity. The Phase II groundwater analyses are presented in Appendix 2.

The priority pollutants detected are listed below. Significant concentrations of metals are also listed.

Phase I Wells

Monitoring Well	Parameter	Concentration (ug/l)	Primary Drinking Water Standards (ug/l)	Detection Limit (ug/l)
S-1	No Organics			
W-1B	No Organics			
E-1	Methylene Chloride	30		10
N-1	Ethlybenzene	55		10
	Toluene	166		10
	Bis (2-ethylhexyl) Phthalate	100		10
	Nickel	230		
	Arsenic	93	50	
	Beryllium	56		
	Cadmium	6.8	10	
	Chromium	400	50	
	Copper	650		
	Lead	600	50	
	Selenium	3.0	10	
	Barium	6,100	1000	

C. ANALYTICAL SUMMARY - continued

Phase II Wells

Monitoring Well	Parameter	Concentration (ug/l)	Primary Drinking Water Standards (ug/l)	Detection Limit (ug/l)
NE-1	Methylene Chloride	16		10
W-2	No Organics			
N-2	No Organics			

The volatile organic compounds and metals were detected at N-1 (Phase I). Well N-2 (Phase II) was placed approximately 400 feet northwest of N-1 specifically to determine if these compounds have migrated. No organics were detected at N-2. In addition, no metals were detected above expected background concentrations.

Methylene chloride was detected in Well E-1 (Phase I) at a low concentration (30 ug/l). Methylene chloride was also detected at NE-1 (Phase II) at a concentration of 16 ug/l. The detection of this compound, only in these two wells on the east side of the property, is not considered significant because of the very low concentrations involved and the absence of other detectable compounds.

TEMP

SIRRINE

Phase II
Landfill Investigation
Singer Furniture

D. CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

1. Certain solvents, varnish, lacquers, and paints have been disposed in the landfill adjacent to Plant No. 3.

2. Certain volatile organics and metals were detected in Well N-1 (Phase I) located near the north face of the landfill.

3. The other Phase I wells, S-1 (background), E-1, and W-1B, did not contain organics or metals of significance.

4. Phase II wells, N-2, W-2, and NE-1, were located further from the landfill to determine if contaminants found in N-1 have migrated.

5. No organics, except 16 ug/l methylene chloride in NE-1, or metals were detected in the Phase II wells.

6. The analytical data collected from the seven monitoring wells does not indicate that contaminant material had migrated significantly from the landfill.

7. From the data collected, it appears that the leachate of organic solvents and metals (Well N-1) is eminating from a very small sector of the landfill. The volume of material detected in Well N-1 may be so limited that down-gradient dispersion in the floodplain alluvium may be diluting these constituents to below the level of detection.

D. CONCLUSIONS AND RECOMMENDATIONS - continued

1. Conclusions - continued

8. The hydrogeologic investigation has determined that the Lower Creek floodplain alluvium is generally relatively permeable, but beds of low-permeability silts and clays are present which may moderate the lateral dispersion of contaminants relative to the actual rate of groundwater movement.

9. The direction of groundwater movement beneath the landfill and in the immediate area is to the north-northwest toward Lower Creek.

10. No water supply wells are threatened by the migration of landfill leachate. The direction of groundwater movement would disperse any landfill contaminant toward Lower Creek and away from the wells located along Virginia Street.

11. Based on one round of sampling and analysis at each monitoring well, there appears to be no threat presented to shallow groundwater resources in the immediate area surrounding the landfill. The hydrogeological report identifies Lower Creek as the local discharge point. Therefore, contamination of deep groundwater resources is unlikely.

2. Recommendations

1. Additional water quality data be periodically collected from the existing well network to monitor the possible movement of contaminants from the immediate area of Well N-1.

D. CONCLUSIONS AND RECOMMENDATIONS - continued

2. Recommendations - continued

2. The seven existing monitoring wells should be sampled and analyzed semi-annually for a minimum of two years to establish analytical trends with respect to the number of constituents detected and their concentrations. may now drop background well # making six wells. Can drop positive run metals & volatiles, acid compounds, ben

3. Should groundwater conditions remain approximately constant or improve, particularly at Well N-1, annual sampling and analysis may be justified after the first two years. $500/a

4. The analysis of groundwater samples during the initial two year period should include the full priority pollutant list. Should the data collected during this two year period indicate improving groundwater conditions, the parameters to be analyzed could be reduced to particular fractions of the priority pollutants or indicator constituents.

5. The depth to groundwater should be measured at each of the seven wells on a quarterly basis to refine the calculation for hydraulic gradient.

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PHASE II
HYDROGEOLOGIC INVESTIGATION
of the
CLOSED LANDFILL AREA
THE SINGER COMPANY
PLANT NO. 3

for

J. E. Sirrine Company, Inc.
Post Office Box 5456
216 South Pleasantburg Drive
Greenville, South Carolina

and

The Singer Company
Post Office Box 1588
Lenoir, North Carolina

Curtis L. Gorman
Project Hydrogeologist
Columbia, South Carolina

B.C. Spigner, PG
Senior Hydrogeologist
Columbia, South Carolina

SOIL & MATERIAL ENGINEERS, INC.

Report No. 04482-129A

November 21, 1983

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SOIL & MATERIAL ENGINEERS INC. ENGINEERING-TESTING-INSPECTION

3025 McNaughton Drive, Columbia SC 29206, Phone (803) 788-6343

November 21, 1983

J. E. Sirrine Company, Inc.
Post Office Box 5456
216 South Pleasantburg Drive
Greenville, South Carolina 29606

Attention: Mr. Jim Brooks, P.E.
Project Manager

The Singer Company
Post Office Box 1588
Lenoir, North Carolina 28645

Attention: Mr. Richard J. McDonald

Subject: Phase II Hydrogeologic Investigation
of the Closed Landfill Area
The Singer Company, Plant No. 3
Lenoir, North Carolina
S&ME Report No. 4483-129A

Gentlemen:

Soil & Material Engineers, Inc. is pleased to submit the above referenced report. This report presents the results of field and laboratory investigations and our conclusions concerning the hydrogeology of the site.

We appreciate this opportunity to again be of service to the J. E. Sirrine Company, Inc. and the The Singer Company. If there are any questions concerning our report or study, we would be pleased to personally discuss the report and any aspects of the study at your convenience.

Respectfully submitted,
SOIL & MATERIAL ENGINEERS, INC.

Curtis L. Gorman
Project Hydrogeologist

B. C. Spigner
Senior Hydrogeologist

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HYDROGEOLOGIC INVESTIGATION
OF THE
CLOSED LANDFILL AREA
THE SINGER COMPANY
PLANT NO 3

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SECTION 1.0 INTRODUCTION

1.1 PROJECT BACKGROUND AND SCOPE

In 1982 Soil & Material Engineers, Inc. (S&ME) and J. E. Sirrine Company made a preliminary (Phase I) hydrogeologic assessment of the closed landfill at Singer Furniture Plant No. 3, Lenoir, N.C. (fig.1). As part of that assessment, 4 monitor wells were constructed within and adjacent to the landfill, and the general hydrogeology of the immediate landfill site was determined.

The Phase I study indicated that the Alluvial Aquifer beneath and immediately adjacent to the landfill contained higher-than-background concentrations of chemicals indicative of leachate contamination. However, the directions and rate of ground-water movement and quality of ground water in the Alluvial Aquifer down-gradient of the landfill were not known. Therefore, a Phase II study was requested by the Singer Company in order to estimate the down-gradient extent of contamination in the Alluvial Aquifer, and to evaluate the hydrologic properties of the Alluvial Aquifer down-gradient of the landfill.

The scope of work for this investigation, as outlined in S&ME Proposal No. 4483-P1163 (March 16, 1983), included constructing 3 Alluvial Aquifer monitor wells, obtaining soil samples for laboratory analysis, estimating the hydraulic properties of alluvial soils, and performing a ground-water use survey of the area surrounding the plant site. This report presents the results of our hydrogeologic assessment. For convenience, this report contains selected data obtained during the Phase I assessment.

1.2 DESCRIPTION OF THE LANDFILL AREA

The area of investigation includes the general area shown on figure 1. The principle facilities located at Singer Furniture Plant No. 3 include the closed landfill, the main plant building located immediately south of the landfill, and the lumber yard, located immediately east of the landfill. The area of investigation for Phase II was expanded to include the well survey area surrounding the plant.

The landfill was previously owned by the City of Lenoir and was used for municipal waste disposal in the late 1950's for about 3 years. The landfill was then used by the Magnavox Company until it was sold to the Singer Company in the early 1970's. Therefore, the landfill contains various waste materials which include municipal refuse, industrial wastes, and rock and soil fill. Information provided by the Plant

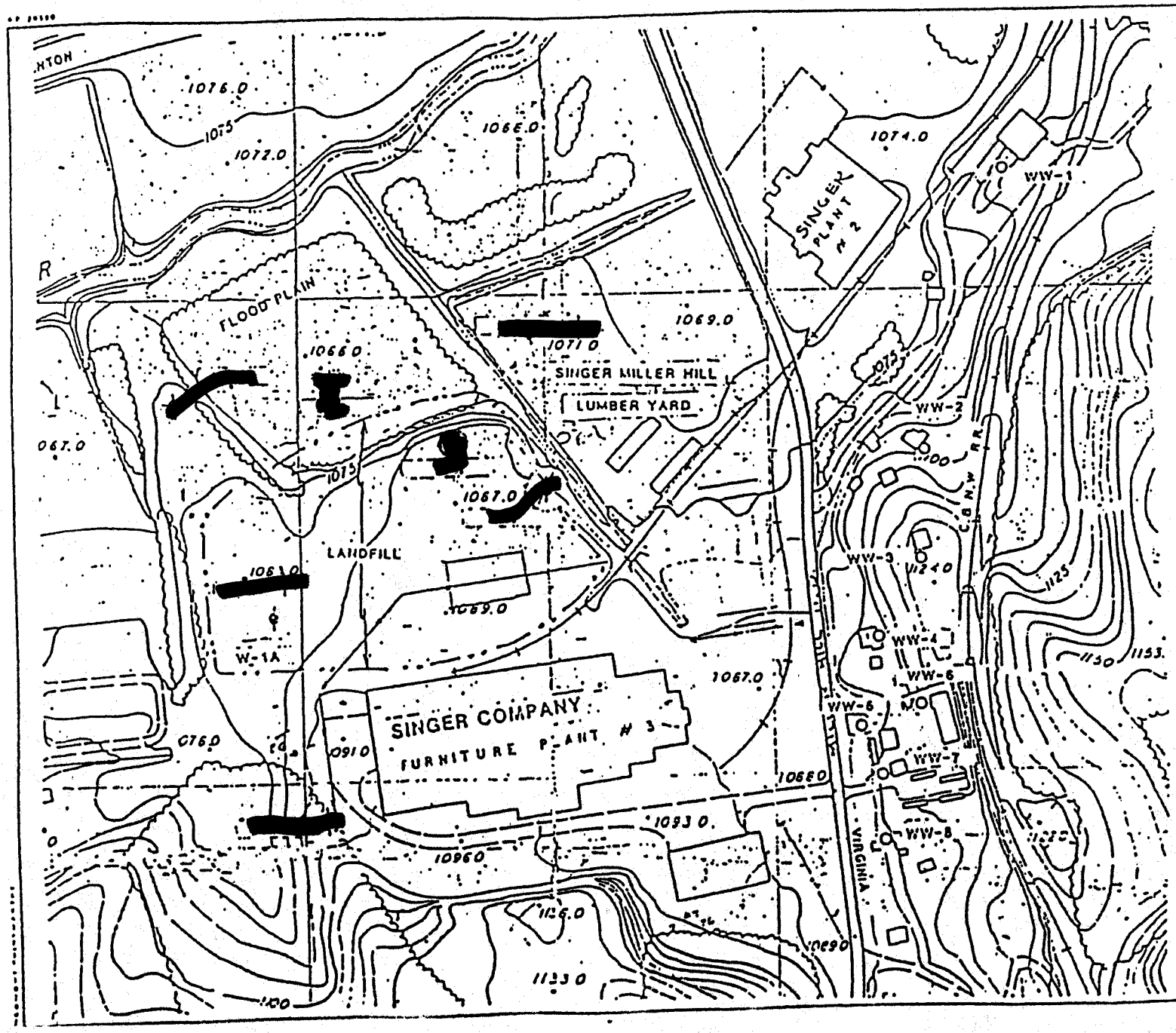

FIGURE 1. SITE MAP SHOWING MONITOR WELL LOCATIONS AND WATER WELL LOCATIONS.

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Engineer indicates that the wastes may include: toluene; acetone; methanol; various organic solvents; resin glues; and ezylene and lead from pigments. Finishing products may include lacquer, staining chemicals and paints that were probably disposed in hard form. Liquids from wash-down were previously burned, dumped or containerized until recovery operations were initiated around 1977. Scrap had been disposed in the landfill until 1981. One test hole (W-1A) was drilled and 2 monitor wells (W-1B, N-1) were installed within the landfill itself during Phase I.

The contents of the landfill were leveled during the last 4 years, and a wood shed was constructed on the landfill near the southern margin of the landfill (fig. 1). The shed is presently used primarily as a vehicle-maintainance garage.

The surface of the landfill slopes gently to the north, where it drops off abruptly near the northern margin. A thin layer of landfill material extends beyond monitor well N-1. The western edge of the landfill material extends beyond well W-1B, and northward of well W-2. The eastern perimeter of the landfill extends to the ditch adjacent to the lumber yard. The southern portion of the landfill overlies excavated fill material upon which Plant No. 3 is located.

1.3 HYDROLOGIC SETTING

Areal Geology and Hydrology

The Singer Plant No. 3 is located in the Inner Piedmont belt of the Piedmont geologic province. Rocks within the Inner Piedmont consist of Paleozoic age crystalline rocks which occur in northeast-trending belts. The plant is located in the valley of Lower Creek which flows to the southwest and empties into the upper reaches of the Catawba River.

As described by Goldsmith and others (1978), the bedrock in the vicinity of the site consists primarily of migmatite gneiss, garnet gneiss, with some biotite schist and gneiss. The bedrock is overlain by a variable thickness of residual soil called saprolite.

There are no current published reports that describe the specific hydrogeology of the area surrounding the plant. Some information on the hydrogeology of the Lenoir area was obtained from Mr. Richard Peace of the N.C. Department of Natural Resources and Community Development (DNR). According to Mr. Peace, the hydrogeology of the Lenoir area is poorly known, and there have been no recently completed ground-water studies of this area.

Land-surface elevations of the site range from approximately 1095 ft mean sea level (msl) at Plant No. 3, to 1065 ft msl in the flood plain just north of the landfill (fig. 1). The surface of the landfill slopes gently northward, and the northern edge of the landfill drops in elevation from about 1085 ft msl to about 1065 ft msl on the flood plain surface.

Surface water from the site drains toward the ditch to the northeast between the landfill and the lumber yard; and to a draw west of the site. Both these intermittent drainage features drain toward the northwest to Lower Creek. The upper portion of the site is adequately drained. The flood plain area from the landfill northward to Lower Creek is poorly drained wooded area, which is periodically flooded.

Climate

Precipitation in the Lenoir area is fairly well distributed throughout the year. The average annual rainfall for the Lenoir area is 49.94 inches. Departures from normal monthly precipitation commonly occur and mild droughts are common. The greatest precipitation generally occurs from early spring through early fall. The least precipitation generally occurs during the late fall and winter. Precipitation is the source of ground-water recharge in the area, and variations in the quantity of precipitation affect the amount of recharge to the aquifers and water levels in wells.

2.1 FIELD METHODS

Four monitor wells (N-1, E-1, W-1B, and S-1) and one abandoned test hole (W-1A) were installed during Phase I, and 3 wells (W-1, N-2, and NE-1) were installed during Phase II. The locations of these wells are shown on figure 1, and well construction information is summarized in table 1.

Split-spoon samples were collected from the test holes every 2.5 ft for the first 10 ft, where conditions while drilling in fill permitted, and at 5-ft intervals thereafter, to the total depth (TD) of each of the test holes. These samples were visually classified in the field, and later in the laboratory by the project hydrogeologist, and geologist (stratigraphic) logs were prepared (see Soil Boring and Well Records - Appendix B). These geologist logs were used in preparing geologic cross-sections of the site in order to define the subsurface stratigraphy and water-bearing character of the strata. The test holes were converted to 2-in diameter monitor wells by installing PVC casing and screen, gravel pack, bentonite annulus seal, and grout. Construction details are recorded on the boring logs in Appendix B.

Proper variances to the DNR requirements for well construction were granted by the Division of Environmental Management (DEM) prior to well construction. Field conditions required modification of the approved well construction guidelines for Phase I wells, and the well construction modifications were approved by personal communication with DEM on October 11 and 12, 1982.

The drill rig and well materials were pressure cleaned between wells to minimize potential cross-contamination. All monitor wells except well W-1B were developed with compressed air; and well W-1B was developed with water to remove sediments, drilling fluid, and contaminants which may have entered the screen/well casing during drilling and well construction.

Falling head field borehole permeability tests were made on Wells W-1B, N-1, and E-1 during Phase I in order to determine the radial permeability (hydraulic conductivity, K) of Alluvial Aquifer strata beneath the site. Falling-head tests were attempted on Phase II wells (W-2, N-2, NE-1) but permeabilities were too high to measure accurately with this method. Therefore, geologist logs and grain-size analyses of selected Alluvial Aquifer samples from wells W-2, N-2, and NE-1 were utilized to estimate the hydraulic properties of the Alluvial Aquifer at these locations.

Borehole permeability test results are summarized in table 4 and are discussed in Section 3.0.

The locations and elevations of the 7 monitor wells were surveyed by Western Carolina Surveyors with vertical control to an accuracy of about 0.01 ft. The elevations of water wells were approximated from the site topographic map and should be regarded as approximate.

Water levels were measured in the 4 Phase I monitor wells on October 13, 1982, and in all 7 monitor wells and 2 water wells on August 3, 1983. Ground-water levels were measured with an electric drop-line and fiberglass tape to an accuracy estimated to be within 0.1 ft. These water levels were then converted to approximate mean sea level (msl) elevations.

Water Well Survey:-- The project hydrogeologist conducted a water-well survey (inventory) of the area in the immediate area surrounding the plant property. Information obtained from the survey is summarized in table 2. Well-construction information was obtained from residents, neighbors, plant personnel, or others who may have had knowledge of the wells. For some wells equipped with pumps and if the owner's permission could be obtained, field analyses were made for pH, temperature, and specific conductance (Ec) on ground-water samples. If accessible, water levels and depths of wells were measured with an electric drop line and fiberglass tape. Measuring instruments were rinsed with deionized water immediately after use.

2.2 LABORATORY METHODS

Laboratory testing of soil samples collected in the field consisted of preparing geologist logs and performing 8 grain-size analyses. The geologist logs (Appendix B) were prepared by the project hydrogeologist from his own field notes, the driller's field notes, and from his lithologic description of samples in the laboratory. The grain-size analyses were made on split-spoon samples from 5 test holes (W-1B, E-1, N-2, W-2, NE-1) in order to characterize the physical properties of Alluvial Aquifer sediments beneath the site. Results of these analyses area summarized in table 3, and Appendix C, and discussed in Section 3.

SECTION 3.0 HYDROLOGY

3.1 GEOLOGY AND GROUND-WATER OCCURRENCE

The landfill and adjacent area is underlain by 3 geologic units that differ in physical and hydrologic properties.

Alluvial Aquifer (Unit I) -- consisting of as much as 35 ft of interbedded and (or) alternating beds of fine-coarse sand, silt, and clay; and various admixtures of these lithologies.

Saprolite and Colluvium (Unit 2) -- consisting of decomposed bedrock (saprolite) and saprolite talus (colluvium).

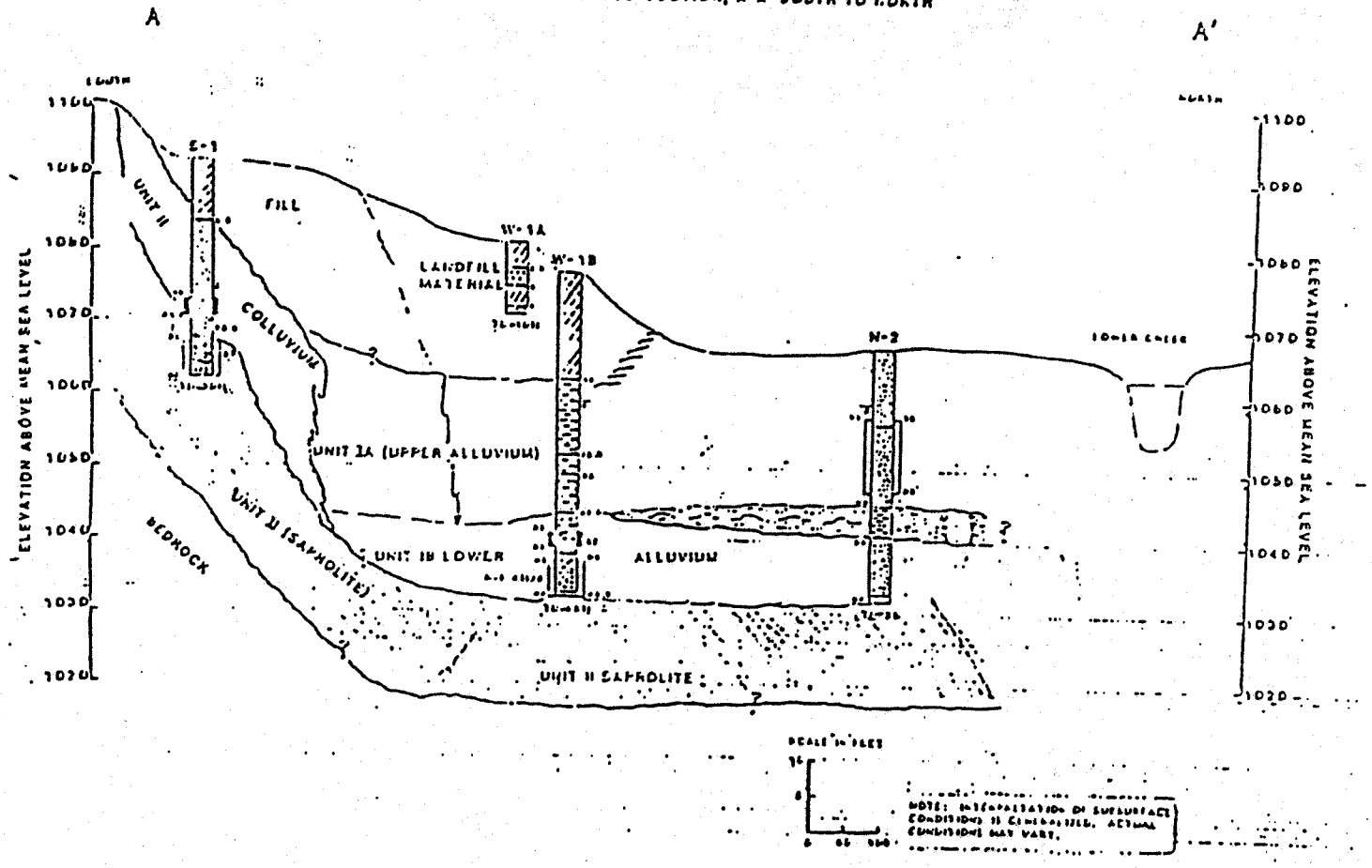
Bedrock Aquifer (Unit 3) -- crystalline (metamorphic) rocks consisting primarily of gneiss.

The stratigraphic relationships and lithology of these units beneath the plant site are illustrated in figure 2.

Initial test drilling during the Phase I study indicated that the saprolite soils contain appreciable silt and clay which are generally considered to have a much lower permeability than overlying alluvial sands. Therefore, borehole drilling depths and the emphasis of this study were limited to the alluvium and uppermost few feet of the saprolite.

Figure 2

GENERALIZED GEOLOGIC CROSS-SECTION, A-A' SOUTH TO NORTH



3.2 HYDROLOGY OF THE ALLUVIAL AQUIFER

Lithology and Thickness

The youngest geologic formation in the landfill area is the alluvium (Qal) presumably of Quaternary (Recent) age, which was deposited by Lower Creek. The alluvium is interpreted to underlie the entire landfill and the flood plain of Lower Creek.

The alluvium consists primarily of poorly sorted sediments, ranging from coarse sand and gravel to clay (see boring logs, Appendix B). The alluvium thickens from zero beneath the south part of the plant to as much as about 35 ft beneath the flood plain of Lower Creek at wells N-2 and NE-1. It is estimated to be about 30 - 35 ft thick beneath the landfill (fig.2). Most of the alluvium consists of water-bearing sands, and is herein referred to as the Alluvial Aquifer.

On the basis of lithology and texture, the alluvium can be divided into an upper unit (Unit 1A) and a lower unit (Unit 1B). The upper unit (Unit 1A) consists primarily of alternating and interbedded thin beds of very fine to fine clayey sand; silty sand; sandy clay; sandy, silty clay; and clayey silt. Although thin beds of moderately sorted sands occur in this unit, the sediments are mainly poorly sorted and the percentage of fines (silt and clay) is estimated to be more than 25 percent in most samples. The percentage of fines in 2 upper unit soil samples is 79.1 percent and 97 percent (table 3).

The lower unit contains coarser-grained and better sorted sediments than those in the upper unit. Unit 1B consists predominantly of medium to coarse sand with various admixtures of very-fine to fine sand. Thin gravel lenses occur near the base of the lower alluvium. Thin (2-4 ft thick) clays occur in the lower unit that may or may not be continuous between monitor wells. The more permeable sands of this unit contain less than 15 percent fines (table 3).

Hydrologic Properties

The hydrologic properties of the Alluvial Aquifer were determined on the basis of geologist (lithologic) logs of the test borings, borehole permeability tests on 3 wells (table 4), grain-size analyses on selected samples (table 3) and water-level measurements in the 7 monitor wells and 2 water wells (table 5).

The hydrologic properties of the Alluvial Aquifer are governed primarily by the lithology and texture of sediments. Because of this variable texture, there is a wide variation in water-bearing characteristics of the

TABLE 3. SUMMARY OF PHYSICAL LABORATORY TESTS
SINGER - LENOIR

Well No.	Depth of Sample (ft)	Sample Description	Hydrogeologic Unit	% Silt and Clay (0.074 mm)	Estimated[1] Effective Porosity n_e
W-1B	28.5 - 30	Slightly Sandy CLAY	Unit 1A	79.1	5 - 10%
E-1	18.5 - 20	Silty SAND	Unit 1B	22.0	20%
NE-1	13.5 - 15	Slightly sandy, silty CLAY	Unit 1A	97.0	5%
NE-1	23.5 - 25	Fine to Coarse SAND	Unit 1B	6.0	30%
N-2	23.5 - 25	Silty, Sandy CLAY	Unit 1B	88.0	5 - 10%
N-2	28.5 - 30	Fine to Coarse SAND	Unit 1B	7.0	30%
W-2	23.5 - 25	Clayey SAND	Unit 1B	12.0	25%
W-2	33.5 - 35	Clayey SAND	Unit 1B	6.0	30%

NOTE: Effective porosity estimates of granular sediments (sands) based on method described in Johnson (1967), U.S. Geol. Survey Water-Supply Paper 1662-D. Effective porosity estimates of silty clays and clays based on general estimates of porosity and permeability values of similar sediments compiled during other investigations by Soil & Material Engineers, Inc.

TABLE 4. SUMMARY OF FIELD BOREHOLE PERMEABILITY TESTS
SINGER - LENOIR

WELL NO.	DEPTH OF SCREEN INTERVAL TESTED (ft)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (cm/sec)	(ft/day)	HYDROGEOLOGIC UNIT	LITHOLOGY	REMARKS
W-1B	40 - 45	3.3×10^{-4}	9.4	Unit 1B	Slightly Silty SAND	
E-1	27 - 32	8.6×10^{-3}	24.4	Unit 1B	Slightly Silty, Medium to Coarse SAND	
N-1	9.7 - 19.7	7.0×10^{-5}	0.2	Unit 1A/Unit 1B	Silt, and Fine to Coarse SAND	Well Screen not fully developed, therefore calculated permeability is considered lower than actual permeability.

Note: Falling head tests performed October 13, 1982

S&ME Job No. 4482-129A

Alluvial Aquifer. The upper unit (1A), which contains poorly sorted, fine sediments is less permeable than the lower unit (1B).

Ground water in the Alluvial Aquifer occurs primarily under water-table (unconfined) conditions, although clays locally cause semi-artesian conditions. Hydraulically, the Alluvial Aquifer is an anisotropic unconfined aquifer. Radial permeabilities (hydraulic conductivity, K) of the more permeable sands are estimated to be in the 25-50 ft/day range; with less permeable, poorly-sorted fine sands having estimated permeabilities in the 1-5 ft/day range.

The porosities (n) of sediments within the Alluvial Aquifer are estimated to be within the range of 20 percent (sands) to about 50 percent (clays). However, the effective porosity (n_e), the percentage of connected pores, governs ground-water movement through saturated sand aquifers. The effective porosity of a granular unconfined aquifer is considered, for practical purposes, to be approximately equal to the specific yield (Sy) of that aquifer. Effective porosities of the well sorted sands in the lower unit are estimated to range from 20 percent to 30 percent; and the effective porosities of the lower permeability clays are estimated to be in the 5-10 percent range (table 3).

Recharge and Lateral Ground-Water Movement

A water-table (potentiometric) map of the Alluvial Aquifer was constructed from water-level measurements made on August 3, 1983 in the 7 monitor wells and 2 water wells located east of the site (fig.3). Water-level elevations in the on-site monitor wells were determined from surveyed top of casing (TOC) measuring points. Water-level elevations in the water wells are based on measuring point elevations estimated from the topographic map, and should be considered approximate.

Interpretation of the water-table map indicates the following:

- The Alluvial Aquifer is recharged in areas southeast of the landfill, and ground water moves from southeast to northwest.

- Hydraulic gradients (dh/dL) along selected ground water flowlines through the landfill area average about 0.01 ft/ft.

- Ground water moving through the Alluvial Aquifer discharges into the Lower Creek flood plain, which is interpreted to be the local discharge area for the Alluvial Aquifer.

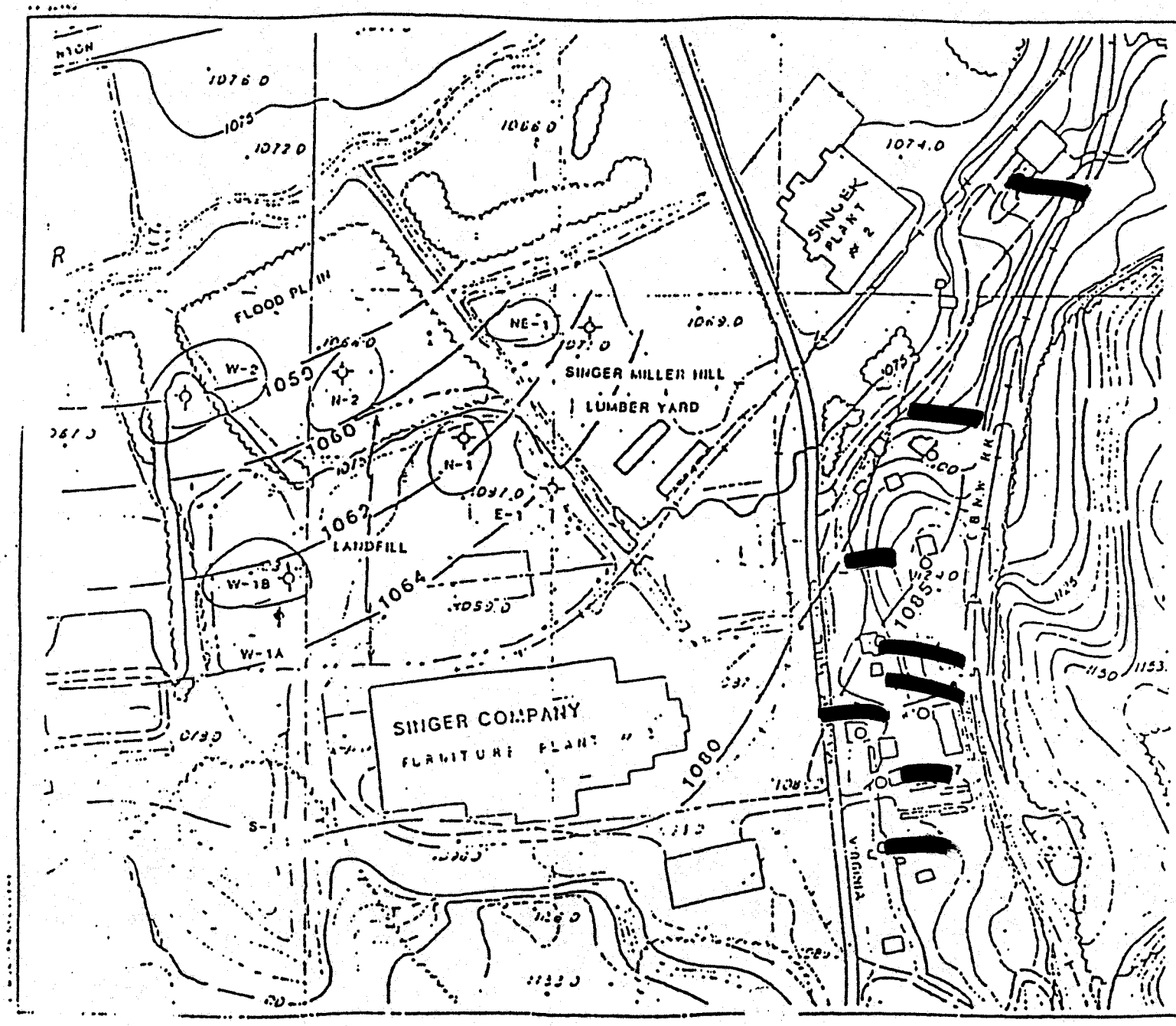


FIGURE 3. POTENTIOMETRIC MAP OF THE ALLUVIAL AQUIFER, AUGUST 3, 1983.

SINGER-LENOIR

4483-129A

TABLE 5. SUMMARY OF WATER-LEVEL DATA, SINGER-LENOIR.

WELL NO.	ELEV. M.P.	DATE MEASURED	WATER LEVEL BELOW M.P.	WATER LEVEL ELEV.	MEASURED BY	REMARKS
W-1B	1082.65	10/13/83 8/3/83	20.5 20.3	1062.15 1062.35	C. Gorman	Well screened in Unit IB
N-1	1072.59	10/13/82 8/3/83	10.4 10.65	1062.19 1061.94	C. Gorman	Well screened in Unit IA/IB
E-1	1073.82	10/13/83 8/3/83	9.9 9.3	1063.92 1064.52	C. Gorman	Well screened in Unit IB
S-1	1098.32	10/14/82 8/3/83	20.2 18.5	1078.12 1079.82	Chris Silkwood C. Gorman	Well screened in Unit II (saprolite)
N-2	1069.84	8/3/83	10.6	1059.24	C. Gorman	Well screened in Unit 1A
W-2	1072.47	8/3/83	13.5	1058.97	C. Gorman	Well screened in Unit 1B
NE-1	1070.65	8/3/83	8.2	1062.45	C. Gorman	Well screened in Unit 1B
WW-2	±1100	8/3/83	19.0	±1081	C. Gorman	Shallow (22 ft) dug well; may tap saprolite (Unit II)
WW-3	±1124	8/3/83	39.0	±1085	C. Gorman	Shallow (42ft) dug well; may tap saprolite (Unit II)

NOTE: Measuring Point (MP) of all wells is top of casing (TOC).

The rate of ground-water movement through the Alluvial Aquifer is assumed to be laminar and governed by Darcy's equation for laminar flow:

$$v = \frac{K}{n_e} \cdot dh/dL$$

where, v = average linear ground-water velocity (in ft/day);
K = radial hydraulic conductivity (in ft/day);
n_e = effective porosity (decimal fraction); and
dh/dL = hydraulic gradient.

Substitution of average estimated values of K= 0.1 ft/day to 50 ft/day, n_e= 0.05 to 0.30, and an average dh/dL= 0.01 ft/ft yields average linear ground-water velocities of 0.02 ft/day (7 ft/yr) to 1.7 ft/day (610 ft/yr) for ground water moving laterally through the Alluvial Aquifer. The higher ground-water flow velocities would occur in the more permeable sands within the lower alluvium (Unit 1B).

Vertical Ground-Water Movement

The vertical movement of ground water in the Alluvial Aquifer is governed by the same hydraulic principles that govern lateral ground-water movement. However, in horizontally bedded alluvial sediments, the vertical permeability (K') is often orders of magnitude lower than radial permeability. There are no laterally continuous, low-permeability confining beds separating the upper unit (1A) and lower unit (1B). Therefore, ground water moves slowly downward from the upper unit into the lower unit.

The Alluvial Aquifer is separated from the Bedrock Aquifer by an unknown thickness of low-permeability silts and clays (saprolite) which was penetrated at wells S-1 (23.5-30 ft), N-2 (34.5-35.0 ft), and NE-1 (34-35 ft). This low permeability saprolite functions as a confining bed which restricts the downward vertical movement of ground water from the Alluvial Aquifer into the Bedrock Aquifer.

Utilization

The area in the vicinity of the Singer Plant is served by public water and sewer by the City of Lenoir. A public water distribution line is located along Virginia Street east of the plant. Some residents east of Virginia Street utilize public water and some utilize wells for drinking-water and other domestic (household) uses.

A well survey was made in the area immediately adjacent to the landfill. The only wells found in close proximity to the landfill area are located east of Virginia Street

(fig.1) and are hydraulically up-gradient of the landfill area. Information obtained from the well survey is summarized in table 2.

Information obtained from the survey indicates that 2 shallow dug wells (WW-2, WW-3) are used for drinking-water supplies and other domestic uses. Two other shallow dug wells (WW-6, WW-7) are used for domestic irrigation, showers, and other domestic uses but not for drinking water. Three wells (WW-4, WW-5, and WW-8) are currently unused, and the residents obtain water from the City of Lenoir public water system.

As shown on table 2, most residents do not recollect particular details regarding well construction. The depths of 2 dug wells (WW-2, WW-3) were measured and are shallow wells (22 ft, 42 ft). The depths of 3 other large-diameter dug wells were reported as 17-22 ft, which are probably reasonably accurate. These wells are located at elevations above about 1095 ft msl and are above the flood plain. Therefore, they probably tap saprolite soils rather than the Alluvial Aquifer.

There are no water wells that tap the Alluvial Aquifer located on Singer property or in the area down-gradient between the landfill and Lower Creek.

3.3 BEDROCK AQUIFER

Distribution and Lithology

Crystalline bedrock underlies the landfill area and immediate vicinity of the landfill and the flood plain of Lower Creek. The Bedrock Aquifer and Alluvial Aquifer are separated by an unknown thickness of saprolite, which is weathered, decomposed bedrock.

The background well (S-1) and 3 monitor wells near the landfill (E-1, N-2, and NE-1) penetrated into the top of saprolite. The depths of these monitor wells were purposely terminated after drilling 1-2 ft into the saprolite; therefore the thickness of saprolite that overlies bedrock is not known.

Samples of saprolite from these wells are composed of quartz, weathered feldspars, dark minerals (probably hornblende or augite), and mica. The texture is primarily silt and silty clay, which is typical of a weathered biotite-hornblende gneiss. Typically in the Piedmont, there is a gradual change from the highly weathered saprolite to the underlying less weathered bedrock.

Crystalline bedrock of the landfill area has been mapped as migmatite gneiss, garnet gneiss, hornblende gneiss, and schist (Goldsmith and others, 1978). The lithology of saprolite form boring samples indicates that the bedrock is probably biotite-hornblende gneiss.

Ground-Water Occurrence and Hydrologic Properties

According to Mr. Richard Peace of the NCDNR, the hydrogeology of bedrock aquifers in the Lenoir area is poorly known. In general, the occurrence, movement, and availability of ground water in the Bedrock Aquifer is probably typical of other crystalline-rock areas where the hydrogeology is known.

Typically, the saprolitic soils overlying bedrock are porous but generally have low permeability and effective porosity. In some areas the saprolite functions as a storage reservoir that slowly recharges fractures in the underlying bedrock; in other areas, the saprolite functions more as a low permeability confining bed over the bedrock aquifer.

In some areas, the saprolite is sufficiently permeable to supply small quantities of ground water to dug and bored wells. The 7 large-diameter dug wells east of Virginia Street probably tap the saprolite.

Ground water in the Bedrock Aquifer occurs within and along water-bearing fractures developed from the weathering along

joints and other planes of weakness. Fractures in the Bedrock Aquifer beneath the landfill area are probably recharged by infiltration of rainfall into and through the saprolite and weathered bedrock in the topographically high areas immediately south and southeast of the plant site. Presumably ground-water movement through the Bedrock Aquifer is northward and northwestward toward the Lower Creek valley. Because the Bedrock Aquifer recharge areas are at comparatively high elevations (1100-1200 ft msl), ground water in the Bedrock Aquifer beneath the landfill area probably exists under considerable artesian pressure.

Apparently, the only utilization of the Bedrock Aquifer in the immediate area of the site is from one well (WW-1) at Southeastern Adhesives Co., located about 1100 ft northeast of the landfill. This 6-inch diameter well, reportedly 300 ft deep, is reportedly pumped at about 3000-4000 gpd (2-4 gpm).

Reference (11)

LAW ENGINEERING TESTING COMPANY
Geotechnical and Materials Engineers
P.O. BOX 11297 / 501 MINUET LANE / CHARLOTTE, NORTH CAROLINA 28209 / (704) 523-2022

October 17, 1978

Singer Furniture Company
P. O. Box 1588
Lenoir, North Carolina 28645

Attention: Mr. Bill Cozart

Subject: Report of Preliminary Subsurface Investigation
Singer Furniture Plant Nos. 3 and 4 Additions
Miller Hill Road
Lenior, North Carolina
LETCo. Job No. CH 4155

Gentlemen:

As authorized by receipt of your Purchase Order No. 17105, Law Engineering Testing Company has completed a preliminary subsurface investigation at the subject site. This report describes the work performed and presents the results obtained, along with our preliminary evaluation and recommendations.

Generally, the investigation indicates that the areas located north of the existing metal warehouse and between plant No. 3 and the metal warehouse are questionable for development. Rather extensive undercutting of existing fill or the use of deep foundations would likely be required in these areas. The area south of Plant No. 3 appears to be the most suitable for development since shallow foundation support could be utilized in this area.

SITE AND PROJECT INFORMATION

The investigated areas are located adjacent to the Singer Furniture Plant Nos. 3 and 4, which are located on Miller Hill Road in Lenoir, North Carolina. We understand that expansion of these existing plants is currently proposed. Three areas are presently under consideration for expansion. One area is located north of an existing 100 by 160-ft, recently constructed, one-story metal warehouse building located on the north side of Plant No. 3. The ground surface in this area is generally level and covered with vegetation and debris. We understand that this area was used up until 1969 as a sanitary landfill for the City of Lenoir. The area extends northward a distance of approximately 300 ft beyond the existing metal building. A slope with a vertical height of 15 to 20 ft is located along the northern edge of this fill area. The ground surface below the bottom of the slope is wooded and appears to be part of the flood plain of a nearby creek.

The second area under consideration for plant expansion is located between Plant No. 3 and the previously described one-story metal building and measures approximately 140 by 500 feet. This area is level at about the same elevation as the previous area described above. A railroad spur line crosses this area and several storage tanks and other facilities and equipment are also located within this area.

The third area is located south of the warehouse and finishing room at the western end of Plant No. 3. Anticipated expansion is this area may

extend several hundred feet south of these existing structures. Presently, a loading and unloading area extends approximately 150 ft south of the existing building and is surrounded by a metal fence. A 25 to 35-ft high cut slope is located south of the metal fence. The top of this slope is relatively level and is wooded. No large rocks or boulders were observed in the face of this cut immediately south of the warehouse and finishing room area. However, intact rock with evidence of presplitting and blasting is exposed in the face of the cut slope located just east of the current proposed area of expansion.

We understand that plans for expansion are very preliminary at this time. No structural information is available. We assume that the proposed design grade for the new construction will be near the ground floor level of the existing plant.

FIELD INVESTIGATION

Soil Test Borings

Soil test borings were drilled in each of the three areas under consideration for plant expansion. Six shallow soil test borings and several additional offset borings were drilled in the most northern area. Three borings were drilled in the area adjacent to the north side of Plant No. 3 and two borings in the area south of plant No. 3. Approximate locations of the soil test borings are shown on the attached Boring Location Plan which we prepared from the furnished site plan entitled "The Singer Company, Plant Nos. 3 and 4,"

dated November 2, 1976. (Index No. 81766.72). We were not furnished any topographic information.

The borings were made by mechanical hollow stem augers. Soil sampling and penetration testing were performed in general accordance with ASTM Specification D-1586. At regular intervals, soil samples were obtained with a standard 1.4-inch I. D., 2-inch O. D., split-tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings and then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final 12 inches was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil's strength and ability to support foundations.

Representative portions of the soil samples thus obtained were placed in glass jars and transported to our laboratory. In the laboratory, the samples were examined by a soils engineer to verify the driller's field classifications. Test Boring Records are attached, graphically showing the soil descriptions and penetration resistances.

SUBSURFACE CONDITIONS

Lenoir is located in the Piedmont Physiographic Province of North Carolina, an area characterized by ancient igneous and metamorphic rocks. The virgin soils encountered in this area are the residual product of in-place chemical weathering

of the underlying parent bedrock. The typical residual soil profile generally consists of clayey soils near the surface where soil weathering is more advanced, underlain by sandy silts and silty sands that generally become harder with depth to the top of parent bedrock. The boundary between soil and rock is not clearly defined; therefore, the transitional zone termed "partially weathered rock" is defined, for engineering purposes, as residual material with standard penetration resistances in excess of 100 blows per foot. Weathering is facilitated by fractures, joints and the presence of less resistant rock types. Consequently, the profile of the partially weathered rock and hard rock is quite irregular and erratic, even over short horizontal distances. Also, it is not unusual to find lenses and boulders of hard rock and zones of partially weathered rock within the soil, well above the general bedrock level.

Quite often, the upper soils along drainage features and in flood plain areas are water-deposited (alluvial) materials that have been eroded and washed down from adjacent higher ground. These alluvial soils are usually soft and compressible, having never been consolidated by pressures in excess of their present overburden.

Area North of Metal Warehouse

All of the soil test borings and offset borings drilled within this area (borings B4 thru B9A) encountered man-made fill underlain by refusal material at a depth ranging from 2.5 to 6 ft below existing grade. The man-made fill

consists of sandy clayey silt and silty sand with numerous rock fragments. The standard penetration resistances recorded in such material are unreliable as to the true consistency due to probable amplification in the blow count caused by the split-spoon sampler striking the numerous hard fragments. Refusal to the soil drilling equipment may result from hard rock lenses, rubble, boulders or the upper surface of sound continuous rock. Diamond core drilling procedures would be required to penetrate and retrieve samples in order to determine the nature and continuity of the refusal material. Diamond core drilling was not performed in this area.

In all likelihood, the refusal material encountered by these borings consist of man-made rock fill, possibly from the excavation at the south end of Plant No. 3. We learned from plant personnel that rock ranging in size from cobbles to boulders was placed in this area over the underlying fill material.

Area Between Plant No. 3 and Metal Warehouse

Borings B-1, B-2, B-3 and B-3A were drilled in this area. An upper layer of man-made fill was encountered to a depth of 13 ft in B-1, 3 ft in B-2 and 8 ft in B-3. The fill consists of clayey sandy silt and silty sand and contains numerous rock fragments. The fill encountered in boring B-1 also contains fragments of wood and glass. The penetration resistances recorded in these fill materials are unreliable as to the true consistency due to the

numerous hard fragments present. Below this fill, material described as fill or possible alluvium was encountered from a depth of 13 to 20 ft in B-1 and 8 to 11 ft in B-3. This fill or possible alluvium consists of firm to stiff sandy clayey silt and sandy silty clay with rounded gravel.

Below the fill or possible alluvium, residual soils resulting from the in-place chemical weathering of parent rock were encountered at a depth of 20 ft in B-1 and 3 ft in B-2. These residual soils consist of firm to dense micaceous silty sand. Possible residual material was encountered from 11 ft to auger refusal at 13 ft in B-3. No sample was recovered of this latter material. Offset boring B-3A was drilled approximately 20 ft northeast of B-3 to help determine the lateral extent of the refusal material. Boring B-3A was augered to a depth of 8.5 ft without soil sampling. Below this depth, fill consisting of sandy clayey silt with rock fragments was encountered to a depth of 10 feet. Possible fill soils consisting of silty sand were encountered from 10 ft to auger refusal at 12 feet. Since diamond core drilling was not performed in borings B-3 or B-3A, it is not known whether the refusal material is boulder or rubble fill or the surface of intact rock.

Area South of Plant No. 3

Two soil test borings, B-10 and B-11, were drilled at the top of the cut slope in this area. Both borings encountered residual soils from the ground surface consisting of stiff micaceous sandy silt and firm to dense silty sand with weathered rock fragments. Partially weathered rock was encountered below the residual soil at a depth of 29 ft in B-10 and 20 ft in B-11. Boring B-11

was terminated in partially weathered rock at a depth of 29.5 feet. Below the continuous partially weathered rock, boring B-10 encountered refusal at a depth of 31 feet. No rock coring was performed in boring B-10 to determine the nature and continuity of the refusal material.

All of the borings, with the exception of B-1, were dry at the time of drilling. Groundwater was encountered at a depth of 19 ft in B-1 at the time of drilling. Groundwater levels may fluctuate several feet with seasonal rainfall variations and with changes in the water level in adjacent streams. Normally, the highest groundwater levels occur in late winter and spring and the lowest levels occur in late summer and fall.

Details of the subsurface conditions encountered in the borings are presented on the attached Test Boring Records.

PRELIMINARY EVALUATION AND RECOMMENDATIONS

Area North of Metal Warehouse

Due to the refusal material encountered at shallow depth in all borings drilled within this area, the nature of the deeper subsurface material is not known. However, based on knowledge gained from plant personnel familiar with this area, we anticipate that the deeper material consists of fill containing debris and other fragments. This material would not provide adequate foundation support for shallow foundations. If the debris fill does not extend to significant depth and competent soil exists below it, it would perhaps be possible to undercut this material and replace it with compacted structural fill.

If the fill extends to considerable depth, a feasible foundation alternative would be driven timber or steel H-piles deriving support primarily from end bearing. If significant amounts of rock and other large debris are present throughout the fill depths (as indicated by the borings), timber piles would probably not be feasible due to the likelihood of damage to the piles upon striking such material. Timber piles could be used, however, if holes could be predrilled by large caisson-type equipment or excavated with a backhoe through the fill prior to installation of piles. Heavy steel H-piles with built up end sections could possibly be driven through the debris fill without the necessity for predrilling. However, if large boulders or other large pieces of debris are present in the fill, even the heavy steel H-piles would likely not be able to penetrate these materials to reach competent bearing material and excavation through the rubble fill with a large backhoe would be required.

Additional subsurface information would be necessary to provide more specific recommendations for foundation design in this area. Test pits excavated by a backhoe would be required to determine the nature and vertical extent of the refusal material. If this refusal material consists of a layer of rock which can be penetrated by the backhoe, it may be possible to extend soil test borings down into the bottom of the pits in order to determine the nature of the deeper fill material and the depths of competent material for end-bearing piles. If test pits reveal that impenetrable large

rock and other large debris is present throughout the fill depths, it is our opinion that the area should not be further considered for development unless it is economically justifiable to remove all such material and replace it with approved structural fill.

Area Between Plant No. 3 and Metal Warehouse

Although fill was encountered by the three soil test borings drilled within this area, the fill does not appear to contain the type and extent of debris that is present within the former sanitary landfill in the area north of this one. However, the existing fill in this area is not considered suitable for support of shallow foundations. Extensive depths of fill were encountered in borings B-1 and B-3. Shallow foundations could likely be used in this area by undercutting the existing fill below the depth stressed by footings and replacing the undercut fill material with compacted structural fill. If the undercut material does not contain significant amounts of deleterious material such as large rock fragments and organic material, it could likely be re-used as structural fill. Boring B-2 encountered competent residual soil adequate for shallow foundation support below a few feet of fill.

Another foundation alternative which appears feasible in this area, based upon the preliminary subsurface information, is a system of driven timber or steel H-piles. The piles would derive support from a combination of side friction and end bearing. Additional soil test borings would be required to determine the minimum tip elevations and working loads for driven piles.

Area South of Plant No. 3

Residual material which could probably be removed by conventional earthmoving equipment was encountered to a depth of about 20 ft in boring B-10 and 29 ft in B-11. The partially weathered rock encountered below these depths would likely require heavy excavating equipment with ripping tools for efficient excavation. As previously stated, the refusal material encountered at a depth of 31 ft in B-10 may be a boulder, a lense of hard rock or may be the upper surface of sound continuous rock. The use of pneumatic hammers and blasting would likely be required for excavation of such material. Since the two borings are widely spaced, it is entirely possible that partially weathered rock or hard rock could be encountered at a higher elevation between the borings.

Based on the results of borings B-10 and B-11, we anticipate that bearing pressures for shallow foundations ranging from 5000 psf in residual soil up to 10,000 psf in partially weathered rock or hard rock would be available. In order to verify these bearing pressures, several additional shallow soil test borings should be drilled within the proposed building area.

QUALIFICATION OF REPORT

Our evaluation of foundation support conditions for this preliminary subsurface investigation has been based on our understanding of the project and site information and the data obtained in our investigation. The general

subsurface conditions utilized in our evaluation of foundations are based on interpolation of subsurface data between the widely spaced borings. In evaluating the boring data obtained in this preliminary subsurface investigation, we have examined previous correlations between penetration resistances and foundation bearing pressures observed in soil conditions similar to those at your site.

The foundation recommendations stated in this report are only preliminary in nature and not intended for use in final foundation design. When the project plans are finalized, we will be glad to work with you in establishing the final investigative program required to give detailed soil and rock-related recommendations for foundation design and site preparation.

Law Engineering Testing Company appreciates the opportunity to provide our geotechnical engineering services on this project. If you have any questions concerning this report or if we may be of further assistance to you during the final design and construction phases of this project, please contact us.

Very truly yours,

LAW ENGINEERING TESTING COMPANY

Mel Y. Browning

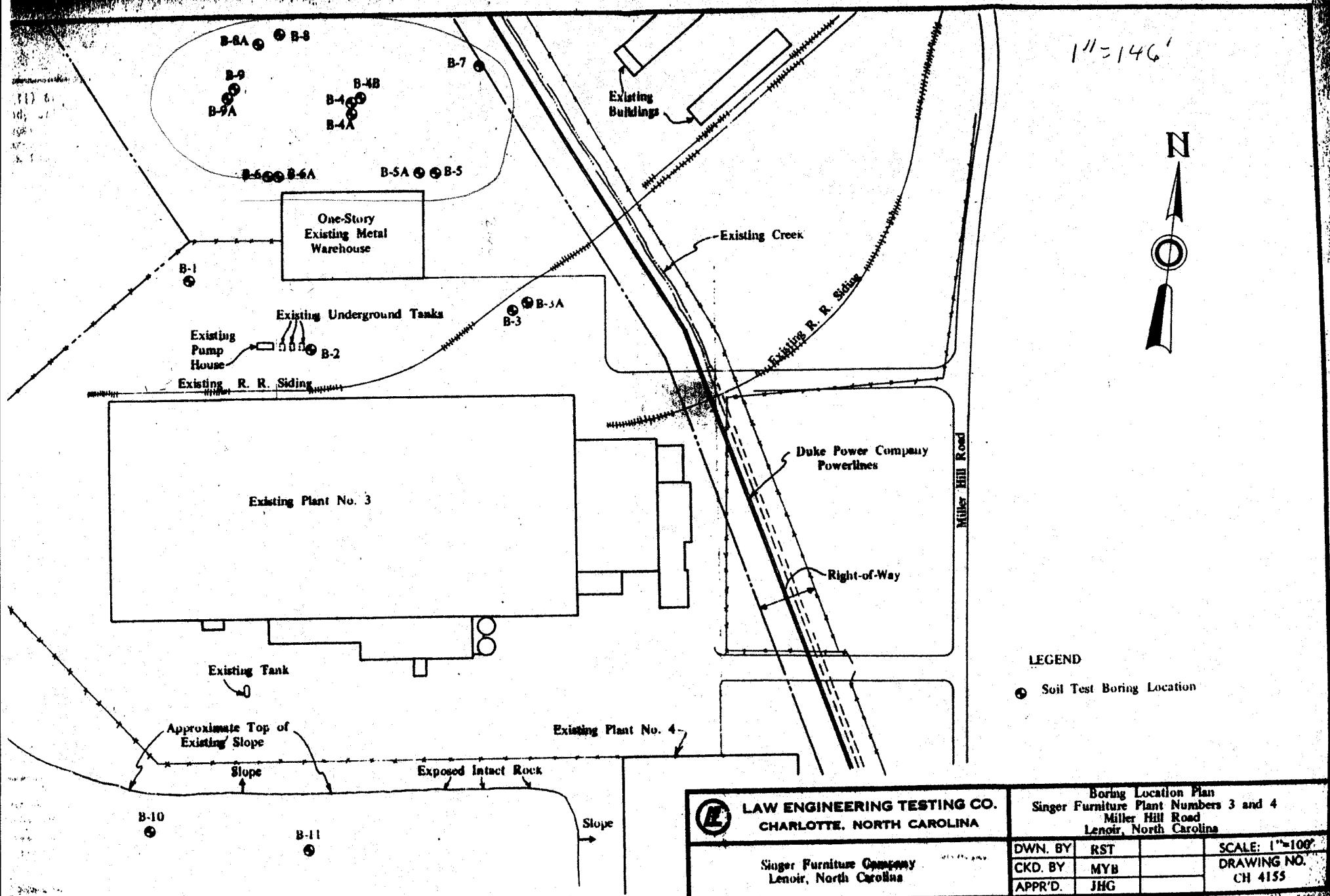
Mel Y. Browning, E. I. T.
Staff Soils Engineer

Jon H. Gould

Jon H. Gould, P. E.
Chief Engineer
Registered, N. C. 7582

MYB/JHG/cm

Attachments



LAW ENGINEERING TESTING CO.
CHARLOTTE, NORTH CAROLINA

Singer Furniture Company
Lenoir, North Carolina

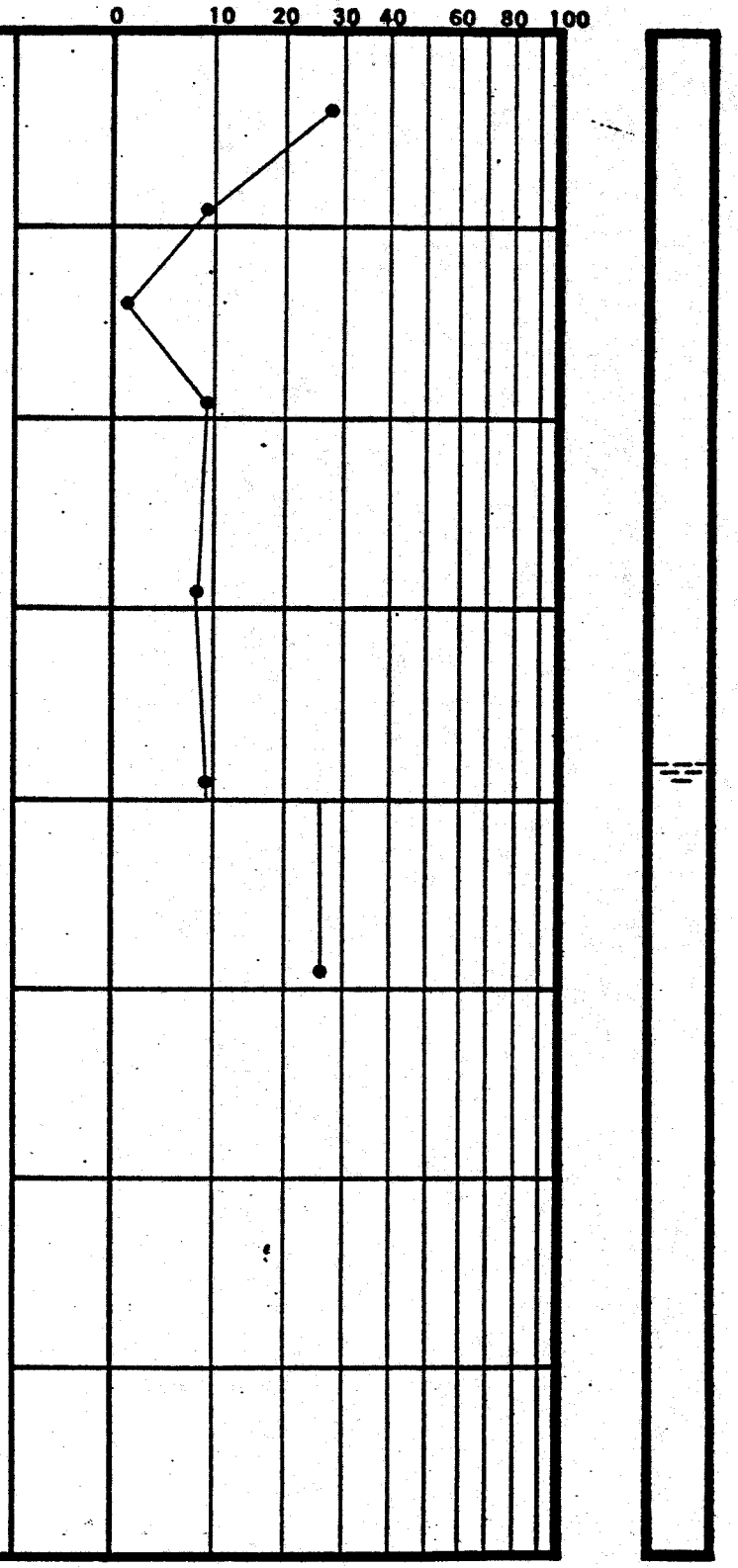
Boring Location Plan
Singer Furniture Plant Numbers 3 and 4
Miller Hill Road
Lenoir, North Carolina

DWN. BY	RST		SCALE: 1"=100'
CKD. BY	MYB		DRAWING NO. CH 4155
APPR'D.	JHG		

Ref: Drawing Entitled, "The Singer Company, Plant Nos. 3 and 4, Lenoir, North Carolina" dated November 2, 1976 (Index No. 81766 72)

DEPTH	DESCRIPTION
0	(Fill) Brown Clayey Fine to Coarse Sandy Silt With Rock And Wood Fragments to Black Silty Fine to Coarse Sand With Wood, Glass and Rock Fragments
3.0	(Fill or Possible Alluvium) Firm to Stiff Tan Brown to Blue Gray and Tan Micaceous Fine to Medium Sandy Clayey Silt
5.0	(Residual) Firm Gray Green Micaceous Silty Fine to Medium Sand
25.0	Boring Terminated At 25.0 Feet Groundwater Encountered At 19 Feet At Time of Boring

● PENETRATION-BLOWS PER FT.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-1

DATE DRILLED 8/31/78

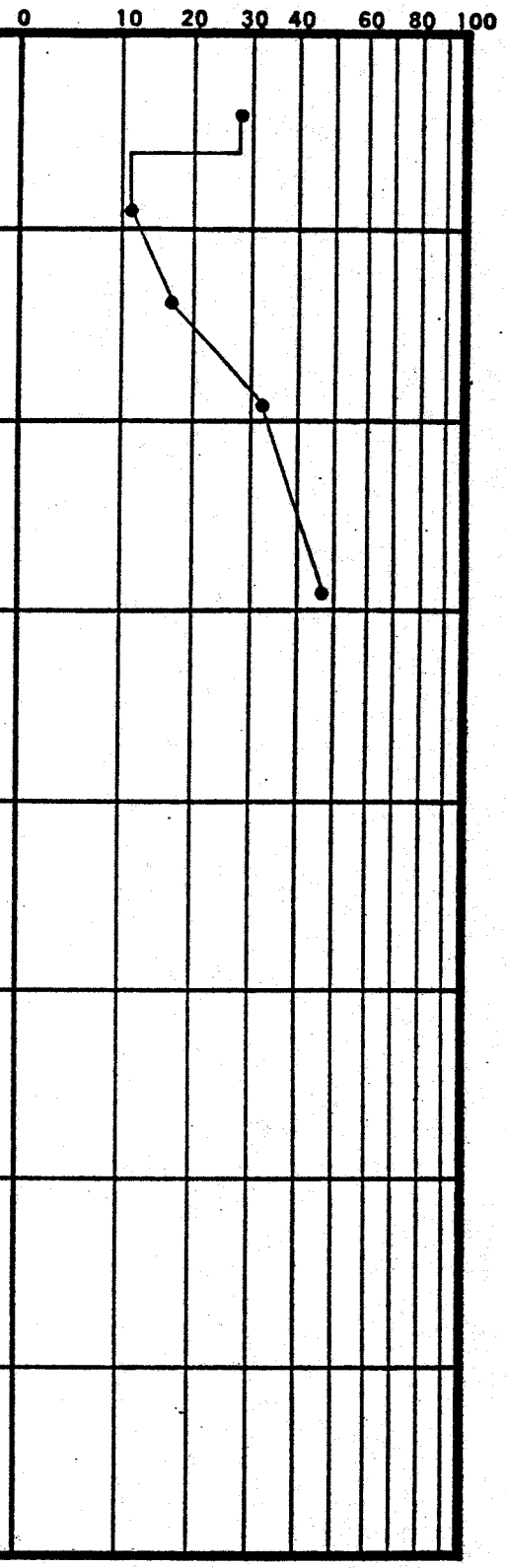
JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION
	(Fill) Green Gray Micaceous Silty Fine to Coarse Sand With Rock Fragments
	(Residual) Firm Green Gray Very Micaceous Silty Fine Sand to Gray Brown and White Micaceous Silty Fine Sand
0	Dense Gray Brown to Green Gray Silty Fine to Coarse Sand
0	Boring Terminated At 15.0 Feet No Groundwater Encountered At Time of Boring

● PENETRATION-BLOWS PER FT.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.

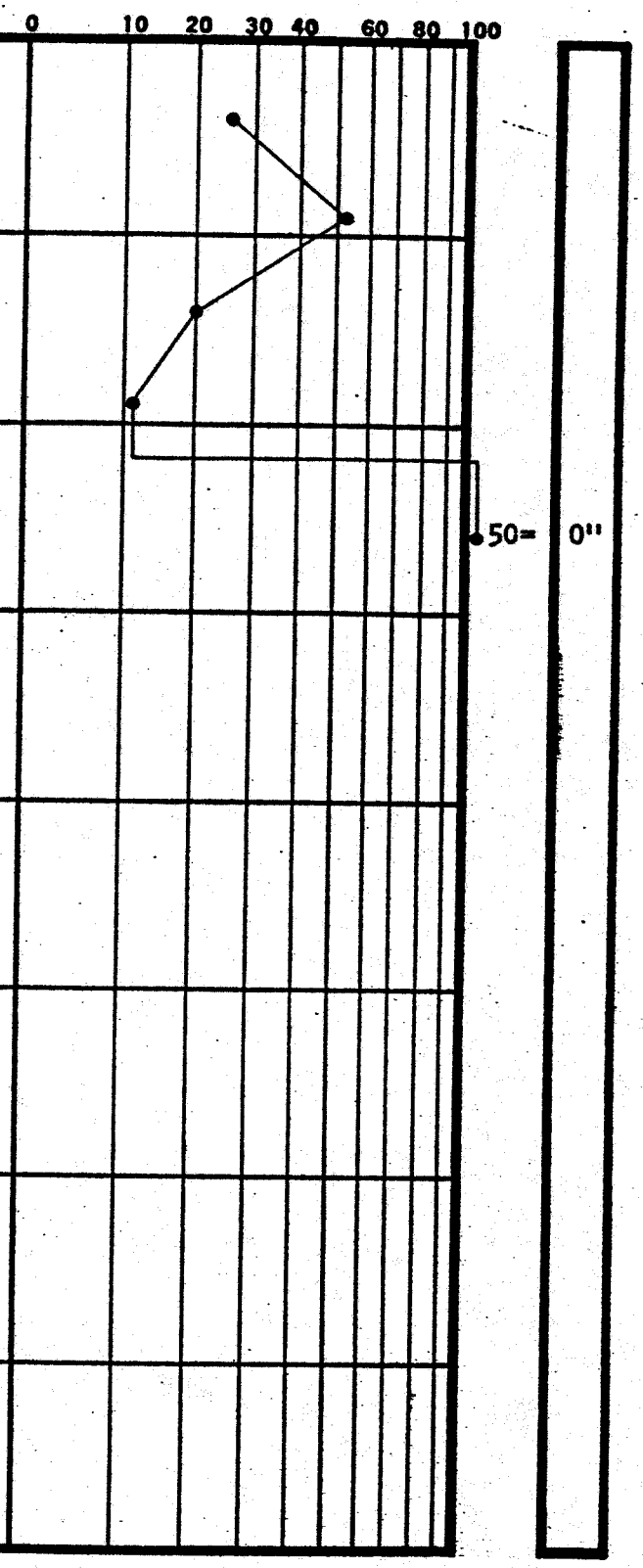
TEST BORING RECORD

BORING NO. B-2
DATE DRILLED 8/31/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT	DESCRIPTION
0	Crushed Stone
.0	(Fill) Gray Green Micaceous Silty Fine to Coarse Sand With Rock Fragments
3.0	(Fill or Possible Alluvium) Tan Brown Fine to Coarse Sandy Silty Clay With Rounded Gravel
.0	(Possible Residual - No Samples Obtained)
..0	Auger Refusal At 13.0 Feet Boring Terminated At 13.0 Feet No Groundwater Encountered At Time of Boring

● PENETRATION-BLOWS PER FT.



BORING AND SAMPLING MEETS ASTM D-1586
HOLE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-3

DATE DRILLED 8/31/78

JOB NO. CH 4155

PAGE 1 OF 1

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
	Augered From 0 to 8.5 Feet Without Soil Sampling	
8.5	(Fill) Red Brown Fine to Coarse Sandy Clayey Silt With Rock Fragments	
10.0	(Possible Fill) Tan Gray Silty Fine to Coarse Sand With Rock Fragments	
12.0	Auger Refusal At 12.0 Feet Boring Terminated At 12.0 Feet No Groundwater Encountered At Time of Boring	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-3A

DATE DRILLED 8/31/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)	
0	(Fill) Red Tan Micaceous Fine to Coarse Sandy Clayey Silt With Rock Fragments	50=	6"
0	Auger Refusal At 3.0 Feet Boring Terminated At 3.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-4
DATE DRILLED 9/1/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0	(Fill) Red Tan Micaceous Fine to Coarse Sandy Clayey Silt With Rock Fragments	
3.5	Auger Refusal At 3.5 Feet Boring Terminated At 3.5 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-4A

DATE DRILLED 9/1/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0	(Fill) Brown Fine to Coarse Sandy Clayey Silt With Rock Fragments	
.0	Auger Refusal At 3.0 Feet Boring Terminated At 3.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

50 % ROCK CORE RECOVERY

TEST BORING RECORD

BORING NO. B-4B

DATE DRILLED 9/1/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
	(Fill) Green Gray Micaceous Silty Fine to Coarse Sand With Rock Fragments	
3.0	Auger Refusal At 3.0 Feet Boring Terminated At 3.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-5

DATE DRILLED 9/5/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
0	(Fill) Red Brown Micaceous Clayey Silty Fine to Coarse Sand With Rock Fragments	
5	Auger Refusal at 3.5 Feet Boring Terminated at 3.5 Feet No Groundwater Encountered at Time of Boring No Groundwater Encountered After 24 Hours	

ING AND SAMPLING MEETS ASTM D-1586
E DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-5A

DATE DRILLED 9/5/78

JOB NO. CH 4155

PAGE 1 OF 1

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)	
	(Fill) Rock Fragments	50=	0"
3.5	Auger Refusal At 3.5 Feet Boring Terminated At 3.5 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-6
DATE DRILLED 9/5/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
0	(Fill) Green Brown Silty Fine to Coarse Sand With Rock Fragments	
6.0	Auger Refusal At 6.0 Feet Boring Terminated At 6.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-6A
DATE DRILLED 9/5/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)	
0	(Fill) Blue Gray Slightly Silty Fine to Coarse Sand With Rock Fragments	●50=	6"
5.5	Auger Refusal At 5.5 Feet Boring Terminated At 5.5 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-7
DATE DRILLED 9/5/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
	(Fill) Red Brown Silty Fine to Coarse Sand With Rock Fragments	
4.5	Auger Refusal At 4.5 Feet Boring Terminated At 4.5 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-7A

DATE DRILLED 9/5/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)	
0	(Fill) Red Brown Silty Fine to Coarse Sand With Rock Fragments	●50=	0"
2.5	Auger Refusal At 2.5 Feet Boring Terminated At 2.5 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-8
DATE DRILLED 9/5/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)
0	(Fill) Red Brown Silty Fine to Coarse Sand With Rock Fragments	
3.0	Auger Refusal At 3.0 Feet Boring Terminated At 3.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-8A
DATE DRILLED 9/5/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)	
0	(Fill) Brown Silty Fine to Coarse Sand With Rock Fragments	●50=	0"
3.0	Auger Refusal At 3.0 Feet Boring Terminated At 3.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours		

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-9

DATE DRILLED 9/5/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0	(Fill) Brown Silty Fine to Coarse Sand With Rock Fragments	
3.0	Auger Refusal At 3.0 Feet Boring Terminated At 3.0 Feet No Groundwater Encountered At Time of Boring No Groundwater Encountered After 24 Hours	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.

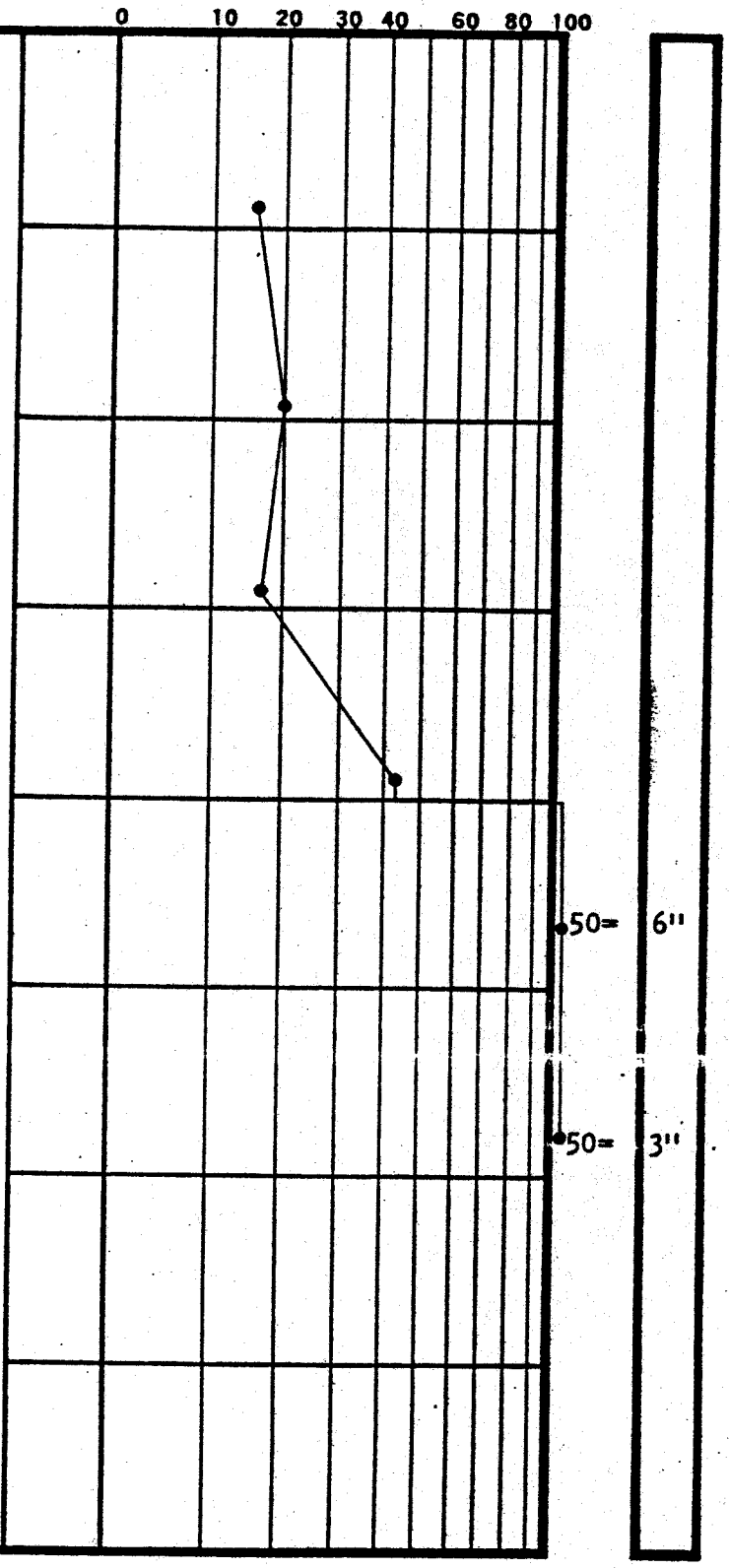
TEST BORING RECORD

BORING NO. B-9A
DATE DRILLED 9/5/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION
0	(Residual) Firm Tan Brown Micaceous Silty Fine to Medium Sand
.0	Dense Green Brown Micaceous Silty Fine to Coarse Sand
.0	Partially Weathered Rock Sampled As Green Brown to Blue Gray And Tan Micaceous Silty Fine to Coarse Sand
.0	Auger Refusal At 31.0 Feet Boring Terminated At 31.0 Feet No Groundwater Encountered At Time of Boring

● PENETRATION-BLOWS PER FT.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

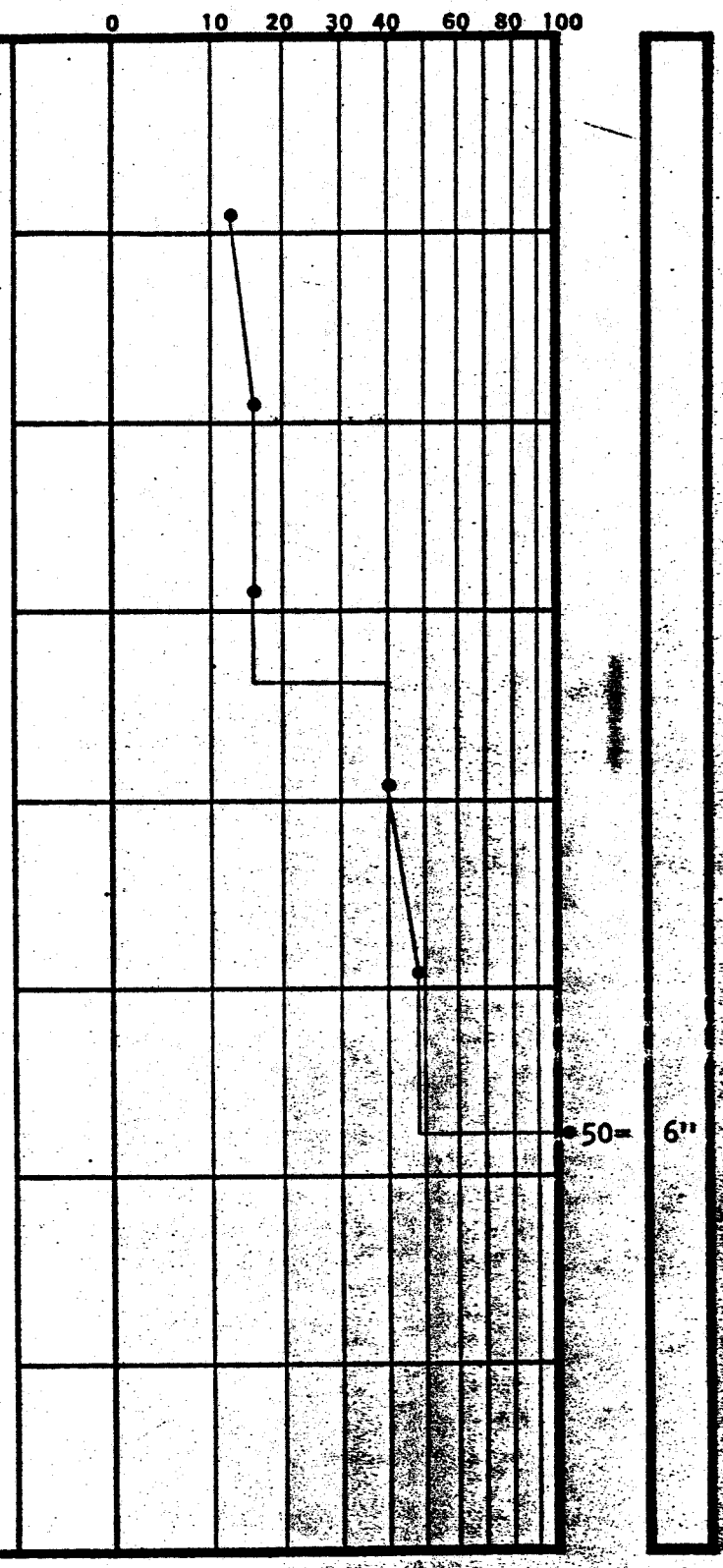
TEST BORING RECORD

BORING NO. B-10
DATE DRILLED 9/6/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION
0	(Residual) Stiff Tan Brown Micaceous Fine Sandy Silt
5.5	Firm Tan Brown And Green Gray Micaceous Silty Fine to Coarse Sand With Weathered Rock Fragments
17.0	Dense Blue Gray, Brown And White Micaceous Silty Fine to Medium Sand With Weathered Rock Fragments
29.0	*
29.5	Boring Terminated At 30.0 Feet No Groundwater Encountered At Time of Boring *Partially Weathered Rock Sampled As Blue Gray Silty Fine to Medium Sand

● PENETRATION-BLOWS PER FT.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-11

DATE DRILLED 9/6/78

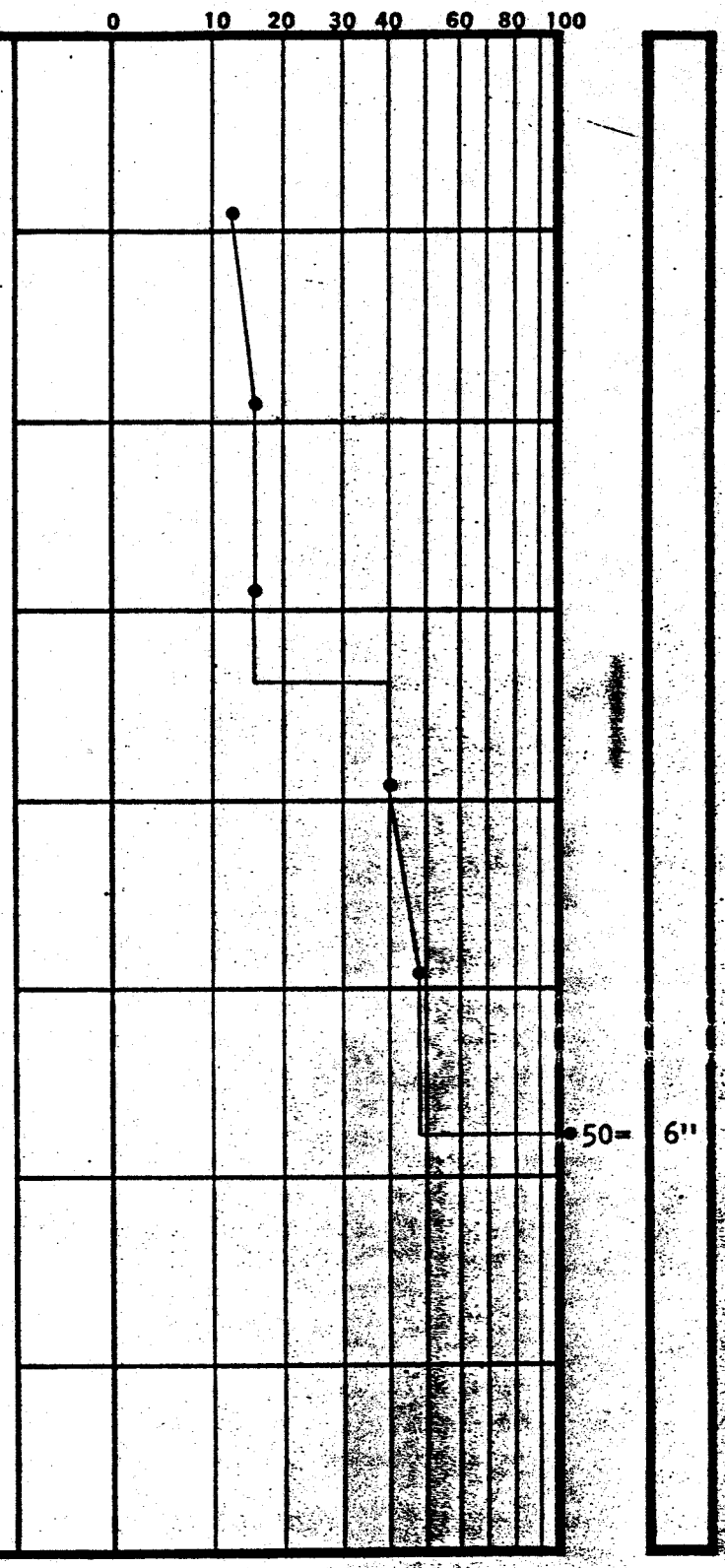
JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH	DESCRIPTION
0	(Residual). Stiff Tan Brown Micaceous Fine Sandy Silt
5.5	Firm Tan Brown And Green Gray Micaceous Silty Fine to Coarse Sand With Weathered Rock Fragments
17.0	Dense Blue Gray, Brown And White Micaceous Silty Fine to Medium Sand With Weathered Rock Fragments
29.0	
29.5	Boring Terminated At 30.0 Feet No Groundwater Encountered At Time of Boring *Partially Weathered Rock Sampled As Blue Gray Silty Fine to Medium Sand

● PENETRATION-BLOWS PER FT.



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-11

DATE DRILLED 9/6/78

JOB NO. CH 4155

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

Reference (12)

LAW ENGINEERING TESTING COMPANY

Geotechnical and Materials Engineers

P.O. BOX 11297 501 MINUET LANE CHARLOTTE NORTH CAROLINA 28220 / (704) 523-2022

August 22, 1980

Singer Furniture
P. O. Box 1588
Lenoir, North Carolina 28645

Attention: Mr. Eklain England
Project Manager

Subject: Report of Preliminary Geotechnical Exploration
Singer Furniture Facilities
Miller Hill Road (Virginia Street)
Lenoir, North Carolina
LETCo. Job No. CH 4467

Gentlemen:

As authorized by your Purchase Order No. 042345 dated August 7, 1980, Law Engineering Testing Company has completed a preliminary geotechnical exploration at the subject site. The purpose of this exploration was to generally define the range of subsurface conditions within the subject property and to determine its geotechnical suitability for future development. This report describes the work performed and presents the results obtained, along with our preliminary evaluation and recommendations.

Previously, we performed a preliminary geotechnical exploration at the site which included some borings within the current area. This previous work was reported as Law Engineering Job No. CH 4155 dated October 17, 1978.

SITE AND PROJECT INFORMATION

The Singer Furniture facilities are located south of Morganton Boulevard on both sides of Miller Hill Road (Virginia Street) in Lenoir, North Carolina. The total site encompasses between 60 and 70 acres. About one-half of this area lies in the moderately wooded flood plain of Lower Creek which runs along

the north boundary of the site. The extreme southern portion of the site has a moderately to steeply sloping topography and rises to as high as 75± ft above the existing Plant No. 3 facility. Part of this higher area has been used as a source for borrow material and is relatively clear. The undisturbed higher part is densely wooded.

Future site development plans call for plant expansion both to the north, within the present flood plain area, and to the south in the present high ground area. Anticipated future construction will be similar to existing site buildings. Approximately 10 ft of fill would be required within the flood plain area to obtain an elevation compatible with the predicted 100-year flood elevation of 1076 feet. South of the existing Plant Nos. 3 and 4, excavation depths ranging from 30 to 70 ft would be required to obtain the finished floor elevation of 1095 ft in Plant No. 3. Borrow soil excavated from this latter area would be available for use in filling in the flood plain area.

Our understanding of the proposed project plan is based on a meeting between our Mr. Jon Gould and Mr. Eklain England of Singer Furniture on July 25, 1980 and the furnished City of Lenoir topographic site plan.

FIELD EXPLORATION

Five soil test borings, designated BB-1 through BB-5 were drilled within the flood plain area. Three borings with infrequent split-spoon sampling, along with one offset auger boring, were drilled within the higher ground area south of existing Plant Nos. 3 and 4. The approximate boring locations are shown on the attached Boring Location Plan which we prepared from the furnished City of Lenoir Topographic Sheet B-5. The boring locations were mutually agreed upon by our Mr. Jon Gould and Mr. Eklain England of Singer Furniture. The borings were field-located by our drill crew by measuring from existing site features with a 100-ft tape, using estimated right angles. Elevations at the boring locations were estimated by interpolating between the ground surface elevation contours (contour interval of 5 ft) shown on the furnished topographic site plan.

The borings were made by both a rotary wash drilling procedure in which clear water was maintained in the borehole to stabilize the soils and by mechanically twisting a continuous steel flight auger into the soil. At regular intervals in the soil test borings and at infrequent intervals in the other borings, the drilling tools were removed and soil samples obtained with a standard 1.4-inch I. D., 2-inch O. D., split-tube sampler. Soil sampling and penetration testing were performed in general accordance with ASTM D 1586. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional 12 inches with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final 12

inches was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil's strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined by a geotechnical engineer to verify the driller's field classifications. Test Boring Records are attached, showing the soil descriptions and penetration resistances.

SUBSURFACE CONDITIONS

Area Geology

The project site is located in the Piedmont Physiographic Province, an area underlain by ancient igneous and metamorphic rocks. The virgin soils encountered in this area are the residual product of in-place chemical weathering of rock which was similar to the rock presently underlying the site. The typical residual soil profile consists of clayey soils near the surface where soil weathering is more advanced, underlain by sandy silts and silty sands. The boundary between soil and rock is not sharply defined. This transitional zone termed "partially weathered rock" is normally found overlying the parent bedrock. Partially weathered rock is defined, for engineering purposes, as residual material with standard penetration resistances in excess of 100 blows per foot. Weathering is facilitated by fractures, joints and by the presence of less resistant rock types. Consequently, the profile of the partially weathered rock and hard rock is quite irregular and erratic, even over short horizontal distances. Also, it is not unusual to find lenses and boulders of hard rock and zones of partially weathered rock within the soil mantle, well above the general bedrock level.

Quite often, the upper soils along drainage features and in flood plain areas are water-deposited (alluvial) materials that have been eroded and washed down from adjacent higher ground. These alluvial soils are usually soft and compressible, having never been consolidated by pressures in excess of their present overburden.

Soil Conditions in Flood Plain

Within the flood plain area of the site, borings BB-4 and BB-5 encountered man-made fill to depths of 4 ft and 1 ft, respectively. The fill encountered in BB-5 (some of which was placed for access) and the upper 1 ft of fill in BB-4 consists of silty sand and gravel. Some wood chips and trash were present in the fill at BB-5. The deeper fill in BB-4 to 4 ft depth consists

of firm silty sand which is relatively clean. Boring BB-1 encountered material to 3 ft depth described as fill or possible alluvium consisting of very loose silty sand.

Below the fill or possible alluvium in borings BB-1, BB-4 and BB-5 and below a surficial topsoil cover in borings BB-2 and BB-3, alluvial materials were encountered to depths ranging from 14 ft in BB-1 to 33.5 ft in BB-5. The alluvium consists of very soft to soft sandy clayey silt and sandy silty clay and very loose to firm silty sand. The upper 18 to 20 ft of alluvium in borings BB-4 and BB-5 and the entire depth of alluvium in BB-1 consists primarily of fine-grained silty clay and clayey silt. This fine-grained alluvium is underlain in borings BB-4 and BB-5 by about 12 ft of alluvial silty sand. The alluvium encountered in borings BB-2 and BB-3 consists predominantly of silty sand for its full depth. The sampled alluvium typically contains decayed organics and wood fragments. The bottom few feet of the alluvium is typically very sandy and contains rounded gravel and small cobbles.

Below the alluvium in these five borings, residual soils resulting from the in-place chemical weathering of parent rock were encountered. The residual soils consist of firm to very dense silty sands which are generally micaceous. Residual material hard enough to be termed partially weathered rock was encountered in borings BB-1, BB-2 and BB-3 slightly above boring termination at depths ranging from 33 to 34 feet.

South of Plant Nos. 3 and 4

Current borings BB-6, BB-7, BB-7A and BB-8 encountered subsurface conditions similar to those encountered by previous soil test borings B-10 and B-11 located within this site area. Previous borings B-10 and B-11 encountered residual soils from the ground surface consisting of stiff micaceous sandy silt and firm to dense silty sand to respective depths of 20 and 29 feet. Partially weathered rock was encountered below these depths to auger refusal at 31 ft in B-10 and to boring termination at 29.5 ft in B-11.

Residual soils consisting of sandy silts and silty sands, with estimated consistencies ranging from loose to very dense, were encountered in borings BB-6 through BB-8 to depths ranging from 39.5 ft in BB-7 to 57.5 ft in BB-8. The residual soils are typically micaceous with the percentage of mica variable with depth and location. Partially weathered rock was encountered at approximate depths of 55 ft in BB-7A and 57.5 ft in BB-8. The depth of partially weathered rock in these borings is very approximate and is based primarily on the driller's assessment of drilling difficulty, along with infrequent split-spoon sampling. Refusal to mechanical augers was encountered at 39.5 ft in BB-7 and refusal to rotary drag bit was encountered at 63.1 ft in BB-7A. Boring BB-7A is located approximately 25 ft south of BB-7 and was drilled to help determine the lateral extent of the relatively shallow refusal material encountered in BB-7. Refusal to the soil drilling equipment may

result from hard rock lenses, pinnacles, boulders or the upper surface of sound continuous rock. Diamond core drilling procedures would be required to penetrate and retrieve samples in order to determine the nature and continuity of the refusal material. Diamond core drilling was not performed in these borings.

Groundwater Conditions

Water levels were checked in all the borings at the time of drilling and again in the majority of the borings after times ranging from 24 hours to several days, to record the stabilized groundwater levels. In the flood plain area, stabilized groundwater levels ranged from 1 to 6 ft in borings BB-1, BB-2 and BB-5. Groundwater was at 5 ft in BB-3 several hours after completion of drilling and at a similar depth in boring BB-4 at the completion of drilling. Only limited groundwater information was obtained in borings BB-6 through BB-8. Groundwater was at 32.5 ft in BB-6 after several days, which corresponds to approximately elevation 1105 feet. After 24 hours, boring BB-7 was dry and caved at 34 feet. Such caved depths are often indicative of groundwater slightly below the caved depth. However, caving of boreholes can also be caused by fall-in or collapse of the walls of the borehole well above the groundwater level, which is likely in this case. Water levels in borings BB-7A and BB-8 were noted at the time of boring but are unreliable since water was used in advancing these boreholes. These borings were not checked for stabilized groundwater. Previous borings B-10 and B-11 were dry to the termination depths at the time of boring. The significant depth of excavation which has been performed south of Plant No. 3 has undoubtedly depressed the groundwater level within the high ground portion of the site below its level before excavation.

Groundwater levels may fluctuate several feet with seasonal rainfall variations and with changes in the water level in adjacent streams. Normally, the highest groundwater levels occur in late winter and spring and the lowest levels occur in late summer and fall.

Details of the subsurface conditions encountered in the recent borings and previous borings B-10 and B-11 are presented on the attached Test Boring Records. A summary of the subsurface conditions encountered in these borings is given on the attached Table I.

PRELIMINARY EVALUATION AND RECOMMENDATIONS

Flood Plain Area

The man-made fill and alluvium encountered in borings BB-1 through BB-5 is not suitable for support of buildings. Foundations bearing in such potentially highly compressible material would be subject to excessive amounts of total and differential settlement. Two possible alternatives to provide suitable structural support in this area are discussed below.

TABLE
SUMMARY OF SUBSURFACE CONDITIONS
LETCo. JOB NO. CH 4467

Boring No.	Approx. Surface Elev.(1) (Ft)	Approx. Depth of Fill (Ft)	Approx. Depth of Alluvium (Ft)	Approx. Depth to PWR (Ft)	Approx. Depth to Refusal(2) (Ft)	Approx. Groundwater Depth(3) (Ft)
BB-1	1070±	3	14	34	--	1
BB-2	1068	--	29	33.5	--	6
BB-3	1067	--	29.5	33	--	5
BB-4	1070	4	34.5	--	--	5 @ TOB
BB-5	1068	1	33.5	--	--	5
BB-6	1137	--	--	--	--	32.5
BB-7	1167	--	--	--	39.5	Caved & Dry @ 34
BB-7A	1165	--	--	55	63.1	--
BB-8	1160	--	--	57.5	--	--
BB-10	1125(4)	--	--	20	31	--
BB-11	1135(4)	--	--	29	--	--

Notes: (1) Surface Elevations Estimated by Interpolation Between Surface Contours Shown on Furnished City of Lenoir Topographic Map.

(2) Refusal May Represent Boulders, Hard Rock Lenses or the Upper Surface of Bedrock.

(3) Groundwater Depths Represent Measurements Made After a Reasonable Stabilization Period Except Where Indicated as TOB (Time of Boring).

(4) Surface Elevation at Previous Boring Estimated from Recently Furnished City of Lenoir Topographic Map.

DUNCAN-PARNELL, INC., CHARLOTTE 280

One possible alternative would be foundation support on compacted structural fill placed above the existing flood plain surface. A sufficient thickness of fill, probably on the order of 10 ft, would be required between the bottom of foundations and the existing alluvial materials to contain significant foundation stresses within the fill. This depth of fill would seem compatible with existing site grade since approximately 10 ft of fill would be required in the flood plain area to obtain the predicted 100-year flood elevation. Construction on top of the fill would have to be delayed until sufficient time had elapsed for the alluvium to adjust to the weight of this fill and for the fill to have adjusted to its own weight. Due to the clayey nature of much of the alluvium, several months would likely be required for this adjustment to occur. Laboratory consolidation testing on undisturbed samples of the alluvium would be required to predict the time necessary for settlement adjustment to occur. Settlement plates installed at the base of the fill and monitored regularly by precision leveling, both during and following the filling operation, would be required to determine when settlements were negligible. Even after this period of settlement adjustment, additional long term "secondary settlement" would continue. The magnitude of this secondary settlement would have to be determined from laboratory consolidation testing of undisturbed samples of this material. Provided that primary settlement was completed and sufficient fill thickness separated the building foundations and underlying alluvium, such long term secondary settlements would likely be negligible. This would have to be confirmed by the laboratory testing program.

Construction on top of the completed fill would impose additional stresses in the fill due to the floor and foundation loads. Provided that the alluvium and fill had previously adjusted to the weight of overlying material, settlements due to the new construction would likely be within the range for typical plant construction. However, heavy floor or column loads could experience undesirable magnitudes of settlement. Such settlements could be minimized by preloading above the proposed subgrade level of compacted structural fill with several feet of uncompacted fill to allow the fill soils to adjust to a loading roughly equivalent to future building loads.

If time is not available for settlements to occur prior to actual building construction, then deep foundations would be required to transfer the structural loads through the compressible alluvial soils to the underlying relatively incompressible residual soil and partially weathered rock. In our opinion, a deep foundation system of driven piles consisting of timber, closed-end, concrete-filled steel pipe piles or steel H-piles, would be feasible. Such piles would derive support primarily from end bearing with some contribution from skin friction in the residual soils and partially weathered rock below the alluvium. Predrilling through the gravel and cobble layer at the base of the alluvium would be required for use of timber piles. Based on the available limited subsurface information, we anticipate maximum allowable working capacities of 20 to 25 tons for timber piles bearing in very

dense residual soil or on partially weathered rock and 50 to 60 tons for closed-end, concrete-filled steel pipe piles extended a few feet into partially weathered rock. The borings indicate that required depths for the timber and pipe piles would likely range from 35 to 40+ feet. The feasibility for use of timber piles would largely depend on the depth of additional fill to be placed above the present flood plain surface, since the maximum length of timber piles readily obtainable is on the order of 60 feet. Steel H-piles driven several feet into partially weathered rock could potentially achieve up to 100 tons of individual working capacity. Additional borings extended to greater depth would be required to more accurately predict pile loads and pile tip elevations.

Even if driven piles were utilized for support of structural loads, it would still be desirable to allow time for the alluvium to adjust to the weight of any fill placed to raise site grade in the flood plain area. Piles installed through the fill and alluvium before such adjustment had occurred would be subject to negative skin friction forces caused by settlement of the fill and alluvium adjacent to the piles. Such negative or downdrag forces would reduce the available working capacity of the piles for structural support. Also, if fill settlement was not allowed to occur prior to construction, floor slabs would have to be pile supported and designed as structural slabs.

Area South of Plant Nos. 3 and 4

The previous and current borings drilled within this area indicate that the surface of partially weathered rock and hard rock is knobby and uneven, as is characteristic of this geologic area. Residual soils with standard penetration resistances of 60 or less can generally be excavated with conventional earthmoving equipment. Harder residual soils and partially weathered rock typically require heavy excavating equipment with ripping tools for efficient excavation. Refusal materials, where continuous, generally require blasting for efficient excavation. Thus, the borings indicate that conventional excavation could be accomplished to depths ranging from about 20 to 57 ft below existing grade, corresponding to a range in elevation from about 1092 (boring termination in BB-6) to 1128 feet. Ripping of partially weathered rock and blasting of refusal materials present below these depths would be required. Some random boulders, ridges or pinnacles of rock requiring blasting would likely be encountered within the general depths of conventional excavation. (Hard rock which required blasting is exposed in the face of the cut south of Plant No. 3.)

Although the groundwater level will likely be permanently depressed as the large, deep excavation is made, some dewatering and drainage will probably be required. Adequate groundwater control could likely be achieved by gravity drainage and pumping from strategically placed, filtered sumps.

Based on the results of the previous and current borings, we anticipate that bearing pressures for shallow foundations ranging from 5000 psf in residual soil up to 10,000 psf in partially weathered rock would be generally available. Much higher bearing pressures are possible on hard, intact rock. These bearing pressures would have to be verified by additional soil test borings drilled within specific building locations after excavation is completed.

Laboratory classification and compaction testing was not within the scope of this preliminary exploration. However, our visual examination of the split-spoon samples and previous experience with similar materials indicate that the proposed cut materials would in general be suitable for use as structural fill. Some of the proposed cut materials contain a significant percentage of mica. Strict moisture control of such material would likely be required to minimize potential "fluffing" during compaction in order to achieve desired density. Partially weathered rock should not be used for structural fill unless it can be broken down by the excavation and compaction equipment into a material with maximum particle size of 6 inches. The sandy nature of the partially weathered rock at this site is favorable in this regard. In general, soils to be used as structural fill in building and pavement areas should have a Plasticity Index less than 30 (15 is ideal) and should have less than 5 percent (by weight) of fibrous organic material.

Before filling commences, a representative sample of each proposed fill material should be tested to determine its compaction characteristics, including maximum dry density and optimum moisture content.

QUALIFICATION OF REPORT

Our evaluation of foundation support and excavation conditions for this preliminary subsurface exploration has been based on our understanding of the project and site information and the data obtained in our exploration. The general subsurface conditions utilized in our evaluation of foundations are based on interpolation of subsurface data between the widely spaced borings. In evaluating the boring data obtained in this preliminary subsurface exploration, we have examined previous correlations between penetration resistances and foundation bearing pressures observed in soil conditions similar to those at your site.

The foundation recommendations stated in this report are only preliminary in nature and not intended for use in final foundation design. When the project plans are finalized, we will be glad to work with you in establishing the final investigative program required to give detailed soil and rock-related recommendations for foundation design and site preparation.

Law Engineering Testing Company appreciates the opportunity to provide our geotechnical engineering services on this project. If you have any questions concerning this report or if we may be of further assistance to you during the final design and construction phases plant expansions, please contact us.

Very truly yours,

LAW ENGINEERING TESTING COMPANY

Mel Y. Browning

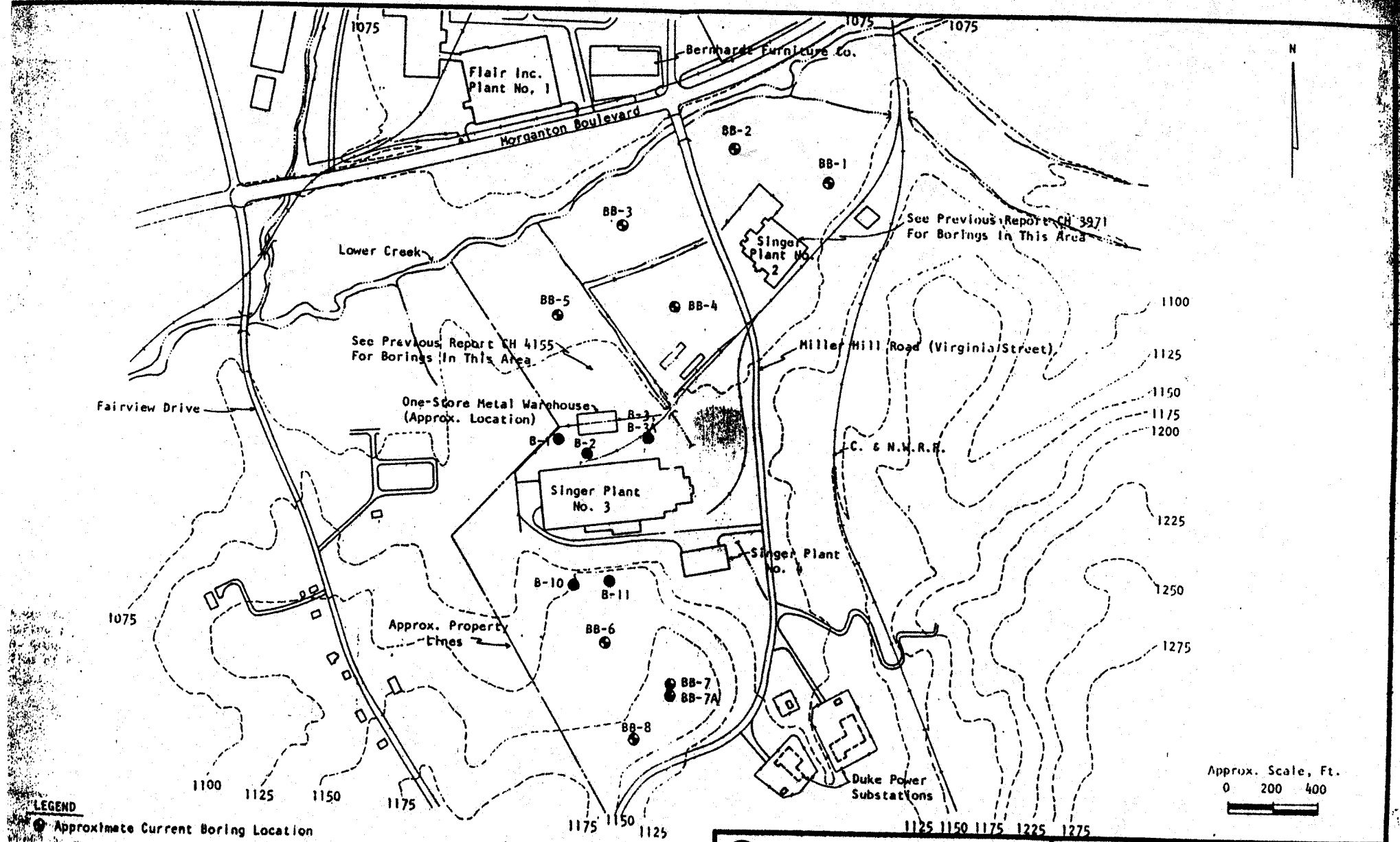
Mel Y. Browning, P. E.
Project Soils Engineer
Registered, N. C. 8696

Jon H. Gould

Jon H. Gould, P. E.
Chief Engineer
Registered, N. C. 7582

MYB/JHG/tmc

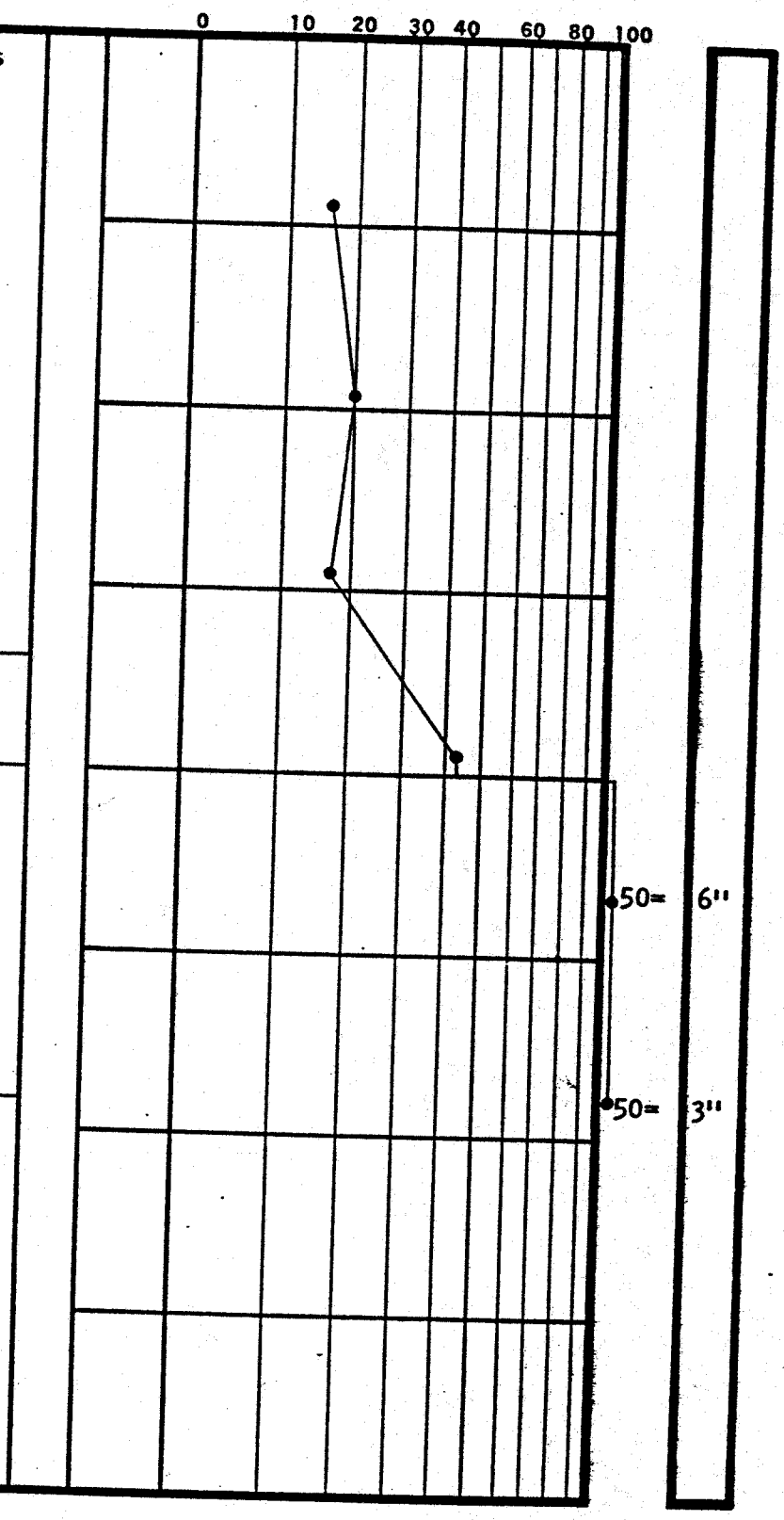
Attachments



LAW ENGINEERING TESTING CO. CHARLOTTE, NORTH CAROLINA	Boring Location Plan Singer Furniture Facilities Miller Hill Road (Virginia Street) Lenoir, North Carolina		
Singer Furniture Lenoir, North Carolina	DWN. BY	DAM	SCALE: Shown
	CKD. BY	MYB	DRAWING NO. 1
	APPR'D.	JHG	CH 4467

Ref: Undated City of Lenoir Topographic Sheet Ref. Furniture [illegible]

DEPTH FT.	DESCRIPTION
0	(Residual) Firm Tan Brown Micaceous Silty Fine to Medium Sand
.0	Dense Green Brown Micaceous Silty Fine to Coarse Sand
.0	Partially Weathered Rock Sampled As Green Brown to Blue Gray And Tan Micaceous Silty Fine to Coarse Sand
0	Auger Refusal At 31.0 Feet Boring Terminated At 31.0 Feet No Groundwater Encountered At Time of Boring



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.

TEST BORING RECORD

BORING NO. B-10
DATE DRILLED 9/6/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	PENETRATION-BLOWS PER FT. (0 10 20 30 40 60 80 100)	
	(Residual) Stiff Tan Brown Micaceous Fine Sandy Silt		
	Firm Tan Brown And Green Gray Micaceous Silty Fine to Coarse Sand With Weathered Rock Fragments		
	Dense Blue Gray, Brown And White Micaceous Silty Fine to Medium Sand With Weathered Rock Fragments		
	*	50=	6"
	Boring Terminated At 30.0 Feet No Groundwater Encountered At Time of Boring		
	*Partially Weathered Rock Sampled As Blue Gray Silty Fine to Medium Sand		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113
PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

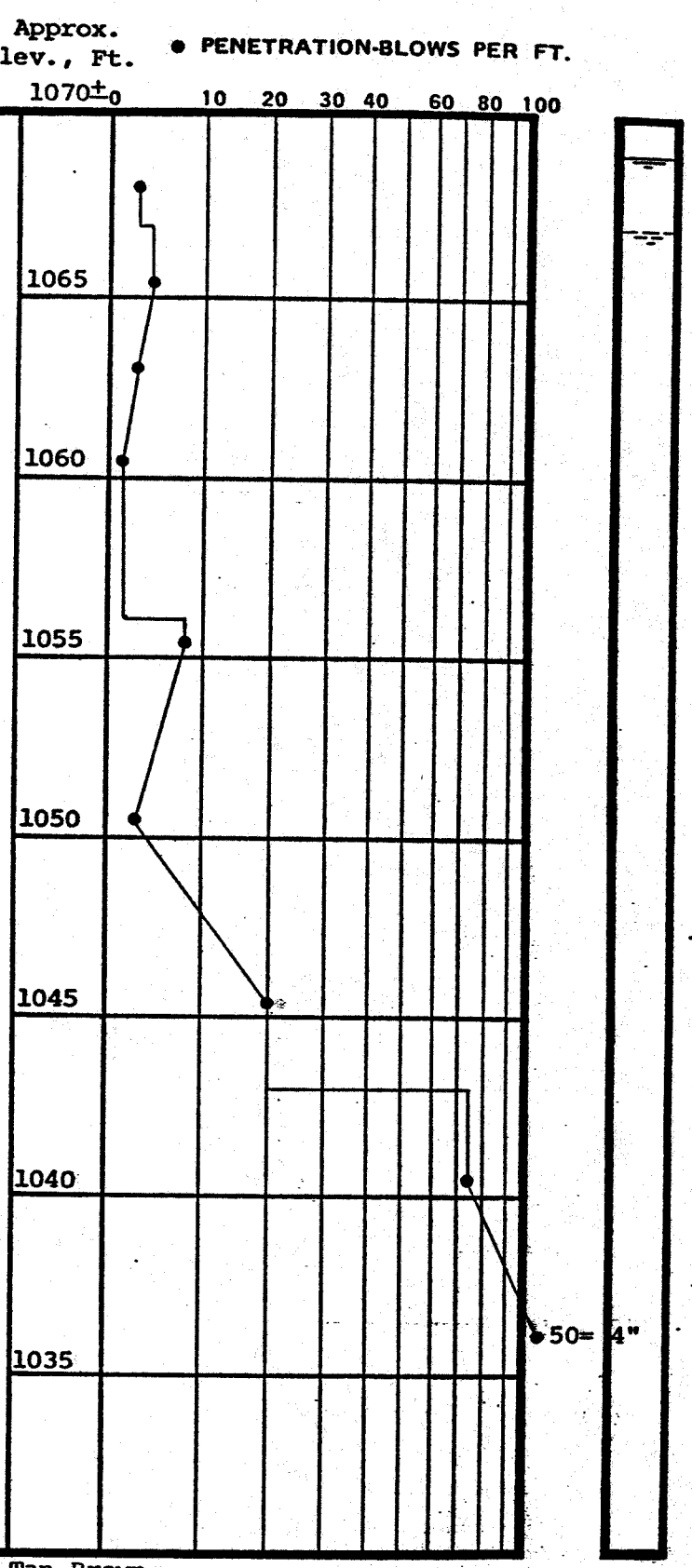
UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. B-11
DATE DRILLED 9/6/78
JOB NO. CH 4155
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION
0	(Fill or Possible Alluvium) Very Loose Gray Black Brown Micaceous Silty Fine to Coarse Sand
3.0	(Alluvium) Firm to Soft Blue Black Silty Clay With Wood Fragments and Decayed Organics
3.0	(Alluvium) Very Soft Blue Black Fine to Medium Sandy Clayey Silt With Decayed Organics and Coarse Sand and Gravel from 13.5 to 14 Feet
1.0	(Residual) Loose Tan Brown Micaceous Clayey Silty Fine to Coarse Sand With Weathered Rock Fragments to Very Loose Tan Micaceous Silty Fine to Coarse Sand
.0	Firm Tan Brown Micaceous Silty Fine to Coarse Sand
.0	Very Dense Mottled Gray, Tan and White Micaceous Silty Fine to Medium Sand
.0	*
.3	Boring Terminated at 34.3 Feet Groundwater at 3 Feet at Time of Boring Groundwater at 1 Foot on 8/13/80



*Partially Weathered Rock Sampled As Green Tan Brown Micaceous Silty Fine to Coarse Sand

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-1

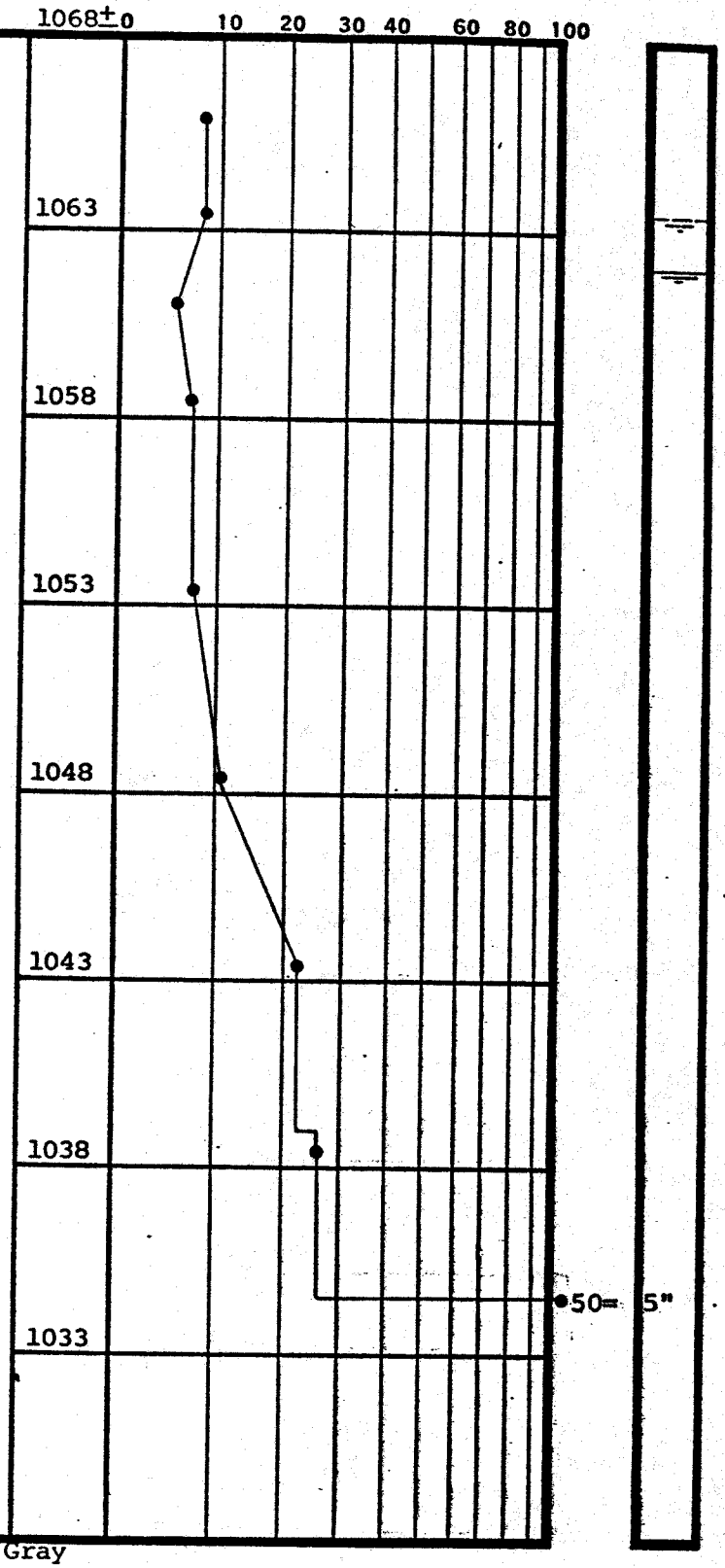
DATE DRILLED 8/8/80

JOB NO. CH 4467

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft.
0		1068±
4"	Weeds and Topsoil	
	(Alluvium) Firm Gray Tan Brown Slightly Micaceous Fine Sandy Silt	
3.0	(Alluvium) Loose Blue Tan Gray Micaceous Silty Fine to Medium Sand With Wood Fragments	1063
		1058
		1053
.0	(Alluvium) Firm Tan Blue Gray Micaceous Silty Fine to Medium Sand With Coarse Sand and Rounded Gravel at 28.5 Feet	1048
		1043
.0	(Residual) Firm Green and White Micaceous Silty Fine to Medium Sand	1038
.5		
.9	Boring Terminated at 33.9 Feet	1033
	Groundwater at 4.5 Feet at Time of Boring	
	Groundwater at 6 Feet on 8/13/80	



*Partially Weathered Rock Sampled as Blue Gray and White Silty Fine to Coarse Sand

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

●ETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER LLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-2

DATE DRILLED 8/7/80

JOB NO. CH 4467

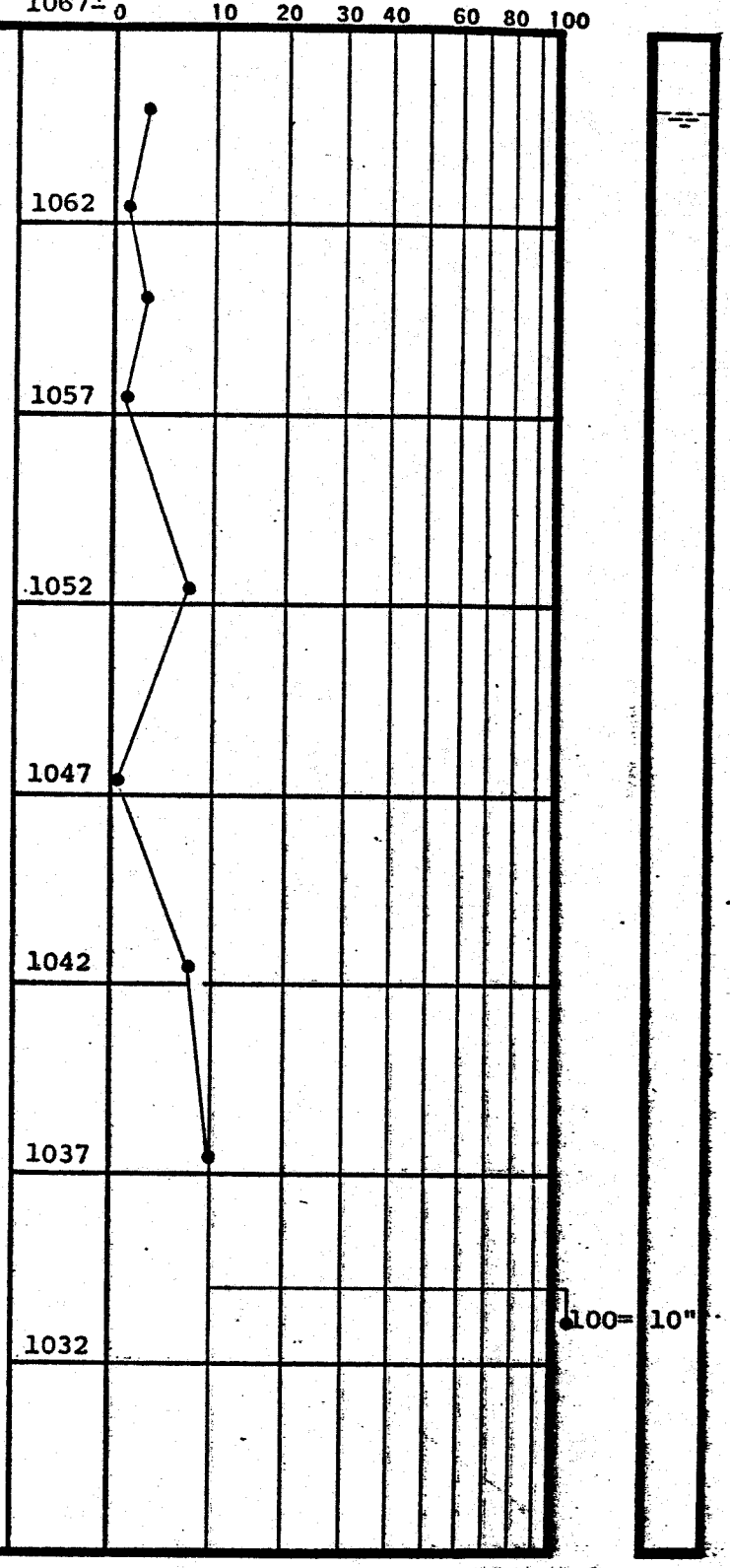
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft. 1067±
0		
3	(Alluvium) Soft to Very Soft Tan Brown to Gray Tan Micaceous Clayey Fine Sandy Silt	1062
5.5	(Alluvium) Very Loose to Loose Tan Blue Gray Micaceous Silty Fine to Medium Sand With Decayed Organics	1057
		1052
7.0	(Alluvium) Very Loose Tan Blue Gray Micaceous Silty Fine Sand to Loose Tan Blue Gray Micaceous Silty Fine to Coarse Sand With Rounded Gravel Below 26.5 Feet	1047
		1042
9.5	(Residual) Loose Green and White Micaceous Silty Fine to Medium Sand	1037
3.0	Partially Weathered Rock Sampled As Green Brown and White Silty Fine**	
4.3	Boring Terminated at 34.3 Feet	1032

Groundwater at 2 Feet at Time of Boring and 5 Feet After Several Hours

*Topsoil
**to Coarse Sand



BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

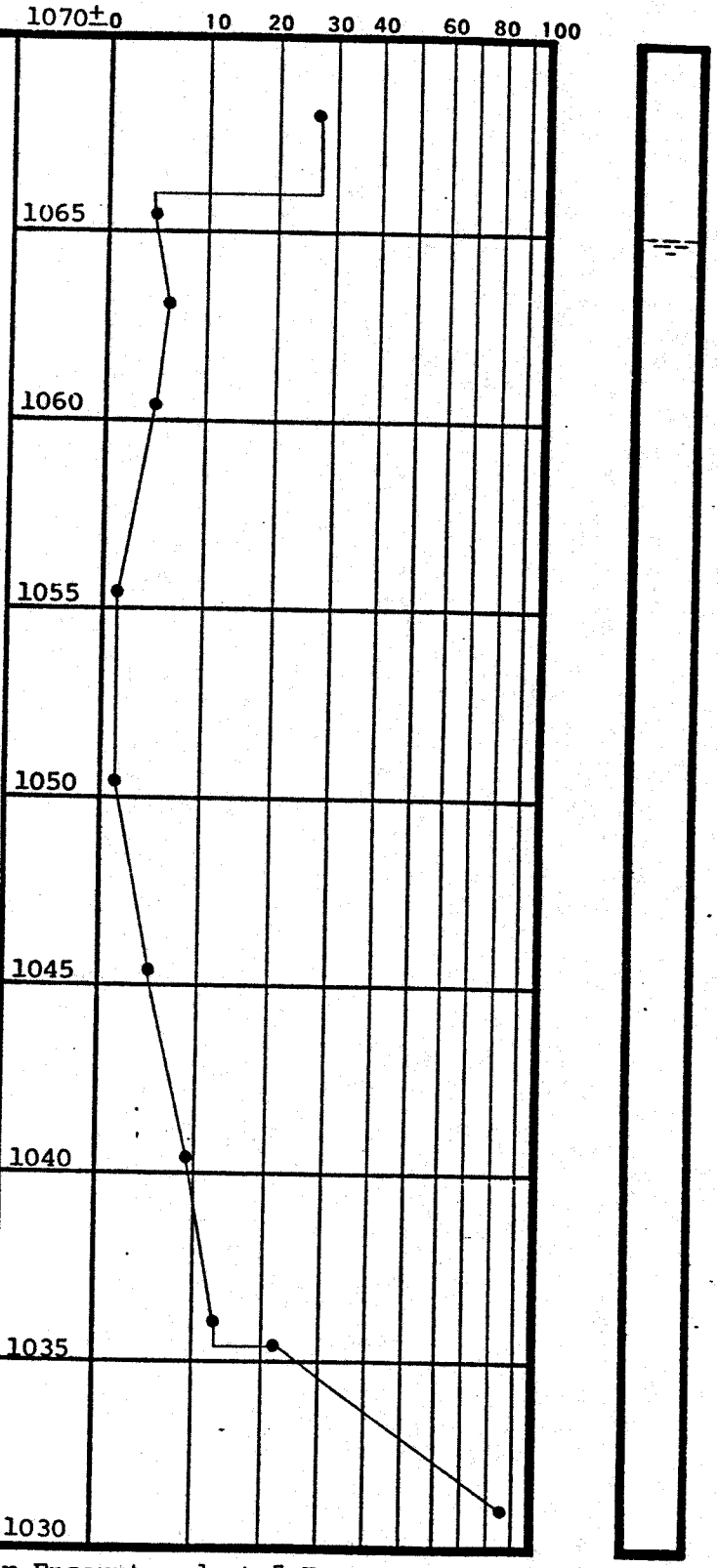
TEST BORING RECORD

BORING NO. BB-3
DATE DRILLED 8/12/80
JOB NO. CH 4467
PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft.
0	(Fill) Gravel and Soil Mixture	1070±
1.	(Fill) Firm Brown Micaceous Silty Fine to Medium Sand	
4.0	(Alluvium) Firm Blue Gray Micaceous Fine to Medium Sandy Silty Clay to Fine Slightly Sandy Silty Clay	1065
		1060
12.0	(Alluvium) Very Soft Blue Gray Micaceous Fine Slightly Sandy Silty Clay With Silty Fine to Coarse Sand Seams	1055
		1050
2.0	(Alluvium) Loose Tan Blue Gray Micaceous Silty Fine Sand	1045
8.5	(Alluvium) Loose to Firm Gray Tan Silty Fine to Coarse Sand With Rounded Gravel. Larger Gravel and Cobbles From 33.5 to 34.5 Feet	1040
1.5	(Residual) Firm Tan Brown Micaceous Silty Fine to Medium Sand	1035
1.5	Very Dense Tan Brown Silty Fine to Coarse Sand	1030
0.0		

● PENETRATION-BLOWS PER FT.



Boring Terminated a5 40.0 Feet

Groundwater Encountered at 5 Feet at Time of Boring

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-4

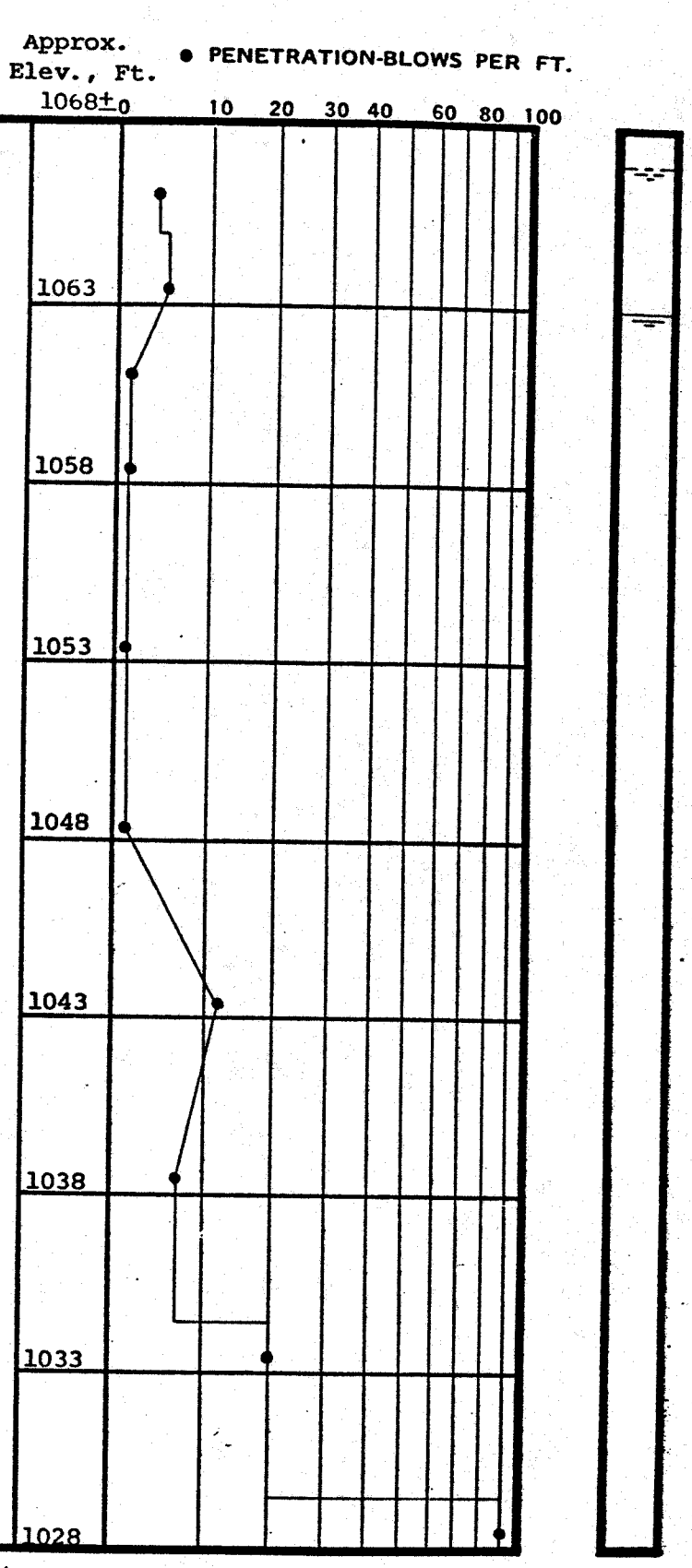
DATE DRILLED 8/8/80

JOB NO. CH 4467

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION
0	(Fill) Tan Micaceous Silty Fine to Medium Sand With Wood Chips and Trash
1.0	(Alluvium) Soft Gray Tan Brown Slightly Micaceous Fine Slightly Sandy Silt With Wood and Decayed Organics
3.0	(Alluvium) Firm Tan Blue Gray Silty Clay
5.0	(Alluvium) Very Soft Tan Blue Gray to Blue Gray Silty Clay
0.0	(Alluvium) Firm Tan Brown Micaceous Silty Fine to Medium Sand to Loose Blue Tan Gray Micaceous Silty Fine to Medium Sand With Organics and Rounded Gravel Below 28.5 Feet
33.5	(Residual) Firm Orange Tan to Gray, Green and White Micaceous Silty Fine to Medium Sand
38.5	Very Dense Residual Soil (No Sample Recovery)
40.0	



Boring Terminated at 40.0 Feet

Groundwater at 1 Foot at Time of Boring

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

Groundwater at 5 Feet After 24 Hours

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

TEST BORING RECORD

BORING NO. BB-5

DATE DRILLED 8/12/80

JOB NO. CH 4467

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft. 1137±	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0	(Residual) Pink Brown Micaceous Silty Fine Sand to Tan Micaceous Fine to Medium Silty Sand (No Split-Spoon Samples Obtained - Soil Descriptions From Samples of Auger Cuttings)	1132	
		1127	
15.0	Residual Soil Sampled as Dense Red Tan Brown Micaceous Silty Fine to Medium Sand From 18.5 to 20.0 Feet and Firm Gray Tan Brown Micaceous Silty Fine to Medium Sand From 43.5 to 45.0 Feet	1122	
		1117	●
		1112	
		1107	
		1102	
50.0		1097	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-6

DATE DRILLED 8/7/80

JOB NO. CH 4467

PAGE 1 OF 2

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft.	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
1.0	Residual Soil Sampled as Dense Red Tan Brown Micaceous Silty Fine to Medium Sand From 18.5 to 20.0 Feet and Firm Gray Tan Brown Micaceous Silty Fine to Medium Sand From 43.5 to 45.0 Feet	1097±	
		1092	●
5.0	Boring Terminated at 45.0 Feet		
	Groundwater at 40.5 Feet at Time of Boring		
	Groundwater at 32.5 Feet on 8/12/80		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER DRILLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-6

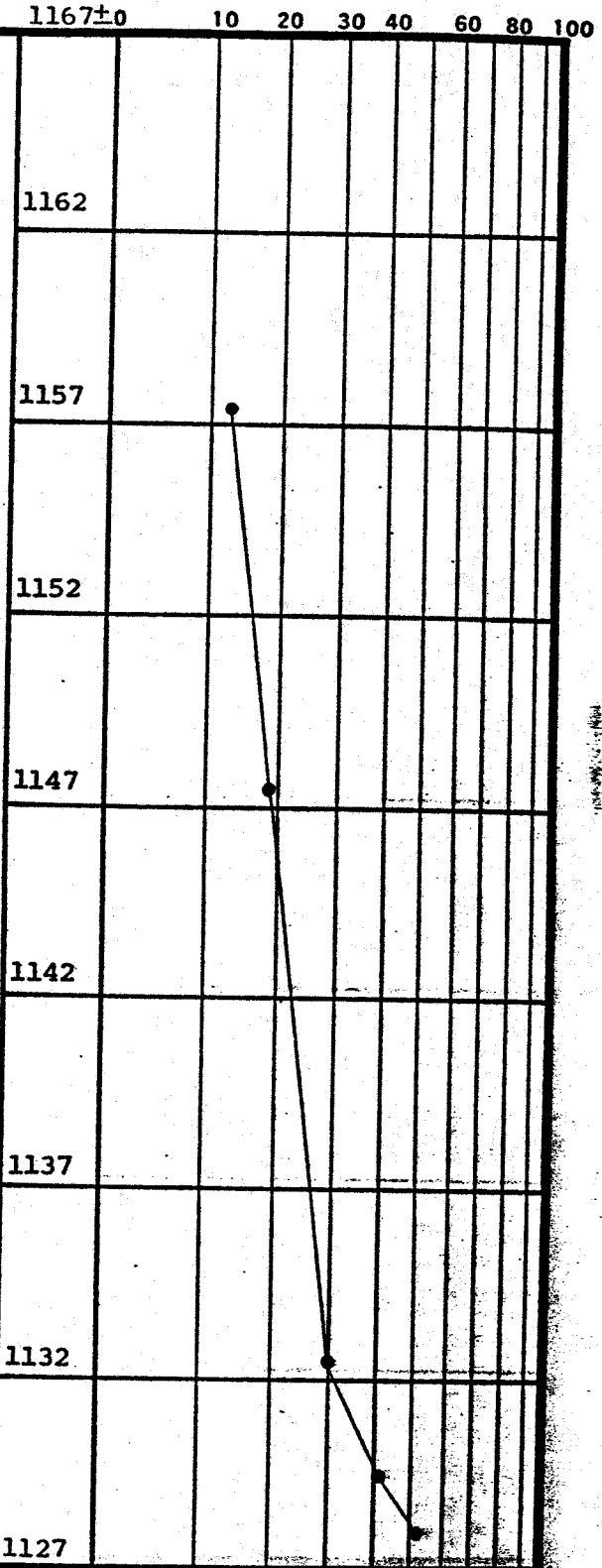
DATE DRILLED 8/7/80

JOB NO. CH 4467

PAGE 2 OF 2

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft.
0	Topsoil and Roots	1167±0
	(Residual) Red Brown Micaceous Slightly Clayey Fine to Medium Very Sandy Silt (No Split-Spoon Samples Obtained - Soil Description From Samples of Auger Cuttings)	
5.0	Firm Tan Brown Micaceous Silty Fine to Medium Sand to Fine to Coarse Sand	
36.0	Dense to Very Dense Tan White to Gray Tan White Silty Fine to Coarse Sand	
39.5	Refusal to Augers at 39.5 Feet	



*Boring Terminated at 39.5 Feet of Boring No Groundwater Encountered at Time Borehole Caved and Dry at 34 Feet After 24 Hours.

BORING AND SAMPLING MEETS ASTM D-1586

CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO: BB-7

DATE DRILLED 8/9/80

JOB NO. CH 4467

PAGE 1 OF 1

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft.	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0	(Residual) Red Brown Micaceous Fine Sandy Silt With Loose to Firm Consistency, Based on Driller's Assessment of Drilling Difficulty (No Split-Spoon Samples Obtained)	1165±	
		1160	
		1155	
15.0	Red Tan Brown Micaceous Silty Fine to Medium Sand With Firm Consistency, Based on Driller's Assessment of Drilling Difficulty (No Split-Spoon Samples Obtained)	1150	
		1145	
		1140	
		1135	
5.0	Tan Brown Micaceous Silty Fine to Medium Sand With Estimated Firm to Dense Consistency (No Split-Spoon Samples Taken)	1130	
).0		1125	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

●NETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER ALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-7A

DATE DRILLED 8/11/80

JOB NO. CH 4467

PAGE 1 OF 2

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft.	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
40.0	Tan Brown Micaceous Silty Fine to Medium Sand With Estimated Firm to Dense Consistency (No Split-Spoon Samples Taken)	1125+	
		1120	
		1115	
52.0	Tan Brown Micaceous Silty Fine to Medium Sand With Estimated Very Dense Consistency	1110	
55.0	Partially Weathered Rock As Estimated by Driller	1105	
63.1	Refusal to Rotary Drag Bit at 63.1 Feet	1100	● 50= 0
	Boring Terminated at 63.1 Feet		

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-7A

DATE DRILLED 8/11/80

JOB NO. CH 4467

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft. 1160±	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0	(Residual) Red Brown Micaceous Fine Sandy Silt With Loose Consistency, Based on Driller's Assessment of Drilling Difficulty (No Split-Spoon Samples Obtained)	1155	
		1150	
3.0	Red Tan Brown to Tan Brown Micaceous Silty Fine to Medium Sand With Firm Consistency Based on Split-Spoon Sample from 13.5 to 15.0 Feet and Driller's Assessment of Drilling Difficulty in Soils Below	1145	●
		1140	
		1135	
		1130	
		1125	
5.0		1120	

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE

50 % ROCK CORE RECOVERY

WATER TABLE, 24 HR.

WATER TABLE, 1 HR.

LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-8

DATE DRILLED 8/12/80

JOB NO. CH 4467

PAGE 1 OF 2

LAW ENGINEERING TESTING COMPANY

DEPTH FT.	DESCRIPTION	Approx. Elev., Ft. 1120±	● PENETRATION-BLOWS PER FT. 0 10 20 30 40 60 80 100
0.0	ed Tan Brown to Tan Brown Micaceous Silty Fine to Medium Sand With Firm Consistency Based on Split-Spoon Sample from 13.5 to 15.0 Feet and Driller's Assessment of Drilling Difficulty in Soils Below	1115	
		1110	
		1105	
7.5	Partially Weathered Rock Sampled As Green Tan Brown Micaceous Silty Fine to Coarse Sand	1100	
3.8	Boring Terminated at 63.8 Feet	1095	● 50= 3"

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

● PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I. D. SAMPLER 1 FT.

UNDISTURBED SAMPLE
50 % ROCK CORE RECOVERY
WATER TABLE, 24 HR.
WATER TABLE, 1 HR.
LOSS OF DRILLING WATER

TEST BORING RECORD

BORING NO. BB-8
DATE DRILLED 8/12/80
JOB NO. CH 4467
PAGE 2 OF 2

LAW ENGINEERING TESTING COMPANY

Reference (13)

LANDFILL INVESTIGATION

REPORT

(PHASE I)

SINGER FURNITURE

PLANT NO. 3

LENOIR,

NORTH CAROLINA

SIRRINE JOB NO. S-2148

J. E. SIRRINE COMPANY
ENGINEERS
SOUTH CAROLINA DIVISION
GREENVILLE, SOUTH CAROLINA

Landfill Investigation
Singer Furniture
Lenoir, North Carolina
Sirrine Job No. S-2148

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Landfill Investigation
Singer Furniture
Lenoir, North Carolina
Sirrine Job No. S-2148

A. INTRODUCTION

At the request of Singer Furniture, J. E. Sirrine Company was retained to technically evaluate the environmental condition of a closed waste disposal site on the property of Plant No. 3 at Lenoir, North Carolina.

There are no written records of the wastes or quantities of wastes which have been disposed at this landfill. However, municipal and industrial waste have been disposed because ownership of the property has proceeded from the City of Lenoir in the 1950's, to Magnavox in the 1960's, and Singer Furniture to the present. J. E. Sirrine Company was retained by Singer Furniture to coordinate a subsurface investigation of the site. As a result, Soil & Material Engineers was retained to perform the subsurface investigation and Enwright Laboratories was retained to perform the analytical portion of the project. The Soil & Material Report is included as Appendix 1. The analytical data, performed by Enwright Laboratories and the Spectrix Corporation, is presented in Appendix 2.

This study was intended to be a preliminary investigation to determine: if material is leaching from the landfill as a result of groundwater percolation and movement; if the groundwater down-gradient of the site contains constituents classified by the Environmental Protection Agency as priority pollutants; and if potentially hazardous constituents exist in the groundwater in concentrations which might present an endangerment to the public, aquatic or terrestrial life, or the environment.

A. INTRODUCTION - continued

The investigation was limited in scope and was intended to serve as an indicator of a possible problem with groundwater contamination. Per the results of this investigation, it was proposed that more intensive study be accomplished if a significant groundwater problem was indicated. This report contains recommendations concerning additional subsurface investigation and maintenance of the landfill.

B. SUMMARY

Singer Furniture disposed of certain wastes; organic solvents, varnish, lacquers, paints, and other chemicals associated with the production and finishing of furniture, in a landfill adjacent to Plant No. 3 in Lenoir, North Carolina. Singer Furniture utilized the site for waste disposal generally during the period 1972 - 1978. Prior to this period, Magnavox utilized the site during the 1960's, and the City of Lenoir used the site for municipal refuse disposal in the late 1950's. Ownership of the site has changed and, as a result, there is no record of the quantities or types of materials disposed. Relative to Singer Furniture, however, it is known that the materials listed above were disposed in the landfill. A portion of the material was drumned and portions were either disposed in bulk or burned in pits.

A monitoring network of four wells was established to determine by analysis if groundwater has been impacted by leachate from the landfill. This study was not designed to determine the total extent of any groundwater impact. The objectives of the study were: to determine the possibility that groundwater beneath and adjacent to the site is being contaminated; to determine the depths to groundwater and the geologic materials adjacent to the landfill, and; to determine the hydrologic properties of the strata beneath and adjacent to the landfill.

Landfill Investigation
Singer Furniture
Lenoir, North Carolina
Sirrine Job No. S-2148

B. SUMMARY - continued

The analysis of groundwater samples indicates that a certain volume of material has leached from the landfill. The total extent of the leachate plume is not known, but significant contamination was detected in only one well. This well (N-1) is located immediately below the north face of the landfill. Two organic solvents, toluene (166 ug/l) and ethylbenzene (55 ug/l) and, a plasticizer, Bis (2-ethylhexyl) phthalate (100 ug/l), were detected. In addition, several metals were detected; most notably, chromium (400 ug/l), copper (650 ug/l), lead (600 ug/l), nickel (230 ug/l), zinc (1,100 ug/l), barium (6,100 ug/l), arsenic (93 ug/l), and beryllium (56 ug/l). The concentrations of chromium, lead, barium, and arsenic are above the Primary Drinking Water Standards. The complete analytical data is presented in Appendix 2.

The complete Hydrogeologic Investigation, as performed by Soil & Material Engineers, is presented in Appendix 1. In summary, this study concluded that groundwater beneath the landfill is moving in a general northwesterly direction toward the predominant area drainage feature (Lower Creek), a distance of approximately 600 -800 feet from the landfill.

The general geologic cross-section of the area beneath and down-grade of the landfill consists of: an upper alluvium of fine-grained silty clays and clayey silts approximately 10-20 feet thick; a lower alluvium of

B. SUMMARY - continued

coarser more permeable material approximately 15-30 feet thick; a saprolite zone of highly weathered feldspathic rock fragments, coarse quartz grains, biotite, and clay; and bedrock.

From soil testing, the radial permeability (K) and vertical permeability (K') were estimated. This data indicates that the lower alluvium is by far the most permeable strata. The less permeable weathered saprolite zone underlying the lower alluvium tends to retard vertical percolation and create more radial flow lines through the lower alluvium to any discharge point. Therefore, deep groundwater flow paths will not likely develop beneath and just downgrade of the landfill due to the short distance to the discharge area (Lower Creek) and the potential of the less permeable saprolite to deflect the water bearing lower alluvium in a horizontal direction.

Soil test information allowed the following permeabilities to be estimated:

Strata	Radial Permeability	Vertical Permeability
Upper Alluvium	0.3 ft/day	6×10^{-4} ft/day
Lower Alluvium	20 ft/day	———
Saprolite	0.001 -5 ft/day (typical range)	———

The actual linear velocity of groundwater in the lower alluvium, considering the porosity of the soil and the hydraulic gradient, is estimated to be approximately 1 - 2 feet/day.

Landfill Investigation
Singer Furniture
Lenoir, North Carolina
Sirrine Job No. S-2148

B. SUMMARY - continued

Considering the above information, it is the conclusion of Soil & Material Engineers that leachate slowly percolates through the upper alluvium due to the flow retarding properties of the clays in this strata. However, once penetration is made to the highly permeable lower alluvium, transport of contaminant material would proceed at a relatively high rate toward the discharge point (Lower Creek). However, it is not likely that the contaminant material would flow directly to Lower Creek. Contaminant material nearing Lower Creek would likely encounter floodplain flow lines which would transport the material in a downstream direction. Actual interception of the contaminants with Lower Creek may occur some distance downstream along a wide, dispered frontal plume.

Considering the real field data and postulating the above groundwater movement scheme, it is the opinion of J. E. Sirrine Company and Soils & Material Engineers that additional contaminant plume movement definition is warranted. This judgement considers that the lower alluvium is a potential, if not actual, large source of potable water. It is also a joint conclusion that the Human Resources Department of the North Carolina Department of Natural Resources and Community Development will arrive at a similar conclusion upon reviewing the hydrogeolgic and analytical data. Recommendations for additional work are made in this report.

C. RECOMMENDATIONS

The Soil & Material Engineers' Hydrogeologic Investigation determined that a high potential exists for contamination of the very permeable lower alluvium down-gradient of the landfill. The existing network of monitoring wells are adequately located for developing the initial groundwater monitoring program. However, no wells are located sufficiently down-gradient of the landfill in the Lower Creek floodplain to better define the extent of contaminant plume movement. It is, therefore, the recommendation of J. E. Sirrine Company and Soil & Material Engineers that two or three additional monitoring wells be installed in the Lower Creek floodplain northwest of the landfill to tap the lower alluvium strata. The water quality would be analyzed in each of the new wells as in Phase I. This recommendation considers that the permeable lower alluvium could transport material beyond the property boundaries of Singer Furniture and contaminate a potential large groundwater source.

General information has been obtained from the North Carolina Department of Natural Resources and Community Development regarding the existence of water wells in the general area of Plant No. 3. It is recommended that a systematic well survey, involving residential and industrial establishments, be performed. Although it is suspected that groundwater flow is generally toward Lower Creek, north and northwest, the well survey should include the area east of the landfill along Virginia Street as well as areas west and northwest adjacent to the floodplain.

Landfill Investigation
Singer Furniture
Lenoir, North Carolina
Sirrine Job No. S-2148

C. RECOMMENDATIONS - continued

The landfill has been recently leveled and grassed. It has been noted that several small holes or pits are located in the landfill. In order to minimize the infiltration of rainfall and surface drainage, these surface depressions should be filled with impermeable soil. In addition, any future investigation should include testing of the soil overlying the landfill to estimate permeability. If the permeability is high, a possible remedial action may involve covering the landfill with a layer of low permeable clay.

The above recommendations are presented as criteria for further study. These recommendations do not represent a proposal for additional investigation, but are presented as a basis for future work. A specific work plan denoting the exact number of wells, soil testing, water quality data, etc., and the costs involved will be formulated at the request of Singer Furniture.

D. LANDFILL CONDITIONS

1. The Surrounding Site

Singer Furniture Plant No. 3 is located in Lenoir, North Carolina near the intersection of Morganton Boulevard (Highway 18) and Virginia Street (also known as Miller Hill Road) (Figure 1.). Plant No. 3 is located on a side hill cut. From the production facility the land slopes moderately to the north toward Lower Creek.

The property is surrounded by relatively low density residential areas along Virginia Street to the east and southeast and along Fairview Drive to the west and southwest. Lower Creek, the predominant area drainage feature, is to the immediate north. Further north across Morganton Boulevard is a large industrial area. To the immediate south of Plant No. 3 is a heavily wooded hill which rises to a height almost eighty feet above the production facility.

The landfill is located to the immediate north of Plant No. 3. Downgrade of the landfill (from the northeast to the northwest) is the undeveloped floodplain of Lower Creek. Periodic floods in this valley area make it totally unusable for residential or commercial purposes. The floodplain is heavily vegetated with trees and undergrowth.

2. The Landfill

The landfill, which is approximately six acres, is located immediately

D. LANDFILL CONDITIONS - continued

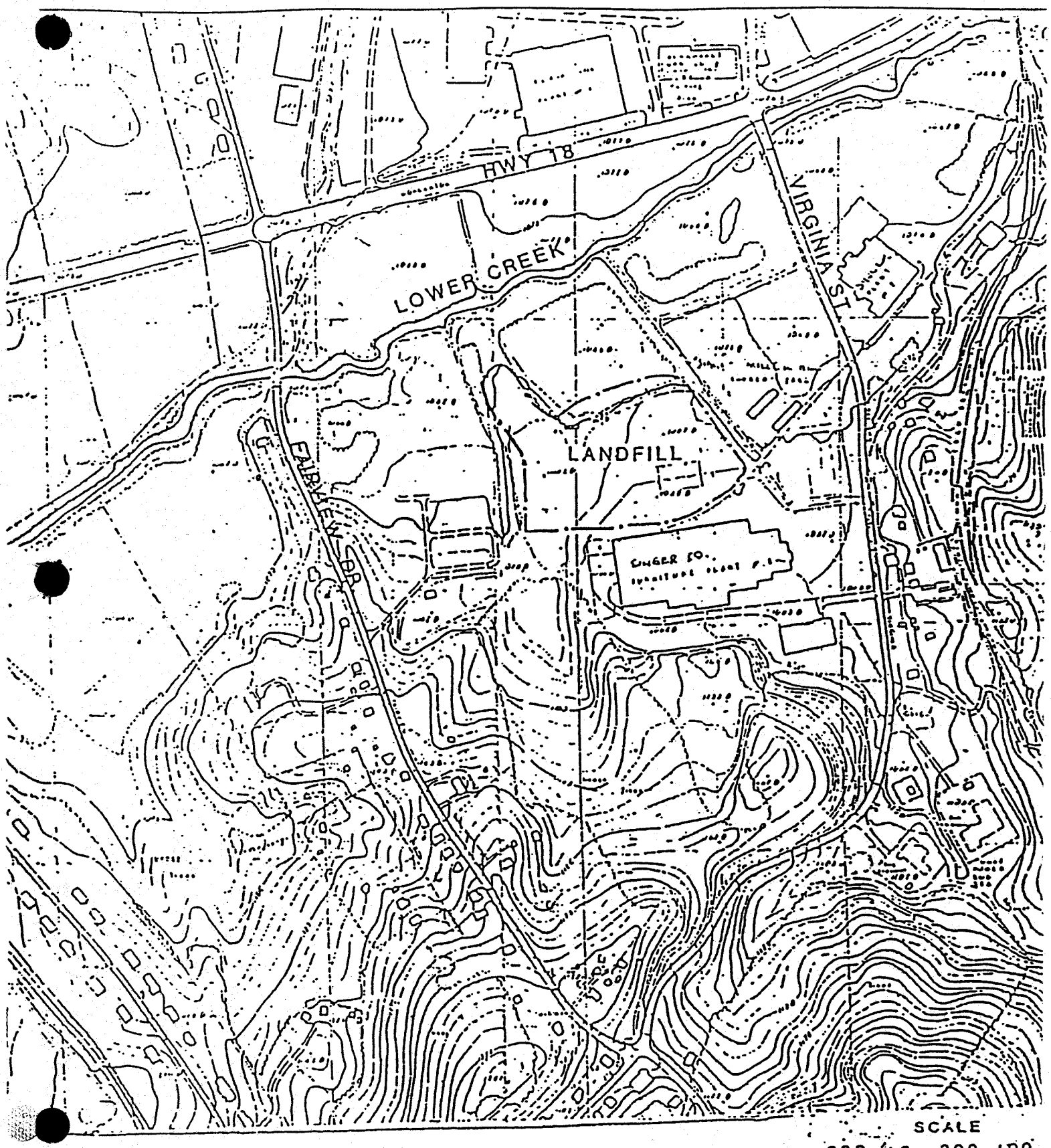
2. The Landfill - continued

north of Plant No. 3 and west of the facility lumber yard. The most recently filled area of the landfill extends to the outer limits of the Lower Creek floodplain (Figure 1.).

The precise boundaries of the landfill are not known. Initially, the City of Lenoir utilized the site for disposal of municipal refuse during a short period in the late 1950's. Municipal garbage and debris was encountered during the installation of monitoring well W-1B to a depth of fifteen feet. From this information it was concluded that garbage was disposed along the western portion of the site in a relatively narrow arm which extends to the 1075 contour interval at a minimum.

It was not the intent of this study to perform auger borings in the landfill to determine the exact extent of the disposal area or to identify the materials disposed. From what is known, however, it appears that the City of Lenoir may have utilized the western portion of the site and subsequent usage by Magnavox in the 1960's and Singer Furniture in the 1970's may be confined predominantly to the eastern section of the site.

During the 1970's Singer Furniture utilized the site for disposal of


HWY 18
LOWER CREEK
VIRGINIA ST
LANDFILL
FAIRVIEW DR
SINGER CO.
SCALE
200 0 200 400
CONTOUR INTERVA

D. LANDFILL CONDITIONS - continued

2. The Landfill - continued

certain industrial wastes, soil fill, and scrap metal. Unknown quantities of industrial wastes; including solvents, lacquers, varnish, glues, and paints were likely disposed in the landfill. A portion of this material was disposed in drums and a portion was burned in open pits in the landfill.

Since disposal activity ceased in the late 1970's, the landfill has been leveled and a uniform fill cover applied. In addition, the entire site has been grassed.

E. METHODS AND PROCEDURES

1. Monitoring Well Locations

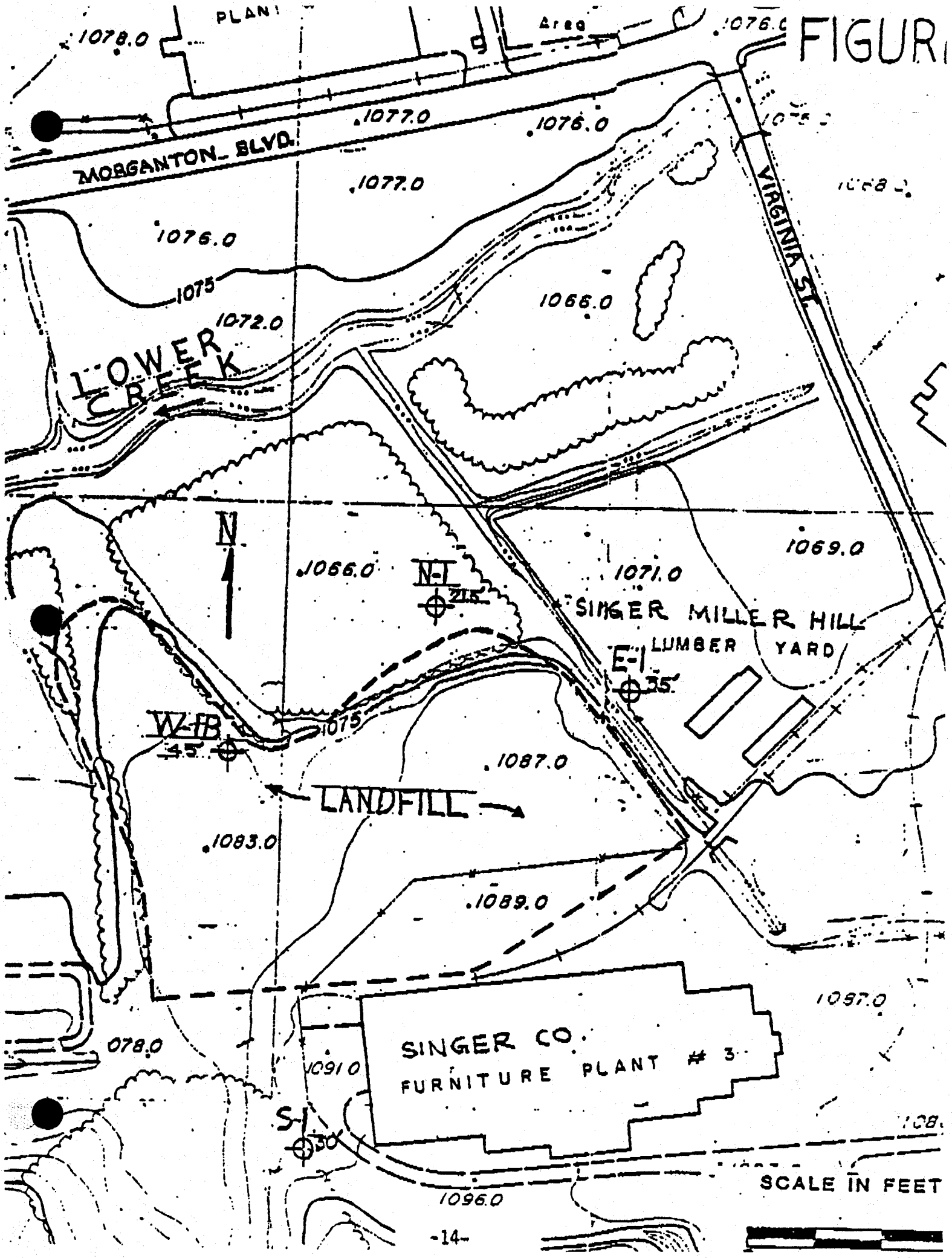
Upon a reconnaisance of the site, it was determined that a monitoring network of four wells would be sufficient to determine if a significant groundwater contamination problem exists. One monitoring well was located up-gradient of the landfill to serve as a background data point. Three wells were located down-gradient of the landfill after a careful consideration of the landfill extent and topographic information.

The monitoring wells, located on Figure 2., are listed below.

Monitoring Well	
S-1	Up-gradient, south of the landfill
E-1	Down-gradient, east of the landfill
N-1	Down-gradient, north of the landfill
W-1B	Down-gradient, northwest of the landfill (In Partial Fill)

Prior to the investigation, it was suspected that groundwater underlying the landfill flowed generally north and northwest toward the predominant drainage feature, Lower Creek. A Lower Creek feeder spring which heads between the landfill and the lumber yard, was also a possible flow direction for groundwater underlying the extreme eastern edge of the landfill. Therfore, well E-1 was located adjacent to the

FIGUR


PLANT
Area
1078.0
1076.0
1077.0
1076.0
MORGANTON BLVD.
1077.0
1076.0
1075
1072.0
1066.0
VIRGINIA ST.
LOWER CREEK
N
1066.0
N-1
21.5
1071.0
1069.0
SINGER MILLER HILL
LUMBER YARD
E-1
35
W-1B
45
1075
1087.0
LANDFILL
1083.0
1089.0
1087.0
078.0
1091.0
SINGER CO.
FURNITURE PLANT # 3
S-1
30
1096.0
SCALE IN FEET

E. METHODS AND PROCEDURES - continued

1. Monitoring Well Locations - continued

spring to detect possible contamination moving in this direction. Because the spring is very small, it is not thought that it forms a complete barrier if groundwater is moving in this direction. Therefore, E-1 was located just east of the spring. The steep east landfill face prevented locating a well between the landfill and the spring.

Well N-1 was located down-gradient of the north face of the landfill. This well is ideally located to detect leachate from the eastern half of the landfill. That portion of the landfill is suspected of containing much of the disposed industrial wastes.

A second small spring heads west of the landfill and flows a short distance to Lower Creek. It was intended to locate a well down-gradient of the landfill between the fill and the spring because this is a possible groundwater flow direction. Well W-1A was abandoned when municipal refuse was encountered. Well W-1B was an attempt to move down-gradient of the fill. Municipal fill material was again encountered. The suspected extent of this narrow arm of the fill and the dense vegetation in this area prevented further relocation of this well to the northwest. This well, and the other three, was sealed with bentonite above the screen to prevent contamination from the landfill material.

E. METHODS AND PROCEDURES - continued

1. Monitoring Well Locations - continued

The monitoring wells were installed October 12-13, 1982. The installation information, i.e., well depths, groundwater levels, soils information, etc., is contained in Soil & Material Engineers' Hydrogeologic Investigation (Appendix 1.).

2. Monitoring Well Installation

The well holes were advanced utilizing a drilling with a rotary head and conventional hollow-stem augers. The augered holes were approximately five inches in diameter and the wells were installed using two-inch PVC piping. Wells screens were typically five feet in length, except ten feet at N-1. A six-inch steel outer casing covered the PVC stick-up at all well locations. The steel casing contained a locking cap.

A typical monitoring well cross-section is shown in Soil & Material Engineers' Hydrogeologic Investigation (Appendix 1.). With the exception of approved variances, the well installations meet the specifications required by the North Carolina Department of Environmental Management.

3. Monitoring Well Sampling

The monitoring wells were installed October 12-13, 1982. The wells were

E. METHODS AND PROCEDURES - continued

3. Monitoring Well Sampling - continued

allowed to stabilize and on October 19, 1982, the wells were bailed per standard procedures to remove a minimum of three times the well volume. The purpose of the bailing was to remove impurities that may have resulted from augering the well holes, the PVC pipe used for well casing, or the quick-drying glue used to cement the PVC pipe connections. The wells were bailed by repeatedly purging the contents of a six-foot sampling tube with nitrogen gas. The six-foot sampling tube was equipped with a foot valve which allowed bailing to near the bottom of the well.

Each of the monitoring wells was sampled on October 20, 1982, for water quality analysis. Samples were taken from the wells using the same six-foot PVC sampling tube used for bailing. Extreme care was taken to avoid cross-contamination of groundwater samples by cleaning the sampling tube between each well sampling. Upon raising the sampling tube to the surface, the samples for each well were transferred to a compositing container. When a sufficient volume of sample had been composited for each well, the sample was immediately transferred to several individual containers that contained the various preservatives for the particular analyses to be performed. The samples were placed in insulated containers with ice and shipped

E. METHODS AND PROCEDURES - continued

3. Monitoring Well Sampling - continued

to Spectrix Laboratories, Houston, Texas, by overnight courier. Certain analyses were performed by Enwright Laboratories of Greenville, South Carolina.

A definitive list of compounds which were disposed in the landfill could not be formulated. Therefore, as an initial effort, a wide range of compounds was analyzed. These included those chemicals listed by the Environmental Protection Agency as Priority Pollutants, certain heavy metals, certain herbicides, phenols, and other miscellaneous constituents. The complete analytical data, as performed by Spectrix Laboratories and Enwright Laboratories, is contained in Appendix 2.

F. MONITORING WELL SAMPLING RESULTS

Groundwater samples were taken from the four monitoring wells on October 20, 1982. Spectrix Laboratory of Houston, Texas, performed the organic priority pollutant analysis and Enwright Laboratories of Greenville, South Carolina performed the analysis for metals, cyanide, phenols, dissolved organic carbon, chloride, nitrate, and sulfate.

Most of the priority pollutants analyzed were below the minimum level of detection. However, four organic priority pollutants were detected in the groundwater samples and several metals were detected at one location in concentrations near or greater than the Federal Primary Drinking Water Standards.

The organic priority pollutants detected are listed below:

Monitoring Well	Location	Constituent	Concentration (ug/l)	Detect Limi (ug/l
S-1	Up-grade of landfill	No Organics		
W-1B	Down-grade of landfill (In Partial Fill)	No Organics		
E-1	Down-grade of landfill	Methylene Chloride	30	10
N-1	Down-grade of landfill	Ethylbenzene	55	10
		Toluene	166	10
		Bis (2-ethylhexyl) Phthalate	100	10

The concentrations of the detected organics are relatively low; however these constituents are listed as priority pollutants based on their hazard potential.

Landfill Investigation
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F. MONITORING WELL SAMPLING RESULTS - continued

The compounds detected and their general industrial uses are discussed below.

Methylene chloride (Dichloromethane) - A volatile liquid, soluble in alcohol (only slightly in water), nonflammable and nonexplosive in air, highly toxic by inhalation of fumes, moderately toxic by ingestion and skin absorption. Primary uses: paint removers, solvent degreasing and cleaning, solvent for cellulose acetate, plastics processing.

Bis (2 ethylhexyl) phthalate, 1, 2 - Benzenedicarboxylic acid bis (2 - ethylhexyl) ester, (di 2 - ethylhexyl phthalate) - a liquid, miscible with mineral oil, insoluble in water, combustible. Primary uses: plasticizer, in vaccum pumps.

Ethylbenzene - A colorless liquid, soluble in alcohol, almost insoluble in water, flammable, moderately toxic by ingestion, inhalation, and skin absorption. Primary uses: solvent, intermediate in production of styrene.

Toluene - A colorless liquid, soluble in alcohol, insoluble in water, flammable, moderately toxic by ingestion, inhalation, and skin absorption. Primary uses: solvent for paints and coatings, gums, resins, most oils, rubber, vinyl organosols; diluent and thinner in certain lacquers; adhesive solvent in plastic items.

Landfill Investigation
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F. MONITORING WELL SAMPLING RESULTS - continued

In addition to the priority pollutant organics, the following metals were detected at N-1. Metals were not detected in any of the other wells in concentrations greater than expected background levels.

N-1

Constituent	Concentration (ug/l)	Primary Drinking Water Standard (ug/l)
Antimony	1.0	No Standard
Arsenic	93	50
Beryllium	56	No Standard
Cadmium	6.8	10
Chromium	400	50
Copper	650	1000*
Lead	600	50
Mercury	0.2	2.0
Nickel	230	No Standard
Selenium	3.0	10
Silver	0.1	50
Thallium	0.1	No. Standard
Zinc	1,100	5000*
Barium	6,100	1000

* Secondary Drinking Water Standard

Several metals were detected in well N-1 at concentrations greater than expected background levels. The concentrations of arsenic, chromium, lead, and barium exceed the Primary Drinking Water Standards. In addition, the concentrations of copper, nickel, zinc, beryllium, and cadmium are much higher than found in the other three wells.

Landfill Investigation
Singer Furniture
Lenoir, North Carolina
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F. MONITORING WELL SAMPLING RESULTS - continued

In addition to the metals, well N-1 contained the only significant organics detected in the monitoring network. Ethylbenzene, toluene, and Bis (2-ethylhexyl) phthalate were detected in relatively low concentrations. Methylene chloride was detected at a very low concentration in well E-1. Although methylene chloride has been used as an industrial solvent, it is also used in the analytical extraction of organic compounds. Therefore, at this low concentration, 30 ug/l, methylene chloride could have been introduced via analytical contamination.

The analysis of groundwater from the monitoring well network indicates that a certain amount of disposed material is leaching from the landfill. The contamination appears limited to well N-1. This may confirm the supposition that the bulk of the industrial wastes was deposited in the eastern half of the landfill. The organics detected at N-1, primarily toluene and ethylbenzene, could have been used as cleaning solvents or be associated with the paints, varnish, and lacquers used in the production of furniture. The metals detected at N-1 could have also resulted from paint pigments that were disposed in bulk.

SOIL & MATERIAL ENGINEERS INC. ENGINEERING-TESTING-INSPECTION

3025 McNaughton Drive, Columbia SC 29206, Phone (803) 788-6343

January 11, 1983

J. E. Sirrine Company, Inc.
Post Office Box 5456
216 South Pleasantburg Drive
Greenville, South Carolina 29606

Attention: Mr. Jim Brooks, P. E.
Project Manager

The Singer Company
Post Office Box 1588
Lenoir, North Carolina 28645

Attention: Mr. Richard J. McDonald

Subject: Hydrogeologic Investigation of the Closed Landfill Area
The Singer Company, Plant No. 3, Lenoir, North Carolina
S&ME Report No. 044-82-129

Gentlemen:

Soil & Material Engineers, Inc. is pleased to submit the above referenced report. This report presents the results of field and laboratory investigations; our conclusions concerning the physical hydrogeology of the site; and the source and potential occurrence and movement of contaminants; and recommendations concerning water-quality monitoring and additional investigation.

This report is submitted as a draft for your review and comment. Should you have any questions or comments concerning the content or style, we would be pleased to receive them. A final report will be issued after your reveiw and approval.

We appreciate this opportunity to be of service to the J. E. Sirrine Company, Inc. and The Singer Company. If there are any questions concerning our report or study, we would be pleased to personally discuss the report and any aspects of the study at your convenience.

Respectfully submitted,
SOIL & MATERIAL ENGINEERS, INC.

Curtis L. Gorman
Project Geologist

B. C. Spigner, RPG
Senior Hydrogeologist

HYDROGEOLOGIC INVESTIGATION
of the
CLOSED LANDFILL AREA
THE SINGER COMPANY
PLANT NO. 3

for

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and

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SOIL & MATERIAL ENGINEERS, INC.

Report No. 04482-129

January 11, 1983

HYDROGEOLOGIC INVESTIGATION
OF THE
CLOSED LANDFILL AREA
THE SINGER COMPANY
PLANT NO. 3

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(All figures and tables are in Appendix A)

FIGURE

1 Topographic Map of the Landfill Site and Vicinity

2 Site Map Showing Monitor Well Locations and Cross-Section Lines

3 Generalized Geologic Cross-Section A-A', South to North

4 Generalized Geologic Cross-Section B-B', West to East

5 Generalized Map of Ground-Water Flow within Unit IB

6 Well Construction Schematic of Typical Monitor Well

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C. Grain-Size Distribution Curves

SECTION 1.0 INTRODUCTION

1.1. PROJECT BACKGROUND

In September, 1982 Soil & Material Engineers, Inc. (S&ME) was retained by the Singer Company through J.E. Sirrine Company to make a hydrogeologic assessment of the closed landfill at Singer Furniture Plant No.3, Lenoir, N.C. (fig.2). The objectives of this assessment were outlined in S&ME Proposal No. P4482-1046, dated September 1, 1982.

1. Install a ground-water monitoring system that will meet State regulatory requirements.

2. Make a hydrogeologic assessment of the landfill area to (1) determine the possibility that ground water beneath and adjacent to the site is being contaminated, (2) determine the depths to ground water and the types of geologic materials immediately adjacent to the landfill, and (3) determine the hydrologic properties of geologic strata beneath and immediately adjacent to the landfill.

1.2 DESCRIPTION OF THE LANDFILL AREA

The site of the investigation includes the general area shown on figure 2. The principal facilities located at Singer Furniture Plant No. 3 include the closed landfill area, the main plant building located immediately south of the landfill, and the lumber yard, located immediately east of the landfill.

The landfill area was previously owned by the City of Lenoir and was used as a municipal disposal site in the late 1950's for about 3 years. The landfill was then used by the Magnavox Company until it was sold to the Singer Company in the early 1970's. The Singer Company disposed waste products in the landfill until the late 1970's. Therefore, the landfill contains various waste materials which include municipal refuse, industrial wastes, and rock and soil fill. Information provided by the Plant Engineer indicates that the

wastes may include: toluene; acetone; methanol; various organic solvents; resin glues; and ezylene and lead from pigments. Finishing products may include lacquer, staining chemicals and paints that were probably disposed in hard form. Liquids from wash-down were previously burned, dumped or containerized until recovery operations were initiated around 1977. Scrap had been disposed in the landfill up to 1981.

The contents of the landfill were leveled during the last 4 years, and a wood shed was constructed on the landfill refuse near the southern margin of the landfill (fig.2). The shed is presently used primarily as a vehicle-maintenance garage.

The surface of the landfill slopes gently to the north, where it drops off abruptly near the northern margin. A thin layer of landfill material extends beyond monitor well W-1. The western edge of the landfill material extends beyond well W-1B, probably to the 1075 ft mean sea level (msl) contour (fig.2). The eastern perimeter of the landfill extends to the ditch adjacent to the lumber yard. The southern portion of the landfill overlies excavated fill material upon which Plant No. 3 is located.

The surface of the landfill is presently vegetated; a thin layer of soil covers the landfill, but small depressions occur in the surface of the landfill which allow surface runoff to percolate into the landfill.

SECTION 2.0 GEOLOGIC AND HYDROLOGIC SETTING

2.1 GENERAL GEOLOGY AND GROUND-WATER CONDITIONS

The Singer Plant No. 3 is located in the Inner Piedmont belt of the Piedmont geologic province. Rocks within the Inner Piedmont consist of Paleozoic age crystalline rocks which occur in northeast-trending belts. The plant is located in the valley of Lower Creek which flows to the southwest and empties into the upper reaches of the Catawba River.

As described by Goldsmith and others (1978), the bedrock in the vicinity of the site consists primarily of migmatite gneiss and garnet gneiss, with some biotite schist and gneiss also occurring. The bedrock is overlain by a variable thickness of residual soil called saprolite. In the valley of Lower Creek, alluvial desposits overlie saprolite or crystalline bedrock.

There are no current published reports that describe the specific hydrogeology of the area surrounding the plant. Information on the hydrogeology of the Lenoir area was obtained from Mr. Richard Peace of the N. C. Department of Natural Resources and Community Development (DNR). According to Mr. Peace, the hydrogeology of the Lenoir area is poorly known, and there have been no recently completed ground-water studies of this area.

The Singer Plant No. 3 and other industries in the immediate vicinity of the Plant purchase water from the City of Lenoir. A municipal water line is located along Virginia Street, and most of the residents east of the Plant are served by City water (Lenoir Water Works, personal communication). Therefore, there are apparently no private wells located in the immediate vicinity of the plant.

The elevation of the site ranges from approximately 1095 ft mean sea level (msl) at Plant No. 3, to 1065 ft msl in the flood plain just north of the landfill (figs. 1 and 2). The surface of the site slopes gently north to the edge of the landfill, where it abruptly drops in elevation from about

1085 ft msl to about 1066 ft msl on the flood plain surface.

Surface water from the site drains toward the ditch to the northeast between the landfill and the lumber yard; and to a draw west of the site. Both these intermittent drainage features drain toward the northwest to Lower Creek. The upper portion of the site is adequately drained. The flood plain area from the landfill northward to Lower Creek is a poorly drained wooded area, which is periodically flooded.

2.2 CLIMATE

Precipitation in the Lenoir area is fairly well distributed throughout the year. The greatest amount of precipitation generally occurs from early spring through early fall. The least generally occurs during the late fall and winter. The average annual rainfall for the Lenoir area is 49.94 inches. Departures from normal monthly precipitation commonly occur and mild droughts are common.

Precipitation is the source of ground-water recharge in the area. Therefore, variations in the quantity of precipitation will have an effect on the amount of recharge to the aquifers. During the two months prior to the field investigation (August and September), precipitation was 6 inches below normal. Therefore, ground-water levels measured during this investigation may have been lower than usual.

SECTION 3.0 METHODS OF INVESTIGATION

3.1 FIELD INVESTIGATION

Five test holes (N-1, E-1, W-1A, W-1B, and S-1) were drilled at the site. Four of these test holes were converted to monitor wells. The locations of these test holes are shown on figure 2, and information on these test holes is summarized in table 1.

Split-spoon samples were collected every 2.5 ft for the first 10 ft, where conditions while drilling in fill permitted, and at 5-ft intervals thereafter, to the total depth (TD) of each of the test holes. These samples were visually classified in the field, and later in the laboratory by the project geologist, and lithologic boring logs were prepared (see Soil Boring and Well Records - Appendix B). These lithologic logs were used in preparing geologic cross-sections of the site in order to define the subsurface stratigraphy and water-bearing character of the strata.

The locations and elevations of the test holes were estimated by measuring the distance from the test hole to a known reference point on a topographic map of the site supplied by The Singer Company. Therefore, land-surface and well elevations should be regarded as approximate.

Water levels were measured in the 4 wells on October 13, 1982 (table 4). Groundwater levels were measured with an electric drop-line and fiberglass tape to an accuracy estimated to be within 0.1 ft. These water levels were then converted to approximate mean sea level (msl) elevations.

Field borehole permeability tests were made on Wells W-1B, N-1, and E-1 in order to determine the radial permeability (hydraulic conductivity, K) of strata beneath the site. These test results are summarized in table 5 and are discussed in Section 4.0.

The 4 test holes at the site were converted to 2-in diameter wells as illustrated in figure 6. Wells W-1B, E-1, and S-1 have a 5-ft length of PVC screen with 0.025-in slots and Well N-1 has a 10-ft length of screen. Well construction data are summarized in tables 1 and 2.

A variance to the DNR requirements for well construction was granted by the Division of Environmental Management (DEM) in a letter dated October 5, 1982. Field conditions required modification of the approved well construction guidelines. The well construction modifications were approved by personal communication with DEM on October 11 and 12, 1982.

The drill rig and all well materials were pressure cleaned between wells to minimize potential cross-contamination. Monitor Well E-1 was developed with compressed air; and Wells N-1, S-1, and W-1B were developed with water to remove sediments, drilling fluid, and contaminants which may have entered the screen/well casing during drill and well construction. Down-gradient Wells N-1 and W-1B were not developed with air because poor weather conditions did not permit access to the wells by vehicle.

3.2 LABORATORY SOILS TESTING

Laboratory testing of soil samples collected in the field consisted of preparing lithologic logs (detailed descriptions) and performing 2 grain-size analyses. The lithologic logs (Appendix B) were prepared by the project geologist from his own field notes, the driller's field notes, and from his lithologic analyses of samples in the laboratory. The grain-size analyses were made on split-spoon samples from 2 test holes (W-1B, E-1) in order to characterize the physical properties of strata beneath the site. These analyses are summarized in table 3, and the grain-size distribution curves are presented in Appendix C.

4.1 STRATIGRAPHY

Geologic formations beneath the landfill area have been divided into 3 geologic units.

Alluvium (Unit I)--near-surface sediments of Quaternary age consisting of clays and silts and permeable fine-to coarse-grained sands.

Saprolite and Colluvium (Unit II)-- soil composed of decomposed bedrock (saprolite) and highly weathered bedrock and saprolite talus (colluvium).

Bedrock (Unit (III)-- metamorphic bedrock consisting of migmatite gneiss, garnet gneiss, and biotite schist and gneiss.

The general stratigraphic relationships, lithology, thickness, and hydrologic characteristics of these units are illustrated on figure 3.

4.1.1 Alluvium (Unit I)

The Alluvium (Unit I) has been subdivided into 2 hydrogeologic units on the basis of hydrologic properties-- the fine-grained Upper Alluvium (Unit IA), and the coarser-grained Lower Alluvium (Unit IB).

The Upper Alluvium (IA) consists primarily of a brown to grayish-black silty clay and clayey silt. Although this unit contains little sand in test holes W-1B and E-1, an interbedded lens of slightly silty sand occurs between the clay and silt beds in Well N-1. As illustrated in figure 4, Unit IA is 18 ft thick at Well W-1B, but thins to as little as 9 ft at Well N-1.

The Lower Alluvium (IB) consists of blue-grey to yellow-brown fine to coarse sand. At the boring locations, this unit becomes coarser-grained and contains less silt with increasing depth. As illustrated in figure 4, gravel occurs at the base of the unit at Wells W-1B and E-1. The top of Unit IB occurs at a

depth of 14 ft at Well N-1 and 33 ft at Well 1B. The total thickness of Unit IB is unknown because the test holes did not penetrate the full thickness of this unit. The maximum thickness penetrated is 20 ft at Well E-1 (fig.4).

4.1.2 Saprolite and Colluvium (Unit II)

Although saprolite was penetrated in only the up-gradient Well (S-1), it is reasonable to assume that it underlies the alluvium (Unit I) beneath the landfill. In Well S-1, saprolite was differentiated from colluvium primarily on the basis of density differences (blow-counts); because these 2 units are lithologically similar (see Boring Record in Appendix B). The saprolite occurs at a depth of 23.5 ft in Well S-1. The thickness of the saprolite is unknown because no boring penetrated the full thickness of the unit. Borehole samples from Well S-1 and exposures in the sand pit south of Plant No.3 indicate that the saprolite consists of layered bands of highly weathered feldspathic rock fragments, coarse quartz grains, biotite, and clay.

The colluvium originates from the downslope movement of highly decomposed bedrock and saprolite from the steep slope of the hill south of the plant, and is limited to this area. As illustrated in figure 3, colluvium overlies the saprolite in Well S-1 from a depth of approximately 8.5 ft to 23.5 ft.

4.2 GROUND-WATER OCCURRENCE AND WATER-BEARING PROPERTIES

4.2.1 Upper Alluvium (Unit IA)

Ground water occurs in very thin sands and silts in the Upper Alluvium (IA) under water-table conditions. The fine-grained sediments within this unit probably function as semi-confining beds because they are considerably less permeable than the sands in the Lower Alluvium (IB).

One grain-size analysis from Well W-1B and visual analysis of split-spoon samples were used to estimate the radial permeability (K) and vertical permeability (K') of Unit IA strata. The estimated radial permeability (K) of these strata ranges from less than 0.1 ft/day to about 5 ft/day. The higher K value is estimated for the thin sand lens which occurs in Well N-1 at a depth of 8-11.5 ft (fig.4). An average radial permeability for Unit IA is estimated to be about 0.3 ft/day because of the overall fine-grained texture of Unit IA strata. .3 ft/day x 12"/ft x 2.54 cm/in x 1.16×10^{-5} days/sec = 1.064×10^{-4} cm/sec

The vertical permeabilities (K') of strata within Unit IA are interpreted to be less than the radial permeabilities of these strata. This interpretation is based on one grain-size analysis, visual examination of split-spoon samples, and vertical permeability values obtained from texturally similar fine-grained alluvial sediments.. The vertical permeabilities of the clays and clayey silts within Unit IA are estimated to be less than about 6×10^{-4} ft/day.

If the fine-grained silty clays and clayey silts of Unit IA were laterally continuous beneath the landfill area, this unit could be regarded as an effective confining unit. However, as illustrated on figure 4, these beds thicken and thin appreciably and change lithology between wells.

4.2.2 Lower Alluvium (Unit IB)

The Lower Alluvium contains the most permeable strata penetrated in the 4 wells. Information from the 3 down-gradient monitor wells indicates that ground water within Unit IB occurs under both artesian (confined) and water-table (unconfined) conditions (see fig. 4). Sediments in Unit IB are coarser and more permeable than the overlying clays and silts of Unit LA.

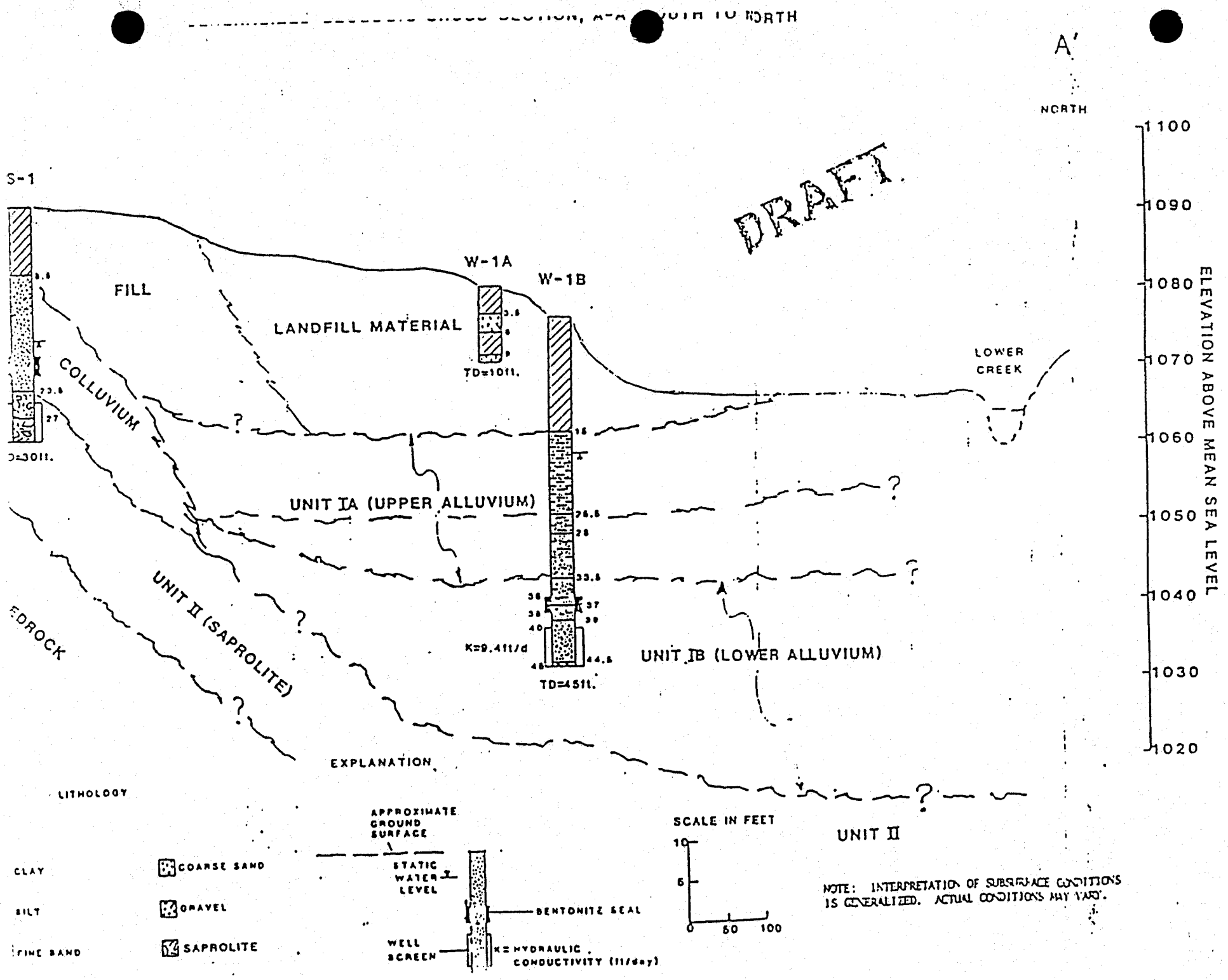
The average thickness of Unit IB strata beneath the landfill area is at least 15 ft and it may be more than 20 ft. Therefore, this unit is considered a fair aquifer.

The permeabilities of Unit IB strata are estimated to range from about 5 ft/day to more than 30 ft/day. The average permeability (K_{av}) is estimated to be about 20 ft/day. These permeability estimates are based on one grain-size analysis from Well E-1, borehole permeability tests at Wells W-1B and E-1, and visual inspection of split-spoon samples.

4.2.3 Saprolite (Unit II)

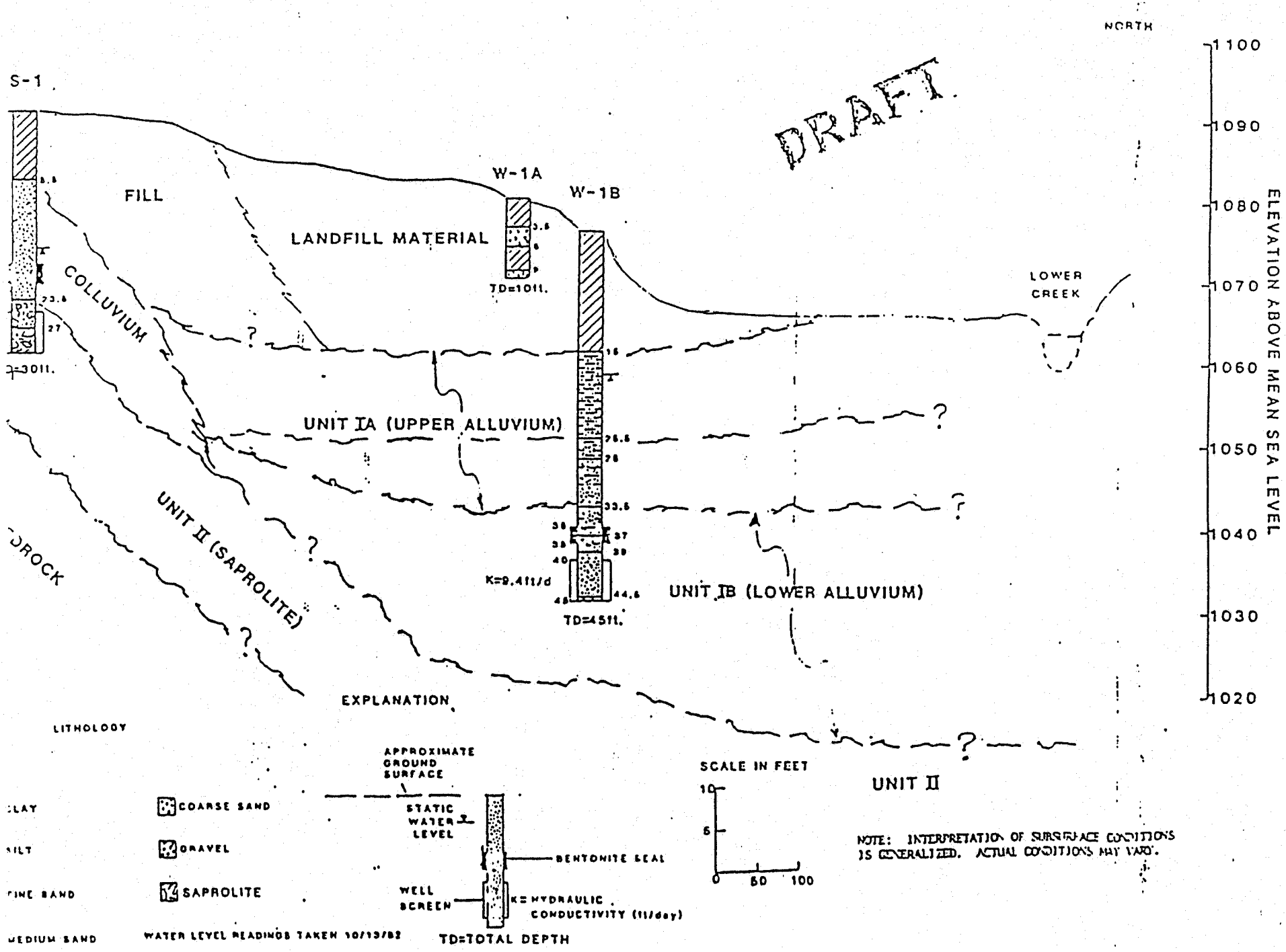
The saprolite was penetrated in only the background well (S-1). Therefore, there is not sufficient information on this unit to make reasonably accurate evaluations of the water-bearing properties of this unit. However, the general hydrologic properties of saprolite in other areas allows the following generalizations to be made.

Saprolite is commonly porous, with bulk porosities ranging from 30 percent to 55 percent, as indicated from porosity data obtained from thin-wall samples in other S&ME ivestigations. However, saprolitic soils commonly have low permeabilities because of the generally high content of silt and clay. Borehole permeability tests from other ground-water investigations in geologically similar areas indicate that saprolite permeabilities vary from less than 0.001 ft/day to about 5 ft/day. High saprolite permeabilities are generally the result of relict fractures and joints, and other planes of weakness. The saprolite probably functions as a confining unit


SOUTH TO NORTH
A'
NORTH
DRAFT
S-1
FILL
COLLUVIUM
LANDFILL MATERIAL
W-1A
W-1B
TD=1011.
TD=3011.
UNIT IA (UPPER ALLUVIUM)
UNIT II (SAPROLITE)
UNIT IB (LOWER ALLUVIUM)
UNIT II
K=9.411/d
TD=4511.
LOWER CREEK
ELEVATION ABOVE MEAN SEA LEVEL
1100
1090
1080
1070
1060
1050
1040
1030
1020
EXPLANATION
LITHOLOGY
CLAY
SILT
FINE SAND
COARSE SAND
GRAVEL
SAPROLITE
APPROXIMATE GROUND SURFACE
STATIC WATER LEVEL
BENTONITE SEAL
WELL SCREEN
K = HYDRAULIC CONDUCTIVITY (ft/day)
SCALE IN FEET
0
50
100
NOTE: INTERPRETATION OF SUBSURFACE CONDITIONS IS GENERALIZED. ACTUAL CONDITIONS MAY VARY.

that retards the vertical downward movenent of ground water from the Alluvium into the underlying bedrock (Unit III). It would be reasonable to assume that the saprolite retains ground water which slowly leaks to fractures in the underlying bedrock.

GENERALIZED GEOLOGIC CROSS-SECTION, A-A' FROM SOUTH TO NORTH



5.1 GROUND-WATER FLOW IN THE LOWER ALLUVIUM (Unit IB)

Ground-water movement through the Lower Alluvium (Unit IB) is primarily controlled by the location of natural recharge and discharge areas, and by the attitude of the underlying saprolite. The Lower Alluvium is recharged by the slow infiltration of precipitation through the overlying sediments of the Upper Alluvium (Unit IA). Lower Creek valley is the local discharge area for ground water moving through the Lower Alluvium. This conclusion is supported by the observation of the difference in water-table elevations (shown on table 4) between up-gradient Well S-1 (1075 ft) and down-gradient Well N-1 (1060 ft). As illustrated on figure 4, the flow of ground water is generally to the northwest toward the Lower Creek.

Estimates of the average linear velocity of ground water were made by using a modified form of the Darcy Equation:

$$v = \frac{K}{n_e} \cdot \frac{dh}{dL} \qquad \text{where,}$$

$\bar{v}$ = average linear velocity (ft/day); K = hydraulic conductivity (ft/day); n_e = effective porosity (percent); and dh/dL = hydraulic gradient (ft/ft).

An effective porosity (n_e) of 20 to 30 percent was estimated from specific yield (Sy) estimates by the method described by Johnson (1967). The hydraulic gradient between Wells E-1 and N-1 is estimated to be 0.02 ft/ft. Therefore, the average linear velocity of ground water moving through the Lower Alluvium is estimated to range from about 1 to 2 ft/day (350 to 700 ft/yr).

Vertical Flow:-- Deep ground-water flow paths will probably not develop beneath the landfill because of the following: 1) The short distance between the discharge and recharge areas generally precludes the development of deep paths of ground-water flow; and 2) It is reasonable to assume that the underlying sapro-

lite is less permeable than Lower Alluvium sands. Therefore, the flow of ground water through Unit IB will be deflected laterally along the top of the saprolite toward the discharge area, the valley of Lower Creek.

5.2 WATER-LEVEL FLUCTUATIONS

Ground-water levels in the North Carolina Piedmont fluctuate both in a seasonal cycle and in response to short-term rainfall events. Normally, ground-water levels are lowest in the late fall to mid-winter and higher during late winter-early spring. Water levels in wells located in recharge areas generally have a greater fluctuation than wells located in discharge areas. The water level measured in Well S-1, although screened in saprolite, is indicative of water-table level located in the recharge area of the site. Therefore, ground-water levels in this well will probably have a greater fluctuation than water levels in Wells N-1 and E-1 located in the flood plain of Lower Creek (discharge area). While no seasonal cycle of ground-water levels have been obtained, water-level fluctuations of 5 to 7 ft would be expected in Well S-1. Water-level fluctuations in Wells W-1B, E-1, and N-1 will probably be less than 5 ft. A greater fluctuation in water levels in up-gradient (recharge area) wells compared to down-gradient wells (discharge area) wells would increase the hydraulic gradient, and therefore the potential linear velocity of the ground water. Therefore, although water-level fluctuations will probably affect the movement and dispersion of contaminants, this affect will probably not be enough to alter the probable flow of potential contaminants toward the discharge area, Lower Creek.

5.5 POTENTIAL CONTAMINANT MOVEMENT

The water table occurs in the Upper Alluvium below the landfill material. Precipitation infiltrating the full thickness of the landfill will generate leachate before intercepting the water table. Therefore, it is reasonable to expect that the ground water of the Upper Aquifer may be affected by leachate. However, upper sediments of Unit IA consist of silty clays of low permeability; therefore, the infiltration of potential contaminants is at least retarded by these clays and silts. These clays afford some protection from contamination of ground water within the underlying sands of the Lower Alluvium (Unit IB). However, where the beds of clay and silt are thin and permeable or where sand beds occur in Unit IA (such as at Well N-1), there is a greater potential for contamination of ground water in the Lower Alluvium.

Potential contamination of ground water in deeper geologic strata (bedrock) is less likely because (1) the underlying saprolite will probably act as a confining bed that retards the downward vertical movement of contaminants, and deflects ground water laterally toward the discharge area, and (2) the higher radial ("horizontal") permeability of the Lower Alluvium (Unit IB) will cause the flow of ground water within Unit IB to be primarily lateral toward Lower Creek valley; and (3) deep ground-water flow paths will probably not develop beneath the landfill because of the short distance between the recharge and discharge areas.

There are no known wells located down-gradient of the landfill. Therefore, the direction of ground-water flow toward the creek is unaffected by pumpage, and it is reasonable to expect that no water supply wells are currently being impacted by leachate contaminants.

SECTION 6.0 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The generation of leachate by the infiltration of precipitation through the landfill is likely. The underlying clays and silts within the Upper Alluvium (Unit IA) will likely retard and attenuate at least some of this leachate. However, where Unit IA is thin and/or contains beds of permeable sand, as at Well N-1, ground water within the underlying sands of the Lower Alluvium (Unit IB) could be contaminated by leachate.

Contamination of ground water within the bedrock that underlies the landfill area is not probable because the saprolitic soils (Unit II) will probably retard the downward movement of contaminants.

Contamination of the Upper Alluvium is likely, and there is a potential for contamination of the Lower Alluvium. However, there are currently no known water-supply wells located in what is interpreted to be the down-gradient direction of ground-water and contaminant movement. Therefore, no known wells are currently being impacted by landfill leachate.

The existing wells are located in the general down-gradient direction of ground-water flow from the landfill, and therefore may be used to monitor potential movement of contaminants in the Lower Alluvium adjacent to the landfill. However, the precise direction of ground-water flow is unknown. Therefore, additional monitor wells would be needed to confirm the direction of ground-water movement and the lateral extent of contamination.

The rates of lateral ground-water movement beneath the landfill and adjacent area presented in this report are estimates which are believed to be reasonable approximations. However, should it be necessary to more accurately determine ground-water flow rates and the rates of contaminant dispersion, additional field and laboratory testing would be necessary.

A systematic ground-water monitoring program is recommended to (1) establish

the range of water-level fluctuations in the hydrogeologic units beneath and adjacent to the landfill, (2) establish baseline, or background, ground-water quality data, (3) monitor the movement of contaminants, and (4) evaluate the effects of contaminant movement.

General information on water wells in the general area of the Plant site were obtained from the N. C. Department of Natural Resources and Community Development and conversations with Singer personnel. It would be prudent to perform a systematic well survey of homes and industrial establishments located east-southeast of the plant site to verify whether the Alluvium is used as a source of drinking water supply.

In order to reduce the generation of leachate, the surface of the landfill should be maintained in order to eliminate as much as possible the infiltration of rainfall and surface drainage. Existing pits on the surface of the landfill should be filled with impermeable soil.

SECTION 7.0 SELECTED REFERENCES

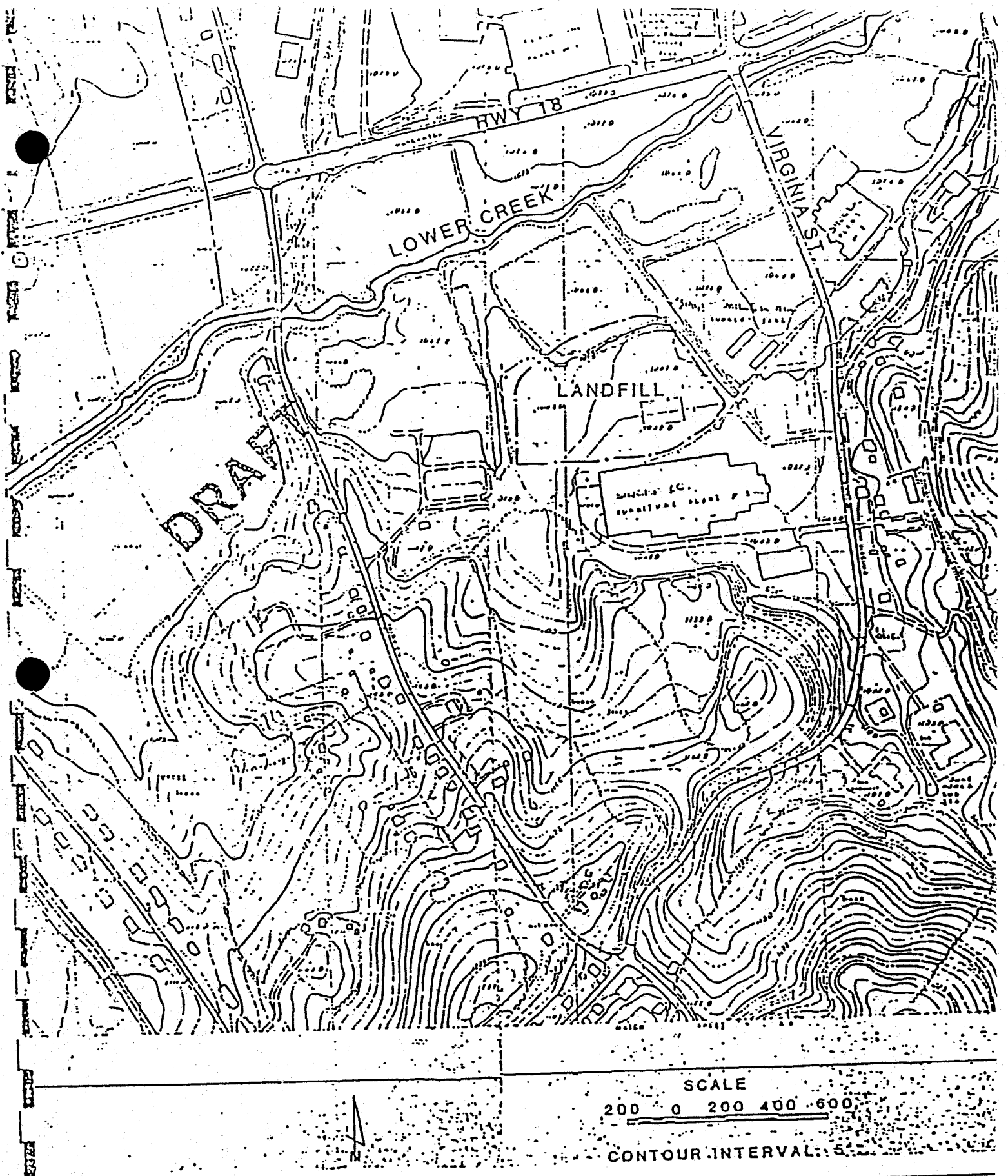
Goldsmith, R., Milton, D. F., and Wilson, F. A., 1978, Preliminary Geologic Map, Geologic Map Index, and Annotated Bibligraphy, Charlotte 2° Sheet, North Carolina and South Carolina: Open-File Rept. No. 78-590, U. S. Geol. Survey, Reston, Virginia.

Johnson, A. I., 1967, Specific Yield of Granular Sediments: U. S. Geol. Survey Water-Supply Paper 1662-D.

DRAFT

APPENDIX A

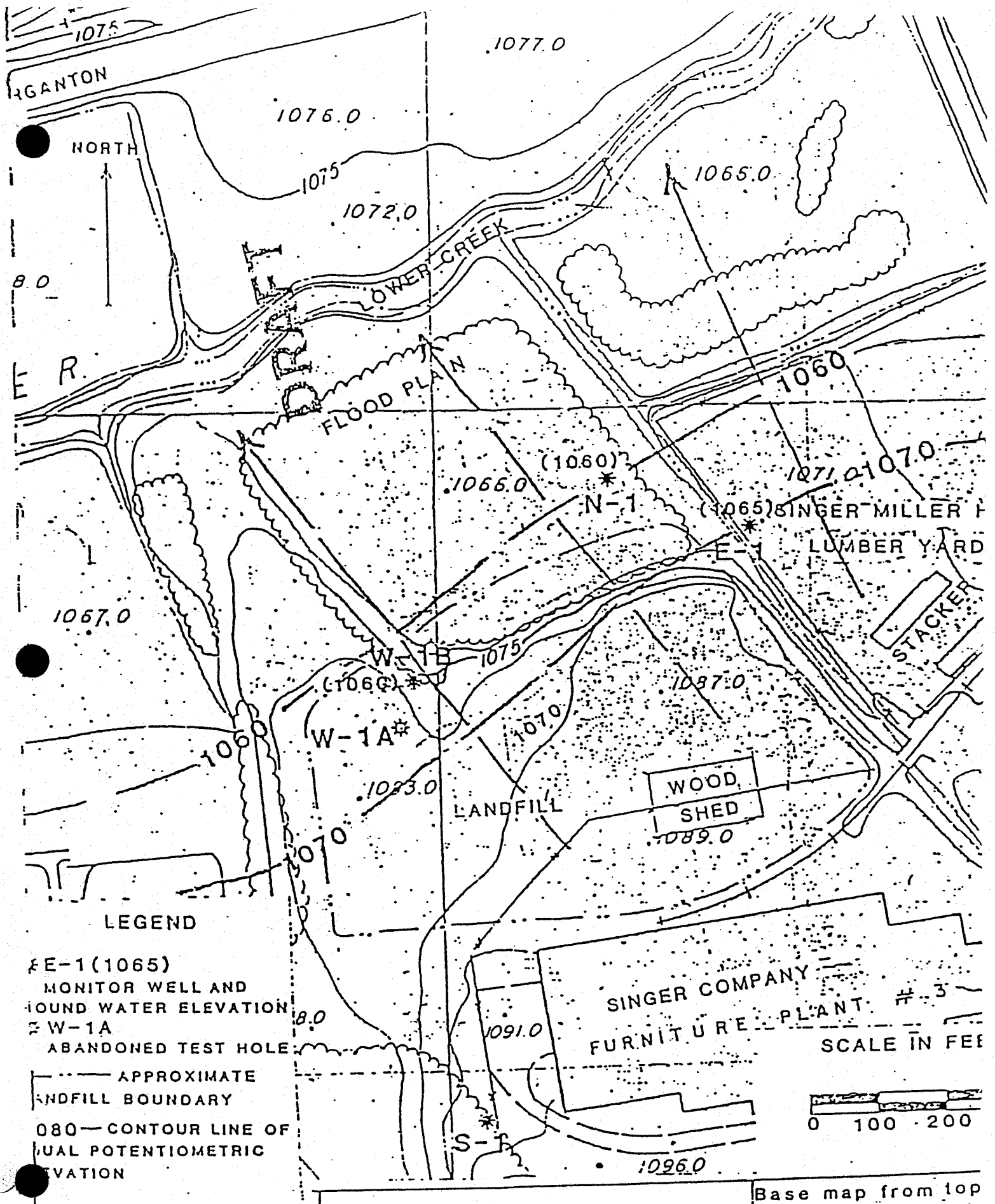
ILLUSTRATIONS AND TABLES



gure 1. Topographic ap of the landfill site and vicinity.

SOIL & MATERIAL ENGINEERS INC.
ENGINEERING-TESTING-INSPECTION
COLUMBIA, SOUTH CAROLINA

Base map from to graphic map supp Singer Co., Lenoi



gure 5. Generalized
p of ground water flow
hin Unit TB.

SOIL & MATERIAL ENGINEERS INC.
ENGINEERING-TESTING-INSPECTION
COLUMBIA, SOUTH CAROLINA

Base map from top
graphic map suppli
Singer Co., Lenoir,

WELL CONSTRUCTION SCHEMATIC

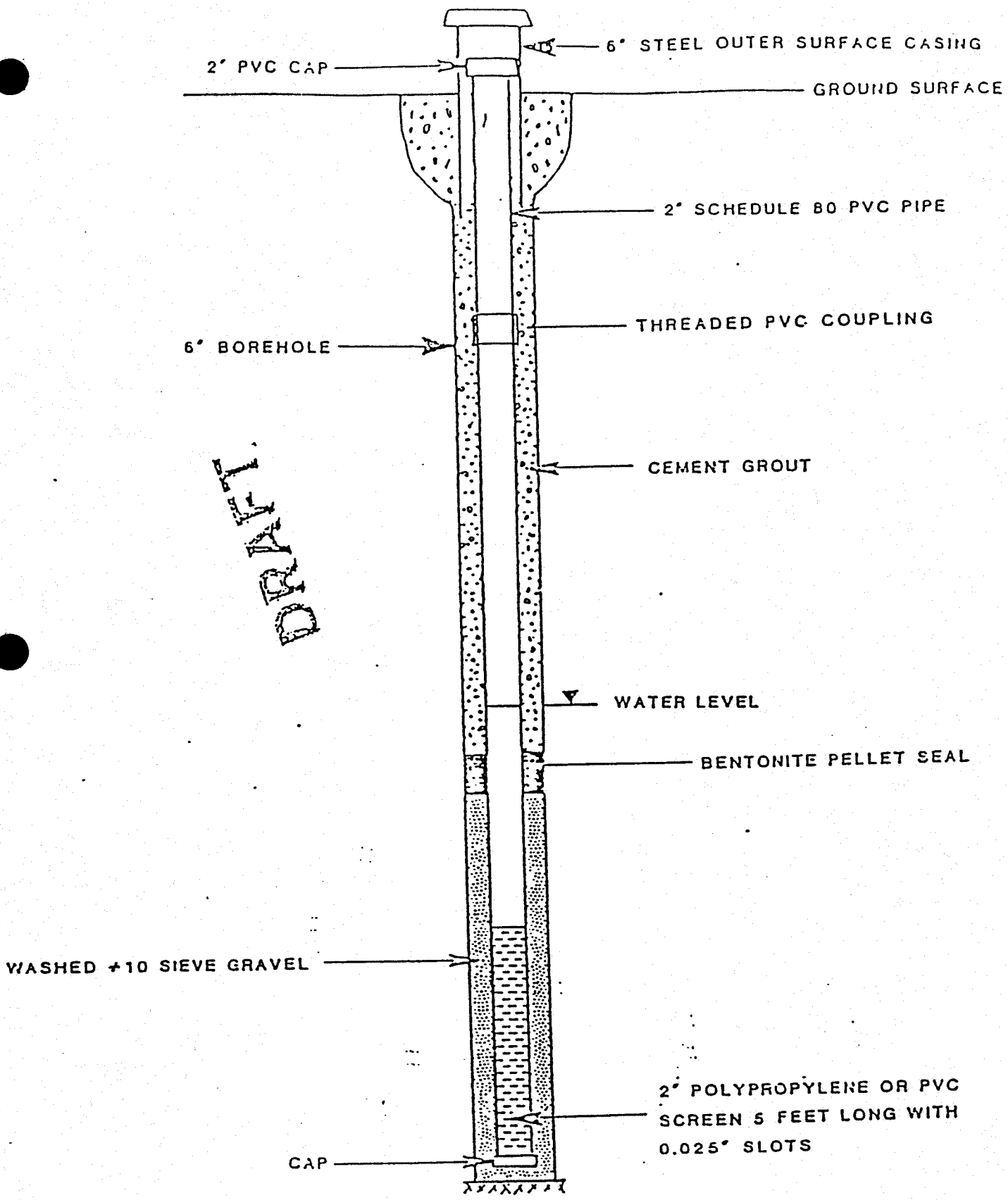


FIGURE 6. Well Construction Schematic of Typical Monitor Well.

TABLE 1. TEST BORING AND WELL CONSTRUCTION DATA

DRAFT

Well Field No.	SEME Well Report No.	Land-Surface Elevation (FT MSL)[1]	Casing Stick Up:	Elevation Top of Casing (TOC)	Original Boring Depth	Screen Depth	Gravel Depth	Depth Well Seal	Remarks
TH-1A	W-1A	1081	None	None	10	None	None	None	Abandoned becau garbage and debr
TH-1B	W-1B	1077	2.9	1079.9	45	40-45	38-45	36-38	
TH-2	N-1	1067	3.3	1070.3	21.5	9.7-19.7	8.5-21.5	6.5-8.5	
TH-3	E-1	1071	3.9	1074.8	35	27-32	25-32	23-25	
TH-4	S-1	1092	2.9	1094.8	30	25-30	21.5-30	19-21.5	Background Observation Well

NOTE: [1]Estimated from topographic map of site supplied by the Singer Company

SEME Job No. 4482-

TABLE 2. SUMMARY OF WELL CONSTRUCTION DATA

DRAFT

STATE: North Carolina

SOIL & MATERIAL ENGINEERS WELL SUMMARY

COUNTY: Caldwell

SME JOB NO. #87-129

Well No.	State Number	SME Well No.	Elevation (MSL)	Owner/Location	Well Use	Total Depth	Casing Dia.	Casing Depth	Pump Rate	Date Comp.	Logs	Chemical Analyses	Well Cons.	Remarks
TH-1A		W-1A	1081 ft.	Singer-Lenoir West of Landfill		10 ft.	None			10/12/82	Drillers			Test hole abandoned because of garbage and debris.
TH-1B		W-1B	1077 ft.	Singer-Lenoir West of Landfill	OBS	45 ft.	2-in.	40 ft.		10/12/82	Drillers Geologists	Inorganic Pesticide Volatile	GP	Screen 40-45 ft, set in slightly silty, medium sand to small gravel.
TH-2		N-1	1067 ft.	Singer-Lenoir North of Landfill	OBS	21.5 ft.	2-in.	9.7 ft.		10/12/82	Drillers Geologists	Inorganic Pesticide Volatile	GP	Screen 9.7-19.7 ft, set in fine to coarse sand, slightly silty to silty.
TH-3		E-1	1071 ft.	Singer Lenoir East of Landfill	OBS	35 ft.	2-in.	27 ft.		10/13/82	Drillers Geologists	Inorganic Pesticide Volatile	GP	Screen 27-37 ft, set in medium to coarse sand.
TH-4		S-1	1092 ft.	Singer-Lenoir South of Landfill by Main Plant Bldg.	OBS	30 ft.	2-in.	25 ft.		10/14/82	Drillers	Inorganic Pesticide Volatile	GP	Screen 25-30 ft, set in saprolite. Background observation well.

SME HD-3 (rev. 11/82)

TABLE 3. SUMMARY OF PHYSICAL LABORATORY TESTS

DRAFT

Well No.	Depth of Sample (ft)	Sample Description	Hydrogeologic Unit	% Silt and Clay (0.074 mm)	Estimated[1] Effective Porosity n_e
W-1B	28.5 - 30	Slightly Sandy CLAY	Unit 1A	79.1	5 - 10%
E-1	18.5 - 20	Silty SAND	Unit 1B	22.0	20%

NOTE: [1]Based on information from Johnson, 1967

S&ME Job No. 4482-129

Table 4. Summary of Water Level Data

DRAFT

WELL NO.	ELEV. M.P.	DATE MEASURED	WATER LEVEL BELOW M.P.	WATER LEVEL ELEV.	MEASURED BY	REMARKS
W-1B	1079.9	10/13/82	20.5	1058.4	Curt Gorman	Well screened in Unit 1B
N-1	1070.3	10/13/82	10.4	1059.9	Curt Gorman	Well screened in Unit 1A/1B
E-1	1074.8	10/13/82	9.9	1064.9	Curt Gorman	Well screened in Unit 1B
S-1	1094.8	10/14/82	20.2	1074.6	Chris Silkwood	Well screened in Unit 1J

NOTE: Measuring Point (MP) of all wells is top of cas (TOC)

SEME Job No. 4482-129

TABLE 5. SUMMARY OF FIELD BOREHOLE PERMEABILITY TESTS

DRAFT

ELL NO.	DEPTH OF SCREEN INTERVAL TESTED (ft)	ESTIMATED RADIAL HYDRAULIC CONDUCTIVITY (cm/sec)	(ft/day)	HYDROGEOLOGIC UNIT	LITHOLOGY	REMARKS
-IB	40-45	3.3×10^{-4}	9.4	Unit IB	Slightly Silty Sand	
-I	27-32	8.6×10^{-3}	24.4	Unit IB	Slightly Silty, medium to coarse Sand	
-I	9.7-19.7	7.0×10^{-5}	0.2	Unit IA/Unit IB	Silt, and fine to coarse Sand	Well screen not fully developed, therefore calculated permeability is considered lower than actual permeability

NOTE: Falling head tests performed October 13, 1982

S&ME JOB NO. 4402-129

DRAFT

APPENDIX B

SOIL BORING AND WELL RECORDS

SOIL BORING AND WELL RECORD

Location: The Singer Co.- Lenoir County: Caldwell, NC Job No.: 4482-129 Boring or Well No.: W-1B

Logged by: C. Corman Drilled by: C. Silkwood Grid Coord.: _____ Lat.-Long.: _____

Date Started: 10/12/82 Boring Depth: 45 ft. Static Water Level: 20.5 ft

Date Completed: 10/12/82 Well Depth: 45 ft. Permeability Tests: Falling Head

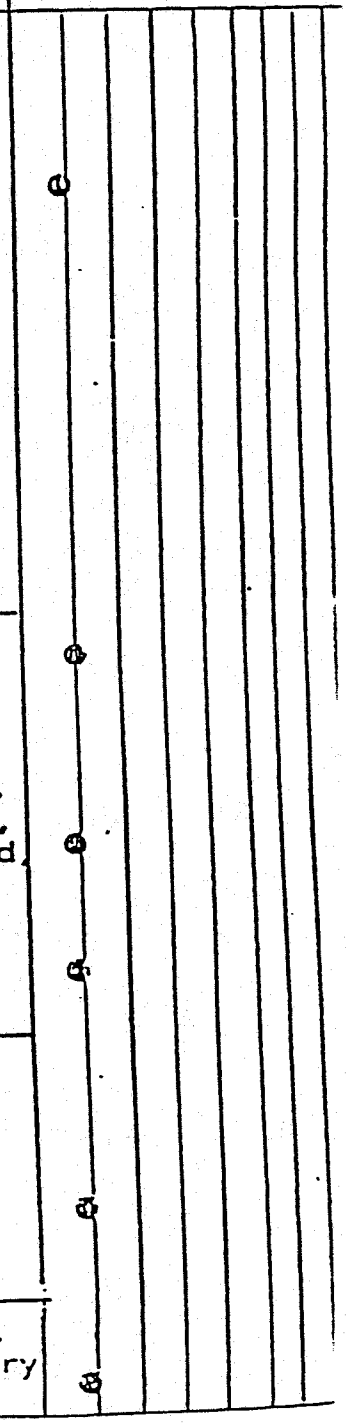
Drilling Method: Auger Casing: 2-in. PVC Sch 80 Thrd. 0-40 ft.

Development Method: Flushed 100 gal. water Screen: 2-in PVC Sch 80 Thrd, .025-in. slot, 40-45 ft. Seal: Bentonite 36-38 ft.

Soil Samples: Split Spoon Grout: Portland, 0-36 ft.

Geophysical Logs: None Chem. Analysis: Inorganic & Organic

Elev. ±1077	Depth Ft.	Description
SS		Fill, silt, wood debris, charcoal, glass.
		Fill, as above.
		Water table at approximately 13 ft in borehole.
SS	15.0	Clay, grey, firm, sticky, silty, some muscovite flakes, with large amounts of imbedded medium-to-coarse grained, subangular sand.
SS		Clay, medium brown, grey, mottled, soft-to-firm, sticky, slightly silty, with some muscovite flakes, sand content very low, medium- to-coarse grained, very faint oil odor.
SS		Clay, as above, plastic, no odor; grading to
SS	25.5	Silt, blue/grey, very clayey, plastic and sticky, with very small amounts of fine grained sand. Very loose, muscovitic, sand content increasing at 28 ft.
SS	28.0	
SS	33.0	Sand blue/grey, very fine, some coarse grained, subrounded to subangular, moderately sorted, very silty, slightly clayey, muscovite.



DRAFT

SOIL & MATERIAL ENGINEERS, INC.

SOIL BORING AND WELL RECORD

Location: The Singer Co.- Lenoir County: Caldwell, NC Job No.: 4482-129 Boring or Well No.: W

Logged by: C. Gorman Drilled by: C. Silkwood Grid Coord.: _____ Lat.-Long.: _____

Date Started: 10/12/82 Boring Depth: 45 ft. Static Water Level: 20.5

Date Completed: 10/12/82 Well Depth: 45 ft. Permeability Tests: Falling Hea

Drilling Method: Auger Casing: 2-in. PVC Sch 80 Thrd. 0-40 ft.

Development Method: Flushed 100 gal. water Screen: 2-in PVC Sch 80 Thrd, .025-in. slot, 40-45 ft. Seal: Bentoni 36-38 ft

Soil Samples: Split Spoon Grout: Portland, 0-36 ft.

Geophysical Logs: None Chem. Analysis: Inorganic & Organic

	Elev.	Depth Ft.	Description
		37.0	Silt, grey, with some fine grained sand.
	SS	39.0	Sand, light yellow/brown, to red/brown from staining, very fine to coarse, predominantly medium grained, subangular, poorly sorted, very slightly silty, muscovite and biotite flakes-fine, some orange oxide stains; grading to medium-to-coarse grained sand at 43.5 ft; large gravelly layer, subangular to rounded at 44.5 ft, imbedded with medium-to-coarse grained sand, muscovite and biotite flakes present.
	SS	43.5	
		44.5	
		45.0	

Boring terminated at 45 ft.

DRAFT

SS = Split-Spoon Sample

SOIL BORING AND WELL RECORD

Location: The Singer Co. Lenoir County: Caldwell, NC Job No.: 4482-129 Boring or Well No.: E-11

Logged by: C. Gorman Drilled by: C. Silkwood Grid Coord.: _____ Lat.-Long.: _____

Date Started: 10/13/82 Boring Depth: 35 ft. Static Water Level: 9.9 ft

Date Completed: 10/13/82 Well Depth: 32 ft. Permeability Tests: Falling Head

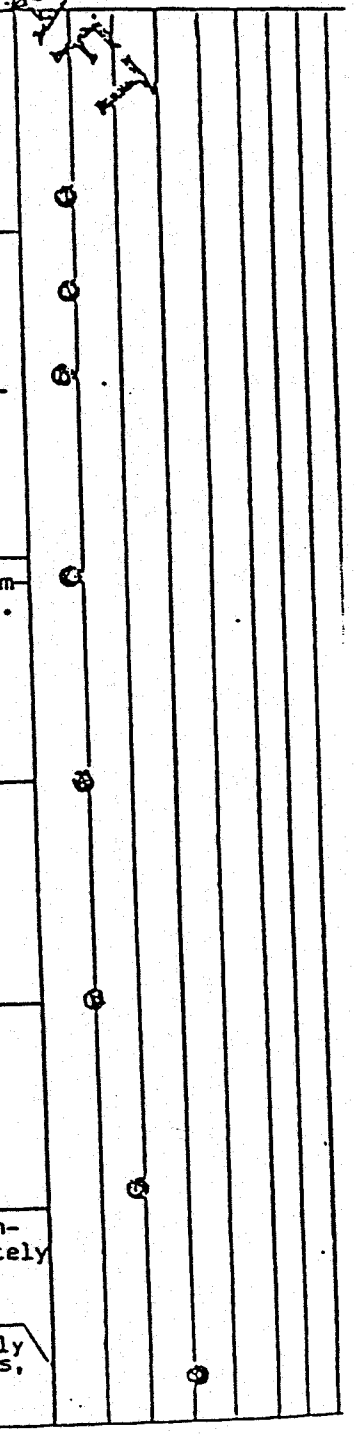
Drilling Method: Auger Casing: 2-in PVC Sch 80 Thrd, 0-27 ft.

Development Method: Air Compressor Screen: 2-in PVC Sch 80 Thrd, .025-in slot, 27-32 ft. Seal: Bentonite, 23-25 ft

Soil Samples: Split Spoon Grout: Portland, 0-23 ft.

Geophysical Logs: None Chem. Analysis: Inorganic & Organic

	Elev. ±1071	Depth Ft.	Description
			Fill, silt, rock fragments, muscovite flakes, debris.
	SS		
		5.5	Clay, dark grey, soft-firm, sticky-plastic, slightly silty, with some fine grained imbedded sand, muscovite flakes present.
	SS		
	SS		Clay, blue/grey, soft, sticky-plastic, slightly silty, with some imbedded medium-to-coarse grained sand, quartzose, abundant muscovite flakes.
		13.5	
	SS		Silt, blue/grey, soft, very clayey, with some imbedded medium-to-coarse grained sand, quartzose, abundant muscovite flakes.
	SS	19.0	Sand, grey, very fine-t-fine grained, some medium grained, subangular, very silty, clayey, poorly sorted, abundant muscovite flakes; interbedded with small silt layers containing very fine sand.
	SS	24.5	Sand, grey, loose, very fine-to-fine grained, some medium grained, subrounded to subangular, slightly silty, slightly clayey, moderately sorted, muscovite flakes present.
	SS	29.5	Sand, light yellow, with some orange/brown staining, medium-to-coarse grained, subangular, very slightly silty, moderately sorted, muscovite-biotite in fine particals, some oxide staining.
	SS	33.5	Sand, fine grained to large gravel, yellow/brown, slightly silty, very poorly sorted, abundant gold muscovite flakes, biotite, quartz and feldspar fragments.
		35.0	Boring terminated at 35 ft.



SOIL BORING AND WELL RECORD

Location: The Singer Co.- Lenoir County: Caldwell, NC Job No.: 4482-129 Boring or Well No.: W-1A

Logged by: C. Gorman Drilled by: C. Silkwood Grid Coord.: _____ Lat.-Long.: _____

Date Started: 10/12/82 Boring Depth: 10 ft Static Water Level: None

Date Completed: 10/12/82 Well Depth: Abandoned Permeability Tests: None

Drilling Method: Auger Casing: None

Development Method: None Screen: None Seal: None

Soil Samples: Split Spoon Grout: None

Geophysical Logs: None Chem. Analysis: None

	Elev. ±1081	Depth Ft.	Description
			Silt, red/brown, finely to medium sandy, quartzose, some muscovite flakes.
	SS	3.5	Garbage, wood debris, cans.
	SS	6.0	Sand, red/brown, very fine-to-coarse grained, subangular, very silty, gneissic composition.
	SS	9.0	Debris hindering drilling - 9.3 ft.
		10.0	Abandoned test hole at 10 ft. due to garbage and debris.

SS = Split-Spoon Sample

SOIL BORING AND WELL RECORD

Location: The Singer Co.-Lenoir County: Caldwell, N.C. Job No.: 4482-129 Boring or Well No.: N-1

Logged by: C. Corman Drilled by: C. Silkwood Grid Coord.: 21.5 ft. Lat.-Long.: ___

Date Started: 10/11/82 Boring Depth: 21.5 ft Static Water Level: 10.4 ft

Date Completed: 10/12/82 Well Depth: 19.7 ft. Permeability Tests: Falling Head

Drilling Method: Auger Casing: 2-in PVC, Sch 80 Thrd, 0-9.7 ft.

Development Method: Flushed 100 gal. water Screen: 2-inch PVC Sch 80 Thrd, .025-in slot 9.7 - 19.7 SEAL: Bentonite 6.5

Soil Samples: Split Spoon Grout: Portland 0-6.5 ft.

Geophysical Logs: none Chem. Analysis: Inorganic & Organic

Elev. ±1067	Depth Ft.	Description
		Silt, red/brown, with very fine grain, some coarse grained, quartzose, subangular sand, strong propellant odor.
		Silt, light red/brown, with very fine grain, some coarse grained, quartzose, subangular sand, clayey, micaceous, feldspar grains, strong propellant odor, rags and debris from 4.5 to 5.0 ft.
	3.5	
SS	4.5	Clay, grey/black, firm, sticky, with some imbedded very fine-to-fine, some coarse grained sand, very fine muscovite flakes, some organic material and rag fibers.
	5.0	
SS		
	8.0	Sand, grey/black, loose, very fine-to-medium grained, slightly silty, predominately quartzose, some feldspathic grains, subrounded to subangular, moderately sorted, abundant muscovite, no odor, wet.
SS		
	12.0	Silt, grey, with fine-grained sand, grading to silty sand.
SS	14.0	Sand, grey, fine-to-very coarse grained, firm, predominantly quartzose, some feldspathic grains, subrounded to subangular, poorly sorted, some muscovite flakes, larger grains are angular.
SS		
	20.0	Grading to brownish-grey silty sand at 20 ft.
	21.5	Boring terminated at 21.5 ft.

SS = Split-Spoon Sample

SOIL BORING AND WELL RECORD

Location: The Singer Co-Lenoir County: Caldwell, N.C. Job No.: 4482-129 Boring or Well No.: S-1(

Logged by: C. Silkwood Drilled by: C. Silkwood Grid Coord.: _____ Lat.-Long.: _____

Date Started: 10/13/82 Boring Depth: 30 ft Static Water Level: 20.2 ft

Date Completed: 10/14/82 Well Depth: 30 ft Permeability Tests: none

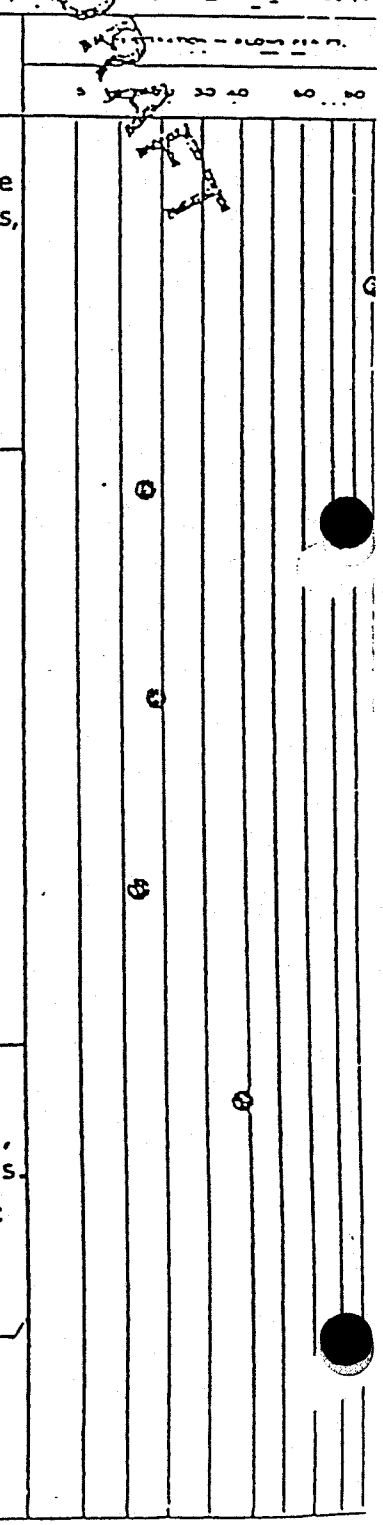
Drilling Method: Auger Casing: 2-in PVC, Sch 80 Thrd, 0-25 ft

Development Method: Flushed 160 gal. water Screen: 2-in PVC, Sch 80, Thrd, .025-in slot, 25-30 ft Seal: Bentonite 19-

Soil Samples: Split Spoon Grout: Portland 0-19 ft.

Geophysical Logs: none Chem. Analysis: Inorganic & Organic

	Elev. ±1092	Depth Ft.	Description
			Silt, red/brown, loose-to-firm, slightly clayey, with fine to medium grained, quartzose sand, some muscovite flakes and weathered feldspar fragments, some organic material. Fill.
	SS		Silt, as above
	SS	8.5	Sand, orange/white, firm, with very fine to coarse grained quartz and feldspar fragments, silty, some biotite and muscovite, highly weathered.
	SS		Sand, as above, yellow/brown, large feldspar fragments, silty.
	SS		Sand, red/brown, firm, with very fine to coarse grained quartz and feldspar grains, large feldspar fragments not as numerous, heavily muscovitic, moist, highly weathered.
	SS	23.5	Saprolite, red/brown, white, mottled, quartzose and feldspathic grains and fragments, feldspars are soft, heavily weathered, dark minerals-augite, in fragments, very silty, very fine rock fragments.
		27.0	Saprolite, white to brown, quartzose and feldspathic grains and fragments, feldspars firmer, abundant muscovite, sand grains predominantly coarse, biotite flakes - very fine, heavily weathered.
	SS	30.0	
			Boring terminated at 30 ft.
			SS = Split-Spoon Sample



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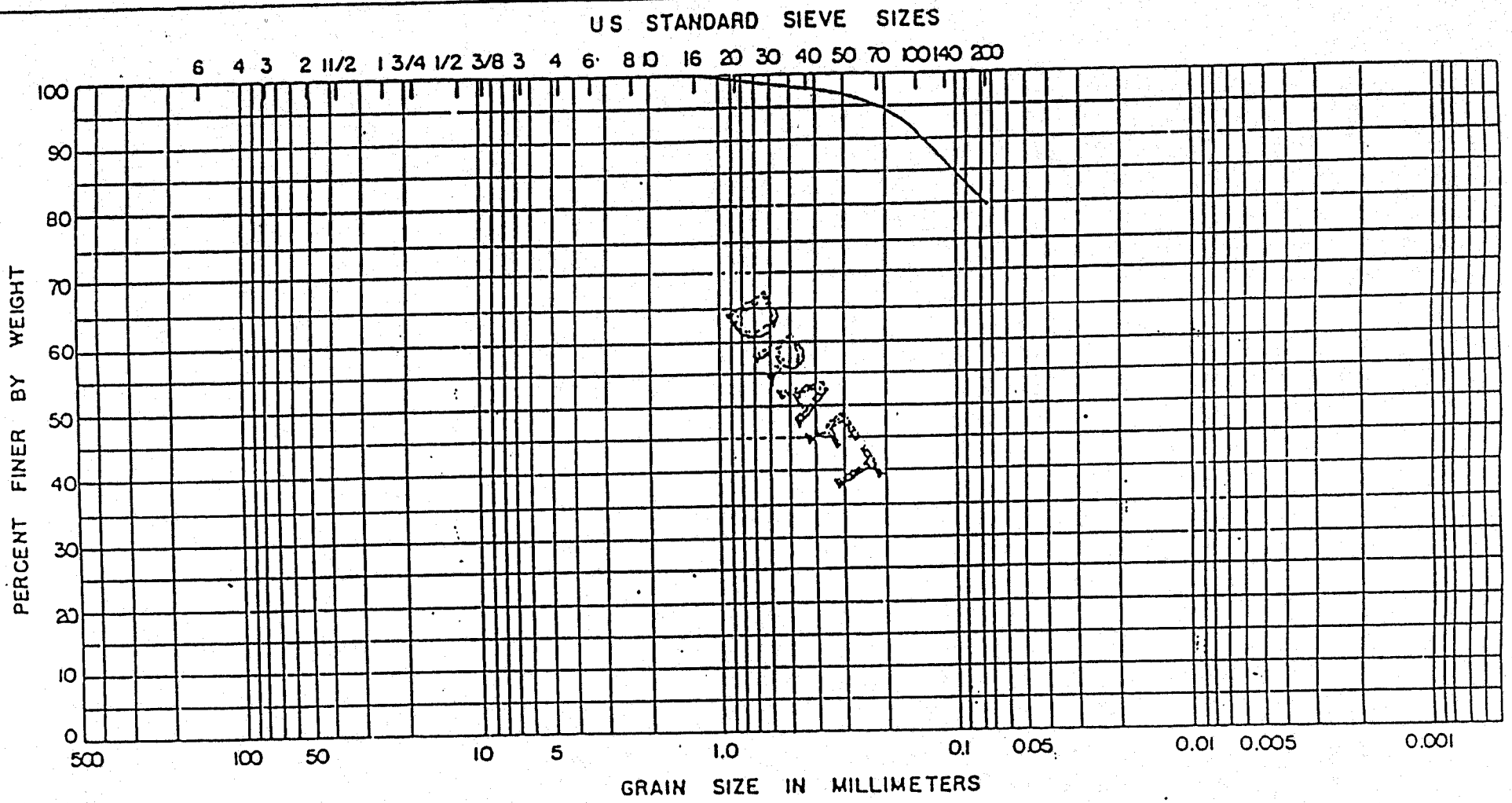
APPENDIX C

GRAIN SIZE DISTRIBUTION CURVES



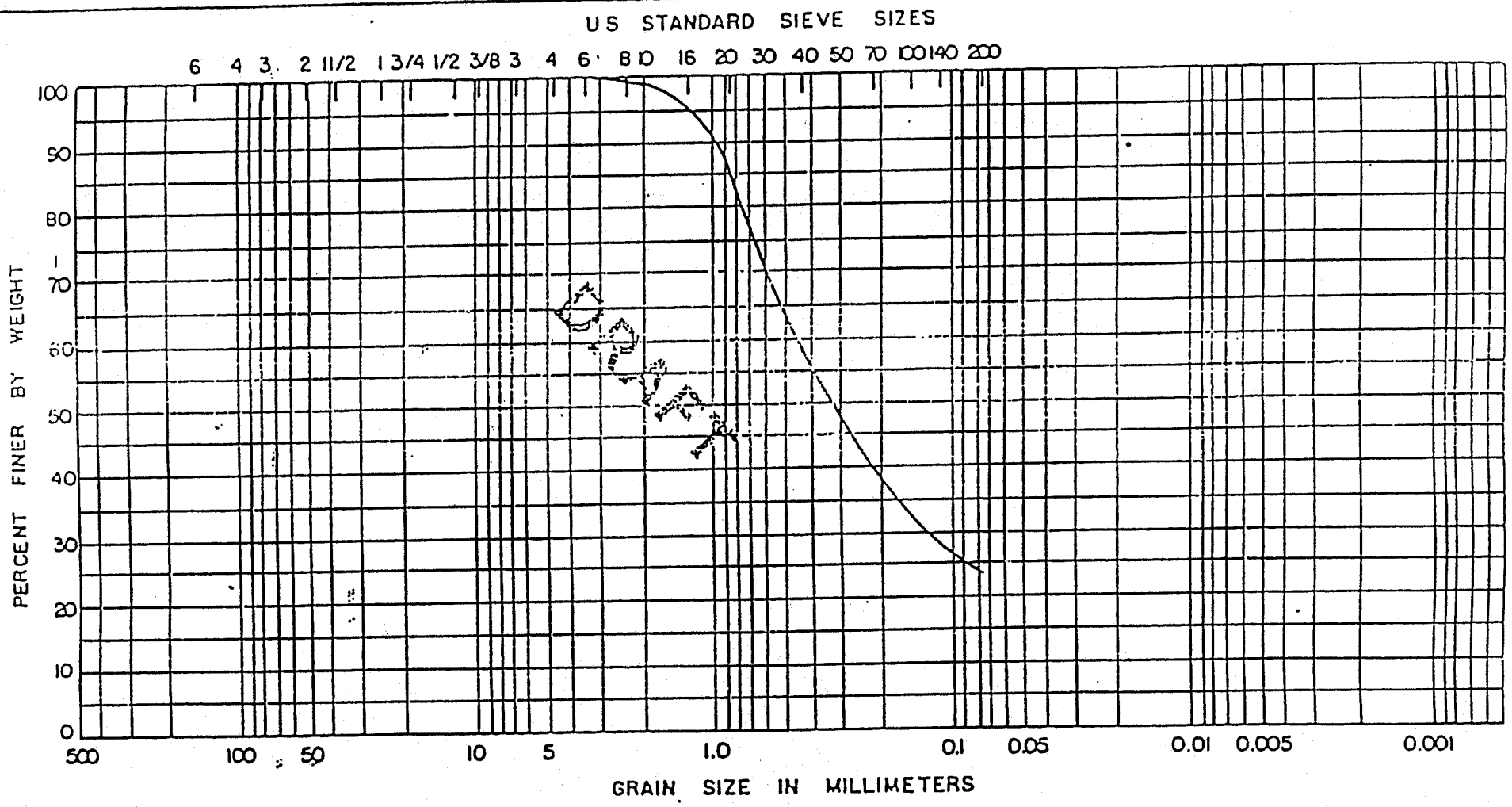
BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	CLASSIFICATION
W-1B	28.5'-30.0'					UNIT 1A Grayish, Slightly Sandy CLAY

GRAIN SIZE DISTRIBUTION

JOB NO. 4482-129

SOIL & MATERIAL ENGINEERS, INC.



BOULDERS	COBBLES	GRAVEL		SAND			FINES	
		COARSE	FINE	COARSE	MEDIUM	FINE	SILT SIZES	CLAY SIZES

BORING NO.	ELEV. OR DEPTH	NAT WC	LL	PL	PI	CLASSIFICATION
E-1	18.5'-20.0'					UNIT IB Grayish, Silty SAND

GRAIN SIZE DISTRIBUTION

JOB NO. 4482-129

SOIL & MATERIAL ENGINEERS, INC.

ENWRIGHT LABORATORIES, INC.
A subsidiary of ENWRIGHT ASSOCIATES, INC.

CLIENT: J.E. Sirrine

PROJECT: Singer - Lenoir

DATE RECEIVED: 10/20/82

AMENDED REPORT

ANALYSES COMPLETED: 11/30/82

DATE REPORTED: 12/7/82

Lab # / Sample ID	11660 Test Hole #1 (W-1B)	11661 Test Hole #2 (N-1)	11662 Test Hole #3 (E-1)	11663 Test Hole #4 (S-1)
Antimony	<1.0	<1.0	<1.0	<1.0
Arsenic	<1.0	93	<1.0	<1.0
Beryllium	1.7	56	<0.5	2.6
Cadmium	0.6	6.8	<0.1	0.9
Chromium	20	400	<1.0	2.3
Copper	30	650	<1.0	100
Lead	14	600	<1.0	10
Mercury	<0.2	<0.2	<0.2	<0.2
Nickel	<40	230	<40	<40
Selenium	<3.0	<3.0	<3.0	<3.0
Silver	<0.1	<0.1	<0.1	<0.1
Thallium	<1.0	<1.0	<1.0	<1.0
Zinc	70	1100	<10	130
Barium	900	6100	200	1100
Phenol, mg/l	<0.002	<0.002	<0.002	<0.002
Cyanide, mg/l	<0.02	<0.02	<0.02	<0.02
pH, units	7.1	6.5	6.7	6.9
Specific Conductance, µmhos	140	360	170	130
Dissolved Organic Carbon, mg/l	10	31	18	1
Chloride, mg/l	2	17	4	4
Nitrate, mg/l	2.0	0.9	1.0	0.4
Sulfate, mg/l	13	30	13	13

All results are reported in µg/l unless otherwise specifed.

Analytical methods used are those approved by the U.S. Environmental Protection Agency for NPDES monitoring, unless otherwise specified.

Respectfully submitted,

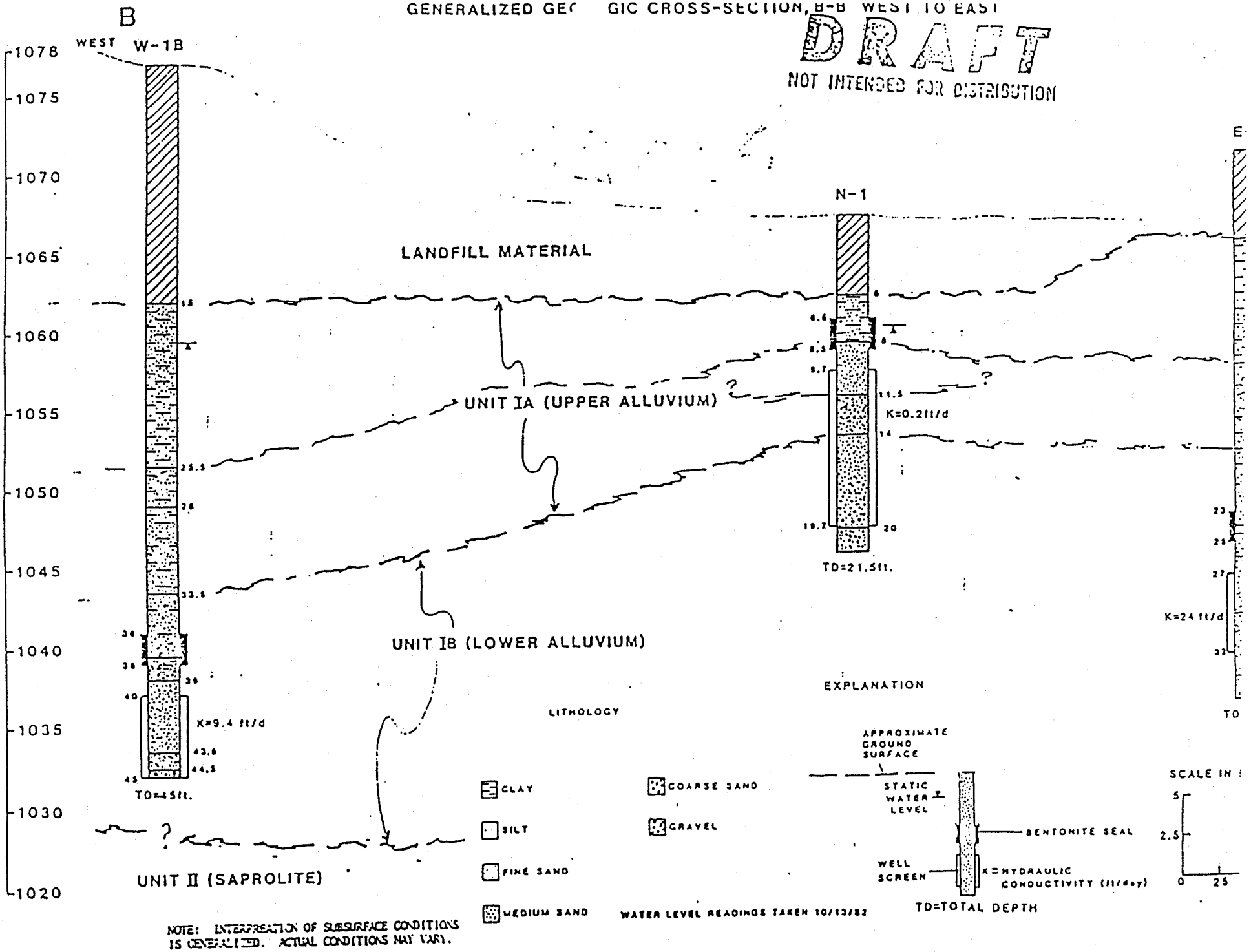
Sam W. Avery, Jr.
Analytical Department Head

SWA/pw

104 Tower Drive Greenville, South Carolina 29607 (803) 235-0707

GENERALIZED GEOLOGIC CROSS-SECTION, B-B' WEST TO EAST

DRAFT
NOT INTENDED FOR DISTRIBUTION



NOTE: INTERPRETATION OF SUBSURFACE CONDITIONS IS GENERALIZED. ACTUAL CONDITIONS MAY VARY.

CEIVED: 10/21/82

RESULTS BY SAMPLE

PLE ID TH-2 FRACTION 02A. TEST CODE BPEST NAME Pesticide Compounds

DATA FILE 4U10039BP02
NC. FACTOR _____

DATE EXTRACTED 10/25/82
DATE INJECTED 11/08/82

ANALYST VL

VERIFIED BY RS
COMPOUNDS DETECTED 0

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1P	89P	aldrin	ND	2P	102P	alpha BHC	ND
10P	90P	dieldrin	ND	3P	103P	beta BHC	ND
6P	91P	chlordane	ND	4P	104P	Lindane - gamma BHC	ND
7P	92P	4,4'-DDT	ND	5P	105P	delta BHC	ND
8P	93P	4,4'-DDE	ND	18P	106P	PCB-1242	ND
9P	94P	4,4'-DDD	ND	19P	107P	PCB-1254	ND
11P	95P	alpha endosulfan	ND	20P	108P	PCB-1221	ND
12P	96P	beta endosulfan	ND	21P	109P	PCB-1232	NI
14P	97P	endosulfan sulfate	ND	22P	110P	PCB-1248	NI
14P	98P	endrin	ND	23P	111P	PCB-1260	NI
15P	99P	endrin aldehyde	ND	24P	112P	PCB-1016	NI
16P	100P	heptachlor	ND	25P	113P	toxaphene	NI
17P	101P	heptachlor epoxide	ND			methoxychlor	N

AMPLE ID TH-2 FRACTION 02A TEST CODE BPEST NAME Pesticide Compounds

ie following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN CODE	COMPOUND	RESULT
1615 IS1P	d10-phenanthrene	10

OTES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
Methoxychlor is routinely searched in all Pesticide scans.
It is not a priority pollutant.
UTD = Unable to determine due to interference from unresolved components.

PLE ID TH-2 FRACTION 02B TEST CODE VOA NAME Volatile Compounds

DATA FILE 4U10039V02R DATE INJECTED 10/25/82 ANALYST VL VERIFIED BY RS

C. FACTOR _____ COMPOUNDS DETECTED 2

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1V	2V	acrolein	ND	17V	32V	1,2-dichloropropane	ND
2V	3V	acrylonitrile	ND	18V	33V	1,3-dichloropropylene	ND
3V	4V	benzene	ND	19V 427	38V	ethylbenzene	55
6V	6V	carbon tetrachloride	ND	22V	44V	methylene chloride	ND
7V	7V	chlorobenzene	ND	21V	45V	methyl chloride	ND
15V	10V	1,2-dichloroethane	ND	20V	46V	methyl bromide	ND
27V	11V	1,1,1-trichloroethane	ND	5V	47V	bromoform	ND
14V	13V	1,1-dichloroethane	ND	12V	48V	dichlorobromomethane	ND
28V	14V	1,1,2-trichloroethane	ND	30V	49V	trichlorofluoromethane	ND
23V	15V	1,1,2,2-tetrachloroethane	ND	13V	50V	dichlorodifluoromethane	ND
9V	16V	chloroethane	ND	8V	51V	chlorodibromomethane	ND
4V	17V	bis (chloromethyl) ether	ND	24V	85V	tetrachloroethylene	ND
10V	19V	2-chloroethylvinyl ether	ND	25V 358	86V	toluene	166
11V	23V	chloroform	ND	29V	87V	trichloroethylene	ND
16V	29V	1,1-dichloroethylene	ND	31V	88V	vinyl chloride	ND
26V	30V	1,2-trans-dichloroethylene	ND				

MPLE ID TH-2 FRACTION 02B TEST CODE VOA NAME Volatile Compounds

e following are results for inter-laboratory QA/QC for EPA Method 624.

SCAN	CODE	COMPOUND	RESULT
89	IS1V	bromochloromethane	40
245	IS2V	2-bromo-1-chloropropane	40
327	IS3V	1,4-dichlorobutane	40
129	S1V	d4-1,2-dichloroethane	87 %
354	S2V	d8-toluene	92 %
421	S3V	d10-ethylbenzene	79 %

TES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 624, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

CEIVED. [illegible]21/82 RESULTS BY SAMPLE

MPLE ID TH-3 (E-1) FRACTION 03A TEST CODE ACID NAME Acid Compounds

DATA FILE 3U10039A03 DATE EXTRACTED 10/26/82 ANALYST RS VERIFIED BY RS
INC. FACTOR _____ DATE INJECTED 11/18/82 COMPOUNDS DETECTED 0

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
11A	21A	2,4,6-trichlorophenol	ND	7A	58A	4-nitrophenol	ND
8A	22A	p-chloro-m-cresol	ND	5A	59A	2,4-dinitrophenol	ND
1A	24A	2-chlorophenol	ND	4A	60A	4,6-dinitro-o-cresol	ND
2A	31A	2,4-dichlorophenol	ND	9A	64A	pentachlorophenol	ND
3A	34A	2,4-dimethylphenol	ND	10A	65A	phenol	ND
6A	57A	2-nitrophenol	ND				

ie following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1052	IS1A	d10-phenanthrene	10
572	S1A	d4-2-nitrophenol	62 %
430	S2A	d5-phenol	49 %

OTES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

MPLE ID TH-3 FRACTION 03A TEST CODE BASE NAME Base Neutral Compounds

DATA FILE 4U10039BP03 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
NC. FACTOR _____ DATE INJECTED 11/08/82 COMPOUNDS DETECTED 0

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1B	1B	acenaphthene	ND	41B	61B	N-nitrosodimethylamine	ND
4B	5B	benzidine	ND	43B	62B	N-nitrosodiphenylamine	ND
46B	8B	1,2,4-trichlorobenzene	ND	42B	63B	N-nitrosodi-n-propylamine	ND
33B	9B	hexachlorobenzene	ND	13B	66B	bis(2-ethylhexyl)phthalate	ND
36B	12B	hexachloroethane	ND	15B	67B	butyl benzyl phthalate	ND
11B	18B	bis(2-chloroethyl)ether	ND	26B	68B	di-n-butyl phthalate	ND
16B	20B	2-chloronaphthalene	ND	29B	69B	di-n-octyl phthalate	ND
20B	25B	1,2-dichlorobenzene	ND	24B	70B	diethyl phthalate	ND
21B	26B	1,3-dichlorobenzene	ND	25B	71B	dimethyl phthalate	ND
22B	27B	1,4-dichlorobenzene	ND	5B	72B	benzo(a)anthracene	ND
23B	28B	3,3'dichlorobenzidine	ND	6B	73B	benzo(a)pyrene	ND
27B	35B	2,4-dinitrotoluene	ND	7B	74B	3,4-benzofluoranthene	ND
28B	36B	2,6-dinitrotoluene	ND	9B	75B	benzo(k)fluoranthene	ND
29B	37B	1,2-diphenyhydrazine	ND	18B	76B	chrysene	ND
31B	39B	fluoranthene	ND	2B	77B	acenaphthylene	ND
17B	40B	4-chlorophenyl phenyl ether	ND	3B	78B	anthracene	ND
14B	41B	4-bromophenyl phenyl ether	ND	8B	79B	benzo(ghi)perylene	ND

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CEIVED: 10/21/82 RESULTS BY SAMPLE CONTINUED FROM ABOVE

MPLE ID TH-3 FRACTION 03A TEST CODE BASE NAME Base Neutral Compounds

12B	42B	bis(2-chloroisopropyl)ether	ND	32B	80B	fluorene	ND
10B	43B	bis(2-chloroethoxy)methane	ND	44B	81B	phenanthrene	ND
34B	52B	hexachlorobutadiene	ND	19B	82B	dibenzo(a,h)anthracene	ND
35B	53B	hexachlorocyclopentadiene	ND	37B	83B	indeno(1,2,3-cd)pyrene	ND
38B	54B	isophorone	ND	45B	84B	pyrene	ND
39B	55B	naphthalene	ND		129B	dioxin	ND
40B	56B	nitrobenzene	ND				

ie following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1620	IS1B	d10-phenanthrene	10
851	S1B	d5-2-nitrobenzene	40 %
968	S2B	d8-naphthalene	61 %
1420	S3B	d10-fluorene	65 %
2161	S4B	d12-chrysene	78 %

OTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

CEIVED: 10/21/82 RESULTS BY SAMPLE

MPLE ID TH-3 FRACTION 03A TEST CODE BPEST NAME Pesticide Compounds

DATA FILE 4U10039BP03 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
NC. FACTOR _____ DATE INJECTED 11/08/82 COMPOUNDS DETECTED 0

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1P	89P	aldrin	ND	2P	102P	alpha BHC	ND
10P	90P	dieldrin	ND	3P	103P	beta BHC	ND
6P	91P	chlordane	ND	4P	104P	Lindane - gamma BHC	ND
7P	92P	4,4'-DDT	ND	5P	105P	delta BHC	ND
8P	93P	4,4'-DDE	ND	18P	106P	PCB-1242	ND
9P	94P	4,4'-DDD	ND	19P	107P	PCB-1254	ND
11P	95P	alpha endosulfan	ND	20P	108P	PCB-1221	ND
12P	96P	beta endosulfan	ND	21P	109P	PCB-1232	ND
14P	97P	endosulfan sulfate	ND	22P	110P	PCB-1248	ND
14P	98P	endrin	ND	23P	111P	PCB-1260	ND
15P	99P	endrin aldehyde	ND	24P	112P	PCB-1016	ND
16P	100P	heptachlor	ND	25P	113P	toxaphene	ND
17P	101P	heptachlor epoxide	ND			methoxychlor	ND

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IVED: 10/21/82

SPECIMIA REPORT
RESULTS BY SAMPLE

LAB # 82-10-037
CONTINUED FROM ABO

LE ID TH-3 FRACTION 03A TEST CODE BPEST NAME Pesticide Compounds

following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN CODE	COMPOUND	RESULT
1620 IS1P	d10-phenanthrene	10

ES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
Methoxychlor is routinely searched in all Pesticide scans.
It is not a priority pollutant.
UTD = Unable to determine due to interference from unresolved components.

SAMPLE ID TH-3 FRACTION 03B TEST CODE VOA NAME Volatile Compounds

DATA FILE 4U10039V03 DATE INJECTED 10/23/82 ANALYST VL VERIFIED BY RS

CONC. FACTOR _____ COMPOUNDS DETECTED 1

NPDES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1V	2V	acrolein	ND	17V	32V	1,2-dichloropropane	ND
2V	3V	acrylonitrile	ND	18V	33V	1,3-dichloropropylene	ND
3V	4V	benzene	ND	19V	38V	ethylbenzene	ND
6V	6V	carbon tetrachloride	ND	22V 62	44V	methylene chloride	30
7V	7V	chlorobenzene	ND	21V	45V	methyl chloride	ND
15V	10V	1,2-dichloroethane	ND	20V	46V	methyl bromide	ND
27V	11V	1,1,1-trichloroethane	ND	5V	47V	bromoform	ND
14V	13V	1,1-dichloroethane	ND	12V	48V	dichlorobromomethane	ND
28V	14V	1,1,2-trichloroethane	ND	30V	49V	trichlorofluoromethane	ND
23V	15V	1,1,2,2-tetrachloroethane	ND	13V	50V	dichlorodifluoromethane	ND
9V	16V	chloroethane	ND	8V	51V	chlorodibromomethane	ND
4V	17V	bis (chloromethyl) ether	ND	24V	85V	tetrachloroethylene	ND
10V	19V	2-chloroethylvinyl ether	ND	25V	86V	toluene	ND
11V	23V	chloroform	ND	29V	87V	trichloroethylene	ND
16V	29V	1,1-dichloroethylene	ND	31V	88V	vinyl chloride	ND
26V	30V	1,2-trans-dichloroethylene	ND				

:EIVED: 10/21/82

RESULTS BY SAMPLE

CONTINUED FROM ABOVE

:PLE ID TH-3

FRACTION 03B TEST CODE VOA NAME Volatile Compounds

e following are results for inter-laboratory QA/QC for EPA Method 624.

SCAN	CODE	COMPOUND	RESULT
91	IS1V.	bromochloromethane	40
247	IS2V	2-bromo-1-chloropropane	40
329	IS3V	1,4-dichlorobutane	40
131	S1V	d4-1,2-dichloroethane	110 %
356	S2V	dB-toluene	94 %
424	S3V	d10-ethylbenzene	95 %

OTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 624, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

MPLE ID TH-4 (S-1) FRACTION 04A TEST CODE ACID NAME Acid Compounds

DATA FILE 3U10039A04 DATE EXTRACTED 10/02/82 ANALYST RS VERIFIED BY RS
NC. FACTOR _____ DATE INJECTED 11/18/82 COMPOUNDS DETECTED 0

DES	SCAN	EPA	COMPOUND	RESULT	NPDES	SCAN	EPA	COMPOUND	RESULT
11A		21A	2,4,6-trichlorophenol	ND	7A		58A	4-nitrophenol	ND
8A		22A	p-chloro-m-cresol	ND	5A		59A	2,4-dinitrophenol	ND
1A		24A	2-chlorophenol	ND	4A		60A	4,6-dinitro-o-cresol	ND
2A		31A	2,4-dichlorophenol	ND	9A		64A	pentachlorophenol	ND
3A		34A	2,4-dimethylphenol	ND	10A		65A	phenol	ND
6A		57A	2-nitrophenol	ND					

e following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1047	IS1A	d10-phenanthrene	10
568	S1A	d4-2-nitrophenol	36 %
426	S2A	d5-phenol	17 %

TES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

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EIVED: 10/21/82

SPECTRIX REPORT
RESULTS BY SAMPLE

LAB # 82-10-039

PLE ID TH-4 FRACTION 04A TEST CODE BASE NAME Base Neutral Compounds

DATA FILE 4U10039BP04 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
C. FACTOR _____ DATE INJECTED 11/09/82 COMPOUNDS DETECTED 0

ES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1B	1B	acenaphthene	ND	41B	61B	N-nitrosodimethylamine	ND
4B	5B	benzidine	ND	43B	62B	N-nitrosodiphenylamine	ND
6B	8B	1,2,4-trichlorobenzene	ND	42B	63B	N-nitrosodi-n-propylamine	ND
3B	9B	hexachlorobenzene	ND	13B	66B	bis(2-ethylhexyl)phthalate	ND
6B	12B	hexachloroethane	ND	15B	67B	butyl benzyl phthalate	ND
1B	18B	bis(2-chloroethyl)ether	ND	26B	68B	di-n-butyl phthalate	ND
6B	20B	2-chloronaphthalene	ND	29B	69B	di-n-octyl phthalate	ND
0B	25B	1,2-dichlorobenzene	ND	24B	70B	diethyl phthalate	ND
1B	26B	1,3-dichlorobenzene	ND	25B	71B	dimethyl phthalate	ND
2B	27B	1,4-dichlorobenzene	ND	5B	72B	benzo(a)anthracene	ND
3B	28B	3,3'dichlorobenzidine	ND	6B	73B	benzo(a)pyrene	ND
7B	35B	2,4-dinitrotoluene	ND	7B	74B	3,4-benzofluoranthene	ND
8B	36B	2,6-dinitrotoluene	ND	9B	75B	benzo(k)fluoranthene	ND
9B	37B	1,2-diphenyhydrazine	ND	18B	76B	chrysene	ND
1B	39B	fluoranthene	ND	2B	77B	acenaphthylene	ND
7B	40B	4-chlorophenyl phenyl ether	ND	3B	78B	anthracene	ND
4B	41B	4-bromophenyl phenyl ether	ND	8B	79B	benzo(ghi)perylene	ND

SAMPLE ID 4 FRACTION 04A TEST CODE BASE NAME Base Neutral Compounds

12B	42B	bis(2-chloroisopropyl)ether	ND	32B	80B	fluorene	ND
10B	43B	bis(2-chloroethoxy)methane	ND	44B	81B	phenanthrene	ND
34B	52B	hexachlorobutadiene	ND	19B	82B	dibenzo(a,h)anthracene	ND
35B	53B	hexachlorocyclopentadiene	ND	37B	83B	indeno(1,2,3-cd)pyrene	ND
38B	54B	isophorone	ND	45B	84B	pyrene	ND
39B	55B	naphthalene	ND		129B	dioxin	ND
40B	56B	nitrobenzene	ND				

The following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1620	IS1B	d10-phenanthrene	10
845	S1B	d5-2-nitrobenzene	23 %
970	S2B	d8-naphthalene	46 %
1425	S3B	d10-fluorene	61 %
2178	S4B	d12-chrysene	62 %

NOTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

:CEIVED. /21/82 RESULTS SUMMARY

:MPLE ID TH-4 FRACTION 04A TEST CODE BPEST NAME Pesticide Compounds

DATA FILE 4U10039BP04 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
)NC. FACTOR _____ DATE INJECTED 11/09/82 COMPOUNDS DETECTED 0

PDES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1P	89P	aldrin	ND	2P	102P	alpha BHC	ND
10P	90P	dieldrin	ND	3P	103P	beta BHC	ND
6P	91P	chlordane	ND	4P	104P	Lindane - gamma BHC	ND
7P	92P	4,4'-DDT	ND	5P	105P	delta BHC	ND
8P	93P	4,4'-DDE	ND	18P	106P	PCB-1242	ND
9P	94P	4,4'-DDD	ND	19P	107P	PCB-1254	ND
11P	95P	alpha endosulfan	ND	20P	108P	PCB-1221	ND
12P	96P	beta endosulfan	ND	21P	109P	PCB-1232	ND
14P	97P	endosulfan sulfate	ND	22P	110P	PCB-1248	ND
14P	98P	endrin	ND	23P	111P	PCB-1260	ND
15P	99P	endrin aldehyde	ND	24P	112P	PCB-1016	ND
16P	100P	heptachlor	ND	25P	113P	toxaphene	ND
17P	101P	heptachlor epoxide	ND			methoxychlor	ND

MPLE ID TH-4 FRACTION 04A TEST CODE BPEST NAME Pesticide Compounds

e following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN CODE	COMPOUND	RESULT
1620 IS1P	d10-phenanthrene	10

TES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
Methoxychlor is routinely searched in all Pesticide scans.
It is not a priority pollutant.
UTD = Unable to determine due to interference from unresolved components.

AMPLE ID TH-4 FRACTION 04B TEST CODE VOA NAME Volatile Compounds

he following are results for inter-laboratory QA/QC for EPA Method 624.

SCAN	CODE	COMPOUND	RESULT
92	IS1V	bromochloromethane	40
248	IS2V	2-bromo-1-chloropropane	40
330	IS3V	1,4-dichlorobutane	40
132	S1V	d4-1,2-dichloroethane	110 %
357	S2V	d8-toluene	91 %
424	S3V	d10-ethylbenzene	92 %

OTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 624, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

MPLE ID TH-4 FRACTION 04B TEST CODE VOA NAME Volatile Compounds

DATA FILE 4U10039V04 DATE INJECTED 10/23/82 ANALYST VL VERIFIED BY RS
DIL. FACTOR _____ COMPOUNDS DETECTED 0

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1V	2V	acrolein	ND	17V	32V	1,2-dichloropropane	ND
2V	3V	acrylonitrile	ND	18V	33V	1,3-dichloropropylene	ND
3V	4V	benzene	ND	19V	38V	ethylbenzene	ND
6V	6V	carbon tetrachloride	ND	22V	44V	methylene chloride	ND
7V	7V	chlorobenzene	ND	21V	45V	methyl chloride	ND
15V	10V	1,2-dichloroethane	ND	20V	46V	methyl bromide	ND
27V	11V	1,1,1-trichloroethane	ND	5V	47V	bromoform	ND
14V	13V	1,1-dichloroethane	ND	12V	48V	dichlorobromomethane	ND
28V	14V	1,1,2-trichloroethane	ND	30V	49V	trichlorofluoromethane	ND
23V	15V	1,1,2,2-tetrachloroethane	ND	13V	50V	dichlorodifluoromethane	ND
9V	16V	chloroethane	ND	8V	51V	chlorodibromomethane	ND
4V	17V	bis (chloromethyl) ether	ND	24V	85V	tetrachloroethylene	ND
10V	19V	2-chloroethylvinyl ether	ND	25V	86V	toluene	ND
11V	23V	chloroform	ND	29V	87V	trichloroethylene	ND
16V	29V	1,1-dichloroethylene	ND	31V	88V	vinyl chloride	ND
26V	30V	1,2-trans-dichloroethylene	ND				

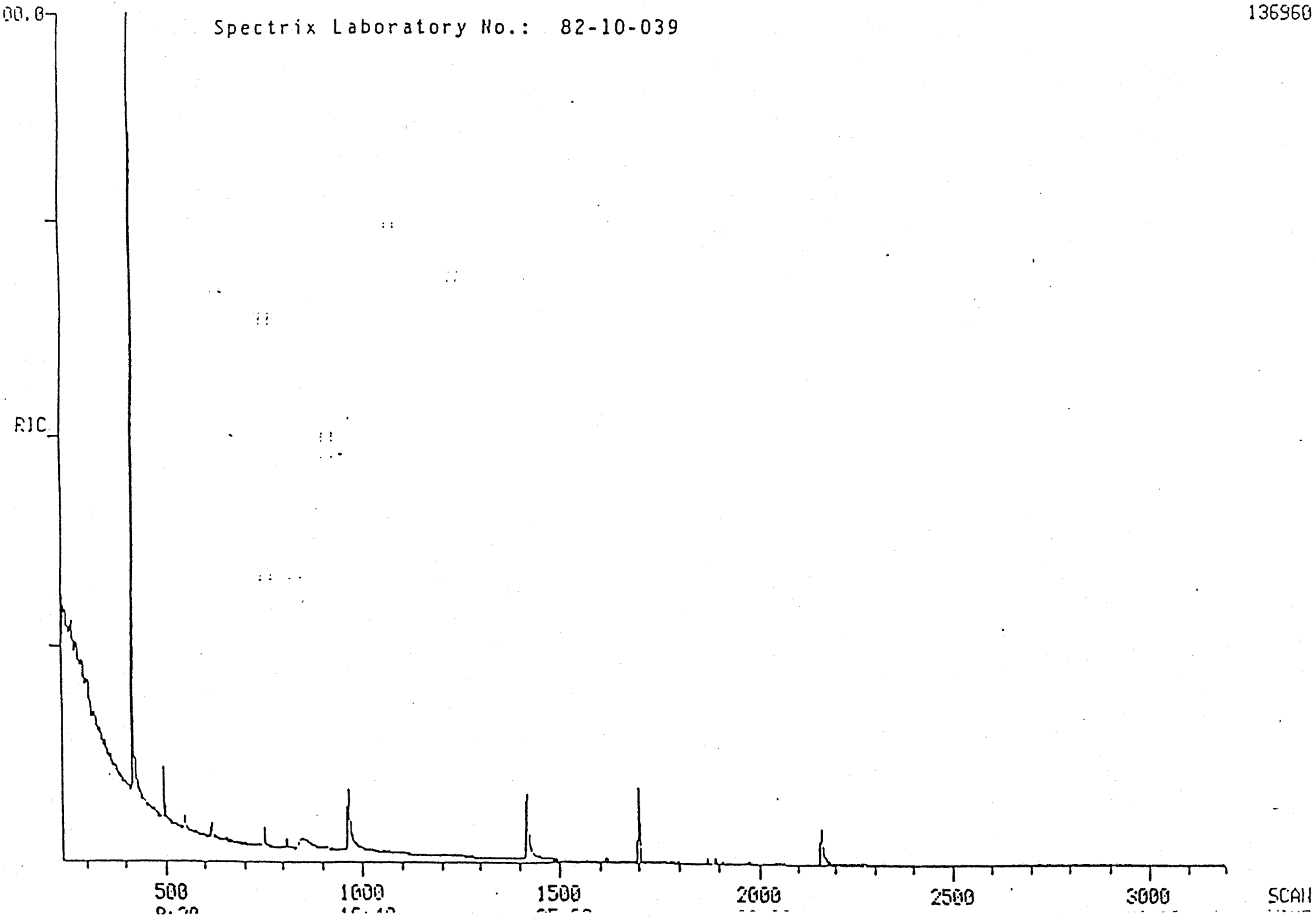
ACTION AND TEST CODES FOR WORK NOT REPORTED ELSEWHERE

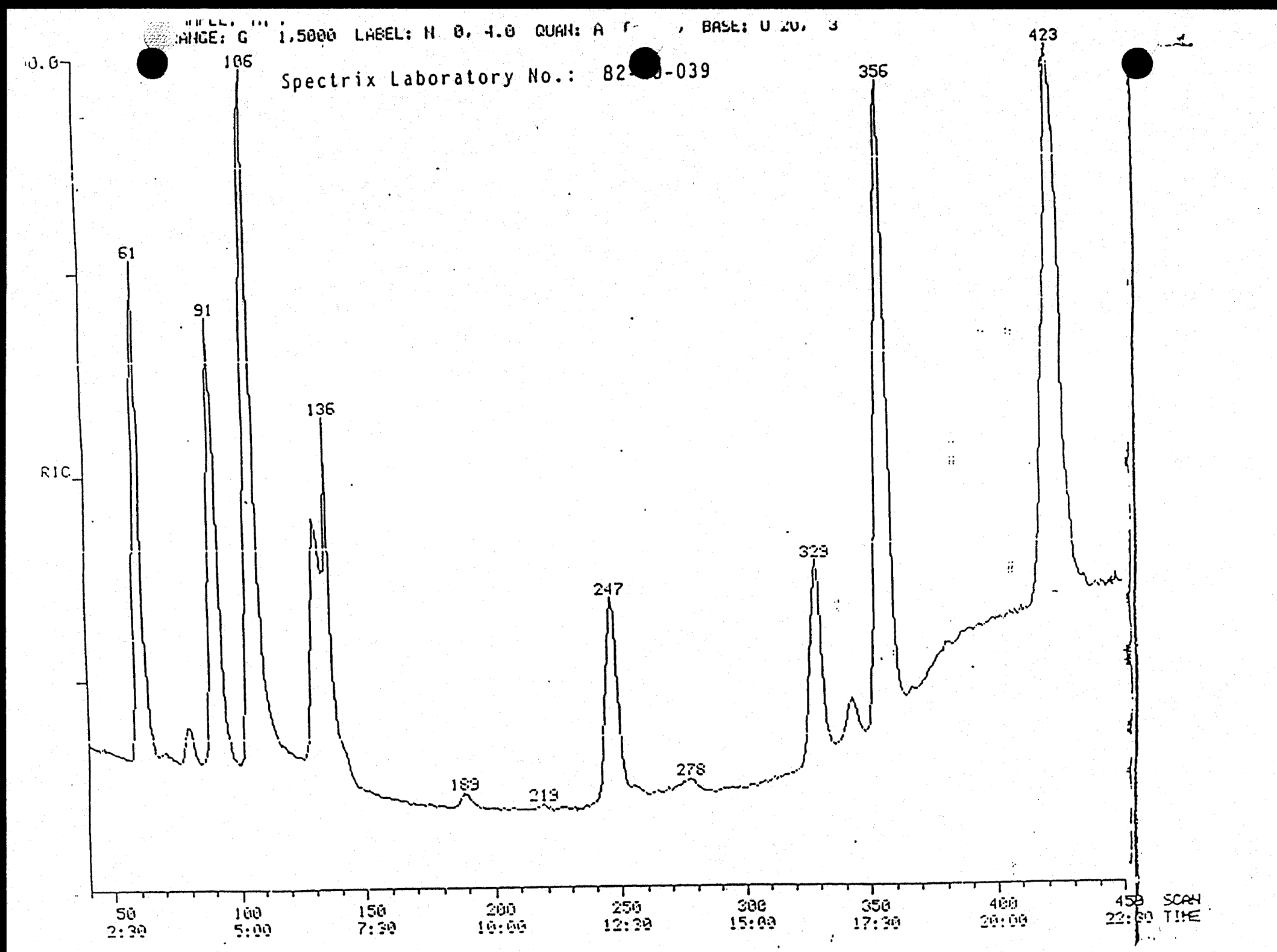
A	EXT			
A	EXT			
A	EXT			
A	EXT	04C	:	GET_PO

RIC
11/08/82 14:43:00
SAMPLE: TH-1
RANGE: G 1,3600 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

DATA: 4U10033BF01 #10
CALI: 4C110882 #3

SCANS 240 200

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BASE: U 20,
Spectrix Laboratory No.: 82 -039
RIC
61
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106
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50
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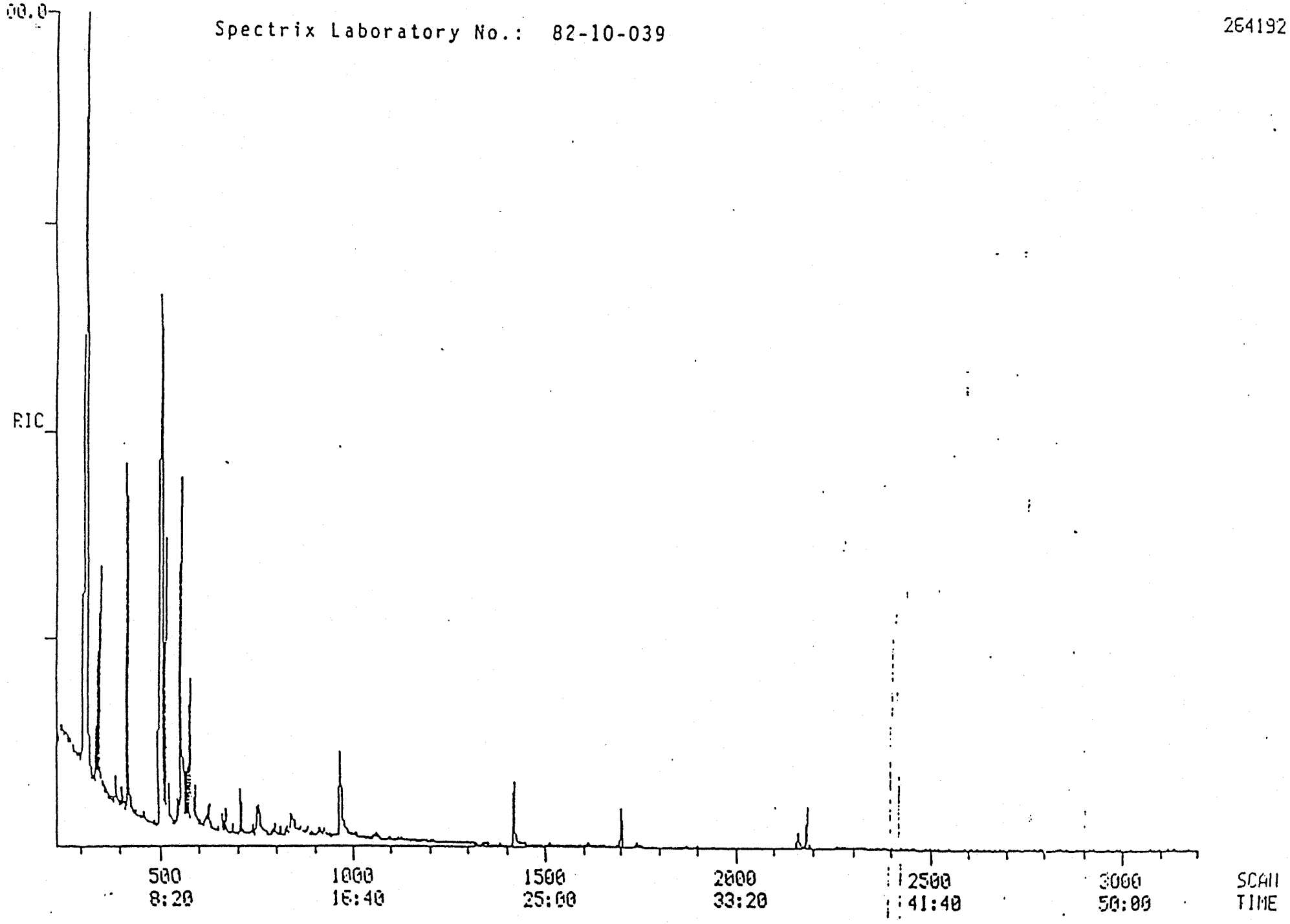
10:00
250
12:30
300
15:00
350
17:30
400
20:00
SCAN
TIME

SAMPLE: TH-2
RANGE: G 1,3600 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

Spectrix Laboratory No.: 82-10-039

264192



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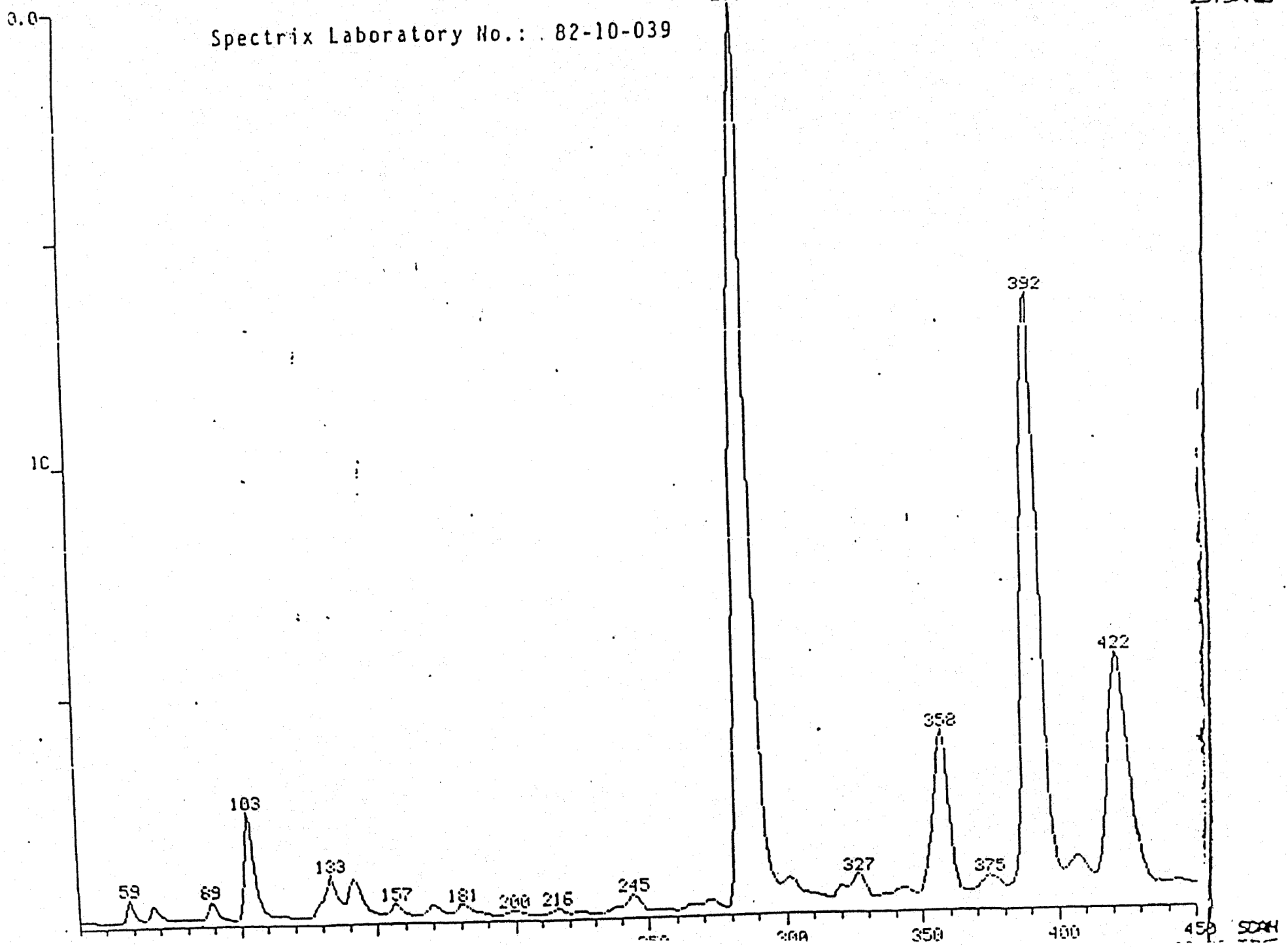
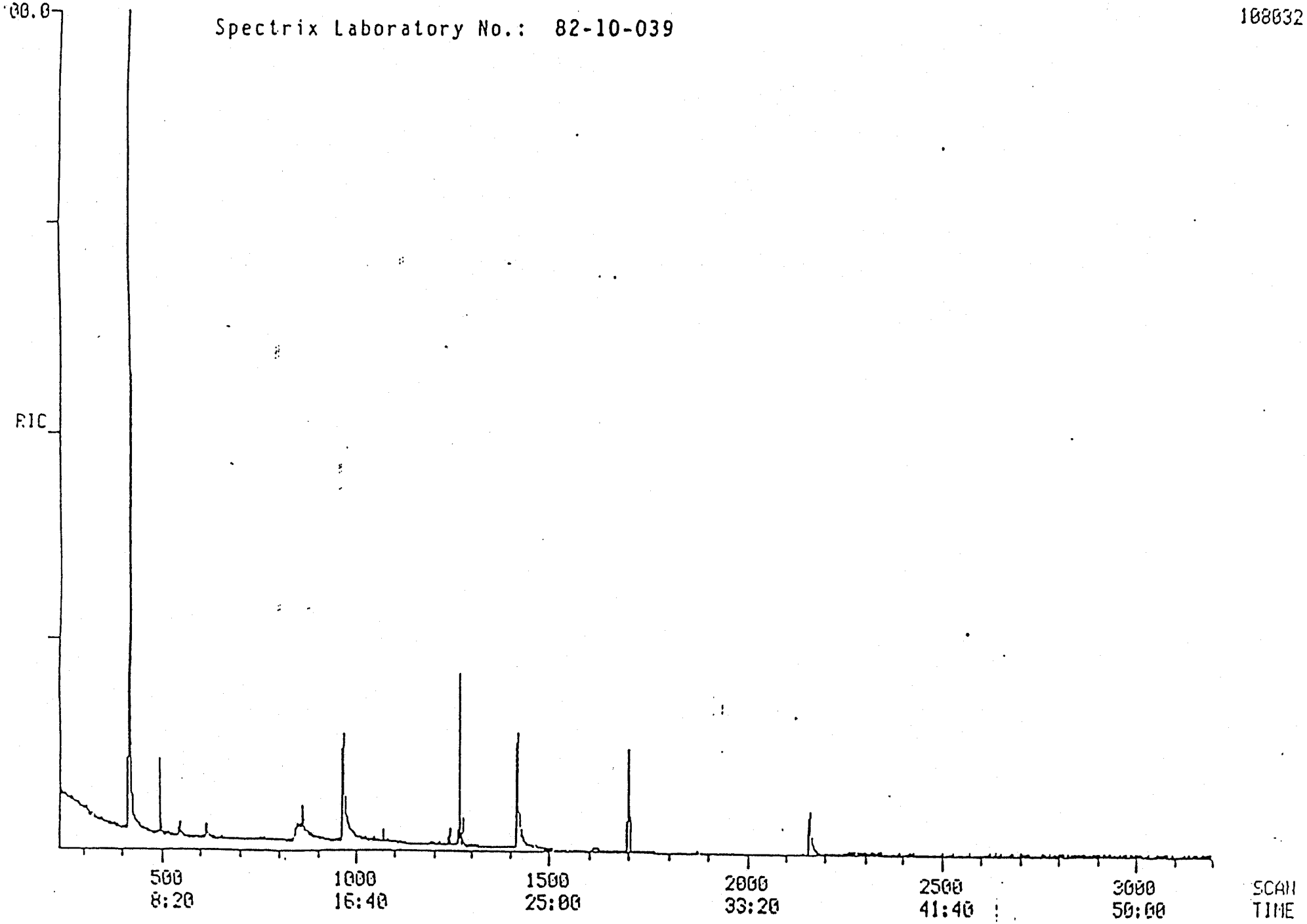
Spectrix Laboratory No.: 82-10-039



SAMPLE: TH-3
RANGE: G 1,3600 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

Spectrix Laboratory No.: 82-10-039

108032



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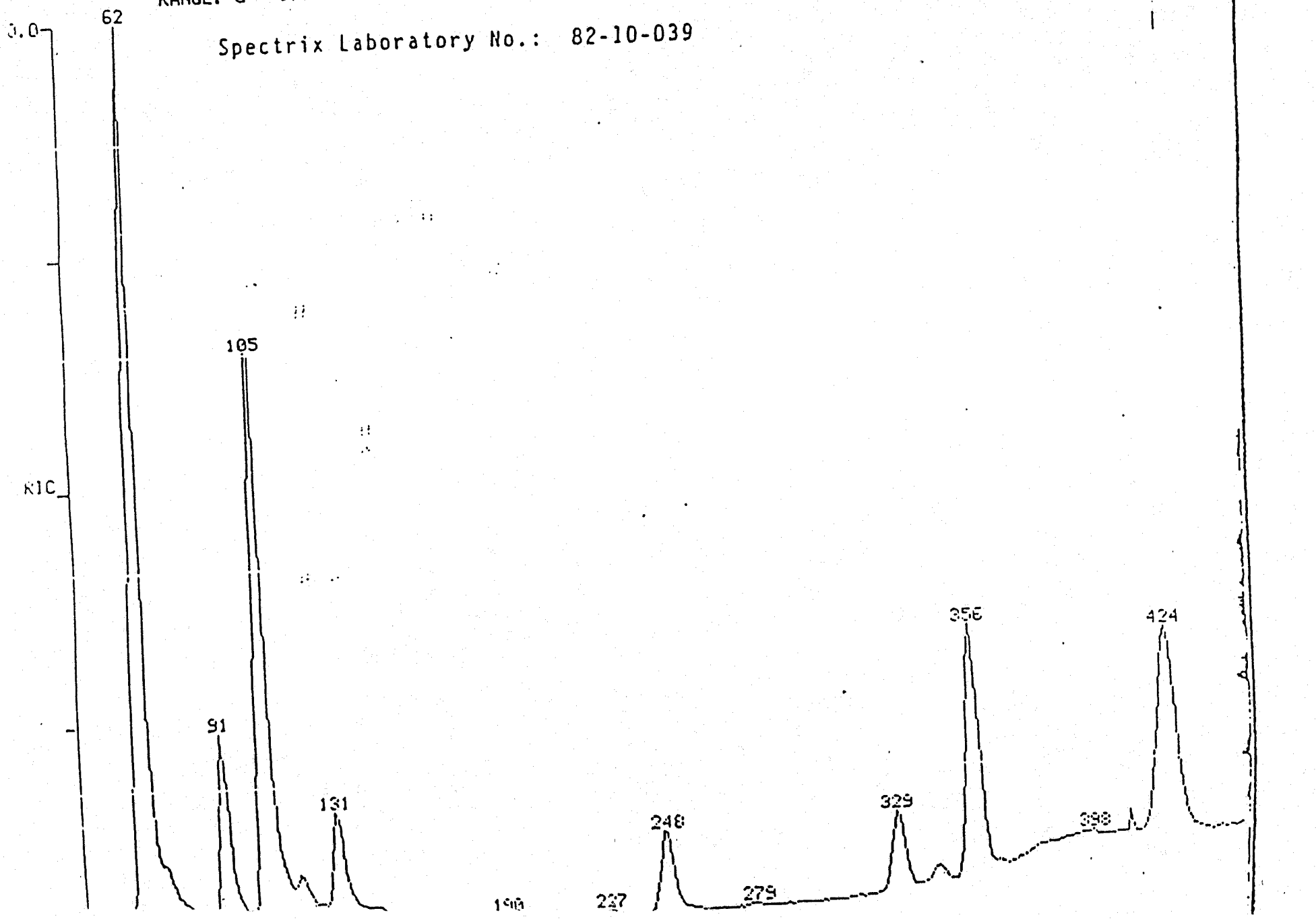
10/23/82 15:52:00
SAMPLE: TH-3
RANGE: G 1,5000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

DATA: 4U16039U03 #1
CALI: 4C102382 #3

SCANS 50 TO 4

Spectrix Laboratory No.: 82-10-039



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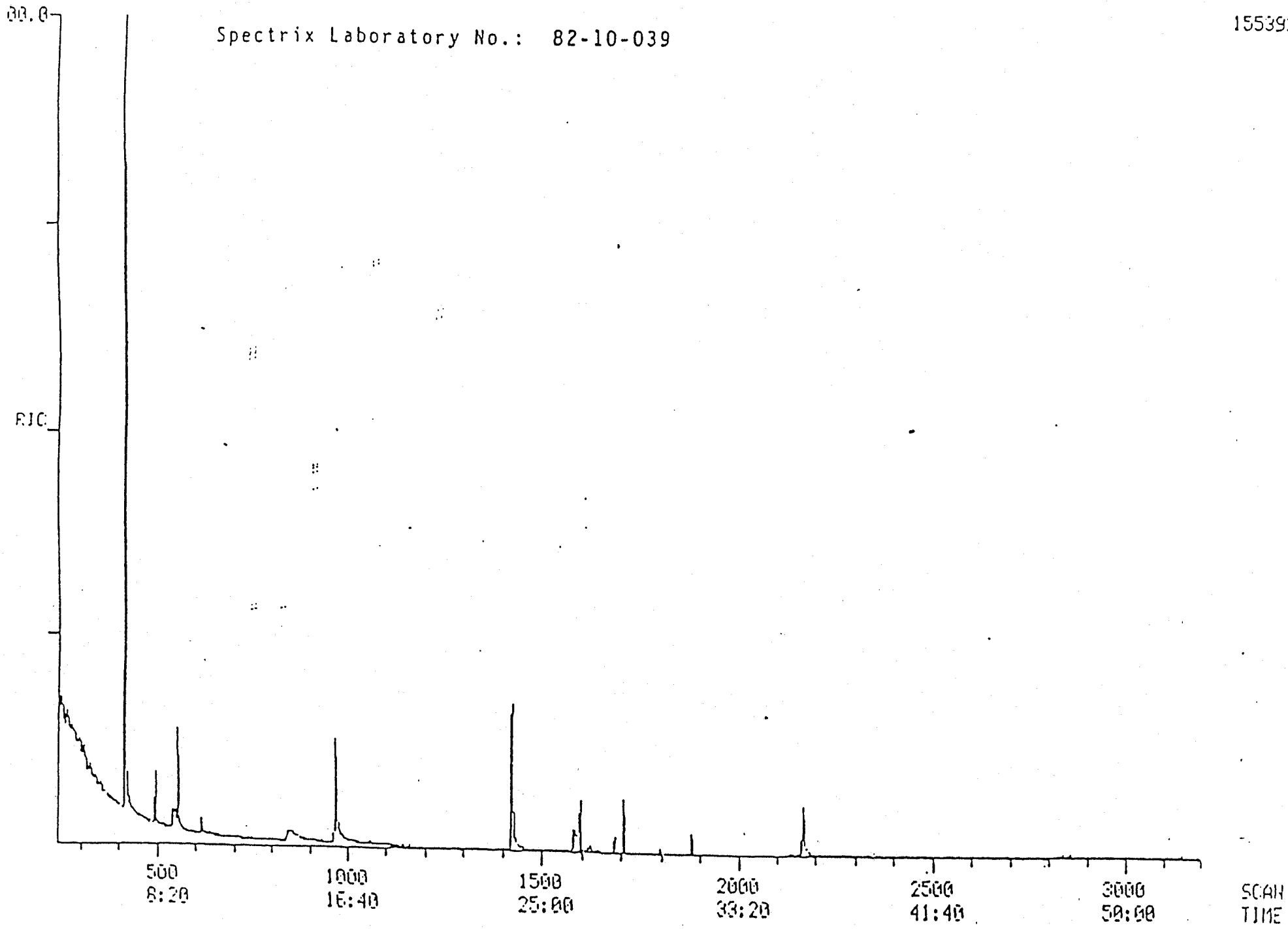
SAMPLE: TH-4
RANGE: G 1,3600 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

155392

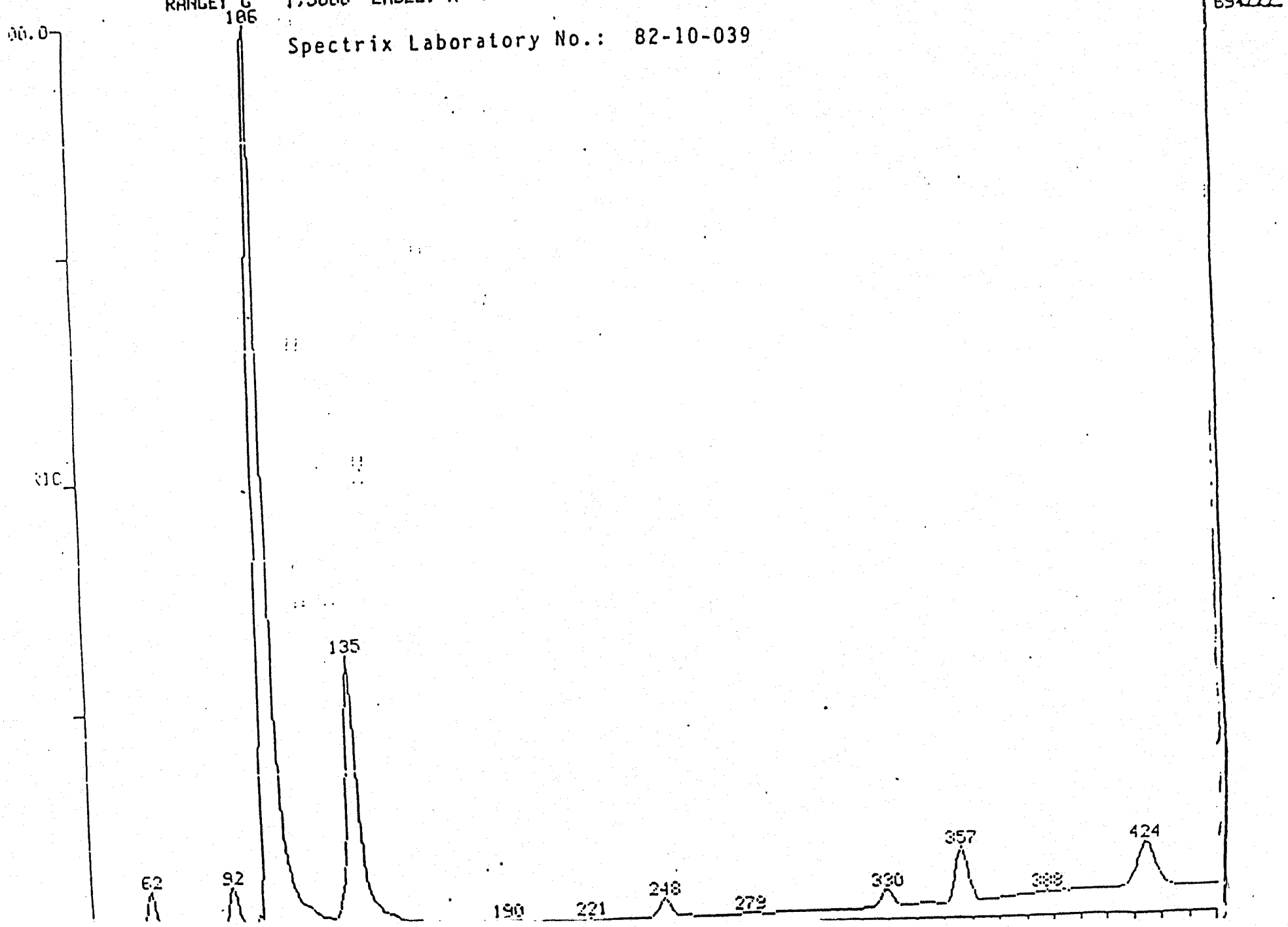
Spectrix Laboratory No.: 82-10-039



CAL1: 4C102382 #3

10/23/82 16:24:00
SAMPLE: TH-4
RANGE: G 1,5000 LABEL: N 0, 4.0 QUAN: A 0, 1.0 BASE: U 20, 3

Spectrix Laboratory No.: 82-10-039



SPECTRIX REPORT

RESULTS BY SAMPLE

LAB # 82-10 037

CEIVED: /21/82

MPLE ID TH-1 (W-1B) FRACTION 01A TEST CODE ACID NAME Acid Compounds

DATA FILE 3U10039A01 DATE EXTRACTED 10/26/82 ANALYST VL VERIFIED BY RS

ONC. FACTOR _____ DATE INJECTED 11/18/82 COMPOUNDS DETECTED 0

PDES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
11A	21A	2,4,6-trichlorophenol	ND	7A	58A	4-nitrophenol	ND
8A	22A	p-chloro-m-cresol	ND	5A	59A	2,4-dinitrophenol	ND
1A	24A	2-chlorophenol	ND	4A	60A	4,6-dinitro-o-cresol	ND
2A	31A	2,4-dichlorophenol	ND	9A	64A	pentachlorophenol	ND
3A	34A	2,4-dimethylphenol	ND	10A	65A	phenol	ND
6A	57A	2-nitrophenol	ND				

he following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1047	IS1A	d10-phenanthrene	10
567	S1A	d4-2-nitrophenol	37 %
425	S2A	d5-phenol	26 %

OTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

PLE ID TH-1 FRACTION 01A TEST CODE BASE NAME Base Neutral Compounds

DATA FILE 4U10039BP01 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
C. FACTOR _____ DATE INJECTED 11/08/82 COMPOUNDS DETECTED 0

ES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1B	1B	acenaphthene	ND	41B	61B	N-nitrosodimethylamine	ND
4B	5B	benzidine	ND	43B	62B	N-nitrosodiphenylamine	ND
16B	8B	1,2,4-trichlorobenzene	ND	42B	63B	N-nitrosodi-n-propylamine	ND
33B	9B	hexachlorobenzene	ND	13B	66B	bis(2-ethylhexyl)phthalate	ND
36B	12B	hexachloroethane	ND	15B	67B	butyl benzyl phthalate	ND
11B	18B	bis(2-chloroethyl)ether	ND	26B	68B	di-n-butyl phthalate	ND
16B	20B	2-chloronaphthalene	ND	29B	69B	di-n-octyl phthalate	ND
20B	25B	1,2-dichlorobenzene	ND	24B	70B	diethyl phthalate	ND
21B	26B	1,3-dichlorobenzene	ND	25B	71B	dimethyl phthalate	ND
22B	27B	1,4-dichlorobenzene	ND	5B	72B	benzo(a)anthracene	ND
23B	28B	3,3'dichlorobenzidine	ND	6B	73B	benzo(a)pyrene	ND
27B	35B	2,4-dinitrotoluene	ND	7B	74B	3,4-benzofluoranthene	ND
28B	36B	2,6-dinitrotoluene	ND	9B	75B	benzo(k)fluoranthene	ND
29B	37B	1,2-diphenyhydrazine	ND	18B	76B	chrysene	ND
31B	39B	fluoranthene	ND	2B	77B	acenaphthylene	ND
17B	40B	4-chlorophenyl phenyl ether	ND	3B	78B	anthracene	ND
14B	41B	4-bromophenyl phenyl ether	ND	8B	79B	benzo(ghi)perylene	ND

IPLE ID TH-1 FRACTION 01A TEST CODE BASE NAME Base Neutral Compounds

12B	42B	bis(2-chloroisopropyl)ether	ND
10B	43B	bis(2-chloroethoxy)methane	ND
34B	52B	hexachlorobutadiene	ND
35B	53B	hexachlorocyclopentadiene	ND
38B	54B	isophorone	ND
39B	55B	naphthalene	ND
40B	56B	nitrobenzene	ND
32B	80B	fluorene	ND
44B	81B	phenanthrene	ND
19B	82B	dibenzo(a,h)anthracene	ND
37B	83B	indeno(1,2,3-cd)pyrene	ND
45B	84B	pyrene	ND
	129B	dioxin	ND

e following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1617	IS1B	d10-phenanthrene	10
852	S1B	d5-2-nitrobenzene	32 %
968	S2B	d8-naphthalene	40 %
1420	S3B	d10-fluorene	49 %
2163	S4B	d12-chrysene	71 %

OTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

SAMPLE ID TH-1 FRACTION 01A TEST CODE BPEST NAME Pesticide Compounds

DATA FILE 4U10039BP01 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
CONC. FACTOR _____ DATE INJECTED 11/08/82 COMPOUNDS DETECTED 0

NPDES	SCAN	EPA	COMPOUND	RESULT	NPDES	SCAN	EPA	COMPOUND	RESULT
1P		89P	aldrin	ND	2P		102P	alpha BHC	ND
10P		90P	dieldrin	ND	3P		103P	beta BHC	ND
6P		91P	chlordane	ND	4P		104P	Lindane - gamma BHC	ND
7P		92P	4,4'-DDT	ND	5P		105P	delta BHC	ND
8P		93P	4,4'-DDE	ND	18P		106P	PCB-1242	ND
9P		94P	4,4'-DDD	ND	19P		107P	PCB-1254	ND
11P		95P	alpha endosulfan	ND	20P		108P	PCB-1221	ND
12P		96P	beta endosulfan	ND	21P		109P	PCB-1232	ND
14P		97P	endosulfan sulfate	ND	22P		110P	PCB-1248	ND
14P		98P	endrin	ND	23P		111P	PCB-1260	ND
15P		99P	endrin aldehyde	ND	24P		112P	PCB-1016	ND
16P		100P	heptachlor	ND	25P		113P	toxaphene	ND
17P		101P	heptachlor epoxide	ND				methoxychlor	ND

E D
EIVED: [redacted]21/82

SPECIFIC REPORT
RESULTS B[redacted]AMPLE

LAB # 82-10-037
CONTINUED FROM A[redacted]VE

PLE ID TH-1 FRACTION 01A TEST CODE BPEST NAME Pesticide Compounds

following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN CODE	COMPOUND	RESULT
1617 IS1P	d10-phenanthrene	10

TES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
Methoxychlor is routinely searched in all Pesticide scans.
It is not a priority pollutant.
UTD = Unable to determine due to interference from unresolved components.

AMPLE ID TH-1 FRACTION 01B TEST CODE VOA NAME Volatile Compounds

DATA FILE 4U10039V01 DATE INJECTED 10/23/82 ANALYST VL VERIFIED BY RS
DNC. FACTOR _____ COMPOUNDS DETECTED 0

PDES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1V	2V	acrolein	ND	17V	32V	1,2-dichloropropane	ND
2V	3V	acrylonitrile	ND	18V	33V	1,3-dichloropropylene	ND
3V	4V	benzene	ND	19V	38V	ethylbenzene	ND
6V	6V	carbon tetrachloride	ND	22V	44V	methylene chloride	ND
7V	7V	chlorobenzene	ND	21V	45V	methyl chloride	ND
15V	10V	1,2-dichloroethane	ND	20V	46V	methyl bromide	ND
27V	11V	1,1,1-trichloroethane	ND	5V	47V	bromoform	ND
14V	13V	1,1-dichloroethane	ND	12V	48V	dichlorobromomethane	ND
28V	14V	1,1,2-trichloroethane	ND	30V	49V	trichlorofluoromethane	ND
23V	15V	1,1,2,2-tetrachloroethane	ND	13V	50V	dichlorodifluoromethane	ND
9V	16V	chloroethane	ND	8V	51V	chlorodibromomethane	ND
4V	17V	bis (chloromethyl) ether	ND	24V	85V	tetrachloroethylene	ND
10V	19V	2-chloroethylvinyl ether	ND	25V	86V	toluene	ND
11V	23V	chloroform	ND	29V	87V	trichloroethylene	ND
16V	29V	1,1-dichloroethylene	ND	31V	88V	vinyl chloride	ND
26V	30V	1,2-trans-dichloroethylene	ND				

:EIVED: [illegible]21/82 RESULTS B[illegible]AMPLE CONTINUED FROM [illegible]

IPLE ID TH-1 FRACTION 01B TEST CODE VOA NAME Volatile Compounds

e following are results for inter-laboratory QA/QC for EPA Method 624.

SCAN	CODE	COMPOUND	RESULT
91	IS1V	bromochloromethane	40
247	IS2V	2-bromo-1-chloropropane	40
329	IS3V	1,4-dichlorobutane	40
131	S1V	d4-1,2-dichloroethane	110 %
356	S2V	d8-toluene	92 %
423	S3V	d10-ethylbenzene	94 %

OTES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 624, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

PLE ID TH-2 (N-1) FRACTION 02A TEST CODE ACID NAME Acid Compounds

DATA FILE 3U10039A02 DATE EXTRACTED 10/26/82 ANALYST VL VERIFIED BY RS
NC. FACTOR _____ DATE INJECTED 11/18/82 COMPOUNDS DETECTED 0

DES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
11A	21A	2,4,6-trichlorophenol	ND	7A	58A	4-nitrophenol	ND
8A	22A	p-chloro-m-cresol	ND	5A	59A	2,4-dinitrophenol	ND
1A	24A	2-chlorophenol	ND	4A	60A	4,6-dinitro-o-cresol	ND
2A	31A	2,4-dichlorophenol	ND	9A	64A	pentachlorophenol	ND
3A	34A	2,4-dimethylphenol	ND	10A	65A	phenol	ND
6A	57A	2-nitrophenol	ND				

e following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1047	IS1A	d10-phenanthrene	10
568	S1A	d4-2-nitrophenol	72 %
427	S2A	d5-phenol	52 %

TES AND DEFINITIONS FOR THIS REPORT.
SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

.IVED: 10. [illegible]2 RESULTS [illegible]

'LE ID TH-2 FRACTION 02A TEST CODE BASE NAME Base Neutral Compounds

:B	42B	bis(2-chloroisopropyl)ether	ND	32B	80B	fluorene	ND
)B	43B	bis(2-chloroethoxy)methane	ND	44B	81B	phenanthrene	ND
1B	52B	hexachlorobutadiene	ND	19B	82B	dibenzo(a,h)anthracene	ND
5B	53B	hexachlorocyclopentadiene	ND	37B	83B	indeno(1,2,3-cd)pyrene	ND
3B	54B	isophorone	ND	45B	84B	pyrene	ND
9B	55B	naphthalene	ND		129B	dioxin	ND
)B	56B	nitrobenzene	ND				

following are results for inter-laboratory QA/QC for EPA Method 625.

SCAN	CODE	COMPOUND	RESULT
1615	IS1B	d10-phenanthrene	10
841	S1B	d5-2-nitrobenzene	63 %
969	S2B	d8-naphthalene	74 %
1420	S3B	d10-fluorene	53 %
2162	S4B	d12-chrysene	47 %

ES AND DEFINITIONS FOR THIS REPORT.

SCAN = scan number on chromatogram.
All results reported in micrograms/liter unless otherwise specified.
ND = not detected at EPA detection limit method 625, (Federal Register, 12/3/79).
IS = Internal Standard for quantitation.
S = Surrogate Compound added for recovery checks.
UTD = Unable to determine due to interference from unresolved components.

EIVED: 10/21/82

RESULTS BY SAMPLE

PLE ID TH-2 FRACTION 02A TEST CODE BASE NAME Base Neutral Compounds

DATA FILE 4U1039BP02 DATE EXTRACTED 10/25/82 ANALYST VL VERIFIED BY RS
C. FACTOR _____ DATE INJECTED 11/08/82 COMPOUNDS DETECTED 1

ES SCAN	EPA	COMPOUND	RESULT	NPDES SCAN	EPA	COMPOUND	RESULT
1B	1B	acenaphthene	ND	41B	61B	N-nitrosodimethylamine	ND
4B	5B	benzidine	ND	43B	62B	N-nitrosodiphenylamine	ND
6B	8B	1,2,4-trichlorobenzene	ND	42B	63B	N-nitrosodi-n-propylamine	ND
33B	9B	hexachlorobenzene	ND	13B 2185	66B	bis(2-ethylhexyl)phthalate	100
36B	12B	hexachloroethane	ND	15B	67B	butyl benzyl phthalate	ND
11B	18B	bis(2-chloroethyl)ether	ND	26B	68B	di-n-butyl phthalate	ND
16B	20B	2-chloronaphthalene	ND	29B	69B	di-n-octyl phthalate	ND
20B	25B	1,2-dichlorobenzene	ND	24B	70B	diethyl phthalate	ND
21B	26B	1,3-dichlorobenzene	ND	25B	71B	dimethyl phthalate	ND
22B	27B	1,4-dichlorobenzene	ND	5B	72B	benzo(a)anthracene	ND
23B	28B	3,3'dichlorobenzidine	ND	6B	73B	benzo(a)pyrene	ND
27B	35B	2,4-dinitrotoluene	ND	7B	74B	3,4-benzofluoranthene	ND
28B	36B	2,6-dinitrotoluene	ND	9B	75B	benzo(k)fluoranthene	ND
29B	37B	1,2-diphenyhydrazine	ND	18B	76B	chrysene	ND
31B	39B	fluoranthene	ND	2B	77B	acenaphthylene	ND
17B	40B	4-chlorophenyl phenyl ether	ND	3B	78B	anthracene	ND
14B	41B	4-bromophenyl phenyl ether	ND	8B	79B	benzo(ghi)perylene	ND

Reference (14)

GEOPHYSICAL INVESTIGATION REPORT

PHASE II: SEISMIC REFRACTION SURVEY

SINGER FURNITURE COMPANY SITE
LENOIR, NC

Prepared for: Environmental Quality Management, Inc.
3325 Chapel Hill Blvd., Suite 250
Durham, NC 27707

March 31, 1995

PYRAMID ENVIRONMENTAL, INC.
2706 PINEDALE ROAD
GREENSBORO, NC 27408
(910) 282-9030

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APPENDIX

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GEOPHYSICAL INVESTIGATION REPORT
Phase II: Seismic Refraction Survey

Singer Furniture Company Site
Lenoir, NC

1.0 EXECUTIVE SUMMARY:

In March, 1995, Pyramid Environmental, Inc. conducted a seismic refraction survey on a portion of the Singer Furniture Company property in Lenoir, North Carolina. The survey consisted of five seismic refraction lines of two spreads each. Each spread consisted of 24 geophones, with a spacing of 20' between geophones, with the exception of Spread 2 of Line 4, which had a geophone spacing of 15'.

Interpretation of the seismic refraction survey data shows three identifiable subsurface layers. Layer 1 is the near surface material with a seismic velocity of between 1200 and 2100 ft/sec. The highest velocities were in the old lumberyard area, while the slowest were in the flood plain. The thickness of this layer ranged from less than 10 to nearly 40', and is well constrained by the seismic data. Layer 1 is interpreted as unconsolidated to moderately consolidated soil and/or fill material.

Layer 2 has a seismic velocity of 5000 to 7100 ft/sec, and a thickness which varies from less than 10' to over 100'. Layer 2 is interpreted as water saturated, clay-rich soil and/or weathered bedrock.

Layer 3 has a velocity which ranges from 16,500 to 27,000 ft/sec. This is interpreted as representing unweathered metamorphic basement rock. The fact that the surface of this layer is poorly constrained by the data, and appears to be highly variable may indicate that it is a transitional rather than an abrupt interface, supporting the interpretation that it is the interface between weathered and unweathered bedrock.

No evidence was observed in the seismic data of hidden low velocity layers, or other local anomalies which would indicate the presence of clay lenses, a perched water table, or similar complex features; however, the seismic data does not exclude the possibility that such features exist. Some of the local variations in seismic velocity within layers 1 and 2 may reflect more complex structures than the seismic refraction method can resolve.

2.0 INTRODUCTION:

2.1 Site Description

The site is located on the property of the Singer Furniture Company in Lenoir, North Carolina. The area of interest consists of the portion of the property north of the main building, including the landfill area, the old lumber yard, the softball field, and the flood plain area north of the landfill. With the exception of the flood plain area, most of the area of interest was open, with few trees, and the ground was dry. In some areas, holes were to be dug with a handpick to plant the geophones. The flood plain area north of the landfill was heavily wooded, and the ground was saturated, with some areas of standing water. The whole property has significant topographic relief, but many areas are relatively flat and level.

There was one road near enough to cause significant seismic noise, but traffic was light and with careful timing during data acquisition, the effect was minimal. During most of the data acquisition, the weather was clear and calm. The last two days of acquisition had moderately high winds, which created significant seismic noise (this affected Line 1, Spreads 1 and 2, and Line 2, Spread 1).

2.2 Scope of Work

Phase I of the geophysical investigation of the subject property consisted of a magnetometer survey conducted in February, 1995, the results of which were presented in a report dated March 9, 1995. The seismic refraction survey which is the subject of this report is Phase II. The purpose of the seismic refraction survey is to determine the depth and structure of subsurface geologic horizons, specifically the basement rock. The scope of work for this Phase included laying out the five survey lines (ten spreads), acquiring the data, analyzing the data, and supplying a written report summarizing the results of the survey and presenting our conclusions.

3.0 GEOPHYSICAL METHODS:

3.1 Seismic Refraction Theory

The seismic refraction method uses the fact that seismic (sound) waves travel at different velocities through different types of rock or soil. Seismic waves are generated by a small source such as a sledge hammer striking the ground, or small explosive charges. Receivers called "geophones" are placed in a line at varying distances from the source. The time the seismic waves take to travel from the source to the near geophones reveals the seismic velocity of the near-surface layer. With increasing distance from the source,

seismic waves traveling through the faster, deeper layers begin to arrive at the geophones first, revealing the velocities and depths of those layers. The seismic refraction method assumes increasing velocity with depth and relatively flat lying layers, and cannot easily distinguish velocity inversions, layers with very large dips, or lateral changes in velocity within a layer.

3.2 Instrumentation

The instrumentation used was an EG&G Geometrics Strataview signal enhancement seismometer with a 24 channel geophone spread using 8 Hz geophones. The geophone spacing for most spreads was 20', giving a total spread length of 460'. Spread 2 of Line 1, had a geophone spacing of 15', giving a total spread length of 345'. The source was a 12 pound sledge hammer striking a steel strike plate. An electronic trigger mechanism attached to the sledge hammer signaled the start time to the seismograph.

The seismic data were recorded digitally on floppy discs, as well as on paper printouts. The digitally recorded data used a 125 μs (.125 ms) sample interval, and a total record length of 192 ms, including a 10 ms delay. No filtering was performed of the digitally recorded data; however, a 25 Hz low-cut filter was applied to the printed output.

4.0 DATA ACQUISITION

4.1 Layout of Lines

The survey consisted of ten lines of two spreads each (Figure 1). Lines 1, 2, and 3 were oriented approximately southwest-northeast, which is roughly parallel to the topographic and assumed structural strike. Lines 4 and 5 were oriented approximately southeast-northwest, roughly parallel to the assumed structural dip. The 460' spread length worked well for most of the spreads, fitting within the physical boundaries constraining the layout. Spread 2 of Line 3 needed to be shortened to fit with in the physical space available, so the geophone spacing was reduced to 15', giving a total spread length of 345'.

The two spreads of Line 5 were able to be laid linearly end-to-end, with no gap or offset. Physical barriers such as streams and fences required gaps of 70', 100', and 40' between spreads for Lines 2, 3, and 4, respectively. The two spreads for Line 1 were overlapped by 5'. In some cases there were also slight offsets and/or changes of orientation between spreads. Distances along each line was measured from geophone G-1 of Spread 1, which was arbitrarily defined as 100'.

Five shot locations were chosen for each spread. For both spreads of Lines 1, 3, and 5, Shot 1 was at 10' beyond the G-1 end of the spread, Shot 2 was between G-6 and G-7, Shot 3 was at the center of the spread between G-12 and G-13, Shot 4 was between G-18 and G-19, and Shot 5 was 10' beyond the G-24 end of the spread. For Lines 2 and 4,

physical barriers at one or both ends of the spreads forced Shot 1 and/or Shot 5 to be moved to between G-1 and G-2, and/or between G-23 and G-24, respectively.

4.2 Seismic Data Acquisition

The Geometrics Strataview Seismometer features a built in computer which controls the data acquisition, records the data geometry, gains, and other information, and prints the recorded data. Before each shot, the information required for that shot is input and double-checked through the control panel and built in view-screen.

The seismometer was operated in the "signal enhancement" mode, so that consecutive blows from the sledge hammer at the same shot point could be "stacked", or added together to give a stronger overall signal-to-noise ratio. Once the nearest geophones had a well-established signal, they could be "frozen" so that additional blows would only be added to the far geophones. The number of blows required to obtain optimal signals varied from one spread to another, but ranged from 8-20 for near geophones and 10-30 for far geophones.

5.0 DATA ANALYSIS & INTERPRETATION

5.1 First Arrival Times

First arrival times for each source-geophone pair were picked using the arrival-picking utility on the Geometrics Strataview Seismometer. These picks were recorded on floppy discs, and were check against the paper records in our office. The paper records allowed time picks to within +/- 0.2 ms for good quality data. Examples of some of the seismic data are shown in Figure 2.

The arrival times for all shots from each spread were plotted on time-distance diagrams (Figure 3). Distinct arrivals from different refractors (subsurface interfaces) are determined by observed changes in the slope of the arrivals on the time-distance diagram. Generally, three distinct arrivals could be seen on most of the records. These were interpreted as the direct wave arrival (layer 1), a shallow refracted wave arrival (layer 2), and a deeper refracted wave arrival (layer 3).

The direct arrivals at the near-geophones had a characteristic shape which was usually easy to pick and could often be picked even at far geophones where it was not the first arrival because of its high amplitude and high frequency. When plotted on a time-distance diagram (Figure 3), the slopes associated with the direct arrivals indicated velocities of between 1200 and 2100 ft/sec (feet per second) for the near-surface material (layer 1), which is consistent with unconsolidated to moderately consolidated unsaturated soils.

The refracted arrivals were lower frequency than the direct arrival, and more difficult to pick accurately and consistently. The apparent velocities associated with the first

refracted arrivals were generally between 5000 and 7100 ft/sec, which is consistent with softer rock such as siltstone or sandstone, or with highly weathered metamorphic rock (saprolite), or with water-saturated soils. The apparent velocities associated with the deeper refracted arrivals were generally between 16,500 and 27,000 ft/sec, which is consistent with hard rock such as unweathered metamorphics which are expected to comprise the basement in this area.

5.2 SIPT Analysis

The first arrival times were analyzed through SIPT, a micro-computer based software program developed by the USGS for the interpretation of seismic refraction data involving complex field situations and geologic settings. The program is a two-dimensional modeling process in which the delay-time technique is used to obtain a first approximation of layer thicknesses and velocities, then an iterative ray-tracing technique is used to refine the model. Error detection, feedback, and automatic adjustment are included in the program, which can handle multi-layer dipping structures, multiple geophone spreads, and complex field situations. The output from all SIPT runs is included in Appendix I.

All arrival times were picked and assigned to one of the three layers (surface-layer 1, 1st refractor-layer 2, or 2nd refractor-layer 3). This information, along with the distance along the line and the elevation of each shot and geophone location, were compiled into an input file for the SIPT program. Elevations were determined from the site topographic map. SIPT then analyzed the data for the layer velocities along the line or spread, and depths and thicknesses of layers beneath each shot and geophone.

Each spread was run separately, and then the two spreads from each line were run together. Running the spreads separately gave better resolution of the areal changes in the velocities, while running the whole lines gave better continuity of depths and thicknesses. Table 1 shows the best-fit velocities for each SIPT run. This table shows that the highest velocities for the near-surface (layer 1) were found in the old lumberyard area (Spreads 4-1 and 2-2, and to a lesser extent Spread 1-2). This area also showed lower than average velocities for layer 2. The highest velocities for both layer 2 and layer 3 were found in the flood plain area north of the landfill. The extremely high velocity for Spread 3-1 is anomalous, and too high for normal earth materials, but should not affect the depth interpretations, which are controlled by the velocities above the interface.

The depth structures determined by the SIPT analysis for each of the whole-line runs are shown in Figures 4-8. The thickness of the near-surface material (layer 1) ranged from less than 10' (beneath the flood plain) to almost 40' (beneath the landfill). The depth and structure of the layer 1-2 interface (top of layer 2) was very consistent from line to line, and there was little scatter in the SIPT modeling, indicating that this interface is well constrained by the refraction data. Figure 9 shows the interpreted structural contours for this interface.

TABLE 1: Velocities of layers determined from each spread and line.

	VELOCITIES		
SPREAD	Layer 1	Layer 2	Layer 3
1-2	1450	6479	21703
1-2	1612	4981	15688
Line 1 (both)	1523	5428	16844
2-1	1234	6020	19383
2-2	2063	5442	19124
Line 2 (both)	1580	5756	19082
3-1	1284	6599	35119
3-2	1206	6166	23512
Line 3 (both)	1246	6446	27151
4-1	2171	5389	17961
4-2	1284	5136	12875
Line 4 (both)	1681	5243	15897
5-1	1232	5474	18197
5-2	1250	7136	19114
Line 5 (both)	1241	6605	19018

Velocities in feet/second.

The thickness of layer 2, and the depth of the layer 2-3 interface (top of layer 3) is much less well constrained by the data. There is considerable relief on the layer 3 surface (Figure 10), with layer 2 thicknesses ranging from less than 10' (beneath the western end of Line 1) to greater than 100' (beneath the flood plain). There was considerable scatter in the SIPT modeling of this interface, in some places as much as 15-20', and the separate lines do not tie well, particularly in areas of high relief. Many of these misties can be explained as due to the different velocities determined for each line, an effect which increases in significance with depth. The overall structure of the layer 3 surface (Figure 10) is probably accurate; however, some of the details may be artifacts of the uncertainties in the data and/or modeling process.

6.0 CONCLUSIONS

Interpretation of the seismic refraction survey data for the Singer Furniture Company property in Lenoir, North Carolina shows three identifiable subsurface layers. Layer 1 is the near surface material with a seismic velocity of between 1200 and 2100 ft/sec. The highest velocities were in the old lumberyard area, while the slowest were in the flood plain. The thickness of this layer ranged from less than 10 to nearly 40', and is well constrained by the seismic data. Layer 1 is interpreted as unconsolidated to moderately consolidated soil and/or fill material.

Layer 2 has a seismic velocity of 5000 to 7100 ft/sec, and thickness which varies from less than 10' to over 100', although the thickness is not well constrained by the seismic data. Layer 2 is interpreted as water saturated, clay-rich soil and/or weathered bedrock.

Layer 3 has a velocity which range from 16,500 to 27,000 ft/sec. This is interpreted as representing unweathered metamorphic basement rock. The fact that the surface of this layer is poorly constrained by the data, and appears to be highly variable may indicate that it is a transitional rather than an abrupt interface, supporting the interpretation that it is the interface between weathered and unweathered bedrock.

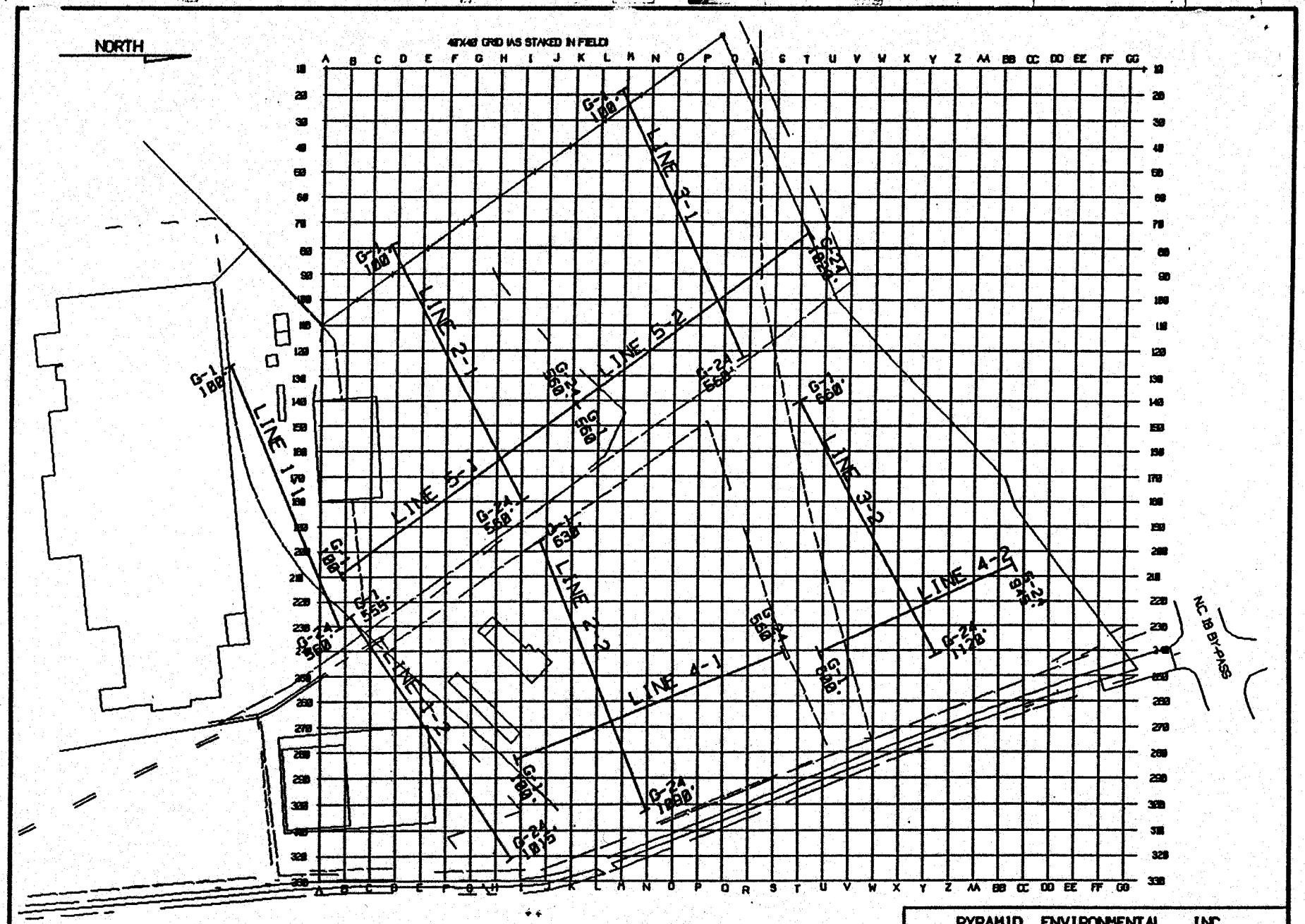
No evidence was observed in the seismic data of hidden low velocity layers, or other local anomalies which would indicate the presence of clay lenses, a perched water table, or similar complex features; however, the seismic data does not exclude the possibility that such features exist. Some of the local variations in seismic velocity within layers 1 and 2 may reflect more complex structures than the seismic refraction method can easily resolve.

7.0 CLOSURE

This report is prepared for, and made available solely for the use of, the Client, and the contents thereof may not be used or relied upon by any other person without the express written consent and authorization of the consultant. The observations, conclusions, and recommendations documented in this report are based on site conditions and information available at the time of Pyramid's investigation. Pyramid Environmental, Inc. appreciates the opportunity to provide this environmental service.

Prepared by: G. VanNess Burbach, PG

Reviewed by: Douglas A. Canavello, PG



SCALE (feet)

0 50 100 200 300 400

G-1 100' First geophone of spread and distance along line.

G-24 560' Last geophone of spread and distance along line.

PYRAMID ENVIRONMENTAL, INC.

Singer Furniture Co., Lenoir, NC

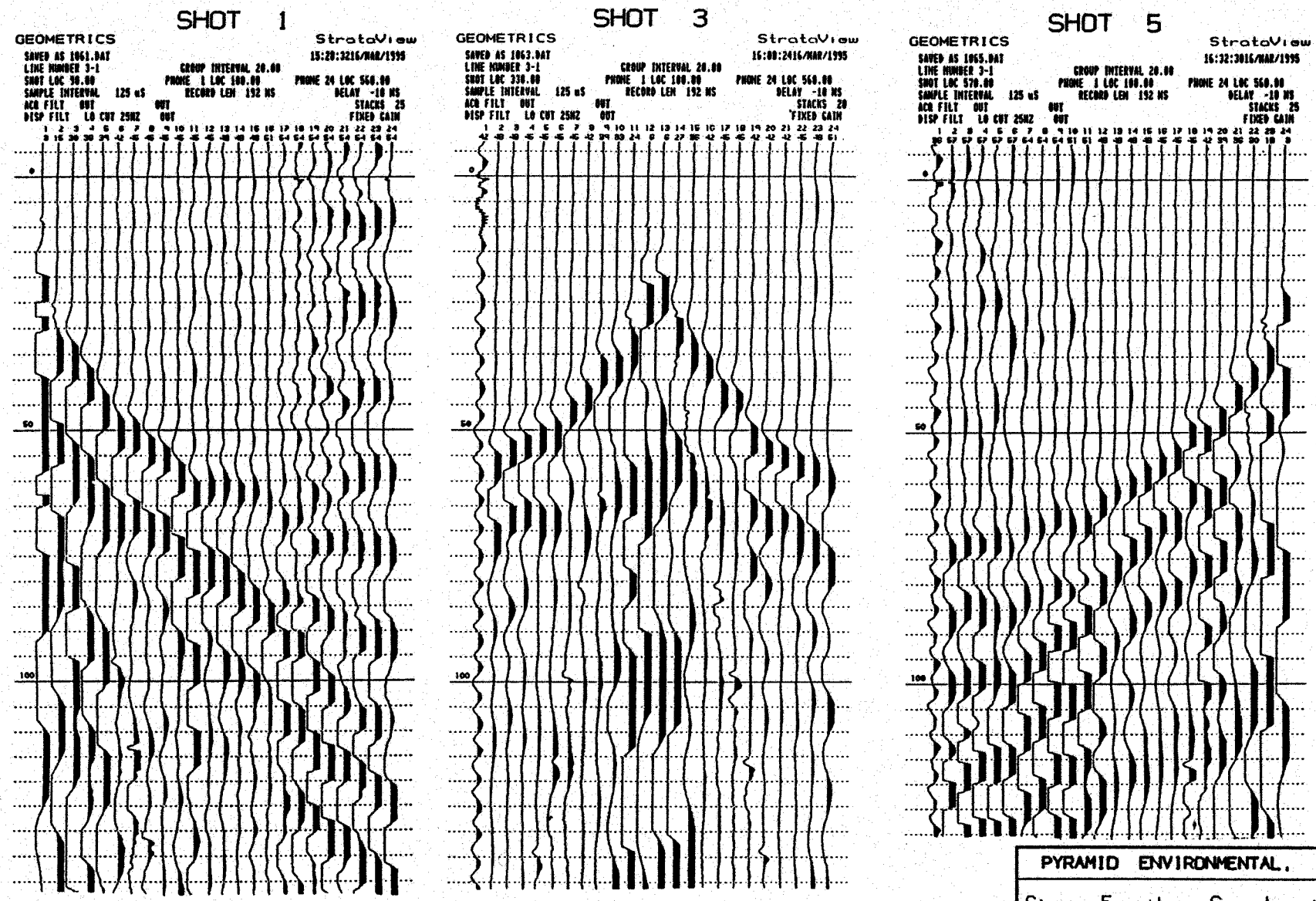
Location of Seismic Refraction Lines

March, 1995

Figure 1

SEISMIC REFRACTION DATA

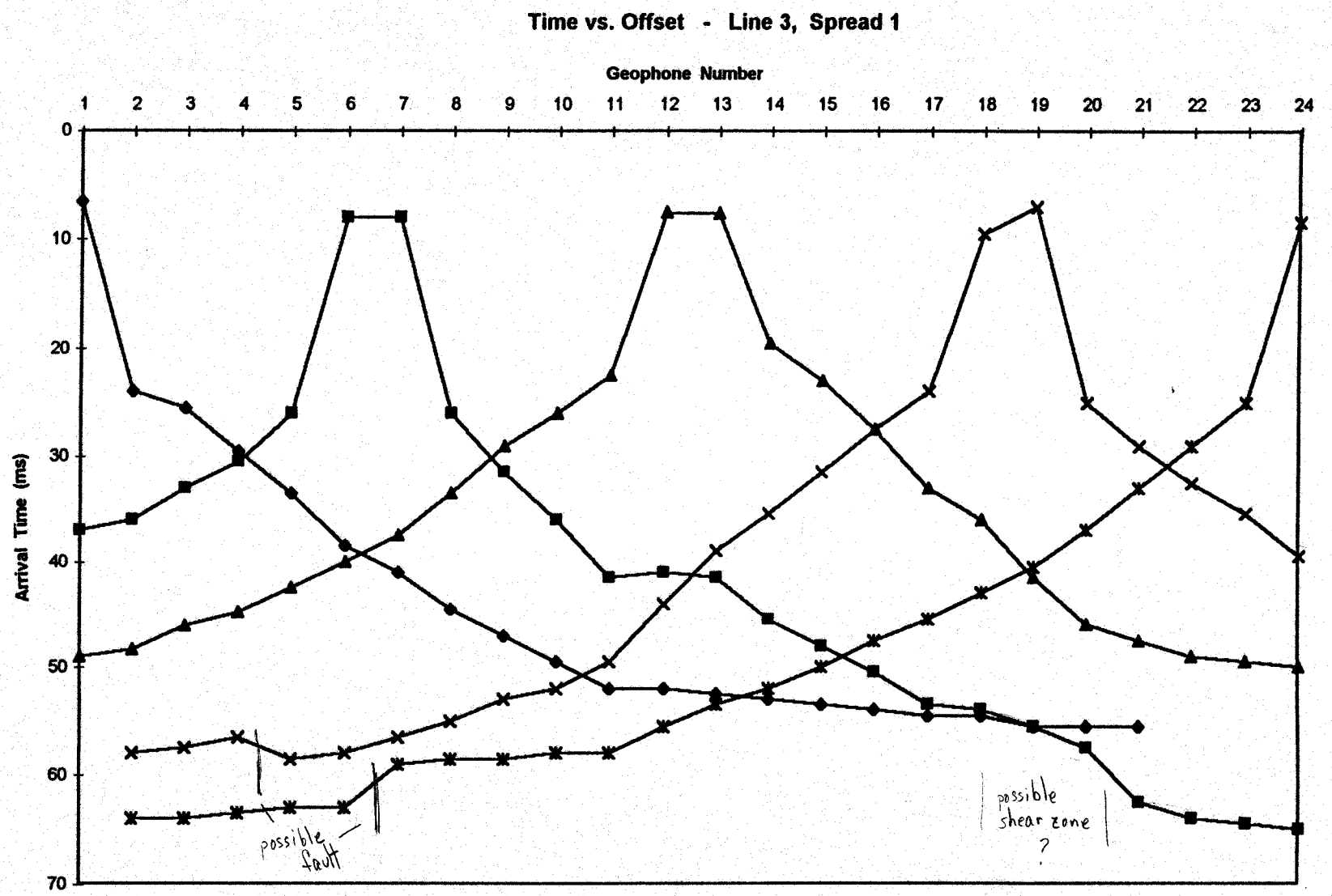
Line 3, Spread 1



Geophone Spacing = 20'

Time Scale in miliseconds (ms)

PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Example of Seismic Data	
March, 1995	Figure 2

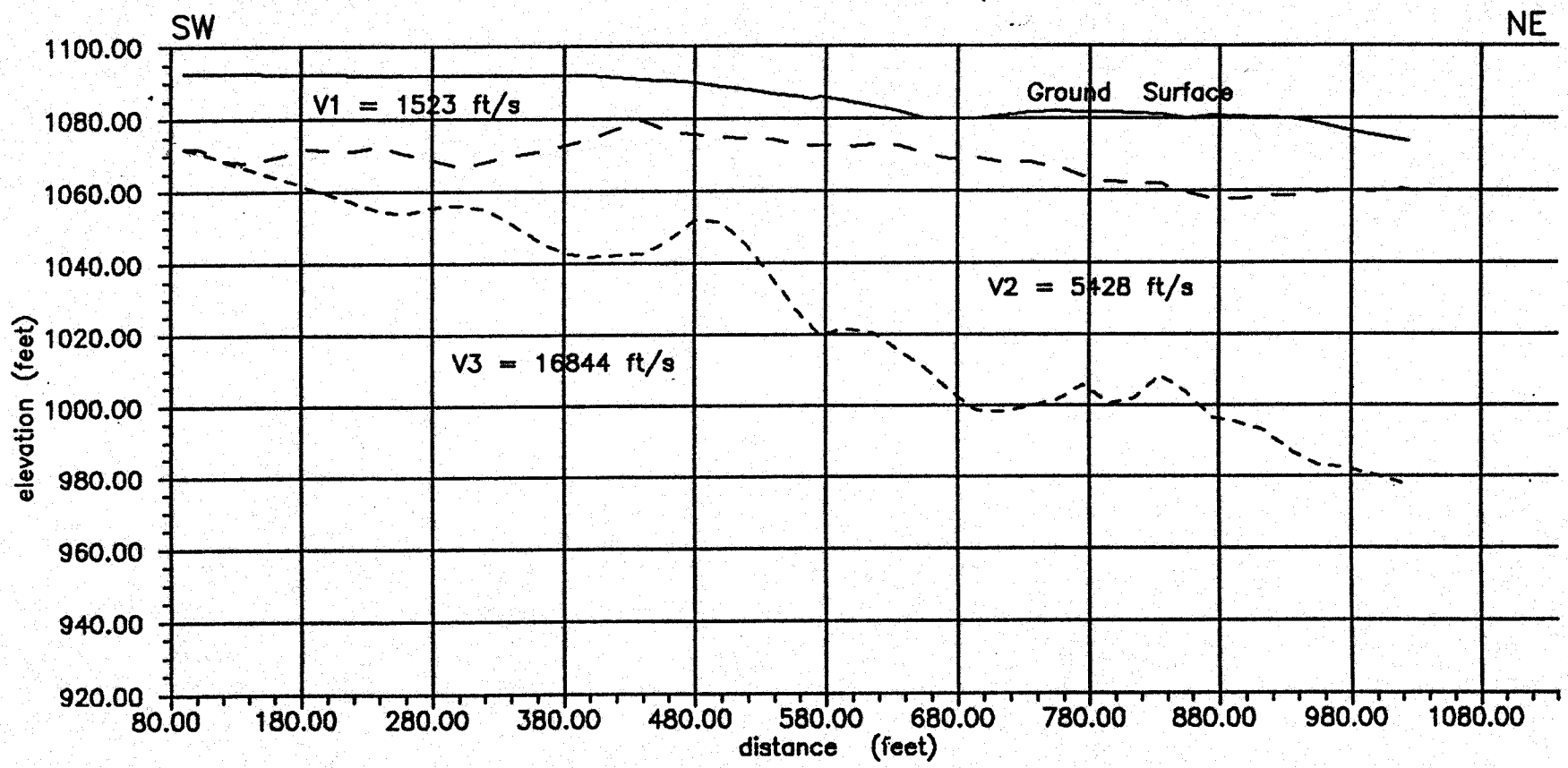


Shot 1
Shot 2
Shot 3
Shot 4
Shot 5

Geophone Spacing = 20'
Time Scale in miliseconds (ms)

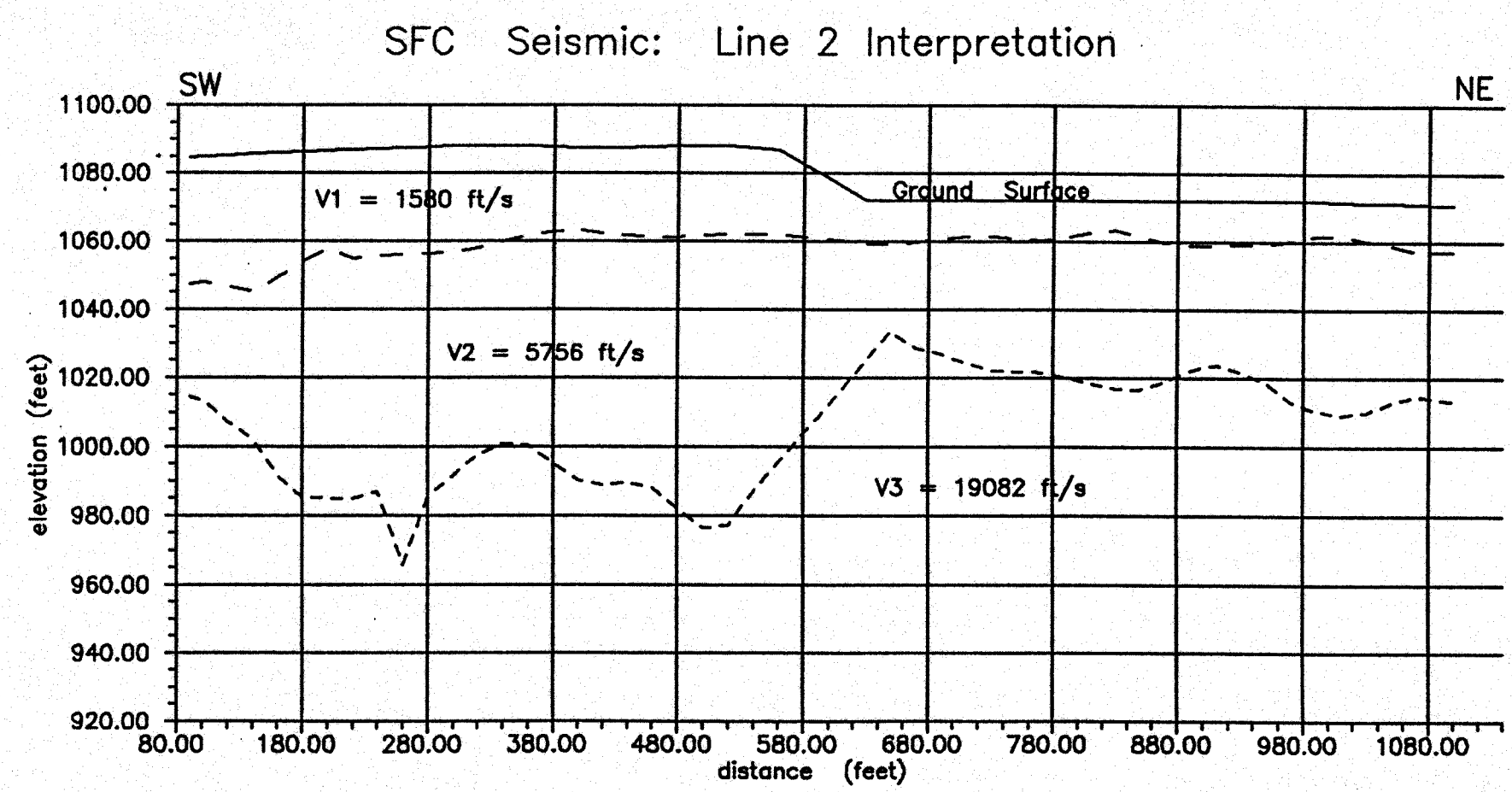
PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Example of Travel Time Curves	
March, 1995	Figure 3

SFC Seismic: Line 1 Interpretation

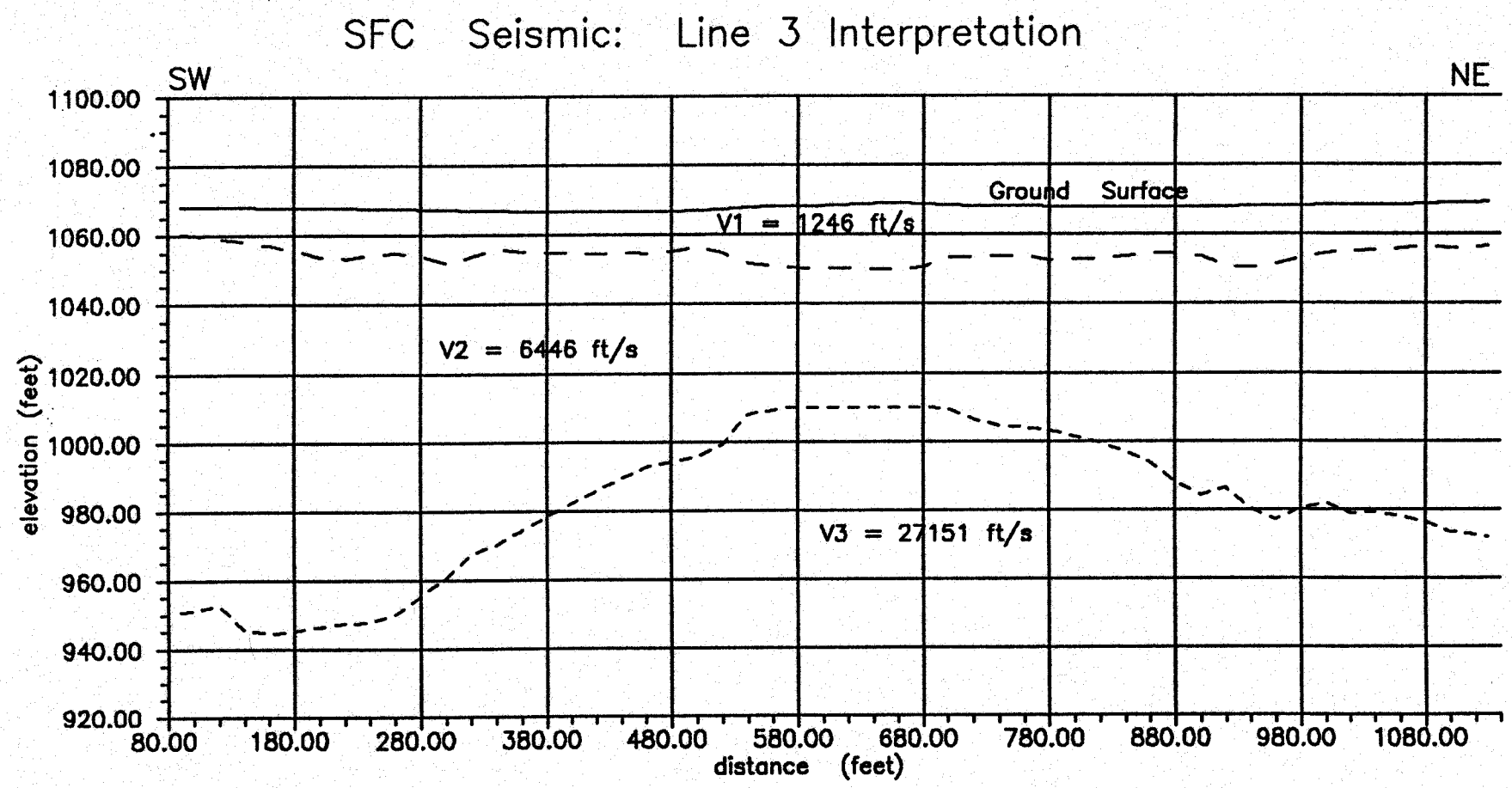


Geophone Spacing = 20'
Time Scale in miliseconds (ms)

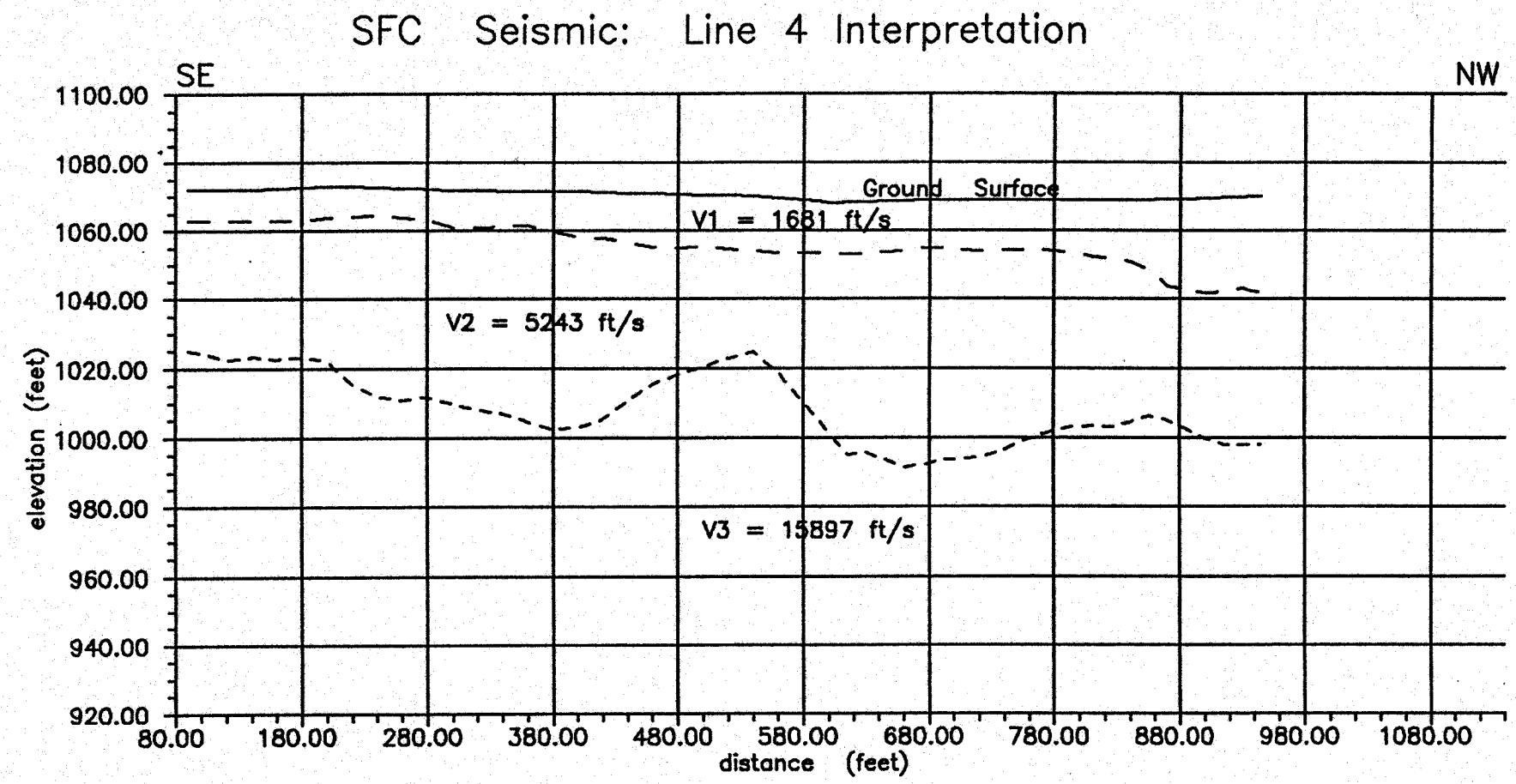
PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Interpreted Cross Section along Line 1	
March, 1995	Figure 4



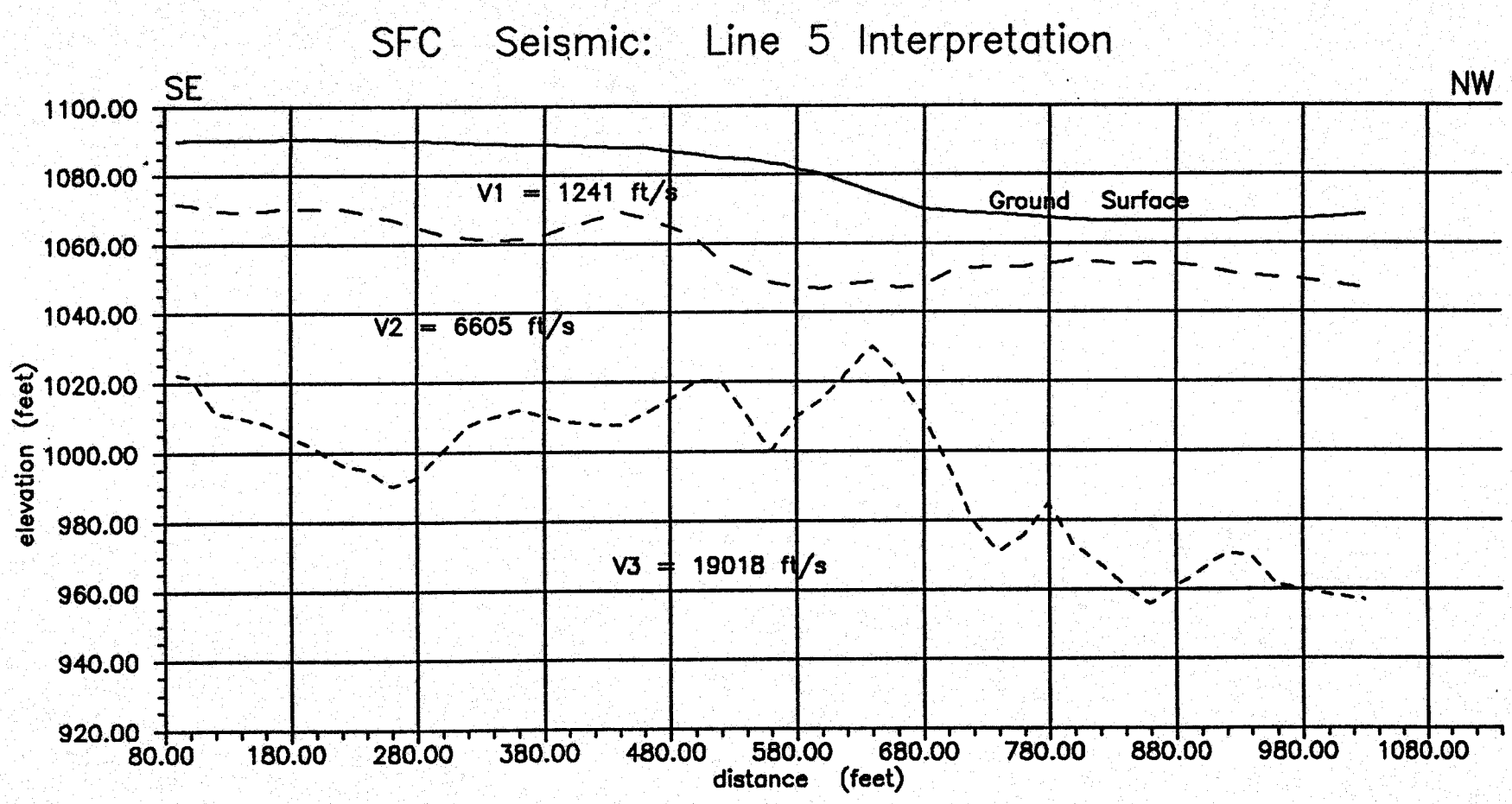
PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Interpreted Cross Section along Line 2	
March, 1995	Figure 5



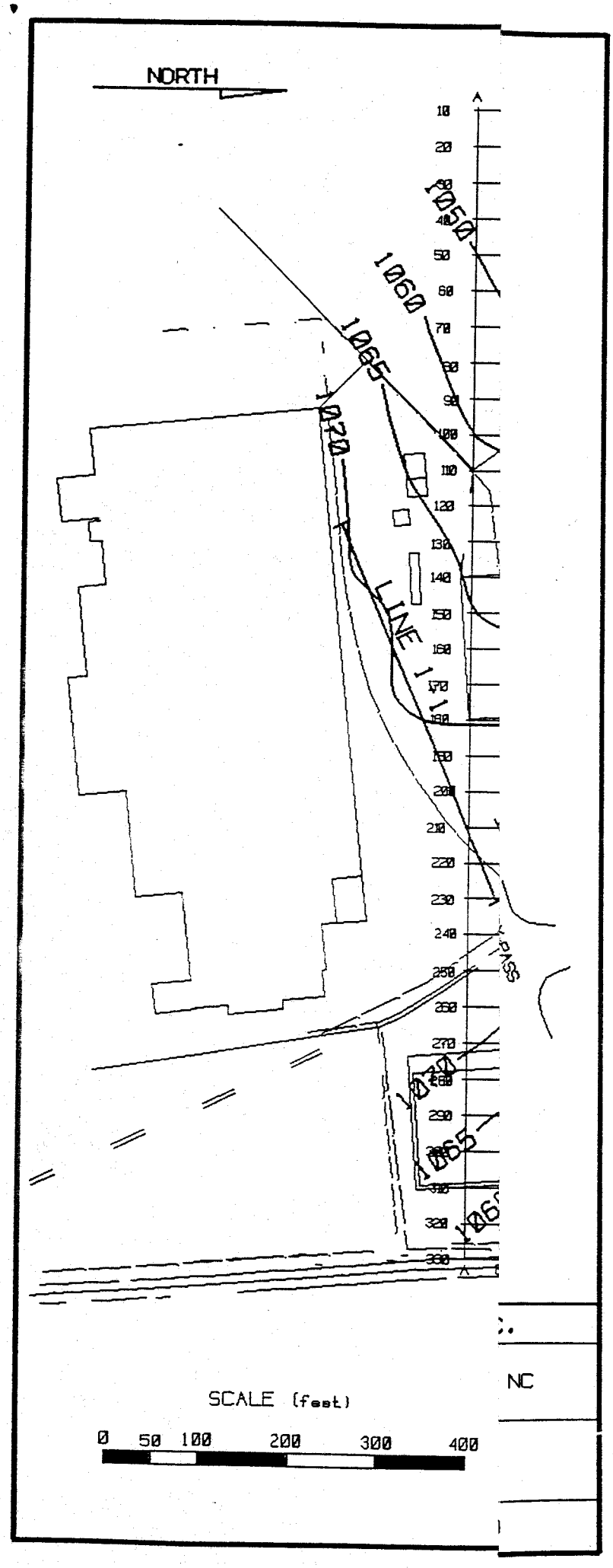
PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Interpreted Cross Section along Line 3	
March, 1995	Figure 6



PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Interpreted Cross Section along Line 4	
March, 1995	Figure 7



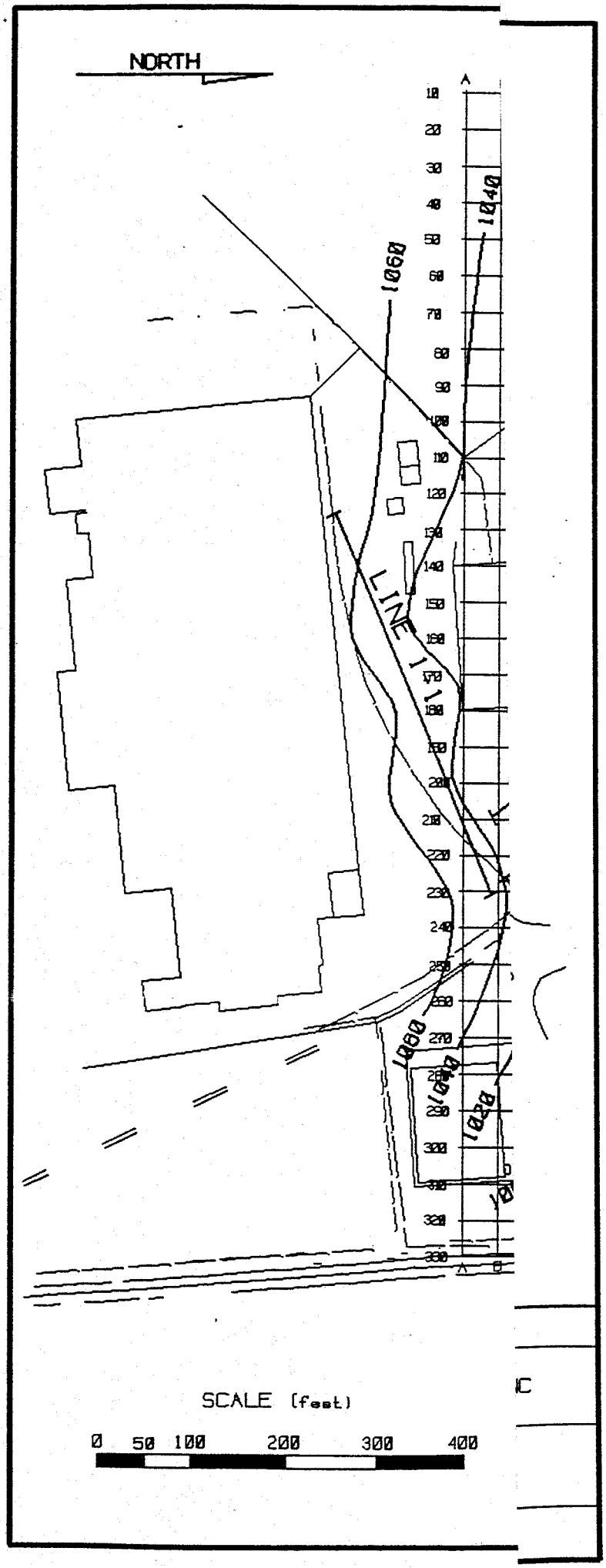
PYRAMID ENVIRONMENTAL, INC.	
Singer Furniture Co., Lenoir, NC	
Interpreted Cross Section along Line 5	
March, 1995	Figure 8


NORTH
1050
1060
1065
1070
LINE 1
BYPASS
SCALE (feet)
0 50 100 200 300 400

NC

? doesn't match profile

WOULD LIKE TO SEE POSTED DATA


NORTH
1040
1060
LINE 1
1060
1040
1020
SCALE (feet)
0 50 100 200 300 400

APPENDIX I

(On Diskette)

SIPT Output:

L1-1.opl - Line 1, Spread 1
L1-2.opl - Line 1, Spread 2
L2-1.opl - Line 2, Spread 1
L2-2.opl - Line 2, Spread 2
L3-1.opl - Line 3, Spread 1
L3-2.opl - Line 3, Spread 2
L4-1.opl - Line 4, Spread 1
L4-2.opl - Line 4, Spread 2
L5-1.opl - Line 5, Spread 1
L5-2.opl - Line 5, Spread 2
L1-1&2.opl - Line 1, Spreads 1 & 2
L2-1&2.opl - Line 1, Spreads 1 & 2
L3-1&2.opl - Line 1, Spreads 1 & 2
L4-1&2.opl - Line 1, Spreads 1 & 2
L5-1&2.opl - Line 1, Spreads 1 & 2

CADD Map:

SFC-GMAP.dxf - Site map with seismic spreads and Layer 2 and 3 structural contours on separate layers.