ADDITIONAL SUBSURFACE EXPLORATIONS
100 BOSWORTH STREET
PROVIDENCE, RHODE ISLAND

PREPARED FOR:
Eastland Savings Bank
Woonsocket, Rhode Island 02895-0985

PREPARED BY:
GZA GeoEnvironmental, Inc.
Providence, Rhode Island

January 1992
File No. 30764.1

GZA
GeoEnvironmental, Inc.

Engineers and Scientists

January 20, 1992
File No. 30764.1

Mr. Donald Heath
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140 Broadway
Providence
Rhode Island 02903
401-421-4140
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Re: Additional Subsurface Explorations
100 Bosworth Street
Providence, Rhode Island

Dear Mr. Heath:

In accordance with our proposal dated December 9, 1991, GZA GeoEnvironmental, Inc. (GZA) has completed additional subsurface explorations at the 100 Bosworth Street site in Providence, Rhode Island. The purpose of this work was to evaluate the number and apparent integrity of underground storage tank(s) (USTs) on site, and investigate the extent of soil and groundwater contamination for the purpose of developing preliminary cost estimates. This work was undertaken based on the findings of our March 20, 1991 Preliminary Environmental Assessment and our April 15, 1991 Phase II Environmental Site Assessment.

Our scope of services for the present study included:

- delineation of the tank or tanks and piping systems with a metal detector,
- subsurface explorations in the form of shallow test borings and groundwater monitoring wells;
- analysis of selected soil and groundwater samples for volatile organic compounds and petroleum hydrocarbons and;
- the preparation of this letter including our opinion regarding the UST systems, the extent of soil and groundwater contamination and preliminary cost estimates for removal of UST(s) and remediation of the observed contamination.

This report has been prepared in accordance with the Limitations and Statement of Terms and Conditions presented in this letter and in Appendix A.

A Subsidiary of GZA GeoEnvironmental Technologies, Inc.

BACKGROUND

Based on information obtained during our Preliminary and Phase II Environmental Assessments of the site, it was GZA's opinion that soil and groundwater at the site was contaminated with low levels of VOCs and petroleum distillates characterized as No. 2 fuel/diesel. The source of the contamination was not known, but the tank(s) were viewed as suspect. Two tanks were tentatively identified at the site based on surface features; at least one of these tanks was thought to contain No. 4 fuel oil, as this grade oil was being used to heat the building.

UST INVESTIGATION

In our earlier studies we identified several features on the southeast side of the building, northeast of the boiler house that were consistent those associated with UST systems. These included a fill pipe and steel plate located in a concrete surfaced area adjacent to the driveway on the southeast side of the building, approximately 20 feet northeast of the boiler house, and a second steel plate and screw-in handle located approximately 30 feet northwest of the fill pipe. Two vents and a standpipe were located adjacent to the boiler house. These features are shown on Figure 2.

On December 20, 1991, GZA personnel conducted a metal detector survey of this area in an attempt to delineate the tank boundaries and the piping systems. The property owner, Mr. Piero Maggiacomo met us at the site and provided some information about one of the tanks. This tank, associated with the fill pipe adjacent to the driveway, reportedly has a 15,000 gallons capacity and holds No. 4 fuel oil for the boiler. Mr. Maggiacomo reported that he had filled this tank to capacity in October, 1991. The steel plate adjacent to the fill pipe covered the pump and piping connections. Inside the boiler house, a pump and a standpipe were located adjacent to the northeastern wall at the approximate location of the standpipe and the area of patched asphalt located outside the building. Mr. Maggiacomo informed us that Universal Burner Systems had performed some work on the piping system in the fall of 1991.

A Metrotech Model metal detector was used in the direct coupling mode to delineate the boundaries of this tank. In the direct coupling mode, a source of electric current is connected to a metal surface feature, inducing an electric current in underground metallic objects connected to this feature. The magnetic fields created by the electric current can be picked up by the metal detector set to a very low sensitivity.

An area of high metal detector readings was determined approximately 10 feet wide and 22 feet long, consistent with the dimensions listed on a gauging chart for a 15,000 gallon tank. Piping appeared to extend approximately 14 feet from the northwest end of the tank to the second metal plate which appeared to be a clean-out port. Additional apparent piping extended approximately 8 feet west of this plate, angling to the southwest along the

zone of patched asphalt to the edge of the building. The standpipe at the edge of the building appeared to be tied into this line. Features identified by the metal detector are shown on Figure 2.

We also delineated an area of high magnetometer readings northwest of the piping identified by our survey. The second vent pipe located adjacent to the building in this area did not appear to be directly connected to the first tank or piping system. However, we could not conclusively determine the boundaries of a tank. Additional work conducted on December 30, 1991 delineated a pipe extending southeast from the vent approximately 30 feet to a T connection; one arm of the T appeared to extend southwestward, terminating approximately 8 feet northwest of the patched asphalt. Again we were unable to determine the presence of a metal tank. It is possible, however, that this piping may connect to a concrete UST. However, there are no records or other information that such a tank, if it is present in this area, is currently being used to store fuel oil.

We also contacted Mr. Peter White of Universal Burner Service, Inc. regarding repairs to the fuel oil pump. Mr. White informed us that in September, 1991 they flushed out the pipelines to the No. 4 fuel oil tank with No. 2 fuel oil to remove paraffin that had clogged the lines. He informed us that they had installed a fill pipe adjacent to the fuel pump inside the boiler room to pump the No. 2 oil into the lines. He also informed us that there were a number of unidentifiable pipelines that had been capped off as they entered the boiler room, and that there were parts of an old fuel oil pump mounted on the wall. However, he had no information concerning a second or former tank at this site.

FIELD EXPLORATIONS, SAMPLING AND TESTING PROGRAM

GZA completed a supplementary field exploration program to further assess the extent of the soil and groundwater contamination at the site and to address the uncertainty regarding the number of USTs present at the site. This program consisted of drilling five additional borings and installing three additional monitoring wells, and the collection and analysis of soil and water samples.

Exploration locations were selected based on results of our initial subsurface exploration program and the magnetometer survey. Due to the configuration of the site, however and the presence of overhead and underground utilities, certain areas were inaccessible for drilling. An Exploration Location Plan is attached as Figure No. 2.

Subsurface Explorations and Monitoring Well Installations

On December 27, 1991, five borings were completed by GZA Drilling, Inc. of Brockton, Massachusetts. Hollow stem auger techniques were employed without the use of drilling water or other fluids. Borings ranged in depth from 9 feet to 18.5 feet below the ground surface.

A monitoring well consisting of 5 to 10 feet of 1.5-inch-diameter PVC wellscreen attached to solid PVC riser pipe was installed in borings GZ-5, GZ-7, and GZ-8. All PVC attachments were completed without the use of solvents or glues to prevent contamination. The wellscreen was set to span the water table encountered in the boring during drilling.

A filter of clean silica sand was placed in the annular space around the wellscreen, and a bentonite clay seal was placed above this filter sand. Each well was completed with a road box. Well installation details are presented on the boring logs in Appendix B.

Soil and Water Sampling

Split spoon soil samples were obtained by Standard Penetration Tests at 5-foot intervals during the drilling operations. Grab samples were also collected from the auger in certain borings. Soil samples were classified by the on-site geologist. A portion of each soil sample was collected in a clean glass jar, stored in an ice-packed cooler and transported to GZA's Environmental Chemistry Laboratory in Newton, Massachusetts, for chemical screening.

On December 31, 1991, groundwater samples were collected from GZ-1 and GZ-7. There was insufficient water in GZ-3 to sample on this date. GZ-5 and GZ-8 contained only petroleum product and GZ-2 contained significant petroleum product (see the following section). A sample of the petroleum product was obtained from GZ-8. A laboratory-cleaned 5-foot stainless steel bailer with a Teflon ballcheck valve was used for each well to avoid cross-contamination. Three times the initial standing volume of the groundwater in the well was evacuated to remove stagnant water, and the well was allowed to recharge. Water samples were collected in hydrochloric acid preserved 40-ml vials with Teflon septa, in one liter amber bottles and in clean 8-ounce glass jars. The samples were kept cool until their delivery to our Environmental Chemistry Laboratory.

Subsurface Conditions

Soil conditions, based on information from borings completed during this study and our earlier studies, generally consisted of five to 10 feet of loose fine to coarse sand and gravel fill, overlying fine to medium sand and fine gravel thought to be natural soils. Weathered bedrock was encountered at depths ranging from 17 feet near the center of the site to 10 feet near the southern, downgradient property boundary. No bedrock was encountered in the upgradient well which extended to a depth of 20 feet. The surface topography slopes steeply from Curtis street at the northeastern end of the site to Aleppo Street at the southeastern end of the site. The bedrock surface also appears to slope in this direction, although less steeply.

As shown on Figure 2, GZ-4 is located approximately three feet northeast of the identified fuel oil tank in an apparent upgradient position. GZ-5 is located approximately four feet downgradient of this tank. A slight petroleum odor and sheen was noted in soil samples collected from depth of 10 to 12 feet in these wells, heavier petroleum odors and sheen were observed in soil samples collected from depths of 15 to 16 feet, just above the bedrock surface. GZ-5 was completed as a monitoring well.

GZ-6 was drilled northwest of the 15,000 gallon tank, in the area where a second tank may exist. This boring encountered what was thought to be a concrete footing to the building at a depth of seven feet and was terminated at nine feet. No obviously contaminated soils were encountered in the upper seven feet. Due to overhead electrical lines, no additional borings could be drilled in this area.

GZ-7 was drilled downgradient of GZ-3 approximately 20 feet north of the end of the building. Due to the presence of underground utilities we were unable to drill closer to the southwestern property line. No obvious visual or olfactory indication of contamination were noted in soils encountered in this boring. This boring was completed as a monitoring well.

GZ-8 was drilled northeast of GZ-5 near the pipeline from the No. 4 fuel oil tank. Strong gasoline or solvent-like odors were encountered in near surface soils from this boring. Petroleum odors characteristic of fuel oil were encountered in the sample from depth of five feet and petroleum-saturated soils were encountered in the sample from 10 feet, again at the bedrock surface. This boring was also completed as a monitoring well.

Groundwater Elevations

The elevations of the monitoring wells were surveyed on December 31, 1991 for the purpose of determining groundwater elevations and flow directions. Well elevations are referenced to an arbitrary datum of 100 feet at GZ-1 (top of PVC). Water levels were measured in GZ-1, GZ-3 and GZ-7 with an electronic water level reader at the time of sampling. Floating product was encountered in GZ-2, GZ-5 and GZ-8. Both an oil-water interface probe and a tape and petroleum-finding paste method were used in an effort to determine the product thickness in those wells with floating petroleum product. Due to the high viscosity of the product, however, product thickness was very difficult to determine. Approximately 0.7 feet of product was measured in GZ-2. We estimate that GZ-5 and GZ-8 both contained over two feet of product. The depths to water table or product are indicated on Figure 2 and on the well logs in Appendix B. Based on groundwater elevations (corrected for product thickness measurements), groundwater flow at the site appears to be southwesterly between GZ-1 and GZ-3, consistent with the topographic gradient. The water table at GZ-7, located 45 feet south-southwest of GZ-3, is elevated approximately two feet above GZ-3. We suspect perched conditions in this area. Groundwater flow from the northeast may be diverted around this mounded area.

ANALYTICAL RESULTS

From these additional explorations a total of 18 soil and two groundwater samples were returned to our laboratory for initial screening. Based on these data, ten soil samples and both groundwater samples were submitted to our Newton, Massachusetts laboratory for more comprehensive testing. In addition, one sample of petroleum product was also submitted for testing.

Soil Samples

Soil samples collected from the site were screened for total volatile organic compounds (VOCs) using a Thermo Instruments Model 105A photoionization detector (PID) with a 10.6 electron volt lamp. The PID measures relative levels of VOCs referenced to a benzene-in-air standard. Although the PID screening cannot be directly used to quantify VOC concentrations or identify individual compounds, the results can serve as a relative indicator of the levels of VOCs in each sample. PID readings of soil samples obtained from the borings are reported on the boring logs in Appendix B, and are summarized in the following table.

SAMPLE NO.	DEPTH (FEET)	PID READING (PPM)	COMMENTS
GZ-4, S-1	0.5 - 2.5	48	slow response
S-2	5 - 7	49	slow response
S-3	10 - 12	52	slow response, slight sheen
S-4	15 - 17	100	slow response, heavy sheen
GZ-5, S-1	0 - 2	56	slow response
S-2	5 - 7	47	slow response
S-3	10 - 12	38	slow response, slight PHC odor
S-4	15 - 17	72	normal response, PHC odor
GZ-6, S-1	1 - 3	31	slow response
S-2	5 - 7	40	slow response
GZ-7, S-2	5 - 7	40	slow response
S-3	10 - 12	43	slow response
GZ-8, S-1	0.5 - 2.5	209	normal response, gasoline-like odor

SAMPLE NO.	DEPTH (FEET)	PID READING (PPM)	COMMENTS
S-2	5 - 7	107	normal response, PHC odor
S-2A	5 - 8	144	normal response, PHC odor, auger sample
S-3	10 - 12	160	normal response, oil-saturated
S-3A	8 - 10	165	normal response, PHC odor, auger sample

As summarized above, all of the samples exhibited PID readings significantly greater than the 1 part per million (ppm) that GZA considers to be representative of background conditions. A number of the samples, particularly from the borings where petroleum-saturated soils and characteristic fuel oil odors were noted had an unusual slow PID meter response time. This observation may reflect the lower volatility of fuel oil compounds. PID readings ranged from 31 to 209 ppm. The highest readings were encountered in GZ-4, GZ-5 and GZ-8 and corresponded to samples with visible petroleum contamination. These PID readings as a whole are generally higher than those observed in our earlier investigation.

Based on the PID results and our field observations, seven soil samples were submitted for VOC screening by static headspace gas chromatograph (GC) techniques using a Hewlett Packard Model 5890A GC. This screening permits the tentative identification and approximate quantification of individual VOCs. Eight samples were submitted for petroleum hydrocarbon analysis using the GC-FID method. The laboratory data, target compounds and the testing procedure are presented in Appendix C; results are summarized below.

Target Compound	GZ-4 S-4	GZ-5 S-2	GZ-5 S-4	GZ-6 S-2	GZ-7 S-3	GZ-8 S-1	GZ-8 S-3A
Trichloroethylene (ppm)	ND	120	ND	ND	ND	ND	ND
No. of Unknowns	53	20	51	1	1	54	65

Most of the samples were characterized by a large number of "unknowns". "Unknowns" are peaks on the chromatograph that have not been identified, but which generally are not associated with priority pollutant VOCs. According to the laboratory the pattern of the chromatograms for these samples indicates the presence of "petroleum distillates such as gasoline or fuel oil." A priority pollutant VOC, trichloroethylene was identified in the five to seven foot sample from GZ-5, immediately downgradient of the tank. No other priority pollutant VOCs were identified in the other samples; however, their detection may have been obscured by interference in those samples with a large number of "unknowns". The samples from GZ-6 and GZ-7 had only one "unknown" compound, which was tentatively identified as methanol. This compound, which was also found in the method blank and in all other samples is thought to be a laboratory remnant.

These samples, plus additional samples from GZ-4 (S-2), GZ-5 (S-3), and GZ-8 (S2A), were also submitted for analysis for petroleum hydrocarbons (PHC-f) using a modified ASTM Method D3328. This GC procedure provides a measure of the concentration of petroleum hydrocarbon compounds in a sample and by comparison with standards can be used to "fingerprint" or qualitatively identify these compounds. The procedure and analytical results in parts per million (ppm) are presented in Appendix C and are summarized below.

	GZ-4 S-2	GZ-4 S-4	GZ-5 S-2	GZ-5 S-3	GZ-5 S-4	GZ-6 S-2	GZ-7 S-3	GZ-8 S-2A	GZ-8 S-3A
PHC (ppm)	22	24,000	2,900	64	3,400	<10	<10	1400	21,000

All the samples except those from GZ-6 and GZ-7 contain moderate to high concentrations of petroleum hydrocarbons. Concentrations were lowest in near surface samples and highest in the samples from 15 to 17 feet in GZ-4 and GZ-5 and eight to ten feet in GZ-8. A fingerprint analysis on GZ-8,S-3A, an obviously petroleum-saturated soil, identified the the contaminant as No. 4 fuel oil.

Groundwater Samples

Groundwater samples collected from GZ-1, GZ-7 and GZ-8 were screened for VOCS. No VOCs were detected in either GZ-1, the upgradient well, or GZ-7, the well closest to the southwestern property line. The sample from GZ-8 was in equilibrium with petroleum product, thus would be expected to have high concentrations of VOCs and/or "unknowns". In addition to 51 "unknowns", this sample contained 2,800 ppb of characteristic gasoline compounds (toluene, ethylbenzene, xylene and MTBE). The laboratory indicated that other priority pollutant compounds may not have been identified due to interference from the large number of unknown compounds.

PHC-f analyses were also conducted on the groundwater sample from GZ-7 and on a sample of the product from GZ-8. The sample from GZ-7 had a PHC concentration of 2.5 ppm characterized as No. 6 fuel oil/asphalt. The laboratory also reports the presence of polynuclear aromatic hydrocarbons in this sample. The sample from GZ-8 was identified as No. 4 fuel oil. The concentration reported (350,000 ppm) is considered to be representative of the approximate order of magnitude only. The GC technique does not provide very accurate quantification at these high concentrations.

Water samples were also screened for pH and specific conductance within 24 hours of collection hours of collection. The pH is a measure of the acid or basic nature of water, and specific conductance is a measure of dissolved ions in water. An (Orion Research

Model 701A Digital Ionalyzer) was used to measure pH, and an (Extech Model 440 Digital Conductivity Meter) was used to measure specific conductivity. Results of this screening are summarized below.

Sample No	pH (standard units)	Specific Conductance (micromhos/cm)
GZ-1	6.1	420
GZ-7	6.5	550

These values are generally considered within the range of New England groundwater collected from urban environments although the specific conductance of sample GA-7 may be slightly elevated. In GZA's experience values grater than 500 micromhos/cm may be influenced by a variety of anthropogenic sources including road deicing salts, dissolved metals and nutrient loading.

CONTAMINANT SOURCE AND DISTRIBUTION

Based on the results of this investigation, the principal contaminant at the site is identified as No. 4 fuel oil. This contamination appears to be associated with the UST currently in use. Comparison of results of this investigation with results of the previous investigation suggests that the petroleum contamination has worsened in the past nine months following the recent filling of the No. 4 fuel oil UST. In the earlier study only No. 2 fuel oil and asphalt were identified as the petroleum contaminants. The maximum PHC concentration of 2,600 ppm was measured in GZ-3 at a depth of 10 feet. No floating product was detected in this well. In addition, only a petroleum sheen was noted in GZ-2 in our earlier study in contrast to the 0.7 feet of product measured in the current study.

The most heavily contaminated soils were found at depths of 10 feet or greater, suggesting that it is the tank that is leaking, rather than or in addition to the piping system. In addition, the highest concentrations of contaminants were identified in GZ-4, immediately upgradient of the tank, suggesting that the leak may be on the upgradient side of the tank. High concentrations of contaminants were also detected at depth in GZ-8, northwest of the UST reflecting the lateral spread of the fuel oil. The contaminant appears to collect at the bedrock surface, and appears to have migrated as far downgradient as GZ-3, 70 feet away. Low concentrations of PHC in groundwater in GZ-7, closest to the southeastern property line suggest that contaminants may have migrated even further in the groundwater.

We also suspect that there may be some leakage from the piping system based on the relatively high concentrations of PHC and gasoline odors in near surface soils from GZ-8 and the reported presence of gasoline constituents in the groundwater from this well. The source of the gasoline is unclear, however, it may have been used in an earlier attempt to clear a blocked pipeline.

Near-surface soils in GZ-5 were also contaminated with low to moderate concentrations of trichloroethylene. This contaminant was identified in our earlier study at trace levels in GZ-2 and moderate levels in GA-3, both in surface soils. This contaminant may also be present in deeper soils and in groundwater in the area of the UST but could not be identified due to interference from petroleum compounds. The source of the trichloroethylene has not yet been identified It does not appear, however, that the groundwater is as significantly contaminated with this compound compared to petroleum products.

RECOMMENDATIONS FOR REMEDIATION

Per your request we have provided conceptual recommendations for remediation at the site. We understand that this request is based on your need to assess the overall value of the property. It must be recognized that the need for, objectives, and extent of site remediation largely rests with the RIDEM. Our recommendations presented below are based on our interpretation of applicable regulations and experience on similar sites. The presence of the observed petroleum product contamination in the soil constitutes evidence of a leak or spill of petroleum and, as such, requires notification by the owner to RIDEM. RIDEM will also need to be consulted prior to undertaking any remediation at the site.

The following recommendations for remediation of the site take into account the urban setting of the site and the existence of public water supply service lines throughout the area (i.e., no use of groundwater for drinking water purposes). We are also assuming that the site is to remain an industrial site and that the existing building is to remain. We have made no provision for removal of any contamination that may exist beneath the building or in areas that can not be excavated without special support/shoring of structures. The primary focus of remediation is assumed to be the UST system. Our recommended actions presented below and preliminary cost estimates presented in Table 1 are subject to the Limitations listed in Attachment A. As noted, it is our understanding that your interest in approximate remediation costs is prompted by a need to assess the total property value rather than to obtain bids for remediation.

For the purposes of these cost estimates we are also assuming that: 1) remediation of groundwater will not be required by RIDEM. 2) the oil contamination can be considered to be from a spill or leak of a fuel oil tank thus can be disposed of at an asphalt batching plant, and 3) free floating petroleum has not migrated beyond the immediate UST area. If these assumptions prove incorrect costs are likely to increase substantially.

Tank Removal and Contaminated Soil Disposal

We recommend removal of the active 15,000 gallon No. 4 fuel oil UST and associated piping system. Associated oil saturated and highly contaminated soils should also be removed. Since RIDEM has no established cleanup criteria for oil contaminated soils, it is difficult to predict residual concentrations of petroleum hydrocarbons that would be permitted to remain on site. We are presenting two relatively conservative estimates, one assuming that a five foot thickness of contaminated soil will need to be removed over 2,800 square foot area surrounding the tank. This volume would include the obviously oil-saturated soils.

The second estimate assumes that a ten foot thickness of soils, characterized by TPH concentrations > 1000 ppm, will need to be removed over this same 2,800 square foot area. Lesser thicknesses of contaminated soils are assumed to be removed downgradient of the tank in both scenarios. Total volumes of soil (excluding the volume of the tank) would be approximately 570 cubic yards for the first estimate and approximately 970 cubic yards for the second estimate. Cleanup costs based on these soil volume estimates are presented in Table 1.

The area of soil removal includes the area where a second tank may exist. We are assuming that if this tank does exist, it is concrete and could also be excavated and disposed of in a similar fashion to the contaminated soil. Excavation costs might be more expensive, however the volume of soil to be disposed of should be reduced, thus, we believe our cost estimates cover the presence of a second tank.

As previously noted, our cost estimates also assume disposal of the contaminated soil at an in-state asphalt-batching plant. We have assumed a relatively high disposal cost of $90/ton including loading and transportation. Depending on the volume of soil to be disposed of, lower disposal rates can often be negotiated.

If high concentrations of chlorinated solvents such as TCE are encountered in the highly oil contaminated soils, such that these soils exceed the Toxicity Characteristic Leaching Procedure (TCLP) limits, they may need to be disposed of at a secured landfill or incinerated at greatly increased costs. Given that some near surface soils had low concentrations of TCE there is the risk that deeper, oil contaminated soils also contain TCE.

It should be recognized that it may prove infeasible to remove significant volumes of soil due to concerns over the integrity of adjacent structures and limitations imposed by above or below ground utilities. We have not considered these limitations in developing the above estimates.

Oil Recovery System

An oil recovery system may need to be installed if significant quantities of petroleum product are encountered during excavation and/or given the presence of floating petroleum product beyond the immediate excavation. A simple trench-type product recovery system is assumed to be feasible. Estimated costs for a simple oil recovery system are presented in Table 1. We have assumed that product recovery will not be required from areas beneath buildings on the site and off-site.

TCE Contaminated Soils

If additional testing shows TCE to be present at significant levels, RIDEM may require that some action be taken to remediate near surface soils contaminated with TCE. Remediation alternatives range from removal and disposal to on-site or in-situ treatment. Since we anticipate that most of these soils will be excavated during the tank removal activities we are presenting cost estimates for both on-site treatment and off-site disposal. On-site treatment would require permitting through RIDEM, a costly and time consuming process, which has no guarantee of success. (No such remediation sites are known to have yet been permitted in Rhode Island.) However if the soil volumes are large and the TCE concentrations high enough to require incineration, the costs of on-site treatment are likely to be less than off-site disposal. For the anticipated soil volume of 550 cubic yards on-site treatment may be slightly less costly than off-site disposal. (Please note the available data only indicates the presence of TCE at relatively low levels in near surface soils, thus this may not be a significant remedial issue).

Summary of Estimated Costs

The estimated costs presented in Table 1 range from $142,000 to $455,000 or more. This range of estimates cannot be further refined without input from RIDEM regarding specific cleanup criteria for this site. The lower estimate assumes that only minimal actions are taken to excavate oil-saturated soils during removal of the tank. In addition, no action would be taken to remediate TCE contaminated soils. The high estimate assumes that all oil contaminated soils with PHC concentrations greater than 1000 ppm are removed and that TCE contaminated soils are removed and disposed of off-site at a secured landfill.

Please note that if TCE contaminated soils require off-site treatment or incineration, costs could be substantially higher, although we do not anticipate that this would be the case. It should also be noted that we have not provided an estimate for ongoing operation of an oil-recovery system nor for additional monitoring of groundwater conditions. Further, our estimates are based largely on the premise that free floating petroleum product is limited to the immediate UST area. There is a potential that product migration pattern are more complex than assumed and that product is present beneath adjacent structures on and/or off-site. If this were found to be the case, it may prove necessary to install a much more expensive recovery system.

SUMMARY AND CONCLUSIONS

Additional subsurface investigations have been conducted at the 100 Bosworth Street Site in Providence, Rhode Island. Our work included a magnetometer survey to delineate the boundaries of UST systems, the performance of borings, installation of groundwater monitor wells and chemical screening and analysis of soil and groundwater samples. In addition we have developed recommendations and preliminary cost estimates for remediation of the site. Our key findings and conclusions are summarized below.

1. A 15,000 gallon UST and associated piping system has been located at the site and is currently in use. This tank was reportedly filled to capacity in October, 1991 with No. 4 fuel oil. A second underground piping system was also delineated, however, no metal tank was identified. This piping system may be connected to a concrete tank, or may have been connected to a tank that has since been removed.

2. Significantly higher concentrations of contaminants were identified at the site in this study as compared with our earlier assessment. The most severe contamination is localized at depth around the active UST. No. 4 fuel oil was identified as the primary contaminant. These findings suggest that the UST may be leaking.

3. Near surface soils and groundwater in the vicinity of the UST piping system also appear to be contaminated with gasoline. Near surface soil downgradient of the UST appear to be contaminated with low to moderate concentrations of TCE. The source of these contaminants (gasoline and TCE) has not been identified.

4. No petroleum or VOC contamination was detected in soils from the furthest downgradient well suggesting that petroleum product has not migrated to the southeastern property boundary. Groundwater in this well, however was contaminated with low concentrations of TPH (2.5 ppm).

Based on these findings, and the findings of our earlier study, GZA is recommending that the UST system be removed together with the severely oil-contaminated soils. RIDEM will need to be consulted to establish cleanup criteria for the site. There is the possibility that RIDEM will also require remediation of TCE-contaminated soils. Preliminary cost estimates for remediation, presented in Table 1, range from $142,000 to $455,000 or more.

LIMITATIONS

GZA's site assessment was performed in accordance with generally accepted practices of other consultants undertaking similar studies at the same time and in the same geographical area, and GZA observed that degree of care and skill generally exercised by other consultants under similar circumstances and conditions. Our findings and conclusions must be considered not as scientific certainties, but rather as our professional opinion concerning the significance of the limited data gathered during the course of the environmental site evaluation. No other warranty, express or implied, is made. Specifically, we does not and cannot represent that the site contains no hazardous material, oil, or other latent condition beyond that observed during our site assessment. This report is also subject to the specific limitations contained in Appendix A.

This study and report have been prepared on behalf of and for the exclusive use of Eastland Savings Bank, solely for use in an environmental assessment of the site. This report and the findings contained herein shall not, in whole or in part, be disseminated or conveyed to any other party, nor used by any other party in whole or in part, without the prior written consent of GZA GeoEnvironmental. However, GZA acknowledges and agrees that the report may be conveyed to the borrowers or site owner associated with the site transactions or to agents, successors or assigns of our Client.

We appreciate having the opportunity to perform this work for you. If you have any questions, please call the undersigned.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Julia C. Crowley
Project Manager

John J. Spirito
Project Reviewer

John P. Hartley
District Office Manager

JCC/JPH:rl

TABLES

TABLE 1

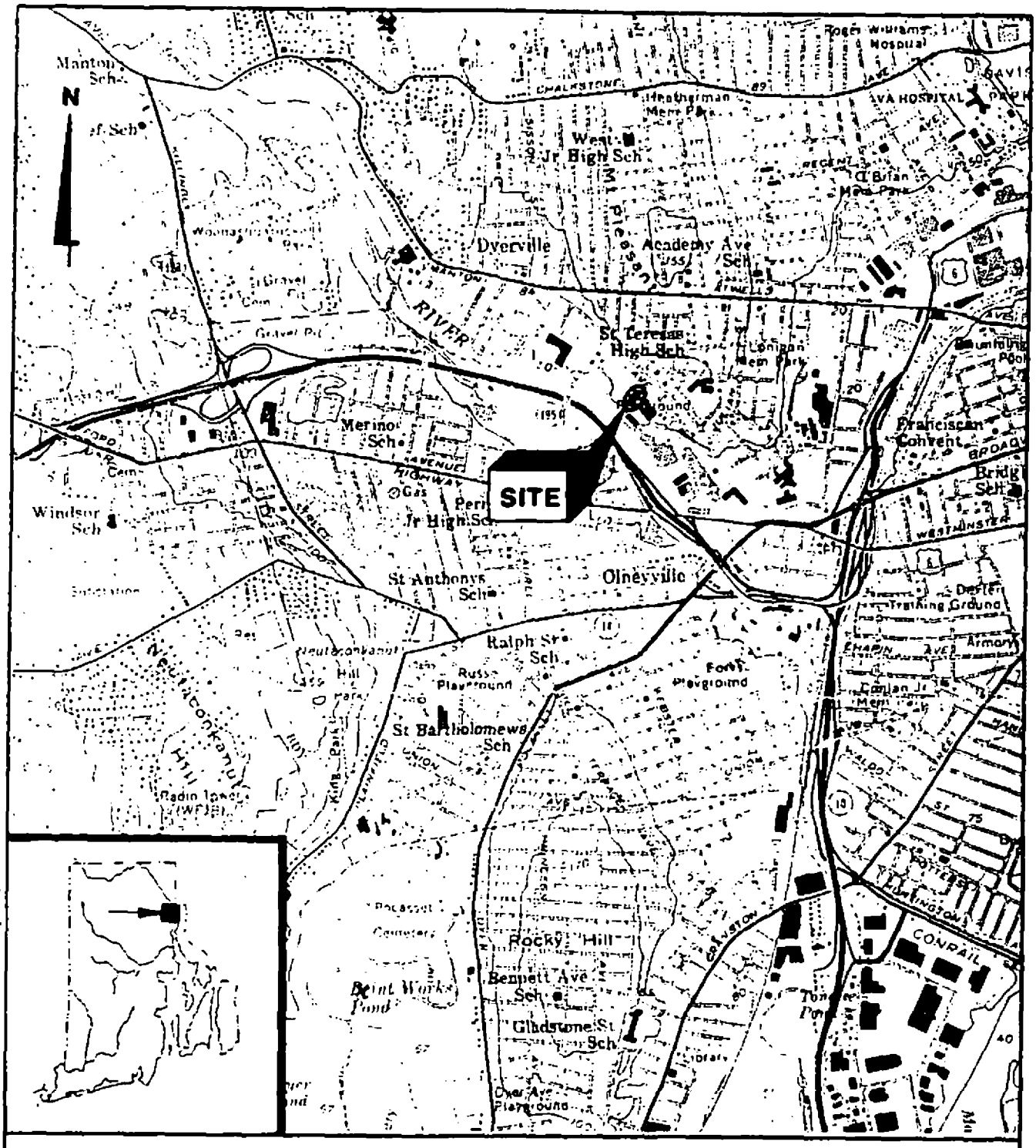
PRELIMINARY REMEDIATION COST ESTIMATES
100 Bosworth Street
Providence, Rhode Island

Remediation Alternative	Estimated Cost	Considerations
UST System 1. Tank Removal 2. Contaminated Soil Removal and Disposal 570 - 970 cu. yds. (includes backfill) 3. Tank Replacement (min. 10,000 gal.)	 $7,000 - $10,000 $90,000 - $170,000 $35,000 - $45,000	2. Lower estimate assumes disposal of oil saturated soils only, higher estimate, soils with >1000 ppm PHC.
Oil Recovery System	$10,000 - $30,000	Simple trench-recovery system
TCE Contaminated Soils (550 cu. yds) 1. On-Site Treatment 2. Off-Site Disposal	 $150,000 - $200,000 $200,000 +	1. On site treatment requires RIDEM Permit. 2. Costs may exceed $200,000 if soils require incineration.
TOTAL COSTS	$142,000 - $455,000+	Low estimate assumes no action for TCE-contaminated soils.

NOTES:

-1- Refer to the text and Appendix A for a discussion of the assumptions and Limitations inherent in the above estimates.

FIGURES



FROM USGS PROVIDENCE, RI QUADRANGLE MAPS

SCALE IN FEET

0' 1000' 2000' 4000'

File No. 30764

GZA

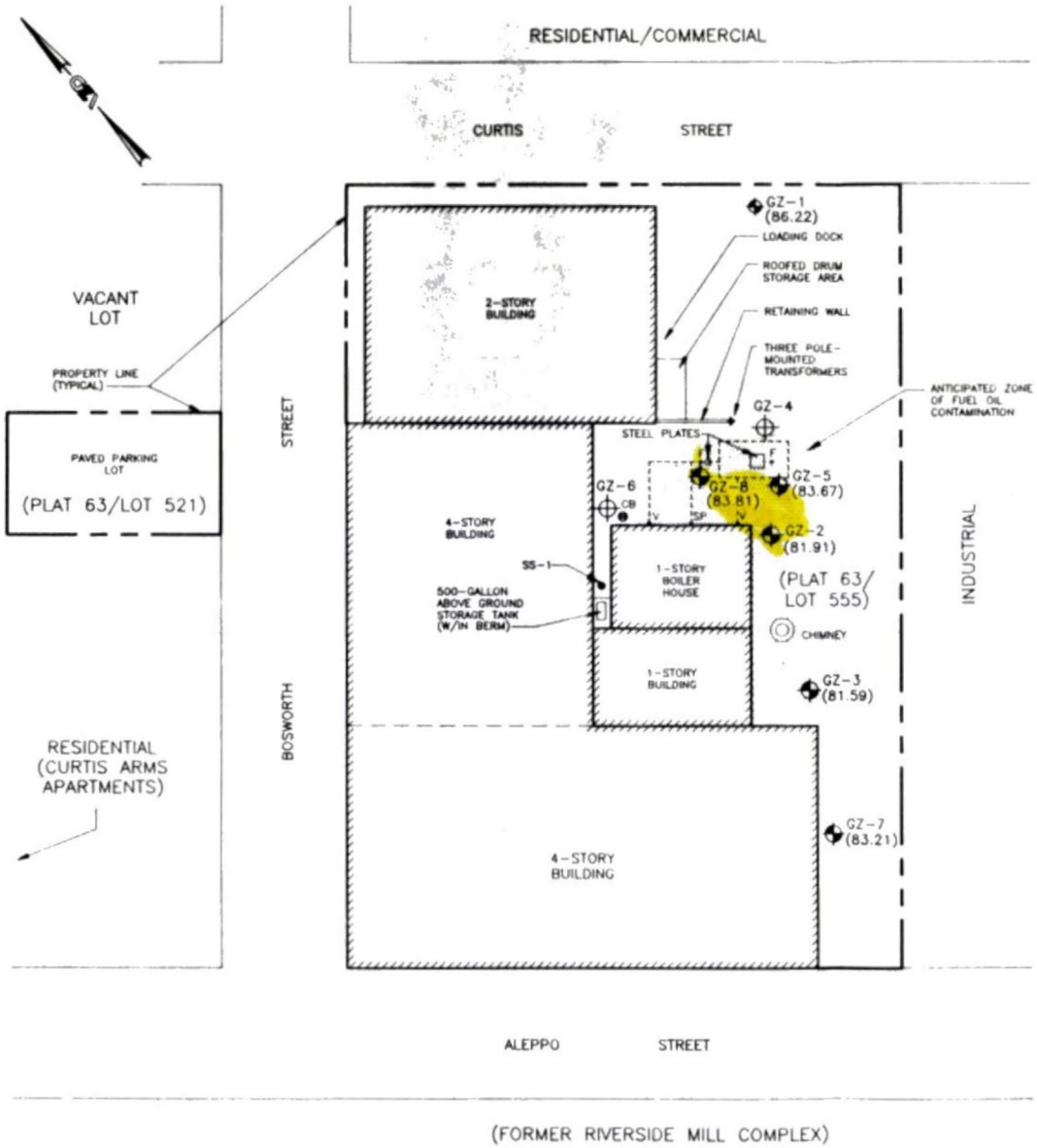
100 BOSWORTH STREET

PROVIDENCE, RHODE ISLAND

LOCUS PLAN

MARCH 1991

FIGURE NO. 1



NOTES:

1. THE BASE MAP WAS DEVELOPED FROM A 1951 SANBORN INSURANCE MAP AND FIELD OBSERVATIONS.
2. THE LOCATIONS OF SELECTED SITE FEATURES WERE APPROXIMATELY DETERMINED BY LINE OF SIGHT AND PACING FROM EXISTING TOPOGRAPHIC AND MAN-MADE FEATURES. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
3. WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT THE TIMES AND UNDER CONDITIONS STATED ON THE LOGS. THESE DATA HAVE BEEN REVIEWED AND INTERPRETATIONS MADE IN THE TEXT OF THE REPORT. HOWEVER, IT MUST BE STATED THAT FLUCTUATIONS IN THE LEVEL OF THE GROUNDWATER MAY OCCUR DUE TO VARIATIONS IN RAINFALL, TEMPERATURE AND OTHER FACTORS DIFFERENT FROM THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

LEGEND:

GZ-1 — BORINGS PERFORMED AND OBSERVATION WELLS INSTALLED BY GZA DRILLING, INC. ON MARCH 26, 1991, OBSERVED BY GZA PERSONNEL

(86.22) — GROUNDWATER ELEVATION (IN FEET) RECORDED ON DECEMBER 31, 1991

GZ-4 — BORINGS PERFORMED BY GZA DRILLING, INC. ON MARCH 26, 1991 AND DECEMBER 26, 1991, OBSERVED BY GZA PERSONNEL

SS-1 — SHALLOW SURFACE SOIL SAMPLING LOCATION, SAMPLE COLLECTED ON MARCH 26, 1991 BY GZA PERSONNEL

F — FILL PIPE

V — VENT PIPE

SP — STAND PIPE

CB — CATCH BASIN

REV. No.	DESCRIPTION	BY	DATE

PROJ. MGR. JPH
CHECKED BY: HDF
REVIEWED BY: JPH

DRAWN BY: BAW
SCALE: 1"=40'
DATE: JAN., 1992

GZA GeoEnvironmental, Inc.

SCALE IN FEET 0' 20' 40' 80'

100 BOSWORTH STREET

PROVIDENCE, RHODE ISLAND

EXPLORATION LOCATION PLAN

PROJECT No. 30764.1

FIGURE No. 2

A

APPENDIX A

LIMITATIONS & STATEMENT OF TERMS AND CONDITIONS

REMEDIAL COST ESTIMATES

ADDITIONS TO LIMITATIONS

1. The costs on which the preliminary remediation estimate is based are limited to those conditions which were discovered in carrying out the assessment of subsurface contamination identified in this report. Actual quantities and unit costs will vary. While the preliminary estimate represents our best professional judgment in this matter, it does not represent an absolute worst-case remedial cost estimate. The preliminary estimate includes only those cost items identified, and should not be assumed to include other costs such as legal, administrative or permitting costs.

2. The estimate is based on limited data which may not be sufficient to identify each and every condition existing at the site which may constitute noncompliance with applicable governmental statutes, rules, and regulations or constitute a release of oil or hazardous materials.

3. The preliminary estimate does not include any element with respect to third-party claims, fines, penalties, or other charges which may be assessed against any responsible party because of either the existence of present conditions or the future existence or discovery of any such conditions.

4. Governmental agencies' interpretations, requirements, and enforcement policies vary from district office to district office, from state to state, and between federal and state agencies. In addition, statutes, rules, standards, and regulations may be legislatively changed and inter-agency and intra-agency policies may be changed form present practices. GZA GeoEnvironmental, Inc. has used its experience and judgment in making assumptions as to how anticipated changes in enforcement policies may affect remediation costs.

5. This report contains approximate cost estimates for purposes of evaluating alternative remedial programs. These estimates involve approximate quantity evaluations. A preliminary estimate of this nature is likely to vary substantially from Contractors' Bid Prices and is not to be considered the equivalent of nor as reliable as Contractors' Bid Prices. Prices for similar work undertaken in the future will be subject to general and sometimes erratic price increases. The costs of future environmental, technical, and engineering services which may be required to implement any corrective action or remediation or installation of any systems cannot be accurately estimated.

6. This report has been prepared for the exclusive use of Client for specific application to the sites, in accordance with generally accepted soil and foundation engineering practices. No other warranty, express or implied, is made.

7. It is recommended that GZA GeoEnvironmental be retained to provide engineering services during final design, construction and/or implementation of any remedial measures recommended in this report. This is to allow GZA GeoEnvironmental to observe compliance with the concepts and recommendations contained herein, and to allow the development of design changes in the event that subsurface conditions differ from those anticipated.

STATEMENT OF TERMS AND CONDITIONS OF ENGAGEMENT

The terms and conditions set forth herein are incorporated, by reference, in the Proposal for Services, dated December 9, 1991, File Number 30764.1, directed to Eastland Savings Bank (the "Client").

This Proposal contains clauses that limit Company's liability to Client and require Client to indemnify Company for some claims for damages. The Proposal should be reviewed carefully, and Client may choose to consult with an attorney.

GZA GeoEnvironmental, Inc. ("Company") and Client agree as follows:

Section 1. Services. Company shall provide Client with the "Services" set forth in the Proposal for Services ("Proposal") with respect to the property identified in the Proposal (the "Site"), under the terms and conditions set forth herein. Client acknowledges that Company's Services require decisions which are based upon judgment stemming from limited data rather than upon scientific certainties. Client, in accepting Company's Proposal, acknowledges the inherent risks to Client and its property associated with the work described in the Proposal and with underground work in general. Company reserves the right to refuse to undertake services on behalf of any project or on behalf of any prospective Client. Client acknowledges that other qualified persons and entities are available to carry out the proposed Services.

Section 2. Billing and Payment. Client will pay Company for services performed in accordance with the rates and charges set forth in the Proposal. Invoices for Company's services will be submitted upon completion of Services. All invoices will be paid by Client within thirty (30) days after invoice date. Invoice balances remaining unpaid for thirty (30) days after invoice date will bear interest from invoice date at 1.5 percent per month or at the maximum lawful interest rate, if such lawful rate is less than 1.5 percent per month. If Client fails to pay any invoice in full within thirty (30) days after invoice date, Company may, at any time, and without waiving any other rights or claims against Client and without thereby incurring any liability to Client, elect to terminate performance of Services upon ten (10) days prior written notice by Company to Client. Notwithstanding any termination of Services by Company for non-payment of invoices, Client shall pay Company in full for all Services rendered by Company to the date of termination of Services plus all interest, termination costs and expenses incurred by Company and related to such termination. Client shall be liable to reimburse Company for all costs and expenses of collection, including reasonable attorneys' fees. Company's non-exercise of any rights or remedies, whether specified herein or otherwise provided by law, shall not be deemed a waiver of any such rights or remedies, nor preclude Company from the exercise of such rights or other rights and remedies under this instrument, or at law.

Section 3. Insurance. Company maintains Workers Compensation Insurance with respect to its employees with statutorily required limits. Company maintains public liability and property damage insurance policies. Certificates of Insurance evidencing such coverage will be provided to Client upon written request.

Section 4. Right of Entry. Client grants to Company the right, exercisable from time to time, of entry to the Site by Company, its agents, employees, consultants, contractors and subcontractors, for the purpose of performing all acts, studies and research, including the making of test borings and other explorations as described in the Proposal. Should Client not own the Site, Client warrants and represents by acceptance of the Proposal that it has authority and permission of Site Owner and any Site occupant to grant Company this right of entry. Company may require evidence of such authority in a form reasonably satisfactory to Company.

Section 5. Subsurface Explorations.

(a) **Normal Disturbance** - Client acknowledges that the use of exploration equipment may affect, alter or damage the terrain, vegetation and buildings, structures, improvements and equipment at, in or upon the Site. Client accepts such risks. Company will not be liable for any effect, alteration or damage arising out of such explorations except that caused by Company's negligent acts. Company will restore site to original grades prior to explorations but has not included costs for paving, landscaping or similar restoration activities.

(b) **Subterranean Structures** - Company will exercise a reasonable degree of care in seeking to locate subterranean structures in the vicinity of proposed subsurface explorations at the Site. Company will contact public utilities and review plans, if any, provided by public utilities and public agencies and plans and information about the Site provided by Client. So long as Company observes such standard of care and does not act in a negligent fashion, Company will not be responsible for any damage, injury or interference with any subterranean structure, pipe, tank, cable or any other element or condition if not called to Company's attention prior to commencement of work or which is not shown, or accurately located, on any plans furnished to Company by Client or by any other party, (public or private).

Section 6. Samples

(a) **General** - Company will dispose of all soil, rock, water and other samples thirty (30) days after submission of Company's initial report. Client may request, in writing, that any such samples be retained beyond such date, and in such case Company will ship such samples to the location designated by Client, at Client's expense. Company may upon written request arrange for storage of samples at one of Company's offices, at mutually agreed storage charges. Company will not give Client prior notice of intention to dispose of samples.

(b) **Disposal of Hazardous Samples** - If samples collected from the Site contain substances defined as "hazardous" by Federal, state or local statutes, regulations, codes, or ordinances, Company shall the have the right to: 1) dispose of samples by contract with a qualified waste disposal contractor; or 2) in accordance with Client's written directions, ship such samples by an appropriately licensed transporter to a licensed disposal site. Client shall pay all costs and expenses associated with the collection, storage, transport and disposal of samples. If Client requests, in writing, that any such sample be retained for a period in excess of thirty (30) days, Company will store such samples at Client's expense, and Client will pay an additional fee as charged by Company in accordance with its standard laboratory schedule for storage of samples of a hazardous nature.

Section 7. Construction Observation Services; Duties.

(a) **General** - Company, upon Client's written request, will provide personnel to observe and report to Client on specific aspects or phases of Client's project construction. Company's observation Services do not include any supervision or direction of work of any contractor or subcontractor, or their respective employees, agents or servants. Client shall notify each contractor and subcontractor that Company's observation Services do not include supervision or direction of the work and that neither the presence of Company's field representative nor the Services of observation and testing by Company, shall excuse the contractor or any subcontractor from the obligation to correct any defects then or thereafter discovered in the respective contractor's or subcontractor's work. Company will not be responsible for any contractor's or subcontractor's compliance with the provisions of any contract nor for the observation or supervision of any contractor's or subcontractor's use of personnel, machinery, equipment, safety precautions or procedures.

(b) **Construction Site Safety** - Company, by entering into an agreement with Client or by performing construction observation services, does not undertake any liability or responsibility for the development, supervision, or enforcement of any job or site safety requirements; nor for any failure of any contractor, subcontractor, or other third person or entity present on the Site to comply with the Occupational Safety and Health Act (Federal OSHA), or with any regulations or standards promulgated thereunder, or with any state, county, or municipal law, regulation, or ordinance of similar import or intent.

Section 8. Documents. All reports, boring logs, field data, field notes, laboratory test data, calculations, estimates and other documents, data or information prepared by Company as instruments of Service, shall remain the sole property of Company. All reports and other work prepared by Company for Client shall be utilized solely for the intended purposes and Site described in the Proposal. Company will retain all pertinent documents for a period of three (3) years following the submission of Company's report to Client. Such documents will be available to Client upon request at Company's office during office hours on reasonable notice, and copies will be furnished by Company to Client for the total cost of reproduction of the same.

Section 9. Client's Duty to Notify Company of Hazards. Client represents and warrants that it will provide Company with any and all information known to or suspected by Client to the extent known or suspected by the agents of Client communicating with Company, with respect to 1) the existence or possible existence at, on or under the Site of any hazardous materials, pollutants or asbestos as defined in the Federal Water Pollution Control Act; the Federal Comprehensive Environmental Response, Compensation and Liability Act of 1980; the Resource Conservation and Recovery Act of 1976, or under the provisions of federal, state, and local laws of similar import now or hereafter existing, 2) any condition known to Client to exist in, on, under or in the vicinity of the Site which might present a potential safety hazard or danger to human health or the environment, or 3) any permit, manifest, title record, or other record of compliance or non-compliance with any federal, state, or local laws relating in any way, directly or indirectly, to the past or present environmental conditions at the site.

Section 10. Hazardous Materials; Pollutants; Asbestos. If unanticipated potentially hazardous materials, pollutants or asbestos are encountered during the course of the work, Company shall have the right 1) to suspend its work immediately and 2) to terminate the work described in the Proposal, upon ten (10) days of Company's written notice of intent to terminate, unless Company and Client agree upon a mutually satisfactory amendment to the Proposal that may include a revision of the scope of services, adjustment of budget estimates, revised Terms and Conditions and revised fees. Client shall remain liable for and shall pay all fees and charges incurred under the provisions of the Proposal through the date of termination, notwithstanding Client and Company not having reached a new, mutually satisfactory, revision of their agreement.

Section 11. Confidentiality. Company will not disclose information regarding the Proposal, Company's Services or its Report, except 1) to Client, 2) parties designated by Client, or 3) as provided in Section 12 below. Information which is in the public domain or which is provided to the Company by third parties is excepted from the foregoing undertaking.

Section 12. Public Responsibility. Client acknowledges that the Client or the Site owner, as the case may be, is now and shall remain in control of the Site for all purposes at all times. Company does not undertake to report to any Federal, state, county or local public agencies having jurisdiction over the subject matter any conditions existing at the Site from time to time which may present a potential danger to public health, safety or the environment.

Notwithstanding the provisions of Section 11 and the foregoing, Company will comply with judicial orders or governmental directives, and federal, state, county and local laws, regulations and ordinances, and applicable codes regarding the reporting to the appropriate public agencies of findings with respect to potential dangers to public health, safety or the environment. If information indicates that there is an imminent and substantial endangerment to public health and safety, Company will notify Client of

such conditions. If Client fails to take appropriate actions, Company will notify appropriate authorities of such conditions. Client shall defend, indemnify and hold Company harmless from and against any and all claims, demands, liabilities and expense, including reasonable attorneys' fees, incurred by Company and arising directly or indirectly in connection with Company's reporting or disclosing such information under a bona fide belief or upon advice of counsel that such reporting or disclosure is required by law.

Section 13. Governing Law; Severability; Modifications; Assignment. Company maintains offices in several states. The agreement between Company and Client as set forth in the Proposal and in these Terms and Conditions shall be governed by and enforceable in accordance with the law of the jurisdiction in which Company's specific office issuing the Proposal is located. Such location shall be deemed the place of contracting.

The provisions of these Terms and Conditions are severable. The invalidity of any part of these Terms and Conditions shall not invalidate the remainder of these Terms and Conditions nor the remainder of any portion hereof.

These printed terms and conditions cannot be modified orally or by any course of conduct. Any modification must be acknowledged in writing by Company. These conditions shall take precedence over any inconsistent or contradictory provisions contained in any proposal, contract, purchase order, requisition, notice to proceed, or like document issued by Client. Client shall not assign any aspect of the agreement between Client and Company except upon the prior written consent of Company.

Section 14. Third Party Indemnity. Client agrees that Company has neither created nor contributed to the creation of any hazardous materials, pollutants, asbestos, or other potentially dangerous substance that is now or may be in the future discovered or introduced at the Site. Company hereby states, and Client acknowledges by acceptance of the Proposal, that Company may not have any professional liability or other coverage insuring Company for acts, errors and omissions, and Company may be unable to obtain such insurance at reasonable cost, for claims arising out of the performance of services, including but not limited to, investigation, assessment or evaluation of hazardous materials or pollutants or the detection, abatement, removal or replacement of products, materials or processes containing asbestos.

Client agrees to defend, indemnify and hold harmless Company, its subcontractors, consultants, agents, officers, directors, and employees harmless from and against any and all claims for damages and all costs, liability or expense, whether direct, indirect, economic, or consequential, including reasonable attorneys' fees, and court and arbitration costs, sustained or alleged by any person or entity other than Client, based upon or arising in connection with: 1) a release of hazardous materials or pollutants; 2) bodily injury including death and property damage (real or personal) or any other claim of damage, expense or loss, caused by the release, removal, remediation, assessment, evaluation or investigation

of hazardous materials or pollutants; 3) removal, assessment, evaluation or investigation of, or remedial action taken because of, the release or suspected release of hazardous materials or pollutants; 4) any federal, state, local or other governmental fines or penalties related to hazardous materials or pollutants; or 5) the detection, abatement, removal, or replacement of products, materials, or processes containing asbestos.

Section 15. Limitation of Professional Liability.

(a) **General** - Client agrees that Company's liability to Client based upon or arising out of Company's alleged breach of contract or negligent professional acts, errors or omissions is limited, in amount, to the aggregate sum of $75,000 or Company's aggregate fee for services rendered on the subject project, whichever amount is greater.

(b) **Construction Projects** - Client agrees that Company's liability to Client and to any and all construction contractors and subcontractors for the project based upon claims arising as a result of Company's alleged breach of contract or negligent professional acts, errors or omissions is limited to the aggregate sum of $75,000 or Company's aggregate fee for services rendered on the subject project, whichever is greater.

(c) **Increased Limit of Professional Liability** - Company, upon Client's written request, agrees to increase the limit of Company's liability for breach of contract or negligent professional acts, errors or omissions in consideration of additional payment by Client or other consideration deemed appropriate by Company at the time. The request for increased limit of professional liability must be made to Company in writing at the time of Client's acceptance of the Proposal.

Client may indicate a requested limit of liability by initialing and dating in the appropriate spaces below.

Limit of Liability	Additional Fee	Initials	Date
$ 75,000	none	_____	_____
$100,000	$2,000	_____	_____

Any additional fee is due at the time of Client's request, and the increased limit of liability will become effective upon payment of the fee and execution of the Proposal. Additional monetary or other consideration given by Client for the additional economic risk assumed by Company shall not be construed as a charge for the placement or provision of additional professional liability insurance by Company.

GZA GeoEnvironmental, Inc. is an
Equal Opportunity - Affirmative Action Employer
M/F/V/H

B

APPENDIX B

BORING LOGS

GZA GEO ENVIRONMENTAL, INC.
140 BROADWAY, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
100 BOSWORTH STREET
Providence, R.I.

REPORT OF BORING No. GZ-4
SHEET 1 OF 1
FILE No. 30764.10
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Chbrlie Lenting
GZA ENGINEER Mike Baer

BORING LOCATION See Exploration Location Plan
GROUND SURFACE ELEVATION DATUM
DATE START 12-26-91 DATE END 12-26-91

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3 3/4" H.S.A.

GROUNDWATER READINGS

DATE	TIME	WATER	CASING	STABILIZATION TIME

DEPTH	CASING	BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION (Burmister CLASSIFICATION)	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	LAB TESTING (ppm)	REMARKS
			S-1	24/10	0.5-2.5	10-7	ASPHALT, COBBLE STONES Loose, brown, fine to coarse SAND and GRAVEL	ASPHALT	Boring Only Equipment Not Installed	48	1.
						5-4		FILL			
5			S-2	24/12	5-7	15-26	Medium dense, tan, fine to coarse SAND and GRAVEL (6 1" stones)	7'+		49	
						25-33					
10			S-3	24/8	10-12	8-8	Loose, tan, medium to fine SAND, trace Silt and fine Gravel (Wet) Slight petroleum sheen	FINE TO MEDIUM SAND TRACE SILT AND FINE GRAVEL		52	
						10-11					
15			S-4	12/8	15-17	3-21	Medium dense, tan, fine SAND, trace Silt. Heavy petroleum sheen	17'+		100	
						50 (0)		ROTTENSTONE 18.5'+			
20							Auger Refusal at 18.5'+ End of Exploration				
25											
30											
35											
40											

REMARKS: 1. Soil samples screened for total organic volatile organic compounds (VOCs) in the office using a Thermo Instruments Model 105A photoionization detector employing a 10.6 eV lamp. Concentrations in parts per million (ppm).

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-4

GZA GEO ENVIRONMENTAL, INC. 140 BROADWAY, PROVIDENCE, RHODE ISLAND GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT 100 BOSWORTH STREET Providence, R.I.	REPORT OF BORING No. GZ-5 SHEET 1 OF 1 FILE No. 30764.10 CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Charlie Lenling
GZA ENGINEER Mike Baer

BORING LOCATION See Exploration Location Plan
GROUND SURFACE ELEVATION DATUM
DATE START 12-26-91 DATE END 12-26-91

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3 3/4" H.S.A.

GROUNDWATER READINGS

DATE	TIME	WATER	CASING	STABILIZATION TIME	
12-31-91		83.67	91.99	5 days	3.

DEPTH	CASING	BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	LAB TESTING (ppm)	REMKS
			S-1	24/5	0-2	3-20	Medium dense, brown, medium to fine SAND	ASPHALT	Cement	56	1.
						24-30					2.
								FILL	2.5' Bentonite Seal 3.5'		
5			S-2	24/10	5-7	12-17	Medium dense, brown, coarse to fine SAND, trace fine Gravel and red Brick		5'+	47	
						19-22		7'+			
								FINE SAND TRACE SILT AND FINE GRAVEL	Filter Sand		
10			S-3	24/10	10-12	20+-20+	Medium dense, tan, fine SAND, trace Silt and fine Gravel (Wet and very little petroleum odors)			38	
						20+-20+					
								15'+	15'+		
15			S-4	9/9	15-16	52-70(3)	Dense, gray to tan Schist or Granodiorite, trace Silt and Clay (Rottenstone) Slight PHC odor	ROTTENSTONE		72	
							End of Exploration at 15.5'+				
20											
25											
30											
35											

REMARKS:
1. Soil samples screened for total organic volatile organic compounds (VOCs) in the office using a Thermo Instruments Model 105A photoionization detector employing a 10.6 eV lamp. Concentrations in parts per million (ppm).
2. A 1.5-inch diameter Sch. 40 PVC well screen was installed from 5 to 15 feet below grade and 5' of riser to the ground surface. Filter sand was placed in the annulus from about 3.5 to 15 feet below grade. A bentonite seal was placed at a depth of 2.5 to 3.5 feet. The well is capped with a 2-foot cast iron, flush mounted road box cemented in place.
3. Floating product encountered at elevation stated. Thickness of product estimated to be >2 feet.

NOTES:
1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-5

GZA GEO ENVIRONMENTAL, INC.
140 BROADWAY, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
100 BOSWORTH STREET
Providence, R.I.

REPORT OF BORING No. GZ-6
SHEET 1 OF 1
FILE No. 30766.10
CHKD. BY

BORING Co. GZA Drilling, Inc.
FOREMAN Charlie Lenling
GZA ENGINEER Mike Beer

BORING LOCATION See Exploration Location Plan
GROUND SURFACE ELEVATION DATUM
DATE START 12-26-91 DATE END 12-26-91

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3 3/4" H.S.A.

GROUNDWATER READINGS

DATE	TIME	WATER	CASING	STABILIZATION TIME

DEPTH	CASING	BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	LAB TESTING (ppm)	REMKS
			S-1	24/2	1-3	3-3	0.5' CONCRETE	CONCRETE		31	1.
						12-16	Loose, brown, fine SAND, trace Silt and fine Gravel				
							Rock in spoon	FILL			
5			S-2	24/6	5-7	26-31	Dense, tan, fine SAND, trace Silt			40	
						40-53	Concrete footing at 7'	7'+			
								CONCRETE 9'+			
10							Auger Refusal at 9.0'+ End of Exploration at 9'+				
15											
20											
25											
30											
35											
40											

REMARKS: 1. Soil samples screened for total organic volatile organic compounds (VOCs) in the office using a Thermo Instruments Model 105A photoionization detector employing a 10.6 eV lamp. Concentrations in parts per million (ppm).

NOTES: 1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED, FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-6

GZA GEO ENVIRONMENTAL, INC.
140 BROADWAY, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
100 BOSWORTH STREET
Providence, R.I.

REPORT OF BORING No. GZ-7
SHEET 1 OF 1
FILE No. 30764.10
CHKD. BY GM

BORING Co. GZA Drilling, Inc.
FOREMAN Charlie Lenting
GZA ENGINEER Mike Baer

BORING LOCATION See Exploration Location Plan
GROUND SURFACE ELEVATION DATUM
DATE START 12-26-91 DATE END 12-26-91

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3 3/4" H.S.A.

GROUNDWATER READINGS

DATE	TIME	WATER	CASING	STABILIZATION TIME
12-31-91		83.21	88.04	5 days

DEPTH	CASING	BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	LAB TESTING (ppm)	REMKS
			S-1	24/0	0.5-2.5	3-7	0.5' ASPHALT	ASPHALT	Road Box		1.
						7-9	Loose, No Recovery	FILL	Riser 1.5' Bentonite Seal 2.5' 3'+		
5			S-2	24/8	5-7	30-38	Dense, brown, coarse to fine SAND, trace Silt and fine Gravel (Wet)	5'+ COARSE TO FINE SAND	Screen Filter Sand	27	
						8-12					
10			S-3	24/24	10-12	3-9	Loose to dense, fine to very fine SAND, trace Silt and fine Gravel	FINE SAND	10'	43	
						17-5					2.
							End of Exploration at 12'+				
15											
20											
25											
30											
35											

REMARKS:
1. Soil samples screened for total organic volatile organic compounds (VOCs) in the office using a Thermo Instruments Model 105A photoionization detector employing a 10.6 eV lamp. Concentrations in parts per million (ppm).
2. A 1.5-inch diameter Sch. 40 PVC well screen was installed from 3 to 10 feet below grade and 3' of riser to the ground surface. Filter sand was placed in the annulus from about 2.5 to 10 feet below grade. A bentonite seal was placed at a depth of 1.5 to 2.5 feet. The well is capped with a 2-foot cast iron, flush mounted road box cemented in place.

NOTES:
1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-7

GZA GEO ENVIRONMENTAL, INC.
140 BROADWAY, PROVIDENCE, RHODE ISLAND
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT
100 BOSWORTH STREET
Providence, R.I.

REPORT OF BORING No. GZ-8
SHEET 1 OF 1
FILE No. 30764.10
CHKD. BY CMC

BORING Co. GZA Drilling, Inc.
FOREMAN Charlie Lenting
GZA ENGINEER Mike Baer

BORING LOCATION See Exploration Location Plan
GROUND SURFACE ELEVATION DATUM
DATE START 12-26-91 DATE END 12-26-91

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in.

CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING A 300 lb. HAMMER FALLING 24 in.

CASING SIZE: OTHER: 3 3/4" H.S.A.

GROUNDWATER READINGS

DATE	TIME	WATER	CASING	STABILIZATION TIME	
12-31-91		83.81	92.68	5 days	3.

DEPTH	CASING	BLOWS	SAMPLE No.	PEN./REC.	DEPTH (Ft.)	BLOWS/6"	SAMPLE DESCRIPTION Burmister CLASSIFICATION	STRATUM DESCRIPTION	EQUIPMENT INSTALLED	LAB TESTING (ppm)	REMKS
			S-1	24/6	0.5-2.5	7-7	0.5' CONCRETE (Gasoline or solvent odors	CONCRETE	Concrete	209	1.
						8-9	Loose, brown, coarse to fine SAND, trace fine Gravel		1.5' Bentonite Seal 2.5'		
								MEDIUM SAND AND GRAVEL (FILL)	3'+		2.
5			S-2	24/1	5-7	3-3	ROCK: brown, medium SAND, fuel oil odors			107	
						5-3			Filter Sand		
								10'+			
10			S-3	12/6	10-12	12-35	Medium dense, oil-saturated "ROTTENSTONE"	ROTTENSTONE 12'+	10'+	160	
						50 (5")					2.
							End of Exploration at 12'+				
15											
20											
25											
30											
35											

REMARKS:
1. Soil samples screened for total organic volatile organic compounds (VOCs) in the office using a Thermo Instruments Model 105A photoionization detector employing a 10.6 eV lamp. Concentrations in parts per million (ppm).
2. A 1.5-inch diameter Sch. 40 PVC well screen was installed from 3 to 10 feet below grade and 3' of riser to the ground surface. Filter sand was placed in the annulus from about 2.5 to 10 feet below grade. A bentonite seal was placed at a depth of 1.5 to 2.5 feet. The well is capped with a 2-foot cast iron, flush mounted road box cemented in place.
3. Floating product encountered at elevation stated. Thickness of product estimated to be >2 feet.

NOTES:
1) STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARY BETWEEN SOIL TYPES. TRANSITIONS MAY BE GRADUAL.
2) WATER LEVEL READINGS HAVE BEEN MADE AT TIMES AND UNDER CONDITIONS STATED. FLUCTUATIONS OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE

GZA

BORING No. GZ-8

C

APPENDIX C

ANALYTICAL DATA

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
(617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: / GZA LAB #:	METHOD BLANK / 010692-QC	GZ-8, S-3A / 03870-FP
1. HYDROCARBON CONTENT	< 10	21,000
2. PERCENT SOLID CONTENT	N/A	90
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	Diluted out

QUALITATIVE IDENTIFICATION: The characteristics of the chromatogram for sample "GZ-8, S-3A" indicate the presence of a petroleum product in the boiling range of fuel oil #4. The phytane /n-C18 ratio of 1.8 indicates that moderate weathering has occurred.

ANALYZED BY: S. Faulkner REVIEWED BY: C.W. Pickering

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
(617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: GZA LAB #:	METHOD BLANK 010692-QC	GZ-4, S-2 03862-PHC
1. HYDROCARBON CONTENT	< 10	22
2. PERCENT SOLID CONTENT	N/A	96
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	126%

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faultner REVIEWED BY: CW Pickering

GZA GEOENVIRONMENTAL, INC.
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320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
(617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: / GZA LAB #:	METHOD BLANK 010692-QC	GZ-4, S-4 03863-PHC
1. HYDROCARBON CONTENT	< 10	24,000
2. PERCENT SOLID CONTENT	N/A	89
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	Diluted out

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faulkner REVIEWED BY: CW Pickering

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
(617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: / GZA LAB #:	METHOD BLANK / 010692-QC	GZ-5, S-2 / 03864-PHC
1. HYDROCARBON CONTENT	< 10	2,900
2. PERCENT SOLID CONTENT	N/A	89
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	Diluted out

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faulkner REVIEWED BY: CW Pahering

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
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MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: / GZA LAB #:	METHOD BLANK 010692-QC	GZ-5, S-3 03866-PHC
1. HYDROCARBON CONTENT	< 10	64
2. PERCENT SOLID CONTENT	N/A	90
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	Diluted out

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faulkner REVIEWED BY: CW Pickering

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
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HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: GZA LAB #:	METHOD BLANK 010692-QC	GZ-5, S-4 03865-PHC
1. HYDROCARBON CONTENT	< 10	3,400
2. PERCENT SOLID CONTENT	N/A	92
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	Diluted out

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faulkner REVIEWED BY: CW Richering

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
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HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: GZA LAB #:	METHOD BLANK 010692-QC	GZ-6, S-2 03867-PHC
1. HYDROCARBON CONTENT	< 10	<10
2. PERCENT SOLID CONTENT	N/A	92
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	120%

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faulkner REVIEWED BY: CW Pickering

GZA GEOENVIRONMENTAL, INC.
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MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: GZA LAB #:	METHOD BLANK 010692-QC	GZ-7, S-3 03868-PHC
1. HYDROCARBON CONTENT	< 10	<10
2. PERCENT SOLID CONTENT	N/A	88
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	131%

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faulkner REVIEWED BY: CW Pulsering

GZA GEOENVIRONMENTAL, INC.
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MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 1/6/92

SAMPLE NAME: / GZA LAB #:	METHOD BLANK / 010692-QC	GZ-8, S-2A / 03869-PHC
1. HYDROCARBON CONTENT	< 10	1,400
2. PERCENT SOLID CONTENT	N/A	90
3. MATRIX	N/A	SOIL
4. DETECTION LIMIT (TOTAL PRODUCT)	10	10
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.5	0.5
6. SURROGATE RECOVERY (O-TERPHENYL)	130%	Diluted out

QUALITATIVE IDENTIFICATION: N/A

ANALYZED BY: J. Faultner REVIEWED BY: CW Pickering

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164
(617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/31/91
DATE TESTED: 1/09/92

SAMPLE NAME: GZA LAB #:	METHOD BLANK 010992-QC	GZ-8 03881-FP
1. HYDROCARBON CONTENT	<0.5	350,000
2. PERCENT SOLID CONTENT	N/A	N/A
3. MATRIX	N/A	PRODUCT
4. DETECTION LIMIT (TOTAL PRODUCT)	0.5	0.5
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.02	0.02
6. SURROGATE RECOVERY (O-TERPHENYL)	105%	Diluted Out

QUALITATIVE IDENTIFICATION: The characteristics of the chromatogram for sample "GZ-8" indicate the presence of a petroleum product in the boiling range of fuel oil #4. The phytane/n-C18 ratio of 1.3 indicates that moderate weathering has occurred.

ANALYZED BY: J. Faulkner REVIEWED BY: K. Walsh

GZA GEOENVIRONMENTAL, INC.
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HYDROCARBON FINGERPRINTING
MODIFIED ASTM METHOD D3328
CONCENTRATION (PPM-ug/g or ug/ml)

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y-30764.1
DATE SAMPLED: 12/31/91
DATE TESTED: 1/09/92

SAMPLE NAME: / GZA LAB #:	METHOD BLANK 010992-QC	GZ-7 03877-FP
1. HYDROCARBON CONTENT	<0.5	2.5
2. PERCENT SOLID CONTENT	N/A	N/A
3. MATRIX	N/A	AQUEOUS
4. DETECTION LIMIT (TOTAL PRODUCT)	0.5	0.5
5. DETECTION LIMIT (INDIVIDUAL HYDROCARBONS)	0.02	0.02
6. SURROGATE RECOVERY (O-TERPHENYL)	105%	67%

QUALITATIVE IDENTIFICATION: The characteristics of the chromatogram for sample "GZ-7" indicate the presence of a petroleum product in the boiling range of fuel oil #6/asphalt. The characteristics of the chromatogram also indicate polynuclear aromatic hydrocarbons (PAHs) products of incomplete combustion at a total concentration of 0.84 ppm.

ANALYZED BY: [signature] REVIEWED BY: [signature]

GZA HYDROCARBON FINGERPRINTING TECHNIQUE BY GAS CHROMATOGRAPHY-FLAME IONIZATION DETECTION (PHC FINGERPRINT, GC-FID)

OVERVIEW

The methodology employed by GZA to determine hydrocarbon content in solid and aqueous environmental samples is a modification of ASTM Method D3328-78 in conjunction with a method developed by the U.S. Coast Guard. Data obtained by this method include an accurate total concentration of hydrocarbon content and an identification based on comparisons with laboratory petroleum standards. Identifications may also be made utilizing a virgin petroleum product acquired from a suspected source at the site.

METHODOLOGY

Solid samples are extracted using a 30 gram subsample which is initially mixed with anhydrous sodium sulfate (Na_2SO_4) to remove water from the matrix. The sample is subsequently mixed with pentane to form a slurry which is then extracted via sonic disruption. This process is repeated three times and the collected extract is cleaned up using a silica gel solid phase extraction (SPE) column. The collected elutriate is automatically concentrated to a 1 milliliter volume with a Zymark Turbovap Evaporator to enhance detection limits of the method. Aqueous samples are extracted using a 200ml aliquot in a liquid/liquid extraction device using the solvent pentane. The extraction is repeated three times and the resulting extract is prepared following the same method as with solid environmental samples.

INSTRUMENTATION

The prepared extract is analyzed for hydrocarbon content using a Hewlett Packard Model 5890A Gas Chromatograph equipped with twin flame ionization detectors and a dual column capillary inlet system. The two Megabore capillary columns chosen for the analysis are a 30meter DB-5 and a 30meter DB-1. The sixty-five minute analysis is electronically controlled by a HP 7673A Autosampler and data are acquired with a Nelson Analytical 760 Series Intelligent Interface. The chromatographic data are then transmitted to an IBM AT personal computer and analyzed using the Nelson Analytical 2600 Series Chromatographic Software. The information for the analytical report is entered manually onto a Lotus Symphony Spreadsheet. The automation of the system allows the analyst to set optimum sample arrangement including calibration standards, method blanks, and duplicates.

QUALITY CONTROL

The gas chromatograph is calibrated using an average response factor determined for hydrocarbons that is calculated from internal and surrogate standards. The calibration is checked with every batch of samples by analyzing petroleum hydrocarbons of known concentration. Identification of petroleum product type is made by comparison with laboratory standards or with suspect petroleum sources on an individual site basis. Tracer compounds such as the isomer pair phytane/ n-octadecane are routinely used to

determine the degree of product "weathering" as in the case of fuel oil number 2. The surrogate standard o-terphenyl is added to samples and method blanks to determine the extraction efficiency of the applied method as a surrogate recovery.

REPORT FORMAT

The method detection limit for total hydrocarbon content has been determined empirically and is modified for each sample as a function of the dilution factor. The total concentration is summarized in the row labeled "Hydrocarbon Content". All reported results for hydrocarbon analysis environmental samples are reported in ug/g (ppm) unless otherwise indicated. Detection limits for individual hydrocarbons are reported for the purpose of determining levels of priority pollutant constituents of petroleums such as polyaromatic hydrocarbons (PAH's). Surrogate recoveries are reported for all method blanks and samples.

DISCLAIMER

Identities and concentrations of petroleum hydrocarbons reported in this analytical method are subject to the limitations inherent in the cited methods. This method is not an approved EPA method but is currently undergoing a review by the ASTM Committee D-29 on water for upgrades and certification.

LABORATORY CONTACT PERSON:

Edward W. Pickering, Manager
Environmental Chemistry Laboratory
GZA GeoEnvironmental, Inc.
Massachusetts Laboratory I.D. No. MA092
Telephone#: (617) 969-0050, x 169

REFERENCES

ASTM, "Standard Methods for Comparison of Waterborne Petroleum Oils by Gas Chromatography," Designation D3328, (1982).

U.S. Coast Guard, "Oil Spill Identification System by Gas Chromatography," Report No.: CG-D-52-77, (1977)

Commonwealth of Massachusetts DEP, "Minimum Standards for Analytical Data for Remedial Response Actions Under M.G.L. c.21E", Policy #WSC-89-004 (1990).

U.S. Coast Guard, "Analytical Method for Oil Spill Identification by Gas Chromatography", Central Oil Identification Laboratory (1988).

U.S. EPA "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846 Third Edition, Volume 1B, Method 3550: Sonication Extraction, Method 3630: Silica Gel Clean up (1986).

1/91/DM

JOB DESCRIPTION: 100 BOSWORTH STREET – PROVIDENCE, RI
JOB #: 30764.1
DATE SAMPLED: 12/31/91
DATE TESTED: 1/3/92

GZA GEOENVIRONMENTAL, INC.
320 NEEDHAM STREET
NEWTON UPPER FALLS, MA 02164
(617) 969-0050, x-289
LAB I.D. No.: MA092

GZA GC SCREENING FOR VOLATILE ORGANICS IN WATER
(CONCENTRATION – PPB, ug/l)

SAMPLE NAME: / GZA LAB #:	Method Blank 07787-B	GZ-1 37787-A	GZ-7 37788-A	GZ-8 37789-A			METHOD DETECTION LIMIT
1. TETRACHLOROETHENE	ND	ND	ND	ND			10
2. TRICHLOROETHENE	ND	ND	ND	ND			10
3. 1,1-DICHLOROETHENE	ND	ND	ND	ND			10
4. TOTAL 1,2-DICHLOROETHENES	ND	ND	ND	ND			10
5. VINYL CHLORIDE	ND	ND	ND	ND			10
6. METHYLENE CHLORIDE	ND	ND	ND	ND			50
7. 1,1,1-TRICHLOROETHANE	ND	ND	ND	ND			10
8. 1,1-DICHLOROETHANE	ND	ND	ND	ND			10
9. 1,2-DICHLOROETHANE	ND	ND	ND	ND			50
10. CHLOROETHANE	ND	ND	ND	ND			10
11. METHYL-t-BUTYL ETHER	ND	ND	ND	--2,000--			30
12. BENZENE	ND	ND	ND	ND			5.0
13. TOLUENE	ND	ND	ND	--290--			5.0
14. ETHYL BENZENE	ND	ND	ND	--100--			5.0
15. m,p-XYLENES	ND	ND	ND	--270--			5.0
16. o-XYLENE	ND	ND	ND	--180--			5.0
17. CHLOROFORM	ND	ND	ND	ND			50
18. FREON 113 (CCl3-CF3)	ND	ND	ND	ND			20
19. CHLOROBENZENE	ND	ND	ND	ND			10
20. STYRENE	ND	ND	ND	ND			10
TOTAL COMPOUNDS (1-20)	ND	ND	ND	2,800			
METHANE (V/V-air, PPM)	ND	ND	ND	30,000			10 PPM
UNKNOWNS (#)	ND	ND	ND	(51)			

COMMENTS: The pattern of the chromatogram for sample GZ-8, along with the detection of some of the "BTX" compounds and MTBE, indicates the presence of gasoline. Some of the above listed compounds may be present but their detection has been obscured by the complex nature of the chromatogram. Reported results in excess of 10,000 ppb are beyond the linear range of instrument calibration and indicated order of magnitude only. The results for MTBE are semi-quantitative and should be confirmed by GC/MS. Results are reported with two (2) significant digits.

ANALYZED BY: R. Sawhney

REVIEWED BY: CW Pickering

GZA GEOENVIRONMENTAL, INC.
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320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164 (617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

GZA GAS CHROMATOGRAPHIC SCREENING FOR VOLATILE ORGANICS
IN AQUEOUS AND/OR SOLID MATRIX
QUALITY CONTROL

DATE: 1/2/92

AQUEOUS AVOA

COMPOUNDS	MATRIX SPIKE RECOVERY (%)	ACCEPTANCE LIMITS (%)	DUPLICATE SPIKE PERCENT DIFFERENCE (%)	ACCEPTANCE LIMITS (%)
Trichloroethene	103	70-130	3.88	35
Toluene	109	70-130	4.59	35

SOLID

COMPOUNDS	MATRIX SPIKE RECOVERY (%)	ACCEPTANCE LIMITS (%)	DUPLICATE SPIKE PERCENT DIFFERENCE (%)	ACCEPTANCE LIMITS (%)
Trichloroethene	---	70-130	---	35
Toluene	---	70-130	---	35

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 12/31/91

GZA GEOENVIRONMENTAL, INC.
320 NEEDHAM STREET
NEWTON UPPER FALLS, MA 02164
(617) 969-0050, x-289
LAB I.D. No.: MA092

GZA GC SCREENING FOR VOLATILE ORGANICS IN SOILS
(CONCENTRATION - PPB, ug/kg of wet soil)

SAMPLE NAME: / GZA LAB #:	Method Blank 0R775-B	GZ-4 S-4 3R775-S	GZ-5 S-2 3R776-S	GZ-5 S-4 3R777-S	GZ-6 S-2 3R778-S	GZ-7 S-3 3R779-S	METHOD DETECTION LIMIT
1. TETRACHLOROETHENE	ND	ND	ND	ND	ND	ND	20
2. TRICHLOROETHENE	ND	ND	--120--	ND	ND	ND	10
3. 1,1-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	10
4. TOTAL 1,2-DICHLOROETHENES	ND	ND	ND	ND	ND	ND	10
5. METHYLENE CHLORIDE	ND	ND	ND	ND	ND	ND	20
6. VINYL CHLORIDE	ND	ND	ND	ND	ND	ND	20
7. 1,1,1-TRICHLOROETHANE	ND	ND	ND	ND	ND	ND	20
8. 1,1-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	10
9. 1,2-DICHLOROETHANE	ND	ND	ND	ND	ND	ND	10
10. CHLOROETHANE	ND	ND	ND	ND	ND	ND	10
11. METHYL-t-BUTYL ETHER	ND	ND	ND	ND	ND	ND	10
12. BENZENE	ND	ND	ND	ND	ND	ND	10
13. TOLUENE	ND	ND	ND	ND	ND	ND	10
14. ETHYL BENZENE	ND	ND	ND	ND	ND	ND	10
15. m,p-XYLENES	ND	ND	ND	ND	ND	ND	20
16. o-XYLENE	ND	ND	ND	ND	ND	ND	20
17. ACETONE	ND	ND	ND	ND	ND	ND	10
18. METHYL ETHYL KETONE	ND	ND	ND	ND	ND	ND	10
19. METHYL ISOBUTYL KETONE	ND	ND	ND	ND	ND	ND	10
20. CHLOROFORM	ND	ND	ND	ND	ND	ND	40
21. FREON 113 (CCl_3-CF_3)	ND	ND	ND	ND	ND	ND	30
22. CHLOROBENZENE	ND	ND	ND	ND	ND	ND	20
23. STYRENE	ND	ND	ND	ND	ND	ND	30
TOTAL COMPOUNDS (1-23)	ND	ND	120	ND	ND	ND	
METHANE (V/V-air, PPM)	ND	ND	ND	ND	ND	ND	10 PPM
UNKNOWNS (#)	(1)	(53)	(20)	(51)	(1)	(1)	

COMMENTS: Low to moderate levels of one (1) early eluting unknown compound, which can be tentatively identified as methanol, were detected in the Method Blank and in all samples. The pattern of the chromatograms for samples GZ-4 S-4, GZ-5 S-2 and GZ-5 S-4 indicates the presence of one or more unknown petroleum distillates such as a gasoline and/or a fuel oil. Some of the above listed compounds may be present but their detection has been obscured by the complex nature of the chromatogram. Results are reported with two (2) significant digits.

ANALYZED BY: R. Sabus

REVIEWED BY: C W Pulsing

JOB DESCRIPTION: 100 BOSWORTH ST. - PROVIDENCE, RI
JOB #: Y30764.1
DATE SAMPLED: 12/26/91
DATE TESTED: 12/31/91

GZA GEOENVIRONMENTAL, INC.
320 NEEDHAM STREET
NEWTON UPPER FALLS, MA 02164
(617) 969-0050, x-289
LAB I.D. No.: MA092

GZA GC SCREENING FOR VOLATILE ORGANICS IN SOILS
(CONCENTRATION – PPB, ug/kg of wet soil)

SAMPLE NAME: / GZA LAB #:	Method Blank 0R775-B	GZ-8 S-1 3R780-S	GZ-8 S-3A 3R781-S				METHOD DETECTION LIMIT
1. TETRACHLOROETHENE	ND	ND	ND				20
2. TRICHLOROETHENE	ND	ND	ND				10
3. 1,1-DICHLOROETHENE	ND	ND	ND				10
4. TOTAL 1,2-DICHLOROETHENES	ND	ND	ND				10
5. METHYLENE CHLORIDE	ND	ND	ND				20
6. VINYL CHLORIDE	ND	ND	ND				20
7. 1,1,1-TRICHLOROETHANE	ND	ND	ND				20
8. 1,1-DICHLOROETHANE	ND	ND	ND				10
9. 1,2-DICHLOROETHANE	ND	ND	ND				10
10. CHLOROETHANE	ND	ND	ND				10
11. METHYL-t-BUTYL ETHER	ND	ND	ND				10
12. BENZENE	ND	ND	ND				10
13. TOLUENE	ND	ND	ND				10
14. ETHYL BENZENE	ND	ND	ND				10
15. m,p-XYLENES	ND	ND	ND				20
16. o-XYLENE	ND	ND	ND				20
17. ACETONE	ND	ND	ND				10
18. METHYL ETHYL KETONE	ND	ND	ND				10
19. METHYL ISOBUTYL KETONE	ND	ND	ND				10
20. CHLOROFORM	ND	ND	ND				40
21. FREON 113 (CCl3-CF3)	ND	ND	ND				30
22. CHLOROBENZENE	ND	ND	ND				20
23. STYRENE	ND	ND	ND				30
TOTAL COMPOUNDS (1-23)	ND	ND	ND				
METHANE (V/V-air, PPM)	ND	ND	68				10 PPM
UNKNOWNS (#)	(1)	(54)	(65)				

COMMENTS: Low to moderate levels of one (1) early eluting unknown compound, which can be tentatively identified as methanol, were detected in the Method Blank and in all samples. The pattern of the chromatograms for samples GZ-8, S-1 and GZ-8 S-3A indicates the presence of one or more unknown petroleum distillates such as a gasoline and/or a fuel oil. Some of the above listed compounds may be present but their detection has been obscured by the complex nature of the chromatogram. Results are reported with two (2) significant digits.

ANALYZED BY: R. Soukup

REVIEWED BY: CW Pickering

GZA RAPID VOLATILE ORGANIC SCREENING OF SOIL SAMPLES BY THE STATIC HEADSPACE TECHNIQUE

SAMPLE PREPARATION AND ANALYTICAL METHODOLOGY

OVERVIEW

The GZA rapid screening technique for volatile organics in soil estimates concentrations of these compounds from gaseous concentrations measured in air above the sample. The method measures concentrations of contaminants released from the soil samples into the headspace. This method has been developed by the GZA Environmental Chemistry Laboratory to provide rapid and cost effective screening of soil samples for volatile organics. Although, this technique is a modification of EPA Method 3810, it is not definitive and is not approved by the EPA for certification purposes.

METHODOLOGY

Soil samples taken in the field are placed in 250 ml glass jars with a teflon gasket lid. The samples are kept at 4 degrees C until the time of analysis. A 10 ml crimp top septum vial is marked and tared with a crimp top on an analytical balance. A subsample of soil is added until all but a 2.5 ml volume of headspace remains. The vial cap is immediately crimped on and the weight of the vial and its contents is again measured to determine the weight of soil added. A 1.0 ml aliquot of headspace gas is withdrawn automatically by a Hewlett Packard 19395A headspace injector. The headspace sample is injected into the sample port of a HP 5890A gas chromatograph where the vapor is split within the injection port and distributed to two 30 meter X 530 micron fused silica capillary columns. Concentrations of eluting volatile organics are measured with dual flame ionization detectors and response data are acquired by a Nelson Analytical 760 Series Intelligent Interface. The chromatographic data are transmitted to an IBM AT personal computer and analyzed using the Nelson Analytical 2600 Series Chromatography Software. The information for the analytical report is entered manually onto a Lotus Symphony spreadsheet.

CALIBRATION

The response of the gas chromatograph is calibrated with external standards prepared for concentrations of 0.1, 1.0, and 10 ug/g (ppm) on a mass response basis and introduced into the chromatograph as headspace samples in the same manner as unknown soil samples. Sample peaks are identified by comparing their retention times from both columns to measured retention times of calibration standards for both columns. Qualitative comparisons are made between the two sets of test data for each sample. Sample peaks identified as known compounds are quantified according to response factors determined from calibration standards.

REPORT FORMAT

The method detection limit (MDL) for each compound is stated for every report with 95% certainty in an average chromatographic run. The method quantitation limit (MQL) is considered to be 5 times the MDL. Concentrations measured in the range of 1 to 5 times the MDL are reported as "Trace". Concentrations less than the MDL may be identified as beneath the method detection limit (BMDL) in instances where the compound's presence is 95% certain in that particular chromatogram. The total concentration for all detected compounds for which a calibration has been made, except methane, is summarized in the row designated as "Total Compounds"; none detected, ND, is reported if no known peaks are found. Unidentifiable peaks are reported as the number of unknown peaks are reported in parentheses. Compounds not detected are reported as "ND".

QUALITY CONTROL

The GZA procedure assumes that response factors are constant over the working range of 10 ppb to 10 ppm and that the precision of the analysis for samples is the same as that for the calibration standards. The 95% confidence limits for a measurement are defined as plus or minus two standard deviations as determined by a Student's t Test on replicate analyses of calibration standards. Quality control standards are analyzed daily and accepted if the relative standard deviation of the response factor is less than 20% of the anticipated value. New calibration curves are prepared when quality control limits are exceeded. Method blanks are prepared in the same manner as samples and are analyzed before each job or no less frequently than every ten samples. Field blanks and trip blanks are submitted at the discretion of the sample submitter. Matrix spikes and duplicate analyses are performed at a frequency of not less than one per twenty or fewer samples and results are reported as matrix spike recoveries and percent differences. Analytical results are not blank corrected.

DISCLAIMER

Identities and concentrations of volatile organic compounds reported by this headspace screening technique are subject to limitations inherent to this method. Chromatographic data are quantified by response factors that assume 100% volatilization of sorbed organic compounds into the headspace. Therefore, the reported concentrations probaby represent the lower limits of contamination. If confirmation is desired, duplicate samples should be submitted to a State certified laboratory for analysis by the appropriate EPA protocol methods.

LABORATORY SAMPLE NOTATION:

S – Solid B – Blank

LABORATORY CONTACT PERSON:

Edward W. Pickering, Manager
Environmental Chemistry Laboratory
GZA GeoEnvironmental, Inc.
Massachusetts Laboratory I.D. No. MA092
Phone #: (617) 969-0050, x169

REFERENCES

Commonwealth of Massachusetts DEP, "Minimum Standards for Analytical Data for Remedial Response Actions Under M.G.L. c. 21E", Policy #WSC-89-004 (1990).

Ettre, L.S., B. Kolb, and S.G. Hurt, "Techniques of Headspace Gas Chromatography," Am. Lab. 15 (10), 76-83, (1983).

Jones, E., M. Davis, R. Gibson, and R. Wallen, "Applications of Headspace GC to Complex Liquid Samples," Am. Lab. 16 (8) 74-81, (1984).

McNally, M.E., and R.L. Grob, "A Review: Current Applications of Static and Dynamic Headspace Analysis: Part One: Environmental Applications," Am. Lab. 17 (1) 20-33, (1985).

Spittler, T.M., R. Siscanaw, M. Lataille, and P.A. Parks, "Correlation Between Field GC Measurement of Volatile Organics and Laboratory Confirmation of Collected Field Samples Using GC/MS," Paper presented at 11/82 Washington, D.C., Hazardous Materials Control Research Institute Conference.

U.S. EPA, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, Third Edition, Volume 1B, Method 3810: Headspace, (1986).

Wylie, P.L., "Trace Analysis of Volatile Compounds in Water Using the HP 19395A Headspace Sampler", Hewlett-Packard Application Note AN 228-40 (1985).

Wylie, P.L., "Comparing Headspace with Purge and Trap for Analysis of Volatile Priority Pollutants", Jour. AWWA 80:8:65 (1988).

July 1991/EWP-DM

GZA GEOENVIRONMENTAL, INC.
ENVIRONMENTAL CHEMISTRY LABORATORY
320 NEEDHAM STREET, NEWTON UPPER FALLS, MA 02164 (617) 969-0050
MASSACHUSETTS LABORATORY I.D. NO. MA092

GZA GAS CHROMATOGRAPHIC SCREENING FOR VOLATILE ORGANICS
IN AQUEOUS AND/OR SOLID MATRIX
QUALITY CONTROL

DATE: 12/30/91 - AVOA

AQUEOUS

COMPOUNDS	MATRIX SPIKE RECOVERY (%)	ACCEPTANCE LIMITS (%)	DUPLICATE SPIKE PERCENT DIFFERENCE (%)	ACCEPTANCE LIMITS (%)
Trichloroethene	103	70-130	8.74	35
Toluene	96.1	70-130	9.26	35

SOLID 12/31/91

COMPOUNDS	MATRIX SPIKE RECOVERY (%)	ACCEPTANCE LIMITS (%)	DUPLICATE SPIKE PERCENT DIFFERENCE (%)	ACCEPTANCE LIMITS (%)
Trichloroethene	103	70-130	6.60	35
Toluene	93.7	70-130	7.58	35

GZA RAPID VOLATILE ORGANIC SCREENING OF WATER SAMPLES BY THE STATIC HEADSPACE TECHNIQUE

SAMPLE PREPARATION AND ANALYTICAL METHODOLOGY

OVERVIEW

The GZA rapid screening technique for volatile organics in water estimates aqueous concentrations of these compounds from gaseous concentrations measures in air over the sample. Dissolved volatile organics are driven from the water phase by equilibrating at an elevated temperature in a hermetic system containing the sample and clean air. An aliquot of the equilibrated headspace gas is injected into the chromatograph to provide an evaluation of the quality of the water sample. This method has been developed by the GZA Environmental Chemistry Laboratory as a rapid, reasonably accurate and reliable, and cost effective screening of water samples for volatile organics. However, this technique is not definitive and is not an EPA approved analytical method.

METHODOLOGY

Water samples taken in the field are placed in 40 ml glass septum vials filled to capacity and capped to exclude air bubbles. Vials are preserved with 250 ul of 1:1 hydrochloric acid and samples are kept at 4 degrees C until the time of analysis. In preparing the sample for analysis, a volume ratio of 3:1 sample to headspace (air) is created by discarding 10 ml of sample (replaced by air) from the 40 ml vial or transferring 7.5 ml to a 10 ml crimp-top septum vial. The vial is resealed and heated to 40 degrees C in a thermostatically controlled bath. A 1.0 ml aliquot of headspace gas is withdrawn manually with a syringe or automatically by a Hewlett Packard 19395A headspace injector. The headspace sample is injected into the sample port of a HP 5890A gas chromatograph where the vapor is split within the injection port and distributed to two 30 meter x 530 micron fused silica capillary columns. Concentrations of eluting volatile organics are measured with dual flame ionization detectors and response data are acquired by a Nelson Analytical 760 Series intelligent interface. The chromatographic data are transmitted to an IBM AT personal computer and analyzed using the Nelson Analytical 2600 Series Chromatography Software. The information for the analytical report is entered manually onto a Lotus Symphony spreadsheet.

CALIBRATION

The response of the gas chromatograph is calibrated with external standards prepared for concentrations of 0.1, 1.0 and 10 mg/l (ppm) and introduced into the chromatograph as headspace samples in the same manner as unknown water samples. Sample peaks are identified by comparing their retention times from both columns to measures retention times of calibration standards for both columns. Qualitative comparisons are made between the two sets of test data for each sample. Sample peaks identified as known compounds are quantified according to response factors determined from calibration standards.

REPORT FORMAT

The method quantitation limit (MQL) for each compound is stated for every report with 95% certainty in an average chromatographic run. Concentrations measured in the range of 1 to 5 times the MQL are reported as "TRACE". Concentrations less than the MQL may be identified as beneath the method quantitation limit (BMQL) in instances where the compound's presence is 95% certain in that particular chromatogram. The total concentration for all detected compounds for which a calibration has been made, except methane, is summarized in the row designated as "Total Compounds"; none detected, (ND) is reported if no known peaks are found. Unidentifiable peaks are reported as "Present" and the number of unknown peaks are reported in parentheses. No unknown peaks detected is reported as "ND".

QUALITY CONTROL

The GZA procedure assumes that response factors are constant over the working range of 10 ppb to 10 ppm and that the precision of the analysis for samples is the same as that for the calibration standards. The 95% confidence limits for a measurement are defined as plus or minus two standard deviations as determined by a Student's t Test on replicate analyses of calibration standards. Quality control standards are analyzed daily and accepted if the relative standard deviation of the response factor is less than 20% of the anticipated value. New calibration curves are prepared when quality control limits are exceeded. Method blanks are prepared in the same manner as samples and are analyzed before each job or no less frequently than every ten samples. Field blanks and trip blanks are submitted at the discretion of the sample submitter. Matrix spikes and duplicate analyses are performed at a frequency of not less than one per twenty or fewer samples and results are reported as matrix spike recoveries and percent differences. Analytical results are not blank corrected.

DISCLAIMER

Identities and concentrations of volatile organic compounds reported by this headspace screening technique are subject to limitations inherent to this method. If confirmation is desired, duplicate samples should be submitted to a State certified laboratory for analysis by the appropriate EPA protocol methods.

LABORATORY SAMPLE NOTATION:

A - Aqueous B - Blank

LABORATORY CONTACT PERSON:

Edward W. Pickering, Manager
Environmental Chemistry Laboratory
GZA GeoEnvironmental, Inc.
Massachusetts Laboratory I.D. No. MA092
Phone #: (617) 969-0050 x169

REFERENCES

Commonwealth of Massachusetts DEP, " Minimum Standards for Analytical Data for Remedial Response Actions Under M.G.L. c. 21E", Policy #WSC-89004 (1990).

Ettre, L.S., B. Kolb, and S.G. Hurt, "Techniques of Headspace Gas Chromatography," Am. Lab. 15 (10), 76-83, (1983).

Jones, E., M. Davis, R. Gibson, and R. Wallen, "Applications of Headspace GC to Complex Liquid Samples," Am. Lab. 16 (8) 74-81, (1984).

McNally, M.E., and R.L. Grob, "A Review: Current Applications of Static and Dynamic Headspace Analysis: Part One: Environmental Applications," Am. Lab. 17 (1) 20-33, (1985).

Spittler, T.M., R. Siscanaw, M. Lataille, and P.A. Parks, "Correlation Between Field GC Measurement of Volatile Organics and Laboratory Confirmation of Collected Field Samples Using GC/MS," Paper presented at 11/82 Washington, D.C. Hazardous Materials Control Research Institute Conference.

U.S. EPA, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, Third Edition, Volume 1B, Method 3810: Headspace (1986).

Wylie, P.L., "Trace Analysis of Volatile Compounds in Water Using the HP 19395A Headspace Sampler", Hewlett-Packard Application Note AN 228-40 (1985).

Wylie, P.L., "Comparing Headspace with Purge and Trap for Analysis of Volatile Priority Pollutants", Jour. AWWA 80:8:65, (1988).

1/91/DM

HITE - Or (Acc ies S) OW (Col P OPY ct M.

CHAIN-OF-CUSTODY RECORD

Station Number	Time (24 hr.)	Container ID	Sampler ID	Location Description	Sample Type	VOA 624	VOA 601	VOA 602	ABN	PEST/PCB	P.P. METAL	D.W. METAL	E.P. TOX.	O&G	PHC	TOC	VOC scan	Total # of Cont.	Note #
GZ-1					GW									✓	✓	✓	✓		
GZ-7					GW									✓		✓			
GZ-8					Product									✓		✓			

ANALYSES REQUIRED

TOTAL NUMBER OF CONTAINERS

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Julia C. Conley	1/2/92	K. Quelen
K. Quelen	1/3/92	[illegible]
[illegible]	1/3/92 9:10	[illegible]
[illegible]		

NOTES:

ANALYTICAL LABORATORY: _____

LABORATORY CONTACT: _____

GZA CONTACT: _____ PHONE: _____

Goldberg-Zoino & Associates
140 Broadway
PROVIDENCE, RHODE ISLAND 02903
401-421-4140

GZA FILE NO. 30764.1 P.O. NO. _____

PROJECT Bosworth Street

LOCATION 100 Bosworth Street, Prov. RI

COLLECTOR H. Baer

DATE OF COLLECTION Dec 31, 1991 SHEET 1 OF 1

CHAIN-OF-CUSTODY RECORD

Station Number	Time (24 hr.)	Container ID	Sampler ID	Location Description	Sample Type	VOA 624	VOA 601	VOA 602	ABN	PEST/PCB	P.P. METAL	D.W. METAL	E.P. TOX.	O&G	PHC	TOC	GC SCREEN	PHC	PHC Fingerprint	Total # of Cont.	Note #
GZ-4		S-2	MJB	5'-7'	Soil												X			1	
		S-4	"	15'-17'												X	X			1	
GZ-5		S-2	"	5'-7'												X	X			1	
		S-4	"	15'-17'												X	X			1	
		S-3	"	10-12'													X				
GZ-6		S-2	"	5'-7'												X	X			1	
GZ-7		S-3	"	10'-12'												X	X			1	
GZ-8		S-1	"	0.5'-2.5'												X	X			1	
		S-2A	"	5'-8'													X			1	
		S-3A	"	8'-10' (Auger)												X		X		1	
TOTAL NUMBER OF CONTAINERS																				9	

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)
Michael J. Baer	12/27/91 13:00	[illegible]
[illegible]	12/27/91 2:05	R. Polack

NOTES:

ANALYTICAL LABORATORY: GZA

LABORATORY CONTACT: TED PICKERING

GZA CONTACT: MIKE BAER PHONE: [illegible]

Goldberg-Zoino & Associates
140 Broadway
PROVIDENCE, RHODE ISLAND 02903
401-421-4140

GZA FILE NO. 30764.1 P.O. NO.

PROJECT 100 BOSWORTH STREET

LOCATION PROV, RI

COLLECTOR M. BAER

DATE OF COLLECTION 12-26-91 SHEET 1 OF 1