REVISED WORK PLAN
FORMER NEW HAVEN WATER COMPANY PROPERTY
HAMDEN, CONNECTICUT

Prepared For:

South Central Connecticut Regional Water Authority

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Revised: August 27, 2002

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1.0 INTRODUCTION

This revised work plan has been prepared to address the comments set forth in the July 31, 2002 letter from the Connecticut Department of Environmental Protection (CTDEP) Staff on the original work plan prepared by Leggette Brashears & Graham (LBG) dated July 11, 2002. The goal of the revised work plan is to evaluate environmental conditions with respect to the CTDEP Remediation Standard Regulations (RSRs) at the Hamden Middle School, athletic field and two residential properties (Middle School Site) formerly owned by the South Central Connecticut Regional Water Authority (RWA). See figure 1 and 2. The investigation proposed also responds, in part, to CTDEP Order No. SRD-128, which requires the investigation and remediation of historical fill areas in the Newhall Street area of Hamden, Connecticut. The revised work plan presents an investigative outline and protocols for characterizing the subject area.

2.0 BACKGROUND

In July 2000, a Phase I Environmental Site Assessment (ESA) was completed at the Hamden Middle School property to address environmental concerns related to a proposed school expansion. The ESA was completed for the Town of Hamden Board of Education by Facility Support Services (FSS) of Hamden, Connecticut.

To address concerns identified in the ESA, a Phase II ESA was completed by FSS in November 2000. The Phase II investigation included the drilling of 15 soil borings to depths ranging from 17 to 36.5 feet below grade (ft bg). Fill material was identified at depth starting at 2 and 3 ft bg, and extending to depths ranging from 7 to 26 ft bg. Depth to water was reported to range from 10 to 19 ft bg. The results of the investigation identified concentrations of various metals, semi-volatile organic compounds (SVOCs) and extractable total petroleum hydrocarbon (ETPH) above the CTDEP RSRs Residential Direct Exposure Criteria (RDEC) and GA Pollutant Mobility Criteria (PMC). The Phase II and subsequent investigations included the collection of soil-vapor samples from beneath the floor of the school during October, November and

December 2000. The results of the October and November samples identified concentrations of methane beneath the boiler room above the lower explosion level (LEL). The December 2000 soil-vapor results showed that methane concentrations were well below the LEL. As a result of the soil-vapor investigations, the Town of Hamden installed methane monitoring and ventilation equipment to address this area of concern.

The results of the investigations above created an awareness of the environmental concerns at the Hamden Middle School, athletic field and surrounding residential areas. To create a better understanding of the situation, LBG, on behalf of the RWA, researched files at the CTDEP. The files indicated that the low lying areas of the Middle School Site were filled with materials supplied from Winchester Arms and residential domestic waste from the early 1900s until at least 1976. The files also identified several limited subsurface investigations that were completed in the late 1980s through the 1990s. These investigations identified the presence of metals, SVOCs, volatile organic compounds (VOCs) and petroleum hydrocarbons in the subsurface material of the athletic field. From 1994 to 1996, the Town of Hamden contracted HRP Associates, Inc. to monitor the placement of an 18-inch thick cap in the Hamden Middle School athletic field. The cap was installed to minimize potential exposure to the underlying fill material.

Subsequent emergency remedial measures were completed at the Middle School Site during the school holidays in December of 2000. The remedial measures included the installation of geotextile and earthen caps at three areas surrounding the school, covering a total area of approximately 120,000 square feet.

During February 2001, the CTDEP supervised the drilling of 26 soil borings to a depth of 4 ft bg throughout the school athletic field. Twenty-six (26) surficial samples were collected from these borings at a depth of 0 to 6 inches below grade. The samples were analyzed for priority pollutant metals (PPM), barium and SVOCs. The results showed no exceedances of criteria in the CTDEP RSRs. Fill material was identified at 7 of the 26 soil boring locations. The results of this investigation showed that the depth of the "cap" at the athletic field ranged from approximately 1.5 ft bg to at least 4 ft bg.

A subsequent shallow soil investigation was completed by the CTDEP in response to an investigation completed by the U.S. Environmental Protection Agency (USEPA) at nearby residential properties. During this investigation, an additional thirty-nine (39) shallow (0-3 inch bg) soil samples were collected May 10, 2001. The results of this shallow soil investigation identified concentrations of arsenic, lead and SVOCs above criteria in the CTDEP RSRs on the southeastern portion of the athletic field and around the tennis courts. Emergency remedial measures were initiated and included fencing the southeastern area and covering this area with wood chips.

On July 10, 2001, the CTDEP issued an Administrative Order to the RWA, Olin Corporation, Town of Hamden and the State of Connecticut Board of Education which requires the investigation and remediation of the Middle School Site, the town-owned Rochford Field and Annex, and several areas which have been developed for residential use.

The Town of Hamden contracted Haley & Aldrich in July 2001 to complete a Phase I ESA of the Middle School Site, the town-owned recreational properties and residential properties in the Newhall area. A draft ESA report was issued in January 2002. As part of the ESA, six test pits were completed in August 2001 at the Middle School Site under the supervision of Haley & Aldrich. Fill material was encountered in all of the test pits and the base of the fill was observed at 2.5 ft bg to at least 7.3 ft bg. The fill material was observed to contain various industrial and domestic wastes.

Regulatory issues that would need to be addressed for the subject property to show compliance with respect to the CTDEP RSRs are presented below.

3.0 REGULATORY ISSUES

The primary focus of this work plan is to gather information regarding the location and characteristics of fill material located at the former New Haven Water Company properties, as well as determine potential impacts to soil and ground water. In addition, the scope of work presented below has been designed to determine potential avenues of compliance available within the CTDEP RSRs. Note that this sampling plan does not focus on an assumed remedial action; however, it is designed to explore potential remedial options available in the CTDEP

RSRs. The current ground-water classification beneath the site is GAA-impaired. For GAA-impaired areas, the following criteria in the RSRs apply:

3.1 Soils

Direct Exposure Criteria (DEC): The residential DEC is applicable to the top 15 feet of material at the site. It is important to characterize the top 4 feet of material due to options in the RSRs. With an environmental land use restriction (ELUR), only the top 4 feet of soil must comply with the residential DEC. If the soil is capped with a certain thickness of pavement (with an ELUR in place), only the top 2 feet must comply.

Pollutant Mobility Criteria (PMC): The GA PMC apply to soils above the water table. For all parameters except metals, the listed criteria are based on total (mass) concentrations of the parameter in the soil. For metals, the remediation criteria is based on the results of a leaching test, typically the synthetic precipitation leaching procedure (SPLP). For the other parameters, SPLP analyses can also be run and compared to GA ground-water protection criteria (GWPC); however, the total concentrations are usually determined first.

With an ELUR, the DEC and PMC do not apply beneath a building (except for VOCs that exceed the PMC).

3.2 Ground Water

Ground-Water Protection Criteria: The GWPC apply to ground water beneath the site, and are generally consistent with drinking water standards.

Surface Water Protection Criteria (SWPC): The SWPC apply to ground water prior to it discharging into a surface-water body.

Residential Volatilization Criteria (RVC): The RVC apply to VOCs in ground water within 15 feet of the ground surface. Note that the CTDEP is currently re-evaluating the Volatilization Criteria. The CTDEP reports that numerical criteria are likely to be lowered for many constituents and apply to ground water at depths greater than 15 feet.

3.3 Soil Vapor

Residential Volatilization Criteria (RVC): The RVC apply to VOCs in soil-vapor beneath a building.

Compliance with the RVC for soil vapor may also be met through interior air sampling, calculating site-specific volatilization criteria or implementing an ELUR.

For all of the criteria listed above, there are numerous exemptions and alternative criteria that can be applied. They are too numerous to list here.

4.0 CONTAMINANTS OF CONCERN

As discussed in the background section, numerous investigations have been completed at the subject property. During the course of these investigations, both soil and fill materials have been analyzed for VOCs, SVOCs, Connecticut extractable total petroleum hydrocarbons (CTETPH), polychlorinated biphenyls (PCBs), and total and toxicity characteristic leaching procedure (TCLP) PPMs, cyanide and barium. Of the constituents analyzed, VOCs, SVOCs, ETPH and various metals were shown to exceed RSR criteria. Note that PCBs and cyanide were not detected in any of the samples collected at the site.

On behalf of the Olin Corporation, Malcolm Pirnie submitted a conceptual work plan for the Newhall Street residential area to the CTDEP in November 2001. In a January 14, 2002 comment letter, the CTDEP indicated that the work plan should include the following constituents as potential contaminants of concern (COCs); VOCs, SVOCs, extractable petroleum hydrocarbons, pesticides, PCBs, cyanide, PPMs and barium (mass and synthetic precipitation leaching procedure (SPLP)).

LBG concurs that all of the aforementioned are COCs. At least one sample from every sampling location will be analyzed for all of the aforementioned parameters. Review of CTDEP, USEPA and historical sample results has shown that there is a lower probability of detecting PCBs, pesticides, cyanide and acid extractable SVOCs (phenols, phthalates, etc.). Therefore, a portion of the total samples collected (just over half; details discussed in Section 5.1.1) will be analyzed for PCBs, pesticides, cyanide and acid extractable SVOCs. If these constituents are detected, additional samples will be analyzed for characterization purposes. Note that total chromium analyses will be replaced with hexavalent chromium. The replacement of total chromium was done to better match RSR criteria.

In the above discussed comment letter regarding the Olin work plan, the CTDEP indicates that ground-water samples should be analyzed for Appendix II landfill leachate parameters. These parameters have been incorporated into this work plan.

5.0 SCOPE OF WORK

The scope of work presented below was prepared to investigate the environmental condition at the formerly owned RWA properties, which constitute the Middle School Site (figure 1 and 2). This scope of work has been prepared in a phased approach so that sample points would be optimally located; thereby reducing expenses by avoiding unnecessary investigative work. The purpose of the initial investigation is to identify the extent and quality of the fill material, determine a ground-water flow direction and identify the general ground-water quality at the subject property. The data gathered from the initial investigation would be utilized to expand the initial monitor well network during the second phase of the investigation, if necessary, and identify locations of test pits for the further defining characteristics of fill material. This second phase would include the excavation of approximately six to eight test pits and installation of deep, intermediate and shallow monitoring wells if the first phase shows that the additional characterization is necessary. Data gathered during the second phase of the investigation would be used to more fully characterize the ground-water quality at the site. At the conclusion of the investigation, LBG would prepare a report summarizing the field work completed and detailing the results of the investigation.

The scope of work incorporates both direct push (Geoprobe) and hollow-stem auger drill rigs to be utilized during the soil boring investigations. A direct push drill rig cannot penetrate as many types of materials as a hollow-stem auger and has a shallower depth limit; therefore the direct push drill rig will be initially utilized in areas presumed with shallow sections of fill, such as the northern, western and southern sides of the athletic field. This assumption of shallow fill material present on these portions of the athletic field is supported by review of the 1934 and 1949 aerial photographs and various historical documents contained at the CTDEP. Benefits to using a direct-push drill rig over a hollow-stem auger include cost and speed of drilling. Therefore, LBG will attempt to utilize the direct-push rig in areas identified with deeper fill at the site. However, because it is not known if the direct-push rig will be successfully utilized in these areas of deeper fill material (eastern athletic field and Hamden Middle School), the schedule was generated with the assumption that these areas would be primarily investigated with use of the hollow-stem auger.

A detailed discussion concerning each phase of the investigations is presented below. The results from the investigations presented below may trigger the need for additional investigations, depending on the findings. The additional investigations cannot be predicted at this time. Note that all purge water and soil cuttings to be containerized will be stored until removal in a temporary fenced area to be constructed east of the Hamden Middle School tennis courts.

5.1 Initial Investigation

The purpose of this initial investigation is to define the thickness and extent of fill material, characterize soil and fill material with respect to the CTDEP RSRs, identify initial ground-water quality and determine the ground-water flow direction.

5.1.1 Soil Investigation

Drill thirty-one (31) soil borings are proposed throughout the Middle School Site (figures 1 and 2). The locations of the soil borings were determined from review of historical

aerial photographs, existing soil boring locations, locations of identified utilities and various other historical data. The location of the soil borings may change depending on field conditions.

All soil borings will be drilled to 12 ft bg or at least 3 feet below the base of the identified fill, which ever is deeper. As discussed above, soil borings will be drilled utilizing the direct push method or hollow stem auger, depending on materials encountered, depth of boring and purpose of soil boring. Six of the soil borings will be completed as monitor wells (figures 1 and 2). All soil borings to be completed as monitor wells will be drilled with use of the hollow stem auger. These borings will be drilled to at least 10 feet below the water table.

Soil samples will be collected continuously at all soil-boring locations until completion. At soil borings drilled by the direct push method, soil and fill samples will be collected utilizing a 2-inch outer diameter, 4-foot long steel macrocore sampler containing an acetate liner. At soil borings drilled with the hollow stem auger, soil and fill samples will be collected utilizing a 3-inch outer diameter, 2-foot long split spoon. Soil samples collected from split spoons and macrocores will be placed into dedicated, sealed plastic bags. The resultant headspace within each plastic bag will be screened for the presence VOCs with use of a photoionization detector (PID) that will be calibrated to an isobutylene standard. Geologic logs will be completed for each boring and soils will be logged in accordance with ASTM D 2488 and ASTM D 2487.

The basis for analyzing fill and soil samples is to characterize the deep and shallow fill materials and to determine if the underlying native materials have been impacted from the filling activity. Between 1 and 5 soil samples will be collected at each soil boring location. Previous investigations have confirmed that the shallow materials (primarily top 2 feet) consist of the earthen cap laid by HRP in the mid 1990s. In addition, the top two feet of material at the subject property has been extensively characterized by the CTDEP and determined overall not to present an imminent health risk. Therefore, soil samples collected from the top 2 feet will only be analyzed if waste fill material, as distinguished from the "HRP cap," is identified in this interval. LBG will inspect soils samples from 0 to 2feet below grade at each sample location to determine the extent of the "HRP cap" placed in the mid-1990s. The need to sample cap materials will be evaluated after the extent and thickness of the cap is characterized. The intervals at which samples will be collected for analyses are shown below:

1) 0 to 2 ft bg (only fill: no sample collected if fill is not encountered);
2) 2 to 4 ft bg (fill or native soil sample);
3) 4 ft bg to 10 ft bg (only fill: no sample collected if fill is not encountered);
4) 10 ft bg to end of fill (only fill: no sample collected if fill is not encountered); and
5) Unconsolidated material underlying fill material.

If no waste fill is identified in the boring, then only 1 sample (interval 2) would be collected for analyses. If no waste fill is identified in intervals 1, 3 or 4, then only 2 samples (interval 2 and 5) will be collected for analyses. If no waste fill is identified in interval 3 or 4, then only 3 samples (interval 1, 2 and 5) would be collected for analyses, etc. The above sampling plan indicates that a minimum of 31 samples (no waste fill identified in any soil borings) and maximum of 155 samples (waste fill identified in top 2 feet of material and extending below 10 ft bg) will be collected for analyses.

The native soil/waste fill sample within each interval measured with the highest VOC concentration would be chosen for analyses from the top four intervals. If no PID readings are detected, the sample identified with the greatest degree of staining and/or odor would be sent from these intervals for analyses. The purpose of the bottom sample analyses is to define the vertical limit of impacts, therefore, this sample would be collected at a depth that appears not to be contaminated (i.e. no PID detections, normal color, no odor, etc.). The sampling protocol is expected to result in analyses of samples from a variety of positions above the water table, including immediately above the water table.

All soil samples would be analyzed for the following:

- VOCs by EPA Method 8021B;
- SVOCs (PAHs only) by EPA Method 8270;
- CTETPH; and
- PPM and barium (hexavalent chromium will replace total chromium analyses).

LBG will review local inorganic data collected by the USEPA during its residential investigation and average concentrations for inorganics found in uncontaminated soil in the

Eastern United States (USGS, 1984). Target metals which are identified in soil samples from above the seasonal low water-table greater than 1.5 times the local background concentrations or average concentration of the element found in uncontaminated soil in the Eastern United States (whichever is lower) will be analyzed by SPLP for the target metal.

Soil/fill samples collected from interval 2 (2 to 4 ft bg) and interval 3 (4 to 10 ft bg) will also be analyzed for pesticides by EPA Method 8081, PCBs by EPA Method 8082, cyanide and SVOCs (complete list) by EPA Method 8270. If fill is not identified below 4 ft bg, a sample will be collected from interval 4 (unconsolidated material underlying fill) for these analyses. If no fill is identified in the soil boring, PCBs, pesticides, cyanide and acid extractable SVOCs will only be analyzed from interval 2. If the results of the analyses show impacts of PCBs, pesticides and/or cyanide, additional samples, which will be held at the laboratory, will be analyzed.

In summary, a minimum of 31 samples and maximum of 155 samples would be analyzed for all of the constituents identified above. The quantity and type of analyses depend on amount of fill identified, if any, and outcome of initial laboratory results. A summary of samples to be collected and analyses completed during this investigation are presented on table 1.

5.1.2 Ground-Water Investigation

To develop an initial site ground-water flow direction and establish initial ground-water quality, six shallow monitoring wells would be installed with use of a hollow-stem auger drill rig (figure 1 and 2). Four of these shallow monitor wells would be installed in the vegetated and wetland area shown in the 1949 aerial photograph at the western side of the athletic field. The remaining two wells would be installed on the eastern portion of the athletic field and Hamden Middle School property. Traditional monitor wells are specified over microwells installed by direct push method due to the superior quality of water samples and water level data.

Monitor well screen settings will cross the water table and, dependant on depth of ground water, measure 10 to 15 feet in length. Any 15-foot screens would have about 5 feet above the water table and 10 feet below the water table. The wells will be constructed of 2-inch diameter SCH 40 PVC, 10-slot screen and 2-inch locking expansion plugs. A FilterSil No. 1 gravel pack will be set from the base of the well to approximately 2 feet above the top of the screen;

thereafter a 2-foot bentonite seal will be set. A bentonite/concrete mixture will be used to fill the annular space up to grade. The remaining annular space will be filled with concrete. Surface completion will include a concrete set drive over protective steel casing. After the wells are installed, a licensed surveyor will survey the top of the PVC casing and grade at each monitor well.

Monitor wells will be developed 24 hours after installation. A minimum of three volumes of water will be removed from each well and development would be deemed complete when normal hydraulic conductivity with the aquifer has been restored. Well purging activities will be properly recorded.

A minimum of 7 to 14 days after well development, ground-water samples will be collected from all 6 site monitor wells for the following COCs:

- VOCs by EPA Method 8021B;
- SVOCs (PAHs only) by EPA Method 8270;
- CTETPH
- PPM, barium and cyanide;
- Pesticides by EPA Method 8081; and
- PCBs by EPA Method 8082

Note that a lower laboratory detection level of 10 parts per trillion will be requested for dieldrin, which is included in the EPA Method 8081 parameter list. The lower detection limit would allow any potential dieldrin ground-water impacts to be better characterized with respect to the RSRs. A summary of samples to be collected and analyses completed during this investigation are presented on table 1.

Ground-water samples will be collected using the low-stress purging and sampling technique. In general, the sampling procedure entails the removal of ground water through a bladder pump, centrifugal pump or even a peristaltic pump at extremely low flow rates (example, 0.1 to 0.4 l/min (liter per minute), even lower rates for low permeable materials). The sample is collected once stabilization for three consecutive readings is achieved for the following

parameter and variance: turbidity (10 percent for values greater than 1 NTU), dissolved oxygen (10 percent), specific conductance (3 percent), temperature (3 percent), pH (0.1 units) and oxygen reduction potential (10 millivolts). The methodology for this technique is outlined in the July 30, 1996 USEPA Region I, "Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells".

The aforementioned sampling technique is not intended for the collection of ground-water samples in instances where non-aqueous phase liquids (NAPLs) are present. If dense NAPLs are identified, the sample will be collected with a double check valve bailer or if the dense NAPL is thick enough, a submersible pump may be used for extraction. In cases where light NAPLs are identified, a sample from the top of the water column will be collected with use of a single or double (depending on thickness) check valve bailer (EPA/530-R-93-001). Sampling procedures for light and dense NAPLS are presented in the November 1992 USEPA "RCRA Ground-Water Monitoring: Draft Technical Guidance."

A minimum of seven days after well development, depth-to-water measurements will be collected to an accuracy of 0.01 foot. A water-table map would be developed using depth-to-water and monitor well survey information.

5.1.3 Test Pit Investigation

After review of the initial soil boring investigation, approximately six to eight test pits will be excavated in areas of the subject property to help determine the source, content and extent of fill material. The location and quantity of test pits will be determined after review of the initial data. The test pits will be excavated with a standard backhoe. Each test pit will be logged and photographed. The test pit program is not designed to explore for any large buried objects that may exist, thus, no geophysics are planned. If any materials are encountered that appears different than what was encountered during the soil boring program, it will be submitted to the laboratory.

5.2 Second Phase of Investigation

This phase of the investigation would be finalized after review of the soil and fill quality,

initial ground-water quality and ground-water flow direction information determined from the initial investigation. This phase of the investigation would be performed to further characterize ground-water quality, if necessary. Additional soil borings will be drilled during this phase of the investigation if the monitor well locations do not provide sufficient coverage to determine the boundaries of the fill along the southern, western and northern portions of the Middle School Site.

We have budgeted for a total of 19 monitor wells to be completed during this phase of the investigation. The wells would be installed with use of a hollow-stem auger drill rig. In new boring locations, soil samples will be collected every five feet by split spoon. This portion of the drilling investigation will be completed primarily to identify the extent and thickness of fill. If any areas of unique filling are identified during this drilling investigation, soil samples will be collected for analyses from the borehole utilizing the protocols discussed in Section 5.1.1. Including the six shallow monitor wells installed during the initial phase of the investigation, the conceptual monitor well network breaks down to a total of: four stand-alone shallow monitor wells; six monitor well clusters (consisting of two wells); and three monitor well clusters (consisting of three wells). This conceptual monitoring well network design is flexible and the final network design will be developed after review of the initial soil boring investigation. All wells would be constructed of 2-inch diameter SCH 40 PVC, 10-slot screen and 2-inch locking expansion plugs. In general, construction of additional shallow monitor wells would be similar to those described in section 5.1.2. Intermediate monitor wells would consist of 5 to 10 foot long screens, set completely within the deeper fill material. Construction features for these wells would be similar to the shallow well design. Deep monitor wells would consist of 5 to 10 foot long screens, and the top of the screen would be set below the fill and unconsolidated material interface. The sand pack would be placed from the base of the well point to 2 feet above the top of the screen. A 2-foot section of a bentonite seal would be placed on top of the sand pack. A bentonite/concrete mixture will used to fill the annular space up to grade. Surface completion will include a concrete set drive over protective steel casing. After the wells are installed, a licensed surveyor will survey the top of the PVC casing and grade at each monitor well.

The wells would be developed utilizing the same protocol discussed in section 5.1.2. A licensed surveyor would survey all of the site monitoring wells. A water-table map would be developed using depth-to-water and monitor well survey information. Ground-water samples from all site monitor wells would be collected using the low-stress purging and sampling technique, bailer or submersible pump, depending on the presence of NAPLs, and analyzed for CTDEP Appendix II landfill leachate parameters. Specific ground-water analyses are shown below:

- VOCs by EPA Method 8260 plus keytones and tentatively identified compounds (TICS);
- SVOCs (complete list) by EPA Method 8270 plus TICs;
- CTETPH (carbon range and oil; identification if applicable);
- PPM, barium, cyanide, cobalt, vanadium;
- Pesticides by EPA Method 8081;
- Herbicides by EPA Method 8151;
- PCBs by EPA Method 8082; and
- Total dissolved solids, total suspended solids, alkalinity, pH, total dissolved iron, total dissolved magnesium, ammonia, nitrate, sodium, potassium, chlorides, sulfates and biological oxygen demand (5 day).

Note that a lower laboratory detection level of 10 parts per trillion will be requested for dieldrin, which is included in the EPA Method 8081 parameter list. The lower detection limit would allow any potential dieldrin ground-water impacts to be better characterized with respect to the RSRs. Note that pH, turbidity, dissolved oxygen and oxygen reduction potential will be measured in the field. A summary of samples to be collected and analyses completed during this investigation are presented on table 1.

Under the aforementioned conditions, a total 25 ground-water samples would be collected for analyses during this phase of the investigation. A summary of samples to be collected and analyses completed during this investigation are presented on table 1.

5.3 Reporting

At the conclusion of the investigation, LBG would prepare a report summarizing the field work completed and detailing the results of the investigation.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance Project Plan (QAPP) that follows is site-specific and has been prepared for the activities to be completed during this and any additional site characterization investigation.

The objective of the QAPP is to provide sufficiently thorough and concise descriptions of the measures to be applied during the investigation such that the data generated will be of a known and acceptable level of precision and accuracy. The QAPP sets forth specific procedures to be used during sampling of relevant environmental matrices and analyses of data.

6.1 Quality Assurance Objectives for Measurement Data

The overall QA objective is to develop and implement procedures for field sampling, sample preparation and handling, sample Chain of Custody, laboratory analyses and reporting, which will provide accurate data.

The purpose of this section is to define the goals for the level of QA effort, namely: accuracy; precision and sensitivity of analyses; and completeness, representativeness, and comparability of measurement data from the analytical laboratory. In addition, QA objectives for field measurements are also defined.

6.2 Level of QA Effort

6.2.1 Field QC Sampling

To assess the quality of data resulting from the field sampling program, field duplicate samples and field blanks and samples for matrix spike analyses will be collected (where appropriate) and submitted to the analytical laboratory.

Field QA/QC samples that will be provided by LBG to the analytical laboratory will be as identified below:

- Field duplicate samples will be collected at a frequency of one per 30 investigative samples.
- Field (rinse) blank samples will be collected at a frequency of one per 60 investigative samples (split spoon sampler only).

- Triple sample volume will be supplied to the laboratory by LBG in order to perform spike and duplicate analyses at a frequency of one per 60 investigative samples.

Field (rinse, equipment) blanks will be analyzed to check procedural contamination from sampling device cleaning procedures, and ambient conditions at the site. Field duplicate samples will be analyzed to assess sampling and analytical reproducibility.

6.3 Laboratory QC Effort

6.3.1 Accuracy, Precision and Sensitivity of Analyses

The fundamental QA objective with respect to the accuracy, precision and sensitivity of analytical data is to achieve the QC acceptance criteria of each analytical protocol. The purpose of the analytical work completed during the investigation is for the chemical characterization of site soil/fill and ground water.

The targeted quantitation limits for this investigation will be in accordance with the analytical methods specified. With the exception of dieldrin in water, the specified methods are capable of achieving detection limits at or below the applicable CTDEP Remediation Standard Regulation numerical criteria.

The method accuracy for samples will be determined by spiking selected samples (Matrix Spikes) with all spiking compounds specified in the analytical methods. Accuracy will be reported as the percent recovery of the spiking compound(s) and will be compared with the criteria given in the appropriate methods.

The method(s) precision (reproducibility between duplicate analyses) will be determined from the duplicate analysis of matrix spike samples for organic parameters.

Sampling and analytical precision will be determined from the collection and analysis of field duplicate samples.

6.3.2 Completeness, Representativeness and Comparability

It is expected that all analyses conducted in accordance with the analytical methods will provide data meeting QC acceptance criteria for 95 percent of all samples tested. Any reasons for variances will be investigated by the laboratory and documented.

Analytical methods used for this study are consistent with published USEPA methodologies to assure comparability of the data. All standards used by the laboratory will be traceable to reliable sources.

6.4 Field Measurements

Measurement data will be generated in many field activities. These data include, but are not limited to, the following:

i) documenting time and weather conditions;
ii) observation of sample appearance and other conditions;
iii) water quality field parameters for the low stress, low flow purging method.

The general QA objective for measurement data is to obtain reproducible and comparable measurements to a degree of accuracy consistent with the use of standardized procedures.

6.4.1 Sampling Procedures

The sampling procedures for the investigation of the unconsolidated materials are discussed in the scope of work. The standard operating procedure for the collection of the ground-water samples is presented above in referenced EPA publications.

6.4.2 Sample Custody and Document Control

The following documentation procedures will be used during sampling and analyses to provide Chain of Custody control during transfer of samples from collection through analyses. Record keeping documentation will include use of the following:

- field log book (bound with numbered pages) to document sampling activities in the field;
- labels to identify individual samples; and
- Chain of Custody record sheet to document analyses to be completed.

6.4.3 Field Log Book

In the field, the sampler will record the following information in the field log book (bound) for each sample collected:

- sample number (all samples will have an unique identification with LBG as part of the nomenclature);
- sample matrix;
- name of sampler;
- sample source;
- time and date;
- pertinent data (e.g., location, sample interval);
- analysis to be conducted;
- sampling method (e.g., low flow stress purging sampling method or bailer)
- appearance of each sample (turbidity, color, smell, etc.);
- number of sample bottles collected; and
- pertinent weather data.

Each field log book page will be signed by the sampler.

A unique sample numbering system will be used to identify each collected sample. This system will provide a tracking number to allow retrieval and cross-referencing of sample information.

6.5 Chain-of-Custody Records

Chain-of-Custody forms will be completed for all samples collected during the investigation to document the transfer of sample containers. A typical sample of the Chain-of-Custody form is included in Appendix II. All samples will be refrigerated at 4^0 C ($\forall 2\ ^0$C) using wet ice and delivered to the analytical laboratory within 48 hours of collection. All samples will be delivered to the laboratory by laboratory personnel, or by LBG field personnel. All samples will be maintained at 4^0 C ($\forall 2^0$ C) by the laboratory.

The Chain-of-Custody record, completed at the time of sampling, will contain, but not be limited to, the sample number, date and time of sampling, and the name of the sampler. The chain-of-custody document will be signed, timed, and dated by the sampler when transferring the samples. LBG will retain one copy of the chain of custody form.

6.5.1 Sample Documentation in the Laboratory

Each sample or group of samples shipped to the laboratory for analysis will be given a unique identification number by the laboratory. The laboratory Sample Custodian will record the client name, number of samples and date of receipt of samples in the Sample Control Log Book. The temperature of one sample/cooler will be measured and recorded on the Chain of Custody. Samples removed from storage for analyses will be documented in the Sample Control Log Book.

The laboratory will be responsible for maintaining analytical log books and laboratory data as well as a sample (on hand) inventory for submittal to LBG on an "as required" basis. Raw laboratory data produced from the analysis of samples submitted for this program will be inventoried and maintained by the laboratory for a period of five years at which time LBG will be notified by the laboratory prior to proper disposal. LBG may require the laboratory to maintain the samples for an extended period.

6.5.2 Storage of Samples

After the Sample Custodian has completed the Chain-of-Custody forms and the incoming sample log, the Chain of Custody will be checked to ensure that all samples are stored in the appropriate locations. All samples will be stored within an access controlled custody room and will be maintained at 4EC(∀2EC) until all analytical work is complete.

6.5.3 Sample Documentation

Evidentiary files for the entire project shall be inventoried and maintained by LBG and shall consist of the following:

i) project related plans;
ii) project log books;
iii) field data records;
iv) sample identification documents;
v) Chain of Custody records;
vi) report notes, calculations, etc.;
vii) lab data, etc.;
viii) references, copies of pertinent literature;
ix) miscellaneous - photos, maps, drawings, etc.; and
x) copies of all final reports pertaining to the project.

The evidentiary file materials shall be the responsibility of the project manager with respect to maintenance and document removal.

7.0 SCHEDULE

The table below shows the preliminary schedule for the work to be completed.

Phase of Investigation	Date (approximate)
31 soil borings and 6 shallow monitor wells	July 15th through July 26th
Development of 6 shallow monitor wells	July 18th
Sampling of initial 6 shallow monitor wells	July 26th
Installation of 19 additional monitor wells and Excavation of Test Pits	August 12th through August 22nd
Development of additional 19 monitor wells	August 22nd and 23rd
Sampling of complete monitor well network	August 30th
Reporting	September – October

A report describing the field activities and analytical results will be completed by late September or early October. LBG is currently preparing a Health and Safety Plan (HASP). The plan will be provided to all field staff and subcontractors. LBG will also provide a copy of the plan to the CTDEP.

LEGGETTE, BRASHEARS & GRAHAM, INC.

Michael Manolakas
Associate

Reviewed by:

Jeffrey B. Lennox, CPG, LEP
Vice President

mg
August 27, 2002
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8.0 REFERENCES

Haley & Aldrich, Inc., January 2002 “Draft Report on ASTM Phase I Environmental Site Assessment Hamden Middle School and Surrounding Newhall Street Neighborhood Hamden Connecticut”, Prepared for Town of Hamden

United States Environmental Protection Agency, July 30, 1996, “Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples From Monitoring Wells”.

United States Environmental Protection Agency, November 1992, “RCRA Ground-Water Monitoring: Draft Technical Guidance”.

TABLE

FIGURES

TABLE
(at end of report)

Table

FIGURES
(at end of report)

Figure

TABLE 1

WORK PLAN
FORMER REGIONAL WATER AUTHORITY PROPERTY
HAMDEN, CONNECTICUT

Summary of Soil/Fill and Ground-Water Samples to be Analyzed

Analyses	Quantity of Soil/Fill Samples	Quantity of Water Samples Analyzed during Initial Phase of Investigation	Quantity of Water Samples Analyzed during Final Phase of Investigation[3/]
Semi-Volatile Organic Compounds (Polynuclear aromatic hydrocarbons only) by EPA Method 8270	31 to 156	6	25[4/]
Volatile Organic Hydrocarbons by EPA Method 8021B	31 to 156	6	--
Connecticut Extractable Total Petroleum Hydrocarbons	31 to 156	6	25
Priority Pollutant Metals[1/] plus barium	31 to 156	6	25[4/]
Semi-Volatile Organic Compounds (acid extractable) by EPA Method 8270	31 to 62[2/]	--	25[4/]
Cyanide	31 to 62[2/]	6	25
Pesticides by EPA Method 8081	31 to 62[2/]	6	25
Polychlorinated Biphenyls by EPA Method 8082	31 to 62[2/]	6	25
Volatile Organic Compound by EPA Method 8260 plus TICs	--	--	25
Herbicides by EPA Method 8151	--	--	25
Cobalt, Vanadium, and Tin	--	--	25
Leachate Indicator Parameters	--	--	25
Synthetic Precipitation Leaching Procedure for Metals	Dependant on Total Metal Results	--	--

Note: Quantities do not include quality assurance/quality control samples.

1/ Hexavalent chromium will replace total chromium for soil/fill samples.
2/ Total to be analyzed may increase, depending on results of initial data set.
3/ Total dependant on number of wells installed during second phase of investigation.
4/ Plus TICs

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