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**Final Work Plan:
Expedited Site Characterization
of the
IES Industries, Inc., Site
at Marshalltown, Iowa**

April 4, 1994

Ames Expedited Site Characterization Project

Ames Laboratory
Environmental Technology Development
Technology Integration Program
Iowa State University
Ames, Iowa 50011

U.S. Department of Energy
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NOTATION

AL	Ames Laboratory
ASL	above sea level
BVWST	B & V Waste Science and Technology
CATD	Center for Advanced Technology Development
CLP	Contract Laboratory Program
CPAH	carcinogenic polynuclear aromatic hydrocarbon
CPT	cone penetrometer test
CVOC	chlorinated volatile organic compound
DNAPL	dense non-aqueous phase liquids
DOE	U.S. Department of Energy
DQO	data quality objective
EM	electromagnetic induction
ESC	expedited site characterization
EQL	estimated quantitation limit
FMGP	former manufactured gas plant
GC/MS	gas chromatography/Mass spectrometry
GIS	geographic information system
GPS	global positioning system
IDNR	Iowa Department of Natural Resources
IES	IES Industries, Inc.
IMA	immunoassay
IR	infrared
IT	innovative technology
K	hydraulic conductivity
LIF	laser induced fluorescence
LOD	limit of detection
MDL	minimum detection limit
NCPAH	non-carcinogenic polynuclear aromatic hydrocarbon
PAH	polynuclear aromatic hydrocarbon
ppb	parts per billion
PQL	practical quantitation level
QA/QC	quality assurance/quality control
STD	standard deviation
SOPT	state of the practice technology
SVOC	semi-volatile organic compound
TIP	Technology Integration Program
TPAH	total polynuclear aromatic hydrocarbon
USEPA	U.S. Environmental Protection Agency
UV	ultraviolet

1.0 INTRODUCTION

This chapter provides an overview of the Ames Laboratory Expedited Site Characterization (ESC) project. The first part of this chapter discusses Expedited Site Characterization methodology in the context of this project. The second part of this chapter describes the technology evaluation tasks. The remaining chapters of this Work Plan focus on the site characterization tasks followed by the Site Safety Plan.

1.1 EXPEDITED SITE CHARACTERIZATION METHODOLOGY

The overall goal of the ESC project is to evaluate and promote both innovative and state-of-the-practice site characterization and/or monitoring technologies. This goal will be accomplished by fielding both types of technologies together in the context of an expedited site characterization. The first site will be at a former manufactured gas plant (FMGP) in Marshalltown, Iowa.

The ESC project is a merger of the technology transfer model developed by the Center for Advanced Technology Development (CATD) at Iowa State University and the Argonne National Laboratory ESC methodology.

The Ames Laboratory Technology Integration Program has successfully used the CATD technology transfer model in the environmental arena. The CATD model treats technology transfer as a process, not a milestone, that begins with intellectual property at the laboratory scale and ends in private sector commercialization. Technology demonstration, pilot plant scale-up, market analysis, customer involvement, and brokering are all important components of the CATD process. Simultaneous fielding of both state-of-the-practice (SOPT) and innovative (IT) technologies fulfills a demonstration component of the CATD technology transfer process.

The ESC methodology, as developed at Argonne National Laboratory, has these characteristics:

- 1) intensive historical research,
- 2) emphasis on hydrogeology and geologic structure as determinants of contaminant fate and transport,
- 3) use of technologies by expert operators with flexible data quality objectives
- 4) on-site data processing using mobile laboratories,
- 5) on-site decision making capability,
- 6) preference for non-intrusive or minimally-intrusive geophysical techniques,
- 7) avoidance of intrusive sampling techniques, and
- 8) the same team that plans site work manages site work.

The Argonne ESC methodology has been successfully applied at several sites since 1990.

This ESC work plan differs from a traditional site characterization work plan. On-site decision-making is an iterative, dynamic process designed to quickly eliminate data gaps. This dynamic aspect of the ESC process is its strength and forms a vital part of its success. Therefore, the exact locations of the required sampling activity are largely unknown at the start of the site work. After the capabilities of the analytical screening methods are known, initial sampling for the screening or first phase will be defined based on historical records. Once the technology capabilities are fully verified, the results of first phase sampling will be incorporated during the quantitative or second phase. But, as the second phase proceeds, the sampling locations will be determined by the on-site team rather than by following a predetermined sampling plan.

At the FMGP site in Marshalltown, the ESC project will field three areas of technology: geophysical, analytical, and data fusion. The geophysical technologies are designed to understand the subsurface geology to help predict fate and transport of the target contaminants. The analytical technologies/methods are designed to detect and quantify the target contaminants. The data fusion technology area consists of software systems designed to rapidly integrate or fuse all site information into a conceptual site model that then becomes the decision making tool for the site team to plan subsequent sampling activity.

Because of limited resources, not all of the contaminants present at the Marshalltown site can be located at the action level. Polynuclear aromatic hydrocarbons (PAHs) are the signature organics associated with the coal tar activities that took place at the FMGP site. As a result, PAHs were selected as the target compounds. The primary emphasis will be on PAH detection and quantitation in both saturated and unsaturated soils, with secondary emphasis on groundwater measurements utilizing existing on-site wells.

During the first stage of the Marshalltown work, screening analytical instruments and non-intrusive geophysical techniques will be fielded to qualitatively map the spatial contaminant distribution. Soil gas surveys, immunoassay testing (IMA), innovative optical techniques, and passive organic sorbent sensors will be deployed along with the geophysical methods. During the second phase, gas chromatography/mass spectrometry (GC/MS) instruments and a cone penetrometer system equipped with a laser-induced fluorescence (LIF) probe will quantitatively map the action level edges of the PAH plume(s). Samples will be taken both by the cone penetrometer test system (CPT) and the Geoprobe® sampler system.

1.2 TECHNOLOGY EVALUATION

Split samples will form a larger percentage of samples analyzed than might be expected from a traditional site characterization because multiple techniques (SOPTs and ITs) will measure the same parameters, so that the relative added value of the techniques can be reliably evaluated. Once this technology evaluation has been made, the confirmed market niche will be mapped

onto the DOE site needs and the targeted promotion of these technologies within the DOE will commence. Because the Ames Laboratory ESC project will be only the second DOE entity to utilize the ESC methodology, modifications of the ESC process that might improve its effectiveness will be proposed.

1.2.1 Data Fusion

During phase one, data fusion will occur off site. Starting with phase two, data fusion will take place at the Marshalltown site. Prior to phase one, data from previous site investigations will be loaded into each of several GIS packages. These data fusion packages vary considerably in functionality. Matching this functionality to site complexity is the technology evaluation goal for the data fusion area. Full evaluation, which would normally include active on-site use of each GIS package, may not be possible because of limited personnel to run each of these packages on site. However, arrangements have been made to have experienced operators from both Dynamic Graphics, Inc. and Intergraph® on site during phase two to assist with the operation of these 3-D systems.

During phase two, daily upgrades of the site model will be generated by the GIS packages. A computer-compatible projection system will facilitate the display of the site model and critical data. It is expected that, during phase two, geostatistical calculations will become vital for making unbiased estimates of the subtle data gaps that remain.

1.2.2 Geophysical Technologies

Both IT and SOPT geophysical technologies will be fielded. ITs include a shallow reflective seismic technique using a high-frequency energy source, a 3-D ground penetrating radar data analysis, and vertical induction profiling. Some of the SOPTs are seismic refraction, borehole geophysics and cone penetrometer testing. Only those techniques that yield useful correlation with cored borehole data will be used to characterize the site.

Another comparison will be made between the capabilities of a typical CPT system versus a Geoprobe®, both with electrical resistivity logging instrumentation. The Marshalltown site provides a nearly ideal setting to evaluate the respective merits of these two push technologies because the soil types are amenable, the depths of interest are 50 feet or less, and physical access issues that impact truck mobility can all be evaluated at this site. Ambiguities remaining after the first phase will be resolved by the CPT system.

1.2.3 Contaminant Distribution

The contaminant distribution will be investigated in two phases, first the screening phase, and second, the quantitative phase.

1.2.3.1 Screening phase In the screening phase nearly all of the techniques, i.e., IMA, passive sorbent, and optical methods, can be considered innovative. The IMA methods are just being approved by USEPA. Our data, from more than one IMA provider, taken from split samples under carefully controlled conditions, will add considerable weight to the effective adoption of IMA methods within and outside DOE. Only a few passive sorbent methods are known for semivolatile PAHs and few potential users realize that they are applicable to saturated as well as unsaturated soils. This is in contrast to volatile organic compound (VOC) passive sorbent methods that are in widespread use but only in unsaturated soil conditions. Likewise, active soil gas methods have been rarely applied to PAHs because of the much reduced volatility of PAHs.

One of the target compound PAHs at Marshalltown is naphthalene, whose vapor pressure defines the boundary between semivolatile organic compounds (SVOCs) and VOCs. Thus naphthalene is an SVOC with the highest vapor pressure and likely would form the highest volume plume. Naphthalene is also an attractive target compound because it was one of the most common PAHs detected in the previous characterizations and it is one of the three most common compounds that make up coal tar. Typically naphthalene ranges from about one to ten percent by volume of typical coal tar waste. However, some of the methods, e.g., IMA, may not be very sensitive to naphthalene. The relative sensitivity to various PAHs will be a focus of the technology evaluation of these screening methods.

The LIF capability is not likely to have sufficient data quality to assist in the accurate delineation of the PAH plume near the action levels nor will it be able to distinguish more than a subset of the 16 PAHs of interest. Once detailed topography of the upper surface of the lower confining layer has been revealed, either by the geophysical methods from phase one or the four probe sensor of the CPT itself, then shallow depressions near edges of main body or bodies of the PAH plume(s) can be directly sampled for free phase, saturated soil, or less contaminated soil for the existence of isolated PAH plumes.

Finally, an innovative optical technique based on chemiluminescence has been identified. It will be compared to the other screening technologies.

1.2.3.2 The quantitative phase In the quantitative phase, the focus will be on GC/MS instruments using five extraction methods: sonic solvent (SOPT), thermal desorption (IT), supercritical fluid extraction (IT), microwave extraction (IT), and microextraction (IT). In addition, the LIF capability of the CPT system, a qualitative but direct method, will be used in this phase.

Samples for the GC/MS systems will be collected by a Geoprobe® truck or, if necessary, by the CPT truck for the deeper samples. Although field duplicates will be taken during the subsurface probing that will address site soil inhomogeneity, it will be important to collect a

sufficient quantity of each sample so that, after homogenization, they can be split and analyzed by each of the extraction modules.

It is realized that little new information about the contaminant distribution will be learned from these split samples, but these samples are necessary for the comparative evaluation of the extraction methods. It is also realized that some of the extraction schemes have been used before and may even have EPA approval, but again, the opportunity to evaluate them under identical conditions will benefit their effective adoption by DOE and others. Variations in recovery percentages among the extraction methods that are due to soil type are suspected to be important in the selection of appropriate extraction methods for similar soil types. In order to isolate the extraction percentage from the variance among the GC/MS instruments, spiked aliquots will be injected directly into the column.

2.0 BACKGROUND

This chapter outlines the site description and setting, site history, previous investigations of the site, and identifiable contaminant source areas.

2.1 SITE DESCRIPTION AND SETTING

The Marshalltown FMGP is located south of East Nevada Street between 4th and 6th Avenue in the SE¼ of the NE¼ of Section 35, T.84N., R.18W. The contiguous property presently owned by IES Utilities is also partially located in Section 36. The site contains several buildings from the FMGP and former electric plant and is currently used as the service and materials distribution center for the IES gas and electric operations. It is located adjacent to an active railroad switching yard owned by the Chicago and Northwestern Railroad.

2.1.1 Physiography/Topography

The site is in an old industrial area of Marshalltown. Nearby industries include an inactive foundry, a scrap metal recycling business, and a variety of manufacturers. The site is situated on the edge of the floodplain of a meandering stream (Linn Creek) within a glacial drift terrain. The ground surface is flat to gently sloping, with approximately 10 feet of relief across the site. Linn Creek is a tributary of the Iowa River and flows from west to east approximately 800 feet south of the FMGP site. Its confluence with the Iowa River is located approximately 2.5 miles northeast of the site.

Surface relief between the uplands and valleys is 50 to 150 feet. Maximum upland elevations range generally from 900 to 1000 feet above sea level (ASL) in the Marshalltown area. The Linn Creek and Iowa River floodplains vary in elevation from 860 to 880 feet ASL in the Marshalltown area.

2.1.2 Geology and Hydrogeology

The stratigraphy of the glacial sediments in the Marshalltown area consists of loess over Kansan till. The terminal moraine of the younger Wisconsin glaciation is located approximately 10 miles to the west of Marshalltown. The thickness of glacial deposition varies markedly around the Marshalltown vicinity, from 0 to 150 feet in the upland areas and from 25 to 250 in valleys.

The glacial drift unconformably overlies Mississippian-age limestone and Pennsylvanian shale bedrock. The limestone units encountered immediately below the alluvial sediments at the site are identified in *Remedial Investigation Report: Marshalltown, Iowa, Former Manufactured Gas Plant Site* (BVWST 1992). as a part of the Mississippian Burlington and Gilmore City Formations and are part of the regional Mississippian aquifer. Outcrops are rare, but several

are reported along railroad cuts and stream channels in the Marshalltown area. The former bedrock erosional surface is incised by multiple minor channels tributary to the pre-glaciation channel of the Iowa River, referred to as the Poweshiek Channel. The Poweshiek Channel more or less follows the general trend of the present Iowa River floodplain and varies from one to two miles in width (Hansen, 1985). The City of Marshalltown is situated above a bedrock knob located south of the Poweshiek Channel. The FMGP site itself is situated over the northeast flank of the knob.

The near-surface stratigraphy of the site is reported in *Remedial Investigation Report: Marshalltown, Iowa, Former Manufactured Gas Plant Site* (BVWST 1992). Limestone bedrock is approximately 50 feet below the surface. According to drilling information reported by BVWST, a steep ridge in the bedrock surface with about 25 feet of relief, trends northwest-southeast across the site. Near surface soils consist of a wide range of fill materials (clay, gravel, sand, cinder, and other debris) of low plasticity and varying in thickness from 0.5 to 14 feet. This is underlain by fine-grained cohesive soils consisting of low plasticity silty clay with interbedded sandy and gravelly clays, ranging in thickness from 6 to 14 feet.

The cohesive silty clay unit grades into alluvial sands and gravels, varying significantly in silt and clay content, except at the farther northeast portion of the remedial investigation area. The thickness of the unit varies from 0 to 26 feet, with the greatest thickness found near the center of the site, possibly indicating the presence of a portion of a former stream channel.

A layer of low plasticity clayey lacustrine sediment and low to high plasticity glacial till separates the alluvial sediments from bedrock in most areas around the site. This unit was logged as absent in one boring near the east edge of the site. The surface of the unit slopes toward the south and generally mimics the bedrock surface.

The water table surface is approximately 18 to 20 feet below grade, correlating to the granular alluvial sediments. Hydraulic conductivity (K) measurements obtained by falling head slug tests indicated K values in the range of 0.0029 to 0.00076 cm/sec for the granular sediments. According to the work done by BVWST (1992), groundwater flow in the alluvial sediments is to the south toward Linn Creek. Bedrock groundwater flow characteristics are not well established and appear to be strongly influenced by the activity of production wells in the area which tap the Mississippian aquifer.

2.1.3 Groundwater and Land Use

According to McDonald (1986), the City of Marshalltown municipal water supply is derived from multiple wells set in the alluvial aquifer of the Iowa River, the buried channel aquifer of the Poweshiek Channel, and the Mississippian aquifer. The relative location of these wells and the distance from the FMGP site make them unlikely receptors of contaminants from the site.

Chlorinated volatile organic compounds (CVOC) have been identified in the alluvial and bedrock aquifers at several locations along the Linn Creek floodplain and in other parts of Marshalltown. The source or sources of the CVOC contamination are not well documented, but the Marshalltown FMGP is not believed to be a source.

The Marshalltown FMGP property is surrounded on all sides by properties currently and formerly used for industrial purposes. Some nearby properties are currently commercial. The nearest residential properties are located to the north several hundred feet. Nearby commercial/industrial facilities include a scrap metal recycler to the east, the Chicago and Northwestern (C&NW) railroad yard to the south, a container redemption/recycle center, former freight depot and restaurant to the west, and C&NW offices to the north. Farther from the site exist a former iron foundry and several industrial manufacturing operations.

Facilities which formerly occupied adjacent properties included a brewery, pickle works, furniture manufacturing and warehousing, barbed wire manufacturing, canning plant, lumber works, and farm implement manufacturers.

2.2 SITE HISTORY

A comprehensive summary of the site history is included in *Remedial Investigation Report: Marshalltown, Iowa, Former Manufactured Gas Plant Site*. (BVWST 1992). The BVWST report was a primary source for information contained in this section. Additional sources of historic information included a preliminary research report by McDonald (1986), Sanborn Company maps dated from 1884 to 1964, and the Marshall County Historical Museum Library.

When the plant first opened in the mid-1870s, gas manufacturing was accomplished by the coal carbonization process. A detailed discussion of this and other gas manufacturing processes is found in a document prepared by the USEPA (1988). At the time the plant opened under the name Marshalltown Gas Light Company, it occupied only Lot 5 of Barden's subdivision. In 1884, the site consisted of the gas plant building (at the approximate location of the present substation materials building), a coal house, and two gasometers (pressurized gas holders) located north of the plant building. Barbed wire and furniture manufacturing facilities and a stock yard existed to the west of the plant on what is now IES Utilities property. The properties to the east were apparently vacant at this time.

Electric generation began at the site sometime between 1888 and 1892. The electrical plant was built on a portion of the gas plant property and Lots 1, 2, and 3 of Cunningham's Addition. Residential properties and warehouses were present to the east of the gas plant at this time, on what is now the IES property. In 1892, the Marshalltown Gas Company, the Marshalltown Electric Company, and the Marshalltown Street Railway Company consolidated into the Marshalltown Light, Power and Railway Company, bringing the electrical and gas operations under common ownership.

By 1901, the original, smaller gasometer had been removed, and the operation utilized a single 25,000 cubic foot gas holder located west of what is now the regulator building. Between 1901 and 1910, a new 200,000 cubic foot gas holder was built just east of the current regulator building.

The gas manufacturing process was converted from coal carbonization to carbureted water gas sometime between 1910 and 1921, and ownership transferred to the Iowa Railway and Light Corporation. During this period, the original purifier room operations were moved to a separate building (now the IES substation department building) and water gas generators were installed in the place of the old purifiers. In addition, a 12,000-gallon tar well was installed east of the new water gas generator building, and an oil storage tank was installed at the north edge of the property west of the original gas holder to feed the carburetion process.

The original coal gasification facilities were demolished sometime in the 1920s. Also during this period, a new 50,000 cubic foot gas holder was constructed immediately south of the 200,000 cubic foot gas holder, and the original 25,000 cubic foot holder was taken out of service but apparently left in place until the plant was shutdown completely in 1950. A second oil tank was also added in the 1920s north of the purifier building.

Although documentation was not available regarding the disposition of tar produced by the gas manufacturing processes, a substantial portion of the tar may have been disposed on site. This is evidenced by, among other things, a 1953 photograph in the McDonald (1986) report showing an excavation immediately east of the present electric substation filled with a substance described as tar. The pit was opened for a construction project, and the tar was pumped from the pit and disposed at an unknown location.

2.3 PREVIOUS INVESTIGATIONS

Documented investigation of the presence of waste product disposal at this site began with a preliminary study by D.B. McDonald Research Associates in 1986. This investigation consisted of gathering regional hydrologic and geologic data and historical information about the operation of the plant, including interviews with former employees.

Later in 1986, a USEPA contractor, Ecology and Environment (E&E), performed a reconnaissance investigation of the site. The E&E investigation included similar historic data and added information regarding fate, transport, and exposure routes of the contaminants of interest. A followup site investigation by E&E in 1987 included surface geophysics and some shallow soil, groundwater, surface water, and manhole sampling. The geophysics work consisted of ground penetrating radar in areas where subsurface structures were suspected. The soil samples indicated the presence of PAH compounds at levels substantially above background levels.

A report prepared by Tuthill, Inc., in 1988 contained a detailed synopsis of the site history, including the development and ownership changes of the site. Tuthill also prepared a report in 1989 which provided a summation of the information contained in the previous reports discussed above. The 1989 report contained data from a public water quality assurance program which had been initiated locally. Also in 1989, Tuthill prepared a detailed report containing more information about the history of the site.

An underground storage tank (UST) was removed in November 1988 from an area near the west end of the site along the east wall of the former spray pond. Soil and groundwater samples were collected as a part of the UST closure operation. Petroleum hydrocarbons in excess of applicable action levels were detected.

BVWST began a detailed remedial investigation of the site in 1990. The investigation included a comprehensive program of soil and groundwater sampling and hydrogeologic characterization. The investigation also included sampling and characterization of material contained in the void space beneath the floor of the former electric generation building. The results are documented in a report submitted to the IDNR (BVWST 1992).

2.4 IDENTIFIABLE CONTAMINANT SOURCE AREAS

At its maximum extent of operations, the FMGP occupied lots only in Barden's subdivision (lots 1-7) and Westlake's subdivision. The present IES Utilities property, located on and east of the vacated 6th Avenue, was not a part of the gas plant and is, therefore, not expected to contain any source areas for gas plant wastes. The former electrical plant located primarily in Cunningham's addition to the west of the FMGP may contain source areas, since the two operations were under the same ownership. It has been documented that waste disposal, some of which appears to have been generated by the FMGP, did occur in the subfloor of the former electrical generation building (BVWST, 1992).

The following potential source areas have been identified.

- 1) The "tar pit" unearthed during a construction project in 1953, which is located immediately east of the existing electrical substation.
- 2) Tar separator indicated on the west side of former purifier building (Sanborn Company maps from 1921 and subsequent years). Based on references on maps dated after 1921, this tar separator may have been an above-grade construction.
- 3) Tar well located east of the original water gas generator building (Sanborn Company map from 1921) and now located off the northeast corner of the present substation material storage building.

- 4) Tar separator located south of the former purifier building. This separator was unearthed and the liquid contents removed in 1992. Based on its location, this structure may have been the one identified in the 1921 map as a tar well.

Other subsurface areas potentially containing high concentrations of PAHs include the alleged coal storage area in the southeast corner of the former FMGP operations and identified by EPA studies as containing high contaminant levels, and the perimeter of and below the subfloor of the former electrical generation plant, particularly the area west of the former electric plant.

3.0 TECHNICAL PROGRAM

This chapter describes the technical program to be performed at the Marshalltown site. The sections detail the geologic/stratigraphic investigations, contaminant distribution determinations, and data management and integration.

3.1 GEOLOGIC/STRATIGRAPHIC CHARACTERIZATION

3.1.1 Existing Data

A fundamental principle of the ESC methodology is a thorough understanding of a site's subsurface structure and hydrology prior to the initiation of intrusive sampling or reconnaissance work. Detailed geologic information will assist the investigator to identify such things as possible source areas, contaminant migration routes or conduits, impermeable or less permeable strata, and other structures (natural or man-made) which may influence the movement of non-aqueous liquid, dissolved, or vapor phase contaminants.

During a preliminary site investigation by an EPA contractor, Ecology and Environment (E&E) in 1987, ground penetrating radar (GPR) was employed in an effort to identify possible tar disposal pits. A small area west of the former purifier building and an area within and east of the former generator building were surveyed. An anomaly was detected in the area west of the former purifier building. The configuration and location of the anomaly suggests that it may be the floor of the original gasometer constructed when the plant was first opened.

Outside of the GPR survey, all geologic characterization has been accomplished by conventional drilling and sample core descriptions from the boreholes and wells. Standard penetration tests were conducted on several of these boreholes.

3.1.2 Technology Selection

All of the wells installed by previous investigations were constructed of PVC and are therefore amenable to several geophysical logging techniques. A suite of geophysical logging techniques will be used on the existing wells and the data generated will be correlated with descriptive geologic logs available from previous investigations by BVWST (1992). Open borehole logging is not possible at this site due to the inconhesive nature of a large portion of the alluvial strata. This eliminates logging methods, such as measurement of electrical and acoustic properties, which require direct contact with the media.

Non-intrusive geophysical methods will also be employed to construct a geologic model of the site. However, the density of cultural interferences (electrical facilities, metallic objects, buildings, etc.) at the site precludes the use of some methods. The non-intrusive program is designed to assess the subsurface, beginning with shallow conditions in terms of artificial fill

areas, buried utilities, and man-made structures, followed by the determination of deeper conditions down to the lower cohesive unit (as described by BVWST, 1992) or the bedrock surface.

The purpose of the geophysical program is to provide useful site characterization data, as well as to apply and evaluate innovative techniques. Innovative geophysical techniques, if anticipated to be feasible and cost effective for this site, will be employed and compared along side state-of-the-practice techniques. Because of the limited time and budget, it is not the intent of this program to address conditions within the bedrock or to determine hydrologic information. While such information is critical to a complete site characterization, the scope of this ESC project is limited to the alluvial strata and contaminants therein.

Geophysical data will be supplemented by intrusive data acquired by use of cone penetrometer test (CPT) technology. Continuous logs of soil property data will be collected across the site using standard CPT methods of sleeve friction, tip stress, and resistivity. This data will be targeted at defining at a high level of detail the topography of the lower cohesive unit and variations in the stratigraphy of the upper cohesive and granular units. Innovative contaminant screening capabilities of the CPT are discussed in later sections.

3.1.3 Borehole Geophysical Logging

Four borehole logging methods have been selected: natural gamma, gamma-gamma, neutron, and electromagnetic (EM) induction. The value of natural gamma and EM induction logs is that they are capable of distinguishing and correlating stratigraphic variability based primarily on relative clay content. EM induction may also provide information on the presence of contaminants based on the contaminants effect on media conductivity.

The bulk density of the media surrounding the wells and boreholes will be measured using gamma-gamma logs. This information will also be used in stratigraphic correlations, as well as to assist in the interpretation of seismic data. Neutron logs will provide information about soil moisture above the water table and porosity below the water table.

To provide more uniform coverage of the site, one or more additional temporary cased boreholes will be installed. These boreholes will be drilled using standard hollow-stem auger methods with continuous-core sampling. A limitation of the nuclear methods is that material installed in the annular space around the existing wells may reduce that ability to resolve the properties of the natural sediments. To minimize this effect in the temporary cased boreholes, casings will be installed with natural annular fill material, with the exception of the bentonite/grout seal near the surface.

3.1.4 Geophysical Profiling

A program of geophysical profiling will begin with identification of shallow features, such as subsurface utilities, fill materials, and buried man-made structures, which may act as contaminant migration routes or means of accumulation. Information about progressively deeper features will be obtained to supplement existing geologic information. Borehole geophysical logs will be obtained in order to develop a detailed site model depicting significant structures, such as the topography of the lower confining layer, the presence and extent of relatively high- or low-permeability strata or seams, and possibly the presence of pooled free-liquid-phase organics.

3.1.4.1 Ground-penetrating radar Ground-penetrating radar (GPR) was successful in previous work by the EPA at identifying a structure buried approximately 4–8 feet below the surface (Ecology and Environment 1987). The previous GPR survey provided areal coverage of important parts of the FMGP site. The ESC project will conduct a comprehensive GPR survey in portions of the site formerly occupied by manufactured gas plant operations and in areas where there is a reasonable potential for further intrusive sampling. GPR is expected to only yield shallow data since the near-surface soils contain significant amounts of clay, which attenuates the GPR signal over relatively short distances.

The quality of data and depth of signal penetration is expected to vary widely across the site depending on various surface pavements and type of fill material present. The previous GPR survey was conducted at an antenna frequency of 500 megahertz (MHz), producing a penetration of approximately 6–8 feet. It is anticipated that further GPR work will be conducted at a slightly lower frequency in an effort to produce better penetration. Testing of several antennae will be performed at several locations prior to data acquisition to determine the optimal operating frequency. In addition, the optimum transmitter-receiver offset and number of soundings to be stacked into a single trace during data processing will be evaluated.

It is anticipated that GPR lines will be oriented north-south from the northern property boundary to the northern-most rail siding in the C&NW yard. Maximum line spacing will be five feet, and station locations along the lines will be no more than one foot apart.

Two-dimensional profiles will be observable in the field. Additional data processing, including management of the data as a three-dimensional set and development of depth slices, will take place off site.

3.1.4.2 Seismic methods A critical target of the subsurface characterization is the continuity and configuration of the lower cohesive unit. To aid in the definition of the surface of this stratigraphic unit, multiple seismic profiles will be gathered by both seismic reflection and refraction techniques. Additionally, the seismic methods will attempt to identify the depth of the water table and significant stratigraphic variations above the lower cohesive unit.

The seismic program will be a phased approach consisting of testing equipment and operational parameters over a portion of the site, followed by acquisition of data over the entire site. The methods to be used are compressional wave (p-wave) reflection and compressional and shear wave (s-wave) refraction. An innovative, high-frequency seismic energy source (Oyo portable vibrator) will be used for the reflection work. The potential advantages of this energy source are related to the elimination of ambient and shot noise and increased resolution of shallow targets.

Seismic reflection will be performed using both a standard hammer and the high frequency vibrator source. Preliminary "walkaways" will be conducted to determine the presence of reflectors at depths less than 50 feet and determine optimal parameters such as geophone and shot spacing. To resolve very shallow reflectors, an actual geophone spacing of as little as one foot may be required. If the test phase is successful, data acquisition will begin. The amount of data which can be acquired by reflection will depend upon the shot and geophone spacing needed. The quantity, length, and orientation of seismic reflection lines will be determined based on the anticipated amount of data acquisition possible following the testing phase.

A seismic refraction line will be acquired in both the s-wave and p-wave mode using a geophone spacing of five feet. This data will be analyzed on site and will be available for comparison to borehole logging information and for determination of the need and location of additional refraction and reflection lines.

3.1.4.3 Electromagnetic induction The site contains a dense array of cultural interferences (physical and electromagnetic) such as railroad tracks, gas and electric utilities, buildings, and various appurtenances associated with IES Utilities' operations, and it is anticipated little if any usable data can be obtained by surface-based EM methods. However, a technology historically used in the mining industry for deep exploration of metallic orebodies has, in recent years, been modified for use in shallow applications to profile ground conductivity anomalies in the search for non-conductive masses of organic liquids. A pilot test of this sub-surface method will be conducted on the central portion of the FMGP where masses of separate phase organic liquid are most likely to be present.

In the sub-surface method, an EM transmitter coil is placed at pre-determined grid locations on the ground surface, and an offset induction log is recorded by a receiver coil in a nearby borehole or well. The receiver records the primary and secondary EM fields produced by the transmitter. Processing of the raw data filters out the primary field, and the secondary field data is converted to apparent resistivity. Surface cultural interferences pose less of a problem to this EM method because the receiver coil records data below the surface.

Transmitter coil locations will be on an approximately 20-foot grid spacing. Receiver coil data will be taken at vertical intervals of approximately 0.1 feet. Relatively large resistivity

gradients are required for EM induction to produce useful results. Therefore, it is not anticipated that this method will directly provide information about subsurface stratigraphy, although inferences may be made about stratigraphic variations based on the locations and configuration of the resistive anomalies identified. Upon completion of all site activity, the results of the subsurface imaging work will be compared to, and evaluated against all of the detailed stratigraphic and contaminant distribution information gathered during other phases.

3.1.5 Geotechnical Measurements

The ESC project will perform a limited suite of geotechnical measurements composed primarily of cone penetrometer probing to provide stratigraphic information for subsurface characterization. The cone penetrometer will also contain a probe capable of performing contaminant screening by laser-induced fluorescence.

3.1.5.1 Methodology The cone penetrometer is an excellent exploration tool in soils where detailed stratigraphic information is desired. It also provides continuous in-situ data on soil parameters, such as bearing and friction for geotechnical design considerations (Robertson and Campanella, 1984). Estimates of soil type are provided by measurement of penetration resistance as the probe is inserted into the subsurface. Most electronic penetrometers have a specialized tip fitted with strain gauges or vibrating wire sensors to measure both tip and sleeve resistance, such as the two shown in Figure 3.2.5-1 below.

1. Conical point (10 cm ²) (cone)	5. O-rings—soil seal—gap
2. Load cell	6. Cable
3. Protective mantle	7. Strain gauges
4. Waterproof bushing	8. Connection with rods

(Robertson and Campanella 1984)

Figure 3.1.5-1. Typical electric cone penetrometer tip

Measurements of sleeve and tip resistance are monitored at intervals appropriate to the instrumentation, which may be continuous or at intervals as low as 1–2 cm. The probe insertion rate is kept constant, typically 1-2 cm/sec, and the reaction force is measured to

determine total penetration resistance. Stress is calculated by dividing the measured force by the cone base area to obtain cone resistance. The sleeve resistance is calculated in a similar manner, calculating stress by dividing the measured force by the surface area of the sleeve to determine friction sleeve resistance. The friction ratio (sleeve friction divided by cone resistance then normalized to percent) is then correlated to soil classification.

3.1.5.2 Field procedures Cone penetrometer soundings will be performed at locations and to depths designated by the site manager after discussion with the cone penetrometer subcontractor. Physical limitations such as access, on-site buildings, and concrete surfaces will dictate many probing locations. A variable depth of uncontrolled fill is assumed across the site, and obstructions such as bricks and concrete rubble may be anticipated. In the case of initial near-surface refusal, the location will be adjusted slightly and another probe attempted. Due to the industrial nature of the site, near-surface refusal may be anticipated to be frequent.

3.1.5.3 Stratigraphic calibration Calibration soundings will be performed adjacent to locations with detailed knowledge of soil stratigraphy from conventional drilling and logging techniques. This may entail probing at a location of a boring from a previous investigation, or at a new location drilled and logged during the ESC activity. In either case, the penetrometer subcontractor will be required to develop a database correlating known stratigraphic information to new penetrometer data. This database will be used to further refine the understanding of the areal stratigraphy of the subsurface for use in site characterization.

3.1.5.4 Quality assurance—Equipment calibration Calibration requirements for the ESC cone penetrometer field work will be as specified in USBR 7021 A1, or as accepted by the site manager. The subcontractor will be required to provide test results of the latest laboratory calibration performed on the equipment to be used on site. A field calibration will also be required prior to beginning penetrometer testing. The field calibration will consist of, at a minimum, loading the tip onto a certified surface load cell to correlate actual tip load versus measured load. Additionally, a field portable apparatus to calibrate sleeve resistance is highly desirable. Calibration of the system will be performed at the beginning of each field day, and at any time during probing when results are suspect, as noted by the equipment operator.

3.1.6 Data Correlation and Interpretation

Each method described above will require calibration to local stratigraphy. Calibration will be accomplished by drilling and logging several new, temporary control borings on site during the field investigation. These control borings will be installed by hollow-stem auger techniques with temporary polyvinyl chloride (PVC) casing to allow insertion of downhole probes, such as the downhole electromagnetic induction (EM) survey discussed in Section 3.2.4.1. Continuous soil cores will be taken in these borings to allow detailed geologic logging of site stratigraphy. The borings will extend to the top of the lower cohesive unit at approximately 40 to 50 feet deep.

The geophysical techniques and the geotechnical techniques will be correlated to the control borings. Each investigative method will be calibrated against the control borings, to determine each method's signature response to stratigraphic changes. Additionally, the geotechnical method results will be correlated to the geophysical methods' results to gain an understanding of how these methods could be best used in conjunction for future expedited site characterizations.

When the method correlations are complete, the data will then be interpreted to develop a detailed understanding of the site stratigraphy. This knowledge will aid sample location selection to better define the limits of the plume within the vadose zone.

3.1.7 Focusing the Sampling Program

After detailed knowledge of the site stratigraphy has been obtained from the investigations described above, this information will be used to determine appropriate locations for sampling. Knowledge of site stratigraphy will be useful in identifying the likely locations of contamination, especially with heavier-than-water contaminants. For example, the upper surface of a lower permeability unit would be a likely location of significant contamination. These locations will be determined in order to recover samples that may range from no contamination to highly contaminated. This range of contaminant concentration will be beneficial in the comparison of different analytical techniques as described in Section 3.2, Contaminant Distribution.

The level of sensitivity of the technique will dictate the type of analytical tool to be used. For example, the screening level techniques (lower sensitivity, higher detection limits) will be applied in areas with known or suspected significant contamination. The more sophisticated techniques (high sensitivity, lower detection limits) will be used for samples with lower suspected contamination levels. By focusing the sampling program, it is possible to apply each analytical technique to an appropriate contaminant concentration.

3.2 CONTAMINANT DISTRIBUTION

The purpose of this section is to describe the approach required to map the contaminant distribution at the Marshalltown site. The target analytes and their cleanup standards for Iowa are given first, followed by the data quality objectives. Finally, the sampling plan is discussed.

3.2.1 Target Analytes

The target analytes for this project consist of 16 polynuclear aromatic hydrocarbons (PAHs) in soils and groundwater that are of concern to the Iowa Department of Natural Resources (IDNR). These 16 PAHs are defined as the total PAHs (TPAHs), and they are grouped into seven non-carcinogenic PAHs (NCPAHs) and nine carcinogenic PAHs (CPAHs). The seven NCPAHs are: naphthalene, acenaphthylene, acenaphthene, fluorene, anthracene, fluoranthene, and benzo(g,h,i)perylene (BgP). The nine CPAHs are: pyrene, chrysene, phenanthrene, benzo(a)anthracene (BaA), dibenzo(a,h)anthracene (DahA), benzo(b)fluoranthene (BbF), benzo(k)fluoranthene (BkF), benzo(a)pyrene (BaP), and indeno(1,2,3-c d)pyrene (IP).

The concentration and distribution of contaminants at the site, along with a site-specific risk assessment, are necessary inputs for IDNR to determine an action level required for remediation. The Ames Laboratory only intends to provide PAH concentration distribution information as part of this work. Geologic data obtained by the Ames Laboratory ESC project, as described in Section 3.1, may provide useful information for the risk assessment, although the Ames Laboratory will not make evaluations of exposure risk. Because each instrument to be utilized at Marshalltown will have different response to each PAH, the minimum detectable amount of each PAH must be determined.

The IDNR guidance for any combination of the individual TPAHs in soils is 500 mg/kg. In groundwater the action level is 0.2 ppb, except naphthalene which is set at 20 ppb. For the total CPAHs the guidance level is 100 mg/kg for soils and the action level is 0.2 ppb for groundwater. During the BVWST remedial investigation, all of the CPAHs, except DahA, were detected in soils.

The following table lists the 16 TPAHs, their class as NCPAH or CPAH, the range they were detected in previous soil data, and the number of times found out of a total of 53 soil sampling locations, exclusive of building interiors. The on-site data were taken from the BVWST report.

Name	Type	Detected Range* (mg/kg)	Hits* Above EQL**	Specific Density^
Naphthalene	NCPAH	ND-1200	29/53	1.1450
Acenaphthylene	NCPAH	ND-980	20/53	0.8988
Acenaphthene	NCPAH	ND-380	10/53	1.0242
Fluorene	NCPAH	ND-370	28/53	1.2030
Anthracene	NCPAH	ND-300	31/53	1.2600
Fluoranthene	NCPAH	ND-500	30/53	1.2520
BgP	NCPAH	ND-81	7/53	NA
Pyrene	CPAH	ND-500	35/53	1.2710
Chrysene	CPAH	ND-230	29/53	1.2740
Phenanthrene	CPAH	ND-1,100	38/53	1.1790
BaA	CPAH	ND-230	26/53	1.2740
DahA	CPAH	ND	0/53	1.2820
BbF	CPAH	ND-190	23/53	NA
BkF	CPAH	ND-140	23/53	NA
BaP	CPAH	ND-160	26/53	1.3510
IP	CPAH	ND-78	3/53	0.0620

* Remedial Investigation Report BVWST, 1992.

** EQL = estimated quantitation limit, typically 0.66 mg/kg.

^ Knox, Sabatini, and Canter 1993.

ND = none detected

Table 3.2-1. TPAHs in soils at the Marshalltown IES site.

3.2.2 Data Quality Objectives

The following discussion of data quality objectives for the ESC project closely follows *The DQQ Process for Environmental Decisions* (USEPA 1991a). This discussion applies only to the decisions required to perform the site characterization task at Marshalltown site and not to the technology evaluation task.

The problem is to determine the spatial extent of the TPAH and CPAH plumes in soils and groundwater at the time of the characterization. The overlap of contaminant distribution data with site hydrogeology data is desired so that fate and transport modelling can be attempted in the future.

Constraints on data collection include time and costs. The site work must be finished no later than mid-May 1994 or it will conflict with time needed to plan for a second Ames laboratory ESC site. The budget for on-site activities for field tasks is limited.

The area of interest includes all of the IES site down to a depth that penetrates, but does not breach, the lower confining layer. Restricting drilling to avoid breaching the lower confining layer is intended to prevent the creation of contaminant pathways.

In those techniques where individual TPAHs are measured, the measurements will be used to calculate the sum of the individual concentrations to derive a concentration for CPAHs and TPAHs. These derived concentrations will then be compared to the guidance levels. In those measurements where groups of TPAHs are measured, the derived individual TPAHs will be calculated based on relative sensitivities. These sensitivities will be based on previous calibrations provided by the supplier. The derived TPAHs will then be summed and compared to the respective action levels.

Limits on uncertainty derive from the capabilities of the instruments and their operators in the field. The technique capable of quantitative measurements is the gas chromatographic/mass spectrometer (GC/MS). For the GC/MS instruments, we have specified the ability to meet CLP or method 8270A quantitation limits, which are both 0.66 mg/kg, if gel clean up is required for low soil contaminant levels. If a one standard deviation (STD) of 0.066 mg/kg is assumed, then a relative uncertainty of plus or minus 0.2% (0.2 mg/kg at the 100 mg/kg level) is possible with a confidence level of 95%. However, the STD is highly matrix-dependent and requires measurement by the chemist/instrument combination at the Marshalltown site as well as daily analysis of QC samples to ensure that the instruments remain under statistical control. If the GC/MS techniques' quantitation levels can be maintained in the mobile laboratory, then it will be clear that the field sampling variances rather than laboratory variances dominate the total sample variance.

The value of STD for the sonic solvent-based mobile laboratory GC/MS will be determined by seven independent measurements of a seven-way split soil sample that has been spiked with 10 mg/kg of each of the nine CPAHs. Independent measurement should be done before the GC/MS system is used at the Marshalltown site to analyze samples and instrument performance should be confirmed once mobilization has been accomplished and statistical control at the site has been established. The ESC project will provide matrix-matched spiked soil samples for this purpose in sufficient quantity to perform this measurement. The total amount of sample material required to prepare each set of split samples is 30 grams.

Some IMA providers claim an STD of 0.3 mg/kg for TPAHs. But sensitivities can be low for selected CPAHs so that these lowered sensitivities must be accurately known before IMA can be used directly for decision making. If double sampling can establish a linear relationship

between the IMA and GC/MS results, then IMAs can be used to accurately guide sampling for the GC/MS measurements.

3.2.3 Sampling Plan

Every on-site boring, with the exception of B-16 and MW1, performed by BWVST at Marshalltown (i.e. B-1 to B-15 and MW2 to MW5) yielded one or more of the TPAHs. Most of the soil samples were taken in the unsaturated region, yet the drilling logs clearly showed visual evidence of free-phase TPAH product and TPAH-saturated soils below the water table to depths approaching 40 feet below the surface. In addition, several of the soil boring samplings, such as B-1, B-2, B-5, B-6, B-8, and MW-4, showed evidence of rapidly increasing TPAH contamination with increasing depth.

These historical data suggest that our site investigation should cover nearly all of the IES property to a depth just below the lower confining unit. Given that most of the TPAHs are dense non-aqueous phase liquids (DNAPLs), they may have migrated over time to form pools at the top of the lower confining clay-like layer. Evidence from the visual borehole logs confirm the presence of free phase at this layer. As a result, the geophysical characterization is focused on the topography of the lower confining layer, and confirmation will come from the CPT geophysical probes and the laser-induced fluorescence (LIF) probe capable of detecting the TPAHs. Previous work indicates that the resistivity probe can detect the presence of free-phase or saturated-phase product because of its high resistivity

3.2.3.1 Screening phase Measurements of soil gas organic vapor concentrations, IMA on-site sample analysis, and insertion of the passive sorbent modules will be performed during the screening phase. Sampling below the upper cohesive layer in the granular layer should improve the likelihood of finding a deep granular aquifer TPAH hot spot. Also during this phase, samples from the upper fill layer, the upper cohesive layer, and the granular aquifer will be taken at locations on the site presumed uncontaminated, e.g., in the NE corner of the site beyond B-3 and B-16. Once confirmed clean by GC analysis, these samples will be used to generate matrix-matched performance evaluation samples by spiking with various concentrations of the 16 TPAHs. Such performance evaluation samples can also be generated by the auger drilling during this phase.

During the screening phase of this site characterization, a search sampling strategy based on a triangular grid will be used to identify those regions of high TPAH concentration. The origin and orientation of the grid will be determined by random selection. Although previous measurements are a good guide as to the vertical extent of a potential hot spot, only a crude estimate of the horizontal extent of a potential hot spot is possible. Using a grid spacing of 50 feet and sampling at the grid nodes, the area extending slightly beyond the location of B-1, B-15, B-3 and MW-3 can be covered by about 25 nodes. At each node two samples will be taken,

one from about three feet below top surface, and the other from about 20 feet. The 20-foot sample depth is designed to reach just inside the upper portion of the granular layer but remain in the vadose zone. Assuming a circular hot spot, the probability of finding it depends only on the ratio of the hot spot diameter to 40 feet. For example, a hot spot of diameter 40 feet has a 92% probability of being discovered, while a hot spot of 32 feet has only a 59% chance of being discovered (Gilbert 1987, 124).

During this phase, samples of soil gas and of soil at the two depths will be taken. The soil gas sampling procedure is standard practice. Typically after the desired depth has been reached, the hole is isolated from the atmosphere and pumped on until several hole volumes have been removed. In the pumping line, a gas sample is taken with a syringe designed for direct injection into the GC. Upon injection, the chromatograph is then acquired and the individual TPAHs and other gases present are analyzed. It is expected that perhaps only naphthalene will be volatile enough to be detected in the gas phase.

Before the soil sorbers are placed at the bottom of each hole, a soil sample sufficient for each IMA and optical technique will be taken at each location. Typically, after removing extraneous material, such as twigs, the soil is split. The necessary splits will be taken by simply dividing the collected sample in the horizontal plane and then putting them directly into the extraction vials of each technique. Soil sample quantities are usually 5 or 10 grams for each IMA method. Results are available within minutes of sample collection from minimally trained samplers. Every five locations a duplicate sample will be measured. Duplicates will be obtained by taking samples at close but distinct locations in the vertical direction and separating them into two samples.

Homogenization of non-cohesive samples will occur at every fifth location using the following method. First sieve with a 20-mesh screen. Next pile the sample into shape of a cone on a hard clean surface, such as an aluminum foil-covered wood plank. Mix by forming a new cone. Flatten the cone with stainless steel spatula and separate into four quarters. Remix opposite quarters, reform cone and repeat five times. After the last time the soil has been separated into quarters, take required 5 or 10 grams from each quarter until each IMA method has its own sample. Remix and retain remaining soil for future reference and store in cleaned, darkened glass container with teflon lined caps. If the soil is wet, it may have to be dried before sieving is effective.

3.2.3.2 Quantitative phase During this phase, the GC/MS instruments will provide the main measurement tool. As recommended by the ESC methodology, the sampling strategy departs from the usual suite of USEPA recommended strategies (such as pure random, stratified random, or systematic grid). Instead, all previous information, including that derived from our screening phase will be evaluated by the field team and data gaps in the horizontal and vertical planes will be identified. Early in this phase these data gaps will be easily identified and determined geostatistically by kriging methods and special techniques such as jackknifing.

Qualitatively, jackknifing systematically removes each data point within a preselected vertical strata and evaluates the change in the average value of either total TPAH or total CPAH. Those points that change the average the most are those nearest to the sought after data gaps. The statistically least biased estimates of the location of the next sampling point can then be determined. Preliminary targeted geologic strata are the fill layer, upper cohesive layer, unsaturated portion of granular aquifer, saturated portion of granular aquifer and lower cohesive layer. Based on all previous information, an initial set of sampling locations will be determined prior to the start of the second phase. This sampling set will guide the Geoprobe® and CPT sampling during the first few days of the second phase.

To ensure the highest degree of uniformity in the sampling process, all of the sample preparation steps (e.g., sieving, homogenization, and splitting) will be done after the samples have been turned over to the mobile laboratory. A standard operating procedure (SOP) will be in place for this activity. The SOP will be based on USEPA recommended practices such as one described above for field sample preparation. The containers used to collect and transport the samples from the field sampling site to the mobile laboratory will be amber glass containers with teflon-lined caps that have been rigorously cleaned according to a procedure designed to minimize organic contamination (USEPA 1992). In some cases, the samples may be collected in containers that have pre-measured amounts of identical solvent to assist in the comparison between the sonic solvent, microextraction, and microwave extraction processes.

3.2.4 Data Quality Assurance

Each of the field and laboratory areas of the data acquisition activity has inherent precision and bias variances. The laboratory phase is often split into two phases, sample preparation and measurement, while the field phase is split into collection and handling. The data QA/QC samples are designed to quantitatively measure the variances associated with these various sub-phases of the total data acquisition process. As such, they are needed only for our second phase for the GC/MS instruments.

We will use uniform terminology from *A Rationale for the Assessment of Errors in the Sampling of Soils* (USEPA 1990). This work is one of the most detailed available USEPA sources and includes a worked example and a list of defined terms. A more general guidance document is *Removal Program Representative Sampling Guidance Vol 1 - Soil*, in which Section 5.4 discusses QA/QC samples (USEPA 1991b).

- **Routine** samples are those taken from the field and are sometimes called environmental samples.
- **Split** samples are a set of sub-samples separated from a homogenized sample. They sometimes called replicate samples.

- **Blank** samples are those samples with concentrations of the targeted compounds below the limit of detection (LOD). Blank samples are used to determine concentration false positives.
- **Spiked** samples are those prepared by adding a known amount of the targeted compounds to the unspiked sample. If the unspiked sample was a blank, then the spiked sample can be used to determine concentration false negatives.
- **Duplicate (triplicate)** samples are two (three) samples taken from adjacent locations treated identically after preparation. This type of sample is never homogenized. Duplicates are sometimes referred to as collocated samples.
- **Evaluation** samples are samples with known concentrations of targeted compounds. Sometimes these are called standard samples or performance evaluation samples. A set of these can be used to produce a calibration curve if the concentrations have been certified.
- A **batch** of samples consists of a set containing both routine and QA/QC samples. Often USEPA specifies a batch will contain 20 samples.

We assume that we want to distinguish between polluted and clean routine samples and that matrix-matched blank and spiked samples are available. By using field and laboratory evaluation QC samples, both precision and bias can be tracked with fewer QC samples. Detailed protocols for the various GC/MS extraction methods will be used to measure laboratory precision and bias from sample preparation through analysis. The matrix-matched blanks and spiked samples prepared from soil samples taken during phase one will provide the requisite field evaluation samples required to track field precision and bias. At least once a day, a blank and a spiked field QC sample will be submitted to the laboratory, with the spiked sample containing a 10 mg/kg concentration of each target analyte. These QC samples will be of sufficient quantity to be split into at least six sub-samples, one for each extraction module and one for storage. At least once a day, triplicate field samples will be taken and two of them will be analyzed by one extraction module; the extra triplicate will be stored for further evaluation. On each subsequent day, a different triplicate set will be analyzed by a different extraction module.

Split samples will be made available for analysis by an independent laboratory.

3.3 DATA MANAGEMENT AND INTEGRATION

Data fusion will occur as data is generated from each of the screening and analysis methods. The following table shows each of the methods, the type of data being gathered, and the time that the data will be incorporated into the GIS databases. Most data is in the form of (x,y,z,p) values where (x,y,z) is the spacial coordinate and (p) is the property value (usually a concentration).

		data type	quantity	information obtained	data collection	data availability
Optical PAH Screening		3-d scatter	50 points	screening TPAH	4/4 - 4/8	real-time or followup
Soil Gas / Portable GC		3-d scatter	50 points	screening Napthalene	4/4 - 4/8	real-time
Passive sorbent modules		3-d scatter	50 points	screening TPAH	4/4 - 4/8	4/25
IMA	Ensys	3-d scatter	50 points	screening TPAH	4/4 - 4/8	real-time
	Millipore	3-d scatter	50 points	screening TPAH	4/4 - 4/8	real-time
	Quantix	3-d scatter	50 points	screening TPAH	4/4 - 4/8	real-time
Hollow-stem auger		2-d stratigraphic	5 wells plus existing data	indirect geological	4/4 - 4/8, 4/25 - 5/6	real-time, historical
Ground penetrating radar		3-d grid	1 grid	indirect geological	4/4 - 4/8	4/25
Geophysical borehole logging		continuous well-data	7-9 locations	direct geological	4/4 - 4/8	before 4/25
Seismic reflection		2-d scatter	4 2-d profile sets	indirect geological	4/4 - 4/8	4/15
Seismic reflection/refraction		2-d scatter	1-2 2-d profile sets	indirect geological	4/18 - 4/22	early may
Resistance logs (CPT)		continuous well-data	60-70 locations	direct geological	4/25 - 5/6	real-time
Friction logs (CPT)		continuous well-data	60-70 locations	direct geological	4/25 - 5/6	real-time
Tip stress logs (CPT)		continuous well-data	60-70 locations	direct geological	4/25 - 5/6	real-time
Sleeve friction logs (CPT)		continuous well-data	60-70 locations	direct geological	4/25 - 5/6	real-time
Resistance logs (Geoprobe)		continuous well-data	20 locations	direct geological	4/25 - 5/6	real-time
Mobile GC lab data		3-d scatter	100 points (up to 5 reps)	quantitative PAH (16 analytes)	4/25 - 5/6	real-time
Vertical induction profiling		faces file and 3-d grid	1 grid	organic and geological screening	4/25 - 5/6	mid may

Figure 3.3-1. Data fusion matrix.

3.3.1 GPS Survey/Site Control

The Global Positioning System (GPS) will provide accurate coordinates for landmarks on and near the site. The GPS system uses two receivers to determine, within millimeters, the vector of displacement between two points by collecting satellite position information over a period of 15-30 minutes. This information, when tied to a known geographical point, will provide very accurate coordinates of site features and landmarks. The system will also be used to quickly and accurately determine coordinates of boreholes and other sampling points.

The basemaps for the site will be created by manually digitizing an aerial photo of the site. Known control points to geographically reference the photo will be obtained using GPS coordinates of permanent landmarks visible on the aerial photo. Some GIS packages provide facilities to digitize map information directly into the GIS database. These GIS programs are: ARC/Info®, EarthVision®, TNTmips®, and RockWorks®. The programs which do not support digitizing functions will import the basemap information as a DXF file generated with AutoCAD v12®.

The basemaps will consist of multiple features to assist in the analysis and display of the databases. Categories of features to be included are: current structures, boundaries, surface

features, and underground utilities, as well as historical site information. All of the basemap information will be grouped in layers that, in general correspond to the features. The layers can then be shown or hidden to allow selection of the information being displayed.

3.3.2 Mobile Command Center

The mobile command center (MCC), a 24-foot truck, provides the workspace and utilities to support field operation of the three workstations and associated peripherals. All of the data storage, manipulation, and analysis will take place in the MCC. Electricity will be provided by IES, but two generators will be on-board for use as a backup power source. Two air conditioners will maintain the proper environment in the MCC. Two uninterruptible power supplies (UPS) will condition the electricity to most of the computer peripherals. Those peripherals which cannot be connected to the UPS system will be connected to a surge suppressor. A cellular phone and three portable radios will be used for communications among field personnel.

3.3.3 Data Integration

The hardware needed to perform the data fusion is listed in the following table. A 10-base-T ethernet network will provide NFS file sharing and LPR printer service to each of the computers. A shared volume will store all of the raw and processed data files. Data can then be easily backed up from the shared volume on a daily basis to the 1200 megabyte (MB) tape cartridges.

Hardware Inventory

Silicon Graphics Indigo2 Extreme			
64 MB ram	5 GB hard disk	19" monitor	CD-ROM drive
3.5" floppy	Howtek Scanmaster 3+ Color scanner		
Zenon 486/66 MHz PC			
48 MB ram	1.2 GB hard disk	21" monitor	CD-ROM drive
128 MB magneto-optical disk	3.5" and 5.25" floppies		
AST Color Notebook 486/25 MHz			
8 MB ram	200 MB hard disk (removable)	fax/modem	
Network Printers			
ImagerPlus12 postscript laser (11" x 17", 1200 dpi)			
HP1200C color postscript ink jet (8.5" x 11", 300 dpi)			
Lexmark 4079 color postscript ink jet (11" x 17", 360 dpi)			
HP650C color HPGL plotter (34" x 44", 300 dpi)			

3.3.3.1 Data gathering Data from each sampling location will be provided on a daily or regular basis to Ames Laboratory personnel for incorporation into the GIS databases. The

format for the data will in general be tabular ascii text. The data files will be transported on regular MS-DOS formatted 1.44 MB 3.5" disks. Other data formats may be more appropriate and will be discussed on an individual basis. After the data is received, simple statistics will be performed on the data set; a visual check for consistency and content of the data will be performed as well. This initial "reality-check" is intended avoid the introduction of gross data errors into the GIS systems.

3.3.3.2 Data storage and management All of the raw data files will be stored in their original format in the network data volume. This data will then be accessible as read-only to all of the workstations. All of the data will also be imported into SiteManager® which will provide a site database. SiteManager® also will provide the mechanism for quality control of data entry, several classifications of data validity, and other data management related functions.

3.3.3.3 Data analysis Data analysis will be performed using the specific features of each GIS package as well as the geostatistics program, GS+/386®. Other analysis will be completed using spreadsheets and other miscellaneous tools. The table below shows the main types of analysis which will be provided by each program.

	Source	Platform	Attributes
EarthVision	Dynamic Graphics, Inc.	Indigo2	3-D GIS with state-of-the-art visualization
ERMA	Intergraph	Proprietary	3-D GIS with state-of-the-art visualization
ARC/Info	Environmental Systems Research Institute	Indigo2	2-D map-oriented GIS; largest market share; not designed for characterization
SitePlanner	Consolve, Inc.	PC/UNIX	2-D GIS designed for environmental site work; used by Argonne
SiteManager	Consolve, Inc.	PC/Windows	Fully-featured site data management system
TNTmips	MicroImages, Inc.	Indigo2	2-D GIS; potential cost/benefit value over Arc/Info
RockWorks	RockWare	PC / DOS	2-D visualization; low cost; targeted to site work
GS+/386	Gamma Design Software	PC / DOS	Kriging and jackknife statistical analysis

Table 3.3-2. Software features and functions.

3.3.3.4 Data visualization Contour maps, surface plots, data posting, and other means will be used to visualize the data. Each GIS package has its own set of visualization tools, but the contour map will be the primary tool for displaying 2-D data.

3.3.3.5 Data presentation An NEC 9PG[®] multisync video projection system will display the screen output of the Silicon Graphics Indigo² Extreme[®] (SGI). A multi-media presentation will be developed on the SGI which will incorporate site photos, maps, analysis, and images/animation generated by the various software packages; video may also be incorporated into the presentation. The presentation will also provide an explanation of the ESC and CATD process. The presentation will be produced and directed by Ames Laboratory personnel. Because the SGI will be used both for presentations and for data fusion, the SGI system will be transported from the MCC to the presentation area daily.

3.3.3.6 Data export Data will be available in both printed form and electronic media. The printed material will be available as part of the site report. Electronic media will be available on 3.5" floppy, QIC tape, 128 MB magneto-optical disk, and on the Internet. Exact details of data availability will be determined based on the quantity of data generated by the field work.

3.3.4 Data Validation

Data validation is a set of procedures designed to detect certain types of errors associated with the laboratory data packages. Data qualifiers are assigned to the data itself after data validation has been completed. Tasks required for data validation for the SVOC analysis by GC/MS based methods are:

- search for transcription/calculation errors,
- validate compliance with holding times for extraction and analysis,
- confirm GC/MS tuning criteria have been met,
- verify that average response factors for GC/MS detected compounds are at least 0.05,
- determine bias through percent recovery,
- determine precision by replicate analysis, including independent analysis of split samples,
- verify levels of compound identification, quantitation and reported detection limits, and
- investigate performance evaluation samples.

4.0 FIELD PROCEDURES

This chapter discusses decontamination procedures, waste management, the site health and safety plan, and public relations and communications activities.

4.1 DECONTAMINATION PROCEDURES

Decontamination of all invasive field equipment will be required to prevent sample cross contamination or transfer of any contaminants between boreholes. Decontamination will be the responsibility of the equipment operator (subcontractor or Ames Laboratory personnel) and will be required when each of the following events occur:

- upon arrival on site
- between each boring location
- between each probing location
- between each soil sampling event
- prior to equipment leaving the site

4.1.1 Geophysical Equipment Decontamination

For the geophysical techniques, initial decontamination will be required for all tools to be used downhole. The surface techniques, such as ground penetrating radar and seismic reflection, will not require decontamination. All tools to be used downhole will be decontaminated with the following procedure:

- 1) rinse with potable water
- 2) brush wash with an Alconox or nonphosphate laboratory-grade detergent and potable water solution
- 3) rinse with potable water
- 4) rinse with deionized or distilled water

In the event that visible residuals remain, reagent-grade ethanol or isopropanol will be applied and the decontamination procedure, as described above, will be repeated.

Ames Laboratory will provide a fully equipped decontamination station.

4.1.2 Downhole Equipment Decontamination

All drilling equipment will be decontaminated upon arrival on site and between each boring location. The drilling equipment will be steam cleaned (or high pressure hot water cleaned) prior to insertion into each boring. The drilling contractor will be responsible for construction of his temporary decontamination pad, and will provide all equipment necessary for

decontamination. This includes temporary pad construction materials, water pump, sprayer, and water storage drums, and any other items needed.

Soil probing equipment (Geoprobe® and cone penetrometer) will be disassembled, to the extent practical, and decontaminated in a manner similar to the process described for geophysical equipment. Devices which cannot be disassembled in the field will be hand washed or wiped clean on their outer surfaces and rinsed.

The soil sampling equipment will require additional care for decontamination. All equipment that will come in contact with any soil which might possibly be used for analysis will be decontaminated prior to sampling in a manner similar to the process described above.

Ames Laboratory will provide a fully equipped decontamination station for this sampling equipment, but the subcontractor will perform the decontamination.

4.2 WASTE MANAGEMENT

All waste materials generated during the field investigation will be collected and temporarily stored on site, pending disposal arrangements through IES. Classification of wastes will be performed at the completion of the field investigation to determine the appropriate disposal method, dependent on waste media (soil or water) and contaminant concentration.

4.2.1 Soil Wastes Management

Soil wastes will be generated during the field investigation from several sources including hollow stem auger drilling, decontamination of equipment, and the collection of soil samples for analysis.

4.2.1.1 Drilling and probing waste soils Soil wastes will be collected at the drill site and the decontamination area, respectively, and drummed in the field. A temporary exclusion zone for drum waste storage will be established after consultation with IES personnel. At the conclusion of the field investigation, a composite soil sample will be retrieved from the drums at a rate of one (1) composite sample for every five (5) drums of material. Drums will be labeled as to their contents and the date of accumulation, and set aside for temporary storage. IES will handle this soil contaminated by FMGP wastes in a manner consistent with standard and accepted practices as used for other FMGP sites in Iowa.

4.2.1.2 Sample analysis of wastes Composite samples of drummed soil waste will typically be analyzed by an off-site laboratory by the EPA toxic characteristics leaching process (TCLP) for volatile organics. However, if the drummed material appears to contain exceptionally high concentrations of, or is saturated with FMGP-waste compounds, additional waste

characterization analyses, including but necessarily limited to TCLP for semi-volatiles and ignitability, will be conducted.

4.2.2 Waste Water Management

The liquid waste generated during the field investigation primarily consists of decontamination wash water. The wash water from the steam cleaner and sampler decontamination stations will be collected in 55 gallon drums and stored in the same temporary exclusion area as the soil wastes. At the completion of the field activity, a sample from each drum will be analyzed for parameters specified in the discharge permit issued to IES by the City of Marshalltown. A determination will be made as to the need for pretreatment of the drummed water prior to discharge to the Marshalltown POTW. Water will not be discharged until it meets the criteria of the permit.

4.3 HEALTH AND SAFETY

All work performed on the site will be conducted in accordance with the Site Safety Plan (SSP) prepared originally by BVWST for the remedial investigation conducted between 1990 and 1992, and adopted by Ames Laboratory. A draft copy of the SSP is contained in the Appendix.

During preliminary phases of on-site work (contaminant screening and geological characterization), a representative of Ames Laboratory present at the site will be designated as the "Site Safety Officer" (SSO) and will be responsible for enforcement of the SSP and documentation of health and safety activity. During the contaminant plume delineation phase, when more intrusive work is planned and a greater number of personnel and contractors will be on site at one time, an outside consultant will be hired to serve as the SSO. A complete description of the SSO's responsibilities is included in the draft SSP.

4.4 COMMUNICATIONS/PUBLIC RELATIONS STRATEGY

Effective communication is an important aspect of achieving stakeholder participation in the ESC methodology. The ESC project will employ a two-way symmetric communications model in our public relations efforts with stakeholder groups. This model stresses a balanced exchange of information between the organization (or program) and its publics. The model seeks mutual understanding as its goal and is characterized by formative and evaluative research on audience/stakeholder interests and attitudes.

We will identify stakeholders using a framework of organizational linkages, as pictured below.

Figure 4.4-1. External linkages of ESC Project.

After identifying these groups by specific name or organization, we will conduct preliminary research to determine their level of awareness of ESC methodology, their interests, and concerns as stakeholders, and demographic factors.

Based on this research and other information-seeking characteristics of our stakeholder groups or "publics", we will define the relative impact of each group on our overall goals, and then develop the appropriate communication or public relations messages and activities.

For example, IES Utilities, an "enabling" public, is critically important to the success of the project. They are unfamiliar with ESC methodology and are concerned that their employees understand the purpose of the ESC and know what will take place on the site. They would also like their participation to result in a positive image with their customers. Because they are responsible to the Iowa Department of Natural Resources (IDNR) for investigation and remediation efforts, they are also sensitive to IDNR's opinions.

The two-way symmetric model would prescribe activities that encourage a two-way exchange of information. This includes such things as face-to-face meetings among IES Utilities, Ames Laboratory, and IDNR to discuss the proposed project, monthly meetings between Ames Laboratory and IES Utilities staff to exchange information, informational meetings with IES employees to explain ESC and allow for open dialogue, and coordination with IES Utilities on the press release and press coverage at the event.

For the other publics in Figure 4.4-1, the two-way symmetric model would prescribe such things as inviting these groups to the ESC demonstration to encourage the exchange of information. We would provide alternate days to visit the site. A tentative outline of the day's agenda would include:

- A mid-morning multimedia presentation explaining ESC methodology, its application at the Marshalltown site (timeline, technologies used and compared) and our approach to transferring this methodology to stakeholder groups.
- The presentation would be followed by a lunch and then a guided tour of the site, rotating groups between areas.
- After the tour, we would reassemble for a question and answer session, and conclude the day's activities.

We would follow up with our stakeholders by providing reports and documentation to maintain this dialogue.

With respect to practical logistics, we will develop:

- a database of contact names, addresses, stakeholder group they belong to, records of communication, etc.

- information packets to provide background on the methodology, lodging options, maps, schedules/programs
- transportation for tours
- miscellaneous supplies (name tags, walkie talkies, etc.)
- accommodations for Ames Laboratory staff and contractors

We will also prepare documentary videos and videos of a more general, descriptive nature.

Finally, after the ESC demonstration is completed, we will evaluate our communication efforts both quantitatively and qualitatively against stated objectives. For our qualitative evaluation method we will choose from either personal interviews, telephone interviews, or written questionnaires.

Our final report will summarize communication research, objectives for each audience, activities designed to meet objectives, evaluation of those objectives, and recommendations for future ESC communication plans.

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**Ames Laboratory - Technology Integration Program
Site Safety Plan
For
Marshalltown, IA Expedited Site Characterization**

(Adapted from Site Safety Plan prepared by B & V Waste Science and Technology)

I. GENERAL INFORMATION

PROPERTY OWNER: IES Utilities, Inc.

CONTACT: Dean Hargens

SITE MANAGER: Albert Bevolo

SITE SAFETY COORDINATOR: David Wonder

SITE SAFETY OFFICER: To be designated during each phase of work.

SITE LOCATION: 601 E. Nevada, Marshalltown, Iowa

II. SITE CHARACTERISTICS

A. Facility Description

Electric generation and manufactured gas production took place at the site. Several structures from both of these operations still remain. These include the former electric generation building; spray pond area; tar separator and boiler rooms of the carbureted water gas plant; purifier building; regulator building; the foundation and one-half the wall of the 200,000 cu ft holder; and the foundation of the 50,000 cu ft gas holder. The facility is currently owned by Iowa Electric Light and Power Company and is used as a gas and electric operating facility.

B. Status

The manufactured gas plant is inactive, but the facility is used as a operating area for gas and electric utilities.

C. Principal Disposal Method

Coal tar, oil, and iron oxide waste may remain or have been disposed of on site.

D. Features and Unusual Conditions

To be identified prior to drilling. Railroad tracks are immediately south of the site.

E. History

According to early documents, the former manufactured gas plant (FMGP) located in Marshalltown, Iowa began operations between 1875 and 1880. Initially,

manufactured gas was produced through the coal carbonization process; however, the carbureted water gas process was implemented between 1910 and 1921. Later, the process was altered to a propane-air system. Finally, between 1950 and 1952, natural gas became available and the manufacturing of gas on site ceased.

III. SCOPE OF WORK

A. Planned Site Activities and Dates

April 4 - 8: Soil contaminant screening.
 Seismic reflection.
 Borehole logging.
 Ground-penetrating radar survey.
April 18 - 22: Seismic reflection and refraction survey.
April 25 - May 6: Contaminant plume delineation.
 Cone penetrometer testing.
 Induction profile demonstration.

B. Number of People On site

Ames Lab - up to 5 persons
Contractors - up to 12 persons

C. Number of Days to Complete Work

Approximately 25 workdays.

IV. WASTE CHARACTERISTICS

A. Waste Type(s)

Liquid X Solid X Sludge
Gas Other

B. Waste Characteristics

Corrosive Ignitable Radioactive
Volatile X Toxic X Reactive
Unknown X Other (Name)

V. HAZARD EVALUATION

A. Chemical Hazards

Polynuclear aromatic hydrocarbons (PAHs) have been associated with similar FMGP sites. Other typical manufactured gas wastes include: oils which contain light aromatics (i.e., benzene, toluene, and xylenes) and spent oxide waste that contains complexed cyanides. The following are regulatory standards and advisory levels for the potential chemical constituents at the Marshalltown FMGP site.

REGULATORY STANDARDS AND ADVISORY LEVELS FOR PAH COMPOUNDS

<u>Compound</u>	<u>Agency</u>	<u>Regulatory Standard</u> <u>AIR</u>	<u>Advisory Level</u>
Benzene soluble fraction of coal tar pitch volatiles	OSHA	0.2 mg/m ³ , h-hr TWA PEL	
Benzene-soluble fraction of coal tar pitch volatiles	ACGIH		0.2 mg/m ³ , 8-hr TWA TLV
Cyclohexane-soluble fraction of coal tar pitch volatiles	NIOSH		0.2 mg/m ³ , 10-hr TWA REL
Benzene [71-43-2]	OSHA	1 ppm, 8-hr TWA PEL 5 ppm, STEL 0.5 ppm action level	
	ACGIH		10 ppm, 8-hr TWA TLV
Toluene [108-88-3]	OSHA	200 ppm, 8-hr TWA PEL 300 ppm ceiling 500 ppm, 10 min. peak	
	ACGIH		100 ppm, TLV
	NIOSH		100 ppm, 10-hr TWA REL
			200 ppm, 10 min. ceiling

Xylenes [1330-20-7]	OSHA	100 ppm, 8-hr TWA PEL	
	NIOSH		100 ppm, 10-hr TWA REL
	ACGIH		200 ppm, 10 min. ceiling 100 ppm, TLV 150 ppm, STEL

<u>Compound</u>	<u>Agency</u>	<u>Regulatory Standard</u> <u>AIR</u>	<u>Advisory Level</u>
Ethyl Benzene	OSHA	100 ppm, 8-hr TWA PEL	
Cyanides [151-50-8; 143-33-9]	OSHA	5 mg/m ³ , 8-hr TWA PEL, hydrogen cyanide 10 ppm or 4 mg/m ³ 8 hr TWA PEL, 5 ppm action level as hydrogen cyanide	
	NIOSH		hydrogen cyanide and cyanide salts 4.7 ppm, 10 min. peak 50 ppm, IDLH
	ACGIH		10 ppm, TLV

NOTE: Cyanide is also skin-absorptive

Abbreviations:

- OSHA - Occupational Safety and Health Administration
- ACGIH - American Conference of Governmental Industrial Hygienists
- NIOSH - National Institute for Occupational Safety and Health
- TWA - Time-Weighted Average
- PEL - Permissible Exposure Limit
- STEL - Short-Term Exposure Limit
- TLV - Threshold Limit Value
- REL - Recommended Exposure Limit
- IDLH - Immediate Danger to Life and Health
- AL/TIP - Ames Laboratory/Technology Integration Program
- SSO - Site Safety Officer

B. Physical Hazards

Slips, trips, and falls. Site is still active as an operations facility, so trucks and other vehicles will be operating on site.

C. Hazards Posed by Site Activities

Drilling hazards. Utilities and electrical lines (buried and above ground) are present on site.

D. Unusual Hazards

Nearby railroad activities.

E. Overall Hazard Level

Low: During ground water sampling, smoke testing of sewers, hydrogeologic measuring and testing, and surveying low concentrations of contaminants are expected.

Moderate: During drilling, well installation, and source sampling, the potential of exposure to contaminants by inhalation or direct skin contact exists. Mechanical failure or operator negligence of drilling equipment also presents a potential threat.

VI. PROCEDURES

A. Training Requirements

All personnel who will be engaged in hazardous waste operations must have completed, within the 12 months prior to the beginning of site activities, a hazardous waste site investigation training course or eight hour refresher course. The training must comply with OSHA regulations found at 29 CR\FR 1910.120 et seq.

B. Level of Protection

A _____ B _____ C X D X

Level D

Tyvek® coveralls or appropriate chemical-resistant suit

Outer gloves - Nitrile rubber or Neoprene

Inner gloves - Disposable Latex

Boots - Steel toe and shank, impermeable and chemical-protective

Outer boot covers - Disposable rubber, impermeable and chemical-protective

Hard hat (to be worn during drilling operations and when overhead hazards exist)

Safety glasses or goggles

Level C

Full-face, air-purifying respirator (OSHA/NIOSH-approved) with appropriate cartridges.

Chemical-resistant suit.

Remaining Level D requirements

C. Action Levels

<u>Instrument</u>	<u>Reading</u>	<u>Action</u>
OVA or HNU (organic vapors)	Background	Level D
	Up to 5 ppm above background	Level C with appropriate cartridges
	Greater than 5 ppm above background	Evacuate and consult AL/TIP Site Safety Officer
O ₂ Meter	Less than 19.5% O ₂	Evacuate and consult AL/TIP SSO; explosimeter readings <u>not</u> valid
	19.5% - 25% O ₂	SCBA not on basis of O ₂ content <u>only</u>
	Greater than 25% O ₂	Evacuate; explosion hazard
LEL Meter	Up to 20% LEL	Continue activities
	20-25% LEL	Continue; identify source
	Greater than 25% LEL	Evacuate; explosion hazard
Draeger Tube or Monitox HCN detector (CN)	Any indication	Evacuate and consult AL/TIP SSO
Draeger Tube (Benzene)	Less than 1 ppm	Level D
	Equal to 1 ppm	Level C

	Greater than 1 ppm	Evacuate and consult AL/TIP SSO
Dust Meter	Up to 5 mg/m ³	Level D, based on dust levels <u>only</u>
	Greater than 5 mg/m ³	Level C, based on dust levels <u>only</u>

D. Monitoring Requirements

Ambient air monitoring will be conducted continuously while site activities are in progress. Monitoring instruments will include the following:

- HNU (PID) or OVA (FID) for organic vapors.
- O₂/LEL meter.
- Draeger pump and tubes for cyanide.
- Dust meter (as required).

The SSO will record instrument readings every 60 minutes or when significant changes occur. Upgrade/downgrade decisions will be based on monitoring results in the breathing zone and the action levels listed above. Hearing protection will be worn during drilling activities, so a noise meter will not be required. Calibration and maintenance of monitoring equipment will be the responsibility of the SSO and will be conducted in accordance with manufacturer's requirements as listed in the appropriate manual.

E. Site Organization and Control

Map/Sketch Attached? yes Site Secured? yes

Perimeter Identified? yes

Zone(s) of Contamination Identified? no

Note: Work areas within the site (exclusion area, contamination reduction area, support area) should be established so that the support area is upwind of the exclusion area. One or more flags should be placed on site to determine wind direction.

Figure F-1 depicts the location of the Marshalltown, Iowa FMGP site and the nearest available hospital. Figure F-2 shows the layout of the site itself.

The SSO will define the exclusion area contamination reduction area, and support area before the field activities begin at each sampling location.

Entry into and exit from the Exclusion Area for all personnel and equipment will be made through the Contamination Reduction Area. The SSO will be responsible for setup of the personnel and equipment decontamination facilities in the Contamination Reduction Area. All personnel will make a final check of their protective equipment in the Contamination Reduction Area before entering the Exclusion Area. All personnel departing the Exclusion Area will decontaminate and remove their equipment before entering the Support Area.

The Support Area will include an equipment staging and storage area. Emergency telephone numbers, directions to the hospital, and the Site Safety Plan will be available in the Support Area. A First-Aid kit will also be located in the Support Area. A vehicle designated for emergency service will be parked within or near the Support Area.

F. Initial Procedures

- Locate nearest available telephone.
- Confirm and post emergency telephone numbers and route to hospital.
- Designate at least one vehicle for emergency use.
- Determine prevailing wind location and establish preliminary work areas (support area, contamination reduction area, exclusion area).
- Perform initial site reconnaissance.
- Hold safety briefing for all participants before work begins.

G. Work Limitations

- No eating, drinking, chewing of gum or tobacco, or smoking in the exclusion and contamination reduction zones.
- No contact lenses to be worn in the exclusion and contamination reduction zones.
- Work restricted to daylight hours only.
- Buddy system to be used at all times in exclusion zone.
- Work to stop during thunderstorms or electrical storms.
- No facial hair that would interfere with respirator fit.

H. Decontamination Procedures

For Personnel: Remove booties and dispose of; remove outer gloves and dispose of as necessary; remove APR; remove Tyvek or chemical-resistant suit and dispose of as necessary; remove inner gloves and dispose of; if Level C, remove cartridges and dispose of and decontaminate respirator; shower immediately after work.

For Equipment: After using monitoring equipment, surfaces of equipment will be wiped with a cloth that has been dampened with a solution of laboratory detergent and water. When not in use, monitoring equipment contamination will be prevented by placing the items in plastic bags or in the appropriate carrying case. Dispose of plastic bags after use. For drilling and sampling equipment, follow instructions specified in the drilling specification and Work Plan.

For Vehicles: Properly decontaminate all vehicles entering the exclusion or contamination reduction zones. All soil, gravel, or particulates must be removed by a high pressure spray or by scrubbing with soap and water. All runoff must be collected and disposed of in DOT specification drums. For the drill rig, follow the instructions in the drilling specifications.

I. Disposal Procedures

Potentially Contaminated Liquids and Cuttings:

Potentially contaminated liquids and cuttings will be placed in DOT specification drums and staged on site for later disposal.

Used Protective Clothing and Miscellaneous Wastes:

Used protective clothing and other miscellaneous wastes will be double-bagged and disposed of in the manner that solid waste or trash that is generated at the Marshalltown facility of disposed of.

J. Safety Equipment

- Fire extinguishers
- Eye-wash bottles
- First aid kit

VII. EMERGENCY INFORMATION

A. Emergency Routes (See Attachment 1)

B. Contingency Plan

1. General Information

The Field Team Leader or SSO will contact the local hospital emergency room, police department, fire department, ambulance, and other emergency services before field activities begin. The Field Team Leader or SSO will inform the hospital emergency room and ambulance service of probable emergencies and fill out insurance information at the hospital, prior to the start of the investigation. This will assist local personnel in being prepared should an emergency arise during investigation.

The SSO will be responsible for establishing, then adjusting as necessary, appropriate levels of eye, skin, and respiratory protection for the investigation. The SSO will ensure that all participants conduct their work in accordance with the Site Safety Plan and applicable safety rules and will direct any assigned employee to leave the site if he or she fails to observe safety requirements or in any way creates a safety hazard.

If ambient temperatures reach 45 F. or below, hourly warm-up breaks will be taken, and cold stress monitoring will be implemented. Warm beverages may be given. If ambient temperatures reach or exceed 80 F., hourly breaks will be taken, and heat stress monitoring will be implemented. Cold beverages may be given to replenish fluids. In either event, work schedule adjustments may be required.

All employees will be directed to bring to the attention of the Field Team Leader and SSO any unsafe condition, practice, or circumstance associated with or resulting from the investigation.

In cases of immediate hazard to employees or the public, employees on the scene will take all practical steps to eliminate, neutralize, or avoid the hazard. This may include leaving the site. The Field Team Leader will take the steps necessary to ensure that the investigation is completed safely. These steps may include changes in field procedures, removal or neutralization of a hazard, consultation with appropriate experts, or use of specialists. All such actions will be coordinated with and approved by the AL/TIP Site Safety Coordinator.

2. Site Safety Briefings

Before the investigation begins, the SSO will hold a site briefing. All members of the investigation team, including drillers, will attend this

meeting. During this meeting, the SSO will discuss safety equipment use, maintenance, and limitations; accident reporting procedures; and decontamination procedures. Questions about the project will be answered, and the Site Safety Plan Certification will be signed by all team members during the initial briefing. The SSO will also hold a similar meeting with individuals who later become a part of the investigation team before they take part in investigation activities. Subsequent periodic briefings will be held throughout the course of the investigation, especially when unsafe practices are noted or a change in site conditions requires modification of the Site Safety Plan.

3. Visitors

Occasionally a situation will arise in which someone visits a site during site activities. In general, most visitors will be accommodated by being permitted to observe activities from the Support Zone. Visitors who present to the SSO certification of completion of a hazardous waste site investigation training course or refresher course (in the last 12 months) in compliance with OSHA regulations found at 29 CFR 1910.120 et seq. will generally be granted access, provided that they are dressed in suitable protective equipment, they assume all responsibility, and the owners do not object. Visitors without the training course who desire access to the Exclusion Zone must obtain permission from the owners and the SSO. All visitors, who enter the Exclusion Zone and/or Contamination Reduction Zone will be advised of the nature and level of exposure likely as a result of AL/TIP-related activities and that they and their employees must assume all risk. Copies of the AL/TIP Site Safety Plan will be provided to these personnel for informational purposes only.

C. Accident Response Procedures

1. General Procedures

In the event that any member of the party experiences any adverse effects or symptoms of exposure during an investigation activity, the individuals involved with the particular investigation activity will leave the Exclusion Area and seek appropriate medical aid for the affected individual. The SSO will be in charge of health and safety measures. If he or she is not present or injured, the Field Team Leader will be in charge.

In the event that any member of the party is overcome, incapacitated, or traumatically injured while on site, the remaining members will immediately don appropriate protective equipment and make reasonable efforts to rescue the affected person. Once removed from the area where the incident occurred, the affected person will not be left unattended, and medical assistance will be summoned. If it is necessary to drive the victim to the hospital, two field personnel will accompany the victim. One other

person from the field crew will be designated by the SSO to call ahead to the emergency room and provide information about the accident before the victim arrives. If the SSO is injured, the Field Team Leader will designate a person to call ahead to the hospital. If possible, limited decontamination will be conducted, but not if time is critical to get the injured person to medical aid. If it is determined that the problem was due to chemical exposure, all members of the party exposed to those chemicals will proceed expeditiously, in a group, to the hospital. In those cases where personal contamination has occurred, all persons involved will make every reasonable effort to decontaminate themselves to minimize spreading of contaminants.

2. Procedures for Emergencies Posing an Immediate Threat to Life, Limb, or Health of One or More Persons in the Exclusion Area.

Examples: explosion, excessive smoke, fire, excessive concentrations of organic contaminants, equipment accident, person unconscious, nausea, dizziness, safety or protective equipment malfunction.

- (1) Any person involved in or witnessing an accident or other threatening situation will notify the other personnel immediately (e.g. sound alarm horn).
- (2) Injured persons' partners or other personnel close to them will lend assistance. Personnel will not unduly jeopardize their own lives to assist an injured person. The injured person will be moved only when necessary to avoid further hazards.
- (3) All activity in the Exclusion Area will cease and personnel not involved in providing assistance to the injured or endangered personnel will depart to the Support Area.
- (4) The SSO will immediately call the proper authorities (ambulance, fire, police, rescue teams, etc.). If the SSO is injured or absent, the Field Team Leader will call the proper authorities.
- (5) Personnel will not reenter the Exclusion Area until allowed by the SSO or Field Team Leader. The SSO or Field Team Leader will assess the nature of the emergency and correct the matter before allowing re-entry.
- (6) A complete written report of the incident will be made by the injured personnel and the SSO or Field Team Leader and sent to the AL/TIP Site Safety Coordinator.

3. Procedures for Minor Accidents in the Exclusion Area.

Examples: sprains, small cuts or scrapes, equipment malfunction.

- (1) The person injured will cease work, notify his/her partner, and exit with the partner to the Support Area and obtain adequate medical attention.

4. Procedures for Emergencies Posing an Immediate Threat to Life, Limb, or Health of One or More Persons in the Contamination Reduction or Support Area.

- (1) Persons at the scene will lend assistance and perform the necessary first aid, CPR, etc.
- 2) The SSO will immediately call the proper authorities (ambulance, fire, police, poison control center, rescue teams, etc.). If the SSO is injured or absent, the Field Team Leader will call the proper authorities.
- (3) Personnel in the Exclusion Area will be signaled to depart the Exclusion Area if they could be affected by the accident.
- (4) A complete written report of the incident will be made by the injured personnel and the SSO or Field Team Leader. The report will be sent to the AL/TIP Site Safety Coordinator.

5. Procedures for Minor Accidents in the Contamination Reduction or Support Area.

The person involved will initiate the appropriate corrective measures and obtain adequate medical attention. A notation of the injury will be entered on the activity report (Attachment 2).

D. Accident Reporting Procedures

In order to comply with federal and state laws concerning worker's compensation and insurance coverage, all accidents will be reported immediately to the AL/TIP Worker's Compensation Administrator. The AL/TIP Site Safety Coordinator will be notified immediately so that corrective actions can be implemented. If immediate notification is not possible, the accident will be reported within 24 hours of occurrence.

E. Emergency Contacts (AL/TIP)
(See Attachment 1)

F. Local Emergency Contacts

(See Attachment 1)

VIII. PLAN PREPARATION

PREPARED BY: _____ Date: _____
(Site Safety Coordinator)

REVIEWED BY: _____ Date: _____
(Site Manager)

IX. CERTIFICATIONS

(Note: This page should be retained by the Site Safety Coordinator and incorporated into the project file.)

By my signature, I certify that:

1. I have read,
2. I understand, and
3. I will abide by

the Site Safety Plan for the Marshalltown, Iowa FMGP site.

Printed Name

Signature

Date

Affiliation

MARSHALLTOWN

Figure F-1. Site vicinity and nearest hospital.

Figure F-2. IES Industries Site

DATE

FILMED

7/27/94

END