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U S EPA REGOIN IV CONCERNS ON DRAFT FINAL ZONE H RESOURCE CONSERVATION AND RECOVERY ACT FACILITY INVESTIGATION REPORT WITH TRANSMITTAL CNC CHARLESTON SC
8/24/1995
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24 August 95

Commanding Officer
SOUTHNAFACENGCOM
Attn: Matthew A. Hunt, Code 1877
2155 Eagle Drive
Charleston, South Carolina 29411-0068

RE: Clarification of "Focused Field Investigation" Information.

Dear Mr. Hunt:

Subsequent to submittal of the *Draft Final-Focused Field Investigation Report* as an appendix to the *Draft-Final Zone H RFI Report*, questions were raised by USEPA with regard as to whether or not the objective of the Focused Field Investigation has been met. During the meeting held on 8 August 95, it was apparent that answers to USEPA's questions were available, but that some additional effort would be required to consolidate the information to assist with the review process. Since the Base Exchange, Building 656, is the focal point of the investigation, the majority of the issues raised relate to the exchange. Each of the identified concerns are listed below along with additional information or references to information intended to address the concern.

- **Concern** - The air monitoring performed did not comply with the "spirit" of the sampling plan as outlined in the *Draft-Final Focused Field Investigation Strategy* included as Appendix G of the *Final Zone H RFI Work Plan*. Specifically the concern was that no air samples were collected from the "dead air" pockets beneath the buildings identified for sampling.

  Response - The strategy listed three goals that needed to be met in order to satisfy the objective of the FFI. One of the goals was to determine whether or not the source of indoor air contaminants was internal or external. To facilitate the evaluation, the strategy proposed to include the collection of air samples between the ground surface and the building sub-floor "at points immediately below the floor separations/penetrations to provide the most representative evaluation of an external source for COPCs". Pages 5 and 15 of the strategy which identify this goal are included as Attachment 1. The void space was created when the ground subsided under structures that remained stationary because they are pile supported. Uneven subsidence of the ground surface around and underneath building foundations has the potential to create "dead air" pockets where there is little or no exchange of trapped air with ambient air. If present, gases could accumulate in these

pockets. At Building 656 however, the subsidence underneath the building is generally uniform which increases the potential for the exchange of ambient air with air under the building thereby decreasing the potential for dead air pockets. In either case, samples were collected from these void spaces at points below the floor separations and penetrations where possible. The samples were collected during Phase II of the FFI in all buildings (which included Building 656) where a crack existed of sufficient width to allow sample tubing to extend through the crack into the void space below. The samples were defined as "Sub-slab interior (SS_{int})" on pages 3-1, 3-2, and 3-3 of the FFI report. Field notes and discussions with sampling personnel indicate that SS_{int} samples were collected by extending the sample tubing approximately .5 to 1.5 feet below the building floor. The distance the tubing was extended through the cracks was dependent upon the distance to the ground surface below the building. Figures depicting locations of these sampling points were also included in the report. The text and figures are included as Attachment 2.

- **Concern** - Analytical results are subject to question because samples of a "standard" were not drawn into a decontaminated SUMMA canister through a length of decontaminated sample tubing and the contents subsequently analyzed to calculate a percent recovery. It was stated that this was standard operating procedure and should have been done.

  Response - Sections 11.2 and 12.2 of EPA Method TO-14 describe a process similar to the concern raised above. Prior to use, sample collection systems must meet certification requirements outlined in the sections listed above. The certification includes a process by which humid "zero air" and humid calibration gases are allowed to pass through all active components of a sampling system into a canister and the contents subsequently analyzed. The relative percent difference between the standard concentrations and the actual results must fall within an acceptable range. The method, which is included as Attachment 3, is somewhat ambiguous with respect to exactly what comprises a sampling system. For this project, calibration gases where allowed to pass through stainless steel sampling inlet line, a flow controller, and into a SUMMA canister. The lengths of sampling inlet line used during the certification process ranged from 2 to 6 feet in length. Certification that all systems met the method requirements was performed by the subcontract laboratory and the results maintained by the laboratory as part of the project file. If necessary these results can be obtained.

- **Concern** - The statement was made that the data quality section of the baseline risk assessment (Section 5.6.4, page 5-63) discussed the presence of blank contamination and subsequent elimination of a large number compounds as a potential source of considerable uncertainty. Furthermore, it was stated by USEPA that since blank contamination was detected, the source of the contamination should have been mitigated and the sites resampled.

  Response - The accuracy of an entire measurement system, which is an indication of any bias, is difficult to measure in environmental measurement systems. Sources of error are the sampling process, field and laboratory contamination, handling, sample matrix, and analysis. The accuracy of a method is an estimate of the difference between the true value and the determined mean value. To either eliminate or at the very least detect measurement errors, the following procedures were utilized. Prior to use, all SUMMA canisters were certified by the supply vendor as "clean" in accordance with the TO-14 method. Field blanks consisting of "zero air" were collected and submitted blind to the laboratory. All laboratory instrument tunings and calibrations were performed in accordance with the TO-14 method. Also in the laboratory, each sample canister was spiked with a surrogate compound and a percent recovery calculated as part of a system monitoring performance to detect positive and negative bias. Pages 3-35 through 3-41 of the FFI report describe this process and have been included as Attachment 4.

  The data quality section in the baseline risk assessment appears to have been misinterpreted as stating that maybe too many compounds (potential COPCs) were eliminated during the data validation process based on the presence of blank contamination. The authors of the risk assessment section clarified the intent of the uncertainty discussion as follows. Several compounds had a very high frequency of detection in both site samples and blanks. According to the Functional Guidelines, a sample result should not be considered positive unless the concentration of the compound in the sample exceeds 10 times the amount in any blank for common laboratory contaminants or 5 times the amount for other constituents. Methylene chloride was used as an example of a common laboratory contaminant that had a high frequency of detection. Methylene chloride results were flagged as non-detected at concentrations which equaled 10 times the associated blank concentration. All positive results that exceeded 10 times the blank results were retained in the risk assessment. Because the frequency of detection was so high, the risk assessment authors contended that there is uncertainty as to whether or not the values that exceeded the blank action level were legitimate positive results. However, a conservative approach was maintained and methylene chloride

was retained in the risk assessment. The values that were retained represent the highest concentrations of methylene chloride detected. The risk assessment determined there was no appreciable risk associated with methylene chloride as evidenced by Table 43 in Section 5 of the FFI report.

With respect to resampling, the data validation process did not determine that the blank contamination was severe enough to warrant rejection of the data. Consequently, the data was deemed useable for risk assessment purposes.

- **Concern** - There is insufficient data or the data is inconclusive to determine whether or not the Building 656 is physically located on the SWMU 9 landfill.

  Response - The boundary of the SWMU 9 landfill was defined during the course of the Zone H RFI. Figure 4.1.1 which is included in the *Draft-Final Zone H RFI Report* depicts the boundary of the landfill. The boundary was determined using historic aerial photographs, geophysical methods, and soil borings/well installations. The boundary of the landfill is approximately 340 feet from Building 656. The map is included as Attachment 5.

- **Concern** - Soil gas may be migrating under Building 656 from the landfill or other nearby sites.

  Response - Two soil gas surveys were performed to during the Zone H RFI. One survey was performed specifically to identify potential "hot spots" within the landfill and the other was performed around the perimeter of all the buildings sampled during the FFI with the intent of identified "hot spots" or contaminant plumes migrating around the buildings. Attachment 6 includes maps from both surveys. The map of the landfill survey clearly delineates potential "hot spots"; however, they do not extend beyond the boundary of the landfill toward Building 656. The second survey performed around the buildings detected numerous compounds. A review of the data for Building 656 does not indicate a strong correlation between compounds detected in soil gas, compounds detected in the building, and compounds detected under the building.

- **Concern** - Groundwater may be acting as a contaminant transport mechanism. Contaminant "off gassing" may then contribute to contamination found in the void space under the buildings. Groundwater elevation fluctuations as a result of tidal influence may be acting as a mechanism to facilitate soil gas migration.

  Response - Figure 3.6 in the *Draft-Final Zone H RFI Report* indicates that a groundwater high exists in the vicinity of Building 656. Groundwater flow is from Building 656 toward the landfill. A tidal influence study was performed as part of the Zone H RFI and is described in the Zone RFI report. With the exception of wells in close proximity (approximately 750 feet or less) to prominent surface water [illegible] well closest to Building 656 that was observed during the tidal influence study is NBCH-009-005. This well also happens to be between the landfill and Building 656. During the study there was no discernable tidal influence on this well. Attachment 7 contains a piezometric surface map, a graph of the continuous water level readings from well NBCH-009-005 during the study, and a table of water level data for multiple observation wells used during the study. In addition, no volatile or semi-volatile organic compounds were detected in groundwater in the vicinity of Building 656.

- **Concern** - Were other media sampled around Building 656 to determine if a source for the air contamination is present?

  Response - Other media sampled included both soil and groundwater. There is not a strong correlation between compounds detected in these media and the air sample results. Attachment 8 contains a summary of the soil and groundwater data derived from samples collected in the immediate vicinity of Building 656. In addition, the attachment includes a summary of the compounds detected in air in Building 656.

- **Concern** - Reports of "musty" odors by employees working in Building 656 raised health concerns.

  Response - The source of the "musty odors" employees reported in Building 656 is unknown but may be attributable to a broken sanitary sewer line that spilled untreated sewage under the building. This information was learned subsequent to the investigation and production of the draft report.

Sincerely,
EnSafe/Allen & Hoshall
A Joint Venture in Professional Services

By: Todd Haverkost
Project Manager

Enclosures

memo; however, since the scope of work is within the realm of the RFI process, the data generated will eventually be incorporated into the RFI for Zone H. The goals of the FFI are as follows:

- Identify the presence/absence of indoor air contaminants.
- Determine whether the source is internal or external.
- Evaluate human health risk or absence of risk associated with exposure to airborne parameters originating from external sources.

In as much as the reports of gas emissions and adverse health affects are associated with the Base Exchange, the investigation will initially encompass an area including the Base Exchange and extending at least one block North beyond the State Department building complex, generally bounded, clockwise, by Hobson Ave./Osprey St./C B Ln./northwest dike of the Spoil Area/West Rd./Least Tern Ln./Bainbridge Ave./Halsey St./Hobson Ave. Figure 1 outlines the study area.

The following paragraphs outline the focused investigation elements necessary to achieve the goals of the FFI. Some elements of the survey were completed during an initial phase of field activities conducted in February and March 1994. Previously collected data is summarized in the appropriate sections below.

3.1 Building Surveys

Separated joints or cracks in floor slabs could constitute migration pathways for soil gases to enter occupied spaces; therefore, each building within the study area was visually examined. Floor plans, acquired during the Base Realignment and Closure (BRAC) environmental baseline survey (EBS), were used to guide the surveys (expansion/construction joint locations) and to record the results. The buildings were inspected for floor separations, unsealed utility penetrations, and land subsidence under the buildings. were used as sampling points during evaluation of sub-floor emission sources and work space air quality.

3.2.2 Sample Period and Frequency — 8 hour sampling periods have been selected to emulate a typical daily work shift. Samples will be collected daily for 3 consecutive days to assess short term variability in air quality. One ambient air sample per day will be collected to establish background conditions. Duplicate samples will be collected at a frequency of 1 per every 10 air samples collected.

3.2.3 Sample Location — Air samples will be collected at three principal locations:

a) Floor separations/penetrations — with the objective of quantifying any sources of airborne contaminants at the potential points of entry within the buildings.

b) The breathing zone in the most frequently/densely occupied areas of the buildings--to assess human exposures to airborne contaminants.

c) Void space between ground surface and building sub-floor. Sampling will be conducted at points immediately below the floor separations/penetrations to provide the most representative evaluation of an external source for COPCs. If at all possible, sampling probes will be extended through the separation into the underlying voids to prevent the necessity of a potential confined space entry by sampling personnel.

Baseline air quality will be established by ambient air sampling outside Building 656.

3.2.4 Sample Analysis and Sensitivity — Samples will be analyzed using EPA Compendium Method TO-14; *The determination of Volatile Organics in Ambient Air Using SUMMA Passivated Canister Sampling and Gas Chromatographic Analysis*, having quantitation limits of 10 $\mu g/m^3$ or less for volatile compounds.

Note: These methods are also sensitive enough to likely detect airborne chemicals associated with retail products routinely present in the building, such as, scented soaps and toiletry items, cleaning products, skin care products, adhesive, felt markers and paints.

3.0 METHODOLOGY

Methods used to achieve the above-mentioned objectives included building surveys, and a dual phased investigation employing indoor air quality (IAQ) surveys.

3.1 Building Surveys

Each building in the area of investigation was visually inspected during Phase I. The survey was conducted by E/A&H engineers to identify and evaluate separated joints and cracks in floor slabs, cracked foundations and open utility chases that could provide pathways for soil gases to seep into buildings. Smoke tubes were used to verify air flow where floor cracks were observed. The survey included 94 suspect buildings at NAVBASE Charleston. The results of the building surveys are summarized in Section 3.2.3 and detailed in Appendix A. As a result of this investigation, eight structures such as personnel barracks, office buildings, training buildings, and retail stores were selected for inclusion in indoor air quality (IAQ) surveys. Figure 1 shows these buildings. Once identified, these structures were targeted for IAQ sampling. Unoccupied buildings, such as storage sheds and mechanical buildings, were not surveyed.

3.2 Indoor Air Quality Surveys — Phase I and Phase II

IAQ surveys were conducted, from February 10, 1994 through February 26, 1994 (Phase I) and from November 8, 1994 to December 8, 1994 (Phase II), to identify and quantify toxic airborne chemicals present in the selected buildings. The building survey described above was used as the basis for selecting buildings for these IAQ surveys.

3.2.1 Sample Types

Four types of air samples were collected during the Phase I and Phase II IAQ surveys. Samples were designated as either "Ground Level" (GL), "Breathing Zone" (BZ), "Sub-slab interior" (SS_{int}), or "Sub-slab exterior" (SS_{ext}). Three air samples were collected at each sample location over three consecutive days, excluding weekends and holidays. In addition to the four types of

air samples collected for building characterization, three additional types of samples were collected for quality assurance.

GL samples were collected at cracks in the building's floor slab or walls during Phase I and Phase II of the IAQ survey. The purpose of GL samples was to provide a quantitative assessment of the "worst-case" indoor air contamination in areas believed to have the highest potential for soil gas infiltration.

During Phase I and Phase II of the IAQ survey, BZ samples were collected in the approximate breathing area of a typical worker, about 5 feet above the floor inside the building. The BZ samples were collected in potentially occupied areas over an eight hour period.

As part of Phase II, SS_{int} air samples were collected from sample points beneath the floor of the building, (i.e., the space between the ground and the structure of the building, or void space). These air samples were collected to identify any volatile contaminants emanating from underlying soil and/ or groundwater that might enter the buildings.

SS_{ext} air samples were collected from void space sample points accessed from outside of the building during Phase II of the IAQ survey. These samples were used to identify potential sources of volatile contaminants that may exist in subslab areas associated with underlying soil and/or groundwater that were not accessible from the building interior.

For data quality assurance, three additional types of air samples were collected: background, field blank and duplicates.

- **Background Samples** are used to quantitatively characterize ambient concentrations of chemicals in the environment that have not been influenced by site-related activities

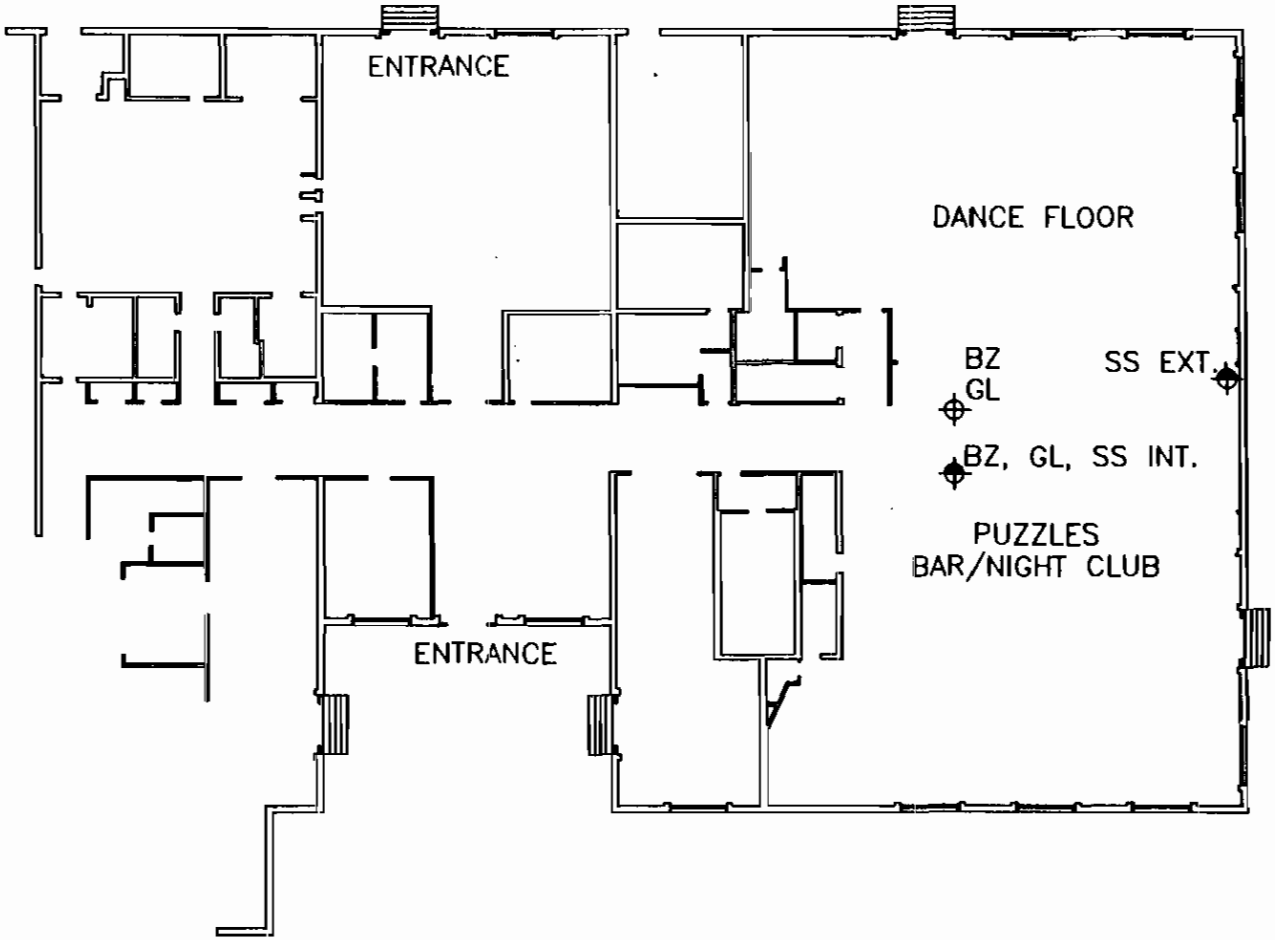
- **Field Blanks** are used to determine the existence and magnitude of potential contamination introduced during sampling, transport, or analysis.

- **Duplicate Samples** are used to measure the reproduceability of sampling and analysis, or precision.

3.2.2 Sampling Methods

As part of both phases of the surveys, air samples were collected in 6 liter stainless steel passivated SUMMA canisters placed under a vacuum of at least 30 inches of vacuum pressure before use. A matched sampling train, consisting of a regulator, flow meter, and stainless steel tubing were calibrated to the desired flow rate using a separate SUMMA canister designated for that purpose. Next, the canister was placed at the sample location and the sampling train was attached. The canister was opened, the flow rate recorded and a sample collected. Flow rates for BZ samples collected during Phase I ranged from 6 to 12 cubic centimeters of air per minute (cc/min) and 4 to 12 cc/min for BZ samples collected during Phase II. Flow rates for GL samples collected during Phase I ranged from 2 to 4 cc/min. The flow rate from subslab samples ranged from 2 to 4 cc/min.

Part of the regulator/flow meter setup for both phases included a piece of stainless steel tubing which extended from the canister to the sample location. In the case of GL samples tubing extended down to a crack in the floor and for BZ samples tubing extended up to approximately 5 feet. SS_{int} samples were collected by placing a stainless steel sampling probe through a crack and sampling an air pocket under the building. SS_{ext} samples were collected by placing a sample canister adjacent to a building's exterior wall and running tubing through a space between the ground surface and the building's structure. The end of the tubing was shaped to bend up after going under the building to sample trapped pockets of air. It was believed that air trapped by the building's structure provided the best conditions for volatile soil gases to accumulate.



LEGEND

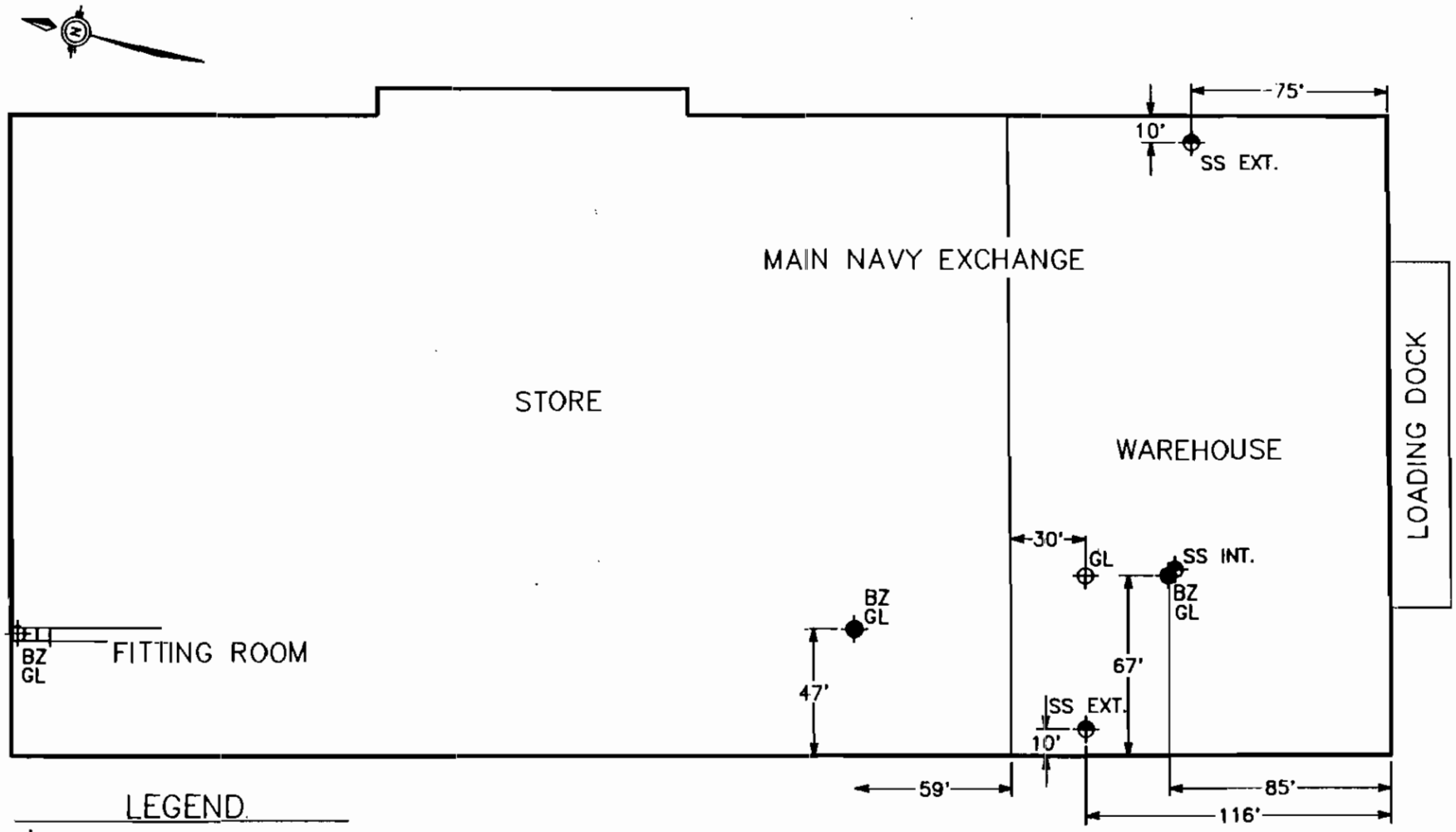
⌖	SAMPLE LOCATION PHASE I
⌖	SAMPLE LOCATION PHASE II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS INT.	SUB-SLAB INTERNAL
SS EXT.	SUB-SLAB EXTERNAL

NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 9
BUILDING 657 ENLISTED CLUB
PRACTICAL FLOOR PLAN
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B657



LEGEND

⊕	SAMPLE LOCATION PHASE I
⊕	SAMPLE LOCATION PHASE II
⊕	SAMPLE LOCATION PHASE I & II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS INT.	SUB-SLAB INTERNAL
SS EXT.	SUB-SLAB EXTERNAL

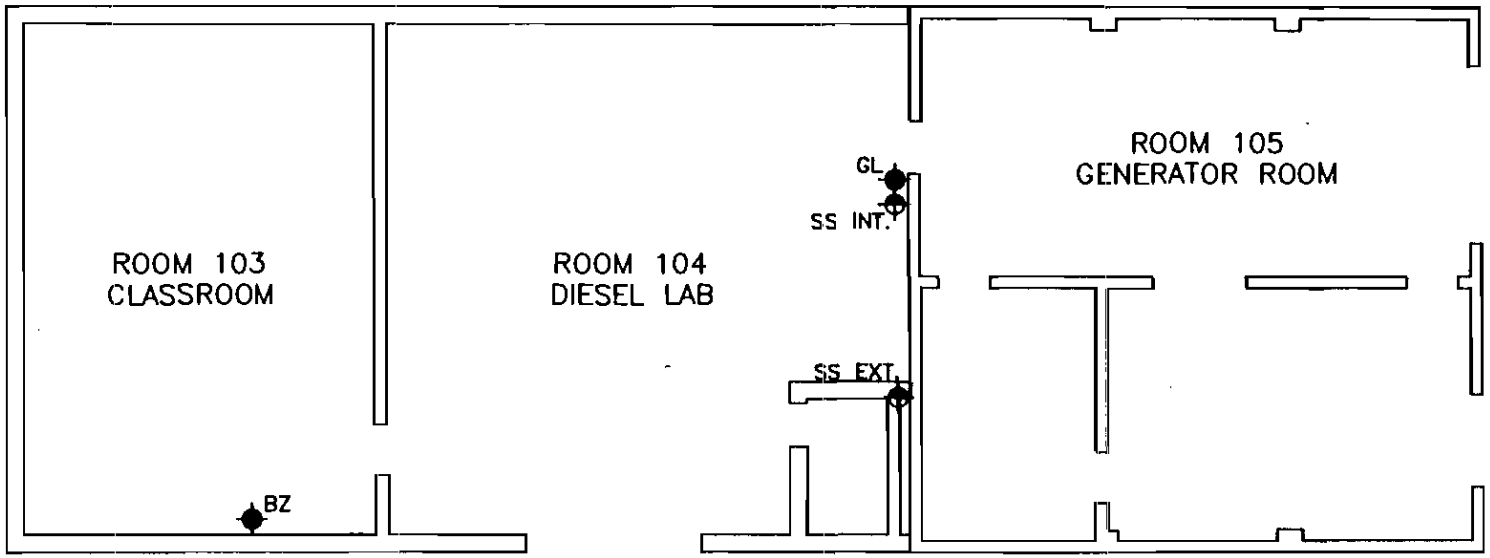
NOTE: MEASUREMENTS ARE APPROXIMATE

NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 8
BUILDING 656
NAVAL EXCHANGE BUILDING
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B656



LEGEND

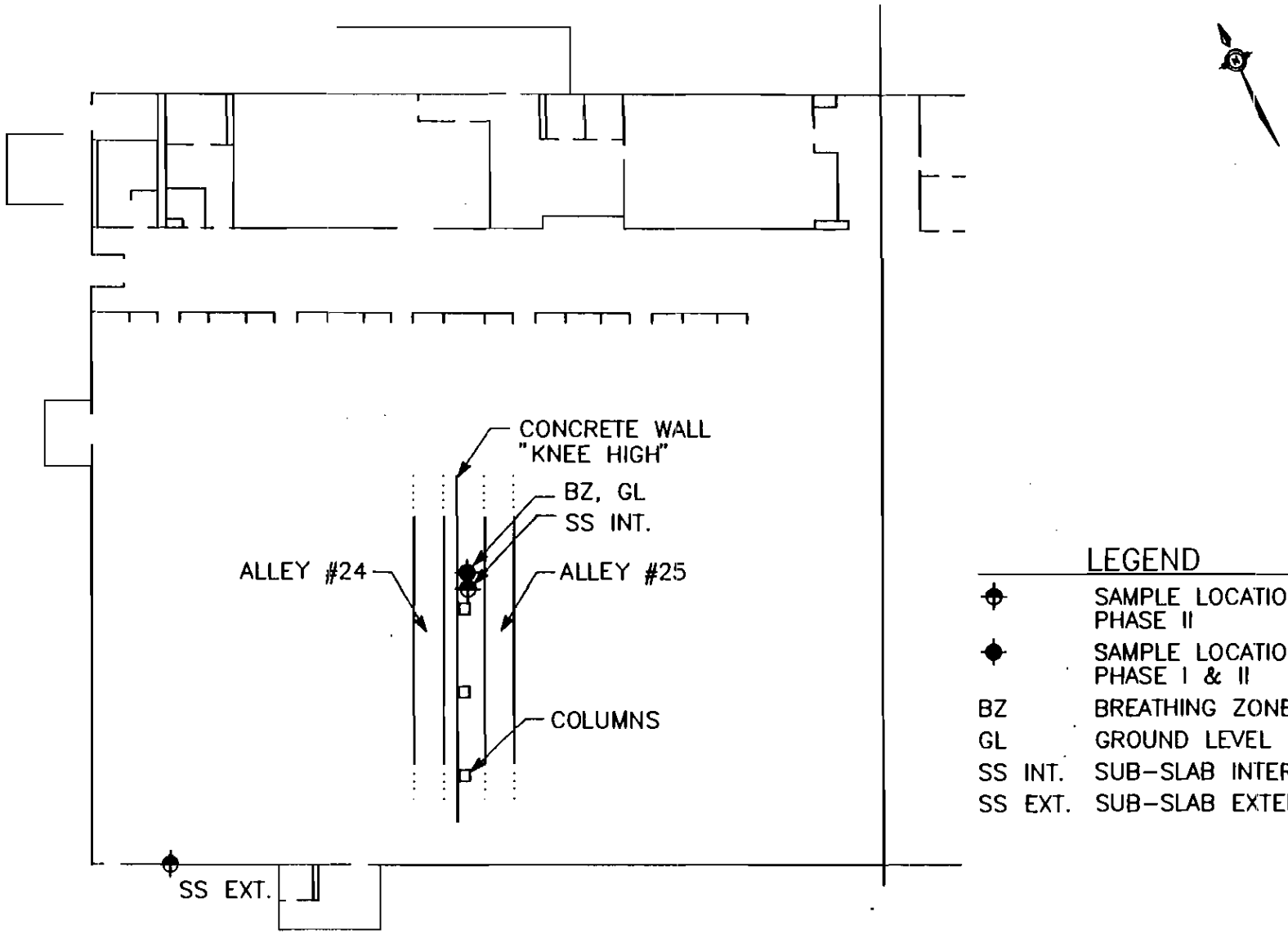
⌖	SAMPLE LOCATION PHASE II
◆	SAMPLE LOCATION PHASE I & II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS INT.	SUB--SLAB INTERNAL
SS EXT.	SUB--SLAB EXTERNAL

NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 7
BUILDING 645
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B645



LEGEND

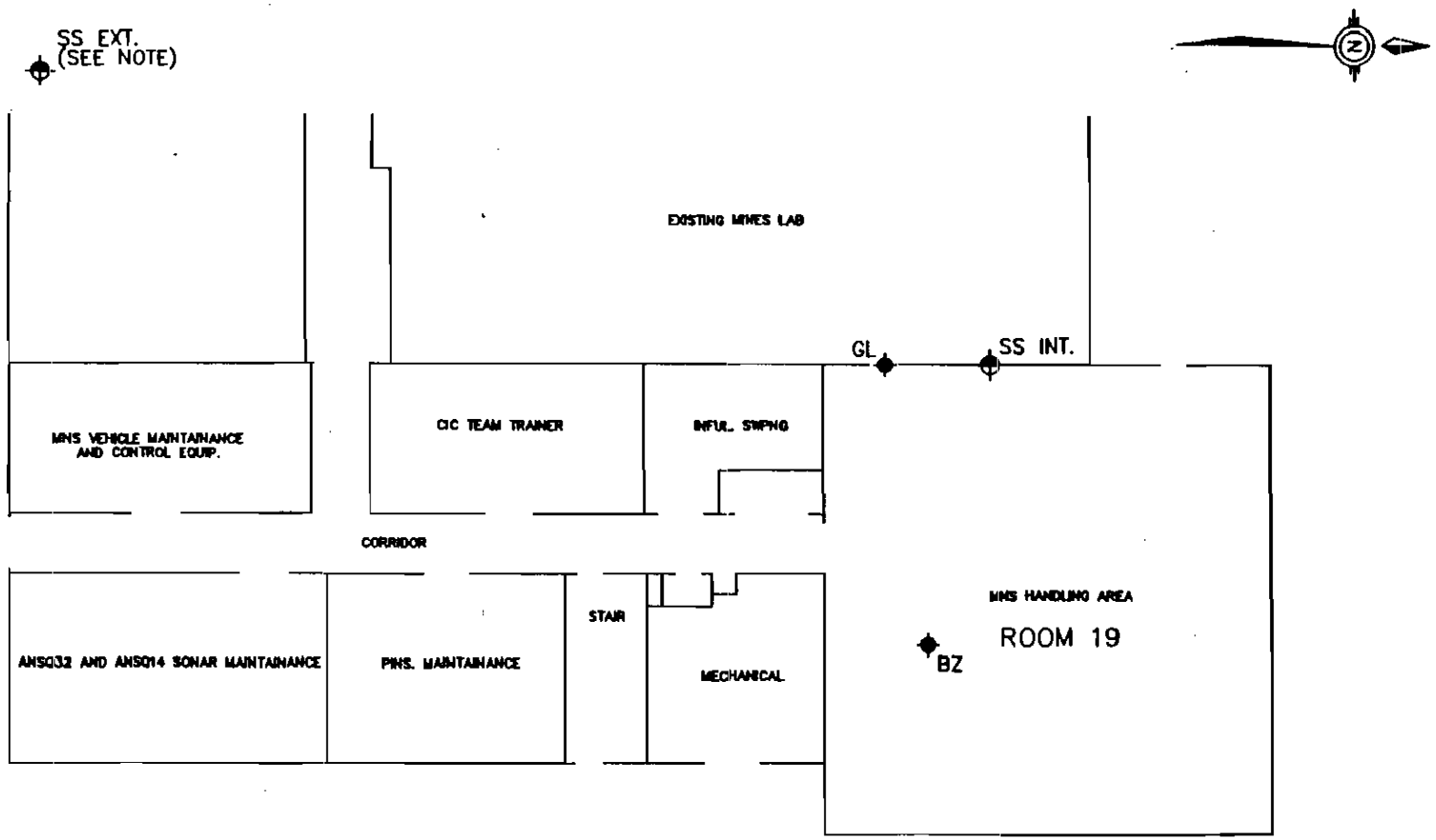
⌖	SAMPLE LOCATION PHASE II
⌖	SAMPLE LOCATION PHASE I & II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS INT.	SUB-SLAB INTERNAL
SS EXT.	SUB-SLAB EXTERNAL

NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 6
BUILDING 644
BOWLING ALLEY ADDITION
AIR SAMPLE LOCATIONS

DWG DATE: 2/1/95 | DWG NAME: 026B644



NOTE: SAMPLE LOCATION OFF PLAN. LOCATION IS APPROXIMATELY 3 FEET NORTH AND 1 FOOT WEST OF THE SOUTHWEST CORNER OF THE BUILDING.

NOT TO SCALE

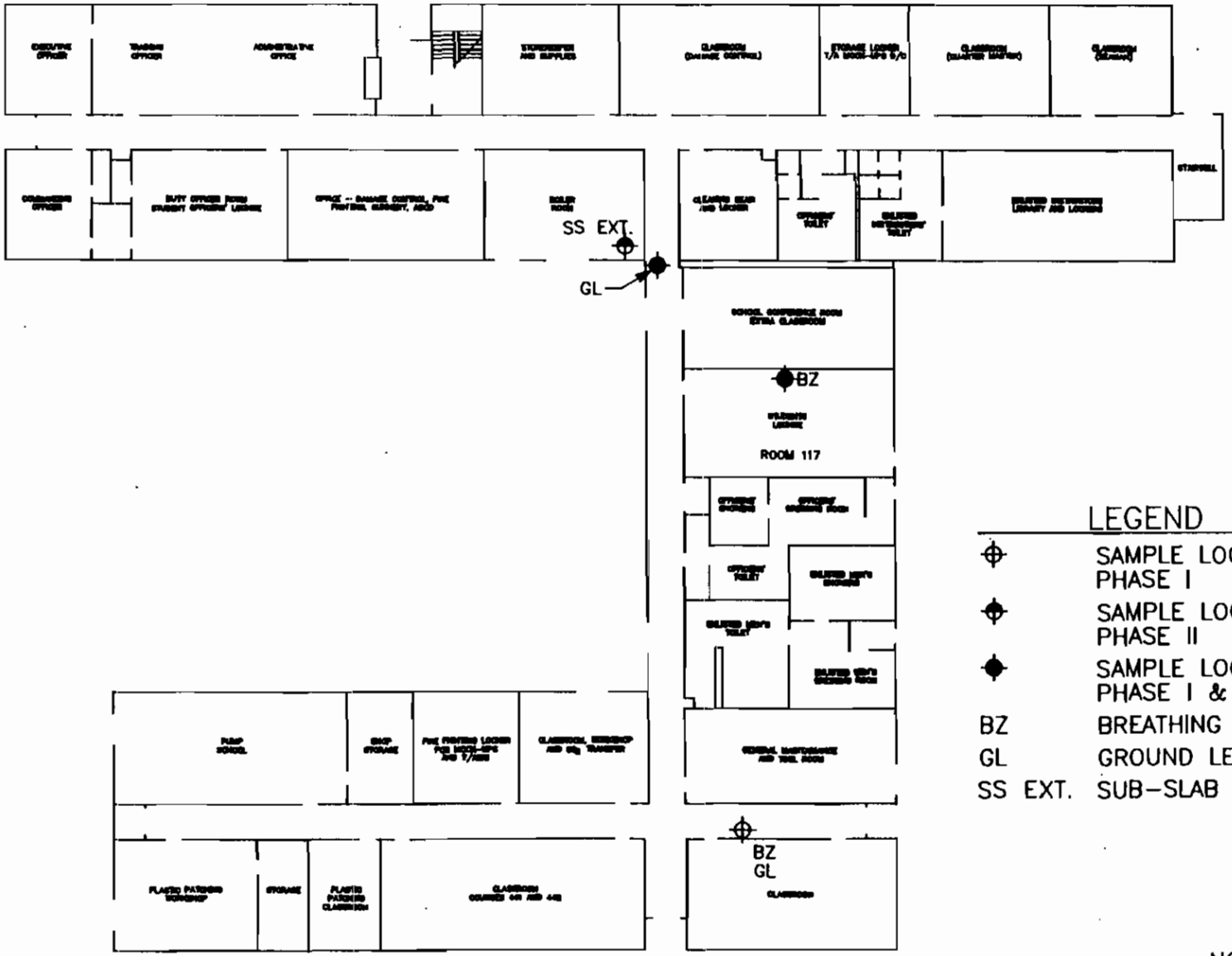
LEGEND

⌖	SAMPLE LOCATION PHASE II
⌖	SAMPLE LOCATION PHASE I & II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS INT.	SUB-SLAB INTERNAL
SS EXT.	SUB-SLAB EXTERNAL

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 5
BUILDING 643
PARTIAL FLOOR PLAN
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B643



LEGEND

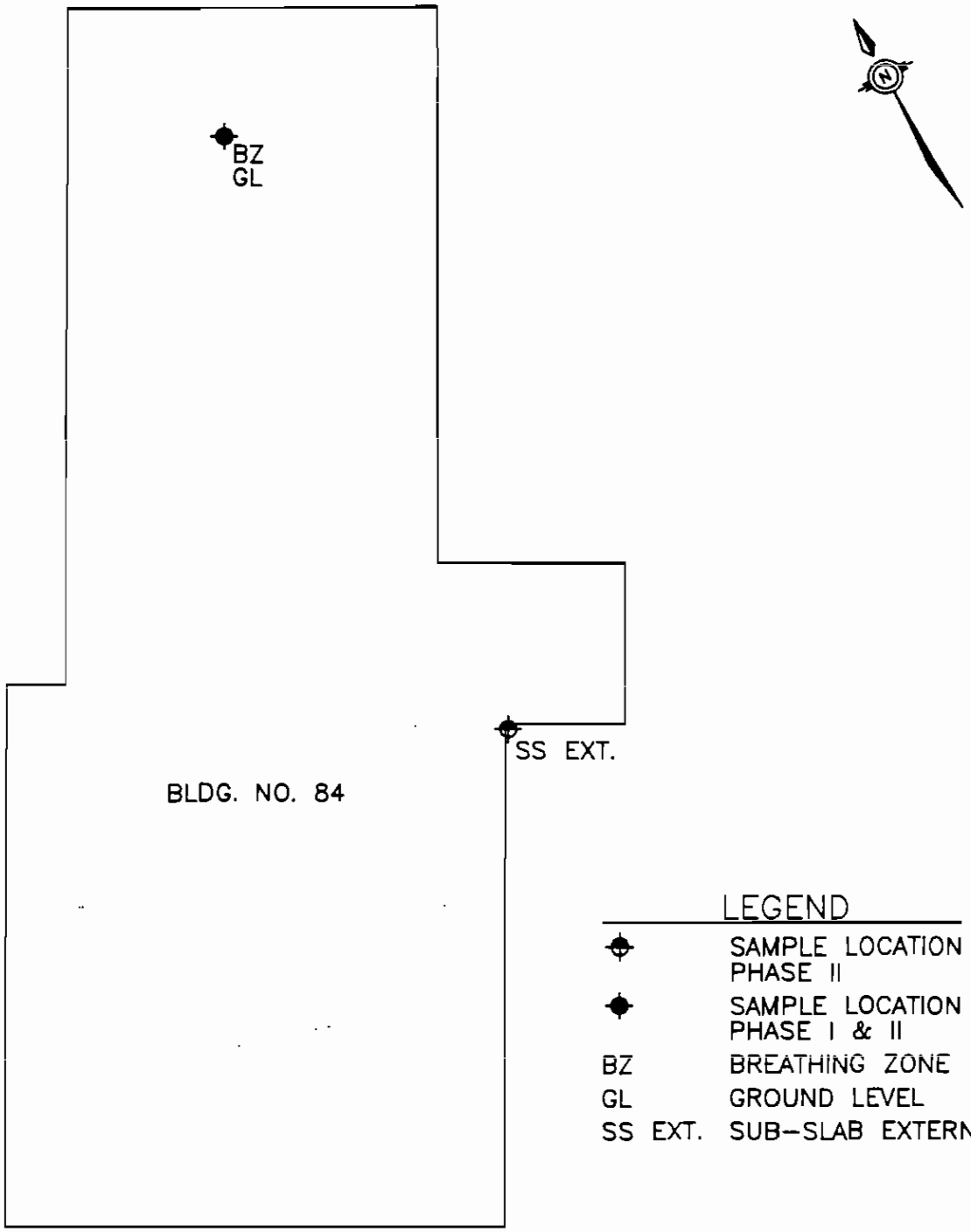
⊕	SAMPLE LOCATION PHASE I
⊕	SAMPLE LOCATION PHASE II
●	SAMPLE LOCATION PHASE I & II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS EXT.	SUB-SLAB EXTERNAL

NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 4
BUILDING 202
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B202

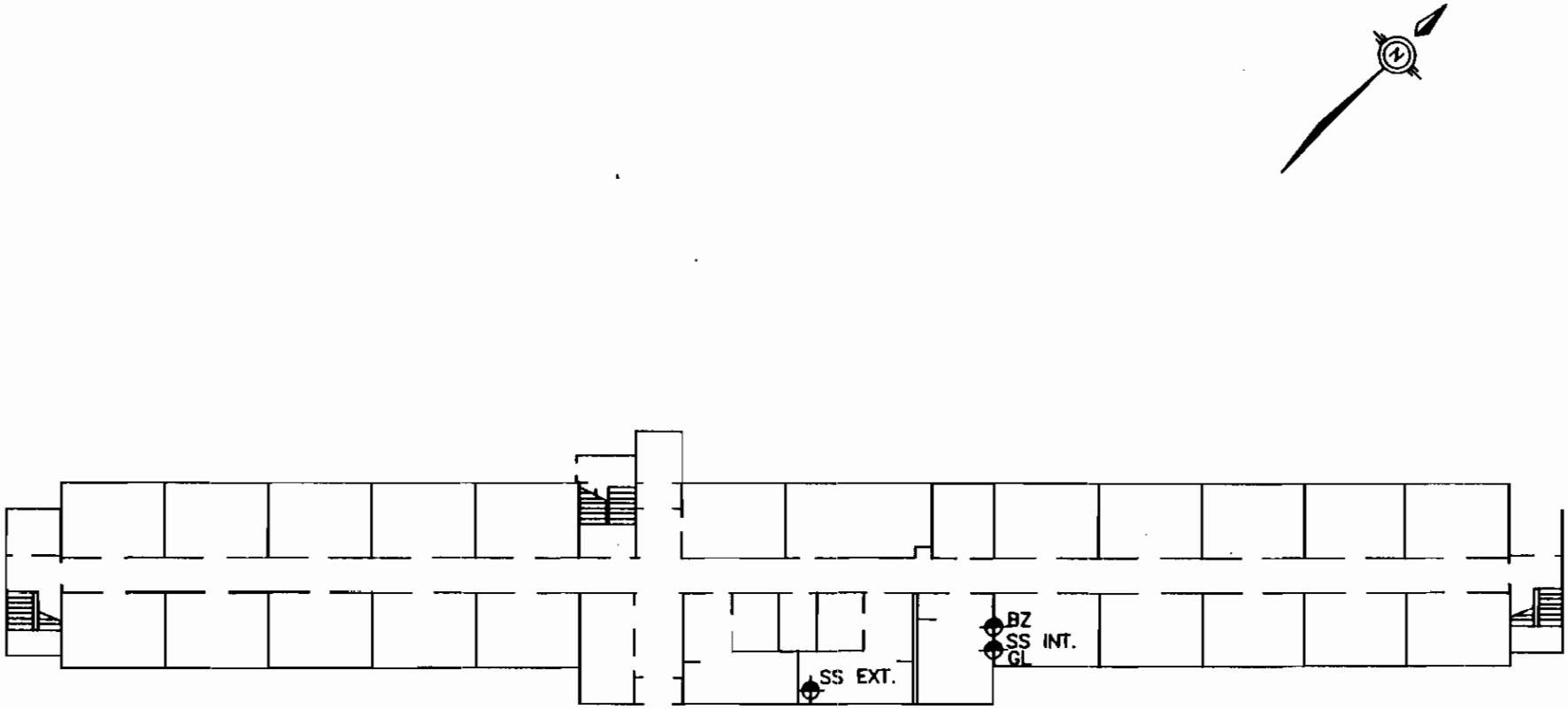


NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 3
BUILDING NS 84
NAVAL SECURITY
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B84



LEGEND

⊕	SAMPLE LOCATION PHASE II
BZ	BREATHING ZONE
GL	GROUND LEVEL
SS INT.	SUB-SLAB INTERNAL
SS EXT.	SUB-SLAB EXTERNAL

NOT TO SCALE

FOCUSED FIELD INVESTIGATION
NAVAL BASE CHARLESTON
CHARLESTON, S.C.

FIGURE 2
BUILDING 36
BARRACKS
AIR SAMPLE LOCATIONS

DWG DATE: 1/26/95 | DWG NAME: 029B39

METHOD TO14 -/

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS (VOCs) IN AMBIENT AIR USING SUMMA® PASSIVATED CANISTER SAMPLING AND GAS CHROMATOGRAPHIC ANALYSIS

1. Scope

1.1 This document describes a procedure for sampling and analysis of volatile organic compounds (VOCs) in ambient air. The method is based on collection of whole air samples in SUMMA® passivated stainless steel canisters. The VOCs are subsequently separated by gas chromatography and measured by mass-selective detector or multidetector techniques. This method presents procedures for sampling into canisters to final pressures both above and below atmospheric pressure (respectively referred to as pressurized and subatmospheric pressure sampling).

1.2 This method is applicable to specific VOCs that have been tested and determined to be stable when stored in pressurized and subatmospheric pressure canisters. Numerous compounds, many of which are chlorinated VOCs, have been successfully tested for storage stability in pressurized canisters (1,2). However, minimal documentation is currently available demonstrating stability of VOCs in subatmospheric pressure canisters.

1.3 The organic compounds that have been successfully collected in pressurized canisters by this method are listed in Table 1. These compounds have been successfully measured at the parts per billion by volume (ppbv) level.

2. Applicable Documents

2.1 ASTM Standards

D1356 - Definition of Terms Related to Atmospheric Sampling and Analysis
E260 - Recommended Practice for General Gas Chromatography Procedures
E355 - Practice for Gas Chromatography Terms and Relationships

2.2 Other Documents

U.S. Environmental Protection Agency Technical Assistance Document (3)
Laboratory and Ambient Air Studies (4-17)

3. Summary of Method

3.1 Both subatmospheric pressure and pressurized sampling modes use an initially evacuated canister and a pump-ventilated sample line during sample collection. Pressurized sampling requires an additional pump to provide positive pressure to the sample canister. A sample of ambient air is drawn through a sampling train comprised of components that regulate the rate and duration of sampling into a pre-evacuated SUMMA® passivated canister.

3.2 After the air sample is collected, the canister valve is closed, an identification tag is attached to the canister, and the canister is transported to a predetermined laboratory for analysis.

3.3 Upon receipt at the laboratory, the canister tag data is recorded and the canister is attached to the analytical system. During analysis, water vapor is reduced in the gas stream by a Nafion® dryer (if applicable), and the VOCs are then concentrated by collection in a cryogenically-cooled trap. The cryogen is then removed and the temperature of the trap is raised. The VOCs originally collected in the trap are revolatilized, separated on a GC column, then detected by one or more detectors for identification and quantitation.

3.4 The analytical strategy for Method TO14 involves using a high-resolution gas chromatograph (GC) coupled to one or more appropriate GC detectors. Historically, detectors for a GC have been divided into two groups: non-specific detectors and specific detectors. The non-specific detectors include, but are not limited to, the nitrogen-phosphorus detector (NPD), the flame ionization detector (FID), the electron capture detector (ECD) and the photoionization detector (PID). The specific detectors include the mass spectrometer (MS) operating in either the selected ion monitoring (SIM) mode or the SCAN mode, or the ion trap detector. The use of these detectors or a combination of these detectors as part of an analytical scheme is determined by the required specificity and sensitivity of the application. While the non-specific detectors are less expensive per analysis and in some cases more sensitive than the specific detector, they vary in specificity and sensitivity for a specific class of compounds. For instance, if multiple halogenated compounds are targeted,

an ECD is usually chosen; if only compounds containing nitrogen or phosphorus are of interest, a NPD can be used; or, if a variety of hydrocarbon compounds are sought, the broad response of the FID or PID is appropriate. In each of these cases, however, the specific identification of the compound within the class is determined only by its retention time, which can be subject to shifts or to interference from other nontargeted compounds. When misidentification occurs, the error is generally a result of a cluttered chromatogram, making peak assignment difficult. In particular, the more volatile organics (chloroethanes, ethyltoluenes, dichlorobenzenes, and various freons) exhibit less well defined chromatographic peaks, leading to misidentification using non-specific detectors. Quantitative comparisons indicate that the FID is more subject to error than the ECD because the ECD is a much more selective detector for a smaller class of compounds which exhibits a stronger response. Identification errors, however, can be reduced by: (a) employing simultaneous detection by different detectors or (b) correlating retention times from different GC columns for confirmation. In either case, interferences on the non-specific detectors can still cause error in identifying a complex sample. The non-specific detector system (GC-NPD-FID-ECD-PID), however, has been used for approximate quantitation of relatively clean samples. The nonspecific detector system can provide a "snapshot" of the constituents in the sample, allowing determination of:

- Extent of misidentification due to overlapping peaks,
- Position of the VOCs within or not within the concentration range of anticipated further analysis by specific detectors (GC-MS-SCAN-SIM) (if not, the sample is further diluted), and
- Existence of unexpected peaks which need further identification by specific detectors.

On the other hand, the use of specific detectors (MS coupled to a GC) allows positive compound identification, thus lending itself to more specificity than the multidetector GC. Operating in the SIM mode, the MS can readily approach the same sensitivity as the

multidetector system, but its flexibility is limited. For SIM operation, the MS is programmed to acquire data for a limited number of targeted compounds while disregarding other acquired information. In the SCAN mode, however, the MS becomes a universal detector, often detecting compounds which are not detected by the multidetector approach. The GC-MS-SCAN will provide positive identification, while the GC-MS-SIM procedure provides quantitation of a restricted "target compound" list of VOCs.

The analyst often must decide whether to use specific or non-specific detectors by considering such factors as project objectives, desired detection limits, equipment availability, cost and personnel capability in developing an analytical strategy.

A list of some of the advantages and disadvantages associated with non-specific and specific detectors may assist the analyst in the decision-making process.

Non-Specific Multidetector Analytical System

Advantages	Disadvantages
o Somewhat lower equipment cost than GC-MS	o Multiple detectors to calibrate
o Less sample volume required for analysis	o Compound identification not positive
o More sensitive - ECD may be 1000 times more sensitive than GC-MS	o Lengthy data interpretation (one hour each for analysis and data reduction)
	o Interference(s) from co-eluting compound(s)
	o Cannot identify unknown compounds - outside range of calibration - without standards
	o Does not differentiate targeted compounds from interfering compounds

Specific Detector Analytical System

GC-MS-SIM

Advantages	Disadvantages
o positive compound identification	o can't identify non-specified compounds (ions)
o greater sensitivity than GC-MS-SCAN	o somewhat greater equipment cost than multidetector GC
o less operator interpretation than for multidetector GC	o greater sample volume required than for multidetector GC
o can resolve co-eluting peaks	o universality of detector sacrificed to achieve enhancement in sensitivity
o more specific than the multidetector GC	

GC-MS-SCAN

o positive compound identification	o lower sensitivity than GC-MS-SIM
o can identify all compounds	o greater sample volume required than for multidetector GC
o less operator interpretation	o somewhat greater equipment cost than multidetector GC
o can resolve co-eluting peaks	

The analytical finish for the measurement chosen by the analyst should provide a definitive identification and a precise quantitation of volatile organics. In a large part, the actual approach to these two objectives is subject to equipment availability. Figure 1 indicates some of the favorite options that are used as an analytical finish. The GC-MS-SCAN option uses a capillary column GC coupled to a MS operated in a scanning mode and supported by spectral library search routines. This option offers the nearest approximation to unambiguous identification and covers a wide range of compounds as defined by the completeness of the spectral library. GC-MS-SIM mode is limited to a set of target compounds which are user defined and is more sensitive than GC-MS-SCAN by virtue of the longer dwell times at the restricted number of m/z values. Both these techniques, but especially the GC-MS-SIM option, can use a supplemental general non-specific detector to verify/identify the presence of VOCs. Finally, the option labelled GC-multidetector system uses a

combination of retention time and multiple general detector verification to identify compounds. However, interference due to nearly identical retention times can affect system quantitation when using this option.

Due to the low concentrations of VOCs encountered in urban air (typically less than 4 ppbv and the majority below 1 ppbv) along with their complicated chromatograms, Method TO-14 strongly recommends the specific detectors (GC-MS-SCAN-SIM) for positive identification and for primary quantitation to ensure that high-quality ambient data is acquired.

For the experienced analyst whose analytical system is limited to the non-specific detectors, Section 10.3 does provide guidelines and example chromatograms showing typical retention times and calibration response factors, and utilizing the non-specific detectors (GC-FID-ECD-PID) analytical system as the primary quantitative technique.

4. Significance

4.1 VOCs enter the atmosphere from a variety of sources, including petroleum refineries, synthetic organic chemical plants, natural gas processing plants, and automobile exhaust. Many of these VOCs are acutely toxic; therefore, their determination in ambient air is necessary to assess human health impacts.

4.2 Conventional methods for VOC determination use solid sorbent sampling techniques. The most widely used solid sorbent is Tenax®. An air sample is drawn through a Tenax®-filled cartridge where certain VOCs are trapped on the polymer. The sample cartridge is transferred to a laboratory and analyzed by GC-MS.

4.3 VOCs can also be successfully collected in stainless steel canisters. Collection of ambient air samples in canisters provides (1) convenient integration of ambient samples over a specific time period, (e.g., 24 hours); (2) remote sampling and central analysis; (3) ease of storing and shipping samples; (4) unattended sample collection; (5) analysis of samples from multiple sites with one analytical system; and (6) collection of sufficient sample volume to allow assessment of measurement precision and/or analysis of

samples by several analytical systems. However, care must be exercised in selecting, cleaning, and handling sample canisters and sampling apparatus to avoid losses or contamination of the samples. Contamination is a critical issue with canister-based sampling because the canister is the last element in the sampling train.

4.4 Interior surfaces of the canisters are treated by the SUMMA® passivation process, in which a pure chrome-nickel oxide is formed on the surface. This type of vessel has been used in the past for sample collection and has demonstrated sample storage stability of many specific organic compounds.

4.5 This method can be applied to sampling and analysis of not only VOCs, but also some selected semivolatile organic compounds (SVOCs). The term "semivolatile organic compounds" is used to broadly describe organic compounds that are too volatile to be collected by filtration air sampling but not volatile enough for thermal desorption from solid sorbents. SVOCs can generally be classified as those with saturation vapor pressures at 25°C between 10^{-1} and 10^{-7} mm Hg. VOCs are generally classified as those organics having saturated vapor pressures at 25°C greater than 10^{-1} mm Hg.

5. Definitions

Note: Definitions used in this document and in any user-prepared Standard Operating Procedures (SOPs) should be consistent with ASTM Methods D1356, E260, and E355. All abbreviations and symbols within this method are defined at point of use.

5.1 Absolute canister pressure = Pg+Pa, where Pg = gauge pressure in the canister (kPa, psi) and Pa = barometric pressure (see 5.2).

5.2 Absolute pressure - Pressure measured with reference to absolute zero pressure (as opposed to atmospheric pressure), usually expressed as kPa, mm Hg or psia.

5.3 Cryogen - A refrigerant used to obtain very low temperatures in the cryogenic trap of the analytical system. A typical cryogen is liquid oxygen (bp -183.0°C) or liquid argon (bp -185.7°C).

5.4 Dynamic calibration - Calibration of an analytical system using calibration gas standard concentrations in a form identical or very similar to the samples to be analyzed and by introducing such standards into the inlet of the sampling or analytical system in a manner very similar to the normal sampling or analytical process.

5.5 Gauge pressure - Pressure measured above ambient atmospheric pressure (as opposed to absolute pressure). Zero gauge pressure is equal to ambient atmospheric (barometric) pressure.

5.6 MS-SCAN - The GC is coupled to a MS programmed in the SCAN mode to scan all ions repeatedly during the GC run. As used in the current context, this procedure serves as a qualitative identification and characterization of the sample.

5.7 MS-SIM - The GC is coupled to a MS programmed to acquire data for only specified ions and to disregard all others. This is performed using SIM coupled to retention time discriminators. The GC-SIM analysis provides quantitative results for selected constituents of the sample gas as programmed by the user.

5.8 Megabore® column - Chromatographic column having an internal diameter (I.D.) greater than 0.50 mm. The Megabore® column is a trademark of the J&W Scientific Co. For purposes of this method, Megabore® refers to chromatographic columns with 0.53 mm I.D.

5.9 Pressurized sampling - Collection of an air sample in a canister with a (final) canister pressure above atmospheric pressure, using a sample pump.

5.10 Qualitative accuracy - The ability of an analytical system to correctly identify compounds.

5.11 Quantitative accuracy - The ability of an analytical system to correctly measure the concentration of an identified compound.

5.12 Static calibration - Calibration of an analytical system using standards in a form different than the samples to be analyzed. An example of a static calibration would be injecting a small volume of a high concentration standard directly onto a GC column, bypassing the sample extraction and preconcentration portion of the analytical system.

5.13 Subatmospheric sampling - Collection of an air sample in an evacuated canister at a (final) canister pressure below atmospheric pressure, without the assistance of a sampling pump. The canister is filled as the internal canister pressure increases to ambient or near ambient pressure. An auxiliary vacuum pump may be used as part of the sampling system to flush the inlet tubing prior to or during sample collection.

6. Interferences and Limitations

6.1 Interferences can occur in sample analysis if moisture accumulates in the dryer (see Section 10.1.1.2). An automated cleanup procedure that periodically heats the dryer to about 100°C while purging with zero air eliminates any moisture buildup. This procedure does not degrade sample integrity.

6.2 Contamination may occur in the sampling system if canisters are not properly cleaned before use. Additionally, all other sampling equipment (e.g., pump and flow controllers) should be thoroughly cleaned to ensure that the filling apparatus will not contaminate samples. Instructions for cleaning the canisters and certifying the field sampling system are described in Sections 12.1 and 12.2, respectively.

6.3 Because the GC-MS analytical system employs a Nafion® permeable membrane dryer to remove water vapor selectively from the sample stream, polar organic compounds may permeate concurrent with the moisture molecule. Consequently, the analyst should quantitate his or her system with the specific organic constituents under examination.

7. Apparatus

7.1 Sample Collection

[Note: Subatmospheric pressure and pressurized canister sampling systems are commercially available and have been used as part of U.S. Environmental Protection Agency's Toxics Air Monitoring Stations (TAMS), Urban Air Toxic Pollutant Program (UATP), and the non-methane organic compound (NMOC) sampling and analysis program.]

7.1.1 Subatmospheric Pressure (See Figure 2 Without Metal Bellows Type Pump)

7.1.1.1 Sampling inlet line - stainless steel tubing to connect the sampler to the sample inlet.

7.1.1.2 Sample canister - leak-free stainless steel pressure vessels of desired volume (e.g., 6 L), with valve and SUMMA® passivated interior surfaces (Scientific Instrumentation Specialists, Inc., P.O. Box 8941, Moscow, ID 83843, or Anderson Samplers, Inc., 4215-C Wendell Dr., Atlanta, GA, 30336, or equivalent).

7.1.1.3 Stainless steel vacuum/pressure gauge - capable of measuring vacuum (-100 to 0 kPa or 0 to 30 in Hg) and pressure (0-206 kPa or 0-30 psig) in the sampling system (Matheson, P.O. Box 136, Morrow, GA 30200, Model 63-3704, or equivalent). Gauges should be tested clean and leak tight.

7.1.1.4 Electronic mass flow controller - capable of maintaining a constant flow rate (± 10%) over a sampling period of up to 24 hours and under conditions of changing temperature (20-40°C) and humidity (Tylan Corp., 19220 S. Normandie Ave., Torrance, CA 90502, Model FC-260, or equivalent).

7.1.1.5 Particulate matter filter - 2-um sintered stainless steel in-line filter (Nupro Co., 4800 E. 345th St., Willoughby, OH 44094, Model SS-2F-K4-2, or equivalent).

7.1.1.6 Electronic timer - for unattended sample collection (Paragon Elect. Co., 606 Parkway Blvd., P.O. Box 28, Twin Rivers, WI 54201, Model 7008-00, or equivalent).

7.1.1.7 Solenoid valve - electrically-operated, bi-stable solenoid valve (Skinner Magnelatch Valve, New Britain, CT, Model V5RAM49710, or equivalent) with Viton® seat and o-rings.

7.1.1.8 Chromatographic grade stainless steel tubing and fittings - for interconnections (Alltech Associates, 2051 Waukegan Rd., Deerfield, IL 60015, Cat. #8125,

or equivalent). All such materials in contact with sample, analyte, and support gases prior to analysis should be chromatographic grade stainless steel.

7.1.1.9 Thermostatically controlled heater - to maintain temperature inside insulated sampler enclosure above ambient temperature (Watlow Co., Pfafftown, NC, Part 04010080, or equivalent).

7.1.1.10 Heater thermostat - automatically regulates heater temperature (Elmwood Sensors, Inc., 500 Narragansett Park Dr., Pawtucket RI 02861, Model 3455-RC-0100-0222, or equivalent).

7.1.1.11 Fan - for cooling sampling system (EG&G Rotron, Woodstock, NY, Model SUZAI, or equivalent).

7.1.1.12 Fan thermostat - automatically regulates fan operation (Elmwood Sensors, Inc., Pawtucket, RI, Model 3455-RC-0100-0244, or equivalent).

7.1.1.13 Maximum-minimum thermometer - records highest and lowest temperatures during sampling period (Thomas Scientific, Brooklyn Thermometer Co., Inc., P/N 9327H30, or equivalent).

7.1.1.14 Nupro stainless steel shut-off valve - leak free, for vacuum/pressure gauge.

7.1.1.15 Auxiliary vacuum pump - continuously draws ambient air to be sampled through the inlet manifold at 10 L/min. or higher flow rate. Sample is extracted from the manifold at a lower rate, and excess air is exhausted. [Note: The use of higher inlet flow rates dilutes any contamination present in the inlet and reduces the possibility of sample contamination as a result of contact with active adsorption sites on inlet walls.]

7.1.1.16 Elapsed time meter - measures duration of sampling (Conrac, Cramer Div., Old Saybrook, CT, Type 6364, P/N 10082, or equivalent).

7.1.1.17 Optional fixed orifice, capillary, or adjustable micrometering valve - may be used in lieu of the electronic flow controller for grab samples or short duration time-integrated samples. Usually appropriate only in situations where screening samples are taken to assess future sampling activity.

7.1.2 Pressurized (Figure 2 With Metal Bellows Type Pump and Figure 3)

7.1.2.1 Sample pump - stainless steel, metal bellows type (Metal Bellows Corp., 1075 Providence Highway, Sharon, MA 02067, Model MB-151, or equivalent), capable of 2 atmospheres output pressure. Pump must be free of leaks, clean, and uncontaminated by oil or organic compounds. [Note: An alternative sampling system has been developed by Dr. R. Rasmussen, The Oregon Graduate Center (18,19) and is illustrated in Figure 3. This flow system uses, in order, a pump, a mechanical flow regulator, and a mechanical compensating flow restrictive device. In this configuration the pump is purged with a large sample flow, thereby eliminating the need for an auxiliary vacuum pump to flush the sample inlet. Interferences using this configuration have been minimal.]

7.1.2.2 Other supporting materials - all other components of the pressurized sampling system (Figure 2 with metal bellows type pump and Figure 3) are similar to components discussed in Sections 7.1.1.1 through 7.1.1.16.

7.2 Sample Analysis

7.2.1 GC-MS-SCAN Analytical System (See Figure 4)

7.2.1.1 The GC-MS-SCAN analytical system must be capable of acquiring and processing data in the MS-SCAN mode.

7.2.1.2 Gas chromatograph - capable of sub-ambient temperature programming for the oven, with other generally standard features such as gas flow regulators, automatic control of valves and integrator, etc. Flame ionization detector optional. (Hewlett Packard, Rt. 41, Avondale, PA 19311, Model 5880A, with oven temperature control and Level 4 BASIC programming, or equivalent.)

7.2.1.3 Chromatographic detector - mass-selective detector (Hewlett Packard, 3000-T Hanover St., 9B, Palo Alto, CA 94304, Model HP-5970 MS, or equivalent), equipped with computer and appropriate software (Hewlett Packard, 3000-T Hanover St., 9B, Palo Alto, CA 94304,

HP-216 Computer, Quicksilver MS software, Pascal 3.0, mass storage 9133 HP Winchester with 3.5 inch floppy disk, or equivalent). The GC-MS is set in the SCAN mode, where the MS screens the sample for identification and quantitation of VOC species.

7.2.1.4 Cryogenic trap with temperature control assembly - refer to Section 10.1.1.3 for complete description of trap and temperature control assembly (Nutech Corporation, 2142 Geer St., Durham, NC, 27704, Model 320-01, or equivalent).

7.2.1.5 Electronic mass flow controllers (3) - maintain constant flow (for carrier gas and sample gas) and to provide analog output to monitor flow anomalies (Tylan Model 260, 0-100 cm^3/min, or equivalent).

7.2.1.6 Vacuum pump - general purpose laboratory pump, capable of drawing the desired sample volume through the cryogenic trap (Thomas Industries, Inc., Sheboygan, WI, Model 107BA20, or equivalent).

7.2.1.7 Chromatographic grade stainless steel tubing and stainless steel plumbing fittings - refer to Section 7.1.1.8 for description.

7.2.1.8 Chromatographic column - to provide compound separation such as shown in Table 5 (Hewlett Packard, Rt. 41, Avondale, PA 19311, OV-1 capillary column, 0.32 mm x 50 m with 0.88 um crosslinked methyl silicone coating, or equivalent).

7.2.1.9 Stainless steel vacuum/pressure gauge (optional) - capable of measuring vacuum (-101.3 to 0 kPa) and pressure (0-206 kPa) in the sampling system (Matheson, P.O. Box 136, Morrow, GA 30200, Model 63-3704, or equivalent). Gauges should be tested clean and leak tight.

7.2.1.10 Stainless steel cylinder pressure regulators - standard, two-stage cylinder regulators with pressure gauges for helium, zero air and hydrogen gas cylinders.

7.2.1.11 Gas purifiers (3) - used to remove organic impurities and moisture from gas streams (Hewlett Packard, Rt. 41, Avondale, PA, 19311, P/N 19362 - 60500, or equivalent).

7.2.1.12 Low dead-volume tee (optional) - used to split the exit flow from the GC column (Alltech Associates, 2051 Waukegan Rd., Deerfield, IL 60015, Cat. #5839, or equivalent).

7.2.1.13 Nafion® dryer - consisting of Nafion tubing co-axially mounted within larger tubing (Perma Pure Products, 8 Executive Drive, Toms River, NJ, 08753, Model MD-125-48, or equivalent). Refer to Section 10.1.1.2 for description.

7.2.1.14 Six-port gas chromatographic valve - (Seismograph Service Corp, Tulsa, OK, Seiscor Model VIII, or equivalent).

7.2.1.15 Chart recorder (optional) - compatible with the detector output signals to record optional FID detector response to the sample.

7.2.1.16 Electronic integrator (optional) - compatible with the detector output signal of the FID and capable of integrating the area of one or more response peaks and calculating peak areas corrected for baseline drift.

7.2.2 GC-MS-SIM Analytical System (See Figure 4)

7.2.2.1 The GC-MS-SIM analytical system must be capable of acquiring and processing data in the MS-SIM mode.

7.2.2.2 All components of the GC-MS-SIM system are identical to Sections 7.2.1.2 through 7.2.1.16.

7.2.3 GC-Multidetector Analytical System (See Figure 5 and Figure 6)

7.2.3.1 Gas chromatograph with flame ionization and electron capture detectors (photoionization detector optional) - capable of sub-ambient temperature programming for the oven and simultaneous operation of all detectors, and with other generally standard features such as gas flow regulators, automatic control of valves and integrator, etc. (Hewlett Packard, Rt. 41, Avondale, PA 19311, Model 5880A, with oven temperature control and Level 4 BASIC programming, or equivalent).

7.2.3.2 Chart recorders - compatible with the detector output signals to record detector response to the sample.

7.2.3.3 Electronic integrator - compatible with the detector output signals and capable of integrating the area of one or more response peaks and calculating peak areas corrected for baseline drift.

7.2.3.4 Six-port gas chromatographic valve - (Seismograph Service Corp, Tulsa, OK, Seiscor Model VIII, or equivalent).

7.2.3.5 Cryogenic trap with temperature control assembly - refer to Section 10.1.1.3 for complete description of trap and temperature control assembly (Nutech Corporation, 2142 Geer St., Durham, NC 27704, Model 320-01, or equivalent).

7.2.3.6 Electronic mass flow controllers (3) - maintain constant flow (for carrier gas, nitrogen make-up gas and sample gas) and to provide analog output to monitor flow anomalies (Tylan Model 260, 0-100 cm^3/min, or equivalent).

7.2.3.7 Vacuum pump - general purpose laboratory pump, capable of drawing the desired sample volume through the cryogenic trap (see 7.2.1.6 for source and description).

7.2.3.8 Chromatographic grade stainless steel tubing and stainless steel plumbing fittings - refer to Section 7.1.1.8 for description.

7.2.3.9 Chromatographic column - to provide compound separation such as shown in Table 7. (Hewlett Packard, Rt. 41, Avondale, PA 19311, OV-1 capillary column, 0.32 mm x 50 m with 0.88 um crosslinked methyl silicone coating, or equivalent). [Note: Other columns (e.g., DB-624) can be used as long as the system meets user needs. The wider Megabore® column (i.e., 0.53 mm I.D.) is less susceptible to plugging as a result of trapped water, thus eliminating the need for a Nafion® dryer in the analytical system. The Megabore® column has sample capacity approaching that of a packed column, while retaining much of the peak resolution traits of narrower columns (i.e., 0.32 mm I.D.).

7.2.3.10 Vacuum/pressure gauges (3) - refer to Section 7.2.1.9 for description.

7.2.3.11 Cylinder pressure stainless steel regulators - standard, two-stage cylinder regulators with pressure gauges for helium, zero air, nitrogen, and hydrogen gas cylinders.

7.2.3.12 Gas purifiers (4) - used to remove organic impurities and moisture from gas streams (Hewlett-Packard, Rt. 41, Avondale, PA, 19311, P/N 19362 - 60500, or equivalent).

7.2.3.13 Low dead-volume tee - used to split (50/50) the exit flow from the GC column (Alltech Associates, 2051 Waukegan Rd., Deerfield, IL 60015, Cat. #5839, or equivalent).

7.3 Canister Cleaning System (See Figure 7)

7.3.1 Vacuum pump - capable of evacuating sample canister(s) to an absolute pressure of <0.05 mm Hg.

7.3.2 Manifold - stainless steel manifold with connections for simultaneously cleaning several canisters.

7.3.3 Shut-off valve(s) - seven (7) on-off toggle valves.

7.3.4 Stainless steel vacuum gauge - capable of measuring vacuum in the manifold to an absolute pressure of 0.05 mm Hg or less.

7.3.5 Cryogenic trap (2 required) - stainless steel U-shaped open tubular trap cooled with liquid oxygen or argon to prevent contamination from back diffusion of oil from vacuum pump and to provide clean, zero air to sample canister(s).

7.3.6 Stainless steel pressure gauges (2) - 0-345 kPa (0-50 psig) to monitor zero air pressure.

7.3.7 Stainless steel flow control valve - to regulate flow of zero air into canister(s).

7.3.8 Humidifier - pressurizable water bubbler containing high performance liquid chromatography (HPLC) grade deionized water or other system capable of providing moisture to the zero air supply.

7.3.9 Isothermal oven (optional) for heating canisters (Fisher Scientific, Pittsburgh, PA, Model 349, or equivalent).

7.4 Calibration System and Manifold (See Figure 8)

7.4.1 Calibration manifold - glass manifold, (1.25 cm I.D. x 66 cm) with sampling ports and internal baffles for flow disturbance to ensure proper mixing.

7.4.2 Humidifier - 500-mL impinger flask containing HPLC grade deionized water.

7.4.3 Electronic mass flow controllers - one 0 to 5 L/min and one 0 to 50 cm^3/min (Tylan Corporation, 23301-TS Wilmington Ave., Carson, CA, 90745, Model 2160, or equivalent).

7.4.4 Teflon® filter(s) - 47-mm Teflon® filter for particulate control, best source.

8. Reagents and Materials

8.1 Gas cylinders of helium, hydrogen, nitrogen, and zero air - ultrahigh purity grade, best source.

8.2 Gas calibration standards - cylinder(s) containing approximately 10 ppmv of each of the following compounds of interest:

vinyl chloride
vinylidene chloride
1,1,2-trichloro-1,2,2-trifluoroethane
chloroform
1,2-dichloroethane
benzene
toluene
Freon 12
methyl chloride
1,2-dichloro-1,1,2,2-tetrafluoroethane
methyl bromide
ethyl chloride
Freon 11
dichloromethane
1,1-dichloroethane
cis-1,2-dichloroethylene
1,2-dichloropropane
1,1,2-trichloroethane
1,2-dibromoethane
tetrachloroethylene
chlorobenzene
benzyl chloride
hexachloro-1,3-butadiene
methyl chloroform
carbon tetrachloride
trichloroethylene
cis-1,3-dichloropropene
trans-1,3-dichloropropene
ethylbenzene
o-xylene
m-xylene
p-xylene
styrene
1,1,2,2-tetrachloroethane
1,3,5-trimethylbenzene
1,2,4-trimethylbenzene
m-dichlorobenzene
o-dichlorobenzene
p-dichlorobenzene
1,2,4-trichlorobenzene

The cylinder(s) should be traceable to a National Bureau of Standards (NBS) Standard Reference Material (SRM) or to a NBS/EPA approved Certified Reference Material (CRM). The components may be purchased in one cylinder or may be separated into different cylinders. Refer to manufacturer's specification for guidance on purchasing and mixing VOCs in gas cylinders. Those compounds purchased should match one's own target list.

8.3 Cryogen - liquid oxygen (bp -183.0°C), or liquid argon (bp -185.7°C), best source.

8.4 Gas purifiers - connected in-line between hydrogen, nitrogen, and zero air gas cylinders and system inlet line, to remove moisture and organic impurities from gas streams (Alltech Associates, 2051 Waukegan Road, Deerfield, IL, 60015, or equivalent).

8.5 Deionized water - high performance liquid chromatography (HPLC) grade, ultrahigh purity (for humidifier), best source.

8.6 4-bromofluorobenzene - used for tuning GC-MS, best source.

8.7 Hexane - for cleaning sampling system components, reagent grade, best source.

8.8 Methanol - for cleaning sampling system components, reagent grade, best source.

9. Sampling System

9.1 System Description

9.1.1 Subatmospheric Pressure Sampling [See Figure 2 (Without Metal Bellows Type Pump)]

9.1.1.1 In preparation for subatmospheric sample collection in a canister, the canister is evacuated to 0.05 mm Hg. When opened to the atmosphere containing the VOCs to be sampled, the differential pressure causes the sample to flow into the canister. This technique may be used to collect grab samples (duration of 10 to 30 seconds) or time-integrated samples (duration of 12 to 24 hours) taken through a flow-restrictive inlet (e.g., mass flow controller, critical orifice).

9.1.1.2 With a critical orifice flow restrictor, there will be a decrease in the flow rate as the pressure approaches atmospheric. However, with a mass flow controller, the subatmospheric sampling system can maintain a constant flow rate from full vacuum to within about 7 kPa (1.0 psi) or less below ambient pressure.

9.1.2 Pressurized Sampling [See Figure 2 (With Metal Bellows Type Pump)]

9.1.2.1 Pressurized sampling is used when longer-term integrated samples or higher volume samples are required. The sample is collected in a canister using a pump and flow control arrangement to achieve a typical 103-206 kPa (15-30 psig) final canister pressure. For example, a 6-liter evacuated canister can be filled at 10 cm^3/min for 24 hours to achieve a final pressure of about 144 kPa (21 psig).

9.1.2.2 In pressurized canister sampling, a metal bellows type pump draws in ambient air from the sampling manifold to fill and pressurize the sample canister.

9.1.3 All Samplers

9.1.3.1 A flow control device is chosen to maintain a constant flow into the canister over the desired sample period. This flow rate is determined so the canister is filled (to about 88.1 kPa for subatmospheric pressure sampling or to about one atmosphere above ambient pressure for pressurized sampling) over the desired sample period. The flow rate can be calculated by

$$F = \frac{P \times V}{T \times 60}$$

where:

F = flow rate (cm^3/min).

P = final canister pressure, atmospheres absolute. P is approximately equal to

$$\frac{kPa_{gauge}}{101.2} + 1$$

V = volume of the canister (cm^3).

T = sample period (hours).

For example, if a 6-L canister is to be filled to 202 kPa (2 atmospheres) absolute pressure in 24 hours, the flow rate can be calculated by

$$F = \frac{2 \times 6000}{24 \times 60} = 8.3 \text{ cm}^3/\text{min}$$

9.1.3.2 For automatic operation, the timer is wired to start and stop the pump at appropriate times for the desired sample period. The timer must also control the solenoid valve, to open the valve when starting the pump and close the valve when stopping the pump.

9.1.3.3 The use of the Skinner Magnelatch valve avoids any substantial temperature rise that would occur with a conventional, normally closed solenoid valve that would have to be energized during the entire sample period. The temperature rise in the valve could cause outgassing of organic compounds from the Viton valve seat material. The Skinner Magnelatch valve requires only a brief electrical pulse to open or close at the appropriate start and stop times and therefore experiences no temperature increase. The pulses may be obtained either with an electronic timer that can be programmed for short (5 to 60 seconds) ON periods, or with a conventional mechanical timer and a special pulse circuit. A simple electrical pulse circuit for operating the Skinner Magnelatch solenoid valve with a conventional mechanical timer is illustrated in Figure 9(a). However, with this simple circuit, the valve may operate unreliably during brief power interruptions or if the timer is manually switched on and off too fast. A better circuit incorporating a time-delay relay to provide more reliable valve operation is shown in Figure 9(b).

9.1.3.4 The connecting lines between the sample inlet and the canister should be as short as possible to minimize their volume. The flow rate into the canister should remain relatively constant over the entire sampling period. If a critical orifice is used, some drop in the flow rate may occur near the end of the sample period as the canister pressure approaches the final calculated pressure.

9.1.3.5 As an option, a second electronic timer (see Section 7.1.1.6) may be used to start the auxiliary pump several hours prior to the sampling period to flush and condition the inlet line.

9.1.3.6 Prior to field use, each sampling system must pass a humid zero air certification (see Section 12.2.2). All plumbing should be checked carefully for leaks. The canisters must also pass a humid zero air certification before use (see Section 12.1).

9.2 Sampling Procedure

9.2.1 The sample canister should be cleaned and tested according to the procedure in Section 12.1.

9.2.2 A sample collection system is assembled as shown in Figure 2 (and Figure 3) and must meet certification requirements as outlined in Section 12.2.3. [Note: The sampling system should be contained in an appropriate enclosure.]

9.2.3 Prior to locating the sampling system, the user may want to perform "screening analyses" using a portable GC system, as outlined in Appendix B, to determine potential volatile organics present and potential "hot spots." The information gathered from the portable GC screening analysis would be used in developing a monitoring protocol, which includes the sampling system location, based upon the "screening analysis" results.

9.2.4 After "screening analysis," the sampling system is located. Temperatures of ambient air and sampler box interior are recorded on canister sampling field data sheet (Figure 10). [Note: The following discussion is related to Figure 2.]

9.2.5 To verify correct sample flow, a "practice" (evacuated) canister is used in the sampling system. [Note: For a subatmospheric sampler, the flow meter and practice canister are needed. For the pump-driven system, the practice canister is not needed, as the flow can be measured at the outlet of the system.] A certified mass flow meter is attached to the inlet line of the manifold, just in front of the filter. The canister is opened. The sampler is turned on and the reading of the certified mass flow meter is compared to the sampler mass flow controller. The values should agree within ±10%. If not, the sampler mass flow meter needs to be recalibrated or there is a leak in the system. This should be investigated and corrected. [Note: Mass flow meter readings may drift. Check the zero reading carefully and add or subtract the zero reading when reading or adjusting the sampler flow rate, to compensate for any zero drift.] After two minutes, the desired canister flow rate is adjusted to the proper value (as indicated by the certified mass flow meter) by the sampler flow control unit controller (e.g., 3.5 cm^3/min for 24 hr, 7.0 cm^3/min for 12 hr). Record final flow under "CANISTER FLOW RATE," Figure 10.

9.2.6 The sampler is turned off and the elapsed time meter is reset to 000.0. Note: Any time the sampler is turned off, wait at least 30 seconds to turn the sampler back on.

9.2.7 The "practice" canister and certified mass flow meter are disconnected and a clean certified (see Section 12.1) canister is attached to the system.

9.2.8 The canister valve and vacuum/pressure gauge valve are opened.

9.2.9 Pressure/vacuum in the canister is recorded on the canister sampling field data sheet (Figure 10) as indicated by the sampler vacuum/pressure gauge.

9.2.10 The vacuum/pressure gauge valve is closed and the maximum-minimum thermometer is reset to current temperature. Time of day and elapsed time meter readings are recorded on the canister sampling field data sheet.

9.2.11 The electronic timer is set to begin and stop the sampling period at the appropriate times. Sampling commences and stops by the programmed electronic timer.

9.2.12 After the desired sampling period, the maximum, minimum, current interior temperature and current ambient temperature are recorded on the sampling field data sheet. The current reading from the flow controller is recorded.

9.2.13 At the end of the sampling period, the vacuum/pressure gauge valve on the sampler is briefly opened and closed and the pressure/vacuum is recorded on the sampling field data sheet. Pressure should be close to desired pressure. [Note: For a subatmospheric sampling system, if the canister is at atmospheric pressure when the field final pressure check is performed, the sampling period may be suspect. This information should be noted on the sampling field data sheet.] Time of day and elapsed time meter readings are also recorded.

9.2.14 The canister valve is closed. The sampling line is disconnected from the canister and the canister is removed from the system. For a subatmospheric system, a certified mass flow meter is once again connected to the inlet manifold in front of the in-line filter and a "practice" canister is attached to the Magnelatch valve of the sampling system. The final flow rate is recorded on the canister sampling field data sheet (see Figure 10). [Note: For a pressurized system, the final flow may be measured directly.] The sampler is turned off.

9.2.15 An identification tag is attached to the canister. Canister serial number, sample number, location, and date are recorded on the tag.

10. Analytical System (See Figures 4, 5 and 6)

10.1 System Description

10.1.1 GC-MS-SCAN System

10.1.1.1 The analytical system is comprised of a GC equipped with a mass-selective detector set in the SCAN mode (see Figure 4). All ions are scanned by the MS repeatedly during the

GC run. The system includes a computer and appropriate software for data acquisition, data reduction, and data reporting. A 400 cm^3 air sample is collected from the canister into the analytical system. The sample air is first passed through a Nafion® dryer, through the 6-port chromatographic valve, then routed into a cryogenic trap. [Note: While the GC-multidetector analytical system does not employ a Nafion® dryer for drying the sample gas stream, it is used here because the GC-MS system utilizes a larger sample volume and is far more sensitive to excessive moisture than the GC-multidetector analytical system. Moisture can adversely affect detector precision. The Nafion® dryer also prevents freezing of moisture on the 0.32 mm I.D. column, which may cause column blockage and possible breakage.] The trap is heated (-160°C to 120°C in 60 sec) and the analyte is injected onto the OV-1 capillary column (0.32 mm x 50 m). [Note: Rapid heating of the trap provides efficient transfer of the sample components onto the gas chromatographic column.] Upon sample injection onto the column, the MS computer is signaled by the GC computer to begin detection of compounds which elute from the column. The gas stream from the GC is scanned within a preselected range of atomic mass units (amu). For detection of compounds in Table 1, the range should be 18 to 250 amu, resulting in a 1.5 Hz repetition rate. Six (6) scans per eluting chromatographic peak are provided at this rate. The 10-15 largest peaks are chosen by an automated data reduction program, the three scans nearest the peak apex are averaged, and a background subtraction is performed. A library search is then performed and the top ten best matches for each peak are listed. A qualitative characterization

10.1.1.3 The packed metal tubing used for reduced temperature trapping of VOCs is shown in Figure 12. The cooling unit is comprised of a 0.32 cm outside diameter (O.D.) nickel tubing loop packed with 60-80 mesh Pyrex® beads (Nutech Model 320-01, or equivalent). The nickel tubing loop is wound onto a cylindrically formed tube heater (250 watt). A cartridge heater (25 watt) is sandwiched between pieces of aluminum plate at the trap inlet and outlet to provide additional heat to eliminate cold spots in the transfer tubing. During operation, the trap is inside a two-section stainless steel shell which is well insulated. Rapid heating (-150 to +100°C in 55 s) is accomplished by direct thermal contact between the heater and the trap tubing. Cooling is achieved by vaporization of the cryogen. In the shell, efficient cooling (+120 to -150°C in 225 s) is facilitated by confining the vaporized cryogen to the small open volume surrounding the trap assembly. The trap assembly and chromatographic valve are mounted on a baseplate fitted into the injection and auxiliary zones of the GC on an insulated pad directly above the column oven when used with the Hewlett-Packard 5880 GC. [Note: Alternative trap assembly and connection to the GC may be used depending upon user's requirements.] The carrier gas line is connected to the injection end of the analytical column with a zero-dead-volume fitting that is usually held in the heated zone above the GC oven. A 15 cm x 15 cm x 24 cm aluminum box is fitted over the sample handling elements to complete the package. Vaporized cryogen is vented through the top of the box.

of the sample is provided by this procedure. A typical chromatogram of VOCs determined by GC-MS-SCAN is illustrated in Figure 11(a).

10.1.1.2 A Nafion® permeable membrane dryer is used to remove water vapor selectively from the sample stream. The permeable membrane consists of Nafion® tubing (a copolymer of tetrafluoroethylene and fluorosulfonyl monomer) that is coaxially mounted within larger tubing. The sample stream is passed through the interior of the Nafion® tubing, allowing water (and other light, polar compounds) to permeate through the walls into a dry air purge stream flowing through the annular space between the Nafion® and outer tubing. [Note: To prevent excessive moisture build-up and any memory effects in the dryer, a clean-up procedure involving periodic heating of the dryer (100°C for 20 minutes) while purging with dry zero air (500 cm^3/min) should be implemented as part of the user's SOP manual. The clean-up procedure is repeated during each analysis (see Section 14, reference 7). Recent studies have indicated no substantial loss of targeted VOCs utilizing the above clean-up procedure (7). This cleanup procedure is particularly useful when employing cryogenic preconcentration of VOCs with subsequent GC analysis using a 0.32 mm I.D. column because excess accumulated water can cause trap and column blockage and also adversely affect detector precision. In addition, the improvement in water removal from the sampling stream will allow analyses of much larger volumes of sample air in the event that greater system sensitivity is required for targeted compounds.]

10.1.1.4 As an option, the analyst may wish to split the gas stream exiting the column with a low dead-volume tee, passing one-third of the sample gas (1.0 mL/min) to the mass-selective detector and the remaining two-thirds (2.0 mL/min) through a flame ionization detector, as illustrated as an option in Figure 4. The use of the specific detector (MS-SCAN) coupled with the non-specific detector (FID) enables enhancement of data acquired from a single analysis. In particular, the FID provides the user:

- o Semi-real time picture of the progress of the analytical scheme;
- o Confirmation by the concurrent MS analysis of other labs that can provide only FID results; and
- o Ability to compare GC-FID with other analytical laboratories with only GC-FID capability.

10.1.2 GC-MS-SIM System

10.1.2.1 The analytical system is comprised of a GC equipped with an OV-1 capillary column (0.32 mm x 50 m) and a mass-selective detector set in the SIM mode (see Figure 4). The GC-MS is set up for automatic, repetitive analysis. The system is programmed to acquire data for only the target compounds and to disregard all others. The sensitivity is 0.1 ppbv for a 250 cm^3 air sample with analytical precision of about 5% relative standard deviation. Concentration of compounds based upon a previously installed calibration table is reported by an automated data reduction program. A Nafion® dryer is also employed by this analytical system prior to cryogenic preconcentration; therefore, many polar compounds are not identified by this procedure.

10.1.2.2 SIM analysis is based on a combination of retention times and relative abundances of selected ions (see Table 2). These qualifiers are stored on the hard disk of the GC-MS computer and are applied for identification of each chromatographic peak. The retention time qualifier is determined to be ± 0.10 minute of the library retention time of the compound. The acceptance level for relative abundance is determined to be ± 15% of the expected abundance, except for vinyl chloride and methylene chloride, which is determined to be ± 25%. Three ions are measured for most of the forty compounds. When compound identification is made by the computer, any peak that fails any of the qualifying tests is flagged (e.g., with an *). All the data should be manually examined by the analyst to determine the reason for the flag and whether the compound should be reported as found. While this adds some subjective judgment to the analysis, computer-generated identification problems can be clarified by an experienced operator. Manual inspection of the quantitative results should also be performed to verify concentrations outside the expected range. A typical chromatogram of VOCs determined by GC-MS-SIM mode is illustrated in Figure 11(b).

10.1.3 GC-Multidetector (GC-FID-ECD) System with Optional PID

10.1.3.1 The analytical system (see Figure 5) is comprised of a gas chromatograph equipped with a capillary column and electron capture and flame ionization detectors (see Figure 5). In typical operation, sample air from pressurized canisters is vented past the inlet to the analytical system from the canister at a flow rate of 75 cm^3/min. For analysis, only 35 cm^3/min of sample gas is used, while excess

is vented to the atmosphere. Sub-ambient pressure canisters are connected directly to the inlet. The sample gas stream is routed through a six port chromatographic valve and into the cryogenic trap for a total sample volume of 490 cm^3. [Note: This represents a 14 minute sampling period at a rate of 35 cm^3/min.] The trap (see Section 10.1.1.3) is cooled to -150°C by controlled release of a cryogen. VOCs and SVOCs are condensed on the trap surface while N_2, O_2, and other sample components are passed to the pump. After the organic compounds are concentrated, the valve is switched and the trap is heated. The revolatilized compounds are transported by helium carrier gas at a rate of 4 cm^3/min to the head of the Megabore® OV-1 capillary column (0.53 mm x 30 m). Since the column initial temperature is at -50°C, the VOCs and SVOCs are cryofocussed on the head of the column. Then, the oven temperature is programmed to increase and the VOCs/SVOCs in the carrier gas are chromatographically separated. The carrier gas containing the separated VOCs/SVOCs is then directed to two parallel detectors at a flow rate of 2 cm^3/min each. The detectors sense the presence of the speciated VOCs/SVOCs, and the response is recorded by either a strip chart recorder or a data processing unit.

10.1.3.2 Typical chromatograms of VOCs determined by the GC-FID-ECD analytical system are illustrated in Figures 11(c) and 11(d), respectively.

10.1.3.3 Helium is used as the carrier gas (4 cm^3/min) to purge residual air from the trap at the end of the sampling phase and to carry the revolatilized VOCs through the Megabore® GC column. Moisture and organic impurities are removed from the helium gas stream by a chemical purifier installed in the GC (see

Section 7.2.1.11). After exiting the OV-1 Megabore® column, the carrier gas stream is split to the two detectors at rates of 2 cm^3/min each.

10.1.3.4 Gas scrubbers containing Drierite® or silica gel and 5A molecular sieve are used to remove moisture and organic impurities from the zero air, hydrogen, and nitrogen gas streams. [Note: Purity of gas purifiers is checked prior to use by passing humid zero-air through the gas purifier and analyzing according to Section 12.2.2.]

10.1.3.5 All lines should be kept as short as practical. All tubing used for the system should be chromatographic grade stainless steel connected with stainless steel fittings. After assembly, the system should be checked for leaks according to manufacturer's specifications.

10.1.3.6 The FID burner air, hydrogen, nitrogen (make-up), and helium (carrier) flow rates should be set according to the manufacturer's instructions to obtain an optimal FID response while maintaining a stable flame throughout the analysis. Typical flow rates are: burner air, 450 cm^3/min; hydrogen, 30 cm^3/min; nitrogen, 30 cm^3/min; helium, 2 cm^3/min.

10.1.3.7 The ECD nitrogen make-up gas and helium carrier flow rates should be set according to manufacturer's instructions to obtain an optimal ECD response. Typical flow rates are: nitrogen, 76 cm^3/min and helium, 2 cm^3/min.

10.1.3.8 The GC-FID-ECD could be modified to include a PID (see Figure 6) for increased sensitivity (20). In the photoionization process, a molecule is ionized by ultraviolet light as follows: $R + h\nu \rightarrow R + e^-$, where R^+ is the ionized species and a photon is represented by $h\nu$, with energy less than or equal to the ionization potential of

the molecule. Generally all species with an ionization potential less than the ionization energy of the lamp are detected. Because the ionization potential of all major components of air (O_2, N_2, CO, CO_2, and H_2O) is greater than the ionization energy of lamps in general use, they are not detected. The sensor is comprised of an argon-filled, ultraviolet (UV) light source where a portion of the organic vapors are ionized in the gas stream. A pair of electrodes are contained in a chamber adjacent to the sensor. When a positive potential is applied to the electrodes, any ions formed by the absorption of UV light are driven by the created electronic field to the cathode, and the current (proportional to the organic vapor concentration) is measured. The PID is generally used for compounds having ionization potentials less than the ratings of the ultraviolet lamps. This detector is used for determination of most chlorinated and oxygenated hydrocarbons, aromatic compounds, and high molecular weight aliphatic compounds. Because the PID is insensitive to methane, ethane, carbon monoxide, carbon dioxide, and water vapor, it is an excellent detector. The electron volt rating is applied specifically to the wavelength of the most intense emission line of the lamp's output spectrum. Some compounds with ionization potentials above the lamp rating can still be detected due to the presence of small quantities of more intense light. A typical system configuration associated with the GC-FID-ECD-PID is illustrated in Figure 6. This system is currently being used in EPA's FY-88 Urban Air Toxics Monitoring Program.

10.2 GC-MS-SCAN-SIM System Performance Criteria

10.2.1 GC-MS System Operation

10.2.1.1 Prior to analysis, the GC-MS system is assembled and checked according to manufacturer's instructions.

10.2.1.2 Table 3.0 outlines general operating conditions for the GC-MS-SCAN-SIM system with optional FID.

10.2.1.3 The GC-MS system is first challenged with humid zero air (see Section 11.2.2).

10.2.1.4 The GC-MS and optional FID system is acceptable if it contains less than 0.2 ppbv of targeted VOCs.

10.2.2 Daily GC-MS Tuning (See Figure 13)

10.2.2.1 At the beginning of each day or prior to a calibration, the GC-MS system must be tuned to verify that acceptable performance criteria are achieved.

10.2.2.2 For tuning the GC-MS, a cylinder containing 4-bromofluorobenzene is introduced via a sample loop valve injection system. [Note: Some systems allow auto-tuning to facilitate this process.] The key ions and ion abundance criteria that must be met are illustrated in Table 4. Analysis should not begin until all those criteria are met.

10.2.2.3 The GC-MS tuning standard could also be used to assess GC column performance (chromatographic check) and as an internal standard. Obtain a background correction mass spectra of 4-bromofluorobenzene and check that all key ions criteria are met. If the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are achieved.

10.2.2.4 The performance criteria must be achieved before any samples, blanks or standards are analyzed. If

any key ion abundance observed for the daily 4-bromofluorobenzene mass tuning check differs by more than 10% absolute abundance from that observed during the previous daily tuning, the instrument must be retuned or the sample and/or calibration gases reanalyzed until the above condition is met.

10.2.3 GC-MS Calibration (See Figure 13)

[Note: Initial and routine calibration procedures are illustrated in Figure 13.]

10.2.3.1 Initial Calibration - Initially, a multipoint dynamic calibration (three levels plus humid zero air) is performed on the GC-MS system, before sample analysis, with the assistance of a calibration system (see Figure 8). The calibration system uses NBS traceable standards or NBS/EPA CRMs in pressurized cylinders [containing a mixture of the targeted VOCs at nominal concentrations of 10 ppmv in nitrogen (Section 8.2)] as working standards to be diluted with humid zero air. The contents of the working standard cylinder(s) are metered (2 cm^3/min) into the heated mixing chamber where they are mixed with a 2-L/min humidified zero air gas stream to achieve a nominal 10 ppbv per compound calibration mixture (see Figure 8). This nominal 10 ppbv standard mixture is allowed to flow and equilibrate for a minimum of 30 minutes. After the equilibration period, the gas standard mixture is sampled and analyzed by the real-time GC-MS system [see Figure 8(a) and Section 7.2.1]. The results of the analyses are averaged, flow audits are performed on the mass flow meters and the calculated concentration compared to generated values. After the GC-MS is calibrated at three concentration levels, a second humid zero air sample is passed through the system and analyzed. The second humid zero air test is used to verify that the GC-MS system is certified clean (less than 0.2 ppbv of target compounds).

10.2.3.2 As an alternative, a multipoint humid static calibration (three levels plus zero humid air) can be performed on the GC-MS system. During the humid static calibration analyses, three (3) SUMMA® passivated canisters are filled each at a different concentration between 1-20 ppbv from the calibration manifold using a pump and mass flow control arrangement [see Figure 8(c)]. The canisters are then delivered to the GC-MS to serve as calibration standards. The canisters are analyzed by the MS in the SIM mode, each analyzed twice. The expected retention time and ion abundance (see Table 2 and Table 5) are used to verify proper operation of the GC-MS system. A calibration response factor is determined for each analyte, as illustrated in Table 5, and the computer calibration table is updated with this information, as illustrated in Table 6.

10.2.3.3 Routine Calibration - The GC-MS system is calibrated daily (and before sample analysis) with a one-point calibration. The GC-MS system is calibrated either with the dynamic calibration procedure [see Figure 8(a)] or with a 6-L SUMMA® passivated canister filled with humid calibration standards from the calibration manifold (see Section 10.2.3.2). After the single point calibration, the GC-MS analytical system is challenged with a humidified zero gas stream to insure the analytical system returns to specification (less than 0.2 ppbv of selective organics).

10.3 GC-FID-ECD System Performance Criteria (With Optional PID System) (See Figure 14)

10.3.1 Humid Zero Air Certification

10.3.1.1 Before system calibration and sample analysis, the GC-FID-ECD analytical system is assembled and checked according to manufacturer's instructions.

10.3.1.2 The GC-FID-ECD system is first challenged with humid zero air (see Section 12.2.2) and monitored.

10.3.1.3 Analytical systems contaminated with less than 0.2 ppbv of targeted VOCs are acceptable.

10.3.2 GC Retention Time Windows Determination (See Table 7)

10.3.2.1 Before analysis can be performed, the retention time windows must be established for each analyte.

10.3.2.2 Make sure the GC system is within optimum operating conditions.

10.3.2.3 Make three injections of the standard containing all compounds for retention time window determination. [Note: The retention time window must be established for each analyte every 72 hours during continuous operation.]

10.3.2.4 Calculate the standard deviation of the three absolute retention times for each single component standard. The retention window is defined as the mean plus or minus three times the standard deviation of the individual retention times for each standard. In those cases where the standard deviation for a particular standard is zero, the laboratory must substitute the standard deviation of a closely-eluting, similar compound to develop a valid retention time window.

10.3.2.5 The laboratory must calculate retention time windows for each standard (see Table 7) on each GC column, whenever a new GC column is installed or when major components of the GC are changed. The data must be noted and retained in a notebook by the laboratory as part of the user SOP and as a quality assurance check of the analytical system.

10.3.3 GC Calibration

[Note: Initial and routine calibration procedures are illustrated in Figure 14.]

10.3.3.1 Initial Calibration - Initially, a multipoint dynamic calibration (three levels plus humid zero air) is performed on the GC-FID-ECD system, before sample analysis, with the assistance of a calibration system (see Figure 8). The calibration system uses NBS traceable standards or NBS/EPA CRMs in pressurized cylinders [containing a mixture of the targeted VOCs at nominal concentrations of 10 ppmv in nitrogen (Section 8.2)] as working standards to be diluted with humid zero air. The contents of the working standard cylinders are metered (2 cm^3/min) into the heated mixing chamber where they are mixed with a 2-L/min humidified zero air stream to achieve a nominal 10 ppbv per compound calibration mixture (see Figure 8). This nominal 10 ppbv standard mixture is allowed to flow and equilibrate for an appropriate amount of time. After the equilibration period, the gas standard mixture is sampled and analyzed by the GC-MS system [see Figure 8(a)]. The results of the analyses are averaged, flow audits are performed on the mass flow controllers used to generate the standards and the appropriate response factors (concentration/area counts) are calculated for each compound, as illustrated in Table 5. [Note: GC-FIDs are linear in the 1-20 ppbv range and may not require repeated multipoint calibrations; whereas, the GC-ECD will require frequent linearity evaluation.] Table 5 outlines typical calibration response factors

and retention times for 40 VOCs. After the GC-FID-ECD is calibrated at the three concentration levels, a second humid zero air sample is passed through the system and analyzed. The second humid zero air test is used to verify that the GC-FID-ECD system is certified clean (less than 0.2 ppbv of target compounds).

10.3.3.2 Routine Calibration - A one point calibration is performed daily on the analytical system to verify the initial multipoint calibration (see Section 10.3.3.1). The analyzers (GC-FID-ECD) are calibrated (before sample analysis) using the static calibration procedures (see Section 10.2.3.2) involving pressurized gas cylinders containing low concentrations of the targeted VOCs (10 ppbv) in nitrogen. After calibration, humid zero air is once again passed through the analytical system to verify residual VOCs are not present.

10.3.4 GC-FID-ECD-PID System Performance Criteria

10.3.4.1 As an option, the user may wish to include a photoionization detector (PID) to assist in peak identification and increase sensitivity.

10.3.4.2 This analytical system is presently being used in U.S. Environmental Protection Agency's Urban Air Toxic Pollutant Program (UATP).

10.3.4.3 Preparation of the GC-FID-ECD-PID analytical system is identical to the GC-FID-ECD system (see Section 10.3).

10.3.4.4 Table 8 outlines typical retention times (minutes) for selected organics using the GC-FID-ECD-PID analytical system.

10.4 Analytical Procedures

10.4.1 Canister Receipt

10.4.1.1 The overall condition of each sample canister is observed. Each canister should be received with an attached sample identification tag.

10.4.1.2 Each canister is recorded in the dedicated laboratory logbook. Also noted on the identification tag are date received and initials of recipient.

10.4.1.3 The pressure of the canister is checked by attaching a pressure gauge to the canister inlet. The canister valve is opened briefly and the pressure (kPa, psig) is recorded. [Note: If pressure is <83 kPa (<12 psig), the user may wish to pressurize the canisters, as an option, with zero grade nitrogen up to 137 kPa (20 psig) to ensure that enough sample is available for analysis. However, pressurizing the canister can introduce additional error, increase the minimum detection limit (MDL), and is time consuming. The user should weigh these limitations as part of his program objectives before pressurizing.] Final cylinder pressure is recorded on canister sampling field data sheet (see Figure 10).

10.4.1.4 If the canister pressure is increased, a dilution factor (DF) is calculated and recorded on the sampling data sheet.

$$DF = \frac{Y_a}{X_a}$$

where:

X_a = canister pressure (kPa, psia) absolute before dilution.

Y_a = canister pressure (kPa, psia) absolute after dilution.

After sample analysis, detected VOC concentrations are multiplied by the dilution factor to determine concentration in the sampled air.

10.4.2 GC-MS-SCAN Analysis (With Optional FID System)

10.4.2.1 The analytical system should be properly assembled, humid zero air certified (see Section 12.3), operated (see Table 3), and calibrated for accurate VOC determination.

10.4.2.2 The mass flow controllers are checked and adjusted to provide correct flow rates for the system.

10.4.2.3 The sample canister is connected to the inlet of the GC-MS-SCAN (with optional FID) analytical system. For pressurized samples, a mass flow controller is placed on the canister and the canister valve is opened and the canister flow is vented past a tee inlet to the analytical system at a flow of 75 cm^3/min so that 40 cm^3/min is pulled through the Nafion® dryer to the six-port chromatographic valve. [Note: Flow rate is not as important as acquiring sufficient sample volume.] Sub-ambient pressure samples are connected directly to the inlet.

10.4.2.4 The GC oven and cryogenic trap (inject position) are cooled to their set points of -50°C and -160°C, respectively.

10.4.2.5 As soon as the cryogenic trap reaches its lower set point of -160°C, the six-port chromatographic valve is turned to its fill position to initiate sample collection.

10.4.2.6 A ten minute collection period of canister sample is utilized. [Note: 40 cm^3/min x 10 min = 400 cm^3 sampled canister contents.]

10.4.2.7 After the sample is preconcentrated in the cryogenic trap, the GC sampling valve is cycled to the inject position and the cryogenic trap is heated. The trapped analytes are thermally desorbed onto the head of the OV-1 capillary column (0.31 mm I.D. x 50 m length). The GC oven is programmed to start at -50°C and after 2 min to heat to 150°C at a rate of 8°C per minute.

10.4.2.8 Upon sample injection onto the column, the MS is signaled by the computer to scan the eluting carrier gas from 18 to 250 amu, resulting in a 1.5 Hz repetition rate. This corresponds to about 6 scans per eluting chromatographic peak.

10.4.2.9 Primary identification is based upon retention time and relative abundance of eluting ions as compared to the spectral library stored on the hard disk of the GC-MS data computer.

10.4.2.10 The concentration (ppbv) is calculated using the previously established response factors (see Section 10.2.3.2), as illustrated in Table 5. [Note: If the canister is diluted before analysis, an appropriate multiplier is applied to correct for the volume dilution of the canister (Section 10.4.1.4).]

10.4.2.11 The optional FID trace allows the analyst to record the progress of the analysis.

10.4.3 GC-MS-SIM Analysis (With Optional FID System)

10.4.3.1 When the MS is placed in the SIM mode of operation, the MS monitors only preselected ions, rather than scanning all masses continuously between two mass limits.

10.4.3.2 As a result, increased sensitivity and improved quantitative analysis can be achieved.

10.4.3.3 Similar to the GC-MS-SCAN configuration, the GC-MS-SIM analysis is based on a combination of retention times and relative abundances of selected ions (see Table 2 and Table 5). These qualifiers are stored on the hard disk of the GC-MS computer and are applied for identification of each chromatographic peak. Once the GC-MS-SIM has identified the peak, a calibration response factor is used to determine the analyte's concentration.

10.4.3.4 The individual analyses are handled in three phases: data acquisition, data reduction, and data reporting. The data acquisition software is set in the SIM mode, where specific compound fragments are monitored by the MS at specific times in the analytical run. Data reduction is coordinated by the postprocessing macro program that is automatically accessed after data acquisition is completed at the end of the GC run. Resulting ion profiles are extracted, peaks are identified and integrated, and an internal integration report is generated by the program. A reconstructed ion chromatogram for hardcopy reference is prepared by the program and various parameters of interest such as time, date, and integration constants are printed. At the completion of the macro program, the data reporting software is accessed. The appropriate calibration table (see Table 9) is retrieved by the data reporting program from the computer's hard disk storage and the proper retention time and response factor parameters are applied to the macro program's integration file. With reference to certain pre-set acceptance criteria, peaks are automatically identified and quantified and a final summary report is prepared, as illustrated in Table 10.

10.4.4 GC-FID-ECD Analysis (With Optional PID System)

10.4.4.1 The analytical system should be properly assembled, humid zero air certified (see Section 12.2) and calibrated through a dynamic standard calibration procedure (see Section 10.3.2). The FID detector is lit and allowed to stabilize.

10.4.4.2 Sixty-four minutes are required for each sample analysis - 15 min for system initialization, 14 min for sample collection, 30 min for analysis, and 5 min for post-time, during which a report is printed. [Note: This may vary depending upon system configuration and programming.]

10.4.4.3 The helium and sample mass flow controllers are checked and adjusted to provide correct flow rates for the system. Helium is used to purge residual air from the trap at the end of the sampling phase and to carry the revolatilized VOCs from the trap onto the GC column and into the FID-ECD. The hydrogen, burner air, and nitrogen flow rates should also be checked. The cryogenic trap is connected and verified to be operating properly while flowing cryogen through the system.

10.4.4.4 The sample canister is connected to the inlet of the GC-FID-ECD analytical system. The canister valve is opened and the canister flow is vented past a tee inlet to the analytical system at 75 cm^3/min using a 0-500 cm^3/min Tylan mass flow controller. During analysis, 40 cm^3/min of sample gas is pulled through the six-port chromatographic valve and routed through the trap at the appropriate time while the extra sample is vented. The VOCs are condensed in the trap while the excess flow is exhausted through an exhaust vent, which assures that the sample air flowing through the trap is at atmospheric pressure.

10.4.4.5 The six-port valve is switched to the inject position and the canister valve is closed.

10.4.4.6 The electronic integrator is started.

10.4.4.7 After the sample is preconcentrated on the trap, the trap is heated and the VOCs are thermally desorbed onto the head of the capillary column. Since the column is at -50°C, the VOCs are cryofocussed on the column. Then, the oven temperature (programmed) increases and the VOCs elute from the column to the parallel FID-ECD assembly.

10.4.4.8 The peaks eluting from the detectors are identified by retention time (see Table 7 and Table 8), while peak areas are recorded in area

counts. Figures 15 and 16 illustrate typical response of the FID and ECD, respectively, for the forty (40) targeted VOCs. [Note: Refer to Table 7 for peak number and identification.]

10.4.4.9 The response factors (see Section 10.3.3.1) are multiplied by the area counts for each peak to calculate ppbv estimates for the unknown sample. If the canister is diluted before analysis, an appropriate dilution multiplier (DF) is applied to correct for the volume dilution of the canister (see Section 10.4.1.4).

10.4.4.10 Depending on the number of canisters to be analyzed, each canister is analyzed twice and the final concentrations for each analyte are the averages of the two analyses.

10.4.4.11 However, if the GC-FID-ECD analytical system discovers unexpected peaks which need further identification and attention or overlapping peaks are discovered, eliminating possible quantitation, the sample should then be subjected to a GC-MS-SCAN for positive identification and quantitation.

11. Cleaning and Certification Program

11.1 Canister Cleaning and Certification

11.1.1 All canisters must be clean and free of any contaminants before sample collection.

11.1.2 All canisters are leak tested by pressurizing them to approximately 206 kPa (30 psig) with zero air. [Note: The canister cleaning system in Figure 7 can be used for this task.] The initial pressure is measured, the canister valve is closed, and the final pressure is checked after 24 hours. If leak tight, the pressure should not vary more than ± 13.8 kPa (± 2 psig) over the 24 hour period.

11.1.3 A canister cleaning system may be assembled as illustrated in Figure 7. Cryogen is added to both the vacuum pump and zero air supply traps. The canister(s)

are connected to the manifold. The vent shut-off valve and the canister valve(s) are opened to release any remaining pressure in the canister(s). The vacuum pump is started and the vent shut-off valve is then closed and the vacuum shut-off valve is opened. The canister(s) are evacuated to < 0.05 mm Hg (for at least one hour). [Note: On a daily basis or more often if necessary, the cryogenic traps should be purged with zero air to remove any trapped water from previous canister cleaning cycles.]

11.1.4 The vacuum and vacuum/pressure gauge shut-off valves are closed and the zero air shut-off valve is opened to pressurize the canister(s) with humid zero air to approximately 206 kPa (30 psig). If a zero gas generator system is used, the flow rate may need to be limited to maintain the zero air quality.

11.1.5 The zero shut-off valve is closed and the canister(s) is allowed to vent down to atmospheric pressure through the vent shut-off valve. The vent shut-off valve is closed. Steps 11.1.3 through 11.1.5 are repeated two additional times for a total of three (3) evacuation/pressurization cycles for each set of canisters.

11.1.6 At the end of the evacuation/pressurization cycle, the canister is pressurized to 206 kPa (30 psig) with humid zero air. The canister is then analyzed by a GC-MS or GC-FID-ECD analytical system. Any canister that has not tested clean (compared to direct analysis of humidified zero air of less than 0.2 ppbv of targeted VOCs) should not be used. As a "blank" check of the canister(s) and cleanup procedure, the final humid zero air fill of 100% of the canisters is analyzed until the cleanup system and canisters are proven reliable (less than 0.2 ppbv of targets VOCs). The check can then be reduced to a lower percentage of canisters.

11.1.7 The canister is reattached to the cleaning manifold and is then reevacuated to <0.05 mm Hg and remains in this condition until used. The canister valve is closed. The canister is removed from the cleaning system and the canister connection is capped with a stainless steel fitting.

The canister is now ready for collection of an air sample. An identification tag is attached to the neck of each canister for field notes and chain-of-custody purposes.

11.1.8 As an option to the humid zero air cleaning procedures, the canisters could be heated in an isothermal oven to 100°C during Section 11.1.3 to ensure that lower molecular weight compounds (C_2-C_8) are not retained on the walls of the canister. [Note: For sampling heavier, more complex VOC mixtures, the canisters should be heated to 250°C during Section 11.1.3.7.] Once heated, the canisters are evacuated to 0.05 mm Hg. At the end of the heated/evacuated cycle, the canisters are pressurized with humid zero air and analyzed by the GC-FID-ECD system. Any canister that has not tested clean (less than 0.2 ppbv of targeted compounds) should not be used. Once tested clean, the canisters are reevacuated to 0.05 mm Hg and remain in the evacuated state until used.

11.2 Sampling System Cleaning and Certification

11.2.1 Cleaning Sampling System Components

11.2.1.1 Sample components are disassembled and cleaned before the sampler is assembled. Nonmetallic parts are rinsed with HPLC grade deionized water and dried in a vacuum oven at 50°C. Typically, stainless steel parts and fittings are cleaned by placing them in a beaker of methanol in an ultrasonic bath for 15 minutes. This procedure is repeated with hexane as the solvent.

11.2.1.2 The parts are then rinsed with HPLC grade deionized water and dried in a vacuum oven at 100°C for 12 to 24 hours.

11.2.1.3 Once the sampler is assembled, the entire system is purged with humid zero air for 24 hours.

11.2.2 Humid Zero Air Certification

[Note: In the following sections, "certification" is defined as evaluating the sampling system with humid

zero air and humid calibration gases that pass through all active components of the sampling system. The system is "certified" if no significant additions or deletions (less than 0.2 ppbv of targeted compounds) have occurred when challenged with the test gas stream.]

11.2.2.1 The cleanliness of the sampling system is determined by testing the sampler with humid zero air without an evacuated gas cylinder, as follows.

11.2.2.2 The calibration system and manifold are assembled, as illustrated in Figure 8. The sampler (without an evacuated gas cylinder) is connected to the manifold and the zero air cylinder activated to generate a humid gas stream (2 L/min) to the calibration manifold [see Figure 8(b)].

11.2.2.3 The humid zero gas stream passes through the calibration manifold, through the sampling system (without an evacuated canister) to a GC-FID-ECD analytical system at 75 cm^3/min so that 40 cm^3/min is pulled through the six-port valve and routed through the cryogenic trap (see Section 10.2.2.1) at the appropriate time while the extra sample is vented. [Note: The exit of the sampling system (without the canister) replaces the canister in Figure 4.] After the sample (400 mL) is preconcentrated on the trap, the trap is heated and the VOCs are thermally desorbed onto the head of the capillary column. Since the column is at -50°C, the VOCs are cryofocussed on the column. Then, the oven temperature (programmed) increases and the VOCs begin to elute and are detected by a GC-MS (see Section 10.2) or the GC-FID-ECD (see Section 10.3). The analytical system should not detect greater than 0.2 ppbv of targeted VOCs in order for the sampling system to pass the humid zero air certification

test. Chromatograms of a certified sampler and contaminated sampler are illustrated in Figures 17(a) and (b), respectively. If the sampler passes the humid zero air test, it is then tested with humid calibration gas standards containing selected VOCs at concentration levels expected in field sampling (e.g., 0.5 to 2 ppbv) as outlined in Section 11.2.3.

11.2.3 Sampler System Certification with Humid Calibration Gas Standards

11.2.3.1 Assemble the dynamic calibration system and manifold as illustrated in Figure 8.

11.2.3.2 Verify that the calibration system is clean (less than 0.2 ppbv of targeted compounds) by sampling a humidified gas stream, <u>without</u> gas calibration standards, with a previously certified clean canister (see Section 12.1).

11.2.3.3 The assembled dynamic calibration system is certified clean if less than 0.2 ppbv of targeted compounds are found.

11.2.3.4 For generating the humidified calibration standards, the calibration gas cylinder(s) (see Section 8.2) containing nominal concentrations of 10 ppmv in nitrogen of selected VOCs, are attached to the calibration system, as outlined in Section 10.2.3.1. The gas cylinders are opened and the gas mixtures are passed through 0 to 10 cm^3/min certified mass flow controllers to generate ppb levels of calibration standards.

11.2.3.5 After the appropriate equilibrium period, attach the sampling system (containing a certified evacuated canister) to the manifold, as illustrated in Figure 8(a).

11.2.3.6 Sample the dynamic calibration gas stream with the sampling system according to Section 9.2.1. [Note: To conserve generated calibration gas, bypass the canister sampling system manifold and attach the sampling system to the calibration gas stream at the inlet of the in-line filter of the sampling system so the flow will be less than 500 cm^3/min.]

11.2.3.7 Concurrent with the sampling system operation, realtime monitoring of the calibration gas stream is accomplished by the on-line GC-MS or GC-multidetector analytical system [Figure 8(b)] to provide reference concentrations of generated VOCs.

11.2.3.8 At the end of the sampling period (normally same time period used for anticipated sampling), the sampling system canister is analyzed and compared to the reference GC-MS or GC-multidetector analytical system to determine if the concentration of the targeted VOCs was increased or decreased by the sampling system.

11.2.3.9 A recovery of between 90% and 110% is expected for all targeted VOCs.

12. Performance Criteria and Quality Assurance

12.1 Standard Operating Procedures (SOPs)

12.1.1 SOPs should be generated in each laboratory describing and documenting the following activities: (1) assembly, calibration, leak check, and operation of specific sampling systems and equipment used; (2) preparation, storage, shipment, and handling of samples; (3) assembly, leak-check, calibration, and operation of the analytical system, addressing the specific equipment used; (4) canister storage and cleaning; and (5) all aspects of data recording and processing, including lists of computer hardware and software used.

12.1.2 Specific stepwise instructions should be provided in the SOPs and should be readily available to and understood by the laboratory personnel conducting the work.

12.2 Method Relative Accuracy and Linearity

12.2.1 Accuracy can be determined by injecting VOC standards (see Section 8.2) from an audit cylinder into a sampler. The contents are then analyzed for the components contained in the audit canister. Percent relative accuracy is calculated:

$$\% \text{ Relative Accuracy} = \frac{Y - X}{X} \times 100$$

Where: Y = Concentration of the targeted compound recovered from sampler.

X = Concentration of VOC targeted compound in the NBS-SRM or EPA-CRM audit cylinders.

12.2.2 If the relative accuracy does not fall between 90 and and 110 percent, the field sampler should be removed from use, cleaned, and recertified according to initial certification procedures outlined in Section 11.2.2 and Section 11.2.3. Historically, concentrations of carbon tetrachloride, tetrachloroethylene, and hexachlorobutadiene have sometimes been detected at lower concentrations when using parallel ECD and FID detectors. When these three compounds are present at concentrations close to calibration levels, both detectors usually agree on the reported concentrations. At concentrations below 4 ppbv, there is a problem with nonlinearity of the ECD. Plots of concentration versus peak area for calibration compounds detected by the ECD have shown that the curves are nonlinear for carbon tetrachloride, tetrachloroethylene, and hexachlorobutadiene, as illustrated in Figures 18(a) through 18(c). Other targeted ECD and FID compounds scaled linearly for the range 0 to 8 ppbv, as shown for chloroform in Figure 18(d). For compounds that are not linear over the calibration

range, area counts generally roll off between 3 and 4 ppbv. To correct for the nonlinearity of these compounds, an additional calibration step is performed. An evacuated stainless steel canister is pressurized with calibration gas at a nominal concentration of 8 ppbv. The sample is then diluted to approximately 3.5 ppbv with zero air and analyzed. The instrument response factor (ppbv/area) of the ECD for each of the three compounds is calculated for the 3.5 ppbv sample. Then, both the 3.5 ppbv and the 8 ppbv response factors are entered into the ECD calibration table. The software for the Hewlett-Packard 5880 level 4 GC is designed to accommodate multilevel calibration entries, so the correct response factors are automatically calculated for concentrations in this range.

12.3 Method Modification

12.3.1 Sampling

12.3.1.1 The sampling system for pressurized canister sampling could be modified to use a lighter, more compact pump. The pump currently being used weighs about 16 kilograms (35 lbs). Commercially available pumps that could be used as alternatives to the prescribed sampler pump are described below. Metal Bellows MB-41 pump: These pumps are cleaned at the factory; however, some precaution should be taken with the circular (4.8 cm diameter) Teflon® and stainless steel part directly under the flange. It is often dirty when received and should be cleaned before use. This part is cleaned by removing it from the pump, manually cleaning with deionized water, and placing in a vacuum oven at 100°C for at least 12 hours. Exposed parts of the pump head are also cleaned with swabs and allowed to air dry. These pumps have

proven to be very reliable; however, they are only useful up to an outlet pressure of about 137 kPa (20 psig). Neuberger Pump: Viton gaskets or seals must be specified with this pump. The "factory direct" pump is received contaminated and leaky. The pump is cleaned by disassembling the pump head (which consists of three stainless steel parts and two gaskets), cleaning the gaskets with deionized water and drying in a vacuum oven, and remachining (or manually lapping) the sealing surfaces of the stainless steel parts. The stainless steel parts are then cleaned with methanol, hexane, deionized water and heated in a vacuum oven. The cause for most of the problems with this pump has been scratches on the metal parts of the pump head. Once this rework procedure is performed, the pump is considered clean and can be used up to about 240 kPa (35 psig) output pressure. This pump is utilized in the sampling system illustrated in Figure 3.

12.3.1.2 Urban Air Toxics Sampler

The sampling system described in this method can be modified like the sampler in EPA's FY-88 Urban Air Toxics Pollutant Program. This particular sampler is described in Appendix C (see Figure 19).

12.3.2 Analysis

12.3.2.1 Inlet tubing from the calibration manifold could be heated to 50°C (same temperature as the calibration manifold) to prevent condensation on the internal walls of the system.

12.3.2.2 The analytical strategy for Method TO-14 involves positive identification and quantitation by GC-MS-SCAN-SIM mode of operation with optional FID. This is a highly specific and sensitive detection technique. Because a specific detector system (GC-MS-SCAN-SIM) is more complicated and expensive than the use of non-specific detectors

(GC-FID-ECD-PID), the analyst may want to perform a screening analysis and preliminary quantitation of VOC species in the sample, including any polar compounds, by utilizing the GC-multidetector (GC-FID-ECD-PID) analytical system prior to GC-MS analysis. This system can be used for approximate quantitation. The GC-FID-ECD-PID provides a "snapshot" of the constituents in the sample, allowing the analyst to determine:

- Extent of misidentification due to overlapping peaks,
- Whether the constituents are within the calibration range of the anticipated GC-MS-SCAN-SIM analysis or does the sample require further dilution, and
- Are there unexpected peaks which need further identification through GC-MS-SCAN or are there peaks of interest needing attention?

If unusual peaks are observed from the GC-FID-ECD-PID system, the analyst then performs a GC-MS-SCAN analysis. The GC-MS-SCAN will provide positive identification of suspect peaks from the GC-FID-ECD-PID system. If no unusual peaks are identified and only a select number of VOCs are of concern, the analyst can then proceed to GC-MS-SIM. The GC-MS-SIM is used for final quantitation of selected VOCs. Polar compounds, however, cannot be identified by the GC-MS-SIM due to the use of a Nafion® dryer to remove water from the sample prior to analysis. The dryer removes polar compounds along with the water. The analyst often has to make this decision incorporating project objectives, detection limits, equipment availability, cost and personnel capability in developing an analytical strategy. Figure 20 outlines the use of the GC-FID-ECD-PID as a "screening" approach, with the GC-MS-SCAN-SIM for final identification and quantitation.

12.4 Method Safety

This procedure may involve hazardous materials, operations, and equipment. This method does not purport to address all of the safety problems associated with its use. It is the user's responsibility to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to the implementation of this procedure. This should be part of the user's SOP manual.

12.5 Quality Assurance (See Figure 21)

12.5.1 Sampling System

12.5.1.1 Section 9.2 suggests that a portable GC system be used as a "screening analysis" prior to locating fixed-site samplers (pressurized or subatmospheric).

12.5.1.2 Section 9.2 requires pre and post-sampling measurements with a certified mass flow controller for flow verification of sampling system.

12.5.1.3 Section 11.1 requires all canisters to be pressure tested to 207 kPa ± 14 kPa (30 psig ± 2 psig) over a period of 24 hours.

12.5.1.4 Section 11.1 requires that all canisters be certified clean (containing less than 0.2 ppbv of targeted VOCs) through a humid zero air certification program.

12.5.1.5 Section 11.2.2 requires all field sampling systems to be certified initially clean (containing less than 0.2 ppbv of targeted VOCs) through a humid zero air certification program.

12.5.1.6 Section 11.2.3 requires all field sampling systems to pass an initial humidified calibration gas certification [at VOC concentration levels expected in the field (e.g., 0.5 to 2 ppbv)] with a percent recovery of greater than 90.

12.5.2 GC-MS-SCAN-SIM System Performance Criteria

12.5.2.1 Section 10.2.1 requires the GC-MS analytical system to be certified clean (less than 0.2

ppbv of targeted VOCs) prior to sample analysis, through a humid zero air certification.

12.5.2.2 Section 10.2.2 requires the daily tuning of the GC-MS with 4-bromofluorobenzene (4-BFB) and that it meet the key ions and ion abundance critera (10%) outlined in Table 5.

12.5.2.3 Section 10.2.3 requires both an initial multipoint humid static calibration (three levels plus humid zero air) and a daily calibration (one point) of the GC-MS analytical system.

12.5.3 GC-Multidetector System Performance Criteria

12.5.3.1 Section 10.3.1 requires the GC-FID-ECD analytical system, prior to analysis, to be certified clean (less than 0.2 ppbv of targeted VOCs) through a humid zero air certification.

12.5.3.2 Section 10.3.2 requires that the GC-FID-ECD analytical system establish retention time windows for each analyte prior to sample analysis, when a new GC column is installed, or major components of the GC system altered since the previous determination.

12.5.3.3 Section 8.2 requires that all calibration gases be traceable to a National Bureau of Standards (NBS) Standard Reference Material (SRM) or to a NBS/EPA approved Certified Reference Material (CRM).

12.5.3.4 Section 10.3.2 requires that the retention time window be established throughout the course of a 72-hr analytical period.

12.5.3.5 Section 10.3.3 requires both an initial multipoint calibration (three levels plus humid zero air) and a daily calibration (one point) of the GC-FID-ECD analytical system with zero gas dilution of NBS traceable or NBS/EPA CRMs gases. [Note: Gas cylinders of VOCs at the ppm and ppb level are available for audits from the USEPA, Environmental Monitoring Systems

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The determination of volatile and some semi-volatile organic compounds in ambient air is a complex task, primarily because of the wide variety of compounds of interest and the lack of standardized sampling and analytical procedures. While there are numerous procedures for sampling and analyzing VOCs/SVOCs in ambient air, this method draws upon the best aspects of each one and combines them into a standardized methodology. To that end, the following individuals contributed to the research, documentation and peer review of this manuscript.

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TABLE 1. VOLATILE ORGANIC COMPOUND DATA SHEET

COMPOUND (SYNONYM)	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°C)	MELTING POINT (°C)	CAS NUMBER
Freon 12 (Dichlorodifluoromethane)	Cl_2CF_2	120.91	-29.8	-158.0	
Methyl chloride (Chloromethane)	CH_3Cl	50.49	-24.2	-97.1	74-87-3
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	$ClCF_2CClF_2$	170.93	4.1	-94.0	
Vinyl chloride (Chloroethylene)	$CH_2{=}CHCl$	62.50	-13.4	-1538.0	75-01-4
Methyl bromide (Bromomethane)	CH_3Br	94.94	3.6	-93.6	74-83-9
Ethyl chloride (Chloroethane)	CH_3CH_2Cl	64.52	12.3	-136.4	75-00-3
Freon 11 (Trichlorofluoromethane)	CCl_3F	137.38	23.7	-111.0	
Vinylidene chloride (1,1-Dichloroethene)	$C_2H_2Cl_2$	96.95	31.7	-122.5	75-35-4
Dichloromethane (Methylene chloride)	CH_2Cl_2	84.94	39.8	-95.1	75-09-2
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	CF_2ClCCl_2F	187.38	47.7	-36.4	
1,1-Dichloroethane (Ethylidene chloride)	CH_3CHCl_2	98.96	57.3	-97.0	74-34-3
cis-1,2-Dichloroethylene	$CHCl{=}CHCl$	96.94	60.3	-80.5	
Chloroform (Trichloromethane)	$CHCl_3$	119.38	61.7	-63.5	67-66-3
1,2-Dichloroethane (Ethylene dichloride)	$ClCH_2CH_2Cl$	98.96	83.5	-35.3	107-06-2
Methyl chloroform (1,1,1-Trichloroethane)	CH_3CCl_3	133.41	74.1	-30.4	71-55-6
Benzene (Cyclohexatriene)	C_6H_6	78.12	80.1	5.5	71-43-2
Carbon tetrachloride (Tetrachloromethane)	CCl_4	153.82	76.5	-23.0	56-23-5
1,2-Dichloropropane (Propylene dichloride)	$CH_3CHClCH_2Cl$	112.99	96.4	-100.4	78-87-5
Trichloroethylene (Trichloroethene)	$ClCH{=}CCl_2$	131.29	87	-73.0	79-01-6
cis-1,3-Dichloropropene (cis-1,3-dichloropropylene)	$CH_3CCl{=}CHCl$	110.97	76		

TABLE 1. VOLATILE ORGANIC COMPOUND DATA SHEET (cont.)

COMPOUND (SYNONYM)	FORMULA	MOLECULAR WEIGHT	BOILING POINT (°C)	MELTING POINT (°C)	CAS NUMBER
trans-1,3-Dichloropropene (cis-1,3-Dichloropropylene)	$ClCH_2CH{=}CHCl$	110.97	112.0		
1,1,2-Trichloroethane (Vinyl trichloride)	$CH_2ClCHCl_2$	133.41	113.8	-36.5	79-00-5
Toluene (Methyl benzene)	$C_6H_5CH_3$	92.15	110.6	-95.0	108-88-3
1,2-Dibromoethane (Ethylene dibromide)	$BrCH_2CH_2Br$	187.88	131.3	9.8	106-93-4
Tetrachloroethylene (Perchloroethylene)	$Cl_2C{=}CCl_2$	165.83	121.1	-19.0	127-18-4
Chlorobenzene (Phenyl chloride)	C_6H_5Cl	112.56	132.0	-45.6	108-90-7
Ethylbenzene	$C_6H_5C_2H_5$	106.17	136.2	-95.0	100-41-4
m-Xylene (1,3-Dimethylbenzene)	$1,3\text{-}(CH_3)_2C_6H_4$	106.17	139.1	-47.9	
p-Xylene (1,4-Dimethylxylene)	$1,4\text{-}(CH_3)_2C_6H_4$	106.17	138.3	13.3	
Styrene (Vinyl benzene)	$C_6H_5CH{=}CH_2$	104.16	145.2	-30.6	100-42-5
1,1,2,2-Tetrachloroethane	$CHCl_2CHCl_2$	167.85	146.2	-36.0	79-34-5
o-Xylene (1,2-Dimethylbenzene)	$1,2\text{-}(CH_3)_2C_6H_4$	106.17	144.4	-25.2	
1,3,5-Trimethylbenzene (Mesitylene)	$1,3,5\text{-}(CH_3)_3C_6H_6$	120.20	164.7	-44.7	108-67-8
1,2,4-Trimethylbenzene (Pseudocumene)	$1,2,4\text{-}(CH_3)_3C_6H_6$	120.20	169.3	-43.8	95-63-6
m-Dichlorobenzene (1,3-Dichlorobenzene)	$1,3\text{-}Cl_2C_6H_4$	147.01	173.0	-24.7	541-73-1
Benzyl chloride (α-Chlorotoluene)	$C_6H_5CH_2Cl$	126.59	179.3	-39.0	100-44-7
o-Dichlorobenzene (1,2-Dichlorobenzene)	$1,2\text{-}Cl_2C_6H_4$	147.01	180.5	-17.0	95-50-1
p-Dichlorobenzene (1,4-Dichlorobenzene)	$1,4\text{-}Cl_2C_6H_4$	147.01	174.0	53.1	106-46-7
1,2,4-Trichlorobenzene	$1,2,4\text{-}Cl_3C_6H_3$	181.45	213.5	17.0	120-82-1
Hexachlorobutadiene (1,1,2,3,4,4-Hexachloro-1,3-butadiene)					

TABLE 2. ION/ABUNDANCE AND EXPECTED RETENTION TIME FOR SELECTED VOCs ANALYZED BY GC-MS-SIM

Compound	Ion/Abundance (amu/% base peak)	Expected Retention Time (min)
Freon 12 (Dichlorodifluoromethane)	85/100 87/ 31	5.01
Methyl chloride (Chloromethane)	50/100 52/ 34	5.69
Freon 114 (1,2-Dichloro-1,1,2,2-tetrafluoroethane)	85/100 135/ 56 87/ 33	6.55
Vinyl chloride (Chloroethene)	62/100 27/125 64/ 32	6.71
Methyl bromide (Bromomethane)	94/100 96/ 85	7.83
Ethyl chloride (Chloroethane)	64/100 29/140 27/140	8.43
Freon 11 (Trichlorofluoromethane)	101/100 103/ 67	9.97
Vinylidene chloride (1,1-Dichloroethylene)	61/100 96/ 55 63/ 31	10.93
Dichloromethane (Methylene chloride)	49/100 84/ 65 86/ 45	11.21
Freon 113 (1,1,2-Trichloro-1,2,2-trifluoroethane)	151/100 101/140 103/ 90	11.60
1,1-Dichloroethane (Ethylidene dichloride)	63/100 27/ 64 65/ 33	12.50
cis-1,2-Dichloroethylene	61/100 96/ 60 98/ 44	13.40
Chloroform (Trichloromethane)	83/100 85/ 65 47/ 35	13.75
1,2-Dichloroethane (Ethylene dichloride)	62/100 27/ 70 64/ 31	14.39
Methyl chloroform (1,1,1-Trichloroethane)	97/100 99/ 64 61/ 61	14.62
Benzene (Cyclohexatriene)	78/100 77/ 25 50/ 35	15.04
Carbon tetrachloride (Tetrachloromethane)	117/100 119/ 97	15.18

(continued)

TABLE 2. ION/ABUNDANCE AND EXPECTED RETENTION TIME FOR SELECTED VOCs ANALYZED BY GC-MS-SIM (cont.)

Compound	Ion/Abundance (amu/% base peak)	Estimated Retention Time (min)
1,2-Dichloropropane (Propylene dichloride)	63/100 41/ 90 62/ 70	15.83
Trichloroethylene (Trichloroethene)	130/100 132/ 92 95/ 87	16.10
cis-1,3-Dichloropropene	75/100 39/ 70 77/ 30	16.96
trans-1,3-Dichloropropene (1,3 dichloro-1-propene)	75/100 39/ 70 77/ 30	17.49
1,1,2-Trichloroethane (Vinyl trichloride)	97/100 83/ 90 61/ 82	17.61
Toluene (Methyl benzene)	91/100 92/ 57	17.86
1,2-Dibromoethane (Ethylene dibromide)	107/100 109/ 96 27/115	18.48
Tetrachloroethylene (Perchloroethylene)	166/100 164/ 74 131/ 60	19.01
Chlorobenzene (Benzene chloride)	112/100 77/ 62 114/ 32	19.73
Ethylbenzene	91/100 106/ 28	20.20
m,p-Xylene(1,3/1,4-dimethylbenzene)	91/100 106/ 40	20.41
Styrene (Vinyl benzene)	104/100 78/ 60 103/ 49	20.81
1,1,2,2-Tetrachloroethane (Tetrachloroethane)	83/100 85/ 64	20.92
o-Xylene (1,2-Dimethylbenzene)	91/100 106/ 40	20.92
4-Ethyltoluene	105/100 120/ 29	22.53
1,3,5-Trimethylbenzene (Mesitylene)	105/100 120/ 42	22.65
1,2,4-Trimethylbenzene (Pseudocumene)	105/100 120/ 42	23.18
m-Dichlorobenzene (1,3-Dichlorobenzene)	146/100 148/ 65 111/ 40	23.31

(continued)

TABLE 2. ION/ABUNDANCE AND EXPECTED RETENTION TIME FOR SELECTED VOCs ANALYZED BY GC-MS-SIM (cont.)

Compound	Ion/Abundance (amu/% base peak)	Expected Retention Time (min)
Benzyl chloride (α-Chlorotoluene)	91/100 126/ 26	23.32
p-Dichlorobenzene (1,4-Dichlorobenzene)	146/100 148/ 65 111/ 40	23.41
o-Dichlorobenzene (1,2-Dichlorobenzene)	146/100 148/ 65 111/ 40	23.88
1,2,4-Trichlorobenzene	180/100 182/ 98 184/ 30	26.71
Hexachlorobutadiene (1,1,2,3,4,4 Hexachloro-1,3-butadiene)	225/100 227/ 66 223/ 60	27.68

TABLE 3. GENERAL GC AND MS OPERATING CONDITIONS

Chromatography	
Column	Hewlett-Packard OV-1 crosslinked methyl silicone (50 m x 0.31-mm I.D., 17 um film thickness), or equivalent
Carrier Gas	Helium (2.0 cm^3/min at 250°C)
Injection Volume	Constant (1-3 uL)
Injection Mode	Splitless
Temperature Program	
Initial Column Temperature	-50°C
Initial Hold Time	2 min
Program	8°C/min to 150°C
Final Hold Time	15 min
Mass Spectrometer	
Mass Range	18 to 250 amu
Scan Time	1 sec/scan
EI Condition	70 eV
Mass Scan	Follow manufacturer's instruction for selecting mass selective detector (MS) and selected ion monitoring (SIM) mode
Detector Mode	Multiple ion detection
FID System (Optional)	
Hydrogen Flow	30 cm^3/minute
Carrier Flow	30 cm^3/minute
Burner Air	400 cm^3/minute

TABLE 4. 4-BROMOFLUOROBENZENE KEY IONS AND ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	Base Peak, 100% Relative Abundance
96	5 to 9% of mass 95
173	<2% of mass 174
174	>50% of mass 95
175	5 to 9% of mass 174
176	>95% but< 101% of mass 174
177	5 to 9% of mass 176

TABLE 5. RESPONSE FACTORS (ppbv/area count) AND EXPECTED RETENTION TIME FOR GC-MS-SIM ANALYTICAL CONFIGURATION

Compounds	Response Factor (ppbv/area count)	Expected Retention Time (minutes)
Freon 12	0.6705	5.01
Methyl chloride	4.093	5.64
Freon 114	0.4928	6.55
Vinyl chloride	2.343	6.71
Methyl bromide	2.647	7.83
Ethyl chloride	2.954	8.43
Freon 11	0.5145	9.87
Vinylidene chloride	1.037	10.93
Dichloromethane	2.255	11.21
Trichlorotrifluoroethane	0.9031	11.60
1,1-Dichloroethane	1.273	12.50
cis-1,2-Dichloroethylene	1.363	13.40
Chloroform	0.7911	13.75
1,2-Dichloroethane	1.017	14.39
Methyl chloroform	0.7078	14.62
Benzene	1.236	15.04
Carbon tetrachloride	0.5880	15.18
1,2-Dichloropropane	2.400	15.83
Trichloroethylene	1.383	16.10
cis-1,3-Dichloropropene	1.877	16.96
trans-1,3-Dichloropropene	1.338	17.49
1,1,2-Trichloroethane	1.891	17.61
Toluene	0.9406	17.86
1,2-Dibromoethane (EDB)	0.8662	18.48
Tetrachloroethylene	0.7357	19.01
Chlorobenzene	0.8558	19.73
Ethylbenzene	0.6243	20.20
m,p-Xylene	0.7367	20.41
Styrene	1.888	20.80
1,1,2,2-Tetrachloroethane	1.035	20.92
o-Xylene	0.7498	20.92
4-Ethyltoluene	0.6181	22.53
1,3,5-Trimethylbenzene	0.7088	22.65
1,2,4-Trimethylbenzene	0.7536	23.18
m-Dichlorobenzene	0.9643	23.31
Benzyl chloride	1.420	23.32
p-Dichlorobenzene	0.8912	23.41
o-Dichlorobenzene	1.004	23.88
1,2,4-Trichlorobenzene	2.150	26.71
Hexachlorobutadiene	0.4117	27.68

TABLE 6. GC-MS-SIM CALIBRATION TABLE

*** External Standard ***

Operator: JDP 8 Jan 87 10:02 am
Sample Info : SYR 1
Misc Info:
Integration File Name : DATA:SYR2A02A.I
Sequence Index: 1 Bottle Number : 2

Last Update: 8 Jan 87 8:12 am
Reference Peak Window: 5.00 Absolute Minutes
Non-Reference Peak Window: 0.40 Absolute Minutes
Sample Amount: 0.000 Uncalibrated Peak RF: 0.000 Multiplier: 1.667

Peak Num	Type	Int Type	Ret Time	Signal Description			Compound Name	Area	Amount	
1		1	PP	5.020	Mass	85.00	amu	FREON 12	12895	4011 pptv	
2		1	PP	5.654	Mass	50.00	amu	METHYLCHLORI	4445	2586 pptv	
3		1	BP	6.525	Mass	85.00	amu	FREON 114	7067	1215 pptv	
4		1	PB	6.650	Mass	62.00	amu	VINYLCHLORID	2892	1929 pptv	*
5		1	BP	7.818	Mass	94.00	amu	METHYLBROMID	2401	1729 pptv	
6		1	BB	8.421	Mass	64.00	amu	ETHYLCHLORID	2154	2768 pptv	*
7		1	BV	9.940	Mass	101.00	amu	FREON 11	25065	6460 pptv	
8		1	BP	10.269	Mass	61.00	amu	VINDENECHLOR	5034	1700 pptv	
9		1	BP	11.187	Mass	49.00	amu	DICHLOROMETH	4802	2248 pptv	
10		1	PP	11.225	Mass	41.00	amu	ALLYLCHLORID	761	8247 pptv	*
11		1	BP	11.578	Mass	151.00	amu	3CHL3FLUETHA	5477	1672 pptv	
12		1	BP	12.492	Mass	63.00	amu	1,1DICHLOETH	5022	1738 pptv	*
13		1	VP	13.394	Mass	61.00	amu	c-1,2DICHLET	4761	1970 pptv	
14		1	PH	13.713	Mass	83.00	amu	CHLOROFORM	5327	1678 pptv	
15		1	BP	14.378	Mass	62.00	amu	1,2DICHLETHA	5009	2263 pptv	
16		1	PB	14.594	Mass	97.00	amu	METHCHLOROFO	6656	2234 pptv	
17		1	VP	15.009	Mass	78.00	amu	BENZENE	8322	2167 pptv	
18		1	VP	15.154	Mass	117.00	amu	CARBONTETRAC	5888	1915 pptv	
19		1	BB	15.821	Mass	63.00	amu	1,2DICHLPROP	3263	1798 pptv	*
20		1	BB	16.067	Mass	130.00	amu	TRICHLETHENE	4386	2109 pptv	
21		1	PB	16.941	Mass	75.00	amu	c-1,3DICHLPR	2225	987.3 pptv	
22		1	BP	17.472	Mass	75.00	amu	t-1,3DICHLPR	1626	689.2 pptv	
23		1	BB	17.594	Mass	97.00	amu	1,1,2CHLETHA	2721	1772 pptv	
24		1	BV	17.844	Mass	91.00	amu	TOLUENE	14417	2722 pptv	
25		1	PB	18.463	Mass	107.00	amu	EDB	4070	1363 pptv	*
26		1	PH	18.989	Mass	166.00	amu	TETRACHLETHE	6674	2063 pptv	
27		1	PB	19.705	Mass	112.00	amu	CHLOROBENZEN	5648	1524 pptv	
28		1	BP	20.168	Mass	91.00	amu	ETHYLBENZENE	11084	1842 pptv	
29		1	PB	20.372	Mass	91.00	amu	m,p-XYLENE	17989	3790 pptv	
30		1	BV	20.778	Mass	104.00	amu	STYRENE	3145	1695 pptv	
31		1	BH	20.887	Mass	83.00	amu	TETRACHLETHA	4531	1376 pptv	
32		1	BP	20.892	Mass	91.00	amu	o-XYLENE	9798	2010 pptv	
33		1	VV	22.488	Mass	105.00	amu	4-ETHYLTOLUE	7694	1481 pptv	
34		1	VB	22.609	Mass	105.00	amu	1,3,5METHBEN	6781	1705 pptv	
35		1	BB	22.144	Mass	105.00	amu	1,2,4METHBEN	7892	2095 pptv	
36		1	BV	22.273	Mass	146.00	amu	m-DICHLBENZE	3046	1119 pptv	
37		1	VV	22.279	Mass	91.00	amu	BENZYLCHLORI	3880	1006 pptv	
38		1	VB	22.378	Mass	146.00	amu	p-DICHLBENZE	6090	2164 pptv	
39		1	BP	23.850	Mass	146.00	amu	o-DICHLBENZE	2896	1249 pptv	
40		1	BB	26.673	Mass	180.00	amu	1,2,4CHLBENZ	562	767.1 pptv	
41		1	BB	27.627	Mass	225.00	amu	HEXACHLBUTAD	6309	1789 pptv	

TABLE 7. TYPICAL RETENTION TIME (MIN) AND CALIBRATION RESPONSE FACTORS (ppbv/area count) FOR TARGETED VOCs ASSOCIATED WITH FID AND ECD ANALYTICAL SYSTEM

Peak Number[1]	Compound	Retention Time (RT), minutes	FID Response Factor (RF) (ppbv/area count)	ECD Response Factor (ppbv/area count x 10^{-5})
1	Freon 12	3.65	3.465	13.89
2	Methyl chloride	4.30	0.693	
3	Freon 114	5.13	0.578	22.32
4	Vinyl chloride	5.28	0.406	
5	Methyl bromide	6.44		26.34
6	Ethyl chloride	7.06	0.413	
7	Freon 11	8.60	6.367	1.367
8	Vinylidene chloride	9.51	0.347	
9	Dichloromethane	9.84	0.903	
10	Trichlorotrifluoroethane	10.22	0.374	3.955
11	1,1-Dichloroethane	11.10	0.359	
12	cis-1,2-Dichloroethylene	11.99	0.368	
13	Chloroform	12.30	1.059	11.14
14	1,2-Dichloroethane	12.92	0.409	
15	Methyl chloroform	13.12	0.325	3.258
16	Benzene	13.51	0.117	
17	Carbon tetrachloride	13.64	1.451	1.077
18	1,2-Dichloropropane	14.26	0.214	
19	Trichloroethylene	14.50	0.327	8.910
20	cis-1,3-Dichloropropene	15.31		
21	trans-1,3-Dichloropropene	15.83		
22	1,1,2-Trichloroethane	15.93	0.336	
23	Toluene	16.17	0.092	
24	1,2-Dibromoethane (EDB)	16.78	0.366	5.137
25	Tetrachloroethylene	17.31	0.324	1.449
26	Chlorobenzene	18.03	0.120	
27	Ethylbenzene	18.51	0.092	
28	m,p-Xylene	18.72	0.095	
29	Styrene	19.12	0.143	
30	1,1,2,2-Tetrachloroethane	19.20		9.856
31	o-Xylene	19.23		
32	4-Ethyltoluene	20.82	0.100	
33	1,3,5-Trimethylbenzene	20.94	0.109	
34	1,2,4-Trimethylbenzene	21.46	0.111	
35	m-Dichlorobenzene	21.50		
36	Benzyl chloride	21.56		
37	p-Dichlorobenzene	21.67	0.188	
38	o-Dichlorobenzene	22.12	0.188	
39	1,2,4-Trichlorobenzene	24.88	0.667	
40	Hexachlorobutadiene	25.82	0.305	1.055

[1] Refer to Figures 15 and 16 for peak location

TABLE 8. TYPICAL RETENTION TIME (minutes) FOR SELECTED ORGANICS USING GC-FID-ECD-PID* ANALYTICAL SYSTEM

Compound	Retention Time (minutes)		
	FID	ECD	PID
Acetylene	2.984	--	--
1,3-Butadiene	3.599	--	3.594
Vinyl chloride	3.790	--	3.781
Chloromethane	5.137	--	--
Chloroethane	5.738	--	--
Bromoethane	8.154	--	--
Methylene Chloride	9.232	--	9.218
trans-1,2-Dichloroethylene	10.077	--	10.065
1,1-Dichloroethane	11.190	--	--
Chloroprene	11.502	--	11.491
Perfluorobenzene	13.077	13.078	13.069
Bromochloromethane	13.397	13.396	13.403
Chloroform	13.768	13.767	13.771
1,1,1-Trichloroethane	14.151	14.153	14.158
Carbon Tetrachloride	14.642	14.667	14.686
Benzene/1,2-Dichloroethane	15.128	--	15.114
Perfluorotoluene	15.420	15.425	15.412
Trichloroethylene	17.022	17.024	17.014
1,2-Dichloropropene	17.491	17.805	17.522
Bromodichloromethane	18.369	--	--
trans-1,3-Dichloropropylene	19.694	19.693	19.688
Toluene	20.658	--	20.653
cis-1,3-Dichloroprupylene	21.461	21.357	21.357
1,1,2-Trichloroethane	21.823	--	--
Tetrachloroethylene	22.340	22.346	22.335
Dibromochloromethane	22.955	22.959	22.952
Chlorobenzene	24.866	--	24.861
m/p-Xylene	25.763	--	25.757
Styrene/o-Xylene	27.036	--	27.030
Bromofluorobenzene	28.665	28.663	28.660
1,1,2,2-Tetrachloroethane	29.225	29.227	29.228
m-Dichlorobenzene	32.347	32.345	32.342
p-Dichlorobenzene	32.671	32.669	32.666
o-Dichlorobenzene	33.885	33.883	33.880

* Varian® 3700 GC equipped with J & W Megabore® DB 624 Capillary Column (30 m X 0.53 I.D. mm) using helium carrier gas.

TABLE 9. GC-MS-SIM CALIBRATION TABLE

Last Update: 18 Dec 86 7:54 am
Reference Peak Window: 5.00 Absolute Minutes
Non-Reference Peak Window: 0.40 Absolute Minutes
Sample Amount: 0.000 Uncalibrated Peak RF: 0.000 Multiplier: 1.000

Ret Time	Pks	Signal	Descr	Amt pptv	Lvl	[Area]	Pk-Type	Partial Name
5.008	1	Mass	85.00 amu	13620	1	72974	1	FREON 12
5.690	2	Mass	50.00 amu	12720	1	36447	1	METHYLCHLORID
6.552	3	Mass	85.00 amu	8380	1	81251	1	FREON 114
6.709	4	Mass	62.00 amu	8050	1	20118	1	VINYLCHLORIDE
7.851	5	Mass	94.00 amu	12210	1	28265	1	METHYLBROMIDE
8.431	6	Mass	64.00 amu	12574	1	16149	1	ETHYLCHLORIDE
9.970	7	Mass	101.00 amu	12580	1	80088	1	FREON 11
10.927	8	Mass	61.00 amu	7890	1	38954	1	VINDENECHLOR:
11.209	9	Mass	49.00 amu	12760	1	43507	1	DICHLOROMETHA
11.331	10	Mass	41.00 amu	12650	1	1945	1	ALLYLCHLORIDE
11.595	11	Mass	151.00 amu	7420	1	40530	1	3CHL3FLUETHAN
12.502	12	Mass	63.00 amu	12710	1	61595	1	1,1DICHLOETH
13.403	13	Mass	61.00 amu	12650	1	50900	1	c-1,2DICHLETH
13.747	14	Mass	83.00 amu	7670	1	40585	1	CHLOROFORM
14.387	15	Mass	62.00 amu	9040	1	33356	1	1,2DICHLETHAN
14.623	16	Mass	97.00 amu	8100	1	38503	1	METHCHLOROFOR
15.038	17	Mass	78.00 amu	10760	1	69119	1	BENZENE
15.183	18	Mass	117.00 amu	8340	1	42757	1	CARBONTETRACH
15.829	19	Mass	63.00 amu	12780	1	32875	1	1,2DICHLPROPA
16.096	20	Mass	130.00 amu	8750	1	30331	1	TRICHLETHENE
16.956	21	Mass	75.00 amu	4540	1	17078	1	c-1,3DICHLPRO
17.492	22	Mass	75.00 amu	3380	1	13294	1	t-1,3DICHLPRO
17.610	23	Mass	97.00 amu	12690	1	32480	1	1,1,2CHLETHAN
17.862	24	Mass	91.00 amu	10010	1	88036	1	TOLUENE
18.485	25	Mass	107.00 amu	6710	1	33330	1	EDB
19.012	26	Mass	166.00 amu	7830	1	43454	1	TETRACHLETHEN
19.729	27	Mass	112.00 amu	7160	1	44224	1	CHLOROBENZENE
20.195	28	Mass	91.00 amu	12740	1	127767	1	ETHYLBENZENE
20.407	29	Mass	91.00 amu	22400	1	200973	1	m,p-XYLENE
20.806	30	Mass	104.00 amu	12390	1	38332	1	STYRENE
20.916	31	Mass	83.00 amu	11690	1	64162	1	TETRACHLETHAN
20.921	32	Mass	91.00 amu	11085	1	90096	1	o-XYLENE
22.528	33	Mass	105.00 amu	12560	1	108747	1	4-ETHYLTOLUEN
22.648	34	Mass	105.00 amu	12620	1	83666	1	1,3,5METHBENZ
23.179	35	Mass	105.00 amu	12710	1	79833	1	1,2,4METHBENZ
23.307	36	Mass	146.00 amu	12650	1	57409	1	m-DICHLBENZEN
23.317	37	Mass	91.00 amu	7900	1	50774	1	BENZYLCHLORID
23.413	38	Mass	146.00 amu	12390	1	58127	1	p-DICHLBENZEN
23.885	39	Mass	146.00 amu	13510	1	52233	1	o-DICHLBENZEN
26.714	40	Mass	180.00 amu	15520	1	18967	1	1,2,4CHLBENZE
27.680	41	Mass	225.00 amu	7470	1	43920	1	HEXACHLBUTADI

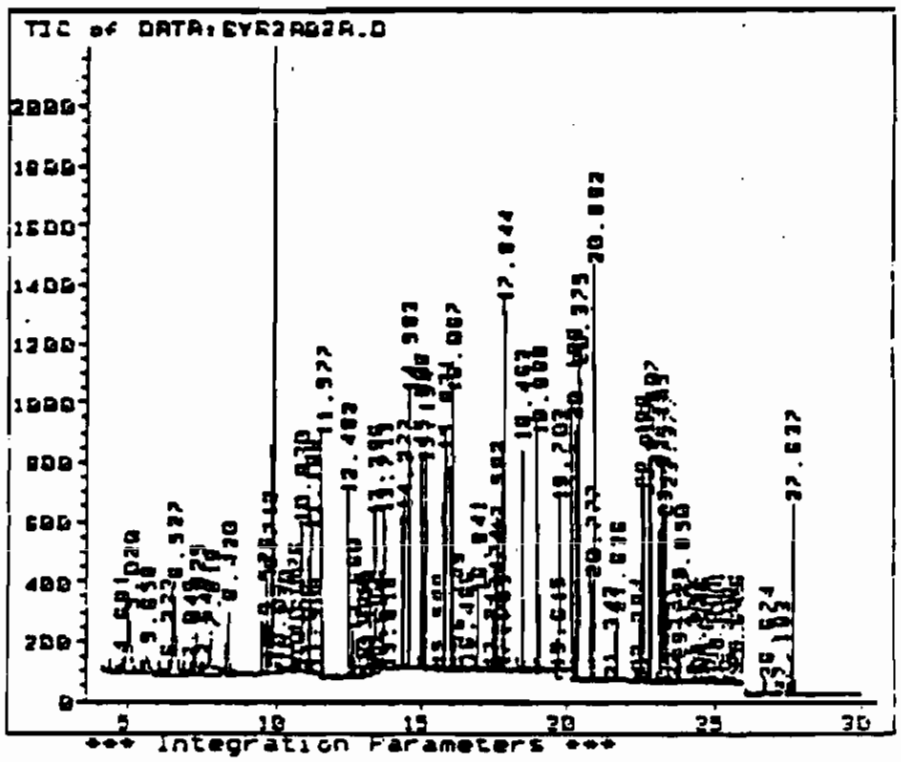
TABLE 10. EXAMPLE OF HARD-COPY OF GC-MS-SIM ANALYSIS

Data file: DATA:SYR2A02A.D
File type: GC / MS DATA FILE

Name Info: SYR 1
Misc Info:
Operator : JDP

Date : 8 Jan 87 10:02 am
Instrument: MS_5970
Inlet : GC

Sequence index : 1
Als bottle num : 2
Replicate num. : 1



*** Integration Parameters ***

FALSE : Shoulder Detection Enabled
0.020 : Expected Peak Width (Min)
11 : Initial Peak Detection Threshold

4.000	THRESHOLD	5.000
4.000	PEAK_WIDTH	0.200
9.800	PEAK_WIDTH	0.060

TABLE 10. EXAMPLE OF HARD-COPY OF GC-MS-SIM ANALYSIS (cont.)

Operator: JDP 9 Jan 87 10:02 am
Sample Info : SYR 1
Misc Info:
Integration File Name : DATA:SYR2A02A.1
Sequence Index: 1 Bottle Number : 2

Last Update: 9 Jan 87 8:13 am
Reference Peak Window: 5.00 Absolute Minutes
Non-Reference Peak Window: 0.40 Absolute Minutes
Sample Amount: 0.000 Uncalibrated Peak RF: 0.000. Multiplier: 1.667

Peak Num	Peak Type	Int Type	Ret Time	Signal Description			Compound Name	Area	Amount	
1		1	PP	5.020	Mass	85.00	amu	FREON 12	12893	4011 pptv	
2		1	PP	5.654	Mass	50.00	amu	METHYLCHLORI	4445	2586 pptv	
3		1	BP	6.525	Mass	85.00	amu	FREON 114	7067	1215 pptv	
4		1	PB	6.650	Mass	62.00	amu	VINYLCHLORID	2392	1929 pptv	*
5		1	BP	7.818	Mass	94.00	amu	METHYLBROMID	2401	1729 pptv	
6		1	BB	8.421	Mass	64.00	amu	ETHYLCHLORID	2134	2769 pptv	*
7		1	BV	9.940	Mass	101.00	amu	FREON 11	25069	6460 pptv	
8		1	BP	10.869	Mass	61.00	amu	VINDENECHLOR	5034	1700 pptv	
9		1	BP	11.187	Mass	49.00	amu	DICHLOROMETH	4802	2348 pptv	
10		1	PP	11.225	Mass	41.00	amu	ALLYLCHLORID	761	8247 pptv	*
11		1	BP	11.578	Mass	151.00	amu	3CHL3FLUETHA	5477	1672 pptv	
12		1	BP	12.492	Mass	63.00	amu	1,1DICHLOETH	5022	1738 pptv	*
13		1	VP	13.394	Mass	61.00	amu	c-1,2DICHLET	4761	1970 pptv	
14		1	PM	13.713	Mass	83.00	amu	CHLOROFORM	5527	1678 pptv	
15		1	BP	14.378	Mass	62.00	amu	1,2DICHLETHA	5009	2262 pptv	
16		1	PB	14.594	Mass	97.00	amu	METHCHLOROFO	6456	2234 pptv	
17		1	VP	15.009	Mass	78.00	amu	BENZENE	8552	2167 pptv	
18		1	VP	15.154	Mass	117.00	amu	CARBONTETRAC	5888	1915 pptv	
19		1	BB	15.821	Mass	63.00	amu	1,2DICHLPROP	2265	1799 pptv	*
20		1	BB	16.067	Mass	130.00	amu	TRICHLETHENE	4386	2109 pptv	
21		1	PB	16.941	Mass	75.00	amu	c-1,3DICHLPR	2228	967.3 pptv	
22		1	BP	17.475	Mass	75.00	amu	t-1,3DICHLPR	1626	689.2 pptv	
23		1	BB	17.594	Mass	97.00	amu	1,1,2CHLETHA	2721	1772 pptv	
24		1	BV	17.844	Mass	91.00	amu	TOLUENE	14417	2723 pptv	
25		1	PB	18.463	Mass	107.00	amu	EDB	4070	1365 pptv	*
26		1	PM	18.989	Mass	166.00	amu	TETRACHLETHE	6874	2065 pptv	
27		1	PB	19.705	Mass	112.00	amu	CHLOROBENZEN	5648	1524 pptv	
28		1	BP	20.168	Mass	91.00	amu	ETHYLBENZENE	11084	1842 pptv	
29		1	PB	20.372	Mass	91.00	amu	m,p-XYLENE	17989	3790 pptv	
30		1	BV	20.778	Mass	104.00	amu	STYRENE	3145	1695 pptv	
31		1	PM	20.887	Mass	83.00	amu	TETRACHLETHA	4551	1376 pptv	
32		1	BP	20.892	Mass	91.00	amu	o-XYLENE	9798	2010 pptv	
33		1	VV	22.488	Mass	105.00	amu	4-ETHYLTOLUE	7694	1481 pptv	
34		1	VB	22.609	Mass	105.00	amu	1,3,5METHBEN	6781	1705 pptv	
35		1	PB	23.144	Mass	105.00	amu	1,2,4METHBEN	7892	2093 pptv	
36		1	BV	23.272	Mass	146.00	amu	m-DICHLBENZE	3046	1119 pptv	
37		1	VV	23.279	Mass	91.00	amu	BENZYLCHLORI	3880	1006 pptv	
38		1	VB	23.378	Mass	146.00	amu	p-DICHLBENZE	6090	2164 pptv	
39		1	BP	23.850	Mass	146.00	amu	o-DICHLBENZE	2896	1249 pptv	
40		1	BB	26.673	Mass	180.00	amu	1,2,4CHLBENZ	562	767.1 pptv	
41		1	BB	27.657	Mass	225.00	amu	HEXACHLBUTAD	6309	1789 pptv	

Reproduced from best available copy.

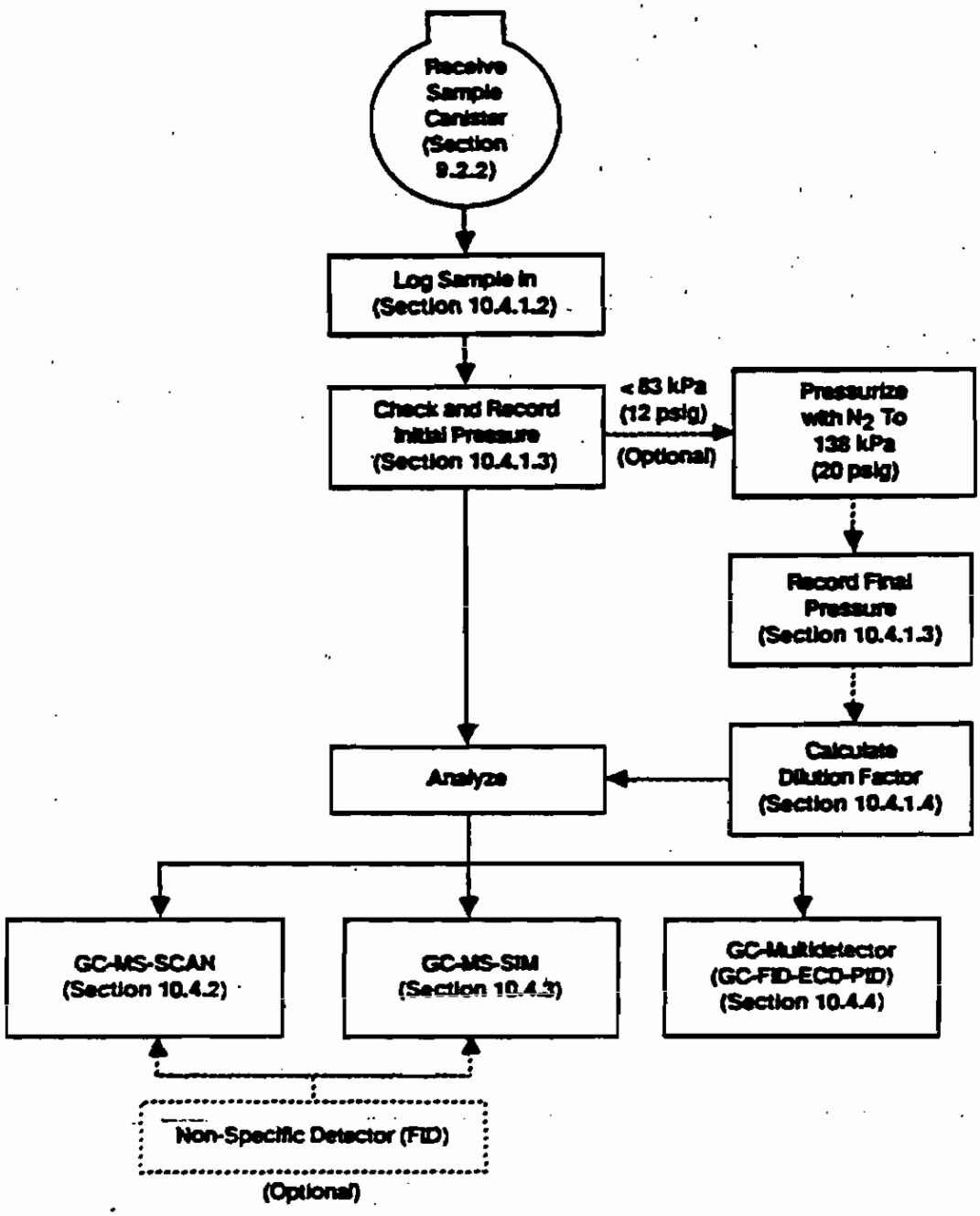


FIGURE 1. ANALYTICAL SYSTEMS AVAILABLE FOR CANISTER VOC IDENTIFICATION AND QUANTITATION

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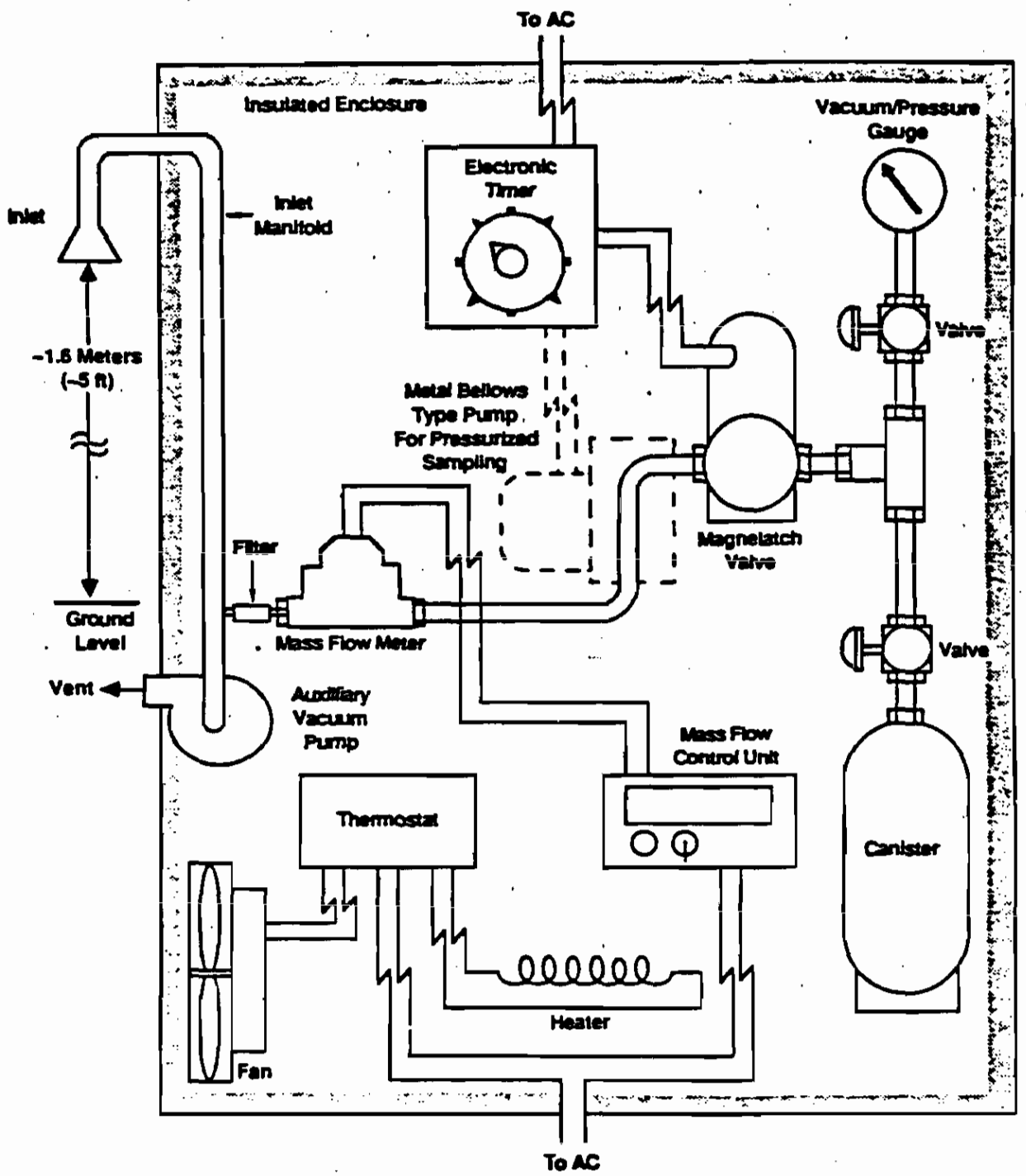

FIGURE 2. SAMPLER CONFIGURATION FOR SUBATMOSPHERIC PRESSURE OR PRESSURIZED CANISTER SAMPLING

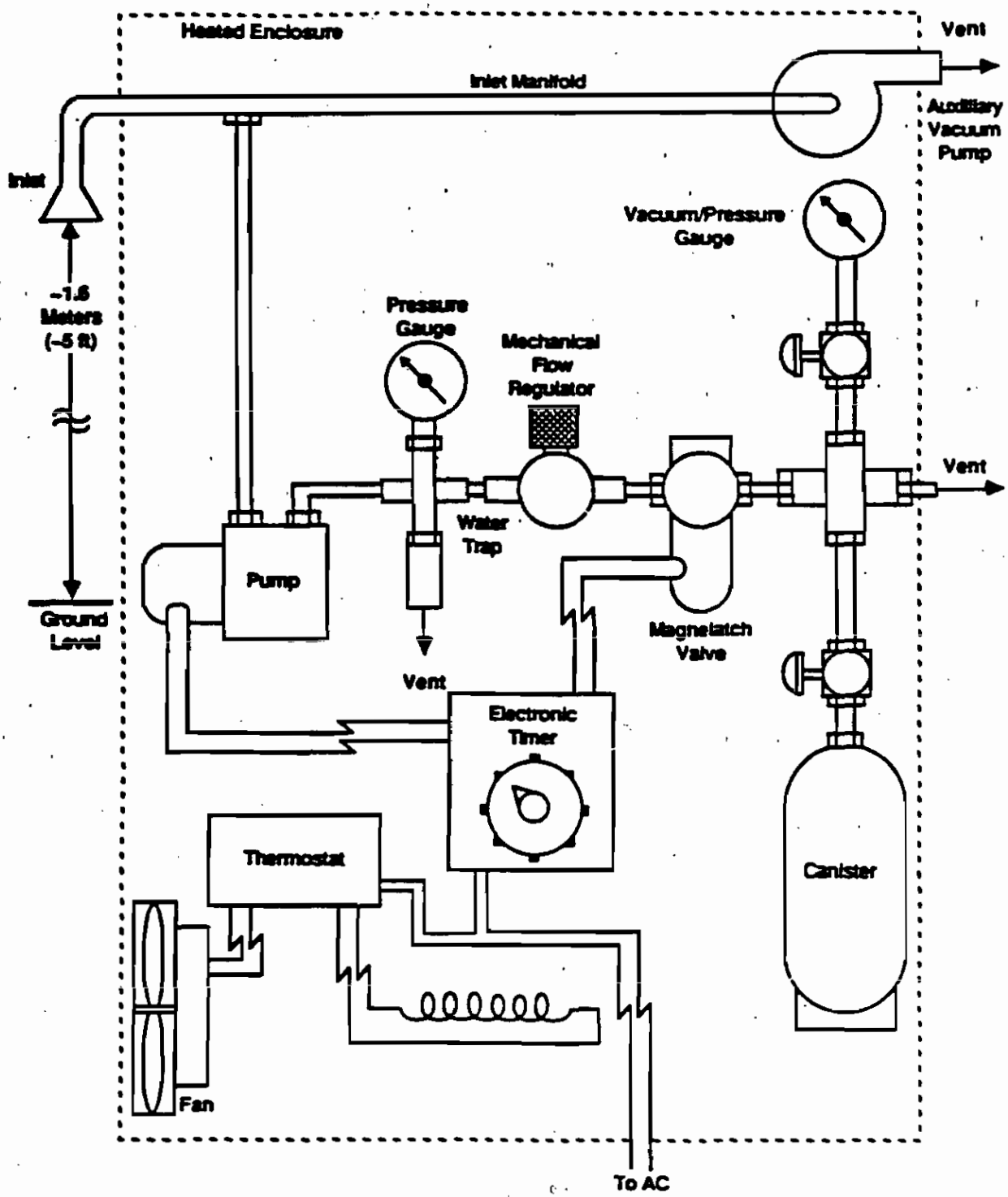

FIGURE 3. ALTERNATIVE SAMPLER CONFIGURATION FOR PRESSURIZED CANISTER SAMPLING

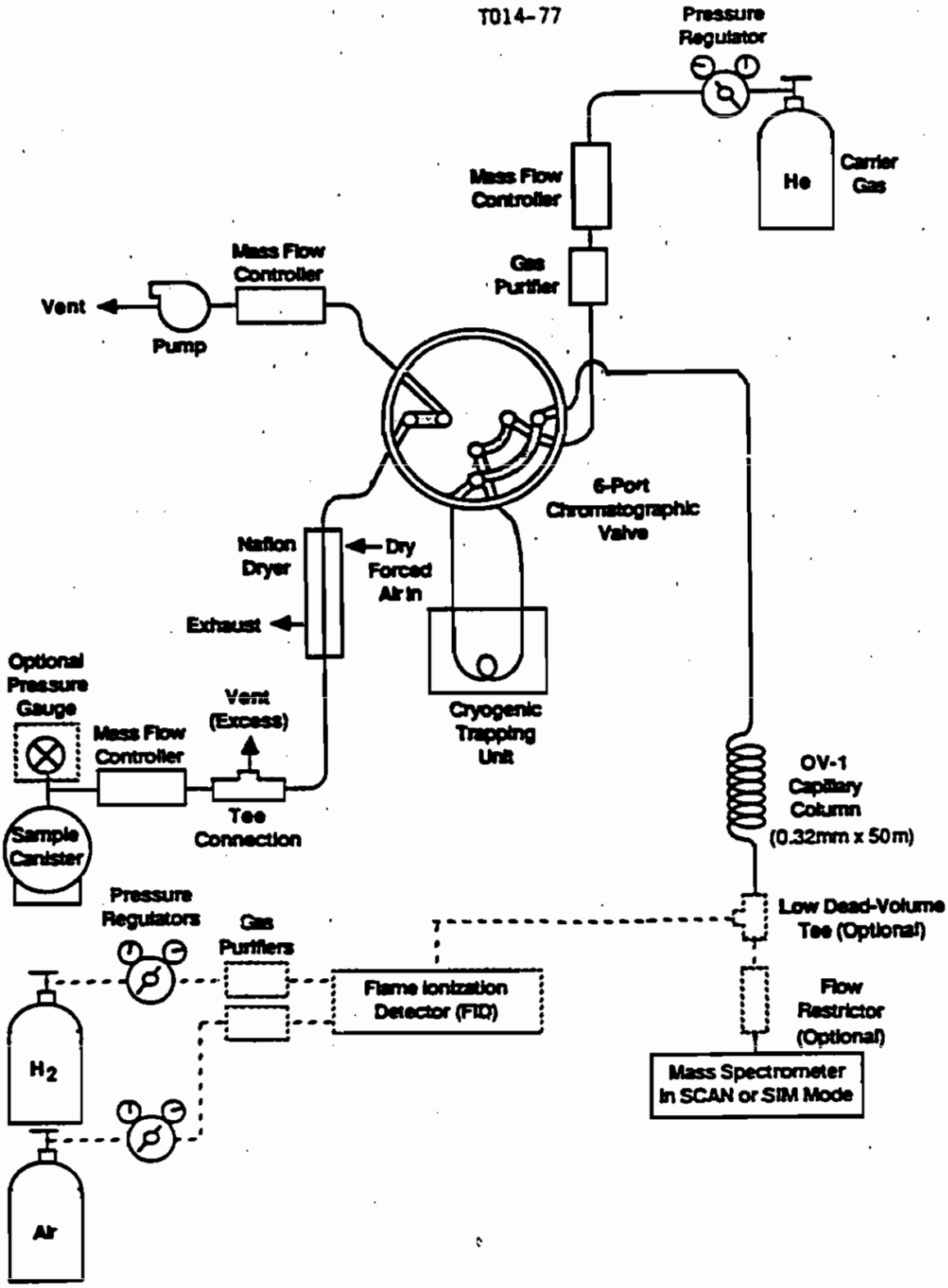

FIGURE 4. CANISTER ANALYSIS UTILIZING GC-MS-SCAN-SIM ANALYTICAL SYSTEM WITH OPTIONAL FLAME IONIZATION DETECTOR WITH THE 6-PORT CHROMATOGRAPHIC VALVE IN THE SAMPLE DESORPTION MODE

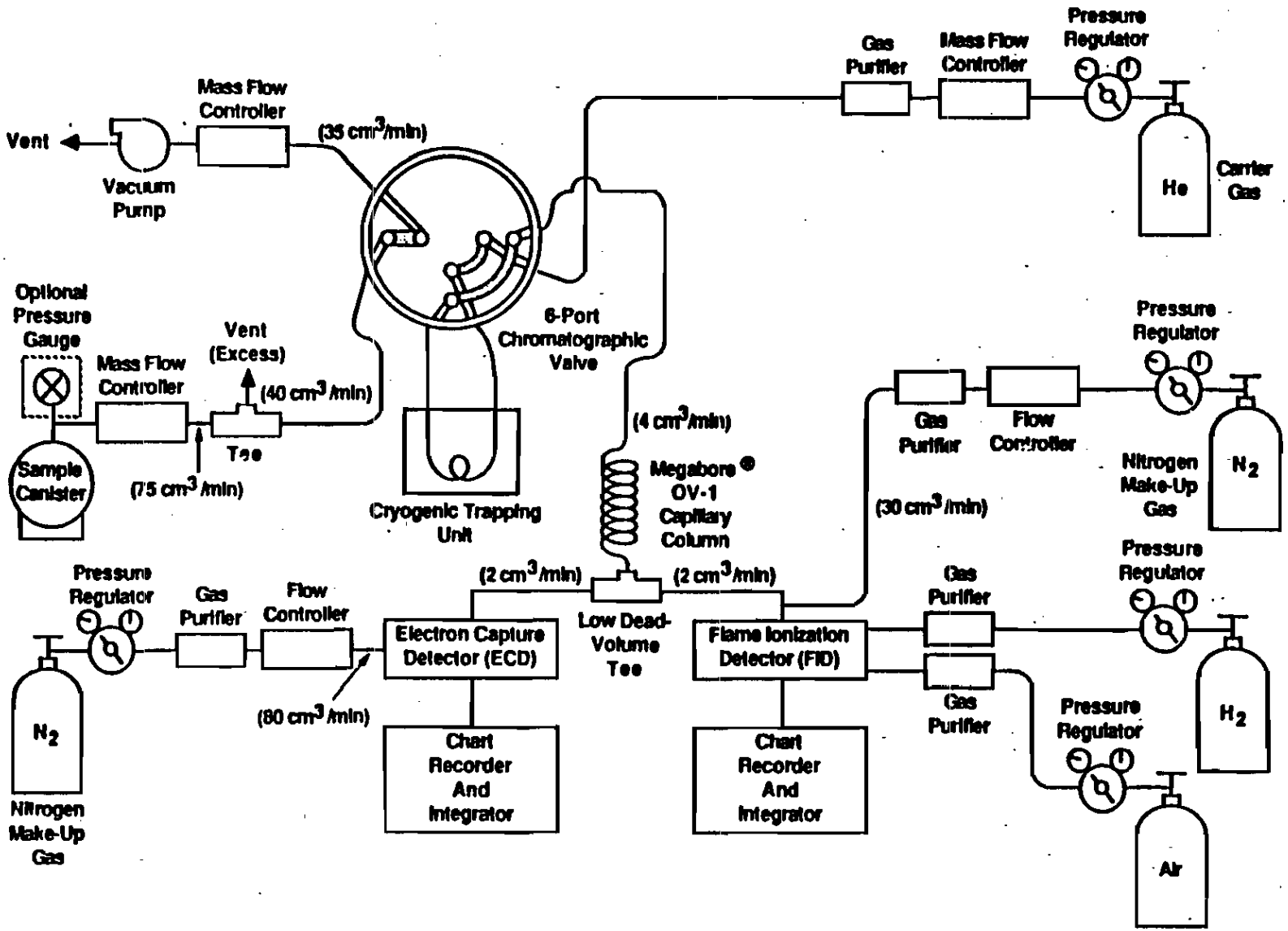

FIGURE 5. GC-FID-ECD ANALYTICAL SYSTEM WITH THE 6-PORT CHROMATOGRAPHIC VALVE IN THE SAMPLE DESORPTION MODE

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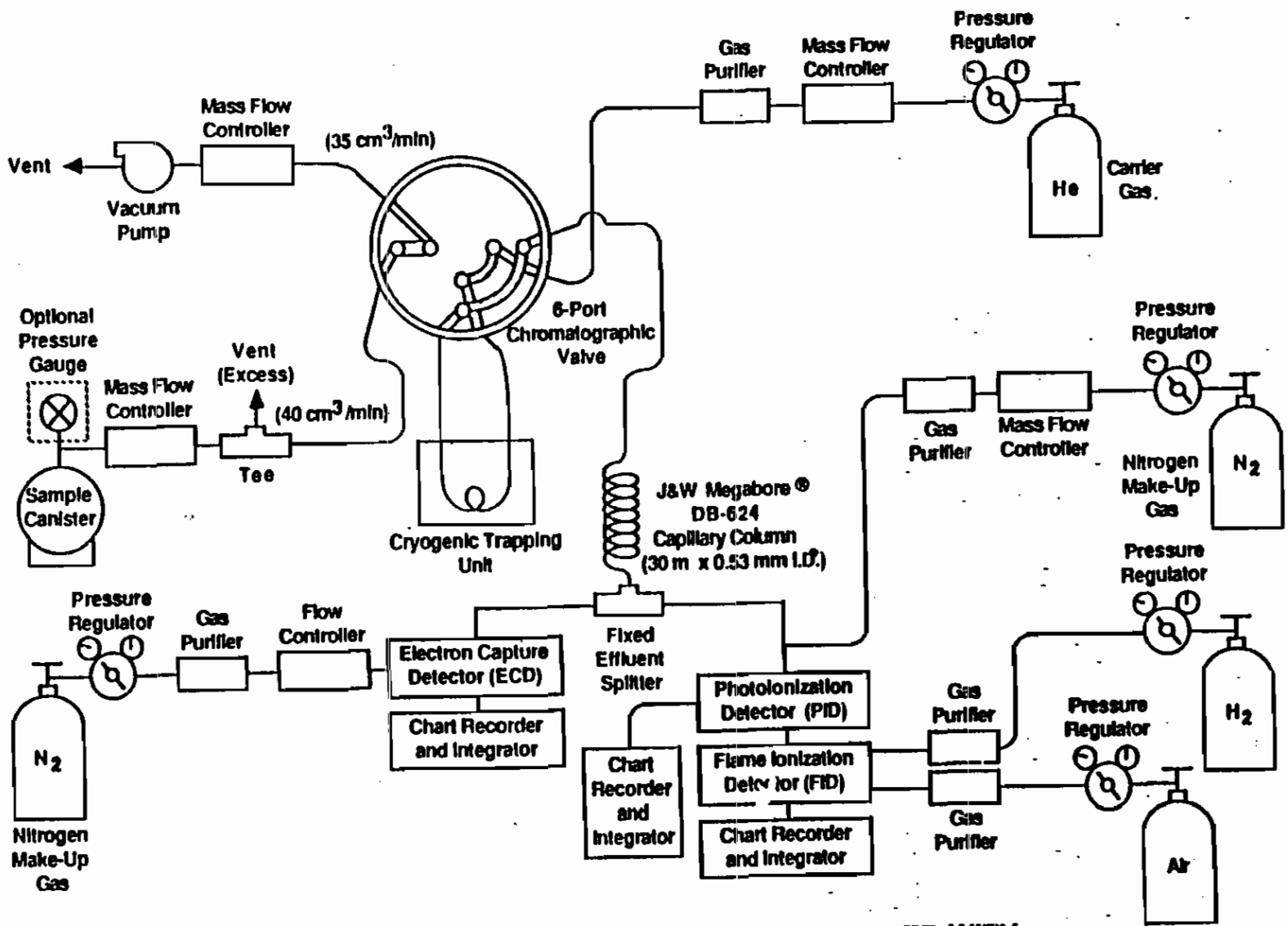

FIGURE 6. SYSTEM CONFIGURATION ASSOCIATED WITH THE GC-FID-ECD-PID ANALYTICAL SYSTEM WITH THE 6-PORT CHROMATOGRAPHIC VALVE IN THE SAMPLE DESORPTION MODE

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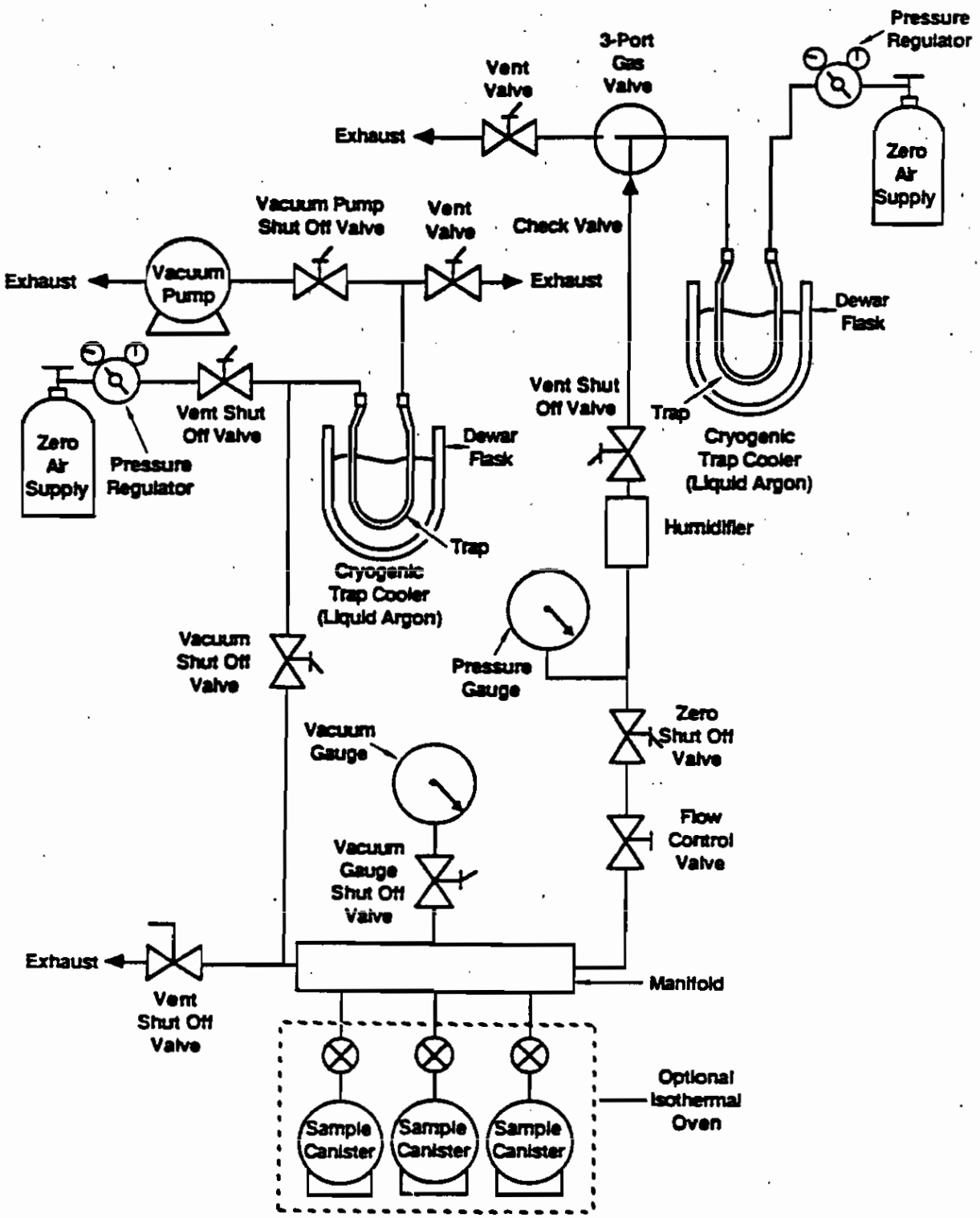

FIGURE 7. CANISTER CLEANING SYSTEM

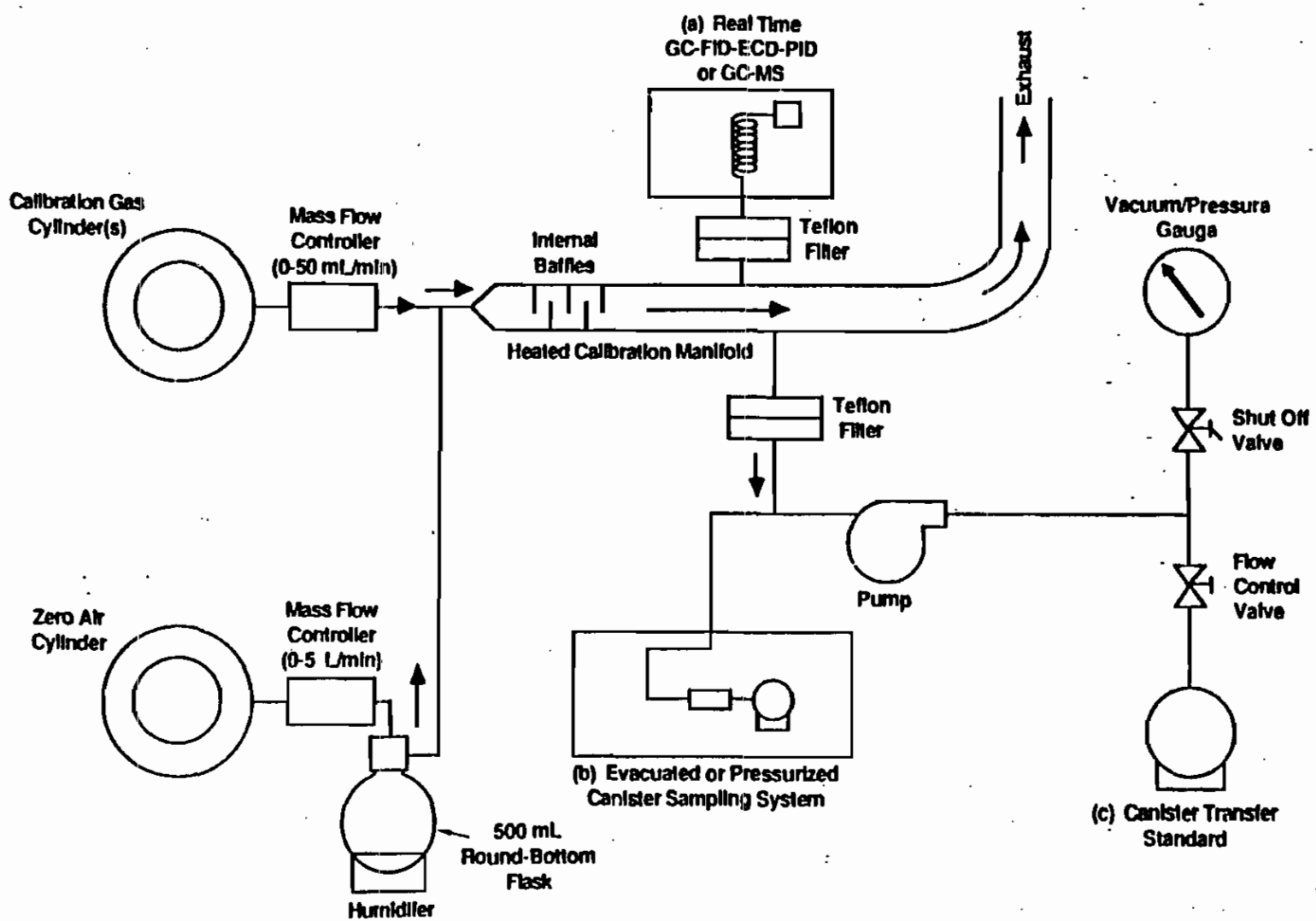

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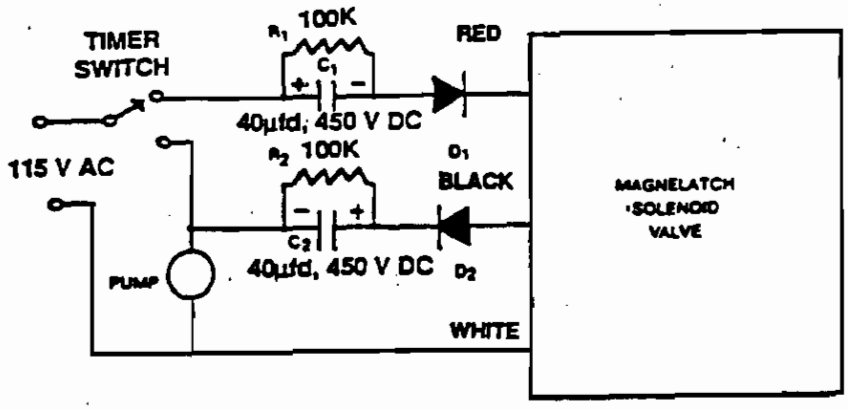
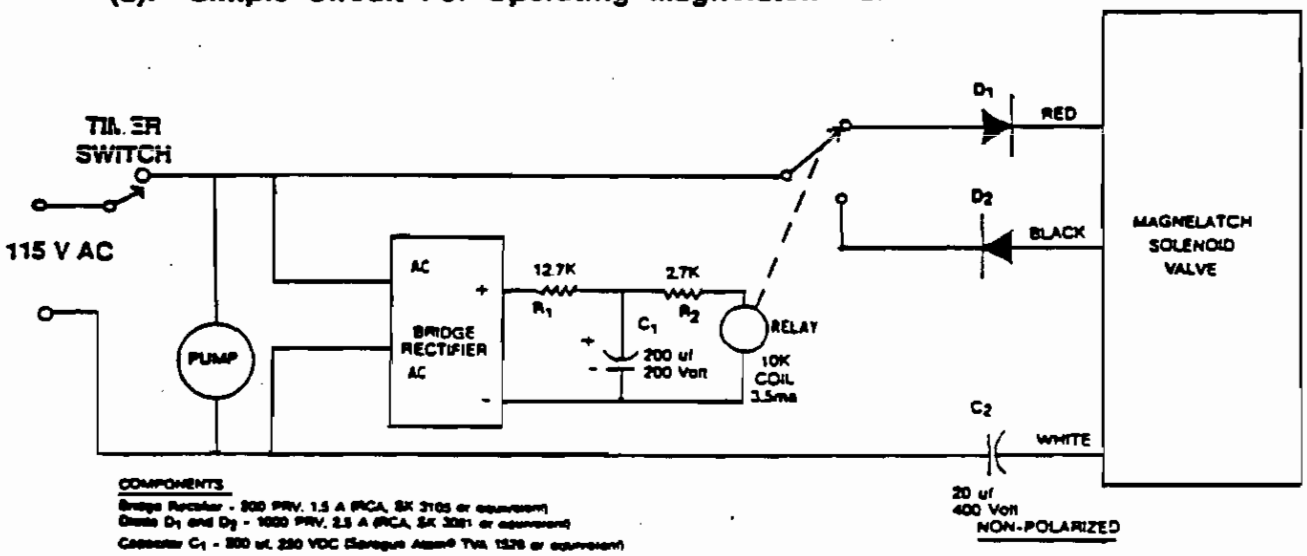
FIGURE 8. SCHEMATIC OF CALIBRATION SYSTEM AND MANIFOLD FOR (a) ANALYTICAL SYSTEM CALIBRATION, (b) TESTING CANISTER SAMPLING SYSTEM AND (c) PREPARING CANISTER TRANSFER STANDARDS.



COMPONENTS
Capacitor C_1 and C_2 - 40 uf, 450 VDC (Sprague Atom® TVA 1712 or equivalent)
Resistor R_1 and R_2 - 0.5 watt, 5% tolerance
Diode D_1 and D_2 - 1000 PRV, 2.5 A (RCA, SK 3081 or equivalent)

(a). Simple Circuit For Operating Magnelatch Valve



COMPONENTS
Bridge Rectifier - 200 PRV, 1.5 A (RCA, SK 3105 or equivalent)
Diode D_1 and D_2 - 1000 PRV, 2.5 A (RCA, SK 3081 or equivalent)
Capacitor C_1 - 200 uf, 250 VDC (Sprague Atom® TVA 1526 or equivalent)
Capacitor C_2 - 20 uf, 400 VDC Non-Polarized (Sprague Atom® TVAN 1652 or equivalent)
Relay - 10,000 ohm coil, 3.5 ma (AMP Potter and Brumfield, KCP 5, or equivalent)
Resistor R_1 and R_2 - 0.5 watt, 5% tolerance

(b). Improved Circuit Designed To Handle Power Interruptions

FIGURE 9. ELECTRICAL PULSE CIRCUITS FOR DRIVING SKINNER MAGNELATCH SOLENOID VALVE WITH A MECHANICAL TIMER

CANISTER SAMPLING FIELD DATA SHEET

A. GENERAL INFORMATION

SITE LOCATION: _____
SITE ADDRESS: _____
_____
_____
SAMPLING DATE: _____

SHIPPING DATE: _____
CANISTER SERIAL NO.: _____
SAMPLER ID: _____
OPERATOR: _____
CANISTER LEAK CHECK DATE: _____

B. SAMPLING INFORMATION

TEMPERATURE

	INTERIOR	AMBIENT	MAXIMUM	MINIMUM
START			X	X
STOP				

PRESSURE

CANISTER PRESSURE	
X	

SAMPLING TIMES

	LOCAL TIME	ELAPSED TIME METER READING
START		
STOP		

FLOW RATES

MANIFOLD FLOW RATE	CANISTER FLOW RATE	FLOW CONTROLLER READOUT

SAMPLING SYSTEM CERTIFICATION DATE: _____
QUARTERLY RECERTIFICATION DATE: _____

C. LABORATORY INFORMATION

DATE RECEIVED: _____
RECEIVED BY: _____
INITIAL PRESSURE: _____
FINAL PRESSURE: _____
DILUTION FACTOR: _____
ANALYSIS
GC-FID-ECD DATE: _____
GC-MSD-SCAN DATE: _____
GC-MSD-SIM DATE: _____
RESULTS*: _____
_____
GC-FID-ECD: _____
GC-MSD-SCAN: _____
GC-MSD-SIM: _____

_____
SIGNATURE/TITLE

* ATTACH DATA SHEETS

FIGURE 10. CANISTER SAMPLING FIELD DATA SHEET

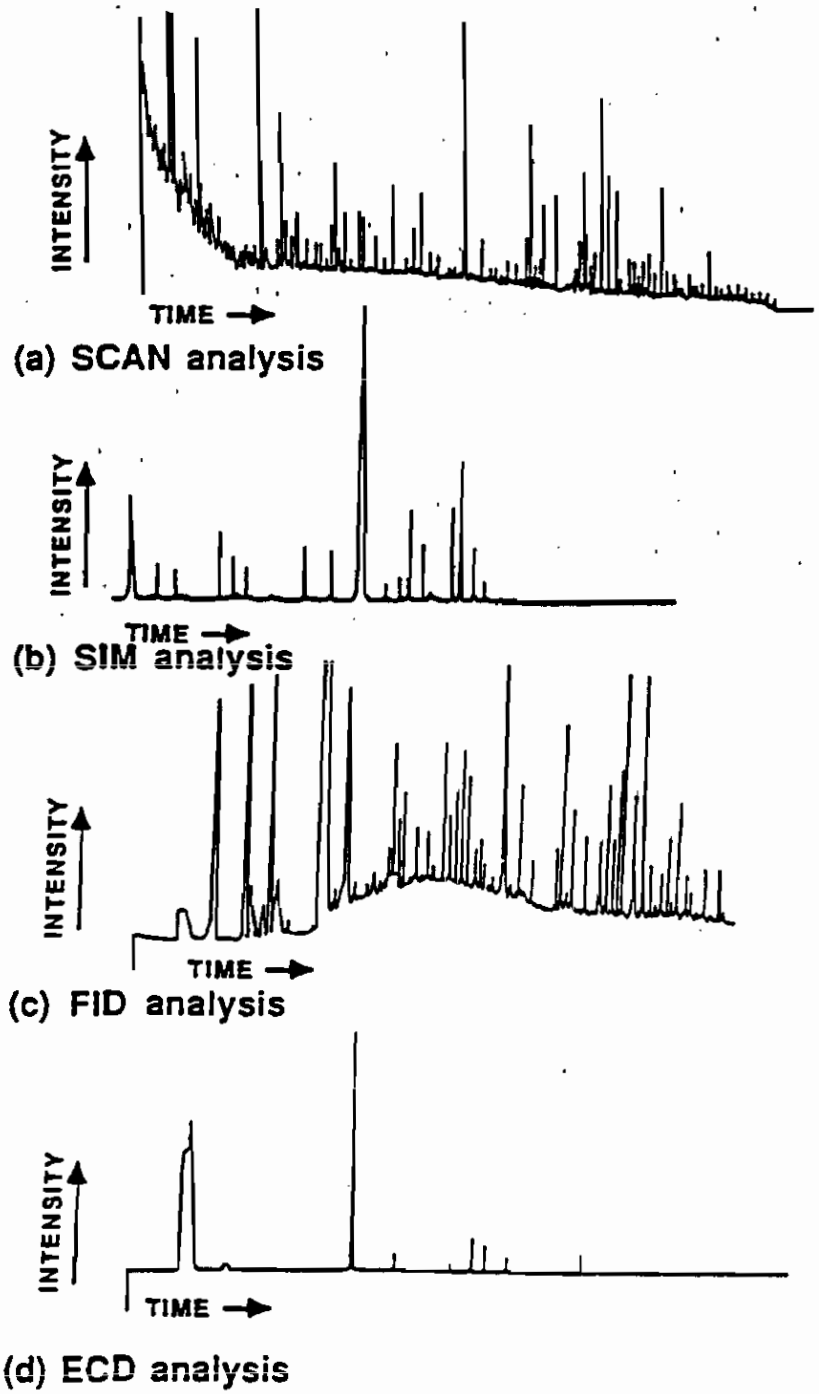


FIGURE 11. TYPICAL CHROMATOGRAMS OF A VOC SAMPLE ANALYZED BY GC-MS-SCAN-SIM MODE AND GC-MULTIDETECTOR MODE

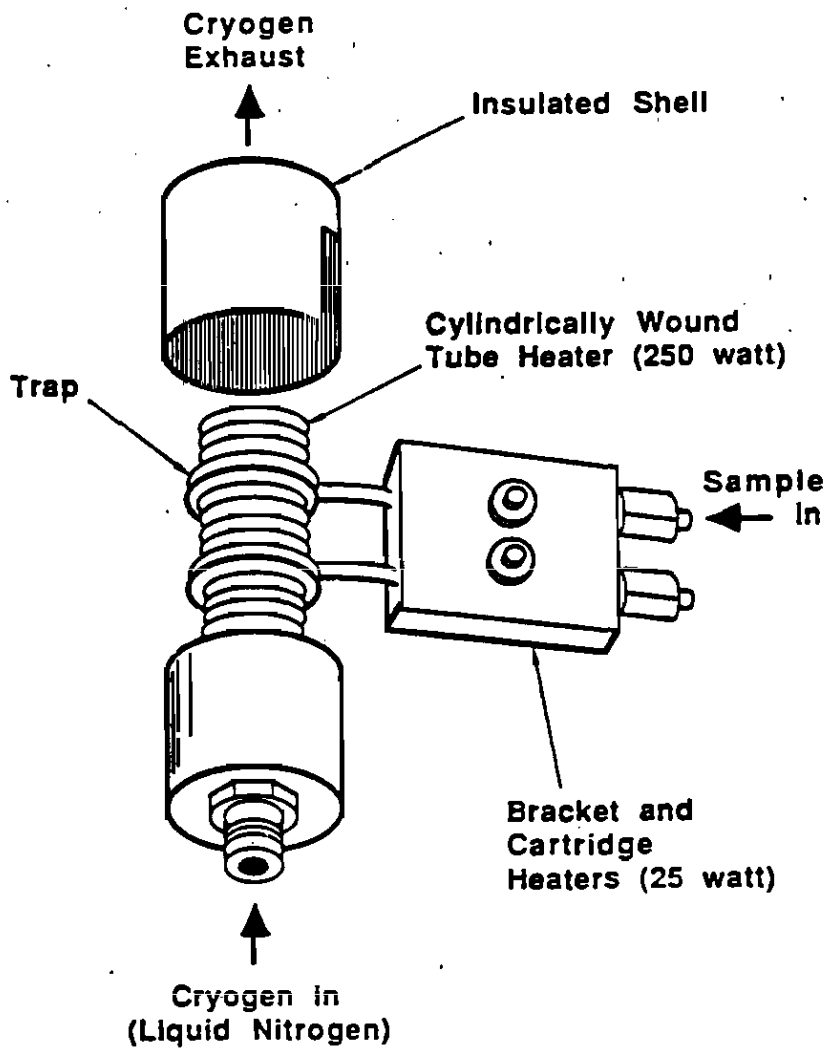


FIGURE 12. CRYOGENIC TRAPPING UNIT

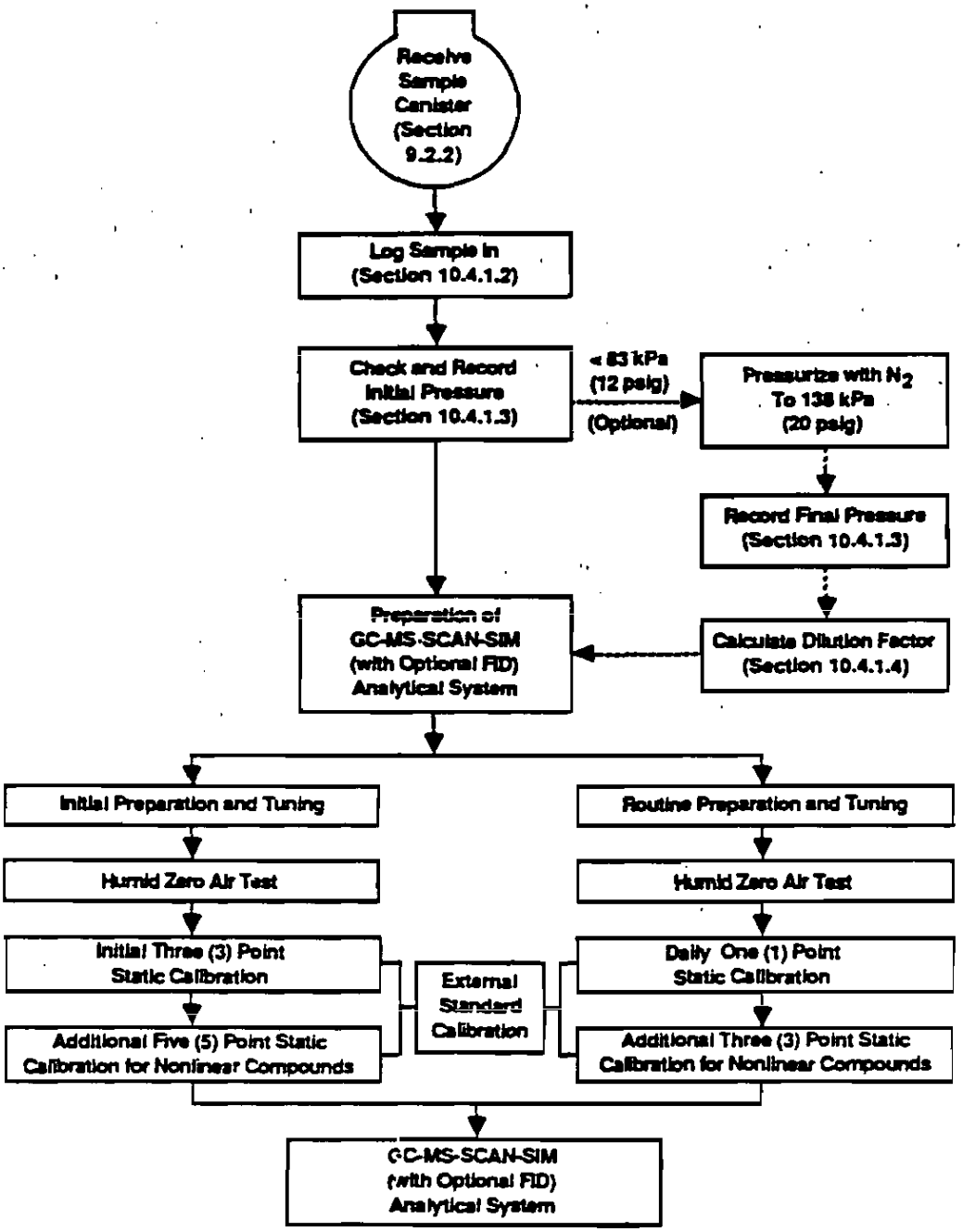


FIGURE 13. FLOWCHART OF GC-MS-SCAN-SIM ANALYTICAL SYSTEM PREPARATION (WITH OPTIONAL FID SYSTEM)

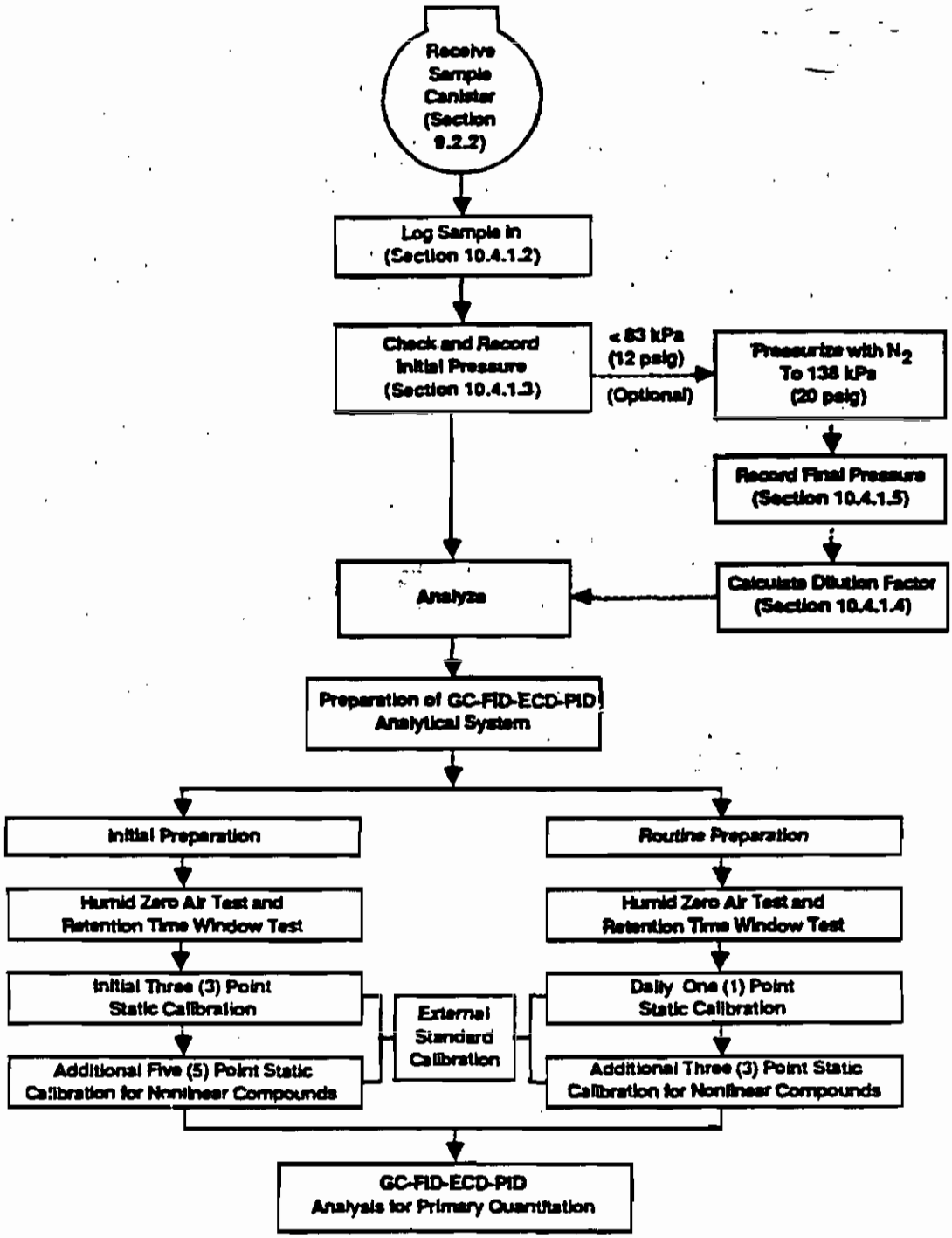
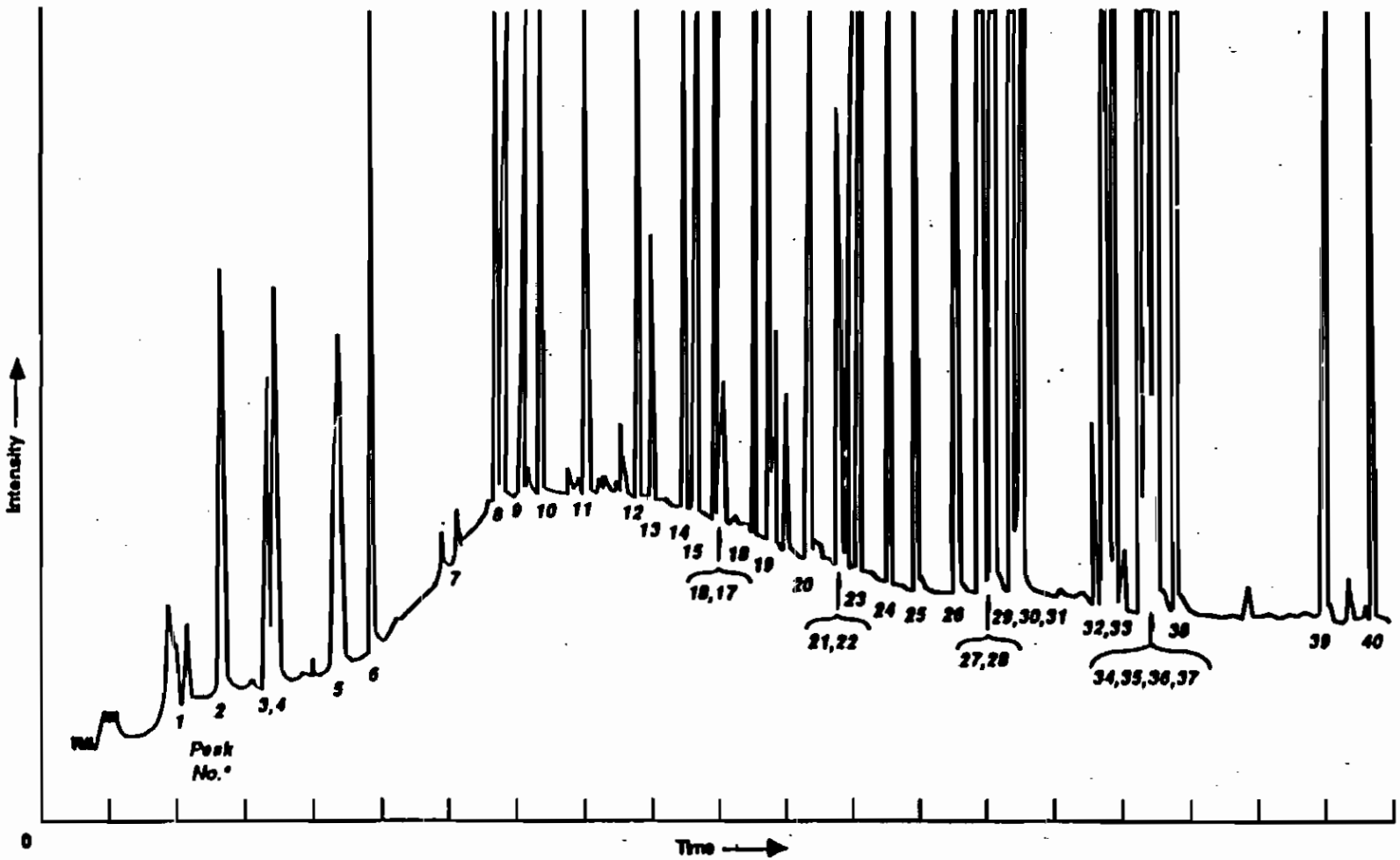


FIGURE 14. FLOWCHART OF GC-FID-ECD-PID ANALYTICAL SYSTEM PREPARATION



* See Table 7.0 For Peak Identification

FIGURE 15. TYPICAL FID RESPONSE TO SELECTIVE VOCs

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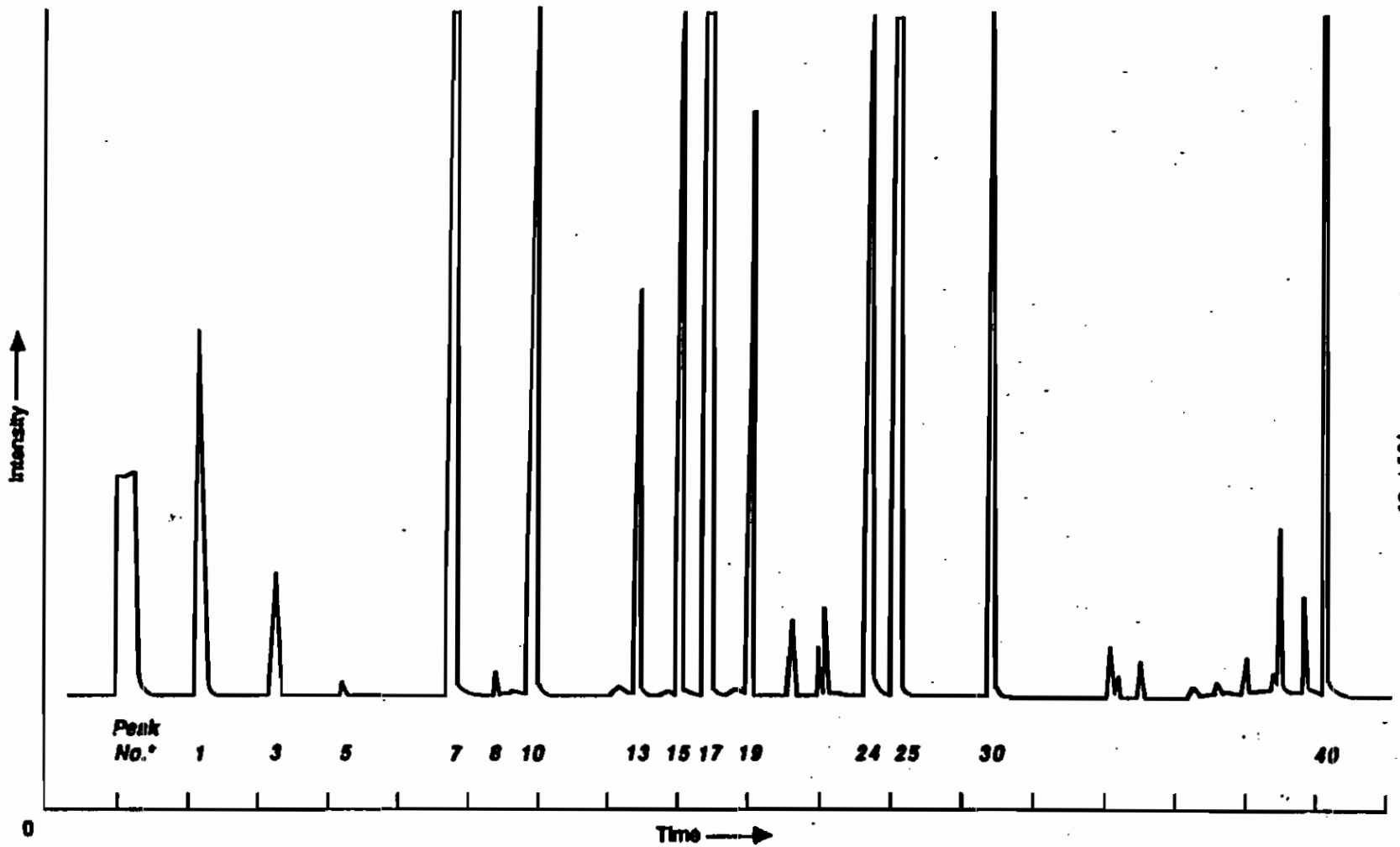

* See Table 7.0 For Peak Identification

FIGURE 16. TYPICAL ECD RESPONSE TO SELECTIVE VOCs

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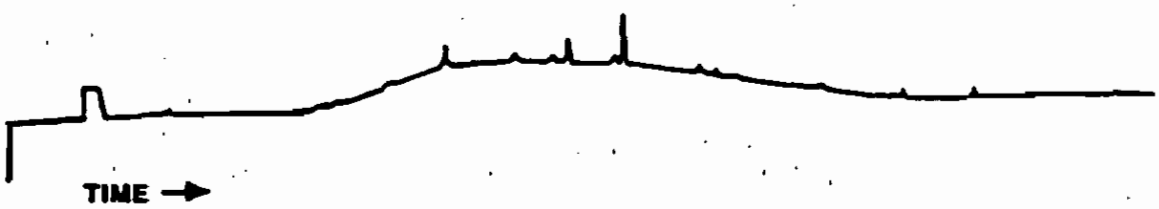
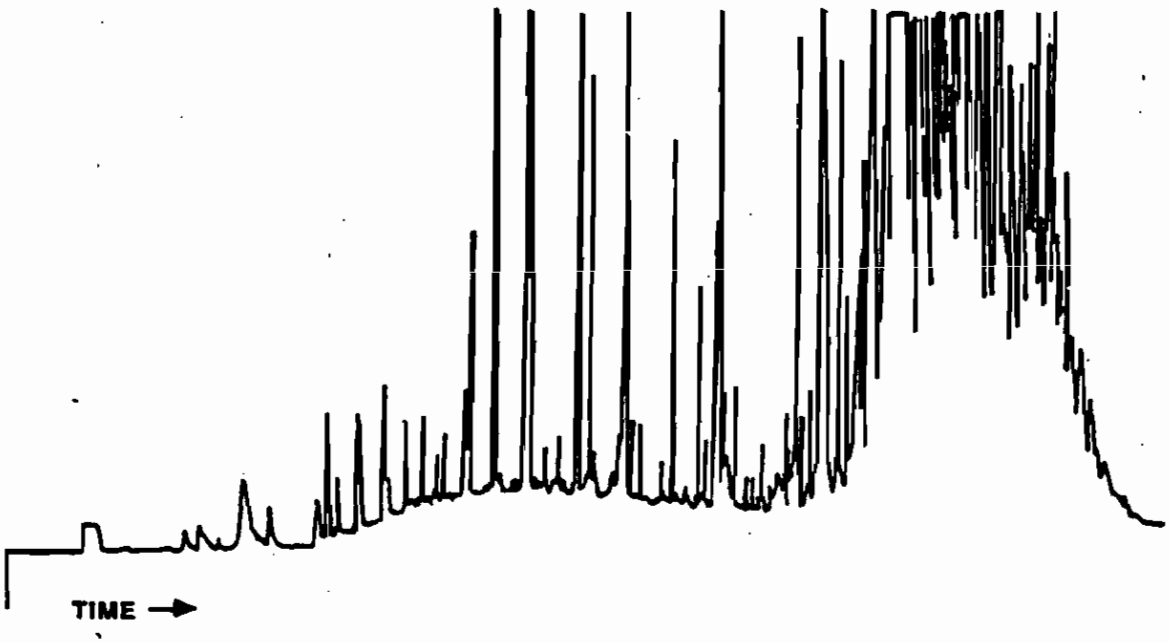


(a). Certified Sampler



(b). Contaminated Sampler

FIGURE 17. EXAMPLE OF HUMID ZERO AIR TEST RESULTS FOR A CLEAN SAMPLER (a) AND A CONTAMINATED SAMPLER (b)

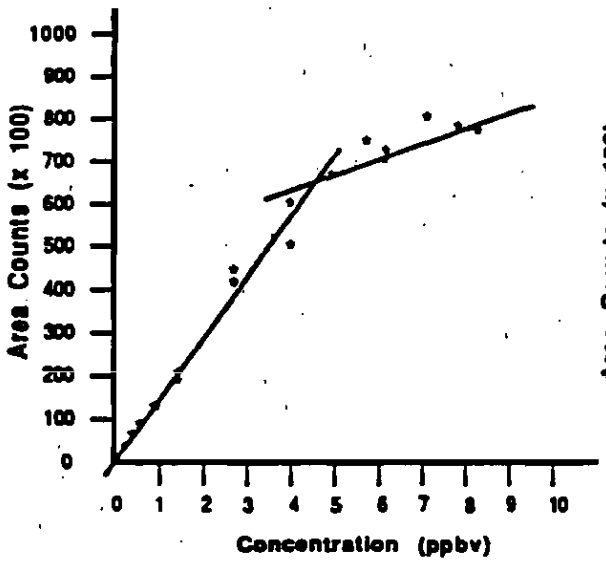


FIGURE 18(a). NONLINEAR RESPONSE OF TETRACHLOROETHYLENE ON THE ECD

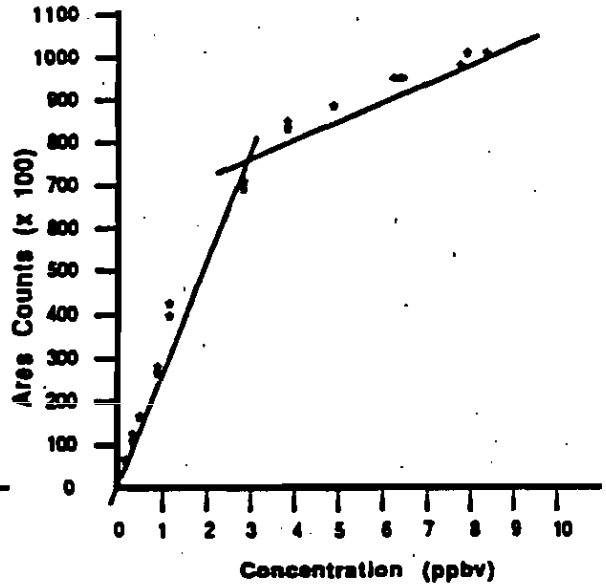


FIGURE 18(b). NONLINEAR RESPONSE OF CARBON TETRACHLORIDE ON THE ECD

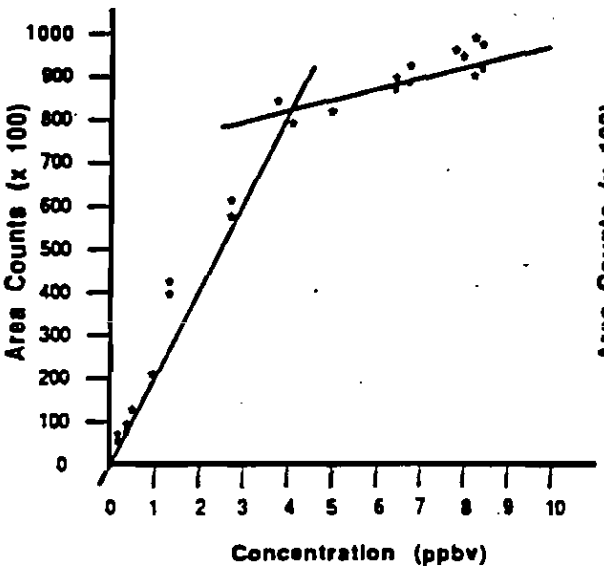


FIGURE 18(c). NONLINEAR RESPONSE OF HEXACHLOROBUTADIENE ON THE ECD

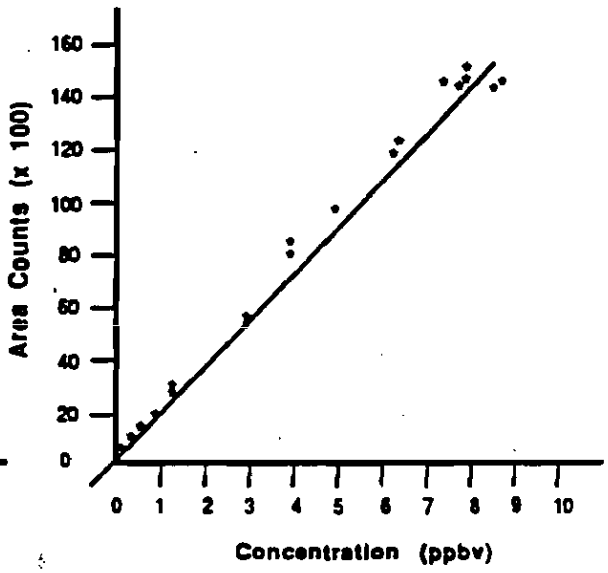


FIGURE 18(d). LINEAR RESPONSE OF CHLOROFORM ON THE ECD

FIGURE 18. RESPONSE OF ECD TO VARIOUS VOCs

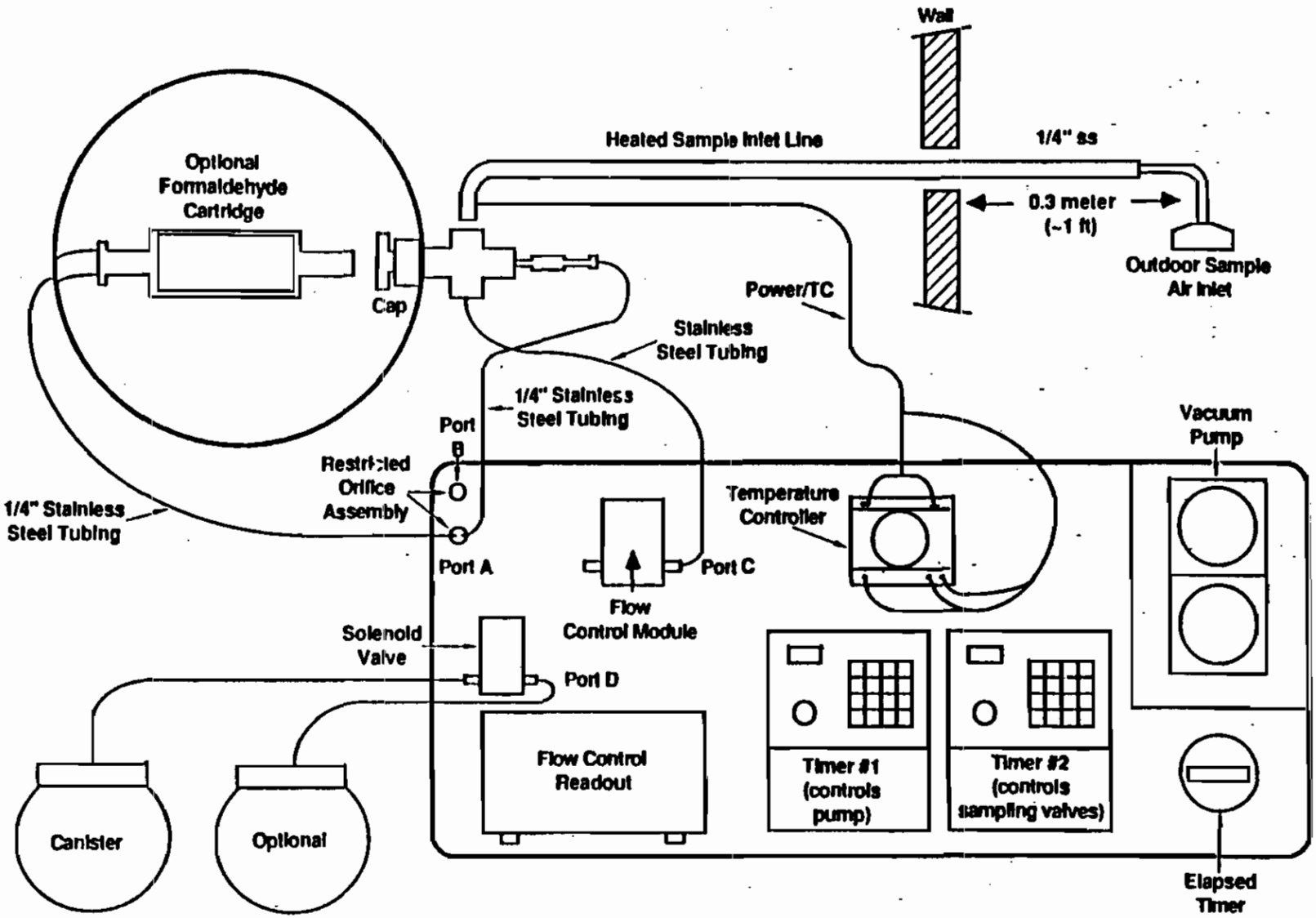


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FIGURE 19. U.S. ENVIRONMENTAL PROTECTION AGENCY UATP, SCHEMATIC OF SAMPLE INLET CONNECTIONS SAMPLER

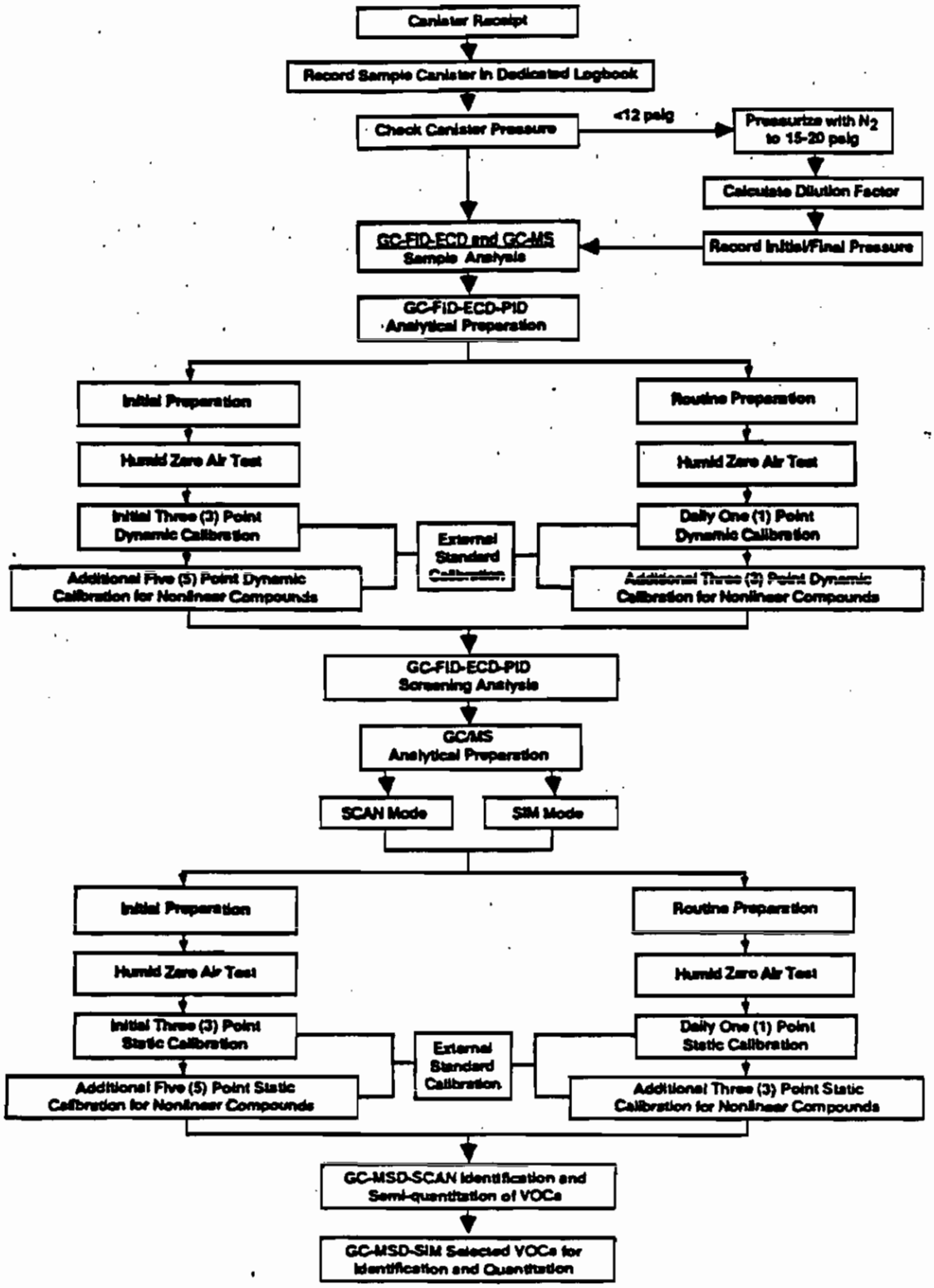

FIGURE 20. FLOWCHART OF ANALYTICAL SYSTEMS PREPARATION.

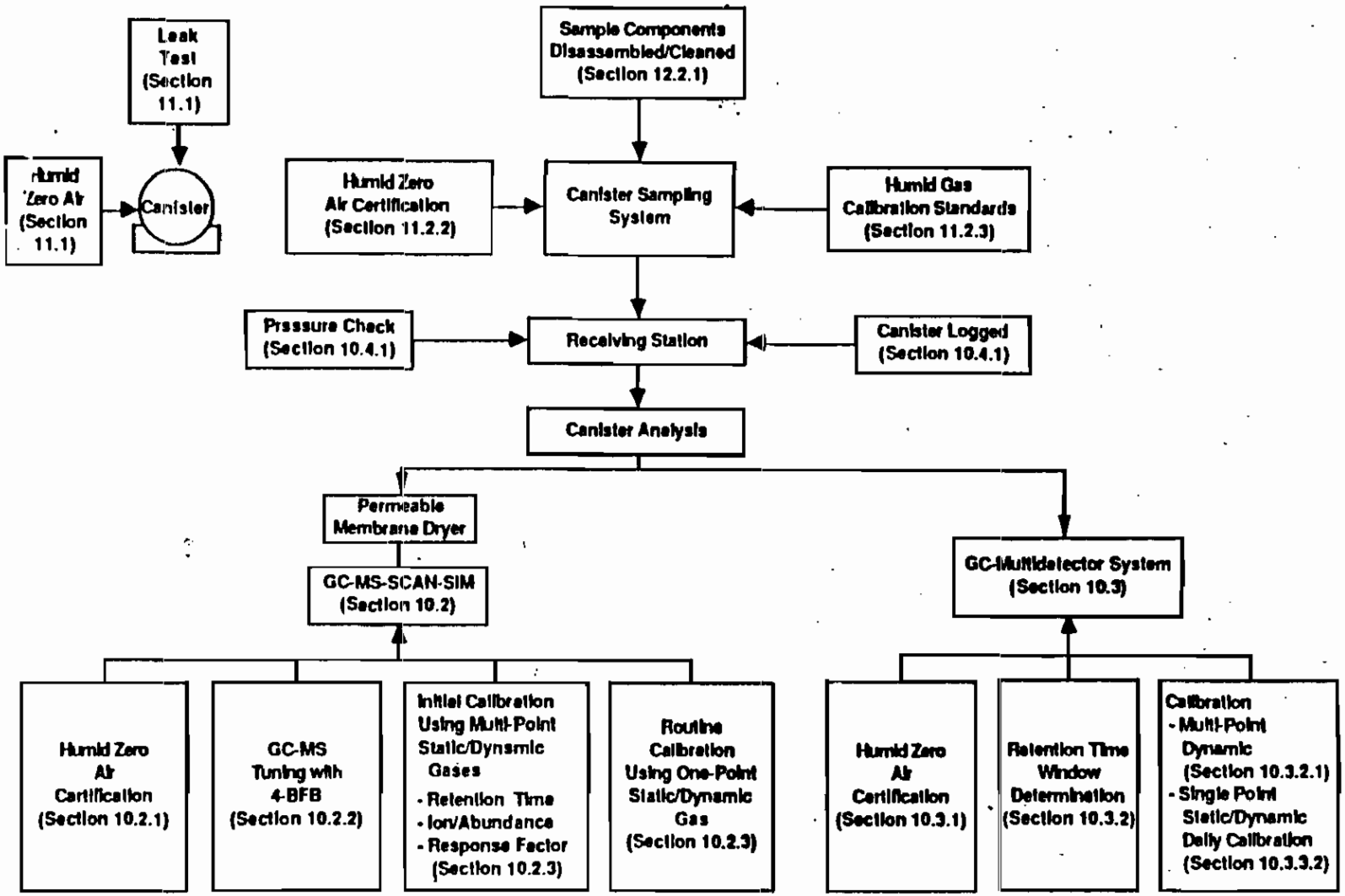

FIGURE 21. SYSTEM QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) ACTIVITIES ASSOCIATED WITH VARIOUS ANALYTICAL SYSTEMS

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APPENDIX A1

AVAILABILITY OF AUDIT CYLINDERS FROM UNITED STATES ENVIRONMENTAL PROTECTION AGENCY USEPA PROGRAMS/ REGIONAL OFFICES, STATE AND LOCAL AGENCIES AND THEIR CONTRACTORS

1. Availability of Audit Cylinders

   1.1 The USEPA has available, at no charge, cylinder gas standards of hazardous organic compounds at the ppb level that may be used to audit the performance of ambient air source measurement systems.

   1.2 Each audit cylinder contains 5 to 18 hazardous organic compounds in a balance of N_2 gas. Audit cylinders are available in several concentration ranges. The concentration of each organic compound in the audit cylinder is within the range illustrated in Table A-1.

2. Audit Cylinder Certification

   2.1 All audit cylinders are periodically analyzed to assure that cylinder concentrations have remained stable.

   2.2 All stability analyses include quality control analyses of ppb hazardous organic gas standards prepared by the National Bureau of Standards for USEPA.

3. Audit Cylinder Acquisition

   3.1 USEPA program/regional offices, state/local agencies, and their contractors may obtain audit cylinders (and an audit gas delivery system, if applicable) for performance audits during:

   - o RCRA Hazardous Waste Trial Burns For PHOC's; and
   - o Ambient Air Measurement of Toxic Organics.

   3.2 The audit cylinders may be acquired by contacting:

   Robert L. Lampe
   U.S. Environmental Protection Agency
   Environmental Monitoring Systems Laboratory
   Quality Assurance Division
   MD-77B
   Research Triangle Park, NC 27711
   919-541-4531

Revision 1.0
June, 1988

METHOD TO14 -2

DETERMINATION OF VOLATILE ORGANIC COMPOUNDS (VOCs) IN AMBIENT AIR USING SUMMA® PASSIVATED CANISTER SAMPLING AND GAS CHROMATOGRAPHIC ANALYSIS

OUTLINE

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     - 10.4.2 GC-MS-SCAN Analysis (With Optional FID System)
     - 10.4.3 GC-MS-SIM Analysis (With Optional FID System)
     - 10.4.4 GC-FID-ECD Analysis (With Optional PID System)

OUTLINE (Cont.) 17-2-a

11. Cleaning and Certification Program
    11.1 Canister Cleaning and Certification
    11.2 Sampling System Cleaning and Certification
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    12.4 Method Safety
    12.5 Quality Assurance
        12.5.1 Sampling System
        12.5.2 GC-MS-SCAN-SIM System Performance Criteria
        12.5.3 GC-Multidetector System Performance Criteria

13. Acknowledgements

14. References

APPENDIX A - Availability of Audit Cylinders from U.S. Environmental Protection Agency (USEPA) to USEPA Program/Regional Offices, State/Local Agencies and Their Contractors
APPENDIX B - Operating Procedures for a Portable Gas Chromatograph Equipped With a Photoionization Detector
APPENDIX C - Installation and Operating Procedures for Alternative Air Toxics Samplers

TABLE A-1. AVAILABLE USEPA PERFORMANCE AUDIT CYLINDERS

Group I Compounds	Group II Compounds	Group III Compounds
Carbon tetrachloride	Trichloroethylene	Pyridine (Pyridine in Group III cylinders but certified analysis not available)
Chloroform	1,2-dichloroethane	Vinylidene chloride
Perchloroethylene	1,2-dibromoethane	1,1,2-trichloro-1,2,2-trifluoroethane (Freon-113)
Vinyl chloride	Acetonitrile	1,2-dichloro-1,1,2,2-tetrafluoroethane (Freon-114)
Benzene	Trichlorofluoromethane (Freon-11)	Acetone
	Dichlorodifluoromethane (Freon-12)	1-4 Dioxane
	Bromomethane	Toluene
	Methyl ethyl ketone	Chlorobenzene
	1,1,1-trichloroethane	

Group I Ranges	Group II Ranges	Group III Ranges
7 to 90 ppb	7 to 90 ppb	7 to 90 ppb
90 to 430 ppb	90 to 430 ppb	90 to 430 ppb
430 to 10,000 ppb		

Group IV	Group V	
Acrylonitrile	Carbon tetrachloride	Methylene chloride
1,3-butadiene	Chloroform	Trichlorofluoromethane (Freon-11)
Ethylene oxide	Perchloroethylene	Bromomethane
Methylene chloride	Vinyl chloride	Toluene
Propylene oxide	Benzene	Chlorobenzene
o-xylene	Trichloroethylene	1,3-Butadiene
	1,2-dichloroethane	o-xylene
	1,2-dibromoethane	Ethyl benzene
	1,1,1-trichloroehtane	1,2-dichloropropane

Group IV Ranges	Group V Ranges
7 to 90 ppb	1 to 40 ppb
430 to 10,000 ppb	

APPENDIX B1

OPERATING PROCEDURES FOR A PORTABLE GAS CHROMATOGRAPH EQUIPPED WITH A PHOTOIONIZATION DETECTOR

1. Scope

This procedure is intended to screen ambient air environments for volatile organic compounds. Screening is accomplished by collection of VOC samples within an area and analysis on site using a portable gas chromatograph/integrator (Photovac Models 10S10, 10S50, or equivalent). This procedure is not intended to yield quantitative or definite qualitative information regarding the substances detected. Rather, it provides a chromatographic "profile" of the occurrence and intensity of unknown volatile compounds which assists in placement of fixed-site samplers.

2. Applicable Documents

2.1 ASTM Standards

E260 - Recommended Practice for General Gas Chromatography Procedures

E355 - Practice for Gas Chromatography Terms and Relationships

2.2 Other Documents

Portable Instruments User's Manual for Monitoring VOC Sources, EPA-34011-86-015, U.S. Environmental Protection Agency, Washington, DC, June, 1986.

3. Summary of Method

3.1 An air sample is extracted directly from ambient air and analyzed on site by a portable GC.

3.2 Analysis is accomplished by drawing an accurate volume of ambient air through a sampling port and into a concentrator, then the sample air is transported by carrier gas onto a packed column and into a PID, resulting in response peak(s). Retention times are compared with those in a standard chromatogram to predict the probable identity of the sample components.

4. Significance

4.1 VOCs are emitted into the atmosphere from a variety of sources including petroleum refineries, synthetic organic chemical plants,

natural gas processing plants, and automobile exhaust. Many of these VOC emissions are acutely toxic; therefore, their determination in ambient air is necessary to assess human health impacts.

4.2 Conventional methods for VOC determination use solid sorbent and canister sampling techniques.

4.3 Collection of ambient air samples in canisters provides (1) convenient integration of ambient samples over a specific time period, (e.g., 24 hours); (2) remote sampling and central analysis; (3) ease of storing and shipping samples, if necessary; (4) unattended sample collection; (5) analysis of samples from multiple sites with one analytical system; and (6) collection of sufficient sample volume to allow assessment of measurement precision and/or analysis of samples by several analytical systems.

4.4 The use of portable GC equipped with multidetectors has assisted air toxics programs by using the portable GC as a "screening tool" to determine "hot spots," potential interferences, and semi-quantitation of VOCs/SVOCs, prior to locating more traditional fixed-site samplers.

5. Definitions

Definitions used in this document and in any user-prepared Standard Operating Procedures (SOPs) should be consistent with ASTM Methods D1356 and E355. Abbreviations and symbols pertinent to this method are defined at point of use.

6. Interferences

6.1 The most significant interferences result from extreme differences in limits of detection (LOD) among the target VOCs (Table B-1). Limitations in resolution associated with ambient temperature, chromatography and the relatively large number of chemicals result in coelution of many of the target components. Coelution of compounds with significantly different PID sensitivities will mask compounds with more modest sensitivities. This will be most dramatic in interferences from benzene and toluene.

6.2 A typical chromatogram and peak assignments of a standard mixture of target VOCs (under the prescribed analytical conditions of this method) are illustrated in Figure B-1. Samples which contain a highly complex mixture of components and/or interfering levels of benzene and toluene are analyzed on a second, longer chromatographic column. The same liquid phase in the primary column is contained in the alternate column but at a higher percent loading.

6.3 Recent designs in commercially available GCs (Table B-2) have preconcentrator capabilities for sampling lower concentrations of VOCs, pre-column detection with back-flush capability for shorter analytical time, constant column temperature for method precision and accuracy and multidetector (PID, ECD, and FID) capability for versatility. Many of these newer features address the weaknesses and interferences mentioned above.

7. Apparatus

7.1 Gas chromatograph. A GC (Photovac Inc., 739 B Parks Ave, Huntington, NY, 11743, Model 10S10 or 10S50, or equivalent) used for surveying ambient air environments (which could employ a multidetector) for sensing numerous VOCs compounds eluting from a packed column at ambient temperatures. This particular portable GC procedure is written employing the photoionization detector as its major sensing device, as part of the Photovac Model 10S10 portable GC survey tool. Chromatograms are developed on a column of 3% SP-2100 on 100/120 Supelcoport (0.66 m x 3.2 mm I.D.) with a flow of 30 cm^3/min air.

7.2 GC accessories. In addition to the basic gas chromatograph, several other pieces of equipment are required to execute the survey sampling. Those include gas-tight syringes for standard injection, alternate carrier gas supplies, high pressure connections for filling the internal carrier gas reservoir, and if the Model 10S10 is used, a recording integrator (Hewlett Packard, Avondale, PA, Model 3390A, or equivalent).

8. Reagents and Materials

8.1 Carrier gas. "Zero" air [<0.1 ppm total hydrocarbon (THC)] is used as the carrier gas. This gas is conveniently contained in 0.84 m^3 (30 ft^3) aluminum cylinders. Carrier gas of poorer quality

may result in spurious peaks in sample chromatograms. A Brooks, Type 1355-00F1AAA rotameter (or equivalent) with an R-215-AAA tube and glass float is used to set column flow.

8.2 System performance mixture. A mixture of three target compounds (e.g., benzene, trichloroethylene, and styrene) in nitrogen is used for monitoring instrument performance. The approximate concentration for each of the compounds in this mixture is 10 parts per billion (ppb). This mixture is manufactured in small, disposable gas cylinders [at 275 kPa (40 psi)] from Scott Specialty Gases, or equivalent.

8.3 Reagent grade nitrogen gas. A small disposable cylinder of high purity nitrogen gas is used for blank injections.

8.4 Sampling syringes. Gas-tight syringes, without attached shut-off valves (Hamilton Model 1002LT, or equivalent) are used to introduce accurate sample volumes into the high pressure injectors on the portable gas chromatograph. Gas syringes with shut-off valves are not recommended because of memory problems associated with the valves. For samples suspected of containing high concentrations of volatile compounds, disposable glass syringes (e.g, Glaspak, or equivalent) with stainless steel/Teflon® hub needles are used.

8.5 High pressure filler. An adapter (Photovac SA101, or equivalent) for filling the internal carrier gas reservoir on the portable GC is used to deliver "zero" air.

9. Procedure

9.1 Instrument Setup

9.1.1 The portable gas chromatograph must be prepared prior to use in the ambient survey sampling. The pre-sampling activities consist of filling the internal carrier gas cylinder, charging the internal power supply, adjusting individual column carrier gas flows, and stabilizing the photoionization detector.

9.1.2 The internal reservoir is filled with "zero" air. The internal 12V, 6AH lead/acid battery can be recharged to provide up to eight hours of operation. A battery

which is discharged will automatically cause the power to the instrument to be shut down and will require an overnight charge. During AC operation, the batteries will automatically be trickle-charged or in a standby mode.

9.1.3 The portable GC should be operated (using the internal battery power supply) at least forty minutes prior to collection of the first sample to insure that the photoionzation detector has stabilized. Upon arriving at the area to be sampled, the unit should be connected to AC power, if available.

9.2 Sample Collection

9.2.1 After the portable gas chromatograph is located and connected to 110V AC, the carrier gas flows must be adjusted. Flows to the 1.22 meter, 5% SE-30 and 0.66 meter, 3% SP2100 columns are adjusted with needle valves. Flows of 60 cm^3/min (5% SE-30) and 30 cm^3/min (3% SP2100) are adjusted by means of a calibrated rotameter. Switching between the two columns is accomplished by turning the valve located beneath the electronic module. During long periods of inactivity, the flows to both columns should be reduced to conserve pressure in the internal carrier gas supply. The baseline on the recorder/integrator is set to 20% full scale.

9.2.2 Prior to analysis of actual samples, an injection of the performance evaluation mixture must be made to verify chromatographic and detector performance. This is accomplished by withdrawing 1.0 mL samples of this mixture from the calibration cylinder and injecting it onto the 3% SP2100 column. The next sample analyzed should be a blank, consisting of reagent grade nitrogen.

9.2.3 Ambient air samples are injected onto the 3% SP2100 column. The chromatogram is developed for 15 minutes. Samples which produce particularly complex chromatograms,

especially for early eluting components, are reinjected on the 5% SE-30 column. [Note: In no instance should a syringe which has been used for the injection of the calibrant/system performance mixture be used for the acquisition and collection of samples, or vice versa.]

9.2.4 Samples have generally been collected from the ambient air at sites which are near suspected sources of VOCs and SVOCs and compared with those which are not. Typically, selection of sample locations is based on the presence of chemical odors. Samples collected in areas without detectable odors have not shown significant PID responses. Therefore, sampling efforts should be initially concentrated on "suspect" environments (i.e., those which have appreciable odors). The objective of the sampling is to locate sources of the target compounds. Ultimately, samples should be collected throughout the entire location, but with particular attention given to areas of high or frequent occupation.

9.3 Sample Analysis

9.3.1 Qualitative analysis. Positive identification of sample components is not the objective of this "screening" procedure. Visual comparison of retention times to those in a standard chromatogram (Figure B-1) are used only to predict the probable sample component types.

9.3.2 Estimation of levels. As with qualitative analysis, estimates of component concentrations are extremely tentative and are based on instrument responses to the calibrant species (e.g., benzene, trichloroethylene, styrene), the proposed component identification, and the difference in response between sample component and calibrant. For purposes of locating pollutant emission sources, roughly estimated concentrations and suspected compound types are considered sufficient.

10. Performance Criteria and Quality Assurance

Required quality assurance measures and guidance concerning performance criteria that should be achieved within each laboratory are summarized and provided in the following section.

10.1 Standard Operating Procedures

10.1.1 SOPs should be generated by the users to describe and document the following activities in their laboratory: (1) assembly, calibration, leak check, and operation of the specific portable GC sampling system and equipment used; (2) preparation, storage, shipment, and handling of the portable GC sampler; (3) purchase, certification, and transport of standard reference materials; and (4) all aspects of data recording and processing, including lists of computer hardware and software used.

10.1.2 Specific stepwise instructions should be provided in the SOPs and should be readily available to and understood by the personnel conducting the survey work.

10.2 Quality Assurance Program

10.2.1 Reagent and materials control. The carrier gas employed with the portable GC is "zero air" containing less than 0.1 ppm VOCs. System performance mixtures are certified standard mixtures purchased from Scott Specialty Gases, or equivalent.

10.2.2 Sampling protocol and chain of custody. Sampling protocol sheets must be completed for each sample. Specifics of the sample with regard to sampling location, sample volume, analysis conditions, and supporting calibration and visual inspection information are detailed by these documents. An example form is exhibited in Table B-3.

10.2.3 Blanks, Duplicates, and System Performance Samples

10.2.3.1 Blanks and Duplicates. Ten percent of all injections made to the portable GC are blanks,

where the blank is reagent grade nitrogen gas. This is the second injection in each sampling location. An additional 10% of all injections made are duplicate injections. This will enhance the probability that the chromatogram of a sample reflects only the composition of that sample and not any previous injection. Blank injections showing a significant amount of contaminants will be cause for remedial action.

10.2.3.2 System Performance Mixture. An injection of the system performance mixture will be made at the beginning of a visit to a particular sampling location (i.e., the first injection). The range of acceptable chromatographic system performance criteria and detector response is shown in Table B-4. These criteria are selected with regard to the intended application of this protocol and the limited availability of standard mixtures in this area. Corrective action should be taken with the column or PID before sample injections are made if the performance is deemed out-of-range. Under this regimen of blanks and system performance samples, approximately eight samples can be collected and analyzed in a three hour visit to each sampling location.

10.3 Method Precision and Accuracy

The purpose of the analytical approach outlined in this method is to provide presumptive information regarding the presence of selected VOCs and SVOCs emissions. In this context, precision and accuracy are to be determined. However, quality assurance criteria are described in Section 10.2 which insure the samples collected represent the ambient environment.

10.4 Range and Limits of Detection

The range and limits of detection of this method are highly compound dependent due to large differences in response of the portable GCs photoionization detector to the various

target compounds. Aromatic compounds and olefinic halogenated compounds will be detected at lower levels than the halomethanes or aliphatic hydrocarbons. The concentration range of application of this method is approximately two orders of magnitude.

TABLE B-1

ESTIMATED LIMITS OF DETECTION (LOD) FOR SELECTED VOCs
BASED ON 1 uL SAMPLE VOLUME

Compound	LOD (ng)	LOD (ppb)
Chloroform[a]	2	450
1,1,1-Trichloroethane[a]	2	450
Carbon tetrachloride[a]	2	450
Benzene	.006	2
1,2-Dichloroethane[b]	.05	14
Trichloroethylene[b]	.05	14
Tetrachloroethylene[b]	.05	14
1,2-Dibromoethane	.02	2
p-Xylene[c]	.02	4
m-Xylene[c]	.02	4
o-Xylene[d]	.01	3
Styrene[d]	.01	3

[a]Chloroform, 1,1,1-Trichloroethane, and Carbon tetrachloride coelute on 0.66 m 3% SP2100.
[b]1,2-Dichloroethane, Tricholroethylene, and Tetrachloroethylene coelute on 0.66 m 3% SP2100.
[c]p-Xylene and m-Xylene coelute on 0.66 m 3% SP2100.
[d]Styrene and o-Xylene coelute on 0.66 m 3% SP2100.

TABLE B-2

COMMERCIALLY AVAILABLE PORTABLE VOC DETECTION INSTRUMENTS

Monitor	Detection principle	Range, ppm	Sensitivity	Response time, s	Accessories	Calibration Techniques	Weaknesses	Service Rate	Lack of Response	Cost, $	Samp Rate L/m
SSU,SSI SSS,SBO (AID, Inc.	PID, FID	0-200, 0-2000, 0-10,000	0.1 ppm at 0-200 ppm	<5		o Bag Sampling	o Umbilical cord too short o Digital readout hard to read o Flame out frequently	8 hrs		4,300	1.5
OVA 108, 128 Century Systems, Inc. (Foxboro)	FID	0-10, 0-100, 0-1000, 0-10,000, 0-100,000	0.2 ppm (Model 128) 0.5 ppm (Model 108)	2 2	o Thermal Desorbers available o Optional GC available	o Head Space o Direct Injection o Bag Samp.	o Battery failure o Sample line kinks o Compounds containing O_2/N give low response o Neg. resp. to CO/CO_2	8 hrs		6,300	
PI-101 (HNu Systems, Inc)	PID	1 1-20 1-200 1-2000	0.1 ppm Low molecular weights aromatics	<5	o Three lamps available o 9.5 (aromatics) o 10.2 (2-4 compounds) o 11.7 (halocarbons)	o External Gas Cyl. o Bag Samp.	o Three lamps - may miss something	10 hrs	o Cl hydrocarbons o CH_4	4,955	0.5
TLV Sniffer (Bacharach)	Catalytic combustion	0-500 0-5000 0-50,000	2.0 ppm	5		o Bag Samp. o Head Space o Bag Samp.				900	
Ecolyzer 400 (Energetics Science)	Catalytic combustion	0-100% LFL	1% LFL	15			o Changes in gas temp/humidity effects response				
Miran 1A (Foxboro)	IR	ppm to %	1 ppm	4,10 40						9,500	
Miran 1B (Foxboro)	IR	ppm to %								12,500	
Scentor (Sentex)	GC/EC, Argon ionization PID		0.01 ppb Cl organics	2	Preconcentrator Thermal Desorption GC Columns Auto Cal. from Integral Gas Cylinder	o Internal gas cyl. o Preconcentrator o GC Column				12,950	
Photovac Standard Automatic Computer Auto Comp. Communication	PID (UV Light)	0	0.1 ppb Benzene with signal-to-noise ratio 4:1, Good for aromatics	2	o Dual Column o Manual/Auto Injection o Column Cond. o Pre-flush o Auto Dial Modem o Programmable		o Column operates at ambient temp. o STD in lab, then to field at diff. temp o Can't inject liquid samp. o Light fractions interfere		o H_2O o O_2	6,995 8,995 10,500 10,955 12,955	
Photovac Tip	PID	0-2000 ppm	0.05 ppm Benzene	3							

TABLE B-3

PORTABLE GAS CHROMATOGRAPH
SAMPLING DATA SHEET

DATE: _____ LOCATION: _____ TIME: _____

CHROMATOGRAPHIC CONDITIONS: _____

COLUMN 1: COLUMN TYPE:

I.D. (mm): _____ LENGTH (mm): _____ FLOW (mL/min): _____

COLUMN 2: COLUMN TYPE:

I.D. (mm): _____ LENGTH (mm): _____ FLOW (mL/min): _____

INJ. NO.	INJ. VOL.	COLUMN NO.	SETTING	LOCATION

SITE PLAN (indicate sampling locations):

DATE _____ SIGNATURE _____

TABLE B-4

SYSTEM PERFORMANCE CRITERIA FOR PORTABLE GC[a]

Criteria	Test Compound	Acceptable Range	Suggested Corrective Action
PID Response	Trichloroethylene	$\geq 10^8$ uV-sec/ng	Re-tune or replace lamp
Elution Time	Styrene	2.65 $\pm$ 0.15 min	Inspect for leaks, adjust carrier flow
Resolution[b]	Benzene/Trichloroethylene	$\geq$ 1.4	Replace column

[a]Based on analysis of a vapor mixture of benzene, styrene, and trichloroethylene.
[b]Define by: $R + = 2d/(W_1+W_2)$; where d = distance between the peaks and W = peak width at base.

TABLE B-5

ESTIMATED LIMITS OF DETECTION (LOD) FOR SELECTED VOCs

Compound	LOD (ng)	LOD (ppb)
Chloroform[a]	2	450
1,1,1-Trichloroethane[a]	2	450
Carbon tetrachloride[a]	2	450
Benzene	.006	2
1,2-Dichloroethane[b]	.05	14
Trichloroethylene[b]	.05	14
Tetrachloroethylene[b]	.05	14
1,2-Dibromoethane	.02	2
p-Xylene[c]	.02	4
m-Xylene[c]	.02	4
o-Xylene[d]	.01	3
Styrene[d]	.01	3

[a]Chloroform, 1,1,1-Trichloroethane, and Carbon tetrachloride coelute on 0.66 m 3% SP2100.
[b]1,2-Dichloroethane, Trichloroethylene, and Tetrachloroethylene coelute on 0.66 m 3% SP2100.
[c]p-Xylene and m-Xylene coelute on 0.66 m 3% SP2100.
[d]Styrene and o-Xylene coelute on 0.66 m 3% SP2100.

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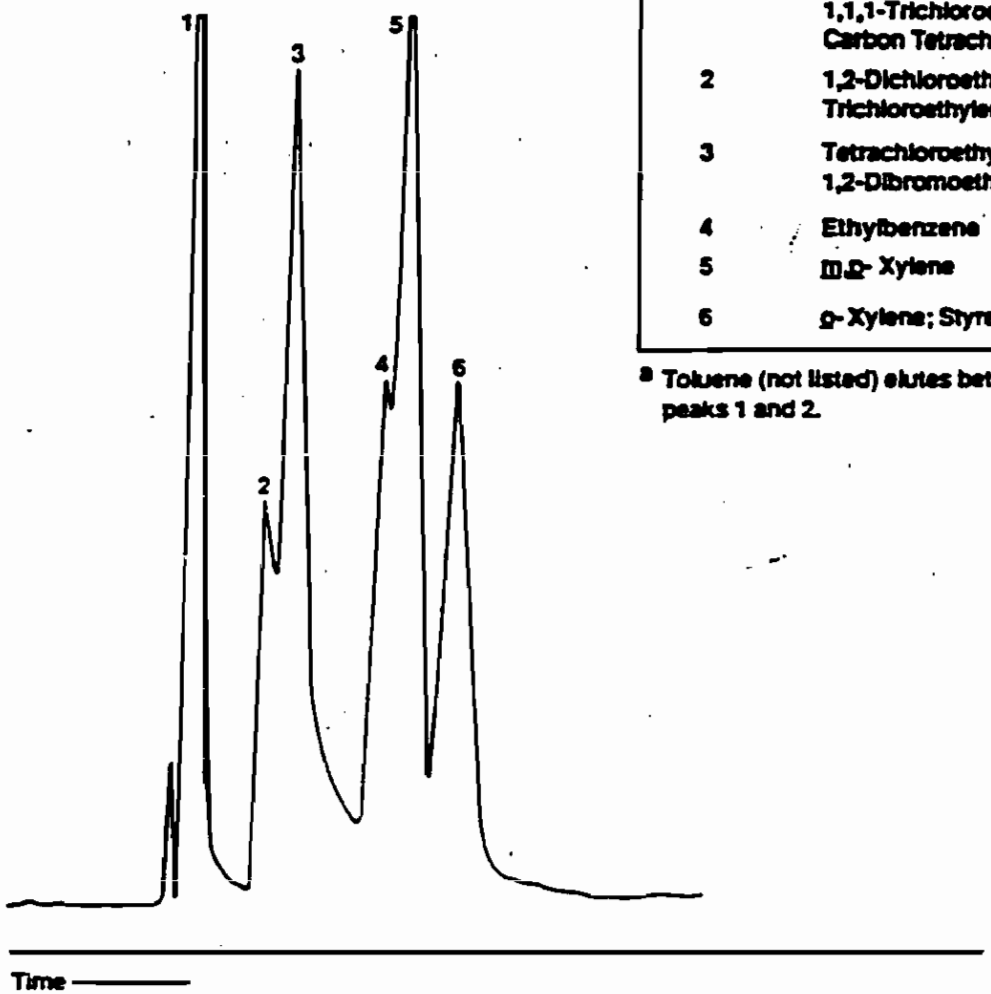


Peak Assignments For Standard Mixture

Peak No.	Compound(s)[a]
1	Benzene; Chloroform; 1,1,1-Trichloroethane; Carbon Tetrachloride
2	1,2-Dichloroethane; Trichloroethylene
3	Tetrachloroethylene; 1,2-Dibromoethane
4	Ethylbenzene
5	m,p- Xylene
6	o- Xylene; Styrene

[a] Toluene (not listed) elutes between peaks 1 and 2.

FIGURE B-1. TYPICAL CHROMATOGRAM OF VOCs DETERMINED BY A PORTABLE GC

APPENDIX C

INSTALLATION AND OPERATION PROCEDURES FOR
U.S. ENVIRONMENTAL PROTECTION AGENCY'S
URBAN AIR TOXIC POLLUTANT PROGRAM SAMPLER

1. Scope

1.1 The subatmospheric sampling system described in this method has been modified and redesigned specifically for use in USEPA's Urban Air Toxic Pollutant Program (UATP), a joint project of USEPA's Office of Air Quality Planning and Standards, the Environmental Monitoring Systems Laboratory, and the participating state air pollution control agencies. The purpose of UATP is to provide analytical support to the states in their assessment of potential health risks from certain toxic organic compounds that may be present in urban atmospheres. The sampler is described in the paper, "Automatic Sampler for Collection of 24-Hour Integrated Whole-Air Samples for Organic Analysis," to be presented at the 1988 Annual Meeting of APCA, Dallas, Texas, June, 1988 (Paper No. 88-150.3).

1.2 The sampler is based on the collection of whole air samples in 6-liter, SUMMA® passivated stainless steel canisters. The sampler features electronic timer for ease, accuracy and flexibility of sample period programming, an independently setable presample warm-up and ambient air purge period, protection from loss of sample due to power interruptions, and a self-contained configuration housed in an all-metal portable case, as illustrated in Figure C-1.

1.3 The design of the sampler is pumpless, using an evacuated canister to draw the ambient sample air into itself at a fixed flow rate (3-5 cm^3/min) controlled by an electronic mass flow controller. Because of the relatively low sample flow rates necessary for the integration periods, auxiliary flushing of the sample inlet line is provided by a small, general-purpose vacuum pump (not in contact with the sample air stream). Further, experience has shown that inlet lines and surfaces sometimes build up or accumulate substantial concentrations of organic materials under stagnant (zero flow rate) conditions. Therefore such lines and surfaces need to be purged and equilibrated to the sample air for some time prior to the beginning of the actual sample collection period. For this reason, the sampler includes dual timers, one of which is set to start the pump several hours prior to the specified start of the sample period to purge the inlet lines and

surfaces. As illustrated in Figure C-1, sample air drawn into the canister passes through only four components: the heated inlet line, a 2-micron particulate filter, the electron flow controller, and the latching solenoid valve.

2. Summary of Method

2.1 In operation, timer 1 is set to start the pump about 6 hours before the scheduled sample period. The pump draws sample air in through the sample inlet and particulate filter to purge and equilibrate these components, at a flow rate limited by the capillary to approximately 100 cm^3/min. Timer 1 also energizes the heated inlet line to allow it to come up to its controlled temperature of 65 to 70 degrees C, and turns on the flow controller to allow it to stabilize. The pump draws additional sample air through the flow controller by way of the normally open port of the 3-way solenoid valve. This flow purges the flow controller and allows it to achieve a stable controlled flow at the specified sample flow rate prior to the sample period.

2.2 At the scheduled start of the sample period, timer 2 is set to activate both solenoid valves. When activated, the 3-way solenoid valve closes its normally open port to stop the flow controller purge flow and opens its normally closed port to start flow through the aldehyde sample cartridges. Simultaneously, the latching solenoid valve opens to start sample flow into the canister.

2.3 At the end of the sample period, timer 2 closes the latching solenoid valve to stop the sample flow and seal the sample in the canister and also de-energizes the pump, flow controller, 3-way solenoid, and heated inlet line. During operation, the pump and sampler are located external to the sampler. The 2.4 meter (8 foot) heated inlet line is installed through the outside wall, with most of its length outside and terminated externally with an inverted glass funnel to exclude precipitation. The indoor end is terminated in a stainless steel cross fitting to provide connections for the canister sample and the two optional formaldehyde cartridge samples.

3. Sampler Installation

3.1 The sampler must be operated indoors with the temperature between 20-32°C (68 to 90°F). The sampler case should be located conveniently

on a table, shelf, or other flat surface. Access to a source of 115 vac line power (500 watts min) is also required. The pump is removed from the sampler case and located remotely from the sampler (connected with a 1/4 inch O.D. extension tubing and a suitable electrical extension cord).

3.2 Electrical Connections (Figure C-1)

3.2.1 The sampler cover is removed. The sampler is not plugged into the 115 vac power until all other electrical connections are completed.

3.2.2 The pump is plugged into its power connector (if not already connected) and the battery connectors are snapped onto the battery packs on the covers of both timers.

3.2.3 The sampler power plug is inserted into a 115 volts ac line grounded receptacle. The sampler must be grounded for operator safety. The electrical wires are routed and tied so they remain out of the way.

3.3 Pneumatic Connections

3.3.1 The length of 1/16 inch O.D. stainless steel tubing is connected from port A of the sampler (on the right side of the flow controller module) to the air inlet line.

3.3.2 The pump is connected to the sampler with 1/4 inch O.D. plastic tubing. This tubing may be up to 7 meters (20 feet) long. A short length of tubing is installed to reduce pump noise. All tubing is conveniently routed and, if necessary, tied in place.

4. Sampler Preparation

4.1 Canister

4.1.1 The sample canister is installed no more than 2 days before the scheduled sampling day.

4.1.2 With timer #1 ON, the flow controller is allowed to warm up for at least 15 minutes, longer if possible.

4.1.3 An evacuated canister is connected to one of the short lengths of 1/8 inch O.D. stainless steel tubing from port B (solenoid valve) of the sampler. The canister valve is left closed. The Swagelok fitting on the canister must not be cross-threaded. The connection is tightened snugly with a wrench.

4.1.4 The end of the other length of stainless steel tubing from port B (solenoid valve) is connected with a Swagelok plug.

4.1.5 If duplicate canisters are to be sampled, the plug is removed from the second 1/8 inch O.D. stainless steel tubing from port B (solenoid valve) and the second canister is connected. The canister valve is left closed.

4.1.6 The ON button of timer #2 is pressed. The flow through the flow controller should be stopped by this action.

4.1.7 The flow controller switch is turned to "READ" and the zero flow reading is obtained. If this reading is not stable, wait until the reading is stabilized.

4.1.8 The flow controller switch is turned to "SET" and the flow setting is adjusted to the algebraic SUM of the most recent entry on Table C-1 and the zero reading obtained in step 4.1.7 (If the zero reading is negative, SUBTRACT the zero reading from the Table C-1 value). Be sure to use the correct Table C-1 flow value for one or two canisters, as appropriate. [Note: If the analytical laboratory determines that the canister sample pressure is too low or too high, a new flow setting or settings will be issued for the sampler. The new flow setting should be recorded in Table C-1 and used until superseded by new settings.]

4.1.9 Timer #2 is turned OFF to again start the flow through the flow controller. With the pump (timer #1) ON and the sampling valve (timer #2) OFF, the flow controller is turned to "READ" and the flow is verified to be the same as the flow setting made in step 4.1.8. If not, the flow setting is rechecked in step 4.1.8 and the flow setting is readjusted if necessary.

4.1.10 The OFF button of timer #1 is pressed to stop the pump.

4.1.11 The canister valve(s) are fully opened.

4.2 Timers

4.2.1 Timer #2 is set to turn ON at the scheduled ON time for the sample period, and OFF at the scheduled OFF time. (See the subsequent section on setting the timers.)
Normal ON time: 12:00 AM on the scheduled sampling day.
Normal OFF time: 11:59 PM on the scheduled sampling day.

(The OFF time is 11:59 PM instead of 12:00 AM so that the day number for the OFF time is the same as the day number for the ON time.) Be sure to set the correct day number.

4.2.2 Timer #1 is set to turn ON six (6) hours before the beginning of the scheduled sample period and OFF at the scheduled OFF time for the sample period (same OFF time as for timer #2). (See the subsequent section on setting the timers.) Normal ON time: 06:00 PM on the day prior to the scheduled sampling day. Normal OFF time: 11:59 PM on the scheduled sampling day. [Note: The timers are wired so that the pump will be on whenever either timer is on. Thus the pump will run if timer #2 is ON even if timer #1 is OFF.]

4.2.3 The elapsed time meter is set to 0.

4.3 Sampler Check

4.3.1 The following must be verified before leaving the sampling site:

(1) Canister(s) is (are) connected properly and the unused connection is capped if only one canister is used.
(2) Canister valve(s) is (are) opened.
(3) Both timers are programmed correctly for the scheduled sample period.
(4) Both timers are set to "AUTO".
(5) Both timers are initially OFF.
(6) Both timers are set to the correct current time of day and day number.
(7) Elasped time meter is set to 0.

4.4 Sampler Recovery (Post Sampling)

4.4.1 The valve on the canister is closed.

4.4.2 The canister is disconnected from the sampler, the sample data sheet is completed, and the canister is prepared for shipment to the analytical laboratory.

4.4.3 If two canisters were sampled, step 2.4.2 is repeated for the other canister.

5. Timer Setting

Since the timers are 7-day timers, the days of the week are numbered from 1 to 7. The assignment of day numbers to days of the week is

indicated on the timer keypad: 1 = Sunday, 2 = Monday, 3 = Tuesday, 4 = Wednesday, 5 = Thursday, 6 = Friday, and 7 = Saturday. This programming is quite simple, but some timers may malfunction or operate erratically if not programmed exactly right. To assure correct operation, the timers should be reset and completely reprogrammed "from scratch" for each sample. The correct current time of day is re-entered to reprogram the timer. Any program in the timer's memory is erased by resetting the timer (pressing the reset button). The timer is set by the following:

(1) pressing the reset button,
(2) entering the correct day number and time of day,
(3) entering the ON and OFF times for the sample period, and
(4) verifying that the ON and OFF time settings are correct.

5.1 Timer Reset

The timer reset button is pressed, which is recessed in a small hole located just above the LED (light emitting diode) indicator light. A small object that will fit through the hole, such as a pencil, match, or pen is used to press the timer. After reset, the timer display should show |1| |10:00|. [Note: The timers may operate erratically when the batteries are discharged, which happens when the sampler is unplugged or without power for several hours. When the sampler is again powered up, several hours may be required to recharge the batteries. To avoid discharging the batteries, the battery pack should be disconnected from the timer when the sampler is unplugged.]

5.2 Date and Time Entry

The selector switch is turned to SET and the number button corresponding to the day number is pressed. (For example, a "2" is pressed for Monday.) The current time of day is entered. (For example, if the time is 9:00 AM, 900 is pressed.) AM or PM is pressed as applicable. (Display should show |2| |'9:00| for 9:00 AM Monday.) [Note: ' indicates AM and indicates PM.] The CLOCK button is pressed. (Display should show |-| |--:--|) If an error is made, |E| |EE:EE| is shown on the display. The CLEAR button is pressed and the above steps are repeated. The selector switch is turned to AUTO or MAN to verify correct time setting.

5.3 ON and OFF Entry

The selector switch is turned to SET. The ON and OFF program is entered in the following order: day, number, time, AM or PM, ON or OFF. (Example: To turn ON at 12:00 AM on day 5 (Thursday); 5, 1200, AM, ON is entered). (Example: To turn OFF at 11:59 PM on day 5 (Thursday), 5, 11:59, PM, OFF is entered.) If the display indicates an error (|E| |EE:EE|), the timer is reset. The selector switch is turned to AUTO.

5.4 ON and OFF Verification

5.4.1 The selector switch is turned to REVIEW. The number of the scheduled sample day is pressed. ON is pressed. The display should show the time of the beginning of the sample period (for example, |5| |'12:00|). [' indicates AM.] ON is pressed again. The display should show |5| |--:--|, indicating no other ON times are programmed.

5.4.2 OFF is pressed. The display should show the time of the end of the sample period, (for example, |5| |, 11:59|). PM is indicated by the "," mark before the time. OFF is pressed again. The display should show |5| |--:--|, indicating no other OFF times are programmed. The selector is switched to AUTO. If anything is incorrect, the timer is reset and reprogrammed.

TABLE C-1

NET FLOW CONTROLLER SETTING

DATE	1 CANISTER	2 CANISTERS

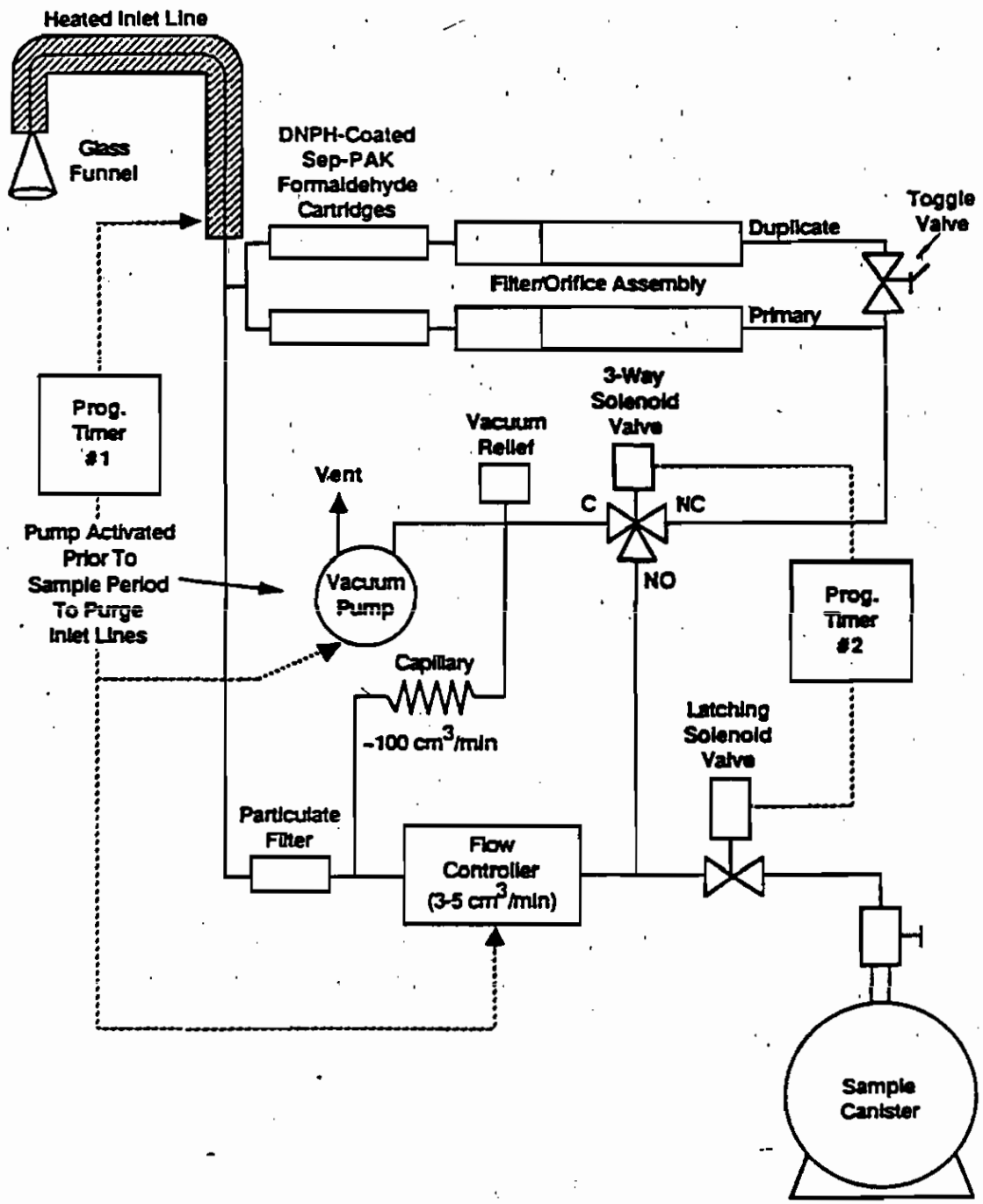


FIGURE C-1. U.S. ENVIRONMENTAL PROTECTION AGENCY UATP SAMPLER SCHEMATIC OF SAMPLE INLET CONNECTIONS

Table 10
Phase I and Phase II
Sample Identification Numbers for Zero Air Samples

Date	Sample ID	Sample Type
11/18/94	12AF4008	Zero Air Blank
11/29/94	12AF4109	Zero Air Blank
12/08/94	12AF4110	Zero Air Blank

Notes:
These samples were collected in order to identify potential exogenous contaminant sources.

3.2.5 Air Sample Data Validation

The purpose of the data evaluation was to verify that the quality control requirements of the data set have been met and to characterize the weaknesses of any questionable data. Due to uncertainty associated with Phase I data, Phase II sampling and analysis strategies were developed incorporating more comprehensive QA/QC evaluation methods in order to facilitate a more rigorous data validation process. Phase I data were formerly reported in the Draft FFI report issued July 1994. Phase II data were subjected to full validation as supported by available field and laboratory QA information. All validated Phase II data are provided in Appendix B.

The data were evaluated based on the following parameters:

- Holding Times
- System Monitoring Compound Analysis
- Blank Analysis
- Bromofluorobenzene (BFB) Tuning Performance
- Instrument Calibration
- Internal Standard Analysis
- Precision (Duplicates)

The USEPA document, *Compendium of Methods For The Determination Of Toxic Organic Compounds in Ambient Air* (June 1988), Method TO-14, defines quality control criteria that the laboratory must meet; however, these criteria do not address data evaluation from a user's perspective.

General evaluation criteria are available in the United States Environmental Protection Agency Contract Laboratory Program's *National Functional Guidelines for Organic Data Review*, February 1994 (Functional Guidelines). According to the Functional Guidelines, when the quality control parameters do not fall within the specific method guidelines, the data evaluator annotates or "flags" the corresponding compounds for samples in which the deficiencies were found. This method was used for the evaluation of Charleston Zone H Focused Field Investigation data. The following flags were used to annotate data exhibiting laboratory and/or field deficiencies or problems:

U ***Undetected*** - The analyte was analyzed for but not detected or found in an sample at a concentration less than five times the corresponding blank concentration; the associated value shown is the Practical Quantitation Limit (PQL).

J ***Estimated value*** - One or more quality control parameters were outside control limits, or the concentration exceeded the method detection limit but was less than the PQL.

UJ ***Undetected and Estimated*** - The analyte was analyzed for but not detected above the listed estimated PQL; the PQL is estimated because one or more quality control parameters were outside control limits.

R ***Unusable Data*** - One or more quality control parameters grossly exceeded control limits.

Where necessary, these flags were affixed to data presented in Appendix B.

Holding times were evaluated. All samples contained within this data set were analyzed within the designated holding time of 30 days.

System monitoring compounds (surrogates) are spiked into samples to establish laboratory performance on individual samples. The surrogate 4-bromofluorobenzene was checked in each sample for the percent recovery.

Nineteen out of 126 samples had surrogate recoveries outside control limits. Two of the 19 recoveries exceeded the upper control limits. In these instances, all positive results were flagged as estimated (J) and the non-detected results were accepted without qualification. Seventeen of the 19 recoveries were less than the control limits and the results were flagged as estimated (J) for positive results and (UJ) for non-detects.

Blanks are clean samples that are processed and analyzed as any other sample to determine the existence and magnitude of potential contamination introduced from exogenous sources during sampling, transport, or analysis. Potential contamination may be introduced by improper decontamination of sampling equipment, by improper sampling procedures, by dirty canisters, during canister transport, and by laboratory contamination. Blanks are treated with the same procedures as samples from the field. Laboratory (method) blanks are prepared from zero-air in the laboratory and processed along with the samples through each sample preparation and analysis step. Field blanks are collected using zero-air and sampling equipment analogous to that used to collect the samples.

When chemicals are found in samples and laboratory blanks analyzed within the same 12-hour period, or in samples and field blanks collected the same week, the usability of the data depends on the judgement of the reviewer and the origin of the blank. According to the Functional Guidelines, a sample result should not be considered positive unless the concentration of the compound in the sample exceeds 10 times the amount in <u>any</u> blank (i.e., method blank, trip

blank, zero air, etc.) for common laboratory contaminants (i.e. methylene chloride) or five times the amount for other constituents. These are referred to as *action levels*.

Blank action levels were compared to sample values. 1,2,4-Trichlorobenzene and meta-and para-xylenes were detected in various method blanks. Only two samples associated with the method blanks were affected in their respective sample. The data were 'U' qualified as non-detect based on the method blank comparison.

The following contaminants were identified in various field blanks and qualified as non-detect (U) due to concentrations less than the respective action level: 1,1,1-trichloroethane was negated in 15 samples, 1,2,4-trichlorobenzene in one sample, 1,2,4-trimethylbenzene in 18 samples, 1,3,5-trimethylbenzene in four samples, 1,4-dichlorobenzene and toluene in 20 samples, 1-ethyl-4-methylbenzene and styrene in 14 samples, benzene in 39 samples, dichlorodifluoromethane and meta-and para-xylenes in 19 samples, ethylbenzene in seven samples, methyl chloride in 24 samples, methylene chloride in 73 samples, and trichlorofluoromethane and o-xylene in 16 samples.

BFB tuning performance checks are performed to ensure appropriate mass resolution, identification, and sensitivity. All ion abundances are normalized to m/z 95, the nominal base peak.

All BFB tuning performance checks in this data set were within the specified control limits.

Initial and continuing calibrations of the instruments with standard solutions are used to check that the instrument is capable of producing acceptable qualitative and quantitative data for the analytes on the target compound list.

An initial calibration is performed to check the performance of the instrument at the beginning of the analytical run and to establish a linear calibration curve. The initial calibration is verified by calculating the relative response factor (RRF) and the percent relative standard deviation (%RSD) for each compound. An RRF less than 0.05 or a %RSD greater than 30 percent is outside the quality control limits for the initial calibration.

In all initial calibrations for styrene, the RRF was less than 0.050 and the %RSD was greater than 30.0 percent. All results for styrene were flagged as unusable (R) for non-detected results and estimated (J) for positive results.

Continuing calibration standard solutions are run periodically to check the daily performance of the instrument and to establish the 12-hour RRF on which the quantitations are based. The initial calibration is verified by calculating the RRF and the percent difference (%D) for each compound. An RRF less than 0.05 or a %D greater than 25 percent is outside the quality control limits for the continuing calibration.

Benzyl chloride, chloroethane, methyl chloride, 1-ethyl-4-methylbenzene, hexachlorobutadiene, styrene, 1,2,4-trichlorobenzene, trichloroethylene, and trichlorofluoromethane exceeded the 25% control limit in various continuing calibrations. These compounds were flagged as estimated (J) for positive results and (UJ) for non-detected results in the associated samples.

Internal standards performance ensures that instrument sensitivity and response are stable during the analysis of each individual standard.

The area of each internal standard for the reported results were all within -50% and +100% of the area of the internal standards in the associated calibration.

Duplicate samples are analyzed to evaluate data precision, which is a measure of the reproduceability of the analysis. The relative percent difference (RPD) between the sample and the duplicate sample results is calculated. According to the TO-14 method, the RPD should not exceed 20% for sample and duplicate values greater than five times the detection limit.

Field duplicates are analyzed to evaluate sampling precision. The RPDs for toluene and trichlorofluoromethane exceeded the 20% control limit in field duplicates N84A2202F2 and N85F4103F2. 1,4-Dichlorobenzene, methyl chloride, and methylene chloride exceeded the 20% control limit in field duplicates 202A3202F2 and 202A3404F2. Methylene chloride and styrene exceeded the 20% control limit in field duplicates 645A2107F2 and 645A4008F2. Styrene, toluene, and trichlorofluoromethane exceeded the 20% control limit in field duplicates 644A3309F2 and 644A3410F2. 1,4-Dichlorobenzene, methylene chloride, and trichlorofluoromethane exceeded the 20% control limit in field duplicates 657A3206F2 and 657A3207F2. 1,4-Dichlorobenzene and toluene exceeded the 20% control limit in field duplicates 036A1203F2 and 036A1204F2. Methylene chloride and trichlorofluoromethane exceeded the 20% control limit in field duplicates 036A2102F2 and 036A2103F2. 1,1,1-Trichloroethane, methylene chloride, tetrachloroethylene, trichlorotrifluoroethane, and meta- and para-xylenes exceeded the 20% control limit in field duplicates 656A2109F2 and 656A2110F2. 1,1,1-Trichloroethane and toluene exceeded the 20% control limit in field duplicates 656A3206F2 and 656A4207F2. There were no compounds to exceed the 20% control limit in field duplicates 656A2302F2 and 656A2403F2. These compounds were not flagged because separate SUMMA canisters were used collecting these samples.

The following list shows the compounds that exceeded 20% of their control limit referenced by the corresponding sample ID's:

N84A2202F2	toluene and trichlorofluoromethane
N85F4103F2	toluene and trichlorofluoromethane

202A3202F2	1,4-dichlorobenzene, methyl chloride, and methylene chloride
202A3404F2	1,4-dichlorobenzene, methyl chloride, and methylene chloride
645A2107F2	methylene chloride and styrene
645A4008F2	methylene chloride and styrene
644A3309F2	styrene, toluene, and trichlorofluoromethane
644A3410F2	styrene, toluene, and trichlorofluoromethane
657A3206F2	1,4-dichlorobenzene, methylene chloride, and trichlorofluoromethane
657A3207F2	1,4-dichlorobenzene, methylene chloride, and trichlorofluoromethane
036A1203F2	1,4-dichlorobenzene and toluene
036A1204F2	1,4-dichlorobenzene and toluene
036A2102F2	methylene chloride and trichlorofluoromethane
036A2103F2	methylene chloride and trichlorofluoromethane
656A2109F2	1,1,1-trichloroethane, methylene chloride, tetrachloroethylene, trichlorotrifluoroethane, and meta- and para-xylenes
656A2110F2	1,1,1-trichloroethane, methylene chloride, tetrachloroethylene, trichlorotrifluoroethane, and meta- and para-xylenes
656A3206F2	1,1,1-trichloroethane and toluene
656A4207F2	1,1,1-trichloroethane and toluene
656A2302F2	none
656A2403F2	none

Methylene chloride exceeded the 20% control limit in the laboratory duplicate sample 036A1101F2. No qualification of the data was made because methylene chloride was previously negated as a result of blank contamination.

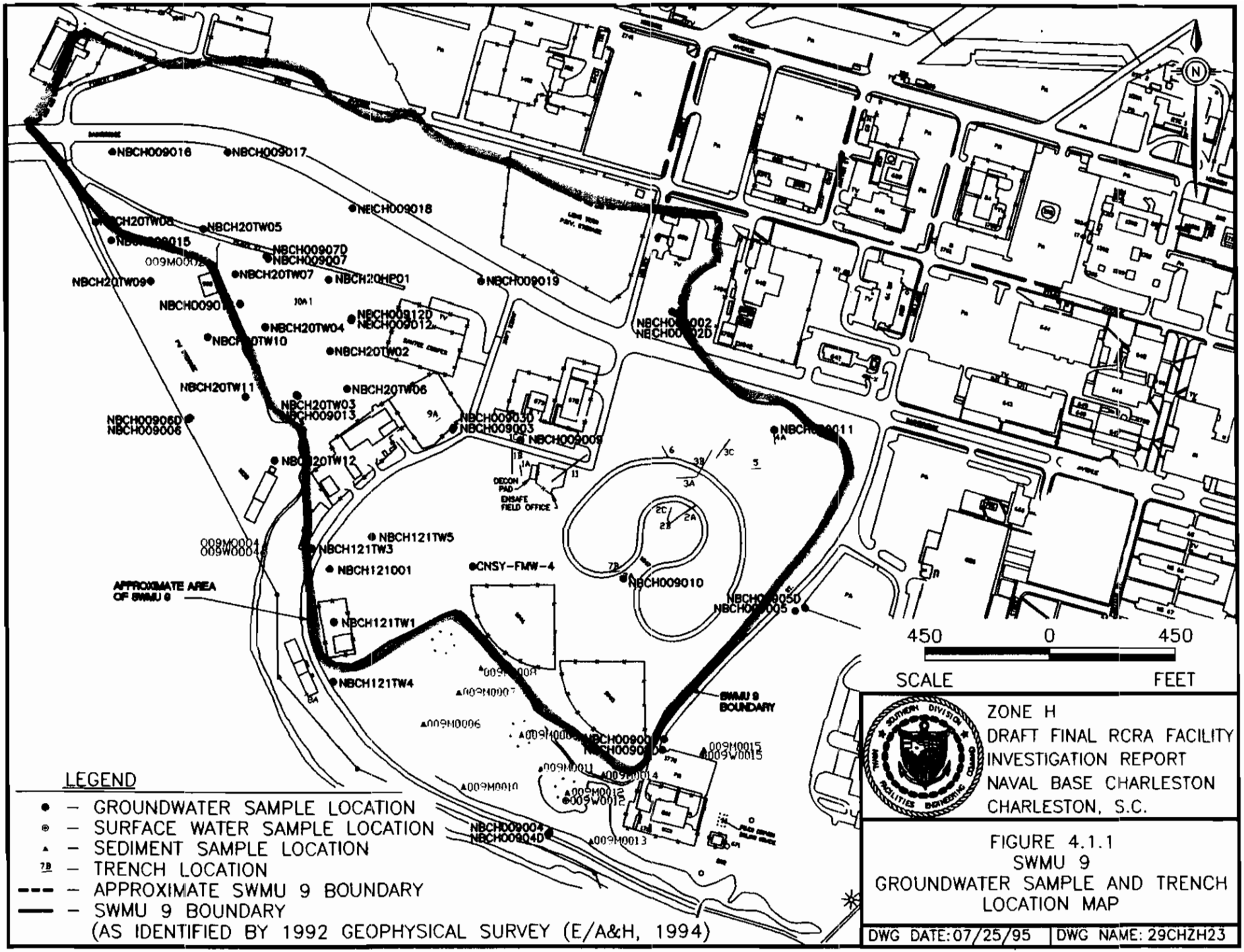
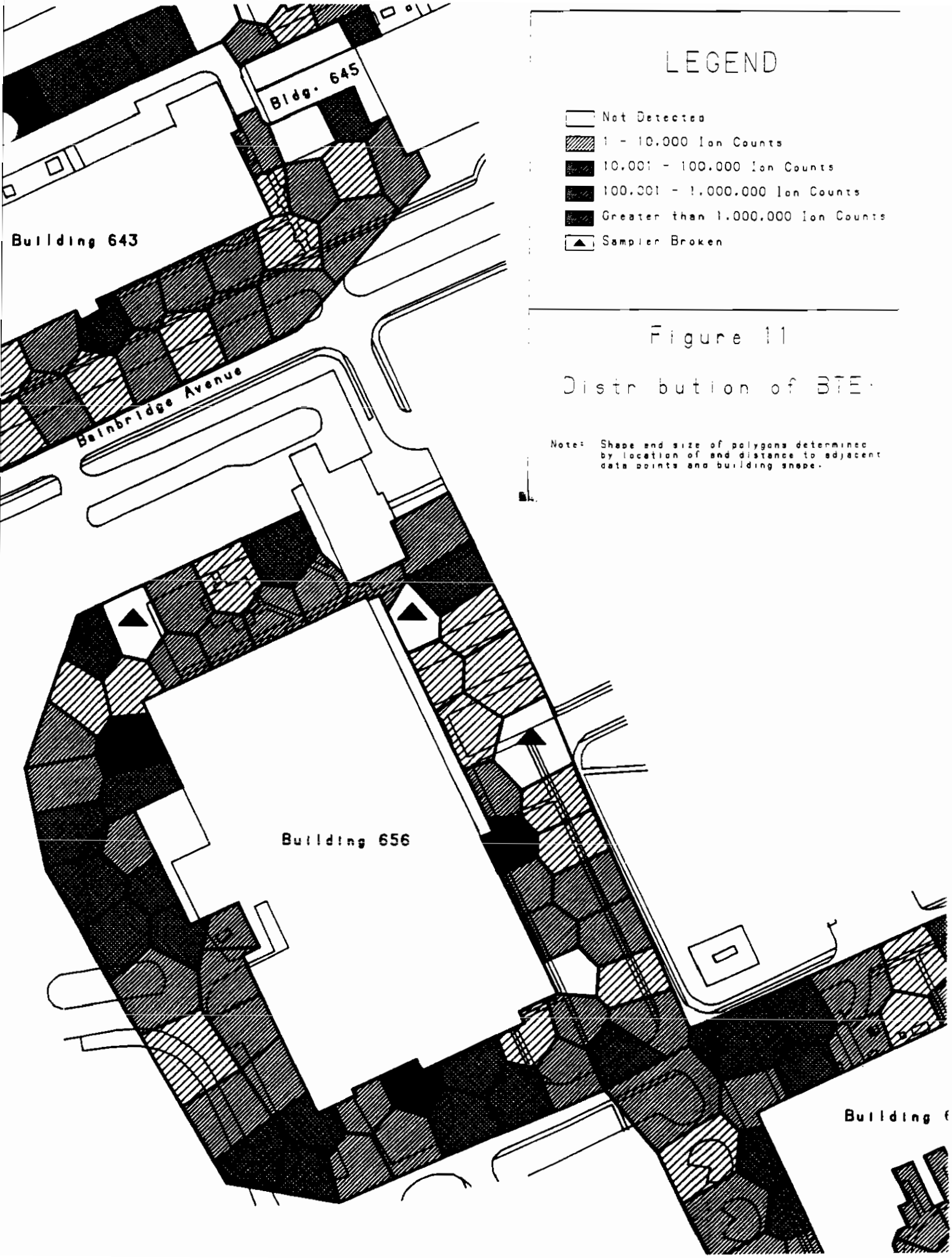

NBCH009016
NBCH009017
NBCH009018
NBCH20TW05
NBCH00907D
NBCH009007
NBCH20TW07
NBCH20HP01
NBCH009019
NBCH20TW09
NBCH20TW04
NBCH20TW02
NBCH20TW11
NBCH20TW06
NBCH20TW03
NBCH009013
NBCH00906D
NBCH009006
NBCH009030
NBCH009003
NBCH009009
DECON PAD
ENSAFE FIELD OFFICE
NBCH121TW5
NBCH121TW3
NBCH121001
CNSY-FMW-4
APPROXIMATE AREA OF SWMU 9
NBCH121TW1
NBCH121TW4
NBCH009010
SWMU 9 BOUNDARY
NBCH009004
NBCH00904D
450 0 450
SCALE FEET
LEGEND
● – GROUNDWATER SAMPLE LOCATION
◉ – SURFACE WATER SAMPLE LOCATION
▲ – SEDIMENT SAMPLE LOCATION
7B – TRENCH LOCATION
– – – APPROXIMATE SWMU 9 BOUNDARY
—— – SWMU 9 BOUNDARY
(AS IDENTIFIED BY 1992 GEOPHYSICAL SURVEY (E/A&H, 1994)
ZONE H
DRAFT FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, S.C.
FIGURE 4.1.1
SWMU 9
GROUNDWATER SAMPLE AND TRENCH
LOCATION MAP
DWG DATE:07/25/95
DWG NAME: 29CHZH23

FIGURE 2. Total FID Volatiles
(calc'd µg/l)

CHARLESTON NAVAL SHIPYARD
CHARLESTON, SOUTH CAROLINA

ARCADIS ENVIRONMENTAL SERVICES, INC.

This map is integral to a written report and should be viewed in that context.



LEGEND

- Not Detected
- 1 - 10,000 Ion Counts
- 10,001 - 100,000 Ion Counts
- 100,001 - 1,000,000 Ion Counts
- Greater than 1,000,000 Ion Counts
- Sampler Broken

Figure 11

Distribution of BTEX

Note: Shape and size of polygons determined by location of and distance to adjacent data points and building shape.

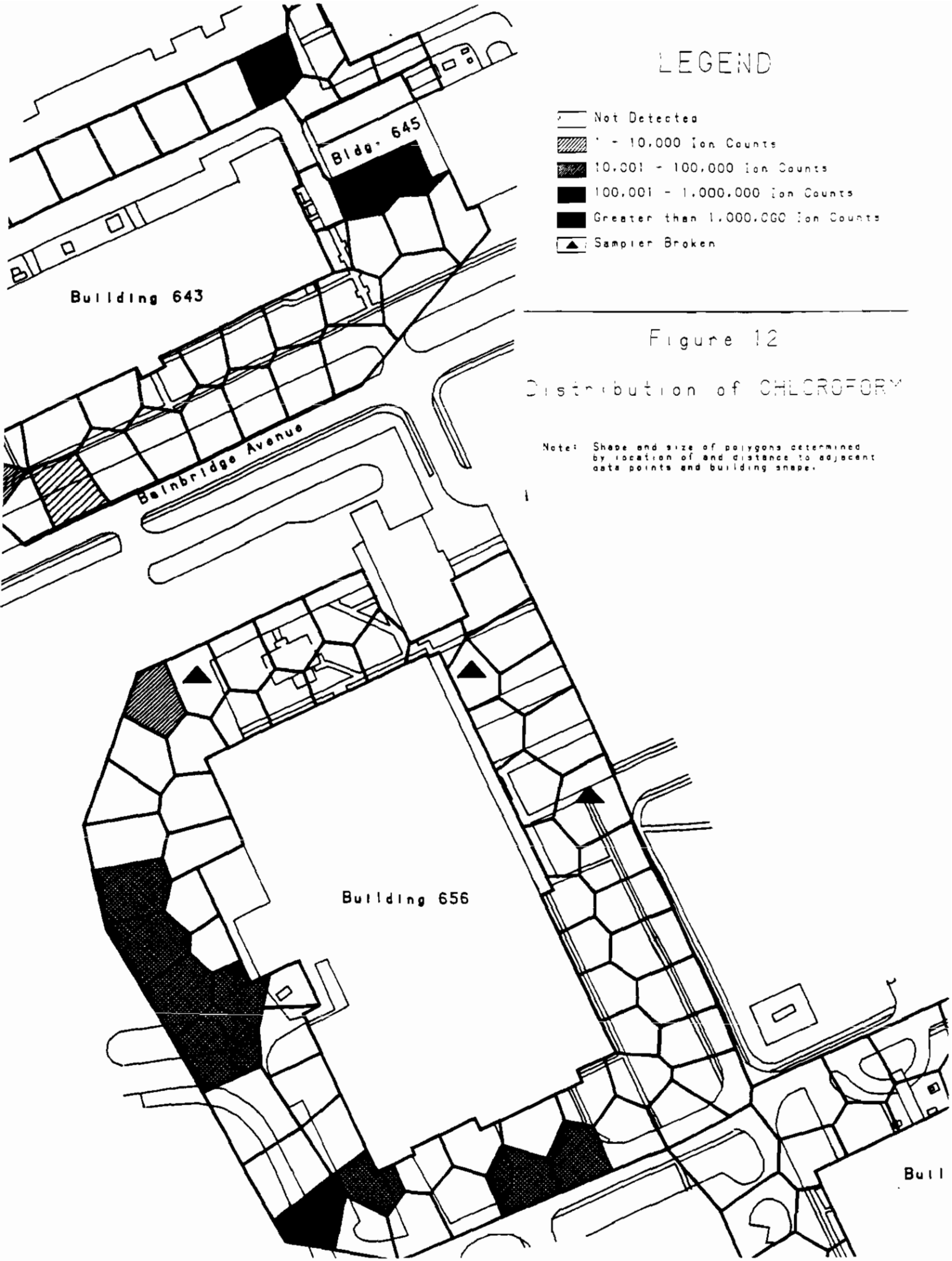


Figure 12

Distribution of CHLOROFORM

Note: Shape and size of polygons determined by location of and distance to adjacent data points and building shape.

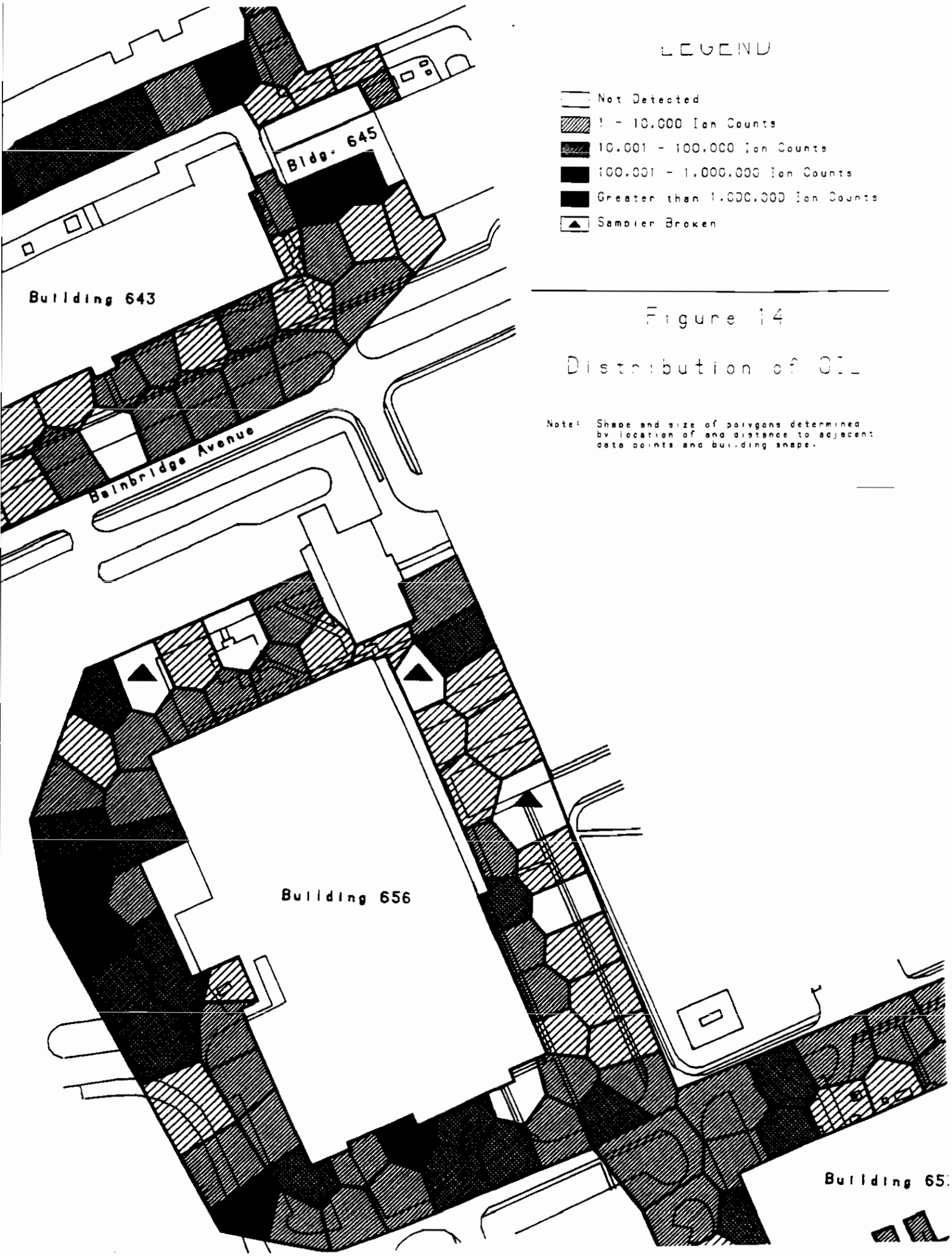


Figure 14

Distribution of OIL

Note: Shape and size of polygons determined by location of and distance to adjacent data points and building shape.

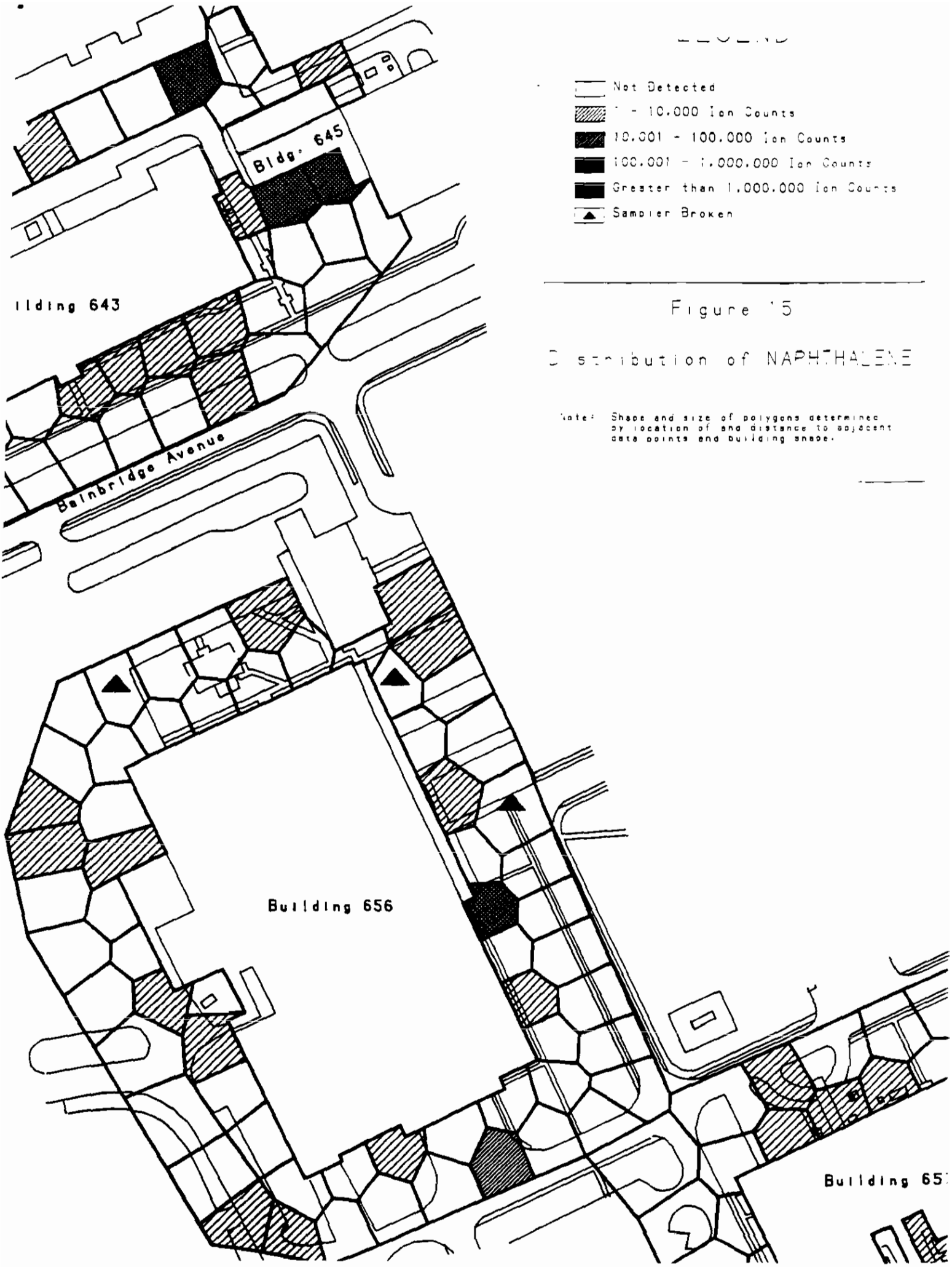


Figure 15

Distribution of NAPHTHALENE

Note: Shape and size of polygons determined by location of and distance to adjacent data points and building shape.

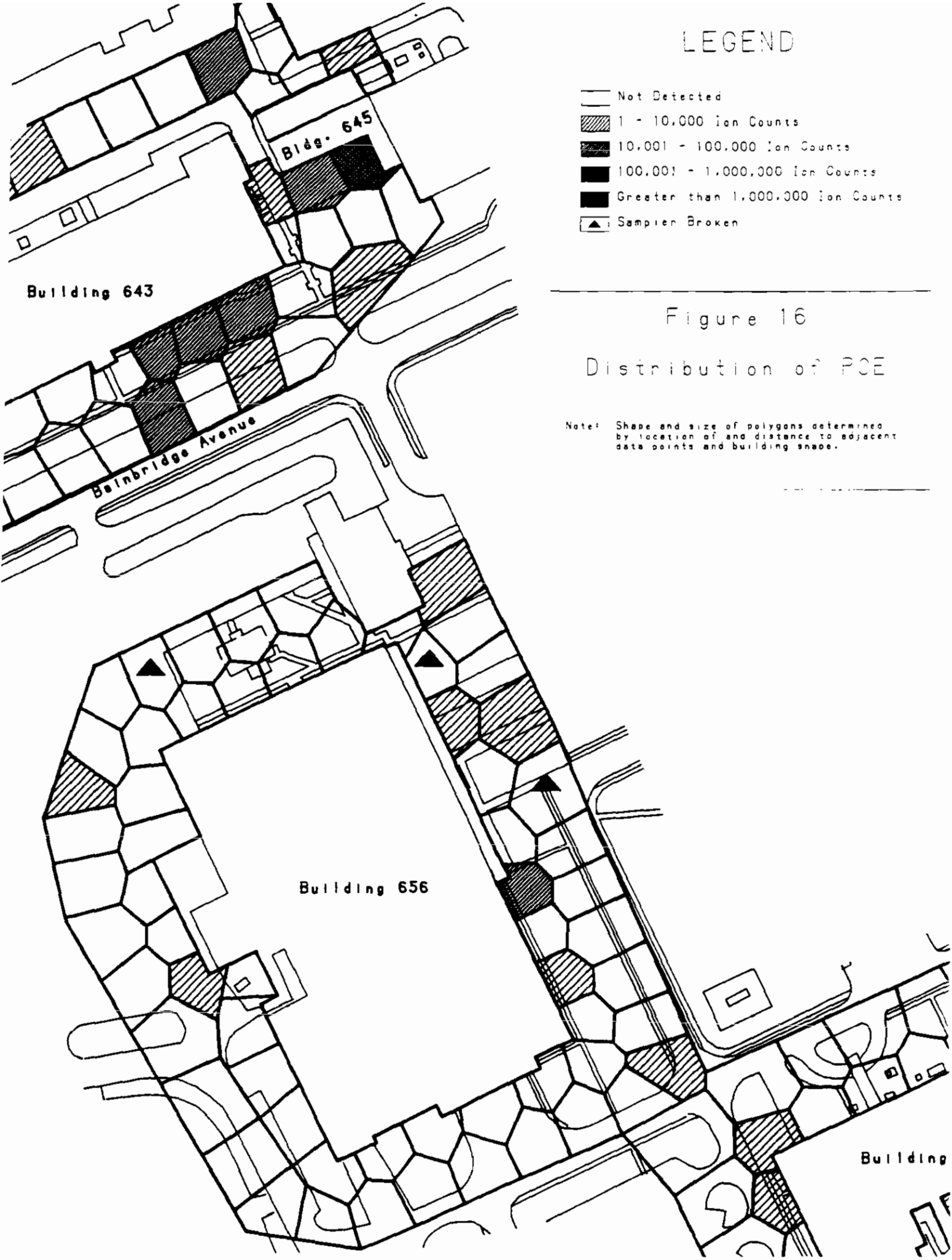


Figure 16

Distribution of PCE

Note: Shape and size of polygons determined by location of and distance to adjacent data points and building shape.

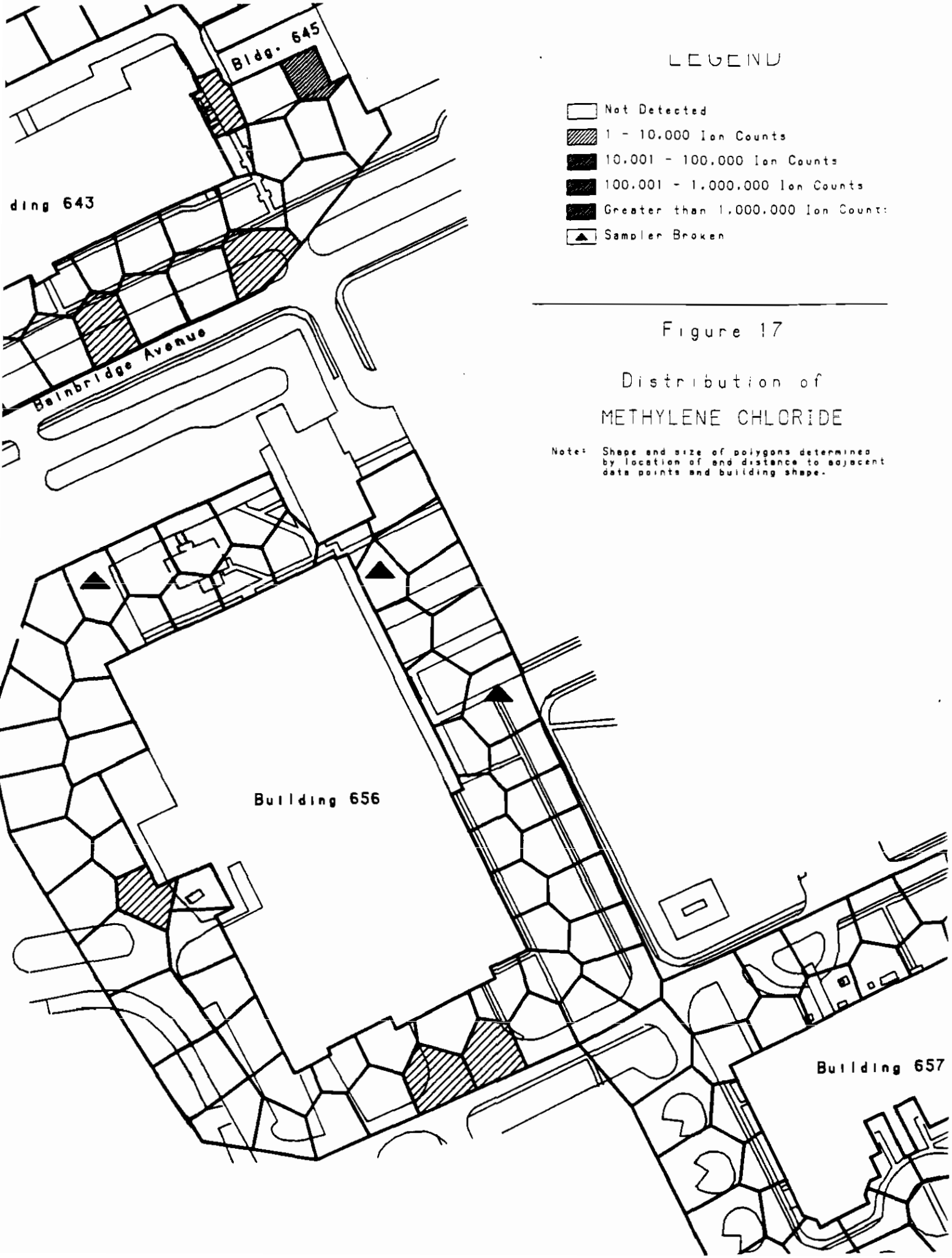


Figure 17

Distribution of

METHYLENE CHLORIDE

Note: Shape and size of polygons determined by location of and distance to adjacent data points and building shape.

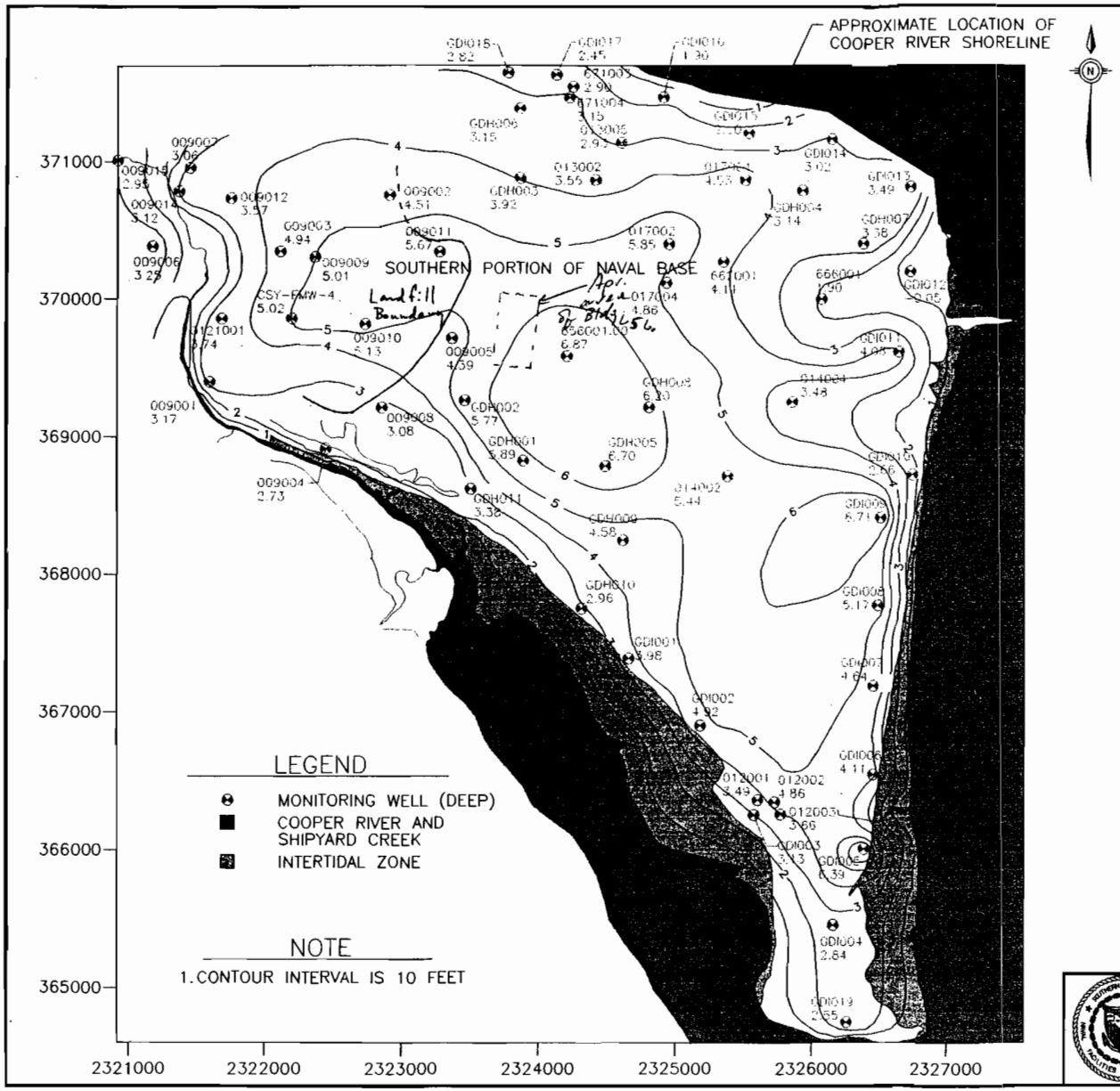
Table 3-9
Comparison of Results from
Soil Gas Survey and Soil Gas Confirmation Soil Samples

Area of Relatively High Soil Gas Response	Soil Samples Collected in Vicinity of Soil Gas Highs	Summary of Soil Sample Analysis	Qualitative Degree of Correlation
West and South sides of Building 656	SGCSB009, GDHSB055, and samples collected at AOC 655	Significant detections of SVOCs at the southwest corner of building and minor detections at eh southeast corner. Low detection of PCE on west side of building.	Low to Moderate
Between Buildings 644 and 643	SGCSB005, SGCSB004, GDHSBO13, GDHSB014, GDHSB066	No SVOCs or VOCs were detected in soil with exception of minor detections of SVOCs bis(2-ethylhexyl)phthalate and di-n-phthalate.	Low
Between Buildings 644 and 643 at the eastern end of the open area.	SGCSB006	No SVOCs were detected. TCE was detected at a minor concentration.	Low
South side of Building 645.	SGCSB007	No SVOCs or VOCs were detected.	None
Northeast corner of Building 640 in the vicinity of the front door.	SGCSB002	No SVOCs were detected. TCE was detected at a minor concentration.	Low
West end of Building 640 in the vicinity of the loading dock.	SGCSB001	No SVOCs or VOCs were detected.	None
North side of Building 84.	SGCSB003	No SVOCs or VOCs were detected.	None
Northwest corner of Building 202	SGCSB008	No SVOCs or VOCs were detected.	None

East side of Building 656 in the vicinity of the automatic teller machine.	655SB006	Minor detection of SVOC, bis(2-ethylhexyl)phthalate. No detections of VOCs.	Low

XX Passive Soil-Gas Survey Conclusions

Confirmatory soil samples were only collected in areas demonstrating the highest soil gas responses and, generally, the correlation between the soil gas and soil analytical results were low to non-existant. No further evaluation of soil gas results will be attempted.



Coordinates X	Coordinates Y	Well	Top of Casing Elevation	Depth to Groundwater (5/11/95)	Groundwater Elevation
2322180	369859.1	CSY-FMW-4	8.05	3.03	5.02
2321585	369398.0	009001	9.68	6.51	3.17
2322898	370759.8	009002	10.89	6.38	4.51
2322112	370341.4	009003	10.42	5.48	4.94
2322451	368919.5	009004	7.10	4.37	2.73
2323331	369705.6	009005	9.16	4.77	4.39
2321174	370378.8	009006	12.61	9.36	3.25
2321459	370945.9	009007	7.91	4.85	3.06
2322861	369251.5	009008	8.44	5.36	3.08
2322353	370304.8	009009	14.27	9.26	5.01
2322720	369818.8	009010	11.25	6.12	5.13
2323258	370342.3	009011	13.77	8.10	5.67
2321753	370727.7	009012	9.62	6.05	3.57
2321358	370786.1	009014	8.84	5.72	3.12
2320901	371010.5	009015	10.72	7.77	2.95
2324390	370867.0	013002	9.12	5.57	3.55
2324579	371139.1	013005	11.47	8.54	2.93
2325378	368702.7	014002	13.23	7.79	5.44
2325851	369243.5	014004	9.72	6.24	3.48
2324931	370399.3	017002	10.47	4.62	5.85
2324907	370122.1	017004	9.80	4.94	4.86
2321674	369851.8	121001	9.15	5.41	3.74
2325481	370865.9	178001	12.23	7.70	4.53
2324188	369586.2	656001	11.23	4.36	6.87
2325329	370272.2	662001	8.62	4.51	4.11
2326044	370000.4	666001	10.59	8.69	1.90
2323892	368830.3	GDH001	13.01	7.12	5.89
2323451	369263.4	GDH002	9.82	4.05	5.77
2323850	370885.1	GDH003	13.20	9.28	3.92
2325925	370792.6	GDH004	11.83	8.69	3.14
2324482	368776.0	GDH005	14.73	8.03	6.70
2323874	371402.2	GDH006	7.59	4.44	3.15
2326380	370412.3	GDH007	12.22	8.84	3.38
2324798	369229.0	GDH008	12.94	6.74	6.20
2324656	368258.4	GDH009	12.78	8.20	4.58
2324284	367779.6	GDH010	9.26	6.30	2.96
2323490	368617.6	GDH011	9.60	6.22	3.38
2325584	366357.8	012001	8.14	4.65	3.49
2325709	366344.0	012002	9.08	4.22	4.86
2325755	366254.8	012003	8.45	4.79	3.66
2324229	371547.5	671003	8.78	5.88	2.90
2324202	371468.5	671004	8.85	5.70	3.15
2324651	367396.1	GDI001	8.73	4.75	3.98
2325176	366908.0	GDI002	11.76	6.84	4.92
2325570	366259.5	GDI003	9.05	5.92	3.13
2326156	365451.3	GDI004	8.65	5.81	2.84
2326383	365995.3	GDI005	9.98	3.59	6.39
2326454	366555.0	GDI006	7.74	3.63	4.11
2326455	367181.4	GDI007	10.31	5.67	4.64
2326482	367772.1	GDI008	11.48	6.31	5.17
2326505	368418.0	GDI009	11.29	4.58	6.71
2326745	368728.6	GDI010	8.05	5.39	2.66
2326636	369618.2	GDI011	8.79	4.73	4.06
2326722	370205.1	GDI012	11.01	11.06	−0.05
2326723	370828.2	GDI013	11.90	8.41	3.49
2326133	371166.9	GDI014	8.75	5.73	3.02
2325533	371205.4	GDI015	11.12	8.52	2.60
2324905	371480.0	GDI016	6.02	4.12	1.90
2324116	371633.4	GDI017	10.25	7.80	2.45
2323773	371635.9	GDI018	7.15	4.33	2.82
2326255	364744.5	GDI019	8.79	6.24	2.55

800 0 800
SCALE FEET

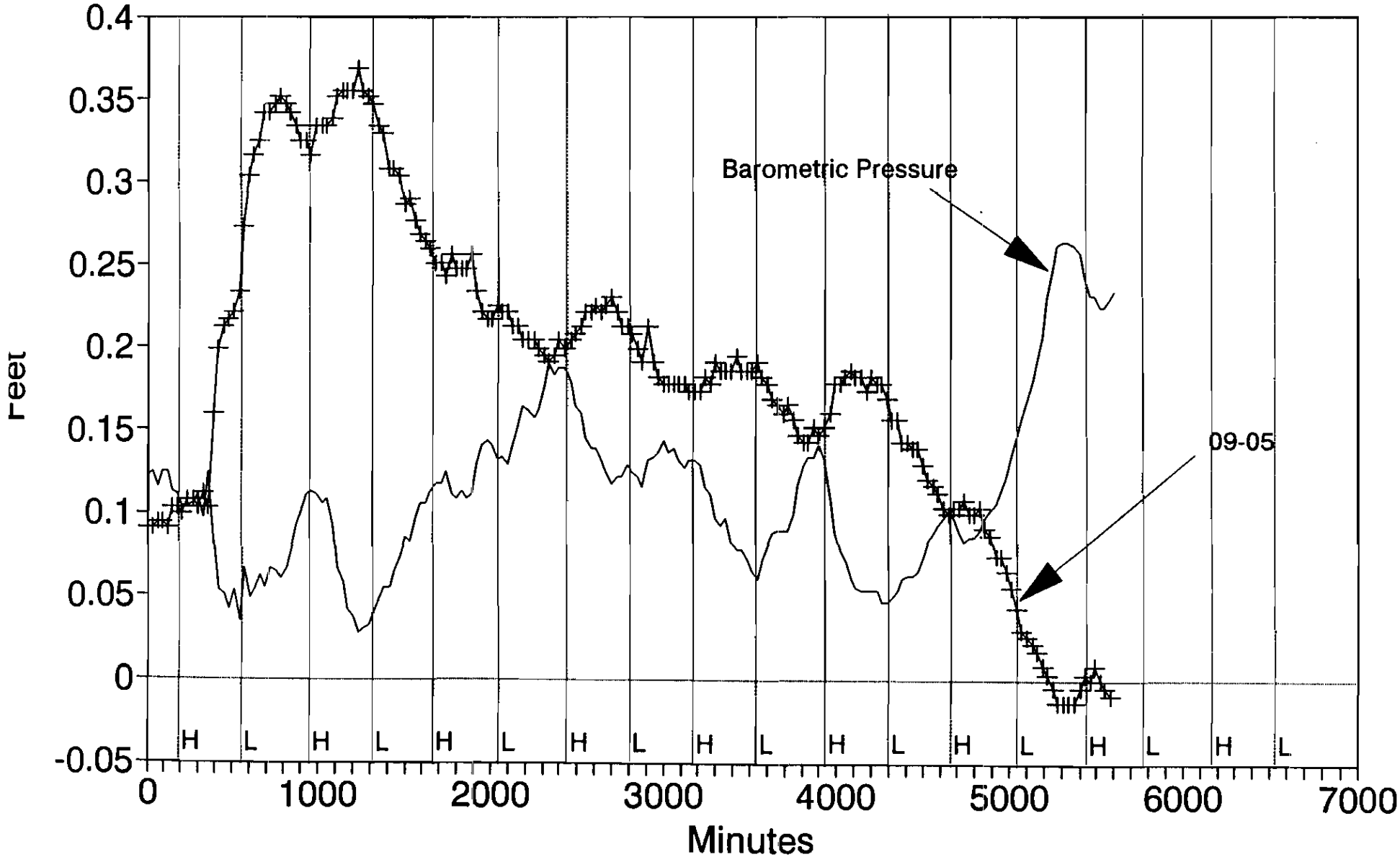
ZONE H
DRAFT FINAL RCRA FACILITY
INVESTIGATION REPORT
NAVAL BASE CHARLESTON
CHARLESTON, SOUTH CAROLINA

FIGURE 3.6
POTENTIOMETRIC MAP OF
UPPER ZONE/SHALLOW AQUIFER
(5/11/95)

DWG DATE: 07/18/95 | DWG NAME: 29CHZH34

NBCH ZONE H TIDAL INFLUENCE STUDY

SHALLOW WELL 09-05



According to Fetter (1988), the lag time of aquifer response to tidal changes is governed by the distance from the tidal source (Cooper River and Shipyard Creek), the extent of hydraulic connection between the aquifer and the source, the tidal period, and the storage coefficient (S) and transmissivity (T) of the aquifer. Generally, lag time increases as distance inland increases.

The lag time for each well was estimated using the graphs in Appendix F. The time of each high tide event (vertical dotted line) was subtracted from the time of each discernable water level high to obtain the lag time associated with each tidal event. For some wells, all nine tidal events were discernable (well NBCH009004 for example) and at others only a few or none were discernable (NBCH009008). The average lag time of all discernable events for each monitored well is presented in Tables 3.6 and 3.7 below.

Table 3.6
Water Level Monitoring Summary of Wells Along Cross Section A-A'

Well	Lag Time (hours)	Maximum Change Between High and Low Tide (feet)	Distance from Well to Cooper River/Shipyard Creek (feet)
NBCH009004	1.0	1.12	3150/150
NBCH00904D	1.44	0.65	3150/150
NBCH009005	—	—	2200/1250
NBCH00905D	—	—	2200/1250
NBCH009008	—	—	2670/580
NBCH009011	—	—	1500/1790
NBCHGDH003	1.78	0.11	760/2570
NBCHGDH006	>6	<0.05	200/3100
NBCHGDH006D	2.2	0.16	200/3100

Note:

— Not Discernible

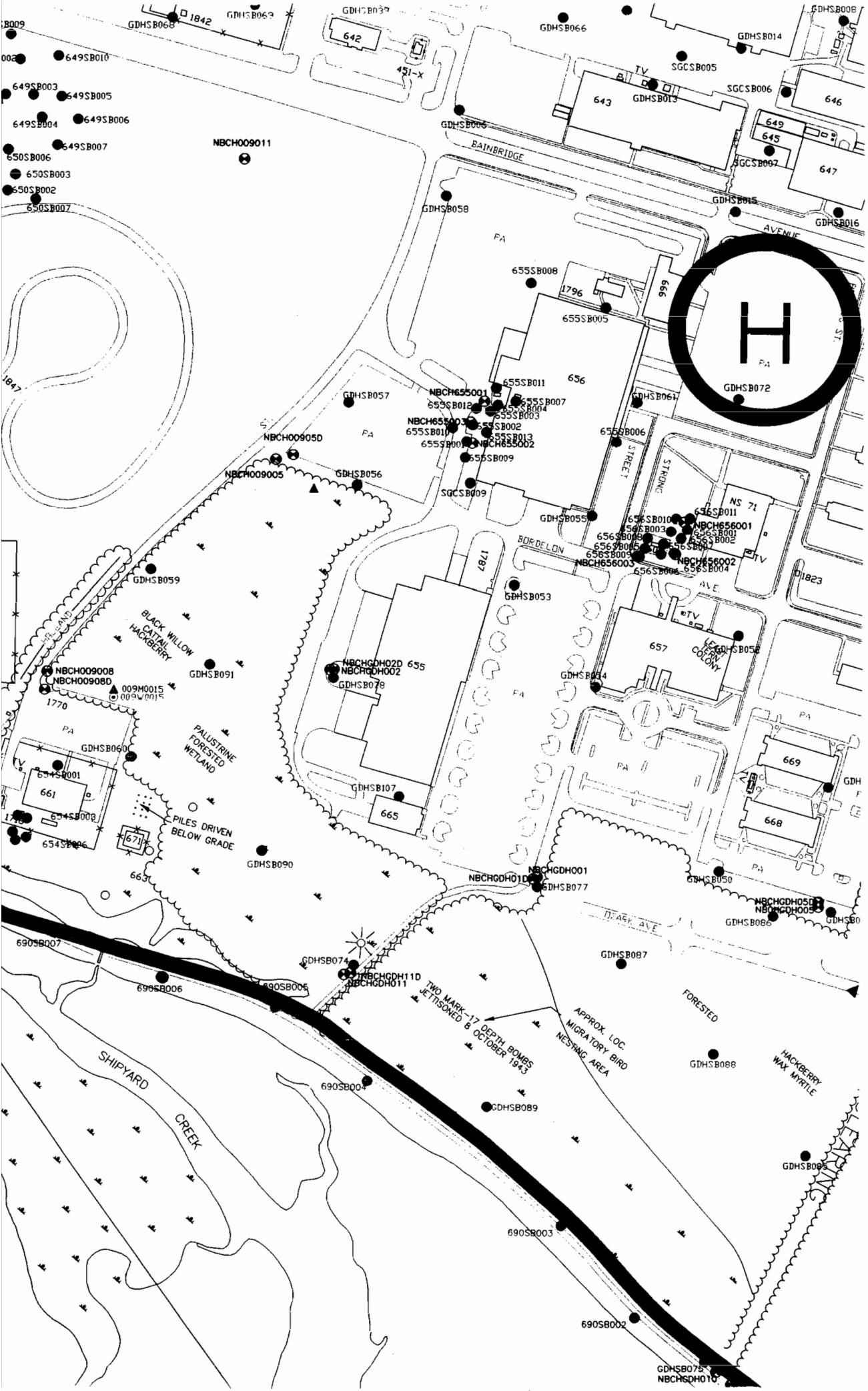

GDHSB068
1842
GDHSB069
GDHSB037
642
451-X
GDHSB066
GDHSB014
GDHSB008
SGCSB005
TV
GDHSB013
643
SGCSB006
646
649
645
647
SGCSB007
649SB010
649SB003
649SB005
649SB004
649SB006
649SB007
650SB006
650SB003
650SB002
650SB007
NBCH009011
GDHSB006
BAINBRIDGE
GDHSB058
GDHSB015
GDHSB016
AVENUE
PA
655SB008
1796
666
655SB005
656
GDHSB072
GDHSB057
NBCH655001
655SB011
655SB012
655SB007
655SB004
655SB003
NBCH655003
655SB002
655SB010
655SB013
655SB001
NBCH655002
655SB009
GDHSB061
655SB006
NBCH00905D
NBCH009005
GDHSB056
SGCSB009
STREET
STRONG
NS 71
GDHSB055
656SB010
656SB011
NBCH656001
656SB003
656SB001
656SB008
656SB002
656SB005
656SB007
656SB009
NBCH656003
NBCH656002
656SB006
656SB004
BORDELON
AVE
1787
GDHSB053
1823
GDHSB059
BLACK WILLOW
CATTAIL
HACKBERRY
NBCH009008
NBCH00908D
GDHSB091
009M0015
009W0015
1770
655
NBCHGDH02D
NBCHGDH002
GDHSB078
657
GDHSB052
LEGION COLONY
GDHSB054
PALUSTRINE FORESTED WETLAND
GDHSB060
654SB001
661
654SB008
654SB006
671
PILES DRIVEN BELOW GRADE
GDHSB107
665
669
668
GDHSB090
663
NBCHGDH01D
NBCHGDH001
GDHSB077
GDHSB050
NBCHGDH05D
NBCHGDH005
GDHSB086
DEARK AVE
690SB007
GDHSB074
NBCHGDH11D
NBCHGDH011
690SB006
690SB005
TWO MARK-17 DEPTH BOMBS JETTISONED 8 OCTOBER 1943
APPROX. LOC. MIGRATORY BIRD NESTING AREA
GDHSB087
FORESTED
GDHSB088
HACKBERRY
WAX MYRTLE
SHIPYARD
CREEK
690SB004
GDHSB089
GDHSB085
690SB003
690SB002
GDHSB075
NBCHGDH010

Table 25
Chemicals Detected In Phase II Ambient Air Samples, Inside Building 656
Comparison to Screening Concentrations
CNC FFI (IAQ)
Charleston, South Carolina

	Chemical	Frequency of Detection (1)	Default Concentration (ug/m3) (2)	Range of Detected Concentrations (ug/m3)	RBCr (ug/m3)	RBCi (ug/m3)	Notes
	1,1,1-Trichloroethane	10 / 12		1.20 - 2.84	100	438	3 4 5
	1,2,4-Trichlorobenzene	1 / 12		1.71 - 1.71	0.94	3.94	5
	1,4-Dichlorobenzene	6 / 12		1.44 - 3.13	0.26	1.79	
*	Benzene	6 / 12	0.4	0.8 - 1.15	0.22	1.47	3 5
	Benzene, 1,2,4-trimethyl	8 / 12		3.09 - 6.18	0.18	0.77	
	Benzene, 1,3,5-trimethyl-	4 / 12		1.97 - 2.44	0.15	0.61	
*	Chloromethane	10 / 12	0.22	0.43 - 1.07	0.99	6.81	3 5
	Dichlorodifluoromethane	12 / 12		1.73 - 10.2	21	87.5	3 4 5
	Ethylbenzene	3 / 12		0.96 - 1.43	100	438	4 5
*	Methylene chloride	11 / 12	0.45	0.9 - 13.5	3.8	26.2	3 5
	Styrene	8 / 12		4 - 16.9	100	438	4 5
	Tetrachloroethene	9 / 12		1.36 - 10.5	3.1	21.1	5
	Toluene	12 / 12		1.28 - 22.4	42	175	3 4 5
	Trichloroethene	2 / 12		1.29 - 1.34	1	7.15	5
	Trichlorofluoromethane	12 / 12		2.08 - 7.13	73	307	3 4 5
	Trichlorotrifluoroethane (Freon 113)	1 / 12		3.83 - 3.83	3100	13337	4 5
	m+p-Xylenes	9 / 12		0.96 - 5.95	730	3066	4 5
	p-Ethyltoluene	8 / 12		2.90 - 5.15	NA	NA	

NOTES:

* Based on the comparison to residential screening concentrations and the potential for an external source (i.e., a source

Table 25
Chemicals Detected In Phase II Ambient Air Samples, Inside Building 656
Comparison to Screening Concentrations
CNC FFI (IAQ)
Charleston, South Carolina

other than internal building operations) this chemical is a COPC, and it will be carried through the formal BRA process.

1 Frequency of detection indicates the number detected over the number analyzed

2 Default concentration indicates the lesser of one-half the lowest detected concentration and one-half the lowest detection limit; used to calculate the mean of the natural log transformed data for applicable COPC (if applicable)

3 This chemical was detected in sub-slab samples; risk will not be quantified for chemicals not detected in sub-slab samples as the corresponding sub-slab data for this building did not identify the presence of a potential external source.

4 The maximum concentration detected does not exceed the residential screening value.

5 The maximum concentration detected does not exceed the industrial screening value.

NA Not available

RBC USEPA Region III Risk based screening concentration for ambient air, March 1994 version; based on target risk of 1E-6 and target hazard quotient of 0.1.

r Residential Based RBC; excerpted as described above.

i Industrial based RBC; calculated as described in the text in accordance with the document referenced above.

- The table above was established using breathing zone and ground level sample data only.

Table 4.13.1
AOC 655
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Volatile Organic Compounds *(12 Samples Collected—8 Upper Interval Samples, 4 Lower Interval Samples, 2 Samples Duplicated)*			
Acetone	8/4	17-4400/72-180	780000
2-Butanone (MEK)	1/0	19/0	4700000
Methylene chloride	7/4	10-34/10-29	85000
Tetrachloroethene	0/1	0/4.4	12000
Toluene	4/1	3.1-8/5	1600000
Semivolatile Organic Compounds *(12 Samples Collected—8 Upper Interval Samples, 4 Lower Interval Samples, 2 Samples Duplicated)*			
Benzo(a)anthracene	1/0	91/0	880
Benzo(b)fluoranthene	1/0	120/0	880
bis(2-Ethylhexyl)phthalate (BEHP)	2/0	150-1800/0	46000
Butylbenzylphthalate	1/0	98/0	1600000
Semivolatile Organic Compounds [cont'd] *(12 Samples Collected—8 Upper Interval Samples, 4 Lower Interval Samples, 2 Samples Duplicated)*			
Chrysene	1/0	100/0	8000
Fluoranthene	1/0	170/0	310000
Phenanthrene	1/0	98.0/0	230000
Pyrene	1/0	160/0	230000
Pesticides *(20 Samples Collected—13 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
Aldrin	0/1	0/105	38
4,4'-DDE	6/1	2.6-13/6.4	1900
4,4'-DDT	4/2	4-23/7-25	1900
alpha-Chlordane	9/2	4-97/3-9	alpha+gamma 470
gamma-Chlordane	9/3	4-130/3.6-22	
Dieldrin	4/2	2.4-360/44-61.8	40
Endosulfan II	1/0	4.0/0	47000
Endrin aldehyde	2/1	8-16/29	2300

Table 4.13.1
AOC 655
Organic Compounds in Soil (μg/kg)

Compound Name	No. of Detections (1st Interval/2nd Interval)	Range of Concentrations (upper interval/lower interval)	Risk-Based Screening Levels
Heptachlor	2/0	1.3-11/0	140
Heptachlor epoxide	5/0	2-24/0	70
Polychlorinated Biphenyls *(20 Samples Collected—13 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
Aroclor 1254	3/1	81-110/180	83
Aroclor 1260	9/1	25.8-610/750	83
Total Petroleum Hydrocarbons *(19 Samples Collected—12 Upper Interval Samples, 7 Lower Interval Samples, 2 Samples Duplicated)*			
TPH	8/4	11000-120000/ 15000-120000	Not Listed
Herbicides *(2 Duplicate Analyses—1 Upper Interval Sample, 1 Lower Interval Sample)*			
No herbicides detected.			
Organophosphate Pesticides *(2 Duplicate Analyses—1 Upper Interval Sample, 1 Lower Interval Sample)*			
No organophosphates detected.			
Dioxins *(2 Duplicate Analyses—1 Upper Interval Sample, 1 Lower Interval Sample)*			
Total TEQ	1/1	1.299/0.818 pg/g	4.3 pg/g

Table 4.13.2
AOC 655
Inorganic Elements in Soil (mg/kg)

Inorganic Elements	Number of Analyses (upper interval/lower interval)	Number of Detections (upper interval/lower interval)	Range of Concentrations for Detections (upper interval/lower interval)	Risk-Based Screening Level	Upper Tolerance Limit of Background[a]
Aluminum[(a)]	8/4	8/4	2500-15300/2720-6640	7800	25310
Iron[(a)]	8/4	8/4	2060-21200/1540-5650	Not Listed	30910
Lead	9/4	4/0	3.2-215/0	400	118
Nickel	9/4	8/4	1.2-12.7/1.1-2.0	160	33.38
Potassium[(a)]	8/4	8/4	117-167/82.4-235	Not Listed	Nutrient[c]
Silver	9/4	0/0	0/0	39	Not Valid[d]

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA						
SAMPLE ID ------->	655-S-B001-01	655-S-B001-02	655-S-B002-01	655-S-B003-01	655-S-B003-02	655-S-B004-01
ORIGINAL ID ----->	655SB00101	655SB00102	655SB00201	655SB00301	655SB00302	655SB00401
LAB SAMPLE ID --->	41411-009	41411-010	41411-011	41411-012	41411-013	41411-014
ID FROM REPORT -->	090201	090202	090203	090204	090205	090206
SAMPLE DATE ----->	09/01/94	09/01/94	09/01/94	09/01/94	09/01/94	09/01/94
DATE EXTRACTED -->	09/09/94	09/09/94	09/09/94	09/09/94	09/09/94	09/09/94
DATE ANALYZED --->	09/20/94	09/20/94	09/20/94	09/20/94	09/20/94	09/20/94
MATRIX ---------->	Soil	Soil	Soil	Soil	Soil	Soil
UNITS ---------->	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG

CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL
62-75-9	N-Nitrosodimethylamine												
606-20-2	2,6-Dinitrotoluene												
108-95-2	Phenol												
99-09-2	3-Nitroaniline												
62-53-3	Aniline												
83-32-9	Acenaphthene												
111-44-4	bis(2-Chloroethyl)ether												
51-28-5	2,4-Dinitrophenol												
95-57-8	2-Chlorophenol												
100-02-7	4-Nitrophenol												
541-73-1	1,3-Dichlorobenzene												
132-64-9	Dibenzofuran												
106-46-7	1,4-Dichlorobenzene												
121-14-2	2,4-Dinitrotoluene												
100-51-6	Benzyl alcohol												
84-66-2	Diethylphthalate												
95-50-1	1,2-Dichlorobenzene												
7005-72-3	4-Chlorophenylphenylether												
95-48-7	2-Methylphenol (o-Cresol)												
86-73-7	Fluorene												
108-60-1	2,2'-oxybis(1-Chloropropane)												
100-01-6	4-Nitroaniline												
106-44-5	4-Methylphenol (p-Cresol)												
534-52-1	4,6-Dinitro-2-methylphenol												
621-64-7	N-Nitroso-di-n-propylamine												
86-30-6	N-Nitrosodiphenylamine												
67-72-1	Hexachloroethane												
101-55-3	4-Bromophenylphenylether												
98-95-3	Nitrobenzene												
118-74-1	Hexachlorobenzene												
78-59-1	Isophorone												
87-86-5	Pentachlorophenol												
88-75-5	2-Nitrophenol												
85-01-8	Phenanthrene												
105-67-9	2,4-Dimethylphenol												
120-12-7	Anthracene												

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA													
	SAMPLE ID ------->	655-S-B001-01		655-S-B001-02		655-S-B002-01		655-S-B003-01		655-S-B003-02		655-S-B004-01	
	ORIGINAL ID ----->	655SB00101		655SB00102		655SB00201		655SB00301		655SB00302		655SB00401	
	LAB SAMPLE ID --->	41411-009		41411-010		41411-011		41411-012		41411-013		41411-014	
	ID FROM REPORT -->	090201		090202		090203		090204		090205		090206	
	SAMPLE DATE ----->	09/01/94		09/01/94		09/01/94		09/01/94		09/01/94		09/01/94	
	DATE EXTRACTED -->	09/09/94		09/09/94		09/09/94		09/09/94		09/09/94		09/09/94	
	DATE ANALYZED --->	09/20/94		09/20/94		09/20/94		09/20/94		09/20/94		09/20/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL
65-85-0	Benzoic acid												
84-74-2	Di-n-butylphthalate												
111-91-1	bis(2-Chloroethoxy)methane												
206-44-0	Fluoranthene												
120-83-2	2,4-Dichlorophenol												
92-87-5	Benzidine												
120-82-1	1,2,4-Trichlorobenzene												
129-00-0	Pyrene												
91-20-3	Naphthalene												
85-68-7	Butylbenzylphthalate												
106-47-8	4-Chloroaniline												
91-94-1	3,3'-Dichlorobenzidine												
87-68-3	Hexachlorobutadiene												
56-55-3	Benzo(a)anthracene												
59-50-7	4-Chloro-3-methylphenol												
218-01-9	Chrysene												
91-57-6	2-Methylnaphthalene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)												
77-47-4	Hexachlorocyclopentadiene												
117-84-0	Di-n-octylphthalate												
88-06-2	2,4,6-Trichlorophenol												
205-99-2	Benzo(b)fluoranthene												
95-95-4	2,4,5-Trichlorophenol												
207-08-9	Benzo(k)fluoranthene												
91-58-7	2-Chloronaphthalene												
50-32-8	Benzo(a)pyrene												
88-74-4	2-Nitroaniline												
193-39-5	Indeno(1,2,3-cd)pyrene												
131-11-3	Dimethylphthalate												
53-70-3	Dibenzo(a,h)anthracene												
208-96-8	Acenaphthylene												
191-24-2	Benzo(g,h,i)perylene												
103-33-3	Azobenzene	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA													
	SAMPLE ID ------->	655-S-B004-02		655-S-B005-01		655-S-B005-02		655-S-B006-01		655-S-B007-01		655-S-B008-01	
	ORIGINAL ID ----->	655SB00402		655SB00501		655SB00502		655SB00601		655SB00701		655SB00801	
	LAB SAMPLE ID --->	41411-015		41447-014		41447-015		41447-016		41447-017		41806-024	
	ID FROM REPORT -->	090207		090811		090812		090813		090814		101214	
	SAMPLE DATE ----->	09/01/94		09/07/94		09/07/94		09/07/94		09/07/94		10/11/94	
	DATE EXTRACTED -->	09/09/94		09/15/94		09/15/94		09/15/94		09/15/94		10/21/94	
	DATE ANALYZED --->	09/20/94		09/21/94		09/21/94		09/21/94		09/21/94		10/26/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS21	VAL
62-75-9	N-Nitrosodimethylamine												
606-20-2	2,6-Dinitrotoluene												
108-95-2	Phenol												
99-09-2	3-Nitroaniline												
62-53-3	Aniline												
83-32-9	Acenaphthene												
111-44-4	bis(2-Chloroethyl)ether												
51-28-5	2,4-Dinitrophenol												
95-57-8	2-Chlorophenol												
100-02-7	4-Nitrophenol												
541-73-1	1,3-Dichlorobenzene												
132-64-9	Dibenzofuran												
106-46-7	1,4-Dichlorobenzene												
121-14-2	2,4-Dinitrotoluene												
100-51-6	Benzyl alcohol												
84-66-2	Diethylphthalate												
95-50-1	1,2-Dichlorobenzene												
7005-72-3	4-Chlorophenylphenylether												
95-48-7	2-Methylphenol (o-Cresol)												
86-73-7	Fluorene												
108-60-1	2,2'-oxybis(1-Chloropropane)												
100-01-6	4-Nitroaniline												
106-44-5	4-Methylphenol (p-Cresol)												
534-52-1	4,6-Dinitro-2-methylphenol												
621-64-7	N-Nitroso-di-n-propylamine												
86-30-6	N-Nitrosodiphenylamine												
67-72-1	Hexachloroethane												
101-55-3	4-Bromophenylphenylether												
98-95-3	Nitrobenzene												
118-74-1	Hexachlorobenzene												
78-59-1	Isophorone												
87-86-5	Pentachlorophenol												
88-75-5	2-Nitrophenol												
85-01-8	Phenanthrene			98.	J								
105-67-9	2,4-Dimethylphenol												
120-12-7	Anthracene												

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA						
SAMPLE ID ------->	655-S-B004-02	655-S-B005-01	655-S-B005-02	655-S-B006-01	655-S-B007-01	655-S-B008-01
ORIGINAL ID ----->	655SB00402	655SB00501	655SB00502	655SB00601	655SB00701	655SB00801
LAB SAMPLE ID --->	41411-015	41447-014	41447-015	41447-016	41447-017	41806-024
ID FROM REPORT -->	090207	090811	090812	090813	090814	101214
SAMPLE DATE ----->	09/01/94	09/07/94	09/07/94	09/07/94	09/07/94	10/11/94
DATE EXTRACTED -->	09/09/94	09/15/94	09/15/94	09/15/94	09/15/94	10/21/94
DATE ANALYZED --->	09/20/94	09/21/94	09/21/94	09/21/94	09/21/94	10/26/94
MATRIX ---------->	Soil	Soil	Soil	Soil	Soil	Soil
UNITS ---------->	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG	UG/KG

CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS21	VAL
65-85-0	Benzoic acid												
84-74-2	Di-n-butylphthalate												
111-91-1	bis(2-Chloroethoxy)methane												
206-44-0	Fluoranthene			170.	J								
120-83-2	2,4-Dichlorophenol												
92-87-5	Benzidine												
120-82-1	1,2,4-Trichlorobenzene												
129-00-0	Pyrene			160.	J								
91-20-3	Naphthalene												
85-68-7	Butylbenzylphthalate			98.	J								
106-47-8	4-Chloroaniline												
91-94-1	3,3'-Dichlorobenzidine												
87-68-3	Hexachlorobutadiene												
56-55-3	Benzo(a)anthracene			91.	J								
59-50-7	4-Chloro-3-methylphenol												
218-01-9	Chrysene			100.	J								
91-57-6	2-Methylnaphthalene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)			1800.				150.	J				
77-47-4	Hexachlorocyclopentadiene												
117-84-0	Di-n-octylphthalate												
88-06-2	2,4,6-Trichlorophenol												
205-99-2	Benzo(b)fluoranthene			120.	J								
95-95-4	2,4,5-Trichlorophenol												
207-08-9	Benzo(k)fluoranthene												
91-58-7	2-Chloronaphthalene												
50-32-8	Benzo(a)pyrene												
88-74-4	2-Nitroaniline												
193-39-5	Indeno(1,2,3-cd)pyrene												
131-11-3	Dimethylphthalate												
53-70-3	Dibenzo(a,h)anthracene												
208-96-8	Acenaphthylene												
191-24-2	Benzo(g,h,i)perylene												
103-33-3	Azobenzene	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA													
	SAMPLE ID ------->	GDH-S-B006-01		GDH-S-B006-02		GDH-S-B053-01		GDH-S-B053-02		GDH-S-B055-01		GDH-S-B056-01	
	ORIGINAL ID ----->	GDHSB00601		GDHSB00602		GDHSB05301		GDHSB05302		GDHSB05501		GDHSB05601	
	LAB SAMPLE ID --->	41665-030		41665-031		41760-025		41760-026		41760-029		41779-006	
	ID FROM REPORT -->	092816		092817		100710		100711		100714		100807	
	SAMPLE DATE ----->	09/27/94		09/27/94		10/06/94		10/06/94		10/06/94		10/07/94	
	DATE EXTRACTED -->	10/05/94		10/05/94		10/17/94		10/17/94		10/17/94		10/17/94	
	DATE ANALYZED --->	10/07/94		10/07/94		10/21/94		10/19/94		10/21/94		10/21/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ----------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS15	VAL	CHS15	VAL	CHS19	VAL	CHS19	VAL	CHS19	VAL	CHS19	VAL
62-75-9	N-Nitrosodimethylamine												
606-20-2	2,6-Dinitrotoluene												
108-95-2	Phenol												
99-09-2	3-Nitroaniline												
62-53-3	Aniline												
83-32-9	Acenaphthene											130.	J
111-44-4	bis(2-Chloroethyl)ether												
51-28-5	2,4-Dinitrophenol												
95-57-8	2-Chlorophenol												
100-02-7	4-Nitrophenol												
541-73-1	1,3-Dichlorobenzene												
132-64-9	Dibenzofuran												
106-46-7	1,4-Dichlorobenzene												
121-14-2	2,4-Dinitrotoluene												
100-51-6	Benzyl alcohol												
84-66-2	Diethylphthalate												
95-50-1	1,2-Dichlorobenzene												
7005-72-3	4-Chlorophenylphenylether												
95-48-7	2-Methylphenol (o-Cresol)												
86-73-7	Fluorene											100.	J
108-60-1	2,2'-oxybis(1-Chloropropane)												
100-01-6	4-Nitroaniline												
106-44-5	4-Methylphenol (p-Cresol)												
534-52-1	4,6-Dinitro-2-methylphenol												
621-64-7	N-Nitroso-di-n-propylamine												
86-30-6	N-Nitrosodiphenylamine												
67-72-1	Hexachloroethane												
101-55-3	4-Bromophenylphenylether												
98-95-3	Nitrobenzene												
118-74-1	Hexachlorobenzene												
78-59-1	Isophorone												
87-86-5	Pentachlorophenol												
88-75-5	2-Nitrophenol												
85-01-8	Phenanthrene											800.	
105-67-9	2,4-Dimethylphenol												
120-12-7	Anthracene											220.	J

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA													
	SAMPLE ID ------->	GDH-S-B006-01		GDH-S-B006-02		GDH-S-B053-01		GDH-S-B053-02		GDH-S-B055-01		GDH-S-B056-01	
	ORIGINAL ID ----->	GDHSB00601		GDHSB00602		GDHSB05301		GDHSB05302		GDHSB05501		GDHSB05601	
	LAB SAMPLE ID --->	41665-030		41665-031		41760-025		41760-026		41760-029		41779-006	
	ID FROM REPORT -->	092816		092817		100710		100711		100714		100807	
	SAMPLE DATE ----->	09/27/94		09/27/94		10/06/94		10/06/94		10/06/94		10/07/94	
	DATE EXTRACTED -->	10/05/94		10/05/94		10/17/94		10/17/94		10/17/94		10/17/94	
	DATE ANALYZED --->	10/07/94		10/07/94		10/21/94		10/19/94		10/21/94		10/21/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS15	VAL	CHS15	VAL	CHS19	VAL	CHS19	VAL	CHS19	VAL	CHS19	VAL
65-85-0	Benzoic acid												
84-74-2	Di-n-butylphthalate												
111-91-1	bis(2-Chloroethoxy)methane												
206-44-0	Fluoranthene											1300.	
120-83-2	2,4-Dichlorophenol												
92-87-5	Benzidine												
120-82-1	1,2,4-Trichlorobenzene												
129-00-0	Pyrene											1200.	
91-20-3	Naphthalene												
85-68-7	Butylbenzylphthalate												
106-47-8	4-Chloroaniline												
91-94-1	3,3'-Dichlorobenzidine												
87-68-3	Hexachlorobutadiene												
56-55-3	Benzo(a)anthracene											880.	
59-50-7	4-Chloro-3-methylphenol												
218-01-9	Chrysene											830.	
91-57-6	2-Methylnaphthalene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)					99.	J			94.	J		
77-47-4	Hexachlorocyclopentadiene												
117-84-0	Di-n-octylphthalate												
88-06-2	2,4,6-Trichlorophenol												
205-99-2	Benzo(b)fluoranthene											710.	
95-95-4	2,4,5-Trichlorophenol												
207-08-9	Benzo(k)fluoranthene											790.	
91-58-7	2-Chloronaphthalene												
50-32-8	Benzo(a)pyrene											860.	
88-74-4	2-Nitroaniline												
193-39-5	Indeno(1,2,3-cd)pyrene											400.	J
131-11-3	Dimethylphthalate												
53-70-3	Dibenzo(a,h)anthracene											190.	J
208-96-8	Acenaphthylene												
191-24-2	Benzo(g,h,i)perylene											400.	J
103-33-3	Azobenzene	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA													
	SAMPLE ID ------->	GDH-S-B056-02		GDH-S-B057-01		GDH-S-B058-01		GDH-S-B058-02		GDH-S-B059-01		GDH-S-B061-01	
	ORIGINAL ID ----->	GDHSB05602		GDHSB05701		GDHSB05801		GDHSB05802		GDHSB05901		GDHSB06101	
	LAB SAMPLE ID --->	41779-007		41780-008		41779-008		41779-009		41780-003		41779-010	
	ID FROM REPORT -->	100808		100814		100809		100810		100812		100811	
	SAMPLE DATE ----->	10/07/94		10/07/94		10/07/94		10/07/94		10/07/94		10/07/94	
	DATE EXTRACTED -->	10/17/94		10/19/94		10/17/94		10/17/94		10/19/94		10/17/94	
	DATE ANALYZED --->	10/21/94		10/24/94		10/21/94		10/21/94		10/24/94		10/21/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS19	VAL	CHS20	VAL	CHS19	VAL	CHS19	VAL	CHS20	VAL	CHS19	VAL
62-75-9	N-Nitrosodimethylamine												
606-20-2	2,6-Dinitrotoluene												
108-95-2	Phenol												
99-09-2	3-Nitroaniline												
62-53-3	Aniline												
83-32-9	Acenaphthene												
111-44-4	bis(2-Chloroethyl)ether												
51-28-5	2,4-Dinitrophenol												
95-57-8	2-Chlorophenol												
100-02-7	4-Nitrophenol												
541-73-1	1,3-Dichlorobenzene												
132-64-9	Dibenzofuran												
106-46-7	1,4-Dichlorobenzene												
121-14-2	2,4-Dinitrotoluene												
100-51-6	Benzyl alcohol												
84-66-2	Diethylphthalate												
95-50-1	1,2-Dichlorobenzene												
7005-72-3	4-Chlorophenylphenylether												
95-48-7	2-Methylphenol (o-Cresol)												
86-73-7	Fluorene												
108-60-1	2,2'-oxybis(1-Chloropropane)												
100-01-6	4-Nitroaniline												
106-44-5	4-Methylphenol (p-Cresol)												
534-52-1	4,6-Dinitro-2-methylphenol												
621-64-7	N-Nitroso-di-n-propylamine												
86-30-6	N-Nitrosodiphenylamine												
67-72-1	Hexachloroethane												
101-55-3	4-Bromophenylphenylether												
98-95-3	Nitrobenzene												
118-74-1	Hexachlorobenzene												
78-59-1	Isophorone												
87-86-5	Pentachlorophenol												
88-75-5	2-Nitrophenol												
85-01-8	Phenanthrene												
105-67-9	2,4-Dimethylphenol												
120-12-7	Anthracene												

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA													
	SAMPLE ID ------->	GDH-S-B056-02		GDH-S-B057-01		GDH-S-B058-01		GDH-S-B058-02		GDH-S-B059-01		GDH-S-B061-01	
	ORIGINAL ID ----->	GDHSB05602		GDHSB05701		GDHSB05801		GDHSB05802		GDHSB05901		GDHSB06101	
	LAB SAMPLE ID --->	41779-007		41780-008		41779-008		41779-009		41780-003		41779-010	
	ID FROM REPORT -->	100808		100814		100809		100810		100812		100811	
	SAMPLE DATE ----->	10/07/94		10/07/94		10/07/94		10/07/94		10/07/94		10/07/94	
	DATE EXTRACTED -->	10/17/94		10/19/94		10/17/94		10/17/94		10/19/94		10/17/94	
	DATE ANALYZED --->	10/21/94		10/24/94		10/21/94		10/21/94		10/24/94		10/21/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS19	VAL	CHS20	VAL	CHS19	VAL	CHS19	VAL	CHS20	VAL	CHS19	VAL
65-85-0	Benzoic acid												
84-74-2	Di-n-butylphthalate												
111-91-1	bis(2-Chloroethoxy)methane												
206-44-0	Fluoranthene												
120-83-2	2,4-Dichlorophenol												
92-87-5	Benzidine												
120-82-1	1,2,4-Trichlorobenzene												
129-00-0	Pyrene												
91-20-3	Naphthalene												
85-68-7	Butylbenzylphthalate												
106-47-8	4-Chloroaniline												
91-94-1	3,3'-Dichlorobenzidine												
87-68-3	Hexachlorobutadiene												
56-55-3	Benzo(a)anthracene												
59-50-7	4-Chloro-3-methylphenol												
218-01-9	Chrysene												
91-57-6	2-Methylnaphthalene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)											290.	J
77-47-4	Hexachlorocyclopentadiene												
117-84-0	Di-n-octylphthalate												
88-06-2	2,4,6-Trichlorophenol												
205-99-2	Benzo(b)fluoranthene												
95-95-4	2,4,5-Trichlorophenol												
207-08-9	Benzo(k)fluoranthene												
91-58-7	2-Chloronaphthalene												
50-32-8	Benzo(a)pyrene												
88-74-4	2-Nitroaniline												
193-39-5	Indeno(1,2,3-cd)pyrene												
131-11-3	Dimethylphthalate												
53-70-3	Dibenzo(a,h)anthracene												
208-96-8	Acenaphthylene												
191-24-2	Benzo(g,h,i)perylene												
103-33-3	Azobenzene	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA							
SAMPLE ID ------->	GDH-S-B078-01	GDH-S-B078-02	GDH-S-B091-01	SGC-S-B009-01			
ORIGINAL ID ----->	GDHSB07801	GDHSB07802	GDHSB09101	SGCSB00901			
LAB SAMPLE ID --->	25250.6	25251.4	42430-007	41821-011			
ID FROM REPORT -->	102208	102209	GDHSB09101	101305			
SAMPLE DATE ----->	10/21/94	10/21/94	11/30/94	10/12/94			
DATE EXTRACTED -->	11/01/94	11/01/94	12/07/94	10/21/94			
DATE ANALYZED --->	11/15/94	11/14/94	12/08/94	10/27/94			
MATRIX ---------->	Soil	Soil	Soil	Soil			
UNITS ---------->	UG/KG	UG/KG	UG/KG	UG/KG			

CAS #	Parameter	CHS23	VAL	CHS23	VAL	CHS27	VAL	CHS21	VAL		
62-75-9	N-Nitrosodimethylamine	??????????		??????????							
606-20-2	2,6-Dinitrotoluene										
108-95-2	Phenol										
99-09-2	3-Nitroaniline										
62-53-3	Aniline	??????????		??????????							
83-32-9	Acenaphthene							140.	J		
111-44-4	bis(2-Chloroethyl)ether										
51-28-5	2,4-Dinitrophenol										
95-57-8	2-Chlorophenol										
100-02-7	4-Nitrophenol										
541-73-1	1,3-Dichlorobenzene										
132-64-9	Dibenzofuran							210.	J		
106-46-7	1,4-Dichlorobenzene										
121-14-2	2,4-Dinitrotoluene										
100-51-6	Benzyl alcohol	??????????		??????????							
84-66-2	Diethylphthalate										
95-50-1	1,2-Dichlorobenzene										
7005-72-3	4-Chlorophenylphenylether										
95-48-7	2-Methylphenol (o-Cresol)										
86-73-7	Fluorene							660.			
108-60-1	2,2'-oxybis(1-Chloropropane)										
100-01-6	4-Nitroaniline										
106-44-5	4-Methylphenol (p-Cresol)										
534-52-1	4,6-Dinitro-2-methylphenol										
621-64-7	N-Nitroso-di-n-propylamine										
86-30-6	N-Nitrosodiphenylamine										
67-72-1	Hexachloroethane										
101-55-3	4-Bromophenylphenylether										
98-95-3	Nitrobenzene										
118-74-1	Hexachlorobenzene										
78-59-1	Isophorone										
87-86-5	Pentachlorophenol										
88-75-5	2-Nitrophenol										
85-01-8	Phenanthrene							4200.			
105-67-9	2,4-Dimethylphenol										
120-12-7	Anthracene							1800.			

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-SVOA									
	SAMPLE ID ------->	GDH-S-B078-01		GDH-S-B078-02		GDH-S-B091-01		SGC-S-B009-01	
	ORIGINAL ID ----->	GDHSB07801		GDHSB07802		GDHSB09101		SGCSB00901	
	LAB SAMPLE ID --->	25250.6		25251.4		42430-007		41821-011	
	ID FROM REPORT -->	102208		102209		GDHSB09101		101305	
	SAMPLE DATE ----->	10/21/94		10/21/94		11/30/94		10/12/94	
	DATE EXTRACTED -->	11/01/94		11/01/94		12/07/94		10/21/94	
	DATE ANALYZED --->	11/15/94		11/14/94		12/08/94		10/27/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS23	VAL	CHS23	VAL	CHS27	VAL	CHS21	VAL
65-85-0	Benzoic acid	??????????		??????????					
84-74-2	Di-n-butylphthalate								
111-91-1	bis(2-Chloroethoxy)methane								
206-44-0	Fluoranthene							4200.	
120-83-2	2,4-Dichlorophenol								
92-87-5	Benzidine	??????????		??????????					
120-82-1	1,2,4-Trichlorobenzene								
129-00-0	Pyrene							5300.	J
91-20-3	Naphthalene								
85-68-7	Butylbenzylphthalate								
106-47-8	4-Chloroaniline								
91-94-1	3,3'-Dichlorobenzidine								
87-68-3	Hexachlorobutadiene								
56-55-3	Benzo(a)anthracene							3300.	J
59-50-7	4-Chloro-3-methylphenol								
218-01-9	Chrysene							2700.	J
91-57-6	2-Methylnaphthalene								
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)	210.	J						
77-47-4	Hexachlorocyclopentadiene								
117-84-0	Di-n-octylphthalate	200.	J						
88-06-2	2,4,6-Trichlorophenol								
205-99-2	Benzo(b)fluoranthene							2100.	J
95-95-4	2,4,5-Trichlorophenol								
207-08-9	Benzo(k)fluoranthene							1800.	J
91-58-7	2-Chloronaphthalene								
50-32-8	Benzo(a)pyrene							2400.	J
88-74-4	2-Nitroaniline								
193-39-5	Indeno(1,2,3-cd)pyrene							1100.	J
131-11-3	Dimethylphthalate								
53-70-3	Dibenzo(a,h)anthracene							520.	J
208-96-8	Acenaphthylene							440.	
191-24-2	Benzo(g,h,i)perylene							960.	J
103-33-3	Azobenzene	??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-VOA													
	SAMPLE ID ------->	655-S-B001-01		655-S-B001-02		655-S-B002-01		655-S-B003-01		655-S-B003-02		655-S-B004-01	
	ORIGINAL ID ----->	655SB00101		655SB00102		655SB00201		655SB00301		655SB00302		655SB00401	
	LAB SAMPLE ID --->	41411-001		41411-002		41411-003		41411-004		41411-005		41411-006	
	ID FROM REPORT -->	090201		090202		090203		090204		090205		090206	
	SAMPLE DATE ----->	09/01/94		09/01/94		09/01/94		09/01/94		09/01/94		09/01/94	
	DATE ANALYZED --->	09/14/94		09/13/94		09/13/94		09/13/94		09/14/94		09/13/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL
100-41-4	Ethylbenzene												
100-42-5	Styrene												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
107-06-2	1,2-Dichloroethane												
108-05-4	Vinyl acetate												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
109-99-9	Tetrahydrofuran												
124-48-1	Dibromochloromethane												
127-18-4	Tetrachloroethene												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												
56-23-5	Carbon tetrachloride												
591-78-6	2-Hexanone												
67-64-1	Acetone	290.		72.		26.	J	17.	J	77.		20.	J
67-66-3	Chloroform												
71-43-2	Benzene												
71-55-6	1,1,1-Trichloroethane												
74-83-9	Bromomethane												
74-87-3	Chloromethane												
75-00-3	Chloroethane												
75-01-4	Vinyl chloride												
75-09-2	Methylene chloride	34.	J	10.	J	10.	J	11.	J	19.	J	12.	J
75-15-0	Carbon disulfide												
75-25-2	Bromoform												
75-27-4	Bromodichloromethane												
75-34-3	1,1-Dichloroethane												
75-35-4	1,1-Dichloroethene												
75-69-4	Trichlorofluoromethane												
78-87-5	1,2-Dichloropropane												
78-93-3	2-Butanone (MEK)												
79-00-5	1,1,2-Trichloroethane												
79-01-6	Trichloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
110-75-8	2-Chloroethylvinyl ether	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-VOA													
	SAMPLE ID ------->	655-S-B004-02		655-S-B005-01		655-S-B005-02		655-S-B006-01		655-S-B007-01		655-S-B008-01	
	ORIGINAL ID ----->	655SB00402		655SB00501		655SB00502		655SB00601		655SB00701		655SB00801	
	LAB SAMPLE ID --->	41411-007		41447-001		41447-002		41447-003		41447-004		41806-012	
	ID FROM REPORT -->	090207		090811		090812		090813		090814		101214	
	SAMPLE DATE ----->	09/01/94		09/07/94		09/07/94		09/07/94		09/07/94		10/11/94	
	DATE ANALYZED --->	09/13/94		09/14/94		09/14/94		09/15/94		09/14/94		10/24/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS21	VAL
100-41-4	Ethylbenzene												
100-42-5	Styrene												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
107-06-2	1,2-Dichloroethane												
108-05-4	Vinyl acetate												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
108-88-3	Toluene			6.	J	5.	J	8.		3.1	J	8.	
108-90-7	Chlorobenzene												
109-99-9	Tetrahydrofuran												
124-48-1	Dibromochloromethane												
127-18-4	Tetrachloroethene	4.4	J										
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												
56-23-5	Carbon tetrachloride												
591-78-6	2-Hexanone												
67-64-1	Acetone	140.		26.	J	180.		230.		29.		4400.	
67-66-3	Chloroform												
71-43-2	Benzene												
71-55-6	1,1,1-Trichloroethane												
74-83-9	Bromomethane												
74-87-3	Chloromethane												
75-00-3	Chloroethane												
75-01-4	Vinyl chloride												
75-09-2	Methylene chloride	11.	J	22.	J	29.	J	25.	J	20.	J		
75-15-0	Carbon disulfide												
75-25-2	Bromoform												
75-27-4	Bromodichloromethane												
75-34-3	1,1-Dichloroethane												
75-35-4	1,1-Dichloroethene												
75-69-4	Trichlorofluoromethane												
78-87-5	1,2-Dichloropropane												
78-93-3	2-Butanone (MEK)											19.	J
79-00-5	1,1,2-Trichloroethane												
79-01-6	Trichloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
110-75-8	2-Chloroethylvinyl ether	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-VOA													
	SAMPLE ID ------->	GDH-S-B006-01		GDH-S-B006-02		GDH-S-B053-01		GDH-S-B053-02		GDH-S-B055-01		GDH-S-B056-01	
	ORIGINAL ID ----->	GDHSB00601		GDHSB00602		GDHSB05301		GDHSB05302		GDHSB05501		GDHSB05601	
	LAB SAMPLE ID --->	41665-011		41665-012		41760-010		41760-011		41760-014		41779-001	
	ID FROM REPORT -->	092816		092817		100710		100711		100714		100807	
	SAMPLE DATE ----->	09/27/94		09/27/94		10/06/94		10/06/94		10/06/94		10/07/94	
	DATE ANALYZED --->	10/10/94		10/10/94		10/18/94		10/19/94		10/19/94		10/17/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS15	VAL	CHS15	VAL	CHS19	VAL	CHS19	VAL	CHS19	VAL	CHS19	VAL
100-41-4	Ethylbenzene												
100-42-5	Styrene												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
107-06-2	1,2-Dichloroethane												
108-05-4	Vinyl acetate												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
108-88-3	Toluene							4.4	J	3.9	J		
108-90-7	Chlorobenzene												
109-99-9	Tetrahydrofuran												
124-48-1	Dibromochloromethane												
127-18-4	Tetrachloroethene												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												
56-23-5	Carbon tetrachloride												
591-78-6	2-Hexanone												
67-64-1	Acetone					23.	J	61.		12.	J		
67-66-3	Chloroform												
71-43-2	Benzene												
71-55-6	1,1,1-Trichloroethane												
74-83-9	Bromomethane												
74-87-3	Chloromethane												
75-00-3	Chloroethane												
75-01-4	Vinyl chloride												
75-09-2	Methylene chloride			3.7	J								
75-15-0	Carbon disulfide							15.					
75-25-2	Bromoform												
75-27-4	Bromodichloromethane												
75-34-3	1,1-Dichloroethane												
75-35-4	1,1-Dichloroethene												
75-69-4	Trichlorofluoromethane												
78-87-5	1,2-Dichloropropane												
78-93-3	2-Butanone (MEK)												
79-00-5	1,1,2-Trichloroethane												
79-01-6	Trichloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
110-75-8	2-Chloroethylvinyl ether	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-VOA													
	SAMPLE ID ------->	GDH-S-B056-02		GDH-S-B057-01		GDH-S-B058-01 RE		GDH-S-B058-02		GDH-S-B059-01		GDH-S-B061-01	
	ORIGINAL ID ----->	GDHSB05602		GDHSB05701		GDHSB05801		GDHSB05802		GDHSB05901		GDHSB06101	
	LAB SAMPLE ID --->	41779-002		41780-007		41779-003RE		41779-004		41780-001		41779-005	
	ID FROM REPORT -->	100808		100814		100809		100810		100812		100811	
	SAMPLE DATE ----->	10/07/94		10/07/94		10/07/94		10/07/94		10/07/94		10/07/94	
	DATE ANALYZED --->	10/17/94		10/20/94		10/18/94		10/18/94		10/19/94		10/18/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS19	VAL	CHS20	VAL	CHS19	VAL	CHS19	VAL	CHS20	VAL	CHS19	VAL
100-41-4	Ethylbenzene												
100-42-5	Styrene												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
107-06-2	1,2-Dichloroethane												
108-05-4	Vinyl acetate												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
108-88-3	Toluene			10.		11.	J					11.	
108-90-7	Chlorobenzene												
109-99-9	Tetrahydrofuran												
124-48-1	Dibromochloromethane												
127-18-4	Tetrachloroethene												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												
56-23-5	Carbon tetrachloride												
591-78-6	2-Hexanone												
67-64-1	Acetone	27.	J	17.	J	24.	J	58.		14.	J	15.	J
67-66-3	Chloroform												
71-43-2	Benzene												
71-55-6	1,1,1-Trichloroethane												
74-83-9	Bromomethane												
74-87-3	Chloromethane												
75-00-3	Chloroethane												
75-01-4	Vinyl chloride												
75-09-2	Methylene chloride												
75-15-0	Carbon disulfide												
75-25-2	Bromoform												
75-27-4	Bromodichloromethane												
75-34-3	1,1-Dichloroethane												
75-35-4	1,1-Dichloroethene												
75-69-4	Trichlorofluoromethane												
78-87-5	1,2-Dichloropropane												
78-93-3	2-Butanone (MEK)												
79-00-5	1,1,2-Trichloroethane												
79-01-6	Trichloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
110-75-8	2-Chloroethylvinyl ether	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

SW846-VOA									
	SAMPLE ID ------->	GDH-S-B078-01		GDH-S-B078-02		GDH-S-B091-01		SGC-S-B009-01	
	ORIGINAL ID ----->	GDHSB07801		GDHSB07802		GDHSB09101		SGCSB00901	
	LAB SAMPLE ID --->	25250.6		25251.4		42430-003		41821-005	
	ID FROM REPORT -->	102208		102209		GDHSB09101		101305	
	SAMPLE DATE ----->	10/21/94		10/21/94		11/30/94		10/12/94	
	DATE ANALYZED --->	10/31/94		11/03/94		12/15/94		10/25/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil	
	UNITS ---------->	UG/KG		UG/KG		UG/KG		UG/KG	
CAS #	Parameter	CHS23	VAL	CHS23	VAL	CHS27	VAL	CHS21	VAL
100-41-4	Ethylbenzene								
100-42-5	Styrene								
10061-01-5	cis-1,3-Dichloropropene								
10061-02-6	trans-1,3-Dichloropropene								
107-06-2	1,2-Dichloroethane								
108-05-4	Vinyl acetate								
108-10-1	4-Methyl-2-Pentanone (MIBK)								
108-88-3	Toluene	41.						2.9	J
108-90-7	Chlorobenzene								
109-99-9	Tetrahydrofuran	??????????		??????????					
124-48-1	Dibromochloromethane								
127-18-4	Tetrachloroethene								
1330-20-7	Xylene (Total)								
540-59-0	1,2-Dichloroethene (total)								
56-23-5	Carbon tetrachloride								
591-78-6	2-Hexanone								
67-64-1	Acetone			137.				180.	
67-66-3	Chloroform								
71-43-2	Benzene								
71-55-6	1,1,1-Trichloroethane								
74-83-9	Bromomethane								
74-87-3	Chloromethane								
75-00-3	Chloroethane								
75-01-4	Vinyl chloride								
75-09-2	Methylene chloride								
75-15-0	Carbon disulfide								
75-25-2	Bromoform								
75-27-4	Bromodichloromethane								
75-34-3	1,1-Dichloroethane								
75-35-4	1,1-Dichloroethene								
75-69-4	Trichlorofluoromethane	??????????		??????????					
78-87-5	1,2-Dichloropropane								
78-93-3	2-Butanone (MEK)			4.	J				
79-00-5	1,1,2-Trichloroethane								
79-01-6	Trichloroethene								
79-34-5	1,1,2,2-Tetrachloroethane								
110-75-8	2-Chloroethylvinyl ether	??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

TPH													
	SAMPLE ID ------->	655-S-B001-01		655-S-B001-02		655-S-B002-01		655-S-B003-01		655-S-B003-02		655-S-B004-01	
	ORIGINAL ID ----->	655SB00101		655SB00102		655SB00201		655SB00301		655SB00302		655SB00401	
	LAB SAMPLE ID --->	41411-023		41411-024		41411-025		41411-026		41411-027		41411-028	
	ID FROM REPORT -->	090201		090202		090203		090204		090205		090206	
	SAMPLE DATE ----->	09/01/94		09/01/94		09/01/94		09/01/94		09/01/94		09/01/94	
	DATE EXTRACTED -->	09/09/94		09/09/94		09/09/94		09/09/94		09/09/94		09/09/94	
	DATE ANALYZED --->	09/12/94		09/12/94		09/12/94		09/12/94		09/12/94		09/12/94	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		MG/KG	
CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL
9999900-00-3	Total Petroleum Hydrocarbons (IR)	120.				110.		77.					
9999900-04-9	Miscellaneous Light Products	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-08-3	Indeterminate Lubricating Oil	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-06-1	Total Gasoline	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-10-7	Heavy Products	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-11-8	Indeterminate Diesel Fuel	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

TPH													
	SAMPLE ID ------->	655-S-B004-02		655-S-B005-01		655-S-B005-02		655-S-B006-01		655-S-B007-01		655-S-B009-01	
	ORIGINAL ID ----->	655SB00402		655SB00501		655SB00502		655SB00601		655SB00701		655SB00901	
	LAB SAMPLE ID --->	41411-029		41447-040		41447-041		41447-042		41447-043		42766-006	
	ID FROM REPORT -->	090207		090811		090812		090813		090814		655SB00901	
	SAMPLE DATE ----->	09/01/94		09/07/94		09/07/94		09/07/94		09/07/94		01/10/95	
	DATE EXTRACTED -->	09/09/94		09/09/94		09/09/94		09/09/94		09/09/94		01/16/95	
	DATE ANALYZED --->	09/12/94		09/12/94		09/12/94		09/12/94		09/12/94		01/20/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		MG/KG		MG/KG		MG/KG		MG/KG		UG/KG	
CAS #	Parameter	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS10	VAL	CHS29	VAL
9999900-00-3	Total Petroleum Hydrocarbons (IR)	120.		75.								??????????	
9999900-04-9	Miscellaneous Light Products	??????????		??????????		??????????		??????????		??????????			
9999900-08-3	Indeterminate Lubricating Oil	??????????		??????????		??????????		??????????		??????????		32000.	
9999900-06-1	Total Gasoline	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-10-7	Heavy Products	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-11-8	Indeterminate Diesel Fuel	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

TPH													
	SAMPLE ID ------->	655-S-B009-01		655-S-B010-01		655-S-B010-01		655-S-B011-01		655-S-B011-01		655-S-B011-02	
	ORIGINAL ID ----->	655SB00901		655SB01001		655SB01001		655SB01101		655SB01101		655SB01102	
	LAB SAMPLE ID --->	42766-014		42766-005		42766-013		42766-010		42766-018		42766-012	
	ID FROM REPORT -->	655SB00901		655SB01001		655SB01001		655SB01101		655SB01101		655SB01102	
	SAMPLE DATE ----->	01/10/95		01/10/95		01/10/95		01/10/95		01/10/95		01/10/95	
	DATE EXTRACTED -->			01/16/95				01/16/95				01/16/95	
	DATE ANALYZED --->	01/12/95		01/20/95		01/12/95		01/20/95		01/12/95		01/20/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		UG/KG		MG/KG		UG/KG		MG/KG		UG/KG	
CAS #	Parameter	CHS29	VAL	CHS29	VAL	CHS29	VAL	CHS29	VAL	CHS29	VAL	CHS29	VAL
9999900-00-3	Total Petroleum Hydrocarbons (IR)	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-04-9	Miscellaneous Light Products	??????????				??????????				??????????			
9999900-08-3	Indeterminate Lubricating Oil	??????????		28000.		??????????		35000.		??????????		43000.	
9999900-06-1	Total Gasoline			??????????				??????????				??????????	
9999900-10-7	Heavy Products	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-11-8	Indeterminate Diesel Fuel	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

TPH													
	SAMPLE ID ------->	655-S-B011-02		655-S-B012-01		655-S-B012-01		655-S-B012-02		655-S-B012-02		655-S-B013-01	
	ORIGINAL ID ----->	655SB01102		655SB01201		655SB01201		655SB01202		655SB01202		655SB01301	
	LAB SAMPLE ID --->	42766-020		42766-008		42766-016		42766-009		42766-017		42766-007	
	ID FROM REPORT -->	655SB01102		655SB01201		655SB01201		655SB01202		655SB01202		655SB01301	
	SAMPLE DATE ----->	01/10/95		01/10/95		01/10/95		01/10/95		01/10/95		01/10/95	
	DATE EXTRACTED -->			01/16/95				01/16/95				01/16/95	
	DATE ANALYZED --->	01/13/95		01/20/95		01/17/95		01/20/95		01/12/95		01/20/95	
	MATRIX ---------->	Soil		Soil		Soil		Soil		Soil		Soil	
	UNITS ---------->	MG/KG		UG/KG		MG/KG		UG/KG		MG/KG		UG/KG	
CAS #	Parameter	CHS29	VAL	CHS29	VAL	CHS29	VAL	CHS29	VAL	CHS29	VAL	CHS29	VAL
9999900-00-3	Total Petroleum Hydrocarbons (IR)	??????????		??????????		??????????		??????????		??????????		??????????	
9999900-04-9	Miscellaneous Light Products	??????????				??????????				??????????			
9999900-08-3	Indeterminate Lubricating Oil	??????????		29000.		??????????		??????????		??????????		11000.	J
9999900-06-1	Total Gasoline			??????????				??????????				??????????	
9999900-10-7	Heavy Products	??????????		??????????		??????????				??????????		??????????	
9999900-11-8	Indeterminate Diesel Fuel	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for Soil in Vicinity of Building656

TPH								
	SAMPLE ID ------->	655-S-B013-01		655-S-B013-02		655-S-B013-02		
	ORIGINAL ID ----->	655SB01301		655SB01302		655SB01302		
	LAB SAMPLE ID --->	42766-015		42766-011		42766-019		
	ID FROM REPORT -->	655SB01301		655SB01302		655SB01302		
	SAMPLE DATE ----->	01/10/95		01/10/95		01/10/95		
	DATE EXTRACTED -->			01/16/95				
	DATE ANALYZED --->	01/12/95		01/20/95		01/13/95		
	MATRIX ---------->	Soil		Soil		Soil		
	UNITS ---------->	MG/KG		UG/KG		MG/KG		
CAS #	Parameter	CHS29	VAL	CHS29	VAL	CHS29	VAL	
9999900-00-3	Total Petroleum Hydrocarbons (IR)	???????????		???????????		???????????		
9999900-04-9	Miscellaneous Light Products	???????????				???????????		
9999900-08-3	Indeterminate Lubricating Oil	???????????		15000.	J	???????????		
9999900-06-1	Total Gasoline			???????????				
9999900-10-7	Heavy Products	???????????		???????????		???????????		
9999900-11-8	Indeterminate Diesel Fuel	???????????		???????????		???????????		

*** Validation Complete ***

4.13.2.1 Volatile Organic Compounds in Groundwater

No VOCs were reported for groundwater samples from near AOC 655.

4.13.2.2 Semivolatile Organic Compounds in Groundwater

No SVOCs were reported in the results for the groundwater samples from near AOC 655.

Table 4.13.3
AOC 655
Organic Compounds in Groundwater (μg/L)
(3 Samples Collected)

Compound Name	No. of Detections	Range of Concentrations	Risk-Based Screening Levels
Volatile Organic Compounds			
No VOCs detected.			
Semivolatile Organic Compounds			
No SVOCs detected.			
Pesticides			
alpha-Chlordane	1	0.04	0.052 alpha + gamma
gamma-Chlordane	1	0.06	
Polychlorinated Biphenyls			
No PCBs detected.			
Total Petroleum Hydrocarbons			
No TPH detected.			

Table 4.13.4
AOC 655
Inorganic Elements in Groundwater (μg/L)
(3 Samples Collected)

Compound Name[a]	No. of Detections	Range of Concentrations	Risk-Based Screening Levels
Aluminum	2	1040-1750	3700
Iron	3	17600-45400	Not Listed
Potassium	3	52200-161000	Not Listed

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

SW846-SVOA													
	SAMPLE ID ------->	009-G-W002-01		009-G-W005-01		009-G-W008-01		655-G-W001-01		655-G-W002-01		655-G-W003-01	
	ORIGINAL ID ----->	009GW00201		009GW00501		009GW00801		655GW00101		655GW00201		655GW00301	
	LAB SAMPLE ID --->	42048-006		42048-007		42381-004		42000-003		41986-005		41986-004	
	ID FROM REPORT -->	110306		110307		009GW00801		102901		102808		102807	
	SAMPLE DATE ----->	11/02/94		11/02/94		11/28/94		10/28/94		10/27/94		10/27/94	
	DATE EXTRACTED -->	11/08/94		11/08/94		11/30/94		11/03/94		11/03/94		11/03/94	
	DATE ANALYZED --->	11/10/94		11/10/94		12/07/94		11/09/94		11/09/94		11/09/94	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	CHS24	VAL	CHS24	VAL	CHS27	VAL	CHS24	VAL	CHS24	VAL	CHS24	VAL
62-75-9	N-Nitrosodimethylamine												
606-20-2	2,6-Dinitrotoluene												
108-95-2	Phenol												
99-09-2	3-Nitroaniline												
62-53-3	Aniline												
83-32-9	Acenaphthene												
111-44-4	bis(2-Chloroethyl)ether												
51-28-5	2,4-Dinitrophenol												
95-57-8	2-Chlorophenol												
100-02-7	4-Nitrophenol												
541-73-1	1,3-Dichlorobenzene												
132-64-9	Dibenzofuran												
106-46-7	1,4-Dichlorobenzene												
121-14-2	2,4-Dinitrotoluene												
100-51-6	Benzyl alcohol												
84-66-2	Diethylphthalate												
95-50-1	1,2-Dichlorobenzene												
7005-72-3	4-Chlorophenylphenylether												
95-48-7	2-Methylphenol (o-Cresol)												
86-73-7	Fluorene												
108-60-1	2,2'-oxybis(1-Chloropropane)												
100-01-6	4-Nitroaniline												
106-44-5	4-Methylphenol (p-Cresol)												
534-52-1	4,6-Dinitro-2-methylphenol												
621-64-7	N-Nitroso-di-n-propylamine												
86-30-6	N-Nitrosodiphenylamine												
67-72-1	Hexachloroethane												
101-55-3	4-Bromophenylphenylether												
98-95-3	Nitrobenzene												
118-74-1	Hexachlorobenzene												
78-59-1	Isophorone												
87-86-5	Pentachlorophenol												
88-75-5	2-Nitrophenol												
85-01-8	Phenanthrene												
105-67-9	2,4-Dimethylphenol												
120-12-7	Anthracene												

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

SW846-SVOA													
	SAMPLE ID ------->	009-G-W002-01		009-G-W005-01		009-G-W008-01		655-G-W001-01		655-G-W002-01		655-G-W003-01	
	ORIGINAL ID ----->	009GW00201		009GW00501		009GW00801		655GW00101		655GW00201		655GW00301	
	LAB SAMPLE ID --->	42048-006		42048-007		42381-004		42000-003		41986-005		41986-004	
	ID FROM REPORT -->	110306		110307		009GW00801		102901		102808		102807	
	SAMPLE DATE ----->	11/02/94		11/02/94		11/28/94		10/28/94		10/27/94		10/27/94	
	DATE EXTRACTED -->	11/08/94		11/08/94		11/30/94		11/03/94		11/03/94		11/03/94	
	DATE ANALYZED --->	11/10/94		11/10/94		12/07/94		11/09/94		11/09/94		11/09/94	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	CHS24	VAL	CHS24	VAL	CHS27	VAL	CHS24	VAL	CHS24	VAL	CHS24	VAL
65-85-0	Benzoic acid												
84-74-2	Di-n-butylphthalate												
111-91-1	bis(2-Chloroethoxy)methane												
206-44-0	Fluoranthene												
120-83-2	2,4-Dichlorophenol												
92-87-5	Benzidine												
120-82-1	1,2,4-Trichlorobenzene												
129-00-0	Pyrene												
91-20-3	Naphthalene												
85-68-7	Butylbenzylphthalate												
106-47-8	4-Chloroaniline												
91-94-1	3,3'-Dichlorobenzidine												
87-68-3	Hexachlorobutadiene												
56-55-3	Benzo(a)anthracene												
59-50-7	4-Chloro-3-methylphenol												
218-01-9	Chrysene												
91-57-6	2-Methylnaphthalene												
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)												
77-47-4	Hexachlorocyclopentadiene												
117-84-0	Di-n-octylphthalate												
88-06-2	2,4,6-Trichlorophenol												
205-99-2	Benzo(b)fluoranthene												
95-95-4	2,4,5-Trichlorophenol												
207-08-9	Benzo(k)fluoranthene												
91-58-7	2-Chloronaphthalene												
50-32-8	Benzo(a)pyrene												
88-74-4	2-Nitroaniline												
193-39-5	Indeno(1,2,3-cd)pyrene												
131-11-3	Dimethylphthalate												
53-70-3	Dibenzo(a,h)anthracene												
208-96-8	Acenaphthylene												
191-24-2	Benzo(g,h,i)perylene												
103-33-3	Azobenzene												

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

SW846-SVOA	SAMPLE ID ------->	GDH-G-W002-01					
	ORIGINAL ID ----->	GDHGW00201					
	LAB SAMPLE ID --->	42084-004					
	ID FROM REPORT -->	GDHGW00201					
	SAMPLE DATE ----->	11/04/94					
	DATE EXTRACTED -->	11/10/94					
	DATE ANALYZED --->	11/15/94					
	MATRIX ---------->	Water					
	UNITS ---------->	UG/L					
CAS #	Parameter	CHS25 VAL					
62-75-9	N-Nitrosodimethylamine						
606-20-2	2,6-Dinitrotoluene						
108-95-2	Phenol						
99-09-2	3-Nitroaniline						
62-53-3	Aniline						
83-32-9	Acenaphthene						
111-44-4	bis(2-Chloroethyl)ether						
51-28-5	2,4-Dinitrophenol						
95-57-8	2-Chlorophenol						
100-02-7	4-Nitrophenol						
541-73-1	1,3-Dichlorobenzene						
132-64-9	Dibenzofuran						
106-46-7	1,4-Dichlorobenzene						
121-14-2	2,4-Dinitrotoluene						
100-51-6	Benzyl alcohol						
84-66-2	Diethylphthalate						
95-50-1	1,2-Dichlorobenzene						
7005-72-3	4-Chlorophenylphenylether						
95-48-7	2-Methylphenol (o-Cresol)						
86-73-7	Fluorene						
108-60-1	2,2'-oxybis(1-Chloropropane)						
100-01-6	4-Nitroaniline						
106-44-5	4-Methylphenol (p-Cresol)						
534-52-1	4,6-Dinitro-2-methylphenol						
621-64-7	N-Nitroso-di-n-propylamine						
86-30-6	N-Nitrosodiphenylamine						
67-72-1	Hexachloroethane						
101-55-3	4-Bromophenylphenylether						
98-95-3	Nitrobenzene						
118-74-1	Hexachlorobenzene						
78-59-1	Isophorone						
87-86-5	Pentachlorophenol						
88-75-5	2-Nitrophenol						
85-01-8	Phenanthrene						
105-67-9	2,4-Dimethylphenol						
120-12-7	Anthracene						

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

SW846-SVOA

SAMPLE ID ------->	GDH-G-W002-01
ORIGINAL ID ----->	GDHGW00201
LAB SAMPLE ID --->	42084-004
ID FROM REPORT -->	GDHGW00201
SAMPLE DATE ----->	11/04/94
DATE EXTRACTED -->	11/10/94
DATE ANALYZED --->	11/15/94
MATRIX ---------->	Water
UNITS ---------->	UG/L

CAS #	Parameter	CHS25	VAL
65-85-0	Benzoic acid		
84-74-2	Di-n-butylphthalate		
111-91-1	bis(2-Chloroethoxy)methane		
206-44-0	Fluoranthene		
120-83-2	2,4-Dichlorophenol		
92-87-5	Benzidine		
120-82-1	1,2,4-Trichlorobenzene		
129-00-0	Pyrene		
91-20-3	Naphthalene		
85-68-7	Butylbenzylphthalate		
106-47-8	4-Chloroaniline		
91-94-1	3,3'-Dichlorobenzidine		
87-68-3	Hexachlorobutadiene		
56-55-3	Benzo(a)anthracene		
59-50-7	4-Chloro-3-methylphenol		
218-01-9	Chrysene		
91-57-6	2-Methylnaphthalene		
117-81-7	bis(2-Ethylhexyl)phthalate (BEHP)		
77-47-4	Hexachlorocyclopentadiene		
117-84-0	Di-n-octylphthalate		
88-06-2	2,4,6-Trichlorophenol		
205-99-2	Benzo(b)fluoranthene		
95-95-4	2,4,5-Trichlorophenol		
207-08-9	Benzo(k)fluoranthene		
91-58-7	2-Chloronaphthalene		
50-32-8	Benzo(a)pyrene		
88-74-4	2-Nitroaniline		
193-39-5	Indeno(1,2,3-cd)pyrene		
131-11-3	Dimethylphthalate		
53-70-3	Dibenzo(a,h)anthracene		
208-96-8	Acenaphthylene		
191-24-2	Benzo(g,h,i)perylene		
103-33-3	Azobenzene		

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

SW846-VOA													
	SAMPLE ID ------->	009-G-W002-01		009-G-W005-01		009-G-W008-01		655-G-W001-01		655-G-W002-01		655-G-W003-01	
	ORIGINAL ID ----->	009GW00201		009GW00501		009GW00801		655GW00101		655GW00201		655GW00301	
	LAB SAMPLE ID --->	42048-002		42048-003		42381-001		42000-001		41986-003		41986-002	
	ID FROM REPORT -->	110306		110307		009GW00801		102901		102808		102807	
	SAMPLE DATE ----->	11/02/94		11/02/94		11/28/94		10/28/94		10/27/94		10/27/94	
	DATE ANALYZED --->	11/08/94		11/09/94		12/07/94		11/08/94		11/08/94		11/08/94	
	MATRIX ---------->	Water		Water		Water		Water		Water		Water	
	UNITS ---------->	UG/L		UG/L		UG/L		UG/L		UG/L		UG/L	
CAS #	Parameter	CHS24	VAL	CHS24	VAL	CHS27	VAL	CHS24	VAL	CHS24	VAL	CHS24	VAL
100-41-4	Ethylbenzene												
100-42-5	Styrene												
10061-01-5	cis-1,3-Dichloropropene												
10061-02-6	trans-1,3-Dichloropropene												
107-06-2	1,2-Dichloroethane												
108-05-4	Vinyl acetate												
108-10-1	4-Methyl-2-Pentanone (MIBK)												
108-88-3	Toluene												
108-90-7	Chlorobenzene												
109-99-9	Tetrahydrofuran												
124-48-1	Dibromochloromethane												
127-18-4	Tetrachloroethene												
1330-20-7	Xylene (Total)												
540-59-0	1,2-Dichloroethene (total)												
56-23-5	Carbon tetrachloride												
591-78-6	2-Hexanone												
67-64-1	Acetone												
67-66-3	Chloroform												
71-43-2	Benzene												
71-55-6	1,1,1-Trichloroethane												
74-83-9	Bromomethane												
74-87-3	Chloromethane												
75-00-3	Chloroethane												
75-01-4	Vinyl chloride												
75-09-2	Methylene chloride												
75-15-0	Carbon disulfide												
75-25-2	Bromoform												
75-27-4	Bromodichloromethane												
75-34-3	1,1-Dichloroethane												
75-35-4	1,1-Dichloroethene												
75-69-4	Trichlorofluoromethane												
78-87-5	1,2-Dichloropropane												
78-93-3	2-Butanone (MEK)												
79-00-5	1,1,2-Trichloroethane												
79-01-6	Trichloroethene												
79-34-5	1,1,2,2-Tetrachloroethane												
110-75-8	2-Chloroethylvinyl ether	??????????		??????????		??????????		??????????		??????????		??????????	

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

SW846-VOA							
	SAMPLE ID ------->	GDH-G-W002-01					
	ORIGINAL ID ----->	GDHGW00201					
	LAB SAMPLE ID --->	42084-001					
	ID FROM REPORT -->	GDHGW00201					
	SAMPLE DATE ----->	11/04/94					
	DATE ANALYZED --->	11/15/94					
	MATRIX ---------->	Water					
	UNITS ---------->	UG/L					
CAS #	Parameter	CHS25 VAL					
100-41-4	Ethylbenzene						
100-42-5	Styrene						
10061-01-5	cis-1,3-Dichloropropene						
10061-02-6	trans-1,3-Dichloropropene						
107-06-2	1,2-Dichloroethane						
108-05-4	Vinyl acetate						
108-10-1	4-Methyl-2-Pentanone (MIBK)						
108-88-3	Toluene						
108-90-7	Chlorobenzene						
109-99-9	Tetrahydrofuran						
124-48-1	Dibromochloromethane						
127-18-4	Tetrachloroethene						
1330-20-7	Xylene (Total)						
540-59-0	1,2-Dichloroethene (total)						
56-23-5	Carbon tetrachloride						
591-78-6	2-Hexanone						
67-64-1	Acetone						
67-66-3	Chloroform						
71-43-2	Benzene						
71-55-6	1,1,1-Trichloroethane						
74-83-9	Bromomethane						
74-87-3	Chloromethane						
75-00-3	Chloroethane						
75-01-4	Vinyl chloride						
75-09-2	Methylene chloride						
75-15-0	Carbon disulfide						
75-25-2	Bromoform						
75-27-4	Bromodichloromethane						
75-34-3	1,1-Dichloroethane						
75-35-4	1,1-Dichloroethene						
75-69-4	Trichlorofluoromethane						
78-87-5	1,2-Dichloropropane						
78-93-3	2-Butanone (MEK)						
79-00-5	1,1,2-Trichloroethane						
79-01-6	Trichloroethene						
79-34-5	1,1,2,2-Tetrachloroethane						
110-75-8	2-Chloroethylvinyl ether	??????????					

*** Validation Complete ***

CHARLESTON - ZONE H
NAVAL BASE CHARLESTON ZONE H (NBCH)
Data for GW in Vicinity of Building 656

TPH							
	SAMPLE ID ------->	655-G-W001-01	655-G-W002-01	655-G-W003-01			
	ORIGINAL ID ----->	655GW00101	655GW00201	655GW00301			
	LAB SAMPLE ID --->	42000-006	41986-014	41986-013			
	ID FROM REPORT -->	102901	102808	102807			
	SAMPLE DATE ----->	10/28/94	10/27/94	10/27/94			
	DATE EXTRACTED -->	11/01/94	11/01/94	11/01/94			
	DATE ANALYZED --->	11/01/94	11/01/94	11/01/94			
	MATRIX ---------->	Water	Water	Water			
	UNITS ---------->	MG/L	MG/L	MG/L			
CAS #	Parameter	CHS24 VAL	CHS24 VAL	CHS24 VAL			
9999900-00-3	Total Petroleum Hydrocarbons (IR)						
9999900-04-9	Miscellaneous Light Products	??????????	??????????	??????????			
9999900-08-3	Indeterminate Lubricating Oil	??????????	??????????	??????????			
9999900-06-1	Total Gasoline	??????????	??????????	??????????			
9999900-10-7	Heavy Products	??????????	??????????	??????????			
9999900-11-8	Indeterminate Diesel Fuel	??????????	??????????	??????????			

*** Validation Complete ***