File on eDOCs X Yes ___ No

Site Name Enarc-O

Site No. 826011

County Livingston

Town Lima

Foilable X Yes ___ No

File Name [redacted] hw.826011.1990-[illegible].

Scanned & eDOC report.

Site_Assessment_plan.pdf

826011 10/90
Enarc-O-Machine-Wasteplan

Interim Technical Memorandum

Enarc-O Machine Products Division of Kaddis Manufacturing Corporation North Bloomfield, New York

October 1990

O'BRIEN & GERE

2387.006

INTERIM TECHNICAL MEMORANDUM

ENARC-0 MACHINE PRODUCTS

DIVISION OF KADDIS MANUFACTURING CORPORATION

NORTH BLOOMFIELD, NEW YORK

OCTOBER, 1990

RECEIVED
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BUREAU OF WESTERN REMEDIAL ACTION
DIVISION OF HAZARDOUS
WASTE REMEDIATION

O'BRIEN & GERE ENGINEERS, INC.
5000 BRITTONFIELD PARKWAY
SYRACUSE, NEW YORK 13221

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APPENDICES

SECTION 1 - INTRODUCTION

1.01 Background

Kaddis Manufacturing Corporation (Kaddis) owns and operates a metal machining facility, Enarc-O Machine Products. (Enarc-O), located at 1175 Bragg Street, community of North Bloomfield, Town of Lima, Livingston County, New York (Figure 1). This facility is situated approximately one mile southeast of the village of Honeoye Falls, about 400 feet west and south of Honeoye Creek, at an approximate elevation of 722 feet above mean sea-level (MSL). The site encompasses an area slightly larger than six acres in size.

In 1985, sampling and analysis of several residential wells in the area surrounding the Enarc-O property was conducted by the New York State Department of Health (NYSDOH), the New York State Department of Environmental Conservation (NYSDEC), and the Livingston County Department of Health (LCDOH). The results of these analyses revealed detectable concentrations of chlorinated solvents, including 1-1-1 trichloroethane and trichloroethylene, in the ground water beneath the Enarc-O facility and some of the neighboring properties.

As a result of the discovery of volatile organic compounds (VOCs) in the ground water, the United States Environmental Protection Agency (USEPA) Region II, in July 1987, requested that Enarc-O develop a site assessment work plan to evaluate the general hydrogeologic characteristics and, in particular, the ground water quality of the property. Specifically, USEPA identified areas on the Enarc-O property which were to be targeted for investigation. A proposed work plan was subsequently prepared and was submitted to the USEPA in August, 1987. Comments to the

August 1987 work plan were received from USEPA on October 22, 1987 and on February 1, 1988. These comments were incorporated into a revised work plan which was resubmitted in March, 1988. Comments to the revised work plan were received From USEPA on June 30, 1988. These comments were addressed in a letter to USEPA dated July 21, 1988. On February 2, 1989 USEPA comments were received and subsequently were incorporated in another work plan revision dated March, 1989. This work plan was accepted by USEPA on July 31, 1989 and was appended to an Administrative Order on Consent between USEPA and Kaddis (Index No. II-CERCLA-90204) which became effective on September 28, 1989.

1.02 Objective

The approved work plan discussed above is divided into several work tasks requiring specific efforts. These tasks include a Background Information Review, a Fracture Trace Analysis and Geophysical Survey, an Interim Technical Memorandum, Soil Sampling and Analysis, Ground Water Monitoring Well Installations, Ground Water Sampling and Analysis, and Data Interpretation and Report Preparation.

Tasks 1 and 2 (Background Information Review and Fracture Trace Analysis and Geophysical Survey) have been completed. This Interim Technical Memorandum is being submitted in fulfillment of Task 3. Results of Tasks 1 and 2 are included in this Interim Technical Memorandum. In addition, information obtained as a result of the completion of Tasks 1 and 2 have been utilized to refine those efforts to be performed in Task 4 (Soil Sampling and Analysis), Task 5 (Ground Water Monitoring Well Installations), Task 6 (Ground Water Sampling and Analysis), and

Task 7 (Data Interpretation and Report Preparation). Refinements to these work tasks are also presented in this Interim Technical Memorandum.

SECTION 2 - RESULTS OF SITE ASSESSMENT TASKS 1 AND 2

2.01 Task 1 - Background Review

To identify potential sources of VOCs and to develop an understanding of the regional and local hydrogeology, available information pertaining to the site history, residential wells, and regional and local geology and hydrogeology were assembled and reviewed. Included in this review were documents regarding Enarc-O's solvent use and handling, as well as publicly available reports and papers pertaining to the local geology and hydrogeology. A summary of the reports, papers, and maps used for this work effort is included at the end of this ITM.

2.01.01 Site History

In December 1985 USEPA submitted a Request for Information Under 42 U.S.C. 9604 and 42 U.S.c. 6927. A response to this Request for Information was submitted by Enarc-O on January 20, 1986. The following discussion of the facility history was obtained from this document.

The area surrounding the Enarc-O facility is predominantly residential. However, the area to the west of the site is agricultural. A small, active auto repair shop is located adjacent and to the south of the Enarc-O property. This shop has reportedly been operating since approximately the mid 1960's.

The former residence of Mr. Wesley P. Crane, founder and previous owner and operator of Enarc-O, is adjacent and to the east of the Enarc-O facility. Enarc-O was started in the basement of this residence in 1954. In 1955 the operations moved into a double garage on Mr. Crane's property. In

1960 the operations moved onto the current Enarc-O Machine Products, Inc. property.

Organic solvent use at the Enarc-O facility has been limited to a vapor degreasing process which is used to clean oil residues off of newly machined parts. This vapor degreasing process is a contained, closed loop system which circulates cleaning fluids, allowing these fluids to be continually reused. Trichloroethylene was used in this system from Enarc-O's inception in 1954, until 1980. Between 1980 and 1985 1-1-1 trichloroethane was used in this process. Since 1985 Stoddard Solvent (Kensol 30) has been used. No chlorinated solvents have been in use at the facility since 1985. No reported loss of solvents has ever occurred from this system.

On June 18, 1985 a small spill of 1-1-1 trichloroethane (approximately 5 gallons) occurred near the facility's above ground solvent storage tank. This loss resulted from overfilling of the tank by an employee of a solvent supply company. The location of this loss is illustrated on Figure 2. Plant personnel immediately notified NYSDEC of the solvent loss. NYSDEC subsequently sent a representative to the spill site. Upon recommendation of the NYSDEC representative, the soils affected by the solvent spill were excavated to a depth of two feet, and were spread out in the southeast corner of the parking area to allow volatilization to occur. The soils were periodically raked by Enarc-O personnel to enhance the volatilization rate. Shortly thereafter Enarc-O removed the solvent storage tank and discontinued use of chlorinated solvents.

In 1985, subsequent to the release, NYSDOH, NYSDEC, and LCDOH conducted analyses of ground water samples collected from the Enarc-O supply well and 35 area residential wells. Analytical results revealed detectable concentrations of VOCs, primarily 1-1-1 trichloroethane and trichloroethylene, in the Enarc-O well and 21 of the 35 residential wells. A summary of the analytical data from the residential wells is included in Table 1. The Enarc-O well contained the highest detectable concentration of 1-1-1 trichloroethane. The Enarc-O samples were reportedly collected directly from the well using a bailer without prior purging of the well. Samples collected at individual residences were collected from spigots.

As a result of the detection of VOCs in the ground water in the area, bottled water was subsequently supplied to those residences whose wells showed detectable concentrations. Bottled water was continued until a public potable water system was installed to serve the residences in 1988.

In addition to the Enarc-O facility, other potential sources of VOCs are in the immediate area. The former Crane residence and property, located adjacent and to the east of the Enarc-O property, was the site of a small machining operation which is known to have used solvents for several years. It also is suspected that the auto repair shop located adjacent and to the south of Enarc-O's property may have used solvents in it's operation in the past and also at present.

2.01.02 Regional Physiography

The Enarc-O site lies within the Erie-Ontario Lowlands Physiographic Province. This area is characterized by intensive glacial modification which results in an undulating, drumlinized plateau (Muller, 1965).

Topographically, the Enarc-O facility is situated on top of a small ridge at an elevation of approximately 722 feet MSL. Honeoye Creek, located approximately 400 feet to the east and north of the site, is approximately 20 to 25 feet lower in elevation then the Enarc-O property. Surface water runoff from the property will generally flow towards the creek.

Surface features in the region in the absence of thick accumulations of glacial sediments are generally typical of karst terrain. Carbonate solution features such as rectangular drainage patterns, closed depressions, sinkholes, and disappearing and resurgent streams are typical (Acres International Corporation Report, 1988). Karst features are not apparent, however, in the immediate vicinity of the Enarc-O site.

2.01.03 Regional Geology

The geology of the area is characterized by unconsolidated deposits of glacial drift comprised of stratified silt, clay, and fine sand overlying sedimentary Devonian Age bedrock (Fairchild, 1935). Bedrock may be found exposed in drainage channels.

Soils found at the Enarc-O site are the Palmyra Fine Sandy Loam and the Genesee Silt Loam. The Palmyra Fine Sandy Loam is a deep, well drained soil developed from stratified sand and gravel deposited on outwash plains. Genesee Silt Loam is a deep, well drained soil developed from recent alluvium (Soil Survey of Livingston County, 1956).

The overburden in the area is variable. Lacustrine silt and clay deposits occur and were originally deposited in proglacial lakes. These deposits are generally laminated and calcareous. Outwash sand and gravel deposits laid down in a proglacial fluvial environment are also present and are typically well rounded and stratified (Muller and Cadwell, 1986).

The bedrock beneath the site is the Onondaga Limestone of Middle Devonian age. This formation is a fine to medium grained, crystalline carbonate rock (Rickard and Fisher, 1970). Depth to bedrock is estimated to be approximately 20 to 25 feet and occurs at an approximate elevation of 700 feet MSL (Grossman and Yarger, 1953). The Onondaga Limestone is known to be approximately 100 feet thick in the area and outcrops in Honeoye Creek. Regular joint patterns typically occur in this unit and were confirmed locally by field reconnaissance.

Beneath the Onondaga Limestone lies the Middle Devonian Bertie Formation. This stratigraphic unit consists of interbedded dolostone, shale, and shaly dolostone. The Bertie is estimated to be approximately 80 feet thick.

Bedrock in the region is for the most part undeformed. It has a very gentle regional dip of approximately 1 to 2 degrees to the south. In the vicinity of the Enarc-O site no faults or fold structures are present and no metamorphism of the Paleozoic strata exist (Fisher et.al., 1971; Isachsen and McKendree, 1977).

2.01.04 Regional Hydrogeology

There is no primary unconsolidated aquifer (an aquifer heavily used by communities and designated Primary Water Supply Aquifers by the NYSDEC) at the location of the Enarc-O site. However, well yields of up to approximately five gallons per minute may be obtained from the unconsolidated deposits found on-site (Grossman and Yarger, 1953; Miller, 1987). Ground water obtained by the Enarc-O supply well is known to be withdrawn from the fractured Onondaga Limestone. It is reported that the ground water recovered by the local residential wells is also obtained from the limestone bedrock.

Conversations between USEPA and Dr. Richard A. Young of SUNY Geneseo revealed that a 'significant yield' of ground water may occur at the overburden/bedrock interface in the vicinity of the site. Dr. Young also reports that a 'fairly good' yield may also be obtained from within the uppermost, weathered portion of the Onondaga Limestone.

Honeoye Creek which is likely the discharge boundary for the shallow ground water in the site area is located north and northeast of the site and flows towards the northwest. As stated previously, the slope of the land surface on the Enarc-O property is in the general direction of the creek. Given this information, it is likely that the ground water flow at the bedrock/overburden interface as well as within the shallow bedrock is towards the north and northeast.

2.02 Task 2 - Fracture Trace Analysis and Geophysical Survey

2.02.01 Fracture Trace Analysis

As ground water flow in bedrock systems is generally confined to fractures, a fracture trace analysis was conducted to evaluate, if possible, the location and pattern of fractures in the study area. The purpose of this analysis was to develop information which may be of aid in selecting locations for ground water monitoring well placement.

Subsurface features such as fractures cannot be directly observed on photographs. However, linear surficial features directly influenced by fractures, such as stream channels and linear geomorphic features, can be mapped and typically reflect the underlying bedrock fracture patterns.

Stereoscopic aerial photographs dated June 21, 1938, August 27, 1954, June 26, 1963, October 24, 1975, and May 5, 1982 were reviewed for fracture patterns. Additionally, topographic and drainage patterns were studied on the USGS 7.5 minute topographic map of the Honeoye Falls quadrangle (1951). This was completed to confirm the patterns observed on the photographs, and to reveal fracture traces which may have been obscured on the aerial photographs by vegetation or cultural features.

On both the aerial photographs and the USGS topographic map an area with a radius of several miles centered around the Enarc-O property was selected for study. Linear features were defined and their orientations measured. These data have been graphically illustrated in rose diagrams presented in Figures 3a through 3f. Additionally, a composite rose diagram which summarizes all of the aerial photographic data is presented as Figure 3g.

The composite rose diagram for the aerial photographs (Figure 3g) indicates two major sets of lineations. A primary lineation pattern trends from N 20 to 60 degrees W. A secondary, conjugate set of linear features strikes from N 40 to 50 degrees E. No linear features were observed to be crossing the Enarc-O property.

The rose diagram for the USGS topographic map (Figure 3a) identifies the primary set of lineations, but the orientation is less defined than those observed on the aerial photographs. The USGS map does not reveal the secondary set of lineations.

To confirm the orientation of these lineations, a field reconnaissance was conducted which evaluated the orientation of the joint fractures within the Onondaga Limestone exposed in Honeoye Creek. These joint fractures appear to control the stepped nature of the stream channel. The orientation of these fractures strike from N 57 to 75 degrees E. These data generally fall within the range for the secondary set of lineations identified in the aerial photographs. The Honeoye Creek channel is nearly perpendicular to these fractures, and therefore consistent in orientation with the primary lineation strike discussed above.

The primary set of linear features is also consistent with a major linear topographic feature defined by Isachsen and McKendree (1977). This feature was defined by utilizing either topographic maps, Landsat ERTS) imagery, and Skylab or U-2 photographs in their study. The feature strikes approximately N 15 degrees W (parallel to the flow of Honeoye Creek), is three miles in length, and is located about one mile east of North Bloomfield.

2.02.02 Geophysical Survey

A surficial geophysical survey was conducted on the Enarc-O property to evaluate general bedrock topography, depth to ground water, and fracture traces. This involved completing an electromagnetic (terrain conductivity) survey.

A Geonics model EM-34-3 was utilized to perform horizontal terrain conductivity profiles. Two coil spacings, 10 meters and 20 meters, were used to allow signal penetration to approximate depths of 7.5 meters and 15 meters, respectively using the horizontal dipole mode of operation. A third coil spacing, 40 meters, which would allow signal penetration to approximately 30 meters, was attempted, but was unsuccessful as electromagnetic interference due to background and cultural effects resulted in erratic instrument readings.

The EM-34 survey was conducted along three lines (Figure 4) which varied in length from 460 feet to 700 feet. The locations of the geophysical survey traverses are illustrated on Figure 4. The locations of the survey lines were related to permanent on-site features and their bearings noted to allow them to be accurately relocated. Lines A-A' and C-C' were oriented perpendicular to the trend of the primary fracture pattern as identified by the fracture trace analysis. Line B-B' was orientated perpendicular to the trend of the secondary fracture pattern. The reading stations along each traverse were separated by 20 feet.

Data obtained during the EM-34 survey have been plotted as vertical profiles which are illustrated in Figure 5. These illustrations suggest that there are locations where overburden thickness increases slightly. These areas are identified as peaks in the 10 M coil spacing curves of Figure 5 (those not influenced by cultural features such as metallic structures or power lines). This increased conductivity is likely a result of an increase in overburden thickness, which is an effect of a lesser volume of the lower conductive bedrock being penetrated by the shorter 10 M coil spacing.

Data obtained from the 20 M spacing are likely more representative of the bedrock material. These data indicate relatively constant conductivity values with the exception of those peaks associated with cultural features. If water-filled fractures were present, a localized increase in conductivity would be expected. In the absence of these variations in conductivity being observed, there does not appear to be large water-filled fractures on-site.

Bedrock appears to be near surface in the southeast corner of the Enarc-O property. In this area conductivity measured by both the short (10 M) and long (20 M) coil spacings reveal similar values.

SECTION 3 - SITE ASSESSMENT PLAN

The following sections outline specific work efforts which will be completed in this site assessment. Detailed protocols are presented in the Quality Assurance Project Plan (QAPP) included in Appendix A. The site's Health and Safety Plan will be adhered to at all times while performing field activities. This document is presented in Appendix B.

3.01 Task 4 - Soil Sampling and Analysis

As stated in Section 1.01 several areas were identified by USEPA for investigation on the Enarc-O property. These areas were located during the Background Information Review and are illustrated on Figure 6 as follows:

1. Area surrounding a recently excavated and removed gasoline storage tank.
2. Area around the removed above-ground solvent storage tank where the 1985 spill of 1-1-1 trichloroethane occurred.
3. Area where waste oil is retained.
4. Area around Enarc-O's loading dock. EPA reportedly has reason to believe the entire area was covered with an oily residue and was used to store drums at some point in the past.
5. Area of the parking lot where used oils were used for dust control. The southeast corner of this area was where the excavated soils from the 1985 spill were spread out to allow volatilization to occur.

6. Area southwest of the storage building where drums are currently stored.

Soil borings will be completed in each of these areas for the purpose of obtaining soil samples for analysis. The locations will be selected in the field with concurrence of the on-site USEPA representative prior to drilling commencement. One (1) boring will be placed in each location, with the exception of area 5 (parking area). In the parking area, five (5) soil borings will be placed, one in each quadrant (which will place one within the area where soils from the solvent spill were spread), and also one in the center. The soils will be analyzed by EPA Method 8010 and 8020 for VOCs. Analysis for lead will also be performed on those samples collected from area 1 (area of removed gasoline storage tank).

The soil borings will be completed using conventional hollow stem auger drilling methods. Soil samples will be collected continuously to fifteen feet below the ground surface using ASTM method D-1586-84. Samples will be collected at standard five foot intervals thereafter. Samples will not be composited. Up to 50% of all samples collected may be split with USEPA, as requested.

The split barrel sampler will be cleaned after collection of each sample using a non-phosphate detergent wash followed by a potable water rinse, a methanol rinse, and a final distilled water rinse.

A portion of each sample will be placed in a jar separate from those filled for laboratory analysis. The mouth of the jar will be covered with aluminum foil prior to replacing the screw top. The sample will subsequently be warmed to room temperatures at which time a photoionization detector (PID) will be used to monitor the headspace for volatile organics. The bottom of each boring will be selected in the field at the point which in field screening of the samples reveals levels of total organic vapors equal to a predetermined background concentration, or bedrock, or the ground water table is encountered, whichever occurs first.

Each sample collected will also be placed into one 4 oz. jar with a teflon-lined cover. Two 4 oz. jars will be filled if lead is to be analyzed. The two samples with the highest PID readings will be selected to be submitted for analysis. If PID readings on samples collected from a given boring all indicate non-detection. The sample just above, and the sample just within the water table will be analyzed. The 4 oz. sample jars will be packed in coolers with ice for shipment to the laboratory for analysis. Chain-of-custody documents will be initiated at the time of collection and maintained throughout the transport of the samples to the laboratory.

Soil removed during the drilling of these borings will be placed in 55-gallon drums. Soil stored in the drums will be handled in an appropriate manner based on the analytical results and USEPA approval.

Drilling equipment that may have come in contact with potentially contaminated material will be decontamination between borings in accordance with the protocol included in the QAPP (Appendix A). A central location will be set up on-site for the decontamination process. All water generated during decontamination will be contained and placed in 55 gallon drums pending analysis. Following receipt of the analytical results, the water will be disposed of in an appropriate manner.

Quality assurance/quality control procedures will be followed as outlined in the QAPP presented in Appendix A.

3.02 Task 5 - Ground Water Monitoring Well Installations

To evaluate the general direction of ground water flow potential and ground water quality on the Enarc-O property, six ground water monitoring wells will be installed. The approximate locations are illustrated on Figure 6. The exact locations will be selected in the field with concurrence of the on-site USEPA representative with consideration of the projection of the strike of the larger joint fractures evident in Honeoye Creek.

Should information obtained during completion of the soil sampling and analysis effort (Task 4) reveal data which would effect the placement or depth of ground water monitoring wells on the property, this information would be used to modify the locations of the wells as required.

The wells will be installed to monitor the first encountered ground water. Should ground water be encountered in the overburden, a seventh well will be installed adjacent to MW-3 to evaluate the ground water quality in the bedrock. It is anticipated that wells installed within the overburden will not exceed 25 feet. If bedrock wells are required, the depths will likely be on the order of 50 feet below grade.

Wells installed within the overburden will be drilled using conventional hollow stem auger drilling methods. The minimum inside diameter of the augers shall be 3.5 inches. Soil samples will be collected continuously through the overburden using split-barrel sampling method ASTM D-1586-84 for soil classification purposes. In addition, a PID will be used to screen the soil samples for volatile organics. Details pertaining to the drilling and sample screening procedures are included in the QAPP (Appendix A).

All soils generated during drilling will be placed in 55-gallon drums. Following receipt of the analytical results, the soil will be disposed of in an appropriate manner.

Monitoring wells installed within the overburden will be constructed of a 10 foot length of 0.010 inch slot, 2 inch I.D., Schedule 40 PVC screen attached to an appropriate length of solid 2 inch I.D. Schedule 40 PVC riser. Installation will be in accordance with procedures accepted by USEPA and NYSDEC and are outlined in the QAPP (Appendix A). These procedures are consistent with those outlined in the USEPA Region II "CERCLA QAPP Review Guidance" document dated April, 1987.

The bedrock wells will be of open hole construction. The borings for the wells will be completed to the top of bedrock using conventional hollow stem auger drilling methods. The minimum inside diameter of the auger will be 6 inches. A length of 4 inch diameter, schedule 80, PVC casing will then be set into the bedrock and grouted in place. Once the grout has set, the bedrock will be drilled using a minimum 3 inch diameter core barrel. Should the bedrock characteristics be such that coring is unproductive, air rotary methods will be used to complete the well. A PID will be used to screen the soil samples, core runs or cuttings for volatile organics in an attempt to select the optimum depth of the monitoring well. Drilling will continue to a maximum of 20 feet below the ground water table. The anticipated maximum depth of the wells is 50 feet below grade. The actual depth of the well will be selected in the field with concurrence of the on-site USEPA representative.

Drilling equipment which may have come in contact with potentially contaminated material will be decontaminated between wells in accordance with the protocol included in the QAPP (Appendix A). A central location will be set up on-site for the decontamination process. All water generated during decontamination will be contained and placed in 55-gallon drums pending analysis. Following receipt of the analytical results, the water will be disposed of in an appropriate manner.

The four monitoring wells will be developed in accordance with the protocol presented in the QAPP (Appendix A). The development will continue until the well yields relatively sediment-free ground water or a maximum time period of three hours. All development water will be placed in 55-gallon drums and stored on-site pending the results of the analyses by EPA Method 502.1 and 503.1 This water will then be properly disposed of based on the analytical results and USEPA approval.

A well location and elevation survey will be completed. The top of PVC and top of protective steel casing elevations will be determined to 0.01 feet, and ground elevations determined to 0.1 feet, for each well using an assumed, arbitrary, but permanent on-site datum. The locations will be tied into the currently available property map.

3.03 Task 6 - Ground Water Sampling and Analysis

Two rounds of ground water samples will be collected from all ground water monitoring wells installed during this investigation. The first round will be performed following a two week stabilization period after well development. The second round will occur a minimum of six weeks after the first round. The actual schedule for collection of the second set of samples will be dependent upon authorization to proceed from USEPA following their review of the analytical data from the first set of samples.

Ground water samples will be collected with a stainless steel bailer in accordance with procedures outlined in the USEPA Region II "CERCLA QAPP Review Guidance" document as set forth in the protocols included in the QAPP (Appendix A). Analysis will be by EPA Methods 502.1 and 503.1 for VOCs. Samples may be split at EPA's request for independent analyses.

The samples will be placed into appropriate containers and placed in a cooler with ice for shipment to the laboratory for analysis. Chain-of-custody documentation will be initiated in the field at the time of sample collection and maintained throughout handling and transport of the samples to the laboratory for analysis. Quality assurance/quality control procedures will be performed as described in the QAPP (Appendix A).

Prior to the initiation of each sampling event, ground water elevations will be collected from all wells to evaluate the direction of potential ground water flow. Water removed from the wells during well purging prior to sample collection will be placed in 55-gallon drums and stored on-site until the analytical results of the ground water samples are obtained. The water will then be properly disposed of following USEPA approval.

The hydraulic conductivity of the six ground water monitoring wells will be assessed to aid in evaluation of the ground water flow characteristics. This will be accomplished by performance of in-situ hydraulic conductivity tests. The method to perform these tests is presented in the QAPP (Appendix A).

In addition to the ground water samples, USEPA has requested that a sample be collected from the drain system illustrated on Figure 6. This drain is the SPDES approved discharge to Honeoye Creek. A sample of water will be collected from the storm drain collector located near location 2 on Figure 6. This sample will be placed into appropriate containers and placed in a cooler with ice for shipment to the laboratory for analysis. Chain-of-custody documents will be initiated in the field at the time of collection and maintained throughout handling and transport of the sample to the laboratory. This sample will be analyzed for volatile organics using EPA Method 502.1 and 503.1.

3.04 Task 7 - Data Interpretation and Report Preparation

Following completion of the Tasks 1 through 6 as outlined above, the collected data will be evaluated and presented in the form of a report. This report will discuss the field investigation methods, findings of the study, and recommendations for additional investigations if needed. Included in the report will be the drilling and well construction logs, ground water analytical results, a ground water hydraulic potential map, and the ground water elevation monitoring data.

Specifically, the report shall include the following data and illustrations:

- Rose diagrams showing the trend direction of the fracture traces observed during the fracture trace analysis.
- Vertical profiles of the EM-34-3 traverses.
- All geophysical data collected during the surveys.
- Drilling logs and well construction details.
- Results of the ground water sample analyses.
- The direction of ground water flow potential in the upper bedrock.
- Recommendations for additional work if warranted.

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PROJECT SCHEDULE

SITE INVESTIGATION
Enarc-O Machine Products
Division of Kaddis Manufacturing Corporation
North Bloomfield, New York

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             TASK           0       2       4       6       8      10      12      14      16      18      20      22      24      26
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                            |
4 Soil Sampling and Analysis|                ========
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5 Ground Water Monitoring   |                        ============
   Well Installations       |
                            |
6 Ground Water Sampling     |                                             =========  ======  =================
   and Analysis             |
                            |
7 Data Interpretation and   |                                                                 =======================================*
   Report Preparation       |
                            |


                     NOTES:       - Sampling Event
                               *  - Submittal to USEPA
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Tables

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TABLE 1

ANALYTICAL RESULTS
Supply Well Samples

Enarc-O Machine Products
North Bloomfield, New York

Name	Street	No.	Sample Date	T41109 TCE	T61209 T-1,2 DCE	T23609 1,1,1-TCA	T50809 1,2-DCA
Boonstra	Martin Rd.	7859	7/1/85	20	4	<1	<1
Bush	Martin Rd.	7787	8/7/85	<1	<1	<1	<1
Cavalier	Martin Rd.	7865	7/1/85	22	2	1	<1
Chambers	Ideson Rd.	1091	9/26/85	0	0	0	0
Colavito	Ideson Rd.	1090	8/7/85	2	<1	<1	<1
Cooper	Ideson Rd.	1121	7/24/85	24	8	1	<1
Enarc-O	Bragg St.	1175	7/1/85	8	4	22	<1
Endicott	Ideson Rd.	1108	8/7/85	<1	<1	<1	<1
Fessler	Martin Rd.	7783	9/26/85	0	0	0	0
Freedman	Ideson Rd.	1147	7/24/85	49	8	1	<1
Garvey,Robert	Martin Rd.	7883	6/19/85	290	75	8	<10
Garvey,Robert	Martin Rd.	7883	7/1/85	318	89	3	2
George, V.	Ontario St.	1886	8/7/85	<1	<1	<1	<1
Ghostlaw	Martin Rd.	7808	9/26/85	0	0	0	0
Hart	Ideson Rd.	1111	7/24/85	19	5	1	<1
Hopkins	Martin Rd.	7852	7/1/85	80	4	1	<1
Horan	Bragg St.	1382	7/24/85	<1	<1	<1	<1
Johnson	Ideson Rd.	1127	7/24/85	19	3	<1	<1
Johnson	Martin Rd.	7820	7/24/85	31	4	<1	<1
Maloy	Ideson Rd.	1116	8/7/85	8	1	<1	<1
Mantegna	Ontario St.	239	8/7/85	<1	<1	<1	<1
Miller	Ideson Rd.	1081	7/24/85	<1	<1	<1	<1
Miller	Martin Rd.	7744	10/31/85	0	0	0	0
Neverett	Martin Rd.	7829	10/31/85	2	0	0	0
O'Brien	Martin Rd.	7801	10/31/85	0	0	0	0
Reano	Ideson Rd.	1146	8/7/85	46	8	2	<1
Rogers,Larry	Martin Rd.	7880	6/19/85	260	75	<10	<10
Rogers,Larry	Martin Rd.	7880	7/1/85	197	43	2	2
Sackett, L.	Ideson Rd.	1140	8/7/85	29	5	1	<1
Saunders,R.	Martin Rd.	7838	8/7/85	22	4	<1	<1
Seltzer	Bean Hill Rd.	9644	7/24/85	<1	<1	<1	<1
Shelman	Ideson Rd.	1154	8/7/85	<5	<5	<5	<5
Slade	Martin Rd.	7796	9/26/85	0	0	0	0
Smith	Bragg St.	1167	6/19/85	77	21	1	2
Smith	Bragg St.	1167	7/1/85	98	17	1	<1
Stinson	Ontario St.	155	9/26/85	0	0	0	0
Swager,C.	Martin Rd.	7750	8/7/85	<1	<1	<1	<1
Tompkins	Ideson Rd.	1155	8/7/85	11	3	2	<1
Tondryk,Edward	Bragg St.	1191	6/19/85	4	<2	<2	<2
Tondryk,Edward	Bragg St.	1191	7/1/85	3	<1	<1	<1
Vellekoop,Harry	Martin Rd.	7886	6/19/85	110	41	8	<10
Vellekoop,Harry	Martin Rd.	7886	7/1/85	92	16	8	<1
Wagner	Ontario St.	1897	7/24/85	<1	<1	<1	<1
Years,Ronald	Martin Rd.	7873	7/1/85	72	19	1	<1

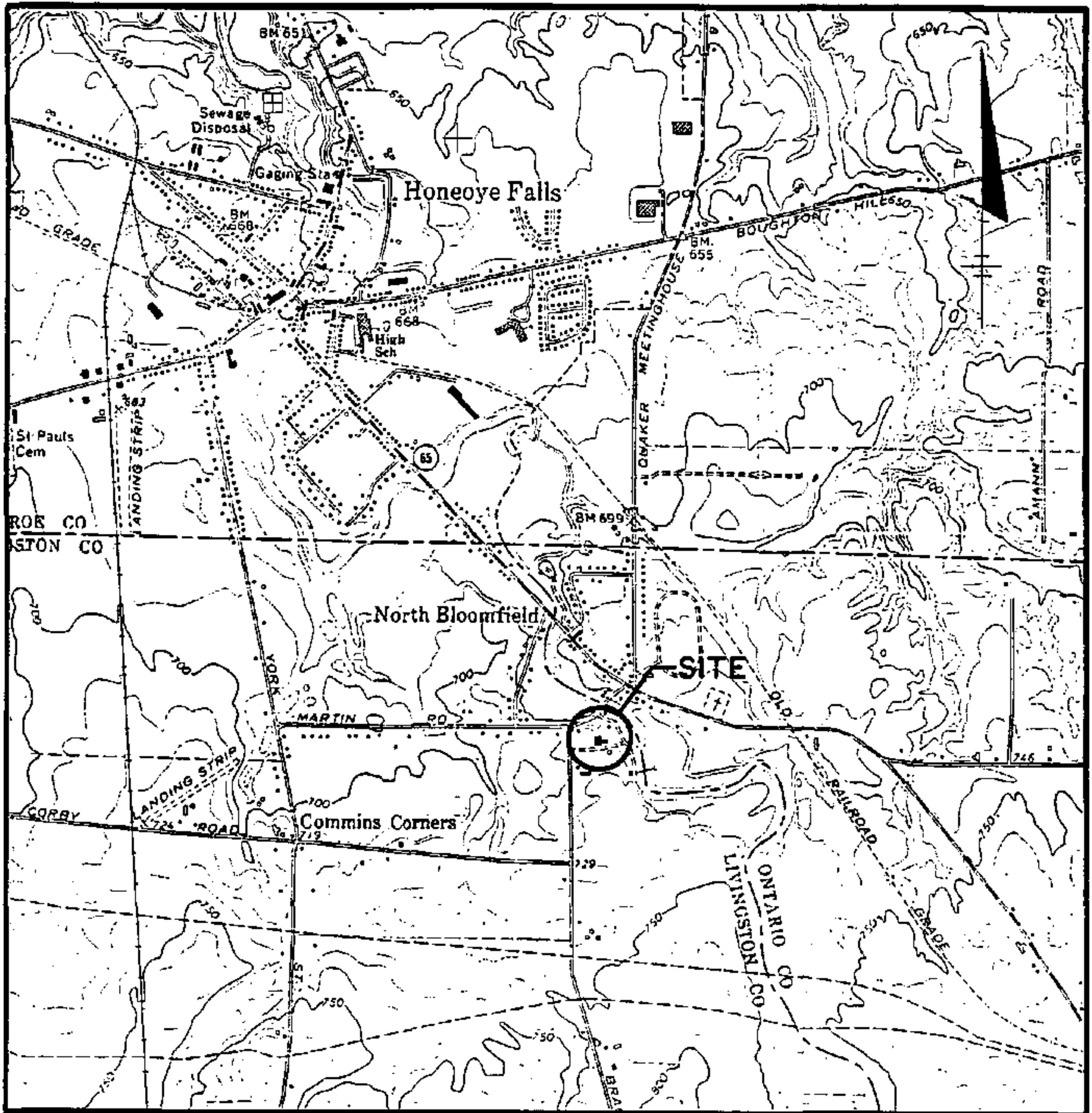
NOTES: Samples collected and analyzed by USEPA.
All results reported in parts per billion (PPB)

TCE - Trichloroethylene
T-1,2-DCE - Trans-1, 2-Dichloroethene
1,1,-TCA - 1, 1, 1-Trichloroethane
1,2-DCA - 1,2-Dichloroethane

Figures

O'BRIEN & GERE

FIGURE 1



KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

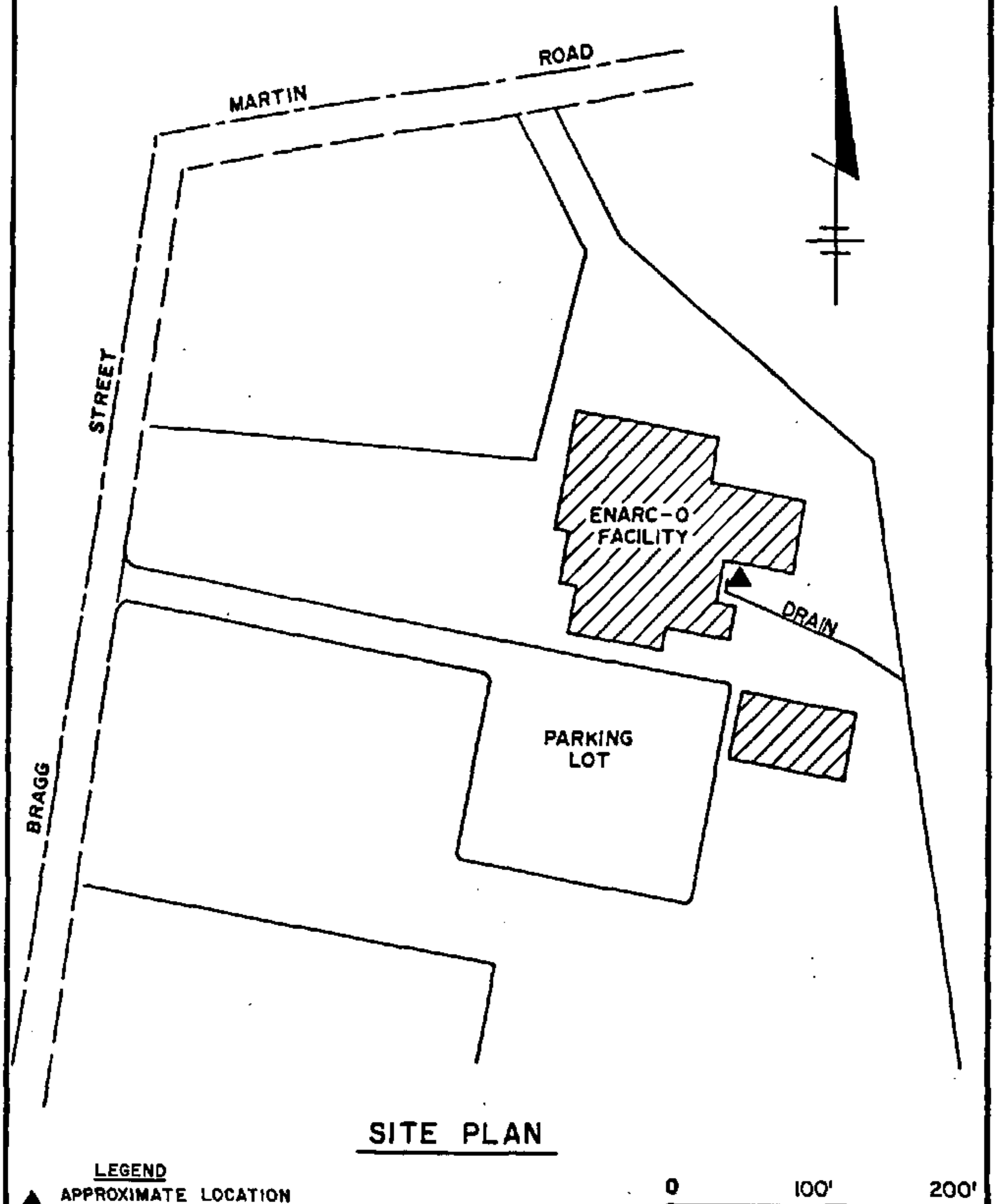
SITE LOCATION MAP

0 2000 4000
SCALE IN FEET

ADAPTED FROM HONEOYE FALLS, NEW YORK 7.5 MIN. U.S.G.S. QUADRANGLE (1971)

O'BRIEN & GERE ENGINEERS, INC.

FIGURE 2



SITE PLAN

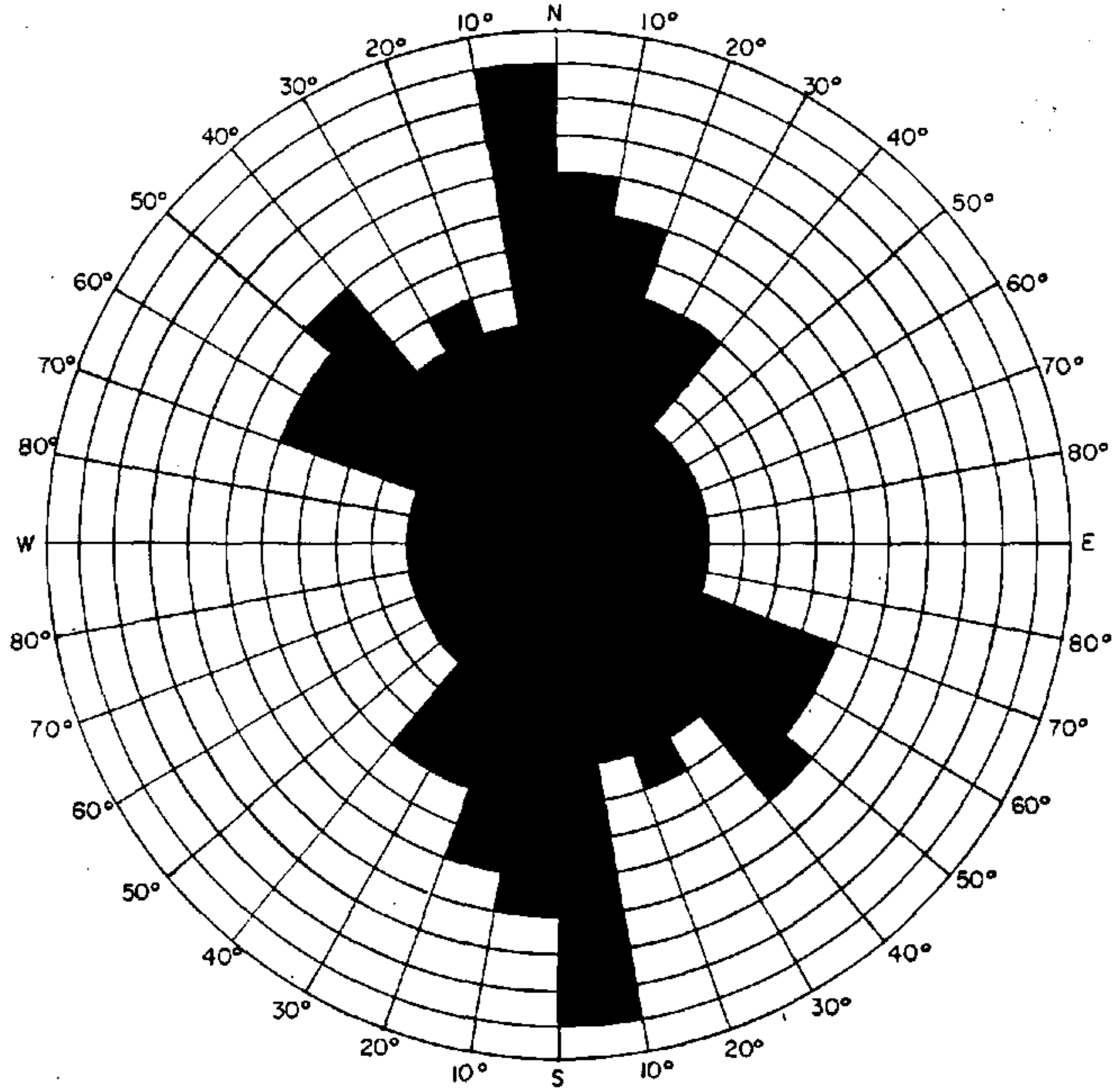
LEGEND

▲ APPROXIMATE LOCATION OF SOLVENT SPILL

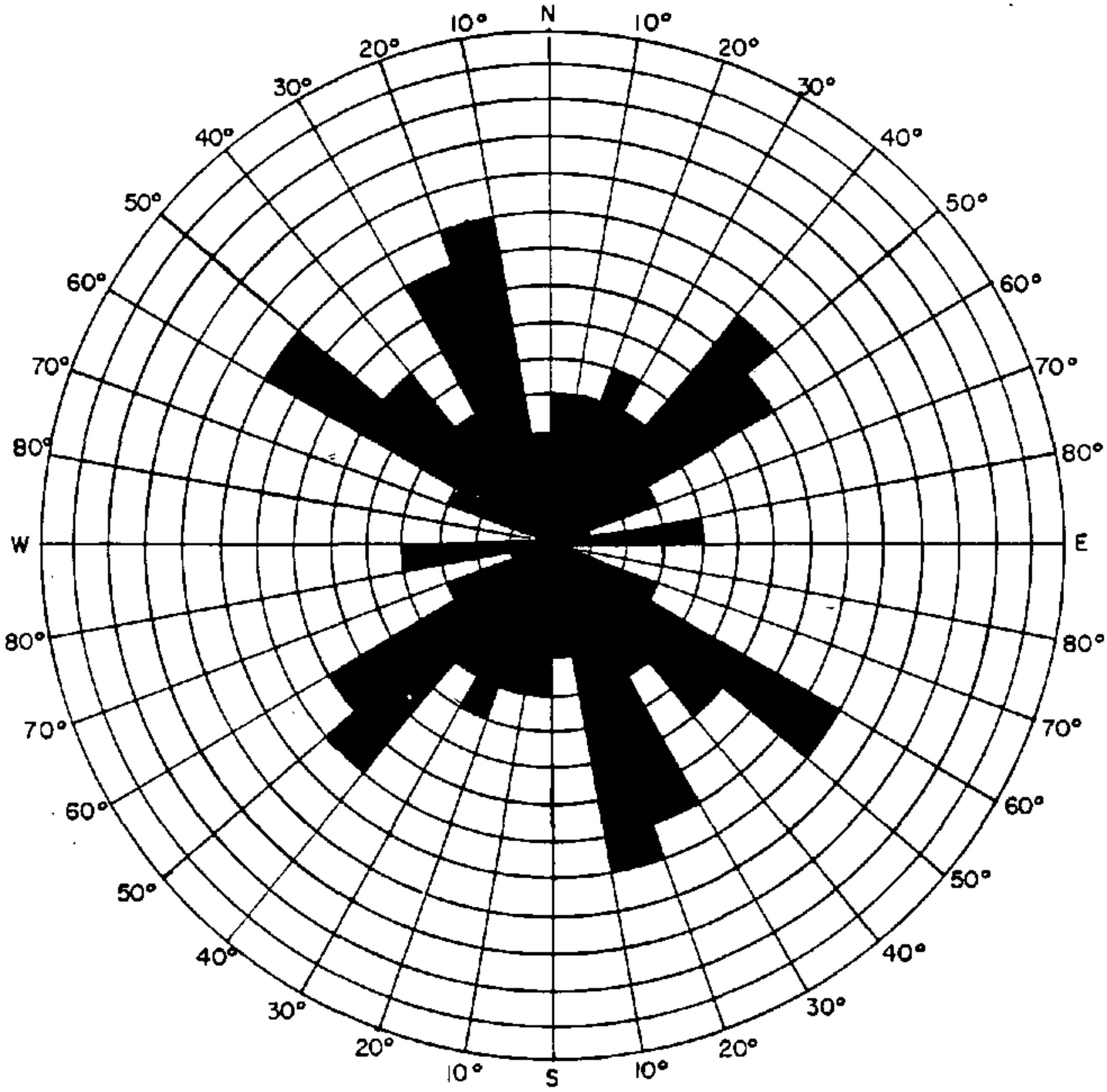
KADDIS CORPORATION (ENARC-O)

NORTH BLOOMFIELD, NEW YORK

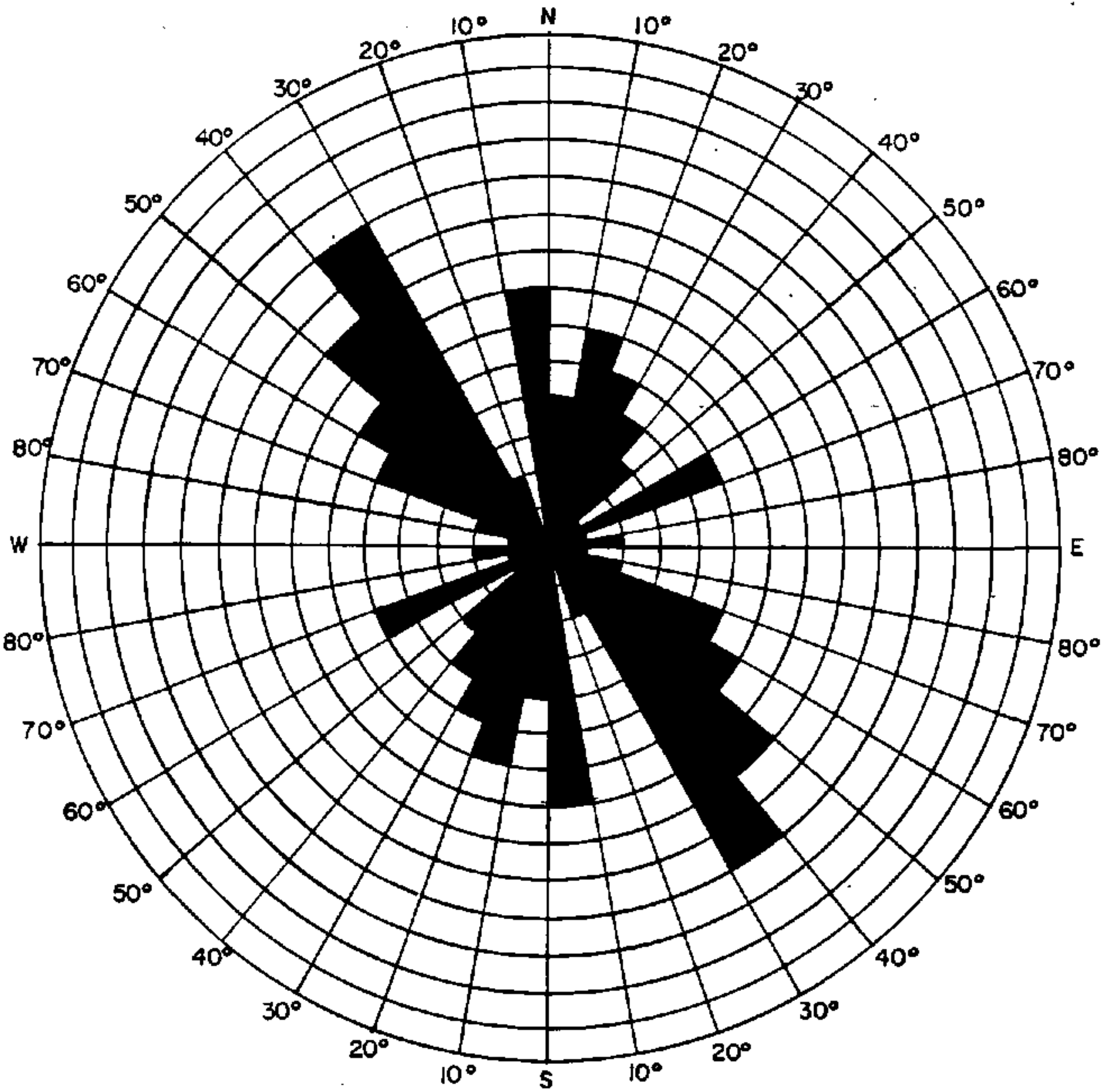
O'BRIEN & GERE ENGINEERS, INC



FRACTURE TRACE ANALYSIS
TOPOGRAPHIC MAP
KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

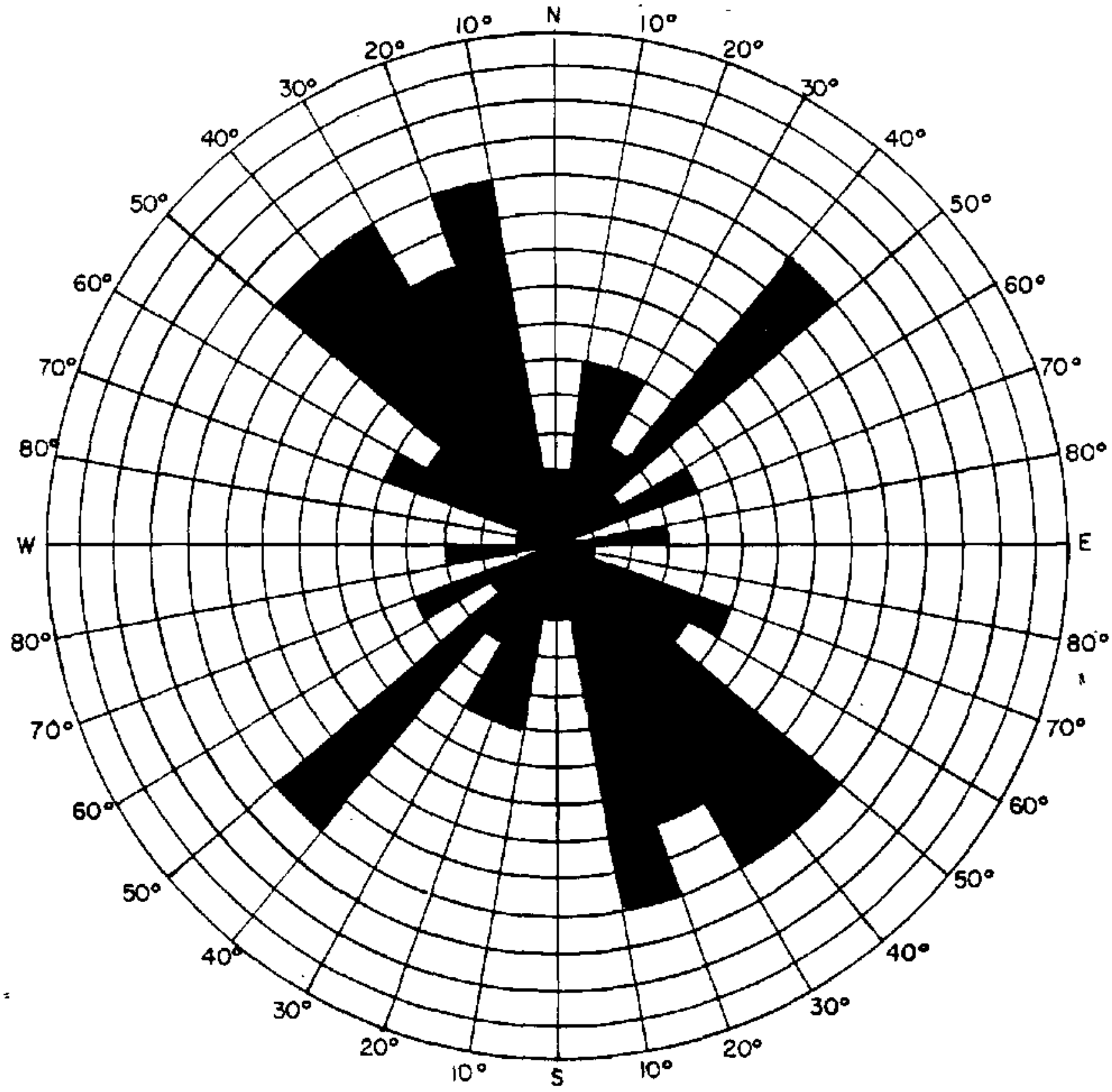


FRACTURE TRACE ANALYSIS
AIR PHOTO AUGUST 27, 1954
KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

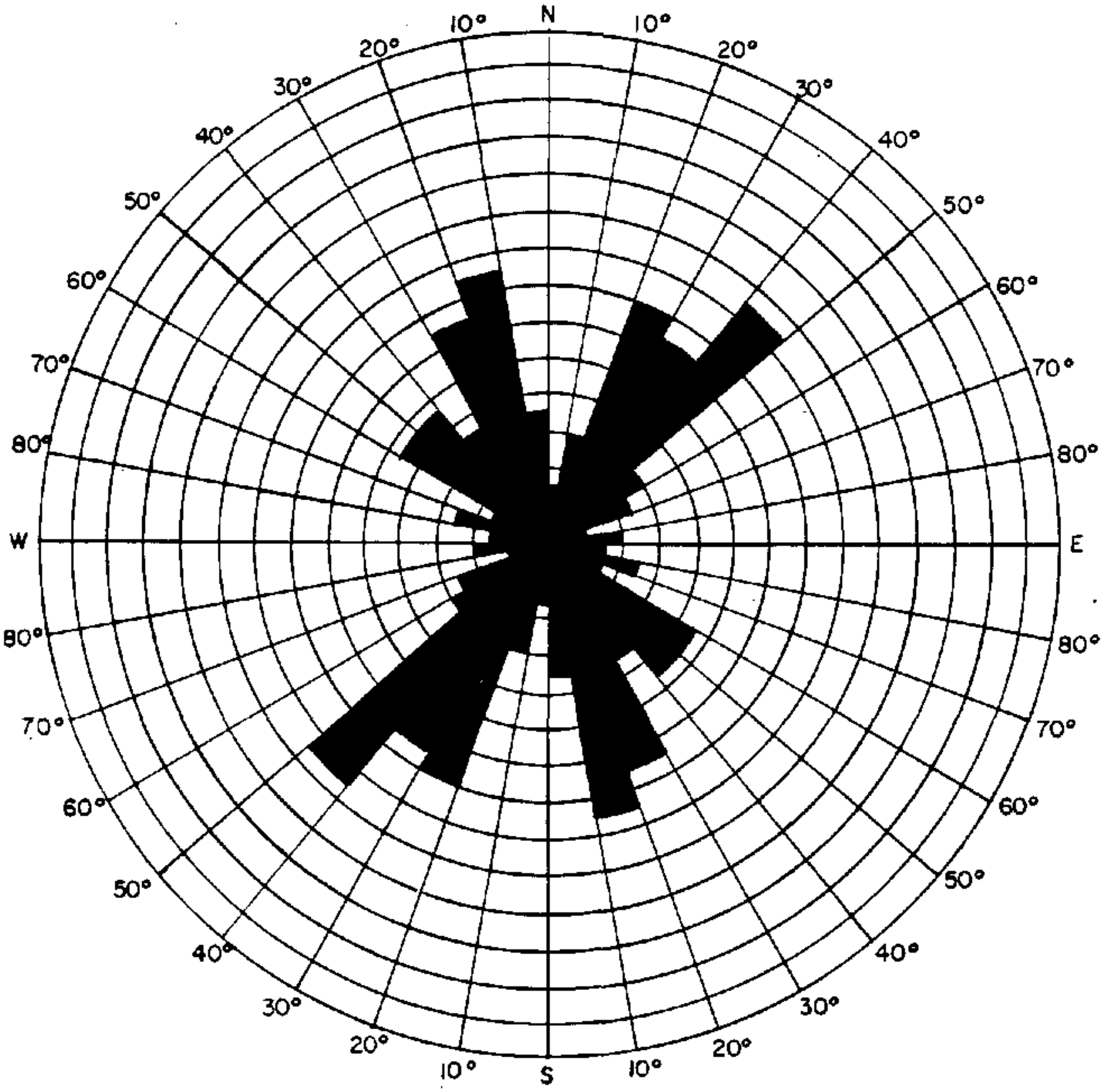


FRACTURE TRACE ANALYSIS
AIR PHOTO JUNE 21, 1938

KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

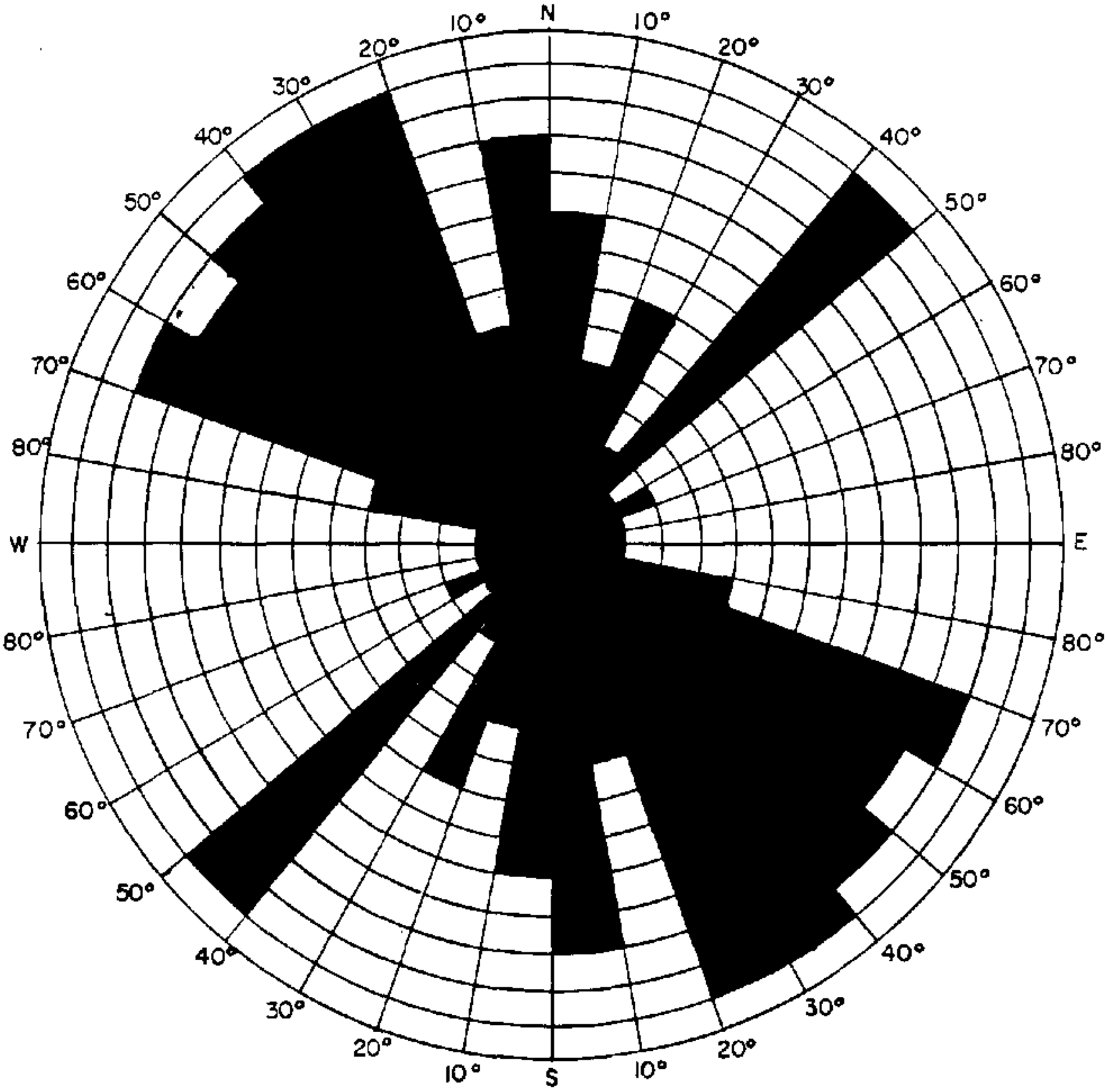


FRACTURE TRACE ANALYSIS
AIR PHOTO JUNE 26, 1963
KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFELD, NEW YORK

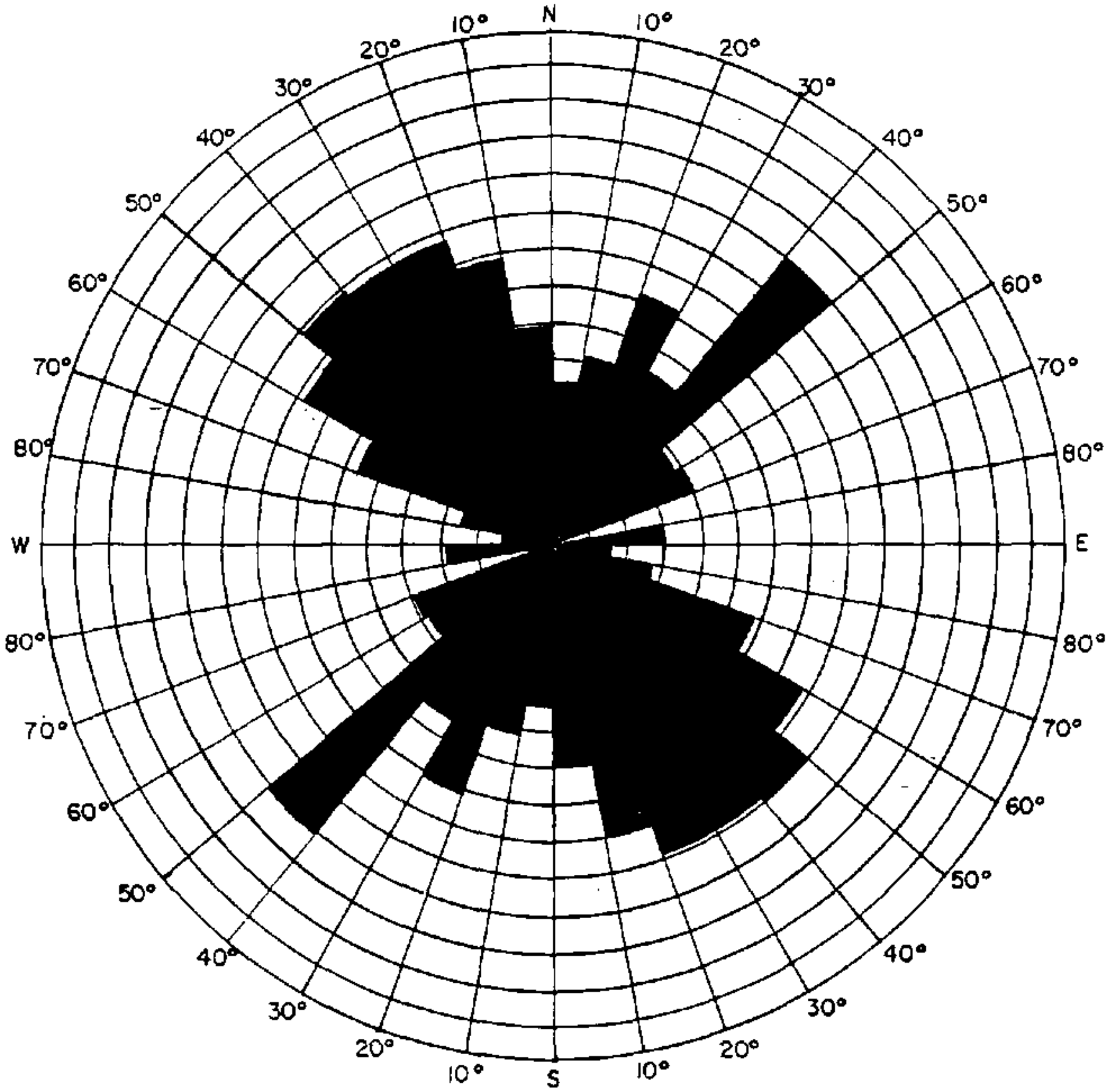


FRACTURE TRACE ANALYSIS
AIR PHOTO OCTOBER 24, 1975
KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

FIGURE 3f

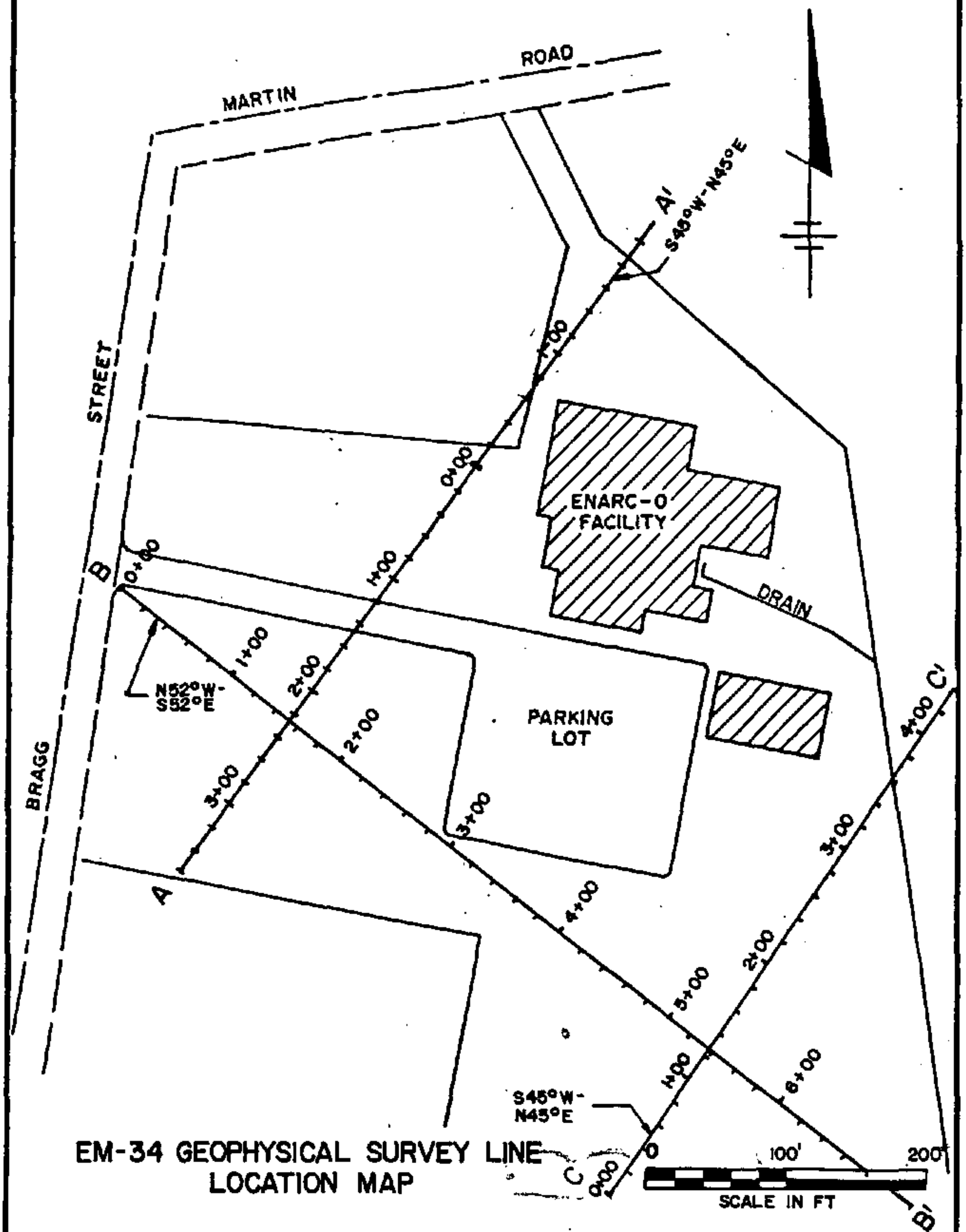


FRACTURE TRACE ANALYSIS
AIR PHOTO MAY 5, 1982
KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK



FRACTURE TRACE ANALYSIS
AIR PHOTOS (CUMULATIVE)
KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

FIGURE 4



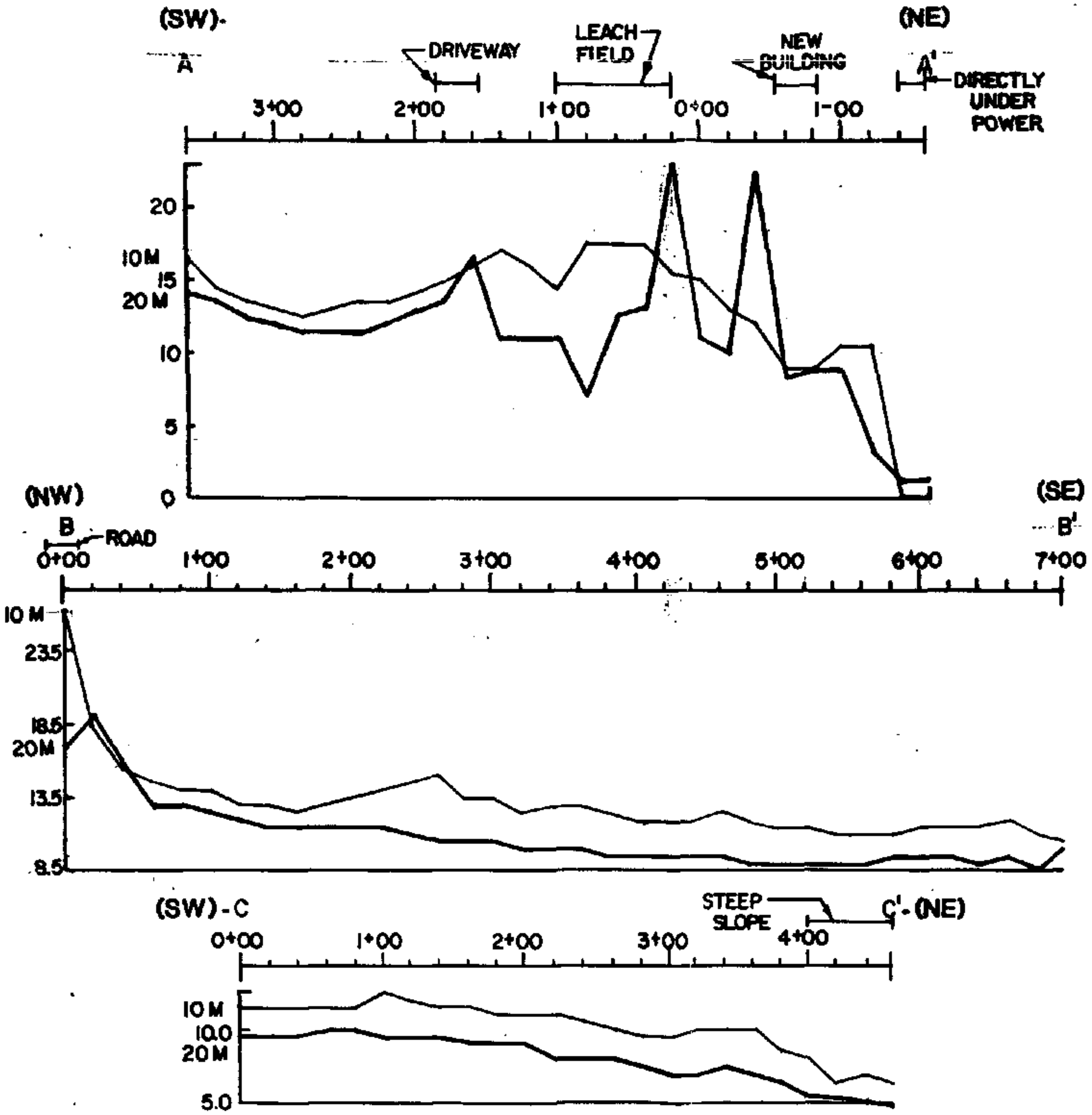
EM-34 GEOPHYSICAL SURVEY LINE
LOCATION MAP

KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

FIGURE 5

KADDIS CORPORATION (ENARC-O)
NORTH BLOOMFIELD, NEW YORK

EM-34 GEOPHYSICAL SURVEY VERTICAL PROFILES



LEGEND

—	10M COIL SPACINGS
—	20M COIL SPACINGS

NOTE:

VERTICAL SCALE IN mmhos/m

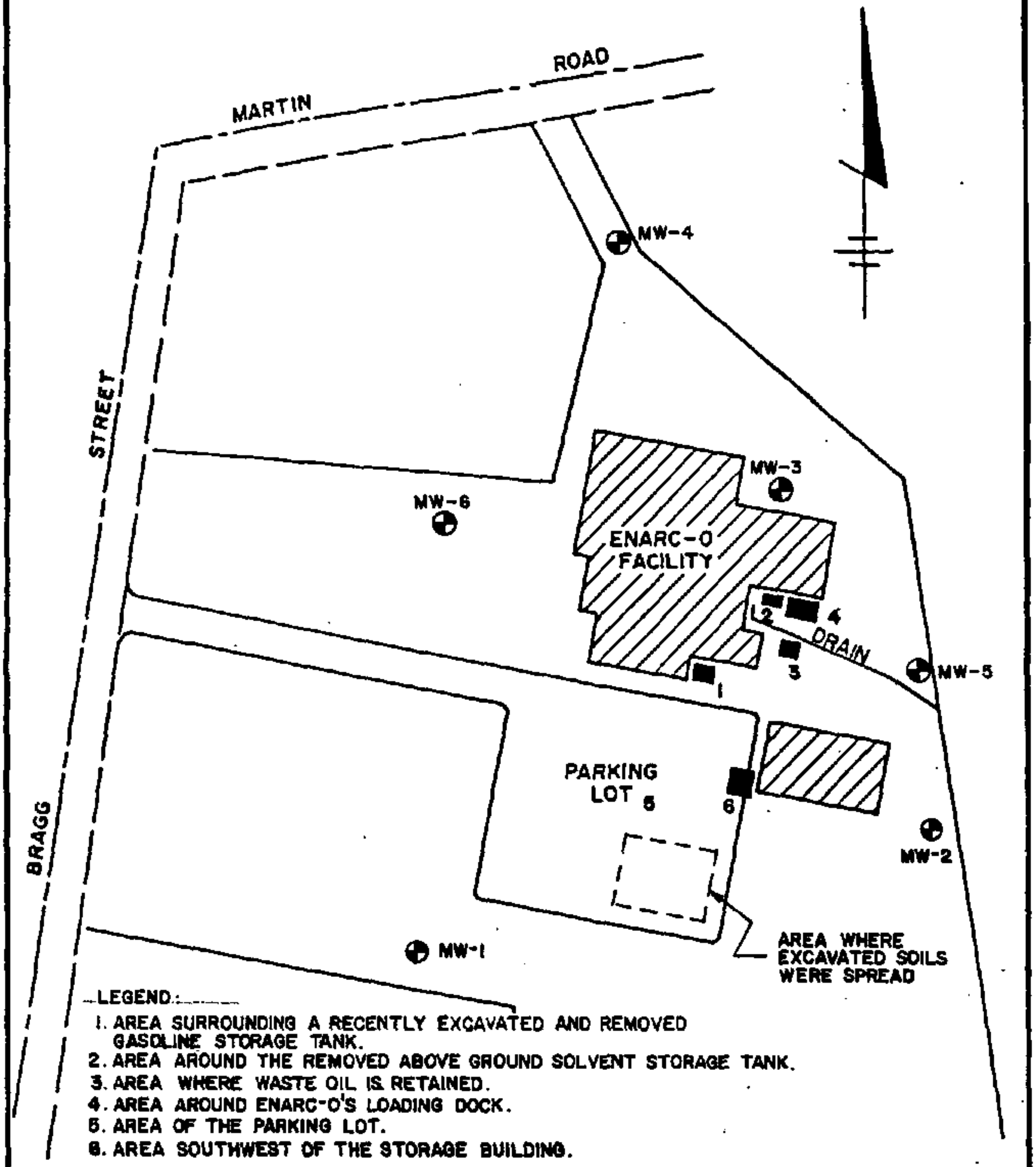
HORIZONTAL SCALE

0 100 200

SCALE IN FEET

O'BRIEN & GERE

FIGURE 6



LEGEND:

1. AREA SURROUNDING A RECENTLY EXCAVATED AND REMOVED GASOLINE STORAGE TANK.
2. AREA AROUND THE REMOVED ABOVE GROUND SOLVENT STORAGE TANK.
3. AREA WHERE WASTE OIL IS RETAINED.
4. AREA AROUND ENARC-O'S LOADING DOCK.
5. AREA OF THE PARKING LOT.
6. AREA SOUTHWEST OF THE STORAGE BUILDING.

PROPOSED GROUND WATER MONITORING WELL
AND SOIL BORING LOCATION MAP

KADDIS CORPORATION (ENARC-O)

NORTH BLOOMFIELD, NEW YORK

O'BRIEN & GERE
ENGINEERS, INC

Appendices

APPENDIX A

QUALITY ASSURANCE/QUALITY CONTROL PLAN

APPENDIX A

QUALITY ASSURANCE PROJECT PLAN (QAPP)

ENARC-O MACHINE PRODUCTS
DIVISION OF KADDIS MANUFACTURING CORPORATION
NORTH BLOOMFIELD, NEW YORK

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TABLES

FIGURES

ATTACHMENTS

SECTION 1 - INTRODUCTION

The following Quality Assurance Project Plan (QAPP) has been prepared for the Site Assessment at the Kaddis Manufacturing Corporation, Enarc-O Machine Products Facility (Enarc-O) North Bloomfield, New York. It was prepared in accordance with U.S. EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans", QAM-005/80, 29 December 1980. This QAPP addresses sampling efforts associated with the tasks described in the Interim Technical Memorandum (ITM). Analytical methods and QA/QC protocols to be followed during completion of the site investigation are included in this document.

SECTION 2 - PROJECT ORGANIZATION AND RESPONSIBILITY

While all personnel involved in an investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specifically designated responsibilities. Within O'Brien & Gere these are the Project Manager, the Quality Assurance Coordinator, the Field Operations Manager, and the Field Environmental Technicians. OBG Laboratories, of Syracuse, New York will provide all analytical services for these investigations. Specific laboratory personnel with quality assurance/quality control responsibilities include the Laboratory Quality Assurance Coordinator and Laboratory Sample Custodian. Figure A-1 presents a project organization chart. Resumes of key personnel are included as Attachment A.

2.01 Project Manager/Quality Assurance Officer

Mr. James T. Mickam, CPGS is Project Manager for the Enarc-O site investigations. The Project Manager will maintain routine contact with the investigation's progress, regularly review the project schedule, and review all major work elements prior to submittal. Mr. Mickam will also serve as Quality Assurance Officer (QAO) for this investigation, with the responsibility of overseeing the day-to-day activities of all work to be conducted including that of subcontractor personnel. The Project Manager will oversee the scheduling and budgeting, and serves as the prime contact with state, local and federal agencies. The Quality Assurance Officer has primary responsibility for the project quality assurance activity. The Quality Assurance Officer's responsibilities include coordinating the development, evaluation, and documentation of the Quality Assurance Project Plan and procedures appropriate to the investigation. It is a major responsibility of a Quality Assurance Officer to insure that all personnel have a good understanding of the project quality assurance plan, an understanding of their respective roles relative to one another, and an appreciation of the importance of the roles to the overall success of the program.

2.02 Quality Assurance Coordinator

O'Brien & Gere's Jeffrey Banikowski will serve as Quality Assurance Coordinator. It is the Quality Assurance Coordinator's responsibility to review project plans and revisions to the plans to assure proper quality assurance is maintained. Frequent and regular meetings will take place between the Quality Assurance Coordinator and the Project Quality Assurance Officer to review all quality assurance activities. The Quality Assurance Coordinator is also responsible for all audits, data processing activities, data processing quality control, data quality review, data validating, and overall quality assurance.

Additionally, Mr. Banikowski will serve as the manager of environmental chemistry evaluations for the project and will be responsible for reviewing all chemical data, validating laboratory analytical data and coordinating the efforts between O'Brien & Gere and OBG Laboratories.

2.03 Field Operations Manager/Project Geologist

Deborah Wright, Senior Project Hydrogeologist will serve as the Field Operations Manager/Project Geologist prior to the start of work. The Field Operations Manager/Project Geologist reports directly to the Project Manager and is immediately responsible for the day-to-day activities of all O'Brien & Gere field personnel. In this capacity, the Field Operations Manager/Project Geologist is responsible for all day-to-day quality assurance project activities and reports directly to the Project Manager concerning the maintenance of the Quality Assurance Project Plan. Further responsibilities include the initialing and verification for accuracy of field notebooks, driller's logs, chain-of-custody records, sample labels, and all other field-related documentation.

2.04 Site Geologists and Technicians

Ground water, soil, and air sampling tasks required by this investigation will be conducted by experienced geologists and/or environmental technicians. Their responsibilities will include the documentation of the proper sample collection protocols, sample collection, field measurements, equipment decontamination, and chain-of-custody documentation.

2.05 OBG Laboratories Quality Assurance Coordinator

The volume of analytical work for a project of this size necessitates the subcontract analytical laboratory to specify a Quality Assurance Coordinator whose duties are specific to the project. Mr. David R. Hill will serve as OBG Laboratories' Quality Assurance Coordinator with the responsibility for maintenance of all laboratory quality assurance activities in association with the project. An organization chart for OBG Laboratories, Inc. is attached as Figure A-2.

2.06 Laboratory Sample Custodian

Ms. Wendy Smith will serve as project Laboratory Sample Custodian for OBG Laboratories, Inc. The sample Custodian's responsibilities include insuring proper sample entry and sample handling procedures by laboratory personnel.

SECTION 3 - QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, REPRESENTATIVENESS, COMPARABILITY, AND COMPLETENESS

Data quality requirements are based on the intended use of the data, the measurement process, and the availability of resources. Data quality requirements include detection limits, accuracy, precision, and quality assurance protocols for the analytical method to be used and the analyses to be conducted. Ground water and soil samples collected in association with this investigation will be analyzed for those analytes selected and presented in the ITM. Table A-1 lists the sample container requirements, preservation and holding times for the analyses to be conducted. Analytical methods, data quality requirements, reporting limits, and quality assurance protocols and objectives are also presented in subsequent sections of this document.

The quality of all data generated and processed during this investigation will also be assessed for representativeness, comparability, and completeness based upon the available external measures of quality. The data quality assessments are qualitative determinations. The methods to be used in assessing the data quality relevant to the field-generated data for the investigation (non-analytical) are as follows:

- Representativeness - Use of USEPA recommended procedures for the collection and preservation, referenced in EPA 600/4-79-020, Methods for Chemical Analysis of Water and Wastes, the Federal Register, 26 October 1984 and CLP SOWs (8/87).

- Comparability - The use of consistent procedures, reporting units, standardized methods of field analysis, and standardized data format with document control.
- Completeness - Obtaining all required data as outlined in the Work Plan.

Precision and accuracy for the field pH and conductivity are dependent on the type and condition of the instrument used and the care used in the standardization and operation. The precision and accuracy objectives for the instrumentation used are according to manufacturers recommendations as follows:

- pH precision will be ±0.3 pH standard units and an accuracy of ±0.3 pH standard units.
- Conductivity precision will be ±3 umhos/cm on the 500 umhos/cm range, ±25 umhos/cm on the 5,000 umhos/cm range, and ±250 umhos/cm on the 50,000 umhos/cm range.

Trip blanks and field blanks described in Section 9 of this QAPP will be subjected to the same quality assurance objectives as samples. Field blanks will be collected at a frequency of one per event per piece of equipment. Blanks are expected to be below detection limits for all analyses.

Data quality assessments (Sections 9, 10, and 12) will be performed on a routine basis to evaluate whether the data quality objectives of the investigation are being met. Should these assessments reveal specific data unacceptable quality, corrective actions will be implemented on a case by case basis as described under Section 13 (Corrective Action).

SECTION 4 - DRILLING AND SAMPLING PROTOCOL FOR GROUND WATER MONITORING WELL INSTALLATIONS

To evaluate the general direction of ground water flow potential and ground water quality on the Enarc-O property, six ground water monitoring wells will be installed. The approximate locations of these wells are illustrated in Figure A-2.

The wells will be installed to monitor the first encountered ground water. Should ground water be encountered in the overburden, a seventh well will be installed adjacent to MW-3 to evaluate the ground water quality in the bedrock. It is anticipated that wells installed within the overburden will not exceed 25 feet. If bedrock wells are required, the depths will likely be on the order of 50 feet below grade.

4.01 Overburden Monitoring Well Completion

4.01.01 Drilling Procedures

The well borings will be completed using conventional hollow stem auger drilling methods. The minimum inside diameter of the augers shall be 3.5 inches to facilitate proper installation of the monitoring well. Soil samples will be collected continuously to the base of the boring using ASTM Method D-1586-84 "Split-Barrel Sampling". Collected soil samples will be described as to soil type, color, percent recovery, moisture content odor and miscellaneous observations such as organic content. A representative portion of each sample will be placed in a glass jar and labelled with 1) site, 2) boring number, 3) sample interval, and 4) date. This sample will be allowed to reach ambient air temperature at which time a PID will be used to screen the sample for relative levels of VOCs.

The maximum depth of the boring will be completed to the top of competent bedrock or 20 feet below the water table, whichever is shallower. The exact depth of the boring will be established in the field with concurrence of the on-site USEPA representative.

4.01.02 Overburden Monitoring Well Installation

Overburden monitoring wells will be constructed of ten (10) feet of 2 inch ID 0.010 inch slot (TIMCO or equivalent) Schedule 40 PVC well screen and a riser casing that will extend from the screened interval to 2-3 ft above existing grade. Other materials utilized for completion will be washed silica sand suitable for use with a 0.010 inch slot screen, bentonite pellets, Portland Cement/bentonite grout, and a protective steel locking well casing and cap with locks.

The monitoring well installation method for 2 inch wells shall be to place the screen and riser assembly into the casing once the screen interval has been selected. At that time a washed silica sand pack will be placed around the well screen, and will extend from the base of the boring to approximately two feet above the top of the screen. Bentonite pellets will then be added to the annulus between the casing and the inside auger to an approximate thickness of two feet to insure proper sealing. Portland cement/ Bentonite grout will continue to be added during the extraction of the augers by tremming until the entire aquifer thickness has been sufficiently filled.

During placement of sand and bentonite pellets frequent measurements will be made to check the height of the sand pack and thickness of bentonite layers by a weighted drop tape measure.

A protective steel casing shall be located over the PVC standpipe extending 2 ft below grade and 2-3 ft above grade secured by a Portland Cement seal. The cement seal shall extend laterally at least 1 ft in all directions from the protective casing and shall slope gently away to drain water away from the well. A vented steel cap will be fitted on the protective casing. The cap shall be constructed so it may be secured with a steel lock. A typical monitoring well detail is provided as Figure A-3.

The well will be subsequently labelled with the well number designated as OBG-#. Should the overburden well be installed adjacent to a bedrock well, the well number will be followed by an S (OBG-#s).

4.02 Bedrock Monitoring Well Installation Procedures

4.02.01 Bedrock Well Completion

Borings shall be completed through the overburden using conventional hollow stem auger methods to the depth as directed by the supervising hydrogeologist. The minimum diameter of the completed boring shall be six (6) inches. Soil samples will be collected continuously using ASTM Method D-1586.

The bedrock wells will be of open hole construction. A length of 4 inch diameter, schedule 80, PVC casing will then be set into the bedrock. Cement/ bentonite grout will then be tremied into the annular space between the casing and the borehole wall to secure the pipe in place. Once the grout has set, the bedrock will be drilled using a minimum 3 inch diameter core barrel. Should the bedrock characteristics be such that coring is unproductive, air rotary methods will be used to complete the well. A PID will be used to screen the soil samples, core runs, or cuttings for volatile organics in an attempt to select the optimum depth of the monitoring well. Drilling will continue to a maximum of 20 feet below the ground water table. The anticipated maximum depth of the wells is 50 feet below grade. The actual depth of the well will be selected in the field with concurrence of the on-site USEPA representative.

Water from the local potable supply shall be allowed to be introduced into the borehole during drilling for cuttings displacement and for tool cooling. If possible, analytical results of this supply will be obtained from the municipal authority prior to use.

Following completion of the drilling process, a lockable cap equipped with a lock will be installed on the black iron pipe. A typical bedrock monitoring well detail is provided as Figure A-4.

The well will subsequently be labelled with the well number designated as OBG-#. Should the bedrock well be nested adjacent to an overburden well, the well number will be followed with a D (OBG-#D).

4.03 Well Development Protocol

All monitoring wells will be developed or cleared of all fine grained materials and sediments that have settled in or around the well during installation to insure the screen is transmitting representative portions of the ground water. The development will be by one of three methods, air surging, pumping or bailing ground water from the well until it yields, relatively sediment free water.

Air surging will consist of a clean polypropylene tubing extended to the screen portion of the well, attached to an air compressor and allowed to surge until ground water clears. Clean polypropylene tubing will be used for each well developed by this method.

Equipment for pumping or bailing will be decontaminated following the procedures outlined in the Decontamination Protocol (Section 5.04) and subsequently decontaminated after each use. Ground water will be pumped from the top of the water column using a submersible pump, bladder pump, positive displacement pump or a foot-valve pump, or bailed using a stainless steel bailer. Clean plastic will be placed on the ground to avoid surface contamination and new polypropylene rope on the bailer will be used for each well. Pumping or bailing will cease when the ground water yields sediment free water.

Development water withdrawn from the monitoring wells will be contained on-site in 55-gallon drums. This water will be disposed of appropriately pending analyses of the ground water samples.

4.04 In-Situ Hydraulic Conductivity Test Procedures

This test will be used to evaluate the hydraulic conductivity of the aquifer in which a well is screened. The objective of the test to create a sufficient hydraulic potential between the aquifer and the well by raising or lowering the water level in the well. The rate of water level change within the well over time is then used to estimate the aquifer hydraulic conductivity.

4.04.01 Slug-Test Methodology

The slug-test requires insertion and withdrawal of a rod of PVC or Teflon® material in and out of a well.

1. Record all Field Data in the Project Field Book and/or the on the "Field Slug Test Log" form.
2. Measure the dimensions of the slug to be used to displace water in the monitoring well and predetermine the volume of water which will be displaced and corresponding water level change which will occur when the slug is removed.
3. Clean the water level probe, the slug following the appropriate decontamination procedures.
4. Measure the static water level in the well on at least twice timed to be a minimum of 5 minutes apart to evaluate whether the water level is stable.
5. If using a data logger system , decontaminate the pressure transducer and insert the transducer at the appropriate depth in the well taking care not to exceed the operating range of the transducer being used. Allow the water level to return to the static water level measured in step 3. Input the necessary operating functions in the data logger. Start the logger and insert or withdraw the slug. Proceed to Step 7.

6. If conducting the slug test manually, the slug should be inserted and the change in water level measured with the water level probe. The frequency of measurement is dependent upon the rate of recovery.
7. Continue the test until the water level recovers approximately 70 percent of the initial change.
8. Repeat the process by withdrawing the slug from the well.

4.04.02 Bailing Methodology

With wells which demonstrate every rate, water may be bailed from the well to lower the water level for completion of the hydraulic conductivity test.

1. Record all Field Data in the Project Field Book and/or the on the "Field Hydraulic Conductivity Test Field Log".
2. Clean the water level probe following the appropriate decontamination procedures.
3. Measure the static water level in the well at least twice timed to be a minimum of 5 minutes apart to evaluate whether the water level is stable.
4. Using a clean, bottom-loading, stainless steel bailer remove water from the well until the water level has been lowered an appropriate distance from the static water level measured in step 2. Place the water in appropriate containers for later disposal is required.

5. Begin measuring the water level recovery rate using the water level probe. The frequency of measurement is dependent upon the rate of recovery.

6. Continue the test until the water level recovers approximately 70 percent of the initial change.

4.04.03 Data Analysis

The collected data will be analyzed in accordance with one of the following methods:

Hvorslev's method - Time Lag and Soil Permeability in Ground-Water Observations; M. Juul Hvorslev; Bulletin No. 36, U.S. Army Corps of Engineers; April 1951.

Cooper et.al. method - Response of a Finite-Diameter Well to an Instantaneous Charge of Water; Hilton H. Cooper, Jr, John Briederhoeft, and Istavros S. Papadopulos; Water Resources Research, Vol. 3, No. 1; First Quarter 1967; pages 263-269.

Bouwer & Rice method - A Slug test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells; Herman Bouwer and R.C. Rice; Water resources Research; Vol. 12, No. 3; pages 423-428.

The method for data analysis will be selected based on the hydrogeologic conditions found to be present on the site.

SECTION 5 - SAMPLING PROCEDURES

Two rounds of ground water samples will be collected from all four ground water monitoring wells installed during this investigation. The first round will be performed following a two week stabilization period after well development. The second round will occur a minimum of six weeks after the first round.

The schedule for collection of the second set of samples will be dependent upon authorization to proceed from USEPA following their review of the analytical data from the first set of samples.

In addition to the ground water samples, USEPA has requested that a sample be collected from the drain system illustrated on Figure A-2. This drain is the SPDES approved discharge to Honeoye Creek. A sample of water will be collected from the storm drain collector located near location 2 on Figure A-2.

The sampling procedures used by O'Brien & Gere are presented in the following subsection. These procedures have been standardized to allow applicability to a wide type of environmental investigations. Sampling procedures associated with the ground water, soil, and drain at the Enarc-O site will be conducted as outlined below:

5.01 Ground Water Sampling Procedures

The general site-specific protocols for the Enarc-O site are presented in this section.

5.01.01 Preparation for Sampling

Preparation for sampling includes the acquisition of all necessary monitoring equipment and site-specific information to perform the required monitoring. Prior to initiating any ground water sampling activities, a complete round of depth to water level measurements will be measured to the nearest 0.01 ft.

Total well depths necessary to calculate the required purge volumes will be tabulated following completion of the well installations.

5.01.02 Well Evacuation

Monitoring wells will be evacuated such that a minimum of three well volumes equivalent to the amount of water standing in the well casing is removed or for low yielding wells, until the well goes dry prior to sample acquisition. The volume of water to be purged for each well will be calculated and recorded.

Either a submersible pump, bladder pump, positive displacement pump, foot valve pump, or bailer will be used to evacuate the monitoring wells. Pump placement depth will be dependent on well yields. High yielding wells will necessitate placement of the pump intake at the top of the water column. Low well yields require pump placement to be at the bottom of the well. Proper pump placement will insure complete and proper evacuation. Upon completion of the required purge volume, the pumping system will be removed from the well. Wells that are inaccessible with the pump system will be hand bailed using a bottom-loading stainless steel bailer.

5.01.03 Sample Acquisition

Prior to obtaining ground water samples for laboratory analysis, all monitoring wells must be developed as described in the Well Development Protocol. A stainless steel bailer will be used to collect ground water samples for transfer into the proper sample containers. If well yields are low at the site, the samples will be collected as the well recovers and provides a sufficient volume for sample collection. The portion of sample required for analysis of volatiles will be collected first.

All ground water samples will be split with USEPA. USEPA is responsible for providing all sample containers, coolers, chain-of-custody documents and ice associated with this effort.

Use of the following procedures for the sampling of ground water observation wells is dependent upon the size and depth of the well to be sampled and the volume of ground water in the well. To obtain representative ground water samples from wells containing only a few gallons of ground water, the bailing procedures is preferred. To obtain representative ground water samples from wells containing more than a few gallons, the pumping evacuation procedure generally facilitates more rapid sampling. The sampling procedure is outlined below.

Sampling Procedures

1. Identify the well and record the location on the Ground Water Sampling Field Log or in a field notebook.
2. Put on a new pair of disposable gloves.

3. Cut a slit in the center of a clean plastic sheet, and slip it over the well creating a clean surface onto which the sampling equipment can be positioned.

4. Clean all meters, tools, equipment, etc., before placing on the plastic sheet (see Section 5.04).

5. Disposable shoe covers should be placed over the samplers shoes to prevent potential contamination from dirty shoes contacting the plastic sheet. Do not kick, transfer, drop, or in any way let soils or other materials fall onto this plastic sheet unless it comes from inside the well.

6. Remove the well cap and plug placing both on the plastic sheet.

7. Monitor the air around the top of the well for VOCs using a PID.

8. Using an electric well probe, measure the depth to the water table. Record this information in the Ground Water Sampling Field Log or field notebook.

9. Clean the well depth probe with a methanol soaked towel and rinse it with distilled water after use.

10. Compute the volume of water in the well, using the depth to water measurement and the total well depth as recorded on the well log. Record this volume on the Ground Water Sampling Field Log or field notebook.

11. Attach enough polypropylene rope to a bailer to reach the bottom of the well, and lower the bailer slowly into the well making certain to

submerge it only far enough to fill one-half full. The purpose of this is to recover any oil film, if one is present on the water table.

12. Pull the bailer out of the well keeping the polypropylene rope on the plastic sheet. Empty the ground water from the bailer into a glass quart container and observe its appearance. NOTE: This sample will not undergo laboratory analysis, and is collected to observe the physical appearance of the ground water.

13. Record the physical appearance of the ground water on the Ground Water Sampling Field Log.

14. **Bailer Evacuation**

    14a. Lower the bailer to the bottom of the well, and agitate the bailer up and down to resuspend any material settled in the well.

    14b. Initiate bailing the well from the top of the water column making certain to keep the polypropylene rope on the plastic sheet. All ground water should be dumped from the bailer into a graduated pail to measure the quantity of water removed from the well.

    14c. Continue bailing the well from the top of the water column until a sufficient volume of ground water in the well has been removed, or until the well is bailed dry. If the well is bailed dry, allow sufficient time for the well to recover before proceeding with Step 16. Record this information on the Ground Water Sampling Field Log.

15. **Pump Evacuation**

15a. Prepare the pump for operation ensuring that a check valve is installed in the pump or tubing.

15b. Lower the pump to the top of the water level in the well and pump the ground water into a graduated pail. Pumping should continue until three well volumes have been removed or the well is pumped dry. If the well is pumped dry, allow sufficient time for the well to recover before proceeding with Step 16. Record this information on the Ground Water Sampling Field Log.

15c. Remove the pump and associated tubing from the well.

16. Remove the sampling bottles from their transport containers, and prepare the bottles for receiving samples. Inspect all labels to insure proper sample identification. Sample bottles should be kept cool with their caps on until they are ready to receive samples. Arrange the sampling containers to allow for convenient filling. Always fill the containers designated for volatile organics analysis first. Filter and/or add preservatives to appropriate samples (see Table A-1).

17. To minimize agitation of the water in the well, initiate sampling by lowering the bailer slowly into the well making certain to submerged it only far enough to fill it completely.

18. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. The vials labeled "volatiles" analysis should be filled from one bailer then securely capped. Add preserva-

tives per Table A-1 to each 40 ml VOA vial. Carefully fill the 40 ml VOA vials to minimize agitation. This is usually done by pouring the sample into a tilted VOA vial. Cap the VOA vial, turn it upside down, and check for air bubbles. If properly filled, there should be no visible air bubbles.

19. If the sample bottle cannot be filled quickly, keep them cool with the caps on until they are filled. The vials designated for purgeable priority pollutant analysis should be filled from one bailer then securely capped. <u>NOTE</u>: Samples must not be allowed to freeze.

20. Record the physical appearance of the ground water observed during sampling on the Ground Water Sampling Field Log or field notebook.

21. After the last sample has been collected, record the date and time, and, and if required, empty one bailer of water from the surface of the water in the well into the 200 ml beaker and measure and record the pH, conductivity and temperature of the ground water following the procedures outlined in the equipment operation manuals. Record this information on the Ground Water Sampling Field Log. The 200 ml beaker must then be rinsed with distilled water prior to reuse.

22. Begin the Chain of Custody Record. A separate entry is required for each well with the required analysis listed individually.

23. Replace the well cap, and lock the well protection assembly before leaving the well location.

24. Place the polypropylene rope, gloves, rags, and plastic sheeting into a plastic bag for disposal.

25. Clean the bailer by rinsing with control water, methanol and/or 1% nitric acid, deionized water. Store the clean bailer in a fresh plastic bag.

5.02 Drain Sampling Procedures

A sample of the water within the storm drain collector near location 2 on Figure B-_ will be collected for analysis to evaluate whether VOCs are present. This drain is the SPDES permitted outfall for the non-contact cooling water used at the facility.

5.02.01 Sample Collection

Access to the drain line will be obtained through the vent or cleanout port. A bottom-loading, stainless steel bailer will be lowered into the collector box to collect the sample. The sample will then be transferred to the appropriate sample container and preserved as indicated on Table A-1. The sample will be handled and transported to the laboratory as detailed in Section 5.05.

5.03 Subsurface Soil Sampling

Ten soil borings will be completed in the following areas on the Enarc-O property for the purpose of obtaining soil samples for analysis:

1. Area surrounding a recently excavated and removed gasoline storage tank.

2. Area around the removed above-ground solvent storage tank where the 1985 spill of 1-1-1 trichloroethane occurred.
3. Area where waste oil is retained.
4. Area around Enarc-O's loading dock. EPA reportedly has reason to believe the entire area was covered with an oily residue and was used to store drums at some point in the past.
5. Area of the parking lot where used oils were used for dust control. The southeast corner of this area was where the excavated soils from the 1985 spill were spread out to allow volatilization to occur.
6. Area southwest of the storage building where drums are currently stored.

The locations of these areas area illustrated on Figure A-2. Specifically one (1) boring will be placed in each location, with the exception of area 5 (parking area). In the parking area, five (5) soil borings will be placed, one in each quadrant (which will place one within the area where soils from the solvent spill were spread), and also one in the center.

Soil borings for collection of subsurface soil samples shall be completed using conventional hollow stem auger drilling methods to a depth specified by the supervising geologist/engineer. The minimum inside diameter of the augers shall be 3.25 inches.

Samples of the encountered subsurface materials shall be collected continuously to the base of the boring. The sampling method employed shall be ASTM D-1586-84/Split Barrel Sampling using either a standard 2' long, 2" outside diameter split spoon sample with a 140 lb. hammer or a 3" outside diameter sampler with a 300 lb. hammer. A copy of the sampling method is attached as Attachment C. Upon retrieval of the sampling barrel, a portion of the collected sample (non-composite) shall be placed in glass jars and labelled, stored on site (on ice in a cooler if necessary), and transmitted to the appropriate testing laboratory or storage facility. Samples will be split with USEPA as requested. Chain of custody procedures will be practiced following Section 15, EPA-600/4-82-029, Handbook for Sampling and Sample Preservation of Water and Waste Waters.

A geologist will be on site during the drilling operations to fully describe each soil sample including 1) Soil type, 2) color, 3) percent recovery, 4) moisture content, 5) odor and 6) miscellaneous observations such as organic content. The supervising geologist will be responsible for retaining a representative portion of each sample in a one pint glass jar labelled with 1) site, 2) boring number 3) interval sample/interval preserved, 4) date, and 5) time of sample collection. This jar will be sealed with aluminum foil followed by the screw top. The sample will be warmed to room temperatures at which time a photoionization analyzer (PID) will be used to monitor the headspace for volatile organics.

The bottom of each boring will be selected in the field at the point which in field screening of the samples reveals levels of total organic vapors equal to a predetermined background concentration, or bedrock or the ground water table is encountered, whichever occurs first.

The drilling contractor will be responsible for obtaining accurate and representative samples, informing the supervising geologist of changes in drilling pressure, keeping a separate general log of soils encountered including blow counts (i.e. the number of blows from a soil sampling drive weight (140 pounds) required to drive the split spoon samples in 6-inch increments and completing soil borings to depths as directed by the supervising geologist.

Following completion, all borings will be filled with a bentonite/cement grout. The grout will be placed in the borehole using tremie methods as the augers are removed from the hole.

All soils generated during the drilling process will be placed in 55-gallon drums. The soil will subsequently be handled in an appropriate manner based on the analytical results and USEPA approval.

All equipment used to complete the wells will be decontaminated following completion of each boring. The decontamination protocol is included as Section 5.04.

5.04 Decontamination

Decontamination procedures will be applicable to all drilling and sampling activities. All drilling and well construction equipment mobilized to the Enarc-O site will receive an initial decontamination. Decontamination will consist of steam cleaning of the entire rig and associated equipment to the satisfaction of the supervising geologist.

The rear portion of the drill rig will be decontaminated by steam cleaning between test borings and/or monitoring well installations. In addition equipment entering a test boring or well boring but not used for sample collection, will be decontaminated using a high pressure steam cleaner to remove soil and volatilize organics. Sample collecting equipment contacting soil and/or rock samples will be decontaminated after each use as follows:

a. wash and scrub with low phosphate detergent

b. tap water rinse

c. an acetone rinse or a methanol followed by hexane rinse (solvents must be pesticide grade or better)

d. deionized demonstrated analyte free water rinse

e. air dry, and

f. wrap in aluminum foil, shiny side out, for transport.

It may be necessary to insert hoses and/or narrow diameter pipe into a test boring and/or well during installation, development, purging, and sampling. These items will also be decontaminated prior to, and following each use. The hoses will be cleaned with a low phosphate detergent and rinsed with potable water. Decontamination procedures required for site personnel will be described in the Health and Safety Plan.

5.05 Sample Preparation and Preservation

Immediately after collection, samples will be transferred to properly labeled sample containers with the necessary preservatives. Samples receiving pH adjustment will be checked with pH paper to ensure the proper pH has been achieved. Table A-1 lists the proper container materials, volume requirement, and preservation needed for the Enarc-O Machine Products site analyses. Samples requiring refrigeration for preservation will be immediately transferred to coolers packed with ice or ice packs. All samples will be shipped via overnight delivery service on the same day they are collected. Proper chain-of-custody documentation will be maintained as discussed in Section 6 of this QAPP.

SECTION 6 - SAMPLE CUSTODY

The primary objective of sample custody procedures is to create an accurate written record which can be used to trace the possession and handling of all samples from the moment of their collection, through analysis, until their final disposition. Sample custody for samples collected during this investigation will be maintained by the Field Operations Manager (FOM) or the field personnel collecting the samples. The FOM or field personnel are responsible for documenting each sample transfer and maintaining custody of all samples until they are delivered to the laboratory.

Sample bottles and preservatives will be supplied by OBG Laboratories, Inc. A self-adhesive sample label and a sample tag will be affixed to each container before sample collection. At a minimum, the sample tag will contain:

- Client - Job name
- Sample identification station number (place of sampling)
- Date and time collected
- Sampler's signature
- Testing required
- Preservatives added
- Sample Type
- Grab or Composite

Immediately after sample collection, the sample will be placed in an insulated cooler for delivery to the laboratory within 24 hours. O'Brien & Gere field Chain-of-Custody records completed at the time of sample collection will accompany the samples inside the cooler for delivery to the laboratory. The forms will include the project name, sampling station number, and sample location. These record forms will be sealed in a ziplock plastic bag to protect them against moisture. Each cooler will contain sufficient ice and/or ice packs to insure that proper temperature of approximately 4°C is maintained, and will be packed in a manner to prevent damage to sample containers. The shipping container will be secured with nylon strapping tape and custody sealed before shipment. The custody seals will be placed on the containers so they cannot be opened without breaking the seal. The samples will be properly relinquished on the field Chain-of-Custody record by the sampling team to the FOM. The FOM will then, in turn, relinquish the samples to the OBG Laboratories Sample Courier. When routine sampling is performed and the FOM is not present, custody will be relinquished by the responsible field personnel.

OBG Laboratories will provide sample pickup at the O'Brien & Gere office daily or on an as-needed basis. The OBG Laboratories Courier will then relinquish the samples to OBG Laboratories Sample Custodian. Upon receiving the samples, the Laboratory Sample Custodian will inspect the condition of the custody seal and samples, compare the information on the sample label against the field Chain-of-Custody record, assign an OBG Laboratories control number, and log the control number into the OBG Laboratories computer sample inventory system. OBG Labs will maintain custody of samples as described in the above sections.

When samples requiring preservation by either acid or base are received at the laboratory, the pH will be measured and documented. The Laboratory Sample Custodian will then store the sample in a secure sample storage cooler maintained at 4°C and maintain custody until assigned to an analyst for analysis.

The Laboratory Sample Custodian will note any damaged sample containers or discrepancies between the sample label and information on the field Chain-of-Custody record when logging in the sample. This information will be communicated to the FOM or field personnel so proper action can be taken. The Chain-of-Custody form will be signed by both the relinquishing and receiving parties each time the sample changes hands, and the reason for transfer indicated.

A serially numbered internal Chain-of-Custody form will be used by OBG Laboratories to document sample possession from the Laboratory Sample Custodian to Analysts and final disposition. The Chain-of- Custody information will be supplied with the analytical reports for inclusion in the document control file.

SECTION 7 - CALIBRATION PROCEDURES AND FREQUENCY

7.01 Laboratory Calibration Procedures

Equipment Calibration, References and Frequency

All field equipment used during this project will be calibrated and operated in accordance with manufacturer's instructions. Any field equipment used during this project that is not covered by the investigator's standard operating procedures will have a specific calibration and operation instruction sheet prepared for it.

A. General

Standards may be generally grouped into two classifications: primary and secondary. Primary standards include United State Pharmaceutical (USP), National Bureau of Standards (NBS), American Society for Testing and Materials (ASTM) materials, and certain designated EPA reference materials. All other standards are to be considered secondary.

B. Testing

1. Primary: No testing is necessary. Do not use if there is any physical indication of contamination or decomposition (i.e. partially discolored, etc.).
2. Secondary: Examine when first received either by comparison to an existing primary, or comparing known physical properties to literature values. Standards which are less stable will be

rechecked at appropriate intervals ranging from approximately six months to one year.

C. Records

1. A records book will be maintained for each grouping of standards (i.e. pesticides, metals, etc.)

2. The record kept for each standard will include:
    a. Name and date received
    b. Source
    c. Code or lot number
    d. Purity
    e. Testing data including all raw work and calculations
    f. Special storage requirements
    g. Storage location

3. These records will be checked periodically as part of the Laboratory Controls Review.

Equipment

A. General

1. Each major piece of analytical laboratory instrumentation used on this project is documented and on file with the analytical laboratory.

2. A form is prepared for each new purchase and old forms will be discarded when the instrument is replaced.

B. Testing

1. Each form details both preventative maintenance activities and the required QA testing and monitoring.
2. In the event the instrument does not perform within the limits specified on the monitoring form, the Laboratory Manager will be notified and a decision made as to what action to take.
3. If repair is deemed necessary, an "out of order" sign will be placed in the instrument until repairs are effected.

7.02 Calibration Records

A bound notebook will be kept with each instrument, requiring calibration, to record all activities associated with a maintained, QA monitoring and repairs program. Additionally, these records will be checked during periodic equipment review.

7.03 Field Calibration

In addition to the laboratory analyses conducted during the course of this investigation, field measurements of pH, specific conductance, and temperature will be taken for all surface and ground water samples. Where necessary, an photo-ionization detection meter will be used to measure volatile organics in air or soils.

The frequency of field calibration procedures will, at a minimum, include the following:

- The pH and specific conductance meters will be calibrated at a minimum of once daily and documented in a calibrator's field book.

Calibration will be checked as necessary to insure proper measurements are taken.

- pH meters will be calibrated using specific techniques according to the manufacturer's instructions and two standard buffer solutions (either 4, 7, or 10) obtained from chemical supply houses. The pH values of these buffers will be compensated for temperature according to the values supplied on the manufacturer's bottle label. The temperature (measured as below) at which the sample pH was measured will then be used to compensate for temperature on the meter.
- Temperature measurements will be performed using field thermometers (Thomas Science No. 9329A10).
- Specific conductance meters will be calibrated using a 1413.0 umho (KCl) solution prepared by OBG Laboratories according to Standard Methods of the Analysis of Water and Wastewater, 16th Edition, 1985-Method 205, 3b, page 79.

SECTION 8 - ANALYTICAL PROCEDURES

The analytical methods which are to be used for analysis of the sample media collected at the Enarc-O site were chosen based on the substances used at the site as revealed by the background information review. The selected methods are discussed in the Interim Technical Memorandum. Specifically, ground water samples will be analyzed for volatile organics in accordance with EPA methods 502.1 and 503.1. The soil samples will be analyzed for volatile organics using EPA methods 8010 and 8020. In addition, the two soil samples collected from the boring located in the vicinity of the removed gasoline storage tank will also be analyzed for lead in accordance with EPA method 7421. A summary of the analytical methods and the detection limits for the individual analytes is included in Table A-4.

SECTION 9 - DATA REPORTING, VALIDATION, AND REDUCTION

9.01 Data Reduction

OBG Laboratories, Inc. will be performing analyses on the environmental samples. The following data handling procedures are employed at OBG Laboratories, Inc.

A. Gas Chromatography/Mass Spectrometry: 1) A Hewlett-Packard Model 5987A GC/MS equipped with a Tekmar Model 400 Dynamic Head Space concentrator and a RTE6 VM Operating System and, 2) a 5996 HP GC/MS with a 7672A HP Auto Sampler and a RTE6 VM Operating System are used for positive identification and quantification of volatile organics and sample extracts. Both instruments use an aquarius software package for data reduction. Output from the GC/MS units is processed for presentation in three formats:

1) A real-time total multiple ion mass chromatogram.
2) A post-run investigation report containing the following:
    a. Retention time
    b. Response factor
    c. Primary, secondary and tertiary ion with their corresponding abundance
    d. Quantitation ion
    e. Reference library name
    f. Concentration

3) A visual comparison of the subject mass spectral output to the library compound.

The post integration report contains the following:

1) Listing of all compounds.
2) Relative retention times.
3) Relative response factor to their internal standards.

Quality Assurance/Quality Control data such as resolution and calibration standards and DFTPP spectra are also processed and stored in the above manner.

B. Gas Chromatography: A Hewlett-Packard Model 5880A Gas Chromatograph (GC) equipped with an Electron Capture Detector and a 7673A H.P. Auto injection system is used for positive identification and quantification of sample extracts.

Output from the GC unit is processed for presentation in two forms:

1) A real time chromatogram
2) A post-run integration report containing the following:
    a. Retention time
    b. Response factors calculated from standards
    c. Surrogate standard reservoir
    d. Listing of all positively identified compounds

Quality Assurance/Quality Control data such as spikes, spike duplicates, and calibration curves are also processed and stored in post integration reports.

C. Trace Metals: A Varian model 575 Atomic Absorption Spectrophotometer (AA) and Perkin-Elmer Model 3030B Atomic Absorption Spectrophotometer with an HGA600 furnace are used for the low level detection of metals by conventional flame and graphite furnace techniques.

The atomic absorption spectrophotometer for inorganic pollutants is calibrated using appropriate calibrating standards and blanks. The calibrations are checked by analyzing synthetic standards at five different concentration levels.

The results are used to generate standard curves by least squares fit of the data via computer programs. The deviation of the standards from the least squares fit (standard curves) and the standard deviation of the fit are printed on the daily printout and the data stored accordingly in appropriate computer bases. If deviations from accepted values occur, analysis of sample and instrumental calibrations are repeated. Standard curves are generated regularly.

D. Spectrophotometry: Spectrophotometric instruments are initially calibrated with commercially available standards. To verify the initial calibration, EPA knowns are analyzed and must be within ± 10% of the true value. At a frequency of 10% a continuing calibration standard is analyzed and quantitated. If the continuing calibration standard is not within 10% the instrument is recalibrated and the previous 10 samples are reanalyzed. The chemist documents any excursions and continuing calibration on the bench analysis log.

Data validation practices will be followed to insure that raw data are not altered and that an audit trail is developed for those data which require reduction. The field data, such as those generated during field measurements, will be entered directly into a bound field notebook. Each project team member will be responsible for proofing all data transfers made.

OBG Labs group leaders will check and validate all data generated by their group as specified in Attachment B. The QAO of the laboratory will provide a signed document verifying the validation of the data.

Upon receipt of OBG Labs Analysis Reports and associated data packages, laboratory analyses will be validated by O'Brien & Gere's Quality Assurance Coordinator by reviewing the laboratory quality control data, laboratory method blanks, trip blanks, agreement between samples and duplicates, and surrogate and spike recovery data.

The analytical data obtained during the course of the investigation for ground and surface waters will be reported as ug/L (ppb). Laboratory data for soil analyses will be reported as ug/kg on a dry weight basis. Analyses conducted in association with the investigation will be reported utilizing OBG Laboratories Level III data package. Table A-8 lists the deliverables that are included in the OBG Labs data package.

The validation program will incorporate a tracking and filing system for documents generated during the investigation. Documents accounted for in this aspect of the validation program will include items such as log books, field data records, correspondences, chain-of-custody records, analytical reports, photographs, computer disks, and reports. The Project Manager is responsible for maintaining a central file in which documents will be inventoried. The raw data generated during field operations will be filed to eliminate or correct errors arising from the transfer of data.

To avoid errors in the transfer of data, copies of raw data from the field notebooks, and the data as received from the laboratory, will be entered into a data file and assigned an appropriate document control identification number. The data file will serve as the ultimate archive for all information and data generated during this investigation.

The documentation of sample collection will include the use of bound field log books in which the information on sample collection will be entered in indelible ink. Enough information will be given to reconstruct the sampling event, including: site name (top of each page), sample identification, brief description of sample, date and time of collection, sampling methodology, field measurements and observations, and sampler's initials (bottom of each page, and dated).

SECTION 10 - INTERNAL QUALITY CONTROL CHECKS

10.01 Laboratory Internal Quality Control Checks

OBG Laboratories Internal Quality Control Checks will meet or exceed analytical QC requirements set forth by USEPA approved methodologies (e.g. Test Methods for Evaluating Solid Wastes, EPA, 1986). These QC checks will be a continuation of O'Brien & Gere's Field Internal Quality Control Checks presented below.

10.02 Field Internal Quality Control Checks

Field Internal Quality Control Checks will be utilized during this investigation through the use of the following QA/QC samples which are summarized on Tables A-5 and A-6.

- Trip Blanks - These blanks consist of ultrapure, deionized water contained in appropriate sample containers with any preservatives required for the analysis. These blanks will be provided by OBG Labs. They will accompany the samplers during the sampling process and will serve as a QC check on container cleanliness, external contamination, and the analytical method. Trip blanks will be submitted once per day per analysis type for samples involving ground water. A volatile trip blank will be submitted daily for soil/sediment samples.
- Field Equipment Rinse Blanks - These blanks will consist of demonstrated analyte free water passed through sampling equipment and collected in appropriate containers. These blanks will verify decontam-

ination of sampling equipment and eliminate the possibility of cross-contamination. Equipment blanks will be collected once daily per analysis type for each type of sampling equipment used.

- Duplicate Samples - Duplicate samples will be collected to allow determination of analytical repeatability. One duplicate sample in every twenty (20) ground and surface water samples collected, and one in every twenty (20) soil or sediment samples, will be collected and submitted for analysis. These samples may be run as matrix spike duplicates (see below).
- Matrix Spike Sample - A matrix spike sample will also be submitted as a further QC check. These will be collected at the same frequency as stated above for the duplicate samples. These will allow recovery rates of compounds (the spike and/or surrogate spike compounds defined in the organic and inorganic methods) to be determined for matrix effects specific to the study site through the addition of known concentrations of compounds into the sample (by OBG Labs at the laboratory) and then performing the analysis.

Therefore, from the above discussion, every twentieth sample or five percent, whichever is more frequent, will be analyzed in duplicate (or matrix spike duplicate) and run as a matrix spike sample.

Duplicate and matrix spike samples will be acquired for ground and surface waters by collecting sequential grab samples after collection of the actual sample. Soil duplicate and matrix spike samples will be collected by splitting the sample between the sample container, duplicate container, and matrix spike container. If insufficient soil sample is present at a particular location to collect the three sample volumes, a single liter sample will be split at the laboratory for duplicate and matrix spike analysis.

SECTION 11 - PERFORMANCE AND SYSTEM AUDITS

11.01 On-Site Audit

An on-site system audit will be performed during major field activities to review all field-related quality assurance activities. The system audit will be conducted by O'Brien & Gere's Quality Assurance Coordinator.

Specific elements of the on-site audit include the verification of:

- Completeness and accuracy of sample Chain-of-Custody forms, including documentation of times, dates, transaction descriptions, and signatures.
- Completeness and accuracy of sample identification labels, including notation of time, date, location, type of sample, person collecting sample, preservation method used, and type of testing required.
- Completeness and accuracy of field notebooks, including documentation of times, dates, drillers names, sampling method used, sampling locations, number of samples taken, name of person collecting samples, types of samples, results of field measurements, soil logs, and any problems encountered during sampling.
- Adherence to health and safety guidelines outlined in the Site Health and Safety Plan including wearing of proper protective clothing.
- Adherence to decontamination procedures outlined in Section 4 of this QAPP, including proper decontamination of pumps and pump tubing, bailers, and soil sampling equipment.

- Adherence to sample collection, preparation, preservation, and storage procedures.

11.02 Laboratory Audit

11.02.1 OBG Laboratories Internal Laboratory Audits

OBG Labs performs regular systems and performance audits. O'Brien & Gere's Quality Assurance Coordinator will also conduct a system audit of the laboratory once during the project to evaluate whether proper quality assurance measures are being incorporated into the sample handling and analysis. Table A-7 lists the checklist that will be used for the system audit.

Results of both the field and laboratory audit will be submitted to O'Brien & Gere's Project Manager and Quality Assurance Coordinator for review and incorporation into the status reports prepared by O'Brien & Gere.

If the results of the audit necessitate further action, the Project Manager will be notified of such and will be appraised of any action taken.

SECTION 12 - PREVENTATIVE MAINTENANCE

12.01 Laboratory Maintenance

Standard operating procedures for maintenance, including specific routine and preventive procedures, and maintenance logs for all analytical instruments are employed at OBG Labs according to manufacturers' recommendations.

12.02 Field Maintenance

O'Brien & Gere's field equipment is maintained regularly according to the manufacturers specifications. When damaged equipment or equipment in need of repair is returned to the equipment warehouse, it is appropriately flagged for the required maintenance to be performed. This process assures only operable and maintained equipment enters the field. Routine daily maintenance procedures conducted in the field will include:

- Removal of surface dirt and debris from exposed surfaces of the sampling equipment and measurement systems.
- Cleaning of filters in the organic vapor analyzer.
- Storage of equipment away from the elements.
- Daily inspections of sampling equipment and measurement systems for possible problems (e.g. cracked or clogged lines or tubing or weak batteries).

Spare and replacement parts stored in the field to minimize downtime include:

- Appropriate size batteries
- Locks

- Extra sample containers
- Bailer line
- Additional stainless steel bailers
- Additional equipment as necessary for the field tasks.

SECTION 13 - SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

13.01 O'Brien & Gere's Data Quality Assessment

O'Brien & Gere's Quality Assurance Coordinator will review and validate all data as it is received. This validated data will then be incorporated into the next report to be submitted.

The data will be checked by OBG Labs prior to its release to O'Brien & Gere. The main objective of O'Brien & Gere's Quality Assurance Coordinator will be to insure that errors have not been made. This will be accomplished by checking all quality assurance precision and accuracy data and insuring that data packages are complete with information such as:

- Title page
- Chain-of-custody records
- Analytical reports
- Quality control data summary
- Chromatograms
- Methodology summary
- Calibration data

Quality control summary forms will be checked to the specified limits in the required methods. If outliers exist, it will be determined what corrective measures were used to locate the problem or determine if it was sample matrix interference. The following documents will be used in support of the data quality assessment review:

- EPA Region III Data Validation Checklist
- EPA 600/4-79-019, "Handbook for Analytical Quality Control in Water and Wastewater Laboratories".
- Technical Directive Document No. HQ-8410-01, "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses".
- EPA 600/479-020, "Methods for Chemical Analysis of Water And Wastes".
- Federal Register, Friday, October 26, 1984.

13.02 Field Data Quality Assessment

To ensure that all field data are collected accurately and correctly, specific written instructions will be issued to all personnel involved in field data acquisition by the Project Manager. The Quality Assurance Coordinator will then review the field books used by project personnel to insure that all tasks were performed as specified in the instructions.

All raw data and reduced data will be submitted by project personnel to the Quality Assurance Coordinator for review. The Quality Assurance Coordinator will then submit these data to the Project Manager for use after all aspects of the data have been approved, initialed, and dated by the Quality Assurance Coordinator. Equations, calculations, data transfers, consistent units and significant figures will all be subject to this quality assurance review.

SECTION 14 - CORRECTIVE ACTION

Corrective action procedures that might be implemented from audit results or upon detection of data unacceptability will be developed on a case-by-case basis. Generally, the following actions may be taken:

1. The reason for the unacceptable data point(s) will be determined as follows:
    a. Precision
        i. The analyst
        ii. Nature of the sample
        iii. Glassware contamination
    b. Accuracy
        i. The analyst
        ii. Glassware contamination
        iii. Contaminated reagents
        iv. Instrument problems
        v. Sample interference with spiked material
2. The corrective actions to be taken may include:
    - Reanalyzing samples if holding times have not been exceeded.
    - Altering field or handling procedures.
    - Resampling.
    - Using a different batch of sample containers.
    - Recommending an audit of laboratory procedures.
    - Accepting data with know levels of uncertainty.

- Discarding data.

Problems encountered during the study affecting quality assurance will be reported on a Corrective Action Form. The Project Manager and the OBG Labs QA Coordinator will be responsible for initiating the corrective actions in the field and laboratory, respectively, in a timely manner. The Project Manager will report to the Quality Assurance Coordinator on the corrective actions taken, the outcome of these actions, and their effect on data produced. Corrective actions will be discussed in the quality assurance report to management described in Section 14.

SECTION 15 - QUALITY ASSURANCE REPORTS TO MANAGEMENT

The Project Manager, in conjunction with the Quality Assurance Coordinator, will submit, in the investigation reports, summaries of all applicable quality assurance activities. These summaries will contain at least the following types of information.

- The status and coverage of various laboratory and field quality assurance project activities.
- Data quality controls including assessment of: accuracy, precision, completeness, representativeness, and comparability.
- Significant quality assurance problems discovered, corrective actions taken, progress and improvements, plans, and recommendations for further implementation or updating of the investigative QAPP.
- Any significant irregularities noted in the field notebook during the sampling procedure.
- Results of performance and system audits, if conducted.
- A discussion of the QA/QC data as it relates to the data quality objectives of the investigation and the interpretation of the results of the field investigation.

TABLES

Table A - 1
Sample Container Requirements
Preservation And Holding Times

SITE INVESTIGATION
Enarc-O Machine Products
Division of Kaddis Manufacturing Corporation
North Bloomfield, New York

Sample Fraction	Sample Matrix	Sample Preservation	Holding Time	Container
Volatile Organics	Soil	Cool, 4 C	7 Days	(2) 40 ml glass vials with teflon liners
Metals	Soil	Cool, 4 C	6 Months	(1) 4 oz. wide mouth bottle w/teflon liner
Volatile Organics	Water	Cool, 4 C 1:1 HCL Ascorbic Acid	7 Days	(2) 40 ml glass vials w/teflon liners
Trip Blank	Water	Cool, 4 C 1:1 HCL	14 Days	40 ml glass vials with teflon liners
Rinsate Blanks	Water	Cool, 4 C 1:1 HCL	14 Days	metals: 1000 ml plastic bottles w/teflon liners; VOA: 40 ml glass vials w/teflon liners

Sources: Test Methods for Evaluating Solid Waste, U.S. EPA, SW-846. November, 1986, 3rd edition.

Table A - 2

Well Numbers And Estimated Depths

SITE INVESTIGATION

Enarc-O Machine Products
Division of Kaddis Manufacturing Corporation
North Bloomfield, New York

Well No.	Estimated Depth (ft.)
MW-1	25
MW-2	25
MW-3	25
MW-3D*	50
MW-4	25
MW-5	25
MW-6	25

Notes: * - This well will only be installed if wells are installed in overburden.

Table A - 3
Conductivity Temperature Corrections
For 1,413 UMHOS/CM Conductivity Standard

SITE INVESTIGATION
Enarc-O Machine Products
Division of Kaddis Manufacturing Corporation
North Bloomfield, New York

Temperature, C	UMHOS/CM
4.0	914.0
5.0	932.7
6.0	951.7
7.0	971.1
8.0	991.0
9.0	1011.9
10.0	1031.8
11.0	1052.9
12.0	1074.3
13.0	1096.3
14.0	1118.7
15.0	1141.5
16.0	1167.5
17.0	1193.6
18.0	1219.9
19.0	1246.4
20.0	1273.0
21.0	1299.7
22.0	1326.6
23.0	1353.6
24.0	1380.8
25.0	1408.1
26.0	1436.5
27.0	1463.2
28.0	1490.9
29.0	1518.7
30.0	1546.7

Table A-4
Analytical Method Detection Limits
Enarc-O Machine Products Site

1. Volatile Organics	Low Water (ug/l)	Low Soil/Sed (ug/kg)
Chloromethane	10.	<10.
Bromomethane	10.	<10.
Dichlorodifluoromethane	10.	****
Vinyl chloride	1.	<10.
Chloroethane	1.	<10.
Methylene chloride	1.	<5.
Trichlorofluoromethane	1.	****
1,1-Dichloroethene	1.	<5.
Bromochloromethane	1.	****
1,1-Dichloroethane	1.	<5.
trans-1,2-Dichloroethene	1.	<5.
cis-1,2-Dichloroethene	1.	****
Chloroform	1.	<5.
1,2-Dichloroethane	1.	<5.
Dibromomethane	10.	****
1,1,1-Trichloroethane	1.	<5.
Carbon tetrachloride	1.	<5.
Bromodichloromethane	1.	<5.
1,2-Dichloropropane	1.	<5.
2,2-Dichloropropane	1.	****
1,1-Dichloropropene	1.	****
cis-1,3-Dichloropropene	1.	****
Trichloroethene	1.	<5.
1,3-Dichloropropane	1.	****
Dibromochloromethane	1.	<5.
1,1,2-Trichloroethane	1.	<5.
trans-1,3-Dichloropropene	1.	<5.
1,2-Dibromoethane	10.	****
Bromoform	10.	<5.
1,1,1,2-Tetrachloroethane	1.	****
1,2,3-Trichloropropane	1.	****
1,1,2,2-Tetrachloroethane	1.	<5.
Tetrachloroethene	1.	<5.
Chlorobenzene	1.	<5.
Bromobenzene	5.	****
2-Chlorotoluene	5.	****
4-Chlorotoluene	5.	****
1,3-Dichlorobenzene	5.	****
1,2-Dichlorobenzene	5.	****
1,4-Dichlorobenzene	5.	****
Acetone	****	<100.
2-Butanone	****	<100.
Carbon disulfide	****	<5.
2-Chloroethyl vinyl ether	****	<10.

Table A-4 (continued)

2-Hexanone	****	<50.
4-methyl-2-pentarone	****	<50.
Benzene	1.	****
Trichloroethene	1.	****
Toluene	1.	****
Tetrachloroethene	1.	****
Ethylbenzene	1.	****
p-Xylene	1.	****
Chlorobenzene	1.	****
m-Xylene	1.	****
a-Xylene	1.	****
Isopropylbenzene	1.	****
Styrene	1.	****
N-Propylbenzene	1.	****
tert-Butylbenzene	1.	****
2-Chlorotoluene	1.	****
4-Chlorotoluene	1.	****
Bromobenzene	1.	****
sec-Butylbenzene	1.	****
1,3,5-Trimethylbenzene	1.	****
4-Isopropyltoluene	1.	****
1,2,4-Trimethylbenzene	1.	****
1,4-Dichlorobenzene	1.	****
1,3-Dichlorobenzene	1.	****
N-Butylbenzene	1.	****
1,2-Dichlorobenzene	1.	****
Hexachlorobutadiene	1.	****
1,2,4-Trichlorobenzene	5.	****
Naphthalene	5.	****
1,2,3-Trichlorobenzene	5.	****
Vinyl Acetate	****	<50.
Xylenes (total)	****	<5.

2. Metals	Low Water (ppm)	Low Soil/Sed (ppm)
Lead (EPA 7421)	<0.05	<5.

Detection limits listed for soil are based on wet weight. The detection limits calculated by the laboratory on a dry weight basis will be higher.

Sources:

Test Methods foe Evaluating Solid Waste, U.S. EPA, SW-846, November, 1986, 3rd edition.

Methods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020, March, 1983.

Fedreal Register, Vol. 49, Appendix A to Part 136-Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, October, 1984.

NIOSH Manual of Analytical Methods, U.S. DHHS, February, 1984.

Table A - 5
Frequency of Quality Control Samples

SITE INVESTIGATION
Enarc-O Machine Products
Division of Kaddis Manufacturing Corporation
North Bloomfield, New York

Matrix	Estimated No. Samples	Sample Fraction/Application Reference No.	Travel Blanks	Rinsate Blanks	Duplicates	MS/MSD
Soil	2	Lead 7421		1	1	1/1
Soil	20	Organics - 8010/8020	1/ship.	2	2	1/1
Water	7*	Organics - 502.1/503.1	1/ship.	1	1	1/1

NOTES Locations are specified in work plan, the actual number of samples obtained will be dependent on the field conditions.

* - This number assumes 6 wells and 1 drain sample. The number will be increased to 8 if 7 wells are installed.

Table A-6

CONTROL LIMITS

LEAD

EPA METHOD: 7421

AUDIT	FREQUENCY	CONTROL LIMIT
Calibration Verification	Calibrated daily and each time instrument is set up; verify at a frequency of 10% or every 2 hr. whichever is greatest.	Within 10% of the true value for all except tin and mercury (20% of true value)
Calibration Blank	During calibration at a frequency of 10% during and at end of run.	No more than CRDL.
Preperation Blank	1 per batch of samples digested or 1 in 20 whichever is greater.	No more than CRDL.
Spiked Sample Analysis	1 per group of similar concentration and matrix, 1 per case of samples, or 1 in 20 whichever is greater	Within 50% of known value.
Duplicate	Same as spiked sample analysis.	50% relative percent difference for values.
Sample Analysis Lab Control Sample	Once a month for each of the procedures (applied) to sample analysis.	Within 35% of recovey.

Table A-6 (cont)

CONTROL LIMITS

VOLATILES

EPA METHOD: 8010/8020

AUDIT	FREQUENCY	CONTROL LIMIT
Calibration Verification	Calibrated daily (morning) with a single point calibration.	Within 10% of the true value.
Organic free Blank	Daily	No compounds present.
Reference Standard	Daily	Within 30% of true value.
MS/MSD Blank	10%	50% of known value.
Surrogates	Each Sample	30% if known value.

Table A-6 (cont)

CONTROL LIMITS

VOLATILES

EPA METHOD: 502.1/503.1

AUDIT	FREQUENCY	CONTROL LIMIT
Calibration Verification	Calibrated daily (morning) with a single point calibration.	Within 20% of the true value.
Organic free Blank	Daily	No compounds present above DL.
Reference Spike	One per day	Within 25% of true value.
MS/MSD Blank	5%	50% of known value. 25% of the RPD.
Surrogates	Each Sample	30% if known value.

DL = Detection Limit
RPD = Relative Percent Difference

Table A-7

O'BRIEN & GERE'S SYSTEM AUDIT CHECKLIST FOR OBG LABORATORIES

I. Chain-of-Custody
- Log-In Procedures Evaluated
- Sample Custodian is Assigned and Oversee Sample Transfer
- Sample Routing and Pickup is Documented and Accounted for
- Separate Area for Sample Storage and Maintained in Locked Storage

II. Sample Preparation
- Correct Sample Preparation Procedures are Followed
- Areas Designed for Sample Preparation (Organic and Inorganic)
- Holding Times Maintained

III. QA/QC Procedures
- Procedures are Being Followed According to Methods Specified
- Data Validation and Reduction Processes Reviewed by Group Leaders
- Proper Documentation of QA Procedures
- Internal QC Maintained
- Data Transfers and Reporting Checked by Group Leaders
- Awareness of Personnel of QA Requirements

IV. Equipment Maintenance
- Maintenance Logs are Up-to-Date
- Instrumentation is in Repair
- Reasonable Spare Parts are on Hand

V. Miscellaneous
- Overall Housekeeping in Order
- Certification Up-to-Date

TABLE A-8

OBG LABORATORIES, INC QA/QC PACKAGE CONTENTS

Site Investigation
Enarc-o Machine Products
Division of Kaddis Manufacturing Corporation
North Bloomfield, New York

OBG Laboratories offers three (3) types of reporting formats to its clientele. For Convenience, they have been termed Level I, Level II and Level III.

Level I is typed sample results with chain of custody documentation showing the receipt and the ultimate disposal of the sample.

Level II is a Level I report with typed Quality Control data. The Quality Control data includes:

Reagent Blanks
Trip Blanks
Field Blanks
Reference Samples
Matrix Spikes
Matrix Spike Duplicates (organics)
Duplicates (inorganics)
Surrogate Recoveries

Level III reports are Level II reports with copies of the raw data. Raw data may consist of:

Calibration Curves
Response Factors
Calculations
Chromatograms
Tuning Criteria
Tuning Criteria and Instrument Settings
Standard Preparation Logs
Extraction Logs
Reagent Water Logs

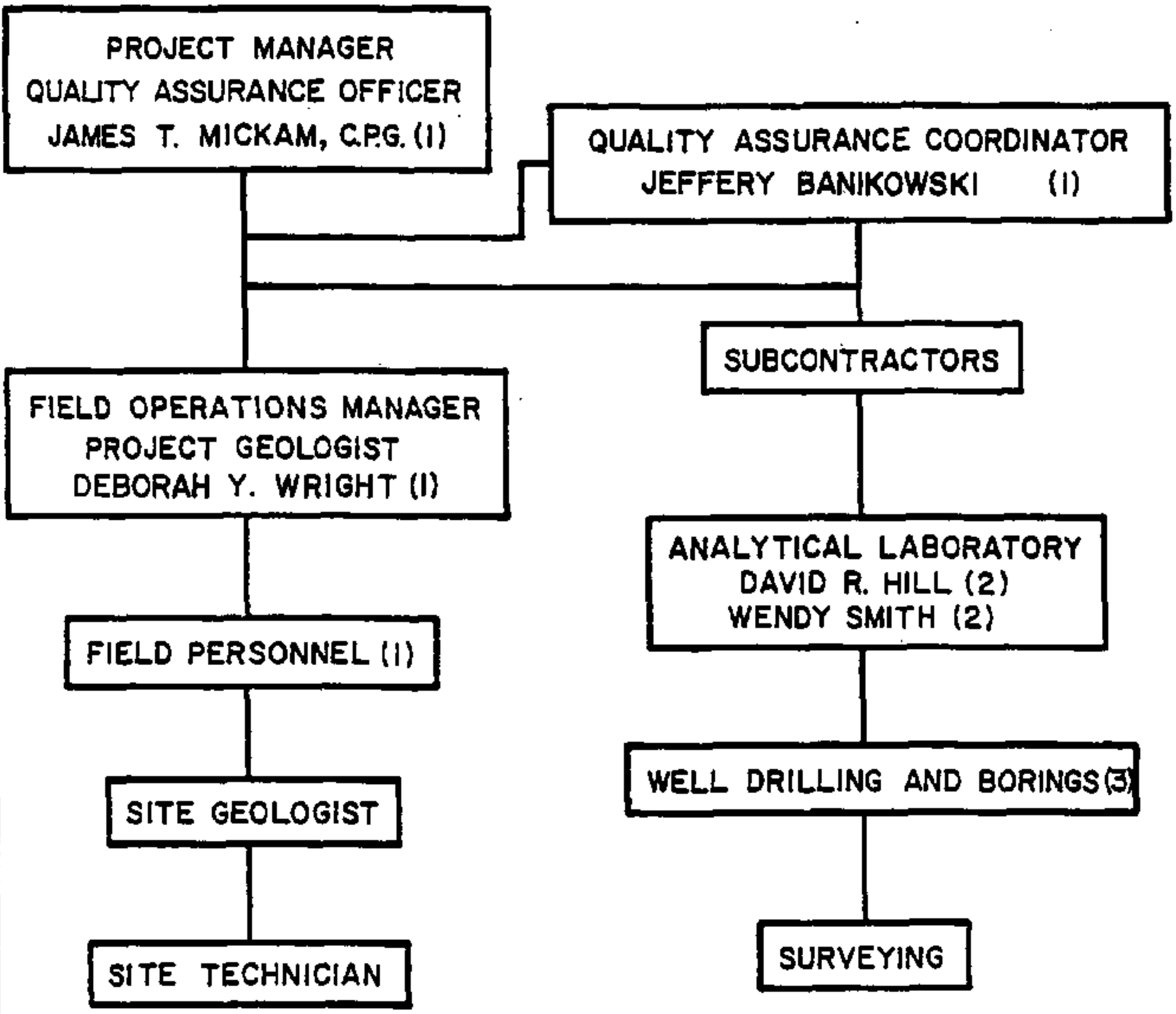
The raw data makes up the bulk of a Level III report. Level III reports can be validated by an independent laboratory.

DYW:bl\A34

FIGURES

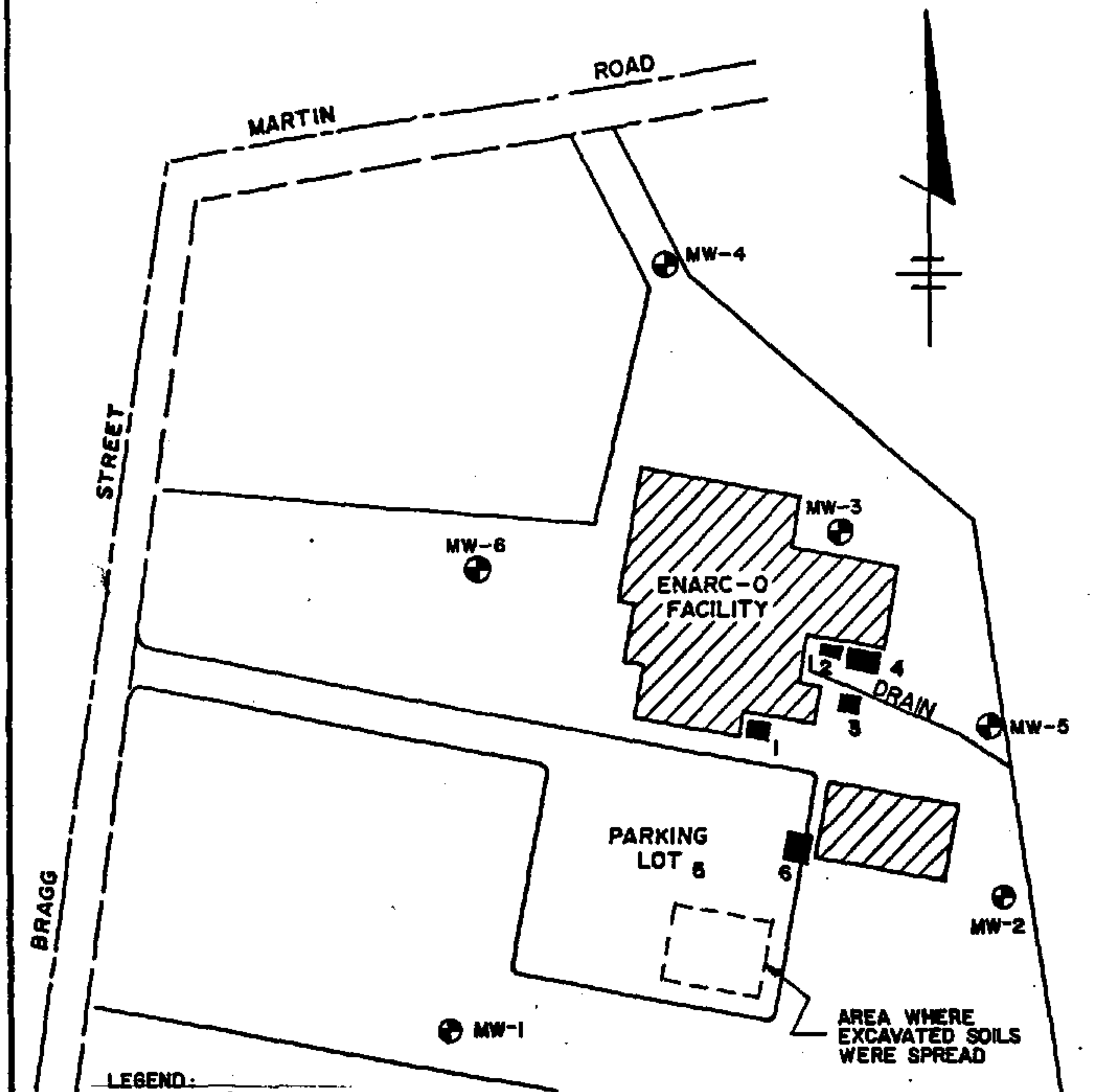
FIGURE A-1

PROJECT ORGANIZATION CHART



(1) OBRIEN & GERE ENGINEERS, INC.
(2) OBG LABORATORIES, INC.
(3) PARRATT-WOLFF, INC.

FIGURE A-2



LEGEND:

1. AREA SURROUNDING A RECENTLY EXCAVATED AND REMOVED GASOLINE STORAGE TANK.
2. AREA AROUND THE REMOVED ABOVE GROUND SOLVENT STORAGE TANK.
3. AREA WHERE WASTE OIL IS RETAINED.
4. AREA AROUND ENARC-O'S LOADING DOCK.
5. AREA OF THE PARKING LOT.
6. AREA SOUTHWEST OF THE STORAGE BUILDING.

PROPOSED GROUND WATER MONITORING WELL AND SOIL BORING LOCATION MAP

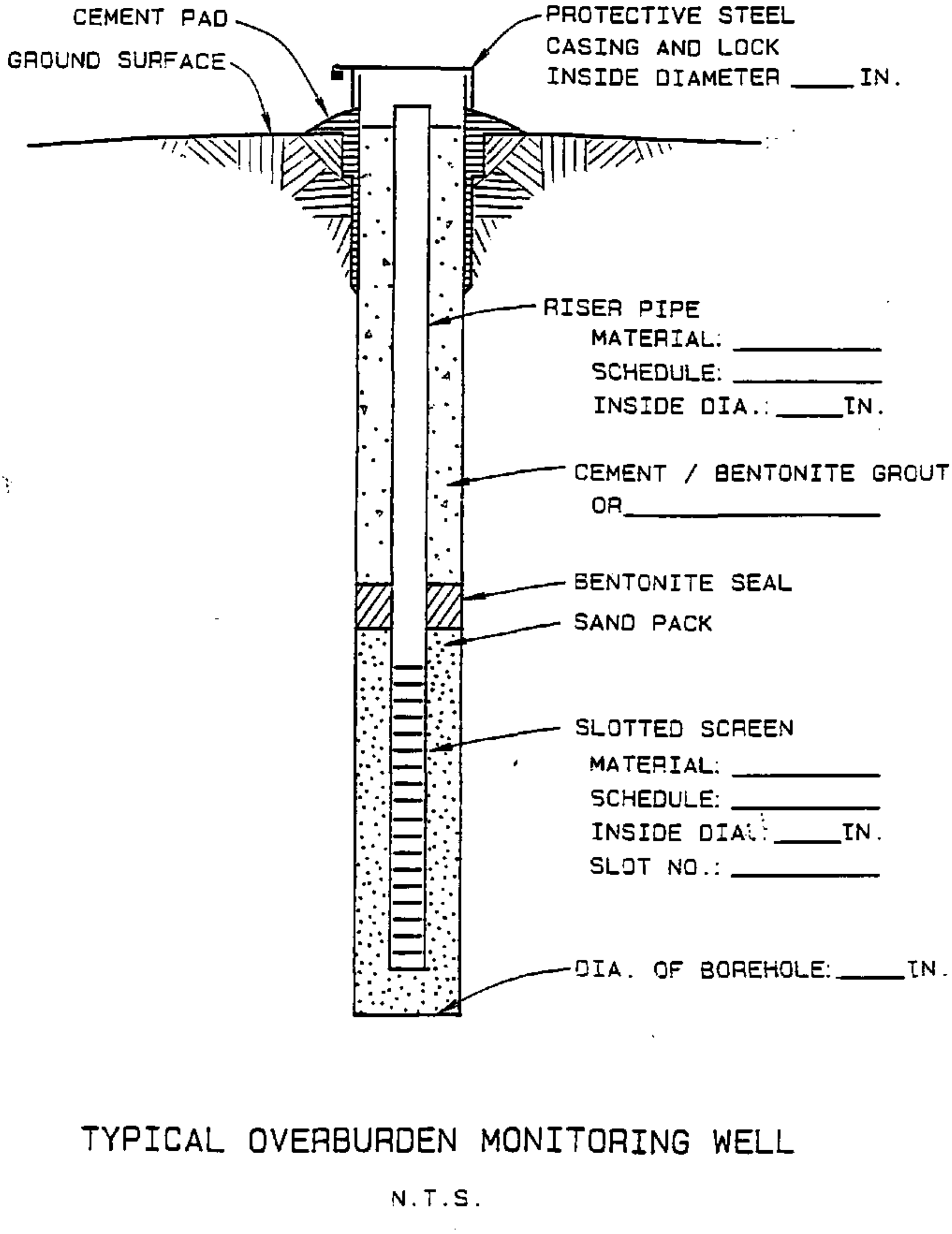
0 100' 200'

SCALE IN FT

KADDIS CORPORATION (ENARC-O)

NORTH BLOOMFELD, NEW YORK

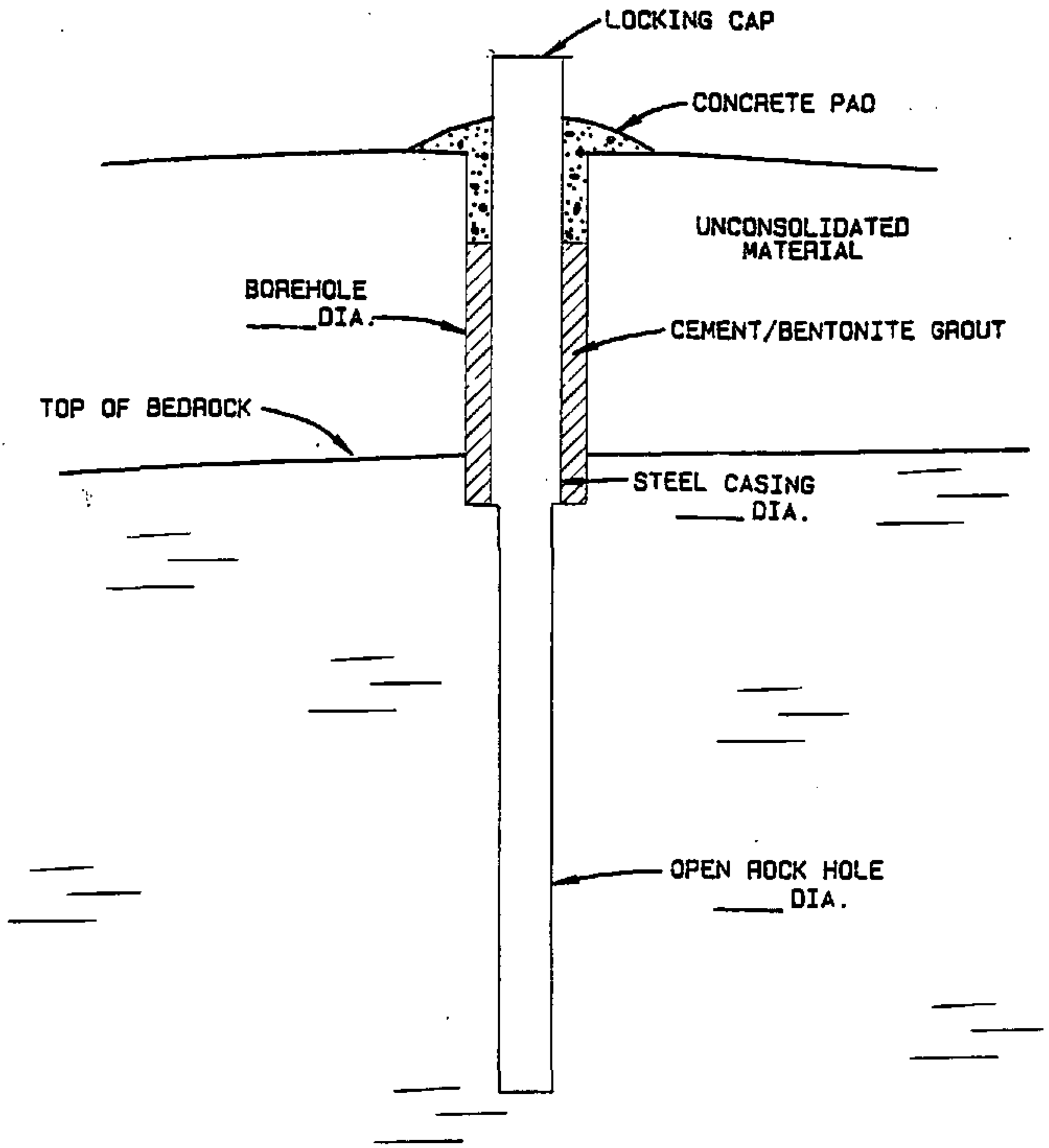
O'BRIEN & GERE ENGINEERS INC



TYPICAL OVERBURDEN MONITORING WELL

N.T.S.

FIGURE A-4



TYPICAL BEDROCK
MONITORING WELL
(NOT TO SCALE)

FIGURE A-5

O'BRIEN & GERE
ENGINEERS, INC.

Job No. ____________

Sheet ___ of ___

ffice: ____________

Address: ____________

hone: ____________

CHAIN OF CUSTODY

CLIENT: LOCATION:	COLLECTED BY: (Signature)

SAMPLE DESCRIPTION	Date	Time	Sample Matrix[1]	Sample Type[2]	No. of Containers	ANALYSIS REQUESTED

[1] Matrix = water, wastewater, air, sludge, sediment, etc.

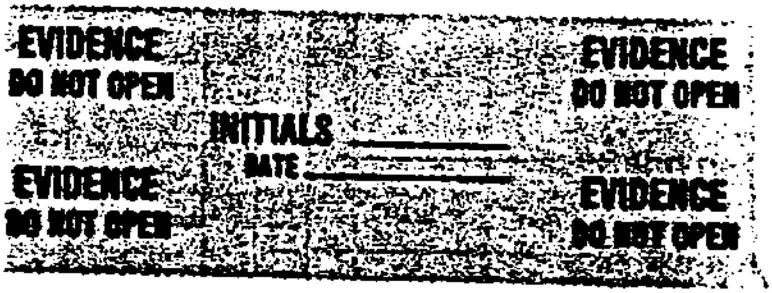
[2] Type = grab, composite

Relinquished by: ____________	Date	Time	Received by: ____________	Date	Time
of: ____________			of: ____________		
Relinquished by: ____________	Date	Time	Received by: ____________	Date	Time
of: ____________			of: ____________		
Relinquished by: ____________	Date	Time	Received by: ____________	Date	Time
of: ____________			of: ____________		
Use this space if shipped via courier (e.g., Fed Ex) Relinquished by: ____________	Date	Time	Courier Name: ____________	Date	Time
of: ____________			____________ *Attach delivery/courier receipt to Chain of Custody		
Relinquished by: ____________	Date	Time	Received by: ____________	Date	Time
of: ____________			of: ____________		

FIGURE A-6

CHAIN-OF-CUSTODY

EVIDENCE TAPE



ATTACHMENT A

RESUMES

JAMES T. MICKAM, C.P.G.
VICE PRESIDENT

BACKGROUND

Mr. Mickam joined O'Brien & Gere Engineers, Inc. in 1982, was promoted to Senior Project Hydrogeologist in 1984 and Managing Hydrogeologist in 1985. In 1988 he was promoted to Vice President.

Fields of special competence include the development, implementation and management of hydrogeologic investigations to evaluate ground water contamination occurrence and migration, and the design of municipal and industrial ground water supply wells. Hydrogeologic environmental experience includes both unconsolidated porous media and fractured bedrock flow systems.

EDUCATION

Michigan State University, 1978, BS Geology

PROFESSIONAL CERTIFICATIONS

Certified Professional Geological Scientist #6824
American Institute of Professional Geologists

PROFESSIONAL AFFILIATIONS

Association of Ground Water Scientists

EXPERIENCE

HAZARDOUS WASTE MANAGEMENT:

Extensive experience in the development of investigation protocols for hazardous waste site hydrogeologic investigations, including test boring methods, monitoring well designs and installation methods, and equipment decontamination procedures in a variety of both hard rock and unconsolidated hydrogeologic systems. Currently responsible for supervising and consulting on a wide variety of hydrogeologic studies at hazardous waste sites. Representative projects include:

Baltimore, MD - Developed and supervised hydrogeologic investigations to evaluate the potential impacts from agricultural chemical waste disposal to a major coastal plain aquifer. Study involved field activities including geophysical surveys, test drilling and insitu hydraulic conductivity testing. Computer modeling techniques were used during data reduction to evaluate feasibility of desirable remedial measures.

Performed hydrogeologic investigation and provided consulting services and expert testimony for a major Ohio law firm representing an industrial client in a federal ground water contamination litigation. Study methods employed included geophysical surveys, air photo interpretation, structural geologic mapping, borehole geophysical logging and computer modeling.

Aiken, SC - Assisted client in developing and implementing a hydrogeologic investigation and hazardous waste characterization plan to develop engineering design criteria for surface impoundment closure plans.

Muskegon County, MI - Conducted hydrogeologic investigation for a large chemical concern to assess potential impacts on a proposed hazardous waste incinerator.

Houghton, Michigan and Wexford County, Michigan Department of Natural Resources - Conducted hydrogeologic investigations to identify ground water contamination sources and developed management strategies to rate ground water contamination sites with regard to their relative severity.

Kalamazoo County, MI - Industrial chrome plating company, conducted hydrogeologic investigation to define the extent of hexavalent chrome contamination in the ground water system.

Washington County, NY - Supervised field investigation for a hydrogeologic study to assess the impact of a PCB disposal site on the ground water system.

Boston, MA - Conducted hydrogeologic investigation for a major oil company to assess extent and impact of a 50,000 gallon petroleum product loss. Designed, supervised construction and monitored a successful spill recovery system.

Muskegon County, MI - Performed hydrogeologic investigation to develop design criteria for a fly ash disposal facility and developed a ground water monitoring system around the completed facility.

Kalkaska County, MI - Conducted electrical earth resistivity surveys for the Northern Michigan Regional Planning Commission to identify areas of potential ground water contamination resulting from abandoned brine pits.

Oswego County, NY - Conducted a hydrogeologic investigation and monitoring program for a major oil company to determine the extent and migration of a gasoline spill in the local aquifer. Evaluated the original recovery system and developed a program to enhance the recovery operation and thereby minimize the potential for contamination of a nearby public supply well.

Ponce, Puerto Rico - Assisted client in developing and implementing hydrogeologic investigation to evaluate the impact of a high specific gravity non-aqueous hydrocarbon fluid. Study elements included ground water monitor well installations, ground water sampling, aquifer performance testing, hydrogeologic mapping and computer modeling.

Marquette, MI - Completed remedial investigation for industrial client at a federal superfund site. Responsibilities included assisting with regulatory negotiations on work plan, coordination of subcontracts, and supervision of hydrogeologic investigation.

WATER RESOURCES:

Experience includes studies to evaluate ground water resource development potential and final designs of municipal and industrial ground water supply wells. Representative projects include:

Conklin, NY - Completed regional hydrogeologic study to evaluate and select potential sites for .5 mgd municipal ground water supply well field. Developed and performed subsequent field investigations, completed well designs and tested completed supply wells for long term safe yield.

McDowell County, NC - Conducted gravity survey along the Linville Fault to evaluate thicknesses of valley fill material and potential ground water resources for a pharmaceutical company.

Tully, NY - Designed and supervised construction of two large diameter deep brine solution mining wells. Included the preparation of contract drawings, bed specifications and contractor cost monitoring.

Pevely, MO - Siting, design and specification review of municipal supply well to be completed in fractured bedrock system for proposed .75 mgd supply.

Cortland, NY - Efficiency and long term yield evaluation of 4 mgd municipal supply well.

Dorado Beach, Puerto Rico - .5 mgd ground water drinking water supply development for proposed housing development.

Ingham County, MI - Conducted electrical earth resistivity surveys, supervised test well installation and prepared hydrogeologic reports to assess and rate potential ground water recharge areas for the Tri-County Regional Planning Commission's ground water availability project.

WASTEWATER, MUNICIPAL:

Experience includes evaluating site suitability to receive treated wastewater via spray irrigation or subsurface drains and designing system hydraulic loading capacity. Representative projects include:

Muskegan County, MI - Completed numerous hydrogeologic investigations for the County of Muskegan to evaluate wastewater spray irrigation systems. Studies include regional ground water mapping and flow analysis, aquifer performance testing and developing regional hydrologic budgets.

Pontiac, MI - Developed and supervised hydrogeologic investigation to evaluate the suitability of a proposed housing development site to support a community septic system. Responsibilities include discharge permit negotiations, construction oversight and system operations monitoring.

Ludington County, MI - Site evaluation to assess area suitability to receive treated wastewater from overland flow loading system.

PUBLICATIONS

Detection of Fractures and Solution Channels in Karst Terranes Using Natural Gamma Ray and Hole Caliper Borehole Logs, Mickam, James T.; Levy, Banjamin S.; Lee George W., Jr.; Surface and Borehole Geophysical Methods in Ground Water Investigations; San Antonio, Texas; February 1984.

JEFFREY E. BANIKOWSKI
SENIOR PROJECT SCIENTIST

BACKGROUND

Mr. Banikowski joined O'Brien & Gere in 1988 following fifteen years of service with the Onondaga County Department of Health. He was promoted to Senior Project Scientist in 1989. Fields of special competence include environmental toxicology, risk assessments and public health evaluations, geologic and hydrogeologic research/investigation, statistics, indoor air monitoring, the implementation of hazardous waste sampling programs and radon mitigation and assessment.

EDUCATION

State University of New York at Fredonia, 1972, BS/Geology
Syracuse University, 1984, MS/Geology

CERTIFICATION

Certified as a Senior Public Health Sanitarian by the State of New York, Certificate #1526.

EXPERIENCE

GROUND WATER SAMPLING PROGRAMS:

Developed ground water evaluation program for Onondaga County, NY in conjunction with Syracuse University and the Central New York Environmental Management Council.

Initiated program to sample over two hundred private drinking water supplies situated in the vicinity of active and inactive landfills.

Performed ambient air monitoring for ammonia and hydrogen sulfide at the Allied-Signal waste beds in Camillus, NY in response to odor complaints. Determined health risk to area residents.

Established ground water and surface water sampling program on behalf of residents living near a former chemical recycling center in Pompey, NY. As a result, the Environmental Protection Agency established an emergency water supply for several residents and placed the center on the National Priorities List of hazardous waste sites.

Implemented a sampling program involving 45 private water supplies located around the Clay Landfill, Clay, NY following allegations of PCB laden material entering the waste stream. Presented findings to the Onondaga County Legislature. Consequently, a public water supply line was installed for the affected residential units.

EMERGENCY RESPONSE:

Liverpool High School, Liverpool, NY - Assisted in the closure and reopening of the High School following a herbicide spraying incident wherein 22 people required medical attention.

Amtrak, Minoa, NY - Coordinated with Chemtrek and local fire department to resolve problems associated with a tank car leaking fuming nitric acid.

Skaneateles Lake, Skaneateles, NY - Assisted NYS Department of Environmental Conservation in evaluating remedial alternatives after a truck overturned and released emulsified asphalt into Skaneateles Lake which provides water to the City of Syracuse.

Stanton Founderies, Solvay, NY - Evaluated health risk posed to workers following an acid spill inside a production facility.

Syroco Corporation, Van Buren, NY - Assessed source and impact of fumes creating noxious odors inside plant facility following its evacuation.

Prepared emergency response protocol to PCB ballast failures for use by local fire departments.

Developed procedure for removal of underground transformer located in a downtown building in the City of Syracuse.

Developed Division of Environmental Health, Onondaga County Department of Health Emergency Response Plan.

AIR MONITORING:

Designed and implemented a Radon Pilot Screening Program on behalf of the Onondaga County Department of Health. This program won recognition from the NY State and National Association of Counties as an innovative and model program for local health departments. Findings from the program were presented to the County Executive, New York State Department of Health, County Legislature, news media, Home Builders Association, and numerous civic groups by request.

North Area Garage Facility, North Syracuse, NY - Developed sampling program for airborne pollutants and made recommendations for ventilation and structural changes to the subject building which housed approximately 40 vehicles.

Administered a residential formaldehyde program on behalf of New York State in order to assess the short and long term retention of this chemical material in air following the installation of urea-formaldehyde foam insulation.

Fairmount Gardens Senior Citizen Center, Camillus, NY - Developed indoor air sampling program for formaldehyde and other aldehydes. Made recommendations for changes in the ventilation system and removal of source materials.

North Syracuse High School, North Syracuse, NY - Performed indoor air sampling related to the replacement of a hot-tar roof. Also, reviewed asbestos documentation to determine compliance with existing regulations and provided recommendations for additional work to the Superintendent of Schools.

HAZARDOUS WASTE INVESTIGATIONS:

Rockwell Plant Site, Syracuse, NY - Conducted oversight of Phase I and Phase II investigations conducted by a private consulting firm on behalf of the Onondaga County Department of Health and the NYS Department of Environmental Conservation.

Stauffer Chemical Corporation, Skaneateles Falls, NY - Reviewed interim clean-up measures and assisted the NYS Department of Health in assessing the health implications associated with an on-site landfill.

Maestri Waste Site, Lakeland, NY - Prepared bid specifications for the installation of monitoring wells, provided field oversight for all work activities, obtained ground water samples and soil samples; presented findings to Town Officials and members of the County Legislature.

Inventoried hazardous waste sites located in Onondaga County in conjunction with City-County Planning Agency.

Administered environmental lead program on behalf of Onondaga County for a period of two years.

Brookhurst, Casper, WY - Participated in soil-gas vapor survey.

Van Buren Landfill, Van Buren, NY - Developed criteria for a Phase II investigation prior to closure.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) PLANS:

Blosenski Landfill, West Caln Township, PA - Prepared QA/QC Plan for pre-design activities associated with RI/FS.

Waldick Aerospace Devices, Wall Township, NJ - Prepared QA/QC Plan for the pre-design phase of the RI.

Fort Drum, Fort Drum, NY - Administered preparation of QA/QC Plan for RI/FS.

HEALTH AND SAFETY PLANS:

Keene Landfill, Parkersburg, WV - Prepared site Health and Safety Plan for drum disposal characterization and removal work.

Metaltec/Aerosystems, Sussex County, NJ - Prepared site Health and Safety Plan for workers engaged in the excavation and heat treatment of approximately 10,000 cubic yards of soil.

Fort Drum, Fort Drum, NY - Prepared Health and Safety Plan for RI/FS work activities.

Schilling Atlas Missile Sites 3,4,5,6,7, and 8, KS and MO - Wrote Health and Safety Plans for work associated with the evaluation of potential on-site chemical contamination.

Forbes Atlas Missile Sites 5 and 9, KS - Prepared Health and Safety Plans for the investigation of potential on-site chemical contamination.

Richards-Gebaur Air Force Base, Belton, MO - Developed Health and Safety Plans for an RI/FS related to five areas of potential chemical contamination.

PUBLICATIONS

Hand, Bryce M. and Banikowski, Jeffrey E., 1988, **Radon in Onondaga County, New York: Paleohydrogeology and redistribution of uranium in Paleozoic sedimentary rocks**, Journal of Geology, v. 16, p. 775-778.

Hand, Bryce M., and Banikowski, Jeffrey E., 1988, **Geologic factors affecting indoor radon in Onondaga County, NY**, Northeastern Geology Abstracts: Radon in the Northeast: Perspectives and Geologic Research, v. 10, no. 3, p. 176.

Hand, Bryce M., and Banikowski, Jeffrey E., 1988, **Radon in Onondaga County, New York: Cenozoic Redistribution of Uranium in Paleozoic Sediments**, EOS, Transactions of the American Geophysical Union, v. 69, no. 16, p. 359-360.

DEBORAH Y. WRIGHT
SENIOR PROJECT HYDROGEOLOGIST

BACKGROUND

Ms. Wright joined O'Brien & Gere Engineers, Inc. in 1982 after two years of field and laboratory experience with other drilling, testing and consulting firms in Central New York. She was promoted to Senior Project Hydrogeologist in 1988.

Fields of special competence include soil and water well drilling methods; soil testing; ground water investigations; aquifer evaluations; geophysical surveys and aerial photograph interpretation.

EDUCATION

State University of New York at Oneonta, 1980, BS/Geology

SPECIALIZED TRAINING

Princeton University - Princeton Associates, Ground Water Pollution and Hydrology, January 1984.
Syracuse University - Advanced Hydrogeology, Spring 1984.
Cornell University - Remote Sensing for Assessing Landfills, June 1985.

PROFESSIONAL AFFILIATIONS

National Water Well Association
Association for Women Geoscientists

EXPERIENCE

HAZARDOUS WASTE MANAGEMENT:

Experience includes site investigations, remedial program design and implementation, including hydrogeologic studies, soil sampling, monitoring well installations, performance of in situ permeability tests, geophysical surveys, ground water and surface water sampling and aerial photograph interpretations. Confidentiality agreements preclude specific client identification. Representative projects include:

Frederick, Howard and Carrol County, MD - Responsible for development, coordination, supervision and completion of site investigations and hydrogeologic assessments of organic substances at industrial facilities. Hydrogeologic environments included unconsolidated deposits, fractured bedrock and karst terrain. Activities included the review of hydrogeologic literature and historic aerial photographs, geologic mapping, geophysical surveys, completion of soil borings and monitoring wells; soil and ground water sampling; geologic evaluations; ground water assessment including direction, velocity, quality; aquifer performance testing, soil gas surveys; and negotiations with regulatory agencies.

Spartanburg County, SC - Developed a work plan and completed a two-phase site investigation at a bulk storage facility owned by a major oil corporation. The investigation included review of historic aerial photographs; installation of monitoring wells; ground water sampling; assessment of ground water flow direction and rate and ground water quality. Based on findings of investigation developed a work plan for ground water recovery and treatment. The site location adjacent to a residential area required that extensive communication with concerned residents as well as negotiations with the South Carolina Department of Health and Environmental Control during completion of the work.

Jefferson County, AL - Completed hydrogeologic investigations at two gas stations and one bulk storage facility owned by a major oil corporation. These investigations were requested by the Alabama Department of Environmental Management (ADEM) as a result of product losses. Included in these investigations was development of work plans for ADEM approval; installation and sampling of monitoring wells; and evaluations of ground water flow direction and rate and ground water quality.

Onondaga County, NY - Developed a work plan and coordinated and supervised completion of a site investigation at a small manufacturing facility. This investigation included a detailed background information review; installation and sampling of ground water, monitoring wells; characterization of the hydrogeology of the area; and negotiations with NYSDEC.

Chautauqua and Steuben Counties, NY - Developed work plans, supervised coordination and completion of RI/FS investigations on property owned by three major manufacturers. The investigations included review of hydrogeologic literature and historic aerial photographs; geophysical surveys; monitoring well installations; soil and ground water sampling; evaluation of the direction and rate of ground water flow; assessment of ground water quality; geologic characterization; and negotiations with NYSDEC.

Washington County, NY - Conducted gamma ray logging of bore holes to delineate subsurface materials and performed laboratory analyses of soils for grain size, permeability, compaction and moisture content. Supervised drilling and monitoring well installations, contributed to geologic and hydrogeologic evaluation of landfill sites, conducted in situ hydraulic conductivity tests on selected monitoring wells.

Indiana - Performed in situ hydraulic conductivity tests, seep and outcrop surveys and contributed to hydrogeologic evaluation of industrial waste disposal area.

Tonawanda and Waterloo, NY - Designed and conducted a NYSDEC Phase II site investigation to determine the types of substance contained at an industrial landfill. This investigation included soil, surface water and ground water sampling; monitoring well installations; geophysical surveys and performance of in situ permeability tests. Developed an NYSDEC RI/FS work plan based on the Phase II investigation results including negotiations with NYSDEC.

Town of Holbrook, MA - Monitored site investigations conducted by EPA subcontractors at a superfund site. This project included review of protocols and site investigations results and procedures.

Waterloo, NY - Developed and conducted a NYSDEC Phase II investigation at an industrial landfill to determine its content. This investigation included geophysical surveys; ground water, surface water and soil sampling; performance of in situ permeability test; and historic aerial photograph interpretation.

Saugerties, NY - Designed and conducted an investigation at an industrial facility to determine the source of ground water contamination by industrial solvents. This program included aerial photograph fracture trace analysis; geophysical surveys; bedrock mapping and indepth analysis of contaminant concentration trends in bedrock and overburden wells.

Baltimore, MD - Conducted a detailed site investigation at a large industrial facility to characterize the flow and the quality of the ground water. This project included well installations, aquifer analysis and the analysis of the influence of tidal fluctuations on the local ground water system.

Newark, NJ - Designed and conducted a detailed sampling program in connection with an ECRA closure of an industrial facility. This program included monitor well installations; soil, ground water and surface water sampling; and performance of in situ permeability tests.

Oswego County, NY - Conducted a hydrogeologic investigation and monitoring program for a major oil company to determine the extent and migration of a gasoline spill in the local aquifer. Evaluated the original recovery system and developed a program to enhance the recovery operation and thereby minimize the potential for contamination of a nearby public supply well.

Boston, MA - Conducted hydrogeologic investigation for a major oil company to assess extent and impact of a 50,000 gallon petroleum product loss. Designed, supervised construction and monitored a successful spill recovery system.

Onondaga County, NY - Conducted hydrogeologic investigation for a major oil company to assess the impact of a gasoline product release on the ground water system. Designed and supervised the installation and operation of a subsurface product recovery system.

ENVIRONMENTAL ASSESSMENT:

Experience includes sampling and analysis of air, water and soil for various environmental concerns. Representative projects include:

Central NY - Performed residential air quality sampling and laboratory analysis to determine the presence of formaldehyde caused by foam insulation.

Maryland - Conducted investigations at two corn fields to determine the presence of residual pesticides in the soil and ground water. This program included soil sampling; monitor well installations; domestic well survey and sampling and ground water sampling.

SOLID WASTE:

Experience includes installation of ground water monitoring wells, soil and ground water sampling, background data review and historic aerial photograph interpretations. Representative projects include:

Seneca County, NY - Developed and completed site investigations associated with the development and construction of a municipal landfill facility. This project included extensive negotiations with NYSDEC; installation of monitoring wells; ground water sampling; geophysical surveys; assessment of the ground water flow direction and rate; establishment of a ground water quality baseline; and full characterization of the hydrogeology of the site and surrounding area.

Broome County, NY - Supervised installation of ground water monitoring wells and collected ground water samples for analysis in connection with the characterization of a closed municipal landfill.

Central NY - Participated in the preliminary environmental assessment of several areas for the selection of a site for a proposed steam generation waste incineration facility.

WATER RESOURCES:

Experience includes drilling supervision, soils analysis, aquifer testing, well design and well installations. Representative projects include:

Tully, NY - Supervised the drilling and installation of two 1,400' industrial supply wells.

Cortland, NY - Conducted an aquifer performance and well efficiency test on an existing public supply well.

Conklin, NY - Participated in a hydrogeologic study in connection with the location of a public supply well.

PUBLICATIONS

Investigation and Remediation of a Mineral Spirit Product Loss in a Shallow Unconfined Aquifer. John C. Tomik, Cornelius B. Murphy, Jr., and Deborah Y. Wright; Association of Ground Water Scientists and Engineers Eastern Regional Ground Water Conference; July 1985.

DONALD T. BUSSEY
HYDROGEOLOGIST

BACKGROUND

Mr. Bussey joined O'Brien & Gere in 1986 following one year of field experience with monitoring, drilling and geophysical firms located in upstate New York.

Fields of special competence include soil and rock water well design and drilling methods; design of petroleum product monitoring and recovery systems; geophysical techniques including seismic refraction and geophysical well logging; and computer mapping applications.

EDUCATION

Syracuse University, 1988, MS/Geology (expected)
Syracuse University, 1982, BA/Geology

PROFESSIONAL AFFILIATIONS

American Association of Petroleum Geologists

EXPERIENCE

HAZARDOUS WASTE MANAGEMENT:

Experience includes drilling supervision, soil analysis, well design and installation, aquifer testing, in situ permeability testing, ground water sampling, geophysical data acquisition and interpretation, and computer modeling and mapping. Representative projects include:

ARCO, Rome, NY - Site monitoring and petroleum product recovery. Site monitoring at three other sites in upstate New York.

Atlantic Refining Company, Endwell, NY - Site monitoring, recovery well design and installation, aquifer testing. Monitoring well design and installation, ground water sampling and site monitoring at five other sites in upstate New York.

Getty, Inc., Valley Cottage, NY - Site monitoring, recovery well design, air stripper tower installation. Site monitoring at one other site in upstate New York.

Crown Central Petroleum Corporation, Spartanburg, SC - Transfer pipeline soil investigation, monitor well design and installation. Monitoring well design and installation at two sites in Birmingham, Alabama and one site in Baltimore, Maryland.

Sun Oil, Booneville, NY - Aquifer testing, product recovery.

Van Dyne Oil Company, Sayre, PA - Site monitoring.

New York State Department of Environmental Conservation:

- Lake Peekskill, NY - Site monitoring.
- Vestal, NY - Monitoring well design and installation.
- Appalachin, NY - Recovery well design and installation, air stripper tower installation.
- Berkshire, NY - Site monitoring and ground water sampling.

SCM Corp., Cortlandville, NY - Natural gamma ray logging, collection of ground water samples, computer modeling and mapping.

U.S. Fish & Wildlife Service, Crab Orchard National Wildlife Preserve, Marion IL - Designed and installed monitoring wells, conducted and analyzed in situ permeability tests.

IBM Corporation, Owego, NY - Ground water sampling, data acquisition, site monitoring, computer mapping of geotechnical data and ground water elevation data.

IBM Corporation, Erie, PA - Monitoring well design and installation, soil and ground water sampling.

Prestolite Corporation, Syracuse, NY - Monitoring well design and installation, soil and ground water sampling.

TRW, Casey, IL - Soil borings and sampling.

General Motors Corporation, Syracuse, NY - Soil borings and sampling at two sites (Meadowbrook and Ley Creek).

Jarl Extrusions, Penfield, NY - Soil sampling.

Gunlocke Co., Wayland, NY - Electromagnetic and resistivity geophysical surveys, monitoring well design and installation, gamma ray logging, ground water sampling and computer mapping.

Brookhurst Development, Casper, WY - Ground water sampling.

OIL AND GAS RESOURCE EVALUATION:

Syracuse University, Syracuse, NY - Research Assistant in project designed to digitize and computer process geophysical well logs. Teaching Assistant in Stratigraphy, Numerical Methods in Geology, and Computer Applications in Petroleum Geology. Masters Thesis in the analysis and evaluation of computer processed geophysical well logs applied on a regional basis. Organized and updated New York State Tops and Production file.

Urban-Snow Gas Development Co. - Well-site geologist on three deep gas wells drilled in Cato, NY.

Applied Information Resources, Inc. - Acquired and analyzed seismic refraction data and constructed and helped build gas production data base for New York State.

PUBLICATIONS

Bussey, D.T., 1985, **Natural Gas Reservoirs in Northern New York State.** Appalachian Basin Industrial Associates program, v.8, p. 231-248.

Brower, J.C. and Bussey, D.T., 1985, **A Comparison of Five Quantitative Techniques for Biostratigraphy**. in Quantitative Stratigraphy, p. 279-306. Paris, UNESCO.

Bussey, D.T., in preparation, **A Computer Assisted Evaluation of Natural Gas Reservoirs in North-Central New York State**. Masters Thesis, Department of Geology, Syracuse University, Syracuse, NY.

ATTACHMENT B

ANALYTICAL SERVICES QUALITY ASSURANCE/QUALITY CONTROL

DESCRIPTION OF POLICY AND PROGRAMS

Laboratory Quality Management Plan

Analytical Services

TABLE OF CONTENTS

I. O'BRIEN AND GERE LABORATORY

Introduction

For several years the O'Brien and Gere laboratory has been involved in the physico-chemical and microbiological analyses of environmental contaminants for federal, state, municipal and industrial clients. The laboratory has analyzed over 10,000 samples for over 100,000 parameters on an annual basis. The organic and inorganic pollutants occur in several matrices, i.e., potable water, industrial and domestic wastewater, hazardous waste, sludges, sediment, biological tissue, solid, air, etc. The ability to accurately characterize the chemical pollutants in these matrices is paramount.

In this document concepts are presented to outline the laboratory program purpose, policies, organization and operations established to support physico-chemical analyses conducted under USEPA compliance. Implementation of this program will better insure the validity of the data acquisition, and, therefore, will provide a more reliable foundation on which to base decisions. The principles and procedures used are the result of considerations of the general operations and trends in the field of analytical chemistry, analytical instrumentation, statistical quality control techniques, and previous experiences in the laboratory programs conducted under USEPA, local and state government compliance.

Laboratory Policy

The management of O'Brien & Gere's Laboratory is firmly committed to the Quality Assurance/Quality Control (QA/QC) program depicted in this manual. The program has been implemented and is maintained to assure any data reported by the laboratory are of known and documented quality commensurate with their intended use. The technical personnel who contribute to all or any portion of the laboratory analyses follow the procedures delineated in this manual.

The QA/QC manual is an integral part of a generalized representation of our Good Laboratory Practice program. It is primarily intended to set control guidelines and direction for all the physico-chemical and microbiological measurements performed by the laboratory. The contents of this manual will be re-evaluated yearly by the QA/QC group leader, and if necessary, revisions will be made, and/or the QA/QC program expanded.

A supplementary laboratory manual dealing with specific technical areas has been written and is available to all laboratory personnel. The laboratory manual is reviewed and approved by the QA/QC, Trace Organics and Wet Chemistry group leaders and management prior to distribution to the laboratory staff.

Quality Control Program Objectives

The primary objective of the O'Brien & Gere Laboratory QA/QC program is to assure the precision and accuracy of all data generated by the laboratory personnel. That is, the data is of known and documented quality.

The QA/QC guidelines are implemented in support of the laboratory surveillance programs and analyses efforts. They reflect the best cost effective effort, and are used to assess, ensure and document that all data collected, stored, reported or used by the laboratory are scientifically valid, defensible and of known precision and accuracy.

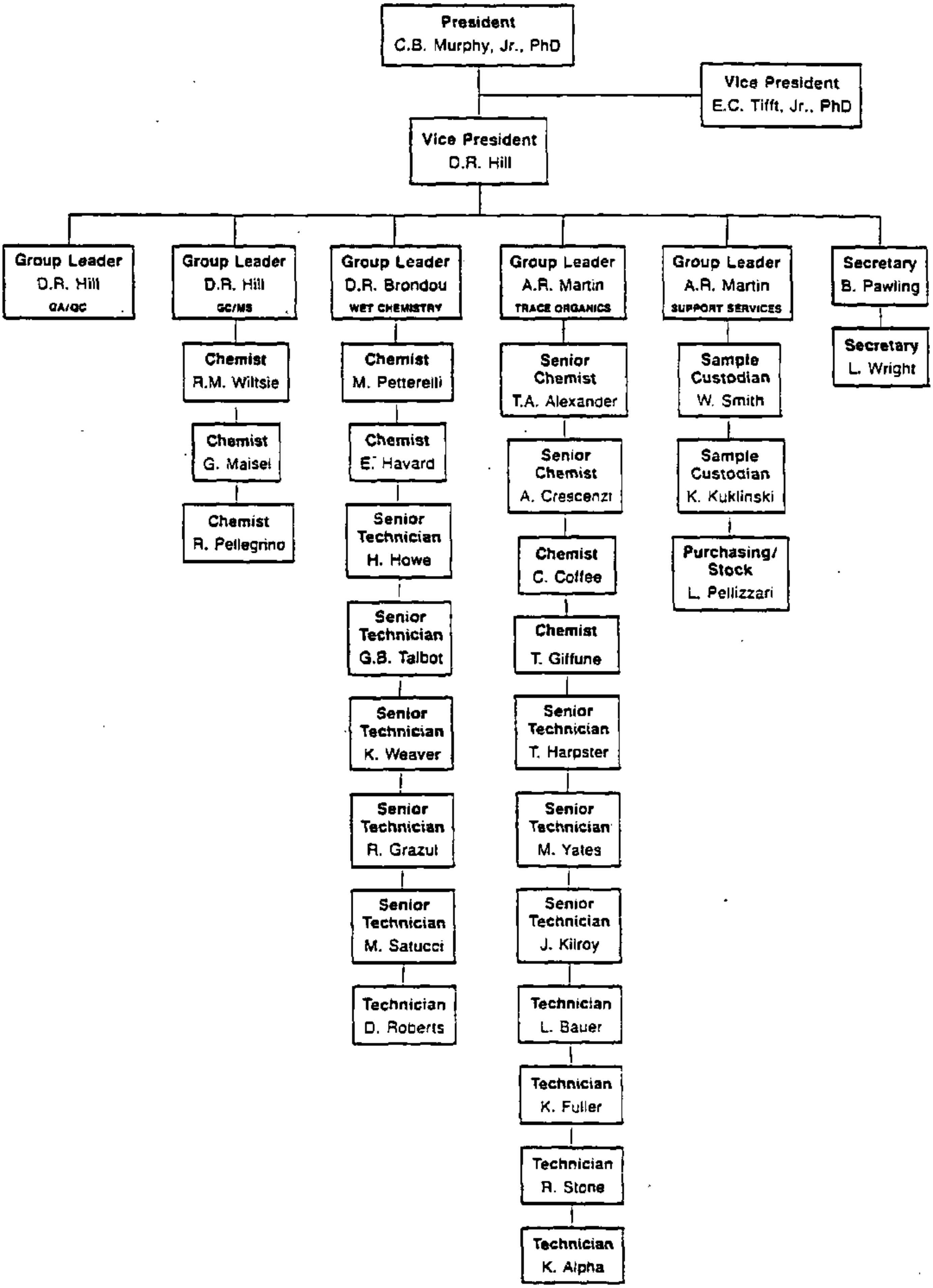
The major effort of the QA/QC program will be to develop a workable day-to-day "QA/QC model", and thus provide the detailed control charts and control limits to measure the laboratory daily performance. The QA/QC activities shall be carried out in accordance with EPA, state and local government mandates. The implementation, coordination and supervision of these procedures will provide the customer with the quality assurance (QA) activities associated with good laboratory practices.

Personnel and Organization

Any organization consists of a number of people whose skills and delegated responsibilities assure the quality of the ultimate product, i.e. analytical services. QA/QC procedures commence when the sample is first collected, and continues until the final product is in the client's hand. An organizational chart of the laboratory technical staff is included in Figure 1 to serve as a frame of reference for all QA/QC procedures.

The Laboratory Manager is responsible for the overall administration of the analytical operations at O'Brien & Gere. The section group leaders handle the day to day scheduling and operation, and report to the manager. Together with the group leaders they review

LABORATORY ORGANIZATION CHART



- **President** C.B. Murphy, Jr., PhD
  - **Vice President** E.C. Tifft, Jr., PhD
  - **Vice President** D.R. Hill
    - **Group Leader** D.R. Hill QA/QC
    - **Group Leader** D.R. Hill GC/MS
      - **Chemist** R.M. Wiltsie
      - **Chemist** G. Maisel
      - **Chemist** R. Pellegrino
    - **Group Leader** D.R. Brondou WET CHEMISTRY
      - **Chemist** M. Petterelli
      - **Chemist** E. Havard
      - **Senior Technician** H. Howe
      - **Senior Technician** G.B. Talbot
      - **Senior Technician** K. Weaver
      - **Senior Technician** R. Grazul
      - **Senior Technician** M. Satucci
      - **Technician** D. Roberts
    - **Group Leader** A.R. Martin TRACE ORGANICS
      - **Senior Chemist** T.A. Alexander
      - **Senior Chemist** A. Crescenzi
      - **Chemist** C. Coffee
      - **Chemist** T. Giffune
      - **Senior Technician** T. Harpster
      - **Senior Technician** M. Yates
      - **Senior Technician** J. Kilroy
      - **Technician** L. Bauer
      - **Technician** K. Fuller
      - **Technician** R. Stone
      - **Technician** K. Alpha
    - **Group Leader** A.R. Martin SUPPORT SERVICES
      - **Sample Custodian** W. Smith
      - **Sample Custodian** K. Kuklinski
      - **Purchasing/ Stock** L. Pellizzari
    - **Secretary** B. Pawling
      - **Secretary** L. Wright

and approve all policies concerning their specific areas of responsibility.

The QA/QC group leader is responsible for the implementation, monitoring and supervision of the QA/QC program. He assures that the program is conducted in strict adherence to procedures and requirements outlined in this manual. He reports to the Laboratory Manager, and interacts daily with other group leaders and laboratory staff. His duties include:

1. Develops and implements new QA/QC programs, including statistical techniques and procedures.
2. Conducts regular inspections and audits of analytical procedures.
3. Daily monitors accuracy and precision and implements correction measures if "out of control".
4. Maintains copies of all procedures routinely used in the laboratory measurements.
5. Informs management of the status of the QA/QC program by annual status reports.
6. Coordinates and conducts investigations of any customer complaints regarding quality.
7. Reschedule any analysis based on poor accuracy or precision data.

The section group leaders are responsible for the day to day operation and technical questions concerning analytical protocol and together with the QA/QC group leader:

1. Maintain and increase the technical skills of the laboratory technical personnel to achieve optimum quality results.

2. Approve analytical methods, sampling procedures, special QA/QC procedures, and any subsequent revisions in analytical procedures used in their respective areas.
3. Approve completed work.

Technical Training

All personnel involved in any function affecting data quality (sample collection, analysis, data reduction, and quality assurance) have sufficient technical training (in their appointed positions) to contribute to the reporting of complete and high quality data. The training is achieved through: a) On-the-job training, b) Short-term courses (one week or less), and c) Long-term courses (one semester or longer).

Short and long term courses are available through universities, colleges, and technical schools in statistics, analytical chemistry, and other disciplines. In addition, short-term courses are provided by commercial training organizations, manufacturers of equipment and others.

The trainee and/or analyst performance is evaluated by providing unknown samples for analysis. An unknown, as defined here, is a sample whose concentration is known to the QA/QC group leader or other group leaders but is unknown to the trainee or analyst. Proficiency is judged in terms of accuracy.

II. GENERAL FACILITIES AND EQUIPMENT

The laboratory is located in the corporate headquarters of O'Brien & Gere in Syracuse. The laboratory maintains a staff of sixteen chemists, biologists and technicians. As many as ten temporary and part-time personnel have been used to meet peak demands. The staff maintains a constant awareness of state-of-the art techniques in environmental analysis through its review of literature. The laboratory has 3700 square feet to utilize for the preparation and analysis of samples and 1200 square feet for receiving and storage of reagents.

The laboratory's involvement in a variety of programs has provided the necessary experience in microbiological, inorganic contaminants and trace organic identification and quantification. Particular expertise has been developed in the area of hazardous waste identification and trace organics analysis including priority pollutants and PCB's. A brief description of available instrumentation, computer services, sample storage and receiving follows.

Laboratory Instrumentation

The following analytical instrumentation is located in the Syracuse office and has been used on a number of major analytical programs:

(a) Hewlett Packard 5993B Gas Chromatograph/Mass Spectrometer Data System - for the low level identification of organic priority pollutants and other compounds. The unit is equipped with a dual disc, 32K computer and 9-track magnetic tape.

(b) Hewlett Packard 5880A - Gas Chromatograph equipped with dual electron capture detectors. The fully automated system has capabilities for both packed and capillary column work. The system can operate unattended around the clock to provide rapid turnaround of results.

(c) Tracor Model MT220 gas chromatograph equipped with electron capture and dual flame ionization. The unit is interfaced to a Hewlett Packard Model 3380 S integrator.

(d) Two Tracor Model 550 gas chromatographs, both equipped with Hall electrolytic conductivity detectors, linearized electron capture detectors, and photoionization detectors interfaced to Hewlett Packard Model 3390 integrators.

(e) Due to the highly specialized procedures for cleaning glassware used in the low level analysis of halogenated organics and other substances, a sonic cleaner is utilized. Additionally, a complete glassware supply including Soxhlet extractors, separatory funnels, flasks and chromatographic columns is maintained.

(f) Two Technicon AutoAnalyzers, single and dual channel, for the automated determination of nutrients and other inorganic parameters.

(g) Perkin-Elmer Model 290B Atomic Absorption Spectrophotometer for the determination of metals by flame techniques.

(h) Varian Model 575 Atomic Absorption Spectrophotometer for the low-level detection of metals by conventional flame and graphite furnace (flameless) techniques.

(i) Beckman Model 915 Total Organic Carbon Analyzer, for the determination of organic, inorganic or total carbon.

(j) Dohrman Model DX-20 Total Organic Halide Analyzer, and Model MCTS 20/30 Elemental Analyzer for the determination of chlorine and sulfur in environmental samples.

(k) Bausch & Lomb Model 340 colorimeter, used for those colorimetric procedures not performed on the AutoAnalyzers.

(l) DuPont Model 760 Luminescence Biometer for the determination of adenosine triphosphate (ATP).

(m) Orion Model 4 Specific Ion Meter.

(n) Mettler Model HE10 Electronic Semi-Micro Balance.

(o) Hiack Particle Counter for the determination of particle sizes in water ranging from 0.5m to 300m.

(p) A walk-in refrigerator for storage of samples prior to analysis.

The laboratory also maintains a wide range of the usual supporting equipment such as pH meters, analytical balances, ovens and incubators, refrigerators and hood space.

Computer Services

The hardware which serves as the foundation of the firm's computer facilities has been responsible for the ability of the O'Brien & Gere laboratory to store and retrieve all data for individual clients.

The quantity of data has led to the development and utilization of a computer-based data management system. Samples are logged in, analyses are scheduled and output is received, all via time-shared or batch computer programs. One of the benefits of this system is that turnaround time has been reduced to a practical minimum. Data can be reported in a variety of formats. The standard computer output includes sample identification and various test results. A variety of statistical and modeling programs are available for the evaluation and interpretation of data.

III. GENERAL CONSIDERATIONS

Maintenance

A preventative maintenance schedule on all instruments, balances, and equipment requiring maintenance is followed. All maintenance, whether performed by the laboratory or other professional sources, is documented in appropriate log books. Entries are made each time maintenance is performed and include the reason for maintenance, what was performed, by whom, and the dates and initials of the analyst in charge during the maintenance.

Calibration

Thermometers needed for critical temperature determination and control are calibrated against an NBS thermometer on site once a year. Analytical balances are professionally calibrated and cleaned once a year and checked with Class S weights daily by analysts who routinely use the balances. Calibration data are entered into a specific calibration notebook, which is kept with the equipment being calibrated. When the balances are professionally calibrated, a document stating the specific balance (model and serial number), its location, and the data calibrated is provided by the company or individual providing such service.

Reagent Quality

The quality of reagents and instrument readings are maintained by the following procedures:

(a) Reagents for quantitative purposes are ACS analytical quality grade or better.

(b) Each sample is collected in a new container to minimize contamination. This rule does not apply to bacteriological samples for which sterilized glass bottles are used, or trace organic samples for which solvent rinsed glass bottles are used.

(c) Distilled deionized water with a conductivity not more than 1.5 micromho/cm is used in the preparation of all reagents and for final rinses. The conductivity is measured daily and recorded in the quality control log. The pH is also checked daily and the values recorded.

(d) All volumetric glassware is National Bureau of Standards Class A grade or better.

(e) All glassware is cleaned and rinsed with distilled water and visually inspected before use. Any volumetric glassware found to be etched or cracked is discarded.

(f) The operating temperatures of all ovens, incubators, water baths and refrigerators are recorded daily in the quality control log.

(g) All reagents are discarded after a set interval which has been established and recorded in the Laboratory Handbook.

(h) The date a prepared reagent is made is entered into the Reagent Log and initialed by the preparer. Therefore, the results which have been affected by a contaminated or otherwise improper reagent can be easily determined. These results are either recalculated or discarded and the analysis may be repeated if possible. Reagent containers are also dated when new solutions are prepared and are initialed. These procedures are followed for all (even daily) preparations.

(i) The pH meter is checked with three buffers (4.0, 7.0 and 10.0) and the results are recorded in the quality control log.

Safety

A safety manual is issued to all laboratory personnel and describes safety policies, procedures and guidelines. Although laboratory workers are trained to be cautious in handling toxic or dangerous materials, they have confidence in the safety features built into their working area, thus enhancing the reliability of their performance.

Audits and Inspections

The Quality Assurance program is audited weekly for overall adherence to the guidelines and procedures outlined in this manual. The QA/QC group leader is responsible for scheduling and ensuring that each audit occurs.

Monthly meetings are scheduled between the QA/QC group leader and manager of Analytical Services to thoroughly discuss the program. Any corrective action required is monitored and ensured by the QA/QC group leader.

IV SAMPLE COLLECTION AND TRACKING

Valid representative samples of environmental matrices are collected through well defined sampling protocols. The sampling may be performed by the laboratory sampling team, or the customer who then assumes responsibility for properly obtaining, handling, preserving and shipping the sample.

Sample Collection and Handling

A well defined sampling protocol must ensure that:

- a. sampling team members are competent and qualified
- b. proper sampling methods are used
- c. equipment is accurately calibrated
- d. all samples are properly handled to prevent contamination
- e. samples analyzed are actually the samples collected under reported conditions.

For these reasons, samples are kept in secure places from time of collection until they are analyzed. It is the joint responsibility of the group leader and sampling team leader to ensure that approved methods are used, and it is the responsibility of each sampling technician to assure that the equipment is accurately calibrated.

Chain of Custody

The laboratory sampling protocol generally follows a chain of custody procedure. The procedure creates an accurate, written, legally defensible document that can be used to trace possession of sample from its collection through analysis and final disposal.

The basic elements in the chain-of-custody phase of our QA/QC program are:

1. Sample collection and handling
2. Sample analysis
3. Preparation and filing of test report

These measures are documented by the chain of custody form (Figure 2) signed by all handlers of the sample(s). As defined here, a sample is "in custody" if it is:

a. in actual physical possession, or
b. in view after being in physical possession, or
c. in a locked repository, or
d. in a secure, restricted area.

Analysis, Preparation and Filing of Test Report

A critical concern of QA/QC program is the maintenance of sample and data base integrity and the timely preparation of data reports. The data management program allows for the identification of samples and the maintenance of the discrete character of the data generated by each respective sample. This system is a unique advantage over manual methods and has permitted the laboratory to successfully tabulate data involving high numbers of samples and multiple analyses. The system may be divided into the following phases:

1. sample identification -- as each sample enters the laboratory, it is assigned a unique access number found on a sample identification ticket. This identifier permits the discrete organization of all information and data relating to that sample, whether for analytical

FIGURE 2

CHAIN OF CUSTODY RECORD

SURVEY	SAMPLERS: (Signature)

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE			SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED
				Water		Air			
				Comp.	Grab.				

Relinquished by: (Signature)		Received by: (Signature)	Date/Time
Relinquished by: (Signature)		Received by: (Signature)	Date/Time
Relinquished by: (Signature)		Received by: (Signature)	Date/Time
Relinquished by: (Signature)		Received by Mobile Laboratory for field analysis: (Signature)	Date/Time
Dispatched by: (Signature)	Date/Time	Received for Laboratory by:	Date/Time
Method of Shipment:			

identification purposes, reference in paper-copy records and correspondence, or computer storage and recall.

2. data organization -- in a preliminary planning phase of any analytical investigation involving the laboratory, a computer codification format can be established which can serve as the basis for storage and retrieval of data. This format is characterized by the categorization of samples, with any type of identification permissible for the classification. The categories may be based on any similarities (or dissimilarities) in the total volume of samples.

The storage and retrieval of quality control sample data is also managed with the laboratory's computer-based data management system. Samples are tagged and data is input, stored and retrieved as with any routine project samples. This has been made possible by the use of a unique quality control project number by which such data may be identified.

V. METHODS AND PROCEDURES

The laboratory analyzes a variety of matrices for a number of different environmental constituents of concern. Therefore, several documents are referenced which include the procedures employed. The following list itemizes the most widely used documents:

1. Standard Methods for the Examination of Water and Wastewater.
2. Methods for Chemical Analysis of Water and Wastewater.
3. ASTM Annual Book of Standards.
4. Code of Federal Regulations.
5. NIOSH Manual of Analytical Methods.
6. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods.

When analyzing samples by the above standardized methods, the accuracy or precision of the data generated by the laboratory is determined through analysis of replicates, spiked samples, synthetic reference standard samples, and/or field or laboratory blanks along with each set of samples. Any interferences are identified and documented.

In general, the methods accuracy is determining by spiking the sample matrix with the analyte at a minimum of three concentration levels. The range of the spiking levels is selected to bracket the concentration of interest. Percent recoveries of the spikes are calculated and are compared with synthetic standards. The methods precision is determined by analyzing a minimum of three replicates at each spiking level. The precision is evaluated by calculating the standard derivation.

The data generated is, whenever possible, input into the laboratory base data management system. Analyst's work sheets are filed for one year as a temporary record. When approved and signed, data reports and pertinent information are reported to the customer.

VI. INTRALABORATORY QA/QC PROGRAM

A quality control program is a systematic attempt to assure the precision and accuracy of analyses by detecting and preventing recurrency of errors, or measuring the degree of error inherent in the proven methods used. By identifying the sources of errors confidence in the precision and accuracy of analytical results can be established and improvements in the analytical methods made. To ensure the precision and accuracy of a result our quality control program requires the measurement and analysis of spiked samples, duplicate samples, synthetic standards and blanks.

Duplicate samples are used to provide assurance that the procedure is under control and to determine the statistical limit of uncertainty (i.e., precisions). Synthetic standards and spiked samples are used to determine the quantification of the laboratory accuracy.

In general, our quality control program incorporates the concepts of: a) calibration to attain accuracy, b) replication to establish precision limits, and c) correlation of quantitatively related tests (synthetic standards and spikes) to confirm accuracy.

The overall effectiveness of the program is dependent upon the evaluation of: a) equipment and instruments, b) current state of the art, c) precision of the analytical method itself, d) expected ranges of analytical results, e) control charts to determine trends as well as gross errors, f) data sheets and laboratory procedures adopted for control of sample integrity, g) quality control results on a daily as well as on varying time frames.

Definitions of Basic Terms

Before we discuss the standard operating practice for the QA/QC program some definitions are in order. These are:

1. Reagent Blank - The reagent (or method) blank is an aliquot of pure, organic free water (or organic reagents) used in the analysis of samples. It is generated by passing the clean matrices through the entire analytical procedure (including all glassware and other materials that come into contact with the sample). These blanks are analyzed along with the samples to verify that: a) qualitatively, no false positives occur, and b) quantitatively, concentrations are accurate and do not reflect contamination.

2. Field Blanks - These are water blanks sent from the laboratory to the sampling site and are returned to be analyzed in the same manner as the samples. If the samples are to be analyzed for purgeable organics, the analysis of field blanks provide a check on possible contamination of the samples by permeation of volatiles through the septum seal. If positive interferences occur the analytical results are rejected unless sufficient data can be obtained from these blanks to allow correction of results.

3. Duplicates - Duplicates are the result of splitting a field sample into equal amounts and are treated throughout as two unique samples. The results of duplicate (or replicate) analyses provide information on the overall precision of the analytical methodology. Quantitative results are obtained by calculating the relative percent difference (RPD) for each analyte in the sample matrix.

4. Spike - Spikes are the result of the addition of a known amount of analyte to a sample or a blank. The analytical results yield

a quantitative measure of accuracy (spiked blanks) or percent recovery (spiked samples). The measured accuracy reflects the best result which can be expected, whereas the percent recovery reflects matrix effects upon the analytical method accuracy.

Because several different environmental matrices are analyzed (e.g., potable water, effluent and influent waters, process wastes, sludges, etc.), two spiking levels are necessary when analyzing different samples. Relatively clean samples are spiked at detection limit and 10 times the detection limit for each component. Highly polluted samples are spiked at 100 times the detection limit for each component. Ideally, the spike should be 50 - 100% of the original concentration of each analyte in the sample matrix. If the added spike is less than 10% of the sample result, the data are questionable and statistically unacceptable.

5. Surrogate Spike - These are the result of the addition of known amounts of standards to every sample prior to the analysis. The standards are chemically similar to the compounds in the fraction being analyzed. In addition, some standards added have compounds which are not likely to be found in environmental samples. The analyses of surrogate spikes provide quality control on every sample by constantly monitoring unusual matrix effects, gross sample processing errors, etc. These spikes are not used as internal standards for quantitation.

6. Reference Standard (reference audits) - These are the analysis of independently prepared standard solutions or synthetic standards. Two types of standards are used, i.e., a) internal reference standard solutions (synthetic standards prepared in-house), and b) external

reference standard solutions obtained from outside sources (i.e., primarily EPA).

The external audits samples are used for monitoring the complete analytical method. These samples are introduced at the onset of the procedure (typically extractions) and carried through the entire analysis.

The internal standard audits are used to verify the "accuracy" of quantitative instrument calibration. All standard solutions are prepared by the QA/QC group leader and are submitted blind for analyses. The analyst analyzes the solutions as discrete samples and a percent recovery or percent error is calculated. Errors greater than 5% are carefully investigated and differences resolved through proper action.

Guidelines for Evaluating the QA/QC Program

This section defines the QA/QC program for the analysis of environmental pollutants, i.e., the analysis of trace organics by gas chromatographic (GC) and GC/MS techniques, and analysis of inorganic pollutants by wet techniques and atomic absorption (AA), etc. The QC program for the analysis of trace organics by GC and GC/MS is different due to the unique nature of the analytical problems addressed by the GC/MS methodology. Therefore, the QC requirements for these two techniques will be addressed separately. A description of the QC program follows.

1. Gas Chromatography

In general, when GC methodologies are used the specific analyte or class of analyte is known. As a result a more specific, less generalized QC program can be defined. For example, accuracy data can be collected prior to analysis of actual samples, and often previous QC data for a particular analyses is available.

The QC program outlined below depicts the procedures used to determine the quality of the data generated in the trace organics analyses. The steps monitored include extractions, concentration, qualitative and quantitative analyses and confirmation.

a) Method Verification

The methods are validated before they are used in routine analysis of samples. Method validation includes analysis of reagent blanks, blanks spiked with compound(s) of interest, analytical standards and standard mixtures. The results from these analysis approximate the best data to be expected from the method.

The extraction and concentration steps are validated by spiking a minimum of 2 blank samples with the same matrix as the sample of interest. The concentration of the analyte used for the spiking is 10 times the detection limit. The accuracy (or percent recovery) of the method is calculated by:

$$\text{ACCURACY} = \frac{\text{(spiked sample result)}}{\text{spike added}} \times 100$$

and is recorded on transcription sheets and is assigned a unique QC number. The data is then logged and stored in the computer.

b) Instrument Calibration and Performance

To insure good analytical data the analytical instruments are calibrated prior to sample analysis by analyzing three standards of analyte which span the suspected concentration range of the analyte in the sample. The performance of the instruments are checked by analyzing a standard mixture. If the retention time or area counts vary more than 10% from previous calibration the standard mix is reanalyzed. If the deviation is still more than 10%, a new standard mix is analyzed. If the new standard mix still yields greater than 10% deviation, instrument malfunction is suspected and proper action is taken to resolve the problem.

Routine Analysis

The quality of the analytical data generated during routine analyses is monitored by the following:

1) Contamination from reagents and glassware is identified by analyzing a reagent blank. One reagent blank is prepared for every 20 or fewer samples analyzed (or when a new lot of reagent is used in the analysis).

2) The analytical method accuracy is determined by spiking a known amount of analyte into a sample and blank. The percent recoveries are then calculated. The amount of analyte recovered from the blank indicates the best result which can be expected from the method. The amount of analyte recovered from a sample reflects matrix effects upon the accuracy of the method. Two spikes are prepared for every 20 or fewer samples analyzed.

3) The analytical method precision is determined by analyzing equal amounts of a split sample. Ideally, the analytical results will be identical; however, differences occur due to variations in the procedure. A quantitative measure of these differences is assessed by calculating the relative percent differences (RPD) for each analyte in the matrix and the results compared.

In general, one duplicate is analyzed for every 20 or fewer samples, and the performance of the analytical instrument verified. Whenever possible identification is confirmed by a second procedure.

GC and GC/MS Characterization of Trace Organics

The requirments for the characterization of trace organics analyses include: 1) the identification and quantitation of unknown pollutants, 2) the specific detection of selected groups of pollutants (i.e., Priority Pollutants by GC/MS), and 3) other analyses requiring GC/MS for identification, verification and/or quantitation. A summary of the required audits is given in Table I. The performance and calibration of the GC and GC/MS systems are monitored and maintained on a regular basis by the procedures and methods discussed below.

TABLE I. SUMMARY OF SAMPLE ANALYSIS AUDITS REQUIRED FOR THE CHARACTERIZATION AND QUANTITATION OF TRACE ORGANICS

AUDIT	AUDIT
Spike	Mass Spectrometer:
Reagent Blank	mass calibration
Duplicate Sample Analysis	response calibration
Standard Mix	standards
Reference Standard	Computer Match
Standards and Calibration Curve	Reference Spectra Comparison
GC Retention Times	Completeness and Accuracy
GC Peak measurement calculation	

1. Calibration of GC/MS System

At the beginning of each day the GC/MS system is calibrated and tuned by examining the mass spectrum of decafluorotriphenylphosphine (DFTPP) or 4-bromofluorobenzene (BFB). The details are discussed below.

a. Base/Neutrals (and Acids or Pesticide) Fractions

The analysis of 50 nanograms of DFTPP is carried out daily by direct injection into the GC inlet. The resulting mass spectrum is then examined. The requirement is that the mass spectrum of 50 nanograms DFTPP must meet the specification of the key ions and ion abundance criteria listed in Table II.

b. Volatile (Purgeable) Fraction

The analysis of 20 nanograms of BFB is carried out by direct injection into the GC/MS. The requirement is that the mass spectrum of 20 nanograms BFB must meet the prescribed specifications of the key ions and ion abundance criteria listed in Table II.

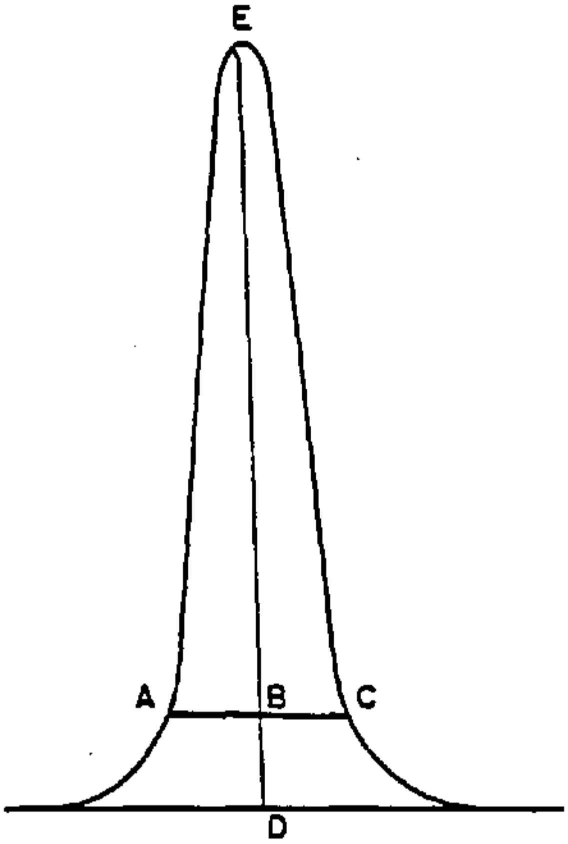
2. GC Column Performance Check

The GC columns performance are checked at the beginning of each day that samples are analyzed. For base/neutrals and acid fractions the columns performance are monitored by injecting 100 nanograms (ng) of benzidine and pentachlorophenol, respectively. For purgeables the column is checked by injecting 20 ng of BFB. Performance acceptance is based on calculations of tailing factors (see Table III).

TABLE II. KEY IONS AND ION ABUNDANCE CRITERIA FOR DFTPP AND BFB

DFTPP		BFB	
MASS	ION ABUNDANCE CRITERIA	MASS	ION ABUNDANCE CRITERIA
51	30-60% of mass 198	50	20-40% of mass 95
68	less than 2% of mass 69	75	50-70% of mass 95
70	less than 2% of mass 69	95	base peak, 100% relative abundance
127	40-60% of mass 198	96	5-9% of mass 95
197	less than 1% of mass 198	173	less than 1% of mass 95
198	base peak, 100% relative abundance	174	70-90% of mass 95
199	5-9% of mass 198	175	5-9% of mass 95
275	10-30% of mass 198	176	70-90% of mass 95
365	greater than 1% of mass 198	177	5-9% of mass 95
441	less than mass 443		
442	greater than 40% of mass 198		
443	17-23% of mass 442		

TABLE III EXAMPLE CALCULATION OF TAILING FACTOR



TAILING FACTOR = (BC/AB)

Example calculation:
Peak Height = DE = 100 mm
10% Peak Height = BD = 10 mm
Peak Width at 10% Peak Height = AC = 23 mm
AB = 11 mm
BC = 12 mm
Therefore: Tailing Factor = (12/11) = 1.1

Wet Chemistry and Bacteriology

The quality of the analytical data generated from inorganic and microbiological analyses of environmental contaminants are monitored as follows:

1. Wet Chemical Instrumental Methods

The atomic absorption (AA) spectrophotometer and AutoAnalyzer are calibrated using appropriate calibrating standards and blanks. The calibrations are checked by analyzing synthetic standards at five different concentration levels. The results are used to generate standard curves by least squares fit of the data via computer programs. The deviation of the standards from the least squares fit (standard curves) and the standard deviation of the fit are printed on the daily printout and the data stored accordingly in appropriate computer data bases. If deviation from accepted values occur analyses of sample and instrumental calibrations are repeated. Standard curves are generated regularly.

For colorimetric analyses that do not use the standard curve program, one or more standards are analyzed with each group of samples. The results are compared to generally accepted criteria, i.e., percent recovery (or percent error) and relative percent error.

Spectrophotometric instruments are checked by comparing the gain settings or percent transmittance for known (synthetic) standards to previous values. This monitoring method shows any decrease in sensitivity or other systematic effects in performance.

The conductivity meter is checked each time a group of samples is analyzed. The conductance of a standard solution is entered in the quality control log. In addition, the cell constant is checked annually by measuring the electrical conductivity of potassium chloride reference solution. The results are also entered in the quality control log book.

2. Bacteriology Techniques

Quality control extends to all aspects of the bacteriological laboratory. The date of preparation of media and the various solutions used in analysis are recorded in the quality control log together with any information which may be important to its preparation such as pH, lot or control number, manufacturer and concentration. In addition, random samples of prepared media are incubated under the same conditions as unknown samples to insure the maintenance of sterility during preparation and use.

The efficiency of autoclave sterility is monitored by the monthly use of Kilit ampules (BBL), a suspension of Bacillus stearothermophilus spores. The sterility of rinse water is checked periodically by the filtration and incubation of a reagent blank (sterile rinse water).

As part of the overall quality control program, the bacteriological quality of the distilled deionized water supply of the laboratory is monitored weekly. Samples for the standard plate count are taken from the water system prior to entry to the deionization cartridge (following distillation), after deionization and from the storage tank. The results are recorded in the quality control log. Additionally, the Suitability Test as described in Standard Methods is performed on a yearly basis by an outside laboratory qualified to undertake this testing. Bacteriological samples are included in the duplicate analyses program described in the chemical section.

Humidity checks are performed monthly on Standard Plate Count petri dishes to determine percent moisture loss upon incubation.

VII. INTERLABORATORY QUALITY CONTROL

To indicate how well our laboratory is performing by comparison with other laboratories performing similar work, O'Brien & Gere Laboratory participates in a variety of proficiency and roundrobin tests. Successful performance in the proficiency analyses of samples results in the laboratory certification.

Certification

The U.S. Environmental Protection Agency certifies state laboratories to conduct their own intrastate program of certification for the proficiency of private laboratories in potable water analysis. The EPA only certifies private laboratories directly in those states which have not assumed primacy. In New York State, the certifying agency is the NYS Department of Health. The firm's laboratory was one of the first participants in the New York State program and has been certified for chemical, atomic absorption, bacteriologgical and gas chromatographic analysis of potable water since 1974. Laboratory certification has been extended to the State of Massachusetts and interm states in the State of New Jersey for potable water and wastewater testing requirements.

In addition, the laboratory participates in the round robin analyses of reference samples supplied by the EPA and in the analysis of commercially available reference samples.

VIII. DEFINITIONS OF STATISTICAL TERMS

The following statistical term definitions are used to identify statistical reports and evaluations:

a. Accuracy and Precision - Accuracy is a measure of the nearness of an analytical result, or a set of results, to the true value. It is usually expressed in terms of error, bias, or percent recovery (PR).

Normally the term "accuracy" is used synonymously with "percent recovery". It describes either the recovery of a synthetic standard of known value, or the recovery of known amount of analyte (spike) added to a sample of known value. The percent recovery (PR) or "accuracy" can be calculated by using:

1. standards: $\text{PR} = (\text{observed value}/\text{true value}) \times 100$

2. spikes: $\text{PR} = \dfrac{(\text{conc. spike} + \text{sample}) - \text{sample}}{\text{conc. spike}} \times 100$

Precision refers to the agreement or reproducibility of a set of replicate results among themselves without assumption of any prior information as to the true result. It is usually expressed in terms of the deviation, variance, or range. Good precision often is an indication of good accuracy, however, one can obtain good precision with poor accuracy if systematic (determinate) errors are present in the method or instrument used. Systematic errors are either positive or negative in sign. Other analytical errors are indeterminate (random) errors. These are inherent in the analytical methods due to uncertainties in measurements.

b. Average - The average or arithmetic mean ($\bar{X}$) of a set of n values (Xi) is calculated by summing the individual values and dividing by n:

$$\bar{X} = \left[\sum_{i=1}^{n} X_i\right] / n$$

c. Range - The range (R_i) is the difference between the highest and lowest value in a group. For n sets of duplicate values (X_2, X_1) the range (R_i) of the duplicates and the average range ($\bar{R}$) of the n sets are calculated by:

$$R_i = \left| X_2 - X_1 \right|$$

and

$$\bar{R} = \left[\sum_{i=1}^{n} R_i\right] / n$$

d. Standard Deviation and Variation - The standard deviation (S) of a sample of n results is the most widely used measure to described the dispersion of a data set. It is calculated by using the equation

$$S = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n-1}}$$

where $\bar{X}$ is the average of the n results and X_i is the value of result i. Normally, $\bar{X}$ ± S will include 68% and $\bar{X}$ ± 2S about 95% of the data in a normal distribution curve.

The variance is equal to S^2. The <u>relative standard deviation</u> (RSD) or <u>coefficient of variation</u> (CV) is the standard deviation divided by the mean and multiplied by 100, i.e.,

$$CV = 100S/\bar{X}$$

It is interesting to note that the precision is increased (value of S reduced) by increasing the number of duplicate analysis. The greater the number of replicate analysis, the greater the statistical confidence that the true mean lies within certain limits about the experimental mean.

e. <u>Standard Calibration Curves</u> - standard calibration curves are widely used in the analysis of inorganic pollutants. These curves are generated from the results of analyses of three or more standard solutions of known concentration and a blank. Typically, they are plots of the instrument response versus concentration. A plot is defined as linear, i.e., obeys the linear equation $Y=a + bX$, if the correlation coefficient (R) calculated from the linear regression analysis is 0.996 or greater.

The intercept (a), slope (b) and correlation coefficients (R_c) can be calculated from:

$$a = \frac{\Sigma X^2 \Sigma Y^2 - \Sigma X \Sigma Y}{n\Sigma X^2 - (\Sigma X)^2}$$

$$b = \frac{n\Sigma XY - \Sigma X \Sigma Y}{n\Sigma X^2 - (\Sigma X)^2}$$

$$R_c = \frac{\Sigma(X_i - \overline{X})^2 (Y_i - \overline{Y})^2}{\sqrt{\Sigma(X_i - \overline{X})^2 \, \Sigma(Y_i - \overline{Y})^2}}$$

We fit the analytical data to a linear regression analysis by using a computer program.

f. Absolute and Relative Errors - An absolute error is the difference between the experimental result and the true value. The relative error is the absolute error divided by the true value and multiplied by 100 to yield the percent relative error (PRE). When the true value is not known, the PRE is a measure of the difference (range) of a replicate analysis divided by the mean of the replicate value and multiplying by 100. That is, for duplicates

$$\mathrm{PRE} = \frac{100\,|X_2 - X_1|}{(X_2 + X_1)/2} = \frac{100\,|X_2 - X_1|}{\overline{X}_j}$$

g. Skewness and Kurtosis - Skewness and kurtosis are the numbers used to understand the shape of a given curve. Our groups are data bases of spikes, duplicates, and knowns. The data points in these groups should fall within a normal curve. Aberrations from the normal curve are detected in values of skewness and kurtosis.

Skewness defines the symmetry of a curve. A symmetrical curve must have a skewness of zero. Positive or negative values denote lack of symmetry. Kurtosis defines the peakedness of a curve. A normal distribution curve will have a kurtotic value of 3. Peaked curves will have values greater than three, and broad flat curves will have values less than 3. These values are monitored by the QA/QC group leader. When aberrant values are noted, the interpretation is usually related to very high or low QC values entering data bases or the persistence of patterns of consistently high or low QC values. It is the QA/QC coordinator's responsibility to research the causes of excessive values and patterns and, where possible, rectify the analytical conditions leading to them.

References

1) "Handbood for Anaylytical Quality Control in Water and Wastewater Laboratories," March, 1979 (EPA-600/4-79-019)

2) "Manual of Analytical Quality Control for Pesticides and Related Compounds in Human and Environmental Samples," January, 1979 (EPA-600/1-79-008)

IX. STATISTICAL QUALITY CONTROL AND THE "DAILY QC MODEL"

Random (indeterminate) and systematic (determinate) errors are inherent in all analytical methods due to uncertainties in measurements. The measurement of physico-chemical and microbiological properties of pollutants in various environmental matrices involve uncertainties which cannot be entirely eliminated. The errors in these measurements, however, can be reduced to tolerable limits by examining and controlling the significant variables.

Additional errors, often unrecognized, are introduced by interfering chemical reactions and other undesirable physico-chemical effects. In many instances absolute values cannot be attained directly.

Although uncertainties cannot be reduced to zero, they can be minimized by using available statistical methods. Estimates of the accuracy (probable "true value") and precision (range of measurement error) can be made for the various analytical methodologies by analyzing blanks, duplicates, spikes and synthetic standards. After sufficient QC data are collected various statistical methods are used to evaluate the quality of data by calculating control and warning limits. A discussion of the statistical methods used follows.

Control Charts

Control charts provide the necessary tool for detecting quality variations in the various analytical methodologies used for the quantitation of environmental pollutants. They are a continuous graphic indication of the state of an analytical procedure with respect to quality, and assist in deciding when and how to take corrective action. The QC charts are generated for each pollutant from the statistical evaluation of QC data. A minimum of 15 duplicates and spiked samples and/or synthetic standard analyses are required to generate a control chart.

The <u>control limits</u> (CL) on QC charts are paramount criteria for assessing the significance of variations in the analytical results. For instance, when the plotted QC indicators (i.e., percent recoveries, relative percent error, etc.) fall within these limits, the analytical methodologies used are under "control". If, however, a QC indicator value falls outside the CL's, there is an indication that some assignable cause is present which has thrown the system "out of control". Thus, control limits can be considered warning or action limits. They enable us to detect deviations in analytical procedures, and therefore, take corrective action before producing erroneous results (or results which exceed the absolute maximum tolerable limits).

Common practice set warning limits (WL) at ± 2 standard (S) deviations (95% confidence level of the normal distribution curve) and control limits (CL) at ±3S limits (99.7% confidence level of the normal distribution curve) on each side of the mean. The CL and WL are calculated from the QC data of duplicates analyses by using the equations and statistical factors listed in Table IV. These CL's and WL's include approximately the entire data set under "in control" conditions, and are equivalent to the commonly used ± 3S and ± 2S limits, respectively. The qualitative relationship between upper and lower control limits, upper and lower warning limits, and the mean is shown in Figure 3.

TABLE IV STATISTICAL FACTORS AND EQUATIONS FOR CALCULATING QC (X BAR AND R) CHART LINES[1]

Observations in Subgroup (n)	Factor			
	A_2	d_2	D_3	D_4
2	1.88	1.13	0	3.27
3	1.02	1.69	0	2.58
4	0.73	2.06	0	2.28
5	0.58	2.33	0	2.12
6	0.48	2.53	0	2.00
7	0.42	2.70	0.08	1.92
8	0.37	2.85	0.14	1.86

Upper control limit for $\bar{X} = UCL_{\bar{X}} = <\bar{X}> + A_2\bar{R}$

Lower control limit for $\bar{X} = LCL_{\bar{X}} = <\bar{X}> - A_2\bar{R}$

Upper warning limit for $\bar{X} = UWL_{\bar{X}} = <\bar{X}> + (2/3)\ A_2\bar{R}$

Lower warning limit for $\bar{X} = LWL_{\bar{X}} = <\bar{X}> - (2/3)\ A_2\bar{R}$

Upper control limit for $R = UCL_R = D_4\bar{R}$

Lower control limit for $R = LCL_R = D_3\bar{R}$

Upper Warning Limit for $R = UWL_R = \bar{R} + (2/3)(D_4\ \bar{R} - \bar{R})$

$= \bar{R}\ (2\ D_4 + 1)/3$

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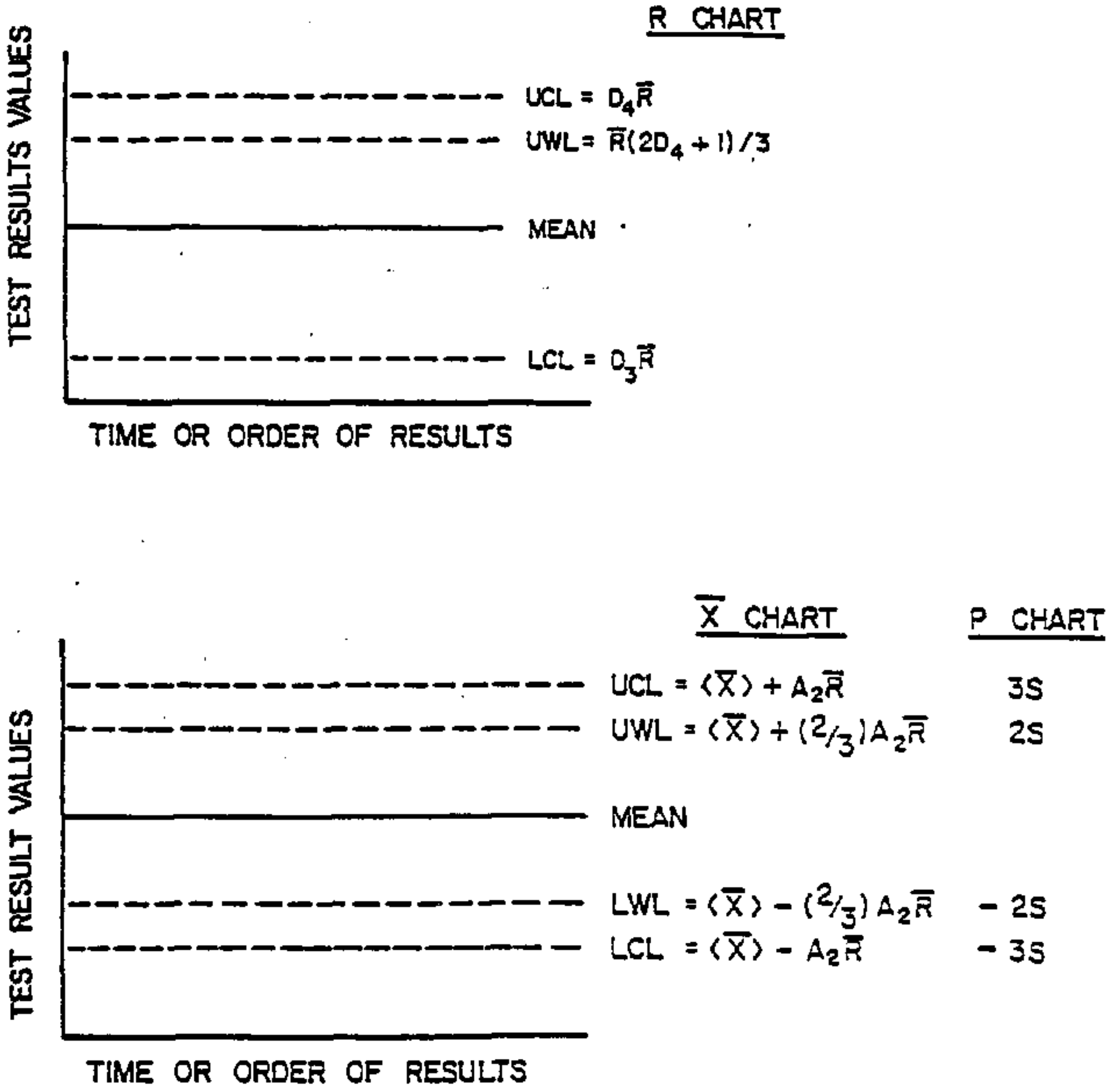
[1] Taken from (1) "Handbook for Analytical Quality Control in Water and Wastewater Laboratories", March, 1979 (EPA-600/4-79-019); and (2) C. Samson, P. Hart and C. Rubin, "Fundamentals of Statistical Quality Control", Addison-Wesley (Massachusetts, 1970), p. 40.

FIGURE 3

ESSENTIALS OF CONTROL CHARTS



Statistical Calculations

The statistical techniques used in generating the data for $\bar{X}$ and R QC charts involves complex mathematics. The short cut methods for calculating the $\bar{X}$ and R limits are based on the equations listed in Table IV. The statistical factors A_2, D_3, D_4, etc. have been calculated by statisticians such that the CL limits involve a maximum risk of making an error only 0.1% to 0.3%. Thus, when the QC charts indicate that the analytical system is "out of control" 997 times out of 1,000 it is likely that something has actually gone wrong and corrective actions are needed. The factors are calculated to yield 3S limits. Examples of QC data and the statistical techniques used to calculate precision and accuracy QC charts follow.

Precision QC Charts ($\bar{X}$ and R Charts)

These charts are developed by using a minimum of 15 to 25 QC data results on duplicate analyses. Once these data have been collected over an extended period of time the warning and controlling limits on the QC charts are calculated by using the equations and statistical coefficients listed in Table IV. The procedure used follows:

(1) For each duplicate sample analysis calculate the range ($R_i = | X_2 - X_1 |$) and the average ($\bar{X}j = (X_2 + X_1)/2$) of the concentration of the duplicate set.

(2) Calculate the relative percent range (R^1_j) defined as

$$R^1_j = PRE/100 = R_j/\bar{X}_j$$

where PRE is the relative error defined in Section VIII.

(3) Calculate the mean ($\bar{R}^1$) relative range by summing the R^1_j values and divide by the total number (n) of duplicate sets, e.g.,

$$\bar{R}' = \left[\sum_{j=1}^{n} R_j\right] / n$$

(4) Calculate the grand average $\langle \bar{X} \rangle$, i.e., the average of the average of n sets of duplicate averages $\bar{X}_j$ by using:

$$\langle \bar{X} \rangle = \left[\sum_{j=1}^{n} \bar{X}_j\right] / n$$

(5) Calculate the warning and control limits for R and $\bar{X}$ (see Table IV) by using:

<u>For R:</u>

$UCL = D_4 \bar{R}^1 = 3.27 \bar{R}^1$

$LCL = D_3 \bar{R}^1 = 0$

$UWL = \bar{R}^1 (2D_4 + 1)/3 = 2.51 \bar{R}^1$

<u>For $\bar{X}$:</u>

$UCL = \langle \bar{X} \rangle + A_2\bar{R} = \langle \bar{X} \rangle + 1.88 \bar{R}$

$LCL = \langle \bar{X} \rangle - A_2\bar{R} = \langle \bar{X} \rangle - 1.88 \bar{R}$

$UWL = \langle \bar{X} \rangle + (2/3) A_2\bar{R} = \langle \bar{X} \rangle + 1.25 \bar{R}$

$LWL = \langle \bar{X} \rangle - (2/3) A_2\bar{R} = \langle \bar{X} \rangle - 1.25 \bar{R}$

where for duplicates $D_3 = 0$, $D_4 = 3.27$, and $A_2 = 1.88$ (Table IV); UCL and LCL are the upper and lower control limits, respectively; and UWL and LWL are the upper and lower warning limits. The WL's and CL's correspond, respectively, to the 95% (2S) and 99.7% (3S) confidence limits of a normal distribution curve.

(6) Graph the $\bar{R}^1$, UCL, LCL and UWL on the QC charts with appropriate scales which allow additions of new results (Figure 3) and the individual (R^1_j) QC data results.

(7) Graph the $<\bar{X}>$, UCL, LCL, UWL, and LWL on the QC charts with appropriate scales which allow additions of new results and individual $(\bar{X}_j)$ QC data.

(8) If QC values are "out of control", i.e., lie outside the control limits, take appropriate corrective action.

Accuracy QC Charts (P Charts)

The P charts are the same as the $\bar{X}$ and R charts since their function is to enable us to detect changes in the laboratory daily performance of analyses and take corrective action. The P QC charts utilize the sigma (i.e., standard deviation, S) as a quantitative measure of the degree of variations in the analytical methodologies.

The accuracy of the laboratory analytical methodologies is monitored via the analysis of various spiked samples and/or audits of synthetic standards. Spiked samples are also analyzed vis a vis field samples and the percent recovery calculated. Once a minimum of 15 QC recovery data have been collected over a period of time the warning and controlling limits are calculated and P charts developed. The procedure used follows:

(1) For each spiked sample analyzed calculate the percent recovery (PR) using the equations given in Section VIII.

(2) Calculate the mean percent recovery $(\overline{PR})$ by summing the total number of PR's and divide by n (see Section VIII).

TABLE VII

SPIKED RECOVERIES DATA BASE
FOR GENERATING CONTROL CHARTS & STATISTICS

```
HG                DATABASE SIZE IS 25   NUMBER OF SAMPLES ARE 54

 FIELD  SAMPLE     VALUE
 ---------------------------
    1    64261   109.000
    2    64456   100,000
    3    64362   110.000
    4    64378   100.000
    5    64322   100.000
    6    66307   124.000
    7    81628   107.000
    8    19633    67.000
    9    82504   112.000
   10    83870    95.000
   11    81075    93.000
   12    90035   104.440
   13    91773   124.000
   14    94287   122.000
   15    95283    80.000
   16    92510    98.000
   17    97001    82.000
   18    97055   106.000
   19    97253   120.000
   20    97906    96.000
   21    98469    98.000
   22    98743   118.000
   23    99151   105.000
   24     2409   129.000
   25     2410   103.000
   26    28598    84.711
   27    28833   100.000
   28    38710    86.364
   29    39461    73.333
   30    39629    96.000
   31    39653    90.625
   32    21292    99.160
   33    21310   125.000
   34    21741    69.841
   35    22011    96.061
   36    88265    95.522
   37    22504   131.657
   38    22611    97.222
   39    14622    82.759
   40    26661   104.687
   41    38006    80.202
   42    30037   108.333
   43    30035   103.446
   44    35771    89.756
   45    30999    95.455
   46     5590   123.529
   47     7507    80.851
   48     7547    71.097
   49    17167   109.091
   50    17514    88.462
   51    17521    94.667
   52    17831   111.753
   53  [illegible]  [illegible]
```

```
BENZ              DATABASE SIZE IS 25   NUMBER OF SAMPLES ARE 45

 FIELD  SAMPLE     VALUE
 ---------------------------
    1    29830   109.677
    2    23250    87.000
    3    44382    99.000
    4     5593    97.500
    5    43077   100.000
    6     5718   120.000
    7     5716   100.000
    8     9646    94.500
    9     9651   103.000
   10     9665    92.000
   11    17041   104.065
   12    17362    89.000
   13    17356    95.500
   14    17410    83.333
   15    17411    90.244
   16    17585   105.000
   17    17586   105.000
   18    17608   105.000
   19    17767   100.000
   20    17774   102.000
   21    17857    77.419
   22    17875    87.948
   23    17930    99.500
   24    18104   102.000
   25    18107   105.000
   26    18125    88.599
   27    18170   105.000
   28    18234    80.645
   29    18236    84.691
   30    18293    93.000
   31    18366   105.000
   32    18464   105.000
   33    18472   105.000
   34    50627    91.667
   35    50648   100.000
   36    50789    91.667
   37    50824   108.333
   38    50869   100.000
   39    50867   100.000
   40    50942   100.000
   41    50943   105.000
   42    51035   105.000
   43    51049   100.000
   44    51051   105.000
   45    51077    91.667
```

[illegible]

FIELD	SAMPLE	RATIO
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	115.000
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]
10	[illegible]	92.000
11	[illegible]	120.000
12	[illegible]	[illegible]
13	[illegible]	[illegible]
14	[illegible]	[illegible]
15	[illegible]	114.000
16	[illegible]	[illegible]
17	[illegible]	104.000
18	[illegible]	111.000
19	[illegible]	[illegible]
20	[illegible]	[illegible]
21	[illegible]	[illegible]
22	[illegible]	[illegible]
23	[illegible]	[illegible]
24	[illegible]	[illegible]
25	[illegible]	[illegible]
26	[illegible]	[illegible]
27	[illegible]	[illegible]
28	[illegible]	[illegible]
29	[illegible]	[illegible]
30	[illegible]	[illegible]
31	[illegible]	[illegible]
32	[illegible]	[illegible]
33	[illegible]	[illegible]
34	[illegible]	[illegible]
35	[illegible]	[illegible]
36	[illegible]	[illegible]
37	[illegible]	[illegible]
38	[illegible]	[illegible]
39	[illegible]	[illegible]
40	[illegible]	[illegible]
41	[illegible]	[illegible]
42	[illegible]	[illegible]
43	[illegible]	[illegible]
44	[illegible]	[illegible]
45	[illegible]	[illegible]
46	[illegible]	[illegible]
47	[illegible]	[illegible]
48	[illegible]	[illegible]
49	[illegible]	[illegible]
50	[illegible]	[illegible]
51	[illegible]	[illegible]
52	[illegible]	[illegible]
53	[illegible]	105.000
54	20620	101.000
55	21009	99.000
56	20913	101.000
57	[illegible]	103.000
58	89675	104.000
59	89182	50.000
60	88913	105.000
61	87415	105.000
62	87401	101.000
63	89100	102.000
64	89672	99.000
65	94635	126.000
66	94674	131.000
67	41561	110.000
68	41567	126.000
69	88034	123.000
70	88082	111.000
71	95158	176.000
72	91563	120.000
73	94976	111.000
74	95412	111.000
75	95565	113.000
76	95456	120.000
77	95600	110.000
78	95627	112.000
79	95720	110.000
80	95830	95.000
81	95671	100.000
82	95956	114.000
83	[illegible]	103.000
84	95750	109.000
85	96231	103.000
86	[illegible]	85.000
87	[illegible]	[illegible]
88	[illegible]	104.000
89	[illegible]	94.000
90	[illegible]	111.000
91	[illegible]	[illegible]
92	[illegible]	[illegible]
93	[illegible]	[illegible]
94	[illegible]	[illegible]
95	[illegible]	[illegible]
96	[illegible]	[illegible]
97	[illegible]	[illegible]
98	[illegible]	[illegible]
99	[illegible]	[illegible]
100	[illegible]	[illegible]
101	[illegible]	[illegible]
102	[illegible]	[illegible]
103	[illegible]	[illegible]
104	[illegible]	[illegible]
105	[illegible]	[illegible]
106	[illegible]	121.000
107	51724	87.000
108	[illegible]	122.000
109	2412	[illegible]
110	2303	115.000
111	98800	113.000
112	2407	86.000
113	2412	86.000
114	2409	136.000
115	99339	114.600
116	28194	98.238
117	28277	80.600
118	28369	97.541
119	28402	115.789
120	28433	99.596
121	28637	102.915
122	30624	97.872
123	33864	99.259
124	[illegible]	[illegible]
125	39106	105.556
126	39268	115.195
127	39590	101.125
128	39620	100.000
129	[illegible]	[illegible]
130	[illegible]	[illegible]
131	21515	99.652
132	21641	[illegible]
133	21657	[illegible]
134	18134	105.977
135	[illegible]	101.504
136	[illegible]	[illegible]
137	[illegible]	[illegible]
138	18600	101.961
139	[illegible]	107.071
140	[illegible]	[illegible]
141	[illegible]	105.456
142	[illegible]	106.567
143	11041	100.000
144	[illegible]	100.000
145	[illegible]	[illegible]
146	[illegible]	[illegible]
147	[illegible]	[illegible]
148	[illegible]	[illegible]
149	[illegible]	[illegible]
150	[illegible]	[illegible]
151	[illegible]	[illegible]
152	[illegible]	[illegible]
153	[illegible]	[illegible]
154	[illegible]	[illegible]
155	[illegible]	[illegible]
156	[illegible]	[illegible]
157	[illegible]	[illegible]
158	40638	[illegible]
159	[illegible]	[illegible]
160	40834	107.143
161	40855	105.882
162	[illegible]	[illegible]
163	40833	[illegible]
164	40832	[illegible]
165	40831	94.737
166	40830	105.747
167	40829	102.703
168	40638	105.263
169	28519	105.135
170	[illegible]	[illegible]
171	37917	[illegible]
172	37949	100.813
173	[illegible]	[illegible]
174	31490	[illegible]
175	[illegible]	[illegible]
176	31033	[illegible]
177	45425	[illegible]
178	[illegible]	[illegible]
179	2491	98.925
180	[illegible]	104.167
181	[illegible]	[illegible]
182	[illegible]	[illegible]
183	[illegible]	[illegible]
184	17541	107.692
185	[illegible]	86.000
186	[illegible]	[illegible]
187	[illegible]	111.000
188	[illegible]	[illegible]
189	[illegible]	[illegible]
190	51103	100.909

(3) Calculate the standard deviation (S) from the percent recoveries (see Section VIII).

(4) Calculate the warning (WL) and control (CL) limits by using:

$$CL = \text{mean} \pm 3S$$

$$WL = \text{mean} \pm 2S$$

where CL and WL denote, respectively, the upper and lower control limits, and the upper and lower warning limits; S the standard deviation; and mean the average percent recovery ($\overline{\overline{PR}}$) for n spiked samples or synthetic standards. The WL and CL on the accuracy charts (similar to the precision charts) correspond, respectively, to the 95% and 99.7% confidence limits of a normal distribution curve.

(5) Graph the mean, WL, CL and the individual (PR) QC data results on the accuracy chart using appropriate scales.

(6) If QC values lie outside the control limits, the analytical method is "out of control" and appropriate corrective actions are taken.

The "Daily QC Model"

The "Daily QC Model" comprises two unique activities of our QA/QC program, i.e., the data management and monitoring specific statistical programs of data management systems on a daily basis. The salient features of the programs are discussed below.

1. Data Management

Integral to the laboratory's QA/QC program is the management of data generated from specified quality control procedures. These procedures are designed to monitor all laboratory analyses and ultimately, to ensure the highest possible quality of results. As previously mentioned, the duplicate, the spiked recovery, the synthetic known and the blank(s) are the analytical tools used to monitor the precision and accuracy of analytical methods. Recall:

(a) duplicate analyses monitor analytical method precision,

(b) spiked samples and synthetic knowns monitor analytical accuracy, and

(c) analyses of blanks account for possible sources of contamination.

The data produced from these tests is maintained via a quality control data management system which has the dual function of relating QA/QC data to analytical performance on a daily as well as varying time frames.

The key to the management of QA/QC data in the laboratory is the Firm's Honeywell X560 computer. Quality control computer programs allow for the calculations, storage, segregation, interpretation, monitoring and retrieval of each bit of QA/QC information. A discrete system of sample identification is used which allows the computer to perform these functions automatically. Each QA/QC sample is assigned a specific code identifying it as a blank, duplicate, spike or synthetic known sample. The code identifiers place each QC value in an appropriate data base which provides a permanent record of each and every quality control sample. These data base are then used as the starting point of various statistical analyses of QC data which aid in understanding the developed analytical information.

Specific statistical programs are available for the various types of QA/QC samples, and generate precision (X bar and R) and accuracy (P bar) quality control charts. These charts provide the graphic representation of the QA/QC information and are used to monitor the accuracy and precision of the various analytical methodologies daily.

2. Monitoring Statistical Programs of Data Management Systems

The QA/QC programs are made available to the QA/QC group leader and the analyst to allow daily response to analysis. The programs offer instant presentation of statistical values which are checked vis a vis the most recent mean, standard deviations and control limits calculated from each data base in the computer. As a result the QA/QC group leader and the analyst will know immediately whether or not the analytical method performance is in control (lie within acceptable ranges) and a decision can be made to accept, reject or repeat the analysis.

In addition, a program exists for the QA/QC group leader which presents all quality control information in a daily printout (see Figures 4 and 5). On this printout, information concerning QC samples is organized for review by the QA/QC group leader. The sample number, the test parameter, the QC sample type, the date of analysis, percent recoveries, relative errors and all values necessary for the calculation of QC data are collected on this printout (Figure 4). In addition to the QC values, commensurate warning and control limits are given. The QA/QC group leader is able to examine these data for acceptability. A quick scan can tell him the status of unfinished samples and values of QC data entering data bases. It is at this point where errors are detected, researched, and corrected whenever possible. We feel that the use of this monitoring program minimizes elapsed time between analysis and data review, therefore, greatly

TABLE V. SUMMARY OF VARIOUS QA/QC ITEMS ON DAILY COMPUTER PRINTOUT

ITEM	INFORMATION
CONTROL CHARTS	X Bar and R Charts (precision) P Charts (accuracy)
TABLES	Blanks Duplicates (Percent Relative Error) Spikes (Percent Recovery) Synthetic Standards (Percent Error)
WARNING PROGRAM	Outliers on all QC Data Base Mean and Standard Deviation Upper and Lower Warning and Control Limits
STATISTICS	Average, Mean and Standard Deviation Upper and Lower Warning and Control Limits Skewness and Kurtosis Percent Relative Error Percent Recovery Percent Error

improves the sensitivity of our QC program to our analyses. The earlier errors are detected and corrected, the less time is required to deliver valid results to a client.

A summary of the various QC activities and statistical calculations found in the daily printout is given in Table V. If QC values are found to lie outside the control limits, corrective actions are taken to bring the analytical method "under control". The various corrective actions are delineated in Table VI.

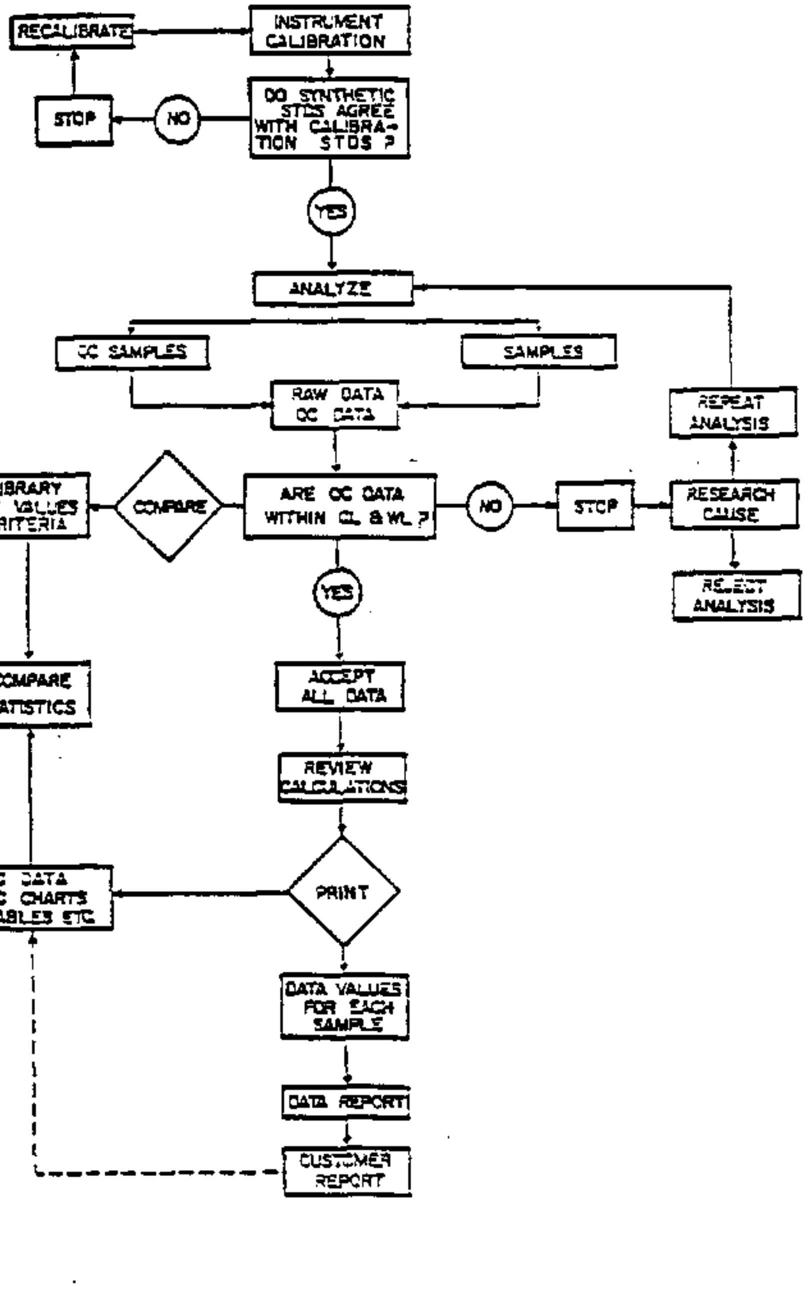
3. Other QA/QC Functions

A further ramification of the QA/QC computer management system is the historical evaluations afforded through data storage. Data may be retrieved over long varying time frames providing solid estimates of performance limits for any given analytical parameter. By the same token knowledge of performance limits and the factors that establish them should allow for the improvement of analyses as these factors are identified and removed. Such review is used in the evaluation of new techniques, instruments, and analysts when comparisons are made to the established quality control data bases.

To assist in evaluation and historical review a statistical package is available for measuring the variability of any given data over varying time frames. The Peursonian coefficient of skewness is utilized to quantify variability of percent recoveries, duplicate ratios, and percent of unknown values.

Automatic storage of data, generation of control charts, and data examination through statistics are the tools used to manage the quality control data. The goal of the data management system is a sensitive quality control program which will allow accurate decision making processes and continuous quality of analytical results.

TABLE VI
DECISION MAKING PROCESS FOR QA/AC PROTOCOL AND ANALYSIS OF SAMPLES



X. FOR THE CLIENT

The overall importance of our quality control program to the client lies in the fact that we are able to guarantee a certain level of confidence in our analyses. This confidence is expressed through our statistics. As mentioned earlier, we have established our acceptability limits to be plus or minus three times the standard deviation of the mean of the quality control values in each data base. Assuming that the values in the data bases describe a normal distribution, it is known that 99% of the values will fall within the range described by 3 standard deviations of the mean of the distribution. There exists a probability of .99 that any data point will be (plus or minus) 3 times the standard deviation of the mean. This may be described as the 99% confidence interval. We may state, therefore, with 99% certainty, that our quality control data will fall within acceptable limits. As we use quality control data to determine the validity of analyses of client samples, the same confidence interval may be ascribed to such data. The client must be aware, however, that the limits of acceptability are based upon the actual quality control data itself. That data derived from quality control analyses directly reflects the variability of the test. The limits, therefore, will vary as the test varies. Accordingly, the confidence interval of 99% will depict a different range in concentration for each test. The use of the confidence interval provides us with a method of checking the quality of our data and providing the client with some guarantee of validity.

The other facet of our operation which must be described is the ability to adapt our quality control options to the client's specific needs. Quality control parameters, blanks, spiked samples, duplicates, and the analysis of knowns may increase or decrease in frequency according to the client's wishes. If, for example, there is a concern over contamination, a client may wish to increase the number of blanks from one per ten client samples to two per set. The same applies to spikes, duplicates, and knowns.

If requested, graphs of all quality control data and lists of the statistical information can be made available. The graphs include sample numbers, mean, warning limits and control limits for acceptability (see Figures 6 and 7). The graphs may be formulated to include any desired number of data points for each of the quality control parameters. Statistical lists for data groups include the mean, standard deviation, median, coefficient of skewness and measures of kurtosis. These values can also be modified to comprise varying groups of data points. The variation is related to the time frame the client may wish to relate the data to provide the best description of the validity of analyses on his samples.

FIGURE B-4

LABORATORIES, INC.

CHAIN OF CUSTODY RECORD

JRVEY	SAMPLERS: (Signature)

STATION NUMBER	STATION LOCATION	DATE	TIME	SAMPLE TYPE			SEQ. NO.	NO. OF CONTAINERS	ANALYSIS REQUIRED
				Water		Air			
				Comp.	Grab.				

elinquished by: (Signature)	Received by: (Signature)	Date/Time
elinquished by: (Signature)	Received by: (Signature)	Date/Time
elinquished by: (Signature)	Received by: (Signature)	Date/Time
elinquished by: (Signature)	Received by Mobile Laboratory for field analysis: (Signature)	Date/Time

ispatched by: (Signature)	Date/Time	Received for Laboratory by:	Date/Time

Method of Shipment:

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Road / Syracuse, New York 13221 / (315) 457-1494

APPENDIX

KEY FOR DAILY QUALITY CONTROL REPORT

PROJECT NO:	denotes client and parameters tested.
SAMPLE:	denotes O'Brien & Gere sample ticket number.
MATE:	client sample that was spiked or duplicated.
TYPE:	Quality control sample type as: 1 - blank sample 3 - denotes duplicate 50 - chemistry spike 51 - trace organics spike 40 - EPA known concentration
QC VALUE:	value obtained for QC sample as blank value, duplicate ratio, percent recoveries for spiked and known samples.
L, WARNING:	lower warning limit as (-2) times the standard deviation of the mean of the last 25 samples.
U, WARNING:	upper warning limit as (+2) times the standard deviation of the mean of the last 25 samples.
SIZE:	number of values in data base.
COMMENTS:	as written.

FIGURE 4

DAILY QUALITY CONTROL REPORT

(SEE KEY)

```
   *** QC REPORT FOR  3/15/83 TO  3/22/83

PROJECT NO.         SAMPLE          MATE  TYPE   DATE   QC VALUE   L. WARNING U. WARNING  SIZE          COMMENTS
---------------------------------------------------------------------------------------------------------------------------
1042- 97-510         18465             0    1   3/15/83
1042- 97-510         50585             0    1   3/16/83

1042- 97-510         50714             0    1   3/15/83

1042- 97-510         50783             0    1   3/15/83

1042- 97-510         50787             0    1   3/15/83

1042- 97-510         50790             0    1   3/16/83

1042- 97-510         50793             0    1   3/16/83                                          NO SCHEDULED ANALYSES

1042- 97-510         50795             0    1   3/16/83

1042- 97-510         50820             0    1   3/16/83                                          NO SCHEDULED ANALYSES

1042- 97-510         50840             0    1   3/16/83                                          NO SCHEDULED ANALYSES

1042- 97-510         50850             0    1   3/16/83

1042- 97-510         50851             0    1   3/17/83

1042- 97-510         50853             0    1   3/17/83

1042- 97-510         50866             0    1   3/18/83

1042- 97-510         50868             0    1   3/18/83

1042- 97-510         50883             0    1   3/21/83                                          NO SCHEDULED ANALYSES

1042- 97-510         50890             0    1   3/21/83

1042- 97-510         50891             0    1   3/21/83

1042- 97-510         50892             0    1   3/21/83

1042- 97-510         50897             0    1   3/21/83                                          NO SCHEDULED ANALYSES

1042- 97-510         50899             0    1   3/21/83

1042- 97-510         50900             0    1   3/21/83

1042- 97-510         50906             0    1   3/22/83
  BENZ                  <1.                              1.000                      481
  CHCL3              <1.000                              1.000                      191
  FREON113           <1.000                              1.000                      593
  CL3CCH3            <1.000                              1.000                      608
  CCL4               <1.000                              1.000                       73
  BRCL2CH            <1.000                              1.000                      191
  CL3C2H             <1.000                              1.000                      609
  CLBR2CH            <1.000                              1.000                      191
  CHBR3             <10.000                             10.000                      190
  CL4C2              <1.000                              1.000                      603
  CH2CL2             <1.000                              1.000                      604
  TOLUENE            <1.000                              1.000                      482
  M-XYLENE           <1.000                              1.000                      473
  CLOROBZ            <1.000                              1.000                      171
  CL4C2H2            <1.000                              1.000                       66
  OCTANIL            <1.000                              1.000                      332
```

```
     DCETAN12         <1,000                              1.000                342
     DCLEN11          <1,000                              1.000                342
     ETHBENZ          <1,000                              1.000                 98
     DCLEN12          <1,000                              1.000                342
     C2H5CL           <1,000                              1.000                316
     CH2CHCL          <1,000                              1.000                315
     XYLENES          <1,000                              1.000                195
     CH3CL            <1,000                              1.000                 66
     CH3BR            <1,000                              1.000                 66
     DCPAN12          <1,000                              1.000                 66
     DCPENT13         <1,000                              1.000                 66
     CL3C2112         <1,000                              1.000                 66
     DCPENC13         <1,000                              1.000                 66
     CLETHER         <10,000                             10.000                 66

   1042- 97-510        50907          0    1    3/22/83
     BENZ                 2.                              2.000                482
     CHCL3            <1,000                              1.000                192
     FREON113         <1,000                              1.000                594
     CL3CCH3          <1.000                              1.000                609
     CCL4             <1,000                              1.000                 74
     BRCL2CH          <1,000                              1.000                192
     CL3C2H           <1,000                              1.000                610
     CLBR2CH          <1,000                              1.000                192
     CHBR3           <10,000                             10,000                191
     CL4C2            <1,000                              1,000                604
     CH2CL2           <1,000                              1,000                605
     TOLUENE          <1,000                              1.000                483
     M-XYLENE         <1,000                              1.000                474
     CLOROBZ          <1,000                              1.000                172
     CL4C2H2          <1,000                              1.000                 67
     DCETAN11         <1,000                              1.000                343
     DCETAN12         <1,000                              1.000                343
     DCLEN11          <1,000                              1.000                343
     ETHBENZ          <1,000                              1.000                 99
     DCLEN12          <1,000                              1.000                343
     C2H5CL           <1,000                              1.000                317
     CH2CHCL          <1,000                              1.000                316
     XYLENES          <1,000                              1.000                196
     CH3CL            <1,000                              1.000                 67
     CH3BR            <1,000                              1,000                 67
     DCPAN12          <1,000                              1,000                 67
     DCPENT13         <1,000                              1.000                 67
     CL3C2112         <1.000                              1.000                 67
     DCPENC13         <1,000                              1.000                 67
     CLETHER         <10,000                             10,000                 67

   1042- 97-510        50913          0    1    3/22/83                        NO SCHEDULED ANALYSES

   1042- 97-510        50700        468    3    3/16/83
     CHCL3          <100,000                                                   < FLAG - SKIPPED
     FREON113        <10,000                                                   < FLAG - SKIPPED
     CCL4           <100.000                                                   < FLAG - SKIPPED
     BRCL2CH        <100,000                                                   < FLAG - SKIPPED
     CLBR2CH         <10.000                                                   < FLAG - SKIPPED
     CHBR3          <100,000                                                   < FLAG - SKIPPED
     CL4C2           <10,000                                                   < FLAG - SKIPPED
     CLOROBZ          <1,000                                                   < FLAG - SKIPPED
     CL4C2H2         <10,000                                                   < FLAG - SKIPPED
     CH3CL           <10,000                                                   < FLAG - SKIPPED
     CH3BR           <10,000                                                   < FLAG - SKIPPED
     DCPAN12         <10,000                                                   < FLAG - SKIPPED
     DCPENT13        <10,000                                                   < FLAG - SKIPPED
     CL3C2112        <10,000                                                   < FLAG - SKIPPED
```

```
   DCPENC13      <10,000                                          < FLAG - SKIPPED
   CLETHER      <100,000                                          < FLAG - SKIPPED

 1042- 97-510      50741      50686   3   3/16/83
   BOD5           <10.0                                           < FLAG - SKIPPED

 1042- 97-510      50791      50605   3   3/16/83

 1042- 97-510      50817      50812   3   3/16/83                 NO SCHEDULED ANALYSES
 1042- 97-510      50816      50660   3   3/16/83

 1042- 97-510      50821      50660   3   3/16/83
   NO2N             <.01                                          < FLAG - SKIPPED

 1042- 97-510      50823        493   3   3/16/83
   BENZ             <10.                                          < FLAG - SKIPPED
   CHCL3        <100,000                                          < FLAG - SKIPPED
   FREON113     <100,000                                          < FLAG - SKIPPED
   CCL4        <1000,000                                          < FLAG - SKIPPED
   BRCL2CH     <1000,000                                          < FLAG - SKIPPED
   CLBR2CH      <100,000                                          < FLAG - SKIPPED
   CHBR3       <1000,000                                          < FLAG - SKIPPED
   CLOROBZ       <10,000                                          < FLAG - SKIPPED
   CL4C2H2      <100,000                                          < FLAG - SKIPPED
   ETHBENZ       <10,000                                          < FLAG - SKIPPED
   C2H5CL       <100,000                                          < FLAG - SKIPPED
   CH2CHCL      <100,000                                          < FLAG - SKIPPED
   CH3CL        <100,000                                          < FLAG - SKIPPED
   CH3BR        <100,000                                          < FLAG - SKIPPED
   DCPAN12      <100,000                                          < FLAG - SKIPPED
   DCPENT13     <100,000                                          < FLAG - SKIPPED
   CL3C2112     <100,000                                          < FLAG - SKIPPED
   DCPENC13     <100,000                                          < FLAG - SKIPPED
   CLETHER     <1000,000                                          < FLAG - SKIPPED

 1042- 97-510      50825        212   3   3/16/83

 1042- 97-510      50827        212   3   3/16/83
   NO2N             <.01                                          < FLAG - SKIPPED

 1042- 97-510      50849        511   3   3/16/83
   BENZ            <100.                                          < FLAG - SKIPPED
   CHCL3       <1000,000                                          < FLAG - SKIPPED
   FREON113    <1000,000                                          < FLAG - SKIPPED
   CCL4        <1000,000                                          < FLAG - SKIPPED
   BRCL2CH     <1000,000                                          < FLAG - SKIPPED
   CLBR2CH     <1000,000                                          < FLAG - SKIPPED
   CHBR3      <10000,000                                          < FLAG - SKIPPED
   CL4C2H2     <1000,000                                          < FLAG - SKIPPED
   DCETAN11    <1000,000                                          < FLAG - SKIPPED
   DCETAN12    <1000,000                                          < FLAG - SKIPPED
   ETHBENZ      <100,000                                          < FLAG - SKIPPED
   C2H5CL      <1000,000                                          < FLAG - SKIPPED
   CH2CHCL     <1000,000                                          < FLAG - SKIPPED
   CH3CL       <1000,000                                          < FLAG - SKIPPED
   CH3BR       <1000,000                                          < FLAG - SKIPPED
   DCPAN12     <1000,000                                          < FLAG - SKIPPED
   DCPENT13    <1000,000                                          < FLAG - SKIPPED
   CL3C2112    <1000,000                                          < FLAG - SKIPPED
   DCPENC13    <1000,000                                          < FLAG - SKIPPED
   CLETHER    <10000,000                                          < FLAG - SKIPPED

 1042- 97-510      50852       3892   3   3/17/83
   BENZ              <1.                                          < FLAG - SKIPPED
```

```
      CHCL3          <1.000                                                  < FLAG - SKIPPED
      FREON113       <1.000                                                  < FLAG - SKIPPED
      CCL4           <1.000                                                  < FLAG - SKIPPED
      BRCL2CH        <1.000                                                  < FLAG - SKIPPED
      CLBR2CH        <1.000                                                  < FLAG - SKIPPED
      CHBR3         <10.000                                                  < FLAG - SKIPPED
      CL4C2          <1.000                                                  < FLAG - SKIPPED
      TOLUENE        <1.000                                                  < FLAG - SKIPPED
      M-XYLENE       <1.000                                                  < FLAG - SKIPPED
      CLOROBZ        <1.000                                                  < FLAG - SKIPPED
      CL4C2H2        <1.000                                                  < FLAG - SKIPPED
      ETHBENZ        <1.000                                                  < FLAG - SKIPPED
      XYLENES        <1.000                                                  < FLAG - SKIPPED
      CH3BR          <1.000                                                  < FLAG - SKIPPED
      DCPAN12        <1.000                                                  < FLAG - SKIPPED
      DCPENT13       <1.000                                                  < FLAG - SKIPPED
      CL3C2112       <1.000                                                  < FLAG - SKIPPED
      DCPENC13       <1.000                                                  < FLAG - SKIPPED
      CLETHER       <10.000                                                  < FLAG - SKIPPED

    1042- 97-510      50854       3858   3   3/18/83
      CHCL3          <1.000                                                  < FLAG - SKIPPED
      CCL4           <1.000                                                  < FLAG - SKIPPED
      BRCL2CH        <1.000                                                  < FLAG - SKIPPED
      CLBR2CH        <1.000                                                  < FLAG - SKIPPED
      CHBR3         <10.000                                                  < FLAG - SKIPPED
      TOLUENE        <1.000                                                  < FLAG - SKIPPED
      M-XYLENE       <1.000                                                  < FLAG - SKIPPED
      CLOROBZ        <1.000                                                  < FLAG - SKIPPED
      CL4C2H2        <1.000                                                  < FLAG - SKIPPED
      DCETAN12       <1.000                                                  < FLAG - SKIPPED
      CH3CL         <10.000                                                  < FLAG - SKIPPED
      CH3BR         <10.000                                                  < FLAG - SKIPPED
      DCPAN12        <1.000                                                  < FLAG - SKIPPED
      DCPENT13       <1.000                                                  < FLAG - SKIPPED
      CL3C2112       <1.000                                                  < FLAG - SKIPPED
      DCPENC13       <1.000                                                  < FLAG - SKIPPED
      CLETHER       <10.000                                                  < FLAG - SKIPPED

    1042- 97-510      50856      18315   3   3/16/83
      AL                <.1                                                  < FLAG - SKIPPED

    1042- 97-510      50858        215   3   3/17/83                         NO SCHEDULED ANALYSES
    1042- 97-510      50860      50660   3   3/17/83
      F                <.10                                                  < FLAG - SKIPPED

    1042- 97-510      50862      18338   3   3/17/83

    1042- 97-510      50885        212   3   3/21/83

    1042- 97-510      50898       3902   3   3/21/83
      BENZ           <100.                                                   < FLAG - SKIPPED
      CHCL3       <1000.000                                                  < FLAG - SKIPPED
      FREON113    <1000.000                                                  < FLAG - SKIPPED
      CCL4        <1000.000                                                  < FLAG - SKIPPED
      BRCL2CH     <1000.000                                                  < FLAG - SKIPPED
      CLBR2CH     <1000.000                                                  < FLAG - SKIPPED
      CHBR3      <10000.000                                                  < FLAG - SKIPPED
      CL4C2       <1000.000                                                  < FLAG - SKIPPED
      CH2CL2      <1000.000                                                  < FLAG - SKIPPED
      TOLUENE      <100.000                                                  < FLAG - SKIPPED
      M-XYLENE     <100.000                                                  < FLAG - SKIPPED
      CLOROBZ      <100.000                                                  < FLAG - SKIPPED
      CL4C2H2     <1000.000                                                  < FLAG - SKIPPED
```

```
   DCETAN12      <1000.000                                                                                < FLAG - SKIPPED
   DCLEN11       <1000.000                                                                                < FLAG - SKIPPED
   ETHBENZ        <100.000                                                                                < FLAG - SKIPPED
   C2H5CL        <1000.000                                                                                < FLAG - SKIPPED
   CH2CHCL       <1000.000                                                                                < FLAG - SKIPPED
   XYLENES        <100.000                                                                                < FLAG - SKIPPED
   CH3CL         <1000.000                                                                                < FLAG - SKIPPED
   CH3BR         <1000.000                                                                                < FLAG - SKIPPED
   DCPAN12       <1000.000                                                                                < FLAG - SKIPPED
   DCPENT13      <1000.000                                                                                < FLAG - SKIPPED
   CL3C2112      <1000.000                                                                                < FLAG - SKIPPED
   DCPENC13      <1000.000                                                                                < FLAG - SKIPPED
   CLETHER      <10000.000                                                                                < FLAG - SKIPPED

 1042- 97-510        50901      50800   3   3/21/83
   BENZ             <1.                                                                                   < FLAG - SKIPPED
   CHCL3          <1.000                                                                                  < FLAG - SKIPPED
   CCL4          <10.000                                                                                  < FLAG - SKIPPED
   BRCL2CH       <10.000                                                                                  < FLAG - SKIPPED
   CLBR2CH        <1.000                                                                                  < FLAG - SKIPPED
   CHBR3         <10.000                                                                                  < FLAG - SKIPPED
   M-XYLENE       <1.000                                                                                  < FLAG - SKIPPED
   CLOROBZ        <1.000                                                                                  < FLAG - SKIPPED
   CL4C2H2        <1.000                                                                                  < FLAG - SKIPPED
   DCETAN12       <1.000                                                                                  < FLAG - SKIPPED
   ETHBENZ        <1.000                                                                                  < FLAG - SKIPPED
   DCLEN12        <1.000                                                                                  < FLAG - SKIPPED
   C2H5CL         <1.000                                                                                  < FLAG - SKIPPED
   CH2CHCL        <1.000                                                                                  < FLAG - SKIPPED
   XYLENES        <1.000                                                                                  < FLAG - SKIPPED
   CH3CL          <1.000                                                                                  < FLAG - SKIPPED
   CH3BR          <1.000                                                                                  < FLAG - SKIPPED
   DCPAN12        <1.000                                                                                  < FLAG - SKIPPED
   DCPENT13       <1.000                                                                                  < FLAG - SKIPPED
   CL3C2112       <1.000                                                                                  < FLAG - SKIPPED
   DCPENC13       <1.000                                                                                  < FLAG - SKIPPED
   CLETHER       <10.000                                                                                  < FLAG - SKIPPED

 1042- 97-510        50902      18543   3   3/21/83                                                       NO SCHEDULED ANALYSES
 1042- 97-510        50909        212   3   3/22/83
   NO2NO3              .45        .41                      1.103        .8154     1.3219    36

 1042- 97-510        50911        212   3   3/22/83
   NO2N               <.01                                                                                < FLAG - SKIPPED

 1042- 97-510        50916        213   3   3/22/83
   ZN                  .13        .25                      1.320 *      .9379     1.1329    49

 1042- 97-510        50918        219   3   3/22/83
   CU                  .24        .24                      1.000        .9394     1.1100    45

 1042- 97-510        50788      50807  40   3/18/83

 1042- 97-510        50789      50629  40   3/16/83

 1042- 97-510        50807          0  40   3/16/83

 1042- 97-510        50824      50629  40   3/16/83

 1042- 97-510        50867      50869  40   3/22/83
   BENZ                 2.         2.                    100.000      78.6607   115.0226    59
   BENZ,F               2.
   CL3CCH3           2.000      2.000                    100.000      71.9670   102.8464    59
   CL3CCH3,F         2.000
```

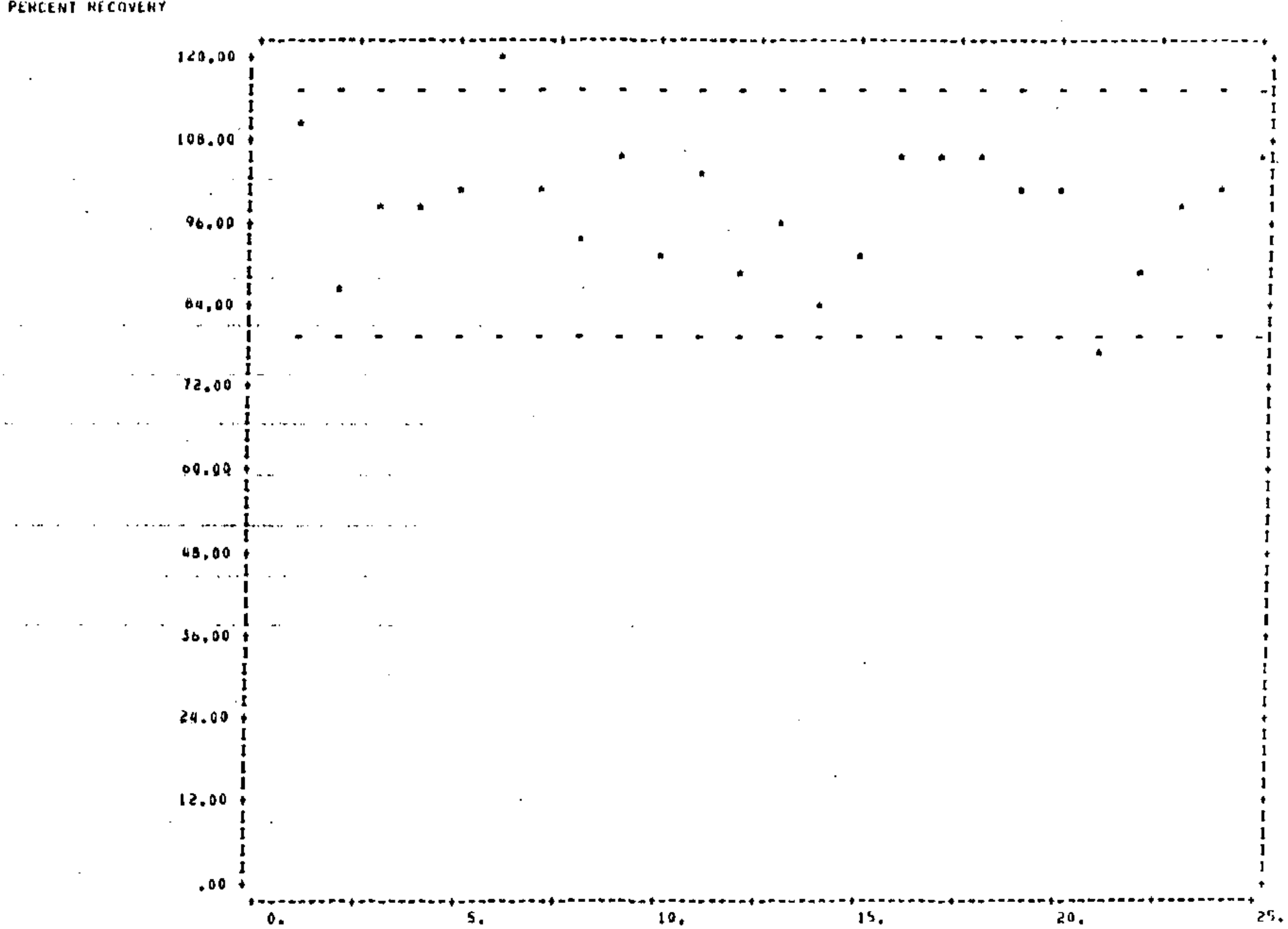
```
      CL3C2H             2.000        2.000                    100.000      80.0254   114.7254    39
      CL3C2H.F           2.000
      CL4C2              2.000                                 100.000        .0000      .0000    35
      CL4C2.F            2.000
      CH2CL2             2.000        2.000                    100.000      75.9820   105.6501    31
      CH2CL2.F           2.000
      TOLUENE            2.000        2.000                    100.000      77.4026   115.4676    39
      TOLUENE.F          2.000
      CLOROBZ            2.000        2.000                    100.000      40.9895   128.4501    25
      CLOROBZ.F          2.000
      DCETAN11           2.000        2.000                    100.000 *    76.4276    96.3720    27
      DCETAN11.F         2.000
      DCETAN12           2.000        2.000                    100.000      52.9445   105.6725    33
      DCETAN12.F         2.000
      DCLEN11            2.000        2.000                    100.000      69.3339   110.3648    33
      DCLEN11.F          2.000
      ETHBENZ            2.000        2.000                    100.000      79.7258   107.1142    37
      ETHBENZ.F          2.000
      DCLEN12            2.000        2.000                    100.000      73.1254   102.0690    31
      DCLEN12.F          2.000

  1042- 97-510          50869            0  40   3/18/83

  1042- 97-510          50645        50605  50   3/16/83

  1042- 97-510          50667        17868  50   3/15/83
     TCOLI                 0.                                                                      QC FILT/UNFILT ANALYSIS NOT DONE


  1042- 97-510          50739        50650  50   3/16/83

  1042- 97-510          50742        50686  50   3/16/83

  1042- 97-510          50792        50604  50   3/16/83

  1042- 97-510          50819        50660  50   3/16/83

  1042- 97-510          50822        50660  50   3/16/83

  1042- 97-510          50826          212  50   3/16/83

  1042- 97-510          50828          212  50   3/16/83

  1042- 97-510          50855        18173  50   3/16/83

  1042- 97-510          50857          214  50   3/17/83

  1042- 97-510          50859        18268  50   3/17/83

  1042- 97-510          50861        50660  50   3/17/83

  1042- 97-510          50863        18338  50   3/17/83

  1042- 97-510          50893          213  50   3/21/83
     TC                   61.                                                                      QC FILT/UNFILT ANALYSIS NOT DONE

     TIC                  52.                                                                      QC FILT/UNFILT ANALYSIS NOT DONE

     TOC                   9.                                                                      QC FILT/UNFILT ANALYSIS NOT DONE


  1042- 97-510          50903          240  50   3/21/83                                           NO SCHEDULED ANALYSES
  1042- 97-510          50904        18333  50   3/22/83
     HG                  1.0           .5                  70.947       63.5830   129.5509    50
```

```
   HG,F             2.0

 1042- 97-510      50910         212  50    3/22/83
   NO2NO3            .52        1.04                 71.943       71.6096   136.7643   112
   NO2NO3,F          .41

 1042- 97-510      50912         212  50    3/22/83
   NO2N              .09        <.10                100.000       79.3854   132.8427    96
   NO2N,F            .19

 1042= 97-510      50915         218  50    3/22/83
   ZN                .62         .20                103.333       91.8367   117.0560   156
   ZN,F             1.00

 1042- 97-510      50917         267  50    3/22/83
   CU                .67         .35                 99.259       92.2782   108.3764   149
   CU,F             1.00

 1042- 97-510      18466       18465  51    3/15/83

 1042- 97-510      50794       50793  51    3/16/83                                          NO SCHEDULED ANALYSES
 1042- 97-510      50816       50815  51    3/16/83                                          NO SCHEDULED ANALYSES
 1042- 97-510      50880         230  51    3/21/83                                          NO SCHEDULED ANALYSES
 1042- 97-510      50908       50907  51    3/22/83
   BENZ             36.           2.                100.000       70.5872   120.1899   143
   BENZ,F           36.
   TOLUENE          35.000     <1.000                97.222       82.1822   110.5127   148
   TOLUENE,F        36.000
   M-XYLENE         41.000     <1.000               105.126       81.6048   111.9041   135
   M-XYLENE,F       39.000
   CLOROBZ          41.000     <1.000                95.349       57.8437   128.8618    31
   CLOROBZ,F        43.000
   ETHBENZ          41.000     <1.000               100.000         .0000      .0000     7
   ETHBENZ,F        41.000
```

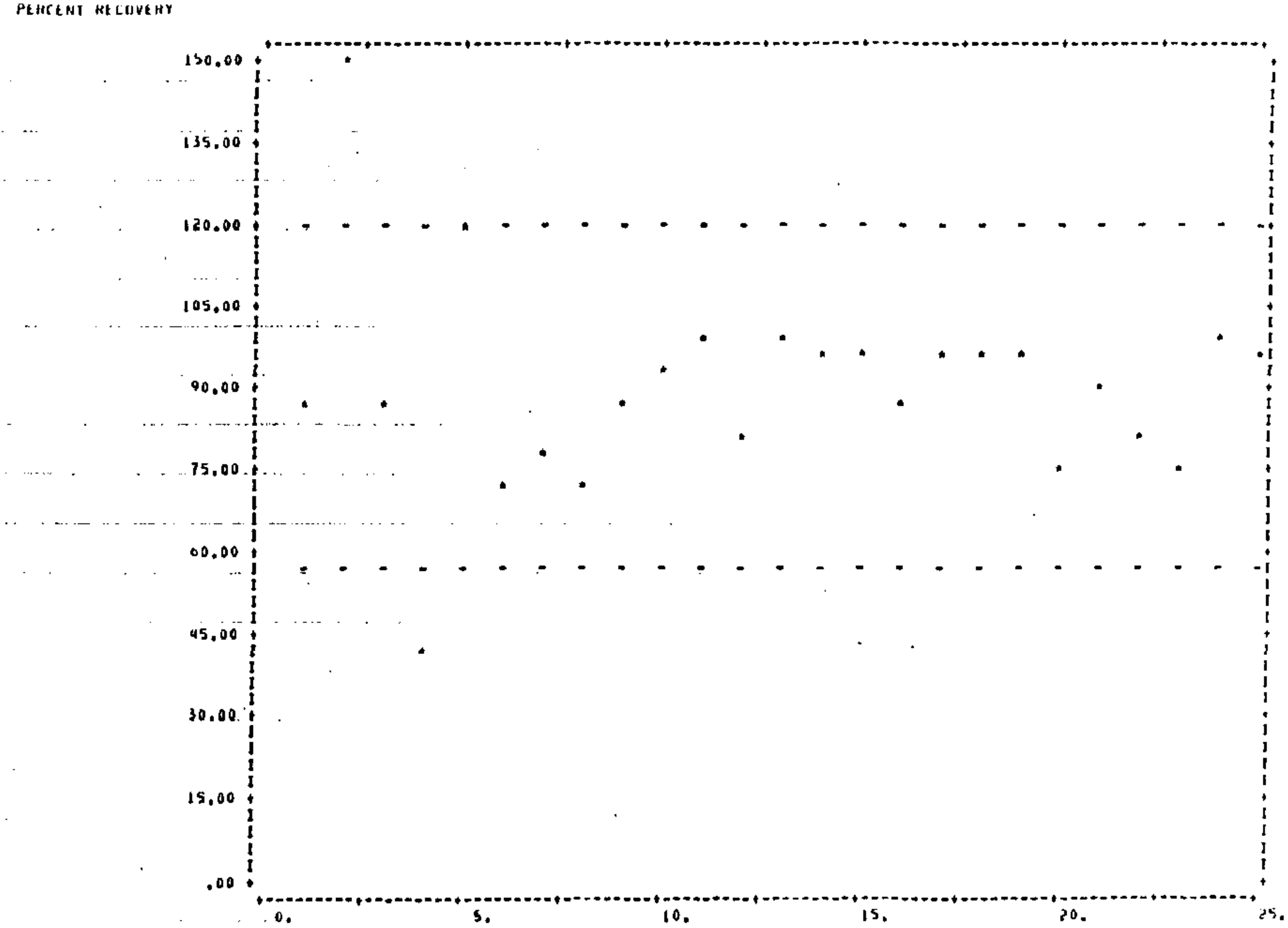
FIGURE 5

DAILY QUALITY CONTROL GRAPH

(SPIKED RECOVERIES)

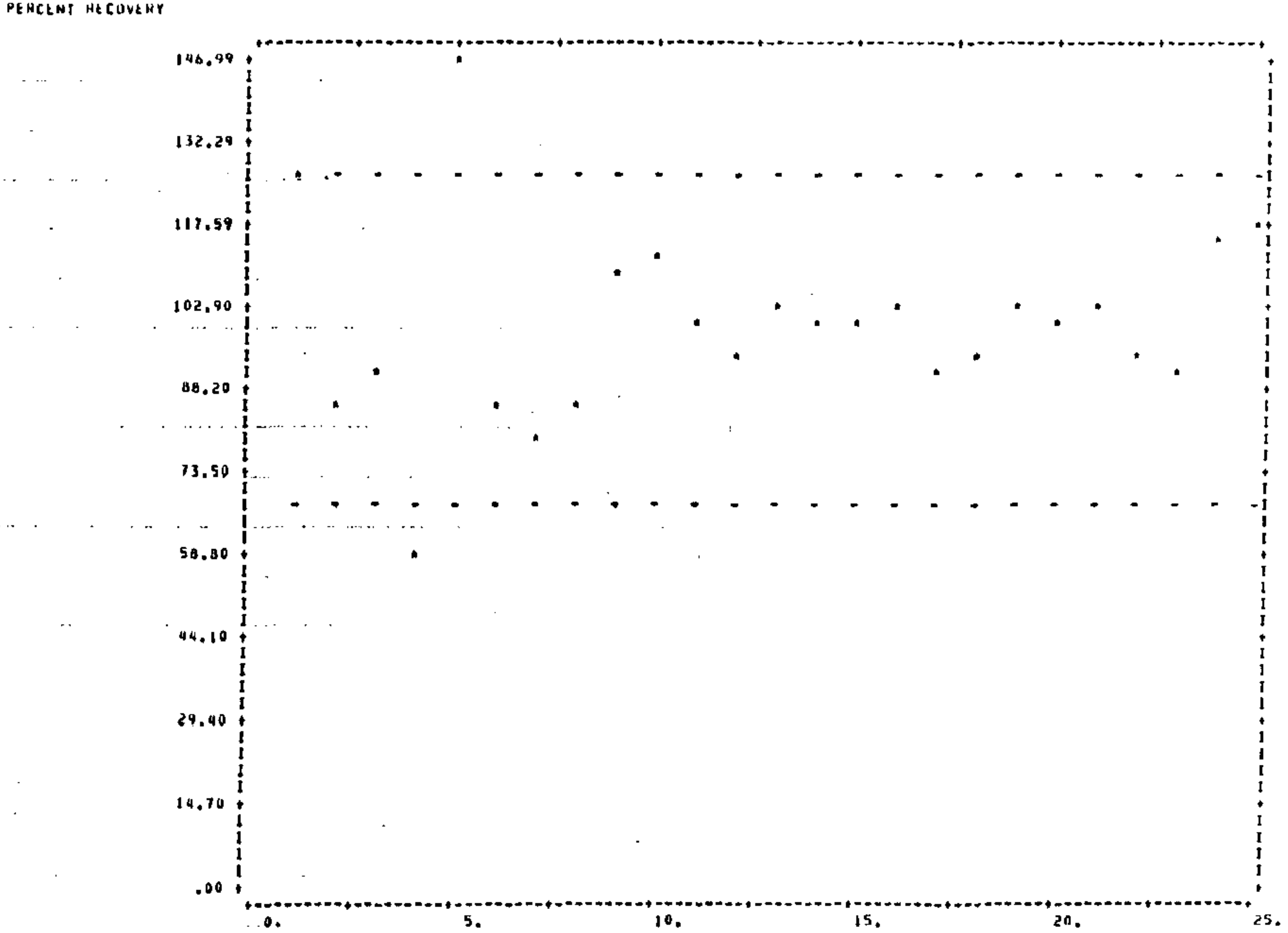


```
                                                                BENZ          SAMPLES  29830 THROUGH  50867
                    (*) = QC VALUES   (-) =WARNING LIMITS
MEAN = 97.6021  STANDARD DEVIATION = 8.87217
MEDIAN = 100.000  SKEWNESS = -.743181  KURTOSIS = 2.95627
```



CL3CCH3 SAMPLES 39705 THROUGH 50867

(*) = QC VALUES (-) =WARNING LIMITS
MEAN = 86.5001 STANDARD DEVIATION = 15.9869
MEDIAN = 87.5000 SKEWNESS = .187665 KURTOSIS = 8.46347

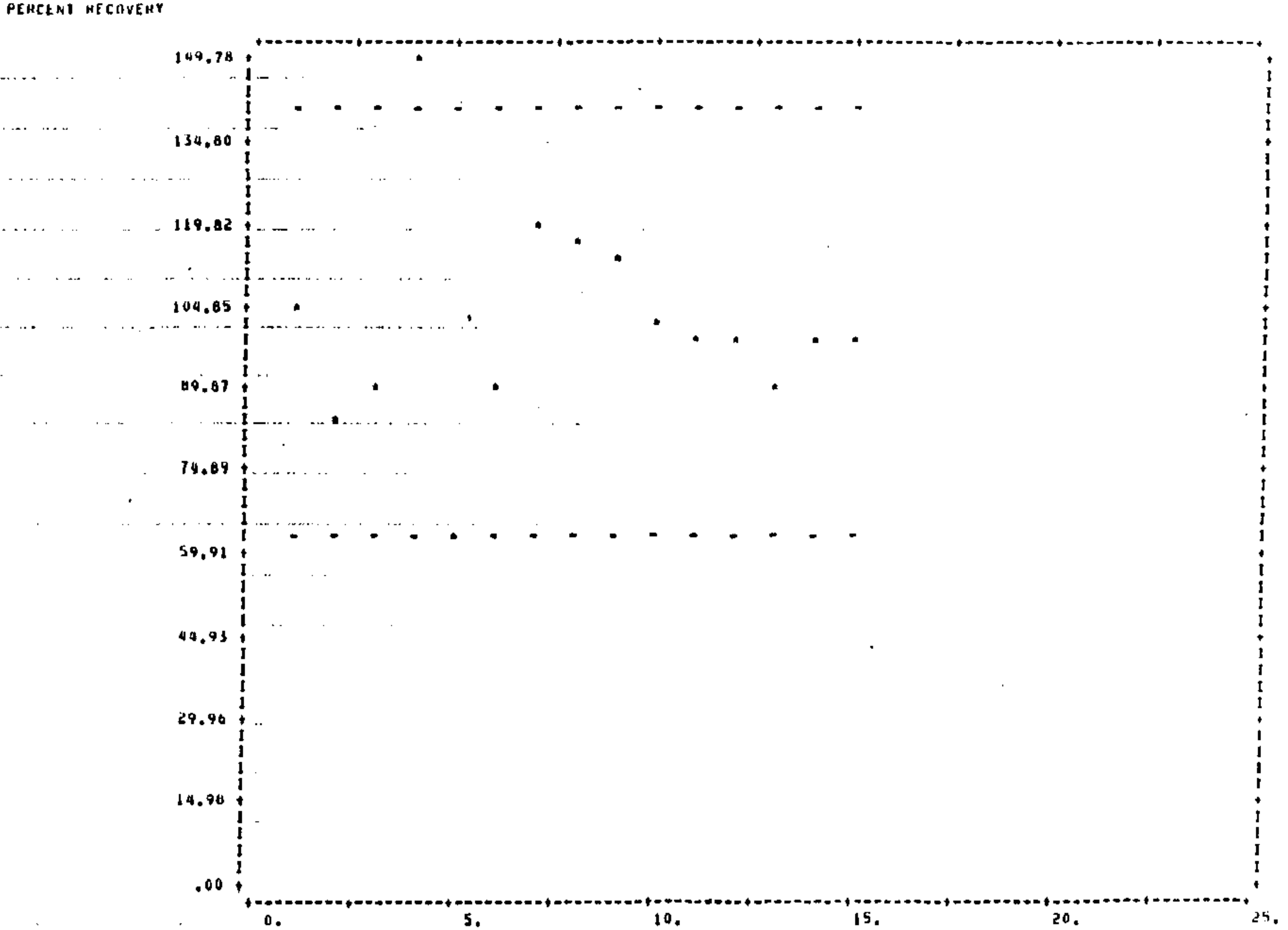


CL3C2H SAMPLES 39705 THROUGH 50867

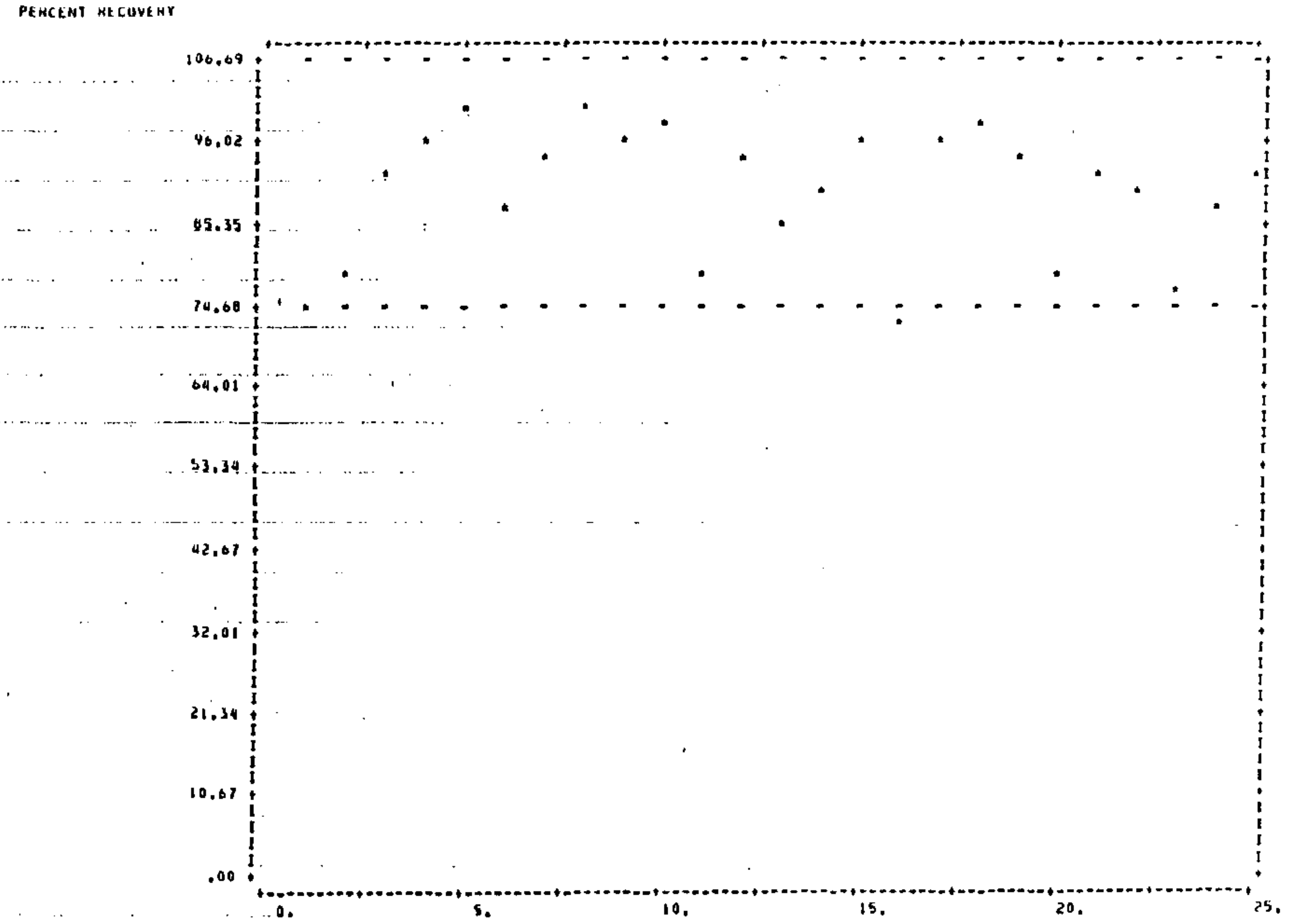
(*) - QC VALUES (-) -WARNING LIMITS

MEAN = 97.1031 STANDARD DEVIATION = 14.3505

MEDIAN = 100.000 SKEWNESS = -.480136 KURTOSIS = 5.97265

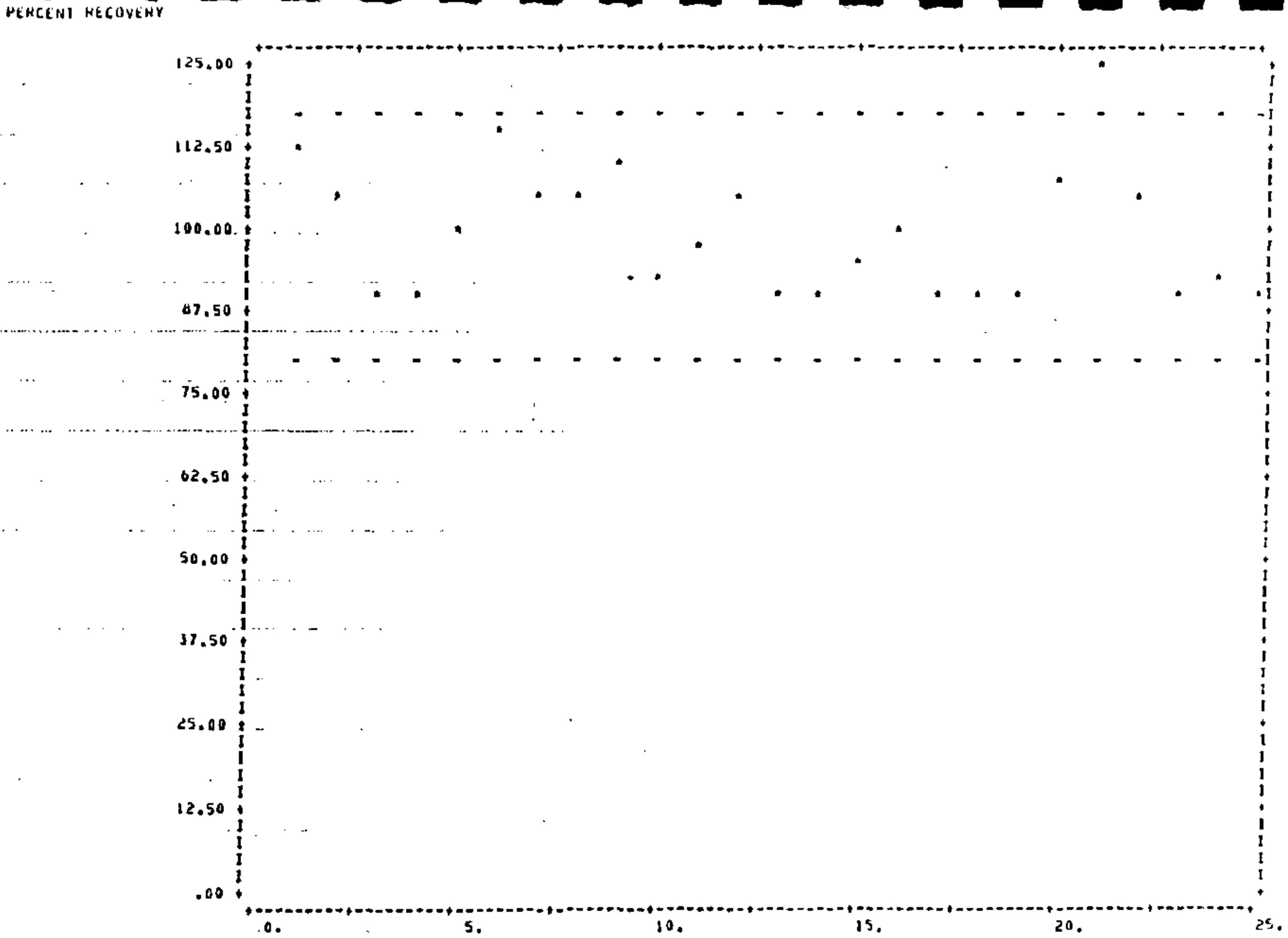


```
                                                  CL4C2          SAMPLES  39705 THROUGH  50867
                    (*) = QC VALUES   (-) =WARNING LIMITS
    MEAN = 101.354  STANDARD DEVIATION = 19.6983
... MEDIAN = 100.000  SKEWNESS = .206263  KURTOSIS = 4.25532
```

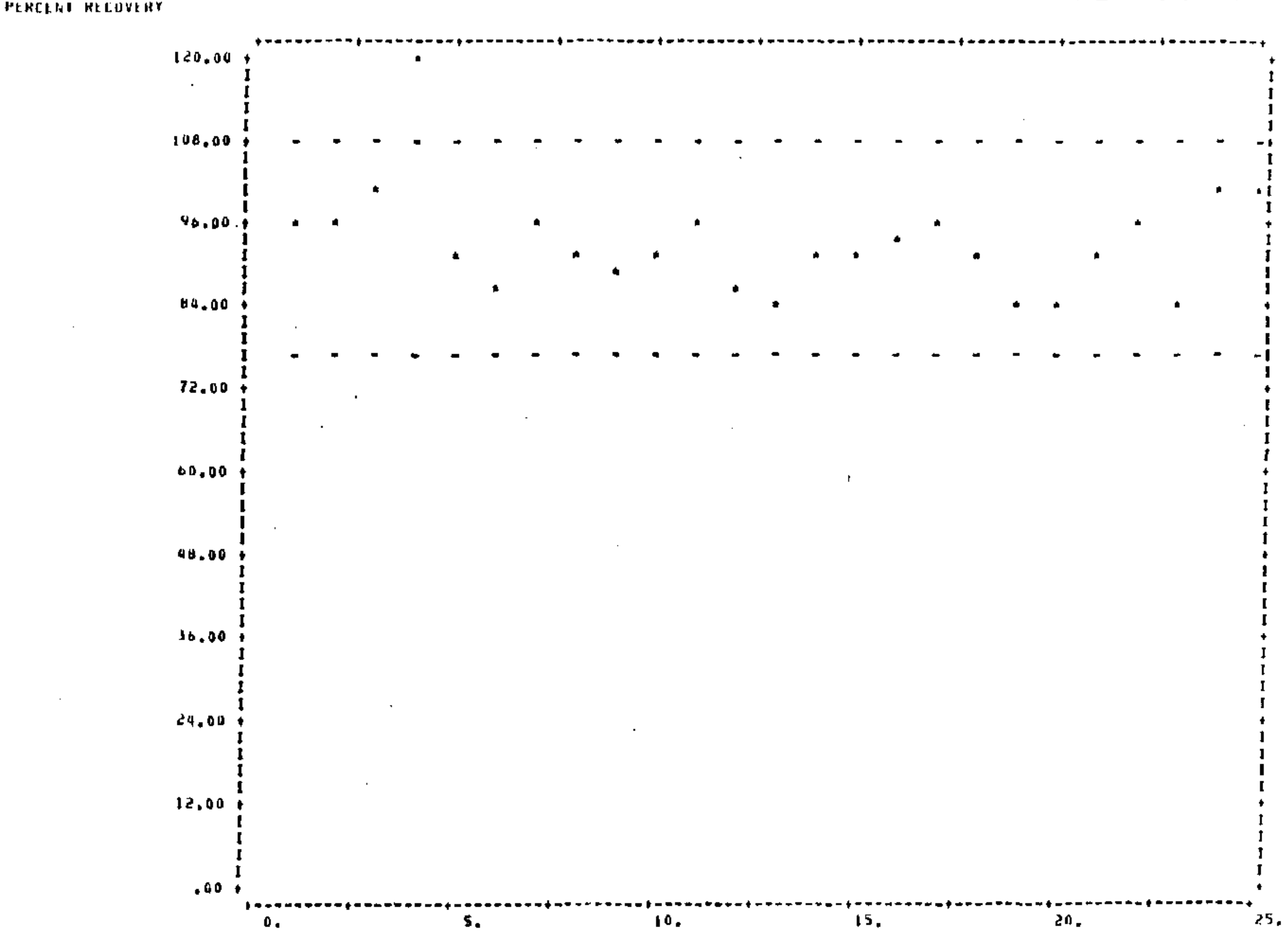


CH2CL2 SAMPLES 23250 THROUGH 50867

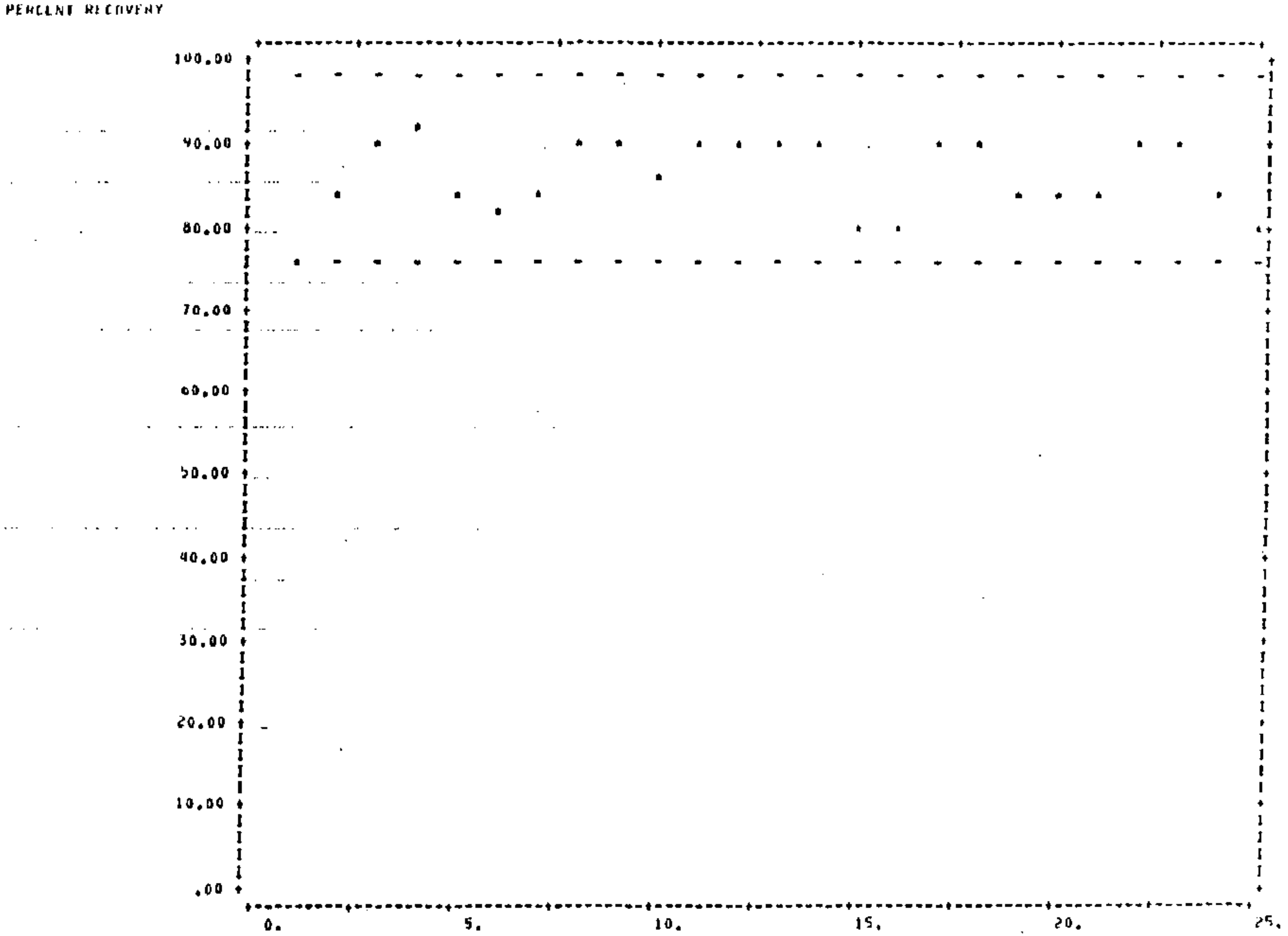
```
                    (*) - QC VALUES   (-) -WARNING LIMITS
MEAN = 90.7871  STANDARD DEVIATION = 7.94928
MEDIAN = 92.5000  SKEWNESS = -.646415  KURTOSIS = 2.47975
```



```
                                                  TOLUENE        SAMPLES  29830 THROUGH  50867
                     (*) - QC VALUES   (-) -WARNING LIMITS
    MEAN = 98.1067  STANDARD DEVIATION = 9.36984
    MEDIAN = 97.0350  SKEWNESS = .103119  KURTOSIS = 3.13778
```



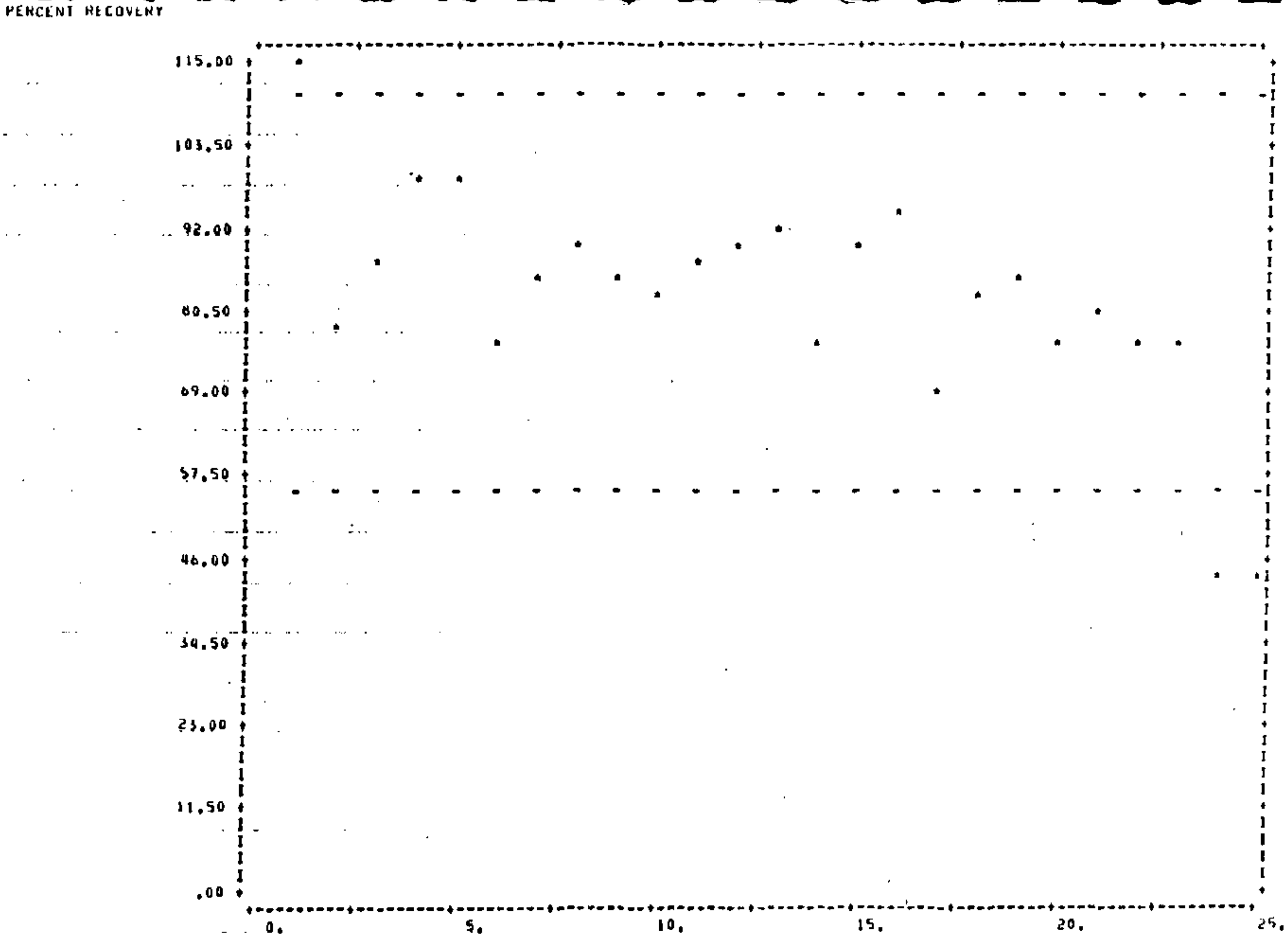
```
                                                          CLOROBZ        SAMPLES  44382 THROUGH  50867
                        (*) - QC VALUES   (-) =WARNING LIMITS
MEAN = 92.7198  STANDARD DEVIATION = 7.43594
MEDIAN = 91.0000  SKEWNESS = .693866  KURTOSIS = 8.25299
```



DCETAN11 SAMPLES 23250 THROUGH 50867

(*) - QC VALUES (-) -WARNING LIMITS

MEAN = 87.4443 STANDARD DEVIATION = 5.44788
MEDIAN = 89.0000 SKEWNESS = -.858704 KURTOSIS = 3.53358

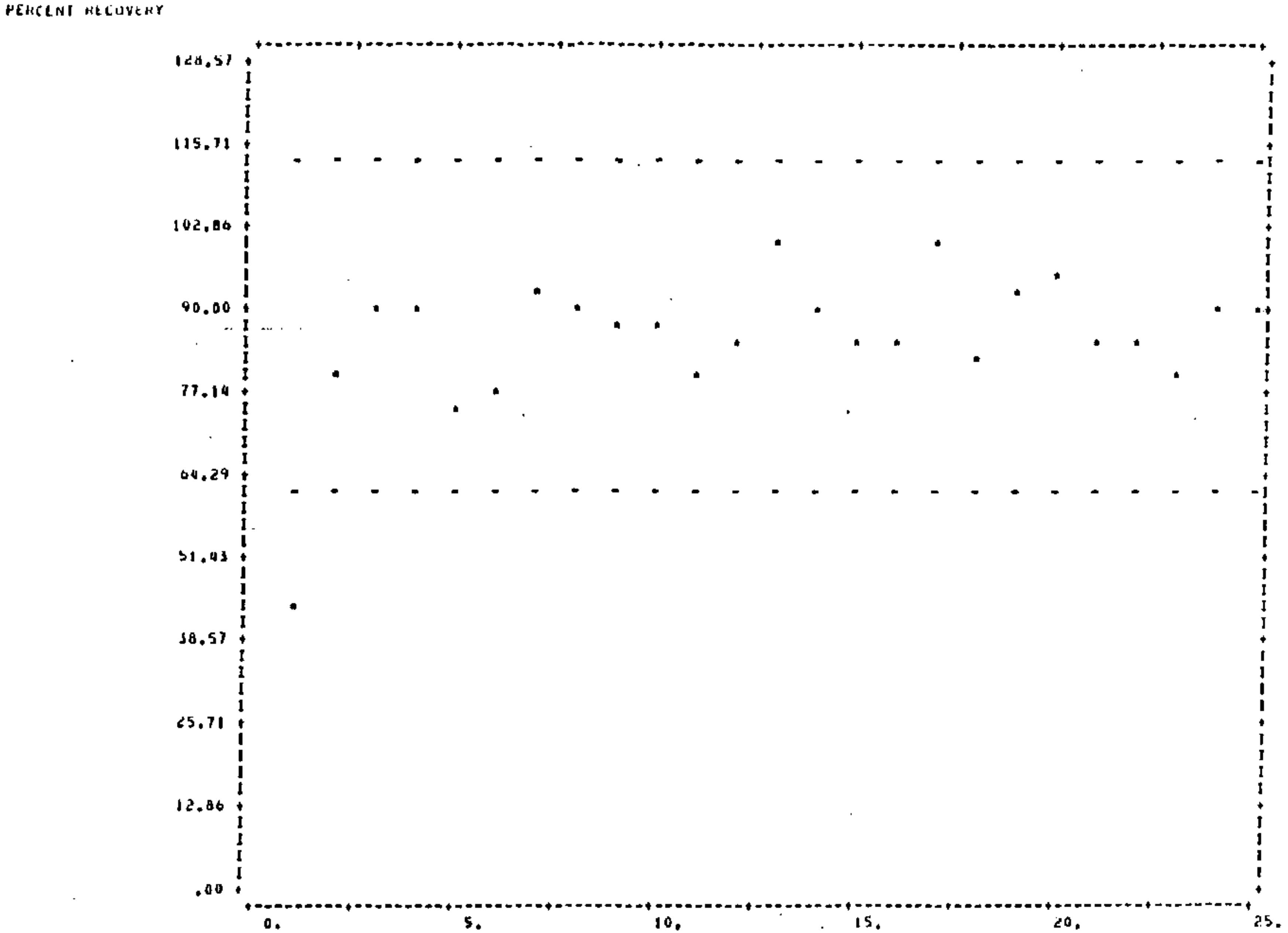


DCLTANI2 SAMPLES 40299 THROUGH 50867

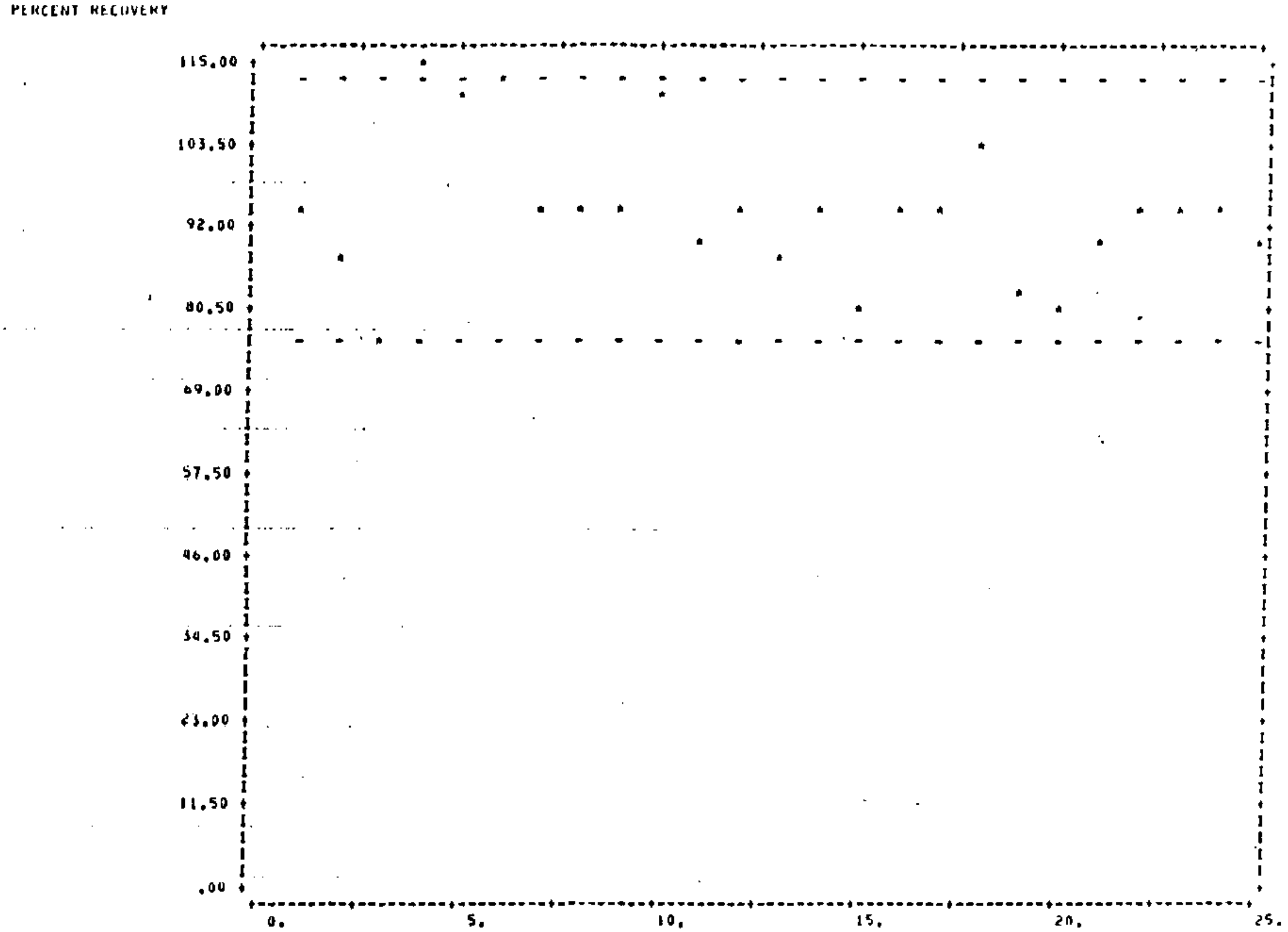
(*) - QC VALUES (-) -WARNING LIMITS

MEAN = 82.4609 STANDARD DEVIATION = 14.1964

MEDIAN = 82.5000 SKEWNESS = -.825153E-02 KURTOSIS = 4.72746

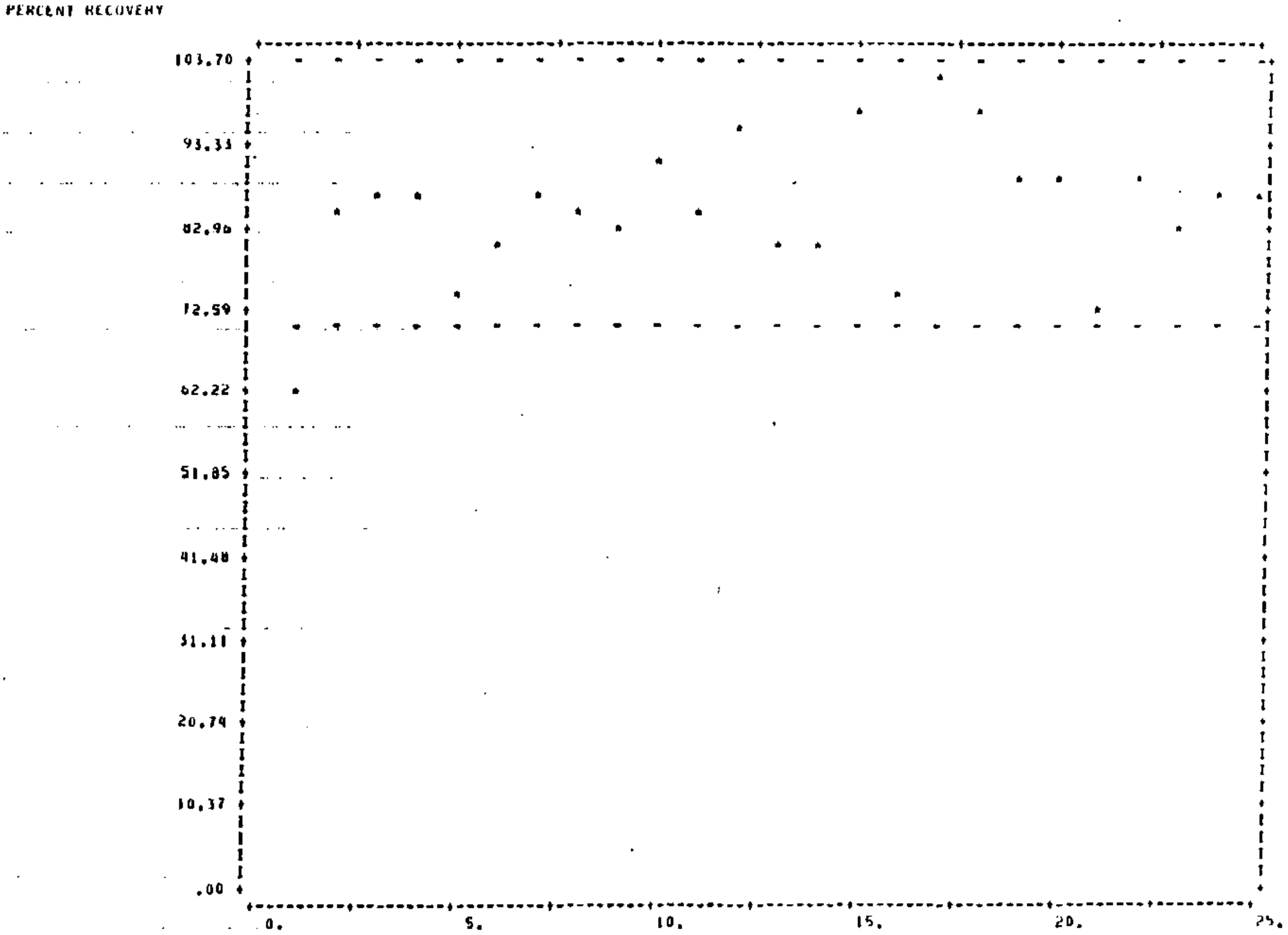


```
                                                        DCLENII        SAMPLES  23250 THROUGH  50867
                 (*) = QC VALUES    (-) =WARNING LIMITS
MEAN = 87.7040  STANDARD DEVIATION = 12.5846
MEDIAN = 88.5000  SKEWNESS = -.189742  KURTOSIS = 8.48701
```

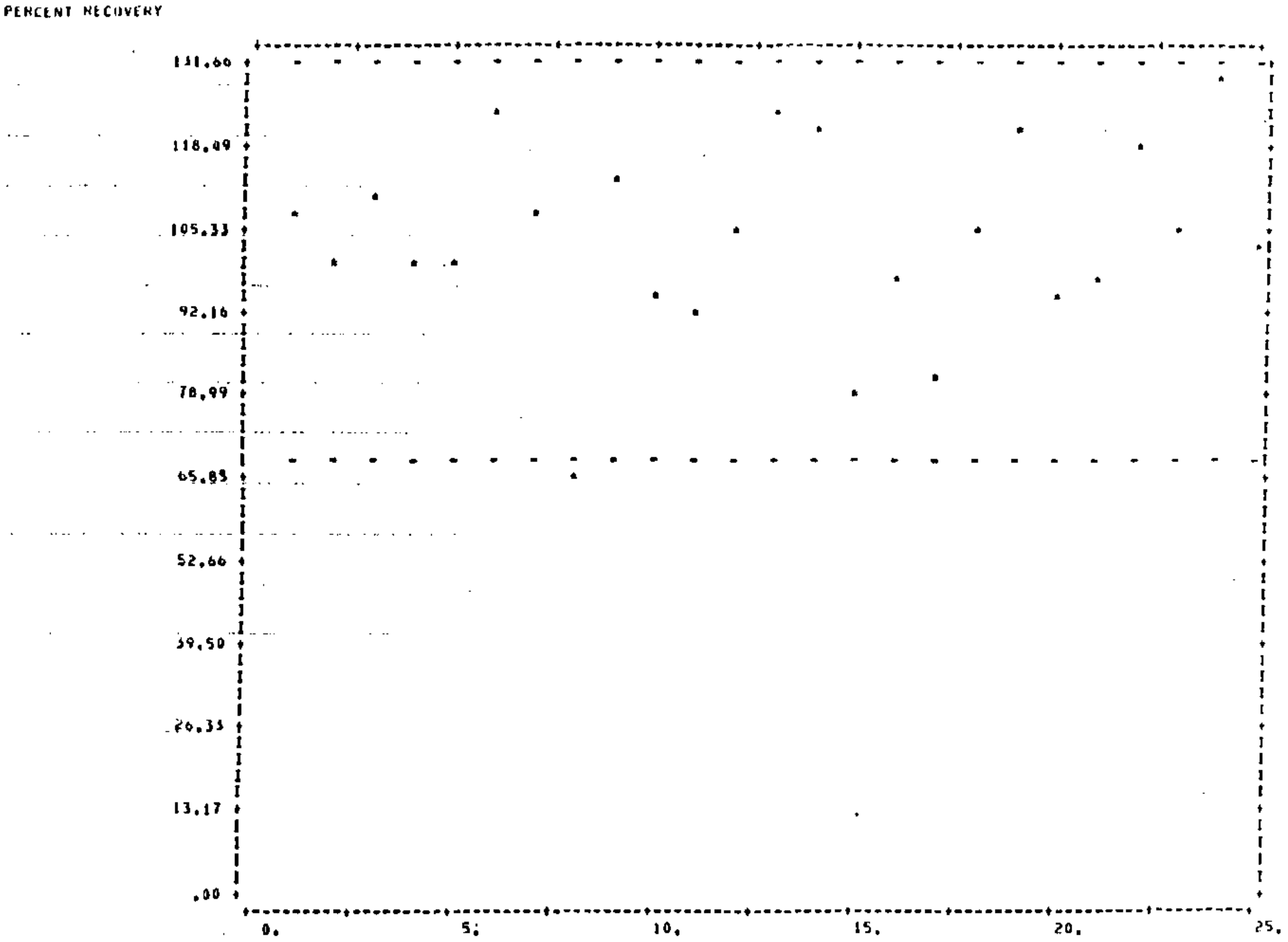


ETHBENZ SAMPLES 5593 THROUGH 50867

(*) - QC VALUES (-) -WARNING LIMITS
MEAN = 95.0119 STANDARD DEVIATION = 8.99539
MEDIAN = 95.0000 SKEWNESS = .396932E-02 KURTOSIS = 3.07061



```
                                                        DCLEN12         SAMPLES  23250 THROUGH  50867

                         (*) - QC VALUES   (-) -WARNING LIMITS
  MEAN = 86.6590  STANDARD DEVIATION = 8.52285
  MEDIAN = 87.0000  SKEWNESS = -.120015  KURTOSIS = 3.67436
```

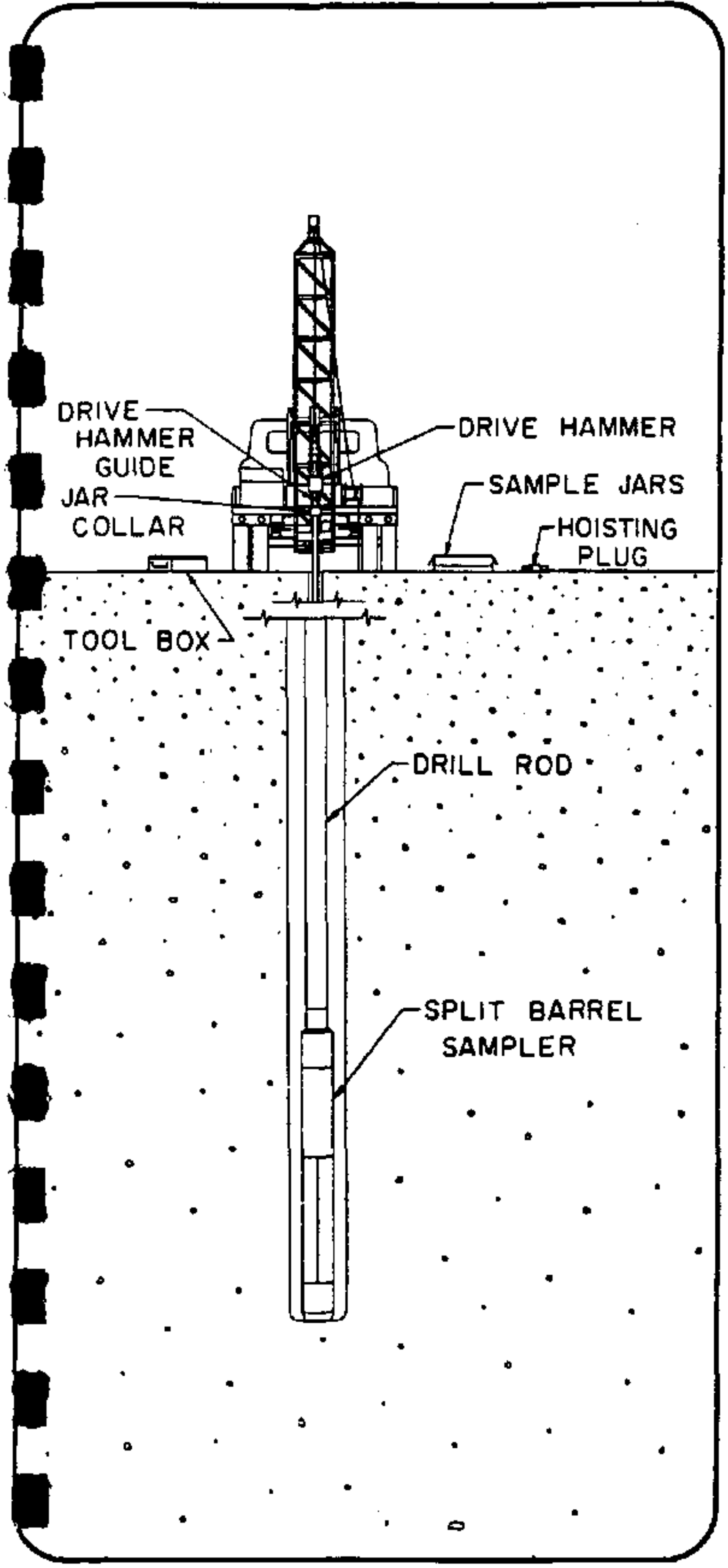


HG SAMPLES 64261 THROUGH 50904

(*) - QC VALUES (-) =WARNING LIMITS
MEAN = 99,1502 STANDARD DEVIATION = 15,7322
MEDIAN = 98,5798 SKEWNESS = ,108757 KURTOSIS = 2,46181

ATTACHMENT C

ASTM METHOD D-1586-84



Split barrel sampling

The following excerpts are from "Standard Method for penetration test and split-barrel sampling of soils."[1] (ASTM designation: D-1586-67 AASHO Designation: T-206-70.)

1. Scope

1.1 This method describes a procedure for using a split-barrel sampler to obtain respresentative samples of soil for identification purposes and other laboratory tests, and to obtain a measure of the resistance of the soil to penetration of the sampler.

2. Apparatus

2.1 Drilling Equipment – Any drilling equipment shall be acceptable that provides a reasonably clean hole before insertion of the sampler to ensure that the penetration test is performed on undisturbed soil, and that will permit the driving of the sampler to obtain the sample and penetration record in accordance with the procedure described in 3. Procedure. To avoid "whips" under the blows of the hammer, it is recommended that the drill rod have stiffness equal to or greater than the A-rod. An "A" rod is a hollow drill rod or "steel" having an outside diameter of 1-5/8 in. or 41.2 mm and an inside diameter of 1-1/8 in. or 28.5 mm, through which the rotary motion of drilling is transferred from the drilling motor to the cutting bit. A stiffer drill rod is suggested for holes deeper than 50 ft (15m). The hole shall be limited in diameter to between 2-1/4 and 6 in. (57.2 and 152mm).

2.2 Split-Barrel Sampler – The sampler shall be constructed with the dimensions indicated (in Fig. 1.) The drive shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The coupling head shall have four 1/2-in. (12.7-mm) (minimum diameter) vent ports and shall contain a ball check valve. If sizes other than the 2-in. (50.8-mm) sampler are permitted, the size shall be conspicuously noted on all penetration records.

2.3 Drive Weight Assembly – The assembly shall consist of a 140-lb (63.5-kg) weight, a driving head, and a guide permitting a free fall of 30 in. (0.76 m). Special precautions shall be taken to ensure that the energy of the falling weight is not reduced by friction between the drive weight and the guides.

2.4 Accessory Equipment – Labels, data sheets, sample jars, paraffin, and other necessary supplies should accompany the sampling equipment.

APPENDIX B

HEALTH AND SAFETY PLAN

APPENDIX B

HEALTH AND SAFETY PLAN (HASP)

ENARC-O MACHINE PRODUCTS
DIVISION OF KADDIS MANUFACTURING CORPORATION
NORTH BLOOMFIELD, NEW YORK

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2387.006

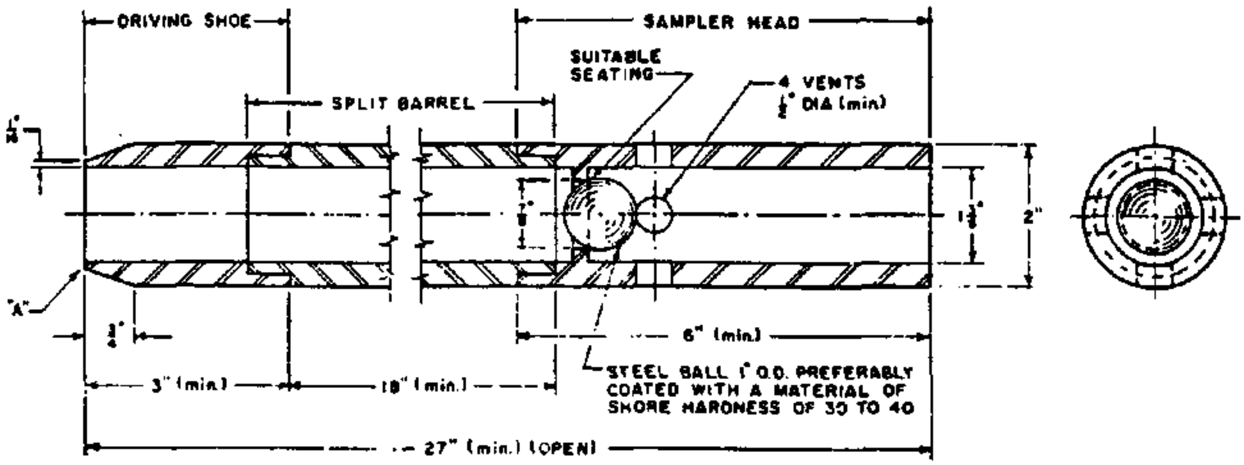
HEALTH AND SAFETY PLAN

KADDIS CORPORATION

DECEMBER 1989

O'BRIEN & GERE ENGINEERS, INC.
1304 BUCKLEY ROAD
SYRACUSE, NEW YORK 13221

SOIL SAMPLING - METHODS



Note 1 — Split barrel may be 1-1/2 in. inside diameter provided it contains a liner of 16-gage wall thickness.

Note 2 — Core retainers in the driving shoe to prevent loss of sample are permitted.

Note 3 — The corners at A may be slightly rounded.

Table of Metric Equivalents.

In.	Mm	Cm	In.	Mm	Cm
1/16 (16 gage)	1.5	. . .	2	. . .	5.08
1/2	12.7	. . .	3	. . .	7.62
3/4	19.0	1.90	6	. . .	15.24
7/8	22.2	2.22	18	. . .	45.72
1-3/8	34.9	3.49	27	68.58	
1-1/2	38.1	3.81			

Fig. 1 — Standard Split Barrel Sampler Assembly

3. Procedure

3.1 Clear out the hole to sampling elevation using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sands and silts withdraw the drill bit slowly to prevent loosening of the soil around the hole. Maintain the water level in the hole at or above ground water level.

3.2 In no case shall a bottom-discharge bit be permitted. (Side-discharge bits are permissible.) The process of jetting through an open-tube sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below sampling elevation. Record any loss of circulation or excess pressure in drilling fluid during advancing of holes.

3.3 With the sampler resting on the bottom of the hole, drive the sampler with blows from the 140-lb (63.5 kg) hammer falling 30 in. (0.76 m) until either 18 in. (0.45 m) have been penetrated or 100 blows have been applied.

3.4 Repeat this operation at intervals not longer than 5 ft (1.5 m) in homogeneous strata and at every change of strata.

3.5 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fractions thereof. The first 6 in. (0.15 m) is considered to be a seating drive. The number of blows required for the second and third 6 in. (0.15 m) of penetration added is termed the penetration resistance, N. If the sampler is driven less than 18 in. (0.45 m), the penetration resistance is that for the last 1 ft (0.30 m) of penetration (if less than 1 ft (0.30 m) is penetrated, the logs shall state the number of blows and the fraction of 1 ft (0.30 m) penetrated).

3.6 Bring the sampler to the surface and open. Describe carefully typical samples of soils recovered as to composition, structure, consistency, color, and condition; then put into jars without ramming. Seal them with wax or hermetically seal to prevent evaporation of the soil moisture. Affix labels to the jar or make notations on the covers (or both) bearing job designation, boring number, sample number, depth penetration record, and length of recovery. Protect samples against extreme temperature changes.

4. Report

4.1 Data obtained in borings shall be recorded in the field and shall include the following:

4.1.1 Name and location of job,
4.1.2 Date of boring — start, finish,
4.1.3 Boring number and coordinate, if available,
4.1.4 Surface elevation, if available,
4.1.5 Sample number and depth,
4.1.6 Method of advancing sampler, penetration and recovery lengths,
4.1.7 Type and size of sampler,
4.1.8 Description of soil,
4.1.9 Thickness of layer,
4.1.10 Depth to water surface; to loss of water; to artesian head; time at which reading was made,
4.1.11 Type and make of machine,
4.1.12 Size of casing, depth of cased hole,
4.1.13 Number of blows per 6 in. (0.15 m)
4.1.14 Names of crewmen, and
4.1.15 Weather, remarks.

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[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee D-18 on Soil and Rock for Engineering Purposes. A list of members may be found in the ASTM Year Book.

Current edition accepted October 20, 1967. Originally issued, 1958. Replaces D-1586-64T.

SECTION 1 - INTRODUCTION

1.01 Background

Kaddis Corporation owns and operates a metal machining facility, Enarc-O Machine Products, Inc. (Enarc-O) located in the Town of Lima, Livingston County, New York. Figure 1 illustrates the general site location. The area surrounding Enarc-O is predominantly residential. A small auto repair shop is located south of the facility. Additionally, a small manufacturing facility was once located on the property adjacent to the eastern boundary of the Enarc-O property.

The site encompasses approximately six acres and is situated on top of a small ridge at an elevation of approximately 720 feet above mean sea level. Honeoye Creek is located about 400 feet east of the property at an elevation approximately 20 feet lower than the site.

The unconsolidated deposits in the site area are reportedly glacial drift comprised of stratified silt, clay and fine-grained sand. One to 35 feet of this material overlies the Onondaga Limestone bedrock. (Fairchild, H.L; Genesee Valley hydrography and drainage; Rochester Academy of Science, V 7; 1935.)

During 1985, sampling and analysis of several residential wells in the area surrounding the Enarc-O property was conducted by the New York State Department of Health (NYSDOH), the New York State Department of Environmental Conservation (NYSDEC) and the Livingston County Department of Health (LCDOH). These analyses revealed detectable concentrations of chlorinated solvents, including 1,1,1-trichloroethane and trichloroethylene, in the ground water at the Enarc-O site and at some of the neighboring properties.

In July 1987 the United States Environmental Protection Agency (USEPA) Region II requested that Enarc-O develop a site assessment work plan to evaluate the general hydrogeologic conditions and in particular the ground water quality on the Enarc-O site. A proposed work plan was subsequently prepared and submitted to USEPA Region II in August 1987. Comments on the August 1987 Work Plan received from USEPA dated October 22, 1987 and February 1, 1988 were then incorporated and the plan was resubmitted in March 1988. Comments pertaining to the March 1988 plan were received on June 30, 1988. These comments were addressed in a letter dated July 21, 1988. On February 2, 1989 USEPA comments were received and subsequently incorporated into this Work Plan.

1.02 Site Investigstion Purpose

The primary objective of this study is to determine if a source of chlorinated solvents detected in local ground water is located on the Enarc-O property. This will be accomplished by evaluating the on-site hydrogeologic conditions. More specifically an assessment of the subsurface geology, ground water flow patterns and ground water chemistry will be completed.

Several areas were identified by USEPA for investigation on the Enarc-O property. These areas were located during the Background Information Review and are illustrated on Figure 2 as follows:

1. Area surrounding a recently excavated and removed gasoline storage tank.
2. Area around the removed above ground solvent storage tank where the 1985 spill of 1-1-1 trichloroethane occurred.

3. Area where waste oil is retained.

4. Area around Enarc-O's loading dock, EPA reportedly has reason to believe the entire area was covered with an oily residue and was used to store drums at some point in the past.

5. Area of the parking lot where used oils were used for dust control. The southeast corner of the is area was where the excavated soils from the 1985 spill were spread out to allow volatilization to occur.

6. Area southwest of the storage building where drums are currently stored.

1.03 Site Investigation Work Tasks

The site investigation (SI) work tasks as discussed in the Work Plan dated March 1989 and the Interim Technical Memorandum (December 1989) are as follows:

Task 1: Background Information Review
Task 2: Fracture Trace Analysis and Geophysical Survey
Task 3: Interim Technical Memorandum
Task 4: Soil Sampling and Analysis
Task 5: Ground Water Monitoring Well Installations
Task 6: Ground Water Monitoring Well Sampling and Analysis
Task 7: Data Interpretation and Report Preparation

To date the following tasks have been completed:

Task 1: Background Information Review
Task 2: Fracture Trace Analysis and Geophysical Survey
Task 3: Interim Technical Memorandum

Task 1 included document compliation and review and a non-invasive site inspection. Task 2 included a visual surficial geologic assessment and a non-intrusive geophysical survey. Task 3 was completed off-site.

The following tasks have yet to be completed:

Task 4: Soil Sampling and Analysis

Task 5: Ground Water Monitoring Well Installations

Task 6: Ground Water Monitoring Well Sampling and Analysis

Task 7: Data Interpretation and Report Preparation

Tasks 4, 5, and 6 involve invasive techniques including drilling and removal of soils and ground water from the subsurface. Task 7 will be completed off-site. Detailed descriptions of these work tasks are provided in the Interim Technical Memorandum (December 1989) and the Quality Assurance Project Plan QAPP) which are provided as a single document which also included this Health and Safety Plan (HASP). This HASP addresses health and safety requirements for personnel completing the on-site activities listed above.

SECTION 2 - PROJECT PERSONNEL

The following responsibilities and authorities have been or will be assigned to designated O'Brien & Gere Engineers personnel for the Enarc-O Site Investigation activities in North Bloomfield, New York.

Project Manager

This person acts in a supervisory capacity over all employees and activities with respect to O'Brien & Gere's contractual obligations to during the Kaddis SI. The Project Manager for this investigation is Mr. James Mickam. The Project Manager is responsible for assuring that Health and Safety responsibilities are carried out in conjunction with this site investigation.

Project Supervisor

This person, under the supervision of Project Manager, oversees field and related activities specific to contractual agreement to Kaddis Corporation. Deborah Wright is appointed to act in this capacity during the SI. (Note: the Project Supervisor is the same as the "Field Operations Manager" as referenced in the QAPP).

Health & Safety Coordinator

The Health & Safety (H&S) Coordinator is responsible solely for O'Brien & Gere's employees, unless otherwise specified in an appropriate written agreement between O'Brien & Gere Engineers, Inc. and the Kaddis Corporation. The Site Health & Safety Coordinator has the following duties:

- responsibility for the field implementation, evaluation, and any necessary field modifications of this Health and Safety Plan.
- responsibility for maintaining adequate supplies of all personal protective equipment as well as calibration and maintenance of all monitoring instrument.
- authority to suspend site operation at the Kaddis Site due to any ineffectiveness of or non-conformance to this Health and Safety Plan.

Mark McGowan, C.I.H. will be the Health & Safety Coordinator. An alternate On-Site Safety Coordinator will be designated by the Health and Safety Coordinator, as necessary.

SECTION 3 - HEALTH AND SAFETY HAZARDS

Table 1 lists chemical compounds which may be present during site investigation (SI) activities, based on available data. The compounds listed have been chosen to provide a framework for the development of this Health and Safety Plan. Several compounds including benzene are present on the site. Of these, benzene has the lowest established Permissible Exposure Limit (PEL). Thus, benzene has been selected as an indicator compound for the health and safety plan based on its toxicity.

Table 2 lists potential health and safety hazards that may be encountered based on general site tasks. This list has been compiled based on scheduled activities and potential site conditions.

SECTION 4 - PERSONAL PROTECTIVE EQUIPMENT

Protective Equipment

All personnel will be provided with appropriate personal safety equipment and protective clothing. Each individual will be properly trained in the use of this safety equipment before the start of field activities. Safety equipment and protective clothing shall be used as directed by the Site Safety Coordinator. All such equipment and clothing will be cleaned and maintained in proper condition by project personnel. The Site Safety Coordinator will monitor the maintenance of personnel protective equipment to ensure proper procedures are followed.

Personal protective equipment will be worn at all times, as designated by this Health and Safety Plan. Levels of protective clothing and equipment have been assigned to specific work tasks at a basic level D. Results from on-site readings will be used to set task and point specific action levels and levels of personal protection. These are detailed below.

The personal protective equipment levels designated below are in conformance with EPA criteria for Level C and D protection. All respiratory protective equipment used will be approved by NIOSH/MSHA.

Level C Protection

A. Full-face or half face air purifying respirator equipped with appropriate organic vapor/dust canisters or cartridges.

B. Chemical-resistant disposable coveralls such as Tyvek^R or Poly-coated Tyvek^R. Suits will be one piece with hoods and elastic wrist bands.

C. Outer nitrile gloves and inner latex surgical gloves (taped to suit).

D. Leather, steel-toe boots with rubber overboots (taped to suit).

E. Options as required:

    1. Coveralls
    2. Disposable outer boots
    3. Escape mask
    4. Hard hat
    5. Face shield
    6. Hearing protection
    7. Safety glasses

Level D Protection

A. Full-face/half-face air-purifying respirator equipped with appropriate canisters or cartridge must be available for use; and all potential users trained and medically approved for such use:

B. Coveralls or long sleeve shirts and long pants.

C. Outer nitrile gloves at a minimum for all material handling activities. Inner latex surgical gloves are recommended where practical.

D. Leather, steel-toe boots with rubber overboots.

E. Level C clothing protection readily available.

F. Options as required:

    1. Disposable outer boots

2. Hard hat
3. Safety glasses
4. Hearing protection

SECTION 5 - SITE ACTIVITIES AND ASSOCIATED PERSONNEL PROTECTIVE REQUIREMENTS

The levels of protection assigned to each activity (below) represent a best estimate of exposure potential and protective equipment needed for that exposure. Determination of levels was based on "worst case" data available from previous site investigations. The site safety officer will revise those levels of protection, up or down, based on air monitoring results and on-site assessment of actual exposures.

Physical Site Activity	Location	Personal Protection Required
Installation of monitoring wells	Clean areas	Level D with safety glasses (or higher, depending upon conditions)
	Contaminated areas	Level C with safety glasses and half-face respirator
Performing ground water and surface water sampling	Monitoring Wells/Run off areas	Level D with Tyvek coverall, outer boots, inner and outer gloves
Soil borings	Various areas	Level D (or higher, depending on conditions) with Tyvek coverall, outer boots, inner and outer gloves
Soil samples	Various areas	Level D with outer boots (or higher, depending on conditions)

Physical Site Activity	Location	Personal Protection Required
Site Surveys (non-intrusive)	Entire Site	Level D with outer boots (or higher depending upon conditions)

SECTION 6 - SITE AIR MONITORING

Field activities associated with the SI may pose potentially hazardous conditions, such as the release of hazardous substances into the breathing space. These substances may be in the form of vapors, dusts, or mists that can enter the body through ingestion, inhalation, adsorption and direct contact. Monitoring of these substances will be performed to ensure appropriate personal protective measures are employed during site activities.

The following describes the monitoring parameters to be evaluated during the SI. Recommended instruments to be used are also provided in the discussion. All instruments to be used during site activities will meet the established requirements set forth OSHA, MSHA, NIOSH, and state agencies were applicable. Table 2-A lists the activities and the associated site monitoring.

Organic Vapor Concentrations - will be monitored in fifteen minute intervals during activities as listed in Table 2-A, in the areas specified with an organic vapor meter model 128 (FID) or TIP II (PID). All activities not denoted in Table 2A can be monitored hourly for the first 2 hours. Organic vapor concentrations will be used as action level criteria for upgrading or downgrading protective equipment (See Section 8) and in implementing additional precautions or procedures. A backup organic vapor meter will be present throughout site activities in the event of an instrument malfunction. Draeger tubes and the associated hand pumps will be employed for the quantification of specific compound concentration, if levels exceed those listed in Table 3.

All site monitoring will be conducted by or under the supervision of the Site Safety Coordinator. All readings obtained will be recorded in a dedicated site notebook by the Project Supervisor or designee. The Site Safety Coordinator will maintain all monitoring instruments throughout the site investigation to ensure their reliability and proper operation.

SECTION 7 - ACTION LEVELS

Action levels have been established for activity cessation, site evacuation, emergency response, and the upgrade or downgrade in the level of personal protective equipment. Table 3 lists the action levels, airborne concentrations and their respective personal protection. Section 6 discusses the minimal personal protection required for specified site activities. Changes to these specified levels are dependent on the results of air monitoring, as described below.

Note that these action levels are for monitoring in the breathing space of workers on the site. The action levels are based on the 1989 Permissible Exposure Limits (PELs) as determined by OSHA for the specific compounds detected during on-site monitoring.

The approach for air monitoring is as follows:

1. The direct-reading PID will be calibrated to most accurately reflect the scope of volatiles identified.
2. Using the PID, work activities will be monitored for organic vapors.
3. Where/when organic vapors are detected with the PID, selected Draeger tubes will be used to identify the presence/absence of benzene. Action levels would then follow the first column of Table 3. The presence of benzene is an important criteria for action levels due to its PEL of 1 ppm.
4. If non-benzene vapors cannot be identified, the third column of Table 3 will be used.
5. Personal monitoring will serve as a back-up to the direct reading instrument data when continuous exposures exceed

the action level in column 1 of Table 3 and provide qualitative and quantitative exposure data for the workers most at risk.

Monitoring for benzene will be performed at the start of every activity, and every fifteen minutes thereafter until the activity is complete. If benzene is detected with the use of Draeger tubes, SKC 224PCXZR7 air sampling pumps and charcoal tubes will be employed for the quantification of the concentration at the breathing zone.

Upon visual observation of air-borne particulate matter associated with on-site activities, a water spray will be applied to the area to control dust/particulate matter generation. If this control is not possible, SKC pumps and PVC filters will be employed for gravimetric analysis.

If organic vapor concentrations are measured (using a photoionization detector) above 1.0 ppm above background at the property line during site operations, said operations will be interrupted and assessed, and only continued if it can be determined that no off site impacts will result.

SECTION 8 - SITE ACCESS AND SITE CONTROL

8.01 Site Access

Access inside the specific worksite location at the Kaddis Corporation will be limited to trained authorized personnel. Such personnel include O'Brien & Gere employees, designated equipment operators, and designated client and state and federal agencies' representatives. However, access into the established exclusion zone where field investigative activities take place will be limited to those authorized personnel wearing appropriate personal protective equipment. The exclusion zones will be cordoned off with flagging tape or other suitable indicators designating the exclusion zone boundary. The zones will also be monitored by the Site Safety Coordinator to ensure personnel do not enter without proper personal protection. The contamination reduction zone, where personnel and equipment are decontaminated, and support zone, where support facilities, extra equipment, transport vehicles, etc. are located, should be located upwind of the current work zone.

Sign-in procedures may be implemented to ensure that authorized personnel only will participate in the investigatory activities. The Project Supervisor will coordinate this effort and maintain the generated documentation accordingly.

8.02 Site Control

Certain procedures must be followed to ensure suitable site control and limitation of access so that those persons who may be unaware of site conditions are not exposed to inherent hazards.

All excavations left open and unattended by site personnel will be appropriately barricaded and visibly posted with "Keep Out Danger", signs, warning flags, or other appropriate signs. Well caps will be secured by suitable locking devices to prevent unauthorized access. All heavy machinery and equipment will be stored in a secured area upon completion of daily activities. Lastly, all potentially contaminated media, such as cuttings and soils, will be secured in an area to prevent unauthorized tampering.

SECTION 9 - MEDICAL MONITORING

The Occupational Safety and Health Administration (OSHA) has established requirements for a medical surveillance programs designed to monitor and reduce health risks for employees potentially exposed to hazardous materials (29 CFR 1910.120). This program has been designed to provide baseline medical data for each employee involved in hazardous waste operations including field activities, and to determine his/her ability to wear personal protective equipment, such as chemical resistant clothing and respirators. Employees who wear or may wear respiratory protection must be provided respirators as regulated by 29 CFR 1910.134. This Standard requires that an individual's ability to wear respiratory protection be medically certified before he/she performs designated duties. Where medical requirements of 29 CFR 1910.120 overlap those of 29 CFR 1910.134, the most stringent of the two will be enforced.

The medical examinations must be administered on a preemployment and annual basis and as warranted by symptoms of exposure or specialized activities. These examinations shall be provided by employers without cost or loss of pay to the employee. For the purposes of this Health and Safety Plan, all subcontractors shall assume the employer's responsibility in obtaining the necessary medical monitoring and training for their employees pursuant to this section of 29 CFR 1910.120.

The examining physician is required to make a report to the employer of any medical condition which would place such employees at increased risk of wearing a respirator or other personal protective equipment. Each employer engaged in site work shall assume the responsibility of maintaining site personnel medical records as regulated by 29 CFR 1910.120 where applicable.

All employees contracted to work at the site designated by this Plan will be responsible to insure their employees have received the proper medical tests as regulated by 29 CFR 1910.120 and shall provide the contractor with certification of same.

SECTION 10 - PERSONNEL TRAINING

All applicable employees must have, at a minimum, received training in the following areas; meeting training requirements specified in 29 CFR 1910.120.

Subcontractor personnel will document their compliance with training and medical program requirements as shown in Exhibit 1.

In addition, site employees will undergo site-specific training prior to the start-up of any given project or task. As activities change at a particular site, related training will address potential hazards and associated risks, site operating procedures, emergency response and site control methods to be employed.

Specialized training will be provided as dictated by the nature of site activities. Specialized training will be provided for activities such as confined space entry, excavations and handling of unidentified substances. Employees involved in these types of activities will be given off-site instruction regarding the potential hazards involved with safety activities and the appropriate health and safety procedures to be followed. Off-site instruction is meant to include any areas where employees will not be exposed to site hazards.

Site personnel involved in the field activities will have received the appropriate basic training plus additional specific training where needed. This Health and Safety Plan must be distributed to all subcontractors prior to the start of field activities. A pre-operation meeting will be held to discuss the content of the Plan. Specialty training will be provided as determine by task and responsibility. All training of personnel will be conducted under direct supervision of qualified Health and Safety Personnel.

SECTION 11 - DECONTAMINATION

It is expected that the highest level of protection used at the Kaddis site will be Level C. Based on the level of expected exposure to contaminants, the following decontamination protocol will be used:

Station 1: Equipment Drop.

1. Deposit equipment used on-site (tools, sampling devices and containers, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths. Segregation at the drop reduces the probability of cross contamination. During hot weather operations, a cool down station may be set up within this area.

Station 2: Outer Garment, Boots, and Gloves Wash and Rinse.

2. Scrub outer boots, outer gloves and splash suit with detergent water. Rinse off using copious amounts of water.

Station 3: Outer Boot and Glove Removal.

3. Remove outer boots and gloves. Deposit in container with plastic liner.

Station 4: Canister or Mask Change.

4. If worker leaves exclusive zone to change canister (or mask), this is the last step in the decontamination procedure. worker's canister is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.

Station 5: Boot, Gloves and Outer Garment Removal.

5. Boots, chemical-resistant splash suit, inner gloves removed and deposited in separate containers lined with plastic.

Station 6: Face Piece Removal.

6. Face piece is removed. Avoid touching face with fingers. Face piece deposited on plastic sheet.

Station 7: Field Wash.

7. Hands and face are thoroughly washed. Shower if body contamination is suspected.

All decontamination waste waters will be collected and disposed of according to applicable regulations. This will be done at the direction of the Project Supervisor or Project Manager.

In general, decontamination involves scrubbing with a nonphosphate soap/water solution followed by clean water rinses. All disposable items will be disposed of in a dry container. Certain parts of contaminated respirators, such as harness assemblies and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. In addition to being decontaminated, all respirators, nondisposable protective clothing, and other personal articles must be sanitized before they can be used again unless they are assigned to individuals. The manufacturer's instructions should be followed in sanitizing the respirator masks. The Site Safety Coordinator will be responsible for supervising the proper protective equipment.

11.02 Equipment Decontamination

Decontamination will be applicable to all drilling, boring, and sampling activities. All drilling equipment mobilized to the Kaddis Site will receive initial decontamination. Decontamination will consist of steam cleaning of the entire rig to the satisfaction of the Site Supervisor or the responsible Quality Assurance Personnel. All dirt, oil grease or other foreign materials that are visible will be removed from metal surfaces. Scrubbing with a wire brush may be required to remove materials that adhere to the surfaces.

All drilling equipment will be stored on plastic sheeting above ground, either on the drill rig at the drill site or on wooden supports. Equipment not in use will be covered with plastic and stored at a designated storage area.

The rear portion of the drill rig will be decontaminated by steam cleaning between test borings and/or monitoring well installations. In addition all equipment entering a test boring or well boring but not used for sample collection, will be decontaminated using a steam cleaning followed by a control water rinse.

Sample collecting equipment contacting soil and/or rock samples will be decontaminated after each use by a low phosphate detergent brushing followed by a clean water rinse. An isopropyl rinse followed by a final rinse with demonstrated analyte free deionized water will complete the decontamination procedure. Decontaminated equipment will be allowed to air dry before wrapping in aluminum foil, shiny side out, for transport. Isopropanol used for decontamination will be pesticide grade or better and will be stored separately from the demonstrated analyte free deionized water.

It may be necessary to insert hoses and/or narrow diameter pipe into test borings and wells during installation, development, purging, and sampling. These items will also be decontaminated initially, and after each use. The outside of the hose or pipe will be decontaminated as specified above for any item entering a well boring. The inside will be cleaned with soapy water and rinsed with deionized water.

SECTION 12 - EMERGENCY RESPONSE

12.01 Notification of Site Emergencies

In the event of an emergency, site personnel will signal distress with three blasts from an appropriate horn (vehicle horn, air horn, etc.). All appropriate authorities will then be immediately notified of the nature and extent of the emergency.

Table 4 contains Emergency Response Telephone Numbers. This table will be maintained at all work sites by the Site Safety Coordinator, so it is always accessible in case of an emergency. The location of the nearest telephone will be determined prior to initiation of on-site activities.

Should someone be transported to a hospital or doctor, a copy of this Health and Safety Plan must accompany them.

12.02 Responsibilities

The Site Safety Coordinator will be responsible for responding to all emergencies. The Site Safety Coordinator will:

1. Notify appropriate individuals, authorities and/or health care facilities of the activities and hazardous of the investigation;
2. Ensure that the following safety equipment is available at the site: eyewash station, first aid supplies, and fire extinguishers;
3. Have working knowledge of all safety equipment available at the site; and

4. Ensure that a map which details the most direct route to the nearest hospital is prominently posted with the emergency telephone numbers.

12.03 Accidents and Injuries

In the event of a safety or health emergency at the site, appropriate emergency measures will immediately be taken to assist those who have been injured or exposed and to protect others from hazards, (See Figures 4 for Hospital Route Map and 5 for Site Emergency Evacuation Map). The Site Safety Coordinator will be immediately notified and will respond according to the seriousness of the injury. Personnel trained in First-Aid will be present during site activities to provide appropriate treatment of injuries or illnesses incurred during operations. The Project Manager and Project Supervisor will be immediately informed of any serious injuries.

Upon notification of an exposure incident, the Site Safety Coordinator will contact the appropriate emergency response personnel for recommended medical diagnosis and, if necessary, treatment. The Project Supervisor and the Site Safety Coordinator will investigate facility/site conditions to determine whether and at what levels exposure actually occurred, the cause of such exposure and means to prevent the incident from recurring.

An exposure-incident reporting form will be completed by the Site Survey Coordinator, the Project Supervisor and the exposed individual. The form will be filed with the employee's medical and safety records to serve as documentation of the incident and the actions taken.

12.04 Site Communications

Two-way radios are available for use during field activities to facilitate communications. Hand signals will be utilized where radios are impractical or unsafe. If possible, mobile phones will be present during site activities for emergency response and office communications. Public telephones will be located prior to the start-up of activities as back up to the mobile phones or as the primary off-site communication network.

12.05 Safe Refuge

The project personnel's vehicles shall serve as the immediate place of refuge in the event of an emergency. If evacuation from the area is necessary, the vehicles will be used to transport all on-site personnel to safety.

12.06 Site Security and Control

Site security and control shall be maintained by the Project Supervisor and/or their designee, and the Health & Safety Coordinator and/or his designee. Their duties include limiting access to the site to authorized personnel, oversight of project equipment and materials, and general oversight of site activities.

12.07 Emergency Response and Decontamination

In case of an emergency, all personnel should evacuate to safe refuge, both for their own personal safety and to prevent hampering response/rescue efforts. In the case of an evacuation, the Site Safety Coordinator (HSC) will account for all personnel. A log of all individuals entering and leaving the site will be kept to so that everyone can be accounted for in an emergency.

In the event of an emergency, the Site Safety Coordinator will direct all notification, response and follow-up actions. Contacts for any outside response personnel (ambulance, fire department, etc.) will be done at the direction of the Site Safety Coordinator. If necessary, immediate medical care should be provided by individuals trained in first aid procedures. If an individual is transported to a hospital or doctor, a copy of the Health & Safety Plan must accompany the individual.

Follow-up activities must be addressed following an emergency before on-site work is resumed. All necessary emergency equipment must be recharged, refilled or replaced. Government agencies must be notified as appropriate. An investigation of the incident needs to be conducted as soon as possible. The resulting report must be accurate, objective, complete and authenticated (signed and dated).

12.08 Medical/First Aid Response

On-site medical and/or first aid response to an injury or illness will be provided only by trained personnel competent in such matters. The Site Safety Coordinator is responsible for directing these actions and contacting the appropriate off-site response personnel (paramedics, etc.)

12.09 Fire Fighting Procedures

A fire extinguisher will be available in the Project Supervisor's (or his designee's) vehicle during all on-site activities. This is only intended for small fires. Where the fire cannot be controlled with the extinguisher, the area should be evacuated immediately. The HSC will direct the contacting of fire department response personnel.

12.10 Emergency Decontamination Procedure

The extent of emergency decontamination depends on the severity of the injury or illness and the nature of the contamination. Whenever possible, decontamination should consist of (at a minimum) washing, rinsing and/or cutting off of contaminated outer clothing and equipment. If there is not time for this, the person should be given first aid treatment, and then wrapped in plastic or a blanket prior to transport to medical care. If heat stress is a factor in the victim's illness/injury, the outer protective garment must be removed from the victim immediately.

12.11 Emergency Equipment

On-site equipment for safety and emergency response shall be maintained, as follows:

- fire extinguisher
- first aid kit
- eye wash station (wash bottles at a minimum)
- extra copy of the Health and Safety Plan

These will be located in the field vehicle of the on-site Project Supervisor and/or the Site Safety Coordinator.

SECTION 13 - SPECIAL PRECAUTIONS AND PROCEDURES

The Kaddis Site Investigation poses potential exposure risks to both chemical and physical hazards. The chemical risks have been explained in detail in the previous sections. The potential for chemical exposure to hazardous substances is significantly reduced through the use of air monitoring, personal protective clothing, engineering controls, and implementation of safe work practices.

Other potential hazards that are associated with the site activities include working around heavy equipment, heat stress and site refuse. Precautionary measures have been established to reduce these risks to a minimum during site activities.

13.01 Heat and Cold Stress

The timing of this project may be such that heat and/or cold stress may pose a threat to the health and safety of site personnel. Work/rest regimens will be employed as necessary so that personnel do not suffer adverse effects from heat and/or cold stress. Special clothing and an appropriate diet and fluid intake will be recommended to all site personnel to further reduce these temperature-related hazards. The work/rest regimens will be developed following the guidelines in the ACGIH, Threshold Limit Values and Biological Exposure Indices for 1988-1989.

13.02 Heavy Machinery/Equipment

All site employees must remain aware of those site activities that involve the use of heavy equipment and machinery. Respiratory protection and protective eyewear may be worn frequently during site activities. This protective equipment significantly reduces peripheral vision of the wearer. Therefore, it is essential that all employees at the site exercise extreme caution during operation of equipment and machinery to avoid physical injury to themselves or others.

13.03 Construction Materials and Site Refuse

All construction materials and site refuse will be contained in appropriate areas or facilities. Site personnel should make certain that fencing, cement, drill cuttings, etc. are not scattered throughout the area of activity and that all trash and scrap materials are immediately and properly disposed of.

13.04 Additional Safety Practices

The following are important safety precautions which will be enforced during this investigation:

1. Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases that probability of hand-to-mouth transfer and ingestion of material is prohibited in any area designated as contaminated.
2. Hands and face must be thoroughly washed upon leaving the work area and before eating, drinking, or any other activity.
3. Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.
4. No excessive facial hair which interferes with the effectiveness of a respirator will be permitted on personnel required

to wear respiratory protection equipment. The respirator must seal against the face so that the wearer receives air only through the air purifying cartridges attached to the respirator. Fit testing will be performed prior to respirator use to ensure a proper seal is obtained by the wearer.

5. Contact with potentially contaminated surfaces should be avoided whenever possible. One should not walk through puddles, mud, or other discolored surfaces; kneel on ground; lean, sit or place equipment on drums, containers, vehicles, or the ground.

6. Medicine and alcohol can potentiate the effect from exposure to certain compounds. Controlled substances and alcoholic beverages must not be consumed by personnel involved in the project. Consumption of prescribed drugs must be at the direction of a physician familiar with the person's work.

7. Personnel and equipment in the work areas should be minimized, consistent with effective site operations.

8. Work areas for various operational activities should be established.

9. Procedures for leaving the work area must be planned and implemented prior to going to the site. Work areas and decontamination procedures and locations must be established on the basis of prevailing site conditions.

10. Respirators will be issued for the exclusive use of one worker and will be cleaned and disinfected after each use by the worker.

11. Safety gloves and boots will be taped to the disposable, chemical-protective suits.

12. All unsafe equipment left unattended will be identified by a "DANGER, DO NOT OPERATE" tag.

13. Hearing protection may be required for site personnel working around heavy equipment. This requirement will be at the discretion of the Site Safety Coordinator. Disposable, form-fitting plugs are preferred.

14. Cartridges for air-purifying respirators in use will be changed daily at a minimum.

15. Self-contained breathing apparatus (SCBA) and air-purifying respirators will be inspected daily by the Site Safety Coordinator.

16. All activities in the exclusion zone will be conducted using the "Buddy System". The Buddy is another worker fully dressed in the appropriate PPE, who can perform the following activities:

    - Provide his/her partner with assistance;
    - Observe his/her partner for sign of chemical or heat exposure;
    - Periodically check the integrity of his/her partner's PPE; and
    - Notify others if emergency help is needed.

TABLE 1

POTENTIAL SITE COMPOUNDS AND ASSOCIATED EXPOSURE INFORMATION

Contaminants	TLV/PEL	Characteristics	Route of Exposure	Symptoms of Overexposure*	Target Organs
Benzene	1 ppm	Colorless liquid, aromatic odor	Inhalation, Absorption, Ingestion	(1), (2), (3), (5)	Blood, CNS, skin, bone marrow, eyes, respiratory system
Trichloroethylene	100 ppm	Odorless liquid, sweet odor	Inhalation Ingestion	(1), (2), (3), (5)	Respiratory System, heart, liver, kidney, CNS, skin
1,1,1 Trichloroethane	350 ppm	Colorless liquid, mild sweet odor	Inhalation, Ingestion Contact	(1), (2), (3), (4)	Skin, CNS, CVS, eyes

(1) Eye, Nose, Throat, Skin Irritation or Burns
(2) Headache, Fatigue, Nausea
(3) Lightheaded, Some Nausea, Dull Visual and Audio Response
(4) Central Nervous System (CNS) Disorder, Convulsions, Sweating
(5) Potential or Known Carcinogens
PEL - Permissible Exposure Limits (OSHA) - 8 hour exposure
TLV - Threshold Limit Value (ACGIH) - 8 hour exposure
* Symptoms may include any or all listed depending upon concentration, duration, and route of exposure.

TABLE 2

HEALTH AND SAFETY HAZARDS

Hazard	Description	Location	Procedure Used to Monitor/Reduce Hazard
Heavy Equipment/ Construction Activity	Drill Rigs, Machinery Backhoes	Throughout Site	Personnel maintain eye contact with operators; hard hats, safety shoes, and eye protection as appropriate worn during equipment operation.
Overhead/Underground Utilities	Electrical, Sewer, Gas Water, Communications	To Be Determined	Locate existing utilities prior to site operations. Design installation of additional utilities so that they do not interfere with site operations.
Refuse and Materials	Drums, hoses, etc.	Throughout Site May be Buried	Use caution when walking or working in areas with debris. Clear debris, if possible. Steel toes.
Heat Producing/ Electrical Equipment	Generators/Drill Rigs	Throughout Site	Operate equipment away from vegetation and other materials that may ignite. Maintain fire-fighting equipment in the vicinity of operating equipment.
Heat Stress	Personnel working under extreme temperature are subject to adverse temperature-related effects	Throughout Site	Employ buddy system. Each worker is responsible for visually monitoring his/her partner for signs of heat stress. Site safety personnel will also monitor worker's conditions and establish work/rest regiments and recommend appropriate diet.
Chemical Exposure	Personnel can be exposed to various compounds associated with the site	Throughout Site	Follow guidelines in Safety Plan. Be familiar with signs and symptoms of exposure and first aid procedures. Report suspected over-exposure to supervisor immediately.
Explosion/Flash Fire	Some compounds on sight have flash points between 123°F and 130°F.	Some drummed material	Use caution when working in high temperatures during summer months. Monitor for explosive vapor levels.

TABLE 2A

Task	Environmental Monitoring	Personal Monitoring
Property Survey	Photoionization Detector (PID) with Draeger or charcoal tube quantification if necessary.	None
Site Walkover	PID with Draeger or charcoal tube quantification if necessary.	None
Metal Detector Survey	PID with Draeger or charcoal tube quantification if necessary.	None
*Surface Soil Sampling	PID with Draeger or charcoal tube quantification.	Yes
*Monitoring Well Installation	PID with Draeger or charcoal tube quantification.	Yes
Aquifer Testing	PID with Draeger or charcoal tube quantification if necessary.	Yes
*Surface Water Investigation	PID with Draeger or charcoal tube quantification.	Yes

8Denotes activities which require 15-minute interval organic vapor monitoring.

TABLE 3

ACTION LEVELS

Benzene Present; Organic Vapor Concentrations (ppm)	Benzene Not Present; Known Organic Vapor Concentrations (ppm)	Benzene Not Present; Unknown Organic Vapor Concentrations (ppm)	Level of Personal Protection
LT 1.0	1/2 the lowest 1989 PEL of the contaminants detected as a result of monitoring performed in Section 7	LT 5	Level D with outer booties and safety glasses.
1 to 5	From the action level above to 10X that action level	5 - 50	Level C clothing with half-face respirator and cartridges appropriate for organic vapors, dust, mists, and acid gases; engineering controls to decrease vapor levels.
5 to 50	From 10X the action level to 100X the action level	50 to 500	Level C clothing with full-face respirator and cartridges appropriate for organic vapors, dust, mists, and acid gases; engineering controls to decrease vapor levels.
LT 50	LT 100X the action level	LT 500	Cessation of site activities until engineering controls are implemented to decrease vapor levels.

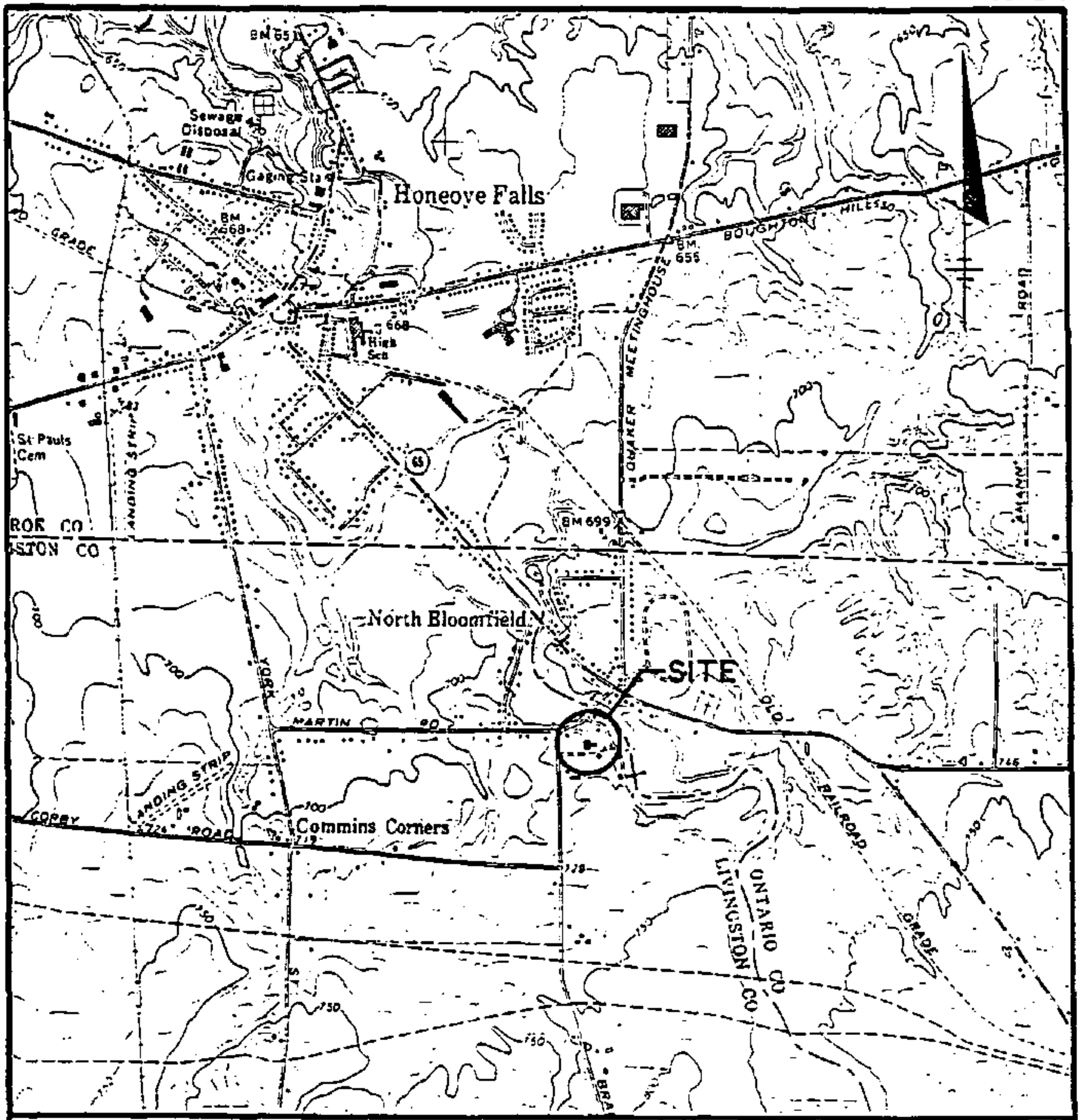
LT = Less Than

TABLE 4

EMERGENCY RESPONSE TELEPHONE NUMBERS

Agency	Address	Telephone No.
O'Brien & Gere Engineers, Inc. James Mickam Deborah Wright Mark McGowan Ed Wilson Caroline Woodward	5000 Brittonfield Parkway P.O. Box 4873 Syracuse, NY 13221	(315) 437-6100
Hospitals	Canandaigua	(716) 394-1100
	Strong Memorial	(716) 275-4551
Fire Department	Available through Police Department	911
Ambulance		911
EPA Regional Office (Region II)	Federal Building 26 Federal Plaza New York, NY 10278	(212) 264-9589
NYSDEC	Avon	(716) 226-2466
NYSDOH	Rochester	(716) 423-8071
Livingston County Department of Health		(716) 658-2866

FIGURE 1



KADDIS CORPORATION
NORTH BLOOMFIELD, NEW YORK

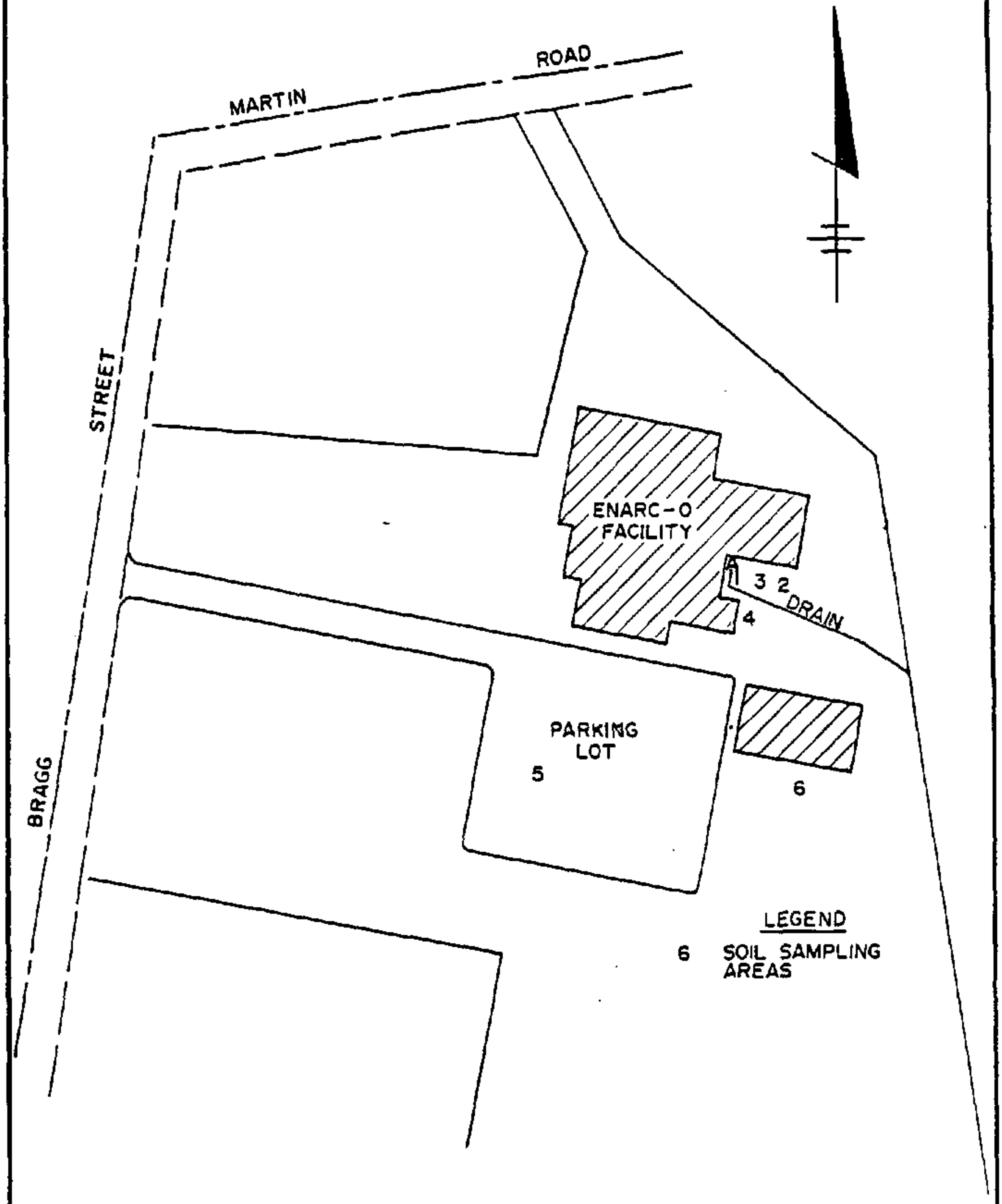
SITE LOCATION MAP

0 2000 4000
SCALE IN FEET

ADAPTED FROM HONEOYE FALLS, NEW YORK 7.5 MIN. U.S.G.S. QUADRANGLE (1971)

O'BRIEN & GERE ENGINEERS INC.

FIGURE 2



KADDIS CORPORATION
HONEOYE FALLS, NEW YORK

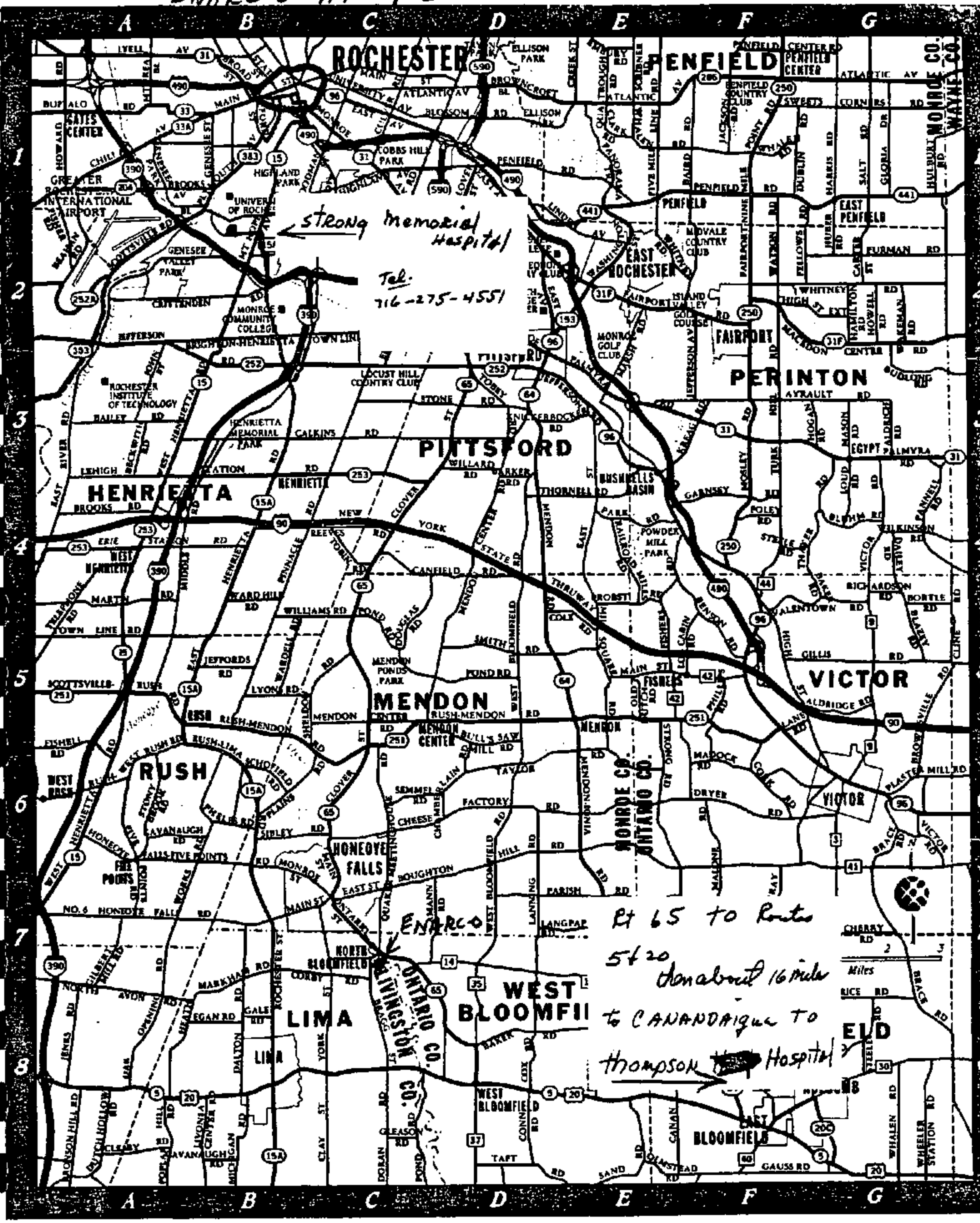
SITE MAP

(NOT TO SCALE)

Strong Memorial Hosp. at 1.5

ENARC-O at 7.2

North



Strong Memorial Hospital

Tel. 716-275-4551

ENARCO

Rt 65 to Route 5&20 then about 16 mile to CANANDAIGUA to Thompson ~~Hosp~~ Hospital

EXHIBITS

EXHIBIT 1

SUBCONTRACTOR OCCUPATIONAL SAFETY AND HEALTH CERTIFICATION

PROJECT: ______________________________

SUBCONTRACTOR: ______________________________

1. Contractor certifies that the following personnel to be employed during the Enarc-O Site Investigation have met the following requirements of the OSHA Hazardous Waste Operations Standard (29 CFR 1910.120) and other applicable OSHA standards, as required by O'Brien & Gere Engineers, Inc.

Subcontractor Personnel	Training	Respirator Certification	Medical Exam

2. Subcontractor certifies that it has received a copy of the Site Safety and Health Plan and will ensure that its employees are informed and will comply with its requirements.

3. Subcontractor further certifies that it has read and understands and will comply with all provisions of its contractual agreement.

RAW:jcp/27.25
May 1989