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July 16, 1984

Mr. Norman H. Nosenchuck, P.E.
Director
Division of Solid and Hazardous Waste
New York State
Department of Environmental Conservation
50 Wolf Road, Room 209
Albany, New York 12233-0001

Subject: Proposal for Brewster Well Field Site
Remedial Investigation/Feasibility Study
Village of Brewster, Putnam County, New York

Dear Mr. Nosenchuck:

We are pleased to submit our Technical Proposal for the above Brewster Well Field Site Remedial Investigation/Feasibility Study. As requested our Cost Proposal is enclosed, bound separately and in a separate envelope.

Metcalf & Eddy has over 75 years of experience in the waste engineering business. Strong capabilities along with a Project Team experienced in hazardous waste work will enable Mecalf & Eddy to oversee and perform the RI/FS for the Brewster Well Field Site. Assisting us in this project with concentrated efforts in the Remedial Investigation will be a geotechnical firm with a great deal of experience in this area, Woodward-Clyde Consultants. Rounding out our Project Team we have as subcontractor for laboratory support, Chemtech Consulting Group, Inc.; for surveying support, Lau & Shabunia Consulting Engineers, P.C.; for graphic and printing support, Marsden Reproductions; and subcontracting to Woodward-Clyde providing drilling services, Warren George, Inc.

We are confident that our Project Team with combined experience, personnel qualifications and project organization, can expertly handle all the Tasks required to successfully complete this project.

We look forward to having the opportunity of working with the NYSDEC.

Very truly yours,

John Dedyo, P.E.

Encl:
JD/lm

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SCOPE OF WORK

Groundwater from the Brewster Well Field has until recently served as a water supply for the Village of Brewster and the Town of Southeast. In August of 1978, the New York State Department of Health detected Volatile Halogenated Organics (VHO's) in concentrations which exceeded state guidelines. The East Branch Croton River has since been used as an alternate source, but it is periodically unavailable. A survey of local industries (September, 1978) and a hydrogeologic survey (1979) failed to indicate a source of the contaminants, mostly tetrachloroethylene (PCE) and trichloroethylene (TCE). A subsequent hydrogeologic study reported no alternate groundwater sources. Treatment technologies - spray aeration and air-stripping columns - have been tested to provide full-scale design data. The United States Environmental Protection Agency (USEPA) placed the site on the proposed National Priorities List in December of 1982. In June of 1983 a USEPA-sponsored Remedial Action Master Plan (RAMP) for the Brewster Well Field Site was completed.

The RAMP acknowledged the inconsistent nature of the available data. It recommended that no remedial actions be taken "...in view of the fact that because an alternate water source is..." (usually) available. The RAMP also recommended that the source of the contamination be found before any remedial actions are undertaken. A final recommendation in the RAMP called for a Remedial Investigation (RI) and Feasibility Study (FS) for the site.

Overall, the RAMP defined the need for the Brewster project. In response, the NYSDEC - under a Cooperative Agreement with USEPA - requested proposals for RI/FS services at the Brewster Well Field Site. This document is Metcalf & Eddy's response to that request.

General Technical Approach

This aim of the project is to locate the contamination and its sources(s), determine where it will move, insure a safe drinking water source and protect public health. Metcalf & Eddy proposes a four part approach to the project:

- Initial Activities (Task 1)
- Remedial Investigation (Task 2)
- Feasibility Study (Task 3)
- Community Relations (Task 4)

Initial activities include collecting and reviewing existing data and develop a work plan, a health and safety plan and a QA/QC plan. The plans developed under this task would be approved by NYSDEC and USEPA. The approved plans would protect worker health and safety during field activities, ensure that lab data is correct and establish efficient and safe field procedures.

Field work for the Remedial Investigation would be preceded by a data collection and review subtask, the results of which would be used to finalize details of the remedial investigation program. The program would use surface geophysical methods to confirm possible sources of contamination and would construct 21 monitoring wells, located upgradient and downgradient of the site and between the site (the well

field) and potential sources. Soil samples would be collected from wells and borings and analyzed for pollutants. Groundwater, surface water and stream sediments would be sampled and the new and existing wells would be monitored for groundwater levels for six months. The data would be used to establish a model of the groundwater flow. The Remedial Investigation would result in a final assessment of the contamination sources, plume geometry and the direction and rate of future plume movement.

The Feasibility Study would evaluate remedial measures to reduce or eliminate public exposure to the VHO's at the Brewster Well Field Site. The hazards posed by the VHO's would be summarized. Remedial measures would be identified and evaluated for: cost, applicability, reliability, effectiveness and whether the measure can be implemented at the site. Each remedial measure evaluated as feasible will be reviewed and a detailed capital and operation and maintenance cost estimate would be developed. Each alternative would be assessed for impacts, and compliance with federal, state and local regulations would be evaluated. Additional data collection efforts such as treatability studies are outlined in the proposal.

Throughout the project, Metcalf & Eddy would provide assistance to the NYSDEC in developing and implementing a community relations plan.

Project Deliverables

Project deliverables (outputs) from the Brewster Well Field Remedial Action Project will be submitted at regular intervals and at important milestones in the progress of the project. Deliverables include project plans, progress reports, progress meetings, community relations meetings, and reports. Deliverables are described in the Work Plan and are listed as follows:

Plans
- Project Work Plan
- QA/QC Plan
- Health and Safety Plan

Monthly Technical and Financial Progress Reports

Progress Meetings with NYSDEC
- following submittal of the three plans listed above
- following the geophysical investigation
- following the submission of Remedial Investigation Report
- following definition of pollutant pathways
- following initial screening of remedial alternatives
- following following detailed evaluation of remedial alternatives
- a final submission of Feasibility Study Report

Community Relations Meetings - see proposed project schedule

Reports - draft and final
- Remedial Investigation (Task 1) Report
- Feasibility Study (Task 2) Report

PROPOSED WORK PLAN

The following sections describe the proposed plan of work at the Brewster Well Field to accomplish Task I, Remedial Investigation, and

Task II, Feasibility Study as defined by the NYSDEC Request for Proposals.

Task 1.0 Initial Activities

1.1 Existing Data Compilation and Review

Metcalf & Eddy and its' subcontractors will obtain all current available existing data; reports, studies, laboratory analysis, etc. from the NYSDEC, Putnam County Health department, etc. This information will be reviewed for its reliability completeness in defining the condition at the Brewster Well Field site. Using this information and understanding the purpose of this study Metcalf & Eddy and its subcontractors will develop a detailed work plan, Health & Safety Plan, and Quality Assurance/Quality Control Plan to be followed in performing the work activities of the project.

1.2 Work Plan

Prior to commencing field activities at the site Metcalf & Eddy will submit a detailed work plan to the NYSDEC and USEPA for approval. This work plan will define the following activities in detail:

- Review existing data base: drilling, sampling, surveying, etc.
- Identify the personnel to be involved and their responsibilities. The procedures to be followed, i.e., drilling, installation of monitoring wells, sampling techniques, analysis to be performed, methods of analysis, surveying requirements, data gathering and review, etc.
- Definition of methods of data analysis and final product, i.e., computer modeling, graphical presentations, etc.
- Identification of meetings and submittal of progress and draft/final reports.

1.3 Health and Safety Plan

At the same time the work plan is submitted M& E will submit a Health and Safety Plan specific to the Brewster Well Field site for review and approval of the NYSDEC and USEPA.

The Health and Safety Plan will be prepared based upon procedures established in Metcalf & Eddy's safety and health manual which provides general information on safety and health issues and outlines site investigative procedures.

The Health and Safety Plan will detail the specific procedures and equipment necessary to protect the health of Metcalf & Eddy employees, subcontractors, and the public during any work conducted on-site as part of the field efforts. The plan as developed by the Project Manager and Health and Safety Officer will be based on:

1. The chemicals at the site and their physical and toxicological properties.
2. The on-site activities planned as part of the investigative phase.
3. The potential for exposure of persons on or near the site.

At a minimum, the plan must include the following information:

a. The name and location of the site.
b. The overall hazard assessment of the site including a discussion of any previous sampling or monitoring results.
c. Discussion of hazards known or suspected to be present during each work activity.
d. The personal protective equipment to be worn and/or available.
e. Identification of the key individual responsible for Health and Safety monitoring, decontamination, emergency response, etc.
f. Names, addresses and phone numbers of emergency response facilities in the area.
g. Dacontamination equipment and procedures required. The Health and Safety Plan must be discussed with all employees and subcontractors before any on-site work begins. Also included with the Health and Safety Plan are the specifications for the handling and disposal of contaminated materials during the project.

All revisions to the plan arising during the course of work must be approved by the Metcalf & Eddy Health and Safety Officer.

1.4 QA/QC Plan

Every monitoring and measurement task required for the hazardous waste remedial investigative and feasibility phase must have a written QA Project Plan. After each plan is prepared, it will be approved by the Metcalf & Eddy Project Manager (PM), the NYSDEC QA Officer, and the Metcalf & Eddy Quality Assurance Manager (QAM). The purpose of these plans will be to present, in detail, quantitative targets for the quality of the sampling, laboratory testing, and data analysis and the procedures to ensure that these targets are met.

Each plan consists of 16 elements:

a. Title page with provision for approval signatures
b. Table of contents
c. Project description
d. Project organization and responsibility
e. QA targets for measurement data in terms of precision and accuracy
f. Sampling procedures
g. Sample custody
h. Calibration procedures and frequency
i. Analytical procedures
j. Data reduction, validation, and reporting
k. Internal quality control checks and frequency
l. Performance and system audits and frequency
m. Preventive maintenance procedures and schedules
n. Specific routine procedures to assess precision, accuracy, and completeness and data
o. Corrective action
p. QA reports to management

The QA Project Plan must include or address all 16 elements. If an element is not applicable, the words "not applicable" should be inserted beside the appropriate element on the contents page. The

reason that this component is not applicable should be briefly stated in the appropriate subsection in the QA Project Plan.

In instances where specific QA procedures are addressed as integral part of the Site Operations Plan, or Site Health and Safety Plan, it will not be necessary to rewrite them in the QA Project Plan. These other documents may be referenced by citing the document and the page numbers on which the QA material appears in that document. This citation should be placed in the appropriate subsection of the QA Project Plan. A "locator page" should then be inserted behind the table of contents of the referenced document. This locator page should list all elements of the QA Project Plan and should indicate the location of each element by document title and page number.

Task 1.5 Submittal for Review of Plans

Metcalf & Eddy will submit the prepared plans for review and approval by the NYSDEC and USEPA. Following this review a meeting will be scheduled to discuss the comments of these agencies and the Final Plans will be prepared by which work will be conducted at the site.

Task 2.0 Remedial Investigation

The remedial investigation will include the collection and analysis of historic data on each potential contamination source and of geologic, hydrologic and chemical data related to local groundwater conditions. This will be followed by geophysical and hydrogeologic field investigations. Data analysis and assessments aided by groundwater modeling will conclude the major Task 2 activities.

2.1 Data Collection and Review

This subtask will involve the collection and analysis of existing information pertaining to the site histories of potential contamination sources and pertaining to local groundwater conditions.

Information on the four potential sources identified in the Remedial Action Master Plan (RAMP) will be obtained from local government agencies and from local residents with the aim of screening out at an early stage those sites least likely to represent hazardous contaminant sources. In the processes of our evaluation, in addition to interviews with local residents and government officals, visits will be made to each site and historical aerial photography will be scrutinized.

In addition to the sites identified in the RAMP, other potential sources may exist in the study area. All of the above information will be reviewed in combination with the results of the analysis of existing groundwater quality data for the area. The final result will be identification of potential sources that will be the subject of the subsequent investigation with respect to geophysical surveys and groundwater monitoring, upgradient and downgradient of specific source areas.

Pertinent hydrologic and groundwater data for the study area will be obtained from a number of sources. We expect to obtain more detailed groundwater quality data than that provided in the RAMP including common mineral properties from among county health departments, the N.Y. State Department of Health, the NYSDEC, the USEPA and the United

States Geologic Survey (USGS). Moreover, additional data will be sought from the N.Y. State Geological Survey and the USGS on aquifer geometry and aquifer trans-missive properties in the study area. The form and content of the final work plan and the level of effort relating to the remaining subtasks will be dependent on the findings of this first subtask. Certain modifications of the remainder of the plan (presented below) must be expected.

An important aspect of the first subtask and one which will require a significant level of effort will be to identify the location of all pumping wells, both private and public within a 3-mile radius of the site. Pumping rates and the influence on the surrounding hydro-geologic regime will be estimated for all wells.

2.2 Geophysical Investigation

Based on a review of available data, and on the Metcalf & Eddy team's consider-able experience in geophysical surveys, we propose that both surface and borehole geophysical methods be utilized to supplement existing data and the proposed drilling and testing program. We believe that implementation of a geophysical program will reduce drilling and sampling costs and will result in a better understanding of the contamination problem, so the most effective remedial alternatives may be more readily identified.

Under surface geophysical methods we proposed to conduct terrain conductivity, surface resistivity and seismic refraction/reflection surveys in the study area. Terrain conductivity will be employed to help identify the most probable sources of contamination. A minimum of 2 exploration depths will be attempted at each site suspected as serving as a contamination source. The Geonics EM34-3 terrain conductivity meter will be utilized in this survey using as the initial target depth the approximate depth to the water table in the study area. The Geonics EM34-3 is capable of exploration depths up to approximately 180 feet. It is anticipated that due to the organic nature of the contaminant, conductance readings within the area of the plume are likely to be less than background conductance. Interference in conductivity readings due to the urban environment is expected in some portions of the study area. Such interference will be dealt with on a site-by-site basis. If remedies to the interference effects are not found, alternate geophysical techniques, such as surface resistivity, will be applied or an exploratory boring or well recommended.

Surface resistivity soundings are proposed to determine stratigraphic and lithologic changes with depth in the study area. We propose using the Bison 2390 earth resistivity meter with a multi-core cable system, which permits soundings to be made at time savings of 70-80% over conventional resistivity equipment. The resistivity data will be reduced by computer; this will assist in the interpretation and correlation of apparent resistivity with vertical and lateral lithologic variations. It is anticipated that 25-30 resistivity soundings will be performed, with particular emphasis in the area along the East Branch Croton River, where existing data indicate that the valley fill and glacial deposits make up a complex stratigraphic profile.

Seismic refraction/reflection techniques will be used to estimate the depth to the top of bedrock in approximately the same locations as the surface resistivity soundings. As many portions of the study area are urban, we propose to use the hammer and plate method for the energy soure rather than explosives. In areas where the depth to bedrock is beyond the ability of detection by refraction techniques, seismic reflection techniques will be utilized which allow the determination of deeper stratigraphic units with the same energy source. It is anticipated that the survey will be conducted at approximately 25-30 locations.

Each well drilled as part of the groundwater monitoring program will be logged geophysically using natural gamma and neutron logs to evaluate the changes in the lithology, porosity and water content with depth. As discussed below, 21 new monitoring wells are tentatively proposed for the drilling/well construction subtask.

It is estimated that the geophysics subtask will require a level of effort of approximately 30 person-days. A progress meeting with NYSDEC is planned at the end of the geophysical investigation to review the results of that study as well as the early findings of the drilling program.

2.3 Drilling, Monitoring Well Construction and Testing

The drilling program has been tentatively formulated based on the objectives of the study and the available data. Fifteen sites proposed for monitoring wells have been identified and are shown on Figure 1. Wells will be nested (completed at different depths) at 6 locations resulting in a total of 21 wells. The final location and number of new wells should be expected to change somewhat based on the results of data collection/review and geophysical investigation.

In planning the drilling program, we attempted to place wells in areas between the well fields and the identified potential sources. In addition, well sites have been selected that are considered upgradient and downgradient of the Brewster Well Field. Some sites will have nested well clusters of up to 3 wells to determine the vertical distribution of contamination and hydrologic head. Schedule 40 PVC is the proposed well casing and screen material with threaded flush joints or bell end joints. No PVC cement will be used. Four-inch ID PVC casing and screen would be used on all but 6 of the wells. For the remaining 6 we propose constructing the well of 6-inch ID PVC casing and screen. This is to permit the establishment of continuous water level recording stations at these wells. Stainless steel screens and risers can be provided as an option if required.

Drilling and well construction will be performed by Warren-George, Inc. of Jersey City, N.J. This company has had extensive experience in the construction of monitoring and in various types of soil sampling and has excellent equipment and drill rig operators. They are the largest geotechnical drilling company in the New York area and are a Womens Business Enterprise (WBE). We propose that drilling be done by the rotary wash method. Between holes the tools will be thoroughly cleaned by steam cleaning to further reduce the chance for cross contamination between borings. The order of drilling will proceed from areas of the lowest potential for groundwater contamination to areas of the highest potential.

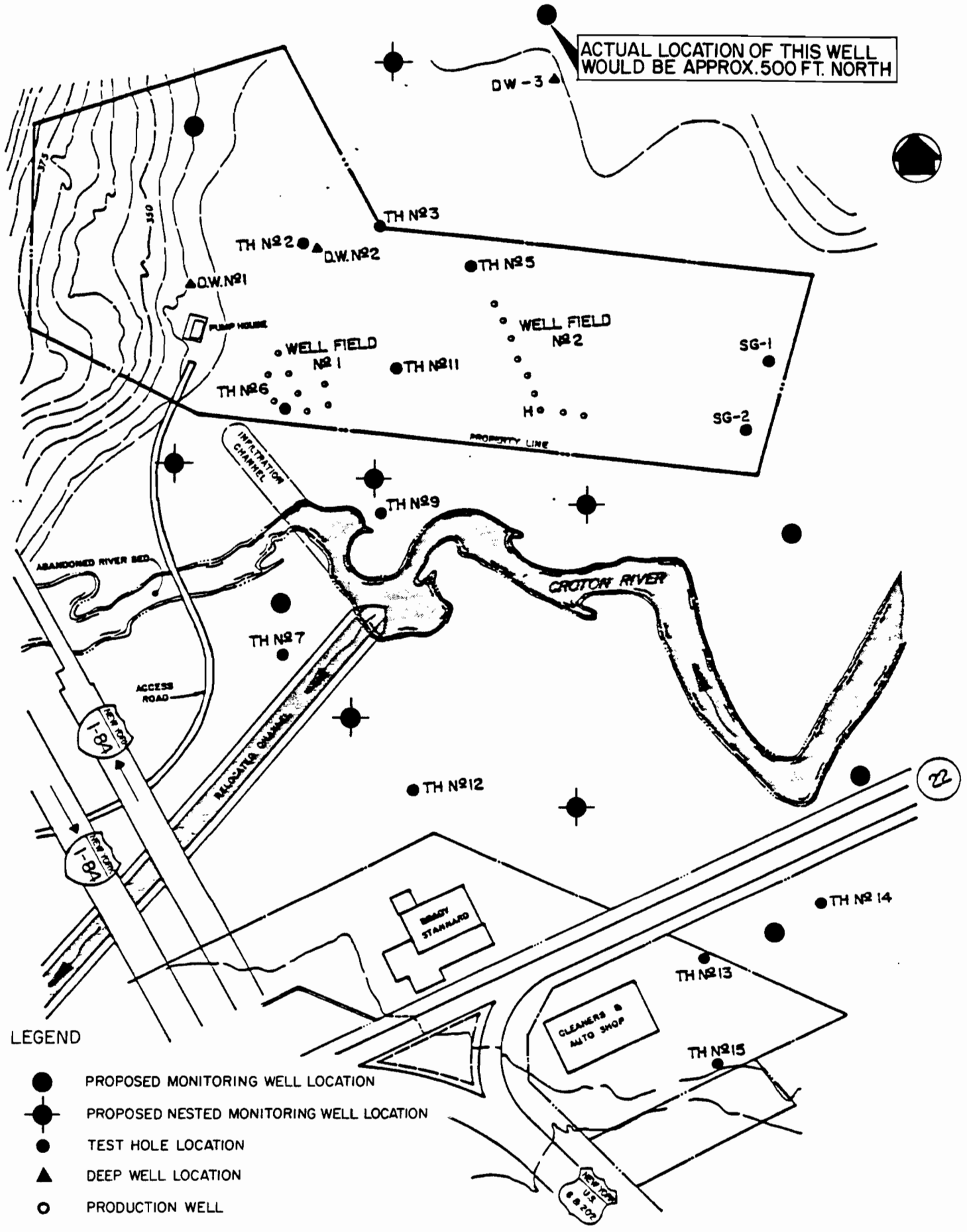

FIGURE 1. PROPOSED MONITORING WELLS
BREWSTER WELL FIELD SITE

Split-spoon samples will be taken at 5 foot intervals and at every major change in lithology. Blow counts will be recorded in accordance with standard penetration test (SPT) procedures. A geologic log will be maintained by a field geologist.

Selected soil samples taken from borings/wells will be stored in specially prepared sealed containers in the field and sent to the analytical laboratory for analyses of priorty pollutants. Tentatively we estimate that 11 soil samples are to be analyzed.

Following the reaming of each boring and the installation of the screen, casing and gravel pack, the remainder of the annular space will be sealed with Volclay bentonite pellets followed by a cement/bentonite grout. The well will then be deveoped by pumping and/or surging and by utilizing a pipe return system so that the discharged water will be controlled (either collected or discharged to an approved location).

In five selected wells aquifer test will be performed to provide estimates of aquifer transmissivity and storitivity. We propose conducting only moderate duration tests approximately 10 hours long. Drawdown measurements would be taken during the pumping period as well as during the recovery period so that transmissivity values could be estimated by two methods. The pumped water would be controlled and discharged to the nearest approved storm drain or collection facility. Prior permission would be sought for discharge from appropriate county and local officials. Each of the remaining 16 wells would be tested by means of slug tests to provide estimates of the aquifer permeability in the vicinity of the well screen. The Metcalf & Eddy team would utilize its specialized slug testing equipment which includes a pressure transducer and chart recorder to provide rapid water level recovery measurements at short intervals.

2.4 Level Surveying of Wells

Following well completion, the elevation at the top of casing (M.S.L. Datum) for each well would be surveyed by Lau & Shabunia. This is essential to determine accurate water level elevations and to construct potentiometric contour maps.

2.5 Groundwater Sampling

Three rounds of sampling are proposed. The wells to be included in this groundwater monitoring program are the 21 proposed monitoring and 11 selected existing wells. The first round of sampling would involve only the existing wells, while the remaining two sampling events would involve all 32 wells (existing and proposed).

Sampling will be performed and sampling documentation will be maintained strictly in conformance with the QA/QC plan. We propose using PVC bailers to collect the samples during each sampling event after the equivalent of 4 well volumes have first been removed from the well. Separate bailers will be acquired for each well, each bailer being dedicated to a given well. At the end of each days' sampling the samples will be transported to Chemtech for analysis.

2.6 Surface Water and Stream Sediment Sampling

Surface water samples will be collected from the unnamed tributary

extending north of the well field and from the East Branch Croton River, both upstream and downstream of the site. We propose to select four locations on the unnamed tributary north of the well field, and 3 locations on the East Branch Croton River. Of the East Branch locations, one would be clearly upstream from the well field, one location would be adjacent to the well field and the third location would be clearly downstream from the site. At each surface water sampling location stream sediment will also be collected and analyzed for volatile organcis for the first sampling event. Two rounds (events) of surface water sampling will be performed.

2.7 Establishment of Continuous Water Level Recording stations

Six of the proposed monitoring wells will be established as continuous groundwater level recording stations. The purpose of these stations would be to provide continuous groundwater data in strategic locations so that an evaluation can be made of the aerial effect of pumpage changes in the major wells in the study area on groundwater levels and flow paths. These stations would compliment the monthly groundwater level monitoring programs discussed in the following section. We propose to install Type F Leupold and Stevens recorders at each of these 6 wells. A lockable protective cover will be provided for each unit to discourage vandalism.

2.8 Laboratory Analysis

All laboratory analysis will be performed by Chemtech of New York, N.Y. This includes the estimated 11 soil samples and 11 groundwater samples from the first round of groundwater sampling, 32 groundwater samples collected during second round of groundwater sampling, 32 groundwater samples from the third round of sampling, 7 surface water and 7 sediment samples for the first round of surface water sampling and 7 surface water samples for the second round. Thirteen of the 32 wells will undergo a full priority pollutant analysis for the first samples obtained. For the remaining groundwater samples from these wells and for all the samples from the remaining 19 wells we asume for purposes of this proposal that it will suffice to analyze only for volatile organics and for the inorganic constitutents specified in the EPA primary and secondary drinking water standards. The 11 proposed soil samples will be analyzed for all priority pollutants.

All analyses performed by Chemtech will strictly conform to the QA/QC plan including sample registering, sample handling, recordkeeping and the method of analysis employed for each constituent. In addition, trip and field blank samples will be analyzed as part of each sampling event and blind record analyses will run on 15% of the samples selected at random during the analysis of each round of samples.

2.9 Monthly Groundwater Level Monitoring

We propose to monitor groundwater levels in the study area on a monthly basis for six months. The 11 existing wells selected for water quality monitoring program will be included. As the proposed 21 new monitoring wells are constructed, they will be included in the monthly water level monitoring. The program will compliment these 6 continuous water level recording stations in providing indications of short-term or longer-term trends in groundwater levels in the study area. This is essential information in identifying the potential

variation in groundwater flow paths and hence subsurface contaminant pathways over time.

Each month when the water levels of the 32 wells are measured, the water level recorders at the 6-inch wells will be inspected and serviced. Also, during each monthly site visit data will be obtained on pumpage records for the major production wells of the study area.

2.10 Data Organization and Analysis

This subtask includes the compilation, organization and analysis of all data acquired as part of the remedial investigation. The following are representative of activities included in this subtask.

- o Editing of geologic logs
- o Preparation of as-built well construction diagrams
- o Preparation of aquifer isopac maps and structure contour maps on top of the till or bedrock
- o Analysis of pumping test data and slug test data
- o Reduction of water level data
- o Preparation of water level contour maps for different times
- o Analysis of the results of soil, sediment and water chemical analysis
- o Preparation of contour maps showing lines of equal concentration for different sampling periods

It is estimated that 45 person days will represent the level of effort for this subtask.

2.11 Groundwater Modeling

Groundwater modeling is proposed to evaluate the impact of differing pumping configurations and recharge conditions in the study area on groundwater flow paths and velocities both of which may impact contaminant plume migrations significantly. All pertinent field data obtained in the course of this project will be incorporated into the model.

The Brewster Well Field site is located in a complex hydrogeologic environment. The heterogenous nature of the glacial/alluvial aquifer and the faulting and facturing of the preCambrian and Cambrian bedrock as well as the physical and chemical properties of the contaminant must all be considered in any serious analysis of the contaminant movement within the hydrologic system. Engineering principles permit an idealization of the hydrologic system when modeling the regional groundwater flow for supply. But these idealizations cannot be used when determining the localized movement and dissemination of a contaminant. The smooth function model as used in groundwater flow determinations must be coupled with a detailed analysis of the heterogeneities of the aquifer and physiochemical properties of the contaminant.

The model will be a 3 dimensional smooth function groundwater model coupled with a heterogeneous element model as described below. Verification of the coupled models capability to predict contaminant concentration and movement will be provided by comparing model results with data measured at monitored points.

The smooth function model will be capable of assessing current and possible future use impacts upon the groundwater in both the overburden and bedrock aquifers in and around the site. From this model the amount of water each aquifer will produce and the potential for changes in flow direction can be estimated. This coupled model will also provide a means to test the feasibility of various remedial actions to mitigate or prevent groundwater contamination.

The determination of the movement of contamination requires an analysis of the following system parameters

1. Regional movement of the groundwater system;
2. Movement of the contaminant as it is transported by hydraulic movement;
3. Dispersion about the flow lines;
4. Subsidence flotation of the components caused by density currents;
5. Sorption processes on the aquifer solid as a collection device and water removal system; and
6. Surface water movement in the area as it is applies to controlling groundwater motion.

Some of the functions listed above can be described by smooth function analyses, i.e., nearly a continuum of flow from a mathematical standpoint. Most often, however, the flow and contaminant transport exists in an extremely heterogeneous condition. The modeling will be performed, then, as both smooth function analysis and as heterogeneous function analysis. The considerations of cost and output reliability will force a partitioning of these studies into separate approaches which will be coupled either in the smooth function modeling or in the data base.

Modeling is basically a relating function. Choices of action by man or nature produce effects; knowledge of the effects to be expected from the actions chosen is needed. The function of mathematics has been to relate the two. As systems have become more complex the mathematics have become so complicated that direct solutions are vitually impossible. Thus, the relating function has been reduced to numerical expressions that computers can handle. In recent years the input data describing a cause (action) have become so complex that computerized data bases that provide automatic entry and storage of data are essential.

Similarly, the description of the effects have become more detailed and more complex over long periods of time. The results are best described by graphical techniques and array printouts. These have become a part of computer analysis. The computer loop the Metcalf & Eddy Team proposes to use is a combination of several government sanctioned programs coupled to provide the modeling functions needed for the Brewster project. The programs that have been developed by the government over a number of years and at great expense represent a considerable amount of experience. Each component of the computer analysis proposed here is chosen to utilize the governments programs that have the versatility to allow modifications to meet the specific needs to analyze the Brewster Well Field area.

Although there are several finite-element and finite-difference programs that could be used in this study, the program selected should use a coupled equation approach for the complex stage analysis i.e., the solution of equations describing groundwater flow, density induced flow and dispersion. Based on modeling experience a program using the coupled approach would yield the most satisfactory results. The coupled solution approach is less cumbersome and the description of time dependent functions is much simpler and smoother when used with finite-difference rather than finite-element techniques. Although finite-difference models are subject to numerical diffusion a smaller element size and finite-difference approximations will reduce the effects of diffusion.

We recommend using the model developed for the USGS "Calculating the Effects of the Liquid Waste Disposal in Deep Saline Aquifer". This model was published as Water Resources Investigations 76-61. The program couples the groundwater flow equation (pressure) with equations describing dispersion and density movement as well as viscosity effects. This program offers a flexibility not found in other models. Documentation of the program is good, the computer code is flexible enough to permit a good description of the aquifer physics at the Brewster Well Field site and because the program is used by the government, the programs ability and limitations have been analyzed extensively. Any modification to the computer code made for this project will be done in Fortran and will be submitted in the final report.

Modeling discussed to this point handles the analysis of systems that are essentially continuous. The models discussed require relatively large elements which limit the ability of the model to analyze local phenomenon on a detailed basis. The smooth function model can handle neither localized changes in measured data nor assess the cause and effect relationship between these data. Smooth function models must necessarily assume an average value of data within each element. For example, the model must assume a uniform, homogenous permeability for a given formation within an element even though the actual permeability may vary with distance and depth. A smaller element size than that which can be reasonably used in a smooth function model would allow a more accurate representation of the permeability variations. The need is for a large element grid for the smooth function model but a smaller element grid with detailed information in three dimensions for the heterogeneous analysis. The contaminant movement is generally slow and pockets of contaminant may be entrapped within the aquifer. The smaller element size data base can be used to determine the localized changes in data and the results superimposed on the smooth function model results.

Heterogeneity (such as permeability variations) can most easily be considered by the use of a grid cell data base system. The data bank will be based on a geographic coordinate system. A grid covering the area is related to the geographic coordinates. These systems are known as geographic information systems. The Metcalf & Eddy Team has both the hardware and software in-house to store data by geographic coordinate. The data can then be located in the data base by its coordinate position. As we have stated earlier a grid finer than that used in the smooth function analysis will be required. The results

for any data in an area is a grid description which is directly related to the geographic position. The data from the heterogeneous modeling are used to determine the direction of the movement along a heterogeneous i.e., discontinuous surface. The heterogeneous model is used to select the parameter from each of the elements of the path of motion of the flow line. Similar computations such as dispersion or adsorption can be made along the flow and summed. This allows us to compute the complex path of movement as effected by various discontinuous non-linear responses. Such computations would be outside the ability of a smooth function model while at the same time making up most of the computations of interest.

Output information will take the form of the computer generated contour plots, stratigraphic fence diagrams or block diagrams, an examples of which is shown in Figure 2.

2.12 Report Preparation for Remedial Investigation

The report will present all previous data collected and reviewed by the Metcalf & Eddy Team, all data obtained in the course of the field program and the results of the modeling. A detailed discussion will be presented on the significance of the data and results generated to the objectives of the study. Text and graphics will be provided to indicate the results of data interpretation with respect to the probable sources of contamination and the plume geometry now and in the future. A draft report will be submitted to NYSDEC for their review and comment (10 copies). It is expected that the final Task 2 report will be issued subsequent to NYSDEC's approaval. We have assumed that 10 copies of the final report will be issued.

Task 3.0 Feasibility Studies

In the Feasibility study phase of this project Metcalf & Eddy will evaluate remedial measures for mitigating or minimizing the impact of the hazardous substances as found at the site. These efforts would be based upon the requirements of the NCP, 40 CFR 300.68 (a) - (j), and consist of three tasks:

- Task 3.1 - Summary of hazards or potential hazard
- Task 3.2 - Evaluation of alternative remedial measures
- Task 3.3 - Detailed evaluation of selected remedial measures identification of recommended measures to be undertaken at the site, and conceptual design of these measures.

Task 3.1 Summary of Hazards or Potential Hazards.

Metcalf & Eddy will summarize the findings of the RIS identifying the hazards or potential hazards, type and quantity; their source, as possible; and the pathways of this contamination. Based upon this information, Metcalf & Eddy will define those elements of the environment to which remedial action measures must be addressed to insure protection of human health and the surrounding environment. These elements would consist of soils, groundwater, surface waters, air, and in this instance the Brewster water distribution system as well as other individual private and public water well systems within the area studied.

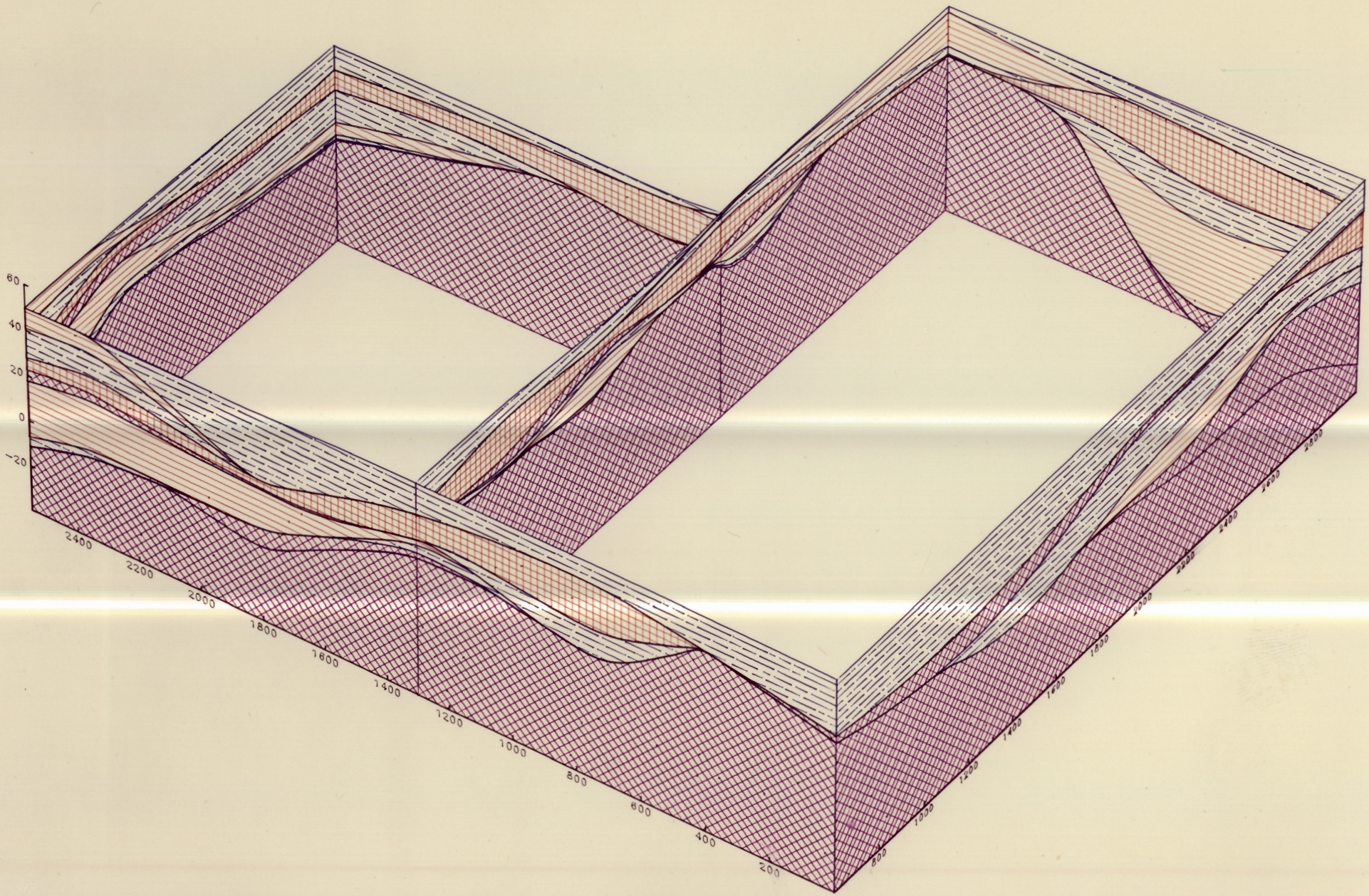

FIGURE 2. EXAMPLE OF COMPUTER MODELING OUTPUTS

Where a hazard source or potential sources have been defined, Metcalf & Eddy will assess whether these sources are existing or a result of previous activities. Many of the VHO's, especially TCE, have been used by a wide variety of industries and are also prevalent in products used around the home. Such uses as metal degressing agents, dry cleaning solvents, refrigerants, fumigants, paints, varnishes, and household sewer and septic tank cleaners have been prevalent. Metcalf & Eddy will identify alternative remedial measures and their associated technologies for each of the environmental elements requiring corrective action. This will be accomplished through a review of technical publications and past experiences of Metcalf & Eddy.

Metcalf & Eddy will prepare a summary report outlining the environmental elements to be addressed and the alternative remedial approaches associated with these elements to be evaluated in the Feasibility Study. This report will be submitted to the NYSDEC for review.

A meeting with the NYSDEC will be held following their review of the summary report and agree upon the alternative remedial approaches to be evaluated in the next task.

Task 3.2 Evaluation of Alternative Remedial Measures

Metcalf & Eddy will evaluate the various alternative remedial measures and their associated technologies as identified in Task 3.1. These alternatives will be screened to arrive at a select group of alternatives for further detailed analysis. For this reason the evaluations as performed in this task will be based upon general rather than specific issues. Cost, effects of the remedial measure, and whether the measure is applicable and reliable will be the primary evaluation factors. The level of development of costs will be an order of magnitude effort. Implementation of the measures will be evaluated for their relative effect with emphasis on any adverse impact. The relative applicability as well as reliability of each of the measures will be assessed. A matrix-type comparative summary evaluation table shall be prepared to ease the evaluation of the various remedial measure alternatives.

Some of these remedial measures and their associated technologies which will be evaluated are as followings:

At-Source Control

- Existing
  - Industrial -chemical substitution
    -tighter process control
    -additional restrictions on discharge
    -require discharge into public system.
  - Residential-Restriction of household product usages.
    -require discharge into public system.
    -complete clean out and/or removal of septic systems
- Past Occurances · addressed in other elements in the following discussions.
- No Action

Soils
- Removal, treatment and/or disposal
- Contaminant and Decontamination
    - Slurry wall and impervious cap
    - Slurry wall, impervious cap and recovery well inside the slurry wall to affect an upward flow through the affected area.
- Combination of removal for highly contaminated areas and containment for low contaminated areas.
- Insitu Treatment
- No Action

Groundwater
-Containment and Decontamination
    - Dynamic pumping using existing and/or new wells
    - Treatment
        -air stripping
        -carbon adsorption
        -synthetic resin adsorption
        -Reduce Pumping rates from the aquifer to slow the movement of the contaminant.
        -No Action
    - Treated Water Disposition
        -use as water supply
        -recharge into aquifer upgradient
        -discharge into surface waters.
- No Action

Surface Waters
- Contain, treat and discharge
- Divert from contaminating source
- No Action

Air
- If emissions from these operation exceed approved levels when excavating then operations shall be reduced and/or ceased for periods of time.

- When treating the various waters and soils in a treatment process if emissions can be expected to exceed air standards, then a collection and scrubbing device shall be installed as part of the treatment system.

Brewster Water Distribution System
- Decontaminate water distribution system by flushing
- Evaluate alternative water supplies
    - Big Brook and East Branch Croton Reservoirs.
    - New well located further away from the zones of contamination.
- No Action

Private and Other Public Water Supply Systems
- Provide home treatment systems for the water
    - Activated Carbon
- Develop alternative water supply
    - Tie into Brewster system

- Develop dual water systems
  - Other uses (i.e. process, etc.)
- No action

While these present some of the options to be considered, and were used as a basis in the preparation of this proposal, it is not intended that these be considered as the only alternatives. As appropriate, expansion of these alternatives as well as additional alternatives will be part of the identification and screening task.

Metcalf & Eddy will prepare and submit to the NYSDEC for review, a summary report of the evaluation of the environmental elements addressed and the alternative remedial approaches associated with these elements.

A meeting with the NYSDEC, following their review, will be held to present the results of these screening activities and agree upon those alternatives to be evaluated in more detail in Task 3.3.

Task 3.3 Detailed Evaluation of Selected Remedial Measures

Once the alternative remedial measures and their associated technologies have been screened, a detailed evaluation will be performed for selected remedial measures. This evaluation will consist of a specific and detailed review of the alternative to assess its reliability and performance based upon past experiences. Detailed Capital Cost estimates, including equipment, installation, engineering fees, contractors fees, etc., will be determined for each alternative. In addition the operation and maintenance costs associated with each alternative will be estimated, including labor, chemicals, power, fuel, etc. These costs will be distributed over the required lifetime of the remedial measure/technology in mitigating or minimizing the hazard or potential hazard. For cost distributions which exceed 30 years the elements for the recurring costs will be summarized as to the frequency that they are incurred; i.e. labor and power-everday; grass cutting weekly in summer; pump replacement-every 10 years; etc.

Each alternative will also be evaluated in detail as to its' applicability, constructability, and the time frame in which it can be implemented to address the hazard. An assessment of the impact of each alternative, especially adverse impacts, shall be performed and as necessary, methods identified and costs prepared for mitigating these effects. Finally compliance of the measure with federal, state, and local regulations will be evaluated.

It may be necessary to generate additional data to evaluate the alternatives, especially with respect to uses of the various treatment systems. These activities will be identified to the NYSDEC prior to the intiation of work in this task. The existing pilot testing of the air stripping process will most likely be sufficient in the evaluation of this process. It is proposed that the data as generated in the air stripping pilot plant program be utilized by Metcalf & Eddy as imput to its VOLSTRIP computor program. By using this program Metcalf & Eddy can evaluate and optimize the design of air stripping systems, varying constituent types and concentrations. By use of this program the effectiveness of the existing larger unit can be evaluated by

comparing its actual operating performance under various conditions as compared to the predicted performance. Metcalf & Eddy has used the VOLSTRIP program in evaluating air stripping in several projects including a study evaluating treatment of contaminated groundwater for the Suffolk County Water Authority. However, as Metcalf & Eddy has determined from previous studies of TCE water well contamination, the carbon absorption capacity is dependent upon the initial concentration of the TCE, degree of removal required, and other factors, e.g., 0.0006 lbs. TCE Removal/ lb. carbon at 115 ppm TCE and 0.016 lbs. TCE Removed/ lb. carbon at 1200 ppm TCE. Some short term testing to specifically define the requirements of this process for application in this instance is anticipated. Metcalf & Eddy will conduct these as well as other necessary treatability tests to fill in any informational gaps.

Metcalf & Eddy will prepare a rough draft report summarizing the results of the evaluation of each of the alternative remedial measures considered. Following review by the NYSDEC, Metcalf & Eddy will incorporate the comments and reviews of the various regulatory agencies in preparing a final engineering document summarizing the recommended alternative remedial measure. This report will define the process by which these remedial measures were determined as the appropriate response to the hazards involved at the site. Also included will be a summary of all pertinent information describing the measures to allow for efficient transition from the feasibility stage to the implementation and design stage of the clean-up of the site, i.e., equipment list, general arrangement drawings, construction health and safety plan, etc.

Task 4 Community Relations

The cleanup of a hazardous waste site is among the most sensitive public policy issues today. To be successful, a public information and community relations program in support of feasibility studies as well as the follow-up design and actual cleanup of these sites must create and sustain meaningful two-way communication and a close working relationship between the project sponsor and affected interested groups, including the public at-large, government officials on all levels and other interested civic and environmental organizations.

For this project, Metcalf & Eddy will provide assistance to the NYSDEC in implementing a community relations program. Items such as graphs, charts, slides and other audio-visual aids, required at these meetings as well as in assisting to advertise for these meetings, will be provided by Marsden Reproductions, a Minority Business Enterprise, as subcontractor to Metcalf & Eddy.

It is envisioned that four one day meetings in the Brewster area shall be required: an initial meeting describing the anticipated project, a meeting at the conclusion of the remedial investigation task, and a meeting at the conclusion of the feasibility task for all interested parties. A fourth meeting will be directed to those parties in the immediate area during the RI Task.

Proposed Schedule

The proposed project schedule for the RI/FS is presented in Figure 3. There will be some time overlay between tasks and some tasks will have more than one person working during the same time period. The estimated project length is 12 months and the total level of effort is estimated to be 934 man-days.

MANAGEMENT APPROACH

Project Organization

The management and staffing for all work performed by Metcalf & Eddy is done on a Project Team basis. This team is assembled through the use of individuals and firms based upon their previous experience and expertise relative to the specific requirements of the Project. The Project Manager, who acts as the direct liaison with the NYSDEC, and the Task Managers form the nucleus of management and assures application of the best talent and expertise available to the project. The Project Manager is responsible for the overall direction and coordination of the technical efforts of the project as well as the total project budget control. For the specific task assignments the Woodward-Clyde Task Manager will be responsible for the specific technical and budgetary efforts of the Remedial Investigation (RI) and the Metcalf & Eddy Project Manager will be responsible for the specific technical and budgetary efforts of the Feasibility Study (FS).

The organization that we propose for the Brewster Well Field site RI/FS is illustrated in Figure 4. Key personnel from Metcalf & Eddy and Woodward-Clyde included on the proposed project team are listed in Table 5. The table presents the key project personnel by name and project responsibility.

MBE/WBE Subcontracting

Metcalf & Eddy is fully committed to implementing the USEPA's "fair share" goal and New York State's requirements for using minority business enter-prizes (MBE) and woman business enterprizes (WBE). Metcalf & Eddy selects MBE/WBE firms based upon careful review of their qualifications and their capacity with respect to project requirements.

For this proposal, we have taken affirmative steps to assure that minority and women's businesses are used where possible in this project. We plan to use the minority firms of Lau & Shabunia Consulting Engineers, P.C., located in New York, for surveying support (approximately 2% of proposed budget); Chemtech Consulting Group, Inc., a New York certified laboratory for analytical support (approximately 14% of proposed budget); and Marsden Reproductions for printing, graphics, audio visual preparation and other support (approximately 2% of proposed budget). The Woman's Business Enterprise of Warren George, Inc., of New York, will provide drilling services (approximately 16% of budget).

Budget and Schedule Control

Managing a project within budget and schedule at Metcalf & Eddy is accomplished by continuous monitoring of manhours and costs on a task

BREWSTER WELL FIELD RI/FS

Figure 3.

PROPOSED PROJECT SCHEDULE

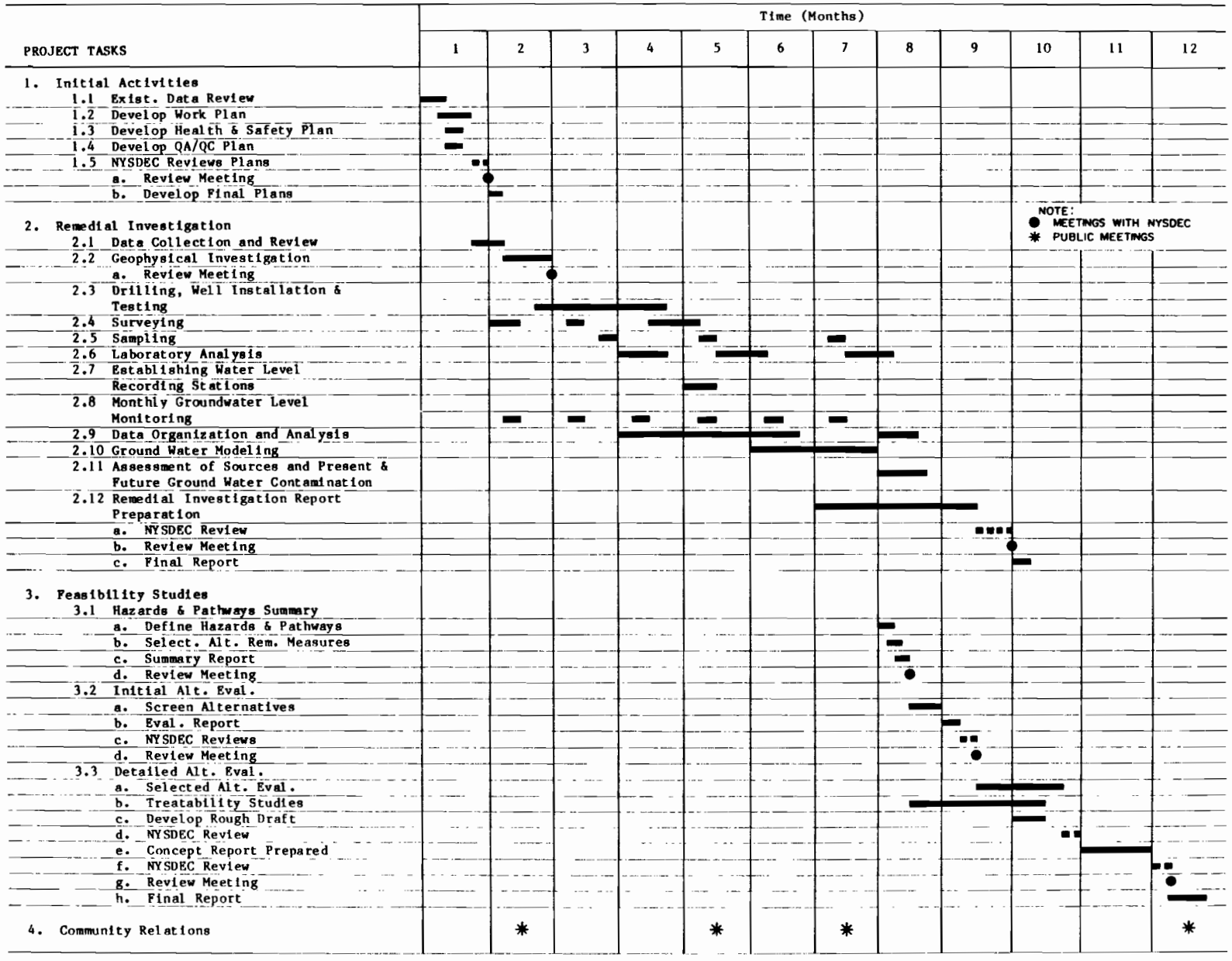

Figure 4.

PROJECT ORGANIZATIONAL CHART

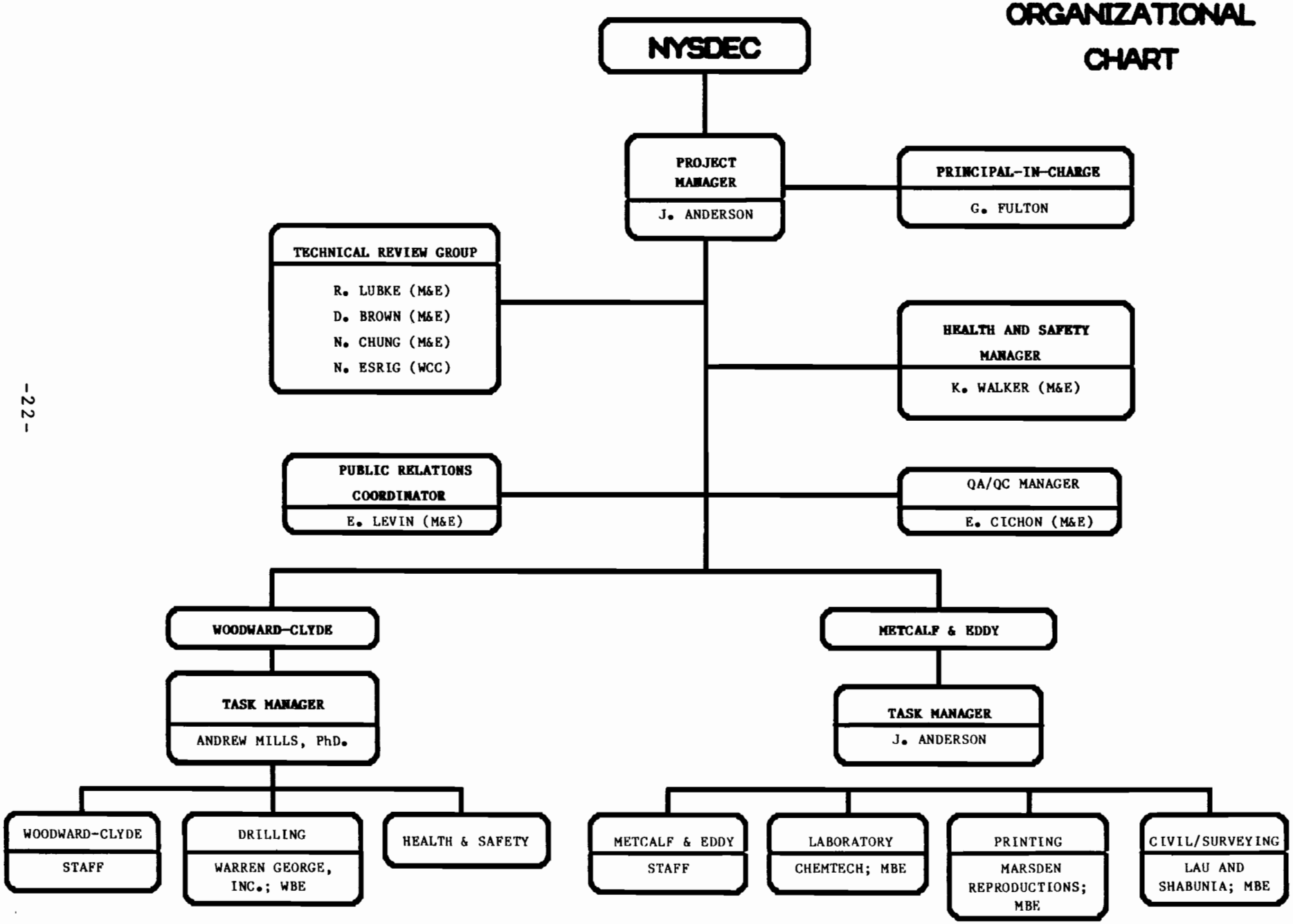

Figure 5. Part I Key Metcalf & Eddy Personnel

Name	Project Assignment	Major Discipline	Education	Years of Experience
George Fulton	Principal-In-Charge	Water Supply Engineering	BS Civ. Engr.	35
James Anderson	Project and Task Manager	Water Supply Engineering		2
Ed Cichon	QA/QC Manager	Chemistry	BS/MS/PhD Chem.	4
Neville Chung	Technical Review Group	Industrial Waste Engineering	BS/MS Civ. Engr.	22
R. Lubke	Technical Review Group			
Don Brown	Technical Review Group	Hazardous Waste Engineering	BS Geology/Earth Science	13
Elizabeth Levin	Public Relations Coordinator	Planning	BA Pol. Sci./MUA Planning	10
Katherine Walker	Health and Safety Manager	Health and Safety; Toxicology	BA Bio./MS Env. Health/Ind. Hyg.	6
Daniel Carvalho	Project Engineer	Industrial Waste Engineering	BS Chem. Engr./MS Env. Engr.	13
Clifford Stein	Geologist	Soils Science	BS/MS Soil Science	7
Christopher Haggar	Project Engineer	Hazardous Waste Engineering	BS Civ. Engr./MS Envir. Engr.	10
Daniel Waltz	Hydrogeologist	Hydrogeology	BS Geology/MS Hydrology	11
Mike Sullivan	Engineer	Chemical Engineering		
Michael Cooley	Engineer	Civil Engineering	BS Civ. Engr.	4
Ralph Schmitt	Project Engineer	Industrial Waste Engineering	BS Chem. Engr./MS San. Engr.	11
Dave Langseth	Computer Modeler	Applications Programming		
Nick D'Agostino	Project Geologist	Geology	BS Civ. Engr.	12
John Iannone	Project Engineer	Civil Engineering	BS/MS Civ. Engr.	9
Don Brailey	Project Engineer	Chemical Engineering	BS Chem. Engr.	10
George Combes	Engineer	Chemical Engineering	BS Chem. Engr.	2
Joan Boegel	Engineer	Chemical Engineering	BS Chemistry/MS Chem. Engr.	1
Cinthia Rudsill	Engineer	Chemical Engineering	BS Chemistry	4

Figure 5. Part II Key Woodward-Clyde Personnel

Name	Project Assignment	Major Discipline	Education	Years of Experience
Andrew Mills	Task Manager	Soils Science	MSE Wat. Res./PhD Soil Science	17
Melvin Esrig	Technical Review Group	Soils Science	BCE, MS Civ. Engr./PhD Civ. Engr.	29
Anthony Scacifero	Field Work: Drilling, Testing, etc.	Geology	BS Geology	13
William Walsh	Geophysics	Geology	AB Physics/PhD Geophysics	26
Steve Cox	Field Work	Geology	BS Geology	4
Steffen Heilbig	Site Manager	Soils Science	BA, MS Geology	4

element basis by the use of Metcalf & Eddy's computerized Project Control Reporting System (PCRS). At the outset of the project the budget will be input to the PCRS, with specific manhour and cost goals assigned to each task element. Each week the Project Coordinator and Project Manager receives two computer printouts;

1. The Weekly Job Status Report (WJSR), which lists the hours and associated costs expended, by task element, for the week, month-to-date and project-to-date, as well as original budgets.

2. The Detail Cost Analysis (DCA), which shows the current week labor and expense details.

These printouts are reviewed for accuracy by the Project Coordinator and Project Managers. By comparing the budget expended with the work to be completed the Project Coordinator has early warning of potential budget variances and can take timely corrective action.

A monthly progress report will be submitted to the NYSDEC which briefly describes the activities completed and provides up-to-date financial project status.

CERTIFICATE OF NON-RESPONSIBILITY

The following signed statement satisfied part 11(g) of the NYSDEC Brewster Well Field Request For Proposal:

Metcalf & Eddy, Inc. hereby certifies that to the best of its' knowledge, and belief, neither Metcalf & Eddy, Inc., its' subsidiaries, its' parent company, Research-Cottrell, Inc., its' affiliates and its' subcontractors, as specified in this Proposal for the Brewster Well Field site Remedial Investigation/Fesibility Study, Village of Brewster, Putnam County, New York, is or would be considered as potential responsible parties at the site. Wherein such information should be determined to alter this knowledge or belief from this date forth, Metcalf & Eddy, Inc. shall immediately disclose such information to the New York State Department of Environmental Conservation.

John Dedyo, P.E.
President

July 16, 1984
Date

RESUMES

GEORGE P. FULTON

EDUCATION:

BS, Civil Engineering, City College of New York, 1942
Registered Professional Engineer

REGISTERED PROFESSIONAL ENGINEER

New Jersey, New York, Pennsylvania, Connecticut

PROFESSIONAL MEMBERSHIPS:

American Water Works Association
American Society of Civil Engineers
New York Water Pollution Control Association
American Academy of Environmental Engineers, Diplomate

BACKGROUND AND EXPERIENCE:

Mr. Fulton is a Vice President of Metcalf & Eddy and has over 35 years experience in the waterworks field. Since joining Metcalf & Eddy in 1963, he has served as Project Manager on comprehensive water supply studies, investigations and reports for water treatment and distribution systems, water storage reservoirs and special projects relating to the disposal of alum sludges for treatment plants.

Mr. Fulton serves on a subcommittee of the American Water Works Association Water Quality division and on advisory committees serving the Research Foundation of the same organization. He is author of over two dozen published articles covering a broad range of waterworks subjects. He holds a patent for a unique alum recovery process for an alternative to disposal of water plant alum wastes.

He was Project Manager on a Report to the Board of Water Supply of the City of New York on Water Supply Development. This project involved demographic studies; water resources, hydrology, hydraulic and supply studies; reuse-recycle studies; economic studies; environmental work; and water quality management studies. He was responsible for an assessment of high flow skimming of the Hudson River to supplement the City's Water Supply. This project involved the development of a framework for future environmental analysis of the Hudson River estuary as well as site selection for the intake, pumping station, and treatment plant. He also conducted comprehensive water supply studies for Orange County, Chautauqua County and Chenango County, New York; and investigations and reports for water distribution and treatment facilities for Middletown and Briarcliff Manor, New York, and the Plainville Water Co., Connecticut. Mr. Fulton also managed the design of an award winning 80-mgd water filtration plant in Jersey City, New Jersey.

JAMES ANDERSON

EDUCATION:

B. E. Civil Engineering, The Cooper Union, 1969
M.E. Environmental Engineering, Rensselaer Polytechnic Institute, 1970

PROFESSIONAL MEMBERSHIPS:

American Society of Civil Engineers
American Society of Mechanical Engineers - Incinerator Division
Association of Energy Engineers - Certified Energy Manager
American Water Works Association

PROFESSIONAL REGISTRATION:

New York, New Jersey, Colorado

BACKGROUND AND EXPERIENCE:

Since graduation in 1970 Mr. Anderson has worked exclusively in the environmental engineering field. Mr. Anderson has been with Metcalf & Eddy since 1973 and has been involved in numerous assignments in the field of water supply and treatment including the award winning Water Treatment Plant for Jersey City, New Jersey.

As waste treatment task manager on the Manasquan Water Supply Project Mr. Anderson directed efforts pertaining to the evaluation and selection of a water treatment process to remove volatile organic compounds, THM precursors as well as other conventional water quality parameters.

On the same project Mr. Anderson reviewed proposed remedial action plans for clean-up of two hazardous waste sites located in the Manasquan River Basin. His review pertained to the plans for treatment of water to be pumped from the sites after construction of containment facilities.

Mr. Anderson served as project manager on polluted wells projects for the New Jersey Department of Environmental Protection.

As Project Manager he directed efforts related to the rehabilitation of water supply facilities in the New York City Croton Water Supply System.

EDWARD J. CICHON

EDUCATION:

BS, Chemistry, Tufts University, 1976
PhD, Chemistry, Brown University, 1980

PROFESSIONAL MEMBERSHIP:

American Chemical Society
American Water Works Association
New England Water Works Association

GENERAL BACKGROUND:

Dr. Cichon is a Technical Specialist responsible for the supervision of all pilot plant activities including staffing, design, implementation, operation and interpretation. He serves as a resource in the areas of chemistry and hazardous waste. His expertise incorporates both inorganic and organic chemistry. He has worked with state-of-the-art analytical techniques in electro-chemistry and gas chromatography for the purpose of identifying chemicals at very low concentrations. He is responsible for the technical aspects of hazardous waste programs including field investigations, laboratory analyses, chemical fate and transport, risk analysis, selection of remedial actions and development of safety and health programs for protecting workers and nearby residents.

EXPERIENCE:

- Developed the field boring and analytical program for collecting data to determine the health risks to workers and residents during construction of a sewer interceptor through a hazardous waste area for SESD. Based on the field data, several predictive methods were employed to estimate the concentrations of volatile organic chemicals reaching workers and residents. A specification was developed delineating the health and safety program to be implemented by the contractor during construction. This specification included personal hygiene monitoring, corrective actions to be implemented, reporting procedures, medical screening, and disposal of contaminated materials.

- Developed the field and laboratory testing program to determine the amount of soils, contaminated with lead and zinc, to be excavated and landfilled in order to bring a

20-acre industrial site into compliance with federal and state hazardous waste and water quality regulations.

- Reviewed and advised on methods and operating procedures for the handling and disposal of hazardous wastes generated from the repair and maintenance of nuclear submarines at the U.S. Navy Base at King's Bay, Georgia.

- Provided technical advice regarding the future impact of hazardous organic chemical wastes that had infiltrated a water treatment plant and intake. Assisted in the selection of remedial alternatives to abort existing entry of contaminants in addition to preventing future contamination based on the predicted transport of chemicals from the landfill through the overburden and into the bedrock. Also determined the appropriate method for removing contamination from within the water treatment plant.

- Reviewed proposed plans for locating a PCB-transformer repair and storage facility within a municipal watershed. Developed the criteria and structural features to be incorporated in the detailed design of the PCB facility in order to prevent contamination of the watershed.

- Responsible for the development, operation and data interpretation of an ozone pilot filtration plant to treat water for potable use for the Connecticut Water Company. Of major concern was the reduction in the trihalomethane formation potential by ozone. Over 100 THMFP tests were conducted over a 6-week period to assess the reduction of this parameter through the treatment train.

- Developed and implemented a field pilot program to treat water for potable use for the Suffolk County Water Authority. Developed design criteria for the removal of organic chemicals from well water by packed tower aeration. Conducted seminars to the Water Authority personnel for the purpose of explaining the theory and operation of this treatment technology.

- Responsible for the operation of a 100 gpm pilot plant for the Metropolitan District Commission, Boston to evaluate the effectiveness of pulsator clarification, plate settling, direct filtration, and ozone-direct filtration, to treat water for potable use from the Sudbury reservoir. Included in the testing program was an evaluation of the unit process to reduce the trihalomethane formation potential (THMFP) in the raw

water. THMFP tests were designed to simulate the complex downstream chlorination practices and reservoir detention periods.

- Directed the development and implementation of an American Water Works Co. Water Treatment for Potable Use pilot program to evaluate the effectiveness of packed-tower aeration to remove volatile organic chemicals from contaminated groundwater. This ultimately led to designing one of the first full-scale packed-tower aeration systems as a remedial measure for removing hazardous contaminants from groundwater.

- Directed the technical evaluation of treatment alternatives for removing ethylene dibromide (EOB), dibromochloropropane (DBCP) and trichloropropane (TCP) from contaminated groundwater in Hawaii. Processes evaluated included granular activated carbon (GAC) and packed tower aeration.

PUBLICATIONS:

"Heavy Metals Removal: Comparison of Alternative Treatment Process," presented at the 13th Mid-Atlantic Industrial Waste Conference.

"Ozone-Direct Filtration: Rejuvenating a New England Surface Water Supply," presented at the AWWA conference, Las Vegas, June 1983.

"Alternative Approaches for Controlling Trihalomethanes in Surface Water Supplies," presented at the NEWWA meeting, June 1983.

"Upflow Clarification of New England Surface Water Supplies," with Steve Bishop, presented at NEWWA meeting, March 1983.

NEVILLE K. CHUNG

EDUCATION:

BS, Civil Engineering, Indiana Institute of Technology, 1961
MS, Sanitary Engineering, New York University, 1968

REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL MEMBERSHIPS:

American Academy of Environmental Engineers, Diplomate
American Petroleum Institute
Association of Iron and Steel Engineers
Hazardous Materials Control Research Institute
Technical Association of the Pulp and Paper Industry
Water Pollution Control Federation

GENERAL BACKGROUND:

An Associate of Metcalf & Eddy, Mr. Chung has over 20 years of multifaceted environmental engineering experience. He has been involved in the management and disposal of waste in the pulp and paper, steel, petroleum, chemical and other industries. He has managed water and wastewater treatment projects with full responsibility for technical and financial control.

EXPERIENCE:

- Project Manager for review and evaluation of field investigation report and proposed remedial design for a National Priority List hazardous waste site. Remedial measures considered included surface water diversions, clay cap, slurry wall, leachate and gas collection, on-site treatment or off-site disposal of leachate.

- Directed field investigations, feasibility studies and design of remedial measures for an abandoned hazardous waste disposal site. Contaminants included heavy metals and organic solvents. Remedial measures evaluated included chemical fixation, on-site or off-site incineration, and excavation and off-site disposal. The recommended action, which was implemented and monitored, consisted of excavation for off-site disposal in a secure landfill, clay capping of fractured bedrock, backfilling and revegetation.

- Evaluated alternative remedial measures for sites containing a wide range of contaminated materials that remained after termination of the manufacture of a toxic organic compound. Contaminant materials included lagooned sludge, water, soil, rubble from plant demolition, residual product and discarded protective gear.

- Project Manager for review and evaluation of plans and specifications for proposed remedial design for a site contaminated with DDT. Evaluation included technical and economic comparisons of excavation and removal of contaminated soil, surface water diversion and capping of the site with alternative materials, and monitoring. An assessment of the fate and transport of DDT in the soil was also made.

- Managed project to identify and quantify the potential emissions to air and surface water associated with implementation of remedial action alternatives at a hazardous waste disposal site.

- Directed process design and detailed design of advanced treatment system for removal of heavy metals and toxic organics. Project included design of surface impoundments with double synthetic lining and leachate detection, groundwater interception and groundwater monitoring.

- Directed site investigations and feasibility studies to identify and evaluate remedial action alternatives for preventing/mitigating the release of PCB's from an electrical equipment manufacturing and testing site.

- Directed project for evaluation of site contamination and development of cleanup plans. Field investigations included sampling of soil, groundwater and building surfaces to evaluate the extent of contamination. Remedial action consisted of excavation and removal of hazardous materials off-site to a hazardous waste landfill.

- Reviewed conceptual plans and provided advice relative to the design of a commercial hazardous waste management facility to treat oily wastes, acids and bases, resins and pigments, solvents and miscellaneous oxidizable wastes for Reclamation Resources, Inc. Planned facilities include receiving, testing, storage, pretreatment, blending and final treatment or disposal systems. In selecting treatment processes, emphasis was placed on the recovery of materials such as oils and solvents for reuse.

- Provided consulting services to Research-Cottrell relative to the identification, reporting, transportation (manifests) and disposal of hazardous wastes company-wide. In addition to the federal requirements, individual state requirements were determined in those states where the company had operations which might potentially be generators of hazardous wastes.

- Project Director for an investigation to identify and quantify wastes at an abandoned disposal site, assess groundwater contamination and contaminant migration potential and evaluate remedial action alternatives for military equipment manufacturer. Involved in installation of monitoring wells, groundwater sampling and analysis, and development of recommendations for site cleanup.

- Soil and water sampling data were reviewed and evaluated for Thomas K. Dyer, Inc. to develop recommendations concerning the disposal of waste materials and the protection of potable well water supply and a lake classified for contact recreational use. The toxic contaminant of concern in the waste material included PCB's, pesticides, herbicides, polynuclear aromatic hydrocarbons and heavy metals.

PUBLICATIONS:

"Geologic Studies of Industrially-Related Contamination: Soil and Groundwater Investigations," with D. Bruehl and W. Diesl, presented at National Conference on Management of Uncontrolled Hazardous Waste Sites, 1980.

"Steel Industry Wastes," with D. J. Vachon and J. Haskill, Journal of the Water Pollution Control Federation, June 1983.

"Treatment and Reuse of Hot Rolling Mill Effluents from Iron and Steel Plants," presented at the International Symposium on Management of Industrial Wastewater in Developing Nations, March 1981.

"Petroleum Processing and Coal Conversion Wastes," with E. S. Stover, Journal of the Water Pollution Control Federation, June 1980.

"Investigation of the Use of Gel Material for Mine Sealing," Office of Research and Monitoring, U.S. Environmental Protection Agency, January 1973.

DONALD P. BROWN

EDUCATION:

BS, Geology and Earth Sciences, Kent State University, 1969
Graduate Studies in Environmental Engineering, Ohio State University
Graduate Studies in Business Administration, University of Dayton

PROFESSIONAL MEMBERSHIPS:

American Society of Photogrammetry and Remote Sensing
American Society of Testing and Materials
Active Member of Committee F-20 Developing Standards for Industrial Chemical Waste Disposal

GENERAL BACKGROUND:

Mr. Brown has extensive experience in the management of hazardous wastes. His expertise covers a broad spectrum of hazardous waste programs: the development of regulations, surveillance networks and quality control programs, spill prevention and spill mitigation, the investigation of hazardous waste projects, the licensing, construction and operation of treatment facilities and hazardous wastes transportation and disposition.

EXPERIENCE:

- Directed development, licensure, and financing of a $90 million hazardous waste treatment center.
- Responsible for the cost-effective management of worldwide technology assessment, environmental permitting, business plan development and scheduling, and corporate public relations.
- Served as Principal Investigator for 14 major projects involving a multi-disciplinary staff of scientists and engineers and $2 million of research annually. Served as Hazardous Waste Management Thrust Leader at Battelle Municipal Institute.
- Program Manager for EPA developing regulations, surveillance networks and quality control programs.
- Chief of Engineering Response Bureau of EPA with three divisions: hazardous waste disposal unit, spill prevention unit, and statewide

spill mitigation unit. Over 3,000 chemical incidents have been mitigated utilizing the skills of between 52 and 140 professionals.

- As Chief of Environmental Assessment Division of EPA, managed a 23-person multi-disciplinary review team.
- Sanitarian-in-Charge of the Ohio Water Quality Program for the Ohio Department of Health. The program was directed through five regional offices.

PRESENTATIONS:

- Brown, D. P., "Hazardous Waste Management in Ohio," Ohio Environmental Council Annual Meeting Proceedings, June 23, 1978.
- Brown, D. P. and D. H. Stewart, "Availability of Battelle as a National Strike Force Team," presented to Third Inland Spills Conference, Cincinnati, Ohio, September 15, 1978.
- Brown, D. P., "R&D Today in Volatile Spill Suppression," presented to U.S. EPA, OEPA and USGG Inland Spill Control Conference, Bellefontaine, Ohio, October 19, 1976.
- Brown, D. P., "Fugitive Emissions Monitoring at a Coal Cleaning Plant Site," presented to the Second Symposium on Fugitive Emissions: Management and Control, Houston, Texas, May 23, 1977.
- Brown, D. P., "Spill Prevention in Ohio," Ohio Petroleum Marketers Association Annual Meeting Proceedings, July 18, 1974.
- Brown, D. P. and R. P. Moffa, Office of Land Pollution Control, OEPA, "Hazardous Waste Management in Ohio: Implementation of SUB C P. L. 94-580 in a Heavy Industry State," presented to American Chemical Society Meeting, Honolulu, Hawaii, April 1-6, 1979.
- Brown, D. P., T. J. Thomas, Major J. P. Tremblay, U.S. Air Force, "Landbased Environmental Monitoring for 2, 4-D, 2,4, 5-T and Dioxin in Support of the U.S. Air Force Herbicide Orange Disposal Operations," presented to American Chemical Society Meeting, Honolulu, Hawaii, April 1-6, 1979.

PUBLICATIONS:

- Brown, D. P., S. E. Rogers, D. A. Tolle, R. Clark, D. A. Sharp, J. Stillwell, B. W. Vigon, "Environmental Assessment of Coal Cleaning Processes: Homer City Power Complex Testing," EPA-600/7-78, May 1979.
- Oxley, J., D. P. Brown, D. A. Sharp, "Assessment of Sulfur Oxides and Particulates Control Technology," U.S. EPA, January 13, 1978.

- Brown, D. P., T. Bowden, H. Small, P. R. Bltz, C. Gaston, G. C. Stotler, "Preliminary Study of the Feasibility of a State-wide Resource Recovery Authority for the State of Illinois," Natural Resources, June 27, 1979.

- Sharp, D. A., V. Breuggemeyer, D. P. Brown, C. Bui, "Ohio Hazardous Waste Management Plan," sponsored by OEPA, July 1979.

- Brown, D. P., "Industrial Waste Survey," Ohio Environmental Health Association Journal, November-December 1975.

- Tremblay, J. W., D. P., Brown, T. J. Thomas, "Landbased Environmental Monitoring for 2, 4-D, 2, 4, 5-T, and Dioxin in Support of the U.S. Air Force Herbicide Orange Disposal Operations," printed for American Chemical Society, Division of Environmental Chemistry, Honolulu, Hawaii April 1979.

- Brown, D. P., R. L. Riggin, T. B. Stanford, L. G. Taft, B. W. Vigon, "An Evaluation of Physical and Chemical Groundwater Conditions at an Industrial Liquid Waste Disposal Facility," sponsored by a Business Sensitive Industrial Corporation, October 27, 1978.

- Brown, D. P., R. Craig, M. Edwards, N. Henderson, T. J. Thomas, "Techniques of Controlling Air Pollution from Spills of Gases and Readily Volatile Hazardous Substances Occurring on Land," sponsored by U.S. EPA, 1977.

- Clark, R., D. P. Brown, J. Burch, R. Ayers, R. Dick, H. J. Henning, D. Hoole, D. Sharp, "Potential Environmental Impact of Compounding and Fabricating Industries: A Preliminary Assessment," sponsored by U.S. EPA, August 1977.

- Brown, D. P., "Civilian Industries Involved in Developing or Implementing Technology in Geotechnical Surveys, Groundwater Control in Situ Treatment of Soils and Treatment of Liquid Chemical Wastes," (Report No. EA 3-3),sponsored by U.S. Department of Defense, May 28, 1976.

- Brown, D. P., B. R. Allen, S. G. Bloom, H. N. Condle, R. B. Engdahl, N. A. Frazier, S. Globe, D. M. Jenkins, S. E. Miller, K. S. Murthy, J. L. Otis, J. H. Oxley, H. S. Rosenberg, D. A. Sharp, T. J. Thomas, B. W. Vidon, "Assessment of Sulfur Oxides and Particulate Control Technology," sponsored by U.S. Department of Energy, January 13, 1978.

- Allen, B. R., D. P. Brown, S. E. Miller, B. W. Vigon, "Philadelphia Electric Company, Eddystone Unit 1 Magnesium Oxide Scrubbing," sponsored by U.S. Department of Energy, December 19-20, 1977.

- Bloom, S. G., D. P. Brown, N. A. Frazier, D. M. Jenkins, S. E. Miller, "Pennsylvania Power Company, Bruce Madsfield Units 1 and 2 Lime Scrubbing," sponsored by U.S. Department of Energy, December 21-22, 1977.

- Sharp, D. A., J. A. Gurklis, D. P. Brown, V. S. Brueggemeyer, "Cost of Compliance with Hazardous Waste Management Regulations (RCRA)," sponsored by U.S. EPA, May 1978.

- Brown, D. P., "Impact of Legislation and Implementation of Disposal Management Practices," Toxic and Hazardous Waste Disposal Series, Vol. III, Ann Arbor Science Publishers, Inc., Cat No. 40253, November 1979 (reprinted February 1980).

- Brown, D. P., "New and Promising Ultimate Disposal Options," Toxic and Hazardous Waste Disposal Series, Vol. IV, Ann Arbor Science Publishers, Inc., Cat. No. 40265, December 1979 (reprinted March 1980).

NATIONAL MEDIA EXPOSURE:

- "Killing Ground" by Mike Brown

- "Herbicide Orange"

- National Waste Alert - March 1981 for Public Broadcasting Corporation in Conjunction with U.S. EPA.

ELIZABETH K. LEVIN

EDUCATION:

B.A., Political Science, Wellesley College, 1967
Masters of Urban Affairs, Planning, Boston University, 1981
Coursework, Management, Simmons School of Management

PROFESSIONAL MEMBERSHIPS:

American Planning Association

BACKGROUND AND EXPERIENCE:

As a Project Manager in the Environmental Planning Division, Ms. Levin is experienced in site selection studies, socio-economic analyses, institutional analyses, demographic studies, community development, environmental evaluations and financial analyses. In addition to her technical responsibilities at Metcalf & Eddy, she handles liaison work with community organizations and government agencies.

Ms. Levin has participated in numerous projects where she was responsible for both the technical work performed and conducting the public participation programs. She managed the environmental impact statements for the U.S. postal facility at Woburn, Massachusetts, the South Station Transportation Project, Boston, and the Kendall Square, Cambridge, Urban Renewal Project. The South Station and Kendall Square projects were sizable land-use development projects for which Ms. Levin coordinated the technical studies and handled the community participation program and governmental relationships. A major issue was the neighborhood impacts of these developments, such as "gentrification", employment of neighborhood residents, and traffic and noise through residential streets. Public participation included workshops, news releases, community surveys, and public meetings. Both projects are now under construction and incorporate many design features recommended through the public participation program.

Ms. Levin also prepared the environmental evaluation and conducted the public participation program for a United States Department of Agriculture Nutrition Center in the Chinatown section of Boston, Massachusetts. Due to the initial opposition by the Chinese community, an elaborate bilingual public participation program was conducted.

She recently was responsible for the environmental evaluation of 11 site options proposed for upgraded wastewater treatment for the 43 communities which comprise the Metropolitan Sewage District, Massachusetts. As part of the study, she participated in numerous workshops and meetings with public officials and community residents.

ELIZABETH K. LEVIN (continued)

In addition to serving municipal clients, Ms. Levin has represented community groups on environmental litigation against government organizations. For Roxse Homes, a low income housing project, she served as the Project Planner for litigation concerning the adverse impacts on Roxse of a proposed highway. For a community group in Lackawanna County, Pennsylvania, she served as an expert witness in Federal Court on the adequacy of the environmental work performed for a Federally-funded "access" road to serve a proposed ski resort.

KATHERINE D. WALKER

EDUCATION:

BA, Biology, Bowdoin College, 1978
MS, Environmental Health Sciences/Industrial Hygiene, Harvard School of Public Health, 1983
University of Aberdeen, Scotland, Faculty of Science, 1976-1977

GENERAL BACKGROUND:

Ms. Walker is a member of Metcalf & Eddy's Industrial Hygiene and Risk Assessment Group. She serves as Metcalf & Eddy's Health and Safety Officer for hazardous projects, and is responsible for conducting hazardous substance risk assessments associated with water quality, potable water treatment, industrial waste management and refuse/waste incineration.

EXPERIENCE:

- Prepared Metcalf & Eddy's Health and Safety Manual for investigations and remedial actions at hazardous waste sites. Developed standard operating procedures for on-site monitoring and sampling of drums, entry into hazardous waste sites and confined spaces, use of respiratory protection and protective clothing, and decontamination procedures.

- Identified health and safety considerations and OSHA regulations for construction/excavation activities in a hazardous waste area. Developed all health and safety procedures, personal protective equipment requirements, and monitoring plans to protect workers and the public from exposure to toxic contaminants emitted during construction.

- Conducted investigation of toxic agents potentially responsible for symptoms reported by wastewater treatment plant employees exposed to uncontrolled discharge of industrial waste containing high concentrations of volatile, synthetic, and organic chemicals. Developed monitoring program to evaluate nature and extent of airborne contaminant exposure.

- Developed site-specific health and safety plan for excavation at site contaminated with solvents from leaking storage tank. Plan included monitoring protocols,

personal protective equipment requirements, and general safety procedures to be implemented during site work.

- Acted as Research Assistant for ongoing health effects study for Department of Energy. Involved analysis of occupational epidemiologic literature to determine nature, magnitude and degree of certainty of potential health effects from population exposure to airborne particulates.

- Prepared written comments on the Environmental Protection Agency's proposed rules for volatile synthetic organic chemicals in drinking water and on EPA criteria documents for sulfur dioxide and particulates. Wrote two chapters of a book on hazardous substances in developing countries.

- As a Research Technician helped collect and process data for a large prospective study of air pollution levels and related health effects in six U.S. cities.

- Conducted a preliminary risk assessment for a proposed municipal refuse "waste-to-energy" incinerator in Albany, New York. This project involved dispersion modeling of projected emissions of toxic substances and comparisons with existing standard and guidelines.

- Worked as a Subcontractor to an economist in benefit-cost analysis of the regulation of toxic substances. Assigned to evaluate the uncertainty or error associated with the benefits (reduced risk of adverse health effects).

PUBLICATIONS:

Morahan, Page S., Paul J. Edelson and Katherine Gass (Walker), "Changes in Macrophage Ectoenzymes Associated with Anti-tumor Activity," Journal of Immunology, Vol. 125, No. 3, September 1980.

Passwell, J. H., J. M. Dayer, K. D. Gass (Walker), and P. J. Edelson, "Regulation by F. Fragments of the Secretion of Collagenase, PEG_2 and Lysozyme by Mouse Peritoneal Macrophages." Journal of Immunology, October 1979.

DANIEL A. CARVALHO

EDUCATION:

BS, Chemical Engineering, Northeastern University, 1970
MS, Environmental Engineering, Northeastern University, 1980

REGISTERED PROFESSIONAL ENGINEER

GENERAL BACKGROUND:

As a Senior Project Engineer in Metcalf & Eddy's Industrial Division, Mr. Carvalho is responsible for projects in the fields of industrial water/wastewater treatment, facilities engineering retrofits, and hazardous waste management. He brings to this position more than ten years of experience in the direction of conceptual and detailed engineering design of industrial wastewater treatment plants and several years of experience in the detailed process design of high purity RO/DI water treatment plants and water recycle/bulk chemical and solvent storage facilities engineering retrofits for a number of major electronic component manufacturers.

EXPERIENCE:

- Assisted an electronics firm in the process design/spill prevention control/fault tree risk assessment analysis for a large bulk chemical/solvent storage tank farm handling xylene, methyl chloroform, isopropyl alcohol and other manufacturing/waste chemicals.

- Assisted in the process design of a hazardous waste site cleanup treatment system under a superfund cleanup program contract to the U.S. EPA.

- Directed the design of a 40,000 gpd waste treatment system for a small coatings manufacturer. The process design involved air stripping for volatile organic solvent removal and gravity oil separation as part of the pretreatment stage; flow equalization followed by solids contact type clarification with lime/polymer treatment for phosphate/heavy metals/suspended solids removal; effluent pH adjustment/polishing sand filter for residual suspended solids removal; and three-stage granular activated carbon (GAC) filtration for dissolved organics removal below detectable limits.

- Prepared technical expert witness testimony and exhibits to successfully defend a large aircraft manufacturer involved in a $2.2 million criminal lawsuit alleging hazardous waste/discharge permit violations.

- Project manager for a large electronics manufacturer, directing the design of a water recycle facilities engineering retrofit project which upgraded and optimized the cold lime softening process for a water treatment plant expansion to 3.24 mgd.

- Project engineer for the design of 18 megohm-cm high purity RO/DI water treatment systems for several electronic component manufacturers. One design included a DI water makeup reclaim system to minimize use of city water. In another instance, a portion of the DI water manufacturing rinses was reclaimed as cooling tower makeup.

- Experienced in preparing federal and state permit applications; Spill Prevention, Control and Countermeasure (SPCC) Plans; Coast Guard operation manuals for oil transfer facilities; environmental impact statements; detailed operation and maintenance (O&M) manuals; technical support for expert witness testimony preparation involving environmental litigation; and numerous waste characterization and treatability studies.

CLIFFORD E. STEIN

EDUCATION:

BS, Agronomy - Soil Science, University of Maryland, 1972
MS, Soil Science, University of Maryland, 1978

PROFESSIONAL MEMBERSHIPS:

American Society of Agronomy
International Soil Science Society
Alpha Zeta, Agricultural Honor Fraternity
Geological Society of Washington

GENERAL BACKGROUND:

Mr. Stein is a soil scientist with over seven years of professional experience. He provides technical assistance and direction for soil and hydrogeologic investigations related to land application of wastes and soil and groundwater contamination problems. His experience includes field investigations and descriptions of soils, soil mapping, soil survey interpretations, laboratory and field testing of soil chemicals, physical and hydraulic properties, installation and sampling of groundwater monitoring wells, assessment of contaminant attenuation and transport in soils, and assistance with agronomic problems. He has experience conducting feasibility studies and design of land application systems for wastewater or sludge.

EXPERIENCE:

- Served as Acting Chief of Groundwater Discharge Permits Section of the Maryland Department of Health and Mental Hygiene. Responsible for all projects involving permits for the discharge of municipal and industrial wastewater to groundwater in the state.

- Described, sampled, and mapped soils on National Capitol Parklands for the Soil Survey of the District of Columbia conducted at the University of Maryland.

- Conducted detailed field investigations to determine design feasibility for paid infiltration and overland flow alternatives at Piney Orchard Development, Maryland.

- Conducted resident inspection for an industrial client during the excavation and removal of soils contaminated with hazardous wastes.

- Conducted soil sampling, and groundwater investigations for an confidential industrial client in California to determine the extent of site contamination from metals and other EPA priority pollutants.

- Reviewed remedial action plans for two National Priority List hazardous waste sites. Work included data evaluation, site reconnaissance and recommendations.

- Provided field supervision and technical direction for closure of a hazardous waste site for a confidential industrial client in Maryland. The project involved field supervision of excavation work, soil sampling and analysis to ensure removal of contaminated materials, and review of groundwater monitoring data to devise a post-closure monitoring program acceptable to the state regulatory agency.

PUBLICATIONS:

- Fanning, Dr. D. S., and C. E. Stein, "Formation, Morphology and Classification of the Soils," Soil Survey of the District of Columbia, Washington, D.C., 1976.

- "Soils of Washington, D.C.," co-author, Geologic Society of America, Northeast Section, Abstract, 1974. Co-author.

- "Classification of Urban Soils and Fill Materials," co-author, American Society of Agronomy, Chicago, Illinois, Abstract, 1974.

- "Variability and Inclusions of Mapping Units of Urban Soils," co-author, American Society of Agronomy, Los Angeles, California, Abstract, 1977.

- "Theories of Genesis and Classification of Highly Man-Influenced Soils," co-author, International Soil Science Congress, Abstract, 1978.

CHRISTOPHER L. D. HAGGER

EDUCATION:

BS, Civil Engineering, Tufts University, 1973
MS, Environmental Engineering, University of North Carolina, 1975

REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL MEMBERSHIPS:

National Water Well Association
Boston Society of Civil Engineers

GENERAL BACKGROUND:

Mr. Hagger has experience in the development, management and supervision of hydrogeologic investigations of numerous landfills, industrial waste sites and hazardous waste sites. He has developed Remedial Action Master Plans and has performed Remedial Investigation/Feasibility Studies for numerous National Priority List Superfund hazardous waste sites. He has supervised safety precautions and equipment/personnel decontamination measures during hazardous waste site field investigations, and has developed detailed groundwater monitoring well specifications for hazardous waste sites. He also has conducted engineering reviews and assessments of remedial alternative designs for a number of hazardous waste sites. Mr. Hagger has served as an expert witness during enforcement-related Superfund site actions for the U.S. Environmental Protection Agency. He serves on the part-time faculty of the Department of Civil Engineering at Tufts University where he has instructed in the areas of groundwater hydrology and hazardous waste site investigations. He has evaluated sludge handling, treatment and final disposal at wastewater and water treatment facilities located throughout the United States.

EXPERIENCE:

- Responsible for the Preliminary Site Assessment and RAMP, Holden Landfill Site, Wachusett River Street, Holden, Massachusetts. This municipal/industrial landfill had serious leachate problems consisting of volatile organics and heavy metals.

- Responsible for a Geophysical Field Investigation for the Grugnale Waste Disposal Site, Milford, New Hampshire. This site was alleged to have buried drums on-site that contaminated local wells.

- Responsible for a hydrogeological investigation, the Remedial Action Master Plan, and the development of alternative remedial actions and data collection methods for the Kingston Steel Drum/Ottati & Goss Site, Kingston, New Hampshire. These abandoned industrial sites had grossly contaminated groundwater and a filled in lagoon contaminated with PCB's and volatile organics.

- Responsible for the Preliminary Site Assessment for the Tappan Site, Laconia, New Hampshire.

- Responsible for the Preliminary Site Assessment for Coastal Industries, Wallingford, Connecticut.

- Responsible for the Site Inspection Report and Hazardous Ranking System Report for the Somersworth Landfill, Somersworth, New Hampshire.

- Responsible for the Preliminary Site Assessment for the South Windham Landfill, Machine Shop Hill Road, Windham, Connecticut.

- Responsible for the Preliminary Site Assessment of the Dover Municipal Landfill, Dover, New Hampshire.

- Performed the site inspection of Country Pond at Kingston, New Hampshire.

- Developed the Remedial Action Master Plan for the Ringwood Mines/Landfill Site, Ringwood, New Jersey. This site consisted of abandoned mine shafts filled with industrial chemical wastes, municipal landfill areas with leachate breakouts, surface disposal areas including paint sludges and a downgradient municipal well field.

- Developed the Remedial Action Master Plan for the Maywood Chemical Sites, Maywood, New Jersey. These sites consisted of vacant property, commercial/industrial property and residential property contaminated with low level radioactive wastes.

- Responsible for the identification and preliminary assessment reports for potential hazardous waste sites in: Exeter, Charlestown, Plaistow, Merrimack, Concord, Swanzey, Petersborough, Rochester, Pelham, Nashua, and Laconia, New Hampshire.

- Managed the feasibility study of the G & H Well Site in Woburn, Massachusetts. This site consisted of an abandoned municipal well field contaminated with volatile organics.

- Evaluated the "Review of Burlington Southern Connector - Pine Street Canal Site - Remedial Action and Highway Construction Assessment Phase II Report," for the Department of Health and Safety, Burlington, Vermont. The site was contaminated by hydrocarbons associated with coal-tar production.

- Evaluated the "Review of Engineering Reports and Design Plans with Remedial Recommendations," for the Charles George Land Reclamation Trust, Tyngsborough, Massachusetts. This site was an industrial/municipal landfill with surface runoff contamination, leachate breakouts and groundwater contamination, contamination consisted of volatile organics and heavy metals.

- Evaluated the "Site Inspection and Proposed Work Plan for Keefe Environmental Services," Exeter Road, Epping, New Hampshire.

- Evaluated the "Assessment of Alternatives for Temporary Stabilization of a Lagoon Containing Hazardous Wastes Located Near Epping, New Hampshire," Exeter Road, Epping, New Hampshire. This lagoon was filled with aqueous and flammable organics and would overflow its embankments during heavy precipitation.

- Designed trunk and sanitary sewers, storm drains and water distribution systems for Lewiston, Maine and Stoughton, Massachusetts.

- Designed sanitary/secure landfills for Plainville and New Bedford, Massachusetts.

- Evaluated sludge handling, treatment and final disposal at the Jones Island WWTP, Milwaukee, Wisconsin, Niagara Falls WTP, Niagara Falls, New York, Richmond Park WTP, Halifax, Massachusetts, Heritage Village WWTP, Southbury, Connecticut and the Chapel Hill WWTP, Chapel Hill, North Carolina.

- Performed hydrologic analyses to determine tidal flooding problems in Shelter Island, Riverhead, Huntington, Sag Harbor, Lloyd Harbor and Smithtown, New York.
- Involved in the design of water treatment facilities for Halifax, Massachusetts and Methuen, Massachusetts.
- Designed a county vehicle maintenance and storage facility for Arlington County, Virginia.

PUBLICATIONS:

Hagger, C. L. and P. F. Clay, "Hydrogeological Investigation of an Uncontrolled Hazardous Waste Site - An Engineering and Field Analytical Approach." Presented at the Second National Conference and Exhibition on Management of Uncontrolled Hazardous Waste Sites, sponsored by the U.S. EPA and the Hazardous Materials Control Research Institute, Washington, D.C., October 1981.

Hagger, C. L. and G. R. Smart, "An Approach to Drilling and Installation of Groundwater Monitoring Wells on Hazardous Waste Sites - Construction Specifications and Preparations for Non-Ideal Field Conditions." Presented at A Northeast Conference - The Impact of Waste Storage and Disposal on Groundwater Resources, sponsored by U.S. Geological Survey and Center for Environmental Research, Cornell University, co-sponsored by U.S. EPA, N.Y. State Department of Environmental Conservation and N.Y. State Department of Health, Ithaca, N.Y., June 1982.

Hagger, C. L. and A. M. C. Desmarais, "An Approach to Drilling and Installation of Groundwater Monitoring Wells on Hazardous Waste Sites." Presented at the Third National Symposium and Exposition on Aquifer Restoration and Ground Water Monitoring, sponsored by the National Water Well Association, Columbus, Ohio, May 1983.

DANIEL P. WALTZ

EDUCATION:

BS, Geology, University of Dayton, 1971
MS Candidate, Hydrology, Ohio University

GENERAL BACKGROUND:

Mr. Waltz is a hydrogeologist who has worked on a variety of site investigations and assessments in the area of hazardous waste management, including surveying, geophysical investigations and design, drilling and sampling of monitoring wells.

EXPERIENCE:

- Participated in hydrogeological aspects of Remedial Action Master Plan (RAMP) study of a landfill site in Edison, New Jersey. Site visits were conducted in personnel protection level B using self-contained breathing apparatus.

- Completed uncontrolled hazardous waste site ranking for two sites in New England (Augusta, Maine and Framingham, Massachusetts).

- Reviewed remedial action plans for a National Priority List hazardous waste site. Work included data evaluation and site reconnaissance. Recommendations were presented to state and federal officials.

- Participated in a groundwater contamination study in Milford, New Hampshire, including the site safety reconnaissance and the subfloor soil averaging and sample collection phases of the study.

- Conducted numerous preliminary hazardous waste site assessments, including coordination with federal, state and local agencies; also conducted perimeter surveys and made recommendations for future site investigations.

- Organized site sampling for priority pollutants, prepared request for bids for installation of monitoring wells, and participated in geological investigations of a number of hazardous waste sites.

- Supervised monitoring well installation, collection of spoon samples, drilling and construction of wells and collection of head-space samples for field screening for volatile organic chemicals.

MICHAEL D. SULLIVAN

EDUCATION:

BS, Chemical Engineering, University of Rhode Island, 1979
MS, Chemical Engineering, University of Rhode Island, 1983

PROFESSIONAL MEMBERSHIP:

American Institute of Chemical Engineers

GENERAL BACKGROUND:

Mr. Sullivan is a chemical engineer experienced in the design and operation of pilot plants and industrial wastewater treatment facilities, and environmental and treatability studies including hazardous waste.

EXPERIENCE:

- Participated in hazardous waste studies for Fairchild Republic Company. These projects included a hydrologic study on an abandoned disposal site adjacent to the plant. The study determined the extent of soil or groundwater contamination resulting from buried electroplating, paint and degreaser wastes (including trichloroethylene). The program included delineation of the contamination source by surface and test pit soil sampling, soil chemical analysis, soil leachability testing, test drilling, installation of monitoring wells, water quality analysis (field and laboratory), and water table mapping. Recommendations and cost estimates were made for closing and rehabilitating the disposal area. Major alternatives were relocating the waste materials to an approved hazardous waste landfill or treating the wastes on-site to remove the possibility of hazardous leachate generation.

- Contributed to the design, construction and operation of an air stripping pilot unit for removing volatile organic compounds from potable water in Dedham, Massachusetts.

- Analyzed operations data produced by an activated carbon company and produced a cost comparison for the two alternative wastewater treatment systems.

- Completed pilot studies of air stripping for the Suffolk County Water Authority in New York. Set up and ran the pilot plant, instructed client personnel on the unit operation, and analyzed the data.

- Completed pilot studies for treating various steel plant effluents for the U.S. EPA. Responsible for operation of the pilot system, sampling for various constituents including priority pollutants, conducting of on-site bench tests, and data reduction and analysis.

- Conducted a filtration pilot study for a major manufacturer. This study involved evaluating both proprietary and conventional filter designs in treating secondary effluent from an industrial wastewater treatment plant.

- Participated in both the preliminary and final design phases of industrial wastewater treatment plant design. Duties included concept development, material and energy balances, assisting various engineering departments in expediting assigned tasks, and assisting in shop drawing review. Also performed treatability studies to evaluate proposed treatment methods and to improve the operation of existing facilities, and feasibility studies to determine the cost-effectiveness of various processes.

- Performed a sludge management study which included the review of land application and the recommendation for dewatering capabilities to be added via a filter press.

MICHAEL COOLEY

EDUCATION:

AAS, Civil Technology, Hudson Valley Community College, 1976
BS, Civil Engineering, State of University of New York, 1980

REGISTERED INTERN ENGINEER

PROFESSIONAL MEMBERSHIPS:

Water Pollution Control Federation
New York Water Pollution Control Association

GENERAL BACKGROUND:

Mr. Cooley has training and experience in hazardous waste management and wastewater treatment. His expertise includes activated carbon treatment, leachate collection and treatment, hazardous waste site remediation, and health and safety related to hazardous materials.

EXPERIENCE:

- Assistant Sanitary Engineer responsible for the operation and maintenance of the leachate collection system and advanced wastewater treatment facility at the abandoned hazardous waste landfill at Love Canal, Niagara Falls, New York. Resposibilities included supervision of on-site personnel in operation and maintenance activities; direction of work performed by private contractors' on-site safety coordination for construction projects; direction of carbon deliveries and disposal; plant operation and design improvements; development of contingency and safety plans in accordance with federal RECRA regulations; hydraulic analysis of flow data; and assistance in groundwater data collection.

- Project Engineer in charge of technical output for projects relating to municipal sewage collection and treatment systems. Projects included a sewer system rehabilitation effectiveness study; a sludge management study, an industrial pretreatment program, and a wastewater facilities plan.

RALPH J. SCHMITT

EDUCATION:

BS, Chemical Engineering, San Jose State University, 1967
MS, Civil/Environmental Engineering, University of Hawaii, 1973

REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL MEMBERSHIPS:

American Institute of Chemical Engineers
Water Pollution Control Federation

GENERAL BACKGROUND:

Mr. Schmitt is a Project Engineer with 13 years of experience in process engineering, tr atment plant design, construction, and operations. He has participated in the evaluation and design of numerous industrial waste treatment systems and hazardous waste management facilities.

EXPERIENCE:

- Provided the process design for a facility to accumulate and pretreat hazardous wastes generated during the refurbishing of solid rocket boosters used to launch the Space Shuttle. This work included EP toxicity and California WET testing of hazardous waste insulation solids, the development of a procedure to oxidize dilute hydrazine waste with hydrogen peroxide, and the development of bulk hazardous waste solids handling procedures.

- Directed the evaluation of a hazardous waste landfill leachate disposal problem for a coastal municipality. Conceptual designs for several alternatives were developed for technical and economic evaluation.

- Designed a contaminated stormwater runoff retention basin and disposal system for a scrap metal recycling plant.

- Redesigned inoperative chemical paint stripping waste treatment plants for the U.S. Navy at Naval Air Station, Alameda, California. Included the treatment process design; coordination of mechanical, electrical, and civil

engineering disciplines; and preparation of construction plans and specifications.

- Developed a treatment procedure to remove phenol and methylene chloride from chemical paint stripping waste. Ozone/ultraviolet light oxidation and hydrogen peroxide oxidation were evaluated in a pilot scale process. The recommended treatment process combined chromium reduction and precipitation treatment with hydrogen peroxide oxidation of phenolics.

- Supervised engineers and geologists in a semiconductor manufacturing site study to characterize the extent of contamination from past on-site disposal practices for waste plating solutions and solvents. Groundwater monitoring wells were installed and site soils and groundwater samples were analyzed in accordance with the California WET test procedure for the determination of hazardous wastes.

- Responsible for performing site closure sampling and analyses services for a 20-acre industrial site. Site had been contaminated with caustic, lead, tin, and zinc during 70 years of heavy metal reclaiming operations.

- Supervised an inventory of hazardous waste generation, accumulation, and disposal procedures for a major airline maintenance facility.

- Designed membrane lined hazardous waste storage ponds for the chemical fertilizer industry. The design included facilities to periodically remove and dispose of an accumulation of solids in the pond bottom.

- Developed conceptual design alternatives and preliminary cost estimates to double the disposal capacity of an existing deep well inspection disposal system for ammonia fertilizer manufacturing wastes. Zero discharge alternatives to deep well inspection disposal were also developed for this 400 tpd ammonia plant.

- A pretreatment process was developed to remove heavy metals and toxic organics from a caustic detinning liquor. The pretreatment process was successful in converting the highly toxic liquor to a material suitable for sewer discharge.

- Directed a waste characterization and treatability study for an electronics component manufacturer's plating shop. The study recommended a metals precipitation

pretreatment process and accumulation and disposal procedure for hazardous waste solids generated by the treatment process.

- Supervised the investigation of the extent of contamination caused by a leaking below-ground hydrofluoric acid waste storage tank. New underground storage facilities were designed for waste solvents and waste acids in compliance with the Santa Clara County, California model code ordinance for the storage of hazardous materials.

PUBLICATIONS:

"Combining Chromium Treatment with Hydrogen Peroxide Oxidation of Phenolics," 36th Purdue Industrial Waste Conference, West Lafayette, Indiana, Ann Arbor, Michigan, May 1981.

"Guidance Manual for Closure of Hazardous Waste Surface Impoundments," USEPA, Cincinnati, Ohio, Contract No. 68-03-2567, Project Officer John F. Martin.

NICHOLAS C. D'AGOSTINO

EDUCATION:

BS, Civil Engineering, Clarkson College of Technology, 1972
Graduate Studies - Massachusetts Institute of Technology and Northeastern University, 1975
Graduate Studies in Earthquake Engineering - Northeastern University
MS, Civil Engineering, Northeastern University, 1982

REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL MEMBERSHIP:

American Society of Civil Engineers

GENERAL BACKGROUND:

Mr. D'Agostino is a Soils Engineer with over eleven years of professional experience. He has conducted subsurface investigations, foundation analyses, settlement analyses and stability analyses for a variety of structures, including dams. He has also participated in Phase I and Phase II Dam Investigations.

EXPERIENCE:

- Analyzed seepage and stability for a variety of conditions to determine the safety of dams in Connecticut, New York, and Virginia.

- Analyzed seepage through the abutments of Freshwater Pond Dam in Enfield, Connecticut. Designed and inspected a grouting program to seal leakage that was occurring.

- Performed hydrogeologic investigations necessary for site selection to handle wastewater streams containing toxic/ hazardous substances.

- Developed boring, test pit, and laboratory testing programs, evaluated results, and evaluated the geologic and hydrogeologic setting of a site for an advanced wastewater treatment plant for Exxon Research and Development Corporation. Prepared a site selection report with special consideration to dolomite bedrock which is subject to solutioning and sinkhole development. Evaluated settlement of buildings, dewatering requirements and special precautions for foundation preparation for structures and storage lagoons, permanent underdrain system and

embankment slope stability; prepared details for drawings and specifications, and prepared geotechnical recommendations for design of the facility.

- Developed subsurface investigations and laboratory testing for a proposed wastewater sludge compost facility in Rockland County, New York. Evaluated subsurface conditions for the site which is to be founded in an active landfill. Determined structural settlements, recommended foundation types, determined site stabilization methods, evaluated methane gas protection requirements and prepared a detailed cost comparison for site development. Prepared a report detailing the findings of the investigation and recommendations.

- Prepared final design drawings and specifications for a storage lagoon which will contain diesel oil, cleaning solvents and PCB contaminated water for the Metropolitan Transit Authority (MTA), New York. Designed liner and underdrainage systems, and embankments for the lagoon. Performed cost comparison for various liner materials including high density polyethylene, clay and soil bentonite.

- Reviewed respondents' proposed remedial measures to EPA for closure plans for controlling erosion transport of contaminated sediments off-site from hazardous waste facilities and made recommendations and cost analysis for conceptual modifications to surface sealing plans.

- Prepared subsurface investigation and laboratory testing program, evaluated hydrogeologic conditions, and determined leachate plume advance and surface water hydrology for a sludge ash landfill for a wastewater treatment plant for the Mattabassett District in Cromwell, Connecticut. Predicted impact of the landfill on domestic water wells and on the adjacent Connecticut River.

JOHN J. IANNONE

EDUCATION:

BE, Civil Engineering, Manhattan College, 1971
MS, Civil Engineering, (Water Quality), Polytechnic Institute of New York, 1980

REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL MEMBERSHIPS:

Water Pollution Control Federation

GENERAL BACKGROUND:

As a Civil Engineer, Mr. Iannone has experience in pretreatment of industrial waste, analysis of environmental risks from synthetic fuel solid wastes, and the disposal and/or cleanup of landfills containing radioactive or hazardous wastes.

EXPERIENCE:

- Project Engineer for New York City Industrial Pretreatment Program - a two-year study to establish a city-run program controlling entry of toxic, industrial waste into the city sewer system. Completed eight task reports, submitted on behalf of New York City Department of Environmental Protection to state and federal regulatory agencies, including:
  - Environmental Assessment.
  - Financial Review.
  - Treatment Plant Tolerance.
  - Executive Summary.
  - Industrial Residuals Survey.
  - Equipment and Facilities.
  - Public Participation.

- Analysis of potential risk to the environment from synthetic fuel solid wastes, investigating the characteristics of individual waste streams to identify health-related concerns, quantifying relative hazard potential, developing waste management strategies and describing the impact of those strategies on the environment.

- Assessment of the effects of RCRA on fossil energy technologies as related to risks of landfill disposal of hazardous residue. Project input included waste stream characterization, development of waste disposal options, determination of factors that affected waste stream composition, evaluation of toxicity and relative hazard potential of each waste, and development of mitigating options to minimize the regulatory impact on the above technologies.

- Analysis of alternatives for disposal and/or cleanup of processed uranium mill tailings waste pile. Two alternatives were considered: removal of the waste pile and landfill it in a strip mine; protect the waste in the landfill area where it is presently located.

- Study of the problems associated with landfill disposal of residues from synthetic fuels being developed for the Ohio River Basin Commission.

- Study of an existing landfill for the U.S. Corps of Engineers, Connecticut. The landfill, containing metal hydroxide waste from an electroplating facility, had to be removed. The study analyzed the depth of the landfill material, what is contained and alternatives for disposal.

PUBLICATIONS:

- Adamastic, R., L. Klien, J. Iannone, S. Bassell, "Current Status of the NYC Industrial Pretreatment Program," NYWPCA, Winter Meeting, January 1983.

- Chesner, W. H., M. Pia, J. Iannone, "Environmental Aspects of Solid Waste Management in Synthetic Fuel from Coal Facilities," WPCF Detroit, October 1981.

DONALD M. BRAILEY

EDUCATION:

B.S., Chemical Engineering, Rensselaer Polytechnic Institute, 1974

REGISTERED PROFESSIONAL ENGINEER

PROFESSIONAL MEMBERSHIPS:

American Water Works Association
Water Pollution Control Federation
New York Water Pollution Control Association
Chemical Engineering Product Research Panel

GENERAL BACKGROUND:

Since joining Metcalf & Eddy, Mr. Brailey has been actively involved as a Process Engineer in a wide variety of projects in the sanitary engineering and energy management fields. Currently a Senior Project Engineer in the New York Office, he specializes in the areas of process system evaluation, design, and operations.

EXPERIENCE:

- Project Engineer for water treatment evaluations for the Manasquan Reservoir Project. This project involves facility planning and preliminary design of a 40 mgd water supply using a surface water source which is potentially contaminated with synthetic organics. Processes evaluated include packed tower air stripping, activated carbon adsorption and ozonation.

- Project Engineer on the Harmon Yard Wastewater Treatment Plant design for the New York Metropolitan Transit Authority. This project involved design of a physical-chemical wastewater treatment plant and decontamination of PCB-contaminated areas.

- As Project engineer, has designed several emissions control systems, including odor removal systems using packed column chemical scrubbers, and activated carbon adsorption.

- Operated the Croton Pilot Plant for the City of New York. Processes operated included chemical feed, mixing, flocculation, filtration, carbon adsorption, and ozonation. Filter media used included dual media, mixed media, activated carbon and diatomaceous earth.

GEORGE D. COMBES

EDUCATION:

BS, Chemical Engineering, Northeastern University, 1982

PROFESSIONAL MEMBERSHIPS:

American Institute of Chemical Engineers
Phi Kappa Phi
Tau Beta Pi

GENERAL BACKGROUND:

Mr. Combes is a chemical engineer in Metcalf & Eddy's Research and Development group. Mr. Combes has been involved in projects combining pilot plant operations, pilot plant design and data analysis. His process experience has incorporated energy and material balances for a silicon carbide plant, development and evaluation of a sulfur dioxide scrubber, and evalution of ozonation, GAC adsorption and packed tower aeration for water treatment.

EXPERIENCE:

- Responsible for designing and conducting a cost comparison between an air stripping column and GAC adsorption process for the removal of pesticides from groundwater.
- Responsible for developing design guidelines and a computer program for the design of air-water stripping columns for the removal of organics from water.
- Responsible for analyzing pilot plant data from an air-water stripping column for the removal of organics from well water and specifying full-scale plant sizing for the American Waterworks Service Co.
- Responsible for developing a pilot plant program using an air-water stripping column for the removal of organics from well water for Burlington, Massachusetts.
- Responsible for designing a pilot scale liquid-liquid extraction process for the removal of phenol from a coal gasification wastewater.

- Responsible for evaluating the performance of and recommending operational procedures for a packed bed sulfur dioxide scrubber for the Fall River, Massachusetts Wastewater Treatment Plant.

- Responsible for developing, conducting and analyzing data from a laboratory-scale testing program for the removal of oil and suspended solids from an oil-in-water emulsion waste stream produced in a metal forging operation.

- Responsible for the operation and data reduction of a three process train, state-of-the-art pilot plant that removed solids and reduced color and turbidity from surface water. Unit processes included direct filtration with ozonation, flocculation, and sedimentation using a pulsator.

- Responsible for determining the chemical dosage required to neutralize an aggresive water supply.

JOAN V. BOEGEL

EDUCATION:

MS, Environmental Engineering, University of Houston, 1983
MS, Chemical Engineering, University of Delaware, 1979
BS, Chemistry, University of Delaware, 1977

GENERAL BACKGROUND:

As a member of Metcalf & Eddy's Research & Development Group, Ms. Boegel is responsible for all research, development, evaluation and start-up of new industrial, industrial waste and hazardous waste treatment processes.

EXPERIENCE:

- As Plant R&D Engineer at E.I. duPont Company, provided technical assistance to plant operations; solved process problems; prepared technical data and cost estimates for long range projects; planned and supervised plant tests. Successfully completed a $500,000 debottlenecking program. Coordinated the efforts of engineering, operations, maintenance and construction personnel in the design, installation, and testing of pigment drying equipment.

- As a Research Engineer planned and carried out bench scale research on polymerization and spinning of new high strength polyesters, started up a semi-works continuous polymerization unit, and supervised four technicians.

- As a Biochemistry Research Assistant at the University of Delaware Chemistry Department performed a mechanistic study of DNA - dependent RNA polymerase.

- As a Chemistry Research Student at Argonne National Laboratory, Argonne, Illinois performed a study of solvent and temperature effects on visible spectra of chlorophylls.

- Responsible for process development and evaluation to remove EDTA, hydrazine, ammonia and metals from metal plating wastes at a naval shipyard.

CINTHIA L. RUDASILL

EDUCATION:

BS, Chemical Engineering, University of Lowell, 1979

PROFESSIONAL MEMBERSHIPS:

American Institute of Chemical Engineers

GENERAL BACKGROUND:

Ms. Rudasill is a Chemical Engineer in Metcalf & Eddy's Industrial Division. She has participated in projects involving pilot studies of industrial wastewater treatment and disinfection processes, wastewater sampling programs, and research.

EXPERIENCE:

- Conducted an in-plant industrial waste survey at a tool manufacturing plant to alleviate problems in a closed-loop water reuse system. Identified the sources of pollutants and the process and thermal piping within the plant. Recommended piping and system changes and a maintenance program.

- Completed an investigation of methods of wastewater treatment for a nuclear fuel processing plant effluent. Worked on a statistical computer analysis of effluent data.

- Wrote procedures and results as part of a secondary treatment waiver application for the Metropolitan District Commission in Boston, Massachusetts, including wastewater sampling for priority pollutants and physical-chemical treatability testing and analysis.

- Completed a comparative study in which a newly developed polymer for sludge dewatering was tested along with polymers currently on the market. The polymers were tested in sludge screening tests, bench scale tests, and pilot studies using municipal and industrial sludges. Responsibilities included researching the polymer market, analyzing and summarizing test data and making recommendations for further testing.

- Involved in data analysis and in the determination of water quality and ozone performance for an EPA research study concerning the high level disinfection of wastewater in Marlborough, Massachusetts.

- Conducted a pilot study for the comparative testing of activated carbons, dealing primarily with data analysis.

- Completed pilot plant studies for the EPA. Included heavy metals precipitation testing on wastewater at three field sites using alkaline chlorination, break point chlorination, and alternative water softening methods. Participated in start-up, operation, sampling and analysis, data evaluation and report writing.

- Member of a project team evaluating Caterpillar Tractor Company's existing industrial and sanitary wastewater treatment systems for the removal of oil, grease, organic solvents and some heavy metals.

- Evaluated alternative disinfection processes for the Nut Island and Deer Island Sewage Treatment Plants. Worked as part of a project team on facilities planning and alternative treatment processes for the expansion of the MDC treatment plants.

- Performed treatability studies on wastewater from zinc electroplating lines for Simplex Time Recorder Company.

- Developed and wrote test plan for the U.S. EPA for conducting pilot plant studies for the treatment of oil shale wastewater.

- Assisted in the preparation of the Raytheon Company and Exxon Company O&M manuals.

- Performed preliminary sizing and cost estimations for Allis Chalmers pilot scale coal gasification plants and 1 mgd wastewater treatment plant.

ABU M.Z. ALAM

EDUCATION:

BS, Civil Engineering, Ahsanullah Engineering College, Dacca, 1961
SM, Civil Engineering, Massachusetts Institue of Technology, 1964
ScD, Civil Engineering (Hydraulics and Water Resources), Massachusetts Institute of Technology, 1966

REGISTERED PROFESSIONAL ENGINEER

PRFESSIONAL MEMBERSHIPS:

American Society of Civil Engineers
Boston Society of Civil Engineers

PRFESSIONAL RECOGNITION

1983 Wesley W. Horner Award, ASCE

GENERAL BACKGROUND:

Dr. Alam has been associated with Metcalf & Eddy on various projects since 1966 and is currently an Associate of the firm. He is responsible for application of state-of-the-art computer technology for solving complex engineering problems. He has designed large wastewater treatment plants, large sewer systems, ocean outfalls and diffusers, tunnels, spillways, pumping stations and force mains requiring complicated control systems. He has also conducted water resource systems studies and large-scale river basin development studies. He is currently Metcalf & Eddy's Technology Leader for Water Quality and Stormwater Management.

EXPERIENCE:

- As a Project Engineer, conducted for the State of Kentucky a Section 303(e) Water Quality Managment Plan for the Ohio River Basin which included modeling of Ohio River dams and impoundments.

- Conducted water quality modeling study of the Cubatao River and Santos Bay Estuary in Sao Paulo, Brazil to establish waste load allocations for meeting water quality criteria.

ABU M.Z. ALAM (Continued)

- Conducted field measurements and water quality modeling of a portion of the Delaware River for waste heat discharge from an industry.

- Conducted hydraulic and water quality modeling of the Great Miami River in Ohio for evaluating impact of combined sewer overflows from Middletown.

- Conducted field measurements and hydrodynamic and water quality modeling of Bombay Harbor and Thana Creek in India for evaluating the effectiveness of alternative wastewater disposal schemes.

- Conducted oceanographic studies and modeling of Port Vladez Fjord, Alaska which involved the design and analysis of an ocean outfall for disposal of treated process and ship ballast water from the proposed ALYESKA Petroleum Company Refinery in Port Valdez.

- Provided technical advice and guidance for hydrodynamic and water quality modeling of tidal canals in Savannah, Georgia.

- Directed near-field and far-field hydrodynamic and water quality modeling of Boston Harbor for the Metropolitan District Commission 301 (h) Secondary Treatment Waiver Application which included extensive field measurements, preliminary design of ocean outfall and diffuser system, and two-dimensional modeling using CAFE DISPER, PLUME DKHPML and other models.

- Directed hydrodynamic and water quality modeling of Plymouth Harbor, Massachussets to evaluate impact of treated wastewater effluent dischargeo Project involved sizing of outfall and diffuser and two-dimensional modeling.

- Directed hydrodynamic and water quality modeling of Cohassett Harbor, Massachusetts for evaluating impact of proposed treatment plant outfall using TPM model.

- Directed hydrodynamic and water quality modling of the Mediterranean Sea off Alexandria, Egypt to investigate a proposed ocean outfall for discharge of primary treated wastewater. Included were preliminary sizing of outfall and diffuser and near-field and far-field modeling of water quality.

ABU M.Z. ALAM (Continued)

- Directed a lake eutrophication study for the Sugden Reservoir in Spencer, Massachusetts which included evaluation of impact of sediment deposition resulting from a coffer-dam break. Included were field measurements and sampling.

- Directed a lake eutrophication and restoration study of the Whitman's Pond in Weymouth, Massachusettso Study included field measurements and sampling during both dry and wet weather.

- Directed modeling and analysis of Tuna Canning industry discharges into the waters off Puerto Rico.

- Directed water quality modeling of the Charles River Basin in Boston.

- Directed the City of Tampa's Hydrodynamic and water quality modeling of the Lower Hillsborough River Estuary which included several synoptic field measurement programs and dynamic modeling of the estuary.

- Directed a joint U.S. EPA sponsored Combined Sewer Overflow (CSO) study for Thomaston, Maine which included modeling of hydrodynamics and water quality of Sto George Estuary.

- Directed a joint U.S. EPA and State of Vermont study of Combined Sewer Overflows from Burlington, Vermont into Lake Champlain.

- Directed a joint U.S. EPA and State of New Hampshire study of water quality of the Contract River and the Upper Ammonoosuc River in New Hampshire.

- Directed a joint U.S. EPA and State of Vermont study of Mixing Zone Determination for Vermont Streams.

- Directed a joint U.S. EPA and Rhode Island Department of Environmental Management study of Combined Sewer Overflows into Providence River and Upper Naragansett Bay which included hydrodynamic and water quality modeling of the estuary.

ANDREW C. MILLS

water-resources engineering
ground-water hydrology

EDUCATION

University of Michigan: M.S.E. Water Resources Engineering
University of California at Davis: Ph.D., Soil Science
University of Missouri: M.S. Rural Sociology
Pennsylvania State University: B.S. Forestry

REGISTRATION

Professional Engineer, State of New Jersey, License No. 23891
Professional Engineer, State of Maryland, License No. 11546
Certified Soil Scientist, State of Maine, Certification No. 39

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Senior Project Hydrogeologist, 1983-date
Earth Technology Corporation, Senior Hydrogeologist, 1982-1983
Dames and Moore, Senior Hydrologist, 1972-1982
Action for Food Production (AFPRO), Water and Soils Specialist, 1967-1971

REPRESENTATIVE EXPERIENCE

Mr. Mills has extensive experience in hydrologic investigations of all types, both in the United States and abroad. He has performed site investigations and established monitoring-well systems in conjunction with potential ground water contamination from chemical waste materials in upstate New York and in Eastern Maryland. Under a contract for the USEPA in 1983, Mr. Mills coordinated research and prepared interim reports on clay cap and liner systems for hazardous-waste landfills, and on hydrogeologic locational factors affecting the performance of landfills.

Mr. Mills has completed numerous ground-water evaluations for municipalities including a water resources evaluation for the Upper Passaic basin in New Jersey in connection with regional sewage planning; a ground-water investigation for water supply in Monroe Township of Middlesex County, New Jersey; an investigation and evaluation of ground-water conditions in the Township of Cedar Grove, New Jersey; a ground-water investigation for the town of Tewksbury, Massachusetts; an evaluation of ground and surface water resources for the Manasquan River basin in Monmouth County, New Jersey, and for Cumberland County in connection with regional sewerage planning in the areas.

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Mr. Mills' experience includes hydrogeologic investigations for a number of power plant sites. He served as principal investigator for the ground water investigation of power plant sites located north of Buffalo, New York, the Delmarva Peninsula, Fulton, New York, and a number of sites in Delaware and Pennsylvania. This work included installation of monitor networks, collection of data, testing of wells and analysis of the data obtained with emphasis on contaminant transport.

Mr. Mills' experience also includes hydrogeologic investigations relative to radioactive waste disposal and management of nuclear facilities, including investigations at solid-waste disposal facilities at five reservations of the Department of Energy and at the Western New York Nuclear Service Center, West Valley, New York. In 1983, he performed an evaluation of the regional ground-water flow system at a site in Mississippi being considered for a terminal repository of high-level radioactive waste, under a contract with the Office of Nuclear Waste Isolation.

Mr. Mills has considerable experience in computer modeling of ground water systems. He has developed a computer model based on analytical equations for estimating interference effects in production well fields and dewatering systems, for leaky confined aquifers.

He has also modified and calibrated an existing two-dimensional finite-difference ground-water flow model for a two-aquifer dewatering system in Salem County, New Jersey, and a two-aquifer system in the Kenai Peninsula of Alaska in which lakes are hydraulically connected to the upper aquifer. Long-term pumping was simulated in both cases using the model.

He has developed computer models based on analytical equations for estimating the downgradient movement of ground water contaminants from a 3-dimensional slug of contaminated fluid instantaneously introduced into an aquifer, and from a continuous source of contaminated materials entering an aquifer. He has applied these models at several locations relative to the possible introduction and movement of contaminants in aquifers as a result of power plant operation.

Other experience includes work with dam seepage in New Jersey and North Carolina, design of well fields, ground-water investigations in India and Egypt and teaching a course on flow in porous media at Rutgers University, New Brunswick, New Jersey.

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AFFILIATIONS

National Water Well Association
American Geophysical Union
Soil Science Society of America

PUBLICATIONS

Mills, A. C., Houlik, C. W. and M. H. Schneider, 1983, Modeling of Ash-Sludge Leachate Movement in Ground Water, Northeastern Environmental Science, 2 (2), p. 110-132.

Mills, A. C., 1982, Water Resources and Their Management in Arid Areas, Dames & Moore's Engineering Bulletin, No. 61, September 1982, p. 11-24.

Mills, A. C. and Biggar, J. W., 1969, Adsorption of Hexachlorocyclohexane from Solution: The Differential Heat of Solution Applied to Adsorption from Dilute Solutions on Organic and Inorganic Surfaces, Journal of Colloid and Interface Science, 29(4), p. 720-731.

ACM 11/83

WILLIAM P. WALSH

exploration geophysics
ground water hydrology
project management

EDUCATION

Massachusetts Institute of Technology: Ph.D., Geophysics, 1957
Boston College: A.B., Physics, 1950

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Chief Geophysicist, 1982-date
Ketron, Inc., Cambridge, MA, Senior Geophysicist and General Manager, 1980-1982
Raytheon Ocean Systems Co., East Providence, RI, Vice President and General Manager, 1976-1980
Environmental Research & Technology, Inc., Concord, MA, Manager, Geoscience Division, 1972-1976
Harbridge House, Inc., Boston, MA, Principal; 1968-1972
Sylvania Electric Products, Inc., Needham, MA, Manager, Advanced Information Systems & Avionics Department, 1961-1968
U.S. Air Force, Geophysics Research Directorate, Captain, 1958-1961

REPRESENTATIVE EXPERIENCE

Dr. Walsh manages programs supportive of mineral resource, and ground water resource development. To these activities he brings specialized professional competence in project management and development, skills in the field of computer and information systems and diverse talents in the geosciences. Recent projects include application of electromagnetic techniques in defining the extent of ground water contamination and high resolution seismic reflection and resistivity methods in the characterization of coal reserves.

Dr. Walsh has been responsible for directing ground water and hazardous waste management services. He directed the installation and application of ground water monitoring systems, managed investigations to learn the effect of contamination in ground water systems associated with certain oil shale processing projects, and directed a comprehensive geohydrological study to replenish a municipal water supply contaminated by toxic wastes.

He has also been responsible for developing and directing the business of a 55 man interdisciplinary group engaged in a wide variety of environmental and marine related services: marine seismic exploration, water quality analysis and monitoring, mathematical modeling, hazardous waste surveillance, marine bottom and sub-bottom profiling, and oceanographic and hydrographic surveys.

Representative projects have included the environmental effects of ocean waste disposal, marine bottom and sub-bottom profiling in the continental shelf, a

hydrographic survey of the Georges Bank, modeling of water quality and mass transfer in stratified estuaries, research in climate prediction utilizing adaptive learning techniques, management of hazardous waste for select chemical firms, and the development of a buoy system capable of operating remotely and acquiring and telemetering oceanographic information in real time for the Bureau of Land Management.

Dr. Walsh managed activities which have involved the analysis of geophysical and geological data in locating mineral and water resources; the determination of environmental impact associated with various coal, copper and phosphate mining ventures - particular emphasis being directed toward fugitive emission of particulates, ground and surface water contamination and flow, and seismic effects of blasting; and the assessment of the environmental consequences of technological development in the mining field.

Early in his career Dr. Walsh's interests centered on the development of computer-based information systems and research in the computer sciences. Although these efforts were applied to military work, the information base was geophysical in character. Research focused largely on multi-processor system organization, adaptive computer organization, associative memory development, multi-programming and advanced operating system software development. Representative systems engineering activities which he either directed or contributed to were an airborne photometer and data recording system utilized in upper atmosphere surveillance; an integrated hydrological survey communication network; command control systems for various military applications; ground-based data management systems supportive of unmanned satellites; an earth resource satellite sensing, processing and communication system; and a deep ocean gravimetric survey system.

During his graduate years and prior to his military service Dr. Walsh participated in seismic exploration throughout Canada and East Africa and in research in geophysical data interpretation.

AFFILIATIONS

American Geophysical Union
American Institute of Professional Geologists
Institute of Electrical and Electronic Engineers
National Water Well Association
Society of Exploration Geophysicists
Society of Mining Engineers - AIME

WPW 1/84

STEFFAN R. HELBIG

geohydrology
geophysics
drilling

EDUCATION

Rutgers University, Newark, NJ: M.S., Geology, 1983
Rutgers University, Newark, NJ: B.A., Geology, 1978
Union College, Cranford, NJ: 1972-1976
Course Concentrations: Physics, Engineering, Chemistry, Biology, Statistics

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Assistant Project Geologist, 1980 to date
Rutgers University, Teaching Assistant, 1978-1979
Rutgers University, Coadjunct Instructor, 1978-1980

REPRESENTATIVE EXPERIENCE

Mr. Helbig's work experience falls into the general category of subsurface investigations requiring the coordination and interpretation of several different methods of data collection, such as, surface geophysics, surface geology, drilling, and borehole geophysics. This type of study often involves the interpretation of seemingly contradictory data. Mr. Helbig posseses the knowledge of the principles, mechanics, and biases of the various techniques needed to resolve the apparent conflicts.

Mr. Helbig has experience in several techniques of geophysical investigation. Representative examples would be the extensive multifunction borehole logging for the Santee Cooper Cross Generating Station, Unit #1, Cross, South Carolina, and for the USBM Discontinuity Subsidence Study, Montcoal, West Virginia. He also has experience with the surface geophysical techniques of seismic refraction, electrical conductivity, electrical resistivity, and gravity surveying.

In addition to Santee Cooper, an example of Mr. Helbig's participation in an integrated investigation would be the NJDEP Buried Valleys project. This investigation utilized the combined techniques of surface geology, surface geophysics, drilling, borehole geophysics, and pump testing to locate drought emergency ground water reserves. Further groundwater experience has been acquired through involvement in projects such as the installation and sampling of monitering wells at the Chevron, Perth Amboy, New Jersey Refinery in compliance with RCRA regulations and geohydrologic assessment of the PAS hazardous waste site in Oswego, New York.

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Mr. Helbig has been involved in several drilling programs such as the subsurface investigation program for the Merrill Creek Reservoir project, Harmony, New Jersey. Through a variety of different investigations he has acquired knowledge of a wide range of the sampling and testing procedures associated with drilling.

Mr. Helbig's geologic background is broadly based and complete. Only a few typical examples are listed here. He has developed an expertise in laboratory analysis of geologic samples with an emphasis on X-ray diffraction, X-ray fluorescence, optical mineralogy-petrology, and wet chemical techniques. His geologic and structural mapping experience is derived from work done in the Rocky Mountain Front Range, Colorado; the Valley and Ridge province, Alabama; and the numerous geologic provinces of the New Jersey area.

PUBLICATIONS

"Geophysical Well Logging Services", WCC Brochure, 1981.

"Borehole Geophysics", Oral presentation, (WCC) Eastern Regional Seminar, "Engineering Geophysics Principles and Applications", August 1981.

"Investigation of a Mineralization Halo Associated with the Talc Deposits near Winterboro, Alabama, as Expressed in the Residual Soil", in preparation.

SRH 1/84

ANTHONY J. SCACIFERO

engineering geology
hydrogeology

EDUCATION

University of Arizona: Bachelor of Science in Geology, 1971
California State University, Los Angeles: Graduate Studies

CERTIFICATION

Registered Geologist: Arizona, No. 12597; California, No. 3527
Certified Engineering Geologist: California, No. EG1050

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Assistant Project Geologist, 1983-date
The Earth Technology Corporation (Ertec), Project Geologist, 1979-1983;
Staff Geologist, 1977-1979
Sergent, Hauskins and Beckwith, Consulting Engineers, Staff Geologist, 1974-1977
Engineers Testing Laboratories, Inc., Staff Geologist, 1973-1974
Environmental Engineering, Staff Geologist, 1971-1973
Amax Exploration, Inc. Geologist, 1971

REPRESENTATIVE EXPERIENCE

Mr. Scacifero has extensive experience in a variety of engineering geologic investigations and hydrogeologic studies throughout the United States. His field experience consists of regional and site-specific geological mapping, exploratory drilling and trench logging, ground-water monitoring, in-situ testing and construction inspection. Office studies include compilation and analysis of geologic, hydrologic, geophysical, and engineering data, air photo interpretation, well permitting, and quality assurance.

Mr. Scacifero has project management experience on several large government projects. He was program manager for a geotechnical study of MX missile deployment on DOD lands. His responsibilities included the supervision of a team of geologists, engineers, and technicians in the collection and compilation of regional geologic and hydrologic data. He also managed and supervised the field characterization studies in Arizona, Nevada, Texas, Utah and Wyoming. His responsibilities included: coordinating between various agencies at the federal, state, county and municipal levels and briefing high-level Air Force personnel on project status.

He also assisted in managing a deep drilling program for high-level radioactive waste disposal in Gulf-coast salt domes and managed a seismotectonic study for various dams and dam sites in Arizona for the Bureau of Reclamation.

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Some of Mr. Scacifero's other relevant projects have included: evaluating information needs and exploration techniques for high-level radioactive waste disposal in granitic rocks; a slope stability study for the Positron-Electron Project, Stanford University; siting studies for a space launch complex at Vandenberg Air Force Base; siting studies for various powerplants and mine facilities throughout Arizona, New Mexico, Utah, Wyoming, and Mexico; numerous route and corridor studies for transmission lines, microwave relay systems, highways and pipelines throughout the western United States; foundation investigations and inspections for numerous commercial and industrial facilities throughout the United States.

Mr. Scacifero's experience includes a number of studies pertaining to ground water contamination, development and monitoring. Projects include investigation of hazardous waste sites in New York and New Jersey, and compliance and ground water monitoring of hazardous waste sites in USEPA Region II. He also has worked on the preparation and evaluation of RCRA, Part B permit applications for EPA Regions I and II.

AFFILIATIONS

Association of Engineering Geologists
National Water Well Association

PUBLICATIONS

"Quaternary Fault Studies in the Arizona Mountain Neotectonic Province", coauthor with C. L. Strand; Geol. Soc. of America, Abs. with Prog., Vol. 14, No. 4, p. 237, 1982.

AJS 11/83

STEPHEN A. COX

geophysics
drilling
hydrology

EDUCATION

Lafayette College, Easton, Pa: B.S., Geology 1981
Course Concentrations: Engineering, Biology, Ecology

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Staff Geologist, 1983 to date
Testwell-Craig Laboratories of New Jersey, Inc., Staff Geologist, 1982-1983
Core Laboratories Australia Pty, Ltd., Well Logging Engineer, 1981-1982

REPRESENTATIVE EXPERIENCE

Mr. Cox is experienced in many facets of subsurface exploration and geotechnical investigation. Presently, his assignments include geophysical exploration using multifunction borehole logging techniques for the Manasquan River Water Supply Basin, Howell and Wall Twps, New Jersey, and several hydrogeologic studies relating to water quality, sampling, and contamination evaluation on projects in the New York metropolitan area.

Mr. Cox's geologic background includes extensive field studies and mapping of the Musconetcong Knappe Complex, which required a geophysical investigation using gravimetric and magnetic methods of the Triassic - Pre-Cambrian border fault in Musconetcong, New Jersey. He has also completed an independent research project studying sediment transport and turbidity flow at the Alpha Aggregates Quarry site, Martins Creek, Pa. He has had considerable laboratory experience utilizing various techniques of X-ray powder and single crystal diffraction, atomic absorption spectrophotometry, and practical field instrumentation using portable seismographs, electrical resistivity meters, and a ground water flowmeter.

Mr. Cox participated in many phases of oil exploration while employed overseas in Australia on wildcat exploration and in proven reserve fields. He was Well Logger on several producing wells in the Kincora Gas Field and Gathering System, Surat Basin, Queensland, Australia before being assigned to a continuous-coring (NX coring surface to TD) exploration program in the Canning Basin, Great Sandy Desert, Western Australia, where he functioned as the Wellsite Geologist on several wildcat wells and accumulated some 4000 meters of diamond-bit core evaluation, analysis, and description.

Mr. Cox completed his assignment in Western Australia as a Well Logger on the WAPET exploration-production operations offshore at Barrow Island, Western Australia. His duties there involved various downhole functions using GC, Hot

Wire, and H_2S photocell gas detection instrumentation during the drilling of an overpressured formation, the Windalia Radiolarite. He became experienced in geologic correlation using SP, IE, Gamma Ray, and Sonic wireline log data in conjunction with well logs to assess the formation trends and production potential of target zones and evaluate flow characteristics of the reservoir.

AFFILIATIONS

Association of Engineering Geologists.

SAC 1/84

MELVIN L. ESRIG

Level P-4
Technical Specialist

EDUCATION

University of Illinois: Ph.D., Civil Engineering, 1961
University of Illinois: M.S., Civil Engineering, 1959
Polytechnic Institute of Brooklyn: B.C.E., Civil Engineering, 1954
City College of New York: B.B.A., Accounting, 1951

REGISTRATION

Professional Engineer: Maryland, 1973; New Jersey, 1970; New York, 1963; and Wisconsin, 1962

PROFESSIONAL HISTORY

Woodward-Clyde Consultants, Principal and Vice President, 1970-date
Dames and Moore, New York, Associate, 1968-1969 (sabbatic leave from Cornell)
Cornell University, Associate Professor, 1962-1970
Warzyn Engineering and Service Company, Inc., Madison, WI, Senior Soil Engineer, 1961-1962
H.G. Holzmacher & Associates, New York, Civil Engineer, 1956-1957
Lockwood, Kessler and Bartlett, Inc., New York, Civil Engineer, 1955-1956
U.S. Army Corps of Engineers, New York District, Trainee, 1954

REPRESENTATIVE EXPERIENCE

Dr. Esrig has been in charge of numerous soil and foundation studies for projects of varying size and complexity. These projects have included investigations for the design and construction of dams, oil refineries, LNG receiving terminals, cryogenic storage tanks, offshore production platforms, high-rise buildings, highways, bridges, earth dams, sewage treatment plants, and investigations of the stability of major slopes in soil and rock.

Dr. Esrig's dam experience includes the design and construction of seven dams at Cove Point, Maryland: one 70 ft high to retain dredged spoil, one 55 ft high for the secondary treatment of spoil effluent, and five erosion control dams ranging in height from 10 ft to 20 ft; the design of the Wildcat Mountain Dam in Wildcat Mountain State Park, Wisconsin; consultation and review on Diamondhead Dams designed by Woodward-Clyde Consultants and constructed under their inspection; dam safety inspection and reports for 25 dams (heights up to 200 ft) owned by the American Electric Power Company; the geotechnical investigation and design of a 260-ft-high dam and associated 40-ft-high dikes for the Merrill Creek project in western New Jersey; and

Principal-in-Charge of the rehabilitation and inundation studies for the Spruce Run/Round Valley Reservoir complex in New Jersey.

Dr. Esrig's experience with cofferdams includes the investigation of the failure of a 147-ft-diameter, internally-braced cofferdam, 80 ft deep, in Lake Charles, Louisiana; the design of a partially clay filled cellular cofferdam, 40 ft in diameter, in Baton Rouge, Louisiana; and consultation on the design of a 75 ft diameter internally-braced cofferdam, 40 ft deep, in Mt. Vernon, Indiana.

Other representative assignments include: foundation investigation, foundation recommendations, and earthwork supervision of the Queens Shopping Center, a five-acre, four-story building and parking facility in New York; foundation investigations and recommendations for the New York Convention Center, a 23-acre facility developed within the former bed of the Hudson River; subsurface investigation and recommendations for the Monmouth County Bayshore Outfall Authority, a 4000 ft outfall in the Atlantic Ocean for onshore outfall line installation and for pumphouse and lagoon; subsurface investigation and recommendations for a proposed new oil refinery on the Delaware River; subsurface investigation and recommendations for the Columbia Gas LNG receiving terminal, Cove Point, Maryland, including the preparation of an erosion control report, the design of a 70-ft dam to retain one million yards of dredged spoil without contaminating a fresh water marsh with salt water or sediment, and foundation recommendations for an offshore unloading platform and submarine tunnel; research sponsored by eleven oil companies on the axial capacity of offshore piles; foundation analyses for deep water platforms in the Gulf of Mexico and for platforms in the North Sea and Gulf of Alaska; studies related to seafloor stability in the Gulf of Mexico; and studies of drilled and grouted piles for offshore structures.

AFFILIATIONS

American Society of Civil Engineers
International Society for Soil Mechanics and Foundation Engineering
Sigma Xi
Tau Beta Pi
Chi Epsilon

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PUBLICATIONS

"The Avoidance of Damage to Historic Structures Resulting from Adjacent Construction", ASCE National Meeting, Preprint 81-052, May 1981, with A. J. Ciancia.

"Soil Capacity for Supporting Deep Foundation Members in Clay", State-of-the-Art Paper, ASTM Symposium on Behavior of Deep Foundations, STP 670, June 1980, with R. C. Kirby.

"Further Development of a General Effective Stress Method for Prediction of Axial Capacity for Driven Piles in Clay", Conference on Recent Developments in the Design and Construction of Piles, Institution of Civil Engineers, London, 1979, with R. C. Kirby.

"Effects of Radial Variation in Material Properties on Stress Changes Due to Consolidation around a Driven Pile", Proceedings of the International Conference on Numerical Methods in Offshore Piling, Institution of Civil Engineers, London, 1979, with R. C. Kirby and S. A. Leifer.

"Advances in General Effective Stress Method for the Prediction of Axial Capacity for Driven Piles in Clay", Eleventh Annual Offshore Technology Conference, Houston, OTC Paper 3406, 1979, with R. C. Kirby and B. S. Murphy.

"Increasing Offshore Pile Driveability through Electroosmosis", Tenth Annual Offshore Technology Conference, Houston, OTC Paper 3269, 1978.

"Initial Development of a General Effective Stress Method for the Prediction of Axial Capacity for Driven Piles in Clay", Offshore Technology Conference, OTC Paper No. 2943, May 1977, with R. G. Bea, R. C. Kirby, and B. S. Murphy.

"Implication of Gas Content for Prediction of the Stability of Submarine Slopes", Marine Geotechnology, Vol. 2, 1977, p. 81-100, with R. C. Kirby.

"Material Properties of Submarine Mississippi Delta Sediments under Simulated Wave Loading", Offshore Technology Conference, OTC Paper No. 2188, May 1975, with R. G. Bea and R. S. Ladd.

"Settlement of Ammonia Storage Tanks; Observation Data", Symposium of Ammonia Plants and Related Facilities, American Institute of Chemical Engineers, August 1974, with S. Ahmad and H. C. Mayo.

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"Electrokinetics in Soil Mechanics and Foundation Engineering", Engineering Division, New York Academy of Sciences, 11 March 1970; Transactions of the New York Academy of Sciences, 33, No. 2, February 1971.

"Design, Construction and Performance of Cellular Cofferdams", Proceedings of ASCE Specialty Conference on Lateral Stresses in the Ground and Design of Earth-Retaining Structures, June 1970, with Y. Lacroix and U. Luscher.

"The Stability of Cellular Cofferdams Against Vertical Shear", Journal of Soil Mechanics and Foundation Division, ASCE, Paper 7659, November 1970.

"Some Temperature Effects on Soil Compressibility and Pore Water Pressure", Proceedings of the International Conference on Effects of Temperature and Heat on Engineering Behavior of Soils, Highway Research Board Special Report 103, 1969, with R. L. Plum.

"The Effective Stress Response of a Saturated Clay Soil to Repeated Loading", Canadian Geotechnical Journal, 6, No. 3, August 1969, with D. J. Henkel and D. A. Sangrey.

"Applications of Electrokinetics in Grouting", Journal of Soil Mechanics and Foundation Division, ASCE, Paper 6124, September 1968.

"Pore Pressures, Consolidation and Electrokinetics", Journal of Soil Mechanics and Foundation Division, ASCE, Paper 6029, July 1968.

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