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ROTO-FINISH REMEDIAL INVESTIGATION
PHASE III SITE INVESTIGATION WORK PLAN

Prepared for:

ITW
Glenview, Illinois

Prepared by:

LTI, Limno-Tech, Inc.
2395 Huron Parkway
Ann Arbor, Michigan

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1.0 INTRODUCTION

This work plan has been prepared by Limno-Tech, Inc. (LTI) and United Environmental Technologies, Inc. on behalf of ITW, Inc. at the request of EPA/MDNR to address additional and continuing investigations on the Roto-Finish site in Portage, Michigan. The proposed Phase III Remedial Investigation and Feasibility Study (RI/FS) field activities include an aquifer performance analysis and an investigation to preliminarily determine the horizontal extent of off-site groundwater degradation. Final groundwater degradation boundary delineation will be conducted during the Remedial Design Phase. The Phase III investigation is a continuation of Phase I and Phase II investigations that were conducted between 1989 and 1991 as summarized in the next section. After approval of this work plan by the EPA/MDNR, the Phase III work plan must be submitted to the Kalamazoo-Battle Creek International Airport and the Federal Aviation Administration (FAA) for review and approval to access the airport property located downgradient from the Roto-Finish site.

This revised work plan reflects the agreed upon modifications to the draft work plan which was submitted to EPA/MDNR on February 14, 1992. EPA/MDNR commented on the draft work plan in a letter from Karen Sikora of EPA to ITW dated April 10, 1992. Each of the EPA/MDNR comments were discussed and resolved during several teleconferences between ITW, LTI and EPA/MDNR in late April and early May, 1992. The EPA/MDNR comments and LTI's understanding of the resolution of each comment is presented in Appendix A and the agreed upon modifications have been incorporated into this revision.

1.1 Summary of Site Background and Previous Investigations

The Roto-Finish site is located at 3700 E. Milham Road in Portage, Michigan. On the 7½ acre site from as early as the 1950's until 1988, when the business was sold and the site facilities closed, the Roto-Finish Company manufactured specialized equipment to debur and polish castings, mechanical parts, and similar objects that required smooth finishes. The manufacturing and testing processes generated wastewater that was discharged to a series of lagoons. The lagoons were tested in 1979 and showed elevated levels of cadmium, chromium, iron and 4,4 - methylenebis (2-chloroaniline) or MOCA. The lagoons and other source areas were excavated, the contaminated soils were disposed with MDNR approval in a licensed landfill, and the excavations were backfilled with clean material prior to 1984. In 1986 the site was included on the National Priorities List (NPL).

Phase I and Phase II Remedial Investigations were conducted between 1989 and 1991 to characterize the extent and distribution of on-site groundwater degradation. The Phase I and II investigations involved analysis of numerous soil and groundwater samples collected from numerous depths (down to 146 feet below surface) from 41 boreholes resulting in 17 permanent monitor wells. The results of the Phase I investigation were reported in the draft report entitled "Phase I Remedial Investigation Report for the Roto-Finish Site, January 1990". In summary, the Phase I soils and groundwater data collected near previously identified and remediated source areas did not indicate the presence of continuing significant existing source areas.

The Phase II Investigation preliminary results indicate the presence of on-site and off-site groundwater degradation. Volatile chlorinated hydrocarbons, metals, and semivolatile chemicals (phthalates and polynuclear aromatic hydrocarbons) were detected in some borings and monitoring wells sampled during Phase I and Phase II. Though data validation is not yet complete, preliminary results for all Phase I and II samples indicate that MOCA was not detected in any groundwater samples and MOCA was detected in only three soil samples, but all measured values were below the Act 307 Type B cleanup criterion.

Substantial data have been collected to characterize the conditions on-site but data for conditions off-site are limited. The proposed Phase III investigation is intended to preliminarily characterize the horizontal extent of off-site groundwater degradation and to provide preliminary feasibility information related to possible remediation alternatives.

2.0 AQUIFER PERFORMANCE ANALYSIS

2.1 Objectives

The purpose of the aquifer performance analysis is to provide direct measurements which will be used to calculate the hydraulic properties of the glacial drift saturated zone at the Roto-Finish site. The hydraulic properties that are calculated will include transmissivity and storativity. The results of the aquifer performance analysis will be used to evaluate the feasibility and design of possible groundwater remediation systems. The results will also be used to estimate the transport characteristics for chemicals detected in the groundwater at the site.

2.2 Methods

2.2.1 General

This subsection provides a brief overview of the work to be conducted. Specific details are supplied in the following subsections. The aquifer performance analysis will consist of a step rate pumping test and a constant rate pumping test. A test well will be installed on the Roto-Finish site (TW1, Figure 1). A step-rate pumping test will be conducted to preliminarily identify aquifer properties and to specify the parameters for a constant rate pumping test. Decisions for specifying parameters of the constant rate test will be made in the field based upon consultation with an EPA/MDNR on-site representative. The well will then be pumped at the specified constant rate for the specified time period. The drawdown caused by the continuous pumping will be measured in existing observation wells over the course of the test. The measured drawdown curves for the observation wells will be used to calculate the aquifer properties of transmissivity, storativity, and specific yield. Determination of these aquifer properties will allow for much more accurate estimates of groundwater velocities and remedial design parameters than can be estimated based upon existing data.

While the purpose of this work plan is to describe the details of the proposed investigation as completely as possible, it is necessary to allow for modifications in the specific pumping durations and rates as the tests proceed. The actual hydraulic properties as determined by the pumping tests may be different than current estimates, and therefore, flexibility has been included in the work plan requirements to allow for changes as the data are evaluated in the field. This will allow for the opportunity to maximize the utility of the information gathered during the pump tests. Field decision criteria that will be used to modify the present pump test scheme are described in detail in Section 2.2.5 and 2.2.6 below. Field decisions will be made in consultation with EPA/MDNR.

2.2.2 Basis for Pumping Test Design

Site specific data are available that allow for the preliminary specification of the pumping test well design and test parameters. A preliminary evaluation of available pump test data from the Roto-Finish water supply well installation in 1976 (see Appendix B) indicates a site-specific transmissivity of between 16,300 - 18,000 gallons per day per foot (gpd/ft).

Based upon this transmissivity range, it is estimated that the maximum pump rate for the test should not exceed 230 gpm to maintain laminar flow and to avoid excessive dewatering of the aquifer. In addition, it is estimated that the radius of influence for measurable drawdowns during a continuous pump test (1-3 days at 100-230 gpm) will range from approximately 190-710 feet. A measurable drawdown is estimated at greater than 0.10 foot until background static fluctuations can be determined. Analysis of a most conservative case scenario, using a transmissivity of 10,000 gpd/ft and a 100 gpm pump rate for one day, indicates a minimum radius of influence for measurable drawdown at 170 feet. These pump test rates are preliminary and final rate determination for the constant rate pump test will be based on the empirical data obtained from the step-drawdown test.

2.2.3 Test Well Installation

A test well (TW1) will be installed on the Roto-Finish site at the location shown on Figure 1 using hollow stem auger drilling methods consistent with the approved QAPP. The design of TW1 is based upon the soil boring log and grain size analyses of nearby MWB2B, which indicates the aquifer bottom to be located at approximately 120 feet. Prior to well installation, soil samples for lithological characterization will be collected as the borehole is advanced, beginning at 40 feet deep (approximately 10 feet above the maximum allowed drawdown level for the pump test) and continuing at five foot intervals until either the bottom of the aquifer is encountered or a depth of 150 feet is reached (which is the practicable depth limits in this area for hollow stem augering). The soil characterization information obtained from TW1 will be used in the lithological profile for the site to help in the interpretation of data obtained during the pump test.

The well will be installed at a depth of approximately 110 feet, allowing for a minimum of 85% of the saturated aquifer thickness to be screened (approximately 85 feet) based upon the well log of nearby MWB2B. This well depth will minimize costs and still ensure that (1) approximately 90% of the specific capacity of the well is available and (2) analytical requirements for horizontal groundwater flow are satisfied for accurate characterization of the entire aquifer (Driscoll, 1989, p. 560 and Kruseman and DeRidder, 1991, Analysis and Evaluation of Pumping Test Data, p. 29-30).

The well string will be constructed of 6 inch diameter PVC riser and screen of 0.010 inch slot size, determined from the 40% retained grain size analysis of soil samples collected from MWB2B. A filter pack will be placed in the annular space around the screen. The filter pack will extend at least two feet above the top of the screen. A bentonite chip seal of at least two feet in thickness will be placed above the filter pack. Finally, a cement/bentonite grout mix will be placed in the annular space from the bentonite seal to the surface. The location, top of casing elevation and ground elevation of the test well will be surveyed to USGS datum.

2.2.4 Test Well Development

The test well will be developed after installation of the filter pack and bentonite chip seal but prior to sealing the annular space with grout. This will avoid a second mobilization of drill rig and field crew and will help to ensure undisturbed conditions for the 10-14 day period required by EPA/MDNR for annular seal materials to set up. The test well will be developed by surge block and submersible pump methods. Well development will continue until the purge water is relatively free of fine grained materials, as determined by turbidity meter readings, and water quality measurements of pH, temperature, and conductivity have stabilized. Purge water samples will be collected and analyzed for volatile organic compounds (VOCs) using a portable GC to provide rapid turn around of results prior to disposal. The water will be disposed in accordance with all environmental and legal requirements, likely through discharge to the sanitary sewer system pending approval from the City of Portage.

2.2.5 Step-Drawdown Test

A step-drawdown test will be conducted on test well TW1. The step-drawdown test will be used to provide preliminary data and to refine the parameters such as pumping rate and duration for the constant discharge pumping test. The step-rate pumping test results will also be used to confirm that adequate monitoring wells exist for the constant rate pumping test. For each step-rate test, the test well will be pumped for one to two hours and the water levels in the test well will be monitored for excessive drawdown (i.e. greater than 25% of saturated aquifer thickness or 25'), well storage effects and delayed yield effects. Field decision criteria to address the selection and analysis of pump rates are flowcharted in Figure 2. The pump will be selected to provide pumping capacities that span the range of anticipated flow rates (50-250 gpm). Pumping rates will be regulated using discharge valves and measured using a flow meter. Water generated during the pumping tests will be managed in accordance with all environmental and legal requirements in the same manner as water generated from well development.

The water level elevations in TW1 during the step-drawdown tests will be measured with a pressure transducer and data logger or, at a minimum, at the beginning and end of each pumping period with a chalked steel tape to the nearest 0.01 foot. The well will first be pumped at a rate of approximately 50-75 gallons per minute (gpm). The specific capacity of the well (gpm/ft) will then be evaluated based upon the measured drawdown. Pumping rates for subsequent tests will be selected based upon the estimated specific capacity of the well and/or drawdown limitations according to the decision criteria in Figure 2. For example, if there is minimal drawdown caused by the initial pump rate, suggesting a relatively large capacity, then subsequent pumping rates would be increased by the appropriate increments until the optimal pumping rate and duration are determined (see Figure 2).

Monitoring wells MWB2A, MWB2B, MWA4, MW310, MW309, MW302, MWA5 and MWA3 will be monitored continuously throughout the step drawdown test with pressure transducers and a data logger. Data from these wells will be used to evaluate the efficiency of TW1.

2.2.6 Constant Rate Test

Following the step rate pump test and on-site EPA/MDNR approval of the selected optimal constant pumping rate, a constant rate pump test will be performed on the test well TW1. The well will be pumped at the designated constant rate for a period of 24-72 hours. The length of the pumping period will be designed in consultation with an EPA/MDNR representative based on an analysis of the optimal constant pump rate and preliminary estimates of transmissivity and storativity derived from the step rate test results. The duration will be selected for the optimal pumping rate so that measurable drawdowns are observed in at least monitoring wells MWB2A, MWB2B, MWA4, MW310 and possibly MW309 and MWA3. The duration and rate of the constant rate pump test will be re-evaluated throughout the constant rate test.

At the end of the constant rate pump test and immediately upon shutdown of the pump, the recovery of water levels in the test well and observation wells will be monitored. The length of the recovery period will be decided in the field in consultation with an EPA/MDNR representative based on the length of the pump test.

Water levels will be monitored continuously during the pumping and recovery levels in TW1, MWA4, MWB2A, MWB2B, MW310, MW309, MW302, MWA5, and MWA3 using pressure transducers and a data logger. The frequency of measurement will be at logarithmic intervals ranging from 1-2 minutes during the early test and up to 8 hours after 24 hours of pumping (Driscoll, 1989, Tables 16.4 and 16.5, p 553). The accuracy of the transducers will be checked manually throughout the test by measuring drawdown using a chalked steel tape at increasing time intervals ranging from 30 minutes during the first 1-2 hours of the test and gradually increasing to 6 hours after 24 hours. Based on these manual measurements, additional wells may be monitored continuously at logarithmic time intervals using a chalked steel tape if the progression of the cone of influence indicates impacts are (or will be) occurring in wells other than the eight listed above.

All water level measurements will be recorded to the nearest 0.01 foot. The flow rate of the pump will be monitored with a flow meter. Any flow rate fluctuations that occur during the test will be recorded.

Water generated during the pump test will be sampled and analyzed for VOCs using a portable gas chromatograph at logarithmic progressions of the cone of influence (e.g., at startup of pumping, 1 hour, 2 hours, 4 hours, 8 hours and perhaps every 16 hours thereafter). These data will be used to evaluate changes in the chemical characteristics of the groundwater during pumping for the purposes of remedial design.

Background fluctuations in groundwater levels will be monitored to evaluate the influences from natural phenomena and the influences of local industrial and municipal groundwater pumping activities as follows:

- Groundwater levels in MWA6, MWB4A, MWB4B, and MWB4C, which are believed to be outside the range of influence expected during the pump test, will be measured using a chalked steel tape at 6 hour intervals during the period from 3 days prior to the pump tests and continuing throughout the pumping and recovery phases.
- Groundwater levels in MWB2A, MWB2B, MWA4 and MW310 will be monitored continuously using pressure transducers and a data logger for the 3 day period prior to the pump tests.
- Atmospheric pressure and precipitation will be measured using a barometer and a rain gage at 6 hour intervals during the 3 day pre-test period and continuing throughout the pumping and recovery phases.

2.2.7 Pumping Test Data Analysis

The drawdown and recovery data collected from the pumping tests will be evaluated to determine the hydraulic parameters of specific capacity, aquifer transmissivity, specific yeild, and storativity. Time-drawdown and/or distance-drawdown curves will be analyzed using analytical and well function curve matching techniques to determine the hydraulic properties of the saturated zone. The analytical solutions used will be chosen based upon appropriateness to the assumed hydrogeologic conditions of the Roto-Finish site. The assumed hydrogeologic conditions that will be considered for analytic purposes include that of an unconfined aquifer, isotropic groundwater flow, partial penetration of observation wells, and well storage. The data generated from measurements of background water table fluctuations, barometric pressure and precipitation will be used during the pump test analysis to correct for any influences on the aquifer not attributable to the pumping of TW1. A technical memorandum will be prepared summarizing the results of the pumping tests, estimated aquifer properties, and supporting calculations.

3.0 INVESTIGATION TO DETERMINE THE PRELIMINARY HORIZONTAL EXTENT OF OFF-SITE GROUNDWATER DEGRADATION

3.1 Objectives

A primary objective of the Phase III investigations is to locate the preliminary horizontal extent of off-site groundwater degradation downgradient from the Roto-Finish site. Confirmatory vertical sampling for horizontal extent and vertical characterization of the aquifer will be conducted during the remedial design phase. To achieve the Phase III objective, initially eight permanent exploratory wells at four locations will be installed downgradient from the site without the use of vertical aquifer profiling techniques. Static level data will be collected and evaluated to determine groundwater flow directions and groundwater samples will be collected for VOC analysis. The rationale for groundwater sampling is presented in Section 3.2.4. These initial exploratory wells will not be vertically sampled but will be installed with screens placed at predetermined depths expected to intercept zones of maximum groundwater degradation. The predetermined screen depths were selected based upon the results of previous vertical sampling conducted in Phase II. The data obtained from the initial exploratory wells will be used to propose appropriate follow-up activities consistent with the investigation objectives. Additional exploratory wells may be proposed according to the decision criteria presented in the following section. Maps showing the proposed locations of the additional wells, if any, will be submitted to EPA/MDNR for approval prior to proceeding with each additional exploratory well installation.

3.2 Methods

3.2.1 General

Eight exploratory monitoring wells (MWB5-MWB8) will be installed at the four locations in clusters as shown on Figure 1. The locations were chosen based upon the following factors:

- Consistency with horizontal and vertical groundwater flow directions based upon the potentiometric surface maps that have been generated during Phase I and Phase II investigations.
- Consistency with the preliminary transport calculations of Technical Memorandum II.2: Preliminary Estimates of Mass Transport at the Roto-Finish Site, May 20, 1991.
- Consistency with preliminary FAA requirements for access to operate on the Kalamazoo-Battle Creek International Airport property (final written requirements based upon review of the draft work plans by FAA are still outstanding but preliminary requirements are summarized later in this sub-section).

Vertical aquifer profiling methods (used in the Phase II investigation) will not be implemented prior to installing an exploratory well. The exploratory well technique will be used as a tool to locate the preliminary horizontal extent of a possible vertically thick band of off-site groundwater degradation. The vertical extent of on-site groundwater degradation was characterized in the Phase II investigation. The exploratory well technique will draw on information obtained in Phase II and is proposed to accomplish the above objective efficiently and cost-effectively and also accommodate constraints imposed by FAA requirements (e.g., placement of wells on or near runways or transmitting equipment would be highly impractible because of the necessity for closing down the airport operations).

Location Rationale

Substantial data were collected during the Phase I and Phase II to characterize the hydrogeology and distribution of chemicals on-site. No data have been collected to characterize the groundwater conditions downgradient of Roto-Finish on the airport property. Without these off-site data, hypotheses regarding the possible presence or distribution of impacted groundwater off-site are speculative and uncertain. The primary objective of the proposed exploratory well investigation is to provide preliminary data to narrow the range of uncertainty and eliminate implausible hypotheses.

Among the most important data that are proposed to be collected are the static water elevation data from the initial exploratory wells. These data will be evaluated along with static water elevation data from the existing wells to provide interpolated potentiometric surface maps from which groundwater flow directions on the airport property can be determined. Presently, without the off-site well data, estimated groundwater flow directions on the airport property must be extrapolated from the on-site data. Extrapolated derivations of flow directions are much less certain than interpolated derivations. The well locations have been selected to provide the necessary data to confidently determine off-site groundwater flow directions. The wells will be located as far as possible downgradient from the site but not so far that information collected from the wells cannot be confidently interpolated with the existing site data set.

Other valuable preliminary information that will be collected from the exploratory wells will be the analytical results for VOC concentrations in the groundwater. The well locations have been selected in an attempt to locate the lateral and longitudinal bounds of off-site impacts. Because of the uncertainty due to the lack of off-site transport and distribution information, the selected well locations may or may not achieve this objective. However, the information obtained from these wells will be extremely useful in selecting subsequent exploratory well locations that will meet the objectives.

Other criteria that influence the placement of wells include accommodating the radial nature of groundwater flow found onsite and minimizing the potential for interferences from possible off-site sources. The exploratory well locations were selected to be close enough to the site such that the potential for the presence of or resulting groundwater impacts from other possible off-site sources would be minimized. Other sources that are of concern include an alleged dump site approximately 1/4 mile south of the site and possible unknown sources on the airport. Finally, the locations selected also reflect physical constraints imposed by working on an international airport. It is not possible to place wells on or near to runways or near radio signalling equipment without closing down the airport, at least in part, which is impractical and extremely costly.

Given the above considerations, MWB5 was placed near the estimated northern lateral limits of groundwater flow streamlines from the Roto-Finish site. MWB8 was placed downgradient near the estimated southern lateral limit of the groundwater flow streamlines but north of the estimated influence of the alleged dump site located south of the Roto-Finish property. MWB6 and MWB7 were placed between MWB8 and MWB5 as far downgradient as initially possible to intersect groundwater flow streamlines that pass directly through the Roto-Finish property. The potentiometric data from these initial exploratory wells will be interpolated with the onsite well data to evaluate whether or not they bound and adequately characterize streamlines passing under the Roto-Finish site. If not, additional exploratory wells will be proposed.

Depth Rationale

The well screens will be set at depths designed to be consistent with vertical and horizontal groundwater flow directions and with the vertical extent and maximum concentrations of VOCs detected in existing upgradient wells. In most vertically sampled Phase II borings, the results indicate a vertical range of VOC groundwater impacts that are greater than 50 feet in thickness. Therefore, with this relatively thick band, it is likely that the exploratory wells will intercept zones of groundwater degradation, if present.

The specific well screen depths for the exploratory wells have been selected to allow for better characterization of vertical gradient components to off-site groundwater flow and to intercept zones of maximum possible VOC concentrations extrapolated from Phase II sampling results. Phase II vertical gradient data has been interpolated between wells near the downgradient boundaries of the Roto-Finish site and are estimated to be one foot downward per one hundred feet. This information was used to select screen depths for the deep wells of the well clusters and the non-clustered wells with the intent to possibly intercept zones of maximum groundwater degradation downgradient from specific on-site well locations. The depths of the intermediate and shallow screen cluster wells are selected primarily to characterize the vertical gradient components of off-site groundwater flow. Groundwater degradation may be detected at intermediate well screen depths, but are not likely to be present at shallow screen depths based on the Phase II data.

A cluster of 3 wells is proposed for installation at the MWB5 location because this will allow for the collection of groundwater samples from additional horizons for use in finding the northeast lateral limits of possible off-site groundwater impacts. A well cluster is proposed at the MWB7 location west of the site because little chemical information exists for the western area of the Roto-Finish site and this location is estimated to be south of any flow paths emanating from MW309, located at the northwest corner of the site.

Decision Criteria for Proposing Additional Exploratory Wells

The exploratory wells will be split-sampled for VOC analysis by portable GC and CLP-VOC analysis after measuring groundwater static levels for both the new and existing wells. The portable GC results will be used in conjunction with the static water elevation data to make decisions in a timely manner about whether an additional round of exploratory wells will need to be placed further downgradient. Samples for portable GC analysis will be sent to the lab for 24 hour expedited reporting. Depending on the results, another series of wells will be proposed downgradient using the same rationale for well and screen location supplemented with the newly acquired data on groundwater flow direction. Two decision criteria will be used for proposing additional exploratory wells. Additional wells will be proposed if:

- VOCs are found significantly above detection levels in samples from existing exploratory wells or:
- Significant changes in groundwater flow direction are noted that indicate additional characterization is necessary.

Maps showing the groundwater flow directions, VOC results and proposed additional well locations will be submitted for EPA/MDNR approval. This process will be repeated until the horizontal limits of off-site groundwater degradation are preliminarily determined. Vertical sampling will take place during the remedial design phase to confirm that the downgradient and horizontal extent of off-site groundwater degradation has been determined and to identify the location(s) of maximum offsite groundwater degradation. Well boring, installation, development and sampling methods will be conducted according to the Phase II Field Sampling Plan (Sections 3 and 4) and the Phase I QAPP except as otherwise discussed herein.

All of the Phase III wells currently proposed will be located on Kalamazoo County Airport property. The Phase III work will therefore be subject to the requirements of the FAA and the airport authorities. In a letter dated June 24, 1992, the Kalamazoo County Airport stated the following requirements:

- The wells will be located in the air operations area. This area is RESTRICTED, ONLY AUTHORIZED PERSONNEL will be granted access to this area. All persons in this area shall comply with Federal Aviation Administration and Airport Regulations. Violations of the FAA regulations may result in civil penalties of $10,000 per violation per day. Any fines associated with this project will be assessed to any parties involved. It is very important that all personnel involved understand and comply with these regulations. Any person that does not comply will be denied access to the airport.

- The regulations that apply to this project are as follows:

1. No person, vehicle or work shall be within 150 feet of a runway or 75 feet from a taxiway pavement edge.
2. No person, vehicle or work shall be within the glide slope critical area identified on the Airport Layout Plan (ALP).
3. No equipment shall exceed a height of 25 feet.
4. All work shall be completed on days that Instrument Flight Rules (IFR) are NOT in effect, (only in good weather). All work is to be completed in daylight hours. All equipment needs to be removed from airport property each day. All vehicles and equipment must remain in the work area and will not be allowed in other areas of the airport.
5. On site supervisor must maintain radio communication with the control tower. The proper frequency(ies) will be provided.
6. A person with an airport ID must be present at all times. Keys will only be issued for the gate to appropriate personnel approved by the airport. A proper escort on the field will be required.
7. Notification shall be made to this office at least 48 hours in advance before work begins or sampling. Office hours are 8:00 am to 5:00 pm Monday to Friday.
8. The exact latitude and longitude of the test wells must be provided on the permit filed with the FAA.

The airport authorities will apply for the FAA permit upon receipt of the exact well locations.

3.2.2 Exploratory Well Installation

Boreholes will be drilled using the hollowstem auger method, as it does not require the use of drilling fluids or additives. Per FAA requirements for work on airport property, the drill rig tower and rod-sections must not exceed 25 feet in height at anytime. A suitable drill rig meeting the requirements is available. Cleaning procedures for equipment and materials are provided in Section 4.2 of the Phase I QAPP. While the borehole is advanced, soil sampling to characterize the nature of the formation will be conducted at five foot intervals according to Section 4.4 of the Phase I QAPP. Representative portions of all split spoon soil samples will be retained in appropriate containers for USCS visual classification and grain size analysis, where appropriate. If zones of heaving sands are encountered that would inhibit split spoon soil sampling or advancement of the borehole, the sands will be removed from the augers using a sand bailer or, as a last resort (only for extreme conditions) in order to save the borehole and speed up operations, the sands will be washed/jetted out of the augers with an approved source of clean water. These field decisions will be made in consultation with the EPA/MDNR on-site representative.

Two inch diameter exploratory wells will be installed according to Section 4.6 of the Phase I QAPP, except that bentonite slurry instead of pellets will be used for the annular seal above the gravel pack for intermediate and deep wells. The 2 inch diameter flush-threaded well string will be constructed of a stainless steel, three foot long, 0.007 inch slot size screen threaded to one ten foot long section of stainless steel riser and schedule 40 PVC riser from there to the top of casing. A filter pack will be installed in the annular space extending at least two feet above the screened portion of the well. A layer of bentonite pellets or fine sand will be installed, prior to placement of a two-foot thick bentonite slurry seal, to ensure that the slurry does not significantly intrude into the filter pack. The annular space will then be filled with a cement/bentonite grout mix from the seal to the surface. A locking air-tight compression cap will be placed in the riser and a flush mount protective steel casing will be installed over each well head. Upon completion of each well, a designated point will be marked on the well and surveyed to USGS datum.

The anticipated exploratory well screen placement depths, consistent with the criteria listed in Section 3.2.1 of this work plan but subject to local lithological characteristics that favor coarser-grained water bearing zones, are as follows:

Well Identification	Estimated Screened Depths (feet below surface)
MWB5A	42-45
MWB5B	77-80
MWB5C	107-110
MWB6	112-115
MWB7A	42-45
MWB7B	77-80
MWB7C	107-110
MWB8	77-80

3.2.3 Exploratory Well Development

Upon completion, each exploratory well will be developed according to the procedures presented in Section 4.7 of the Phase I QAPP, using surge block and submersible pump techniques to remove fine-grained materials that settle in or around the well screen during installation. Development will continue until the water is relatively free of fines, as determined by turbidity meter readings, and water quality measurements of pH, temperature, and conductivity have stabilized.

Purge water will be collected in drums, sampled and disposed in accordance with all environmental and legal requirements, likely through discharge to the City of Portage sanitary sewer system pending approval from the City.

3.2.4 Groundwater Sampling

Groundwater samples will be collected from the exploratory wells and analyzed for VOCs by portable GC. For samples from intermediate and deep screened wells, a split sample will be sent to the laboratory for CLP-VOC analysis. Shallow well samples will be sent for CLP-VOC analysis only if VOCs are detected by portable GC analysis. Prior to collecting samples, groundwater static levels will be measured for both new and existing wells. Air-tight compression caps will be removed from flush-mounted wells for a sufficient time period (1-2 hours) to allow for water level equilization prior to measuring. The static level data will be used to generate potentiometric surface maps of the Roto-Finish site area. Groundwater samples and groundwater level measurements will be obtained from these wells in accordance with the procedures in Sections 5.3.3 and 5.3.4 of the Phase I QAPP. As stated in the QAPP, groundwater samples will preferentially be collected using a stainless steel and Teflon bladder pump. A packer will be used with the bladder pump to provide for sampling from the stainless steel portion of the well and prevent water samples from coming into contact with the PVC riser. Equipment cleaning procedures for groundwater sampling are provided in Section 5.3.3.2 of the Phase I QAPP with the exception that use of organic solvent rinses (hexane, acetone, methanol) will be avoided. Wells will be purged prior to sampling according to Section 5.3.3.3 of the Phase I QAPP.

4.0 FIELD SAMPLING QUALITY ASSURANCE/QUALITY CONTROL

Quality control samples will be collected for field activities including trip blanks, field blanks, and replicates as presented in Section 10.1 of the Phase I QAPP. Sample custody procedures will be followed including documentation, handling, and shipping, as presented in Section 6.0 of the Phase I QAPP. Field instrument calibration procedures to be followed for the thermometer, specific conductance meter, and pH meter are presented in Section 7.0 of the Phase I QAPP. For all instruments used during the investigation, the manufacturer's recommended calibration procedures will be used.

All project personnel have the responsibility as part of their normal work duties to promptly identify and report conditions that are adverse to quality work practices or data generation. Corrective action procedures are presented in Section 14.0 of the Phase I QAPP.

5.0 HEALTH AND SAFETY

All work conducted during the Phase III investigations will be in accordance with the Phase II Health and Safety Plan, including the revised Table I from this document which lists the chemicals detected during the Roto-Finish Remedial Investigations, maximum detected concentrations, and health effects information (Table I).

6.0 SCHEDULE OF WORK

A Gantt chart summarizing the estimated schedule is shown in Figure 3. The aquifer performance analysis is anticipated to be completed within 45 days after approval of this workplan by EPA/MDNR. The exploratory well investigation will begin within 15 days after approval by EPA/MDNR and FAA/Kalamazoo-Battle Creek International Airport authorities and after completion of the aquifer performance analysis. Field work for the initial round of exploratory wells is anticipated to require approximately three to four weeks. Unforeseen conditions, such as inclement weather, alterations in off-site access agreements, or newly obtained data suggesting a need for additional exploratory well installations, could extend the total time to completion. It is estimated that work will begin on the draft RI/FS report by late 1992, and require approximately 90 days for completion.

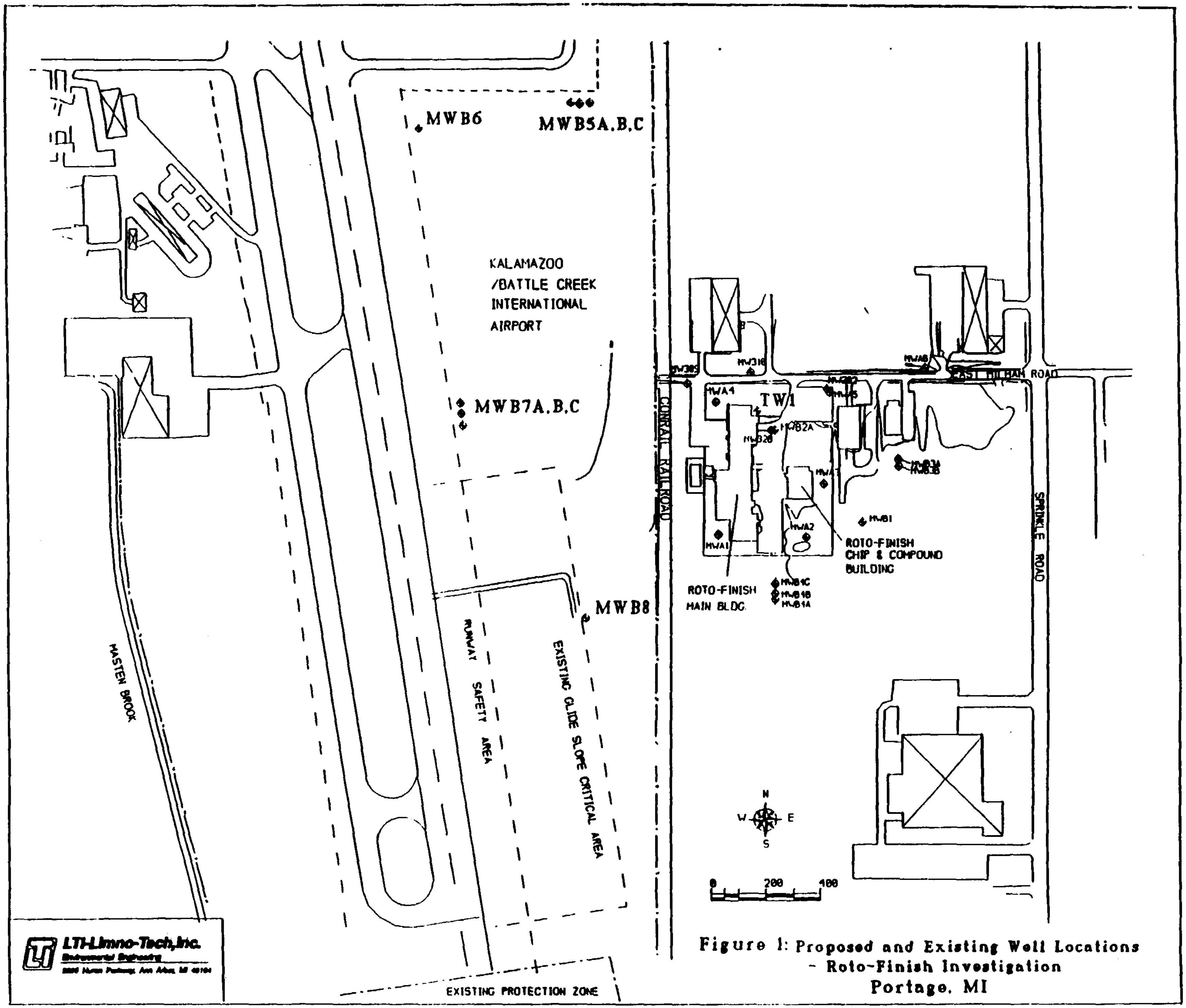


Figure 1: Proposed and Existing Well Locations - Roto-Finish Investigation Portage, MI

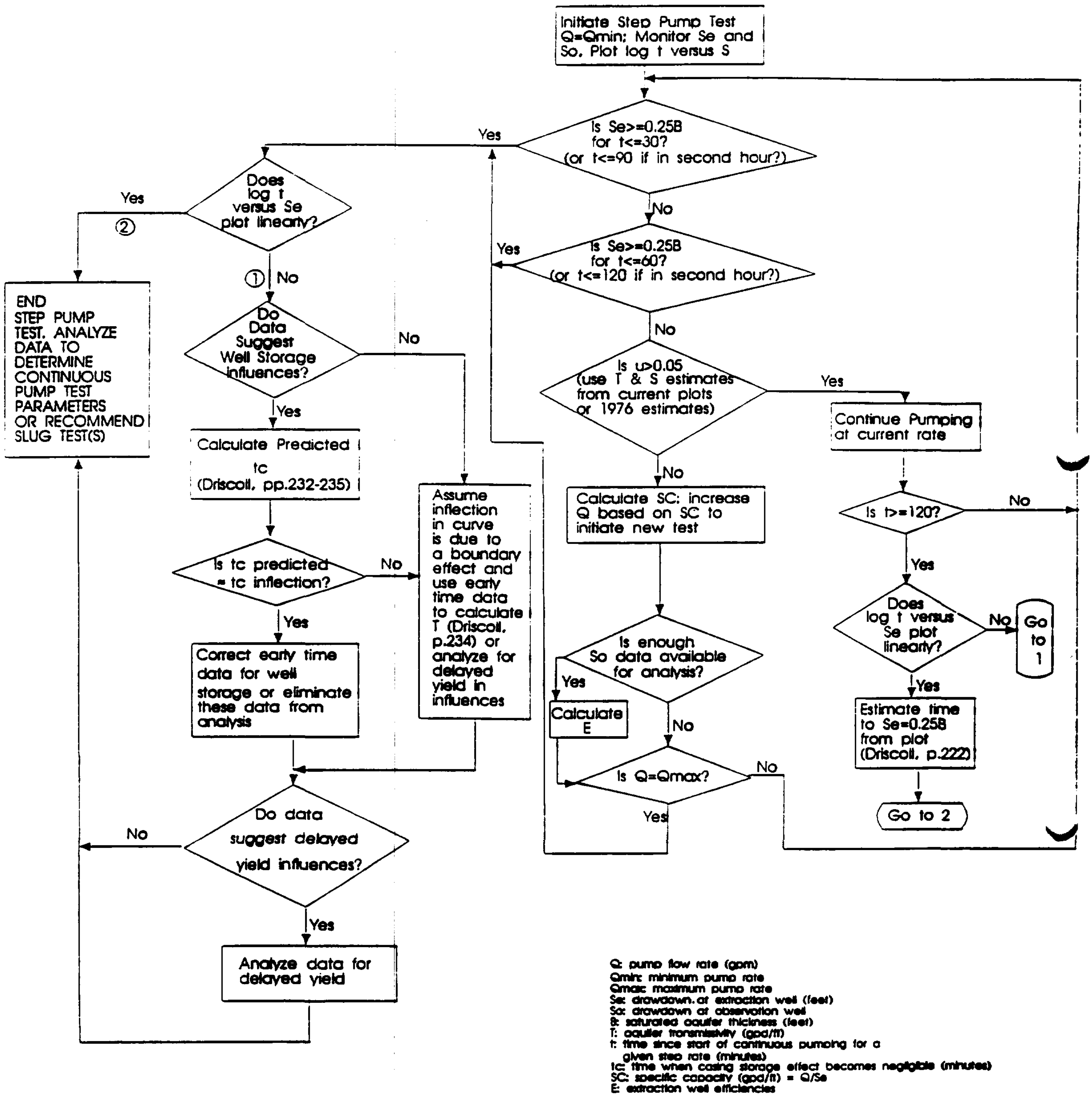
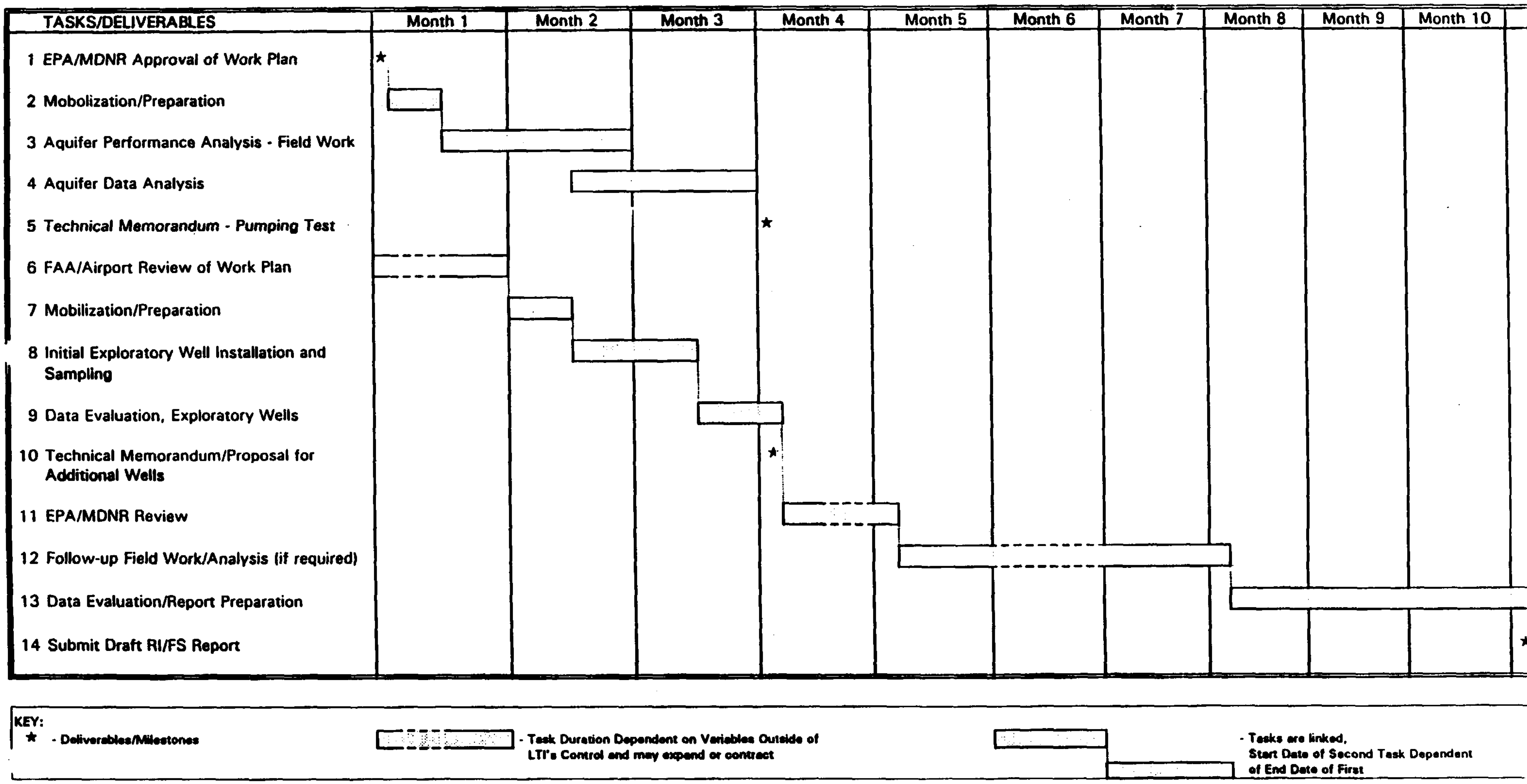


FIGURE 2: STEP-RATE PUMP TEST DECISION CRITERIA FOR UNCONFINED AQUIFERS

FIGURE 3: Proposed Schedule for Roto-Finish RI/FS
Phase III Investigations



HEALTH AND SAFETY PLAN

TABLE 1 Revised 1/28/92

Chemicals detected in samples from Roto-Finish Site Remedial Investigations, 1989-1991

(from laboratory results that have not undergone QA/QC data validation)

	Maximum Detected Concentration				Exposure Limits (TWA or as noted)	
	Soils (ug/kg)	Groundwater (ug/L)	Potential Route of Entry	Health Effects or Symptoms	ppm	mg/cu.m
METALS						
Aluminum	12700000	892				
Antimony	16200	nd	I, S	SYS		0.5
Arsenic	61200	26.7	I, S, O	Carc., SYS		0.002 [15 min]
Barium	145000	279	I, O, S	SYS		0.5
Beryllium	1400	1.5	I	Carc., SYS		0.0005
Calcium	98500000	259000				
Chromium	20600	nd	O, S	Carc., ETA		0.5
Cobalt	16000	12.4	O, S	SYS		0.5
Copper	55100	26.2				
Iron	48600000	2000				
Lead	162000	6.3	I, O, S	SYS		0.1
Magnesium	61000000	66200				
Manganese	2590000	1490	I, O	SYS		1
Mercury	370	0.24	I, S, O	SYS		0.01
Nickel	33300	57.1	I, O, S	Carc., SYS		0.015
Potassium	2520000	35000				
Selenium	1600	nd	I, S, O	SYS		0.2
Sodium	1160000	246000				
Vanadium	97400	11.3				
Zinc	370000	2680				
Cyanide	nd	21.8	I, S, O	SYS		5 [10 min] (OSHA)
VOLATILES						
Vinyl Chloride	nd	120	I	Carc., SYS	1 (OSHA)	
Acetone	140	180	I, O, S	SYS	250	590
Carbon Disulfide	nd	2	I, S, O	SYS	1 (NIOSH)	3 (NIOSH)

HEALTH AND SAFETY PLAN
TABLE 1 Revised 1/28/92
Chemicals detected in samples from Roto-Finish Site Remedial Investigations, 1989-1991
(from laboratory results that have not undergone QA/QC data validation)

	Maximum Detected Concentration				Exposure Limits	
	Soils (ug/kg)	Groundwater (ug/L)	Potential Route of Entry	Health Effects or Symptoms	(TWA or as noted) ppm	mg/cu.m
Chloroethane	nd	79	I, S, O	SYS	1000	2600
1,1-Dichloroethane	nd	270	I, O, S	SYS	100	400
1,1-Dichloroethene	nd	480				
1,2-Dichloroethene (total)	1	130	I, O, S	SYS	200	790
Methylene chloride	53	130	I, O, S	Carc., SYS	500	
1,2-Dichloroethane	nd	1	I, O, S	SYS		
1,1,1-Trichloroethane	nd	2700	I, O, S	SYS	350 (NIOSH)	1900 [15 min] (NIOSH)
Trichloroethene	nd	170	I, O, S	Carc., SYS	50 (OSHA)	270 (OSHA)
1,1,2-Trichloroethane	nd	5	I, S, O	Carc., SYS	10 (NIOSH)	45 [skin](NIOSH)
Benzene	nd	14	I, S, O	Carc., SYS	1 (OSHA)	
4-Methyl-2-pentanone	2	nd	I, O, S	SYS	50	205
1,1,2,2-Tetrachloroethane	7	nd	I, S, O	Carc., SYS	1 [skin]	7 [skin]
Toluene	18	40	I, S, O	SYS	100	375
Chlorobenzene	nd	270	I, O, S	SYS	75 (OSHA)	350 (OSHA)
Ethylbenzene	nd	17	I, O, S	SYS	100 (NIOSH/ OSHA)	435 (NIOSH/ OSHA)
Tetrachloroethene	nd	25	I, O, S	Carc., SYS	25 (OSHA)	170 (OSHA)
Total Xylenes	nd	24	I, S, O	SYS	100 (NIOSH/ OSHA)	435 (NIOSH/ OSHA)
SEMIVOLATILES						
Phenol	nd	40	I, S, O	SYS	5 (NIOSH)	19[15 min skin] (NIOSH)
1,4-Dichlorobenzene	nd	2				
1,2-Dichlorobenzene	480	27	I, S, O	SYS	50 (ceiling)	300
Naphthalene	56	nd	I, S, O	SYS	10	50
Dimethyl Phthalate	nd	2	I, O, S	SYS		5 (NIOSH/OSHA)
Acenaphthene	250	nd				

HEALTH AND SAFETY PLAN

TABLE 1 Revised 1/28/92

Chemicals detected in samples from Roto-Finish Site Remedial Investigations, 1989-1991
(from laboratory results that have not undergone QA/QC data validation)

	Maximum Detected Concentration				Exposure Limits (TWA or as noted)	
	Soils (ug/kg)	Groundwater (ug/L)	Potential Route of Entry	Health Effects or Symptoms	ppm	mg/cu.m
4-Nitrophenol	nd	1				
Dibenzofuran	95	nd				
Diethylphthalate	nd	1				
Fluorene	230	nd				
Pentachlorophenol	56	2	I, S, O	SYS		0.5 [skin]
Phenanthrene	3300	4				
Di-n-Butyl phthalate	120	3	I, O, S	SYS		5
Fluoranthene	5500	3				
Pyrene	3800	nd				
Butylbenzylphthalate	77	6	I			
Benzo(a)anthracene	2700	6	O, I	Carc.		
Chrysene	2400	6	O, I	Carc.		
bis(2-Ethylhexyl)phthalate	700	47	I, O, S	Carc., SYS		
Di-n-Octylphthalate	nd	17	I, S, O	Carc., SYS, TER		5
Benzo(b)fluoranthene	5100	5	O, I	Carc.		
Benzo(k)fluoranthene	5100	6	O, I	Carc.		
Benzo(a)pyrene	nd	4	O, I	Carc.		
Indeno(1,2,3-cd)pyrene	nd	2	O, I	Carc.		
Dibenzo (a,h) Anthracene	340	nd				
Benzo(g,h,i)perylene	1000	3	O, I	Carc.		
4,4'-Methylenebis(2-chloroaniline)	310	nd	S, O, I	Carc., ETA, MUT	0.02 [skin]	0.22

nd = not detected
O = oral
I = inhalation
S = skin

Carc. = carcinogen
ETA = equivocal tumorigenic agent
MUT = mutagen
NEO = neoplastic effects
SYS = systemic effects
TER = teratogenic