EPA Region 5 Records Ctr.
365818

MULTI-AREA FIELD SAMPLING PLAN

12TH STREET LANDFILL SITE (OPERABLE UNIT NO. 4) AND PLAINWELL MILL SITE (OPERABLE UNIT NO. 7)

ALLIED PAPER, INC./PORTAGE CREEK/ KALAMAZOO RIVER SUPERFUND SITE

Revision 05
November 20, 2009

Submitted in connection with Phase II Remedial Investigation Work Plan, Plainwell Mill and the Remedial Action Work Plan, 12th Street Landfill

Prepared by Conestoga-Rovers & Associates in conjunction with RMT on behalf of Weyerhaeuser Company

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LIST OF ACRONYMS AND ABBREVIATIONS

µg/L	micrograms per liter
µg/kg	micrograms per kilogram
AA	atomic absorption
ARAR	Applicable, or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
BFB	p-bromofluorobenzene
BNA	base-neutral-acid extractable
CCB	continuing calibration blank
CCC	calibration check compound
CCV	continuing calibration verification
CD	Consent Decree
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	Chain-of-Custody
COPC	constituent of potential concern
CRA	Conestoga-Rovers & Associates
CVAA	cold vapor atomic absorption
DFTPP	decafluorotriphenylphosphine
DI	deionized
DO	dissolved oxygen
DQI	data quality indicators
DQO	Data Quality Objective
ECD	electron capture detector
EDD	electronic data deliverable
Eh	redox
FB	field blank
FS	Feasibility Study
FSK	Field Sample Key
FSP	Field Sampling Plan
GC/MS	gas chromatograph/mass spectrophotometer
HSP	Health and Safety Plan
ICB	initial calibration blank
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectroscopy
ICS	interface check samples
ICV	initial calibration verification

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

IDW	investigation-derived waste
KRSG	Kalamazoo River Study Group
L	liter
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LRA	linear range analysis
MDEQ	Michigan Department of Environmental Quality
MDL	Method Detection Limit
MS	matrix spike
MS/MSD	matrix spike/matrix spike duplicate
MSD	matrix spike duplicate
NCP	National Contingency Plan
NIST	National Institute of Standards and Technology
NTU	nephelometric turbidity unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pH	negative logarithm (base 10) of hydrogen ion activity
PID	photoionization detector
PQO	Project Quality Objective
POTW	publicly-owned treatment works
PM	Project Manager
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QC	quality control
QL	Quantitation Limit
RAS	routine analytical services
RD/RA	Remedial Design/Remedial Action
RF	response factor
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

RPD	relative percent difference
RL	reporting limit
RPM	Remedial Project Manager
RSD	relative standard deviation
RT	retention time
SAP	Sampling and Analysis Plan
SAS	special analytical services
SOP	standard operating procedure
SOW	Statement of Work
SPCC	system performance check compound
SRI/FS	Supplemental Remedial Investigation/Feasibility Study
SRM	standard reference material
SW846	Test Methods for Evaluating Solid Waste, 1996
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Removal Action
TEMP	temperature
TB	trip blank
TSS	Total suspended solids
U.S. EPA	United States Environmental Protection Agency
VAS	Vertical Aquifer Sampling
VOC	volatile organic compound
WATS	Weyerhaeuser Analytical Testing Services

1.0 INTRODUCTION

1.1 BACKGROUND

Weyerhaeuser Company (Weyerhaeuser) was identified as a Potentially Responsible Party (PRP) for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site (Site) in a General Notice letter dated April 8, 2004, that was received by Weyerhaeuser and two other PRPs. Concurrently, Weyerhaeuser was negotiating a Consent Decree (CD) to undertake specific activities on the former Plainwell Mill and 12th Street Landfill sites. On February 22, 2005, Weyerhaeuser entered into a CD with the United States Environmental Protection Agency (U.S. EPA) for the Design and Implementation of Certain Response Activities at the 12th Street Landfill site (Operable Unit No. 4) and the Plainwell Mill site (Operable Unit No. 7). Both sites are part of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site (Figure 1-1), which is located in southwestern Michigan. A Statement of Work (SOW) for the Remedial Design/Remedial Action (RD/RA) at the 12th Street Landfill site was attached to the CD. A SOW for the Remedial Investigation/Feasibility Study (RI/FS) at the Plainwell Mill site was subsequently issued by the U.S. EPA, with an effective date of August 17, 2006.

The U.S. EPA requires that all parties involved in environmental monitoring and measurement efforts mandated or supported by the U.S. EPA participate in a centrally managed quality assurance program. Any party generating data under this program has the responsibility to implement minimum procedures to ensure that the precision, accuracy, completeness, and representativeness of the data are known and documented. To ensure that the responsibility is met uniformly, a written Quality Assurance Project Plan (QAPP) and associated Field Sampling Plan (FSP) must be prepared for each project. A Multi-Area QAPP for the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site has been submitted for review under separate cover. It has been prepared to support field activities by describing specific protocols that will be followed for sampling, sample handling and storage, chain-of-custody procedures, and laboratory analysis for multiple areas of the Site. The Multi-Area QAPP also defines objectives, organization, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with implementing the following activities:

1. Emergency Response in the former powerhouse discharge channel at the 12th Street Landfill
2. Emergency Response of portions of the riverbank along the Plainwell Mill
3. Predesign investigations for the remedial design for the 12th Street Landfill

4. Phase 2 of Addendum No. 1 Plainwell Mill Investigations
5. Plainwell Mill RI/FS – Phase I Initial Groundwater Assessment
6. Remedial Action for the 12th Street Landfill
7. Phase II RI Work Plan for the Plainwell Mill Investigations

QAPP amendments will be submitted to supplement the current QAPP as additional work activities are authorized and defined.

This associated Multi-Area FSP establishes sample collection and field monitoring methods and procedures to be followed to ensure that sampling and investigatory activities at the Site are conducted in a consistent manner and in accordance with technically acceptable protocols. The objective of the FSP is to facilitate the collection of environmental monitoring data that meet Data Quality Objectives (DQOs) established in the Multi-Area QAPP (CRA, 2009). This FSP will be modified in the future as other sampling programs are developed for Operable Unit Nos. 4 and 7, as well as other areas of the site, as appropriate.

1.2 DOCUMENT ORGANIZATION

This FSP was prepared to establish Standard Operating Procedures (SOPs) for environmental monitoring activities expected or likely to be conducted for purposes of completing activities associated with the following activities:

1. Emergency Response in the former powerhouse discharge channel at the 12th Street Landfill
2. Emergency Response of portions of the riverbank along the Plainwell Mill
3. Predesign investigations for the remedial design for the 12th Street Landfill
4. Remedial Action for the 12th Street Landfill
5. Phase 2 of Addendum No. 1 Plainwell Mill Investigations
6. Plainwell Mill RI/FS – Phase I Initial Groundwater Assessment
7. Plainwell Mill Phase II RI Work Plan
8. 12th Street Landfill Remedial Action Work Plan

Additional SOPs will be submitted as work areas are added or work tasks are modified. SOPs developed as components of amended scope documents will become common to all sampling activities of the same type (e.g., sediment core collection).

As additional work plans are prepared, it is anticipated that they will be incorporated as additional addenda to this document, referencing a combination of the same SOPs, amended SOPs, or additional SOPs. If additional SOPs are required, they will be added to Attachment A. If modified SOPs are required, they will replace existing SOPs in this document. Specific addenda will be provided as standalone documents.

In September 2009, the FSP was amended to include the sampling and analysis activities associated with the Phase II RI Work Plan for the Plainwell Mill and the removal of paper residuals from outside of the landfill footprint as part of the Remedial Action (RA) at the 12th Street Landfill. At that time modifications were made to the FSP to reflect the change in Project Coordinator as defined in the 2005 CD from RMT to Conestoga-Rovers & Associates (CRA).

1.3 PROJECT SETTING

The 12th Street Landfill and Plainwell Mill sites are located in Allegan County, Michigan (Figure 1-2). The 12th Street Landfill is located in Otsego Township (Section 24, Township 1N, Range 12W), and the Plainwell Mill is located in the City of Plainwell (Section 30, Township 1N, Range 11W). Both sites are located adjacent to the Kalamazoo River, with the 12th Street Landfill located approximately 1½ miles northwest and downstream of the Plainwell Mill site. The 12th Street Landfill site is composed of approximately 6.5 acres and is situated on roughly a 24-acre property that is bordered to the east by woodlands and a former hydroelectric powerhouse discharge channel on the Kalamazoo River, to the north and west by wetlands, to the south and southwest by an asphalt plant, and to the south and southeast by industrially developed lands and the Plainwell Dam (which is scheduled to be removed as part of the U.S. EPA-approved TCRA in 2007-2008). The Plainwell Mill site covers approximately 36 acres and is bordered by the Kalamazoo River to the north (to the top of the riverbank, as defined in the CD), the Plainwell central business district to the east, residential properties to the south, and commercial properties and the City of Plainwell wastewater treatment plant to the west.

Weyerhaeuser recently took ownership of the 12th Street Landfill property from Plainwell, Inc., a bankrupt entity with no ongoing business operations. The City of Plainwell is the current owner of the Plainwell Mill property, having purchased the mill site out of the Plainwell bankruptcy in 2006. The Mill property has been vacant since the former Simpson Plainwell Paper Company filed for bankruptcy in 2000. Weyerhaeuser

owned and operated the Mill for an approximate 9-year period, between 1961 and 1970. During that period, dewatered sludge from wastewater treatment operations was excavated from lagoons on the Mill property and transported for disposal at the 12th Street Landfill site.

1.4 APPLICABILITY OF THE FSP

This FSP is applicable for work performed by Weyerhaeuser under its 2005 CD with the U.S. EPA and for other specified work in areas to be determined. The FSP addresses specific projects at operable units at the Site, as well as other projects as may be specified later. The applicable operable units are as follows:

- Operable Unit No. 4 – 12th Street Landfill Site
- Operable Unit No. 5 – Kalamazoo River
- Operable Unit No. 7 – Plainwell Mill Site

The organization and specific Quality Assurance/Quality Control (QA/QC) activities associated with the various data collection activities are presented in the Multi-Area QAPP, which was submitted under separate cover.

This FSP has been developed in general accordance with the U.S. EPA's document entitled, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," dated October 1988.

1.5 SCOPE AND DESCRIPTION OF REVISION PROCESS

This FSP provides guidance for the various fieldwork activities by defining the sampling and data-gathering methods to be used. The scope of the document is outlined as follows:

- Section 1 provides the introduction, purpose, and scope of the FSP.
- Section 2 describes a summary of the sampling program, including sample locations and frequency.
- Section 3 covers the logistics of sample designation and field records.
- Section 4 summarizes the sample handling and analysis procedures to be followed. Details regarding the sample analytical procedures are discussed in the QAPP.

- Section 5 describes field physical measurements.
- Section 6 describes the management of investigation-derived waste.

As new projects are initiated, new information will be added to this Multi-Area FSP to cover the new project and additional revisions will made, as needed. A new revision number will also be assigned to the document (*e.g.*, Revision 02 will be revised to Revision 03, and so on). Specifically, the following additions/revisions will be made:

- **Summary of Sampling Program** – A subsection will be added to Section 2, to provide a summary of the sampling program. In addition, a new table will be added in Section 2 to provide a summary of the sample types and locations for the new project. The subsections and tables in the previous version of Section 2, which describe previous projects conducted under this Multi-Area FSP, will not be revised or deleted.
- **Other Text Sections** – New information will be added to other sections of the Multi-Area FSP, as necessary to cover the new activities. Information pertaining to previous projects will not be revised or deleted.
- **Standard Operating Procedures (Attachment A)** – If the previously developed SOPs, which are included in Attachment A of the Multi-Area FSP, do not cover the sampling procedures that will be utilized for the new project, new SOPs will be added to Attachment A, as necessary. The SOPs that were included for previous projects will not be deleted. SOP revisions will only be made if necessary to update standard sampling procedures or protocols, and if revised, the revision number and date (located in the upper right-hand corner) will be modified as appropriate.
- **Example Forms/Logs (Attachment B)** – If the previously developed sampling forms, which are included in Attachment B of the Multi-Area FSP, do not include forms that will be utilized for the project, new sampling forms will be added to Attachment B, as necessary.

2.0 SUMMARY OF SAMPLING PROGRAM

2.1 OVERVIEW

Environmental sampling for the various activities associated with OU-4, OU-5, and OU-7 will include sampling of various media to meet a range of information needs. These information needs will vary depending upon the specific tasks being conducted. At a minimum, this Multi-Area FSP will be used to support the following work activities:

- Operable Unit No. 4 – Emergency response activities in the former powerhouse discharge channel and RD/RA activities in connection with the 12th Street Landfill, as defined in the CD and SOW.
- Operable Unit No. 5 – Emergency response activities on portions of the riverbank along the Plainwell Mill.
- Operable Unit No. 7 – RI/FS and RD/RA activities in connection with the Plainwell Mill, as defined in the CD and SOW.
- Operable Unit No. 4 – RA Work Plan activities in connection with 12th Street Landfill, as defined in the CD and SOW.
- Operable Unit No. 7 – Phase II RI Work Plan activities in connection with Former Plainwell, Inc. Mill Property (Plainwell Mill).

The subsections below provide a summary of the sample types and locations for each project conducted under this Multi-Area FSP to date, as well as new projects being added in this revision. These projects include the following (note: as described in Subsection 1.5 of this Multi-Area FSP, the summaries of projects included in previous revisions of this document have not been revised or deleted):

- Emergency response activities in the former powerhouse discharge channel at the 12th Street Landfill (as initially described in Revision 00, June 2007).
- Emergency response activities on portions of the riverbank along the Plainwell Mill (as initially described in Revision 01, September 2007).
- Predesign investigations for the remedial design for the 12th Street Landfill (as initially described in Revision 02, April 2008).
- Phase 2 of Addendum No. 1 Plainwell Mill Investigation [Revision 03, September 2008]).
- Plainwell Mill RI/FS – Phase I Initial Groundwater Assessment (added as described in Revision 04, November 2008).

- Remedial Action for the 12th Street Landfill (added in this version of the Multi-Area FSP [Revision 04, November 2008]).
- Phase II RI Work Plan activities at Plainwell Mill including a installation of new groundwater monitoring locations, soil sampling at various locations of the Site, and a Site-wide groundwater monitoring.
- RA Work Plan activities for 12th Street Landfill including removal of paper residuals from outside of the landfill footprint.

The subsections below also reference Standard Operating Procedures (SOPs; Attachment A), and example forms and logs (Attachment B). To date, a total of 17 SOPs have been prepared to describe applicable sampling procedures and protocols (SOPs F-1 through F-17; see Attachment A). New SOPs, forms, logs, and QAPP worksheets, which are developed as part of future work plan submittals, will be included in later revisions of this Multi-Area FSP, as described in Subsection 1.5.

2.2 OU-4: EMERGENCY RESPONSE – FORMER POWERHOUSE DISCHARGE CHANNEL SAMPLING AND MONITORING ACTIVITIES

In late February 2007, the U.S. EPA authorized a Time-Critical Removal Action (TCRA) to remove polychlorinated biphenyl (PCB)-contaminated sediment in the former Plainwell Impoundment (a section of Operable Unit No. 5 of the Allied Paper/Portage Creek/Kalamazoo River Superfund site). This work was subsequently implemented through an administrative settlement agreement and Order on Consent for Removal Action (V-W-07-C-8-63). As part of the TCRA, the earthen section of the Plainwell Dam will be removed and the Kalamazoo River will be rerouted through the former powerhouse channel. The 12th Street Landfill abuts the river and is located directly downstream of the earthen section of the Plainwell Dam. The Plainwell Mill also abuts the Kalamazoo River and PCB-containing materials have been documented along the river bank at the Mill. The change in the Kalamazoo River channel will result in an increased river gradient and higher velocities upstream and along the rerouted channel (USGS, 2004 and USDA, 2004). The modified river flow is expected to mobilize residuals currently present in the powerhouse channel downstream and to erode bank material in the area of the Mill. Thus, the TCRA scope of activities are actions or occurrences which threaten releases of waste material (as defined in the CD) from both the 12th Street Landfill and the Plainwell Mill property. Since any such release may present an immediate threat to public health or welfare of the environment,

Weyerhaeuser has been authorized to conduct several emergency response actions in conjunction with completing the required work under the CD.

The following subsections describe sample collection procedures, sample handling methods, and other procedures pertaining to the following general sampling categories:

- Surface water sampling and field measurements
- Surface water and flow measurement
- Water treatment system sampling
- Sediment sampling
- Soil sampling using direct push equipment

SOPs for each type of sampling activity are provided in Attachment A. These SOPs describe or reference ancillary procedures for equipment cleaning, field measurements, and calibration and maintenance of field instruments, as appropriate.

2.2.1 SAMPLE COLLECTION PROCEDURES

Water Monitoring and Field Measurements

Surface water monitoring and field measurements will be performed during the emergency action activities to meet various objectives including:

- Measurement of surface water PCB and total suspended solids (TSS) concentrations in river water.
- Measurement of potentially transported polychlorinated biphenyls (PCBs), and suspended sediments in river water.
- Monitoring of trends in surface water PCB concentrations over time.
- Monitoring of the relative effects of removal activities on turbidity and PCBs in the main river water column outside the channel during the removal actions.
- Monitoring of turbidity of infiltrating groundwater to establish discharge location.
- Evaluation of water quality associated with the water treatment system.

Several data collection methods will be used to achieve these objectives, depending on the purpose and intent of the data, and the DQOs specified in the applicable area-specific work plan and FSP addendum. SOPs for surface water data collection are

provided in appendices to this document that can be used together or separately as needed to satisfy the goals of data collection. Specific SOPs are provided for:

Surface Water and Field Measurement Procedures (SOP F-1). This SOP will be used for the collection of a water column sample for laboratory analysis and can be applied to grab samples, vertically integrated samples, bottle sampling, or sampling using a specific device, such as an ISCO automated sampler or peristaltic pump. This SOP will be used for most samples collected from the river for PCB and TSS analysis. It can also be used for the collection of grab samples from an open channel, the end of a pipe, or from anywhere within a water treatment stream. This SOP includes the use of standard hand-held metering devices and should be used to collect field measurements of surface water quality parameters including turbidity, temperature, dissolved oxygen (DO), and conductivity.

Surface Water Flow Measurement Procedures (SOP F-2). This SOP will be used to measure flow in the river by measuring cross-sectional area and velocities across the channel at the point of measurement.

Water Treatment System Monitoring Procedures (SOP F-3). This SOP describes the field procedures for collection of in-field water treatment system measurements including grab samples for PCB analysis at the effluent of the water treatment system, grab samples for TSS at the effluent of the water treatment system, and grab samples for phosphorus at the effluent of the water treatment system.

Sediment Sampling

Sediment sampling will be performed during the OU-4 Emergency Response activities to meet various objectives, including:

- Identify the distribution and physical characteristics of sediments.
- Characterize the nature and extent of PCBs in sediments present in the Former Powerhouse Channel.
- Monitor the effects of removal activities and determine post-removal PCB concentrations in sediment.

To support these objectives, sediment samples will be collected as intact cores to provide samples at depth, or as surficial grab samples to characterize the sediment at the top of the sediment bed. Core samples will be collected using polycarbonate tubing unless

other methods are identified by the area-specific work plan or FSP addendum. Surface grab samples will be collected using sediment core methods or using a petit Ponar dredge. SOPs for sediment collection methods are provided in:

Sediment Sampling Procedures (SOP F-4). This SOP provides field procedures for the collection of sediment samples, sediment cores, and probing for bathymetric surveys.

Geotechnical Soil Sampling

The purpose of the geotechnical investigation is to determine the extent, height and width, and materials used in the berm along the Kalamazoo River so that a slope stability evaluation can be completed. The location of the berm will be used to assess potential adverse affects to the stability of the fill material that may occur as a result of cutting back existing material along the riverfront. Visual observation of the materials used in the construction of the berm will be used to approximate the physical characteristics of the material, which will be used in the stability model. Together, the location and the physical characteristics of the berm will be used to model the stability of the landfill, provide data to help assess whether or not the vegetation present along the river can be preserved, and ultimately to provide inputs to the design of a stable final slope.

Soil Sampling Procedures with Direct Push Equipment (SOP F-5). This SOP provides field procedures for the collection of soil samples utilizing a direct push sampler.

2.2.2 SAMPLE LOCATIONS

Specific sample locations depend upon both the types of samples being collected and field conditions. Many sample locations will be established based in the field based upon site-specific conditions that impact the ability to collect representative samples and the guidelines in the work plan, QAPP and this FSP. Available information by sample type is summarized in Table 2-1.

2.3 OU-5: EMERGENCY RESPONSE – PLAINWELL MILL BANKS

In a letter dated June 29, 2007, the U.S. EPA has authorized Weyerhaeuser Company, under Paragraph 67 of their 2005 Consent Decree, to take actions to prevent, abate, or

minimize a release or potential release of hazardous substances from the former Plainwell Mill banks (part of the Kalamazoo River Operable Unit [OU-5]).

The following subsections describe sample collection procedures, sample handling methods, and other procedures pertaining to the following general sampling categories.

- Surface water sampling and field measurements
- Surface water and flow measurement
- Water treatment system sampling
- Sediment sampling
- Surficial soil sampling

SOPs for each type of sampling activity are provided in Attachment A. These SOPs describe or reference ancillary procedures for equipment cleaning, field measurements, and calibration and maintenance of field instruments, as appropriate.

2.3.1 SAMPLE COLLECTION PROCEDURES

Water Monitoring and Field Measurements

Surface water monitoring and field measurements will be performed during the Plainwell Mill Banks Emergency Action activities to meet various objectives including:

- Measurement of surface water PCB and TSS concentrations in river water.
- Measurement of potentially transported PCBs and suspended sediments in river water.
- Monitoring of trends in surface water PCB concentrations over the duration of the construction activities.
- Monitoring of the relative effects of removal activities on turbidity and PCBs in river water column adjacent to the banks during the residual removal actions.
- Evaluation of water quality associated with the water treatment system.

Several data collection methods will be used to achieve these objectives, depending on the purpose and intent of the data, and the DQOs specified in the applicable area-specific work plan and FSP addendum. SOPs for surface water data collection are provided in appendices to this document that can be used together or separately as needed to satisfy the goals of data collection. Specific SOPs are provided for:

Surface Water and Field Measurement Procedures (SOP F-1). This SOP will be used for the collection of a water column sample for laboratory analysis and can be applied to grab samples, vertically integrated samples, bottle sampling, or sampling using a specific device, such as an ISCO automated sampler or peristaltic pump. This SOP will be used for most samples collected from the river for PCB and TSS analysis. It can also be used for the collection of grab samples from an open channel, the end of a pipe, or from anywhere within a water treatment stream. This SOP includes the use of standard hand-held metering devices and should be used to collect field measurements of surface water quality parameters including turbidity, temperature, DO, and conductivity.

Surface Water Flow Measurement Procedures (SOP F-2). This SOP will be used to measure flow in the river by measuring cross-sectional area and velocities across the channel at the point of measurement.

Water Treatment System Monitoring Procedures (SOP F-3). This SOP describes the field procedures for collection of in-field water treatment system measurements including grab samples for PCB analysis at the effluent of the water treatment system, grab samples for TSS at the effluent of the water treatment system, and grab samples for phosphorus at the effluent of the water treatment system.

Sediment Sampling

Sediment sampling will be performed during the Plainwell Mill Banks Emergency Action activities to meet various objectives, including:

- Identify the distribution and physical characteristics of bank sediments.
- Characterize the nature and extent of PCBs in sediments present along the Plainwell Mill Banks.
- Monitor the effects of removal activities and determine post-removal PCB concentrations in near-bank sediment.

To support these objectives, sediment samples will be collected as intact cores to provide samples at depth, or as surficial grab samples to characterize the sediment at the top of the sediment bed. Core samples will be collected using polycarbonate tubing unless other methods are identified by the area-specific work plan or FSP addendum. Surface grab samples will be collected using sediment core methods or using a petite Ponar dredge. SOPs for sediment collection methods are provided in:

Sediment Sampling Procedures (SOP F-4). This SOP provides field procedures for the collection of sediment samples and cores.

Post Construction Soil Confirmation Sampling

The purpose of the post construction soil confirmation sampling is to evaluate the success of the residual removal activities in the Plainwell Mill bank along the Kalamazoo River. A geotechnical evaluation may be required in order to evaluate slope stability. The need for this evaluation will be confirmed in the field during removal activities.

Surficial Soil Sampling Procedures (SOP F-6). This SOP provides field procedures for the collection of soil confirmation samples utilizing stainless steel scoops.

2.3.2 SAMPLE LOCATIONS

Specific sample locations depend upon both the types of samples being collected and field conditions. Many sample locations will be established based in the field based upon site-specific conditions that impact the ability to collect representative samples and the guidelines in the work plan, QAPP and this FSP. Available information by sample type is summarized in Table 2-2. Additional details regarding the sampling program are included in Table 3-1 of the Design Report.

2.4 OU-4: PREDESIGN INVESTIGATIONS – REMEDIAL DESIGN FOR THE 12TH STREET LANDFILL

Operable Unit No. 4 (OU-4) of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site consists of the closed 12th Street Landfill and four areas outside the landfill where PCB-contaminated residual material has been observed. The 24-acre parcel includes the 6.5-acre landfill and approximately 17 acres of wetlands to the north/northwest of the landfill. Additional portions of OU-4 include the woodland area owned by the State of Michigan (State) under management of the Michigan Department of Natural Resources (MDNR), the asphalt plant operation adjacent to the landfill, and the former powerhouse discharge channel, which are located outside the landfill property line. Contamination in the former powerhouse discharge channel was addressed as part of Emergency Actions implemented in 2007.

The 12th Street Landfill accepted paper residuals from the former Plainwell Mill, located in Plainwell, Michigan, during the period from approximately 1955 to 1981. The landfill reportedly also accepted solid waste from the mill during part of its period of active operation. A number of investigations have been performed at the site. The investigations have confirmed the nature of the material in the landfill and have shown that paper residuals are present in certain areas outside of the landfill (i.e., in the wetlands to the north/northwest, the asphalt plant property, and the State property). Some of the residuals/native soil beyond the toe of the landfill (*i.e.*, outside the footprint of the landfill) may contain PCBs at concentrations exceeding State of Michigan or Kalamazoo River Superfund Site-specific ecological risk-based criteria.

A Record of Decision (ROD) for OU-4 was issued on September 28, 2001. The major components of the selected remedy include the following: "(1) the excavation and relocation into the landfill of contaminated residuals currently in the woodland, wetlands, and adjacent property, and the residuals in the former powerhouse discharge channel that are contiguous with the eastern side of the landfill, followed by the construction of a containment system; (2) the excavation and relocation into the landfill of the east side of the landfill along the former powerhouse discharge channel to create a buffer zone sufficient to insure no hydraulic connection between the wastes within the landfill containment system and the Kalamazoo River or the former powerhouse discharge channel; (3) the restoration of areas excavated, cleared and grubbed, or otherwise affected by the remedial action; (4) the construction of a side wall containment system around the outside of the landfill; (5) the construction of a cover (cap) over the landfill; (6) the installation of an appropriate groundwater monitoring network and the performance of long-term groundwater monitoring; (7) the performance of short-term surface water monitoring; (8) the placement of deed restrictions; (9) the construction of a fence, permanent markers, and warning signs; (10) the investigation of the need for a leachate collection system and, if deemed necessary, the construction of a leachate collection system; and (11) the implementation of long-term maintenance and post-closure care."

In January 2005, Weyerhaeuser negotiated a CD with the U.S. EPA (Civil Action No. 1:05-CV0003) for the design and implementation of certain response actions at Operable Unit No. 4 and the Plainwell Inc., Mill. Specifically, the CD requires RD and RA activities for the 12th Street Landfill and RI/FS and RD/RA activities for the former Plainwell Mill (Operable Unit No. 7). This revision of the Multi-Area FSP has been prepared in fulfillment of the requirements for a RD Work Plan for the 12th Street Landfill that are contained in the CD and the SOW.

The RD Work Plan for the 12th Street Landfill includes a number of predesign investigations, some of which involve field data collection and visual observations. Field data collection activities will include visual information obtained by the advancement of test pits, visual information obtained by the advancement of Geoprobe® borings, and gas concentration measurements (methane, carbon dioxide, and oxygen) in certain existing monitoring wells and in the Geoprobe® borings advanced as part of the predesign investigation. Pressure will also be recorded in certain existing monitoring wells.

The field investigations will involve: 1) a refined estimate of the extent of visible paper residuals beyond the landfill footprint; 2) the collection of data to support the grading design for the landfill; and 3) the collection of data for use in the design of a landfill gas management system. SOPs for each type of sampling activity are provided in Attachment A. These SOPs describe or reference ancillary procedures for equipment cleaning, field measurements, and calibration and maintenance of field instruments, as appropriate.

2.4.1 SAMPLE COLLECTION PROCEDURES

Data for Grading Design

Additional data is required to better estimate the thickness of paper residuals along the property boundaries with 12th Street, the asphalt plant to the southwest, and with the State property to the southeast, in order to reduce uncertainties in designing the final cover grades, and to support discussions with the owners of these adjacent properties concerning access. The scope of the investigative work necessary to obtain these data is as follows:

- Advance approximately nine Geoprobe® borings into the 12th Street Landfill at select locations where fill material is believed to extend beyond the property boundary to the southwest and to the southeast. The borings will be advanced to approximately 5 feet into the native soil underlying the fill, or to refusal. Each borehole will be given a unique identification number.
- Advance a minimum of two soil borings near the southern end of the landfill to confirm the thickness of the fill in this area. Advance the borings approximately 5 feet into the native soil underlying the fill or to refusal. The locations of these

borings may be adjusted in the field as necessary to avoid underground or aboveground utility lines. Additional borings may be installed to the north of the initial borings as may be deemed useful by Weyerhaeuser, in consultation with oversight agencies as needed, for purposes of designing the landfill cover (*e.g.*, if fill material is not encountered at a location where existing data indicates fill is present).

- Prepare a Soil Boring Log (refer to Attachment B for a sample log) for each borehole based on visual observation. Classify the materials encountered based on the procedures outlined in ASTM D2488. The logs will document the borehole identification number, the drilling dates and times, names of field personnel, soil descriptions, sample depths, and recovery. Retain a representative sample of each type of material encountered (no laboratory analyses are planned). As may be appropriate, photographs of the materials encountered or other pertinent observations will be documented. Photographs will be labeled to indicate the subject, location, date, name of photographer, and project identification number.
- The on-site geologist/engineer will prepare the Soil Boring Logs in the field. The logs will be reviewed by the senior engineer in the office. A field notebook will also be maintained by the on-site geologist/engineer to document other pertinent field information. The senior engineer will review the field notebook for clarity and completeness in meeting the investigation objectives.
- Following completion of the borehole logs, abandon the boreholes by filling them with a bentonite grout.
- Dispose of the Geoprobe® samples in an area on-site that will be covered by the final cover and in a manner that will not result in erosion before the final cover is installed.
- Decontaminate the Geoprobe® equipment following completion of the work. Decontamination will be performed at a decontamination pad constructed on top of the landfill. Refer to Subsection 6.1.2 of this FSP for additional information regarding the construction of the decontamination pad.
- Decontamination of Geoprobe® equipment between borings is not necessary because new acrylic tubes will be used at each location to collect material for visual observation (samples are not being collected for laboratory analysis).
- Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the technical

memorandum documenting the findings and conclusions of the Predesign Studies (to be submitted as part of the Design Report).

- Survey the locations and ground surface elevations of the boreholes following completion. The accuracy of the survey will be ± 0.01 foot for the horizontal coordinates and ± 0.1 foot for the vertical elevations. The survey locations will be added to the boring logs.

A more detailed description of field procedures for soil sampling using direct push methods (*i.e.*, Geoprobe®) is provided in SOP F-5 (Attachment A). The decontamination procedures are described above.

Landfill Gas Evaluation

Based on experience at other landfills containing similar materials, a passive gas venting system may to be necessary to prevent potential off-site migration from the landfill and to protect the integrity of the landfill cover. Thus, a detailed design for a passive gas venting system will be prepared during the design phase for the 12th Street Landfill. The design for the gas venting system may include features that support a potential future educational nature park. The passive gas venting system will also be designed such that it could be retrofitted to an active gas system if deemed necessary during the operation, monitoring, and maintenance (OM&M) period for the landfill.

To assist in the design for the passive gas venting system, the following scope of field investigations will be performed:

- As accessible, measure the concentrations of methane, carbon dioxide, and oxygen in the existing groundwater monitoring wells at the 12th Street Landfill that are screened in the vadose zone (MW-6A, MW-7A, and MW-8A), and in the Geoprobe® boreholes used to estimate the depth of the paper residuals along the property boundaries.
- As accessible, measure the gauge pressure in the existing groundwater monitoring wells at the 12th Street Landfill that are screened in the vadose zone (MW-6A, MW-7A, and MW-8A).

A passive gas venting system can be designed without the above information. If these data cannot be readily obtained, additional efforts will not be employed to collect this information.

Field procedures for soil gas collection and sampling, and pressure measurements, are provided in SOP F-7 (Attachment A).

Extent and Depth of Residuals Outside the Landfill Footprint

Wetland Area to the North of the Landfill - The approximate areal extent of visible paper residuals beyond the toe of the landfill within the wetland has been defined through previous investigations. This delineation needs to be confirmed at limited locations as part of the predesign studies. In addition, constructability issues associated with a high water table in the wetland and the degree of difficulty in distinguishing the visible paper residuals from the native soil also need to be evaluated. The scope of the investigative work recommended to provide this information is as follows:

- A backhoe will be used to excavate approximately three test pits in the wetland to the north of the landfill to confirm the approximate areal extent of visible paper residuals beyond the toe of the landfill, to evaluate potential constructability issues associated with working in the wetland, and to assess the degree of difficulty in distinguishing the visible paper residuals from the native soil.
- The test pits are anticipated to be approximately 10 to 15 feet long (perpendicular to the edge of the landfill) and approximately 2 to 4 feet wide. The test pits will be excavated to a maximum depth of 3 feet if no paper residuals are apparent, or to the bottom of visually-identifiable residuals. The depth and lateral extent of residuals in each test pit will be documented in the field by preparing a Test Pit Log (refer to Attachment B for a sample log).
- If visible residuals are observed in the end of a test pit furthest from the landfill, the test pit may be extended further away from the landfill and/or an additional test pit (or more) may be excavated nearby in order to confirm the areal extent of the visible residuals contiguous with the landfill within the wetland. If an additional test pit (or more) is needed, the U.S. EPA project manager, or designated alternate, will be contacted to discuss the situation and to agree on a course of action.
- Equipment used to excavate the test pits will be decontaminated following completion of the work. Decontamination will be performed at a decontamination pad constructed on the top of the landfill. Refer to Subsection 6.1.2 of this FSP for additional information regarding the construction of the decontamination pad. Decontamination of equipment between test pits is not necessary because samples are not being collected for laboratory analysis. Clumps and loose material will be removed from the bucket of the excavating equipment using hand tools as needed to

obtain good visual characterization of the material present in the test pits. The clumps and loose material will be placed in the test pits.

- Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on-site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the technical memorandum documenting the findings and conclusions of the Predesign Studies (to be submitted as part of the Design Report).
- In the event that in-field conditions limit use of excavating equipment, other tools, such as hand augers or shovels, may be used instead. In such instances, the U.S. EPA project manager, or designated alternate, will be contacted to discuss the situation and to agree on a course of action.
- In addition, Weyerhaeuser will conduct a kick-off meeting with the U.S. EPA and its field representative(s) at the outset of the predesign field investigation. During this meeting, the schedule for conducting the predesign field activities and the process for obtaining U.S. EPA approval of field modifications will be reviewed.

Asphalt Plant/State Properties - The aerial extent of visible paper residuals on the asphalt plant property to the southwest and on the State property to the southeast need to be delineated and the depth of visible paper residuals needs to be estimated more accurately in order to support discussions with the owners of these adjacent properties concerning access for future removal activities. The scope of the investigative work recommended to provide this information for the asphalt plant/State properties is as follows:

- A backhoe will be used to excavate approximately three test pits on the asphalt plant property and approximately four test pits on the State property.
- The test pits are anticipated to be approximately 10 to 15 feet long (perpendicular to the edge of the landfill) and approximately 2 to 4 feet wide. The test pits will be excavated to a maximum depth of 3 feet if no paper residuals are apparent, or to the bottom of visually-identifiable residuals. The depth and lateral extent of residuals in each test pit will be documented in the field by preparing a Test Pit Log (refer to Attachment B for a sample log).
- If visible residuals are observed in the end of a test pit furthest from the landfill, the test pit may be extended further away from the landfill and/or an additional test pit (or more) may be excavated nearby in order to confirm the areal extent of the visible

residuals contiguous with the landfill within the wetland. If an additional test pit (or more) is needed, the U.S. EPA project manager, or designated alternate, will be contacted to discuss the situation and to agree on a course of action.

- Equipment used to excavate the test pits will be decontaminated following completion of the work. Decontamination will be performed at a decontamination pad constructed on the top of the landfill. Refer to Subsection 6.1.2 of this FSP for additional information regarding the construction of the decontamination pad. Decontamination of equipment between test pits is not necessary because samples are not being collected for laboratory analysis. Clumps and loose material will be removed from the bucket of the excavating equipment using hand tools as needed to obtain good visual characterization of the material present in the test pits. The clumps and loose material will be placed in the test pits.
- Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on-site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the technical memorandum documenting the findings and conclusions of the Predesign Studies (to be submitted as part of the Design Report).
- In the event that in-field conditions limit the use of excavating equipment, other tools, such as hand augers or shovels, may be used instead. In such instances, the U.S. EPA project manager, or designated alternate, will be contacted to discuss the situation and to agree on a course of action.
- In addition, Weyerhaeuser will conduct a kick-off meeting with the U.S. EPA and its field representative(s) at the outset of the predesign field investigation. During this meeting, the schedule for conducting the predesign field activities and the process for obtaining U.S. EPA approval of field modifications will be reviewed.

2.4.2 SAMPLE LOCATIONS

Specific sample locations depend upon the types of samples being collected and on the field conditions. Many sample locations will be established in the field based upon site-specific conditions that impact the ability to collect representative samples and the guidelines in the work plan, QAPP, and this FSP. Available information by sample type is summarized in Table 2-3. Additional details regarding the field program are included in the RD Work Plan (RMT, 2008b).

2.5 OU-7: PHASE 2 OF ADDENDUM NO. 1 PLAINWELL MILL INVESTIGATIONS

In a letter to Weyerhaeuser dated February 19, 2008, the U.S. EPA requested additional work along the former Plainwell Mill banks was requested in response to discovery of elevated concentrations of PCBs and oily soil encountered along the Plainwell Mill banks during the separate Plainwell Mill Banks Emergency Response activities. On July 15, 2008, a Draft Phase 2 Addendum No. 1 to the Plainwell Mill Remedial Investigation/Feasibility Study Work Plan was prepared and provided to U.S. EPA for review. The U.S. EPA provided technical review comments on the Draft Phase 2 Addendum No. 1 in a letter dated July 31, 2008. Subsequently, Weyerhaeuser provided response to comments and a redlined version of the Work Plan Addendum in a letter dated August 8, 2008. This Multi-Area FSP Addendum provides information to update the Multi-Area FSP sample collection and field monitoring methods and procedures for the RI/FS activities at the former Plainwell Mill property.

The following subsections describe sample collection procedures, sample handling methods, and other procedures pertaining to the following general sampling categories:

- Test Pit Sampling
- Photoionization Detector (PID) sampling

SOPs for each type of sampling activity are provided in Attachment A. These SOPs describe or reference ancillary procedures for equipment cleaning, field measurements, and calibration and maintenance of field instruments, as appropriate.

2.5.1 SAMPLE COLLECTION PROCEDURES

Test Pit Investigation

Test pit investigation and sampling will be performed during the RI activities to meet various objectives including:

- To assess the validity of the preliminary site conceptual model.
- To identify the source of elevated PCBs.
- To identify the source of oil material impact soil observed during the emergency removal action activities.

Several data collection methods will be used to achieve these objectives, depending on the purpose and intent of the data, and the DQOs specified in the applicable area-specific work plan and FSP addendum. SOPs for test pit sampling are provided in Attachment A of this document and can be used together or separately as needed to satisfy the goals of data collection. Specific SOPs are provided for:

Test Pit Sampling Procedures (SOP F-8). This SOP will be used for the development of test pits and for collection of soil samples for laboratory analysis. This SOP will be used for test pit samples collected from the Plainwell Mill. It can also be used for the collection of additional test pit samples from other Operable Units, as necessary. This SOP includes the use of standard techniques for excavating a test pit and collecting a sample from the excavated soil. Equipment decontamination procedures are also included. A separate SOP is included for the PID readings that will occur with test pit excavation.

Photoionization Detector (PID) Sampling (SOP F-9). This SOP will be used to screen soil samples in the field and establish a background for PID comparison. PID readings will be used as one of the criteria for identification of samples for additional analysis.

2.5.2 SAMPLE LOCATIONS

Specific sample locations depend upon both the types of samples being collected and field conditions. Many sample locations will be established in the field based upon site-specific conditions that impact the ability to collect representative samples and the guidelines in the work plan, QAPP, and this FSP. Available information by sample type is summarized in Table 2-1. Additional details regarding the sampling program are included in Tables 6 and 7 of the Phase 2 Addendum to the RI Work Plan.

2.6 OU-7: PLAINWELL MILL RI/FS – PHASE I INITIAL GROUNDWATER ASSESSMENT

The Plainwell Mill RI/FS – Phase I Initial Groundwater Assessment includes a collection of shallow groundwater samples to assess the possible presence of floating product and to quantify the concentrations of constituents in shallow groundwater that may have been contributed by suspected or known contamination present on site. The limited existing groundwater data, the generally permeable subsurface sands present along the Kalamazoo River, the site history, and the size and configuration of the Plainwell Mill

property make a phased groundwater investigation especially useful for focusing future data collection activities needed to meet the overall objectives of the required RI/FS.

The following subsections describe sample collection procedures, sample handling methods, and other procedures pertaining to the following general sampling categories:

- Groundwater Sampling
- Staff Gage Installation

SOPs for each type of sampling activity are provided in Attachment A. These SOPs describe or reference ancillary procedures for equipment cleaning, field measurements, and calibration and maintenance of field instruments, as appropriate.

2.6.1 SAMPLE COLLECTION PROCEDURES

Groundwater Assessment

Groundwater well installation and sampling will be performed during RI/FS – Phase I Groundwater Assessment activities to meet various objectives including:

- Determine direction of groundwater flow on the Plainwell Mill Site and relationship with the Kalamazoo River and Mill Race.
- Evaluate the relationship between the elevation of onsite fill and residuals materials and the groundwater table.
- Evaluate potential for groundwater impacts associated with historic site operations.
- Collect sufficient groundwater analytical data for comparison to MDEQ Part 201 Criteria.
- Evaluate groundwater analytical results and refine list of Potential Contaminants of Concern for future sample analysis.

Several data collection methods will be used to achieve these objectives, depending on the purpose and intent of the data, and the DQOs specified in the applicable area-specific work plan and FSP addendum. SOPs for groundwater activities are provided in Attachment A of this document and can be used together or separately as needed to satisfy the goals of data collection. Specific SOPs are provided for:

Groundwater Well Sampling (SOP F-11). This SOP will be used to collect groundwater samples in the field.

Staff Gage Installation (SOP F-10). This SOP will be used for installation and reading of staff gages elevations.

2.6.2 SAMPLE LOCATIONS

Specific sample locations depend upon both the types of samples being collected and field conditions. Sample locations will be established based in the field based upon site-specific conditions that impact the ability to collect representative samples and the guidelines in the work plan, QAPP, and this FSP. Available information by sample type is summarized Table 2-5. Additional details regarding the sampling program will be included in the Phase I RI/FS - Groundwater Sampling Work Plan.

2.7 OU-4: REMEDIAL ACTION FOR THE 12TH STREET LANDFILL

As described in Section 2.4, the 12th Street Landfill is composed primarily of the 6.5-acre closed landfill and the four areas outside the landfill where PCB-contaminated residual material has been observed. The landfill is situated with 17 acres of wetlands on an approximately 24-acre parcel. Additional portions of OU-4 that are located outside the landfill property include the woodland area owned by the State under the management of the MDNR, the asphalt plant operation adjacent to the landfill, and the former powerhouse discharge channel. Contamination in the former powerhouse discharge channel was addressed as part of the Emergency Actions implemented in 2007.

A ROD for OU-4 was issued on September 28, 2001 (see Section 2.4 for a description of the major components of the ROD). In January 2005, Weyerhaeuser negotiated a CD with the U.S. EPA (Civil Action No. 1:05-CV0003) for the design and implementation of certain response actions at OU-4 and the Plainwell, Inc., Mill. These actions include the RD and RA activities for the 12th Street Landfill. The addendum to the Multi-Area QAPP has been prepared in fulfillment of the requirements for the Design Report for the 12th Street Landfill, as described in the CD and the SOW.

The Design Report for the 12th Street Landfill (RMT, 2008) includes a number of data collection activities, some of which are short-term activities to be performed during

implementation of the RA and some of which are long-term activities. Short-term monitoring activities include verification soil sampling, ambient air monitoring for fugitive dust and VOCs, and surface water monitoring. Long-term monitoring activities include landfill gas monitoring and groundwater monitoring.

SOPs for each type of sampling activity are provided in Attachment A. These SOPs describe or reference ancillary procedures for equipment cleaning, field measurements, and calibration of field instruments, as appropriate.

2.7.1 SAMPLE COLLECTION PROCEDURES

Verification Soil Sampling

Upon completion of the excavation activities on the MDNR's property and the asphalt plant property to remove paper residuals, samples of the native soil underlying the excavated paper residuals will be collected and analyzed to confirm the adequacy of the excavation activities. The scope of the verification soil sampling includes the following activities:

- Collect approximately nine soil samples in the excavation on the MDNR's property and approximately 13 samples in the excavation on the asphalt plant property. The soil samples will be collected from approximately 6 inches below the surfaces of the excavation base and sidewalls, and analyzed for PCBs, and for the asphalt plant property, for VOCs. At least one sample will be collected from each sidewall of an excavation. The samples will be collected using a stainless-steel scoop, as described in SOP F-6 (see Attachment A).
- Determine the actual number of soil samples using a systematic random sampling strategy, following the MDEQ's S^{3}TM guidance (see Section 6.1.2 of the Design Report for a detailed discussion). The samples will be submitted to the laboratory for quick-turn analysis, so that the results can be reviewed and the adequacy of the excavation verified before restoring the excavated areas. As necessary, additional excavation, followed by sample collection and analysis, may be performed.
- Prepare samples collected for VOC analysis using the methanol preservation method, as described in MDEQ Procedure for Collection and Methanol Preservation Of Soil Samples for Volatile Organics May 1, 2000. (Attachment C)
- Collect QC samples, including one equipment rinsate blank and one field duplicate soil sample from each excavation (*i.e.*, one on the MDNR's property and one on the

asphalt plant property). Submit the QC samples for analysis of the same parameters as the field samples.

- Prepare a Sample Log (refer to Attachment B for a sample log form) for each sample. Describe the soil samples in the field using the Unified Soil Classification System. The logs will document the sample identification number, the sampling dates and times, the names of field personnel, soil descriptions, and sample depths. As may be appropriate, photographs of the materials encountered or other pertinent observations will be documented. Photographs will be labeled to indicate the subject, location, date, name of photographer, and project identification number.
- Perform decontamination, and manage investigation-derived waste in accordance with Sections 6.1.4 and 6.2.5.

Ambient Air Monitoring for Fugitive Dust

During implementation of the RA, preventive measures will be used to control fugitive dust, including watering frequently traveled unpaved roads and soil, and working surfaces on an as-needed basis. In addition, real-time ambient particulate measurements will be conducted. The general scope of the fugitive dust monitoring includes the following activities:

- Conduct real-time ambient particulate measurements at locations that are downwind of activities that have the potential to create fugitive dust, including the following activities: construction equipment traveling over unpaved surfaces, the unloading of soil, grading activities, cover placement, and other construction activities, as determined by visual observation and best professional judgment.
- During these activities, collect real-time ambient particulate measurements at three to four locations on the landfill property line with an MIE, Inc., Miniram monitor or equivalent, three times each day (*i.e.*, a total of 9 to 12 measurements per day). Each measurement will be taken at a different downwind location, unless elevated readings are measured at a particular location. In this case, readings may be repeated at this location during the day. If applicable, locations in which visible dust is evident will be preferentially selected for monitoring.
- The measurements will be taken in accordance with the active air sampling procedure described in SOP F-12 (see Attachment A). A total of three values will be recorded each time a location is monitored, with the average of the three values being used for comparison with the standards.

Ambient Air Monitoring for VOCs

During implementation of the RA, ambient air monitoring will be performed for VOCs. The general scope of the ambient VOC monitoring includes the following activities:

- Collect VOC measurements with a PID during work at the landfill in which paper residuals will be exposed. The measurements will be taken in accordance with SOP F-9 (see Attachment A).

Surface Water Monitoring

As part of the RA, additional riprap will be placed north of the existing riprap for added protection. During the placement of the riprap, surface water monitoring using a turbidity meter will be performed. The general scope of the surface water monitoring will include the following activities:

- Collect surface water samples at two locations, including an upstream location and a downstream location, at the following times:
  - prior to placement of any equipment or materials in a work area
  - every other hour during the installation of the riprap along the channels edge
  - whenever field conditions warrant additional samples
- Collect turbidity measurements using a hand-held turbidity meter, as described in SOP-F14 (see Attachment A).
- If the turbidity reading at the downstream location is greater than two times the result for the upstream location and exceeds 15 NTUs, work will be suspended until it can be determined what is causing the increased turbidity and the situation is rectified.

Landfill Gas Monitoring

As part of the RA, landfill gas probes will be installed and monitored on the southern side of the property, along the MDNR's property, and along the asphalt plant property. Landfill gas vents will also be installed and monitored in the landfill cover. The general scope of the landfill gas monitoring includes the following activities:

- Install six gas probes at locations spaced approximately 250 feet apart.
- Monitor the gas in the probes for combustible gas, carbon dioxide and oxygen concentrations (as a percent by volume), using a portable combustible gas meter.

Pressure will also be measured at the gas probes. The samples will be collected and analyzed in accordance with SOP F-7 (see Attachment A). The results of the gas monitoring will be evaluated in accordance with Section 3.4 of the PSVP (RMT, 2008d).

- Assess nuisance odors at the property line concurrent with the monitoring of the gas probes, If nuisance odors are detected, then contingency actions will be taken as described in Section 3.4.2 of the PSVP (RMT, 2008d).

Groundwater Monitoring

As part of the RA activities, groundwater monitoring wells will be installed and monitored on the upgradient and downgradient edges of the landfill. The general scope of the groundwater monitoring activities includes the following:

- Install a total of nine shallow groundwater monitoring wells, including two shallow monitoring wells along the upgradient edge of the landfill and seven shallow monitoring wells along the downgradient edges of the landfill. In addition, install a total of three deep groundwater monitoring wells, including one deep monitoring well on the upgradient edge of the landfill and two deep monitoring wells on the downgradient edges of the landfill. The wells will be constructed and developed in accordance with the procedures described in the groundwater monitoring plan (Section 4.4 of the PSVP [RMT, 2008]).
- For at least the first 2 years of monitoring, collect groundwater samples on a quarterly basis from the seven shallow monitoring wells along the downgradient edges of the landfill. During each round of monitoring, the groundwater samples will be analyzed for PCBs, VOCs on the Target Compound List (TCL) for organics, mercury, cyanide, magnesium, and sodium. The samples will be analyzed for additional parameters on a semiannual basis, including semivolatile organic compounds (SVOCs) on the TCL for organics, the remaining metals on the Target Analyte List (TAL) for inorganics, and dioxins. Field parameters will be measured in the groundwater monitoring wells, including groundwater levels, turbidity, temperature, pH, and conductivity. The groundwater samples will be collected in accordance with SOP F-11 (see Attachment A).
- Measure water levels in the two shallow monitoring wells along the upgradient edge of the landfill and in the three deep monitoring wells.
- Measure surface water levels at a staff gauge in the Kalamazoo River.
- Perform decontamination, and manage investigation-derived waste in accordance with Sections 6.1.3 and 6.2.3.

- After the first 2 years of groundwater monitoring, Weyerhaeuser may petition the U.S. EPA to reduce the monitoring frequency, as described in Section 4.8 of the PSVP (RMT, 2008).

2.7.2 SAMPLE LOCATIONS

Specific sample locations depend on the types of samples being collected and on the field conditions. Many sample locations will be established in the field (*i.e.*, soil samples, ambient air samples, and surface water samples), based on site-specific conditions that impact the ability to collect representative samples and the guidelines in the Design Report, QAPP, and this FSP. The locations of the groundwater monitoring wells and the landfill gas probes and vents are shown on Figure 2-1. Available information by sample type is summarized in Table 2-6.

2.8 OU-4: REMEDIAL ACTION WORK PLAN FOR THE 12TH STREET LANDFILL

The scope of the RA for the 12th Street Landfill includes excavation of paper residuals present outside the footprint of the landfill (on adjacent properties), landfill grading, the construction of a landfill cover and erosion protection measures, and surface water management, landfill gas management, construction of access road, abandonment of existing groundwater monitoring wells, installation of groundwater monitoring wells, and various environmental monitoring activities.

2.8.1 EXCAVATION ACTIVITIES

The areal limits of visible paper residuals outside the footprint of the landfill on the MDNR property, the asphalt plant property, and in the wetlands were previously delineated based on information obtained by Geraghty and Miller and the U.S. EPA in 1994 and 2003, respectively (G&M, 1994b and U.S. EPA, 2004), and have been refined based on the findings of the predesign investigation performed by Weyerhaeuser in 2008. Sufficient information is available from previous investigations to implement the excavation activities. Upon completion of the excavation activities on the MDNR property and the asphalt plant property to the visual extent of the distinguishable paper residuals, samples of the native soil underlying the excavated paper residuals at the base of the excavation will be collected and analyzed to confirm the adequacy of the

excavation activities. Collected soil samples will be analyzed for PCBs. In addition samples collected from asphalt plant property will be analyzed for VOCs.

This verification sampling will be used to demonstrate completion with the Michigan Part 201 GRCC pursuant to the MDEQ's Sampling Strategies and Statistics Training Materials for Part 201 Cleanup Criteria (STM; MDEQ, 2002).

2.9 OU-7: PLAINWELL MILL PHASE II RI WORK PLAN

Weyerhaeuser provided the U.S. EPA with a Phase II RI Work Plan for the Plainwell Mill on September 23, 2009. A formal notification from the U.S. EPA to proceed with implementation of the Work Plan has not been received yet.

The Phase II RI Work Plan investigation was developed to meet the following objectives:

- Perform a supplemental groundwater investigation, developed based on the results of the Phase I RI groundwater investigation and review of historical data to further evaluate the nature and extent of impacts to groundwater and their potential sources;
- Further assess shallow, site-specific hydrogeologic characteristics and interconnections with the Kalamazoo River;
- Perform soil investigations in the former wastewater sludge and dewatering lagoon and aeration basin area, the area of the mill buildings, and the north central portion of the Plainwell Mill, to adequately characterize the nature and extent of impacts to soil in the unsaturated zone that may have occurred due to historical operations; and
- Perform surface water sampling to determine the characteristics of the Kalamazoo River and Mill Race for comparison to the MDEQ criteria.

2.9.1 SAMPLE COLLECTION PROCEDURES

To facilitate the evaluation of the historical information, Plainwell Mill Site has been divided into three areas based on their locations and noted historical environmental impacts. The three areas are the former wastewater sludge dewatering lagoons and aeration basin (Area 1), mill buildings area (Area 2), and north central portion area of the Plainwell Mill Site (Area 3).

Table 2-7 provides a tabular descriptions of the sample types, sample locations, and required analysis as described in the following sections.

SOPs for the field activities are provided in Appendix A. The following summarizes the field activities proposed in the Phase II RI Work Plan and the associated SOP Section/Subsection corresponding to each activity.

Soil Sampling

Soil borings will be advanced to predetermined depths as described in Table 2-7 and in accordance with SOP F-5 provided in Appendix A.

To satisfy the needs for a comprehensive soil characterization program to fill the data gaps and confirm the historical exceedances at Plainwell Mill, three soil sampling programs have been developed based on the historical operations at the Site and available information for the purpose of proceeding with the proposed Phase II RI Work Plan sampling activities at the Plainwell Mill. These programs will be referred to during the descriptions of scope of investigatory activities at the Site.

Upon advancement of soil borings, soil cores will be examined for presence of visual and/or olfactory evidence of impact, and will be screened across their entire length using a PID to determine relative concentrations of undifferentiated volatile organic vapors. At each soil boring, soil samples will be collected on a continuous basis (i.e., 2 feet intervals) as described in SOP F-5 and Vertical Aquifer Sampling (VAS) in SOP F-17.

Test Pits
Test pits will be 5 to 10 feet in length and will be completed in accordance with the SOP F-8.

Surface Soil Samples
Surficial soil samples will be collected to determine the quality of surficial soils across the Site. Soil samples will be collected from 0 to 1 foot bgs at locations described in Table 2-7. If non-soil materials are present (i.e., gravel fill or concrete slabs) the soil sample will be collected from 0 to 1 foot below the non-soil material.

Soil Samples collected for VOCs analysis Procedures

To ensure that soil samples collected for VOCs are preserved prior to selection of samples for laboratory analysis, the following process will be completed:

- The 0 to 1 foot soil sample interval (surface sample collected as noted above) will be preserved.
- Sample intervals below the 0 to 1 foot interval will be preserved if the material is non-native and the PID reads are greater then 5 parts per million (ppm). For example, all samples of the fill material will be collected if there is field evidence of VOC impact.
- The first sample below the interface of non-native/native material will be preserved.
- The non-native material samples will not be preserved unless there is field evidence of impacts (i.e., PID, visual, olfactory, etc.).

To aid in the screening of soil quality across the Site, the following sampling programs have been selected for the completion of the RI.

Sampling Program 1:

- One surficial soil sample will be collected at the locations indicted in Table 2-7. One biased soil sample will be collected from what has been deemed fill material from a depth of 2 to 10 feet bgs based on field screening. If no impacts are noted, one soil sample will be collected from 0 to 2 feet above the interface between the fill and native material within the vadose zone.
- One soil sample from 0 to 2 feet below the observed impact will be collected. If no impact is observed the soil sample will be collected from 0 to 2 feet below the interface of the fill/ native material within the vadose zone.
- One soil sample will be collected from the vadose zone, 0 to 2 feet above the saturated zone.

Sampling Program 2:

- One surficial soil sample will be collected at the locations indicted in Table 2-7.
- If no impact noted, a discrete soil sample will be collected from 0 to 2 feet above the interface of the vadose and saturated zone. If impact noted one soil sample will be collected within 2 to 10 feet bgs and a third sample collected from 0 to 2 feet above the interface of vadose and saturated zone.

Sampling Program 3:

- One surficial soil sample will be collected.
- One soil sample will be collected from the fill material which is expected to be encountered at approximate depths of 2 to 10 feet bgs based on field screening methods. Soil borings not exhibiting any evidence of impact will be sampled at 0 to 2 feet above the interface of fill/native material within vadose zone.
- One soil sample will be collected from 0 to 2 feet below the observed contamination. If no evidence of impact is observed the soil sample will be collected from 0 to 2 feet below the interface of fill/native material within vadose zone.
- One soil sample will be collected from vadose zone at 0 to 2 feet above the saturated zone.

Soil samples will be collected at predetermined intervals based on specific data needs. The samples will be classified in accordance with the Unified Soil Classification System (USCS), and field logs will be prepared (SOP F-5).

Groundwater Monitoring Program

Monitoring well purging and groundwater sampling will be performed in accordance to SOP F-11. Groundwater samples will be collected at the locations presented in Table 2-7 and the Phase II Work Plan.

Vertical Aquifer Sampling

The VAS technique will be used to obtain samples from various depths within the aquifer to profile of the potential contaminant distribution. VAS samples will be collected as per SOP F-17.

Surface Water Sampling

Surface water samples will be collected form the Kalamazoo River and Mill Race at approximate location presented on Figure 2-3. Surface water will be collected in accordance with SOP F-16.

2.9.2 REMEDIAL INVESTIGATION ACTIVITIES

The following paragraphs provide a general scope of investigation that has been developed to determine the potential impacts associated with historical activities and provide a complete assessment of the Plainwell Mill Site. As outlined in the Phase II RI Work Plan, surface samples will collected as indicated in Table 2-7.

Inspection of On-Site Buildings

There are several buildings and structures currently present at the Site, including the mill building (Area 2), Former Quality Products and Sludge Dewatering Buildings (Area 3A), and Former Specialty Minerals Inc. Building (Area 3B). Limited information regarding historical land use and operations of these buildings are available. Therefore, additional investigations may be warranted based on initial inspections of the buildings for present of any visual or olfactory evidence of impact which will be conducted during the field activities at the Plainwell Mill Site.

Area 1: Former Wastewater Sludge Dewatering Lagoons and Aeration Basin Area

The proposed sampling and analysis plan for Area 1 is presented in Table 2-7 with proposed sample locations identified on Figure 2-2a and 2-2b. The rationale for the sampling approach for Area 1 is outlined below.

Soil Investigation

The following sampling activities will be conducted to address data gaps identified in the Phase II RI Work Plan and further details including the location of surface samples including depths of soil borings, are presented in Table 2-7:

- Investigation of the identified lagoon areas is proposed to confirm the depth and extent of potential contamination. Installation of two soil borings one at each of the assumed peripheral ends of the former lagoons is proposed. The location of the deep soil borings would be based on field identification to assess physical constraints and previous investigations. An additional soil boring within Lagoon J will be installed to confirm the depth of paper waste in this lagoon area. Soil sampling will be conducted as per Sampling Program 1;

- Confirmation of exceedances noted during historical investigations and further delineation of soil chemistry from across the lagoon area as needed to meet the objectives of the RI. Sampling will be focused on the 0 to 1 foot bgs interval to determine any direct exposure hazards to the public in relation to potential construction activities relating to the redevelopment of the Site;
- Investigation of any potential impacts associated with the aeration basin will be completed as per Sampling Program 1;
- Investigation of potential impacts in the areas adjacent to the lagoons, and aeration basin will be completed as per Sampling Program 1;
- Confirm the extent of the lagoons and, if any, impacts associated with the surrounding soils resulting from migration of contaminants toward the Kalamazoo River will be completed as per Sampling Program 1;
- Determination of potential historical morphing of the lagoon areas will be completed as per Sampling Program 1;
- Investigation of potential impacts associated with the former secondary clarifier. Sampling will be completed as per Sampling Program 1;
- Collection of soil samples as per Sampling Program 1 will occur during installation of MW-13, MW-14 and MW-15;
- Collection of soil samples as per Sampling Program 2 will be conducted in the wooded area as indicated on Table 2-7; and
- Collection of five samples to determine the soil physical properties for risk assessment purposes.

Groundwater Investigation

The following sampling activities will be conducted to address data gaps identified in the Phase II RI Work Plan:

- Installation of one monitoring well (i.e., MW-13) screened within the paper waste to determine contaminate concentrations of the waste for comparison to the Site's analytical data;
- Re-installation of SGWB-2 (i.e., MW-14) located south west of the lagoon areas to characterize groundwater flow direction through this area and provide an upgradient monitoring well location for the lagoon area;
- Installation of a monitoring well north of the former secondary clarifier (i.e., MW-15) to determine any potential groundwater impacts related to prior discharges;

- Completion of VAS at location MW-13 within Lagoon J. This area was selected to characterize the groundwater above, within and below the residual paper waste location in this former lagoon area. As indicated in historical borehole logs, residual paper waste has been noted. Further, this location will provide information related to the depth of potential confining layers within the native soil beneath the paper waste; and
- Sampling of current monitoring wells (i.e., MW-8, MW-9, MW-10, MW-11 and MW-12) and the three new monitoring wells (i.e., MW-13, MW-14, and MW-15) to determine and confirm groundwater impacts.

Area 2: Mill Buildings Area

The soil and groundwater locations in Area 2 are presented on Figure 2-3.

Soil Investigation

The following sampling activities will be conducted to address data gaps identified for this area as presented in the Phase II RI Work Plan including the location of surface samples. Further details, including depths of soil borings are presented in Table 2-7:

- Confirmation and vertical delineation of potential contamination in the area of TP-17 and TP-18 surrounding the historical transformer pad located in the north east portion of the Site adjacent to the Kalamazoo River. Sampling will be conducted as per Sampling Program 1. Collection of one surface sample from each location will be completed.
- Visual inspection of outflow points identified during previous investigations along the Kalamazoo River to ensure capping was conducted properly and no further issues pertain to these outflows. Surface sampling may be conducted if any visual evidence of impact is noted.
- Visual inspection of the surface soils surrounding the mill buildings to determine if any staining is present in relation to historical Site activities. Surface soil sampling may be conducted if necessary.
- Installation of one soil boring (i.e., MW-16) adjacent to the Mill Race to determine soil conditions adjacent to the mill buildings. Samples will be collected as per Sampling Program 1.
- Installation of one soil boring (i.e., MW-17) in the southern corner of the parking lot area adjacent to the Mill Race for visual inspection. Samples will be collected as per Sampling Program 2.

- Completion of three test pits within the undeveloped south parking lot and former background location BK5 to confirm the presence of fill below the parking lot areas and determine impacts associated with historical activities. Sampling will be conducted as per Sampling Program 2 including the collection of surface samples at each location.
- Collection of samples to determine the soil physical properties for risk assessment purposes.

Groundwater Investigation

The following sampling activities will be conducted to address data gaps identified in the Phase II RI Work Plan for this area.

- Installation of a monitoring well (i.e., MW-16) adjacent to the mill buildings near the end of the Mill Race to further define the groundwater flow patterns at this area.
- Installation of one monitoring well (i.e., MW-17) in the southeast portion of the Site to determine influences of the Mill Race on the water levels at the southern property boundary in relation to water levels at SG-1.
- VAS will occur adjacent to MW-4. This location is within the proximity of the Kalamazoo River and downgradient of the mill buildings. Historical impacts have been noted at this location; therefore, sampling will determine the depth of impact within this area and identify potential confining layers along the Kalamazoo River and capturing any residual impacts downgradient of the mill buildings.
- Collection of groundwater samples from previously installed monitoring wells (i.e., MW-1, MW-2, MW-3, MW-4, and MW-5) and the newly installed monitoring wells (i.e., MW-16 and MW-17) to confirm the groundwater chemistry at the Site.

Surface Water Investigation

Sampling within the Mill Race and the Kalamazoo River will be conducted to collect analytical data necessary for use of the applicable Part 201 GSI screening criteria (i.e., collection of hardness data). Sampling will also be conducted for low-level mercury, and methyl mercury to determine levels within the two adjacent water bodies for completion of the RI report. Further, surface water levels will be measured to further understand the hydrogeologic conditions on-Site.

Area 3: North Central Portion Area

The soil and groundwater locations in Area 3 are presented on Figure 2-4.

Soil investigation:

The following sampling activities will be conducted to address data gaps identified for this area as presented in the Phase II RI Work Plan including the location of surface samples. Further details, including depths of soil borings are presented in Table 2-7:

- Test pitting at seven locations will be carried out within the undeveloped areas to confirm the presence of fill materials beneath the parking lot areas. Sampling will be conducted as per Sampling Program 2.
- Eight Test pits (i.e., TP-308 through TP-315) will be excavated to depths of approximately 10 feet bgs to further identify the potential subsurface coal contamination within this area, to determine the locations/depths of potentially contaminated soils, and to confirm soil quality. Soil sampling will be conducted in accordance with Sampling Program 2.
- Three soil borings (i.e., SB-301, SB-302, and SB-321) will be advanced in the northern portion of the Area 3 to confirm the historical exceedances (i.e., DG3, DG4, and SGWB-10) observed at this portion of the Site. Soil sampling activities at this locations will be completed in accordance with Sampling Program 1.
- Five soil borings (i.e., SB-303 through SB-307) will be advanced at the proximity of No. 6 Fuel Tank Area to characterize potential sources of impact. Soil samples will be collected in accordance with Sampling Program 3.
- Five soil borings (i.e., SB-308 through SB-312) around the perimeter of the former Coal Storage Tunnel will be advanced to characterize potential sources of contamination around the fuel oil lines and to determine potential soil impacts at depths below the bottom of the tunnel, based on the results of the Phase I RI. Soil sampling will be conducted in accordance with Sampling Program 2.
- Soil samples will be collected during installation of MW-18 and MW-19 in accordance with Sampling Programs 1 and 2, respectively.

Groundwater Investigation

- Re-installation of SGWB-10 to confirm groundwater exceedances previously noted (i.e., MW-18).
- Installation of one monitoring well (i.e., MW-19) to replace SGWA-5 for confirmation of previous groundwater impacts noted at No. 6 Fuel Tank Area.
- Collection of groundwater samples from existing monitoring wells (i.e., MW-2, MW-6, and MW-7) and the new monitoring well (i.e., MW-18 and MW-19) as part of the proposed Site-wide groundwater monitoring program to confirm the groundwater chemistry at the Site.

3.0 SAMPLE DESIGNATION, CONTROL, AND FIELD RECORDS

3.1 SAMPLE DESIGNATION

Samples will be assigned unique identification designations and will be labeled as follow:

[sample matrix]–[job number]–[sampler's initial]–[date (dd/mm/yy)]–[sample number]
e.g., GW-56393-GC-110609-001

- Sample matrix is a letter which designates a group of samples. This will designate sample type (e.g., sediment, soil, groundwater, surface water, air, etc.), or sample source. For example, "GW" means samples of groundwater, "SW" means samples of surface water, "SO" means samples of soil, etc. Letters should be used, not numbers.
- Job number together with the sample matrix, will allow easier tracking of samples.
- Sampler's initials will allow identification of the sampler, and so allow all project personnel to contact the correct person for information regarding that sample and its collection. The use of three initials is requested. Special arrangements will need to be made if two individuals have the same initials.
- Sample date will allow monitoring of actual holding time of samples and should ensure that all sample numbers are unique, even if sample location designation is used in a system, as opposed to assigned at random.
- Sample identification designation will identify the sample, and can be any numerical or letter designation.

QA/QC samples will be assigned unique identification designations (e.g., TB-56393-GC-110609-001) and will be labeled as described above. QA/QC sampling will be conducted as outlined in the Multi-Area QAPP.

Sample matrixes are provided in Section 3.1.2. MS/MSDs and filed duplicate samples will be labeled as discussed above and will be assigned unique identification designation. Sample information including sample type (e.g., field duplicate, MS/MSDs) and sample location/depth will be documented in Site specific, serially numbered bound field notebooks and the Field Sample Key (FSK). An example of FSK is provided in Appendix B.

Assignment of sampling numbering will be determined prior to initiation of field activities.

3.1.2 SAMPLE MATRIX

The second portion of each alpha-numeric sample descriptor will be a two-letter alphabetical code that describes the sample matrix. Matrix codes for the investigation are as follows:

- "SD" for sediment
- "SW" for surface water
- "SO" for soil
- "EW" for effluent water from treatment system
- "FB" for field blanks
- "TB" for trip blanks
- "FD" for blind field duplicate samples
- "EB" for equipment blank
- "GW" for groundwater samples
- "VAS" for vertical aquifer sampling

3.2 SAMPLE CONTAINERS AND PRESERVATION

The sample containers, preservation and handling procedures will follow the standard analytical requirements as described in the QAPP and collection procedures described in the SOPs. The analytical laboratory will supply the appropriate containers for sample collection and preservation. The field personnel is responsible for proper collection, labeling, recording and preservation (*i.e.*, on ice) of samples. Sample containers will be labeled in accordance will the sample designation described in Section 3.1.

3.3 CHAIN-OF-CUSTODY PROCEDURES

The sampler is responsible for sample custody from the time of sample collection to receipt at the laboratory or until samples are shipped by commercial carrier. A sample is considered under custody if one of the following conditions apply:

- The sample is in a person's possession.
- The sample is in that person's view after being in his or her possession.
- The sample was in that person's possession and then placed in a secured location.
- The sample is in a designated secure area.

Sets of sample containers that are shipped together will be assigned a Chain-of-Custody Record, which will travel with the sample containers. A copy of the Chain-of-Custody Record with its assigned sample numbers will be kept in the laboratory to help identify samples that might become separated from the discrete sample delivery group. When shipped by a commercial carrier, custody seals will be attached to each cooler to ensure that tampering with the samples does not occur in transit, and the shipment airbill will be kept as Chain-of-Custody documentation.

3.4 PACKING

When possible, sample container preparation and packing for shipment should be completed in a well organized and clean area, free of any potential cross-contaminants. Unless weather conditions do not permit it, sample containers should never be prepared for shipment in the field office trailer due to the risk of breakage and area/personnel exposure.

Sample containers should be prepared for shipment as follows:

1. Containers should be wiped clean of all debris/water using paper towels (paper towels must be disposed of with other contaminated materials).
2. Clear, wide packing tape should be placed over the sample label for protection.

The following packing guidelines will be followed:

1. Adequate time to pack the samples will be plan in advance (and make delivery to shipper if applicable). Always more coolers and more padding is desirable rather than crowd samples.
2. Container should not be bulk packed. Each sample must be individually padded.
3. Large glass containers (1 liter and up) require much more space between containers.
4. Ice is not a packing material due to the reduction in volume when it melts.

The following is a list of standard guidelines which must be followed when packing samples for shipment:

1. When using ice for a cooling media, ice will be double bagged in zip-lock bags.

2. The packed cooler will be double checked to ensure trip and temperature blanks have been included for all shipments containing VOCs, or where otherwise specified in the QAPP or Work Plan.
3. The chain-of-custody form will be placed in a zip-lock bag.
4. Custody seals (two, minimum) are placed on each cooler. Coolers with hinged lids should have both seals placed on the opening edge of the lid. Coolers with "free" lids should have seals placed on opposite diagonal corners of the lid. Place clear tape over custody seals.
5. "Hazardous Material" stickers/markings should be removed from coolers being used which previously contained such materials.

3.5 FIELD RECORDS

This section of the FSP describes requirements and procedures for documentation of field activities. It is essential that all field documentation provide a clear, unbiased description of field activities. Examples of all of the forms mentioned in this FSP are included in Attachment B.

3.5.1 DAILY LOG

Serially numbered, bound field notebooks will be used on work assignments requiring field activities. Daily field activities will be recorded in the bound field notebooks. In addition, several sample collection notebooks will contain bound sample collection forms, including soil boring logs, monitoring well construction diagrams, monitoring well development forms, groundwater sampling summary forms, and groundwater and surface water level measurement forms. Representative forms are provided in Attachment B. The Field QA Officer will be responsible for issuing field notebooks. A record will be maintained by the OSC documenting the assignment of field notebooks. The OSC will distribute and track bound and numbered field notebooks. Transfers of field notebooks to other individuals (including subcontractors) who have been designated to document specific tasks on the project will be recorded. No field notes may be destroyed or discarded, even if they are illegible, or known to contain inaccuracies.

Entries into field notebooks will be legibly written and will provide a clear record of field activities. Entries will be made in waterproof ink and in language that is objective, factual, and free of personal opinions or terminology that might later prove unclear or

ambiguous. Errors in the field notes will be indicated by drawing a single line through the text, such that the text in error remains legible. Errors addressed in this manner will be initialed and dated by the person making the correction. The person taking notes in the field notebook will sign, number, and date each page and will document the date, time, location on site, name of field personnel present, and weather conditions observed. Specific sample collection methods will be included in the field notes.

Field personnel responsible for taking notes will log photographs in the field notebook. Locations of the photographs will be referenced to a site sketch or map. Use of measurements and readings from on-site health and safety equipment will be recorded. Observed potential hazards to health and safety will be described. The level of protection and the decontamination procedure used will be documented.

3.5.2 SOIL BORING LOGS

Soil borings completed by the field team will be documented in a Soil Boring Log. The log will document the drilling locations, drilling dates and times, names of drilling personnel and logging personnel, soil descriptions, sample depths, and recovery.

3.5.3 SOIL SAMPLE LOGS

Soil samples collected by the field team will be documented in a Soil Sample Log. The log documents the sample identifiers; soil types; sampling times, depth and location of each sample; sampling equipment used; color, odor, and appearance of the samples; sample parameters; container descriptions; sample preservatives; and names of sampling personnel.

3.5.4 WATER SAMPLE LOG

All surface water and/or groundwater samples collected by the field team will be documented in a Water Sample Log. The log will document the sample identifiers, replicate identifiers, if any; purging (groundwater) and sampling times and locations; sampling equipment; color, odor, and appearance; sample container descriptions; sample preservatives; and sampling personnel.

3.5.5 SEDIMENT SAMPLE LOG

All sediment samples collected by the field team will be documented in the Sediment Sample Log. The log will document the sample identifiers, replicates, sample times, date and location. In addition, sediment appearance, type color, odor etc, will be described. Sample containers, preservatives and sampling personnel will be recorded in the Sediment Sample Log.

3.5.6 CHAIN-OF-CUSTODY RECORD

The Chain-of-Custody (COC) Record is a multi-copy record, which documents the custody of the samples from sample collection through laboratory analysis. The record includes spaces for signatures of those receiving and relinquishing the samples. The sampler, the individual preparing the samples for shipment, and the individual receiving the samples at the laboratory normally sign the record.

The field personnel collecting the sample will fill out the COC Records. The COC process will be initiated upon sample collection. The field person who signs the record will be responsible for the samples until they are transferred to the custody of the laboratory or another custodian. Once the record has been completed, all remaining field sample identification spaces will be crossed through to prevent unauthorized addition of sample information.

The information required on the COC Record includes the complete sample identifier, date and time of sample collection; number of sample containers; analyses and methods required; container type; project number; name of sample collection personnel; complete name, address, and telephone number of the person who will receive analytical reports; turnaround time; and signatures of all sample custodians, excluding shippers. In addition, the method of shipment, and the courier's name and air bill number must be included. The back copy of the record will be retained. The original record will accompany the sample shipment to the laboratory.

3.6 PHOTOGRAPHS

As discussed in Subsection 3.4.1, photographs taken in the field will be documented in the field notebook at the time the photograph is taken. Locations of photographs will be referenced to a site sketch or map. After the film is developed or the images are

uploaded onto a computer, the photographs will be labeled with the following information:

- Project identification number
- Date
- Location
- Direction viewed in photograph
- Roll number (if applicable)
- Frame number
- Sample number (if appropriate)
- Initials of the photographer

4.0 SAMPLE HANDLING AND ANALYSIS

This section presents general sample handling and analysis protocols. Additional detailed information is contained in the QAPP.

4.1 SAMPLE CONTAINERS AND SHIPPING

A table summarizing the sample containers, preservation methods, and holding times for solid and liquid samples, which are collected under this Multi-Area FSP and intended for chemical analyses, is provided in Worksheet #19 in the Multi-Area QAPP. These sample containers, preservation methods, and holding times meet the U.S. EPA and Michigan Department of Environmental Quality (MDEQ) standards. For samples intended for VOC analysis, the sample containers will be filled completely to minimize airspace. Sample containers for other analytical group analyses will be filled to nearly full to avoid overtopping and loss of preservative (if applicable), and to meet the minimum sample volume/mass required by the laboratory (see Worksheet #19 in the Multi-Area QAPP). Soil samples intended only for physical testing (*e.g.*, grain size) will be placed in clean glass jars (minimum 8-oz. volume).

From the time the samples are collected and labeled until delivery to the laboratory, samples will be kept in a dark or otherwise lower temperature location, on ice and within a hard plastic ice chest or cooler that has a white interior. For delivery of samples to the laboratory, the following procedure will be implemented:

1. Collect and preserve the samples as outlined in the FSP and QAPP.
2. Place sample containers in a laboratory shipping container(s). Samples will be packed securely with packing material to protect sample containers from accidental breakage during shipment and to prevent leaks or spills.
3. Fill shipping container with enough ice to last the trip. Double-bag the ice to ensure sample integrity. Dry ice and/or blue ice (ice packs) will not be used.
4. Complete the Chain-of-Custody Record as described in Subsections 3.3 and 3.5.6 and in the QAPP.
5. Tape the Chain-of-Custody Record to the inside of the shipping container lid.
6. Seal shipping container with strapping tape, and place a custody seal (provided by the laboratory) on the shipping container prior to shipping.
7. Deliver or ship the container to the laboratory using an overnight shipping service.

Responsibility for proper use of containers and preservatives will be under the oversight of the OSC.

4.2 SELECTION OF PARAMETERS

The number and location of the samples to be collected and the selection of parameters to be analyzed are summarized in Tables 2-1 through 2-4 and in Worksheets Nos.17-1 through 17-6, and, 18-1 through 18-4in the Multi-Area QAPP.

4.3 ANALYTICAL PROCEDURES

The selection of analytical procedures reflect the U.S. EPA-approved methodology from the SW-846 Methods and MDEQ-approved methodology under the Michigan Part 201 Program, where applicable, as stated in the QAPP. Other methods designed to meet project-specific objectives are also defined in the QAPP. A list of the analytical procedures is provided in Worksheet #23 in the Multi-Area QAPP.

4.4 SAMPLING QUALITY ASSURANCE PROCEDURES

The sample collection procedures presented in this FSP are designed to provide samples of the required quality to meet site investigation objectives. All field personnel will be required to understand the requirements of this FSP and will be trained in the use of the specified equipment and techniques.

The CRA Field QA Officer is responsible for reviewing the day-to-day activities to ensure that the procedures in the FSP are followed. Specific activities that will be implemented by the Filed QA Officer include the following:

- Convene a meeting of field personnel at the start of a specific sampling event to review the sampling requirements of the FSP, the necessary equipment and decontamination requirements and use, and the required documentation.
- Review all documentation on a daily basis for completeness, errors, problems, and corrective actions taken.

- Convene daily project team meetings at the start of the day to discuss health and safety, to address any problems developed during the previous day's work, and to review the work to be completed that day.
- Manage the implementation of in-field corrective actions. The CRA Project Manager will be notified of significant problems and, if necessary, will work with the Field QA Officer to develop corrective actions. The Project Manager will be responsible for implementing corrective actions that need to be applied to areas other than field activities.

4.4.1 FIELD MEASUREMENTS

The equipment used for in-field measurement will be maintained, calibrated, and operated in the field in accordance with the procedures described in the select SOPs in Attachment A. Field calibration of equipment is described within the QAPP Worksheet #22. The process will be documented, and the Field QA Officer will periodically review the documentation and inspect the equipment to ensure that the procedures are followed by the personnel collecting the samples. Significant deviations from the FSP, errors, equipment failures, or other problems will be documented in a bound notebook by the Field QA Officer and reported to the CRA Project Manager. Corrective actions and additional notifications will be coordinated by the Project Manager.

4.4.2 SAMPLE COLLECTION

Personnel involved in the collection of samples are required to read, understand, and follow the procedures specified in this FSP. Problems that may affect the quality of the sampling effort will be documented by the field personnel most directly involved with the problem, and the Field QA Officer will be notified. The Field QA Officer is responsible for coordinating the development and implementation of corrective actions with the CRA Project Manager.

4.4.3 FIELD DATA REDUCTION

Raw data from field measurements and sample collection activities will be recorded in the field logs as specified in Section 3.5. With the exception of the temperature correction for specific conductance, no calculation will be required in field data

reduction. Only direct-reading instrumentation will be employed in the field. The Field QA Officer will proofread all forms and notebooks to for consistency with the planned activities and to also determine if transcription errors have been made by the field crew.

4.4.4 ANALYTICAL QUALITY ASSURANCE CONSIDERATIONS

Field Duplicates

Blind field duplicate samples, prepared by splitting a single sample into two separate containers, will be used to evaluate sampling precision. Points at which duplicate samples are to be collected will be selected by field personnel and will be submitted as blind duplicates to the laboratory. Field personnel are expected to provide a general range of expected concentrations to the laboratory for these samples to minimize impacts on laboratory equipment.

Blind field duplicates will be collected at a frequency of one sample per 10 primary samples for soil and groundwater matrices, as summarized in Worksheet No. 20 in the Multi-Area QAPP. Sample identification protocols are provided in Subsection 3.1 of this FSP.

Field Equipment Blanks

Field equipment blanks consisting of analyte-free water will be collected and submitted to the analytical laboratory to assess the quality of the data resulting from the field sampling program. Field equipment blanks are analyzed to check for procedural contamination at the site that may cause sample contamination. Field blanks will be collected following decontamination of the non-dedicated sampling equipment, including pumps and soil samplers. Field blanks will not be collected for disposable or dedicated sampling equipment, such as tubing dedicated to a specific well.

Field equipment blank frequencies are also provided in Worksheet No. 20 in the Multi-Area QAPP. In general, field equipment duplicates will be collected at the rate of one duplicate per ten primary samples for groundwater and soil matrices. The exception is the low-level mercury sampling locations, at which one equipment blank will be generated for each location sampled. Identification protocols are provided in Subsection 3.1 of this FSP.

Trip Blanks

Trip blanks will be analyzed to assess the possible cross-contamination of VOCs resulting from diffusion through septa during sample shipment. Trip blanks, consisting of 40-mL VOA vials with deionized ASTM Type 2 organic-free water, are generated in the laboratory and accompany VOC sample coolers from the laboratory to the field and back to the laboratory. Trip blank containers are not opened in the field. Trip blanks prepared by the laboratory will meet holding time requirements. One trip blank, consisting of two VOA vials, will be shipped with each cooler containing VOC sample containers. Trip blank identification protocols are provided in Subsection 3.1.

Field Blanks

Field blanks will be analyzed to assess the suitability of the container, preservative, and sample handling. The field blank is generated by pouring the solution provided in one of the sample containers into another sample container the contents of which had been emptied at the facility. One field blank will be collected per every 10 primary samples, as described in Worksheet #20 in the Multi-Area QAPP.

Field blanks identification protocols are provided in Subsection 3.1.

Matrix Spikes/Matrix Spike Duplicates (MSs/MSDs)

MS/MSD samples provide information about the effect of the sample matrix on the sample preparation and measurement methodology. MS/MSD samples will be analyzed in accordance with the laboratory operating procedures provided in the QAPP. In conjunction with other QC data, the spikes and duplicates give information on the precision and accuracy of the analytical method on the various sample matrices. One MS/MSD sample will be collected and prepared for every 20 or fewer primary samples collected during a sampling round, as described in Worksheet #20 of the Multi-Area QAPP. The MS/MSD samples will consist of triple the normal sample volume for each analytical group, provided adequate sample volume is available. Field personnel will select the sampling locations at which MS/MSD samples are collected. MS/MSD identification protocols are provided in Subsection 3.1.

4.5 FIELD AUDITS

The Project Manager/Coordinator will monitor daily field performances through daily communications with the Field QA Officer and Construction Manager. Field performance audits and field system audits will be performed as follows:

- Field performance audits will be conducted in order to confirm that the activities are being performed according to the established plans. The field performance audits will be performed by the Project Manager (or designee) at an appropriate frequency for the field activities. The audits will include a discussion of the project progress with the Project Coordinator and/or Field QA Officer and /or the review of field reports, as appropriate. The Project Manager will record and document any observations made during field system audits, and will discuss the audit and any recommended changes/deviations to the field procedures with the project coordinator.
- Field system audits will be performed by the QA Officer including a review of rinse and trip blank data to identify potential deficiencies in field sampling and decontamination procedures, and a comparison of the scheduled QA/QC activities described in the QAPP with the QA/QC procedures being performed on the project. Field system audits will be performed at a frequency appropriate for field activities. The QA Officer will record and document any observations made during field system audits, and will discuss the audit and any recommended changes/deviations to the field procedures with the Project Manager.

4.6 CORRECTIVE ACTION

Field measurement corrective action may be necessary when the sample network is modified or when sampling procedures and/or field analytical procedures require modification in response to unexpected conditions. Technical staff and project personnel will be responsible for reporting all suspected technical or QA nonconformances or deficiencies of any activity or issued document by reporting the situation to the CRA Field QA Officer or designee. The Field QA Officer will assess the suspected problems in consultation with the Project Coordinator and/or Project Manager or QA Officer or designee, and will assist in making a decision based on the potential for the situation to impact the data quality. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, the Field QA Officer will issue the nonconformance report. If appropriate, the Field QA Officer will ensure

that no additional work is dependent on the nonconforming activity is performed until the corrective actions are completed.

Details regarding laboratory data reduction, validation and reporting requirements are provided in Worksheet #14 and Worksheets #34 through #36 of the QAPP. In addition details on field and laboratory audits and corrective actions are included in Worksheets #6-1, #6-2, #6-3,#6-4, #6-5 #14, and #31-1, #31-2,#31-3, #31-4, #31-5, #32-1, #32-2, #32-3, #32-4, and #33 in the Multi-Area QAPP.

5.0 FIELD PHYSICAL MEASUREMENTS

Field measurements of topographic features, water levels, reference points, and other physical features will be required during the field investigations. The scope of such measurements depends upon the purpose for the particular measurement data.

Physical measurements will be traceable to the person making the measurement and to the specific piece of field equipment used to make that measurement. Equipment maintenance and calibration records will be kept in a bound field notebook, making all such procedures traceable. Time records will be kept using local time in the 24:00-hour military format, recorded to the nearest 5 minutes.

Sampling locations will be surveyed and depicted on existing topographic maps. Surveying will be conducted according to the standard procedures described below. Control points used during the survey will be marked in the field and noted on the topographic maps.

5.1 SURVEYING OF SAMPLING LOCATIONS

Accurate, complete, and informative surveying field notes are a primary objective in site mapping. The field notes are the most reliable record of measurements made and information gathered in the field. As stated in Subsection 3.5, information gathered will be recorded in bound notebooks. Notes will be permanent, legible, and complete.

The field notes will accomplish the following:

- Provide adequate and complete information that can be understood by someone other than the notetaker.
- Provide documentation of work completed or data gathered.

Two important aspects of each survey to be addressed in the field notes are as follows:

- *Starting and ending points of the survey* - The surveyor will explain and document the starting and ending points of the survey. This applies to both horizontal and vertical control. This will require a paragraph of explanation and sketches and/or cross-references to data in notes of previous surveys.

- ***Clear indication of final results and checking procedures*** - The final results and checks will be plainly indicated. Erasures will not be used, as they raise uncertainties about the reliability of the data. Alterations, additions, revisions, reductions, or comments added to field notes will be written in colored ink to indicate that such information is not part of the original field record. The person making such notations will initial and date each page so affected.

The following is a checklist of information to be included in the notebook:

- Date
- Names of survey crew members
- Weather conditions: observed temperatures, relative wind speed, and barometric pressure if an electronic distance meter (*e.g.*, a total station) is to be used
- Equipment used, listing the serial number or other identification
- Location of survey by section description or other legal parcel identification
- Project number
- North arrow
- Description of all monuments found
- Measurements (slope distance and vertical angles, temperature, taping, horizontal angles, etc.)
- Corrected distances and angles
- Description of monuments set
- Outline or sketch of major traverse or property boundary

The elevation of the measuring point of monitoring wells and a reference point on staff gauges will be surveyed to allow correlation of water levels. Additionally, ground elevations may be required for topographic purposes. Standard engineering leveling techniques, as described in basic surveying textbooks, establish the methodology for providing vertical control. The datum referenced for elevation control is the National Geodetic Vertical Datum (NGVD) of 1929, informally known as sea level datum, established by the U.S. Coast and Geodetic Survey. Benchmarks of known elevation will be used. If no benchmark is located in the vicinity of a site investigation, an arbitrary temporary benchmark will be established on a permanent location (*i.e.*, foundation or corner post). The locations of benchmarks utilized will be shown on a site sketch map. Elevation surveys will be conducted to form a circuit (*i.e.*, the survey line will be closed back to a benchmark). Third-order accuracy will be obtained on level circuits; for example, on a 1-mile circuit, the closure will be within 0.05 foot. Length of sight will not

ordinarily exceed 250 feet, with turning point back-shots and fore-shots deviating no more than 50 feet from one another.

5.2 SURFACE WATER STAGE

Surface water stage will be measured on staff gauges graduated to 0.01 foot. Staff gauges will be surveyed at the same time that monitoring wells are surveyed, and will be referenced to NGVD. Measurements of water stage will be noted in field logs with date, time, and site location. Water stage will be recorded to the nearest 0.01 foot.

6.0 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

6.1 PURGE WATER AND DECONTAMINATION WATER

6.1.1 OU-4 AND OU-5 EMERGENCY ACTIONS

Wastewater produced from well development and well purging and decontamination water will be temporarily stored in appropriately sized container. This water will be appropriately managed, as follows.

- All decontamination water generated during cleaning of equipment will be stored in a temporary storage tank(s) at the site.
- During operations, the water will be treated in the on-site treatment system.
- Decontamination water that is generated after the treatment system is unavailable will be characterized to identify appropriate methods of off-site treatment and/or disposal. The water samples will be analyzed for the analytes required by the treatment and/or disposal facility.

6.1.2 OU-4 PREDESIGN INVESTIGATION

Decontamination activities performed during the predesign investigation at OU-4 will be performed at a decontamination pad constructed on top of the landfill. The decontamination pad will be roughly 15 feet wide and 25 feet long and will generally consist of a flexible membrane liner (FML) placed over an area on top of the landfill that is gently sloped and bermed so that the decontamination water will flow to one location to be collected. Wood or a thin layer of soil may be placed on top of the FML so that equipment can be driven on the pad without potentially puncturing the FML. The actual construction of the decontamination pad may be modified based on the selected contractor's means and methods.

Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the technical memorandum documenting the findings and conclusions of the Predesign Studies (to be submitted as part of the Design Report).

Following completion of the predesign field activities, the decontamination pad will be dismantled and the bermed soil will be regraded to match the existing cover slope. The decontamination pad materials will be stockpiled and covered with the existing cover soil in a designated area that will not erode before the final cover is installed. These materials will be incorporated under the final landfill cover as part of the RA.

6.1.3 OU-7 – PLAINWELL MILL RI/FS – PHASE I INITIAL GROUNDWATER ASSESSMENT

Decontamination water will be collected and containerized in 55-gallon barrels that will be property labeled and temporarily stored on-site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the technical memorandum documenting the findings and conclusions of the Plainwell Mill RI/FS – Phase I Groundwater Assessment activities.

6.1.4 OU-4 REMEDIAL ACTION

Decontamination activities performed during the predesign investigation at OU-4 will be performed at a decontamination pad constructed near the site entrance of the landfill. The construction of the decontamination pad will be based on the selected contractor's means and methods, but may consist of an approximate 8-foot by 8-foot piece of HDPE flatstock with 6-inch–high sides or a roughly 15-foot–wide and 25-foot–long FML placed over an area near the site entrance that is gently sloped and bermed so that the decontamination water will flow to one location to be collected. Wood or a thin layer of soil may be placed on top of the FML so that equipment can be driven on the pad without potentially puncturing the FML.

Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site

disposal activities will be included in the report documenting the remedial action construction.

6.1.5 OU-4 REMEDIAL ACTION WORK PLAN

Decontamination activities performed during the excavation activities at OU-4 will be performed at a decontamination pad constructed near the site entrance of the landfill. The construction of the decontamination pad will be based on the selected contractor's means and methods, but may consist of an approximate 8-foot by 8-foot piece of HDPE flatstock with 6-inch–high sides or a roughly 15-foot–wide and 25-foot–long FML placed over an area near the site entrance that is gently sloped and bermed so that the decontamination water will flow to one location to be collected. Wood or a thin layer of soil may be placed on top of the FML so that equipment can be driven on the pad without potentially puncturing the FML.

Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the report documenting the remedial action construction.

If groundwater is encountered during excavation activities it will be collected and containerized in 55-gallon barrels and will be transported off-site for proper disposal as described above for decontamination water disposal.

6.1.6 OU-7 – PLAINWELL MILL PHASE II RI WORK PLAN

Decontamination activities performed during the soil investigation activities at OU-7 will be performed at a decontamination pad constructed near the Site entrance of the Plainwell Mill Site. Decontamination activities will ensure that potentially contaminated equipment will not leave the investigation Site. The construction of the decontamination pad will be based on the selected contractor's means and methods, but may consist of an approximate 8-foot by 8-foot piece of HDPE flatstock with 6-inch–high sides or a roughly 15-foot–wide and 25-foot–long FML placed over an area near the site entrance that is gently sloped and bermed so that the decontamination water will flow to one

location to be collected. Wood or a thin layer of soil may be placed on top of the FML so that equipment can be driven on the pad without potentially puncturing the FML.

Decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on site. A sample of the decontamination water will be collected and tested for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the report documenting the remedial action construction.

Wastewater produced from well development and well purging and decontamination water will be temporarily stored in appropriately sized container. This water will be appropriately managed, as follows.

- All decontamination water generated during cleaning of equipment will be stored in a temporary storage tank(s) at the site;
- During operations, the water will be treated in the on-site treatment system; and
- Decontamination water that is generated after the treatment system is unavailable will be characterized to identify appropriate methods of off-site treatment and/or disposal. The water samples will be analyzed for the analytes required by the treatment and/or disposal facility.

6.2 SOIL

6.2.1 OU-4 AND OU-5 EMERGENCY ACTIONS

Excess soil and samples that are produced during the drilling operations will be temporarily staged at each drilling site and placed on a plastic liner. In the event of rain, and at the end of each work day, the pile will be covered with a plastic sheet. As drilling is completed at each work area, the temporarily staged material will be collected and placed into the sediment management areas at the top of the 12th Street Landfill, or into roll-off bins, barrels, 5-gallon buckets, or equivalent located in the primary staging area. After all drilling operations are completed, samples of the accumulated soil will be collected and characterized in accordance with landfill profile requirements. After determining the proper regulatory classification, the soil will be transported for off-site

disposal at the 12th Street Landfill site or another permitted disposal facility (if necessary).

6.2.2 OU-4 PREDESIGN INVESTIGATION

After the test pits are logged, the excavated material will be placed back into the excavation and compacted sufficiently to prevent erosion from surface water runoff. Vegetation will be reestablished through natural propagation of native species.

Soil cuttings generated during the drilling of Geoprobe® borings will either be placed in appropriately labeled containers (*e.g.*, 55-gallon barrels) or stockpiled and covered with a low-permeability material in a designated area that will not erode before the final cover is installed. These materials will be incorporated under the final landfill cover as part of the RA.

6.2.3 OU-7 – PHASE 2 OF ADDENDUM NO. 1 (TEST PITS)

The soil excavated while performing test pits will initially be placed on a tarp to minimize contact with surface soils. If test pit soils are visually stained, have a strong petroleum odor, or as measured with a PID indicate volatiles greater than 10 (PID units), excavated soils will be containerized in a small lined 5 cubic yard dumpster for landfill characterization and disposal. Three small dumpsters will be on site during the investigative activities to manage contaminated soil encountered from the area of oil impacted soil and elevated PCB area separately and one extra, for use as needed. If soils appear to be native or other non-contaminated fill materials, the soil will be placed back into the original excavation area.

6.2.4 OU-7 – PLAINWELL MILL RI/FS – PHASE I INITIAL GROUNDWATER ASSESSMENT

Excess soil and samples that are produced during the drilling operations will be temporarily stockpiled at each drilling site and placed on a plastic liner. As the drilling activities are completed in each area the temporary stockpile will be collected and placed into 55-gallon drums. After all drilling activities are complete samples of the accumulated soil will be collected and characterized in accordance with landfill profile

requirements. After determining the proper regulatory classification, the soil will be transported for off-site disposal.

6.2.5 OU-4 REMEDIAL ACTION

Excess soil and samples that are produced during the drilling operations will be temporarily stockpiled at each drilling site. As drilling is completed at each work area, the temporary stockpile will be collected and the soil may be thinly spread over areas on the landfill final cover or site access roads. The soil may also be used to backfill erosional channels on the landfill final cover or site access roads.

6.2.6 OU-4 - 12TH STREET LANDFILL REMEDIAL ACTION

Paper residuals excavated from below the water table will be temporarily stockpiled immediately adjacent to the excavation area (within the silt fencing), where the material will be allowed to dewater, (excess water can gravity-drain back into the excavation) prior to being transported to the landfill. After being transported to the landfill, if the paper residuals are still too wet to support additional fill, they may be spread in thin lifts (not exceeding 12 inches) and allowed to air-dry, mixed with mulched materials or dryer fill materials generated from the landfill grading activities, or mixed with solidification agents (e.g., Portland cement).

6.2.7 OU-7 – PLAINWELL MILL PHASE II RI WORK PLAN

Excess soil and samples that are generated during the drilling activities will be placed into 55-gallon drums. After all drilling activities are complete; samples of the accumulated soil will be collected and characterized in accordance with landfill profile requirements. After determining the proper regulatory classification, the soil will be transported for off-site disposal.

The soil excavated while performing test pits will initially be placed on a tarp to minimize contact with surface soils. If test pit soils are visually stained, have a strong petroleum odor, or as measured with a PID indicate volatiles greater than 5 (PID units), excavated soils will be containerized in a small lined 5 cubic yard dumpster for landfill characterization and disposal. Three small dumpsters will be on-Site during the investigative activities to manage contaminated soil encountered from the area of oil

impacted soil and elevated PCB area separately and one extra, for use as needed. If soils appear to be native or other non-contaminated fill materials, the soil will be placed back into the original excavation area.

6.3 USED PERSONAL PROTECTIVE EQUIPMENT AND NONCONTAMINATED REFUSE

Used personal protective equipment and other types of general noncontaminated debris or waste materials produced during the fieldwork will be collected daily in sealed plastic bags, and placed in a waste dumpster that will be brought to the site for the project. The wastes will be disposed by a local commercial waste disposal contractor at the end of the fieldwork.

7.0 REFERENCES

CRA, 2009. Multi-Area Quality Assurance Project Plan, Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. Revision 03, Addendum 04. September 2009.

CRA, 2009. Phase II Remedial Investigation Work Plan, Former Plainwell, Inc., Mill Property, Plainwell, Michigan. Operable Unit No. 7 of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. Version 3. September 23, 2009.

CRA, 2009. Remedial Action Work Plan for 12th Street Landfill, Otsego Township, Michigan. Operable Unit No. 4 of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. Revision 2. June 17, 2009.

RMT, Inc. 2008a. Multi-Area quality assurance project plan, Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. Revision 02, Addendum 03. September 2008.

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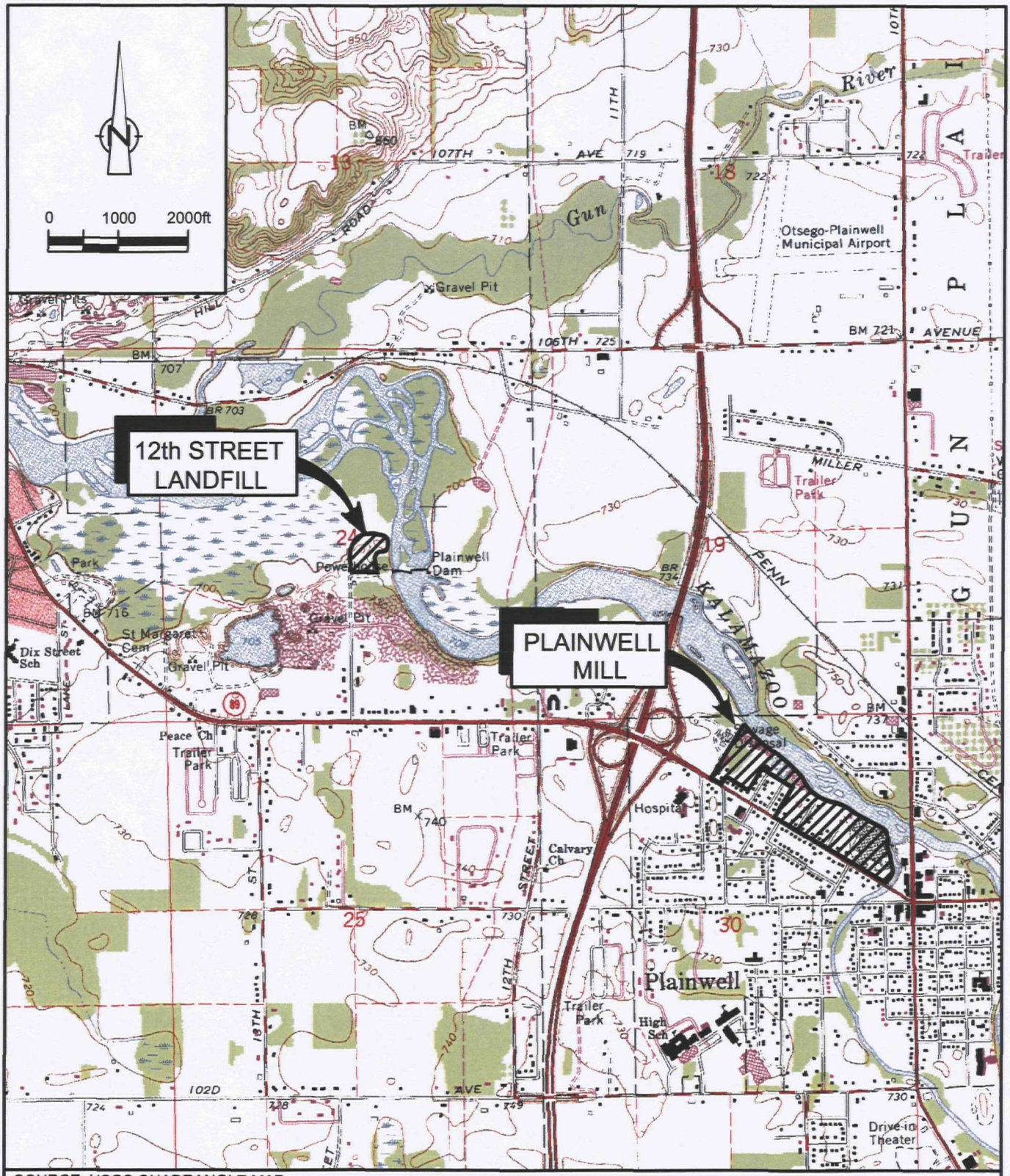
RMT, Inc. 2008d. Performance standards verification plan.

USDA. 2004. Wells, R., E.J. Langendoen, and A. Simon. Numerical simulation of sediment loads and channel changes along the Kalamazoo River between Plainwell and Otsego City, Michigan. USDA-ARS National Sedimentation Laboratory Research Report. No. 44. 46 pp.

USGS. 2004. Syed, A.U., J. P. Bennett, and C.M. Rachol. A pre-dam-removal assessment of sediment transport for four dams on the Kalamazoo River between Plainwell and Allegan, Michigan. U.S. Geological Survey Scientific Investigations Report 2004-5178. 41 pp.

FIGURES



SOURCE: USGS QUADRANGLE MAP;
OSTEGO, MICHIGAN
1967, REVISED 1973

figure 1-1

SITE LOCATION MAP
MILTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC. MILL AND
12TH ST. LANDFILL SITES
Plainwell, Michigan

056394-04(005)GN-SC004 SEP 23/2009

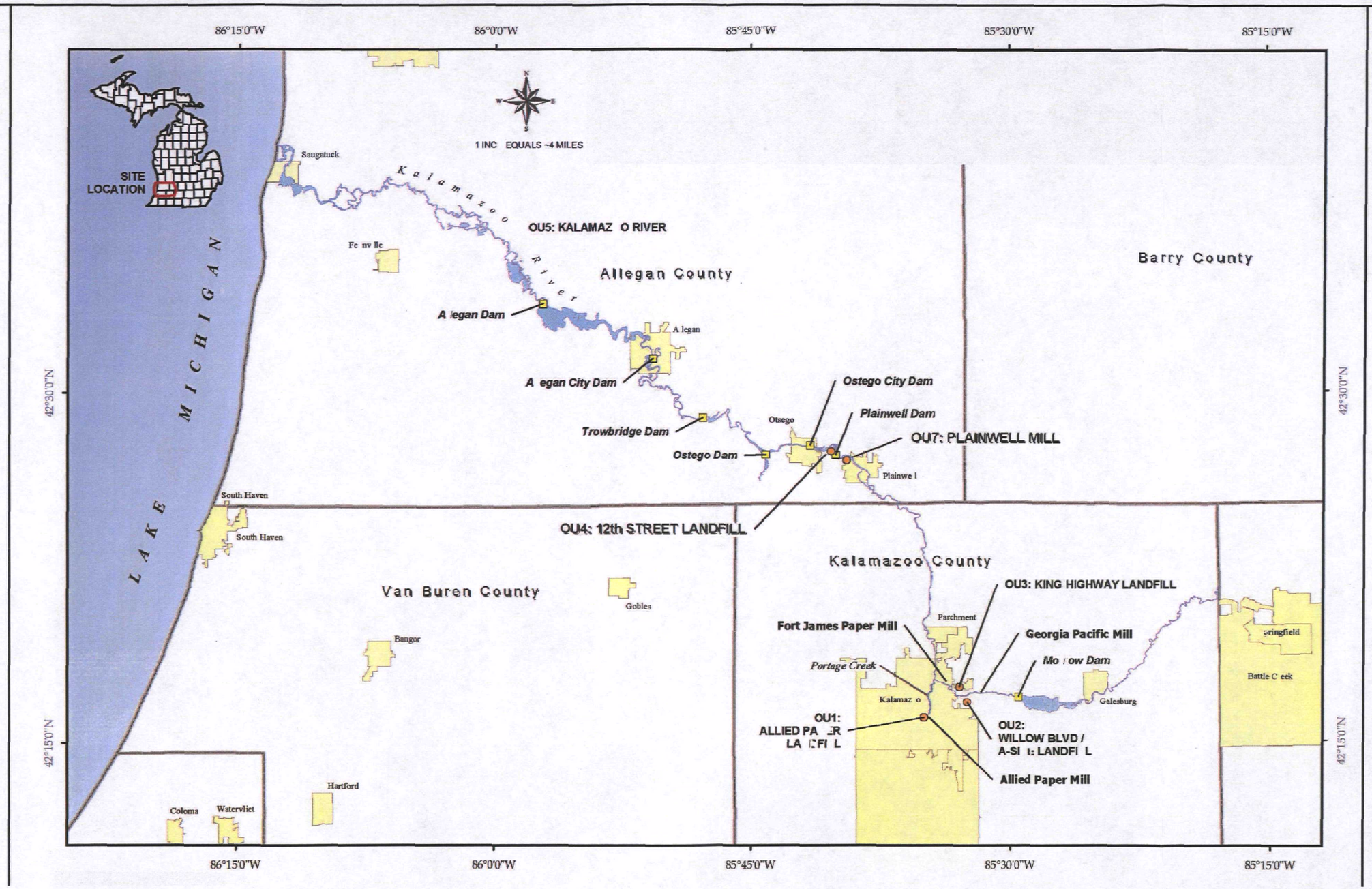
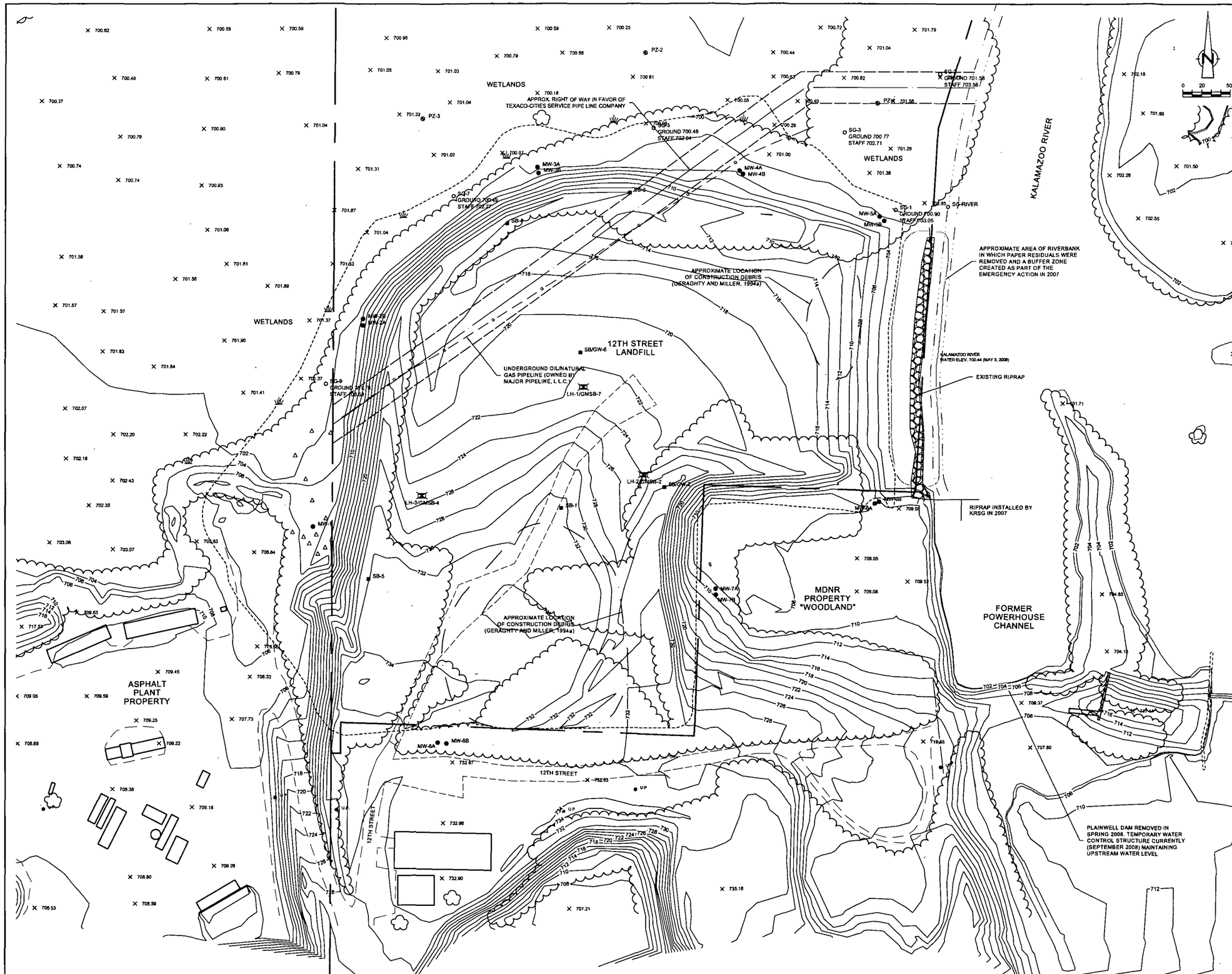


figure 1-2

KALAMAZOO RIVER SUPERFUND SITE
MULTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC. MILL AND 12TH ST. LANDFILL SITES
Plainwell, Michigan

056394-04(005)GN-SC006 SEP 23/2009



NO	Revision	Date	Initial
1	UPDATED FOR SECOND EPA SUBMISSION	JUNE 15, 2009	C.R.H.

LEGEND

- APPROXIMATE PROPERTY BOUNDARY
- EXISTING PAVED ROAD
- EXISTING UNPAVED ROAD
- EXISTING FENCE
- EXISTING BUILDING
- EXISTING GROUND CONTOUR ELEVATION
- EXISTING SPOT ELEVATION
- EXISTING TREES AND/OR BRUSH
- EXISTING WET AREA AND WETLAND
- EXISTING EDGE OF WATER
- EXISTING LIMITS OF PAPER RESIDUALS
- APPROXIMATE LIMITS OF CONSTRUCTION DEBRIS
- MW-1 EXISTING MONITORING WELL LOCATION
- PZ-2 EXISTING PIEZOMETER LOCATION
- LH-1/GMSB-7 EXISTING LEACHATE HEAD WELL LOCATION
- SG-1 EXISTING STAFF GAUGE
- EXISTING VANE SHEAR TEST LOCATION
- SB-5 EXISTING INSPEC-SOL SOIL BORING LOCATION
- SB/GW-6 EXISTING INSPEC-SOL SOIL BORING LOCATION/GAS WELL

NOTES:

1. BOUNDARY AND TOPOGRAPHIC SURVEY COMPLETED BY PREIN & NEWHOFF ON MAY 19, 2009.
2. THE APPROXIMATE LIMITS OF VISIBLE PAPER RESIDUALS WERE DERIVED FROM THE ALLIED PAPER, INC./PORTAGE CREEK / KALAMAZOO RIVER SUPERFUND SITE REMEDIAL INVESTIGATION, TECHNICAL MEMORANDUM 8, (G & M 1994b) AND REVISED BASED ON THE U.S.EPA'S 2003 PREDESIGN INVESTIGATION (U.S. EPA, 2004), THE EMERGENCY ACTIONS PERFORMED ALONG THE RIVERBANK IN 2007 (RMT, 2008b), AND THE PREDESIGN INVESTIGATION CONDUCTED IN JUNE 2008 (COPIED IN APPENDIX A OF THIS REPORT).
3. THE OIL/NATURAL GAS PIPELINE IS CURRENTLY (SEPTEMBER 2008) INACTIVE. IT WAS BURIED IN NATIVE SOIL PRIOR TO DISPOSAL OF PAPER RESIDUALS IN THE LANDFILL. THIS PIPELINE IS BURIED BELOW GRADE.

SCALE VERIFICATION

THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

Approved

DRAWING STATUS

Status	Date	Initial

12th STREET LANDFILL
Otsego Township, Michigan

MULTI-AREA FIELD SAMPLING PLAN

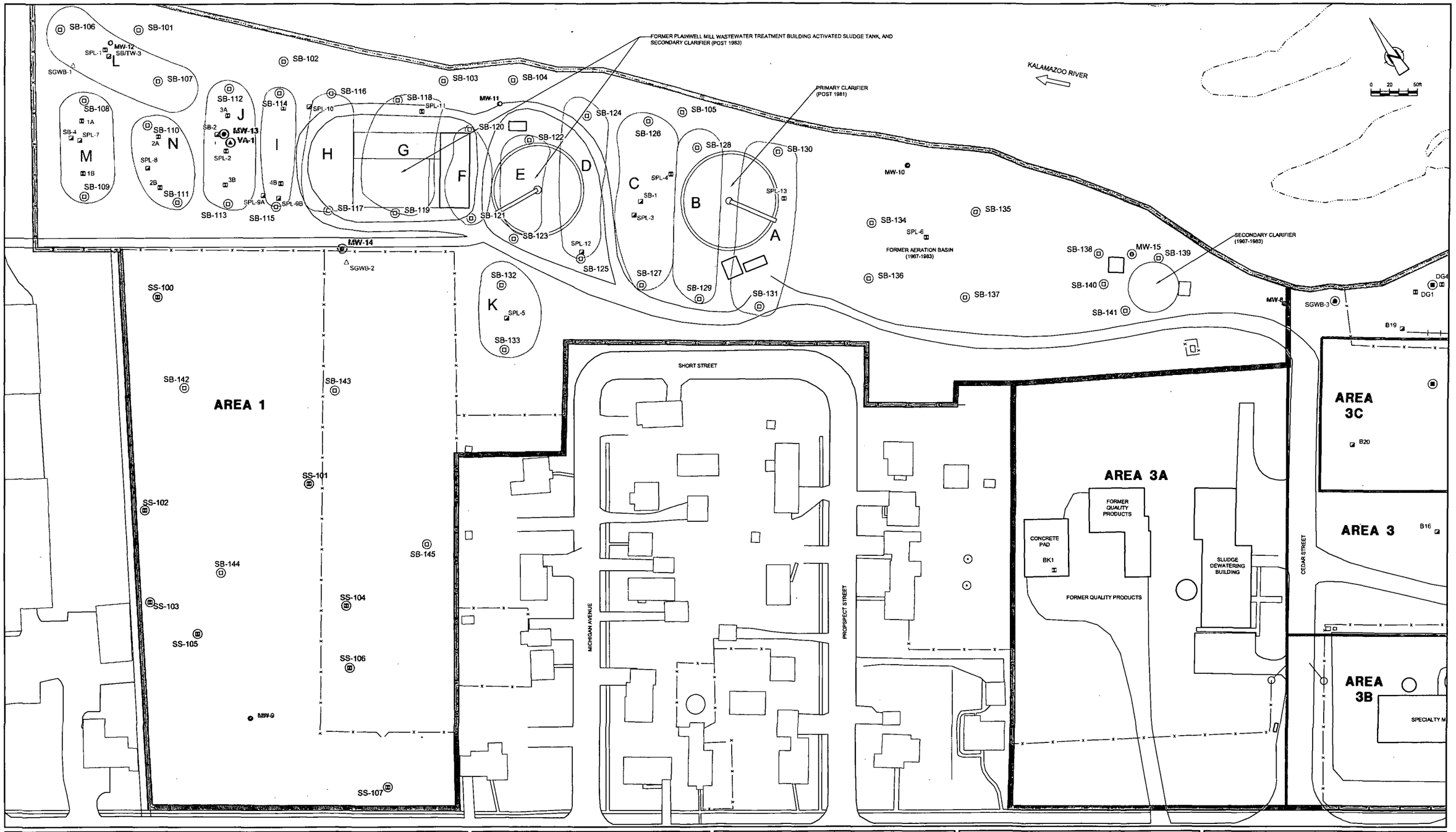
ENVIRONMENTAL MONITORING PLAN

CONESTOGA-ROVERS & ASSOCIATES

Source Reference:
BASE ADAPTED FROM PREVIOUS RMT DESIGN

Project Manager:	Reviewed By:	Date:	
G. CARLI	G. BOLOURANI	SEPTEMBER 2009	
Scale	Project N°:	Report N°:	Drawing N°:
1" = 50'-0"	056394-04	005	2-1

056394-04(005)GN-SC005 SEP 23/2009



LEGEND

- AREA BOUNDARY
- SHORELINE
- FORMER WASTEWATER SLUDGE DEWATERING LAGOONS
- FENCELINE
- VEGETATION
- PROPOSED MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED SURFACE SOIL SAMPLE LOCATION
- PROPOSED VERTICAL AQUIFER SAMPLING LOCATION
- PREVIOUS SOIL SAMPLE LOCATION
- PREVIOUS SOIL BORING LOCATION
- EXISTING MONITORING WELL LOCATION
- PREVIOUS TEMPORARY WELL LOCATION
- PREVIOUS GROUNDWATER SAMPLE LOCATION
- PREVIOUS STAFF GAUGE LOCATION (APPROXIMATE)

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

AREA 1 PROPOSED PHASE II SAMPLE LOCATIONS

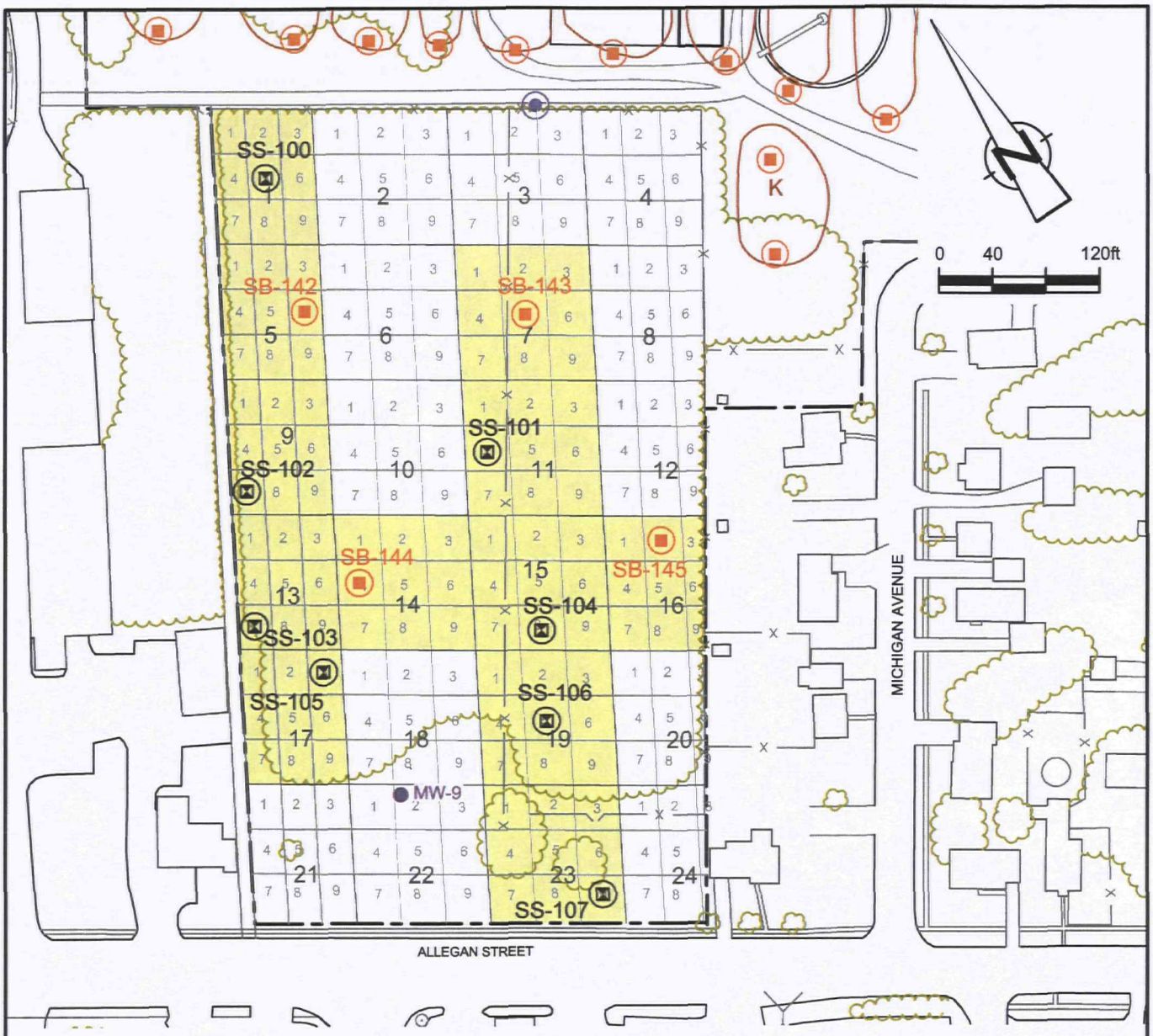
MULTI-AREA FIELD SAMPLING PLAN

FORMER PLAINWELL, INC MILL PROPERTY
PLAINWELL, MICHIGAN

CONESTOGA-ROVERS & ASSOCIATES

Source References: RMT PROJ. 00-05121.03			Date: NOVEMBER 2009
Project Manager: G. CARLI	Reviewed By: G. BOLOURANI	Designed By:	Drawn By: C. JACOBI
Scale: 1:100	Project No: 056394-04	Report No: 005	Drawing No: FIGURE 2-2a

056394-04(005)GN-SC009 NOV 18/2009



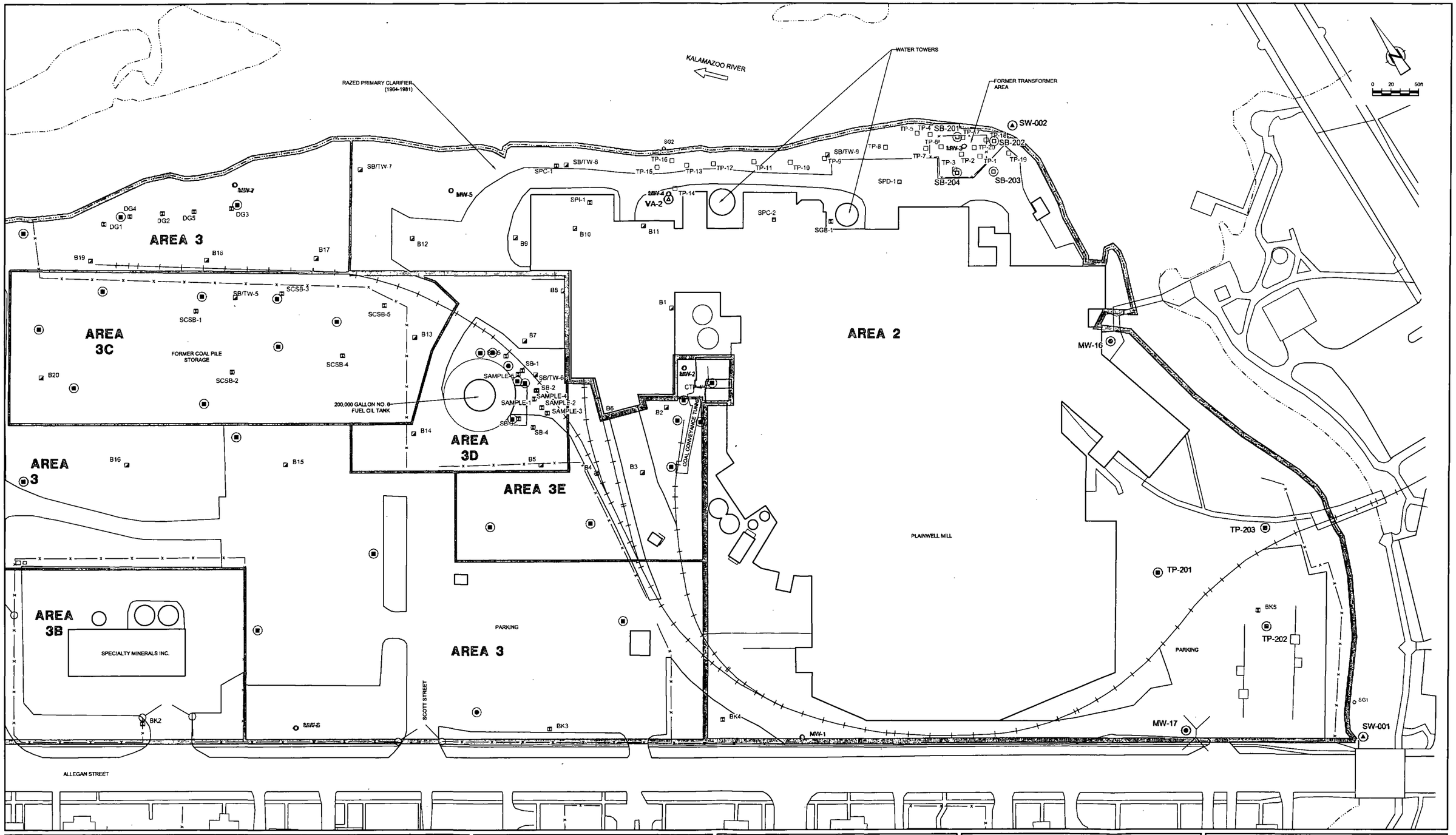
LEGEND

- PROPERTY BOUNDARY
- FORMER WASTEWATER SLUDGE DEWATERING LAGOONS
- FENCELINE
- VEGETATION
- MW-9 EXISTING MONITORING WELL LOCATION
- PROPOSED MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED SURFACE SOIL SAMPLE LOCATION

figure 2-2b

AREA 1 - WOODED AREA PROPOSED SAMPLE LOCATIONS
MULTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC MILL PROPERTY
Plainwell, Michigan

056394-04(005)GN-SC008 NOV 18/2009



LEGEND

- AREA BOUNDARY
- SHORELINE
- RAILWAY
- FENCELINE
- VEGETATION
- PROPOSED MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED TEST PIT LOCATION
- PROPOSED SURFACE WATER SAMPLE LOCATION
- PROPOSED VERTICAL AQUIFER SAMPLING LOCATION
- PREVIOUS SOIL SAMPLE LOCATION
- PREVIOUS SOIL BORING LOCATION
- PREVIOUS TEST PIT
- PREVIOUS SEDIMENT SAMPLE LOCATION
- EXISTING GROUNDWATER MONITORING WELL LOCATION
- PREVIOUS GROUNDWATER SAMPLE LOCATION
- PREVIOUS STAFF GAUGE LOCATION (APPROXIMATE)

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

AREA 2 PROPOSED PHASE II SAMPLE LOCATIONS

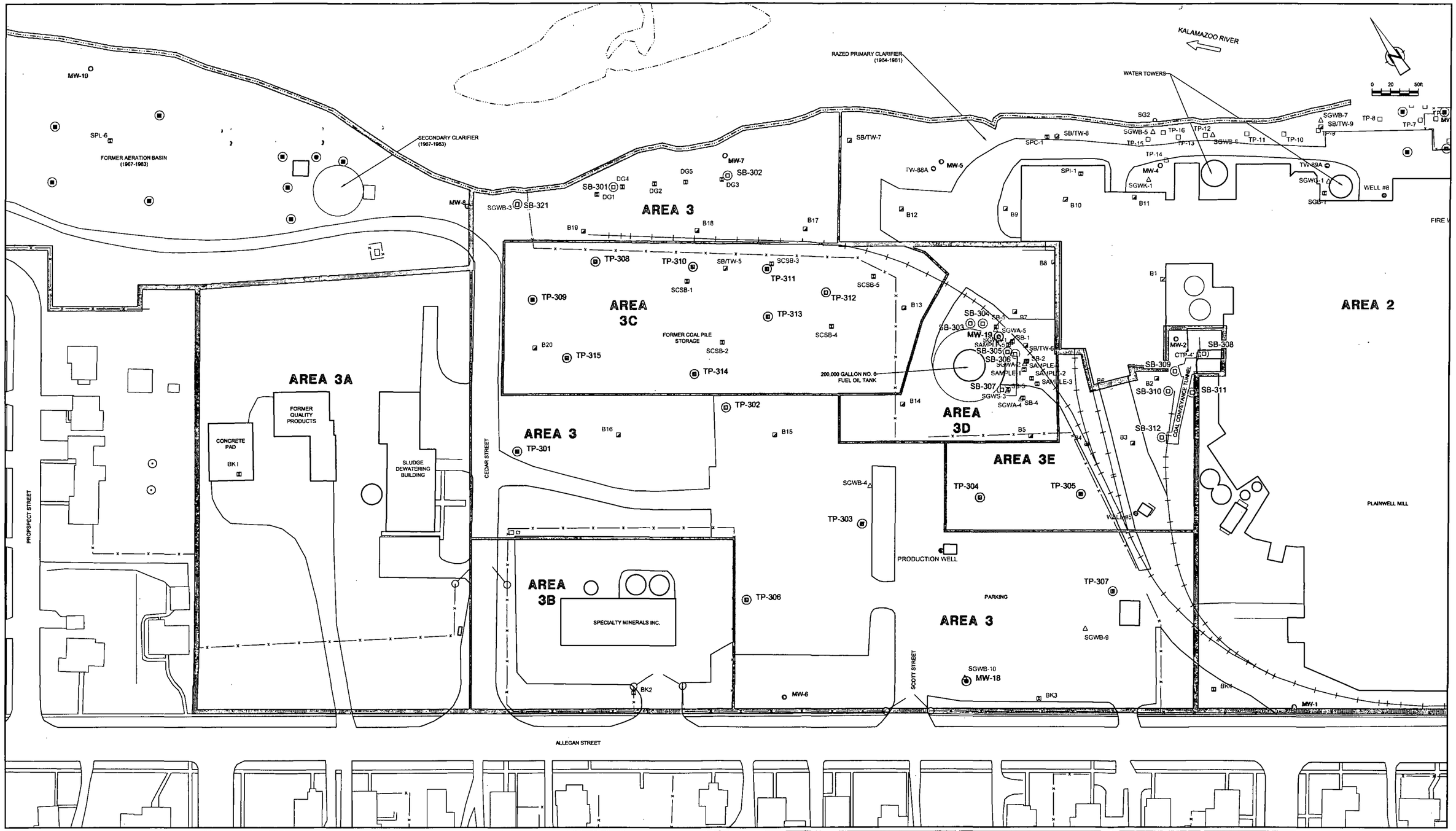
MULTI-AREA FIELD SAMPLING PLAN

FORMER PLAINWELL, INC MILL PROPERTY
PLAINWELL, MICHIGAN

CONESTOGA-ROVERS & ASSOCIATES

Source Reference			Date:
RMT PROJ 00-05121.03			NOVEMBER 2009
Project Manager: G. CARLI	Reviewed By: G BOLOURANI	Designed By:	Drawn By: C. JACOBI
Scale: 1:100	Project No: 056394-04	Raport No: 005	Drawing No: FIGURE 2-3

056394-04(005)GN-SC007 NOV 18/2009



LEGEND

- AREA BOUNDARY
- SHORELINE
- RAILWAY
- FENCELINE
- VEGETATION
- PROPOSED MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED TEST PIT LOCATION
- PREVIOUS SOIL SAMPLE LOCATION
- PREVIOUS SOIL BORING LOCATION
- PREVIOUS TEST PIT
- PREVIOUS SEDIMENT SAMPLE LOCATION
- EXISTING GROUNDWATER MONITORING WELL LOCATION
- PREVIOUS GROUNDWATER SAMPLE LOCATION
- PREVIOUS STAFF GAUGE LOCATION (APPROXIMATE)

SCALE VERIFICATION: THIS BAR MEASURES 1" ON ORIGINAL. ADJUST SCALE ACCORDINGLY.

No	Revision	Date	Initial

Approved

AREA 3 PROPOSED PHASE II SAMPLE LOCATIONS

MULTI-AREA FIELD SAMPLING PLAN

FORMER PLAINWELL, INC MILL PROPERTY
PLAINWELL, MICHIGAN

CONESTOGA-ROVERS & ASSOCIATES

Source Reference: RMT PROJ. 00-05121 03			Date: NOVEMBER 2009
Project Manager: G. CARLI	Reviewed By: G. BOLOURANI	Designed By:	Drawn By: C. JACOBI
Scale: 1:100	Project No: 056394-04	Report No 005	Drawing No: FIGURE 2-4

056394-04(005)GN-SC010 NOV 18/2009

TABLES

Table 2-1
Summary of Sample Types and Locations (Former Powerhouse Discharge Channel)

Type of Sample	Assumed Location	Purpose
Surface Water Quality	Immediately upstream or near the Plainwell Spillway. Mid depth in the water column.	Establish background conditions for turbidity comparisons.
	Approximately 200 and 300 feet downstream of the former powerhouse discharge channel. Sample within the channel may be collected from pier or boat depending upon flow conditions. Mid-depth in the water column.	Establish water quality during removal activities.
	Groundwater collection sump (or equivalent) within isolated removal area (discharge water).	Measure turbidity for comparison to background conditions and determination of discharge location.
Surface Water Flow Measurements	To be determined if needed.	To be determined if needed.
Water Treatment System Monitoring	Effluent sampling from Portable Treatment unit.	To confirm treatment system effectiveness.
Sediment Sampling	At selected nodes within a final sampling grid. Grid size depends upon the final size of the removal area. Node selections will consider random and spatially distributed locations. Samples will be collected within the top 6 inches of sediment.	Document PCB sediment concentrations after removal is complete.
Geoprobe Soil Sampling	Predesign sample collection at transects along the edge of the landfill closest to the former powerhouse discharge channel.	Determine possible existence of former berm at edge of landfill and assess collected soil samples for implications on slope stability.

Table 2-2
Summary of Sample Types and Locations
(Plainwell Mill Banks)

Type of Sample	Assumed Location	Purpose
Surface Water Quality	Immediately upstream or near the Plainwell Mill banks. Mid depth in the water column.	Establish background conditions for turbidity comparisons. Turbidity will be measured hourly.
	Approximately 200 and 300 feet downstream of the Plainwell Mill banks. Sample within the channel may be collected from pier or boat depending upon flow conditions. Mid-depth in the water column.	Establish water quality during removal activities. Turbidity will be measured hourly
Surface Water Flow Measurements	To be determined if needed.	To be determined if needed.
Water Treatment System Monitoring	Effluent sampling from Portable Treatment unit.	To confirm treatment system effectiveness.
Sediment Sampling	At selected nodes within a final sampling grid. Grid size depends upon the final size of the removal area. Node selections will consider random and spatially distributed locations. Samples will be collected within the top 6 inches of sediment.	Document PCB sediment concentrations after removal is complete.
Soil Sampling	At selected nodes within a final sampling grid. Grid size depends upon the final size of the removal area. Node selections will consider random and spatially distributed locations. Samples will be collected within the top 6 inches of soil.	Document PCB soil concentrations after removal is complete.

Table 2-3
Summary of Sample Types and Locations
(Predesign Investigations for the Remedial Design for the 12th Street Landfill)

Type of Sample	Assumed Location	Purpose
Test Pits (visual)[1]	***Wetland Area to the North of the Landfill*** - Advance approximately 3 test pits to confirm the approximate areal extent of visible paper residuals beyond the toe of the landfill. ***Asphalt plant/State Properties*** - Advance approximately 3 test pits within the asphalt plant property and approximately 4 test pits within the State property to delineate the areal extent and the depth of visible paper residuals.	***Wetland Area to the North of the Landfill*** - Evaluate potential constructibility issues in the wetland, and to assess the degree of difficulty in distinguishing the visible paper residuals from the native soil. ***Asphalt plant/State Properties*** - Support discussions with the owners of these adjacent properties concerning access for implementation of the Remedial Action.
Geoprobe® Borings (visual)	Advance approximately 9 Geoprobe® borings into the 12th Street Landfill at select locations where fill material is believed to extend beyond the property boundary to the southwest and to the southeast and a minimum of 2 Geoprobe® borings near the southern end of the landfill. The borings will be advanced to approximately 5 feet into the native soil underlying the fill, or to refusal.	Better estimate the depth of the paper residuals along the property boundaries with 12th Street, the asphalt plant to the southwest, and with the State property to the southeast, in order to reduce uncertainties in designing the final landfill grades.
Gas Monitoring	Measure gas concentrations (methane, oxygen, and carbon dioxide) and pressures at the existing groundwater monitoring wells screened in the vadose zone (MW-6A, MW-7A, and MW-8A). In addition, measure gas concentrations at each Geoprobe® boring used to better estimate the depth of the paper residuals along the property boundaries to the southwest and to the southeast.	To collect readily accessible information about the subsurface landfill gas conditions at the 12th Street Landfill that may be useful in designing a passive gas venting system.

Note:
[1] In the event that in-field conditions limit the use of test pit excavating equipment (*e.g.*, a backhoe), other tools, such as hand augers or shovels, may be used instead.

Table 2-4
Summary of Test Pit Sample Types and Locations

Type of Sample	Assumed Location/ Estimated Sample Number	Purpose
Test Pit Samples	Oil Impacted Soil Area – Estimated 10 test pits	Test pits will be used to identify the source of the oil impacted soil as well as the extent of area impacted. Test Pits will also be used to inspect the area in the vicinity of the oil impacted soil. A minimum of one sample per test pit will be collected and analyzed for PCBs and total petroleum hydrocarbons. A minimum of one sample per test pit will be collected and analyzed for PCBs and total petroleum hydrocarbons.
	Elevated PCB Area – Estimated 5 test pits along the bank of the Kalamazoo River	Test pits will be used to evaluate whether the two areas of concern are related and whether NAPL, if present is the cause of the high PCB concentrations observed and if there is potential for NAPL to enter the river. A minimum of one sample per test pit will be collected and analyzed for PCBs and total petroleum hydrocarbons. A minimum of one sample per test pit will be collected and analyzed for PCBs and total petroleum hydrocarbons.

Table 2-5
Summary of Groundwater Sample Types and Locations

Type of Sample	Assumed Location/ Estimated Sample Number	Purpose
Groundwater Samples	Mill Buildings Area – Install five groundwater wells and two staff gages. Northcentral Portion of the Site – Install three groundwater wells. Former Wastewater Sludge Dewatering Lagoons – Install four groundwater wells and one staff gage.	Groundwater well samples will provide additional information on groundwater quality for comparison to applicable ARARs and completion of the risk assessment. In addition, groundwater wells will provide key information regarding the interface between the groundwater system and the river system and the direction of the groundwater gradient at the site.
Staff Gage	Three staff gages will be placed along the bank of the Plainwell Mill. The first will be placed at the upstream end of the Mill Race. The second gage will located near the mill buildings in the Kalamazoo River and the third downstream near the wastewater sludge dewatering lagoons.	Staff gages will be used in conjunction with the groundwater wells to determine the groundwater flow direction onsite. In addition, the slope of the river along the bank of the Plainwell Mill.

Table 2-6
Summary of Sample Types and Locations
(Remedial Action for the 12th Street Landfill)

Type of Sample	Assumed Location	Purpose
Verification Soil Sampling[1]	***MDNR's Property*** – Collect approximately nine soil samples at the base and sidewalls of the excavation, and analyze the samples for PCBs. ***Asphalt Plant Property*** – Collect approximately 13 soil samples at the base and sidewalls of the excavation, and analyze the samples for PCBs and VOCs.	To demonstrate compliance with the lowest of the Part 201 GRCC in *Table 2. Soil: Residential and Commercial I*, of the MDEQ's Remediation and Redevelopment Division's Operational Memorandum No. 1 (January 23, 2006). For PCBs, the applicable criterion is 4 mg/kg, which is the criterion for direct contact.
Ambient Air Monitoring for Fugitive Dust	Collect real-time ambient particulate measurements at locations that are downwind of activities that have the potential to create fugitive dust. Collect samples at three to four locations on the landfill property line, three times each day during such activities (i.e., a total of 9 to 12 measurements per day).	To demonstrate compliance with the administrative rules promulgated pursuant to Part 55, Air Pollution Control, of the Natural Resources and Environmental Protection Act (NREPA).
Ambient Air Monitoring for VOCs	Collect VOC measurements with a photoionization detector (PID) during work at the landfill in which paper residuals will be exposed, at background locations, in the workers' breathing zone, and if necessary, at the downwind property line.	To determine if ambient VOC concentrations are at acceptable levels for compliance with the site health and safety plan.
Surface Water Monitoring	Record surface water turbidity concentrations at two locations, including an upstream location and a downstream location, during the placement of additional riprap along the riverbank.	To determine if the turbidity reading at the downstream location is within two times the result for the upstream location.
Landfill Gas Monitoring	Collect gas samples from six gas probes and 20 gas vents, and determine combustible gas, carbon dioxide, and oxygen concentrations. Pressure will also be recorded at the gas probes.	To demonstrate that combustible gas and other decomposition gases generated by the landfill are not traveling laterally from the landfill or accumulating within structures, and to demonstrate that the concentration of combustible gas is below the Lower Explosive Limit (LEL) at the property line.
	Assess nuisance odors at the property line.	To demonstrate that nuisance odors are not present at the property line.

Table 2-6 (continued)
Summary of Sample Types and Locations
(Remedial Action for the 12th Street Landfill)

Type of Sample	Assumed Location	Purpose
Groundwater Monitoring[2]	Collect groundwater samples from a total of seven shallow groundwater monitoring wells. Measure field parameters, including turbidity, temperature, pH, and conductivity.	To demonstrate compliance with the State of Michigan Part 201 groundwater–surface water interface (GSI) criteria (MDEQ, 2006), for those analytes specified in the ROD (Target Analyte List [TAL] inorganics, Target Compound List [TCL] organics, PCBs, and dioxins).

Note:

(1) The actual number of soil samples will be determined using a systematic random sampling strategy, following the MDEQ's S³TM guidance (see Section 6.1.2 of the Design Report [RMT, 2008] for a detailed discussion).

(2) See the groundwater monitoring plan in the Performance Standards Verification Plan (RMT, 2008) and Section 8.1 in the Design Report (RMT, 2008) for a detailed discussion of parameters, locations, and sampling frequency.

TABLE 2.7
SUMMARY OF PROPOSED SAMPLING ACTIVITIES
MULTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

ACTIVITY/ LOCATION	PROPOSED ASSESSMENT LOCATION			RATIONALE FOR LOCATION SELECTION	SAMPLE/DATA COLLECTION DETAILS	SAMPLE MATRIX	FIELD SCREENING	LABORATORY PARAMETERS	SAMPLE LOCATIONS	INVESTIGATIVE SAMPLES	QUALITY CONTROL SAMPLES			TOTAL NUMBER OF SAMPLES
	DESIGNATION	TYPE	DEPTH (FT BGS)								TRIP BLANKS	FIELD DUPLICATES	MS/MSDS	
Soil Sampling														
Lagoon A through N	SB-106 through SB-133	Soil Boring	20	Confirmation and determination of paper waste	- Collection of surface soil samples - Sampling Program 1 [5]	Soil	Visual and Olfactory Evidence of Impact and PID Screening	TCL VOCs TCL SVOCs TAL Metals SPLP Metals [1] PCBs General Chemistry [2]	28	112	--	12	6	130
Lagoon J (SB-2)	MW-13	Monitoring Well Vertical Aquifer Testing	20 (MW)	Determine the groundwater chemistry at the depth of the residual waste buried within the former lagoon area.					1	4	--	--	--	4
SGWB-2	MW-14	Monitoring Well	20	To determine background groundwater chemistry south of the lagoons					1	4	--	1	1	6
Former Secondary Clarifier	MW-15	Monitoring Well	20	To determine groundwater impacts associated with historical operations					1	4	--	--	--	4
Former Secondary Clarifier	SB-138 SB-139 SB-140 SB-141	Soil Boring	20	To determine extent of impact surrounding the former secondary clarifier					4	16	--	2	1	19
Aeration Basin	SB-137	Soil Boring	20	To determine extent of impact surrounding the aeration basin					1	4	--	--	--	4
Areas adjacent to the lagoons and Aeration Basin	SB-134 SB-135 SB-136	Soil Boring	20	To define historical morphing of the sizes of the lagoons and the aeration basin					3	12	--	1	--	13
North of Lagoon Area	SB-101 SB-102 SB-103 SB-104 SB-105	Soil Boring	20	To determine extent of potential paper waste north of the lagoon area adjacent to the Kalamazoo River					5	20	--	2	1	23
Wooded Area	SB-142 to SB-145 SS-100 to SS-107	Soil Boring/ Hand Auger	20	To confirm no impacts associated with historical operations within this area. Location of samples will be dependant based on inspection of the area.	- Collection of one surficial soil sample at all locations (SS and SB) -Sampling Program 2 [6] at proposed soil boring (SB) locations				12	20	--	2	1	23
Soil Physical Properties	SB-134 SB-135 SB-136 SB-137	Soil Boring/ Hand Auger	5	Collection of samples to determine the potential for vapor intrusion through native soil materials within the unsaturated zone	- Collection of one sample from what is field screened as native material within the vadose zone			Soil Physical Properties [3]	5	5	NA	NA	NA	5
								Soil Sampling Total	*61*	*201*	*0*	*20*	*10*	*231*
Groundwater Sampling														
MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14, MW-15	--	Groundwater Sample	--	To confirm on-Site groundwater quality	- Completion of a monitoring well inspection - Collection of groundwater levels and surface water levels (at associated staff gauges) - Collection of one groundwater sample per location	Groundwater	pH, Conductivity, Temperature, Dissolved Oxygen, ORP, Turbidity	TCL VOCs TCL SVOCs PCBs TAL Inorganics [4]	8	8	3	1	1	13
MW-13	VA-1	Vertical Aquifer Sampling - Groundwater Samples	40	Complete vertical aquifer testing to determine groundwater conditions below the confining unit	- Collection of groundwater samples every 5 feet until the confining layer is reached or 40 feet bgs			TCL VOCs TCL SVOCs TAL Metals (filtered and unfiltered)	1	8	2	1	--	11
								Groundwater Sampling Total	*9*	*16*	*5*	*2*	*1*	*24*

Notes:
Please see Page 4 for Notes and Sampling Program Details

TABLE 2.7
SUMMARY OF PROPOSED SAMPLING ACTIVITIES
MULTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

ACTIVITY/ LOCATION	PROPOSED ASSESSMENT LOCATION			RATIONALE FOR LOCATION SELECTION	SAMPLE/DATA COLLECTION DETAILS	SAMPLE MATRIX	FIELD SCREENING	LABORATORY PARAMETERS	SAMPLE LOCATIONS	INVESTIGATIVE SAMPLES	QUALITY CONTROL SAMPLES			TOTAL NUMBER OF SAMPLES
	DESIGNATION	TYPE	DEPTH (FT BGS)								TRIP BLANKS	FIELD DUPLICATES	MS/MSD	
Soil Sampling														
TP-17 and TP-18	SB-201 SB-202 SB-203 SB-204	Soil Boring	20	Confirmation of noted potential contamination associated with the former Transformer Pad	- Collection of one surfical soil samples from each location - Sampling Program 1 (5)	Soil	Visual and Olfactory Evidence of Impact and PID Screening	TCL VOCs TCL SVOCs TAL Metals SPLP Metals (1) PCBs General Chemistry (2)	4	16	--	1	1	18
Mill Building Outflow Points	TBD	Hand Auger	2	Inspection and confirmation of capped outflows from the Mill Buildings	- Surface sampling only to be conducted if impacts are suspected from field screening				4*	4*	--	1*	1*	6*
Mill Building	TBD	Hand Auger	2	Inspection of soils around the perimeter of the Mill Buildings	- Surface sampling only to be conducted if impacts are suspected from field screening				5*	5*	--	--	--	5*
North East of Mill Building	MW-16	Monitoring Well	20	Installation of monitoring well to determine hydraulic connection with the Mill Race	- Sampling Program 1 (5) -Collection of one surficial soil sample				1	4	--	--	--	4
South Parking Lot	MW-17	Monitoring Well	20	Installation of monitoring well to determine hydraulic connection with the Mill Race	- Sampling Program 2 (6) - Collection of one surficial soil sample				1	4	--	1	--	5
South Parking Lot and BK5	TP-201 TP-202 TP-203	Test Pit	10	-Confirm the presence of fill material beneath the parking lot area -Determine potential impacts with historical activities	- Sampling Program 2 (6) - Collection of surface samples at all test pit locations				3	12	--	1	1	14
Soil Physical Properties	SB-201 SB-202	Soil Boring/ Hand Auger	5	Collection of samples to determine the potential for vapour intrusion through native soil materials within the unsaturated zone	- Collection of one sample from what is field screened as native material within the unsaturated, vadose zone			Soil Physical Properties (3)	2	2	NA	NA	NA	1
								Soil Sampling Total	20	47	0	4	3	53
Groundwater Sampling														
MW-1, MW-3, MW-4, MW-5, MW-16 MW-17	--	Groundwater Sample	--	To Confirmation of on-Site groundwater chemistry	- Completion of a monitoring well inspection - Collection of groundwater and surface water levels (at associated staff gauges) - Collection of one groundwater sample per location	Groundwater	pH, Conductivity, Temperature, Dissolved Oxygen, ORP, Turbidity	TCL VOCs TCL SVOCs PCBs TAL Inorganics	6	6	3	1	1	11
MW-4	VA-2	Vertical Aquifer Testing-Groundwater Samples	40	Complete vertical aquifer testing to determine groundwater conditions below the confining unit	- Collection of groundwater samples every 5 feet until the confining layer is reached or 40 feet bgs			TCL VOCs TCL SVOCs TAL Metals (filtered and unfiltered)	1	8	2	1	--	11
								Groundwater Sampling Total	7	14	5	2	1	22
Surface Water Sampling														
Mill Race and Kalamazoo River	SW-001 SW-002	Surface Water Sample	--	Confirm surface water quality of the Mill Race and Kalamazoo River related to mercury. Determine analytical data needed for data comparison.	- Collection of two surface water samples -Collection of surface water levels	Water	pH, Conductivity, Temperature, Dissolved Oxygen, ORP, Turbidity	Low level Mercury Methyl Mercury Hardness	2	2	--	1	--	3
								Surface Water Sampling Total	2	2	0	1	0	3

Notes:
Please see Page 4 for Notes and Sampling Program Details

TABLE 2.7
SUMMARY OF PROPOSED SAMPLING ACTIVITIES
MULTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

ACTIVITY/ LOCATION	PROPOSED ASSESSMENT LOCATION			RATIONALE FOR LOCATION SELECTION	SAMPLE/DATA COLLECTION DETAILS	SAMPLE MATRIX	FIELD SCREENING	LABORATORY PARAMETERS	SAMPLE LOCATIONS	INVESTIGATIVE SAMPLES	QUALITY CONTROL SAMPLES			TOTAL NUMBER OF SAMPLES
	DESIGNATION	TYPE	DEPTH (FT BGS)								TRIP BLANKS	FIELD DUPLICATES	MS/MSD, MS/DUP	
Soil Sampling														
DG3 and DG4 (Area 3)	SB-301, SB-302	Soil Boring	20	Confirmation of impact noted in historical sampling	- Collection of one surface soil sample at each borehole location - Sampling Program 1 [5]	Soil	Visual and Olfactory Evidence of Impact and PID Screening	TCL VOCs, TCL SVOCs TAL Metals SPLP Metals [1] PCBs General Chemistry [2]	2	8	--	1	1	10
SGWB-10	MW-18	Monitoring Well	20						1	4	--	--	--	4
SGWB-3	SB-321	Soil Boring	20						1	4	--	1	--	5
Coal Pile Storage Area (Area 3C)	TP-308 TP-309 TP-310 TP-311 TP-312 TP-313 TP-314 TP-315	Test Pit	10	Confirmation of extent of coal impacts	- Collection a minimum of 5 surface soil samples - Sampling Program 2 [6]				8	29	--	2	1	32
No. 6 Fuel Oil Tank Area (Area 3D)	SB-303 SB-304 SB-305 SB-306 SB-307	Soil Boring	10	Confirmation of impacted soil removal activities	- Sampling Program 3 [7]				5	20	--	3	1	25
SGWA-5 (Area 3D)	MW-19	Monitoring Well	20	Confirmation of historical groundwater impacts	- Collection of one surficial soil sample-Sampling Program 2 [6]				1	4	--	--	--	4
Former Coal Tunnel (Area 3E)	SB-308 SB-309 SB-310 SB-311 SB-312	Soil Boring	10	Confirmation of potential contamination noted in historical sampling	- Collection a minimum of 3 surface samples - Sampling Program 2 [6]				5	18	--	1	1	20
Undeveloped Lands	TP-301 TP-302 TP-303 TP-304 TP-305 TP-306 TP-307	Test Pit	10	-Confirm the presence of fill material beneath the parking lot area -Determine potential impacts with historical activities	- Collection of surficial soil samples - Sampling Program 2 [6]				7	28	--	2	1	31
Soil Physical Properties (Undeveloped Lands)	TP-302	Soil Boring/ Hand Auger	5	Collection of samples to determine the potential for vapour intrusion through native soil materials within the unsaturated zone	- Collection of one sample from what is field screened as native material within the vadose zone			Soil Physical Properties [3]	1	1	NA	NA	NA	1
								Soil Sampling Total	31	116	0	10	5	131
Groundwater Sampling														
MW-2, MW-6, MW-7, MW-18, MW-19	--	Groundwater Sample	--	Confirmation of on-Site groundwater chemistry	- Completion of a monitoring well inspection - Collection of groundwater and surface water levels (at associated staff gauges) - Collection of one groundwater sample per location	Water	pH, Conductivity, Temperature, Dissolved Oxygen, ORP, Turbidity	TCL VOCs TCL SVOCs PCBs TAL Inorganics [4]	5	5	2	1	1	9
								Groundwater Sampling Total	5	5	2	1	1	9

Notes:
Please see Page 4 for Notes and Sampling Program Details

TABLE 2.7
SUMMARY OF PROPOSED SAMPLING ACTIVITIES
MULTI-AREA FIELD SAMPLING PLAN
FORMER PLAINWELL, INC. MILL PROPERTY
PLAINWELL, MICHIGAN

Notes:

(1) Soil samples for analysis of SPLP will be collected and placed on hold pending results of TAL metal analysis
(2) General Chemistry - Nitrogen compounds and phosphorous
(3) Soil Physical Properties- grain size analysis, dry bulk density, porosity, moisture content, fraction of organic carbon
(4) TAL Inorganics- TAL Metals plus low level mercury, methly mercury, and cyanide

(5) Sampling Program 1
- One surficial soil sample will be collected as indicted in Tables
- One biased soil sample will be collected from what has been deemed fill material from a depth of 2 to 10 feet bgs based on field screening. If no impacts are noted, one soil sample will be collected from 0 to 2 feet above the interface between the fill and native material within the vadose zone
- One soil sample from 0 to 2 feet below the observed impact will be collected. If no impact is observed the soil sample will be collected from 0 to 2 feet below the interface of the fill/ native material within the vadose zone
- One soil sample will be collected from the vadose zone, 0 to 2 feet above the saturated zone.

(6) Sampling Program 2
- One surficial soil sample will be collected as indicted in Tables
- If no impact noted, a discrete soil sample will be collected from 0 to 2 feet abovebelow the interface of the vadose and saturated zone. If impact noted one soil sample will be collected within 2 to 10 feet bgs and a third sample collected from 0 to 2 feet above the interface of vadose and saturated zone

(7) Sampling Program 3
- One surficial soil sample will be collected
- One soil sample will be collected from the fill material which is expected to be at approximately depths of 2 to 10 feet bgs based on field screening methods. Soil borings not exhibiting any evidence of impact will be sampled at 0 to 2 feet above the interface of fill/native material within vadose zone
- One soil sample will be collected from 0 to 2 feet below the observed contamination. If no evidence of impact is observed the soil sample will be collected from 0 to 2 feet below the interface of fill/native material within vadose zone
- One soil sample will be collected from vadose zone at 0 to 2 feet above the saturated zone

* Sampling to be conducted if necessary, the noted number of locations are subject to change depending on field findings.
bgs - below ground surface
MS/MSDs - Matrix Spike/Matrix Spike Duplicates
SPLP - Synthetic Precipitation Leaching Procedure
TAL - Target Analyte List
TCL - Target Compound List
VAS- Vertical Aquifer Sampling
VOC - Volatile Organic Compound
SVOC - Semi-Volatile Organic Compound
TBD - To be determined
PCBs - Polychlorinated Biphenyls
ORP - Oxidation-Reduction Potential
PID - Photoionization Detector
NA - Not Applicable
- Surficial Soil sample will be collected from 0 to 1 foot bgs. If non-soil materials are present (i.e., gravel fill or concrete slab) the soil sample will be collected from 0 to 1 foot below the non-soil material.
- Field Screening will consist of PID readings to determine the presence of undifferentiated volatile organic vapors, visual screening for lithologic changes, stained soils, residuals, and olfactory evidence of impacts
- Collect soil samples on a continuous basis at 2 feet intervals
- Collection of all samples as per Field Sampling Plan and Quality Assurance Project Plan including the references listed below
- Samples to be submitted on a regular turn around time
- All necessary MS/MSDS and Field Duplicates will be added where required
- Groundwater samples will be collected using low flow techniques
- VAS samples will be collected with a bailer and TAL Metals will filtered and unfiltered for metals analysis
- Test pit length is 5 to 10 feet

Field Sampling References:

Sample Type	*Reference Document*	*Procedure*
Soil Sampling with Direct Push Sampler	FSP	Standard Operating Procedure F-5
Surficial Soil Sampling	FSP	Standard Operating Procedure F-6
Excavation and Test Pits and Test Pit Soil Sampling	FSP	Standard Operating Procedure F-8
Photoionization Detector (PID) Screening	FSP	Standard Operating Procedure F-9
Monitoring Well Installation	FSP	Standard Operating Procedure F-15
Groundwater Sampling	FSP	Standard Operating Procedure F-11
Surface Water Sampling	FSP	Standard Operating Procedure F-16
Staff Gauge Installation and Measurement	FSP	Standard Operating Procedure F-10
Vertical Aquifer Sampling	FSP	Standard Operating Procedure F-17
Sample Handling and Analysis/ Quality Assurance	FSP/ QAPP	Section 4/ Section 4.4.4 (with reference to QAPP Worksheets)
Sample Labeling	FSP	Section 3.1
Chain-of-Custody Records	FSP	Section 3.3
Management of Investigation-derived Waste	FSP	Section 6.0
Field Physical Measurements/ Surveying	FSP	Section 5.0/ Section 5.1
Hand Auguring	FSP	Standard Operating Procedure F-6

ATTACHMENTS

ATTACHMENT A

STANDARD OPERATING PROCEDURES

Table A-1
Standard Operating Procedures
Applicable for Corresponding Operable Units

SOP		Operable Unit
F-1	Water Sampling and Field Measurement Procedures	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 5 – Kalamazoo River Operable Unit No. 7 – Plainwell Mill site
F-2	Surface Water Flow Measurement Procedures	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 5 – Kalamazoo River Operable Unit No. 7 – Plainwell Mill site
F-3	Water Treatment System Monitoring Procedures	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 5 – Kalamazoo River Operable Unit No. 7 – Plainwell Mill site
F-4	Sediment Sampling	Operable Unit No. 5 – Kalamazoo River
F-5	Soil Sampling with Direct Push Sampler	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-6	Surficial and Shallow Subsurface Soil Sampling	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-7	Landfill Gas Monitoring	Operable Unit No. 4 – 12th Street Landfill site
F-8	Excavation of Test Pits and Test Pit Soil Sampling	Operable Unit No. 7 – Plainwell Mill site
F-9	Photoionization Detector (PID) Screening	Operable Unit No. 7 – Plainwell Mill site
F-10	Staff Gage Installation and Measurement	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 5 – Kalamazoo River Operable Unit No. 7 – Plainwell Mill site
F-11	Groundwater Sampling and Field Measurement Procedures	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-12	Ambient Air Monitoring for Fugitive Dust	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-13	Ambient Air Monitoring for VOCs	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-14	Real-Time Turbidity Measurement Procedures for Surface Water	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-15	Monitoring Well Installation Procedures	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site

Table A-1
Standard Operating Procedures
Applicable for Corresponding Operable Units

SOP		Operable Unit
F-16	Surface Water Sampling Procedure	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site
F-17	Vertical Aquifer Sampling Procedure	Operable Unit No. 4 – 12th Street Landfill site Operable Unit No. 7 – Plainwell Mill site

Standard Operating Procedure F-1
Water Sampling and Field Measurement Procedures

This standard operating procedure (SOP) sets forth the field procedures for the collection of water column samples via boat, sampling from shore, or sampling from a bridge. Water column samples will be collected using a stainless steel Kemmerer water sampler, utilizing a peristaltic pump with Teflon tubing, or using an ISCO automated sampler. Samples collected downstream of construction to monitor TSS and PCB transport will utilize an ISCO automated sampler. Treated water from construction activities will be obtained using a direct grab sampling method.

Decontamination Procedures for Nondedicated Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

The submersible pumps are not designed to withstand acid rinsing. Decontamination of this equipment will therefore consist of washing the downhole portions of the equipment with nonphosphate detergent and rinsing with DI or distilled water.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. Details regarding the decontamination of field equipment is included in the sampling procedures described below. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Appendix 7 (MDEQ, 2004).

The field decontamination of sampling equipment will take place at the sampling location. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination pad for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Appendix 7 (MDEQ, 2004).

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material.

Water Column Sampling Procedures

Water column samples will be collected using a stainless steel Kemmerer water sampler, a peristaltic pump with Teflon tubing, or a discrete grab sample in appropriate sample containers. The sample collection method will be determined based on river flow, water depth, and site conditions at the time of collection. The Kemmerer sample collection device is lowered to the appropriate sample depth on a cable in an open position and a weighted messenger is sent along the cable to trip the sampler closed. The peristaltic pump with disposable silicone pump tubing and Teflon sample tubing is lowered to depth and directly pumps water from the river. Grab sample collection is utilized for shallow water river conditions or when collecting water out of a sample port for water treatment system evaluation.

Prior to initiating field activities, the water quality meter will be calibrated according to the manufacturer's instructions and the calibration data recorded in the logbook or on the Water Quality Meter Calibration Log. The procedures for collection of water column samples are provided below.

1. Record the sample location on the sample log or in field notebook along with other appropriate information [include a sketch indicating location relative to shore features, if appropriate].
2. Don health and safety equipment (as required by the Multi-Area HSP).
3. Decontamination of the sampling equipment prior to initial use, between sampling at each transect, and at the completion of sampling as follows: distilled water rinse; acetone rinse; hexane triple rinse; and distilled water triple rinse. All decontamination rinsate water will be contained in a MDOT-approved container. If using a peristaltic pump with disposable tubing or a discrete grab sample into appropriate lab supplied glassware, no equipment cleaning is needed.
4. Prepare one rinse-blank sample prior to and after sampling activities, by pouring deionized water supplied by the laboratory through the cleaned Kemmerer and filling the sample containers as described in Steps 8 and 9. If a peristaltic pump and Teflon tubing or a discrete grab sample is used, no rinse blanks are required.
5. Measure the total depth of the water column. Initial field checks with a survey rod will be performed to confirm accuracy.
6. Lower the water sampler to 0.8 times the total water column depth and either release the trigger on the Kemmerer, start peristaltic pump, or lower sample bottle.
7. Raise the water sampler from the water column with minimal disturbance, continue to pump river water, or secure grab sample jars.
8. Remove the covers from the appropriate laboratory supplied containers and slightly tilt the mouth of the container below the sampling device.
9. Empty the sampler slowly, allowing the sample stream to flow gently down the side of the sample container (with minimal entry turbulence).

10. Repeat Steps 6 through 9 for collection of sample at 0.2 times the total water column depth.
11. Repeat Steps 5 through 10 at the other river locations.
12. At each station, collect field measurements for temperature, pH, turbidity, conductivity, and DO at 0.2 and 0.8 times the total water column depth record results on the appropriate in the field logbook or Surface Water Sampling Log.
13. Secure all sample jar caps tightly.
14. Label all sample containers.
15. Place filled sample containers on ice in a cooler.
16. Collect field duplicate and matrix spike (MS) and matrix spike duplicate (MSD) samples during each sampling event. Field duplicates and MS/MSD samples will be prepared by filling additional sets of sample containers with water collected at the same time and depth. One additional set of sample containers will be filled for field duplicates and two sets of containers will be filled for MS/MSD samples.
17. Follow procedures for preservation of samples and packing, handling, and shipping with associated chain-of-custody procedures for samples
18. Record required information in the field logbook or Surface Water Sampling Log.

Continuous Water Column Sampling Procedures During Construction

Three movable YSI Sonde units, each equipped with probes to measure dissolved oxygen, turbidity, pH, conductivity, and temperature will be used upstream and two locations downstream of the construction area. The YSI logs the above data at predetermined time intervals. The unit will be programmed to sample hourly during construction operations. The data will be downloaded daily onto a computer hard drive for backup.

Calibration Procedures - The YSI will be calibrated weekly in accordance with manufacturer's instructions. Calibration information will be recorded in the field logbook.

Operation Procedures - The YSI will be operated according to the manufacturer's instructions.

Maintenance Procedures - The YSI will be maintained according to the manufacturer's instructions. Maintenance information will be recorded in the field logbook. A replacement meter and probes will be available onsite or ready for overnight shipment, as necessary.

The units will be placed within a perforated PVC pipe for protection and anchored to the river bottom. A buoy will be attached to the PVC pipe for accessibility, and the unit attached to shore for security. In addition to the Sonde units, a sampling line will also connected to tubing which feed to an ISCO sampler located on shore for discreet sampling of the water throughout the construction activities. Samples will be taken every 15 minutes during material placement.

The water sample that corresponds to the highest turbidity reading over the placement period should be submitted to WATS laboratory for analysis of Total Suspended Solids (TSS), Volatile Suspended Solids (VSS) and polychlorinated biphenyls (PCBs).

Collection Procedures - The procedures for collection of water column samples using the YSI and ISCO sampler are provided below.

1. Record the sample location on the sample log or in field notebook along with other appropriate information [include a sketch indicating location relative to shore features, if appropriate].
2. Measure the total depth of the water column at mid-river location using a portable depth finder. Initial field checks with a survey rod will be performed to confirm accuracy.
3. Place Sonde unit and ISCO intake tubing at a mid-river location, if possible. Attach the tubing to the upstream side of the monitoring using cable ties. Depending upon site conditions, placement of a station at mid-river may not be safe or feasible. In this event, water samples may be collected from a pier or boat.
4. Set the ISCO composite sampler and portable power source on shore and attach to an immovable object (tree, fence, etc) to deter theft/vandalism.
5. Place necessary glassware in the sampler and surround glassware with up to 20 pounds of ice.
6. Attach the intake tubing to the tubing in the pump head. Ensure that the tubing slopes downhill from the pump head to the intake point to ensure draining between sampling events.
7. Program the sampler according the manufacturers instructions including two rinse cycles prior to collection. Set the appropriate sample time and volume to fill an individual container. Ensure that the sampler is in "Run" mode prior to leaving the sampler. Close the top of the sampler for protection against the elements.
8. Retrieve the sample containers from the ISCO sampler upon completion of the timed sampling event.
9. Download the information from the Sonde unit for the timed sampling event.
10. Match the highest turbidity readings from the Sonde unit with the corresponding ISCO sample.
11. Remove the covers from the appropriate laboratory supplied containers and slightly tilt the mouth of the container below the ISCO sample container.
12. Empty the sample container slowly, allowing the sample stream to flow gently down the side of the laboratory supplied sample container (with minimal entry turbulence).
13. Secure all sample jar caps tightly.
14. Label all sample containers.
15. Place filled sample containers on ice in a cooler.
16. Collect field duplicate and matrix spike (MS) and matrix spike duplicate (MSD) samples during each sampling event or as required. Field duplicates and MS/MSD samples will be prepared by filling additional sets of sample containers with water collected at the same time and depth. One additional set of sample containers will be filled for field duplicates and two sets of containers will be filled for MS/MSD samples.
17. Follow procedures for preservation of samples and packing, handling, and shipping with associated chain-of-custody procedures for samples.

18. Record required information on the field logbook or Surface Water Sampling Log.
19. Follow appropriate decontamination procedures describe above for the sample equipment as necessary.

Standard Operating Procedure F-2
Surface Water Flow Measurement Procedures

This standard operating procedure (SOP) describes the field procedures for determining surface water flow at a river transect. In general, these procedures include dividing the width of the channel conveying flow into segments and measuring the average velocity and cross-sectional area of each segment. The total flow is then calculated as the sum of the product of average flow velocity and cross-sectional area of each segment.

Decontamination Procedures for Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

The submersible pumps are not designed to withstand acid rinsing. Decontamination of this equipment will therefore consist of washing the downhole portions of the equipment with nonphosphate detergent and rinsing with DI or distilled water.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. Details regarding the decontamination of field equipment is included in the sampling procedures described below. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Appendix 7 (MDEQ, 2004).

The field decontamination of sampling equipment will take place at the sampling location. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination pad for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Appendix 7 (MDEQ, 2004).

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material.

Surface Water Flow Measurement Procedures

The general procedures to be followed when obtaining surface water flow measurements at a river or creek transect are described below.

The following materials will be available, as required, during water column sampling:

- health and safety equipment to be worn when working around surface water, as described in the Multi-Area Health and Safety Plan (HSP)
- field notebook and pen
- calculator
- rope
- survey rod
- duct tape
- 200-foot measuring tape
- electromagnetic velocity meter

Surface Water Flow Measurement Sampling Procedures

The following procedures will be used to determine the velocity profile at a cross-section:

1. Measure the width of the water body, then divide and mark into equally spaced measurement locations. For water bodies less than 30 feet in width, the spacing should be 5 feet. For water bodies between 30 feet and 100 feet in width, the spacing should be 10 feet. For water bodies greater than 100 feet in width, the spacing should be 20 feet.
2. Calibrate the velocity meter according to manufacturer's specifications.
3. Lower the survey rod and measure and record the water depth to the nearest 0.1 foot at each measurement location in the field logbook or on the Velocity Profile Measurement Log. Measurements should be collected at the center of each 5-foot (or 10- or 20-foot) increment.
4. Velocities will be determined using the two-point method. Attach the velocity meter probe to the survey rod, measure and record the velocity in feet per second at depths equaling 0.2 and 0.8 times the total depth at each measurement location. Average the two velocity measurements to obtain the average velocity for that vertical section. Record all measurements in the field logbook or on the Velocity Profile Measurement Log.

5. Calculate the average total flow by multiplying the average velocity reading times the cross-sectional area of the 5-foot (or 10- or 20-foot) increment. The cross-sectional area is determined by multiplying the width of the increment (*i.e.,* 5, 10, or 20 feet) times the average water depth within that increment. The total flow is the sum of the velocity times the area for each increment and can be calculated using the following formula:

$$QT = V1\ A1 + V2\ A2 + ... + Vn\ An$$

where:

QT = Total flow in cubic feet per second

V1-n = Average velocity for a vertical section (feet per second)

A1-n = Cross-sectional area of each increment (square feet)

6. For flow measurements at bridges, water surface will be measured using a weighted rope or tape measure as a "tape down" distance from a distinct reference point on the bridge.
7. Surface water flow measurement locations and "tape down" locations will be recorded in a field notebook sketch as appropriate.
8. Conduct appropriate decontamination procedures described above.

Standard Operating Procedure F-3
Water Treatment System Monitoring Procedures

This standard operating procedure (SOP) describes the field procedures for collection of in-field water treatment system measurements including grab samples for PCB analysis at the influent, intermediate stage and effluent of the water treatment system, grab samples for TSS at the effluent of the water treatment system and grab samples for phosphorus at the effluent of the water treatment system.

Decontamination Procedures for Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Appendix 7 (MDEQ, 2004).

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material.

Water Treatment System Monitoring Procedures

Grab samples of surface water will be collected at a specified frequency during the response activities for PCB analysis. Surface water samples will be collected from the influent, at the intermediate stage and at the effluent of the water treatment system. Surface water grab samples will be collected at the effluent of the water treatment system for phosphorus and TSS monitoring at a specified frequency during the response activities. Turbidity measurements will also be collected during the water treatment system operation activities. The general procedures to be followed when the surface water grab samples are

collected or measurements taken are outlined below. Specific analytical methods are described in the QAPP.

The procedures for collection of water treatment system grab samples are provided below.

1. Record the surface water grab sample location (*i.e.* effluent, influent) on the sample log or in field notebook along with other appropriate information [include a sketch indicating location of sample relative to the water treatment system].
2. Don health and safety equipment (as required by the Multi-Area HSP).
3. Collect the grab samples by quickly immersing the specified sample container with the mouth of the container pointing towards the influent.
4. Raise the sample jar from the water with minimal disturbance and secure the jar.
5. At each station, collect field measurements for temperature, pH, turbidity, conductivity, and DO and record results in the field logbook or Surface Water Sampling Log.
6. Secure all sample jar caps tightly.
7. Label all sample containers.
8. Place filled sample containers on ice in a cooler.
9. Collect field duplicate and matrix spike (MS) and matrix spike duplicate (MSD) samples during each sampling event. Field duplicates and MS/MSD samples will be prepared by filling additional sets of sample containers with water collected at the same time and depth. One additional set of sample containers will be filled for field duplicates and two sets of containers will be filled for MS/MSD samples.
10. Follow procedures for preservation of samples and packing, handling, and shipping with associated chain-of-custody procedures for samples.
11. Follow appropriate decontamination procedures described above.
12. Record required information in the field logbook or Surface Water Sampling Log.

Standard Operating Procedure F-4
Sediment Sampling

This standard operating procedure (SOP) is applicable to the collection of representative sediment samples. The methodologies discussed in this SOP are applicable to the sampling of sediment in both flowing and standing water. They are generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. Modifications of sampling methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, sediments are those mineral and organic materials situated beneath an aqueous layer.

Method Summary

Sediment samples may be collected using a variety of methods and equipment, depending on the depth of the water, the portion of the sediment profile required (surface vs. subsurface), the type of sample required (disturbed vs. undisturbed), contaminants present, and sediment type. Sediment is collected from beneath the water either directly, using a hand held device such as a shovel, trowel, or auger; or indirectly, using a device such as an Ekman or Ponar dredge. Following collection, sediment is transferred from the sampling device to a sample container of appropriate size and construction for the analyses requested. If composite sampling techniques are employed, multiple grabs are placed into a container constructed of inert material, homogenized, and transferred to sample containers appropriate for the analyses requested.

Equipment/Apparatus

Equipment needed for collection of sediment samples may include:

- Maps/plot plan
- Safety equipment
- Compass
- Tape measure
- Survey stakes, flags, or buoys and anchors
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels

- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spade or shovel
- Spatula
- Scoop
- Trowel
- Bucket auger
- Tube auger
- Extension rods
- "T" handle
- Sediment coring device (tube, suction head, extension rods, "T" handle)
- Ponar dredge
- Ekman dredge
- Nylon rope or steel cable
- Messenger device

Decontamination Procedures

Decontamination Prior to Sampling

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material.

In-Field Sampling Decontamination Procedures

As described above, this sampling protocol describes multiple methods for sediment sample collection. The decontamination procedures described below will be relied upon in the field as appropriate for equipment decontamination.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. Details regarding the decontamination of field equipment is included in the section below. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Appendix 7 (MDEQ, 2004).

The field decontamination of sampling equipment will take place at the sampling location. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination pad for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Appendix 7 (MDEQ, 2004).

Sample Collection

Selection of a sampling device is most often contingent upon: 1) the depth of water, and 2) the physical characteristics of the sediment to be sampled. The following procedures may be utilized:

Sampling Surface Sediment with a Trowel or Scoop

The sampling method is accomplished by wading into the surface water body and while facing upstream (into the current), scooping the sample along the bottom of the surface water body in the upstream direction. Excess water may be removed from the scoop. However, this may result in the loss of some fine particle size material associated with the bottom of the surface water body.

This method can be used to collect consolidated sediments but is limited somewhat by the depth of water. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. In surface water bodies that are too deep to wade, but less than eight feet deep, a stainless steel scoop or spoon attached to a piece of conduit can be used either from the banks if the surface water body is narrow or from a boat. The sediment is placed into a glass pan and homogenized.

A stainless steel scoop or lab spoon will suffice in most applications. Follow these procedures to collect sediment samples with a stainless steel scoop:

1. Using a precleaned stainless steel scoop, remove the desired thickness of sediment from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container.

Sampling Surface Sediment with a Bucket Auger or Tube Auger

This system consists of an auger, a series of extension rods, and a "T" handle. The auger is driven into the sediment and used to extract a core. A sample of the core is taken from the appropriate depth.

Use the following procedure to collect sediment samples with a thin-walled auger:

1. Insert the auger into the material to be sampled at a 0° to 45° angle from vertical. This orientation minimizes spillage of the sample from the sampler. Extraction of samples may require tilting of the sampler.
2. Rotate the auger once or twice to cut a core of material.
3. Slowly withdraw the auger, making sure that the slot is facing upward.
4. An acetate core may be inserted into the auger prior to sampling, if characteristics of the sediments or body of water warrant. By using this technique, an intact core can be extracted.
5. Transfer the sample into an appropriate sample or homogenization container.

Sampling Surface Sediment with a Ponar Dredge

The Ponar dredge uses a self-tripping sampler featuring hinged jaws and a spring loaded pin that releases. when the sampler makes impact with the bottom. The top is covered with a stainless steel screen with neoprene rubber flaps which allows water to flow through for a controlled descent and less interference with the sample.

Follow these procedures for collecting sediment with a Ponar dredge:

1. Attach a sturdy nylon or steel cable to the hook provided on top of the dredge.
2. Arrange the Ponar dredge sampler in the open position, setting the trip bar so the sampler remains open when lifted from the top.
3. Slowly lower the sampler to a point just above the sediment.
4. Drop the sampler sharply into the sediment, then pull sharply up on the line, thus releasing the trip bar and closing the dredge.
5. Raise the sampler to the surface and slowly decant any free liquid through the screens on top of the dredge. Be careful to retain fine sediments.
6. Open the dredge and transfer the sediment to a stainless steel or plastic bucket. Continue to collect additional sediment until sufficient material has been gained. Thoroughly mix sediment to obtain a homogeneous sample, and then transfer to the appropriate sample container.

Sampling Subsurface Sediment with a Coring Device

Core samplers are used to sample vertical columns of sediment. They are particularly useful when a historical picture of sediment deposition is desired since they preserve the sequential layering of the deposit, and when it is desirable to minimize the loss of material at the sediment-water interface.

Follow these procedures when using a sample coring device to collect subsurface sediments. It consists of a coring device, handle, and acetate core barrel:

1. Assemble the coring device by inserting the core into the sampling tube assembly.
2. Insert the "vacuum plug" into the tip of the sampling tube with the wire connected through the top portion of sampling equipment.
3. Tighten the plug so the fit is snug within the tube.
4. Tighten the rubber fitting, associated with the sampling equipment, around the top end of the tube.
5. Screw the handle onto the upper end of the sampling tube and add extension rods as needed.
6. Place the sampler in a perpendicular position on the material to be sampled.
7. With left hand holding the wire (connected to the plug inside the core assembly), place downward pressure on the sampler into the material to the desired depth. Do not allow the plug to proceed deeper (hold left hand at constant elevation, while advancing core with right hand).
8. Place downward pressure on the device until the desired depth is reached.
9. Withdraw the sampler by puling the sampling assembly upwards, until the bottom of the core can be reached below the surface of the water.
10. Place cap on core, while end of the core is still underneath the water's surface.
11. Remove core from water and loosen rubber fitting.
12. Remove core from sampling equipment and place an additional cap on top of core (it may be appropriate to reduce the core length prior to capping the core).
13. The sample may be used in this fashion, or the contents transferred to a stainless steel or plastic bucket and mixed thoroughly to obtain a homogeneous sample representative of the entire sampling interval.

Sediment Probing and Bathymetric Survey

The metal calibration rod will be used to probe sediment depths along the sediment characterization transects. From a boat, at each station, the water depth to top of sediment will be measured by probing with a surveyor's rod. The sediment depth will then be measured by pushing a calibrated 5/8-inch galvanized hollow pipe into the sediment until refusal using reasonable human force. The depth of the penetrated sediment will be noted by subtracting the length of the rod above the water surface and the water depth at the point being probed from the length of the entire rod. Measurements made of location, depth, time, and field samples will be noted by subtracting the length of the rod above the water surface and the water depth at the point being probed from the length of the entire rod. Measurements made of location (using a GPS unit, if applicable), depth, time, and field samples will be noted in the field logbook.

References

Mason, B.J. Preparation of Soil Sampling Protocol: Technique and Strategies. 1983 EPA-600/4-83-020.

Barth, D.S. and B.J. Mason. Soil Sampling Quality Assurance User's Guide. 1984 EPA-600/4-84-043.

U.S. EPA. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II. Available Sampling Methods, Second Edition. 1984 EPA Hazardous Waste Streams. 1980 EPA-600/2-80-018.

Field Sampling Guidance Document #1215 – Sediment Sampling, U.S. EPA Region 9 Laboratory Richmond California. 1999. Sediment Sampling SOP #2016. U.S. EPA. 1994.

CRA, 2008, Field Training Manual, Waterloo, Ontario, 2008

Standard Operating Procedure F-5
Soil Sampling with Direct Push Sampler

The primary means for the collection of subsurface soil samples will be a direct-push technique using a Geoprobe® or equivalent driver. Direct-push soil samples will be obtained using the Macro Core® sampling method on continuous basis using a closed-piston soil sampler with a liner (or equivalent sampling system). The Sampler will be operated in accordance with the manufacturer's recommended operating procedures for the type of equipment used.

Soil samples will be collected at predetermined intervals based on specific data needs. The samples will be classified in accordance with the Unified Soil Classification System (USCS), and field logs will be prepared.

Small subsamples representative of the major soil types will be retained for use in developing visual classification as described later in this subsection, and for physical testing, as required.

Subsamples selected for laboratory analysis will be placed in appropriate sample containers provided by the analytical laboratory, labeled, placed in an iced cooler, and stored in accordance with chain-of-custody requirements specified in the QAPP until shipment to the laboratory (or laboratories) is arranged. Chain-of-Custody Records will be completed for all samples according to the methods described in the QAPP.

Geoprobe®, and support equipment will not come in direct contact with the samples, so cross-contamination of samples is not a concern. However, this equipment will likely come in contact with impacted soil and must therefore be decontaminated prior to moving from one location to another.

The Geoprobe® equipment used for soil sampling and monitoring well installation will be cleaned with high-pressure/hot water washing equipment prior to initiating the field investigation. The same procedure will be applied to all drilling equipment between each boring location. The cleaning will occur at a decontamination pad constructed at a suitable location(s) at the site. Water used for cleaning will be obtained from a local potable water source. Equipment subject to these decontamination procedures includes, but is not limited to, the following:

- Direct Push drill rig
- Direct Push sampler components

In addition, downhole equipment that comes in direct contact with samples will be decontaminated between each sample interval. This procedure will include washing with a nonphosphate detergent and rinsing with clean potable water.

A piece of Direct Push equipment that comes in direct contact with soil samples (*e.g.,* split-barrel samplers) will be selected for collection of one field equipment blank. After the equipment has been cleaned, it will be rinsed with DI water. The rinse water will be collected and submitted for analysis of all constituents for which the normal samples collected with the equipment are being analyzed.

Standard Operating Procedure F-6
Surficial and Shallow Subsurface Soil Sampling

This standard operating procedure (SOP) is applicable to the collection of representative surficial or shallow subsurface soil samples. The methodology is generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. Modifications of sampling methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, soils are those mineral and organic materials not submerged in water for an extended period of time sufficient to support aquatic life.

Equipment/Apparatus

Equipment needed for collection of soil samples may include:

- Maps/Plot plan
- Safety equipment
- Compass
- Hand augers
- Spade or Shovels
- Tape measure
- Survey stakes, flags,
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels
- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spatula
- Scoop
- Trowel

Decontamination Procedures

Decontamination Prior to Sampling

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material.

In-Field Sampling Decontamination Procedures

As described above, this sampling protocol describes multiple methods for soil sample collection. The decontamination procedures described below will be relied upon in the field as appropriate for equipment decontamination.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. Details regarding the decontamination of field equipment are included in the section below. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Appendix 7 (MDEQ, 2004).

The field decontamination of sampling equipment will take place at the sampling location. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination pad for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Appendix 7 (MDEQ, 2004).

Sample Collection

Sampling Surface Soil with a Trowel or Scoop

The sampling method is accomplished by scooping the soil sample along the top 6 inches of the surface with a stainless steel scoop. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. Once collected, the sample is placed in a glass or stainless still bowl and homogenized.

A stainless steel scoop or lab spoon will suffice in most applications. Follow these procedures to collect soil samples with a stainless steel scoop:

1. Using a precleaned stainless steel scoop, remove the desired thickness of soil from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container.

Sampling Shallow Subsurface Soil

Several manual methods are available for the collection of shallow subsurface soil samples (e.g., hand augers, post hole augers). Hand auger or post-hole digging equipment to will be used to advance the boreholes to a sufficient depth followed by collection of soil samples as described above.

Standard Operating Procedure F-7
Landfill Gas Monitoring

This standard operating procedure (SOP) is applicable to landfill gas monitoring. The methodology is generic in nature and may be modified in whole or in part to meet the constraints presented by site conditions and equipment limitations. Modifications of monitoring methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and monitoring results.

Equipment

Equipment needed for landfill gas monitoring may include the following:

- Portable combustible gas meter
- Pressure gauges with varying sensitivity ranges
- Site plan
- Logbook
- Field data sheets
- Safety equipment

Targeted Compounds and Measurements

The gas composition will be monitored in groundwater monitoring wells, Geoprobe® borings, gas vents, or gas probes using a portable combustible gas meter (e.g., a Landtec®, or equivalent). The instrument selected will directly analyze the gas for methane, carbon dioxide, and oxygen (as percent by volume). Although nitrogen is not read directly, it can be calculated in the following manner:

$$\text{Balance gas} = 100\% - (\%CH_4 + \%CO_2 + \%O_2)$$

The balance gas represents the nitrogen content of the gas, as the trace gases typically make up much less than 1 percent of the total gas collected.

In addition, pressure will be measured at gas probes or groundwater monitoring wells, using a pressure gauge (a Magnehelic®, or equivalent) with the appropriate sensitivity range to obtain an accurate pressure reading, to determine if excess landfill gas is contributing to excess pressure.

Operational Procedures

The portable combustible gas meter and pressure gauges will be operated according to the manufacturers' instructions. A summary of the operational procedures that will be used for the portable combustible gas meter and pressure gauges (*i.e.,* calibration and monitoring procedures) is provided below.

General Information

On each day that landfill gas monitoring is being performed, record the following general information:

- Date
- Weather conditions
- Barometric pressure and trend
- Temperature
- Ground condition (saturated, frozen, etc.)
- Names of personnel performing the monitoring

Meter Calibration

Prior to initiating gas monitoring, the portable combustible gas meter will be calibrated in an area where the ambient concentrations of gases of concern are not present. The oxygen sensor and methane sensor will be calibrated in accordance with the manufacturer's recommended procedures.

The pressure gauges are calibrated by the manufacturer and do not require field calibration. Prior to measuring pressures, the appropriate pressure gauge will be selected (*i.e.,* the gauge with the appropriate sensitivity range to obtain an accurate pressure reading), and the pressure gauge will be set to zero, to the extent possible. If the pressure gauge cannot be set precisely to zero prior to monitoring, the initial reading will be noted and subtracted from the measured reading.

Landfill Gas Monitoring at Gas Vents, Gas Probes, or Groundwater Monitoring Wells (Pressure and Composition)

If sampling gas probes or vents, the probes or vents will be installed with sampling ports. If sampling groundwater monitoring wells, the wells will be retrofitted with a sampling port. The sampling port will include a labcock valve (or equivalent), which will be used to connect the portable combustible gas meter. For gas probes or groundwater monitoring wells, the sampling will also be used to connect the pressure gauge (or gauges, if appropriate).

The following procedures will be followed to monitor the gas composition and gauge pressure (if present):

Pressure

1. Attach the low-pressure port of the pressure gauge to the monitoring port using silicone tubing. Open the labcock valve, record the pressure, and then close the labcock valve. If the gauge indicates a negative reading, switch the tubing on the gauge to the high-pressure sampling port and repeat the previous steps.

Gas Composition

1. Attach the portable combustible gas meter to the monitoring port using silicone tubing. Engage the internal pump of the combustible gas meter, and open the labcock valve. When the readings stabilize, record the concentrations and close the labcock valve.
2. After each reading using the portable combustible gas meter, remove the tubing from the monitoring port and allow the methane and carbon dioxide readings to return to zero.

Landfill Gas Monitoring at Geoprobe® Boreholes (Composition)

The following procedures will be followed to measure the gas composition within Geoprobe® borings:

1. After reaching the desired vertical depth with the Geoprobe® rods, retract the rods approximately 1 foot to disengage the expendable drive point.
2. Push the Post-Run Tubing (PRT) adapter into the landfill gas sampling tubing. Insert the adapter end of the tubing down the inside of the probe rods until it hits the bottom on the expendable drive point holder.
3. Turn the tubing in a counterclockwise direction, and apply slight downward pressure to engage the adapter threads with the expendable drive point holder.
4. Connect the outer end of the tubing to a silicone tubing adapter (if needed) or directly to the portable combustible gas meter. Engage the internal pump of the combustible gas meter, and purge the tubing for a minimum of 1 minute prior to recording and/or measuring the landfill gas concentrations (methane, oxygen, and carbon dioxide). When the readings stabilize, record the concentrations.

Maintenance Procedures

The portable combustible gas meter and pressure gauges will be maintained according to the manufacturers' instructions. A replacement meter and/or gauges will be ready for overnight shipment, if needed.

Standard Operating Procedure F-8:
Excavation of Test Pits and Test Pit Soil Sampling

This standard operating procedure (SOP) is applicable to the excavation of test pits and the collection of soil samples from the test pits. The methodology is generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. Modifications of sampling methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, soils are those mineral and organic materials not submerged in water for an extended period of time sufficient to support aquatic life.

Equipment/Apparatus

Equipment needed for excavation of test pits and the collection of test pit soil samples may include:

- Excavation equipment (*e.g.,* backhoe)
- Hand augers
- Spade or Shovels
- Maps/plot plan
- GPS
- Safety equipment
- Tape measure
- Survey stakes, flags,
- Camera and film
- Stainless steel, plastic, or other appropriate composition bucket
- 4-oz., 8-oz., and one-quart wide mouth jars w/Teflon lined lids
- Ziploc plastic bags
- Logbook
- Sample jar labels
- Chain of Custody records, field data sheets
- Cooler(s)
- Ice
- Decontamination supplies/equipment
- Spatula
- Stainless Steel Scoop
- Plastic or Stainless Steel Spoons
- Trowel

Decontamination Procedures

Decontamination Prior to Sampling

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

In-Field Sampling Decontamination Procedures

As described above, this sampling protocol describes multiple methods for excavation of test pits and collection of soil samples from test pits. The decontamination procedures described below will be relied upon in the field as appropriate for equipment decontamination.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. Details regarding the decontamination of field equipment are included in the section below. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Attachment 7 (MDEQ, 2004).

The field decontamination of the excavation equipment (backhoe) will take place on a specified decontamination area. Equipment used to excavate the test pits will be decontaminated following completion of each test pit Decontamination of the excavator bucket will consist of removing remaining soil at the test pit location. The backhoe will then move to the decontamination area and the bucket washed with decontamination water. The decontamination water will be collected and containerized in 55-gallon barrels that will be properly labeled and temporarily stored on-site. A sample of the decontamination water will be collected and analyzed for the parameters required by a permitted off-site disposal facility. Following receipt of the analytical results, the decontamination water will be transported and disposed at the off-site facility. Documentation of off-site disposal activities will be included in the Remedial Investigation Report. Final

decontamination of the backhoe bucket and tires will be performed prior to the equipment leaving the site.

The field decontamination of soil sampling equipment (stainless steel scoops, etc.) will take place at the sampling location or decontamination area. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination area for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Attachment 7 (MDEQ, 2004).

Test Pit Excavation Procedures

Prior to initiation of the excavation activities, a kick-off meeting with the field representatives will be conducted. The health and safety guidelines will be discussed during the meeting. Additional information regarding health and safety measures is included in the Health and Safety Plan prepared in conjunction with the Remedial Investigation. All sampling locations will be clear of any overhead or identified buried utility.

Test pits will be excavated using a backhoe or other appropriate equipment at approximate locations according to the sampling plan. In the event that in-field conditions limit the use of excavation equipment, hand augers or shovels may be used. Test pit locations will be identified in the appropriate project workplan. Test pits will not be located immediately adjacent to the waterways (e.g. Kalamazoo River) or rip rap present along the banks in order to maintain the current containment. Appropriate spill containment and control measures will be implemented at each test pit location. Spill kits will be available on site for immediate deployment if needed according to the site specific Spill Response Contingency Plan.

Depending upon conditions the size of test pits can have a wide range. Typically test pits are anticipated to be approximately 5 to 15 feet long and approximately 2 to 4 feet wide. The text pits will be excavated to a depth of 3 to 12 feet depending on field conditions. In general, test pits are placed to a depth to either intersect the groundwater table or to natural soils. Test pits may be excavated to a greater depth if conditions warrant and all visual observations will be documented. Test pits may be used to identify free product or oil saturated soil for PCB investigations. The test pits will be logged according to the Unified Soil Classification System by the on-site field geologist or engineer.

At a minimum, field logs for the test pits will include the following documentation:

1. Plan and profile sketches of the test pit showing materials encountered, the depth of material, and sample locations

2. Sketch of the test pit and distance and direction from permanent, identifiable location marks as appropriate.
3. A description of the material removed from the excavation
4. A record of samples collected
5. The presence or absence of water in the test pit and the depth encountered
6. Other readings, or measurements taken during excavation, including field screening reading

Unless otherwise specified and the site-specific Health and Safety Plan discusses appropriate procedures, no personnel will enter the test pit. In addition, all test pits will be backfilled on the day of excavation. In most cases, excavation materials will be used to fill the test pit. In the event that highly contaminated soil is encountered, excavated soils may be stockpiled on polypropylene or placed within lined dumpsters and the excavation will be filled with clean soil.

Test Pit Soil Sample Collection

Sampling Surface Soil from a Test Pit

The sampling method is accomplished by scooping a representative soil sample of the excavated soil from the backhoe bucket with a stainless steel scoop. Accurate, representative samples can be collected with this procedure depending on the care and precision demonstrated by the sample team member. Once collected, the sample is placed in a glass or stainless steel bowl and homogenized. Samples will be collected and analyzed for PCBs and total petroleum hydrocarbons. Other select analysis will be performed based upon visual and olfactory conditions observed in the test pits. Samples will also be screened with a photoionization detector (PID) following procedures presented in SOP-8.

A stainless steel scoop or lab spoon will be used for sampling in most applications. Follow these procedures to collect soil samples with a stainless steel scoop:

1. Using a precleaned stainless steel scoop, remove the desired thickness of soil from the sampling area.
2. Transfer the sample into an appropriate sample or homogenization container.

Samples will be visually classified for soil types in the field and screened with a photoionization detector (PID). Selected samples with elevated PID readings or the presence of industrial fill material will be submitted for analysis of PAHs, VOCs and/or metals. The selection of samples to submit for analysis will utilize a biased sampling approach that will rely on a variety of specific site observations including:

- visible residuals;
- visible petroleum impacts;

- PID readings greater than a baseline of 10 ppm above background ambient air readings which will be taken on site beyond the influence of exhaust from equipment;
- notable odors; and
- soil stratigraphy.

The number of samples collected for analysis from each test pit is also dependent upon specific observations made during the test pit excavations. A minimum of one sample per test pit will be collected and analyzed for PCBs and total petroleum hydrocarbons. This sample will be taken at one of several locations:

- From unsaturated soil just above the saturated soil zone as evidenced by the visible presence of groundwater
- From the center bottom of the test pit if there is no groundwater visible

If observed conditions in the test pit warrant collection of additional samples, a total of up to three soil samples may be collected within a single test pit and analyzed for selected parameters based upon visible conditions. Samples will be collected for analysis based upon several possible test pit conditions including:

- Changes in fill or soil types
- Modifications in soil color or soils with noticeable odors
- Presence of free product
- Extended size of the test pit that needs additional characterization

Standard Operating Procedure F-9
Photoionization Detector (PID) Screening

This standard operating procedure (SOP) is applicable to the use of a PID/FID instrument during in-field soil sampling activities. The methodology is generic in nature and may be modified in whole or part to meet the handling and analytical requirements of the contaminants of concern, as well as the constraints presented by site conditions and equipment limitations. Modifications of sampling methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and analytical results. For the purposes of this procedure, soils are those mineral and organic materials not submerged in water for an extended period of time sufficient to support aquatic life.

Equipment/Apparatus

Equipment needed for PID screening of soil samples may include:

- PID/FID instrument
- Clear glass jar
- Ziploc bags

Procedure

When using PID/FID instrument the following procedure must be used:

1. Half- fill **either** a glass jar, or a Ziploc® baggie.
   a) When using glass jars:
      i) Fill jars with a total capacity of 8 oz. or 16 oz.
      ii) Seal each jar with one (1) or two (2) sheets of aluminum foil with the screw cap applied to secure the aluminum foil.
   b) When using Ziploc® baggies:
      i) Half fill bags from the split spoon or the excavation.
      ii) Zip to close.
2. Vigorously shake the sample jars or bags for at least thirty (30) seconds once or twice in a 10-15 minute period to allow for headspace development.
3. If ambient temperatures are below 320 Fahrenheit (00 Celsius) headspace development is to be within a heated vehicle or building.
4. Quickly insert the PID/FID sampling probe through the aluminum foil. If plastic bags are used, unzip the corner of the bag approximately one to two inches and insert the probe or insert the probe through the plastic. Record the maximum meter response (should be within the first 2 to 5 seconds). Erratic responses should be discounted as a result of high organic vapor concentrations or conditions of elevated headspace moisture.
5. Record headspace screening data from both jars or bags for comparison.

6. A PID equipped with a 10.2 eV lamp source will be used. Calibration will be checked/adjusted daily. In addition, all manufacturers' requirements for instrument calibration will be followed.
7. If sample jars are re-used in the field, jars will be cleaned according to field decontamination procedures. In addition, headspace readings must be taken to ensure no residual organic vapors exist in the cleaned sample jars.
8. Plastic bags will not be re-used.

Standard Operating Procedure F-10
Staff Gage Installation and Measurement

This standard operating procedure (SOP) is applicable to the installation and measurement of staff gages. This SOP is generic in nature and may be modified in whole or part depending on constraints presented by site conditions and equipment limitations. Modifications of methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities. The procedures have been adapted from the Oklahoma Water Resources Program Division procedures for installation and monitoring of non-recording staff gages.

Installation of Staff Gages

The gage height is a critical component for establishing the stage to discharge relationship and can be measured through a variety of accepted means. It is used to establish the river gage, or height of water to a known fixed point. This known fixed point is referenced or leveled to a Reference mark or Benchmark. These marks are assigned either an arbitrary elevation or known elevation that is tied to a national elevation network. Thus over time, with periodic leveling, the reference points can be measured for movement. Movement of these points will affect the stage discharge rating; therefore, it is critical that periodic measurements be conducted so that the gage heights remain leveled with the stage datum. This document is meant to be a guide only. Since staff gage equipment varies with respect to installation requirements, this SOP will be provided for a guideline and the specific manufacturer's instruction manual will be relied upon for more detailed guidance on the use of specific staff gages.

Accuracy and Use of Staff Gages

Vertical Staff Gages

Vertical staff gages are used as a stand-alone outside gage, an outside gage at a recording station, or a reference gage to another non-recording device. Vertical gages are available in a variety of lengths, widths, and increments in both U.S. and metric scales. However, because of the necessary accuracy, comparability, and ruggedness, gages should be a Style A gage, if available, which is made of porcelain enameled iron sections measuring 3 1/3' by 4" and graduated at every foot, tenth, and 0.02 foot. They are accurate only to 0.02 foot and can be damaged or lost due to high flows or ice. They have a tendency to drift if not consistently kept free of debris. Accuracies to 0.01 foot may be obtained if needed by reading the gage with a point gage.

Inclined Staff Gages

Because of their uniqueness to each station, inclined gages are normally not available commercially for stream gaging. They are used in situations where placement of another type of outside gage is not possible. They can be used as stand-alone outside gages or as an outside gage at a recording station.

Inclined gages have a low level of accuracy of up to 0.10 foot. Because of issues with installation, maintenance, and accuracy, inclined staff gages should be used only when other options are not feasible.

Installation and Measurement of Staff Gages

A vertical gage is mounted to permanently placed structure such as a piers or beam sunk to bedrock. If mounted in a stable location, a number of plates may be mounted one on top of the other. When mounting, find the high water bench and attempt to place the top of gage above that mark. Vertical height of gages should be kept to one plate and may require the installation of two or more to account for the vertical height of banks and potential high water level. When mounting to a pier, special equipment may be needed. The gage should be kept free of obstructions and be in an area readily accessible by personnel. A reference point should be placed on the backing of the gage plates and tied into the level circuit, and a reference point reading should be noted by measuring against the steel plate using a steel tape. During subsequent surveys, new RP readings should be made and compared to the elevation for that reference point. If these are different, a correction should be made to the gage datum. If a series of gages are used, each should be tied to the level circuit with a separate reference point.

The water level is read by a three-step method. The following example describes the three step process:

1. As an example, 20.64 is used as a measurement.
2. The footmark, 20.0, is noted. The next mark (6) is the inch mark.
3. The next step is to locate the hundredth mark and count 8 the marks backward from the next highest inch mark.

Using the example, the water level is at 0.64, and to determine the hundredth mark (0.04), the technician would count back from 0.7 to the water level. In this instance, the count was 0.06. By subtracting 0.06 from the inch mark, the hundredth mark (0.04) is obtained.

References

Oklahoma Water Resources Board, 2004. Standard Operating Procedure for the Installation of Nonrecording Gages and Measurement of Stage in Streams. Water Quality Program Division, Oklahoma City, OK.

Oklahoma Water Resources Board, 2004. Standard Operating Procedure for Surveying Gaging Stations. Water Quality Program Division, Oklahoma City, OK.

Standard Operating Procedure F-11
Groundwater Sampling and Field Measurement Procedures

This standard operating procedure (SOP) sets forth the field procedures for the sampling of groundwater. The procedures include monitoring well inspection, groundwater elevation measurement, decontamination of nondedicated sampling equipment, and groundwater sampling. A separate SOP, F-15 is included for well construction activities.

Monitoring Well Inspection

The condition of the monitoring wells will be inspected and documented during each sampling event prior to the collection of data. The following information will be noted on a monitoring well inspection form (Attachment B):

- The ground surface condition around the well (vegetation, safety hazards, access hazards, etc.)
- Well security features (presence of lock, lock key number, protective bollards, paint, visibility devices, evidence of tampering, traffic hazards, etc.)
- Condition of the well surface completion, including surface protector, protector cover, inner casing cap or plug, and concrete pad
- Evidence of potential contamination at the wellhead, including staining or suspicious containers

Groundwater Elevation Measurement

In order to determine the static water elevation (SWE), the static water level (SWL) will be measured prior to purging and sampling at each monitoring well in the sampling program. All static water level measurements will be obtained on the first day of the sampling event or within a 24-hour period, except as described in the following section. The measurements will be obtained prior to purging the monitoring wells for water quality sampling. Each well has a top-of-casing (TOC) reference point marked on it, from which all water level measurements will be taken. The vertical reference points have been surveyed to the nearest 0.01 foot and referenced to North American Vertical Datum (NAVD) 88.

Decontamination Procedures for Nondedicated Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for sampling various environmental media (soil, groundwater, surface water, etc.) will be cleaned before its initial use in the field and again before use at each subsequent sampling site.

All nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.

3. Rinse with deionized (DI) or distilled water.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. Details regarding the decontamination of field equipment are included in the sampling procedures described below. The field decontamination procedures will be in accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Appendix 7 (MDEQ, 2004).

The field decontamination of sampling equipment will take place at the sampling location. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination pad for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Appendix 7 (MDEQ, 2004).

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material.

Groundwater Sampling Procedures

The wells will be developed to ensure that the wells have a good hydraulic connection with the shallow aquifer. The wells will be developed by surging and purging with a surge block and submersible pump system. Well development will be performed until the water discharged from the wells is free of sediment, if possible. Well development procedures involving the introduction of water will be performed in consultation with the U.S. EPA and are further described in SOP-15, included in this FSAP.

Groundwater samples from monitoring wells will be collected using a low-flow sampling methodology specifically designed for the project specific analytical sampling as described in the workplan. Low-level sampling and analytical methods will be used for mercury, as appropriate. The sampling will be consistent with Attachment 7 (MDEQ, 2004).

Low-level mercury sample collection is performed by a strict protocol designed to minimize contamination. The protocol involves a two-person team approach. One member of the team is designated as "Dirty Hands," and the second member is designated as "Clean Hands." "Clean Hands" handles all operations involving contact with the sample bottle and transfer of the samples from the tubing or pump outlet to the sample bottle. "Dirty Hands" prepares the sampling equipment, operates the sampling equipment, and is responsible for any other activities that do not involve direct contact with the sample. Non-talc gloves and lint-free outer clothing are required to protect the samples from contamination by lint and dust. Sampling equipment, materials, and containers are cleaned and double-

bagged for protection from contamination during storage and transportation. The field equipment is decontaminated with deionized water. The samples are preserved with high-purity, diluted hydrochloric acid (HCL).

Each monitoring well will be pumped using a peristaltic pump and fluoropolymer tubing. At wells where the depth to water is greater than 20 feet, a QED bladder pump (or equivalent) will be used instead of the peristaltic pump. The bottom of the tubing (or bladder pump intake) will be placed approximately 1 to 2 feet above the base of the well screen, and the well will be pumped at a flow rate ranging from 0.1 to 0.7 liter/min. The pumping rate for each monitoring well is dependent on the hydraulic properties of the formation the well is screened across, and will be determined in the field to be the highest flow rate attainable without creating drawdown greater than approximately 0.1 meter, or at a minimum of 100 mL/min. In the event that the aquifer transmissivity is too low to yield sufficient water to limit drawdown to 0.1 meter at the lowest specified pumping rate (0.1 liter/min), sampling will be conducted at the 0.1 liter/min rate since this is the minimum flow rate necessary for accurate measurements through the flow-through cell.

A Geotech P3 flow-through cell (or equivalent) equipped with temperature, turbidity, dissolved oxygen, specific electrical conductance, and pH electrodes will be connected to the discharge tubing from the peristaltic pump. Equipment operation manuals for this meter is included in this SOP. In addition, a hard copy of the instruction manual specific for the field instrument will be available in the field during implementation activities. If this specific model is unavailable at the time of sampling, a comparable model will be substituted and the appropriate version of the instruction manual will be provided to the USEPA in the next monthly progress report. Each of these parameters will be measured at each well during purging to evaluate stabilization. Wells will be considered stable when the following conditions apply between three successive 1-liter sampling intervals:

- The temperature change is within 0.5°C.
- The conductance change is within 20 µhmos/cm.
- The turbidity change is ± 10 percent or <10 NTUs.
- The dissolved oxygen change is within 0.5 mg/L.
- The redox (Eh) change is within 30 mv.
- The pH change is within 0.2 pH units.

The wells will be sampled immediately following stabilization. The samples will be taken from the pump discharge after the flow-through cell has been disconnected. The low-level mercury sample will be collected first following the Clean Hands/Dirty Hands method described in Attachment 7 (MDEQ, 2004). The remaining sample bottles will then be collected from the pump discharge.

Regardless of the sampling technique used, efforts will be made to minimize agitation/disturbance of samples during purging and sampling activities. Likewise, efforts will be made to avoid purging wells dry if at all possible.

Groundwater purged during sampling, used pump tubing, and other general waste materials generated by the sampling process will be collected and managed as investigation-derived waste.

Calibration Procedures - The pH, ORP, specific conductance, turbidity, and dissolved oxygen meters will be calibrated daily in accordance with manufacturer's instructions. As noted previously, manufacturer's instructions will be included in the SOP and hard copies will be available to field personnel. Calibration information will be recorded in the field logbook.

Operation Procedures - The sampling pump, flow-through cell, and meters will be operated according to the manufacturer's instructions. As noted previously, manufacturer's instructions will be included in the SOP and hard copies will be available to field personnel.

Maintenance Procedures - The sampling pump, flow-through cell, and meters will be maintained according to the manufacturer's instructions. Maintenance information will be recorded in the field logbook. Replacement sampling pumps, flow-through cells, and meters will be available on-site or ready for overnight shipment, as necessary. As noted previously, manufacturer's instructions will be included in the SOP and hard copies will be available to field personnel.

Sample Handling and Chain of Custody

Field personnel will be aware of the holding times for specific parameters and will make arrangements to have the samples delivered to the laboratory to meet these holding times. No samples will be held overnight for field activities lasting longer than 1 day. All samples will be stored on ice after collection and shipped to the laboratory on the same day on which they are collected.

This Chain-of-Custody documentation enables possession of a sample to be traced from sample collection through analysis and disposal. A Chain-of-Custody protocol will be established to document control of the samples from the point of collection to delivery to the analytical laboratory. Samples will be under the custody of a designated person at all times. The control of custody will be documented on a Chain-of-Custody form supplied by the laboratory. The Chain-of-Custody form will document the names, signatures, and affiliations of personnel in custody of the samples, and the dates and times custody was transferred. The sampling personnel will be responsible for sample custody in the field. The laboratory sample custodian and analysts will be responsible for custody of the sample at the laboratory.

A copy of the Chain-of-Custody form will be placed in the project files, and the original will accompany the samples to the laboratory. The identity of field duplicate samples will not be disclosed to the analytical laboratory. Sample analysis request forms will be prepared by sampling personnel and

reviewed by the project coordinator or project manager. The analytical request forms will either accompany the samples to the laboratory or will precede the delivery of samples to the laboratory.

Shipping containers will be sealed and will be accompanied by the Chain-of-Custody form, with appropriate signatures. The transfer of custody is the responsibility of the sampling personnel and the laboratory staff. The procedures to be implemented are as follows:

- Place completed chain-of-custody forms in a plastic bag, seal the bag, and tape it to the inside cover of the shipping container.
- After the samples are iced, seal the coolers with strapping tape and custody seals (if applicable), add the date to the custody seals, and ship the coolers to the laboratory using overnight delivery or by delivering them directly to the laboratory.
- Identify common carriers or intermediate individuals on the Chain-of-Custody form, and retain copies of all bills-of-lading.
- When the samples are received in the laboratory, handle and process them in accordance with the procedures in the laboratory's standard operating procedures (SOPs), or specified analytical methods.

In the laboratory, a sample custodian will be assigned to receive the samples. Upon receipt of the samples, the custodian will inspect the condition of the samples, reconcile the samples received against the Chain-of-Custody form, check the temperature of the samples, log the samples in the laboratory log book, and store the samples in a secured sample storage room or cabinet maintained at an appropriate temperature until assigned to an analyst for analysis. Custody will be maintained until the samples are discarded.

When samples requiring preservation by either acid (except samples for VOC analysis) or base are received at the laboratory, the pH will be measured and documented. The laboratory sample custodian will adjust the pH, if necessary, and will notify the laboratory Quality Assurance/Quality Control (QA/QC) Coordinator of the pH adjustment so that sample collection procedures can be reviewed to determine if a modification is necessary.

Discrepancies observed between the samples received, the information on the Chain-of-Custody form, and the sample analysis request sheet will be resolved before the sample is assigned for analysis. The laboratory QA/QC Coordinator will be informed of any such discrepancy, as well as its resolution. Results of the inspection will be documented in the laboratory sample logbook. Discrepancies will be documented in the analytical case narrative, as appropriate.

Field Filtering

Scope and Application:

This method is applicable to groundwater sampling. Field filtration will be performed if dictated by the project Work Plan. Field filtering is required for some parameter, including but not limited to dissolved metals (unless samples are sent unpreserved to the laboratory and analyzed within 24 hours of collection) and dissolved organic carbon (DOC). Sediment presence can interfere or bias sample results; false positive findings have been observed when turbid samples for hexavalent chromium (and other analytes) are analyzed. Field filtration can eliminate this concern; generally applicable to only inorganic/DOC/PCB analysis. In line disposable filter cartridges are generally the easiest and quickest method for field filtration.

Equipment: In line disposable 0.45 μm filter cartridges.

Procedure:

- Purge the monitoring well to achieve stabilization prior to sampling.
- Attach the in-line disposal filter cartridge to the sample tubing.
- Collect the groundwater sample.
- Use a new filter at each location and discard used filters following appropriate procedures after each use.
- Repeat steps 1 through 3 for each sample.

References

MDEQ. 2004. Remediation and Redevelopment Division operation memorandum Number 2, Appendix 7.

Standard Operating Procedure F-12
Ambient Air Monitoring for Fugitive Dust

This standard operating procedure (SOP) is applicable to fugitive dust monitoring. The methodology is generic in nature and may be modified in whole or in part to meet the constraints presented by site conditions and equipment limitations. Modifications of monitoring methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and monitoring results.

Equipment

Equipment needed for fugitive dust monitoring may include the following:

- Miniram monitor or equivalent
- Personal attachment pump (if performing active air sampling)
- Site plan
- Logbook
- Field data sheets
- Safety equipment

Targeted Compounds and Measurements

Airborne particles will be measured using an MIE, Inc., Miniram monitor or equivalent. This is a hand-held field instrument that measures dust concentrations in the range of 0.001 to 400 milligrams/cubic meter (mg/m^3). The Miniram monitor displays the 10-second averaged concentration, as well as the real-time concentration, on a direct-read liquid-crystal display.

Operational Procedures

General Information

On each day that fugitive dust monitoring is being performed, record the following general information:

- Date
- Time
- Location
- Weather conditions
- Names of personnel performing the monitoring
- Visual observations
- Problems and corrective actions taken

- Maintenance performed
- Monitoring results
- Miniram calibrations
- Concerns or complaints from the public

Meter Calibration

Prior to initiating fugitive dust monitoring, calibrate the Miniram monitor in accordance with the manufacturer's recommended procedures.

Data Collection

- Before initiating data collection, zero the Miniram monitor in a particle-free area, in accordance with the manufacturer's recommended procedures.
- Conduct passive or active air sampling, as follows:
  - **Passive Air Sampling** – The collection of passive air samples involves allowing ambient air to freely access the sensing chamber of the instrument by means of convection, diffusion, and adventitious air motion. No additional equipment (i.e.,, pump) needs to be connected to the Miniram monitor.
  - **Active Air Sampling** – The collection of active air samples involves connection of a personal attachment pump to the Miniram monitor. The pump flow rate is set at 2 L/min for standard applications, but can be adjusted according to the anticipated particle size.
- Record the following measurements: run start time and date, time-averaged concentration, elapsed run time, maximum and short-term exposure limits (STEL) with times of occurrence, and end run time.
- Download the data from the Miniram monitor to a computer.

Maintenance Procedures

The Miniram monitor will be maintained according to the manufacturer's instructions. A replacement meter and/or gauges will be ready for overnight shipment, if needed.

Standard Operating Procedure F-13
Ambient Air Monitoring for VOCs

This standard operating procedure (SOP) is applicable to ambient volatile organic compound (VOC) monitoring. The methodology is generic in nature and may be modified in whole or in part to meet the constraints presented by site conditions and equipment limitations. Modifications of monitoring methodologies will be documented in the appropriate field logbook and discussed in reports summarizing field activities and monitoring results.

Equipment

Equipment needed for ambient VOC monitoring may include the following:

- Photoionization detector (PID)
- Site plan
- Logbook
- Field data sheets
- Safety equipment

Targeted Compounds and Measurements

Organic vapors will be measured using a PID, or equivalent. This is a hand-held field instrument that measures the concentration of organic vapors in the range of 0.1 to 1,000 ppm.

Operational Procedures

General Information

On each day that ambient VOC monitoring is being performed, record the following general information:

- Date
- Time
- Location
- Weather conditions
- Names of personnel performing the monitoring
- Visual observations
- Problems and corrective actions taken

- Maintenance performed
- Monitoring results
- PID calibrations

Meter Calibration

Prior to initiating ambient VOC monitoring, the PID will be calibrated in accordance with the manufacturer's recommended procedures. In addition, the PID will be recalibrated in accordance with the operating procedures.

Data Collection

- Power the PID on. The liquid crystal display (LCD) displays the real-time organic vapor concentration while the PID is running.
- Wait for the concentration to stabilize before recording a value.

Maintenance Procedures

The PID will be maintained according to the manufacturer's instructions. A replacement meter and/or gauges will be ready for overnight shipment, if needed.

Standard Operating Procedure F-14
Real-Time Turbidity Measurement Procedures for Surface Water

This standard operating procedure (SOP) sets forth the field procedures for the collection of surface water samples from shore for the measurement of turbidity.

Equipment

Equipment needed for turbidity monitoring may include the following:

- Hand-held turbidity meter
- Polyethylene scoop with an extended handle
- Site plan
- Logbook
- Field data sheets
- Safety equipment

Targeted Compounds and Measurements

Turbidity will be measured using a hand-held turbidity meter.

Operational Procedures

General Information

On each day that turbidity monitoring is being performed, record the following general information:

- Date
- Time
- Location
- Weather conditions
- Names of personnel performing the monitoring
- Visual observations
- Problems and corrective actions taken
- Maintenance performed
- Monitoring results
- Turbidity meter calibrations
- Concerns or complaints from the public

Meter Calibration

Prior to initiating turbidity monitoring, calibrate the turbidity meter in accordance with the manufacturer's recommended procedures.

Surface Water Sampling Procedures

Surface water samples will be collected using a polyethylene scoop with an extended handle and analyzed using a hand-held turbidity meter. Prior to initiating field activities, the turbidity meter will be calibrated according to the manufacturer's instructions, and the calibration data will be recorded in the logbook or on the Water Quality Meter Calibration Log. The procedures for collection of the surface water samples are provided below.

1. Record the sample location on the sample log or in field notebook, along with other appropriate information (include a sketch indicating location relative to shore features, if appropriate).
2. Don health and safety equipment (as required by the Multi-Area HSP).
3. Lower the scoop into the water, and raise it from the water column with minimal disturbance.
4. Measure the turbidity of the sample, and record it in a logbook or on a Surface Water Sampling Log.

Maintenance Procedures

The turbidity meter will be maintained according to the manufacturer's instructions. A replacement meter will be ready for overnight shipment, if needed.

Standard Operating Procedure F-15
Monitoring Well Installation Procedures

This standard operating procedure (SOP) sets forth the field procedures for the installation of monitoring wells.

Equipment

Equipment needed for installation of monitoring wells may include the following:

- Personal Protective Equipment (PPE) and safety equipment;
- Decontamination equipment;
- Maps, figures, or plot plans;
- Drilling method is selected based on site geologic and hydrogeologic conditions;
- PVC well screen and riser pipe;
- Stainless steel well screen and riser pipe;
- Stainless steel screen and black iron (low carbon steel) riser pipe;
- Stainless steel screen and PVC riser pipe;
- Sand pack;
- Filter pack placement;
- Bentonite seal;
- Grout;
- Protective casings and well caps;
- Surface seal;
- Protective posts (if required);
- Well development equipment including waterra, surge block, pumping/overpumping/backwashing, bailing, or airlifting;
- Camera and film; and
- Logbook.

Decontamination Procedures

Prior to use and between each borehole location, drilling and sampling equipment must be decontaminated in accordance with the Work Plan, the QAPP, or the methods presented in the following section.

The minimum wash procedures for decontamination of drilling equipment are:

- High pressure hot water detergent wash (brushing as necessary to remove particulate matter); and
- Potable, hot water, high pressure rinse.

Cover the clean augers with clean plastic sheeting to prevent contact with foreign materials. For geotechnical, geologic, or hydrogeologic studies where no contaminants are present, it is sufficient to clean the drilling or excavating equipment simply by removing the excess soils.

Monitoring Well Installation Procedure

1. Select the exact location of each well consistent with the site and project requirements. If a well must be relocated more than 20 feet (5.7 m) from the initially identified location, confirm the new location's suitability with the Project Coordinator. Ensure all utilities have been cleared prior to initiating borehole advancement activities;
2. To the extent practical, wells should be located adjacent to permanent structures (e.g., fences, buildings) that offer some form of protection and a reference point for future identification. Wells located in high traffic areas or road allowances or low lying wet areas are undesirable, but may be unavoidable. Field tie ins must be completed to accurately identify each well location. These will ensure that the wells are properly identified on plans and for future identification in the field;
3. The following drilling methods are listed in order of preference. However, final selection will be based on Site geologic and hydrogeologic conditions. During drilling activities, it is required that detailed descriptions of the Site geologic conditions be documented:

    a. Hollow Stem Augering (HAS);
    b. Direct Push Drilling;
    c. Dual Wall Reverse Circulation Air Drilling;
    d. Rotosonic Drilling; and
    e. Rotary Method.

4. The diameter of a well is primarily dictated by the purpose of the well. Generally, wells installed for groundwater and hydraulic monitoring should be between 1 and 2 inches in diameter. The diameter is also dependent on the drilling method being used;
5. Screen length should be consistent with the hydrogeologic conditions and the desired monitored interval. A 5 to 10-foot long screen is suitable for groundwater table wells when the screen is completely submerged and a specific monitoring interval is required;
6. Well slot sizes are described in thousandths of an inch. For most monitoring wells, a No. 10 slot (0.01 inch) well screen is adequate in most hydrostratigraphic units. PVC wells screens are typically available in No. 10 (0.01 inch) or No. 20 (0.02 inch) slot sizes. Stainless steel screens are available in a wider range of slot sizes. Typically, stainless steel screens must be specially ordered and require additional delivery time. Wells screens can be slotted, continuous slot, or louvered. Well points come in very limited slot sizes;
7. The silica sand pack placed around the well screen should be no finer than the slot size of the screen. Grain size curves should be obtained from the driller or well materials supplier to ensure proper sand size prior to placement;
8. All wells must be properly sealed. A seal is placed over the silica sand pack. Cuttings must never be used to seal a well. Certain well applications require specific well seals including bentonite gravel or chips, bentonite grout, cement/bentonite grout, and cement

grout. Prior to initiating well installation activities, confirm sealing requirements with local, state/provincial, or federal regulations;

9. Well installation requires the components includes annular space, instrumentation details, filter pack placement, bentonite seal, grouting, protective casings and well caps, surface seal, protective posts (if required);
10. Prior to installation through the auger or into the borehole, the well assembly (i.e., well screen and riser components) and the length of each component must be measured and recorded. The borehole must be measured to ensure installation at the desired interval to be monitored;
11. Placement of the primary filter pack is as follows:

    i. The primary filter pack is placed using the tremie line method;
    ii. A minimum 6 inches of the primary filter pack material is placed under the bottom of the well screen. This interval of primary filter pack provides a firm footing for the well;
    - Where DNAPL is present, or is being monitored for, the well may be sumped into a confining unit. In this case, no primary filter pack is placed under the bottom of the well screen;
    - The top of the primary filter pack is determined in the field based on the geologic and hydrogeologic conditions encountered during borehole advancement;
    - The primary filter pack should extend a minimum of 2 feet above the top of the well screen;
    - For shallow overburden wells it is common to extend the primary filter pack to about 2 feet above the water table to account for anticipated seasonal groundwater fluctuations;
    - In shallow overburden wells the sand pack should not be extended across a native and fill unit. For deeper overburden wells, it is common to select a specific hydrogeologic unit to monitor; and
    - The primary filter pack should never extend through a confining unit causing two or more permeable units to become connected.

12. Placing the primary filter pack by pouring may be acceptable if measurements are taken to ensure that the filter pack is reaching the assigned depth;
13. Install the secondary filter pack. The secondary filter pack is finer than the primary filter pack. The first secondary filter pack prevents the intrusion of grout from reaching the primary filter pack. The final secondary filter pack limits the migration of grout material into the bentonite seal. Generally, a bentonite seal over the primary filter pack is sufficient to stop grout from reaching the primary filter pack;
14. Install a protective casing over the completed well and sealed in place. Once installed and grouted, the casing should extend about 2.5 feet above ground surface. The outer protective casing is made of steel and has a locking cap that is hinged, waterproof, and resistant to vandalism. The protective casing should have sufficient clearance around the inner well casing so that no contact is made with the outer protective casing;

15. Install flush a concrete surface seal to promote drainage away from the outer protective casing at a depth below the frost line to deter frost heaving. Check local, state/provincial, and federal regulations pertaining to requirements for concrete surface seals;

16. The well is installed as follows:

- Before placing the well assembly at the bottom of the borehole, place at least 6 inches of filter pack at the bottom of the borehole to serve as a footing;
- If monitoring for DNAPL, the well assembly may be set directly on the bottom of the borehole. Place the well into the borehole plumb;
- On a well installed to a depth greater than 50 feet, centralizers are required. Place the centralizers on the well casing or well assembly above the proposed bentonite seal interval. Place the centralizers so as not to interfere with the placement of the filter pack, bentonite seal, and annular grout. (Generally, wells less than 50 feet deep will not require centralizers unless required by local, state/provincial, or federal regulations, or the Work Plan.);
- During well installation through a HSA, slowly pull back the auger as the filter pack, bentonite seal, and annular grout are tremied or poured in place;
- When the well has been lowered into the borehole, place the filter pack around and above the top of the screen, as required;
- When the filter pack has been installed, place a minimum 2-foot thick bentonite seal directly on top of the filter pack;
- Allow the bentonite seal to hydrate for a reasonable amount of time (generally, 30 minutes is sufficient);
- When the bentonite seal has hydrated sufficiently, seal the remaining borehole annular space grout placed with a tremie line using positive displacement methods. Generally, the grout will be brought to 2 feet (0.6 m) below ground surface or below the frost line, whichever is greater. In situations where no concrete seal is being placed, the grout can be brought to 0.5 to 1 foot (0.15 to 0.3 m) below ground surface;
- During grout placement, ensure the end of the tremie line is always submerged in the grout to ensure positive displacement;
- During grout placement on contaminated sites, containerize all fluids for future disposal;
- Allow the grout to set for about 24 hours before installing the concrete surface seal. If the grout level has subsided, top off the borehole annular space with grout or bentonite pellets to the required depth; and

- Install protective casings in a minimum 2-foot (0.6 m) thick concrete surface seal graded to divert surface water away from the monitoring well. Check local, state/provincial, and federal regulations for concrete surface seal requirements. Some agencies require that concrete pads be constructed around the wells.

17. When installation is complete, label the well in at least two locations for future identification;
18. After installation of the monitoring well ensure that monitoring wells are installed and develop properly;
19. Record activities undertaken in the field correctly and completely in a bound field books; and
20. Notify the Project Manager or Project Coordinator of any improprieties or failures on the part of the contractor.

Surveying Activities

Geodetic benchmark elevations are established relative to a vertical datum such as Mean Sea Level. Benchmarks (BM), at the national level, are precisely established by federal agencies utilizing first order survey methods and first order instruments. The same high requirements are also specified for state and provincial networks. Wherever possible, the use of geodetic benchmarks is recommended.

Please refer to SOP F-5 for more information on surveying activities.

Standard Operating Procedure F-16
Surface Water Sampling Procedures

This standard operating procedure (SOP) sets forth the field procedures for surface water sampling.

Equipment

Equipment needed for installation of monitoring wells may include:

- Bailers;
- Fluoropolymer (FEP, PTFE) sample bottles/preservatives;
- Ziploc bags;
- Ice;
- Coolers;
- Chain of Custody records, custody seals;
- Field data sheets;
- Decontamination equipment;
- Maps/plot plan;
- Safety equipment;
- Compass;
- Tape measure;
- Camera and film;
- Logbook/waterproof pen; and
- Sample bottle labels.

Decontamination Procedures

Equipment is decontaminated between sampling locations and prior to leaving the site. Upon completion of the sampling program, all equipment is decontaminated at the site and then returned clean to the appropriate field equipment manager.

For surface water sampling programs, sampling equipment is cleaned as follows:

- Wash with clean potable water and laboratory detergent, using a brush as necessary to remove particulates;
- Rinse with tap water;
- Rinse with deionized water;
- Air dry for as long as possible;
- Rinse with 10-percent nitric acid (only if samples are to be analyzed for metals);
- Rinse with deionized water;
- Rinse with appropriate solvent (pesticide grade isopropanol, methanol, acetone, hexane, if required);
- Rinse again with deionized water;

- Air dry for as long as possible; and
- Wrap samplers in aluminum foil to prevent contamination.

Surface Water Sampling Procedure

General

Surface water sampling is performed to obtain samples for surface water bodies that are representative of existing surface water conditions.

Surface water sampling locations for surface water quality and groundwater interaction studies are selected based on the following:

- Study objectives.
- Location of point surface discharges;
- Non point source discharges and tributaries;
- Presence of structures (e.g., bridge, dam); and
- Accessibility.

Surface Water Sample Location Selection

Prior to conducting surface water sampling activities, the first requirement is the consideration and development of surface water sampling locations. It is important that all surface water sampling locations be selected in accordance with the Work Plan and described to and discussed with the Project Coordinator. Representative surface water samples will be collected in sections of surface water bodies that have a uniform cross section and flow rate.

Surface water samples must be collected with no suspended sediments. Surface water samples are collected commencing with the furthest downstream location to avoid sediment interference with upstream locations.

Sampling Procedure

When collecting surface water samples, direct dipping of the sample container into the stream or water is acceptable unless the sample container contains preservatives. However, surface water samples being analyzed for low level mercury and methyl mercury requires preservatives for both filtered and unfiltered samples. Therefore, a pre-cleaned unpreserved sample container should be used to collect the surface water sample. The surface water sample is then transferred to the appropriate preserved sample container. When collecting surface water samples, submerse the inverted bottle to the desired sample depth and tilt the opening of the sample container upstream to fill. During surface water sample collection, wading or movement may cause sediment deposits to be re-suspended and can result in biased samples. Wading is acceptable if the stream has a noticeable current and the samples are collected directly in the sample container when faced upstream. If the stream is too deep to wade in or if addition samples must be collected at various depths, additional sampling

equipment will be required. Surface water samples should be collected about 6 inches (15 cm) below the surface, with the sample bottles being completely submerged. Taking the surface water sample at this depth eliminates the collection of floating debris in the sample container.

Surface water sample collection where the flow depth is less than 1 inch (<2.5 cm) requires the use of special equipment to eliminate sediment disturbance. Surface water sampling may be conducted with a container then transferred to the appropriate sample container, or collection may be performed using a peristaltic pump. A small excavation in the stream bed to create a sump for sample collection can also be considered but should be prepared in advance to allow all the sediment to settle prior to surface water sampling activities.

Teflon™ bailers can be used for surface water sampling if it is not necessary to collect surface water samples at specific depths. A bottom loading bailer with a check ball is sufficient. When the bailer is lowered through the water, the water is continually displaced through the bailer until the desired depth is reached. The bailer is retrieved and the check ball prohibits the release of the collected surface water sample. Bailers are not suitable in surface water bodies with strong currents, or where depth specific sampling is required.

In all instances, properly document all surface water sampling locations in a standard CRA field book. Documentation may include photographs and tie ins to known structures.

Standard Operating Procedure F-17
Vertical Aquifer Sampling Procedures

This standard operating procedure (SOP) sets forth the field procedures for the completion of vertical aquifer sampling (VAS).

Equipment

Equipment needed for installation of monitoring wells may include the following:

- Personal Protective Equipment (PPE) and safety equipment;
- Decontamination equipment;
- Sample bottles/preservatives;
- Ziploc bags;
- Ice;
- Coolers;
- Chain of Custody records, custody seals;
- Field data sheets;
- Decontamination equipment;
- Bottle labels;
- Maps, figures, or plot plans;
- SP16 Sampler Sheath sampler (other drilling method may be selected based on site geologic and hydrogeologic conditions);
- Screen, wire-wound Stainless Steel,
- Bailer or mini-bailers;
- Bentonite grout Bailer;
- Protective posts (if required);
- Camera and film; and
- Logbook.

Decontamination Procedures

Prior to use and between each borehole location, drilling and sampling equipment must be decontaminated in accordance with the Work Plan, the QAPP, or the methods presented in the following section.

The minimum wash procedures for decontamination of drilling equipment are:

- High pressure hot water detergent wash (brushing as necessary to remove particulate matter); and
- Potable, hot water, high pressure rinse.

Cover the clean augers with clean plastic sheeting to prevent contact with foreign materials. For geotechnical, geologic, or hydrogeologic studies where no contaminants are present, it is sufficient to clean the drilling or excavating equipment simply by removing the excess soils.

Sampling Procedure

1. Select the exact location of each VAS locations consistent with the site and project requirements. If the VAS location must be relocated more than 20 feet (5.7 m) from the initially identified location, confirm the new location's suitability with the Project Manager. Ensure all utilities have been cleared prior to initiating borehole advancement activities;
2. To the extent practical, VAS location should be located adjacent to permanent structures (e.g., fences, buildings) that offer some form of protection and a reference point for future identification. Field tie ins must be completed to accurately identify each location. These will ensure that the VAS locations are properly identified on plans and for future identification in the field;
3. The drill rig will be set up at the drilling location;
4. Soil borings will be advance to predetermined depths using direct push technologies;
5. Upon advancement of soil boring to predetermined interval, soil cores will be retrieved and examined for presence of visual and/or olfactory evidence of impact, and will be screened across their entire length using a PID to determine relative concentrations of undifferentiated volatile organic vapors. At each soil boring, soil samples will be collected on a continuous basis as described in SOP F-5;
6. Geoprobe® Screen Point 16 Groundwater Sampler (1.6 in. outer diameter screen sheath) will be driven to depth within a sealed, steel sheath. Once the sampling interval is reached, an extension rod equipped with an insert tool will be used to hold the screen in place at the base of the cutting shoe. The outer sheath then will be retracted as the screen is held in position with the extension rods. As the rod is retracted, the screen will be exposed to the formation and groundwater will be collected using a bailer. Purging of the groundwater is not required prior to sample collection;
7. Measurement of water levels before retracting sheath and after retracting sheath to ensure that only formation water is present. Water levels will be recorded the field notes;
8. Groundwater sample will be placed in Laboratory supplied containers, packed in coolers supplied with ice, and will be shipped to laboratory under chain of custody protocols; and
9. Sample information will be documented in field notebook and field sample key; and
10. Equipment will be decontaminated for re-use.

It is noted that the Project Manager or Project Coordinator should be notify of any improprieties or failures during the field activities.

Surveying Activities

Geodetic benchmark elevations are established relative to a vertical datum such as Mean Sea Level. Benchmarks (BM), at the national level, are precisely established by federal agencies utilizing first order survey methods and first order instruments. The same high requirements are also specified for state and provincial networks. Wherever possible, the use of geodetic benchmarks is recommended. Please refer to SOP F-5 for more information on surveying activities.

References

ASTM Method D-5092-90. American Society for Testing and Materials (ASTM), Standard D 5092-90, Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

R 299.5716. RRD Operational Memorandum No. 5, Groundwater Surface Water Criteria, Michigan Department of Environmental Quality, Remediation and Redevelopment Division, September 30, 2004

CRA, 2008, Field Training Manual, Waterloo, Ontario, 2008

Thomas Cok, T., Robins, D., Schult, M., Bolt, W., Push-Ahead™ Vertical Aquifer Sampling Methodology with Sonic Drilling, Technical Paper Study by MDEQ.

U.S. EPA, 2005, Groundwater Sampling and Monitoring with Direct Push Technologies, U.S. EPA Office of Solid Waste and Emergency Response, Washington, DC., August 2005,

Genuine Geoprobe, 2006, Geoprobe® Screen Point 16 Groundwater Sampler Standard Operating Procedure, Technical Bulletin No. MK3142, November, 2006

ATTACHMENT B

EXAMPLE FORMS/ LOGS

Date: _____ Reference No.: _____

PROJECT PLANNING COMPLETION AND FOLLOW-UP CHECKLIST

PRIOR PLANNING AND COORDINATION:

- ☐ Confirm well numbers, location and accessibility
- ☐ Review of project documents, Health and Safety Plan (HASP), sampling Quality Assurance/Quality Control (QA/QC) and site-specific sampling requirements
- ☐ Historical well data; depth, pH, performance and disposition of purge water
- ☐ Site access notification and coordination
- ☐ Coordination with laboratory through CRA Chemistry Group
- ☐ Procurement, inventory and inspection of all equipment and supplies
- ☐ Prior equipment preparation, calibration or maintenance
- ☐ All utilities located and approved

FIELD PROCEDURE:

- ☐ Instruments calibrated daily
- ☐ Sampling equipment decontaminated in accordance with the QAPP
- ☐ Field measurements and sampling details logged in appropriate field books or an appropriate field form
- ☐ Well volume calculated and specified volumes removed
- ☐ Specified samples, and QA/QC samples taken per Quality Assurance Project Plan (QAPP)
- ☐ Samples properly labeled, preserved and packed
- ☐ Sampling locations secured or completed according to Work Plan
- ☐ Sample date times, locations and sample numbers have all been recorded in applicable log(s)
- ☐ Samples have been properly stored if not shipped/delivered to lab same day
- ☐ Samples were shipped with complete and accurate Chain of Custody Record

FOLLOW-UP ACTIVITIES:

- ☐ Questionable measurements field verified
- ☐ Confirm all samples collected
- ☐ All equipment has been maintained and returned
- ☐ Sampling information reduced and required sample keys and field data distributed
- ☐ Chain of Custody Records filed
- ☐ Expendable stock supplies replaced
- ☐ CRA and client-controlled items returned (i.e., keys)
- ☐ Arrange disposal of investigation generated wastes with client
- ☐ Confirm all samples collected

Completed by: _____ Date: _____

CRA

WELL PURGING FIELD INFORMATION FORM

JOB# _____ - ____

SITE/PROJECT NAME: _____

WELL# _____

WELL PURGING INFORMATION

PURGE DATE (MM DD YY)	SAMPLE DATE (MM DD YY)	WATER VOL. IN CASING (LITRES/GALLONS)	ACTUAL VOLUME PURGED (LITRES/GALLONS)

PURGING AND SAMPLING EQUIPMENT

PURGING EQUIPMENT.....DEDICATED Y N (CIRCLE ONE)

SAMPLING EQUIPMENT.....DEDICATED Y N (CIRCLE ONE)

PURGING DEVICE	____	A - SUBMERSIBLE PUMP B - PERISTALTIC PUMP	D - GAS LIFT PUMP E - PURGE PUMP	G - BAILER H - WATERRA®	X- _____ PURGING OTHER (SPECIFY)
SAMPLING DEVICE	____	C - BLADDER PUMP	F - DIPPER BOTTLE		X- _____ SAMPLING OTHER (SPECIFY)
PURGING MATERIAL	____	A - TEFLON B - STAINLESS STEEL	D - PVC E - POLYETHYLENE		X- _____ PURGING OTHER (SPECIFY)
SAMPLING MATERIAL	____	C - POLYPROPYLENE			X- _____ SAMPLING OTHER (SPECIFY)
TUBING PURGING	____	A - TEFLON B - TYGON	D - POLYPROPYLENE E - POLYETHYLENE	F - SILICONE G - COMBINATION TEFLON/POLYPROPYLENE	X- _____ PURGING OTHER (SPECIFY)
TUBING SAMPLING	____	C - ROPE x- _____ (SPECIFY)			X- _____ SAMPLING OTHER (SPECIFY)
FILTERING DEVICES 0.45	____	A - IN-LINE DISPOSABLE	B - PRESSURE	C - VACUUM	

FIELD MEASUREMENTS

WELL ELEVATION	____	(m/ft)	GROUNDWATER ELEVATION	____	(m/ft)
DEPTH TO WATER	____	(m/ft)	WELL DEPTH	____	(m/ft)

pH	TURBIDITY	CONDUCTIVITY	SAMPLE TEMPERATURE
____ (std)	____ (ntu)	____ (µm/cm) AT 25°C	____ (°C)
____ (std)	____ (ntu)	____ (µm/cm) AT 25°C	____ (°C)
____ (std)	____ (ntu)	____ (µm/cm) AT 25°C	____ (°C)
____ (std)	____ (ntu)	____ (µm/cm) AT 25°C	____ (°C)
____ (std)	____ (ntu)	____ (µm/cm) AT 25°C	____ (°C)

FIELD COMMENTS

SAMPLE APPEARANCE: _____ ODOR: _____ COLOR: _____ TURBIDITY: _____

WEATHER CONDITIONS: WIND SPEED _____ DIRECTION _____ PRECIPITATION Y/N OUTLOOK _____

SPECIFIC COMMENTS _____

I CERTIFY THAT SAMPLING PROCEDURES WERE IN ACCORDANCE WITH APPLICABLE CRA PROTOCOLS

CRA

DATE _____ PRINT _____ SIGNATURE _____

SAMPLE COLLECTION DATA SHEET - GROUNDWATER SAMPLING PROGRAM

PROJECT NAME _____ PROJECT NO. _____

SAMPLING CREW MEMBERS _____ SUPERVISOR _____

DATE OF SAMPLE COLLECTION _____

[Note: For 2" dia. well, 1 ft. = 0.14 gal (imp) or 0.16 gal (us)]

Sample I.D. Number	Well Number	Measuring Point Elev. (ft. AMSL)	Bottom Depth (ft. btoc)	Water Depth (ft. btoc)	Water Elevation (ft. AMSL)	Well Volume (gallons)	Bailer Volume No. Bails	Volume Purged (gallons)	Field pH	Field Temp.	Field Cond.	Time	Sample Description & Analysis

Additional Comments: _____

Copies to: _____

CRA

MONITORING WELL RECORD FOR LOW-FLOW PURGING

Project Data:

Project Name: _____ Date: _____

Ref. No.: _____ Personnel: _____

Monitoring Well Data:

Well No.: _____

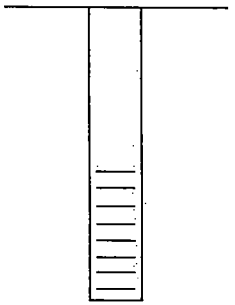
Vapour PID (ppm): _____ Saturated Screen Length (m/ft): _____

Measurement Point: _____ Depth to Pump Intake (m/ft)[1]: _____

Constructed Well Depth (m/ft): _____ Well Diameter, D (cm/in): _____

Measured Well Depth (m/ft): _____ Well Screen Volume, V_s (L)[2]: _____

Depth of Sediment (m/ft): _____ Initial Depth to Water (m/ft): _____



Time	*Pumping Rate (mL/min)*	*Depth to Water (m/ft)*	*Drawdown from Initial Water Level[3] (m/ft)*	*Temperature °C*	*Conductivity (mS/cm)*	*Turbidity NTU*	*DO (mg/L)*	*pH*	*ORP (mV)*	*Volume Purged, Vp (L)*	*No. of Well Screen Volumes Purged[4]*
			Precision Required[5]:	±3 %	±0.005 or 0.01 [5]	±10 %	±10 %	±0.1 Units	±10 mV		

Notes:

(1) The pump intake will be placed at the well screen mid-point or at a minimum of 0.6 m (2 ft) above any sediment accumulated at the well bottom.

(2) The well screen volume will be based on a 1.52 metres (5-foot) screen length (L). For metric units, $V_s=\pi*(r^2)*L$ in mL, where r (r=D/2) and L are in cm. For Imperial units, $V_s=\pi*(r^2)*L*(2.54)^3$, where r and L are in inches

(3) The drawdown from the initial water level should not exceed 0.1 m (0.3 ft). The pumping rate should not exceed 600 mL/min.

(4) Purging will continue until stabilization is achieved or until 20 well screen volumes have been purged (unless purge water remains visually turbid and appears to be clearing, or unless stabilization parameters are varying slightly outside of the stabilization criteria and appear to be stabilizing), No. of Well Screen Volumes Purged= Vp/Vs.

(5) For conductivity, the average value of three readings <1 mS/cm ±0.005 mS/cm or where conductivity >1 mS/cm ±0.01 mS/cm.

WATER LEVEL RECORD

PROJECT NAME: _____ LOCATION: _____

JOB NO. : _____ DATE: _____

CLIENT: _____ ENGINEER/GEOLOGIST: _____

OBSERVATION WELL	TOP OF CASING ELEVATION A		DEPTH TO WATER B		WATER LEVEL ELEVATION A-B	
	feet	metres	feet	metres	feet	metres

CRA

Date: _____ *Reference No.* _____

BOREHOLE INSTALLATION/SOIL SAMPLING EQUIPMENT AND SUPPLY CHECKLIST

INSTRUMENTS

- ☐ Steel Tape (50 foot)
- ☐ Air Monitoring Equipment
- ☐ Water Level Meter
- ☐ Pocket Penetrometer

SUPPLIES

- ☐ Foil
- ☐ Plastic Sample Bags
- ☐ Paper towels
- ☐ Decontamination Fluids (as required by QAPP)
- ☐ Deionized water
- ☐ Labels
- ☐ Sample knives
- ☐ Trash bags
- ☐ Plastic spray bottles
- ☐ Sampling Glassware
- ☐ Coolers

PERSONAL PROTECTIVE EQUIPMENT

- ☐ Tyveks (assorted sizes and types)
- ☐ Protective gloves
- ☐ Hard hats/liner(s)
- ☐ Field overboots
- ☐ Work gloves (cotton and chemical resistant)
- ☐ Safety glasses or OSHA-approved prescription lenses
- ☐ First Aid Kit
- ☐ Respirators and Cartridges
- ☐ Check Health and Safety Plan

DOCUMENTATION

- ☐ Notebook/Field book
- ☐ Photolog
- ☐ Site pass/badge
- ☐ Previous well logs/previous historical well data
- ☐ Site map
- ☐ Access Agreement Documentation
- ☐ Utility Clearance Documentation
- ☐ Stratigraphic Log (Overburden) - at least one for each 20 feet of drilling
- ☐ Chain-of-Custody Forms

MISCELLANEOUS

- ☐ Camera/film
- ☐ Spare batteries for instruments
- ☐ Carpenters Rule (6 foot)
- ☐ Clipboard
- ☐ Indelible Pen/pencil/indelible marking pen
- ☐ Tool box
- ☐ Spare locks/keys
- ☐ On Site Transportation (all Terrain Vehicle/Snowmobiles)

* Do not use pen with water soluble ink

Completed by: _____ *Date:* _____

CRA

STRATIGRAPHY LOG (OVERBURDEN)

PAGE ____ OF ____

PROJECT NAME _____
PROJECT NUMBER _____
CLIENT _____
LOCATION _____

DRILLING CONTRACTOR _____
DRILLER _____
SURFACE ELEVATION _____
WEATHER (A.M.) _____
(P.M.) _____

HOLE DESIGNATION _____
DATE/TIME STARTED _____
DATE/TIME COMPLETED _____
DRILLING METHOD _____
CRA SUPERVISOR _____

STRATIGRAPHIC INTERVALS (DEPTHS IN ft/m BGS)			SAMPLE DESCRIPTION	SAMPLE DETAILS											
FROM	AT	TO	ORDER OF DESCRIPTORS: SOIL TYPE SYMBOL(S) – PRIMARY COMPONENT(S), (NATURE OF DEPOSIT), SECONDARY COMPONENTS, RELATIVE DENSITY/CONSISTENCY, GRAIN SIZE/PLASTICITY, GRADATION/STRUCTURE, COLOUR, MOISTURE CONTENT, SUPPLEMENTARY DESCRIPTORS NOTE: PLASTICITY DETERMINATION REQUIRES THE ADDITION OF MOISTURE IF THE SAMPLE IS TOO DRY TO ROLL (INDICATE IF MOISTURE WAS ADDED OR NOT).	SAMPLE #	SAMPLING METHOD	PENETRATION RECORD SPLIT SPOON BLOWS (RECORD N-VALUES & RECOVERIES) 6"	6"	6"	6"	N	R	SAMPLE INTERVAL	PID / FID (ppm)	CHEMICAL ANALYSIS	GRAIN SIZE

NOTES AND COMMENTS

DEPTH OF BOREHOLE CAVING _____ DEPTH OF FIRST GROUNDWATER ENCOUNTER _____ TOPSOIL THICKNESS _____

WATER LEVEL IN OPEN BOREHOLE ON COMPLETION _____, AFTER ____ HOURS ____

COMPLETION DETAILS: _____

NOTE: FOR EACH SPLIT-SPOON SAMPLE, RECORD BLOW COUNTS, N-VALUE, SAMPLE RECOVERY LENGTH, AND SAMPLE INTERVAL.

NOTES:

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.S.)

MAJOR DIVISIONS			GROUP SYMBOL	TYPICAL DESCRIPTION
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS MORE THAN HALF OF COARSE FRACTION LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES, < 5 % FINES
			GP	POORLY GRADED GRAVELS AND GRAVEL-SAND MIXTURES, < 5 % FINES
		DIRTY GRAVELS	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES, > 12 % FINES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES, > 12 % FINES
	SANDS MORE THAN HALF OF COARSE FRACTION SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS	SW	WELL GRADED SANDS, GRAVELLY SANDS, < 5 % FINES
			SP	POORLY GRADED SANDS, OR GRAVELLY SAND, < 5 % FINES
		DIRTY SANDS	SM	SILTY SANDS, SAND-SILT MIXTURES > 12 % FINES
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES > 12 % FINES
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML	INORGANIC SILTS AND VERY FINE SAND, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY
			MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			CI	INORGANIC CLAYS OF MEDIUM PLASTICITY, SILTY CLAYS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
	ORGANIC SILTS & ORGANIC CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
			OH	ORGANIC CLAYS OF HIGH PLASTICITY

CONVENTIONAL SOIL DESCRIPTIONS

NON-COHESIVE (GRANULAR) SOIL

RELATIVE DENSITY	BLOWS PER FOOT (N-VALUE)
Very loose	less than 5
Loose	5 to 9
Compact	10 to 29
Dense	30 to 50
Very Dense	greater than 50

COHESIVE (CLAYEY) SOIL

CONSISTENCY	BLOWS PER FOOT (N-VALUE)
Very Soft	0 to 2
Soft	3 to 4
Firm	5 to 8
Stiff	9 to 15
Very Stiff	16 to 30
Hard	greater than 30

GRAIN SIZE CLASSIFICATION

COBBLES	Greater than 3 inches (76 mm)
GRAVEL	3 in. to No. 4 (4.76 mm)
Coarse Gravel	3 in. to 3/4 in.
Fine Gravel	3/4 in. to No. 4 (4.76 mm)
SAND	No. 4 (4.76 mm) to No. 200 (0.074 mm)
Coarse Sand	No. 4 (4.76 mm) to No. 10 (2.0 mm)
Medium Sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine Sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
SILT	No. 200 (0.074 mm) to 0.002 mm
CLAY	Less than 0.002 mm

NOTE: The "No. __ " refers to the standard sieve sizes.

COMPONENT PERCENTAGE DESCRIPTORS

Noun(s) (e.g. SAND and GRAVEL)	35 to 50 %
Adjective (e.g. SANDY)	20 to 35 %
With	10 to 20 %
Trace	Less than 10 %

SOIL STRUCTURE TERMS

Stratified	Blocky
Laminated	Lenses/Seams
Fissured	Homogeneous

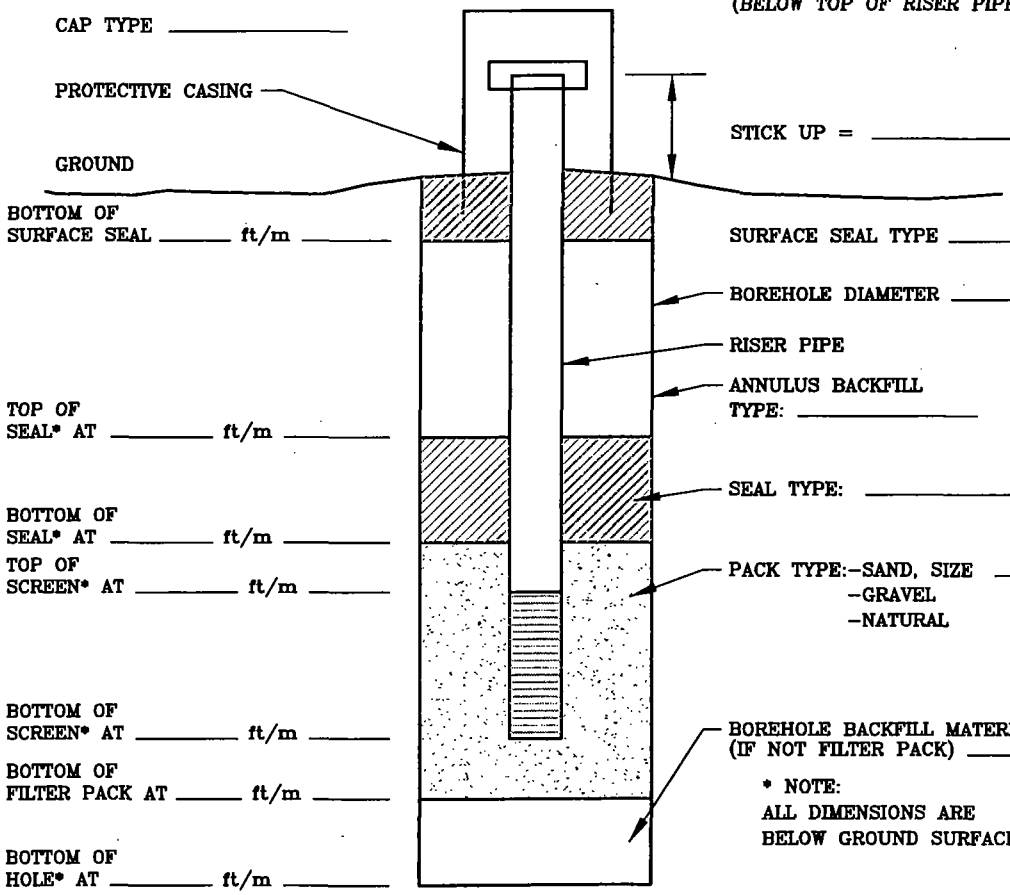
WELL INSTRUMENTATION LOG

PROJECT NAME _____ WELL DESIGNATION _____

PROJECT NUMBER _____ DATE COMPLETED _____

CLIENT _____ DRILLING METHOD _____

LOCATION _____ CRA SUPERVISOR _____



SCREEN TYPE: ☐ continuous slot ☐ wire wrapped ☐ louvre ☐ other: _____

SCREEN MATERIAL: ☐ stainless steel ☐ pvc ☐ other: _____

SCREEN LENGTH: _____ ft/m SCREEN DIAMETER: _____ in/cm SCREEN SLOT SIZE: _____

RISER PIPE MATERIAL: _____ RISER PIPE DIAMETER: _____ in/cm

SURFACE CASING (Y/N) _____ MATERIAL _____ DEPTH _____ ft/m

DIAMETER _____ in/cm SEALANT _____

DEVELOPMENT: METHOD: _____ DURATION: _____

DESCRIPTION OF PURGED WATER: _____

Date: _____ *Reference No.* _____

EQUIPMENT AND SUPPLY CHECKLIST
SURFACE WATER SAMPLING, SEDIMENT SAMPLING, AND FLOW MEASUREMENT

INSTRUMENTS:

- ☐ Measuring tape
- ☐ Steel tape (100 ft)
- ☐ Air monitoring equipment
- ☐ Velocity meter
- ☐ Flow meter
- ☐ Depth recorder/data logger
- ☐ Calculator
- ☐ Laptop computer with communication cable
- ☐ Stop watch
- ☐ Camera

EQUIPMENT:

- ☐ Sampling telescopic pole
- ☐ Sampling scoop/bucket
- ☐ Boat/motor (if required)
- ☐ Bailers
- ☐ Kemmerer/Van Dorn sampler
- ☐ Peterson/Ponar Dredge
- ☐ Core sampler/split spoon sampler
- ☐ Stainless steel mix bowl
- ☐ Hand tools
- ☐ Other _____

SUPPLIES

- ☐ Foil
- ☐ Paper towels
- ☐ Decontamination Fluids (as required by Work Plan)
- ☐ Deionized Water
- ☐ Labels
- ☐ Sample knives
- ☐ Trash bags
- ☐ Sample Glassware
- ☐ T-bars/stakes
- ☐ Duct tape
- ☐ Markers
- ☐ Film
- ☐ Paint
- ☐ Thumbtacks

DOCUMENTATION

- ☐ Topographic Maps
- ☐ Notebook/Field book
- ☐ Photolog
- ☐ Site pass/badge
- ☐ Site Map
- ☐ Work Plan

PERSONAL PROTECTIVE EQUIPMENT:

- ☐ Waders/overboots
- ☐ Tyveks (if required)
- ☐ Life vest
- ☐ Safety line
- ☐ Protective gloves
- ☐ Hardhat
- ☐ Safety glasses
- ☐ First Aid Kit
- ☐ Check Health and Safety Plan

Completed by: _____ *Date:* _____

*Date:*_____ *Reference No.* _____

LANDFILL GAS MONITORING EQUIPMENT AND SUPPLY CHECKLIST

INSTRUMENTS:

- O Water level indicator (Narrow Diameter) with measuring tape
- O Steel Tape
- O Plopper
- O Air Monitoring Equipment
- O Combustible Gas Instrument
- O Pressure Measuring Instrument
- O Digital Thermometer

SUPPLIES:

- O Foil
- O Paper towels
- O Decontamination Fluids (as required by Work Plan)
  - O 2 - Propanol
  - O Deionized water
  - O Hexane (pesticide grade)
  - O Methanol (pesticide grade)
  - O Other
- O Trash bags
- O Plastic spray bottles
- O Tubing (Tygon or teflon)
- O Assorted adaptors and connectors (to connect instrument to probe)

PERSONAL PROTECTIVE EQUIPMENT:

- O Tyveks (assorted sizes and types)
- O Latex gloves
- O Hard hats/liner(s)
- O Field overboots
- O Work gloves (cotton and chemical resistant)
- O Safety glasses/or side shields on OSHA-approved prescription lenses
- O First Aid Kit
- O Respirators
- O Check Health and Safety Plan
- O Confined Space Entry equipment

DOCUMENTATION

- O Notebook/field book
- O Site pass/badge
- O Previous well logs/previous historical well data
- O Site map
- O Blank landfill gas monitoring data forms
- O Property access/utility clearance
- O Confined Space Entry Permit

MISCELLANEOUS

- O Well Cap Keys
- O Bolt cutters
- O Camera/film
- O Knife
- O Spare batteries for instruments
- O Lock deicer (winter)
- O Measuring Tape
- O Pen/pencil/indelible marking pen
- O Tool box
- O Spare locks/keys
- O On site transportation (all Terrain Vehicle/Snowmobiles)

Completed by: _____ *Date:* _____

CRA

FIELD DATA RECORD FORM
MONITOR, PID, MINIRAE 2000

(QSF-295D)

Control No.: _____ **Project No.:** _____
Date: _____ **Project Name:** _____
User: _____ _____
Location: _____

Additional Equipment Control Numbers and Descriptions: _____

FIELD PROCEDURE BEFORE USE:

	Check when completed
• Gently unscrew the lamp housing cap.	
• Remove the sensor adaptor with the gas inlet probe, and remove the metal and dust filters from the probe using tweezers.	
• Check to ensure the probe is clean.	☐
• Replace the filters back into the probe cavity and replace the probe assembly.	
• Turn the PID on by pressing the (Mode) key.	
• During the warm-up period, check the pump inlet flow using your finger to detect suction. The warm-up ends when "Ready" is displayed.	☐
• Press the (Mode) key several times until the battery voltage is displayed.	
• Check battery level and record on the space provided. Recharge if below 4.4 V.	_____ V
• Press the (Mode) key several times until "Survey/Ready" is displayed.	
• Press and hold both the (Mode) and the (N/-) keys for 3 seconds.	
• At the prompt "Calibrate/select Gas?", press the (Y/+) key.	
• If calibrating in unclean air, attach the charcoal filter to the PID probe.	☐
• At the prompt "Fresh air cal?", press the (Y/+) key to begin the zero calibration. The display will indicate "zero in progress" followed by a 15 second waiting period. At the end of the calibration, "zeroed!" will be displayed followed by the zero reading.	
• Ensure that the instrument is properly zeroed.	☐
• Press any key to continue. Remove the charcoal filter from the PID probe.	
• At the prompt "Fresh air cal?", press the (N/-) key.	
• Place the regulator onto the calibration gas and connect to the PID probe.	☐
• At the prompt "Span cal?", press the (Y/+) key.	
• At the prompt "Apply gas now!", quickly turn on the calibration gas valve. The calibration takes 30 seconds after which the display will indicate "cal'ed!" followed by the calibration reading.	
• Ensure that the calibration reading is +/- 2 ppm of the calibration gas value.	☐
• Press any key to continue.	
• Turn off the valve of the calibration gas and disconnect from the PID.	
• Press the (Mode) key several times until the "Ready" prompt is displayed.	
• Press the (Y/+) key to start the measurement.	
• To end the measurements, press the (Mode) key followed by the (Y/+) key.	
• Press and hold the (Mode) key for 5 seconds to turn off the PID.	

Filing: Field File

Signature: _____

THIS COMPLETED FORM IS A QUALITY RECORD

FIELD DATA: **(QSF-295D)**

Sample No.	*Time*	*Location*	*Reading*	*Comments*

Filing: Field File

Project No: _____ **Name (please print):** _____

Date: _____ **Signature:** _____

THIS COMPLETED FORM IS A QUALITY RECORD

PUMPED WELL - DRAWDOWN DATA

Project No.: _____ Project Name: _____

Date: _____ Project Location: _____

Pumped Well No.: _____ Type of Test: _____

CRA Supervisor: _____ W/L Before Pumping Ceased: _____

Screened Interval: _____ to _____ Pumping Rate (Q): _____

Aquifer Thickness: _____ Datum Point: _____ Datum Point Elevation _____ amsl

Static Water Level: _____ ☐ Confined ☐ Unconfined

Time			Time (t) Since Pumping Stopped (min.)	Ratio t/t'	Water Level	Residual Drawdown	Remarks
Day	Hr.	Min.					

CRA 1001 (29) Form SP25

TABLE 1
SAMPLE KEY

Project Number - 056427.10	Template Ver: FSK v3.1 8/31/2005	Blue	Required for all samples
Site Code -		Yellow	Required for aqueous and solid samples
Event Description - Work Plan IV	Sample Batching daily	Green	Required for solid samples
Laboratory - TestAmerica North Canton	SSOW Ref. Code 056427-10-001	Light Green	Required for aqueous samples

Sample ID	Location Code	Location is already in the database Y/N	Sample Date (mm/dd/yyyy)	Sample Time (hh:mm)	Sent to Lab Date (mm/dd/yyyy)	Chain of Custody Number	Sample Type	Sample Matrix	Start Depth (ft bgs)	End Depth (ft bgs)	Parent Sample ID (Sample ID of original sample for duplicates, etc.)	Hold (Y/N?)	VOCs	SVOCs	MT 10 Metals	PCBs	Molybdenum	Nickel	# Containers Collected	Composite (Y/N)	Sample Method	Sampler Name(s)	Sampling Company	Sampling Reason
													Analytes/Parameters											
S-56427-042109-DR-126	SS1-09	N	4/21/2009	14:25	4/21/2009	6153/6152	N	SO	0	1		N	X	X	X	X			6	N	Core Barrel	D. Rivers	CRA	Stockpiled Soil and Surficial Debris
S-56427-042109-DR-127	SS2-09	N	4/21/2009	14:40	4/21/2009	6153/6152	N	SO	0	1		N	X	X	X	X			6	N	Core Barrel	D. Rivers	CRA	Stockpiled Soil and Surficial Debris
S-56427-042109-DR-128	SS3-09	N	4/21/2009	15:00	4/21/2009	6153/6152	N	SO	0	1		N	X	X	X	X			6	N	Core Barrel	D. Rivers	CRA	Stockpiled Soil and Surficial Debris
S-56427-042109-DR-129	SS4-09	N	4/21/2009	15:15	4/21/2009	6153/6152	N	SO	0	1		N	X	X	X	X			6	N	Core Barrel	D. Rivers	CRA	Stockpiled Soil and Surficial Debris
S-56427-042109-DR-130	SS5-09	N	4/21/2009	16:00	4/21/2009	6153/6152	N	SO	0	1		N	X	X	X	X			6	N	Core Barrel	D. Rivers	CRA	Stockpiled Soil and Surficial Debris
S-56427-042109-DR-122	SB48-09	N	4/21/2009	13:40	4/21/2009	6668/6667	N	SO	8	10		N	X	X	X	X	X	X	6	N	Core Barrel	E. Mickelson	CRA	Potential On-Site Fill Activities
S-56427-042109-DR-123	SB49-09	N	4/21/2009	15:20	4/21/2009	6668/6667	N	SO	5	7		N	X	X	X	X	X	X	6	N	Core Barrel	E. Mickelson	CRA	Potential On-Site Fill Activities
S-56427-042109-DR-124	SB50-09	N	4/21/2009	17:30	4/21/2009	6668/6667	N	SO	12.5	14.5		N	X	X	X	X	X	X	6	N	Core Barrel	E. Mickelson	CRA	Potential On-Site Fill Activities
S-56427-042209-EM-132	SB56-09	N	4/22/2009	8:45	4/22/2009	5503	N	SO	16.5	18.5		N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042209-EM-133	SB56-09	N	4/22/2009	8:50	4/22/2009	5503	FD	SO	16.5	18.5	S-56427-042209-EM-132	N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042209-EM-134	SB58-09	N	4/22/2009	11:00	4/22/2009	5503	N	SO	5	7		N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042209-EM-135	SB57-09	N	4/22/2009	13:30	4/22/2009	5503	N	SO	6.6	8.6		N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042209-EM-136	SB54-09	N	4/22/2009	15:45	4/22/2009	5503	N	SO	3	5		N	X	X					13	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042209-EM-137	SB52-09	N	4/22/2009	17:30	4/22/2009	5503	N	SO	13	15		N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042209-DR-140	SB61-09	N	4/22/2009	12:30	4/22/2009	5503	N	SO	14	15		N	X						5	N	Core Barrel	D. Rivers	CRA	VOC-Impacted Soil and Groundwater
S-56427-042209-JY-141	SS6-09	N	4/22/2009	13:22	4/22/2009	5503/5502	N	SO	0	1		N	X	X	X	X	X	X	5	N	Core Barrel	J. York	CRA	Stockpiled Soil and Surficial Debris
S-56427-042209-JY-142	SS7-09	N	4/22/2009	13:49	4/22/2009	5503/5502	N	SO	0	1		N	X	X	X	X	X	X	5	N	Core Barrel	J. York	CRA	Stockpiled Soil and Surficial Debris
S-56427-042209-JY-143	SS7-09	N	4/22/2009	13:55	4/22/2009	5503/5502	FD	SO	0	1	S-56427-042209-JY-142	N	X	X	X	X	X	X	5	N	Core Barrel	J. York	CRA	Stockpiled Soil and Surficial Debris
S-56427-042209-JY-144	SS8-09	N	4/22/2009	14:20	4/22/2009	5503/5502	N	SO	0	1		N	X	X	X	X	X	X	5	N	Core Barrel	J. York	CRA	Stockpiled Soil and Surficial Debris
S-56427-042209-JY-145	SS9-09	N	4/22/2009	14:40	4/22/2009	5503/5502	N	SO	0	1		N	X	X	X	X	X	X	5	N	Core Barrel	J. York	CRA	Stockpiled Soil and Surficial Debris
S-56427-042209-JY-146	SS10-09	N	4/22/2009	15:05	4/22/2009	5503/5502	N	SO	0	1		N	X	X	X	X	X	X	5	N	Core Barrel	J. York	CRA	Stockpiled Soil and Surficial Debris
S-56427-042209-DR-147	Trip Blank	N	4/22/2009		4/22/2009	5503	TB	SOQ				N	X						3	N	Core Barrel	D. Rivers	CRA	Trip Blank
S-56427-042309-EM-138	SB53-09	N	4/23/2009	8:40	4/23/2009	6671	N	SO	7	9		N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042309-EM-139	SB55-09	N	4/23/2009	10:35	4/23/2009	6671	N	SO	10.8	12.8		N	X	X					5	N	Core Barrel	E. Mickelson	CRA	Former Fuel Oil and Diesel Fuel USTs
GW-56427-042309-DR-148	SB61-09	N	4/23/2009	8:55	4/23/2009	6671	N	WG	69	74		N	X						9	N	Core Barrel	D. Rivers	CRA	VOC-Impacted Soil and Groundwater
GW-56427-042309-JY-149	TW56-09	N	4/23/2009	10:06	4/23/2009	6671	N	WG				N	X	X					5	N	Pump	J. York	CRA	Former Fuel Oil and Diesel Fuel USTs
GW-56427-042309-JY-150	TW56-09	N	4/23/2009	10:10	4/23/2009	6671	N	WG			GW-56427-042309-JY-149	N	X	X					5	N	Pump	J. York	CRA	Former Fuel Oil and Diesel Fuel USTs
S-56427-042309-EM-152	SB51-09	N	4/23/2009	14:30	4/23/2009	6670/5504	N	SO	11.8	13.8		N	X	X	X	X	X	X	5	N	Core Barrel	E. Mickelson	CRA	Potential On-Site Fill Activities
S-56427-042309-EM-153	SB51-09	N	4/23/2009	12:00	4/23/2009	6670/5504	FD	SO	11.8	13.8	S-56427-042309-EM-152	N	X	X	X	X	X	X	5	N	Core Barrel	E. Mickelson	CRA	Potential On-Site Fill Activities
S-56427-042309-DR-154	SB60-09	N	4/23/2009	14:20	4/23/2009	6671	N	SO	13.5	14.5		N	X						4	N	Core Barrel	D. Rivers	CRA	VOC-Impacted Soil and Groundwater
S-56427-042309-DR-155	SB60-09	N	4/23/2009	14:25	4/23/2009	6671	FD	SO	13.5	14.5	S-56427-042309-DR-154	N	X						4	N	Core Barrel	D. Rivers	CRA	VOC-Impacted Soil and Groundwater
GW-56427-042309-DR-156	TW60-09	N	4/23/2009	15:00	4/23/2009	6671	N	WG	9	17		N	X						3	N	Pump	D. Rivers	CRA	VOC-Impacted Soil and Groundwater
S-56427-042309-EM-157	SB62-09	N	4/23/2009	17:45	4/23/2009	6671	N	SO	4.6	6.6		N	X						4	N	Core Barrel	E. Mickelson	CRA	VOC-Impacted Soil and Groundwater
TB-56427-042309-DR-158	Trip Blank	N	4/23/2009		4/23/2009	6671	TB	SOQ				N	X						3	N	Direct Fill	D. Rivers	CRA	Trip Blank
TB-56427-042309-DR-159	Trip Blank	N	4/23/2009		4/23/2009	6671	TB	WGQ				N	X						1	N	Direct Fill	D. Rivers	CRA	Trip Blank

ATTACHMENT C

RRD OPERATIONAL MEMORANDUM NO. 2

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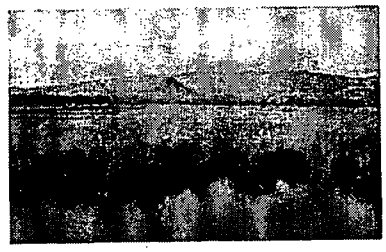

Draft Field Sampling Plan for the Remedial Investigation/Feasibility Study

Plainwell Mill
Plainwell, Michigan

Operable Unit No. 6 of the Allied Paper, Inc./ Portage Creek/Kalamazoo River Superfund Site

Revision 0
September 2006

Prepared by
RMT, Inc.
on behalf of Weyerhaeuser Company

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List of Acronyms and Abbreviations

[Refer to Table of Contents for the Quality Assurance Project Plan in this document for a list of acronyms and abbreviations that may be used in this Field Sampling Plan.]

Section 1
Introduction

1.1 Background

On behalf of Weyerhaeuser Company (Weyerhaeuser), RMT, Inc. (RMT), is submitting this Field Sampling Plan for the Remedial Investigation/Feasibility Study (RI/FS) for the Plainwell, Inc., Mill (the Plainwell Mill) site, located at 200 Allegan Street, in Plainwell, Michigan. The Plainwell Mill site is an approximately 34-acre property, which is Operable Unit No. 6 of the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund site. On February 22, 2005, Weyerhaeuser entered into a Consent Decree with the United States Environmental Protection Agency (U.S. EPA), for the Design and Implementation of Certain Response Actions at Operable Unit No. 4 (the 12th Street Landfill site) and the Plainwell Mill site. A Statement of Work (SOW) for the RI/FS at the Plainwell Mill site was subsequently issued by the U.S. EPA, with an effective date of August 17, 2006.

1.2 Purpose

This document presents a Field Sampling Plan (FSP) for performing the remedial investigation/feasibility study (RI/FS) program at the Plainwell Mill Site, in Plainwell, Michigan. The purpose of the FSP is to define, in detail, the sampling and data-gathering methods to be used during the remedial investigation program. The site activities included in the program are defined in the Remedial Investigation/Feasibility Study Work Plan (the RI/FS Work Plan).

The organization and specific quality assurance (QA) and quality control (QC) activities associated with the remedial investigation program are presented in the Quality Assurance Project Plan (QAPP), which is being submitted concurrently with the FSP.

This FSP has been developed in accordance with the U.S. EPA's document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," dated October 1988.

1.3 Scope

This FSP provides guidance for the RI fieldwork by defining the sampling and data-gathering methods to be used. The scope of the document is outlined as follows:

- Section 1 provides the introduction, purpose, and scope of the FSP.
- Section 2 describes a summary of the sampling program, including sample locations and frequency.
- Section 3 covers the logistics of sample designation and field records.
- Section 4 describes the sampling equipment and procedures for each media to be investigated.

- Section 5 summarizes the sample handling and analysis procedures to be followed. Details regarding the sample analytical procedures are discussed in the QAPP.
- Section 6 describes field analytical techniques.
- Section 7 describes field physical measurements.
- Section 8 describes management of investigation-derived waste.
- Section 9 is a list of the references cited in this FSP.

Section 2
Summary of Sampling Program

This section presents the field and analytical program for the RI/FS. The locations and the frequencies of sampling are also outlined in the RI/FS Work Plan. The QAPP contains a complete description and the number of QA/QC samples that will be collected during the fieldwork. The QA/QC samples are not referenced in the tables in this section. An overview of the sample collection means and methods is included in this section, and a detailed description is included in Section 4 of this FSP.

The overall purpose of the remedial investigation program is to collect sufficient data to support the feasibility study for the site specifically addressing potential areas of concern regarding the proposed site redevelopment. The location of the Plainwell Mill site is illustrated on Figure 2-1.

As provided in the SOW, the objectives for the RI/FS for the Plainwell Mill site are as follows:

- **To determine the nature and extent of contamination to assess risk and support development and evaluation of remedial alternatives** – To collect the data necessary to adequately characterize the nature and extent of contamination at the mill, consistent with the requirements of the National Oil and Hazardous Substance Pollution Contingency Plan (March 8, 1990) ("NCP") and the Consent Decree.
- **To evaluate potential risk** – To assess any current and potential risks to human health or the environment caused by the release or threatened release of hazardous substances, pollutants, or contaminants at or from the mill.
- **To develop and evaluate potential remedial alternatives** – To develop and evaluate potential remedial alternatives, consistent with reasonably anticipated future land use(s) at the mill, for remedial action to prevent, mitigate, control, or eliminate risks posed by any release or threatened release of contaminants at or from the mill.

2.1 Soil Sampling

2.1.1 Sampling Objectives

Soil screening and sampling activities are designed to meet the following objectives:

- ***To characterize soil*** – Does soil in potential source areas pose an unacceptable risk to human health or the environment and/or exceed applicable State of Michigan Part 201 criteria, under the current and reasonably anticipated future land uses?
- ***To confirm the thickness of the overburden soil (in the former wastewater sludge dewatering lagoon area)*** – Is the overburden soil (i.e., topsoil and sandy fill) present above the wastewater residuals and black darkened soil in the former wastewater sludge dewatering lagoon area at least 1 foot thick?

- ***Determine the horizontal and vertical extent of coal fragments, fill material, and darkened soil (in the northcentral portion of the site)*** – What is the horizontal and vertical extent of coal fragments and surface staining at the ground surface, and of coal- and/or ash–containing fill material at depth? Are COPCs present in the layer of soil located directly below the visual impacts?

2.1.2 Sample Locations and Depths

Soil samples will be collected with a Geoprobe® or hand-auger at the approximate locations shown on Figures 2-2 and 2-3 and described in Table 2-1.

- **Former wastewater sludge dewatering lagoon and aeration basin area** - Advance approximately 22 borings at the locations shown on Figure 2-2 using a Geoprobe® to visually determine and/or confirm the thickness of overburden soil (i.e., topsoil and sand fill) overlying the wastewater materials. At selected locations, to be determined based on field observations, advance the borings into the wastewater materials, in order to visually confirm previous information on the extent of the materials. At 14 of the 22 boring locations, collect samples of near-surface soil (0 to 1 foot bgs), and analyze the samples for metals, PCBs, and PAHs.
- **Northcentral portion of site** - Nine near-surface soil samples will be collected in the former coal pile storage area at the approximate locations shown on Figure 2-3 (GP-CEN1 through GP-CEN9). The near-surface soil samples will be collected from 0 to 1 foot bgs. If the soil that is present very near to the ground surface (e.g., 0 to 2 inches below ground surface) contains a considerably higher percentage of visible coal fragments than the remaining portion of the near-surface soil, this soil interval will be segregated and will not be analyzed with the remainder of the soil sample. Instead, one to three samples of the highly coal-containing portion would be analyzed separately, for metals and PAHs. In addition, samples of the underlying fill material will be collected at seven of the locations in this area (GP-CEN3 through GP-CEN9 on Figure 2-3). An additional sample will be collected from the soil encountered directly below the fill material at approximately four locations. Deeper samples will not be collected at GP-CEN1 or GP-CEN2 because the purpose of these borings is to determine the horizontal extent of the potential near-surface soil risk, which was identified at DG-3 and DG-4 (ERM, 1996).

  Two near-surface soil samples will be collected in the spill area near the No. 6 fuel oil tank (HA-FUEL1 and HA-FUEL2 on Figure 2-3). The near-surface soil samples will be collected from 0 to 1 foot bgs. Two additional soil samples will be collected from soil that is present directly below the near-surface staining.
- **Background samples** - Soil samples will be collected during the installation of the background monitoring wells (MW-11, MW-12, and MW-13) at depths that correlate with the soil samples collected in the former wastewater sludge dewatering lagoon and aeration basin area and the northcentral portion of the site. Two near-surface samples (0 to ½ foot bgs and ½ to 1 foot bgs) will be collected from each background monitoring well location. Two additional soil samples will be collected from 3 to 4 feet bgs and 4 to 5 bgs (or at depths that correlate with samples collected in other portions of the site) at each background monitoring well location.

2.1.3 Chemical Analysis

Soil samples collected from the northcentral portion of the site, as well as background samples, will be analyzed for metals and polycyclic aromatic hydrocarbons (PAHs). Soils samples collected from the former wastewater sludge dewatering lagoon and aeration basin area will be analyzed for metals, PAHs, and polychlorinated biphenyls (PCBs). Details on sample analysis methods are included in the QAPP.

2.2 Groundwater Sampling

Thirteen new monitoring wells (ten downgradient and three upgradient) will be installed at the site to characterize site groundwater conditions. One round of groundwater samples will be collected from the 13 newly installed monitoring wells. The samples will be analyzed for metals, PCBs, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and total suspended solids (TSS).

2.2.1 Sampling Objectives

The installation of the additional monitoring wells and the sampling and analysis of groundwater samples collected from these monitoring wells are intended to meet the following specific objectives:

- To evaluate groundwater quality downgradient of areas of potential environmental concern where existing data are not available or to assess the usefulness of groundwater monitoring results collected by ERM.
- To collect groundwater samples using sampling methods and detection limits that are acceptable under the Michigan Part 201 Program.
- To detect any major sources of environmental release to the shallow groundwater that may be present beneath the mill facility.
- To assess groundwater flow and quality in the vicinity of the Plainwell Mill site.

2.2.2 Monitoring Well Locations

The locations of the new monitoring wells with respect to the areas of potential environmental concern are shown on Figure 2-3. A summary of the well and screen length locations for these new monitoring wells is presented in Table 2-2. The proposed wells will be water table wells. The depth to water at the site varies from approximately 15 to 20 feet bgs. The well screens will be 10 feet in length with approximately 5 feet of well screen above the water table and 5 feet below the water table. The well screen location may be adjusted if the water level is thought to be at an extreme elevation at the time of well installation.

The thirteen new groundwater monitoring wells (MW-1 through MW-13) will be installed in the three areas of potential environmental concern as described below.

Former Wastewater Sludge Dewatering Lagoon and Aeration Basin Area

Six wells will be installed in the vicinity of the former wastewater sludge dewatering lagoon and aeration basin area: one upgradient well and five downgradient wells. The locations of the proposed wells are depicted on Figure 2-4.

Northcentral Portion of the Site

Four wells will be installed in the northcentral portion of the site: one upgradient well and three downgradient wells. The locations of the proposed wells are depicted on Figure 2-4.

Mill Buildings Area

Three wells will be installed in the proximity of the mill building: one upgradient well and two downgradient wells. The locations of the proposed wells are depicted on Figure 2-4.

2.2.3 Groundwater Measurements and Analysis

In situ hydraulic conductivity tests (slug tests) will be performed in each new monitoring well following completion of development. Static water levels will be measured in all of the site monitoring wells to confirm that groundwater is flowing toward the river.

Groundwater samples will be collected from all 13 newly installed monitoring wells at the site and analyzed for metals, PCBs, VOCs, and PAHs. Details on sample analysis are included in the QAPP.

2.3 Investigation-derived Waste Sampling

2.3.1 Purge Water and Decontamination Water

All well development water, purge water generated during well installation and sampling, and decontamination water generated during cleaning of equipment will be stored in a temporary storage tank(s) at the site. Approximately one to two samples of this water will be collected to characterize it for subsequent treatment and/or disposal. The water samples will be analyzed for the analytes required by the treatment and/or disposal facility.

2.3.2 Soil

Soil cuttings generated during the drilling of soil borings will be placed in appropriate temporary containers until all drilling operations are completed. At that time, representative samples will be collected to allow for the transportation and disposal of this material at an off-site, permitted disposal facility.

Section 3
Sample Designation, Control, and Field Records

3.1 Sample Designation

Samples will be assigned a unique alpha-numeric sample descriptor identifying the media types, the sample location, and in certain instances, the sample depth (or sample number). Each sample will be labeled as follows:

[sample matrix] -[sample location]-[sample number]-[sample date] (YYMMDD)

The following sections discuss the sample numbering system in greater detail, and Tables 2-1 and 2-2 show sample ID numbers for each sample.

3.1.1 Sample Matrix

The first portion of each alpha-numeric sample descriptor will be a two-letter alphabetical code that describes the sample matrix. Matrix codes for the investigation are as follows:

- "MW" for groundwater from monitoring wells
- "SOIL" for investigative-derived waste soil
- "GP" for soil from the Geoprobe®
- "HA" for soil from hand-augers
- "WW" for purge water and decontamination water
- "FB" for field blanks
- "TB" for trip blanks
- "FDUP" for blind field duplicate samples

3.1.2 Sample Location

The second entry for each alpha-numeric sample descriptor will be a sample location designator, which will be assigned as described below.

Monitoring Wells and Soil Borings

Each sample location will be designated with the identification number/letter of the monitoring well, Geoprobe® boring, or hand-augered boring assigned for that location.

Soil borings in the former wastewater lagoon area and aeration basin area will be identified by the letter designation of the lagoon, followed by the number assigned for that boring (*e.g.*, M1 will be the sample location designation for the first boring completed in lagoon M). Soil borings completed in the northcentral portion of the site will have a location designation of "CEN," followed by the number sequentially assigned for that boring (*e.g.*, CEN1 will be the sample location designation for boring number 1 in the northcentral portion of the site). Likewise, soil borings completed near the No. 6 fuel oil tank will have a location designation of "FUEL," followed by the number sequentially assigned to that boring.

Groundwater monitoring wells will have a unique location designation consisting of a number consecutively starting at "1."

Purge Water and Decontamination Water

Wastewater from purging and developing monitoring wells and from pumping extraction wells will be accumulated in a temporary tank. Samples of this water will be analyzed to provide data to determine the appropriate treatment and disposal method. No sample location designation will be used, unless more than one storage tank is used, in which case the location will be designated as TNK1 for Tank #1, TNK2 for Tank #2, etc.

Soil

Soil cuttings and excess soil sample material will be temporarily stored on-site in appropriate containers. Samples of this material will be collected and analyzed to determine the appropriate treatment and disposal method. No sample location designation will be used unless more than one container is used, in which case the location will be designated CON1 for Container #1, CON2 for Container #2, etc.

3.1.3 Sample Number

For environmental samples, a unique sample number will be designated only in the event that samples are collected at more than one depth at a given location, or when multiple samples of the same type (*e.g.*, water) are collected at a given location within 1 day. In soil borings where more than one subsurface soil sample is obtained at a given location, the first (shallowest) sample collected from the soil boring will be assigned the alphabetical designation "A" (*e.g.*, GP-CEN3-A). The remaining samples from the same borehole will be assigned letter designations in alphabetical order (*e.g.*, GP-CEN3-B, GP-CEN3-C, etc.). The specific depth interval at which each sample is collected will be recorded to the nearest tenth of a foot in the

comments section of the Chain-of-Custody Record and in the appropriate field notebooks. If multiple samples of groundwater are obtained at a given location within 1 day, these samples will be numbered consecutively starting at "01."

For QA/QC samples such as field blanks, trip blanks, and blind duplicates, samples will be numbered sequentially beginning with "001," and will be recorded in the appropriate field notebook. A sample for which additional volume is collected for matrix spike/matrix spike duplicate analyses will have the suffix of "-MS/MSD" added to the sample identification number.

3.1.4 Sample Date

The final entry for each sample descriptor will be the date on which the sample was collected using 2-digit numeric codes for the year, month, and date of the sample (*e.g.*, 070501 would be the sample date for a sample collected on May 1, 2007).

3.2 Chain-of-Custody Procedures

The sampler is responsible for sample custody from the time of sample collection to receipt at the laboratory or until samples are shipped by commercial carrier. A sample is considered under custody if one of the following conditions apply:

- The sample is in a person's possession.
- The sample is in that person's view after being in his or her possession.
- The sample was in that person's possession and then placed in a secured location.
- The sample is in a designated secure area.

Sets of sample containers that are shipped together will be assigned a Chain-of-Custody Record, which will travel with the sample containers. A copy of the Chain-of-Custody Record with its assigned sample numbers will be kept in the laboratory to help identify samples that might become separated from the discrete sample delivery group. When shipped by a commercial carrier, custody seals will be attached to each cooler to ensure that tampering with the samples does not occur in transit, and the shipment airbill will be kept as Chain-of-Custody documentation. A further discussion of Chain-of-Custody procedures and a copy of the Chain-of-Custody Record are included in Subsection 2.3 of the QAPP.

3.3 Field Records

This section of the FSP describes requirements and procedures for documentation of field activities. It is essential that all field documentation provide a clear, unbiased description of field activities. Examples of all of the forms mentioned in this FSP are included in Appendix A.

3.3.1 Daily Log

Serially numbered, bound field notebooks will be used on work assignments requiring field activities. Daily field activities will be recorded in the bound field notebooks. In addition, several sample collection notebooks will contain bound sample collection forms, including soil boring logs, monitoring well construction diagrams, monitoring well development forms, groundwater sampling summary forms, and groundwater and surface water level measurement forms. Representative forms are provided in Appendix A. The on-site coordinator (OSC) will be responsible for issuing field notebooks. A record will be maintained by the OSC documenting the assignment of field notebooks. The OSC will distribute and track bound and numbered field notebooks. Transfers of field notebooks to other individuals (including subcontractors) who have been designated to document specific tasks on the project will be recorded. No field notes may be destroyed or discarded, even if they are illegible, or known to contain inaccuracies.

Entries into field notebooks will be legibly written and will provide a clear record of field activities. Entries will be made in waterproof ink, and in language that is objective, factual, and free of personal opinions or terminology that might later prove unclear or ambiguous. Errors in the field notes will be indicated by drawing a single line through the text, such that the text in error remains legible. Errors addressed in this manner will be initialed and dated by the person making the correction. The person taking notes in the field notebook will sign, number, and date each page and will document the date, time, location on-site, name of field personnel present, and weather conditions observed.

Use of measurements and readings from on-site health and safety equipment will be recorded. Observed potential hazards to health and safety will be described. The level of protection and the decontamination procedure used will be documented.

3.3.2 Soil Boring Logs

Soil borings and monitoring well installations completed by the field team will be documented in a Soil Boring Log. The log will document the drilling locations, drilling dates and times, names of drilling personnel and logging personnel, soil descriptions, sample depths, and recovery.

3.3.3 Soil Sample Logs

Soil samples collected by the field team will be documented in a Soil Sample Log. The log documents the sample identifiers; soil types; sampling times, depth and location of each sample; sampling equipment used; color, odor, and appearance of the samples; sample parameters; container descriptions; sample preservatives; and names of sampling personnel.

3.3.4 Test Pit Log

Test pits and hand-augered borings conducted by the field team will be documented in a Test Pit Log. This log will document the locations of the test pit borings, names of field personnel, test pit boring identification numbers, soil descriptions, sample depths, and any additional observations.

3.3.5 Well Construction Diagram

Monitoring well installation completed by the field team will be documented on a Monitoring Well Construction Diagram. The diagram will document the well identifiers, installation dates, names of installation personnel, well locations, construction materials, material depths, and development methods.

3.3.6 Water Level Data Log

Water level measurements collected by the field team will be documented in a Water Level Data Log. The log will document the names of sampling personnel, well locations, measurement dates and times, reference elevations, depths to water, and depths to the bottom of the well.

3.3.7 Stabilization Test Log

The results of field measurements recorded while purging monitoring wells prior to collecting a sample will be documented in the Stabilization Test Log. This form records time series measurements of conductivity, temperature, turbidity, redox potential, and water level. The form also provides a record of the volumes of water purged prior to sample collection.

3.3.8 Water Sample Log

All groundwater samples collected by the field team will be documented in a Water Sample Log. The log will document the sample identifiers, replicate identifiers, if any; purging and sampling times and locations; sampling equipment; color, odor, and appearance; sample container descriptions; sample preservatives; and sampling personnel.

3.3.9 pH and Conductivity Meter Calibration Log

The field team will record daily calibration results for field instruments in the Calibration Log.

3.3.10 Field Hydraulic Conductivity Test

The data from the slug tests conducted in monitoring wells will be documented on the Field Hydraulic Conductivity Test form. This form documents the well numbers and diameters, static water levels, initial displacements, and changes in the water level versus time.

3.3.11 Chain-of-Custody Record

The Chain-of-Custody (COC) Record is a multi-copy record, which documents the custody of the samples from sample collection through laboratory analysis. The record includes spaces for signatures of those receiving and relinquishing the samples. The sampler, the individual preparing the samples for shipment, and the individual receiving the samples at the laboratory normally sign the record.

The field personnel collecting the sample will fill out the COC Records. The COC process will be initiated upon sample collection. The field person who signs the record will be responsible for the samples until they are transferred to the custody of the laboratory or another custodian. Once the record has been completed, all remaining field sample identification spaces will be crossed through to prevent unauthorized addition of sample information.

The information required on the COC Record includes the complete sample identifier, date and time of sample collection; number of sample containers; analyses and methods required; container type; project number; name of sample collection personnel; complete name, address, and telephone number of the person who will receive analytical reports; turnaround time; and signatures of all sample custodians, excluding shippers. In addition, the method of shipment, and the courier's name and air bill number must be included. The back copy of the record will be retained. The original record will accompany the sample shipment to the laboratory.

3.4 Photographs

Any photograph taken in the field will be documented in the field notebook at the time the photograph is taken. Locations of photographs will be referenced to a site sketch or map. After the film is developed or the images are uploaded onto a computer, the photographs will be labeled with the following information:

- Project identification number
- Date
- Location
- Direction viewed in photograph
- Roll number (if applicable)
- Frame number

- Sample number (if appropriate)
- Initials of the photographer

Section 4
Sampling Equipment and Procedures

This section describes the equipment to be used and the procedures to be followed for collecting samples in the field. Samples will be collected to obtain a representative portion of the matrix being sampled. Valid and reliable results depend on the following actions:

- Obtaining samples that are as representative as possible of the matrix being sampled.
- Using proper sample collection, handling, and preservation techniques.
- Identifying the collected samples and documenting their collection in permanent field records.
- Maintaining sample chain-of-custody procedures.
- Protecting the collected samples by properly packing and transporting them to a laboratory for analysis.

The procedures presented in this FSP will be followed as precisely as possible, given the specific conditions present at the time of sampling. Deviations from the specified procedures will be documented in the bound field notebooks. If the field conditions require significant procedural modifications (*e.g.*, change in sampling apparatus), these will be orally approved by the U.S. EPA oversight representative prior to use and also documented in the Field Activities Log.

4.1 General Considerations

The following factors and procedures are to be used in planning and performing sampling. These factors and procedures will be considered in view of the specific objectives and scope of the field investigation, as presented in this FSP and the QAPP:

- Safety of sampling personnel
- Selection of representative sampling sites
- Selection and proper preparation of sampling equipment
- Selection of parameters to be measured and evaluation of sample fractions to be analyzed (*e.g.*, dissolved, suspended, or total fractions for water samples)
- Required sample volumes
- Selection and proper preparation of sample containers
- Sample preservation
- Sample holding times
- Sample handling and mixing
- Special precautions for trace contaminant sampling

- Sample identification
- Procedures for identifying potentially hazardous samples
- Collection of auxiliary data
- Transportation and shipping of samples
- Sample chain-of-custody

4.2 Decontamination Procedures

4.2.1 Nondedicated Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Nondedicated equipment used for purging monitoring wells or for sampling soil, groundwater, or purge water, or decontamination water will be cleaned before its initial use in the field and again before use at each subsequent sampling site. Equipment subject to this decontamination procedure includes, but is not limited to, the following:

- Split-spoon sampler
- Submersible pumps
- Spatulas
- Mixing bowls
- Water level indicator
- Geoprobe® sampler components that contact samples
- Geoprobe® acetate liner cutting tool

With the exception of the Geoprobe® equipment and the split-spoon sampler, all nondedicated sampling equipment will be new, or will be decontaminated at RMT prior to its initial use on-site. Decontamination procedures will include the following steps:

1. Wash the equipment in a nonphosphate detergent.
2. Rinse with potable tap water.
3. Rinse with deionized (DI) or distilled water.

The water level meters and submersible pumps are not designed to withstand acid rinsing. Decontamination of this equipment will therefore consist of washing the downhole portions of the equipment with nonphosphate detergent and rinsing with DI or distilled water.

Nondedicated equipment that is to be used at additional locations at the site will be field-decontaminated between sampling locations. The field decontamination procedures will be in

accordance with the Michigan Department of Environmental Quality (MDEQ) Remediation and Redevelopment Division Operation Memorandum Number 2, Attachment 7 (Attachment 7) (2004) included in Appendix B.

The field decontamination of sampling equipment will take place at the sampling location. All decontamination water will be contained in 5-gallon buckets and transported to the decontamination pad for collection with other decontamination wastewater.

The field equipment blanks will be collected in accordance with the sampling methodology specified in Attachment 7 (MDEQ, 2004) (see Appendix B).

4.2.2 Dedicated and Single-Use Sampling Equipment

To the extent practicable, single-use sampling equipment and materials will be used for the collection of all environmental samples. The materials used will be new and clean, and will be placed in plastic for transport to the site. Special equipment required for low-level mercury sampling will be provided by the laboratory. Once used, this equipment will be placed in plastic bags and managed as investigation-derived waste material. Single-use equipment may include, but is not limited to, the following:

- HDPE, Tygon®, silicon tubing, and fluoropolymer tubing
- HDPE scoops
- Sample filters
- Transfer containers
- Polypropylene rope
- HDPE bailers
- Geoprobe® acetate sampler liners and end caps

4.2.3 Geoprobe®, Drilling, and Support Equipment

Drilling and support equipment will not come in direct contact with the samples, so cross-contamination of samples is not a concern. However, this equipment will likely come in contact with impacted soil and must therefore be decontaminated prior to moving from one location to another.

The drilling equipment used for soil sampling and monitoring well installation will be cleaned with high-pressure/hot water washing equipment prior to initiating the field investigation. The same procedure will be applied to all drilling equipment between each boring location. The cleaning will occur at a decontamination pad constructed at a suitable location(s) at the site.

Water used for cleaning will be obtained from a local potable water source. Equipment subject to these decontamination procedures includes, but is not limited to, the following:

- Geoprobe® drill rig
- Geoprobe® sampler components
- Hollow-stemmed auger drill rig
- Auger flights
- Hand-augers
- Excavator bucket

In addition, downhole equipment that comes in direct contact with samples (*e.g.*, Geoprobe® and split-barrel samplers) will be decontaminated between each sample interval. This procedure will include washing with a nonphosphate detergent and rinsing with clean potable water.

A piece of Geoprobe® or drilling equipment that comes in direct contact with soil samples (*e.g.*, split-barrel samplers) will be selected for collection of one field equipment blank. After the equipment has been cleaned, it will be rinsed with DI water. The rinse water will be collected and submitted for analysis of all constituents for which the normal samples collected with the equipment are being analyzed.

4.3 Soil Sampling

4.3.1 Geoprobe® Soil Samples

The primary means for the collection of subsurface soil samples will be a direct-push technique using a Geoprobe® or equivalent driver. Direct-push soil samples will be obtained using a closed-piston soil sampler with a liner (or equivalent sampling system). The Standard Operating Procedure for the closed-piston soil sampler is included in Appendix C.

Soil samples will be collected at the approximate intervals specified in Table 2-1. The samples will be classified in accordance with the Unified Soil Classification System (USCS), and field logs will be prepared. A summary of the USCS is included in Appendix D.

Small subsamples representative of the major soil types will be retained for use in developing visual classification as described later in this subsection, and for physical testing, as required.

Subsamples selected for laboratory analysis will be placed in appropriate sample containers provided by the analytical laboratory, labeled, placed in an iced cooler, and stored in accordance with chain-of-custody requirements specified in the QAPP until shipment to the laboratory (or

laboratories) is arranged. Chain-of-Custody Records will be completed for all samples according to the methods described in the QAPP.

4.3.2 Split-Barrel Soil Samples

Soil samples from borings advanced for monitoring well installation will be collected using a split-spoon sampler or Shelby tube. These samples will be used for soil classification and physical soil analysis. In addition, soil samples collected from upgradient monitoring well locations will be used to establish background concentrations for selected constituents. Sample intervals and the analytical testing program for these samples are presented in Table 2-1. The soil samples will be placed in appropriate containers provided by the laboratory, labeled, placed in an iced cooler, and stored and shipped to the analytical laboratory under chain-of-custody procedures.

After samples for chemical and physical analysis have been prepared, a visual soil or lithologic description of each sample will be made according to the USCS, and will be documented in a bound log notebook. Subsamples representative of the materials will be placed in plastic bags or glass jars and retained for QC review of boring logs. These samples do not need to be collected from every core if samples from previous soil cores collected at the boring are available for a particular soil type. Boring logs will be prepared from these descriptions and observations.

4.3.3 Test Pit and Hand-Augered Borehole Soil Samples

Test pit and hand-augered borehole soil samples will be used to collect information on the horizontal and vertical extent of residuals, coal fragments, and/or soil staining. Test pits will be dug with a small excavator to obtain a visual delineation of the horizontal and vertical extent of residuals or soil containing coal fragments. The approximate locations of the proposed test pits are shown on Figure 2-3. The actual number and location of test pits will be determined in the field. A hand-auger will be used to delineate the horizontal extent of areas containing visible coal fragments or surface staining. The locations of the hand-augered boreholes will be decided in the field and will be based on visual observations from Geoprobe® borings.

4.3.4 Borehole/Test Pit Abandonment Documentation and Decontamination

All boreholes that are completed above the groundwater table will be backfilled to the ground surface with granular bentonite. Boreholes that extend below the groundwater table will be grouted from the bottom of the borehole to the ground surface with a bentonite slurry grout. For boreholes installed through pavement or concrete structures, asphalt or concrete (to match the existing materials) will be placed at the top of the borehole. Test pits will be backfilled with the excavated material from the test pit.

Each boring and test pit location will be photographed, the approximate location will be measured relative to a nearby permanent reference, and the location will be marked on a site map. The field location will be marked with a stake or spray paint for subsequent surveying, which will be performed in accordance with the procedures presented in Subsection 7.1.

Drilling and sampling equipment that may contact soil will be decontaminated before use at each boring according to procedures outlined in Subsection 4.2.3. After use, the liners and excess soil will be disposed as investigation-derived waste materials as specified in Section 8.

4.4 Monitoring Well Installation

The design, location, and depth of placement of proposed monitoring wells have been chosen to meet the specific objectives of this investigation and to be compatible with the hydrogeologic setting. The monitoring well installation methods, well materials, and construction details have been selected to provide representative hydrogeologic data and groundwater samples.

Groundwater monitoring wells will be installed using hollow-stemmed auger (HSA) drilling methods. To drill and install shallow monitoring wells, 4¼-inch augers will be used. Soil samples will be collected from the borings using a standard split-spoon sampler continuously to 15 feet bgs, and then at 5-foot intervals to the final depth of the boring, as appropriate. The samples will be classified in accordance with the USCS, and field logs will be prepared. Selected samples from the screened zone of each monitoring well will be retained for analysis of grain-size distribution. Samples may be selected for other physical testing, as specified in the QAPP.

Monitoring well construction details are shown on Figure 4-1. The wells will be constructed of 2-inch–diameter Schedule 40 PVC well casing and screen. The well casing will be equipped with a vented PVC expansion cap. All PVC casing and screen sections will have flush-threaded connections. The well screens will have factory-made 0.010-inch slots. Well and screen sections either will be precleaned and shipped from the manufacturer in sealed plastic bags, or will be decontaminated on-site using the procedures described in Subsection 4.2.3.

The well casing and screen will be inserted through the auger flights after the boring has reached the planned depth of the bottom of the well. A filter pack consisting of medium sand will be placed around the well screen using the hollow-stemmed augers to tremmie the sand to the screen depth. The filter pack will extend from approximately 6 inches below to 2 feet above the top of the well screen. The remaining borehole annulus will be sealed with bentonite chips using the auger flights to tremmie material to the bottom of the open hole. Bentonite chips placed above the water table will be hydrated with clean potable water as the augers are removed. A concrete surface seal will be placed from a depth of approximately 3 feet bgs to about 0.5 foot above ground surface. The top of the well casing will extend 2 to 3 feet above

ground surface. A protective steel casing with a lockable cover will be placed over the well casing and embedded in the concrete. The top of the protective casing will extend from 0.2 to 0.5 foot above the well pipe cap. The concrete surface seal will be sloped away from the casing, and the protective casing will be equipped with a drain hole at its base.

Each monitoring well will be developed after installation is completed to remove drilling fluids and aquifer fines from the filter pack and the immediate surrounding formation, to minimize the production of suspended solids during subsequent sampling. Development will consist of mild surging of the well interval that is screened in the aquifer using a surge block or similar apparatus, followed by the pumping of approximately three well volumes of groundwater to remove suspended sediment released from the aquifer by the surging. Cycles of surging and pumping will continue until the water pumped from the well has low turbidity (defined as less than 10 NTU) and when the change in specific conductance, pH, and temperature is less than 10 percent between two consecutive measurements, or until a maximum of five surging/pumping cycles have been completed. Distilled water may be introduced into the wells to aid in the removal of suspended sediment in the event that the formation does not yield sufficient water to allow adequate development in a reasonable amount of time. The locations and elevations of the monitoring wells will be surveyed as described in Subsection 7.1. The surveyed elevation of the top of PVC casing will be accurate to the nearest 0.01 foot, and the surveyed elevation of the ground surface adjacent to the well will be accurate to the nearest 0.1 foot.

All water generated by the development process will be collected in containers and managed as described in Section 8.

4.5 Staff Gauge Installation

Two surface water staff gauges will be installed in the Kalamazoo River to aid in the interpretation of the groundwater/surface water interaction. Staff gauges SG-1 and SG-2 will be installed in the river at locations approximately perpendicular to the shoreline from monitoring wells MW-3 and MW-8, respectively, as indicated on Figure 2-4. The gauges will be attached to a steel fence post that has been driven into the streambed with a fence-post driver. The location and elevation of the reference point of the staff gauges will be surveyed as described in Subsection 7.1. The elevation will be accurate to the nearest 0.01 foot.

4.6 Groundwater Sampling

Groundwater samples from monitoring wells will be collected using a low-flow sampling methodology specifically designed for low-level mercury sampling. The sampling will be consistent with Attachment 7 (MDEQ, 2004) (see Appendix B).

Low-level mercury sample collection is performed by a strict protocol designed to minimize contamination. The protocol involves a two-person team approach. One member of the team is designated as "Dirty Hands," and the second member is designated as "Clean Hands." "Clean Hands" handles all operations involving contact with the sample bottle and transfer of the samples from the tubing or pump outlet to the sample bottle. "Dirty Hands" prepares the sampling equipment, operates the sampling equipment, and is responsible for any other activities that do not involve direct contact with the sample. Non-talc gloves and lint-free outer clothing are required to protect the samples from contamination by lint and dust. Sampling equipment, materials, and containers are cleaned and double-bagged for protection from contamination during storage and transportation. The field equipment is decontaminated with deionized water. The samples are preserved with high-purity, diluted, hydrochloric acid (HCL).

Each monitoring well will be pumped using a peristaltic pump and fluoropolymer tubing. At wells where the depth to water is greater than 20 feet, a QED bladder pump (or equivalent) will be used instead of the peristaltic pump. The bottom of the tubing (or bladder pump intake) will be placed approximately 1 to 2 feet above the base of the well screen, and the well will be pumped at a flow rate ranging from 0.1 to 0.7 liter/min. The pumping rate for each monitoring well is dependent on the hydraulic properties of the formation the well is screened across, and will be determined in the field to be the highest flow rate attainable without creating drawdown greater than approximately 0.1 meter, or at a minimum of 100 mL/min. In the event the aquifer transmissivity is too low to yield sufficient water to limit drawdown to 0.1 meter at the lowest specified pumping rate (0.1 liter/min), sampling will be conducted at the 0.1 liter/min rate since this is the minimum flow rate necessary for accurate measurements through the flow-through cell.

A Geotech P3 flow-through cell (or equivalent) equipped with temperature, turbidity, dissolved oxygen, specific electrical conductance, and pH electrodes will be connected to the discharge tubing from the peristaltic pump. The manufacturer's instructions for this instrument are included in Appendix E. Each of these parameters will be measured at each well during purging to evaluate stabilization. Wells will be considered stable when the following conditions apply between three successive 1-liter sampling intervals:

- The temperature change is within 0.5°C.
- The conductance change is within 20 μhmos/cm.
- The turbidity change is ± 10 percent or <10 NTUs.
- The dissolved oxygen change is within 0.5 mg/L.
- The redox (Eh) change is within 30 mv.
- The pH change is within 0.2 pH units.

The wells will be sampled immediately following stabilization. The samples will be taken from the pump discharge after the flow-through cell has been disconnected. The low-level mercury sample will be collected first following the Clean Hands/Dirty Hands method described in Attachment 7 (MDEQ, 2004) (see Appendix B). The remaining sample bottles will then be collected from the pump discharge.

Regardless of the sampling technique used, efforts will be made to minimize agitation/disturbance of samples during purging and sampling activities. Likewise, efforts will be made to avoid purging wells dry if at all possible.

Groundwater purged during sampling, used pump tubing, and other general waste materials generated by the sampling process will be collected and managed as investigation-derived waste as described in Section 8.

4.7 Sampling QA Procedures

4.7.1 General

The sample collection procedures presented in this FSP are designed to provide samples of the required quality to meet site investigation objectives. All field personnel will be required to understand the requirements of this FSP and will be trained in the use of the specified equipment and techniques.

The OSC is responsible for reviewing the day-to-day activities to ensure that the procedures in the FSP are followed. Specific activities that will be implemented by the OSC include the following:

- Convene a meeting of field personnel at the start of a specific sampling event to review the sampling requirements of the FSP, the necessary equipment and decontamination requirements and use, and the required documentation.
- Review all documentation on a daily basis for completeness, errors, problems, and corrective actions taken.
- Convene daily project team meetings at the start of the day to discuss health and safety, to address any problems developed during the previous day's work, and to review the work to be completed that day.
- Manage the implementation of in-field corrective actions. The RMT project manager will be notified of significant problems and, if necessary, will work with the OSC to develop corrective actions. The project manager will be responsible for implementing corrective actions that need to be applied to areas other than field activities.

4.7.2 Field Measurements

The equipment used for in-field measurement will be maintained, calibrated, and used in the field according to the procedures described in Section 6. The process will be documented, and the OSC will periodically review the documentation and inspect the equipment to ensure that the procedures are followed by the personnel collecting the samples. Significant deviations from the FSP, errors, equipment failures, or other problems will be documented in a bound notebook by the OSC and reported to the RMT project manager. Corrective actions and additional notifications will be coordinated by the project manager.

4.7.3 Sample Collection

The contractors operating drilling rigs and/or soil sampling equipment will be required to understand the use of their equipment and to clean and maintain the equipment in proper working order. Field staff will observe contractor activities and note any actions that may impair the quality of the sample collection efforts. Problems will be documented, and the OSC will be notified. Corrective actions, if required, will be coordinated by the OSC.

Personnel involved in the collection of samples are required to read, understand, and follow the procedures specified in this FSP. Problems that may affect the quality of the sampling effort will be documented by the field personnel most directly involved with the problem, and the OSC will be notified. The OSC is responsible for coordinating the development and implementation of corrective actions with the RMT project manager.

4.7.4 Analytical Quality Assurance Considerations

Field Duplicates

Blind field duplicate samples, prepared by splitting a single sample into two separate containers, will be used to evaluate sampling precision. Points at which duplicate samples are to be collected will be selected by field personnel and will be submitted as blind duplicates to the laboratory. Field personnel are expected to provide a general range of expected concentrations to the laboratory for these samples to minimize impacts on laboratory equipment.

Blind field duplicates will be collected at a frequency of one sample per 10 primary samples for soil and groundwater matrices (see Table 1-7 in the QAPP). Sample identification protocols are provided in Subsection 3.1 of this FSP.

Field Equipment Blanks

Field equipment blanks consisting of analyte-free water will be collected and submitted to the analytical laboratory to assess the quality of the data resulting from the field sampling program. Field equipment blanks are analyzed to check for procedural contamination at the site that may cause sample contamination. Field blanks will be collected following decontamination of the nondedicated sampling equipment, including pumps and soil samplers. Field blanks will not be collected for disposable or dedicated sampling equipment, such as tubing dedicated to a specific well.

Field equipment blank frequencies are described in detail in Table 1-7 of the QAPP. In general, field equipment duplicates will be collected at the rate of one duplicate per 10 primary samples for groundwater and soil matrices. The exception is the low-level mercury sampling locations, at which one equipment blank will be generated for each location sampled. Identification protocols are provided in Subsection 3.1 of this FSP.

Trip Blanks

Trip blanks will be analyzed to assess the possible cross-contamination of VOCs resulting from diffusion through septa during sample shipment. Trip blanks, consisting of 40-mL VOA vials with deionized ASTM Type 2 organic-free water, are generated in the laboratory and accompany VOC sample coolers from the laboratory to the field and back to the laboratory. Trip blank containers are not opened in the field. Trip blanks prepared by the laboratory will meet holding time requirements. One trip blank, consisting of two VOA vials, will be shipped with each cooler containing VOC sample containers. Trip blank identification protocols are provided in Subsection 3.1.

Field Blanks

Field blanks will be analyzed to assess the suitability of the container, preservative, and sample handling. The field blank is generated by pouring the solution provided in one of the sample containers into another sample container the contents of which had been emptied at the facility. One field blank will be collected per day or per sampling event, whichever is greater.

Field blanks will be denoted by "F" followed by a 3-digit number, similar to the system used for duplicate samples (F-001-[Date], F-002-[Date]).

Matrix Spikes/ Matrix Spike Duplicates (MSs/MSDs)

MS/MSD samples provide information about the effect of the sample matrix on the sample preparation and measurement methodology. MS/MSD samples will be analyzed in accordance with the laboratory operating procedures provided in the QAPP. In conjunction with other QC data, the spikes and duplicates give information on the precision and accuracy of the analytical method on the various sample matrices. One MS/MSD sample will be collected and prepared for every 20 or fewer primary samples collected during a sampling round. The MS/MSD samples will consist of triple the normal sample volume for each analytical group, provided adequate sample volume is available. Field personnel will select the sampling locations at which MS/MSD samples are collected. MS/MSD identification protocols are provided in Subsection 3.1.

Section 5
Sample Handling and Analysis

This section presents general sample handling and analysis protocols. Additional detailed information is contained in the QAPP.

5.1 Sample Containers and Shipping

Sample containers, preservation methods, and holding times that meet U.S. EPA and MDEQ standards for solid and liquid samples intended for chemical analyses are summarized in the QAPP, and are included in Tables 5-1 and 5-2 of this FSP. For samples intended for VOC analysis, the sample containers will be filled completely to minimize airspace. Sample containers for other analytical group analyses will be filled to nearly full to avoid overtopping and loss of preservative (if applicable), and to meet the minimum sample volume/mass required by the laboratory (see Table 2-2). Soil samples intended only for physical testing (e.g., grain size) will be placed in clean glass jars (minimum 8-oz. volume). Two jars will be filled from each sample whenever sufficient sample volumes are available.

Samples will be kept in the dark and on ice in a hard plastic ice chest or cooler with a white interior from the time the samples are collected until delivery to the laboratory.

For delivery of samples to the laboratory, the following procedure will be implemented:

1. Collect and preserve the samples as outlined in the FSP and QAPP.
2. Place sample containers in a laboratory shipping container(s). Samples will be packed securely with packing material to protect sample containers from accidental breakage during shipment and to prevent leaks or spills.
3. Fill shipping container with enough ice to last the trip. Double-bag the ice to ensure sample integrity. Dry ice and/or blue ice (ice packs) will not be used.
4. Complete the Chain-of-Custody Record as described in Subsection 3.3 and in the QAPP.
5. Tape the Chain-of-Custody Record to the inside of the shipping container lid.
6. Seal shipping container with strapping tape, and place a custody seal (provided by the laboratory) on the shipping container prior to shipping.
7. Deliver or ship the container to the laboratory using an overnight shipping service.

Responsibility for proper use of containers and preservatives will be under the oversight of the OSC.

5.2 Selection of Parameters

The number and location of the samples to be collected and the selection of parameters to be analyzed are summarized in Tables 2-1 and 2-2 and shown on Figures 2-2, 2-3, and 2-4. The selection of parameters is discussed further in the RI Work Plan and the QAPP.

5.3 Analytical Procedures

The selection of analytical procedures will reflect U.S. EPA-approved methodology from the SW-846 Methods and MDEQ-approved methodology under the Michigan Part 201 Program, where applicable, as stated in the QAPP. Other methods designed to meet project-specific objectives are also defined in the QAPP. A summary of the analytical procedures is provided in Table 5-3.

Section 6
Field Analytical Methods for Groundwater

With any field analytical measurement, the equipment used must be suitable for the analytical method to be used and must be properly calibrated. In addition to being accurate, field analyses must be conducted on a sample representative of the source from which it was collected. Therefore, the type of sample and the location of the sampling site are critical. A discussion of the rationale for the selection of sample types and sampling locations is provided in Section 2.

Specific field analytical techniques to be used are presented in this section. Field analyses described below will be performed on groundwater samples.

Groundwater samples will be collected using low-flow pumping techniques, as discussed in Section 4. Temperature, pH, dissolved oxygen, Eh, and specific conductance and turbidity will be measured at each well during development and purging to evaluate stabilization. Wells will be considered stable when the following conditions apply between three successive 1-liter sampling intervals:

- The temperature change is within 5°C.
- The conductance change is within 20 μmhos/cm.
- The turbidity change is ± 10 percent or <10 NTUs.
- The dissolved oxygen change is within 0.5 mg/L.
- The redox (Eh) change is within 30 mv.
- The pH change is ± 0.2 pH units.

Field measurements will be made and laboratory samples will be collected following stabilization. Well sampling information will be recorded in a bound notebook.

A Geotech P3 flow-through cell (or equivalent) equipped with temperature, specific conductance, and pH electrodes will be placed in the flow-through cell on the discharge from the peristaltic pump or bladder pump.

The equipment will be checked for any mechanical or electrical failures, weak batteries, and cracked or fouled electrodes before mobilizing for field activities. Calibrations and repairs will be recorded in a bound notebook with the date and the name of the person making repairs/calibrations. The equipment will be calibrated at a minimum at the beginning of each sampling day, and at least once for every ½ day of use. A calibration check will be performed at the end of each day.

6.1 pH

The pH measurements will be made using a Geotech P3 flow-through cell (or equivalent). During use, the pH probe will be calibrated utilizing pH 4 and pH 7 buffer solutions. The pH of each sample will be measured in the flow-through cell. The pH measurements will be recorded to the nearest 0.1 pH unit.

6.2 Specific Conductance

The specific conductance probe will be calibrated to a stock calibration solution. The calibration must be within 10 percent of the calibration value of the solution. Specific conductance measurements will be made in the flow-through cell, and are automatically corrected by the instrument to 25°C. Measurements will be reported in μmhos/cm.

6.3 Temperature

The temperature probe will be checked prior to field activities against an NIST-certified thermometer. Temperature will be measured to the nearest 0.2°C within the flow-through cell. Temperature measurements are utilized directly by the instrument to correct the specific conductance reading.

6.4 Turbidity

To assess monitoring well development and the representative nature of groundwater samples, the groundwater will be field-analyzed for turbidity using an in-field nephelometer (Hach Model 2100P, or equivalent). The meter will be calibrated before use according to procedures outlined in the operations manual (see Appendix E). Measurements will be reported in nephelometric turbidity units (NTUs).

6.5 Dissolved Oxygen

Sample DO measurements will be measured using the flow-through cell. Calibration will consist of exposing the probe to a known oxygen concentration such as air at 100 percent relative humidity, or water of known oxygen content, and then adjusting the calibration control so the display shows a reading that matches the oxygen concentration of the known sample (the instrument automatically compensates for temperature to an accuracy of ± 1 percent of the dissolved oxygen reading between 5°C and 45°C, and to an accuracy of ± 1.5 to 2 percent between 0°C and 5°C).

6.6 Eh

The Eh measurements will be made using a Geotech P3 flow-through cell (or equivalent). During use, the Eh probe will be calibrated using calibration solution. The Eh measurements will be recorded to the nearest 0.1 mv.

Section 7
Field Physical Measurements

Field measurements of topographic features, water levels, reference points, and other physical features will be required during the field investigations. The scope of such measurements depends upon the purpose for the particular measurement data.

Physical measurements will be traceable to the person making the measurement and to the specific piece of field equipment used to make that measurement. Equipment maintenance and calibration records will be kept in a bound field notebook, making all such procedures traceable. Time records will be kept using local time in the 2400-hour military format, recorded to the nearest 5 minutes.

Sampling locations will be surveyed and depicted on existing topographic maps. Surveying will be conducted according to the standard procedures described below. Control points used during the survey will be marked in the field and noted on the topographic maps.

7.1 Surveying of Monitoring Wells and Soil Sampling Locations

Accurate, complete, and informative surveying field notes are a primary objective in site mapping. The field notes are the most reliable record of measurements made and information gathered in the field. As stated in Subsection 3.3, information gathered will be recorded in bound notebooks. Notes will be permanent, legible, and complete.

The field notes will accomplish the following:

- Provide adequate and complete information that can be understood by someone other than the notetaker.
- Provide documentation of work completed or data gathered.

Two important aspects of each survey to be addressed in the field notes are as follows:

- ***Starting and ending points of the survey*** - The surveyor will explain and document the starting and ending points of the survey. This applies to both horizontal and vertical control. This will require a paragraph of explanation and sketches and/or cross-references to data in notes of previous surveys.
- ***Clear indication of final results and checking procedures*** - The final results and checks will be plainly indicated. Erasures will not be used, as they raise uncertainties about the reliability of the data. Alterations, additions, revisions, reductions, or comments added to field notes will be written in colored ink to indicate that such information is not part of the original field record. The person making such notations will initial and date each page so affected.

The following is a checklist of information to be included in the notebook:

- Date
- Names of survey crew members
- Weather conditions: observed temperatures, relative wind speed, and barometric pressure if an electronic distance meter (*e.g.*, a total station) is to be used
- Equipment used, listing the serial number or other identification
- Location of survey by section description or other legal parcel identification
- Project number
- North arrow
- Description of all monuments found
- Measurements (slope distance and vertical angles, temperature, taping, horizontal angles, etc.)
- Corrected distances and angles
- Description of monuments set
- Outline or sketch of major traverse or property boundary

The elevation of the measuring point of monitoring wells and a reference point on staff gauges will be surveyed to allow correlation of water levels. Additionally, ground elevations may be required for topographic purposes. Standard engineering leveling techniques, as described in basic surveying textbooks, establish the methodology for providing vertical control. The datum referenced for elevation control is the National Geodetic Vertical Datum (NGVD) of 1929, informally known as sea level datum, established by the U.S. Coast and Geodetic Survey. Benchmarks of known elevation will be used. If no benchmark is located in the vicinity of a site investigation, an arbitrary temporary benchmark will be established on a permanent location (*i.e.*, foundation or corner post). The locations of benchmarks utilized will be shown on a site sketch map. Elevation surveys will be conducted to form a circuit (*i.e.*, the survey line will be closed back to a benchmark). Third-order accuracy will be obtained on level circuits; for example, on a 1-mile circuit, the closure will be within 0.05 foot. Length of sight will not ordinarily exceed 250 feet, with turning point back-shots and fore-shots deviating no more than 50 feet from one another.

7.2 Surface Water Stage

Surface water stage will be measured on staff gauges graduated to 0.01 foot. Staff gauges will be surveyed at the same time that monitoring wells are surveyed, and will be referenced to NGVD. Measurements of water stage will be noted in field logs with date, time, and site location. Water stage will be recorded to the nearest 0.01 foot.

7.3 Groundwater Level Measurement

The measurement of groundwater level in monitoring wells is typically conducted in conjunction with groundwater sampling. Data from such measurements are needed to establish groundwater gradients, and ultimately, the direction of groundwater flow.

Groundwater level measurements are made in reference to an established reference point on the monitoring well casing. This reference point will be documented in field records, as described in Subsection 3.3. Reference point elevations will be surveyed to NGVD, as described in Subsection 7.1. Groundwater level measurements will be made and recorded to the nearest 0.01 foot. The calculated elevations will be reported to the nearest 0.01 foot.

7.3.1 Measurement Method

The depth to groundwater will be measured using an electric water level indicator. This method consists of a spool of small-diameter insulated steel cable with a probe attached to the end. A Slope Indicator Model 51453 (or equivalent) small-diameter water level indicator will be used. When the probe comes in contact with water, the circuit is closed and a meter, light, and/or buzzer attached to the probe signals contact with water. Batteries are normally used for a power source. Depth to water is read from permanent marks on the cable to which the probe is attached. Depth is recorded to the nearest 0.01 foot by measuring the distance between the nearest permanent foot mark and the point at which the meter indicated the water level.

7.3.2 Quality Control Procedures

Groundwater level measuring devices will be calibrated to 0.01-foot accuracy prior to the fieldwork. Before use, these devices are prepared according to the manufacturer's instructions (if appropriate) and checked for visual damage or defects.

7.4 *In Situ* Hydraulic Conductivity Testing

In situ hydraulic conductivity tests will be completed following well development. Rising-head, single-well response tests will be performed on each new monitoring well. The necessary water displacement will be generated through the rapid removal of a "slug" (the slug could be in the form of a solid, a volume of well water, or air pressure). The "slug" will be withdrawn from an equilibrated well, displacing water. Water level measurements will be collected with a pressure transducer/data logger or water level indicator prior to removal of the slug and as the water level re-equilibrates. The record of water level recovery over time will be used to estimate the horizontal conductivity of the formation immediately surrounding the well. Determination of hydraulic conductivity will be based on standard methods described by Bouwer and Rice (1976).

Section 8 Management of Investigation-derived Waste

8.1 Soil

Soil that is produced during the drilling operations will be temporarily stockpiled at each drilling site, and placed on a plastic liner. In the event of rain, and at the end of each work day, the pile will be covered with a plastic sheet. As drilling is completed at each work area, the temporary stockpile will be collected and placed into roll-off bins, drums, 5-gallon buckets, or equivalent located in the primary staging area. After all drilling operations are completed, samples of the accumulated soil will be collected and characterized in accordance with landfill profile requirements. After determining the proper regulatory classification, the soil will be transported for off-site disposal at a permitted disposal facility.

8.2 Purge Water and Decontamination Water

Wastewater produced from well development and well purging and decontamination water will be temporarily stored in a 1,000-gallon to 3,000-gallon polyethylene storage tank(s). Upon completion of the fieldwork, a representative sample(s) of the water will be collected and analyzed for parameters specified by the waste hauler and the publicly-owned treatment works (POTW) and/or permitted facility to which it will be transported for disposal, after obtaining the required permit or written approval.

8.3 Used Personal Protective Equipment and Noncontaminated Refuse

Used personal protective equipment and other types of general noncontaminated debris or waste materials produced during the fieldwork will be collected daily in sealed plastic bags, and placed in a waste dumpster that will be brought to the site for the project. The wastes will be disposed by a local commercial waste disposal contractor at the end of the fieldwork.

Section 9
References

Bouwer and Rice. 1976. A slug test for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells. Water Resources Research. Volume 12. pp. 423-428. June 1976.

Michigan Department of Environmental Quality (MDEQ). 2004. RRD operational memorandum No. 2 - sampling and analysis - Attachment 7, low level mercury sampling specifications. October 22, 2004.

Table 2-1
Summary of Sample Intervals and Analytical Program for Soil Investigation
Plainwell Mill – Plainwell, Michigan

BORING LOCATION	NUMBER OF BORINGS	NUMBER OF SAMPLES	SAMPLE INTERVAL (feet bgs)[1]	FIELD SAMPLE ID	ANALYTES
Former Wastewater Sludge Dewatering Lagoon and Aeration Basin Area					
Former aeration basin	1	1	0-1	GP-AB1	PCBs, metals, PAHs
Lagoon B	1	1	0-1	GP-B1	PCBs, metals, PAHs
Lagoon C	1	1	0-1	GP-C1	PCBs, metals, PAHs
Lagoon K	2	1	0-1	GP-K1	PCBs, metals, PAHs
		1	0-1	GP-K2	
Lagoon H	2	1	0-1	GP-H1	PCBs, metals, PAHs
		1	0-1	GP-H2	
Lagoon I	2	1	0-1	GP-I1	PCBs, metals, PAHs
		1	0-1	GP-I2	
Lagoon J	1	1	0-1	GP-J1	PCBs, metals, PAHs
Lagoon L	2	1	0-1	GP-L1	PCBs, metals, PAHs
		1	0-1	GP-L2	
Lagoon M	1	1	0-1	GP-M1	PCBs, metals, PAHs
Lagoon N	1	1	0-1	GP-N1	PCBs, metals, PAHs
MW-11	1	4	0-0.5	S-MW-11-A	Metals, PAHs
			0.5-1	S-MW-11-B	
			3-4	S-MW-11-C	
			4-5	S-MW-11-D	

Table 2-1 (continued)
Summary of Sample Intervals and Analytical Program for Soil Investigation
Plainwell Mill – Plainwell, Michigan

BORING LOCATION	NUMBER OF BORINGS	NUMBER OF SAMPLES	SAMPLE INTERVAL (feet bgs)(1)	FIELD SAMPLE ID	ANALYTES
Northcentral Portion of the Site					
Former coal pile and subsurface fill area	9	1	0-1	GP-CEN1	Metals, PAHs
		1	0-1	GP-CEN2	Metals, PAHs
		2-3	0-1	GP-CEN3-A	Metals, PAHs
			3-4(2)	GP-CEN3-B	
			4-5(2)	GP-CEN3-C(3)	
		2-3	0-1	GP-CEN4-A	Metals, PAHs
			3-4(2)	GP-CEN4-B	
			4-5(2)	GP-CEN4-C(3)	
		2-3	0-1	GP-CEN5-A	Metals, PAHs
			3-4(2)	GP-CEN5-B	
			4-5(2)	GP-CEN5-C(3)	
		2-3	0-1	GP-CEN6-A	Metals, PAHs
			3-4(2)	GP-CEN6-B	
			4-5(2)	GP-CEN6-C(3)	
		2-3	0-1	GP-CEN7-A	Metals, PAHs
			3-4(2)	GP-CEN7-B	
			4-5(2)	GP-CEN7-C(3)	

Table 2-1 (continued)
Summary of Sample Intervals and Analytical Program for Soil Investigation
Plainwell Mill – Plainwell, Michigan

BORING LOCATION	NUMBER OF BORINGS	NUMBER OF SAMPLES	SAMPLE INTERVAL (feet bgs)[1]	FIELD SAMPLE ID	ANALYTES
Northcentral Portion of the Site *(continued)*					
Former coal pile and subsurface fill area (*continued*)		2-3	0-1	GP-CEN8-A	Metals, PAHs
			3-4[2]	GP-CEN8-B	
			4-5[2]	GP-CEN8-C[3]	
		2-3	0-1	GP-CEN9-A	Metals, PAHs
			3-4[2]	GP-CEN9-B	
			4-5[2]	GP-CEN9-C[3]	
Area near the No. 6 fuel oil tank	2	2	0-1	HA-FUEL1-A	Metals, PAHs
			1-2 or 2-3[4]	HA-FUEL1-B	
		2	0-1	HA-FUEL2-A	Metals, PAHs
			1-2 or 2-3[4]	HA-FUEL2-B	
MW-12	1	4	0-0.5	S-MW-12-A	Metals, PAHs
			0.5-1	S-MW-12-B	
			1-2	S-MW-12-C	
			2-3	S-MW-12-D	

Table 2-1 (continued)
Summary of Sample Intervals and Analytical Program for Soil Investigation
Plainwell Mill – Plainwell, Michigan

BORING LOCATION	NUMBER OF BORINGS	NUMBER OF SAMPLES	SAMPLE INTERVAL (feet bgs)[1]	FIELD SAMPLE ID	ANALYTES
Mill Buildings Area					
MW-13	1	4	0-0.5	S-MW-13-A	Metals, PAHs
			0.5-1	S-MW-13-B	
			3-4	S-MW-13-C	
			4-5	S-MW-13-D	

Notes:
(1) Approximate depths of soil samples. Sample intervals will be adjusted in the field.
(2) Soil sample intervals will be adjusted based on field observation. The intent is to collect samples representative of the fill material and samples representative of the soil directly below the fill material.
(3) A sample of the soil directly below the fill material will be collected at approximately half of these locations (i.e., four locations).
(4) Soil sample intervals will be adjusted based on field observation. The intent is to collect samples of soil directly below the near-surface staining.

Table 2-2
Summary of Analytical Program for the Groundwater Investigation
Plainwell Mill - Plainwell, Michigan

WELL NUMBER	LOCATION	SCREEN LENGTH (feet)	NUMBER OF SAMPLES	FIELD SAMPLE ID	ANALYTES	COLLECT SOIL SAMPLES?
Former Wastewater Sludge Dewatering Lagoon and Aeration Basin Area						
MW-1	Downgradient	10	1	MW-1-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-2	Downgradient	10	1	MW-2-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-3	Downgradient	10	1	MW-3-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-4	Downgradient	10	1	MW-4-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-5	Downgradient	10	1	MW-5-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-11	Upgradient	10	1	MW-11-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing; refer to Table 2-1 for Analytical program

Table 2-2 (continued)
Summary of Analytical Program for the Groundwater Investigation
Plainwell Mill - Plainwell, Michigan

WELL NUMBER	LOCATION	SCREEN LENGTH (feet)	NUMBER OF SAMPLES	FIELD SAMPLE ID	ANALYTES	COLLECT SOIL SAMPLES?
Northcentral Portion of the Site						
MW-6	Downgradient	10	1	MW-6-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-7	Downgradient	10	1	MW-7-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-8	Downgradient	10	1	MW-8-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-12	Upgradient	10	1	MW-12-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing; refer to Table 2-1 for analytical program
Mill Buildings Area						
MW-9	Downgradient	10	1	MW-9-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-10	Downgradient	10	1	MW-10-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing
MW-13	Upgradient	10	1	MW-13-YYMMDD	VOCs, PAHs, PCBs, Metals, TSS	Yes, from screened interval for physical testing; refer to Table 2-1 for analytical program

Table 5-1
Groundwater Sample Containers and Preservation Methods
Plainwell Mill – Plainwell, Michigan

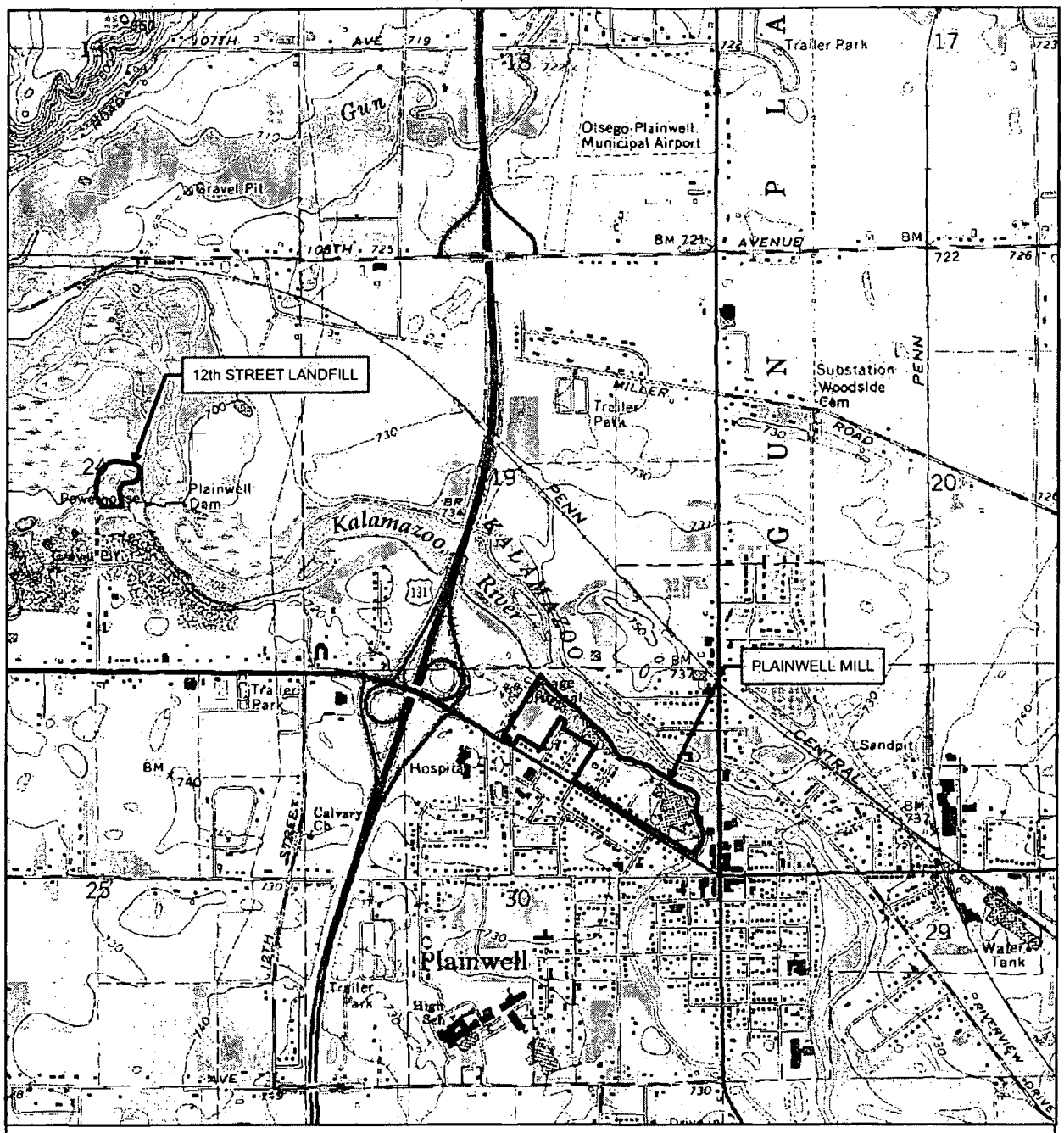
PARAMETER	CONTAINER(S)	MINIMUM SAMPLE VOLUME	FIELD PRESERVATION METHOD	HOLDING TIME
VOCs	3 x 40-mL glass VOA vials with Teflon® septum	1 x 40 mL VOA vial	Cool to 4°C; add HCl to pH <2; protect from light	14 days (sample should remain on-site less than 24 hours)
PAHs	2 x 1,000-mL amber glass bottle, Teflon®-lined cap	1,000 mL	Cool to 4°C; protect from light	Extract within 7 days; analyze within 40 days of extraction
PCBs	2 x 1,000-mL amber glass bottle, Teflon®-lined cap	1,000 mL	Cool to 4°C; protect from light	Extract within 7 days; analyze within 40 days of extraction
Metals (total)	1 x 1,000-mL high-density polyethylene bottle	500 mL	Cool to 4°C; add nitric acid to pH <2	6 months
Low-level mercury (total)	1 x 500-mL fluorinated LPE bottle	300 mL	Cool to 4°C; add nitric acid to pH <2 2.5 mL of BrCl is added at laboratory	90 days
Total cyanide and amenable cyanide	1 x 500-mL high-density polyethylene bottle, Teflon®-lined cap	--	Cool to 4°C; add NaOH to pH>12; if chlorine is present, add ascorbic acid.	14 days
TSS	1 x 1,000-mL high-density polyethylene bottle	--	Cool to 4°C	28 days 7 days

Table 5-2
Soil Sample Containers and Preservation Methods
Plainwell Mill – Plainwell, Michigan

PARAMETERS	CONTAINER	MINIMUM SAMPLE VOLUME	FIELD PRESERVATION METHOD	HOLDING TIME
PCBs (Method 8082, SW-846)	250-mL wide-mouthed amber glass bottle (Teflon®-lined cap); leave small amount of headspace	50-100 g	Cool to 4°C; protect from light	Extract within 14 days from sample collection; analyze within 40 days of extraction
Metals	500-ml wide-mouthed amber glass bottle (Teflon)®-lined cap)	50 g	Cool to 4°C	6 months
PAHs	500-ml wide-mouthed amber glass bottle (Teflon) ®-lined cap)	100 g	Cool to 4°C	14 days
Moisture content	Use an aliquot from the PCB bottle	--	Cool to 4°C	None specified

Table 5-3
Summary of Analytical Procedures
Plainwell Mill - Plainwell, Michigan

PARAMETER	ANALYTIC METHOD
TAL metals	6010B and 6020
Mercury	7470A/7471A
PCBs	8082
Volatile organic compounds	8260B
Polycyclic aromatic hydrocarbons	8270C
TSS	160.2



BASE MAP FROM USGS 7.5 MINUTE QUADRANGLE, OSTEGO, 1967, REVISED 1973.

RMT
744 Heartland Trail
Madison, WI 53717 - 1934
P.O. Box 8923
Madison, WI 53708 - 8923
Phone: 608-831-4444
Fax: 608-831-3021

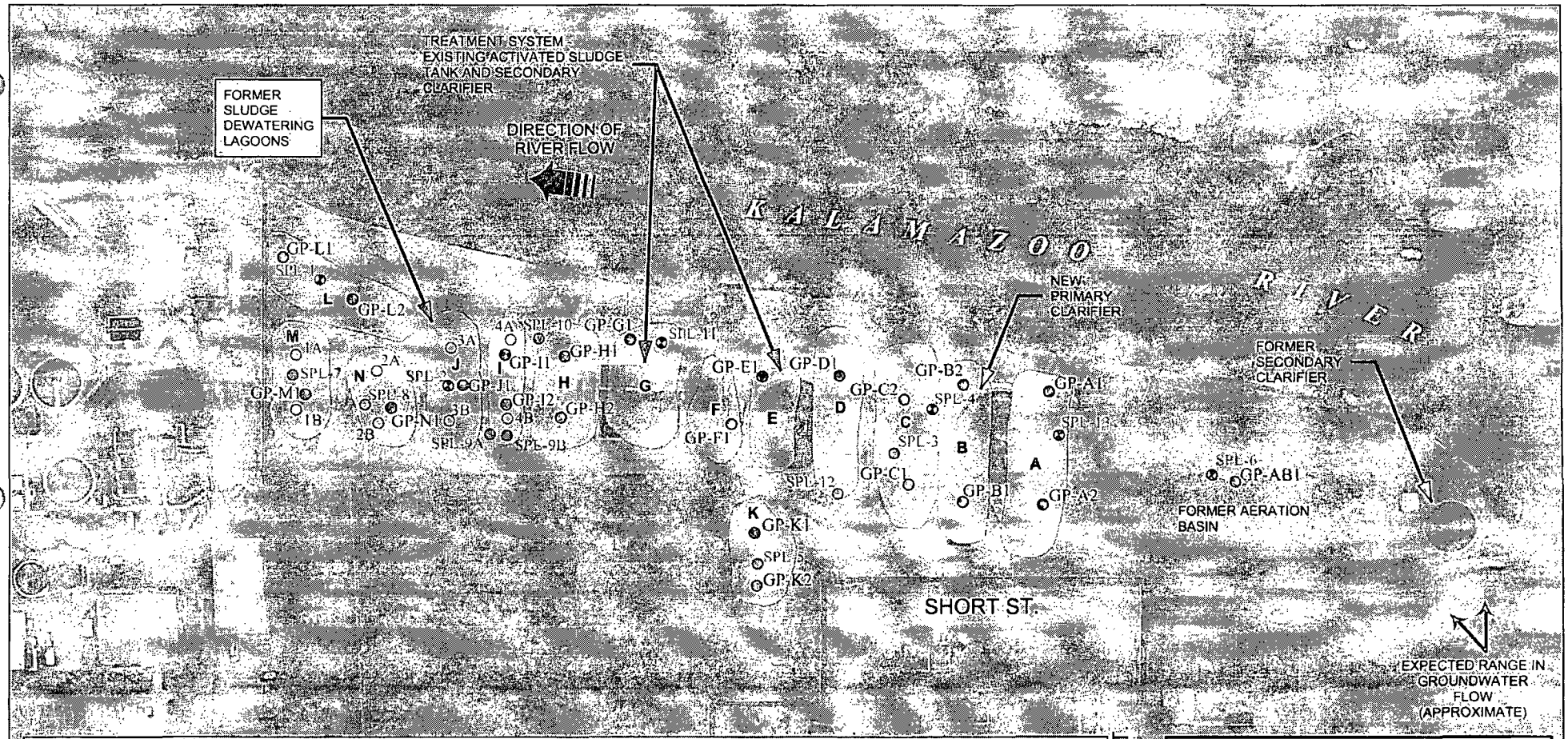
SITE LOCATION MAP

RI/FS FIELD SAMPLING PLAN
PLAINWELL MILL
PLAINWELL, MICHIGAN

DRAWN BY:	PAPEZ J
APPROVED BY:	LEH
PROJ. NO.:	00-05121 03
FILE NO.	51210306fs mxd
DATE:	SEPTEMBER 2006

D:\05121\03\GIS\FLD_SMPLNG\51210306fs.mxd 9/28/2006 08:47:11

FIGURE 2-1



LEGEND

- APPROXIMATE PROPERTY LINE (SURVEYED BY FTC&H ON 11/09/2005)
- A FORMER WASTEWATER SLUDGE DEWATERING LAGOONS
- PREVIOUS SOIL SAMPLE LOCATION (ERM, 1997)
- PREVIOUS SOIL SAMPLE LOCATION, FOR THE ANALYSIS OF PCBs (BBL, 1996a)
- PREVIOUS SOIL BORING LOCATION, FOR VISUAL CLASSIFICATION ONLY (BBL, 1996a)
- APPROXIMATE RI/FS SOIL BORING LOCATION WITH NEAR SURFACE (0 TO 1 FOOT BGS) SOIL SAMPLE ANALYZED FOR METALS, PCBs, AND PAHs
- APPROXIMATE RI/FS SOIL BORING LOCATION, FOR VISUAL CLASSIFICATION ONLY

0 50 100 FEET
1:1,200
1 inch equals 100 feet

NOTES

1. AERIAL PHOTOGRAPH FROM OAS, INC. (MARCH 30, 2005).
2. FORMER SLUDGE DEWATERING LAGOONS INTERPRETED FROM AERIAL PHOTOGRAPHS (1955, 1960, 1967, 1974, 1981, 1986, AND 1991) (BBL, 1992).
3. PROPERTY BOUNDARY TRANSFORMED APPROXIMATELY TO MICHIGAN STATE PLANE COORDINATE SYSTEM IN ORDER TO MATCH OTHER DATA SETS.

PROJECT:	RI/FS FIELD SAMPLING PLAN PLAINWELL MILL PLAINWELL, MICHIGAN		
SHEET TITLE:	RI/FS SOIL BORING LOCATIONS IN THE FORMER WASTEWATER SLUDGE DEWATERING LAGOON AND AERATION BASIN AREA		
DRAWN BY: PAPEZ J	SCALE: AS NOTED	PROJ. NO: 00-05121 03	
CHECKED BY: CPJ		FILE NO.: 51210310fs.mxd	
APPROVED BY: LEH	DATE PRINTED: 9/28/2006	FIGURE 2-2	
DATE: SEPTEMBER 2006			

RMT

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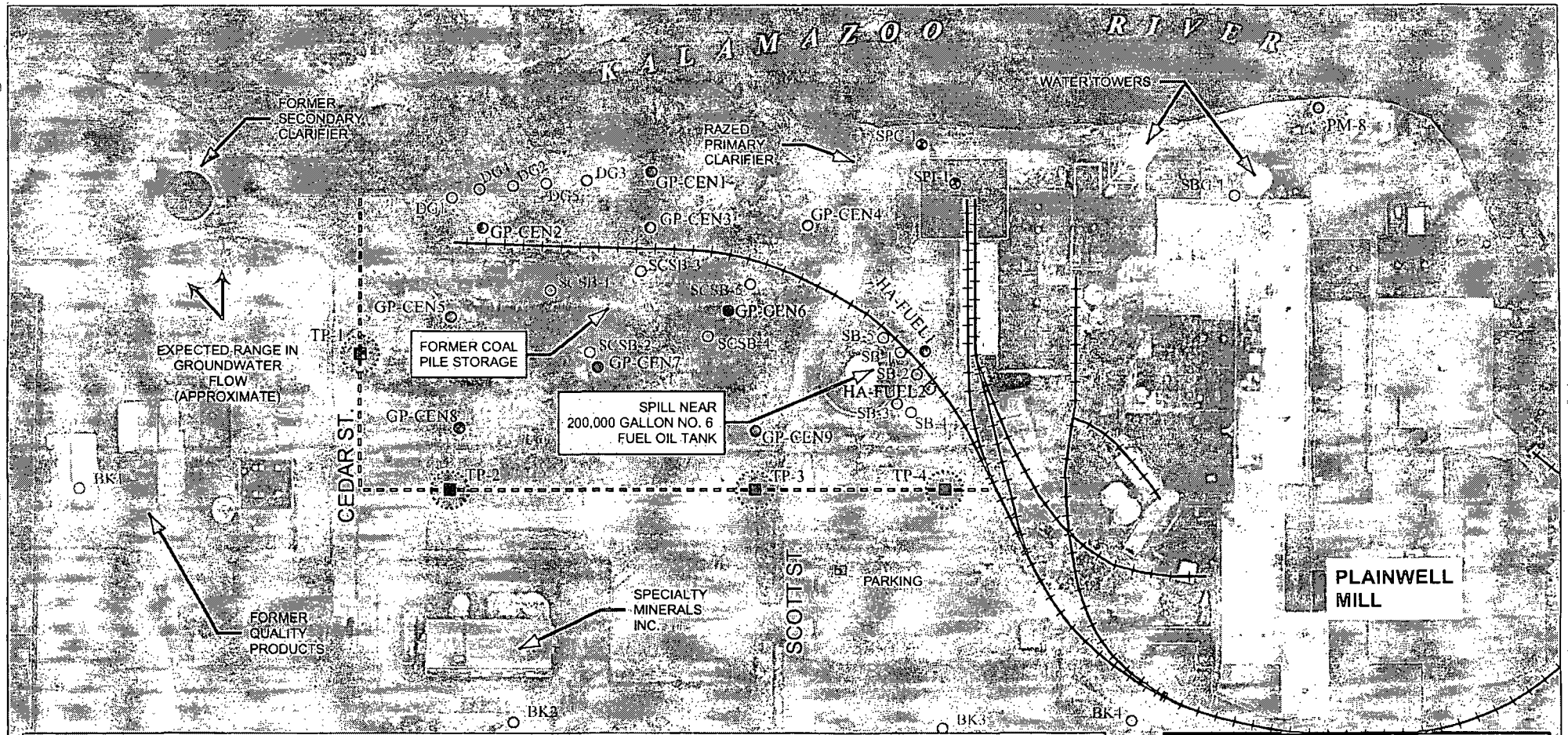
Fax: 608-831-3021

D:\05121\03\GIS\FLD_SMPLNG\51210310fs.mxd 9/28/2006 08:48:05



NOTES

1. AERIAL PHOTOGRAPH FROM OAS, INC. (MARCH 30, 2005).
2. PROPERTY BOUNDARY TRANSFORMED APPROXIMATELY TO MICHIGAN STATE PLANE COORDINATE SYSTEM IN ORDER TO MATCH OTHER DATA SETS.
3. ADDITIONAL TEST PITS MAY BE INSTALLED TO THE SOUTH AND WEST OF TP-1 THROUGH TP-4, IF THE EXTENT OF FILL MATERIAL IS NOT FOUND AT THESE PREDETERMINED TEST PIT LOCATIONS.
4. PREVIOUS SOIL SAMPLES WITH "BK" IDENTIFIERS (e.g. BK3) WERE COLLECTED FOR THE PURPOSE OF ESTABLISHING BACKGROUND METALS CONCENTRATIONS (ERM, 1997).
5. A BUILDING ADDITION WAS CONSTRUCTED IN 1995 OVER THE AREA WHERE SPI-1 WAS COLLECTED IN 1994 (BBL, 1996a).
6. THE LOCATION OF SBG-1 WAS ADJUSTED FROM THE LOCATION DEPICTED IN THE MAP PROVIDED BY ERM, IN ORDER TO BE APPROXIMATELY COINCIDENT WITH THE LOCATION OF THE FORMER GASOLINE UST.

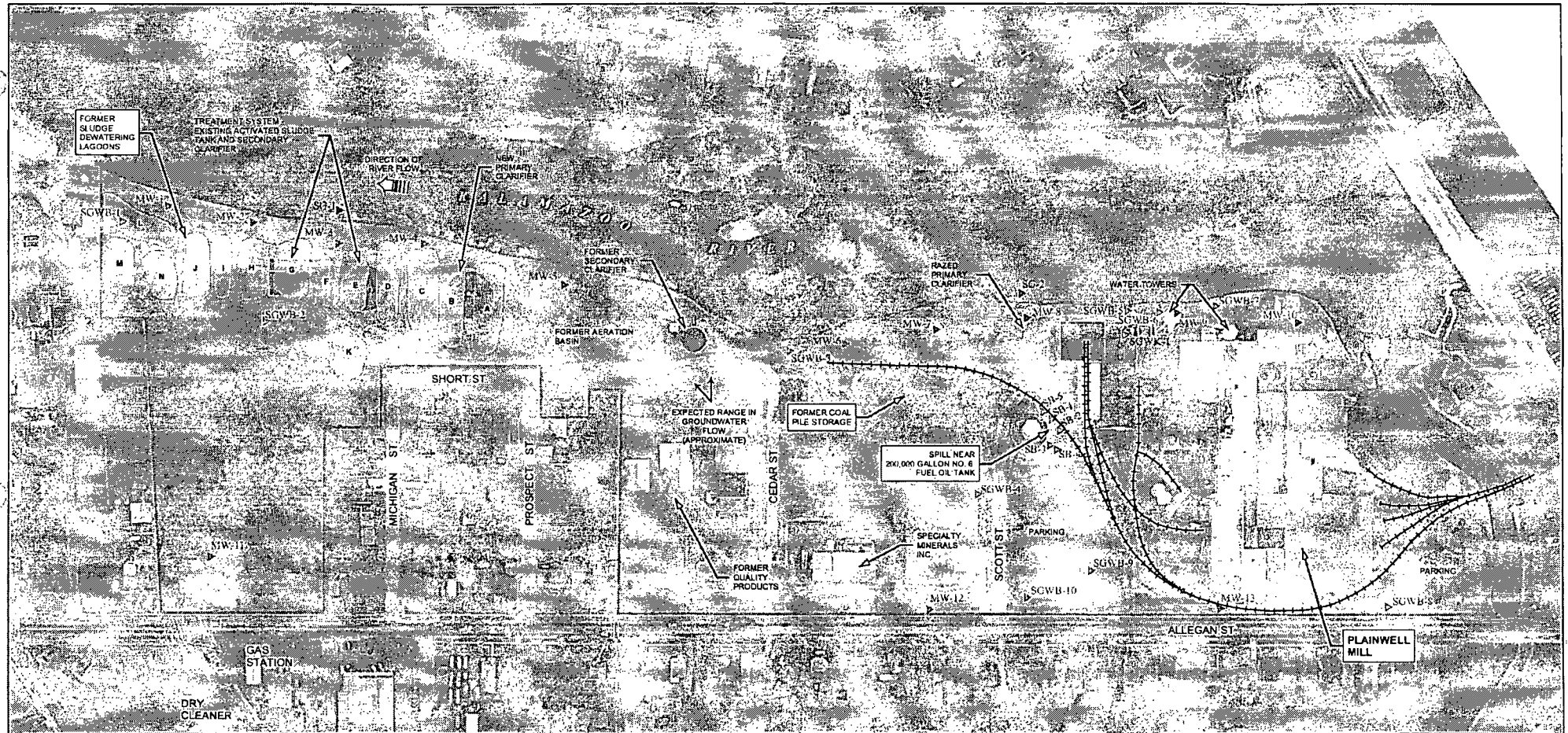
PROJECT:	RI/FS FIELD SAMPLING PLAN PLAINWELL MILL PLAINWELL, MICHIGAN		
SHEET TITLE:	RI/FS SOIL SAMPLING LOCATIONS AND APPROXIMATE TEST PIT LOCATIONS IN THE NORTH CENTRAL PORTION OF THE SITE		
DRAWN BY: PAPEZ J	SCALE: AS NOTED	PROJ. NO.: 00-05121.03	
CHECKED BY: CRJ		FILE NO.: 51210311fs.mxd	
APPROVED BY: LEH	DATE PRINTED 9/28/2006	FIGURE 2-3	
DATE: SEPTEMBER 2006			

RMT

744 Heartland Trail
Madison, WI 53717 - 1934

P.O. Box 8923
Madison, WI 53708 - 8923
Phone 608 831-4444
Fax 608-831-3021

)\05121\03\GIS\FLD_SMPLNG\51210311fs.mxd 9/28/2006 15:39:37



LEGEND

- APPROXIMATE LOCATION OF RAILROADS (BBL, 1996b)
- APPROXIMATE PROPERTY LINE (SURVEYED BY FTC&H ON 11/09/2005)
- FORMER WASTEWATER SLUDGE DEWATERING LAGOONS
- PREVIOUS GROUNDWATER SAMPLE LOCATION (TEMPORARY MONITORING WELL) (ERM, 1997)
- RI/FS GROUNDWATER MONITORING WELL LOCATION (APPROXIMATE - MAY BE ADJUSTED BASED ON FIELD CONDITIONS (e.g. UTILITIES))
- RI/FS STAFF GAUGE LOCATION (APPROXIMATE)

0 50 100 200 FEET

1:2,400
1 inch equals 200 feet

N

NOTES

1. AERIAL PHOTOGRAPH FROM OAS, INC. (MARCH 30, 2005).
2. FORMER SLUDGE DEWATERING LAGOONS INTERPRETED FROM AERIAL PHOTOGRAPHS (1955, 1960, 1967, 1974, 1981, 1986, AND 1991) (BBL, 1992).
3. PROPERTY BOUNDARY TRANSFORMED APPROXIMATELY TO MICHIGAN STATE PLANE COORDINATE SYSTEM IN ORDER TO MATCH OTHER DATA SETS.

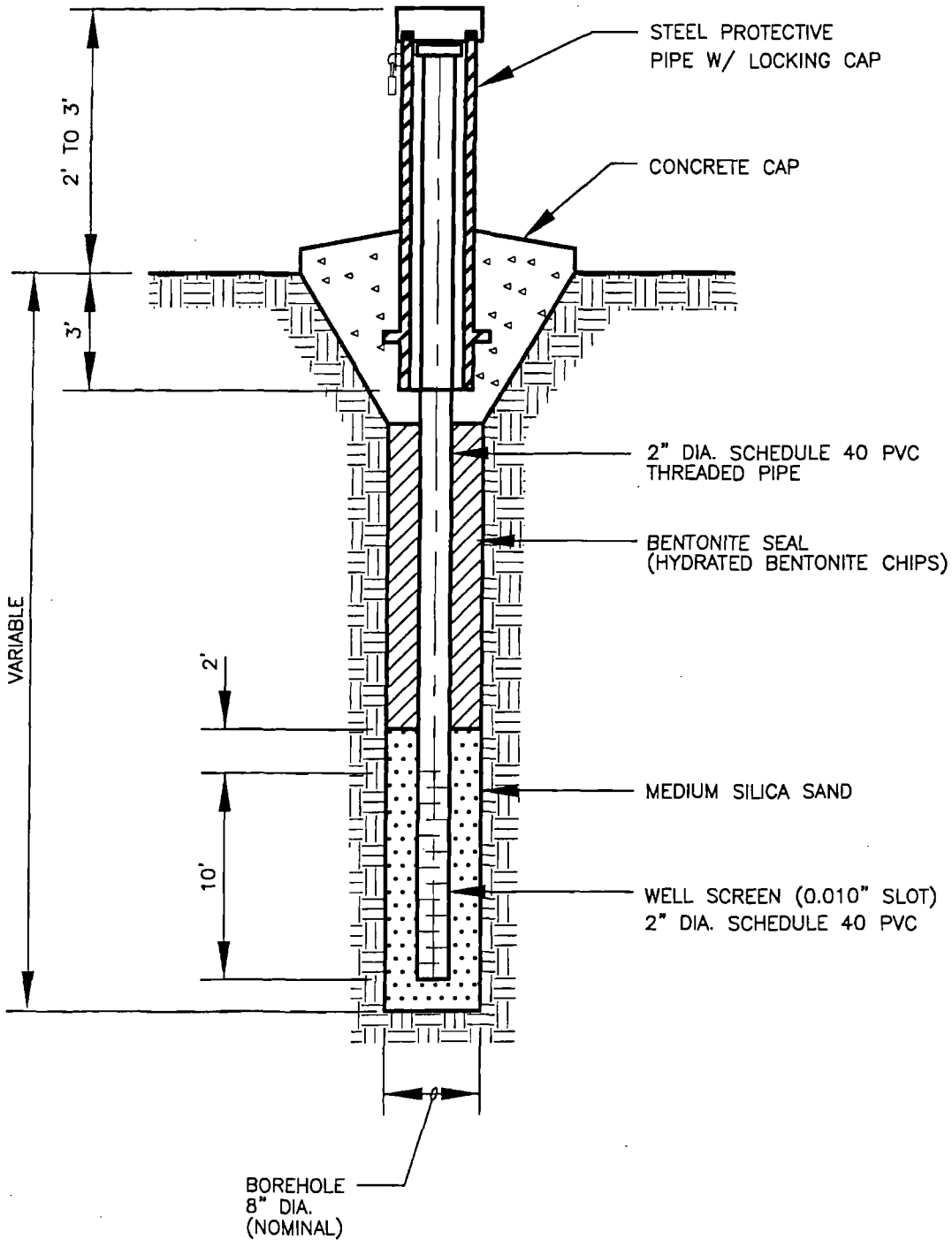
PROJECT: RI/FS FIELD SAMPLING PLAN PLAINWELL MILL PLAINWELL, MICHIGAN			
SHEET TITLE: RI/FS GROUNDWATER MONITORING WELL AND STAFF GAUGE LOCATIONS			
DRAWN BY: PAPEZ J	SCALE: AS NOTED	PROJ. NO.: 00-05121 03	
CHECKED BY: CRJ		FILE NO.: 51210305A's.mxd	
APPROVED BY: LEH	DATE PRINTED: 9/28/2006	FIGURE 2-4	
DATE: SEPTEMBER 2006			

RMT

744 Heartland Trail
Madison, WI 53717 - 1934
P.O. Box 8923
Madison, WI 53708 - 8923
Phone: 608-831-4444
Fax: 608-831-3071

D:\05121\03\GIS\FLD_SMPLNG\51210305Afs.mxd 9/28/2006 08:45:42

PLOT DATA
Drawing Name: J:\05121\03\51210301.dwg
Operator Name: metza Scale: 1"=1'



--NOT TO SCALE--

RMT	MONITORING WELL DETAILS PLAINWELL MILL PLAINWELL, MICHIGAN	DRAWN BY: METZA
		APPROVED BY:
		PROJECT NO. 05121.03
	FIELD SAMPLING PLAN	FILE NO. 51210301.DWG
		DATE: SEPTEMBER 2006

FIGURE 4-1

Appendix A
Example Forms/Logs

WATER SAMPLE LOG

Sheet _____ of _____

744 Heartland Trail Madison, WI 53717-8923 P. O. Box 8923 (Zip: 53708-8923) (608) 831-4444 FAX: (608) 831-3334

PROJECT NAME	PREPARED		CHECKED		PROJECT NO.
	By:	Date:	By:	Date:	

SAMPLE NO.: _____ WELL DIAMETER: ☐ 2" ☐ 4" ☐ Other _____

WELL MATERIAL: ☐ PVC ☐ SS ☐ Iron ☐ Other _____

SAMPLE TYPE: ☐ GW ☐ WW ☐ SW ☐ DW ☐ Leachate ☐ Other _____

PURGING

TIME: _____ DEPTH TO WATER: _____ + _____ T/ _____

WELL VOLUME: _____ gallons DEPTH TO BOTTOM: _____ + _____ T/ _____

TOTAL VOLUME REMOVED: _____ gallons METHOD: ☐ Bailer, _____ ☐ Pump, _____

ODOR: ☐ None ☐ Other _____ COLOR: _____ TURBIDITY: ☐ None ☐ Slight ☐ Moderate ☐ Very

DISPOSAL METHOD: ☐ Ground ☐ POTW ☐ Drum ☐ Other _____

SAMPLE

TIME: _____ DATE: _____

ODOR: ☐ None ☐ Other _____ COLOR: _____ TURBIDITY: ☐ None ☐ Slight ☐ Moderate ☐ Very

pH: _____ CONDUCTIVITY: _____ µmhos/cm TEMPERATURE: _____ °C

COMMENTS: _____ **CORRECTED CONDUCTIVITY: SC ÷ {1 + [0.0191 x (T - 25)]}:** _____

FILTRATE (0.45 µm)

☐ NOT APPLICABLE

ODOR: ☐ None ☐ Other _____ COLOR: _____ COMMENTS: _____

BOTTLES FILLED

*PRESERVATIVE CODES:
A - None B - HNO3 C - H_2SO4 D - NaOH E - HCL F- _____

Number	Size	Type	Preservative*	Filtered	Number	Size	Type	Preservative*	Filtered
				Y N					Y N
				Y N					Y N
				Y N					Y N
				Y N					Y N

CHAIN-OF-CUSTODY NUMBER: _____ DATE SHIPPED: _____ METHOD: _____

AIRBILL NUMBER: _____ SIGNED: _____ DATE: _____

RMT, Inc.
F205B (1-81)

LOG OF TEST PIT RMT, INC. PROJECT: _____ LOCATION: _____ LOGGED BY: _____ DATE: _____	JOB NO.: _____ PIT NO.: _____ SURFACE ELEV.: _____ SHEET NO.: _____

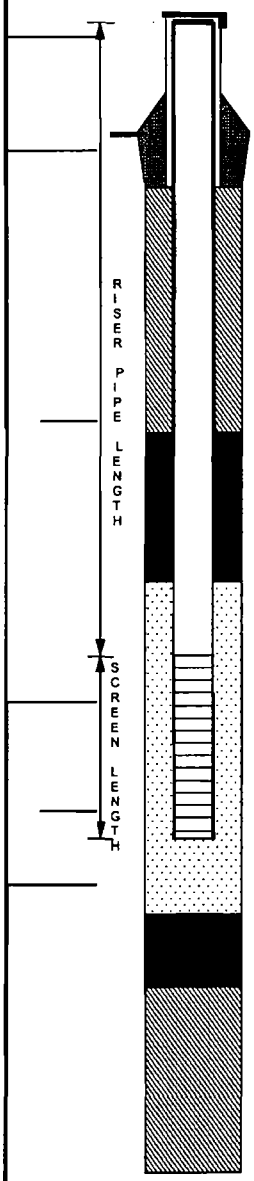
SAMPLE						VISUAL CLASSIFICATION and Remarks
Recovery			Moisture			
No.	Type			N	Depth	
					5	
					10	
					15	
					20	
					25	

OBSERVATIONS: _____

WELL CONSTRUCTION DIAGRAM

PROJECT:						WELL NO.:	
PROJ. NO:		DATE INSTALLED:		OBSV. BY:		CHECKED BY:	

ELEVATION (BENCHMARK: USGS)	DISTANCE BELOW OR ABOVE GROUND (FT.)



_____ **TOP OF CASING**

_____ **GROUND**

_____ CEMENT SURFACE PLUG

Grout/Backfill Material: _____

Grout/Backfill Method: _____

_____ GROUT

Bentonite Seal Material: _____

_____ BENTONITE SEAL

_____ **TOP OF SCREEN**

Filter Pack Material: _____

_____ **BOTTOM OF SCREEN**

_____ BOTTOM OF FILTER PACK

_____ BENTONITE PLUG

Backfill Material: _____

_____ **HOLE BOTTOM**

1. CASING AND SCREEN DETAILS:

A) Type Of Pipe: _____ Pipe Schedule: ____

B) Pipe Joints: _____

C) Solvent Used? _____

D) Screen Type: _____ Screen Slot Size: _____

E) Borehole Diameter: ____ In. From ____ To ____ Ft.
____ In. From ____ To ____ Ft.

F) Surf. Casing Diameter: ____ In. From ____ To ____ Ft.
2nd Surface Casing: ____ In. From ____ To ____ Ft.

G) Installed Protective Cover W/ Lock? ____

2. WELL DEVELOPMENT:

A) Method: _____

B) Time Spent Developing: _____ Hours

C) Water Removed: _____ Gallons
Added: _____ Gallons

D) Water Clarity Before/After Development:
Before: _____
After: _____

F) Odor (Descr. if present) _____

3. WATER LEVEL SUMMARY:

A) After Developing: _____ Ft. Below Top Of Casing

B) Other Date/Time: _____ Ft.
Other Date/Time: _____ Ft.

Notes: _____

RMT INC.

FIELD HYDRAULIC CONDUCTIVITY TEST

PROJECT NAME: _____ DATE: _____

PROJECT NUMBER: _____ SAMPLER(S): _____

WELL NUMBER: _____ WELL DIAMETER: _____

DTW: _____ + _____ T/PVC DTB: _____ + _____ T/PVC

Water Volume Removed: _____ Depth to Bottom: _____

Type of Test: _____ Initial Time: _____ End Time: _____
(slug/baildown)

Time (H/M/S)	Water Level	Drawdown	Time (H/M/S)	Water Level	Drawdown
0/0/0	(Initial)	--------			

* For water table wells, remove at least one well (borehole volume):

one well/borehole volume (gallons) - $\pi\ h_{water}\ [r_w^2 + n_{sp}\ (r_b^2 - r_w^2)] \times 7.48\ gal/ft^3$

n_{sp} = porosity of sand pack = 0.25, w = well, b = borehole

* For piezometers, remove sufficient water to produce at least 1 foot of drawdown, but no not lower water level into the sandpack.

Signed _____ Date _____ QC'd By _____ Date _____

PUMP TEST DATA

Client: _____

Project No.: _____

Well Name: _____

Static Depth to Water: _____

Test Start Date/Time: _____

_____

Notes/Comments:

Date	Time	Elapsed Time	D to W[1]	PC[2]	s[3]	Inits[4]	Comments

Notes: [1] D to W = Depth to water (nearest 0.01 foot). [2] PC = Plopper correction. [3] s = Drawdown. [4] Inits = Sampler's initials.

RECOVERY RATE TEST

PROJECT NAME: _____ WELL NUMBER: _____

PROJECT NUMBER: _____ WELL DIAMETER: _____

DATE: _____ SAMPLER: _____

Water level before (nearest 0.01 ft. below reference point) _____ + _____ T/ _____

Depth to bottom of well _____ + _____ T/ _____

Weather Conditions _____

Initial: pH (units) _____ Recharged: pH (units) _____

Conductivity (µmhos/cm) _____ Conductivity (µmhos/cm) _____

Temperature (°C) _____ Temperature (°C) _____

Temperature Corrected Conductivity _____ Temperature Corrected Conductivity _____

TIME FROM EVACUATION	WATER LEVEL (nr 0.01 feet)	CALCULATED RECHARGE RATE Volume/Time

The test is finished when the water level has recovered to its pre-evacuation level.

Signed _____ Date _____ QC'd By _____ Date _____

STABILIZATION TEST

PROJECT NAME: _____ WELL NUMBER: _____

PROJECT NUMBER: _____ WELL DIAMETER: _____

DATE: _____ SAMPLER: _____

Type of pump or bailer used _____

Pumping rate (gallons/minute) _____

Water level before purging (nearest 0.01 ft. below reference point) _____ + _____ T/ _____

Depth to bottom of well _____ + _____ T/ _____

Calculated volume of water in casing _____

Weather conditions _____

Time	pH (units)	Conductivity		Temperature (°C)	Water Level (nearest 0.01 ft.)	Cumulative Volume of Water Removed From Well (measured in gallons)
		Uncorrected	Corrected			
						0 (initial readings)

NOTE: STABILIZATION TEST IS COMPLETE WHEN **3 SUCCESSIVE WELL VOLUMES** AGREE WITHIN THE FOLLOWING LIMITS: pH - ±0.1 pH UNIT; COND. - ±5% (TEMP CORRECTED); TEMP. - ±0.5°C.

_____ _____ _____ _____

Signed Date QC'd By Date

pH AND CONDUCTIVITY METER CALIBRATION LOG

PROJECT NAME: _____ DATE: _____

PROJECT NUMBER: _____ SAMPLER: _____

pH METER

MODEL: _____ SERIAL NO.: _____

Meter Check	Buffer Check	Slope Reading	Time

Buffer Lot Numbers: pH 4: _____ pH 7: _____

CONDUCTIVITY METER

MODEL: _____ SERIAL NO.: _____

Instrument Zero	Red Line	Reading of Calibration Soln	Temp. of Calibration Soln	Corrected* Cond. @ 25°C	Time

Conductivity Calibration Solution Lot Number: _____

Problems/Corrective Actions: _____

_____

_____

* FORMULA FOR TEMPERATURE NORMALIZING CONDUCTIVITY: SC ÷ {1 + [0.0191 x (T - 25)]} = Cond @ 25°C

NOTE: METER CHECKS AND CALIBRATIONS MUST BE PERFORMED A MINIMUM OF 4X/DAY.

_____ _____ _____ _____

Signed Date QC'd By Date

RMT INC.

WATER LEVEL DATA

PROJECT NAME: _____ DATE: _____

PROJECT NUMBER: _____ SAMPLER: _____

Well Location	Time	Reference Elev (MSL)	Depth to Water (feet)*	Depth to Bottom (feet)	Water Elev (MSL)

* All Water Levels Must Include Reference Point and Tape Correction factor, i.e., 1.1 + 0.00 T/PVC.

Signed _____ Date _____ QC'd By _____ Date _____

GENERAL NOTES - EQUIPMENT SUMMARY

WATER LEVEL MEASUREMENTS WERE COLLECTED WITH:

Name and Model Number of Instrument | Serial Number (if applicable)

DEPTH TO BOTTOM OF WELL MEASUREMENTS WERE COLLECTED WITH:

Name and Model Number | Serial Number (if applicable)

PURGING METHOD:

Name and Model Number of Pump or Type of Bailer | Serial Number (if applicable)

PURGE WATER DISPOSAL METHOD:

SAMPLING METHOD:

Name and Model Number of Pump or Type of Bailer | Serial Number (if applicable)

pH/CONDUCTIVITY: *See meter calibration logs

FILTRATION METHOD:

Name and Model Number of Device | Serial Number (if applicable)

Filter Type | Tubing Type

DECONTAMINATION AND FIELD BLANK WATER SOURCE:

Potable Water Source (if applicable) | DI Water Source

Signed | Date | QC'd By | Date

Appendix B
Low-Level Mercury Sampling Specifications

October 22, 2004

RRD OPERATIONAL MEMORANDUM NO. 2

**SUBJECT: SAMPLING AND ANALYSIS - ATTACHMENT 7
LOW LEVEL MERCURY SAMPLING SPECIFICATIONS**

Key definitions for terms used in this document:

NREPA:	The Natural Resources and Environmental Protection Act, 1994 PA 451, as amended
Part 201:	Part 201, Environmental Remediation, of NREPA
Part 211:	Part 211, Underground Storage Tank Regulations, of NREPA
Part 213:	Part 213, Leaking Underground Storage Tanks, of NREPA
MDEQ:	Michigan Department of Environmental Quality
RRD:	Remediation and Redevelopment Division
U.S. EPA:	United States Environmental Protection Agency
Criteria or criterion:	Includes the cleanup criteria for Part 201 and the Risk-based Screening Levels as defined in Part 213 and R 299.5706a(4)
Facility:	Includes "facility" as defined by Part 201 and "site" as defined by Part 213

PURPOSE

This attachment to RRD Operational Memorandum No. 2 provides guidance for the collection of groundwater samples from monitoring wells for analysis using U.S. EPA Method 1631, Revision B; Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry, U.S. EPA, Office of Water, EPA-821-R-99-005, May 1999, to evaluate mercury concentrations in groundwater venting to surface water and determine compliance with the groundwater to surface water interface (GSI) criterion. The GSI criterion is based on "total" mercury, i.e., all forms of mercury existing in the groundwater. This includes both inorganic and organic types, dissolved or attached to particulate present in the groundwater.

This attachment is applicable to site investigation and response activities under Part 201, and Part 213 of NREPA.

SUMMARY

The U.S. EPA Method 1669, Sampling Ambient Water for Trace Metals at EPA Water Criteria Levels, July 1996, U.S. EPA, Office of Water, Engineering and Analysis Division, Washington D.C., was used as a reference to develop this attachment. The two-person team approach, as described in Method 1669, "Dirty Hands," and "Clean Hands" sampling was adopted, and quality assurance and control requirements of that method have been incorporated.

Modifications of this method, and other methods, may be proposed and used if found adequate by the MDEQ to produce reliable results for sampling groundwaters for low level mercury. The presentations of information that validate the use of other methods or modifications of this method are the responsibility of the parties proposing their use. This attachment is not intended to be used in place of Method 1669 when the use of that method is required.

CONTACTS

Information regarding this operational memorandum attachment may be directed to:

A. Ralph Curtis: Lab and General Information: 517-373-8389; curtisar@michigan.gov

Sandra Gregg: Lab Analysis: 517-335-9800; greggs@michigan.gov.

The following documents are rescinded with the issuance of this attachment:

- Environmental Response Division Procedure, "Groundwater Sampling from Monitoring Wells for Low Level Analysis of Mercury" dated April 13, 2001.

APPENDAGE:

Low Level Mercury Sampling and Analysis Specification

This memorandum and its attachment are intended to provide direction and guidance to foster consistent application of Part 201, Part 211, and Part 213 and the associated administrative rules. This document is not intended to convey any rights to any parties or create any duties or responsibilities under the law. This document and matters addressed herein are subject to revision.

LOW LEVEL MERCURY SAMPLING AND ANALYSIS SPECIFICATIONS

Summary

Sampling equipment, materials, and containers are cleaned using high purity chemicals and double bagged for protection from contamination during storage and transportation. Highly purified reagent water is provided to the field personnel for the decontamination of the equipment and collection of field blanks. High purity, diluted, hydrochloric acid (HCl) is also provided to field staff for preservation of the sample.

A two-person team, as described in Method 1669, is used for sample collection. One member of the two-person sampling team is designated as "Dirty Hands," and the second member is designated as "Clean Hands." The individual designated as "Clean Hands" will handle all operations involving contact with the sample bottle and transfer of the samples from the sample collection device to the sample bottle. "Dirty Hands" is responsible for the preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample. Sampling teams wear clean non-talc gloves as well as clean, lint-free, outer clothing to protect samples from contamination by lint and dust.

Special precautions are incorporated to minimize contamination. When possible the facility history and results showing previous results of mercury levels at specific locations are used to design the collection process, in order to minimize the chances of cross contamination. Where decontamination of the equipment is required, equipment blanks are taken before each sample. Sample collection is performed by a strict protocol designed to minimize contamination.

Because of the likelihood of positive blanks and the affect they have upon the results, staff should carefully evaluate blank levels before making regulatory decisions. For application to regulatory requirements, it is recommended that blank mercury levels be less than one-fifth of the mercury in the associated sample. This is the guideline recommended in Method 1631.

Definitions

1. Trace Metal Grade Reagents – Reagents that make no significant contribution of mercury to the sample.
2. Dirty and Clean Hands: All operations involving contact with the sample bottle, and transfer of the samples from the sample collection device to the sample bottle, are handled by the individual designated as "Clean Hands." An individual designated as "Dirty Hands" is responsible for the preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.

Contamination and Interferences

The need to avoid contamination when collecting samples for extremely low level measurements cannot be over emphasized. Field collection personnel should be familiar with the potential sources of mercury contamination, and implement those steps necessary for adequate control. Field and equipment blanks are used to discover contamination problems during the collection steps.

1. Potential Sources of Mercury Contamination: These include metallic and metal-containing equipment, containers, lab ware, reagents, and de-ionized water, improperly cleaned, and stored equipment, as well as atmospheric sources such as dirt and dust, automobile

exhaust, laboratory workers, and cigarette smoke. Well construction materials, e.g., the gravel pack and well screen, may also be a source of contamination.

2. Potential Contamination from Well Construction Materials: Levels of mercury in groundwater samples can be a result of natural background, well construction material, or environmental contamination. To reliably distinguish the mercury contribution of both natural background and well construction materials from environmental contamination, measurements from up-gradient background wells, constructed in the same manner as down-gradient wells, are necessary. RRD Operational Memorandum No. 4 provides guidance on establishing background.
3. Use of Peristaltic Pumps: Peristaltic pumps have distinct advantages in controlling contamination, and should be used when possible. Most other pumps have metal parts that may come in contact with the sample; hence, pumps must be decontaminated. For peristaltic pumps, only the tubing is in contact with the sample: consequently, clean tubing is all that is necessary to minimize contamination.
4. Control: The best way to control contamination is to minimize exposure of the sample and sampling equipment to possible sources of contamination. When possible, prior knowledge of mercury levels at sampling locations is used for planning collection activities to minimize chances of contamination from high sources, cross contamination resulting from sequentially sampling locations of high and low levels, and cross contamination during storage and transportation. Appropriate equipment and field blanks are used to discover contamination.
5. Filtering: If filtering is determined necessary (see RRD Operational Memorandum No. 2, Attachment 5 for direction on filtering) it must be performed at the laboratory to prevent contamination.
6. Preservation: Preservation at the laboratory is optional for samples not requiring filtering. Unpreserved samples should be sent to the laboratory overnight.

Apparatus and Materials

1. Disposable Materials: Disposable materials such as gloves, storage bags, and plastic wrap, may be used new without additional cleaning unless the equipment blank results identify any of these materials as a source of contamination. If new disposable materials are found to be a source of contamination, then a different supplier must be obtained or the materials must be cleaned.
2. Sample Bottles: Fluoropolymer (FEP, PTFE) or borosilicate glass, 125 ml to 1 L, depending upon laboratory specifications with fluoropolymer or fluoropolymer lined caps, cleaned according to Method 1669/1631 procedures, with air tight cap. Containers are filled with 0.1 percent HCl (v/v), tightly capped, double bagged in new polyethylene zip-type bags until needed, and stored in cardboard boxes until use. Sample bottles are transferred to the facility with 0.1 percent HCl, or emptied and filled with reagent water for transportation.
3. Tubing for use with low-flow sampling pump: Use fluoropolymer tubing in lengths as required to reach the sampling point. Tubing must be cleaned by soaking in a 5-10 percent HCl solution for 8-24 hours, rinsing with reagent water in a clean bench in a clean room, and drying in the clean bench by purging with mercury-free air or nitrogen. Tubing must be double-bagged in clear polyethylene bags, serialized with a unique number to identify it in case of contamination problems, and stored until use.
4. Peristaltic Pump: 115V A.C., 12V D.C. internal battery, variable-speed, single head, Cole-Palmer or equivalent, portable, "Masterflex L/S," Catalog No. H-07570-10 drive with Quick Load Pump head, Catalog No. H-07021-24, or equivalent.
   a. Tubing for use with peristaltic pump. Styrene/ethylene/butylene/silicone (SEBS) resin, approximately 3/8 in. internal diameter (i.d.) by approximately 3 ft., Cole-Palmer size 18,

Cat. No. G-06464-18, or approximately ¼ in. i.d., Cole-Palmer size 17, Catalog No. G06464-17, or equivalent. Tubing is cleaned and stored as provided above.

b. Tubing for connection to peristaltic pump as provided above. Fluoropolymer, 3/8 or ¼ in. outside diameter (o.d.), in lengths required to reach the point of sampling. Tubing is cleaned and stored as provided above. If necessary, more aggressive cleaning (e.g., concentrated nitric acid) may be used.

5. Bladder Pump: QED[1] model MP-SP-4P.
   a. Water Level Meter – Provided as part of the QED bladder pump equipment, QED part number MP30-150.
   b. Controller – Provided as part of the QED bladder pump equipment, QED part number MP-15.
   c. Bladders – QED Bladder Kit, part number 38360. Unless it is known, the bladders do not contribute to contamination, the bladders must be cleaned and stored as provided above.
   d. Spare CO2 Tank – QED part number 38304.
6. Water Quality Instruments: Use instruments capable of measuring temperature, hydrogen ion activity (pH), specific conductance, redox, dissolved oxygen, and turbidity to determine when formation water is entering the pump. With the equipment provided to staff, a separate meter is necessary for turbidity measurements.
7. Gloves: Clean, non-talc polyethylene, latex, vinyl, or polyvinylchloride (PVC): various lengths.
8. Gloves: PVC—Fisher Scientific Part No. 11-394-100B, or equivalent.
9. Wind Suit: Suitable to protect samples from contamination from lint and dust. Unlined, long sleeve wind suit consisting of pants and jacket constructed of nylon or synthetic fiber are suitable. Tyvek® suits are used in this procedure.
10. Storage bags: Clean, zip-type, non-vented, colorless polyethylene (various sizes). Large size bags are needed for storage of the pump during transportation between sampling locations.
11. Plastic Wrap: Clean, colorless polyethylene.
12. Cooler: Clean, nonmetallic, with white interior for shipping samples.
13. Ice: Use ice to keep samples chilled during shipment. Chemical packs are less effective.
14. Carboys: Dedicate one specific carboy for "Reagent Water."
15. Plastic Decontamination Tubs: Containers of various sizes to immerse the submersible pump, sampling tubing, and the wetted parts of the water level meter and multi-parameter monitor. Four tubs are needed, one for a soap solution, one for tap water rinse solution, one for reagent water rinse, and one to hold the reagent water for obtaining field blanks.
16. Pipette: Automatic pipette, capable of dispensing 10.0 ml and automatic tip ejector.
17. Pipette Tips: Colorless, 10 ml, for use with automatic pipette. Pipette tips must be cleaned and stored as described under tubing above.

Reagents

1. Reagent Water: Ultra pure deionized water, starting from a pre-purified (distilled, reverse osmosis, etc.) source, 18 Megaohms minimum, provided in a carboy suitable to prevent mercury contamination. The water should be tested at the laboratory for suitability for sampling. The quantity needed depends on the amount of water needed for each decontamination cycle and the number of wells sampled. The laboratory should provide this water.
2. Preservative: Hydrochloric acid (HCl), 6 N (normal) made from Trace Metal Grade acid and reagent water, and tested to contain less than 0.5 ng/L of mercury. The laboratory should provide this reagent.

3. Soap: Alconox [2] CITRANOX®, suitable for cleaning instruments for low level mercury sampling. Prepare a 2 percent solution as per the manufacturer's instructions.

Site Sampling Plans and Sample Delivery Strategies to Minimize Contamination

1. Sample Collection Strategy: Sample collection activities should be designed that will minimize the potential for cross contamination.
   a. If possible, use previous facility data showing mercury levels at the locations to be sampled. If mercury data is not available, use other information to make a judgement whether the mercury level is suspected to be high or low. For example, if data is available for other metal levels, the relative levels of these metals may be a good indicator of whether high or low mercury levels are suspected.
   b. Arrange the sampling sequence in order of their known or expected levels of mercury. Collect samples starting from locations known to have the lowest and approximate same levels of mercury, and proceed to those of higher levels. In this manner, if decontamination procedures fail to remove all residual mercury, the effect on samples will be minimized.
   c. Group samples so that samples of high and low levels are separately grouped in storage and transportation. For purposes of separating samples based on expected concentration levels, samples believed to have concentrations more than 200 ng/L of mercury should be identified as high level samples, and low level samples less than or equal to 200 ng/L.
2. Sample Information Provided to the Laboratory: Laboratory areas and instrumentation used for low level analysis of mercury are extremely clean and designed to prevent mercury contamination from outside sources. Processing a sample with an extremely high level of mercury in these areas can result in contamination of the area and instrumentation, resulting in delays and additional expense. Using the evaluation described above, provide information to the laboratory regarding the known or expected levels of mercury for each location sampled. Information useful to the laboratory and recommended to be provided is as follows:

Mercury (Hg) Level	**Provide to Laboratory**
Hg levels not known and high levels expected.	Expected > 200 ng/L
Hg levels not known and low levels expected.	Expected < 200 ng/L
Hg levels previously found	Provide Data
Hg levels and expectations not known	Not Known

Sample Collection, and Handling Considerations

Sampling precautions should be taken as follows:
1. Use low-flow rates (0.5 L/min.) during both purging and sampling to maintain minimal draw-down in the well.[3]
2. Place the sampling pump intake at the proper sampling point.
3. Minimize disturbance of the stagnant water column above the screened interval during water level measurement and sampling device insertion.
4. Make proper adjustments to stabilize the flow rate as soon as possible.
5. Monitor water quality indicators during purging.
6. Collect unfiltered samples to represent contaminant loading and transport potential in the subsurface system.

7. Filtering (if necessary): If it is not feasible to collect samples representative of the water flowing in the aquifer, and filtering is determined necessary, (see RRD Operational Memorandum No 2 – Attachment 5 for direction on filtering), collect duplicate samples and identify one of these to be filtered and preserved upon receipt at the laboratory. Appropriate arrangements must be made with the laboratory to ensure the filtering and subsequent preservation is accomplished for identified samples immediately upon receipt. Arrangements with the laboratory to utilize appropriate filters should be made well in advance of sample collection, so that immediate filtering and preservation at the laboratory can be accomplished upon receipt of samples.
8. Water samples should not be taken immediately following well development. Sufficient time should be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on facility conditions and methods of installation but often exceeds one week.
9. Well purging is nearly always necessary to obtain samples of water flowing through the formation associated with the screened interval. The required purging procedure relies on the stabilization of several water quality parameters to determine when formation water is being pumped. The pH, specific conductance, redox, dissolved oxygen, and turbidity are monitored for this purpose. Temperature is also measured and recorded during this process but is not used as an indicator for formation water. Data on pumping rate draw-down, not to exceed 0.1 meter, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.
10. Water Level Measurements and Monitoring: Well depth should be obtained from the well logs. Since measuring to the bottom of the well casing will cause re-suspension of the settled solids and require longer purging times for turbidity equilibration, measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point, which is surveyed relative to ground elevation.

Sample Collection using Bladder Pumps

1. Upon arrival at the sample location, one member of the two-person sampling team is designated as "Dirty Hands," and the other as "Clean Hands."
2. An area, expected or known to be free of high levels of mercury, is selected.
3. The team removes the bags containing the pump, monitoring instruments, tubing, carbon dioxide (CO2) cartridges, gloves, plastic wrap, and wind suits, from the coolers or storage containers in which they are packed.
4. The team puts on Wind Suits and PVC gloves.
5. The team generates the Initial Equipment Blank, following the steps listed under Decontamination and Initial Equipment Blank.
6. The team proceeds to the sampling location.
7. The team opens the well.
8. The team changes gloves.
9. Keeping both bags together, Dirty Hands opens the outer bag containing the pump.
10. Clean Hands opens the inner bag and removes the pump.
11. Clean Hands lowers the submersible sampling pump into the monitoring well. Lower the pump slowly and carefully to the middle of the screened interval or slightly above the middle. This should minimize excessive mixing of the stagnant water above the screen with water in the screened interval and minimize suspension of solids from the bottom of the well.
12. Dirty Hands opens bag containing static water level meter. Clean Hands removes water level meter. Clean Hands sets up the water level meter.

13. Clean Hands connects the multi-meter flow through cell to the pump outlet.
14. Dirty Hands turns on the submersible pump, sets the pump for the allowable water level draw-down (not to exceed 0.1 meters), and slowly pumps the water while monitoring the water level to assure that that the pumping rate does not result in draw-down of the water level. With the QED bladder pump in this standard operating procedure (SOP), the pump will turn off automatically if this level is exceeded. As the well is pumped, water quality parameters are monitored to determine when formation water is flowing through the pump. Formation water is considered to be flowing, if three consecutive measurements of the water quality parameters, conducted at 3-5 minute intervals, meet the following requirements:
    a. Turbidity, within ± 10 percent.
    b. pH, within ± 0.1 pH units.
    c. Specific conductance, within 3 percent.
    d. Redox, within ± 10 millivolts
    e. Dissolved oxygen, within ± 10 percent. If dissolved oxygen is used for comparison to criteria or a mixing zone calculation, the dissolved oxygen calibration must be corrected for local barometric pressure and elevation. The equipment in this procedure (YSI multi-parameter meter) automatically corrects the dissolved oxygen for these conditions.
15. After stabilization, Clean Hands disconnects the meter.
16. The team changes gloves.
17. Dirty Hands retrieves the sample containers required, and unzips their outer bags. Retrieve two sample containers if filtering is required, for duplicate samples, or for field blanks. If split samples are to be generated a larger size container is required, at least twice the size of normal samples.
18. Dirty Hands prepares the label(s).
19. Clean Hands opens the inner bag, removes the sample container, and reseals the inner bag.
20. Clean Hands removes the cap for the sample being collected, and while holding the cap upside down, discards the diluted acid into a waste carboy, or empties the reagent water onto the ground.
21. If a field blank is being generated, proceed as follows:
    a. Clean Hands opens the inner bag and places the emptied sample bottle and its cap in its inner bag. This bottle is to be identified as the field blank.
    b. Clean Hands obtains another sample bottle from its inner bag, removes and, discards its cap.
    c. Clean Hands retrieves the field blank bottle, and pours the contents of the sample bottle into the field blank bottle.
    d. Skip to step 27 below.
22. Clean Hands rinses the sample bottle and cap three times with the formation water flowing from the pump, and collects the sample from the flowing tube.
23. Clean Hands caps the sample, opens the inner bag, and places the sample in its inner bag.
24. If filtering is required or a duplicate sample is to be taken, Steps 18 through 23 are repeated to immediately take another sample.
25. For samples required to be filtered or preserved at the laboratory, skip to step 27 below.
26. Preserve each sample taken as follows:
    a. Dirty Hands opens the outer bag containing the preservative, pipette, and tips.
    b. Clean Hands opens the inner bag, opens the preservative, retrieves the pipette, and prepares it for dispensing.

c. Use the information included in Sample Preservation and Holding Time for the correct amount of preservative. Clean Hands pipettes the required amount of preservative into the sample container(s), ejects the pipette tip into the waste container, places the pipette back into its inner bag, recaps the preservative, and seals the inner bag.
d. Dirty Hands seals the outer bag for the preservative.

27. Clean Hands caps the sample(s), opens the inner bag(s) for the sample(s), places the sample bottle(s) into the inner bag(s), and seals the inner bag(s).
28. Dirty Hands seals the outer bag(s), writes sample identification information in permanent ink on the outside of the plastic bag, places the sample(s) in the cooler (on ice), and closes the cooler.
29. Dirty Hands measures and records the depth to the bottom of the well.
30. Dirty Hands records the sample number(s) in the sampling log, water quality parameters, and notes any unusual observations.
31. Clean Hands removes the equipment from the well, removes the water level meter, and places them into bags for transportation.
32. Both Dirty and Clean Hands move to the decontamination area with the equipment.
33. Decontamination Between Sampling Locations steps are used to decontaminate the equipment.
34. Generating the Equipment Blank steps are used to collect an equipment blank.
35. If other samples are to be taken at the facility, the team proceeds to the next sampling location, and collects another sample beginning with step 6 above.
36. If samples are to split, proceed as follows:
    a. The team selects a suitable place for splitting samples.
    b. The team changes gloves.
    c. Dirty Hands opens the cooler, removes the bag containing the sample to be split. The volume of this sample must be at least twice the volume of normal samples.
    d. Dirty Hands removes two bags with sample containers, and unzips their outer bags. These containers will hold the split samples.
    e. Dirty Hands prepares the label(s).
    f. Clean Hands opens the inner bags holding all containers, removes the containers, removes the caps of all containers and places them in their respective inner bags.
    g. Clean Hands discards the diluted acid from the two sample containers, into a waste carboy, or empties the reagent water onto the ground.
    h. Clean Hands pours from the container holding the sample to be split, into each of the sample containers.
    i. Clean Hands discards the container that held the sample to be split.
    j. Clean Hands retrieves the caps, seals the samples with their respective caps, places the samples into their inner bags, and seals the inner bags.
    k. Dirty Hands seals the outer bag(s), writes sample identification information in permanent ink on the outside of the plastic bag, places the sample(s) in the cooler (on ice), and closes the cooler.
    l. Equipment blanks associated with the respective samples must be provided to both parties receiving split samples.
    m. Repeat steps for each additional split sample.
    n. Information specific for splitting samples must be documented. If others request split samples, use the MDEQ Laboratory's chain of custody sheet. If the MDEQ is requesting the split sample, and a chain of custody is not forthcoming from the sampler, use the MDEQ chain of custody, fill out information, sign it, and request this be signed by the provider of the samples.

Sample Collection using Peristaltic Pumps

1. Upon arrival at the sample location, one member of the two-person sampling team is designated as "Dirty Hands," and the other as "Clean Hands."
2. The team opens the well to be sampled.
3. An area, expected or known to be free of high levels of mercury, is selected. Sampling should proceed from lowest to highest expected level of contamination.
4. The team removes the bags containing the pump, batteries, monitoring instruments, SEBS resin tubing, gloves, plastic wrap, and wind suits, from the coolers or storage containers in which they are packed.
5. The team puts on Wind Suits and PVC gloves.
6. Dirty Hands removes the pump from its storage bag and opens the bag containing SEBS resin tubing.
7. Clean Hands installs the tubing in the well. Lower the tubing slowly and carefully to the middle of the screened interval or slightly above the middle, to minimize excessive mixing of the stagnant water above the screen with water in the screened interval, and to minimize resuspension of solids from the bottom of the well.
8. Clean Hands installs tubing on the pump.
9. Dirty Hands opens bag with water level meter.
10. Clean Hands removes water level meter and lowers it into the well.
11. Clean Hands connects the multi-parameter meter flow through the cell to the pump outlet.
12. Dirty Hands turns on the peristaltic pump and slowly pumps the water while monitoring the water level to assure that that the pumping rate does not result in excessive draw-down of the water level (not to exceed 0.1 meters). As the well is pumped, water quality parameters are monitored to determine when formation water is flowing through the pump. Formation water is considered to be flowing if three consecutive measurements of the water quality parameters, conducted at 3-5 minute intervals, meet the following requirements:
    a. Turbidity, within ± 10 percent.
    b. pH, within ± 0.1 pH units.
    c. Specific conductance, within 3 percent.
    d. Redox, within ± 10 mv.
    e. Dissolved oxygen, within ± 10 percent. If dissolved oxygen is used for comparison to criteria or a mixing zone calculation, the dissolved oxygen calibration must be corrected for local barometric pressure reading and elevation. The equipment in this procedure (YSI multi-parameter meter) automatically corrects the dissolved oxygen for these conditions.
13. After stabilization, Clean Hands disconnects the meter.
14. The team changes gloves.
15. Dirty Hands opens the cooler containing the sample bottle, and unzips the outer bag containing the sample container. If the sample is to be split, a larger size container is required at least twice the size of normal samples. If filtering is necessary, a field blank is being generated, or a duplicate sample is to be taken, Dirty Hands unzips the outer bag of another sample container.
16. Dirty Hands prepares the sample label(s).
17. Clean Hands opens the inner bag, removes the sample container, and reseals the inner bag.
18. Clean Hands unscrews the cap, and while holding the cap upside down, discards the diluted acid into a waste carboy, or empties the reagent water onto the ground.
19. If a field blank is being generated, proceed as follows:

   a. Clean Hands places the sample bottle and its cap in its bag. This is to be identified as the field blank.
   b. Clean Hands obtains another sample bottle from its bag, unscrews and discards the cap.
   c. Clean Hands retrieves the field blank bottle, and pours the contents of the other bottle into the field blank bottle, discards this other bottle, retrieves the cap of the field blank and caps the field blank.
   d. Skip to step 22 below.
20. Clean Hands rinses the sample bottle and cap three times with the formation water, and collects the sample from the flowing tube.
21. Clean Hands caps the sample.
22. Clean Hands places a label on the sample container, and places it in its inner bag.
23. If filtering is required, or a duplicate sample is to be taken, steps 17 through 22 are repeated to immediately take another sample.
24. For samples required to be filtered, and samples requiring preservation at the laboratory, skip to step 26 below.
25. Preserve sample as follows:
   a. Dirty Hands opens the outer bag containing the preservative, pipette, and tips.
   b. Clean Hands opens the inner bag, opens the preservative, retrieves the pipette, prepares it for dispensing, and pipettes the required amount of preservative into the sample container(s). Use the information included in Sample Preservation and Holding Time for the correct amount of preservative.
   c. Clean Hands ejects the pipette tip into the waste container, places the pipette back into its inner bag, and seals the inner bag.
   d. Clean Hand caps the preservative, places it in its inner bag, and seals the inner bag.
   e. Dirty Hands seals the outer bags for the pipette and preservative.
26. Clean Hands caps the sample(s), opens the inner bag(s) for the sample(s), places the sample bottle(s) into the inner bag(s), and seals the inner bag(s).
27. Dirty Hands seals the outer bag(s), writes sample identification information on the outer bag, places the sample(s) in the cooler (on ice), and closes the cooler.
28. Dirty Hands measures and records the depth to the bottom of the well.
29. Dirty Hands records the sample number(s) in the sampling log, water quality parameters, and notes any unusual observations.
30. Clean Hands removes the equipment from the well, removes the water level meter, and places them into bags for transportation.
31. Both Dirty and Clean Hands move to the decontamination area with the equipment.
32. Decontamination Between Sampling Locations steps are used to decontaminate the water level meter and multi-parameter meter. The SEBS resin tubing is replaced prior to sampling each new monitoring well.
33. If other samples are to be collected, the team proceeds to the next sampling location, and collects another sample beginning with the step 1.
34. If samples are to be split, follow the steps in Sample Collection Using Bladder Pumps, starting with step 36.

Decontamination and Initial Equipment Blank

1. Dirty Hands prepares the decontamination solutions.
2. Dirty Hands opens outer bag containing tubing and pump bladder.
3. Dirty Hands opens bags containing pump and water level meter.
4. Dirty Hands removes the pump.

5. Dirty Hands holds the pump while Clean Hands removes the bladder from the inner bag and places the bladder on the pump. Clean Hands removes tubing from the inner bag and installs tubing on pump and controller.
6. Dirty Hands lowers pump into tub 1 containing the soap solution.
7. Dirty Hands turns on controller and pumps three volumes of soap solution through the pump and tubing.
8. Clean Hands moves the pump to tub 2 containing tap water.
9. Dirty Hands turns on controller to pump three volumes of tap water through the pump.
10. Clean Hands moves the pump to tub 3 and pumps three volumes of reagent water.
11. Clean Hands places the pump in tub 4 containing reagent water.
12. An equipment blank is taken following steps in Generating the Equipment Blank.
13. Clean Hands removes the water level meter from its storage bag, decontaminates the water level meter by successively cleaning with solutions from tub 1, 2, and 3, and places the meter into a clean storage bag.

Decontamination Between Sampling Locations

1. The team changes gloves.
2. Dirty Hands prepares the decontamination solutions.
3. Dirty Hands lowers pump into tub 1 containing the 2 percent Alconox/tap water solution.
4. Dirty Hands turns on controller and pumps three volumes of Alconox solution through the pump.
5. Clean Hands moves the pump to tub 2 containing tap water (fresh tap water should be used between each sampling location.)
6. Dirty Hands turns on controller to pump three volumes of tap water through the pump.
7. Clean Hands moves the pump to tub 3 and pumps three volumes of reagent water (fresh reagent water should be used between each sampling location.)
8. Clean Hands changes gloves.
9. Dirty Hands opens outer bag containing tubing and pump bladder.
10. Dirty Hands changes gloves.
11. Dirty Hands removes the pump from tub 3.
12. With Dirty Hands holding the pump, Clean Hands removes the bladder from the inner bag and places the bladder on the pump. Clean Hands removes tubing from the inner bag and installs tubing on pump and controller.
13. Clean hands places pump in reagent water in tub 4.
14. The team changes gloves.
15. An equipment blank is taken following steps in Generating the Equipment Blank.
16. Clean Hands places the pump in the storage bag or proceeds to place pump in monitoring well.
17. Clean Hands removes the water level meter from its storage bag, decontaminates the water level meter by successively cleaning with solutions from tub 1, 2, and 3, and places the meter back into a clean storage bag or into the monitoring well.
18. Clean Hands changes gloves.

Generating the Equipment Blank

1. One equipment blank is generated for each location sampled.
2. With the submersible pump in tub 4 holding the fresh reagent water, Dirty Hands turns on the pump and allows several volumes of reagent water to be pumped.
3. The team changes gloves.

4. Dirty Hands opens the box or cooler containing the sample bottles, and unzips the bag containing a sample container. If a split sample is scheduled to be taken, Dirty Hands unzips another bag containing a sample container.
5. Clean Hands opens the inner bag, removes the sample container, and reseals the inner bag.
6. Dirty Hands reseals the outer bag.
7. Clean Hands unscrews the cap, and while holding the cap upside down, discards the diluted acid into a waste carboy, or empties the reagent water on the ground.
8. As reagent water is flowing through the pump, Clean Hands collects the sample by emptying the solution from the sample bottle, rinsing the sample bottle and cap three times with the flowing reagent water, and collecting the sample from the flowing tube.
9. If preservation is performed at the laboratory, skip to step 11.
10. Preserve sample(s) as follows:
    a. Dirty Hands opens the outer bag holding the automatic pipette and preservative.
    b. Clean Hands opens the inner bag containing the preservative and automatic pipette, opens the preservative bottle, and pipettes 10 ml of the preservative into the sample bottle.
    c. Clean Hands recaps the preservative bottle, removes the pipette tip, and places the preservative and pipette back into its bag.
    d. Clean Hands seals the inner bag holding the preservative and pipette.
    e. Dirty Hands seals the outer bag.
    f. Clean Hands opens the inner bag for the sample, places the sample bottle into the inner bag, and seals the inner bag.
11. Dirty Hands seals the outer bag, opens the sample cooler, places the equipment or field blank in the cooler (on ice), and closes the cooler.
12. Dirty Hands records the sample in the sampling log as the "Equipment Blank".
13. If the scheduled sample to be taken is a split sample, follow the steps in Sample Collection Using Bladder Pumps, starting with step 36.
14. Clean Hands removes the pump from the tub, places it in a clean protective bag, and seals the bag.

Sample Preservation and Holding Time

1. Preservation: Samples are transported on ice during shipment to the laboratory. Samples are preserved in the field using 10 ml/L 6N HCl per liter of sample. If filtering and preservation is required at the laboratory, equivalent amounts of HCl per liter of sample can be used.
2. Laboratory Processing of Filtered/Preserved Samples: If filtering and preservation is to be performed at the laboratory, make arrangements with the laboratory for receipt of samples well in advance. If special filters are necessary, these must be provided to the laboratory prior to sample collection activities or arrangements made with the laboratory to ensure they are available upon sample receipt. It is not advisable to plan sampling immediately proceeding non-working days for the laboratory. Upon shipment of samples to a laboratory, it is good practice to immediately contact the laboratory. If the laboratory is not advised of these arrangements, extra effort and expense must be incurred to ensure necessary filtering and preservation.
3. Sample analysis must be performed within 28 days of sample collection.

Quality Assurance/Quality Control

Equipment Blank: The equipment blanks are used to verify the equipment is free from contamination prior to the collection of the sample. (See Decontamination and Initial Equipment Blank and Generating the Equipment Blank)

1. Frequency of Collection: Collect one initial equipment blank, and an equipment blank per monitoring well sampled.
2. Evaluation Criteria: If the mercury concentration in the blank is greater or equal to 0.5 ng/L, or greater than one-fifth of sample concentration, whichever is higher, the associated sample result is an estimate and may be unusable for regulatory application.
3. Corrections: If the initial equipment blank indicates contamination, above 0.5 ng/L, review the process used for cleaning, and have reagents replaced as appropriate.

Field Blanks: The purpose of field blanks is to assess the suitability of the container, preservative, and sample handling. The field blank is generated by simply pouring the solution provided in one of the sample containers into another sample container whose contents have been emptied at the facility. (See Sample Collection Using Bladder Pumps step 21 and Sample Collection using Peristaltic Pumps step 19)

1. Frequency of Collection: One per facility, per day, or one per sampling event, whichever is greater.
2. Evaluation: If the mercury concentration in the blank is greater or equal to 0.5 ng/L, or greater than one-fifth of sample concentration, whichever is higher, the associated sample result is an estimate and may be unusable for regulatory application.

Field Duplicates: The purpose of field duplicates is to assess the precision for the field sampling and analytical process. A field duplicate is collected by filling a second sample container, in rapid succession after the first sample, from the outlet of the sampling stream.

1. Frequency of Collection: Collect duplicates minimally for every 10 samples collected, or at the frequency specified in the project objectives. If possible, select a location with detectable amounts of mercury.

Split Samples: Split samples are used to independently confirm results of the laboratory performing the analysis. Typically a laboratory known to produce valid, unbiased results, is selected as the laboratory to which the split samples are sent.

1. Collection: Split samples are created by dividing one sample collected in the field into two aliquots. This requires the collection of at least twice the volume of sample normally collected, properly preserved if field preservation is performed. Because of the influence that equipment blanks may have upon the use of the data, an equipment blank associated with the sample should be provided along with the split sample. This will require the generation of two equipment blanks prior to the collection of the sample to be split.

Footnotes

1. QED, P.O. Box 3726, Ann Arbor, MI 48160.
2. Alconox, Inc., 30 Glenn Street, Suite 309, White Plains, NY, 10603.
3. Puls, R. W. and Barcelona, M. J. 1996 Low-Flow (Minimal Draw Down) Ground-Water Sampling Procedures, EPA Ground Water Issues, U.S. EPA Office of Research and Development, EPA/540/S-95/504.

Disclaimer

Mention of specific manufacturers and associated instruments does not constitute endorsement by the MDEQ RRD of that manufacturer and equipment.

This SOP is intended to be a performance-based method. Acceptance of results using modifications of this procedure, and using other procedures, will depend upon the demonstration of equivalent performance.

Appendix C
Geoprobe® Sampler
Standard Operating Procedure

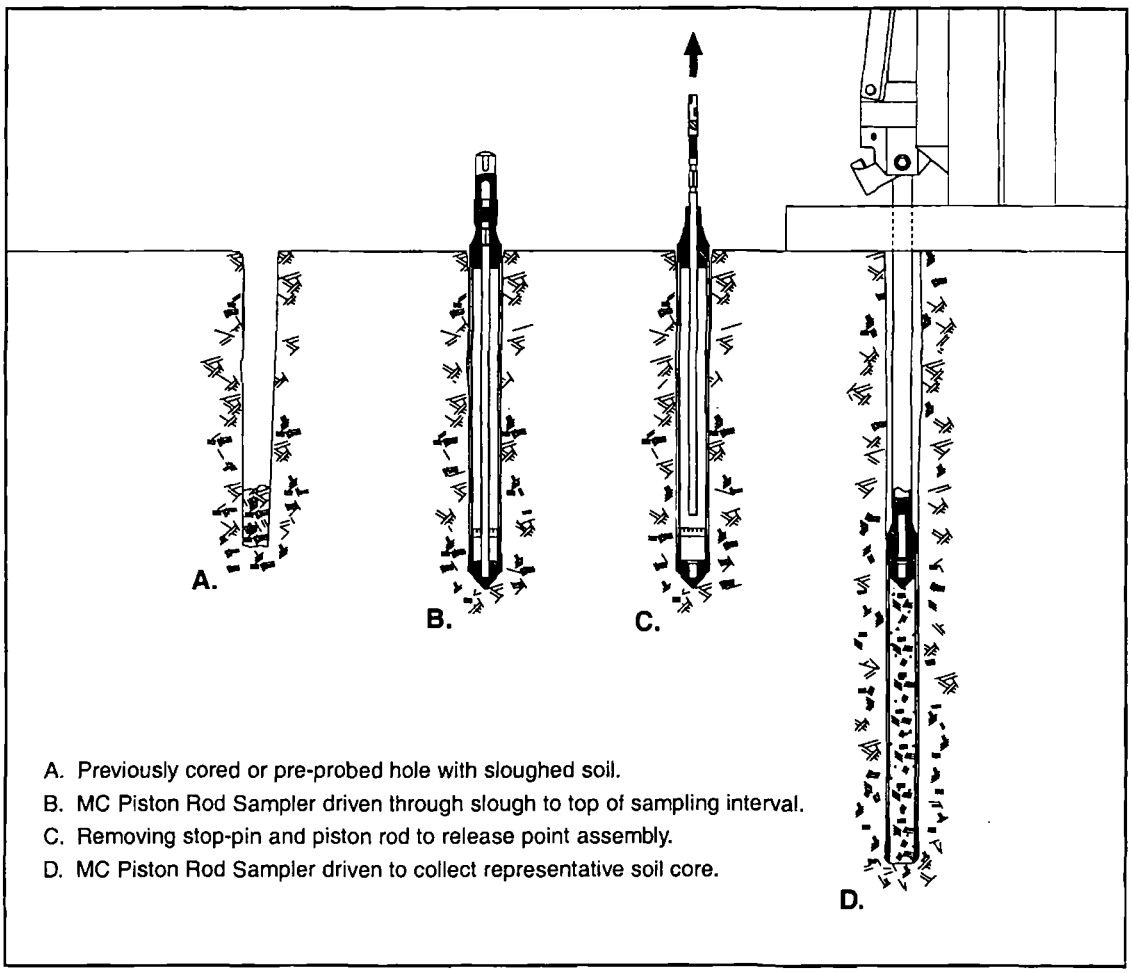
GEOPROBE MACRO-CORE® SOIL SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. 95-8500

PREPARED: November, 1995

REVISED: September, 1998



OPERATION OF MACRO-CORE® PISTON ROD SOIL SAMPLING SYSTEM

Geoprobe® Systems

A DIVISION OF KEJR, INC.

Geoprobe® is a Registered Trademark of Kejr, Inc., Salina, Kansas

Macro-Core® is a Registered Trademark of Kejr, Inc., Salina, Kansas

Macro-Core® and Large Bore Soil Samplers manufactured under US Patent 5,606,139.

Macro-Core® Closed-Piston Drive Point manufactured under US Patent 5,542,481

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1.0 OBJECTIVE

The objective of this procedure is to collect a representative soil sample at depth and recover it for visual inspection and/or chemical analysis.

2.0 BACKGROUND

2.1 Definitions

Geoprobe®*: A brand name of high quality, hydraulically-powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface.
** Geoprobe® is a registered trademark of Kejr, Inc., Salina, Kansas*

Macro-Core® Soil Sampler*: A solid barrel, direct push device for collecting continuous core samples of unconsolidated materials at depth. Although other lengths are available, the standard Macro-Core® Sampler has an assembled length of approximately 52 inches (1321 mm) with an outside diameter (OD) of 2.2 inches (56 mm). Collected samples measure up to 1300 ml in volume in the form of a 1.5-inch x 45-inch (38 mm x 1143 mm) core contained inside a removable liner. The Macro-Core® Sampler may be used in an open-tube or closed-point configuration.
** Macro-Core® is a registered trademark of Kejr, Inc., Salina, Kansas*

Liner: A removable/replaceable, thin-walled tube inserted inside the Macro-Core® sample tube for the purpose of containing and storing soil samples. While other lengths are available, the standard Macro-Core® Liner is 1.75 inches OD x 46 inches long (44 mm x 1168 mm). Liner materials include stainless steel, Teflon®, PVC, and PETG.

2.2 Discussion

In this procedure, an assembled Macro-Core® Soil Sampler is driven one sampling interval into the subsurface and then retrieved using a Geoprobe soil probing machine. The collected soil core is removed from the sampler along with the used liner. After decon, the Macro-Core® sampler is reassembled using a new liner. The clean sampler is then advanced back down the same hole to collect the next soil core. The Macro-Core® Sampler may be used as an open-tube or closed-point sampler.

The Macro-Core® Soil Sampler is most commonly used as an open-tube sampler (Fig. 2.1A). In this configuration, coring starts at the ground surface with a sampler that is open at the leading end. The sampler is driven into the subsurface and then pulled from the ground to retrieve the first soil core. In stable soils, an open-tube sampler is advanced back down the same hole to collect the next core.

In unstable soils which tend to collapse into the core hole, the Macro-Core® Sampler can be equipped with a piston rod point assembly (Fig. 2.1B). The point fits firmly into the cutting shoe and is held in place by a piston rod and stop-pin. The MC Piston Rod System prevents collapsed soil from entering the sampler as it is advanced to the bottom of an existing hole, thus ensuring collection of a reprentative sample.

The Macro-Core® Piston Rod Sampler is not designed to be driven through undisturbed soil. A probe hole must be opened above the sampling interval either by removing continuous soil cores with an open-tube sampler, or by advancing a Macro-Core® Pre-Probe to depth.

Once a hole is opened to the appropriate depth, an assembled MC Piston Rod Sampler is advanced through any slough material to the top of the next sampling interval. Extension rods are inserted through the probe

rod string and threaded onto the MC Stop-Pin Assembly. When unthreaded, the stop-pin is removed from the tool string with the extension rods. (MC Piston rod is removed with stop-pin if MC Stop-Pin Coupler is utilized). With the point assembly now released, the tool string is driven into the subsurface to fill the sampler with soil. The point assembly is later retrieved from the sampler with the liner and soil core.

Loose soils may fall from the bottom of the sampler as it is retrieved from depth. The MC Core Catcher (Fig. 3.1) alleviates this problem. Excellent results are obtained when the core catcher is used with saturated sands and other non-cohesive soils. A core catcher should not be used with tight soils as it may actually inhibit sample recovery. Constructed of PVC, the core catcher is suitable for use with all Geoprobe liners.

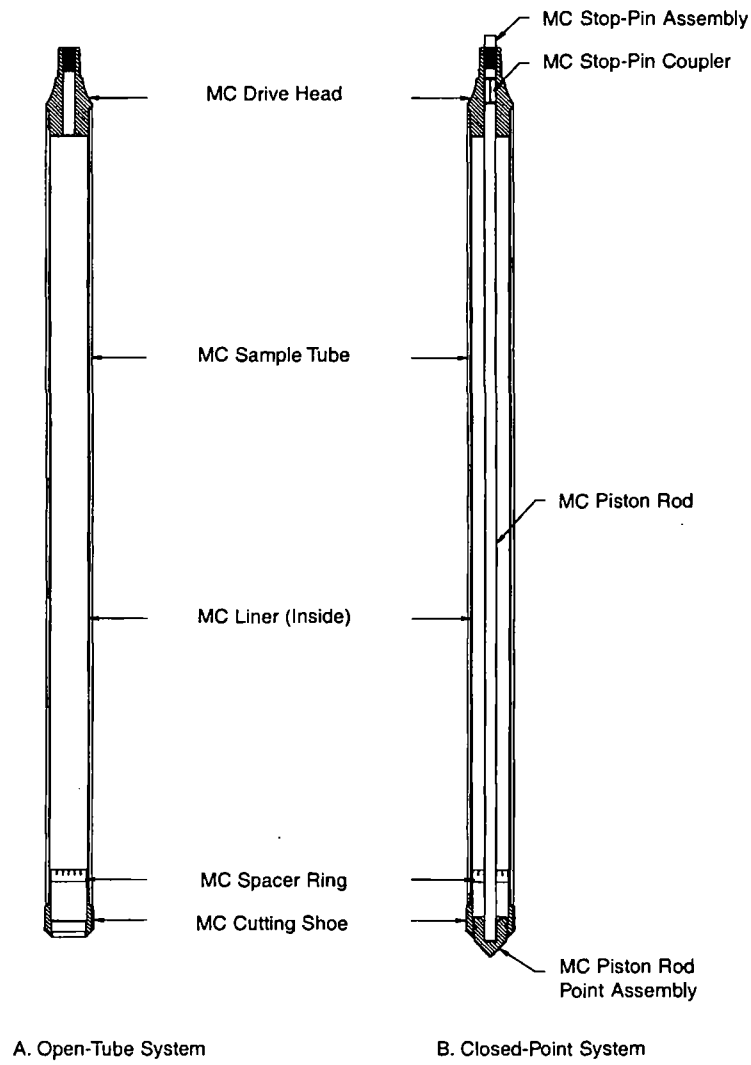


FIGURE 2.1
Macro-Core® Soil Sampler Configurations

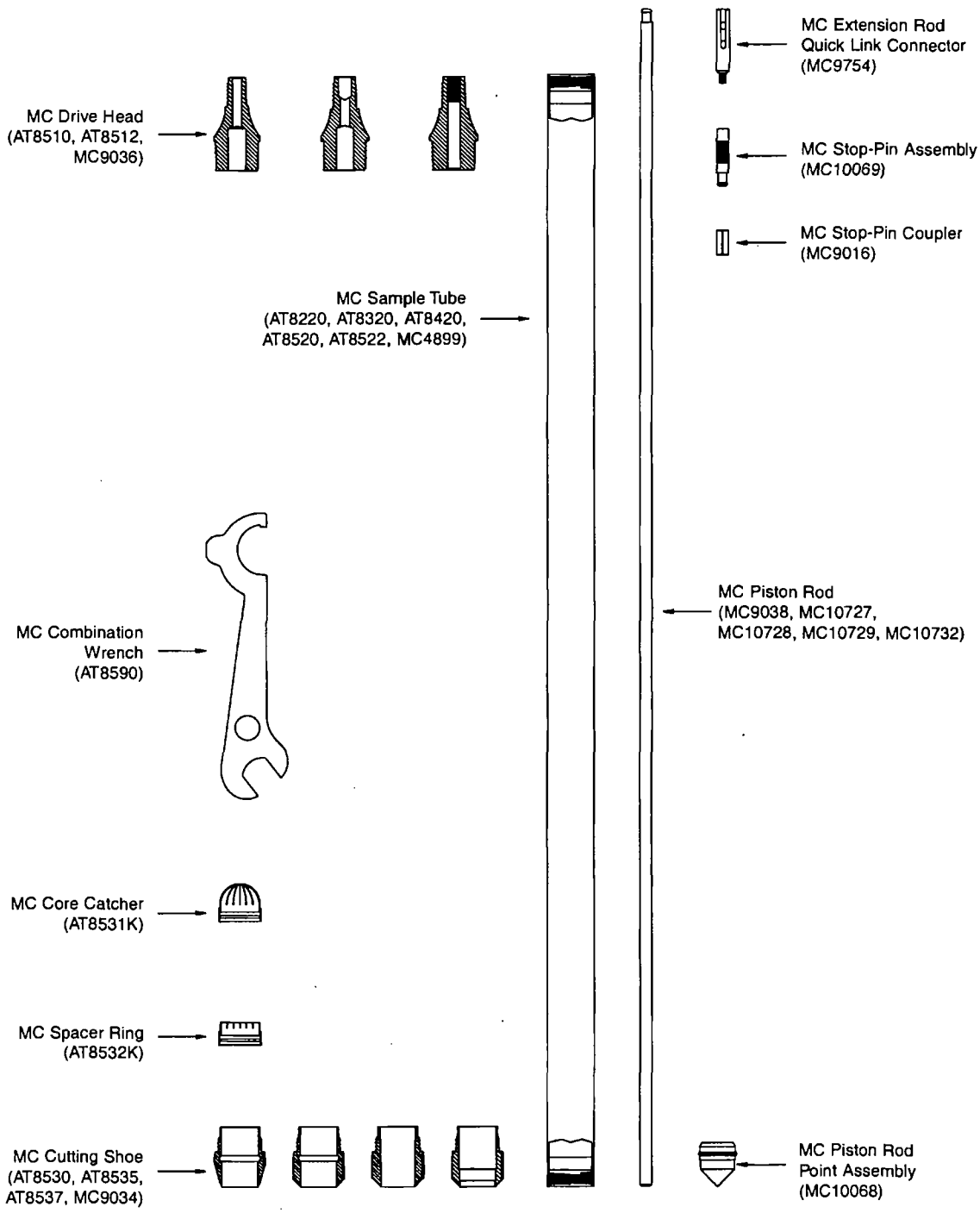


FIGURE 3.1
Macro-Core® Soil Sampler Parts

3.0 REQUIRED EQUIPMENT

The following equipment is used to recover samples using the Geoprobe Macro-Core® Soil Sampler and probing system. Although many options are available (sampler length, liner material, etc.), the basic sampler configuration does not change. Refer to Figure 3.1 (previous page) to view the major components of the Macro-Core® sampler.

MACRO-CORE® SAMPLER PARTS	PART NUMBER
MC Drive Head, for use with 1.0-inch probe rods	AT8510
MC Drive Head, for use with 1.25-inch probe rods	AT8512
MC Sample Tube, 24-inch, unplated	AT8220
MC Sample Tube, 36-inch, unplated	AT8320
MC Sample Tube, 1-meter, unplated	AT8420
MC Sample Tube, 48-inch, Ni-plated	AT8520
MC Sample Tube, 48-inch, unplated	AT8522
MC Sampler Tube, 60-inch, unplated	MC4889
MC Cutting Shoe, standard	AT8530
MC Cutting Shoe, heavy-duty	AT8535
MC Cutting Shoe, 0.125 inches undersized	AT8537
MC Combination Wrench	AT8590
Nylon Brush for MC Sample Tubes	BU700

MACRO-CORE® PISTON ROD SYSTEM PARTS	PART NUMBER
O-Rings for MC Stop-Pin (pkg. of 25)	AT6312R
O-Rings for MC Piston Rod Point (pkg. of 25)	DT4070R
MC Stop-Pin Coupler (pkg. of 5)	MC9016
MC Cutting Shoe, for use with piston rod point	MC9034
MC Drive Head, for use with 1.25-inch probe rods and stop-pin	MC9036
MC Piston Rod, 48-inch	MC9038
MC Extension Rod Quick Link Connector	MC9754
MC Piston Rod Point Assembly	MC10068
MC Stop-Pin Assembly	MC10069
MC Piston Rod/Stop-Pin Assembly, 48-inch	MC10070
MC Piston Rod, 60-inch	MC10727
MC Piston Rod, 36-inch	MC10728
MC Piston Rod, 24-inch	MC10729
MC Piston Rod, 1-meter	MC10732
MC Piston Rod/Stop-Pin Assembly, 60-inch	MC11881
MC Piston Rod/Stop-Pin Assembly, 36-inch	MC12028
MC Piston Rod/Stop-Pin Assembly, 24-inch	MC12029
MC Piston Rod/Stop-Pin Assembly, 1-meter	MC12030
MC Quick Link Kit	MC12131

MACRO-CORE® LINERS AND ACCESSORIES	PART NUMBER
MC Stainless Steel Liner Assembly, 48-inch	AT7235
MC Teflon® Liner Assembly, 48-inch	AT724
MC PETG Liner, thin-wall, 48-inch, (box of 66)	AT725K
MC Vinyl End Caps (66 pair)	AT726K
MC Heavy-Duty PETG Liner Assembly, 48-inch (box of 66)	AT825K
MC PVC Liner Assembly, clear, 24-inch (box of 66)	AT922K
MC PVC Liner Assembly, clear, 36-inch (box of 66)	AT923K
MC PVC Liner Assembly, clear, 1-meter (box of 66)	AT924K
MC PVC Liner Assembly, clear, 48-inch (box of 66)	AT925K
MC Liner Cutter Kit	AT8000K
MC Liner Cutting Tool*	AT8010
MC Liner Cutter Holder*	AT8020
MC Liner Cutter Blades (pkg. of 5)*	AT8030
MC Liner Circular Cutting Tool	AT8050
MC Core Catchers (pkg. of 25)	AT8531K
MC Spacer Rings (pkg. of 25)	AT8532K
MC PVC Liner Assembly, clear, 60-inch (box of 66)	11984

GEOPROBE TOOLS**	PART NUMBER
Drive Cap, for use with 1.25-inch probe rods	AT1200
Slotted Drive Cap, for use with 1.25-inch probe rods	AT1202
Pull Cap, for use with 1.25-inch probe rods	AT1204
Probe Rod, 1.25 inches x 36 inches	AT1236
Probe Rod, 1.25 inches x 1 meter	AT1239
Probe Rod, 1.25 inches x 48 inches	AT1248
Probe Rod, 1.25 inches x 60 inches	AT1260
MC Pre-Probe, 2-inch OD	AT1247
MC Pre-Probe, 2.5-inch OD	AT1242
MC Pre-Probe, 3-inch OD	AT1252
Extension Rod, 36-inch	AT67
Extension Rod, 48-inch	AT671
Extension Rod, 1-meter	AT675
Extension Rod Coupler	AT68
Extension Rod Handle	AT69
Extension Rod Quick Links	AT694K
Machine Vise	FA300

ADDITIONAL TOOLS

Combination Wrench, 1/2-inch (or) Adjustable Wrench
Pipe Wrenches (2)

*The items are included in the MC Liner Cutter Kit (AT8000K).
**Geoprobe tools and accessories are also available for use with 1.0-inch OD (outside diameter) probe rods.

4.0 OPERATION

Size and material options have resulted in an extensive list of Macro-Core® part numbers. To simplify the instructions presented in this document, part numbers are listed in the illustrations only. Refer to Pages 6 and 7 for a complete parts listing.

4.1 Decontamination

Before and after each use, thoroughly clean all parts of the soil sampling system according to project requirements. A new, clean liner is recommended for each sample if using PETG, PVC, or Teflon® liners.

Stainless Steel Liners from Geoprobe Systems are cleaned at the factory with an agitated detergent bath at a temperature of approximately 180 degrees F. After rinsing with 180-degree tap water, the liner is air dried, wrapped in PVC outer cladding, and capped with vinyl end caps.

Thoroughly clean the sampler before assembly, not only to remove contaminants but also to ensure correct operation. Dirty threads complicate assembly and may lead to sampler failure. Sand is particularly troublesome as it can bind liners in the sample tube resulting in wasted time and lost samples.

4.2 Field Blank

It is suggested that a field blank be taken on a representative sample liner prior to starting a project and at regular intervals during extended projects. Liners can become contaminated in storage. A field blank will prove that the liners do not carry contaminates which can be transferred to soil samples. The following information is offered as an example method which may be used to take a field blank. Make the appropriate modifications for the specific analytes of interest to the investigation.

Example Procedure:

REQUIRED EQUIPMENT

MC Liner ..... (1)
MC Vinyl End Caps ..... (2)
Distilled Water ..... (100 ml)
VOA Vial (or other appropriate sample container) ..... (1)

1. Place a vinyl end cap on one end of the liner.

2. Pour 100 milliliters of distilled water (or other suitable extracting fluid) into the liner.

3. Place a vinyl end cap on the open end of the liner.

4. From the vertical position, repeatedly invert the liner so that the distilled water contacts the entire inner surface. Repeat this step for one minute.

5. Remove one end cap from the liner, empty contents into an appropriate sample container, and cap the container.

6. Perform analysis on the extract water for the analytes of interest to the investigation.

4.3 Open-Tube Sampler Assembly

1a. **(With MC Core Catcher)** Place the open end of an MC Core Catcher over the threaded end of an MC Cutting Shoe as shown in Figure 4.1. Apply pressure to the core catcher until it snaps into the machined groove on the cutting shoe.

NOTE: AT725K (thin-wall PETG) liners have a swedged end which is generally slipped directly over the groove in the cutting shoe (Fig. 4.2). To use a core catcher with these liners, cut approximately 0.25 inches (6 mm) of material from the swedged end of the liner and proceed to Step 2.

1b. **(Without MC Core Catcher)** Push the base of an MC Spacer Ring onto the threaded end of a cutting shoe until it snaps into place (Fig. 4.3).

NOTE: With the exception of AT-725K (thin-wall PETG) liners, all liners must utilize either a spacer ring or core catcher. PETG liners have a swedged end which slides directly over the end of the cutting shoe. Attach the liner to the cutting shoe (Fig. 4.2) before proceeding to Step 2.

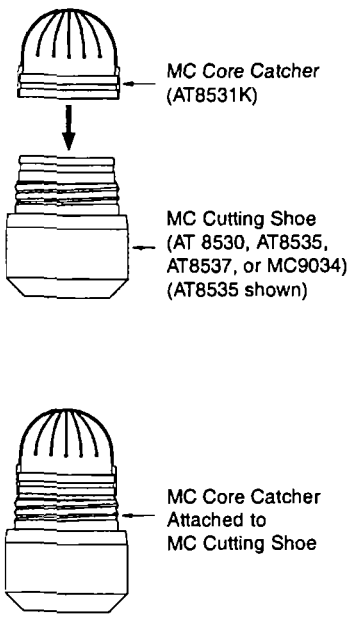


FIGURE 4.1
Core Catcher Attachment

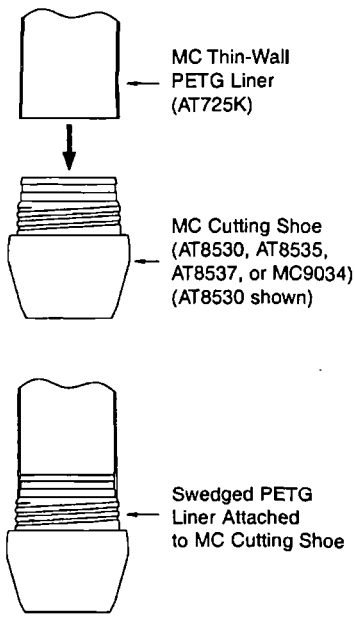


FIGURE 4.2
Thin-Wall Liner Attachment

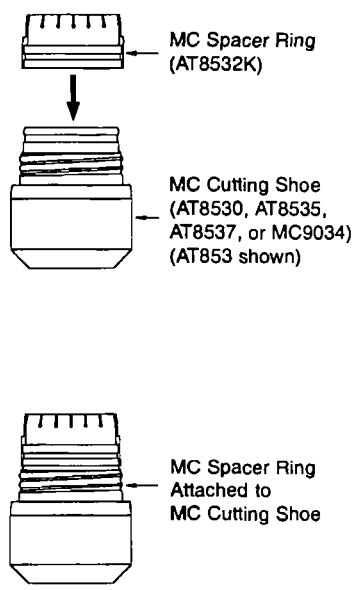


FIGURE 4.3
Spacer Ring Attachment

Refer to Figure 4.4 for identification of sampler parts and assembly sequence

2. Thread the cutting shoe into one end of an MC Sample Tube (Fig. 4.5). Tighten shoe with MC Combination Wrench (Fig. 4.6) until end of sample tube contacts machined shoulder of cutting shoe.

3. Insert a liner into the opposite end of the sample tube (Figure 4.7). The liner is all ready installed if using thin-wall PETG liners (AT725K) without an MC Core Catcher.

4. Thread an MC Drive Head into the top of the sample tube (Fig. 4.8) and securely tighten with the MC Combination Wrench (Fig. 4.9). Ensure that the end of the sample tube contacts the machined shoulder of the drive head.

Sampler Assembly is Complete.

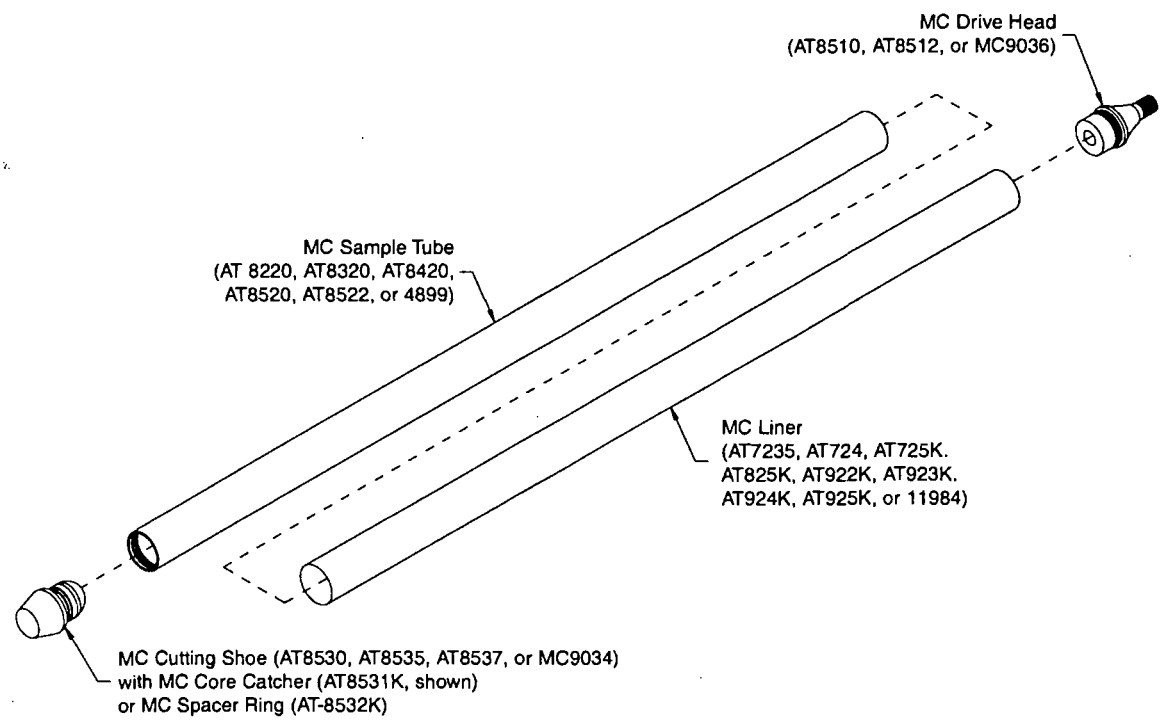


FIGURE 4.4
Macro-Core® Open-Tube Sampler Assembly

Figure 4.5. Thread an MC Cutting Shoe (shown with MC Core Catcher) into either end of a MC Sample Tube.

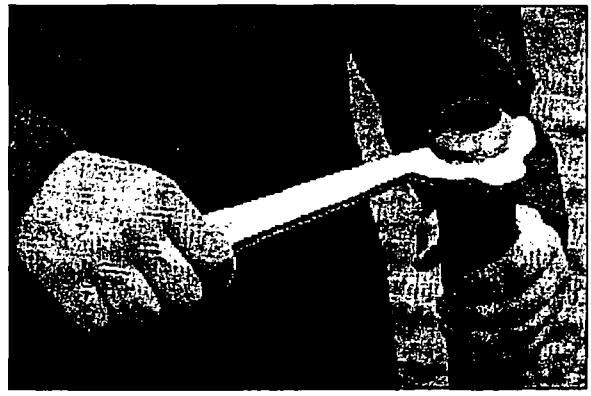


Figure 4.6. Tighten MC Cutting Shoe with MC Combination Wrench.

Figure 4.7. Insert liner into opposite end of MC Sample Tube.

Figure 4.8. Thread MC Drive Head into top of MC Sample Tube.

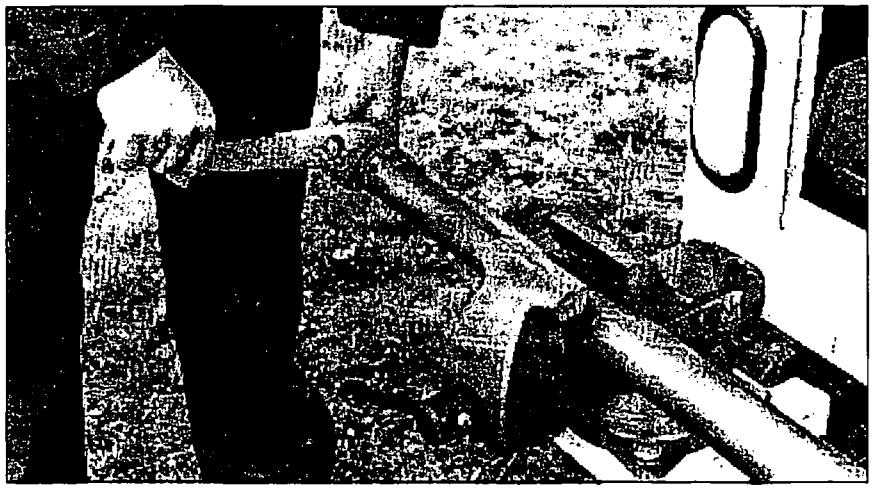


Figure 4.9. Tighten MC Drive Head with MC Combination Wrench. A vise is often used to hold the MC Sample Tube during this step.

4.4 Stop-Pin Coupler

The Stop-Pin Coupler attaches the Stop-Pin to the Piston Rod (Fig. 4.10). When connected together, these three parts form the Stop-Pin/Piston Rod Assembly. All three items may be ordered either individually or together as one complete assembly. Refer to Section 3.0 for specific assembly and item part numbers.

It is not always necessary to use the stop-pin coupler with the MC Piston Rod System. The coupler allows the piston rod to be removed from the sampler along with the stop-pin so that sample recovery is not hindered by the weight of the piston rod. If you find that recovery is not a problem with the formation you are sampling (such as clays), do not use the stop-pin coupler.

If sampling in formations where sample recovery may be a problem (such as loose sands), the stop-pin coupler is highly recommended. Removing the piston rod with the stop-pin significantly reduces the amount of tooling weight that the soil core must support as the sampler is driven. Sample compression is also reduced when the stop-pin coupler is utilized.

Instructions for connecting the stop-pin coupler to the stop-pin and piston rod are given below.

1. Hold a piston rod in vertical position with leading end resting on a solid surface.
2. Place a Stop-Pin Coupler on top of the Piston Rod and tap with a hammer to seat (Fig. 4.11).
3. Snap a Stop-Pin into the coupler using a hammer or 12-inch probe rod and drive cap (Fig. 4.12).

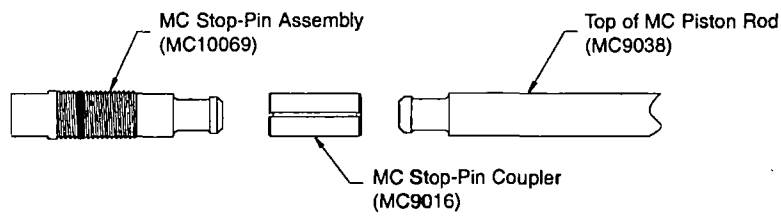


FIGURE 4.10
MC Stop-Pin Coupler Attaches MC Stop-Pin to MC Piston Rod

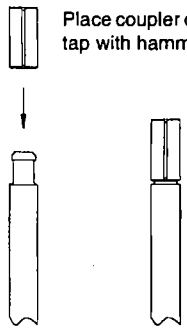


FIGURE 4.11
Tap Stop-Pin Coupler onto Piston Rod

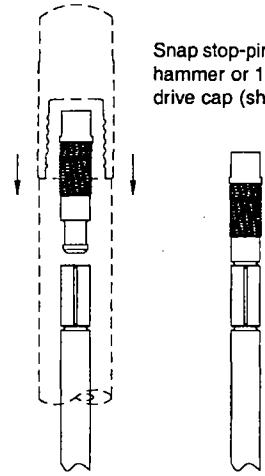


FIGURE 4.12
Tap Stop-Pin into Coupler with Probe Rod

4.5 MC Piston Rod Sampler (closed-point system) Assembly

The MC Piston Rod System seals the leading end of the sampler with a point assembly that is held in place with a piston rod and stop-pin. Once advanced to the top of the sampling interval, the stop-pin is removed with extension rods that are inserted down through the probe rod string. The piston rod will be extracted along with the stop-pin if a stop-pin coupler was used. Refer to Section 4.4 for help in determining when a stop-pin coupler is needed.

NOTE: The MC Piston Rod System requires an MC9036 MC Drive Head and an MC9034 MC Cutting Shoe. No other Macro-Core® drive heads or cutting shoes are compatible with this system. The larger 1.25-inch OD Probe Rods are also required to operate MC Piston Rod System.

1. Install an O-ring in the machined groove on the piston rod point (Fig. 4.13). Lubricate the O-ring with a small amount of deionized water.

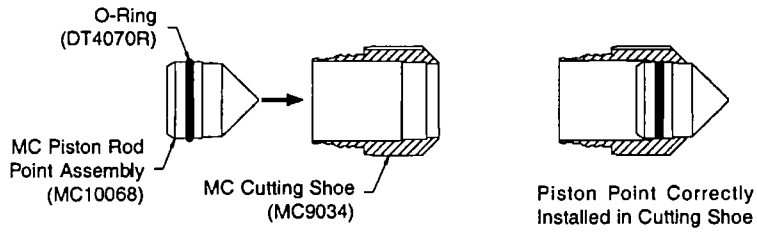


FIGURE 4.13
Installation of MC Piston Rod Point Assembly in MC Cutting Shoe

2. Push the piston rod point completely into the cutting shoe as shown in Figure 4.13.

3a. **(With MC Core Catcher)** Place the open end of a core catcher over the threaded end of the cutting shoe as shown in Figure 4.14. Apply pressure to the core catcher until it snaps into the machined groove on the cutting shoe.

NOTE: AT725K (thin-wall PETG) liners have a swedged end that is slipped directly over the groove in the cutting shoe (Fig. 4.15). To use a core catcher with these liners, simply cut approximately 0.25 inches (6 mm) of material from the swedged end of the liner and continue to Step 4.

3b. **(Without Core Catcher)** Push the base of an MC Spacer Ring onto the threaded end of the cutting shoe until it snaps into place (Fig. 4.16).

NOTE: With the exception of AT725K (thin-wall PETG) liners, all liners must utilize either a spacer ring or core catcher. Thin-wall liners have a swedged end which slides directly over the end of the cutting shoe. If using thin-wall liners, attach the liner to the cutting shoe (Fig. 4.15) before proceeding.

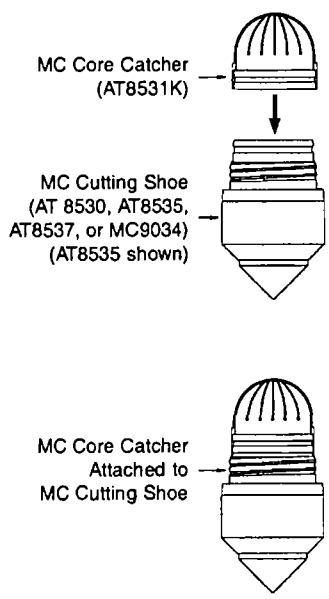


FIGURE 4.14
Core Catcher Attachment With Point Assembly

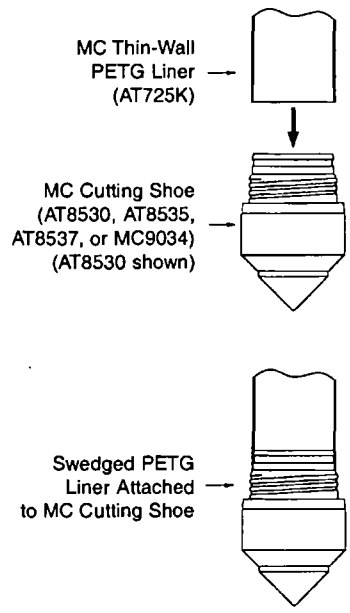


FIGURE 4.15
Thin-Wall Liner Attachment With Point Assembly

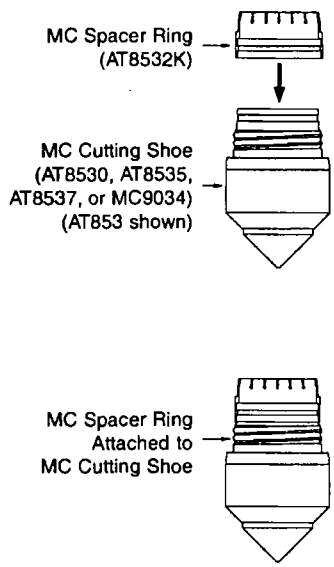


FIGURE 4.16
Spacer Ring Attachment With Point Assembly

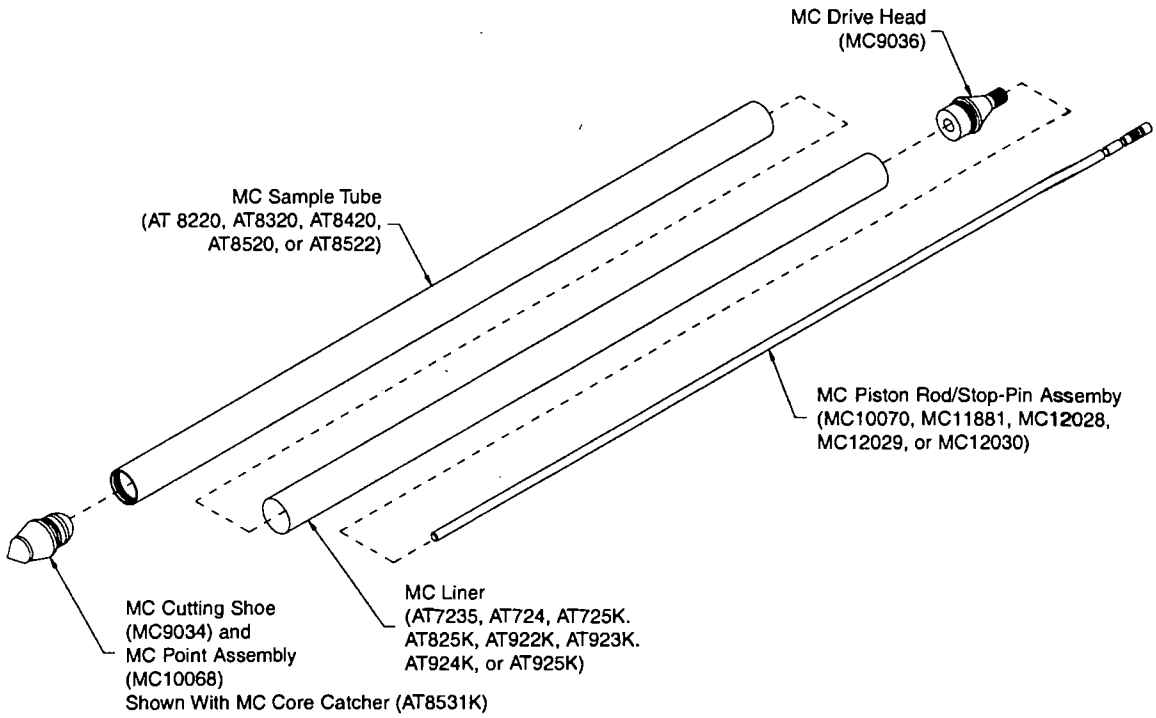


FIGURE 4.17
Macro-Core® Closed-Point Sampler Assembly

Refer to Figure 4.17 for identification of sampler parts and assembly sequence

4. Thread the cutting shoe (with point) into one end of an MC Sample Tube. Tighten until the end of the sample tube contacts the machined shoulder of the cutting shoe.

5. Insert an appropriate MC Liner into the sample tube (Fig. 4.18). The liner is all ready installed if using thin-wall PETG liners without a core catcher.

6. Thread an MC Drive Head into the top of the sample tube (Fig. 4.19) and securely tighten with the combination wrench (Fig. 4.20) until the end of the sample tube contacts the machined shoulder of the drive head.

(continued on Page 16)

Figure 4.18. Insert liner into opposite end of MC Sample Tube.

Figure 4.19. Thread MC Drive Head into top of MC Sample Tube.

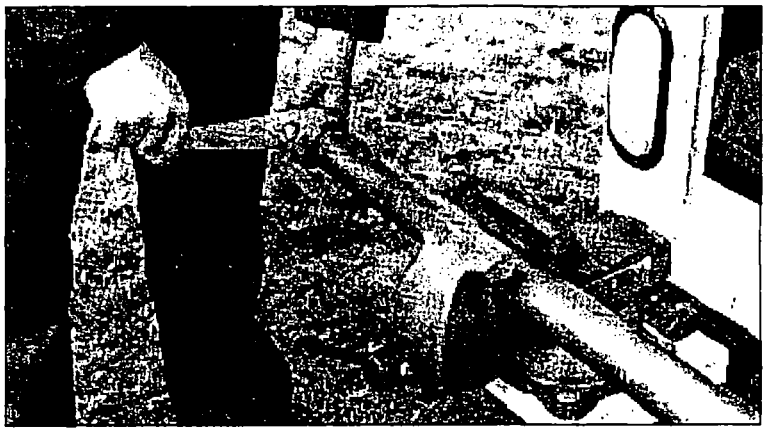


Figure 4.20. Tighten MC Drive Head with MC Combination Wrench. A vise is often used to hold the MC Sample Tube during this step.

7. Insert an MC Piston Rod/Stop-Pin Assembly through the drive head until the stop-pin threads contact the top of the drive head (Fig. 4.21). Ensure that an O-ring has been placed on the stop-pin.

   The leading end of the piston rod may hangup on the core catcher during assembly. When this happens, raise the assembly 6-8 inches above the core catcher and then allow the assembly to fall back down into the sampler. This should allow the piston rod to pass through the fingers of the core catcher.

   Note: The MC Stop-Pin Coupler may be omitted under certain sampling conditions. Refer to Section 4.4 for information regarding when a coupler is needed and instructions for coupler installation.

8. Thread the stop-pin into the drive head (left-hand threads) with an adjustable or 1/2-inch combination wrench. Fully tighten the stop-pin and then back it off slightly (~10 degrees). This avoids locking the stop-pin threads and allows it to later be unthreaded from the ground surface with extension rods.

Sampler Assembly is Complete.

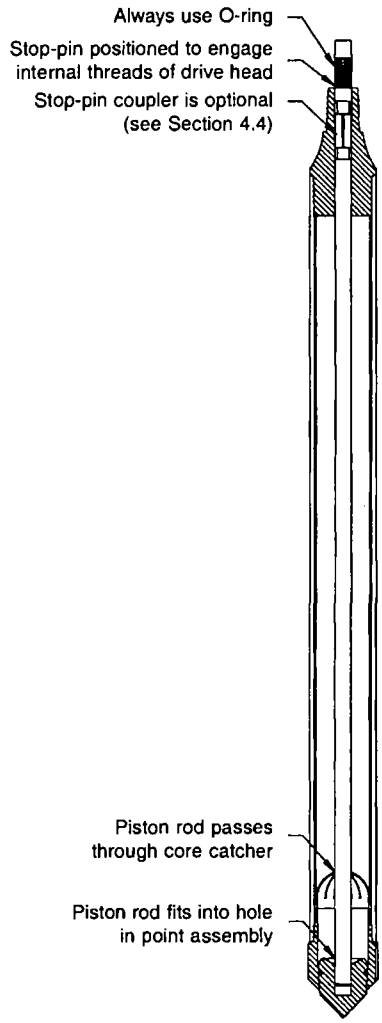


FIGURE 4.21
MC Piston Rod/Stop-Pin Assembly Installs Through MC Drive Head

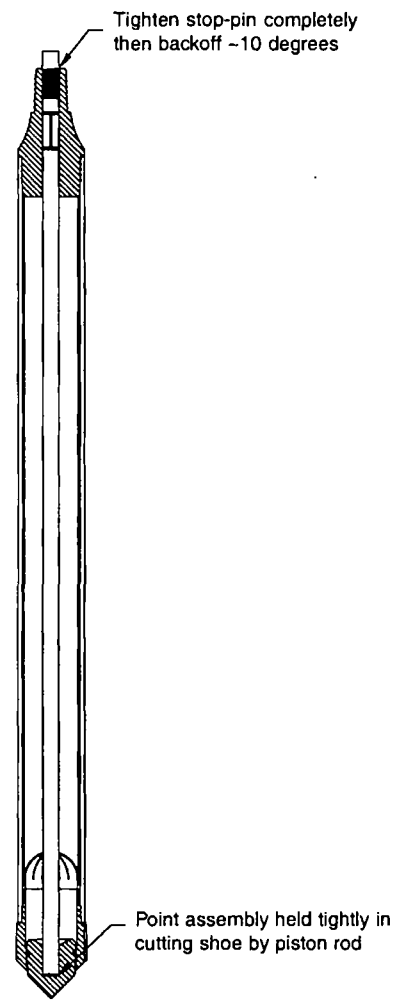


FIGURE 4.22
Thread MC Stop-Pin tachment with Piston Assembly

4.6 Pilot Hole

A pilot hole prevents excessive sampler wear in tough soils and saves time when a discrete soil core is desired. The pilot hole is created by driving a 2.0-, 2.5-, or 3.0-inch MC Pre-Probe (see Section 3.0 for part numbers) to the top of the sampling interval. Soil surfaces containing gravel, asphalt, hard sands, or rubble should be pre-probed to reduce wear on the cutting shoe and to avoid damage to the sampler. To save time when collecting a discrete soil core, pre-probe to the sampling interval rather than coring to depth with the sampler.

4.7 Open-Tube Sampling

The Macro-Core® Open-Tube Sampler is used to gather continuous soil cores beginning from ground surface. A representative soil sample is obtained by driving the assembled sampler one sampling interval into the subsurface through undisturbed soil. Upon retrieving the sampler, the liner and soil core are removed. The sampler is then properly decontaminated, reassembled with a new liner, and inserted back down the same hole to collect the next soil core.

Instructions for operationg of the Open-Tube Macro-Core® Sampler are given in this section.

1. Thread a Drive Cap (AT1200) onto the drive head of an assembled Open-Tube Macro-Core® Sampler as shown in Figure 4.23. (Refer to Section 4.3 for sampler assembly).

2. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

3. Position the MC Sampler for driving as shown in Figure 4.24. Place the sampler directly under the hammer with the cutting shoe centered between the toes of the probe foot. The sampler should now be parallel to the probe derrick. Step back from the unit and visually check sampler alignment.

4. Apply static weight and hammer percussion to advance the sampler until the drive head reaches the ground surface (Fig. 4.25A)

   NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

5. Raise the hammer assembly a few inches to provide access to the top of the sampler.

6. Remove the drive cap and thread a Pull Cap (AT1204) onto the sampler drive head.

7. Lower the hammer assembly and hook the hammer latch over the pull cap (Fig. 4.26). Raise the hammer assembly to pull the sampler completely out of the ground.

8. Procede to Section 4.9 for instructions on recovering the soil core from the MC Sampler.

To sample consecutive soil cores, advance a clean sampler down the previously opened hole (Fig. 4.25B) to the top of the next sampling interval (Fig. 4.25C). Drive the tool string the length of the sampler to collect the next soil core (Fig. 4.25D). Switch to an MC Piston Rod Sampler if excessive side slough is encountered.

NOTE: Use caution when advancing or retrieving the sampler within an open hole. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

Figure 4.23. Thread drive cap onto sampler drive head.

Figure 4.24 MC Sampler positioned for driving into subsurface.

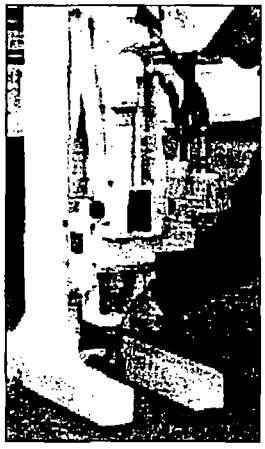
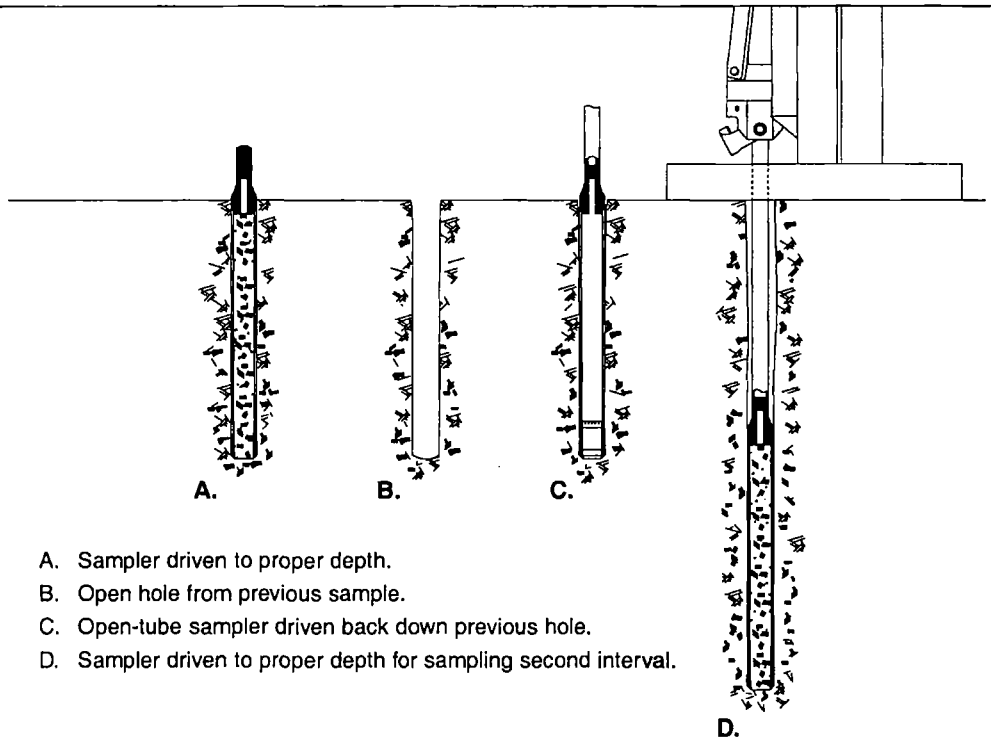


Figure 4.26. Hook hammer latch onto pull cap.



A. Sampler driven to proper depth.
B. Open hole from previous sample.
C. Open-tube sampler driven back down previous hole.
D. Sampler driven to proper depth for sampling second interval.

FIGURE 4.25
Phases of Macro-Core® Open-Tube Soil Sampling

4.8 Closed-Point Sampling with the MC Piston Rod System

Material collapsing from the probe hole sidewall can make it difficult to collect representative soil cores from significant depths with an open-tube sampler. To overcome this problem, the Macro-Core® Sampler can be equipped with a point assembly that is held tightly in the cutting shoe with a piston rod and threaded stop-pin. This allows the sealed sampler to pass through the slough material and then opened at the appropriate sampling interval. Intructions for sampling with the MC Piston Rod System are given in this section.

NOTE: The MC Piston Rod System is designed for continuous core sampling. A probe hole must be opened above the sampling interval either by removing soil with an open-tube Macro-Core® Sampler or by preprobing to depth. Never drive the MC Piston Rod System through undisturbed soil.

1. Attach a Slotted Drive Cap (AT1202) to the drive head of an assembled MC Piston Rod Sampler as shown in Figure 4.27. (Refer to Section 4.5 for sampler assembly.)

   NOTE: The MC Stop-Pin extends slightly from the top of the MC Drive Head. A slotted drive cap is therefore required to allow room for the stop-pin (Fig. 4.27). A standard drive cap may be used once probe rods are added to the tool string.

2. Raise the probe unit hammer assembly to its highest position by fully extending the probe cylinder.

3. Place the leading end of the MC Sampler into the **previously opened hole** (Fig. 4.28A).

4. Advance the sampler down the open hole for the full stroke of the probe machine.

   NOTE: Use caution when advancing the sampler down an open hole. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

5. Remove the slotted drive cap and thread a probe rod onto the MC Drive Head. Thread a standard Drive Cap (AT1200) onto the probe rod.

6. Continue advancing the sampler and adding probe rods to the tool string until the desired sampling interval is reached (Fig. 4.28B).

7. Raise the hammer assembly and retract the probe derrick to gain access to the top probe rod.

8. Remove the drive cap and insert extension rods down the inside of the probe rod string. A male Extension Rod Quick Link and an MC Extension Rod Quick Link Connector should be placed on the leading end of the extension rod string (Fig. 4.29) if an MC Stop-Pin Coupler was used during assembly. Nothing is placed on the leading extension rod if a stop-pin coupler was not used.

   Use Extension Rod Couplers or Extension Rod Quick Links (Fig. 4.30) to connect extension rods together until the leading rod contacts the stop-pin . Use an Extension Rod Jig (Fig. 4.30) to hold the down-hole rods while adding more rods to the string.

9. Attach an Extension Rod Handle (Fig. 4.30) to the rod string and slowly rotate the handle clockwise to engage the stop-pin threads. The rods will become harder to turn when the stop-pin threads are fully engaged. Pull up on the rod string to ensure that it is connected to the stop-pin. Continue rotating and periodically lifting the extension rods until the stop-pin is completely unthreaded from the drive head.

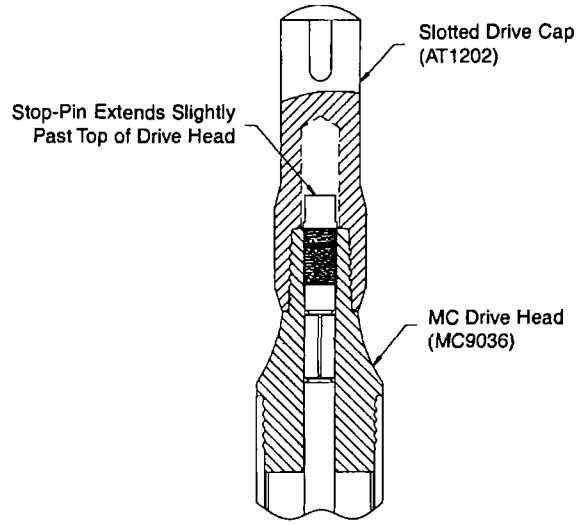
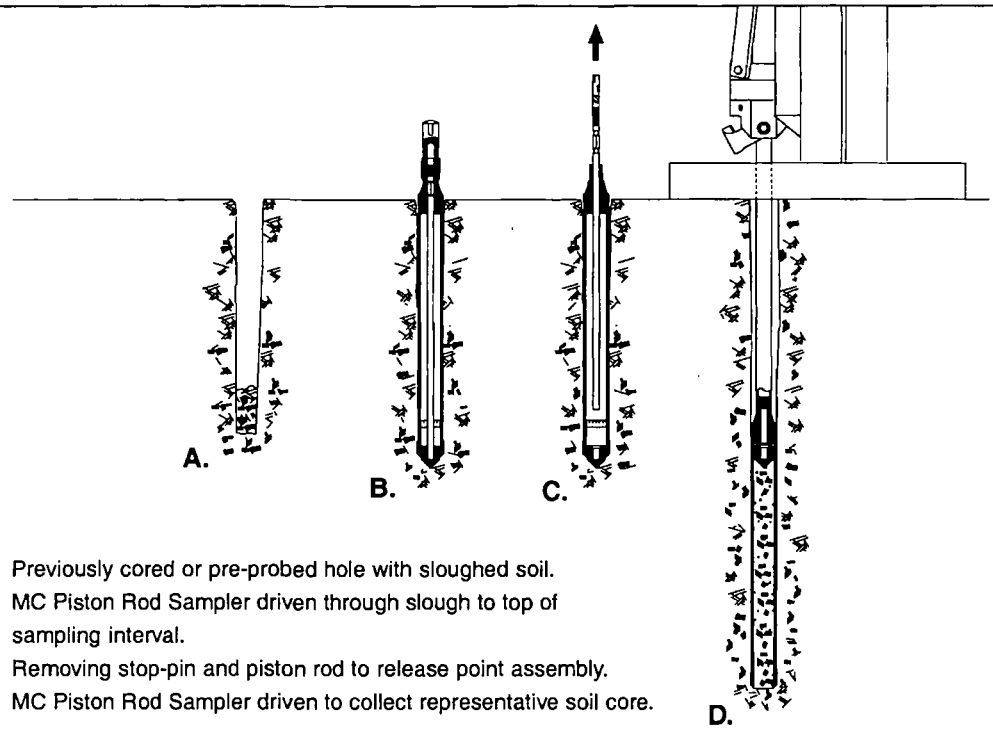


FIGURE 4.27
Slotted Drive Cap Accomodates Stop-Pin



A. Previously cored or pre-probed hole with sloughed soil.
B. MC Piston Rod Sampler driven through slough to top of sampling interval.
C. Removing stop-pin and piston rod to release point assembly.
D. MC Piston Rod Sampler driven to collect representative soil core.

FIGURE 4.28
Phases of Macro-Core® Closed-Point (Piston Rod System) Sampling

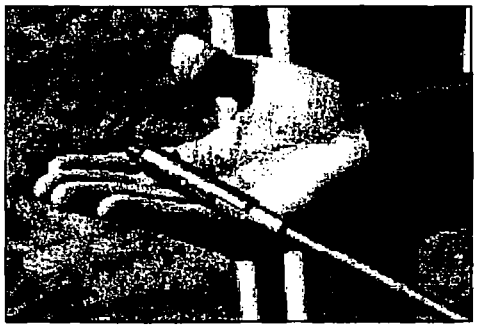


Figure 4.29. Use an MC Extension Rod Quick Link Connector if stop-pin coupler was used in sampler.

NOTE: If the stop-pin is excessively difficult to unthread, pull the entire tool string up approximately 2 inches. This should relieve the force exerted on the point assembly and make releasing the stop-pin much easier.

10. Lift and remove extension rods until the stop-pin is visible above the drive head (Fig. 4.28-C). The stop-pin and piston rod will both be removed from the sampler if a stop-pin coupler was used during assembly (Fig. 4.31-A). Only the stop-pin will be connected to the last extension rod if a coupler was not used (Fig. 4.31-B). Remove the extension rod and stop-pin if the piston rod is not attached.

11. If the piston rod is attached to the stop-pin, carefully unhook the extension rod and male quick link from the MC Extension Rod Quick Link Connector (Fig. 4.31-A). Take care not to deform the stop-pin coupler when removing the extension rod. Now remove the piston rod from inside the tool string.

12. Thread the Drive Cap (AT1200) onto a probe rod and then attach the probe rod to the tool string.

13. Completely raise the probe unit hammer assembly and reposition the probe derrick over the tool string.

14. Apply static weight and hammer percussion to advance the tool string the length of the sampler and collect the soil core (Fig. 4.28-D).

    NOTE: Activate hammer percussion whenever collecting soil. Percussion helps shear the soil at the leading end of the sampler so that it moves into the sample tube for increased recovery.

15. Raise the hammer assembly a few inches to provide access to the top of the tool string.

16. Remove the drive cap and thread a Pull Cap (AT1204) onto the top probe rod.

17. Lower the hammer assembly and hook the hammer latch over the pull cap. Raise the hammer assembly to pull the first probe rod out of the ground. Remove the rod and place the pull cap on the next rod of the tool string. Continue pulling probe rods until the MC Sampler is brought to the ground surface.

    NOTE: Use caution when retrieving the MC Sampler from depth. Low side friction may allow the sampler and probe rods to drop down the hole when released. To prevent equipment loss, hold onto the tool string with a pipe wrench when needed.

18. Procede to Section 4.9 for instructions on recovering the soil core from the MC Sampler.

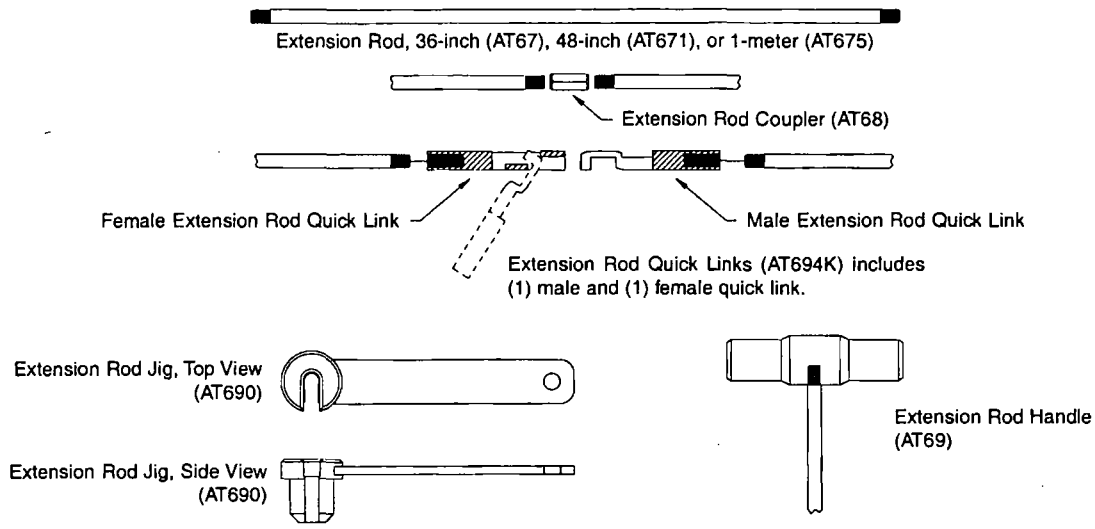


FIGURE 4.30
Extension Rods and Accessories

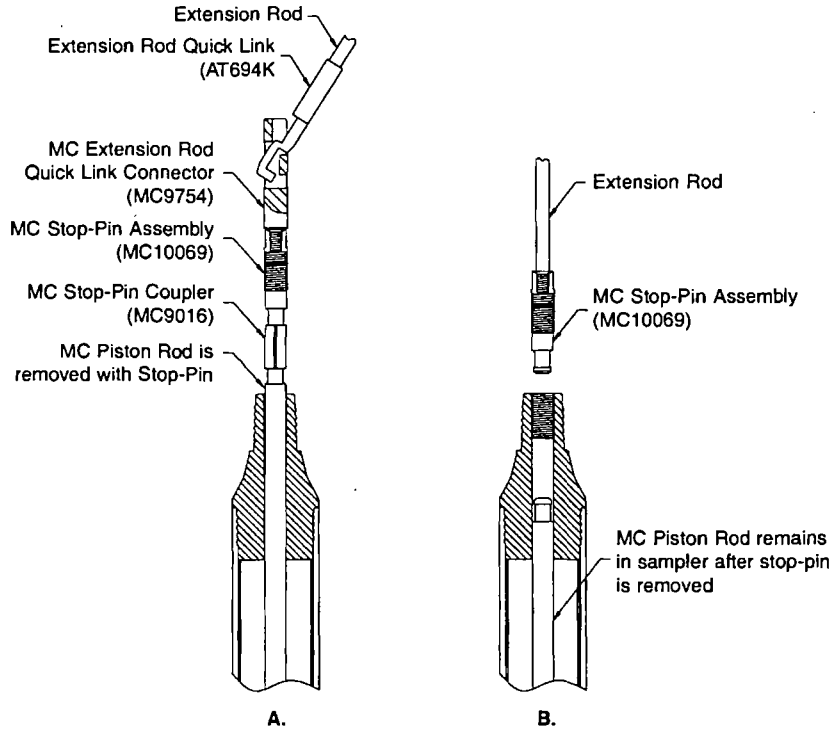


FIGURE 4.31
MC Piston Rod is Removed With Stop-Pin if Stop-Pin Coupler was Used

4.9 Soil Core Recovery

The soil sample is easily removed from the Macro-Core® Sampler by unthreading the cutting shoe and pulling out the liner. A few sharp taps on the cutting shoe with the combination wrench will often loosen the threads sufficiently to allow removal by hand. If needed, the exterior of the cutting shoe features a notch for attaching the combination wrench to loosen tight threads (Fig. 4.32). With the cutting shoe removed (Fig. 4.33), simply pull the liner and soil core from the sample tube (Fig. 4.34).

If the closed-point sampler is used, the MC Piston Rod Point Assembly is now retrieved from the end of the liner (Fig. 4.35). Secure the soil sample by placing a vinyl end cap on each end of the liner.

Undisturbed soil samples can be obtained from Teflon®, PVC, and PETG liners by splitting the liner. Geoprobe offers two tools for cutting sample liners. The MC Liner Cutter Kit (AT8000K) is used to make longitudinal cuts in the liner and includes a tool that holds the liner for cutting (Fig. 4.36). The MC Liner Circular Cutting Tool (AT8050) is used to segment the liner by cutting around the outside circumference of the liner (Fig. 4.37).

Figure 4.32. Loosening the MC Cutting Shoe with the MC Combination Wrench.

Figure 4.33. Removing MC Cutting Shoe and liner from MC Sampler Tube.

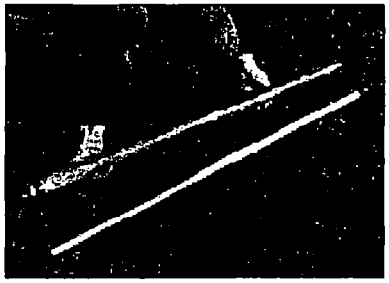


Figure 4.34. Macro-Core® liner filled with soil core.

Figure 4.35. MC Piston Rod Point Assembly is retrieved from top of liner.

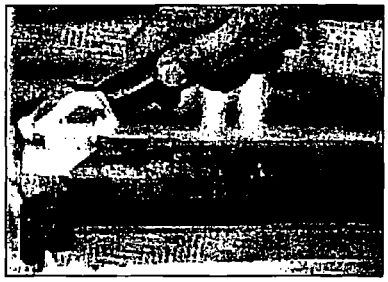


Figure 4.36. MC Liner Cutter makes two longitudinal cuts in polymer liners.

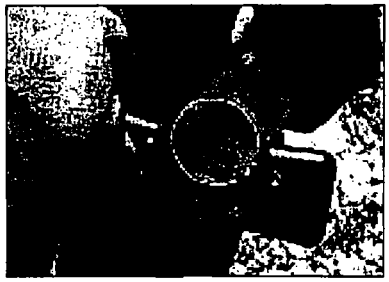


Figure 4.37. MC Circular Cutting Tool cuts around the outside of MC liner.

4.10 MC Piston Rod Sampler Tips

Macro-Core® Samplers are available in lengths of 24 inches, 36 inches, 1 meter, 48 inches, and 60 inches. This means that MC Sample Tubes, MC Liners, MC Piston Rods and MC Piston Rod/Stop-Pin Assemblies are also available in these five sizes. Keep this in mind when ordering Macro-Core® parts to ensure that the items you receive are of the appropriate length.

During development of the MC Piston Rod System, it was common for operators to remove the MC Piston Rod/Stop-Pin assembly from inside the probe rods with the last extension rod still threaded onto the stop-

pin. The MC Stop-Pin Coupler is not designed to withstand the considerable side load placed on it by the extension rod and is easily damaged if the extension rod is allowed to swing around unsupported. The MC Quick Link Connector was developed to prevent damage to the coupler by allowing the last extension rod to be disconnected from the piston rod/stop-pin assembly before removing the assembly from the probe rods. Always use the quick link connector whenever the sampler is assembled with a stop-pin coupler.

4.11 Tips to Maximize Sampling Productivity

The following suggestions are based on the collective experiences of Geoprobe operators:

1. Organize your truck or van. Assign storage areas to all tools and equipment for easy location. Transport sample tubes, piston rods, extension rods, probe rods, and liners in racks. Above all, minimize the number of items lying loose in the back of the vehicle.

2. Take three or four samplers to the field. This allows the collection of several samples before stopping to clean and decontaminate the equipment. A system is sometimes used where one individual operates the probe while another marks the soil cores and decontaminates the used samplers.

3. A machine vise is recommended. With the sampler held in a vise, the operator has both hands free to remove the cutting shoe (Fig. 4.38), drive head, and sample liner (Fig. 4.39). Cleanup is also easier with both hands free. Geoprobe offers an optional Machine Vise (FA300) that mounts directly on the probe derrick (Fig. 4.40).

4. Extension Rod Quick Links (Fig. 4.41) are real time savers. A good method for deploying extension rods is to assemble sections of up to three rods using threaded connnectors. Each section is then connected with Quick Links so that up to three rods can be added or removed from the string at once.

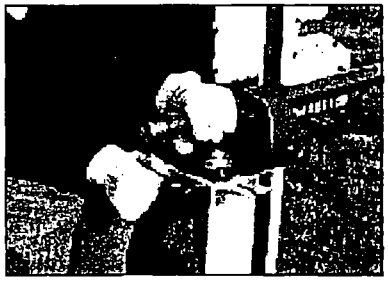


Figure 4.38. Removing MC Cutting Shoe with sample tube held in machine vise.

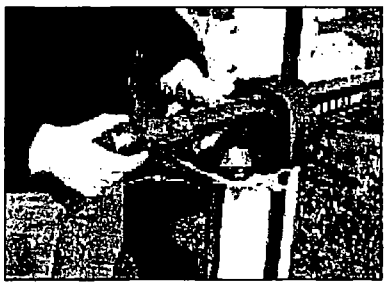


Figure 4.39. Removing filled liner with sample tube held in machine vise.

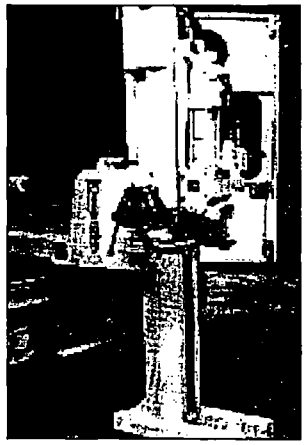


Figure 4.40. Machine vise mounted directly on Geoprobe Soil Probing Unit.

Figure 4.41. Using Extension Rod Quick Links to connect Extension Rods.

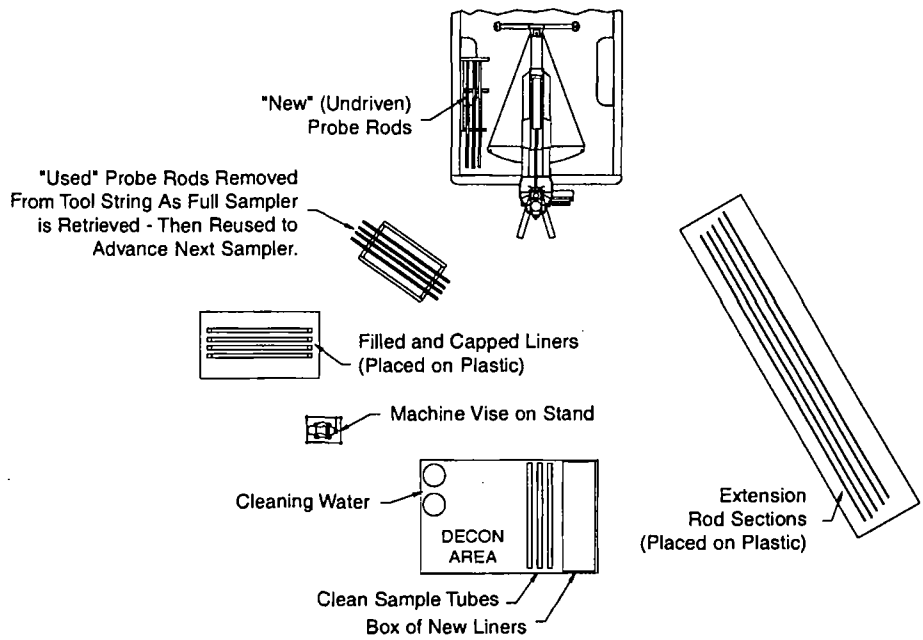


FIGURE 4.42
Equipment Layout Example to Maximize Sampling Productivity.

5. When releasing the stop-pin, a pair of locking pliers can be used to turn the extension rods. Locking pliers may be quicker and easier to install than the extension rod handle.

6. Organize your worksite. Practice with the sampler to identify a comfortable setup and then use this layout whenever sampling. An example layout is shown in Figure 4.42.

   A collapsible table or stand is handy to hold decontaminated sampler tubes and liners. Equipment may also be protected from contamination by placing it on a sheet of plastic on the ground.

   Instead of counting probe rods for each trip in-and-out of the probe hole, identify separate locations for "new" rods and "used" rods. Collect the first sample from the open hole using "new" rods. As each probe rod is removed during sampler retrieval, place it in the "used" rod location. Now advance a clean sampler back down the same hole using all of the rods from the "used" location. Add one "new" rod to the string and then drive the tools to collect the next soil core. Once again, remove each probe rod and place it in the "used" rod location as the sampler is retrieved. Repeat this cycle using all the "used" rods to reach the bottom of the probe hole, and one "new" rod to fill the sampler.

7. Cleanup is very important from the standpoint of operation as well as decontamination. Remove all dirt and grit from the threads of the drive head, cutting shoe, and sample tube with a nylon brush (BU700). Without sufficient cleaning, the cutting shoe and drive head will not thread completely onto the sample tube. The threads may be damaged if the sampler is driven in this condition.

Ensure that all soil is removed from inside the sample tube. Sand particles are especially troublesome as they can bind liners in the sampler. Full liners are difficult to remove under such conditions. In extreme cases the soil sample must be removed from the liner before it can be freed from the sample tube.

8. Although MC Drive Heads are available for open-tube sampling with 1.0-inch OD probe rods, 1.25-inch rods are recommended for the Macro-Core® Sampler. The larger rod diameter limits downhole deflection of the tool string and ultimately provides a more durable system. The double-lead thread design also makes the 1.25-inch rods thread together faster than previous 1-inch probe rods.

9. The Heavy-Duty MC Cutting Shoe (AT8535) is machined with more material at the critical wear areas. It can be used in place of the Standard MC Cutting Shoe (AT8530) and is designed to lengthen service life under tough probing conditions.

   Expansive clays and coarse sands can "grab" and collapse liners as the sample tube is filled with soil. A 1/8-inch Undersized MC Cutting Shoe (AT8537) helps alleviate this problem. The smaller core (1.375 inches OD) allows expanding clays and coarse sands to travel past the liner without binding.

   The standard, heavy-duty, and undersized cutting shoes will not accept the MC Piston Rod Point Assembly (MC10068). Only the MC9034 cutting shoe is compatible with the MC Piston Rod System.

10. Maximize the thread life of the sample tube by varying the ends in which the drive head and cutting shoe are installed. The dynamic forces developed while driving the sampler are such that the threads at the drive head wear more quickly than at the cutting shoe. Regularly switching ends will maintain relatively even wear on the sample tube.

5.0 REFERENCES

Geoprobe Systems, September, 1997, "97-98 Tools and Equipment Catalog."

Geoprobe Systems, May, 1995, "1995-96 Tools and Equipment Catalog."

Equipment and tool specifications, including weights, dimensions, materials, and operating specifications included in this brochure are subject to change without notice. Where specifications are critical to your application, please consult Geoprobe Systems 1-800-436-7762.

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Appendix D
Unified Soil Classification System

UNIFIED SOIL CLASSIFICATION SYSTEM (VISUAL-MANUAL PROCEDURE)

F-245A (12/92-R2)

FLOW CHART FOR IDENTIFYING INORGANIC FINE-GRAINED SOIL (50% OR MORE FINES)

GROUP SYMBOL					GROUP NAME
CL	<30% plus No. 200	<15% plus No. 200			Lean clay
		15-25% plus No. 200	% sand ≥% gravel		Lean clay with sand
			% sand <% gravel		Lean clay with gravel
	≥30% plus No. 200	% sand ≥% gravel	<15% gravel		Sandy lean clay
			≥15% gravel		Sandy lean clay with gravel
		% sand <% gravel	<15% sand		Gravelly lean clay
			≥15% sand		Gravelly lean clay with sand
ML	<30% plus No. 200	<15% plus No. 200			Silt
		15-25% plus No. 200	% sand ≥% gravel		Silt with sand
			% sand <% gravel		Silt with gravel
	≥30% plus No. 200	% sand ≥% gravel	<15% gravel		Sandy silt
			≥15% gravel		Sandy silt with gravel
		% sand <% gravel	<15% sand		Gravelly silt
			≥15% sand		Gravelly silt with sand
CH	<30% plus No. 200	<15% plus No. 200			Fat clay
		15-25% plus No. 200	% sand ≥% gravel		Fat clay with sand
			% sand <% gravel		Fat clay with gravel
	≥30% plus No. 200	% sand ≥% gravel	<15% gravel		Sandy fat clay
			≥15% gravel		Sandy fat clay with gravel
		% sand <% gravel	<15% sand		Gravelly fat clay
			≥15% sand		Gravelly fat clay with sand
MH	<30% plus No. 200	<15% plus No. 200			Elastic silt
		15-25% plus No. 200	% sand ≥% gravel		Elastic silt with sand
			% sand <% gravel		Elastic silt with gravel
	≥30% plus No. 200	% sand ≥% gravel	<15% gravel		Sandy elastic silt
			≥15% gravel		Sandy elastic silt with gravel
		% sand <% gravel	<15% sand		Gravelly elastic silt
			≥15% sand		Gravelly elastic silt with sand

FLOW CHART FOR IDENTIFYING ORGANIC FINE-GRAINED SOIL (50% OR MORE FINES)

OL/OH	<30% plus No. 200	<15% plus No. 200			Organic soil
		15-25% plus No. 200	% sand ≥% gravel		Organic soil with sand
			% sand <% gravel		Organic soil with gravel
	≥30% plus No. 200	% sand ≥% gravel	<15% gravel		Sand organic soil
			≥15% gravel		Sandy organic soil with gravel
		% sand <% gravel	<15% sand		Gravelly organic soil
			≥15% sand		Gravelly organic soil with sand

FLOW CHART FOR IDENTIFYING COARSE-GRAINED SOIL (LESS THAN 50% FINES)

				GROUP SYMBOL		GROUP NAME
GRAVEL % gravel > % sand	≤5% fines	Well graded		GW	<15% sand	Well graded gravel
					≥15% sand	Well graded gravel with sand
		Poorly graded		GP	<15% sand	Poorly graded gravel
					≥15% sand	Poorly graded gravel with sand
	10% fines	Well graded	fines=ML or MH	GW-GM	<15% sand	Well graded gravel with silt
					≥15% sand	Well graded gravel with silt and sand
			fines=CL or CH	GW-GC	<15% sand	Well graded gravel with clay
					≥15% sand	Well graded gravel with clay and sand
		Poorly graded	fines=ML or MH	GP-GM	<15% sand	Poorly graded gravel with silt
					≥15% sand	Poorly graded gravel with silt and sand
			fines=CL or CH	GP-GC	<15% sand	Poorly graded gravel with clay
					≥15% sand	Poorly graded gravel with clay and sand
	≥15% fines		fines=ML or MH	GM	<15% sand	Silty gravel
					≥15% sand	Silty gravel with sand
			fines=CL or CH	GC	<15% sand	Clayey gravel
					≥15% sand	Clayey gravel with sand
SAND % sand ≥ % gravel	≤5% fines	Well graded		SW	<15% gravel	Well graded sand
					≥15% gravel	Well graded sand with gravel
		Poorly graded		SP	<15% gravel	Poorly graded sand
					≥15% gravel	Poorly graded sand with gravel
	10% fines	Well graded	fines=ML or MH	SW-SM	<15% gravel	Well graded sand with silt
					≥15% gravel	Well graded sand with silt and gravel
			fines=CL or CH	SW-SC	<15% gravel	Well graded sand with clay
					≥15% gravel	Well graded sand with clay and gravel
		Poorly graded	fines=ML or MH	SP-SM	<15% gravel	Poorly graded sand with silt
					≥15% gravel	Poorly graded sand with silt and gravel
			fines=CL or CH	SP-SC	<15% gravel	Poorly graded sand with clay
					≥15% gravel	Poorly graded sand with clay and gravel
	≥15% fines		fines=ML or MH	SM	<15% gravel	Silty sand
					≥15% gravel	Silty sand with gravel
			fines=CL or CH	SC	<15% gravel	Clayey sand
					≥15% gravel	Clayey sand with gravel

Appendix E
Instrument Manufacturers' Instructions

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- OVM/Datalogger Model 580B
- Geotech P3
- HACH Portable Turbidimeter Model 2100P

OVM/Datalogger Model 580B

Instruction Manual

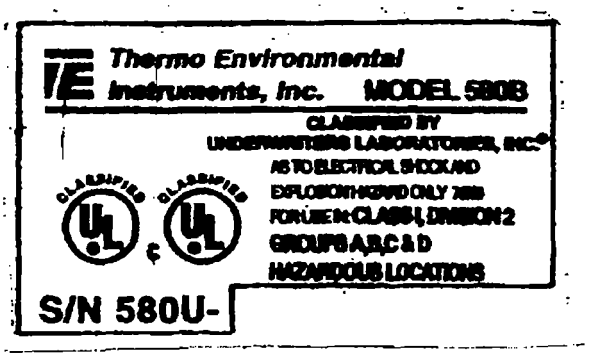
Model 580B
Organic Vapor Meter/Datalogger

ELECTRON CORPORATION

MODEL 580B

ORGANIC VAPOR METER (OVM) / DATALOGGER

INSTRUCTION MANUAL
P/N 16860



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SECTION I

INTRODUCTION

1 INTRODUCTION

The 580B is a portable Organic Vapor Meter (OVM), which detects and quantitates most organic vapors with a highly sensitive photoionization detector (PID). The 580B has an operating range of 0-2000 parts per million (ppm) with a minimum detectable of 0.1 ppm. No support gases are required.

The 580B is controlled by a microprocessor which provides many features that were not previously available. Maximum signal hold, detector linearization, overrange lockout, IBM PC (or compatible) interface, extensive data logging capabilities and much more. With the many features provided by the 580B leak detection, head space measurements, and field survey are all easily accomplished. Completely portable, the 580B operates from internal batteries for eight hours in the field.

1.1 ABOUT THIS MANUAL

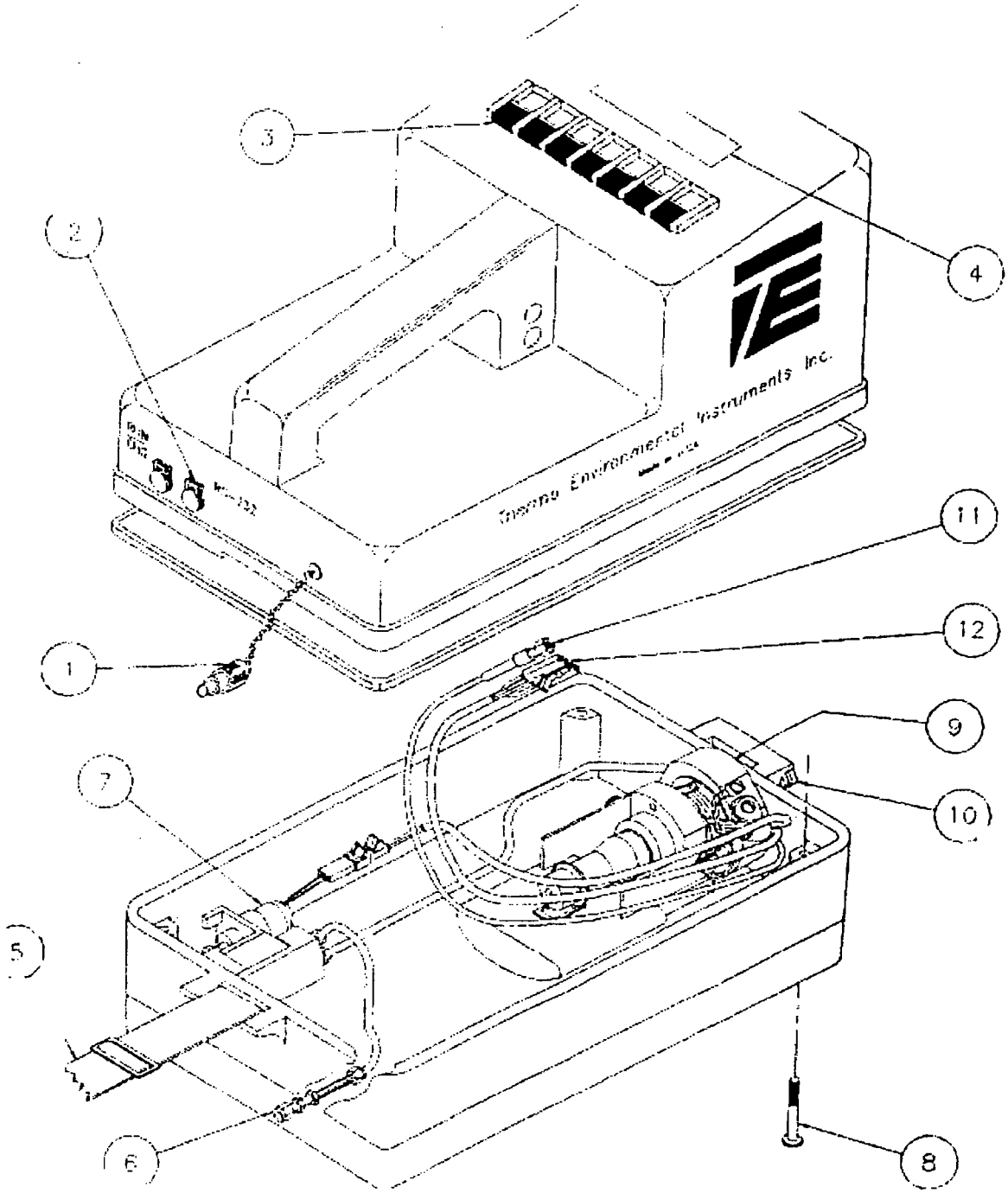
This manual is broken down into eight chapters. The first chapter (this one) provides a general overview of the 580B. Chapter two discusses, in great detail, the extensive facilities of the 580B. The focus of this chapter is on how to use the seven switches to access the various facilities. Chapter three explains, in detail, how to perform routine maintenance on the 580B. Chapter four is a technical discussion of calibration and methods for generating standards. Chapter five is a technical discussion of a few applications which illustrate some of the uses of the 580B. Chapter six is a technical discussion of methods for collecting a sample using the 580B. Chapter seven is a discussion of the communication facilities provided by the 580B. Chapter eight contains two flow charts which illustrate the 580B software flow. This chapter is a helpful tool for the new user. Appendix A is a detailed explanation of the 580B communication protocol. This chapter is provided in order to allow a programmer to develop specialized communication software for the 580B. There are several other addendums which contain miscellaneous information about the 580B.

1.2 INSTRUMENT OVERVIEW

This section describes various points of interest on the 580B. Each number refers to a number in Figure 1.1.

1. **POWER PLUG** - The power plug is used to run the instrument from its internal batteries. There is a chain attached to the power plug so that it will not be lost.

2. **RS-232 CONNECTOR** - This connector is used for communi-



Figur
rumen As: emb

cation with a serial printer or computer. A communication cable provided with the instrument fits into the receptacle.

3. **KEY PAD** - There are seven switches which operate the 580B. The switch marked ON/OFF is used to turn the pump and lamp on and off. The switch marked LIGHT will turn on backlighting for the two line display. The other five switches perform various functions. For a detailed description of the function of each switch see chapter two or the flow charts in chapter eight.

4. **DISPLAY** - The 580B has a two line by sixteen character display.

5. **SHOULDER STRAP** - There is an adjustable shoulder strap for carrying the 580B.

6. **SAMPLE EXIT PORT** - The 580B sample is drawn into the detector by a positive displacement pump and then sent back out through the exit port.

NOTE : The photoionization detector is a non destructive detector so the sample may be collected at the exit for further analysis (see Chapter Six).

7. **PUMP** - The 580B pump draws the sample into the detector.

8. **MOUNTING SCREWS** - There are four captive screws which hold the 580B top and bottom together. The screws are specially designed so that they do not fall out when they are loosened out of the case top.

9. **DETECTOR** - The photoionization detector is shown with the lamp and high voltage power supply.

10. **SAMPLE INLET** - Sample is drawn into the detector through the sample inlet at the front of the 580B.

11. **SIGNAL CABLE** - The PID signal is brought up to the microprocessor, for analysis, via the coaxial signal cable.

12. **BASE HARNESS** - The base harness plugs into a connector on the case top.

1.3 580B FEATURES

This section provides a brief overview of the various features of the 580B. After reading this section the user should have a good idea of what the instrument can do. Chapters two and three will explain, in detail, how each feature is selected.

TURNING ON PUMP AND LAMP - The pump and lamp are turned on by pressing the ON/OFF switch (the instrument power must already be on).

CALIBRATION - Calibration of the 580B is extremely impor-

tant. Chapter two explains how to calibrate the 580B in great detail. Chapter four discusses at length some of the basic theory and methods behind calibration. It is strongly suggested that this chapter be read in order to gain a deeper understanding of usage of the 580B. Chapter three also discusses calibration.

CONCENTRATIONS - Once the lamp and pump have been turned on the 580B begins to display the concentration of the incoming sample on the bottom line of the display. Normally the top line of the display will be a bar graph (logarithmic on a scale of zero to 2000). The operator may however select the MAX HOLD mode of operation. When in MAX HOLD, the top line of the display will show the highest concentration recorded.

LOGGING - The 580B provides extensive facilities for logging information. The operator may save a particular reading along with a six digit location code and a date and time stamp. If the 580B is in the MAX HOLD mode when logging is initiated then the max hold value will be logged.

AUTO LOGGING - Logging may be performed automatically by using the 580B's auto logging feature. Auto logging is not allowed while in the MAX HOLD mode. When auto logging is selected a LOGGING INTERVAL is selected (anywhere from one second to 99 minutes and 59 seconds). At the end of each logging interval the present concentration will be logged (the location code is automatically incremented each time).

AVERAGE - The 580B normally updates the concentration once per second. The operator has the option of setting the averaging time anywhere from one second up to four minutes.

NOTE : The bottom line of the display will be blank until the first averaging interval is completed. The top line will however be updated each second.

RESPONSE FACTOR - A response factor may be used in order to relate a particular gas to the calibration gas. When computing the displayed concentration the microprocessor multiplies the measured concentration by the response factor and displays the result. If the response factor is one, then the concentration is not changed. Chapters four and five explain some uses of the response factor.

LAMP SELECTION - The 580B allows for calibration data to be saved for one 10.0 eV lamp and one 11.8 eV lamp. This allows lamps to be switched in the field without requiring recalibration. A lamp serial number may also be entered.

ALARM - An alarm level may be selected. The 580B will sound an audible alarm (the top line will also indicate an alarm) whenever the concentration goes above the selected alarm level.

ACCESS - The 580B provides four access levels so that various features may be "locked out." User identification number

and instrument number are also provided.

CLOCK - The 580B has an internal clock which will run even when the instrument power is cut off.

COMMUNICATION - The 580B has a serial communication port for outputing data to a serial printer. Many of the 580B features may be accessed from a remote computer through the serial communication port (there is communication software available which will run on an IBM PC or clone).

DISPLAY LOGGED DATA - The logged data may be displayed on the 580B's two line display.

SECTION II

PRINCIPAL OF OPERATION

PHOTOIONIZATION DETECTOR OPERATION & THEORY

1 GENERAL

The sample is drawn into the ion chamber by a pump down stream of the detector. Here the sample is bombarded by ultra-violet light (UV) exciting the molecule. If the energy, (hU) of the UV light is greater than the ionization potential (IP) of the sample molecule (R) an electron will be removed, ionizing the molecule. A positively charged molecule and a free electron are produced, as :

$$R + hu \rightarrow R^{+} + e^{-}$$

Several typical reactions follow:

C_6H_6 (benzene) + hu -> $C_6H_6^{+} + e^{-}$ IP = 9.2 eV

$H_2C{=}CHCl$ (VCM) + hu -> $H_2C{=}CHCl^{+} + e^{-}$ IP = 9.9 eV

C_3H_8 (propane) + hu -> $C_3H_8^{+} + e^{-}$ IP = 10.9 eV

For this reason the ionization potential of the subject molecule plays an important role in selecting the lamp energy. Ionization potentials are expressed in electron volts (eV). A list of ionization potentials can be found in Appendix E of this manual or a more complete list in the CRC "Handbook of Chemistry and Physics".

2.1.2 LAMP ENERGIES

There are three lamps available from TEI, 10.0 eV, 10.6 eV, and 11.8 eV. The different energies are obtained by filling the lamp envelopes with different gases and selecting a window which will pass the wavelength produced when the gas is excited. The combination of gas and windows which produce these energies are listed below:

ENERGY	GAS	WINDOW	WAVELENGTH (nm)
10.0 eV	Krypton	MgF	123.6
10.6 eV	Krypton	MgF	117.4
11.8 eV	Argon	LiF	105.1

Though ionization potential will help the user select a lamp, it will not give any information as to the performance of

the detector in measuring a specific compound. The response of the system varies considerably from compound to compound even though they may have the same ionization potential. Some generalizations may help the user obtain a feeling for the difference in response between compounds.

2.1.3 COMPARATIVE RESPONSE

The following is an idealized response chart. No attempt is made to quantitate the relationship, it's a guideline.

Decreasing PID Response:
- Aromatic Compounds
- Unsaturated Compounds
- Saturated Compounds
- Ketones
- Alcohols
- Compounds with Sub Groups

It becomes obvious that sensitivity is influenced by the electronegativity of the molecule though this is not a predictable measure of performance. The only true test of performance is to measure the specific compound of interest and compare it to a good performing standard such as isobutylene.

2.1.4 RESPONSE FACTORS

This relative comparison with isobutylene mentioned above is a very effective way of measuring a variety of compounds without the need to recalibrate for each compound.

The development of a RESPONSE FACTOR allows the operator to correct the instrument's response given a one to one correspondence for all compounds measured, using isobutylene as the reference standard.

Note: Because there is variation in lamp production and hence performance, it is suggested that all calibration and subsequent development of response factors be done on the same lamp/instrument combination.

The preparation of standards and the development of response factors is discussed in subsequent sections of this manual. Once the response factor is generated, it is entered into the 580. The instrument automatically reports the concentration of the compound measured in relative units. It is important to recognize that all compounds measured at that time will be reported relative to the response factor entered in the instrument. For example, if we have calibrated the instrument on isobutylene and have entered a response factor for benzene, we will read concentrations with a one to one correspondence to benzene. If during these measurements toluene or any other compound is encountered, the instrument will report the concentration as if it was measuring benzene. For this reason care should be taken when using this facility.

The above discussion should give the reader a good overview of PID performance. To further understand the intricacies of the

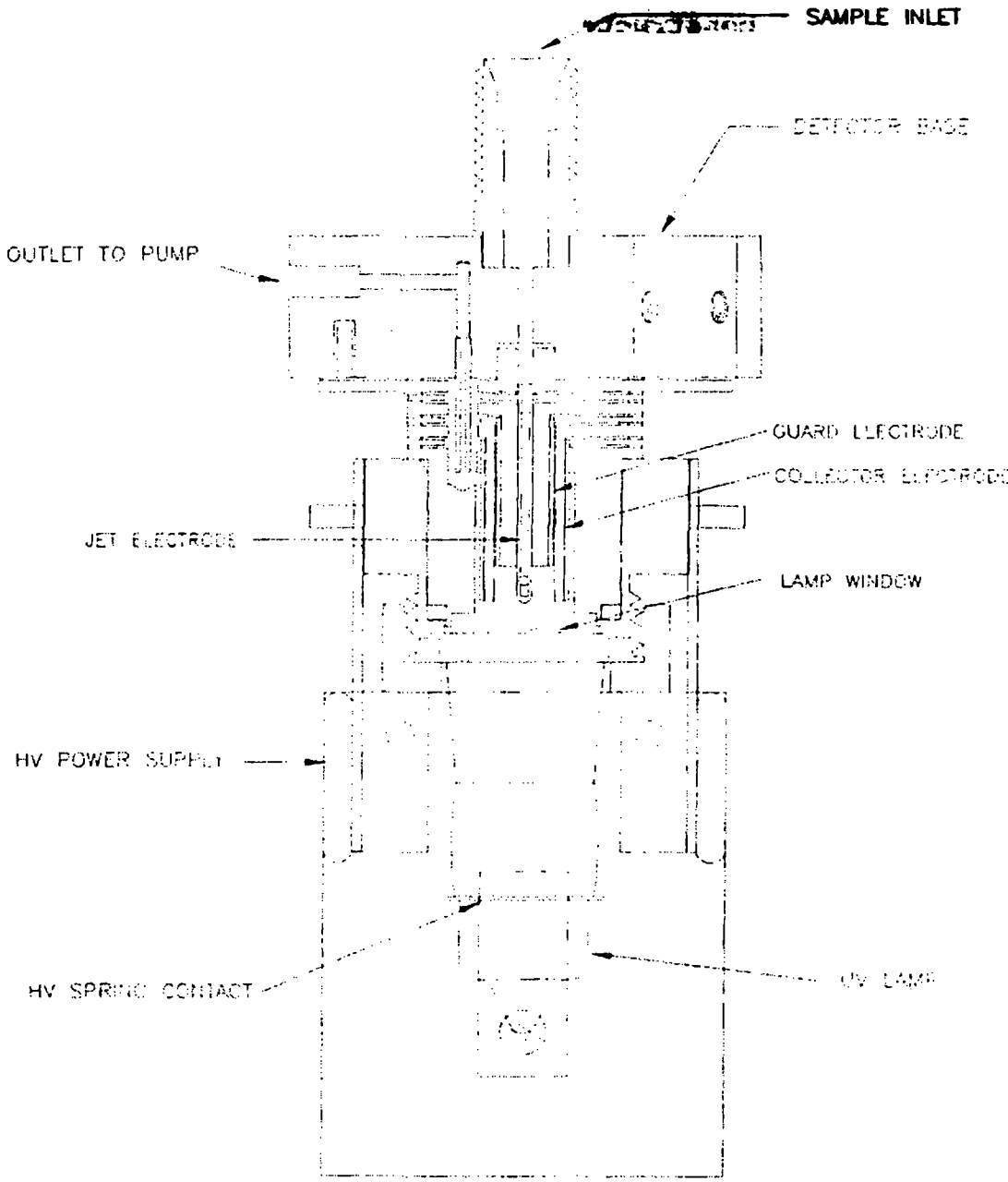


Figure 2.1
Photo Ionization Detector

instrument it is suggested that the user prepare a number of standards of different compounds and measure them relative to isobutylene. Included in this comparison should be several mixtures of compounds such as gasoline, paint thinner, or cleaning solvent, etc. Through this type of study the inequity of the PID response will be better understood making the Model 580 a more effective tool. The use of the instrument is discussed in greater detail in subsequent sections.

2.1.5 PHOTOIONIZATION DETECTOR

The detector is constructed of Teflon and stainless steel to eliminate chemical interaction with the surfaces that are encountered by the sample. To further reduce possible interaction with the surfaces, the flow rate thru the detector is high, 400 - 500 cc/min developing a very dynamic transport of the sample.

Referring to Figure 2.1, the sample is drawn into the ionization chamber through the jet electrode where the UV radiation from the lamp ionizes the sample. A bias voltage of several hundred volts is applied to the jet to aid in the collection of ions. As a result of the ionization process and the impingement of the UV energy from the lamp on the sample, positively charged ions and free electrons are produced. The jet is negative relative to the collector where the electrons are collected.

Between the jet and the collector, separated on both sides by Teflon, is the guard electrode. Its function is to eliminate surface currents which could flow between the two active electrodes. When the Teflon surfaces become dirty during use, there can be the development of a conduction path on the Teflon, which increases in high humidity situations. The guard electrode eliminates this path. The collector electrode is connected to the electrometer which measures the ion current produced during the ionization process. The sample is moved through the detector by an external pump which is on the exit of the detector.

2.2 PROGRAM OPERATION

2.2.1 INTRODUCTION

The 580B has seven switches located just below the display. They are labeled:

ON/OFF MODE/STORE RESET LIGHT +/INC -/CRSR SPKR

The ON/OFF switch toggles the lamp and pump power between on and off. The MODE/STORE, RESET, +/INC, -/CRSR and SPKR switches all have various meanings (including none at all) depending upon the mode. The SPKR switch normally is used to toggle the instrument speaker between on and off. Pressing the MODE/STORE switch will cause the 580B to return to the Run mode, except when the 580B is already in this mode. In which case it will cause the 580B to enter the Log mode.

The LIGHT switch is used to illuminate the display.

The 580B has several modes. Some of the modes may have sub modes. The modes and sub modes are tabulated below.

- Run mode
  - Concentration meter normal
  - Max hold
- Log mode
- Parameter mode
  - Calibration mode
- Access mode
- Clock mode
- Communication mode

The following sections will describe each mode and how to get to them and through them. It is strongly suggested that this section be carefully read and that the 580B be used along with the manual in order to re-enforce the manual.

2.2.2 POWER FOR LAMP AND PUMP

When the 580B is first turned on (see section 1.3) the display will indicate that the lamp is not lit. Pressing the ON/OFF switch will tell the microprocessor to turn on the lamp and the pump. The microprocessor will send power to the lamp and pump and then "look" to see if the lamp is actually lit. If it did not light then the microprocessor will try again.

If after fourteen seconds the lamp still will not light, then the microprocessor will indicate a lamp out condition.

In the event that the microprocessor is unable to light the lamp, check the seating of the lamp (see section 3.1). If the problem persists, call service.

Once the lamp is lit, the display will show the PPM (parts per million) on the bottom line. The top line will either be a bar graph or the maximum reading (see section 2.2.3).

To turn the lamp and pump off simply press the ON/OFF switch.

2.2.3 RUN MODES

The 580B has two run modes, Max Hold and Concentration meter. The run mode is selected in the Parameters section (see Section 2.4). In the concentration meter mode the top line of the display will be a bar graph. The bar graph is a logarithmic bar graph over the range of 0 to 2000 PPM. The bar graph is intended as a rough visual indication of the current PPM. The bottom line will indicate the exact PPM.

In the Max Hold mode the top line of the display will indicate the maximum reading. The bottom line of the display will indicate the current PPM. Whenever a new maximum is seen, the top line will be updated. The Max Hold reading may be reset by pressing the RESET switch while in the run mode.

2.2.4 LOG MODE

The ability to "log" data is one of the 580B's greatest

features. Readings may be stored for later analysis. Each reading will have a date and time as well as a location code associated with it. Up to over 700 readings may be stored. Logged data may even be sent to a printer or computer via an RS-232 serial communication port (see section 2.7).

The Log mode is entered from the Run mode by pressing the MODE/STORE switch. When this switch is pressed from the Run mode the display will show:

LOG THIS VALUE?

on the top line and either PPM or MAX PPM on the bottom line depending upon which run mode the 580B is currently in. By pressing the +/INC switch the display will then show:

LOC. CODE 000001

on the top line (the actual location code may not be 000001). The location code may now be entered. By pressing the +/INC switch the number above the cursor may be incremented. By pressing the -/CRSR switch the cursor may be moved to the next digit. The 580B automatically increments the location code each time a data point is logged.

Once the desired location code has been entered, pressing the MODE/STORE switch will "log" the data point. This means that the reading displayed on the bottom line, along with the location code, the current date and the current time will be stored into the 580B's memory. The 580B will then return to the Run mode.

If for any reason logging is not desired, pressing the RESET switch rather than the MODE/STORE switch will cause the value not to be stored. The 580B will then go back to displaying:

LOG THIS VALUE?

Pressing the mode switch will now return the 580B to the Run mode.

It is possible, when attempting to log a data point, that rather than the display showing "LOC. CODE 000001" it will show "BAR CODE: ." Don't be alarmed. This has happened becouse the location mode selection is not properly set. Section 2.4.3 describes how to set this parameter. Pressing the mode/store switch will cancel the logging operation and return to the run mode. The location mode selection should be changed as described in section 2.4.3.

2.2.4A AUTO LOGGING MODE

The 580B may be instructed to automatically log data according to a predefined time interval. AUTO LOGGING is selected from within the Parameters section (see section 2.4). At the end of the logging interval (settable from 1 second up to 99 minutes and 59 seconds) the current average ppm value will be logged and the logging interval will be restarted.

NOTE: Auto logging is not allowed with the Max Hold mode.

2.2.5 SPEAKER

While the 580B is in the Run mode the speaker may be turned on. The speaker will generate a "clicking" which will increase in speed as the concentration increases. The purpose of the speaker is to give the operator an audible indication of the PPM. The speaker may be turned on or off by pressing the SPKR switch. The speaker rate may also be changed by changing the switches located inside of the instrument. Only one of the four speaker rate switches should be on (in the down position) at any time.

2.2.6 LOW BATTERY

The 580B will display a warning when the battery is low. The warning will be a flashing B in the left hand corner of the bottom line of the display when the 580B is in the Run mode. The 580B should be recharged when the low battery warning is activated.

2.2.7 OVERRANGE

The 580B will display an overrange warning if the concentration goes above 2000 PPM. The top line of the display will show:

OVERRANGE

Once an overrange condition occurs the instrument will "lock out". This means that the overrange warning will continue to be displayed until the instrument is brought to a "clean" area. A clean area is defined to be an area where the concentration of organic vapors is below 20 PPM. The 580B will continue to indicate PPM on the bottom line during an overrange condition.

2.2.8 ALARM

The 580B has an alarm which will sound if the PPM rises above the alarm setting. The alarm setting is entered in the Parameters mode (see section 2.4.3). If the speaker is not activated then the alarm will of course not be heard. Once the PPM drops below the alarm setting the alarm will turn off. The top line of the display will also indicate when there is an alarm condition.

MAIN MENU

By pressing the MODE/STORE switch from the Run mode and then pressing the -/CRSR switch when asked if logging is desired,

580B will display the main menu:

R/COMM	-/PARAM
+/ACCESS	S/CLOCK

The other four operating modes (Communication, Parameters, Access and Clock) may be entered from the Main menu. The operating mode may always be returned to by pressing the MODE/STORE switch.

2.4 PARAMETERS MODE

All of the 580B operating parameters are entered in the Parameters mode. The 580B is also calibrated from within the Parameters mode.

The Parameters mode may be entered by pressing the -/CRSR switch from the main menu.

There are nine different sections in the Parameters mode.

1. Run mode selection
2. Auto logging selection
3. Location mode selection
4. Average time selection
5. Alarm setting
6. Lamp selection
7. Response factor setting
8. Calibration
9. Free space indication

Pressing the +/INC switch will advance the 580B to the next section. Pressing the -/CRSR will advance the 580B to the previous section. Each section and any of its sub-sections will be described in the following pages. It is important to note that when the 580B is in a sub-section of any of the above sections that the +/INC and -/CRSR switches will have a different meaning. This may seem confusing at first but will become clear after stepping through each section.

2.4.1 RUN MODE SELECTION

There are two Run modes. Concentration meter normal and Max Hold (see Section 2.2.3). The top line of the display will show:

CONC. METER

the bottom line will show:

"RESET" TO CHG

the bottom line will alternate every two seconds with:

MAX HOLD

if the 580B is in the Max Hold mode. Pressing the RESET switch will cause the 580B to show:

MAX HOLD
+ = USE/ - = NO

if the +/INC switch is pressed then the Max Hold mode will be selected. If the -/CRSR switch is pressed then the Concentration meter normal mode will be selected. In either case the 580B will then return to the previous screen.

2.4.2 AUTO LOGGING SELECTION

The 580B can be configured to automatically log data points. The top line of the display will show:

AUTO LOGGING

The bottom line will alternate between "RESET TO CHG." and "ON" or "OFF". Pressing the RESET switch will cause the 580B to show:

AUTO LOGGING
+/ON -/OFF

Pressing the -/CRSR switch will turn auto logging off and return operation to the previous screen. Pressing the +/INC switch will enable auto logging and allow setting of the logging interval. The display will show:

INTERVAL 00:01
"RESET"WHEN DONE

The +/INC switch will increment the number above the cursor and the -/CRSR switch will move the cursor. The logging interval format is MM:SS (where M is minute and S is second). Pressing the RESET switch will return operation to the first auto logging screen.

2.4.3 LOCATION MODE SELECTION

The 580B may be configured to accept a six digit location code which is entered via the keypad. There is an alternate method for entering location codes however UL approval has not yet been obtained for this option. For updated information contact Thermo Environmental Instruments inc.

The display shows the currently selected location mode. For example the display will show:

Loc. code mode
"reset" to chg.

When the 580B is configured to enable operator editing of the location code, pressing the RESET switch causes the 580 to show:

Bar code mode
"reset" to chg.

The 580B is now configured for the alternate location mode (which is not presently available for use in hazardous locations). Pressing the reset switch will cause the 580B to be configured for location code mode.

2.4.4 AVERAGE TIME SELECTION

The 580B can be configured to display the average PPM from once a second up to once every four minutes. The display will show:

AVERAGE = 0:01
"RESET" TO CHG

Pressing the RESET switch will cause the 580B to show:

AVERAGE = 0:01
"RESET"WHEN DONE

The +/INC switch will increment the number above the cursor and the -/CRSR switch will move the cursor. The average time format is M:SS (where M is minutes and S is seconds).

NOTE: The maximum averaging interval is four minutes.

2.4.5 ALARM SETTING

The 580B will display the current alarm setting on the top line of the display. The setting may be changed by simultaneously pressing the RESET switch with either the +/INC switch to increment the digit above the cursor or the -/CRSR switch to move the cursor.

2.4.6 LAMP SELECTION

The 580B will display:

LAMP

on the top line. The bottom line will alternate every two seconds between:

"RESET" TO CHG

and the currently selected lamp setting and its associated serial number.
i.e.

11.8eV 000000

By pressing the RESET switch, the 580B will display:

+/10eV -/11eV

on the bottom line. Pressing the +/INC switch will select the 10.0 eV lamp. Pressing the -/CRSR switch will select the 11.8eV lamp. In either case the 580B will then allow editing of the lamp serial number. The display will show:

SERIAL # 000000
"RESET"WHEN DONE

The +/INC switch will increment the number above the cursor and the -/CRSR switch will move the cursor. Pressing the RESET switch will return operation to the original lamp screen.
When using a 10.0 eV lamp or a 10.6 eV setting should be selected. When using an 11.8 eV lamp the 11 eV setting should be selected.

2.4.7 RESPONSE FACTOR SETTING

The current Response Factor setting will be displayed on the top line of the display. The Response Factor may be changed by simultaneously pressing the RESET switch with either the +/INC switch to increment the digit above the cursor or the -/CRSR switch to move the cursor.

The response factor is used to equate the response of one organic vapor with that of the calibration gas. The current reading is always multiplied by the response factor in order to obtain the displayed concentration. A response factor of one will not change the displayed concentration.

2.4.8 CALIBRATION

The 580B will display:

"RESET" TO
CALIBRATE

The calibration mode may be entered by pressing the RESET switch.
The 580B will display:

RESTORE BACKUP
+ = YES

The previous calibration information may be restored by pressing the +/INC switch. The 580B will then return to the previous screen. If the backup is not desired, by pressing the -/INC switch the calibration routine will continue. The display will show:

ZERO GAS
RESET WHEN READY

Once zero gas has been introduced the RESET switch should be pressed. The 580B will then zero the instrument. The 580B will display:

MODEL 580B
ZEROING

Once the 580B has been zeroed the 580B will display:

SPAN PPM = 0000

The Span gas concentration may now be entered by simultaneously pressing the RESET switch and either the +/INC switch to increment the digit above the cursor or the -/CRSR switch to move the cursor. Once the span gas concentration has been entered the +/INC switch should be pressed.

The 580B will then display:

SPAN GAS
RESET WHEN READY

Once the span gas has been introduced the RESET switch should be pressed. The 580B will then calibrate the instrument. The 580B will display:

MODEL 580B
CALIBRATING

Once the 580B has been calibrated the 580B will go back to the beginning and display:

"RESET" TO
CALIBRATE

If during the zeroing or calibrating of the 580B a steady reading was not seen then the 580B will display:

CAL ERROR
RESET WHEN READY

Pressing the RESET switch will return the 580B to zeroing or calibrating (depending of course on which it came from).

See Section 4.1 for tips on calibrating the 580B.

2.4.9 FREE SPACE INDICATION

This section will give a rough indication of how much room is left for logging data points. The screen will display a bar graph on the top line and the amount of free space on the bottom line. The number indicates the total number of bytes which are available. Each data point takes fifteen bytes. Other bytes may also be needed in order to store other important information. This is why only a rough indication of room may be given.

2.5 ACCESS MODE

The Access mode is entered by pressing the +/INC switch from the main menu. The 580B has four access levels, zero through three. Level zero will only allow the operator to log data points and of course to change access levels (only if the access code is known). Level one will also allow the user to change the user identification number. Level two will allow the user complete access to the Parameters mode, and allow viewing of the date and time. Access level three allows complete access.

The access mode has three sections:

1. Access level
2. User identification number
3. Instrument number

Pressing the +/INC switch will advance the 580B to the next section. Pressing the -/CRSR switch will advance the 580B to the previous section.

TABLE OF ACCESS LEVELS

ACCESS LEVEL	OPERATIONS ALLOWED
0	Change access level Log data
1	All above operations View time and date View communication format Display logged data Change user I.D.
2	All above operations Change operating Parameters Reset logged data
3	All operations available

2.5.1 ACCESS LEVEL

The screen will display:

ACCESS LEVEL 3
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

KEY 00003
"RESET" WHEN DONE

Please note that in both screens the 3 indicates the current access level and may not necessarily be a three.

In order to change the access level the +/INC switch may be pressed to increment the digit above the cursor and the -/CRSR switch may be pressed to move the cursor. The desired access level should be entered in the right most digit. Note that only access levels between zero and three are legal. The remaining four digits are the access code. The access code will be 0000 when the instrument is shipped. The access code should then be entered. Once this is done press the RESET switch. The 580B will then return to the previous screen.

If the access code entered was not the proper access code, or if the access level was not a legal access level then the access level will not be changed.

The last and most important point regarding the access level is how to change the access code. The access code is the four rightmost digits of the instrument number. The instrument number is only viewable (and therefore only changeable) while in access level three.

2.5.2 USER IDENTIFICATION NUMBER

The screen will display:

I.D.# 014563977
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

I.D.# 014563977
"RESET" WHEN DONE

The user identification number may be changed by pressing the +/INC switch to increment the digit above the cursor and the -/CRSR switch to move the cursor. The user identification number is a nine digit number (just right for fitting a social security number). Once the user identification number has been entered press the RESET switch and the 580B will return to the previous screen.

2.5.3 INSTRUMENT NUMBER

The screen will display:

INSTR # 000000
"RESET" TO CHG

By pressing the RESET switch the 580B will display:

INSTR # 000000
"RESET" WHEN DONE

The instrument number may be changed by pressing the +/INC switch to increment the digit above the cursor and the -/CRSR switch to move the cursor. Once the instrument number has been entered the RESET switch should be pressed. The 580B will then display the previous screen.

When the instrument number is changed it is very important that the last four digits be remembered. These digits are the access code and therefore will need to be known in order to change the access level.

2.6 CLOCK MODE

The Clock mode is entered from the Main menu by pressing the SPKR switch. The screen will display the date and time on the top line. The bottom line will display:

"RESET" TO CHG

By pressing the RESET switch the 580B will display:

"RESET" WHEN DONE

The date and time may be changed by pressing the +/INC switch to increment the number (or in the case of the month the months abbreviation) above the cursor. The -/CRSR switch will move the cursor. Once the proper month has been entered the RESET switch should be pressed. The 580B will return to the previous screen.

The date and time will be maintained even when the instrument is turned off! It is however advisable that the date and time periodically be checked to ensure that it is correct.

2.7 COMMUNICATION MODE

The Communication mode is entered from the main menu by pressing the RESET switch. The Communications mode has four sections.

1. Communicate with printer or computer
2. Display logged data
3. Reset logged data
4. Set communication parameters

Pressing the -/CRSR switch will advance the 580B to the next section.

NOTE: A detailed discussion of communication protocol is given in Appendix A. Further discussion of communication may be found in Section Seven.

2.7.1 COMMUNICATE WITH PRINTER OR COMPUTER

The 580B is capable of communicating with a computer or outputting logged data to a printer. The 580B will display:

COMMUNICATE?

"+" = YES

if the computer format is selected or it will display:

OUTPUT TO PRINTER
"+" = YES

if the printer format is selected. In either case pressing the +/INC switch will cause the 580B to try to establish communication. Pressing the -/CRSR switch instead will cause the 580B to advance to the next section.

2.7.2 DISPLAY LOGGED DATA

If at least one data point has been logged the 580B will display:

DISP. LOG DATA?
"+" = YES

By pressing the +/INC switch the 580B will display the first data point. The date and time which the data point was logged will be displayed on the top line. The bottom line will alternate between the location code and the PPM. Pressing the +/INC switch will advance to the next logged data point. This will continue until there are no more data points at which time the 580B will display:

NO DATA STORED

The MODE/STORE switch may be pressed to return to the Run mode.

2.7.3 RESET LOGGED DATA

The logged data can be erased so that more data points may be logged. The screen will display:

RESET LOG DATA?
"+" = YES

Pressing the +/INC switch will erase all of the logged data points. The 580B will then advance to the next section.

2.7.4 COMMUNICATIONS PARAMETERS

The 580B can be configured to communicate with a printer or a computer. The baud rate may also be set for 9600, 4800, 2400, 1200, 900, 600, 300, or 150 baud. The 580B will display the current communication format (computer or printer) on the top line and the current baud rate on the bottom line. Pressing the RESET switch will cause the 580B to display:

COMPUTER FORMAT
+ = USE - = NO

Pressing the +/INC switch will select the computer format and the 580B will advance to the baud rate screen (see below). Pressing the -/CRSR switch will cause the 580B to display:

PRINTER FORMAT
+ = USE - = NO

Pressing the +/INC switch will select the printer format and the 580B will advance to the baud rate screen (see below). Pressing the -/CRSR switch will cause the 580B to display the previous screen.

The baud rate screen will display the currently selected baud rate on the top line. The bottom line will display:

+ = USE - = NO

Pressing the +/INC switch will cause the displayed baud rate to be selected and the 580B to show the selected format on the top line and the baud rate on the bottom line. Pressing the -/CRSR switch instead will cause the next lowest baud rate to be displayed.

2.8 BATTERY / CHARGER

The model 580B uses a 1.2 amp hour lead acid (gel cell) battery. There is protection circuitry potted directly on top of the battery. The battery is rechargeable with the charger provided with the instrument. The charger is regulated so that there is no danger of "over charging" the battery. It is suggested that the 580B be charged over the weekend (as well as each evening) during periods of heavy usage in order to ensure maximum battery charge.

SECTION III

ROUTINE MAINTENANCE

The routine maintenance of the 580B involves the calibration of the instrument, the cleaning of the lamp window, and the maintaining of charge on the battery. The following pages give instructions for routine maintenance. Figure 3.1 illustrates the detector assembly.

3.1 LAMP INSERTION AND REMOVAL

3.1.1 REMOVAL

NOTE: The 580B must be off while removing the lamp.

In order to remove the lamp the four screws which hold the case top and bottom together must first be loosened. The case bottom should be placed flat on the table and the top placed on its side next to the bottom.

The high voltage power supply is removed next by loosening the thumb screws on each side and then pulling the power supply towards the rear of the instrument (see figure 3.1). The lamp may now be removed by loosening the lamp nut.

3.1.2 INSERTION

Insertion of the lamp is accomplished by performing the above tasks in the reverse order. The lamp should be placed flat against the o-ring and the lamp nut fastened down in order to create a proper seal. The high voltage power supply should then be inserted and the thumb screws fastened down. There are three pins protruding from the high voltage power supply which should fit snugly into connectors located beneath the detector. The lamp spring (mounted in the center of the high voltage power supply) should make contact with the lamp ring.

3.1.3 LAMP CLEANING

On occasion the lamp should be removed for cleaning. Cleaning of the lamp is accomplished by cleaning the lamp surface of the UV lamp. The procedures for cleaning the different lamps are as follows:

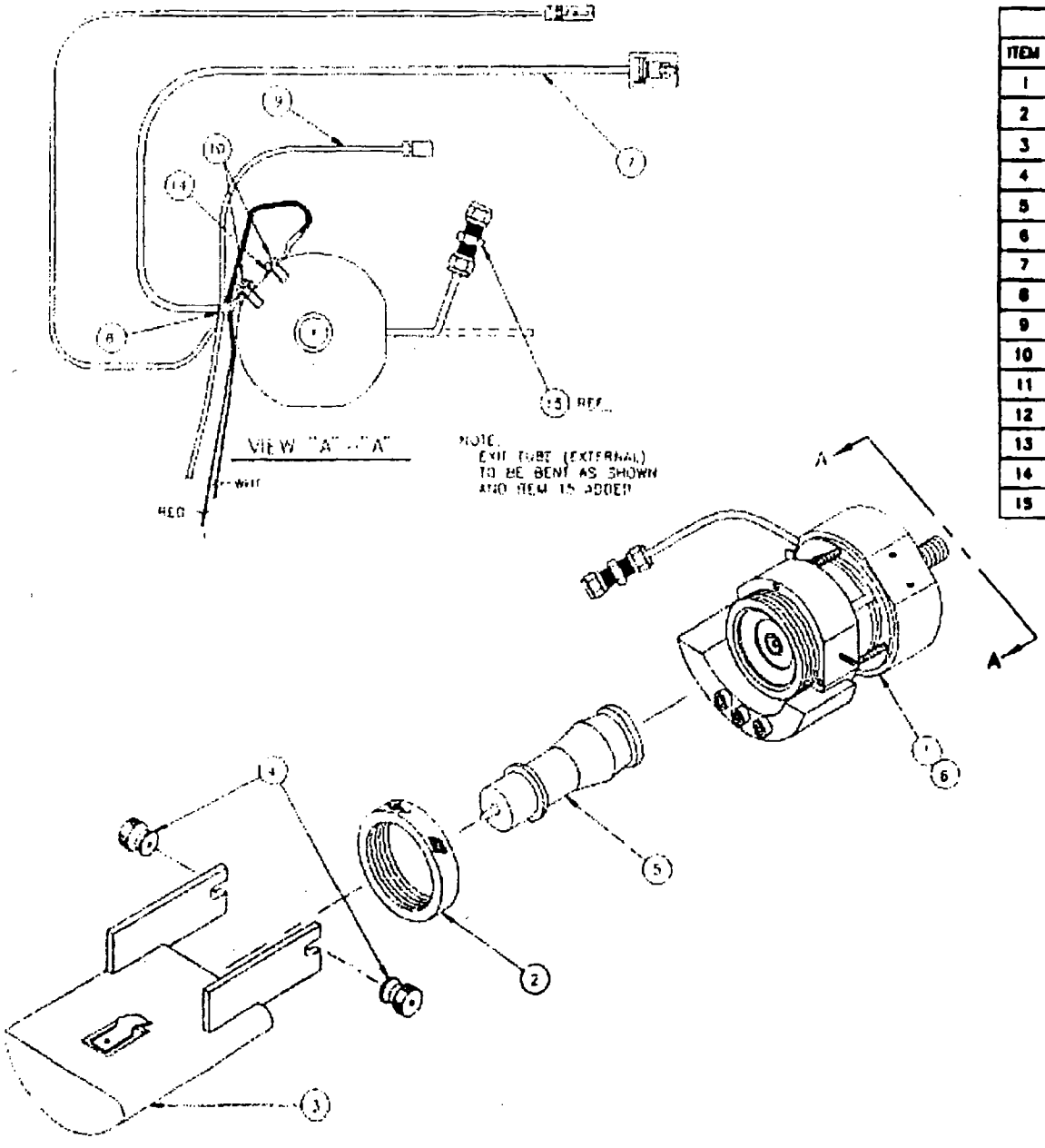
3.1.3.1 LAMP CLEANING METHOD FOR 10.6 eV OR LESS

This is accomplished by using the Aluminum Oxide scouring powder provided with the 580. First place a small amount of Aluminum Oxide scouring powder on the lens of the UV lamp. Next gently scour the lens surface with a soft tissue or cloth. Scour the lens in a rotary type motion.

After scouring the lens surface, gently blow the remaining powder from the lens. Follow this with an alcohol or acetone rinse, and then wipe dry with a soft tissue. The lamp is now able to be inserted into the detector.

3.1.3.2 LAMP CLEANING METHOD FOR 11.7 eV OR MORE

This is accomplished by gently polishing the surface of the window with anhydrous alcohol on a cotton swab, followed by an anhydrous methanol or ethanol rinse, and then wiping dry with a soft tissue. Do not allow the alcohol to remain on the surface as it will leave a film. Stubborn films may require multiple cleanings for complete removal. The lamp is now able to be inserted into the detector.



MATERIAL LIST			
ITEM	PART NO.	DESCRIPTION	QTY
1	5808-6003	DETECTOR SUB ASSY	1
2	5803-2010	NUT - LAMP (13507)	1
3	5803-6019	PWR SUPPLY ASSY. (13560)	1
4	12062	NUT -, KNURLED	2
5	11929	U.V. LAMP 10.0	1
6	5803-6035	DETECTOR WIRING ASSY. (13575)	1
7	5808-6001	BASE HARNESS ASSY.	1
8	4168	STRAIN RELIEF	1
9	5803-6028	SIGNAL CABLE (13568)	1
10	5814	#4-40 X 1/4" BINDER HD SCREW	2
11			
12			
13	5510	TEFLON TUBING 1/8 6.5" LG	1
14	5868	#4 INT. TOOTH STAR WASHER	1
15	4417	UNION-2U-316	1

Figure 3.1
Detector Assembly

5808-6004

3.2 CALIBRATION

NOTE: Chapter four should be read before calibrating the 580B in order to gain a better understanding of the concepts behind calibration of the 580B.

The following is a brief discussion of calibration as it relates to different lamps. One of the parameters in the Parameters mode (see Section 2.4) allows selection of lamp setting. The two types of lamps are the 10.0 eV and the 11.8 eV lamp. Whenever a new lamp is used the 580B must be calibrated. This is true even if the new lamp is the same type, e.g., the new and old lamp are both 10.0 eV. This is due to the fact that each lamp will have a slightly different sensitivity.

It is important to note that the 11.8 eV lamp will in general be less sensitive than the 10.0 eV lamp. This is true despite the higher energy level of the 11.8 eV lamp. The 11.8 eV lamp will however "see" certain gases which the 10.0 eV lamp will not. See Table E.1 for a list of common organic vapors and their associated ionization potentials. Any questions regarding the use of the 580B should be directed to Environmental Instruments Company Application Laboratory.

The 580B is quite simple to calibrate. A source of "zero air" and "span gas" are all that is needed to calibrate the 580B.

The zero air is introduced to the 580B in order to determine the "background" signal. The concentration of the span gas is then selected. The span gas is finally introduced to the 580B. The instrument makes all of the necessary calculations (including linearization) to arrive at a "calibration constant." When in the Run mode the signal is multiplied by the calibration constant in order to arrive at the current PPM.

$$\text{CALIBRATION CONSTANT} = \frac{\text{SPAN PPM}}{\text{SPAN SIGNAL} - \text{ZERO SIGNAL}}$$

$$\text{PPM} = (\text{SPAN SIGNAL} \quad \text{ZERO SIGNAL})\ \text{CALIBRATION CONSTANT}$$

NOTE: The PPM is then multiplied by the RESPONSE FACTOR before being displayed. Chapter four explains the use of response factors when calibrating.

Section 2.4.8 gives a detailed explanation of which buttons to press in order to calibrate the 580B. The flow chart at the back of this manual may also be helpful.

CHARGE

When there is a flashing "B" in the lower left corner of the display (while in the run mode) the battery is low. The battery is recharged by plugging the charger into the RUN/CHARGE plug at the rear of the 580B. The instrument runs while it is charging.

SECTION IV

CALIBRATION

GENERAL

The Model 580B Organic Vapor Meter is indeed a quantitative instrument and can certainly be used as such. It makes use of the Photoionization Detection System using a lamp with an ionization energy of 10.0 eV which is standard in the Model 580B. Almost all organic materials will be ionized at this energy level. There are some organic materials, such as a few of the freons, methane, ethane and propane that are not ionized and thus will not be detected. The ionization potentials for the various organic materials will simply tell whether the material will be detected by the Photoionization Detector. It does not give any clue as to the sensitivity of the detector for that particular material. Certainly, different organic vapors will have different sensitivities. It is important to understand that the Model 580B does indeed sense most organic vapors and that its response to these different organic vapors will be different.

In this section of the manual, the aspects of calibrating the Model 580B for various vapors will be discussed. In the following section discussing applications, various ways of using the features of the Model 580B will be explained along with the various methods for calibration of the 580B. There will also be applications of the Model 580B in specific instances where the organic vapors or the mixtures of organic vapors are completely unknown. The 580B can be an extremely useful tool, even in areas such as those.

FACTORY CALIBRATION TEST OF THE MODEL 580B

The Model 580B has been tested for calibration and linearity tested at the factory. The particular gas chosen for this calibration is isobutylene. The Model 580B has good response for isobutylene. Isobutylene standards prepared in air are relatively stable with time, undergoing no serious adsorption or reaction problems. The test information is included in the instrument packet. In addition to the above test a benzene standard is also run. It is important to note that the instrument was not calibrated. It was tested for calibration. Therefore, it should be calibrated by the operator before use.

4.3 METHODS OF GENERATING CONCENTRATIONS OF VARIOUS MATERIALS IN AIR

This section is not intended to be all inclusive as far as the preparation of gas and vapor standards in air are concerned. Only those methods that have been found most practical for the calibration of the 580B are discussed here. There are basically two types of standards, cylinder and bag.

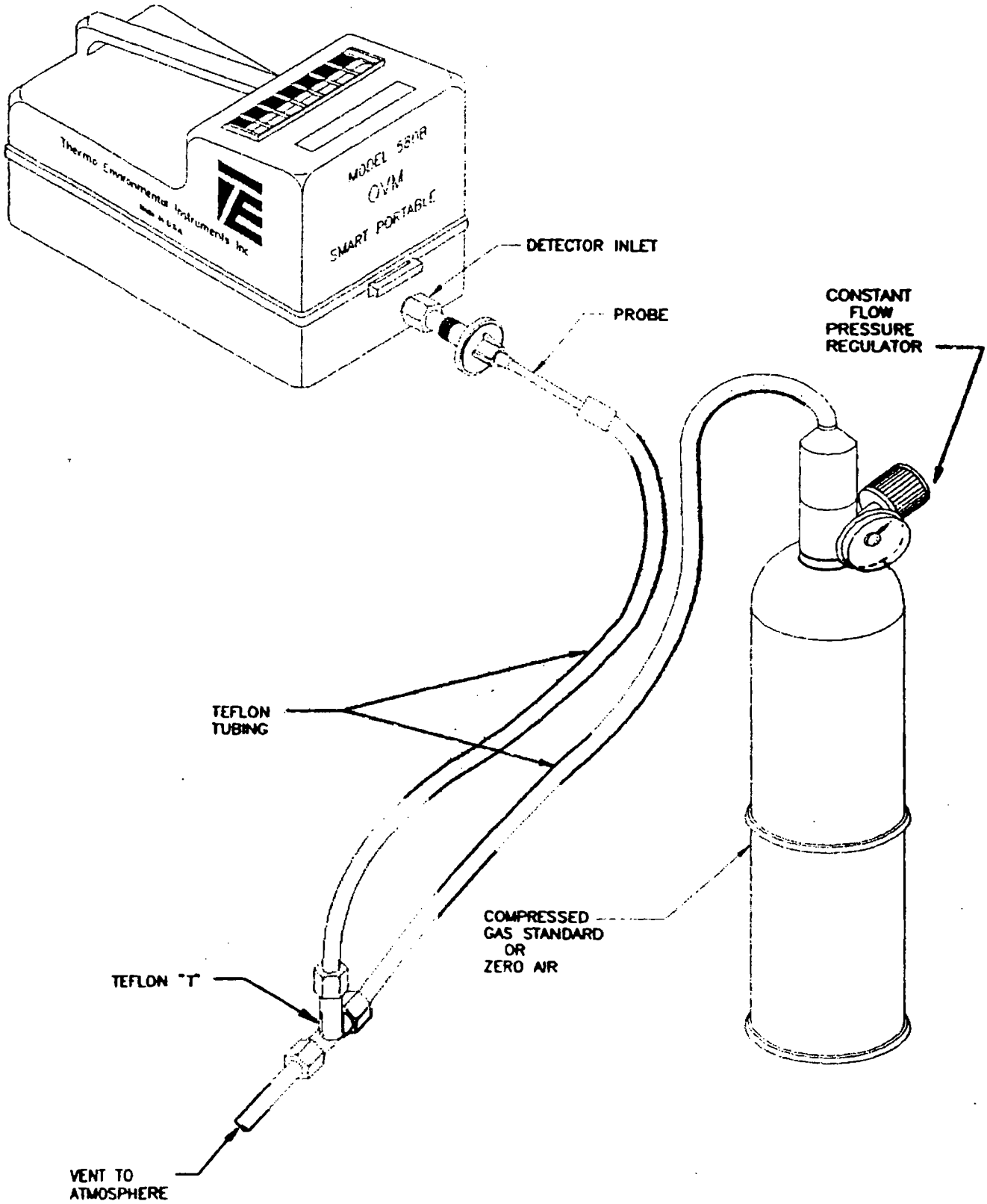


Figure 4.1
Cylinder Calibration

4.3.1 CYLINDER STANDARDS

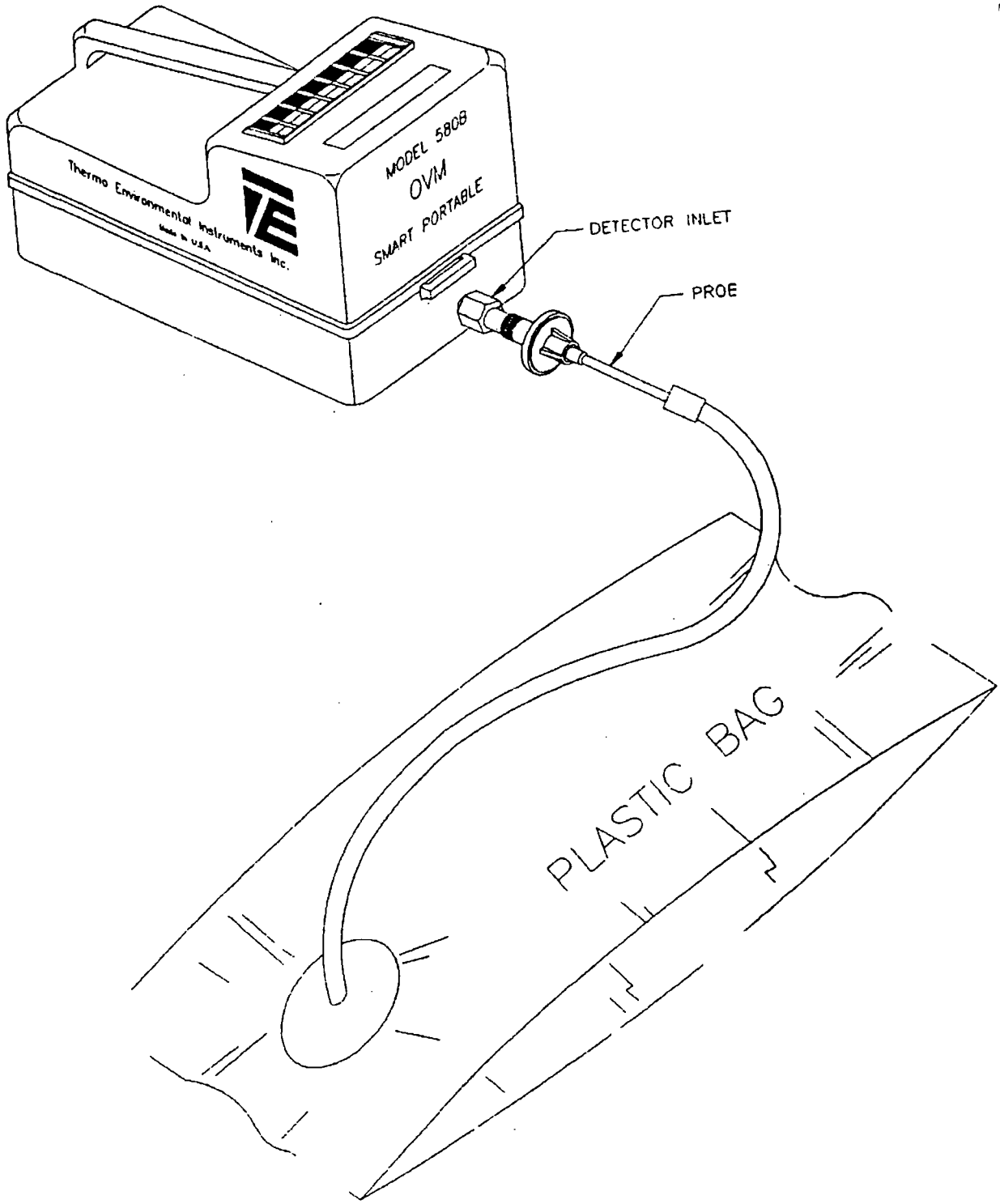
Certainly commercially available standard cylinders of gaseous materials in air offer the most convenient method of calibration. However, these are static standards. Standards prepared in this fashion in air for vapors of various organic liquids often show concentration reduction with time due to adsorption problems. In general, gases when mixed with air will maintain their concentrations with time since adsorption is generally not a problem.

However, some gases are sufficiently reactive that chemical reaction of the gas will cause a reduction of it in air. These precautions must be observed when using commercially prepared standards for calibration of the Model 580B. It is for this reason that isobutylene in air was chosen as a reference standard for factory calibration. TEI offers a cylinder standard which includes both zero and isobutylene standards. A constant flow pressure regulator sets the flow needed for calibration of the 580B. Figure 4.1 illustrates the physical calibration procedure. The inlet to the 580B is connected to the "T" as shown. It is important that this connection is tangent to the gas flow. The "T" is connected to the regulator on the standard cylinder. It is important that a length of tubing is attached to the "T" location. This prevents diffusion of ambient air into sample line. The regulator and tubing assembly will have to be moved between both the zero air and standard cylinder.

4.3.2 BAG STANDARDS (ISOBUTYLENE)

Bag standards can be prepared in a laboratory and in general are reasonable ways of calibrating the Model 580B. However, it is important that these standards be used shortly after their preparation to reduce the significance of any adsorption problems. Static standards prepared for calibration of the Model 580B are best prepared in collapsible plastic bags. This is opposed to a fixed volume container. The sampling rate of the 580B, which is 500 ml/min, requires an appreciable amount of sample. Even one minute's sampling out of a fixed container will remove 500 ml/min from it. This should not significantly reduce the pressure inside the container. Thus, the collapsible bag provides the best means as opposed to a fixed volume. A 5 gallon polyethylene bag is a convenient size to use for the preparation of static standard.

A tube is inserted into the opened end of the bag and the bag opening then sealed around the tube. The tube should have a cutoff valve or some means of closing the volume of the bag. The volume of air introduced into the bag must be measured. This is most conveniently measured by a wet test meter. However, a source of air flowing through a flow meter can be used if the flow can be held constant, then time is a measure of the volume of the air placed into the bag. All air is expelled from the bag by completely collapsing it prior to connection to the source of air.


MODEL 580B
OVM
SMART PORTABLE
Thermo Environmental Instruments Inc.
Made in U.S.A.
DETECTOR INLET
PROE
PLASTIC BAG

Fi;
ag

It can then be connected to a wet test meter or flow meter via a short length of rubber tubing hooked to the plastic tube of the bag. The air flow is started into the bag at a rate of approximately 5L/min. A total of 10 liters is a convenient volume for a 5 gallon bag. This would mean approximately 2 minutes for filling the bag. Figure 4.2 illustrates the physical configuration needed to develop bag standards.

For gaseous samples, the trace organic will be added via a glass hypodermic syringe. The 1 cc Tuberculin syringe is a convenient size. For an isobutylene standard, the 1 cc syringe is flushed with pure isobutylene and then filled to the 1cc mark. While the air is flowing into the plastic bag, the short piece of rubber tubing is pierced by the needle from the 1 cc syringe and the plunger slowly depressed such that the 1 cc of isobutylene is added to the air flowing into the plastic bag. When 10 liters of air have been added to the plastic bag, the flow is immediately stopped and the valve on the tube or the closing clamp is applied to contain the air and isobutylene within the plastic bag. It is best at this stage of the procedure not to rely solely on the diffusion of isobutylene to form a uniform mixture inside the plastic bag. Slight kneading of the plastic bag will hasten the mixing of the isobutylene in air. The plastic tube from the bag is then connected to the probe on the Model 580B via a short length of rubber tubing and the valve on the plastic tube immediately opened. The Model 580B withdraws a sample from the bag at the sampling rate of 500 ml/min. Thus, 10 liters of sample in the bag will provide approximately 20 minutes. Certainly the calibration of the 580B can be accomplished in a shorter period of time. The concentration of isobutylene in ppm by volume will be equal to the sample size, which was 1 cc, divided by the volume of the bag in liters, which would be 10 liters, times 1000. In this particular instance, the concentration would be:

$$\text{Conc (ppm by Vol)} = \frac{\text{1cc Isobutylene} \times 1000}{\text{10 L Air}} = 100 \text{ ppm}$$

4.3.3 BAG STANDARDS (ORGANICS)

On occasion there is the need to prepare standards other than the normal calibration standard. As mentioned previously, isobutylene was chosen as a standard because of its stability. If other standards are to be used, it is best to develop a relation of the other standard to a standard of known stability like isobutylene. If this procedure is followed, a response factor can be developed by comparing the other organic standard to isobutylene this technique will be discussed in a later section. The following is a suggested technique for preparing other standards.

For organic materials, which are normally liquids at room temperature, the procedure is essentially the same except that an extremely small liquid sample is injected into the flowing air stream rather than the gas sample. This technique works well

only for relatively volatile organic materials. The flowing air stream must vaporize all of the material or the calculation will be off. If the material is not rapidly volatile in that flowing air stream, the liquid should be injected through the surface of the plastic bag. Immediately after withdrawing the needle, the hole in the plastic bag should be covered with a piece of plastic tape.

Again, significant kneading of the bag will hasten the evaporation of the sample and mixing of the vapor into the air to provide homogeneous samples. The introduction of this sample into the 580B is the same as before. The calculation of the concentration of the vapor in air is a two-step procedure whereby the small volume of liquid injected into the air stream and into the plastic bag is converted to a volume of vapor. This volume of vapor is then used in the same manner as the volume of gas in the case of isobutylene. The following equations apply:

$$\text{Volume Vapor (uL)} = \frac{\text{Liquid Volume (ul)} \times \text{Liquid Density} \times 24.45}{\text{Molecular Weight}}$$

The above equation gives the vapor volume at atmospheric pressure (760 torr) and 25° C (77F).

Then:

$$\text{Concentration (ppm by Volume)} = \frac{\text{Vapor Volume (ul} \times 1000}{\text{Air Volume (liters)}}$$

The following is a sample calculation for benzene:

Liquid Volume = 2 ul

Benzene Density = 0.879 g/cc

Molecular Weight Benzene = 78.1

Air Volume = 10 Liters

$$\text{Vapor Volume} = \frac{2 \times 0.879 \times 24.45 = 0.55 \text{ ul}}{78.1} \quad \text{Benzene Vapor}$$

$$\text{Conc} = \frac{0.55 \times 1000}{10} = 55 \text{ ppm (vol}$$

The syringe used for the measurement of liquids in this particular instance is a small volume-type such as those manufactured by the Hamilton Company. A convenient size syringe is the 10 microliter volume.

4.4 580B CALIBRATION

The following procedure is applicable for both Cylinder and Bag Standards. The sequence requires both Zero gas and Span gas to be used. Span gas can be either contained as a cylinder or bag, in either case the exact concentration used must be known. This concentration will be entered to the 580 when the program provides its entry. With respect to Zero gas, there are several choices. Obviously a certified zero air standard in a cylinder presents no problem. Another choice would be to build a zero air standard in a bag. This can be simply accomplished with the set-up in Figures 4.1 and 4.2 using a charcoal scrubber to remove all the hydrocarbons present in the air. Charcoal does not absorb Methane; this does not cause a problem because the PID does not respond to it. Another approach which could be used in an emergency is to use room air unscrubbed.

This is acceptable if you know that there are no hydrocarbons present or they are exceptionally low in concentration. However, it is not recommended as a standard practice. The physical set up for cylinder calibration is illustrated in Figure 4.1; bag calibration in Figure 4.2.

4.4.1 CALIBRATION ROUTINE

(A) Set-up calibration assembly with zero air cylinder or bag as described in Figures 4.1 and 4.2.
(B) Model 580B set-up and zero calibration.

1. Power-up instrument using power plug.
2. Depress ON/OFF Key to ignite lamp and initiate sample pump.
3. Depress MODE/STORE Key.
4. Depress-/CRSR Key in response to LOG THIS VALUE? Prompt.
5. Depress-/CRSR Key to select Parameters Mode from the Main Menu.
6. Depress +/INC Key to advance thru the Run Mode selection parameter prompt.
7. Depress +/INC Key to advance thru the Auto Logging Mode selection parameter prompt.
8. Depress +/INC Key to advance thru the Average Time selection parameter prompt.
9. Depress +/INC Key to advance thru the Alarm Setting parameter prompt.
10. Depress +/INC Key to advance thru Lamp Selection parameter prompt.
11. Depress +/INC Key to advance thru Response Factor Setting parameter prompt.
12. Depress RESET Key to initiate calibration sequence.
13. Depress-/CRSR Key to decline restoration of the backup calibration.
14. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet as illustrated in Figure 4.2.
15. Introduce Zero Air to Model 580B by opening flow regulator.

16. Depress RESET Key to "Zero" Model 580B.
17. Close Flow Regulator.

C) Span Calibration - assuming that the Span gas has a concentration of 250 ppm isobutylene the following procedure is followed:

18. Simultaneously Depress RESET and -/CRSR Keys to activate the movable cursor.
19. Repeat Step 18 until the cursor is at the ones place.
20. Simultaneously Depress RESET and +/INC Keys to increment the ones place value.
21. Repeat Step 20 until the ones place value reads 0.
22. Repeat Step 18 to move cursor to the tens place.
23. Repeat Step 20 until the tens place value reads 5.
24. Repeat Step 18 to move the cursor to the hundreds place.
25. Repeat Step 20 until the hundreds place value reads 2.
26. Repeat Step 18 to move the cursor to the thousands place.
27. Repeat Step 20 until the thousands place value reads 0.
28. The LCD should now read:

SPAN PPM = 0250
"+" TO CONTINUE

29. Depress +/INC to accept the span conc. value.
30. Connect isobutylene cylinder (250 ppm) to calibration tubing assembly.
31. Connect outlet of calibration tubing assembly to the Model 580B Detector Inlet.
32. Introduce isobutylene standard to Model 580B by opening flow regulator.
33. Reset key to "CALIBRATE" Model 580B.
34. Close Flow Regulator.
35. Depress +/INC. Key in response to "RESET" TO CALIBRATE message.
36. Depress MODE/STORE to return to the Run Mode.

The instrument has been calibrated and is ready to make measurements.

4.5 DETERMINATION OF RESPONSE FACTORS

As mentioned above, the Model 580 can be calibrated with isobutylene but be set to read correctly, the concentration of another substance. This is done by using the Response Factor that is set in the parameter routine. The default for the response factor is 1.0. The Response Factor is the number that is multiplied by the measured concentration to obtain the correct concentration of the measured component. If the chemical to be measured is less sensitive on a PID than the standard, (usually isobutylene) then the Response Factor is greater than 1.0. If it is more sensitive than the standard then the Response Factor is less than 1.0.

The reason for a Response Factor is practicality. If it is

know that the sample to be measured contains only benzene and therefore the user would like to read benzene concentration directly, there are two approaches. The user could make a bag standard daily of benzene vapor in air and calibrate the 580 directly. Or the Response Factor could be used. In the latter case a bag with benzene is made only once for comparison to a cylinder of a stable standard (such as isobutylene). Then daily, the Model 580 is calibrated with the cylinder standard, a simple operation compared to the work of preparing a bag standard.

As an example, if the bag containing 55 ppm benzene in air as prepared above were measured in a 580 calibrated against isobutylene, the concentration might have been read as 91 ppm. thus the 580 is more sensitive for benzene than for isobutylene.

The Response Factor can now be calculated as:

$$\text{Response Factor (RF)} = \frac{\text{Factor STD Concentration}}{\text{580 Reading of Factor STD}}$$

$$RF = 55/91 = 0.604$$

When 0.60 is entered into the 580 as the Response Factor, the 580 will read 55 ppm for the bag.

Now the 580 need only be calibrated using an isobutylene standard and a Response Factor of 0.60 to correctly respond to benzene.

SECTION V

APPLICATIONS

5.1 GENERAL

This section discusses six applications which were done on the old model 580. These applications are discussed as they relate to the model 580B. The following applications of the Model 580B are given to show some different uses and means of calibration of the Model 580B in various practical applications. It is certainly not intended to be an exhaustive list of the uses of the Model 580B. In each situation, the stress is placed on the means of calibration and the interpretation of the readout of the Model 580B. Since the Photoionization Detector responds to virtually all organic materials and since its response varies for the different organic materials, questions can certainly arise as to just how the numbers presented on the digital display relate to anything meaningful. These applications will hopefully illustrate several ways in which these numbers can be quantitative and also illustrate uses of the 580B where accurate quantitation may be impossible.

5.2 VINYL CHLORIDE MONOMER IN REACTION VESSELS.

This particular application involved measuring the vinyl chloride content in vinyl chloride polymerization vessels following the polymerization reaction and the removal of the polymer slurry. Any residual vinyl chloride left in the reaction vessel has to be flushed and scrubbed prior to the opening of the vessel. The vinyl chloride content must be below a certain prescribed level prior to this opening. The reaction vessel is flushed with nitrogen to remove the vinyl chloride from the vessel and purge it through the filter media which remove the vinyl chloride from the nitrogen stream for recovery. During this particular operation, it is known that vinyl chloride monomer comprises significantly more than 90% of the entire organic material. In this instance, if the Model 580B is calibrated for vinyl chloride measurement, indeed the readout will be virtually the true vinyl chloride concentration inside the reactor vessel. The nitrogen exit stream prior to the vinyl chloride recovery was the point used for the analysis.

Since the plant was a considerable distance from the laboratory and since the study would require a significant period of time encompassing several weeks, it was decided to calibrate the Model 580B with the isobutylene reference standard and determine a response factor setting for a vinyl chloride standard in the laboratory.

With the response factor set at 1.0, the instrument was calibrated with isobutylene. The Model 580B was then presented with a known concentration of vinyl chloride monomer in nitrogen. The response factor for the vinyl chloride was then set in order for the Model 580B to read the correct concentration of vinyl chloride in the nitrogen. Static

standards of vinyl chloride are very definitely not stable with time due to the reaction of the vinyl chloride with itself. Thus, standards need to be prepared fresh each time vinyl chloride is to be used to calibrate an instrument. Since bag preparation, which was the technique used for this laboratory calibration of the 580B, would have been inprac tical at the plant; the use of a stable reference standard of isobutylene was chosen. Thus, at the plant site, the Model 580B could be calibrated using the isobutylene standard from a cylinder. This of course, greatly simplified the plant use of the Model 580B. This relationship to a reference standard reduces the time and equipment required at the plant such that the survey of all of the reactor vessels was completed in a short period of time with the items established for the nitrogen flush of the reactor vessels prior to opening the reactor vessels.

It is important to note that when the response factor setting was determined in the laboratory, nitrogen was used as the matrix for the bag preparation of the vinyl chloride standard. If air were used a different setting (higher) would be obtained. Since the sample was in a nitrogen matrix so should be the standard. Note also it is not necessary to have the isobutylene standard in nitrogen. In addition to correcting for differences in response between isobutylene and vinyl chloride, the response factor setting can also adjust for the different readings in nitrogen and air.

5.3 MONITORING ISOLATED PLANT AREAS FOR TOLUENE AND METHYL ISOBUTYL KETONE.

Two areas of an extensive plant operation were required to be monitored for the levels of methyl isobutyl ketone and toluene. Both of these areas were relatively isolated. In one area, methyl isobutyl ketone was the only solvent to which the atmosphere was exposed other than the potential leaks that might occur in process equipment in that same area. There were no other known solvents in use in that area and the ventilating system in effect isolated this area from other areas in the plant. In the second area, toluene had just very recently been substituted as a solvent in place of benzene due to the lower TLV for benzene. Average workplace levels were therefore needed for the toluene concentration in this work area. Again, toluene was the only solvent in this area and there was no other process equipment in the immediate area for even possible leak problems.

Notice that in both of these areas in the plant, it is certainly known from the processes occurring in that area and its relative isolation from the other areas in the plant, exactly which organic vapors will be by far the predominant vapors in the workplace air. In many instances, by simply knowing the processes involved and the chemicals in use in those processes, the qualitative aspects of the environment can indeed be established without the use of instrumentation. This is one of the most overlooked aspects in establishing what organic vapors are present in the environment. It simply involves determining what are the possible organic vapors that can be present. In general, this narrows it to several and in many cases, a single organic

vapor.

In these cases, the Model 580B can be calibrated specifically for these materials and will provide quantitative data on the levels of these materials in the workplace environment. In this particular instance, even though the laboratory to be used for the calibration of the Model 580B was at the plant site, it was desired to use a single 580B to monitor both work areas sequentially and several times throughout the course of a single day. This was to be done over a period of time to establish the variations of both methyl isobutyl ketone and the toluene in these work areas. In this particular instance, changing the response factor setting can avoid considerable calibration changes, as one moves from determining concentrations of methyl isobutyl ketone to the area where one is measuring the concentrations of the toluene vapor.

For calibration, the Model 580B response factor was set at 1.0 and the instrument spanned properly using a known reference standard of isobutylene. The Model 580B was then presented with a flowing air stream containing toluene vapor as generated in the Thermo Electron Model 360 using a toluene diffusion tube. The response factor was then adjusted so that the readout of the Model 580B corresponded to the toluene concentration in this standard.

The Model 580B was then presented with a flowing air stream containing methyl isobutyl ketone. This also was generated via a diffusion tube in the Model 360 Standards Generator. Once again, the response factor was adjusted so that the digital display gave the correct reading for the concentration for the methyl isobutyl ketone presented to the instrument.

With the instrument then calibrated with the reference isobutylene standard and knowing the proper settings of the response factors for methyl isobutyl ketone and toluene, the Model 580B was then ready for its plant survey. The area containing the toluene was monitored for a period of time with the toluene levels as noted by the 580B being recorded.

The response factor was set for this toluene reading. The instrument was then moved directly to the methyl isobutyl ketone area and the response factor adjusted to read methyl isobutyl ketone. The 580B was then able to read directly the methyl isobutyl ketone concentration in the second area. There was the possibility of leaks in process equipment in this particular area. The area in general was surveyed. If significant changes in the reading of the 580B were observed, the 580B was used as a leak sourcing instrument as described in a later section. In this fashion, it could be determined if some of the varying concentrations in this area were indeed coming from a leak in the process equipment. During the survey of this particular area, no leaks from process equipment were observed, therefore, the readings obtained on the 580B could indeed be considered the methyl isobutyl ketone concentration in this particular area.

Throughout the survey of these two workplaces, the 580B could move back and forth rapidly due to its portability and could be, in effect, recalibrated for each of the two different vapors by the mere setting of the response factor.

5.4 PETROLEUM ETHER VAPORS IN WORKSPACE AIR.

A given workplace was using petroleum ether as a paint solvent and for cleaning purposes. It was desired to quantitate the amount of petroleum ether in the air being recirculated in this particular area. Petroleum ether is a distillation fraction from crude oil. Its boiling point is slightly lower than the boiling point of gasoline. This means that petroleum ether is not a single chemical entity, but a multitude of hydrocarbons in a certain boiling range fraction. Reasonable quantitative data can be obtained here without knowing the exact chemical composition of each hydrocarbon that composes petroleum ether . For this purpose, the Model 580B can be used to measure these vapors. The 580B is initially calibrated with the response factor set at 1.0 using a reference standard of isobutylene.

The 580B is calibrated on isobutylene. Then a bag sample is prepared, as detailed above, for the quantitation of the instrument to measure the petroleum ether. In this particular instance, the petroleum ether is injected into the bag in the same fashion that liquid samples are injected. The calculation, however, has to change slightly because the ppm on a volume basis cannot be calculated without knowing the exact chemical composition of the petroleum ether. However, in a situation such as this, one can still quantitate it on a weight basis of the solvent in air. The equations below show this calculation.

Weight Vapor (mg)=Liquid Volume (uL) x Density g/ml

$$\text{Conc (mg/m3)} = \frac{\text{Weight Vapor (mg x 1000}}{\text{Air Volume liters)}}$$

For Petroleum Ether In This Example:

Liquid Volume = 3 uL

Petroleum Ether Density = 0.66

Air Volume = 10 liters

Vapor Weight = 3 uL x 0.66 g/mL = 1.98 mg

$$\text{Conc} = \frac{1.98 \times 1000}{10} = 198 \text{ mg/m3}$$

This sample in the bag is then presented to the Model 580B and the response factor adjusted so that the digital readout on the front panel provides the proper reading in mg/m3. The setting of the response factor that is needed for this reading is noted. The Model 580B can now be used to monitor reasonably quantitatively the petroleum ether in the workplace environment. Any further calibration of the instrument can be done using the reference standard of isobutylene. This is a reasonably accurate

way of giving quantitative information on the amount of solvent in air even though the results are not reported in ppm on a volume basis.

This technique can be used in general when the solvents are a mixture of materials which in general will probably be petroleum distillation fractions. It would certainly also be used in the case of gasoline vapors in air. Notice from the equations used versus the equations for determining the ppm concentration in bag samples for pure liquids, the only real thing missing is the molecular weight of the material. It may be possible to assume an average molecular weight of the solvent mixture and actually report a ppm by volume basis.

5.5 LEAK SOURCING

In this particular instance, the Model 580B is to be used for determining the presence, or absence of leaks in a chemical process plant. The Model 580B is uniquely adapted to this particular operation due to its light weight. In this particular instance, it is not necessary to accurately attempt to quantitate the readings from the Model 580B. It will be used simply to determine presence of leaks and to locate these leaks.

The Model 580B is simply calibrated against a reference standard of isobutylene as normal. No further calibration is used. It is not necessary to know the particular chemicals flowing in the different pipes or what they are in the various reaction chambers. It is only necessary to know that these materials will have some response on the Photoionization Detector. That is, that their ionization potentials are below the energy of the lamp. The standard probe of the Model 580B, with the 580B fully operational, is then simply moved along the various pipes and reactor vessels in the chemical process.

All seals are traced clear around the seal with the end of the probe. As one approaches a leak, the concentration of the organic materials in the air being sampled by the Model 580B will increase significantly. The point of maximum reading will indicate the point of the leaks. As one moves further away from the leak, the concentration of the organics in air will certainly decrease. In this very rapid fashion, the presence of leaks can be detected and their source fairly accurately pinpointed so that the leak can be repaired.

In many instances, it is not necessarily the workplace hazards of these leaks that is important, but the economics of the chemical process itself. In this instance, as in many instances, the exact composition of the organic materials being measured is really unimportant to the successful use of the 580B in a specific application. Also the exact numbers that are displayed on the digital readout of the 580B are unimportant. It is only relative magnitudes that are important in this instance.

5.6 AFTERBURNER EFFICIENCY

In a particular coating process, the material, after it has been coated, is passed into a dryer where the solvents of the coating are removed. These solvents are then vented into a

stack. To reduce the hydrocarbon emission from this plant, an afterburner had been installed to combust the organic solvents from the coating prior to release to the atmosphere. It is important to determine the efficiency of this afterburner and to follow the efficiency of the afterburner to avoid dumping excess solvent into the atmosphere and, thus, become subject to pollution fines.

The Model 580B is ideally suited to this type of operation. Again, it will be unnecessary to know the exact chemical composition of the coating solvent. The Model 580B is simply standardized against the reference standard isobutylene in the usual fashion.

The Model 580B is then connected to sample the stack gas in the dryer prior to the afterburner, noting the steady state number displayed on the digital panel meter. The 580B is then connected to the exhaust gases from the stack following the afterburner.

Again, the steady state number, as displayed on the Model 580B, is noted.

The reading prior to the burner minus the reading after the burner divided by the reading prior to the burner times 100 gives efficiency of the afterburner in the stack. This number is quite accurate, even though the Model 580B was not calibrated specifically for the solvents or solvent mixture used in this particular coating operation. The individual readings before and after the afterburner may not have the exact quantitative relationship to the actual amount of material, but their ratio will be accurate since basically the same chemical or mixture of chemicals is being measured before and after the afterburner.

5.7 SAMPLE COLLECTION OF UNKNOWN ENVIRONMENTS

The Model 580B can also be used in areas where organics are known to be present, but perhaps the exact composition of the environment is not known. This may be due to several solvents being in the same general workplace or various separate processes occurring in that same workplace, all of which could and possibly are admitting organic vapors. In plant areas such as these, the Model 580B can still be extremely useful.

The 580B is calibrated against a reference standard of isobutylene, as mentioned above. The 580B is then used as a survey tool throughout the entire plant area. The readings are logged, especially changes in these readings. The exact numbers displayed will not, in general, be a quantitative measure of the ppm of the organic vapor since it is impossible to know what organic chemical or mixture of chemicals should be used for the calibration. When high readings are obtained on the Model 580B, an evacuated sample bag can be connected to the rear of the 580B at the sample exhaust port. This bag could be virtually identical to the type of bag used for standards preparation. The Model 580B is sampling the atmosphere at the rate of 500 ml/min. The detection system of Photoionization is a nondestructive system such that the sample that is exiting the Model 580B is indeed the same material that is giving the readings on the 580B. When the 580B is seeing high readings, this is the time the bag is con-

nected to the rear for sample collection. The bag, if the same type is used for sample preparation, can hold approximately 10 liters of air sample; which would permit a sampling time of 20 minutes.

This bag sample can then be closed on removal from the 580B and transported to a laboratory for subsequent analysis to identify the individual chemical compounds present in the sample causing the high readings and to ascertain if the workplace environment is harmful at those high readings.

The use of the Model 580B coupled with the bag collection ensures that the sample that is returned to the laboratory for analysis is a sample containing the desired organic vapors. This is assured because the bag collection is used only when the Model 580B is detecting high levels of organic vapor in the environment. This is an instance of the use of the Model 580B when the type of organic vapors are not known and it is desired to know them. The 580B has a very useful function even in these areas. It should be noted that a charcoal tube could be connected to the rear of the 580B as well as an evacuated plastic bag. The charcoal tube will pass the bulk of the sample, which is air, and adsorb the organic vapors. This charcoal tube can be returned to the lab for subsequent analysis for both a qualitative identification of the materials present as well as a quantitative measure of their levels.

SECTION VI

COLLECTION TECHNIQUES

6.1 GENERAL

As mentioned in the Application Section, it is possible to use the 580B in completely unknown areas as far as the organic vapors present are concerned and still obtain meaningful data. One of the techniques described here is the use of the 580B as a means of collecting the representative samples for further identification in the laboratory regarding the specific organics that may be present in addition to their concentrations.

Two techniques were mentioned in the section under the heading "Sample Collection of Unknown Environments". One of these techniques involves the use of a bag for collection and the other involves the use of charcoal tubes as a means of trapping organic vapors. In this section, each of these techniques will be explored in further depth as to the proper way of using the 580B to collect the samples for subsequent analysis. These collection techniques are quite useful when one is using the Model 580B simply as a survey instrument. When readings on the 580B become quite high in certain areas, it is impossible to determine the exact source of the high readings to perhaps pinpoint the specific organic chemical giving rise to the reading. One may very well want to identify what the chemical or chemical mixture is that is providing the high reading. This will have to be done with instrumentation significantly more sophisticated than the Model 580B; namely, an instrument that can provide specificity as well as qualitative identification. A Gas Chromatograph is such an instrument.

If it is desired to collect some of the air to send to a laboratory for further analysis, one needs to be sure that the proper samples are taken at the proper time. This means simply that one needs to be assured that the sample sent to the laboratory is indeed a sample that has a high concentration of organic vapor present in the sample. The 580B is used to indicate the presence of the high level organic vapors. The sample then is gathered at the exit port of the 580B when the 580B is reading high values. This assures that the sample sent to the laboratory does indeed have the high level vapors present in it. This generally simplifies the sampling technique of the environment and reduces the number of samples and, therefore, the expense needed to accurately identify the organics present and to quantitate them in a laboratory.

Two design features of the Model 580B make this type of operation possible. The first is that the detection system used in the Model 580B is the Photoionization Detector which is basically a nondestructive detector. Thus, the instrument is able to sense the organic vapor using the detector and virtually the same concentration of the same materials exits the detector as entered it. This does make it possible for the collection of the exact sample contributing to the high readings.

The second feature of the 580B that allows this sample collection is that a positive displacement pumping system is used to draw the sample into the Model 580B. It is a very simple procedure then connect to the exit of this positive displacement pump and trap the sample exiting the 580B after it has passed through the detector.

6.2 BAG SAMPLE COLLECTION.

One of the most convenient ways to sample the environmental air is to simply trap the entire air sample in a collection bag. As discussed before, the bags used for the calibration of the Model 580B, as discussed under the Calibration Section, can certainly be used for collection of the air samples. There are several precautions that must be mentioned immediately relative to the use of bag sample collection. When a bag has been filled with air that has organic vapor in the air sample, the organic vapor molecules will absorb onto the inside surface of the bag. This adsorption will begin immediately on introduction of the air into the bag. It will continue to progress with time until the vapor molecules that adsorb onto the wall of the bag are in equilibrium with the vapor molecules in the air. This equilibrium depends very strongly on the bag material and the chemical entity of the vapor itself. The ambient temperature also has some effect.

As mentioned under the Calibration Procedure, when one is preparing a known vapor concentration in a bag, the bag should be analyzed very rapidly after its preparation to ensure proper calibration of the instrument. The technique here is to use the standard prepared in this fashion as soon as possible such that the adsorption that has occurred is an absolute minimum amount. This adsorption becomes a bit more serious problem in using bags for sample collection. The first problem is simply when one is reusing the bag, one has to be sure that the sample contained in the bag previously has been completely desorbed from the wall. This, in general, can be checked by using clean air to fill a bag allowing the bag to set for a short period of time, about 1 hour, and then analyzing the air in the bag. If on using the 580 to analyze this air, it shows measurable organics, then the air in the bag should be dumped and new air introduced and allowed to set for the same period of time. There will be a reduction of organic vapor on the second go-around.

If it is still too high, this procedure is repeated until the bag shows virtually no organic vapor. The bag can be evacuated and reused.

The other problem associated with adsorption and sample collection is that the sample that is collected in the bag must be analyzed as soon as possible after collection if one is going to determine quantitatively the amount of organic vapor in that bag sample. The longer the sample stays in contact with the bag, the greater the adsorption will be of the organic vapors on the surface of the bag and, therefore, the lower the concentration of the organic vapors in the air sample.

If one is interested here in only doing a qualitative analysis of the organic vapors, that is identify what vapors are

present in the air sample, the bag certainly is a convenient way of taking the sample. If one in addition to getting the qualitative analysis desires to quantitate one or more of the specific organic vapors in the sample, the bag sample should be analyzed within an hour of taking this sample. If the bag sample cannot be analyzed this soon, it is recommended that one use the charcoal tube technique explained in the next section.

There are two considerations to be given relative to the size of the bag and, therefore, the size of the sample taken. The first consideration is the amount of sample needed by the laboratory for its analysis. If the analysis is to be done by gas chromatography directly on the air sample, in general only 1 to 5 mL of sample would be required for the analysis. Therefore, this does not become a major consideration here. If, however, other analytical techniques were to be used that would require significantly higher volumes of sample, this should be taken into account.

The other consideration is the sampling time. The Model 580B samples at the rate at which the bag attached to the exit port of the 580B will be filled. If the bag can conveniently hold 10 liters of air, this means that the sampling time can be up to 20 minutes. In general, collection techniques using the Model 580B are not intended to supply a four or eight hour integrated sample. They are used simply to help identify the materials contributing to a high concentration and possibly the analysis of individual toxic organic vapors in that particular air sample. Thus, a 20 minute limitation on sampling time should not be too severe.

Certainly larger bags could be used on the exit of the 580B, allowing up to several hours of sampling time should this be desired. The difficulty then becomes that the bags are quite large and physically become difficult to manipulate. It was recommended back in the Calibration Section that perhaps a 10 liter bag would certainly be the convenient bag for the calibration of the 580B. It would appear to be also a convenient bag for collection of the samples. For this purpose, a bag that has no adsorbed vapors on the interior surface is evacuated and closed to the atmosphere. Several of these bags could be carried in a very small container. When the Model 580B is reading high values, and it is impossible to determine the source of the high values, then a bag can be connected to the exit port of the 580B and immediately opened to accept the sample exiting the 580B. The bag is kept connected to this exit as long as the 580B is giving high readings or until the bag has reached its volume capacity. At this point, the bag is removed from the exit port of the 580B, immediately closed, and returned to the laboratory for analysis.

6.3 COLLECTION USING CHARCOAL TUBES

A technique very common in industrial hygiene-type analysis is to use a small charcoal tube as a collection device. An air sample is pulled through the charcoal tube at a known flow rate for a known period of time. This flow rate and time determine the total volume of air or total sample size. The organic vapors

in the air are adsorbed on the charcoal in the tube. These vapors are then desorbed from the charcoal by adding a known volume of desorbing solvent, usually carbon disulfide. The organics end up in the carbon disulfide. The carbon disulfide is then injected into a gas chromatograph using Flame Ionization Detection. The individual organic vapors can then be identified and quantitated.

The usual charcoal tubes that are used for this type of work contain two sections. One section has approximately 100 milligrams of charcoal and a backup section has 50 milligrams. The backup section is analyzed separately from the main section to determine if there is organic vapor breakthrough in the main section. These particular size tubes have a recommended maximum flow in the neighborhood of 250 to 300 mL/min. The exit of the Model 580 is at 500 mL/min. The most advantageous way of using a smaller charcoal tube would be to split the exit stream and pass it through two parallel charcoal tubes. This would give approximately 250 mL through each tube. For analysis purposes, the charcoal of each tube is removed and combined using double the amount of solvent that would be required for a single tube.

The amount of total air that can be passed through charcoal tubes certainly depends on the concentration of organic vapor in the air. It also depends to some extent on the particular organic vapor. In general, a total sample through the smaller charcoal tube of 10 liters is a reasonably safe number to use. Since the flow is split exiting the 580B using the smaller charcoal tubes, only 250 ml/min is going through the tube. It would take 40 minutes to accumulate 10 liters passing through each of the tubes. There are charcoal tubes available in the marketplace containing 300 milligrams of charcoal in the front section and 150 milligrams of charcoal in the rear section. These tubes have correspondingly larger diameter and can accommodate higher volumetric throughputs. One of these tubes could be hooked to the exit of the 580B without doing the split. Conceivably since it contains 3 times the amount of charcoal, a safe operating total volumetric throughput would be approximately 30 liters. This would be a full hour's operating time on the Model 580B. Again, it must be stressed that the 580B when used in the particular form, is not being used as a personnel sampler to end up with the time weighted average concentration over an eight hour period. The intent here is to identify the high level organics observed on the 580B and to quantitate them following identification to determine the safe working area.

SECTION VII

COMMUNICATION

The 580B provides a serial (as opposed to parallel) communication port. There is also a communication cable provided for easy link up to a serial printer or RS-232 port of a computer. Logged data may be "dumped" (sent through the communication port) to a serial printer. Many of the 580B parameters may be set by a remote computer by using the serial port and the 580B communication software (the software is an option, part number 580A-9014).

Note: The serial port is not to be used in a hazardous location

PRINTER

The 580B can be instructed to send all of its logged data through the serial port to a printer (or a dumb terminal). The 580B printer mode should be selected (see Section 2.7.4).The serial communication cable should then be plugged into the RS-232 port at the rear of the instrument and the other end of the cable plugged into the serial port of a printer. The 580B should finally be instructed to output to the printer (see section 2.7.1).

COMPUTER

The 580B provides capabilities for remote operation. Appendix A includes a detailed technical explanation of the 580B printer and computer interface protocol. The information in this appendix is sufficient for custom software to be developed for interfacing to the 580B. Thermo Environmental however has developed communication software which implements all of the available communication capabilities in a simple "menu driven" format. Remote communication may also be accomplished by using generic communication software package such as CrossTalk. Appendix A will be helpful if this route is taken.

NOTE: Generally, the RS-232 port on an IBM PC (or compatible) is a male connector. Since the communication cable provided with the 580B is also male, a "gender changer" (a DB-25 connector which converts from male to female) is needed.

7.3 COMMUNICATION SOFTWARE (OPTIONAL)

There is communication software available which will run on an IBM PC or compatible. The software provides the capability of obtaining or changing the 580B parameters (alarm setting, response factor, or operating mode to name a few). Logged data may be stored to disk or printed to a parallel printer. Concentrations may be read and displayed on the computer screen. There are a few operations which may not be accomplished remotely (for obvious reasons). The lamp may not be changed remotely. The lamp and pump may not be turned on from the computer either.

NOTE: The communication software will not work unless the 580B is attached via the communication cable.

7.3.1 HOW TO GUIDE FOR COMMUNICATION SOFTWARE

#1. The 580B must be turned on and connected to the computer's RS-232 port. The 580B must be in the computer mode (this is the default setting).

#2. The floppy disk should be inserted into the computer. Type 580B (this software was originally developed for the 580B) and then hit return. The introduction screen will appear.

#3. The software defaults to 2400 baud (as does the 580B). If some other baud rate is desired it must match the setting on the 580B.

#4. After selection of the baud rate press return. The main menu will appear.

NOTE: If the computer's screen goes blank and the main menu does not appear, then there is a problem with the communication link. Check to be sure that the communication cable is plugged into the RS-232 port and that the 580B is on.

SECTION VIII

FLOW CHART

There are two flow charts which illustrate the structure of the 580B software. The first is a "Quick Start-up" flow chart. Much of the detail is not included in this flow chart in order to diagram the basic structure of the software. The second flow chart includes extensive detail of each screen and the function of the seven buttons. These flow charts provide an easy method for determining how to get at each of the many facilities provided by the 580B.

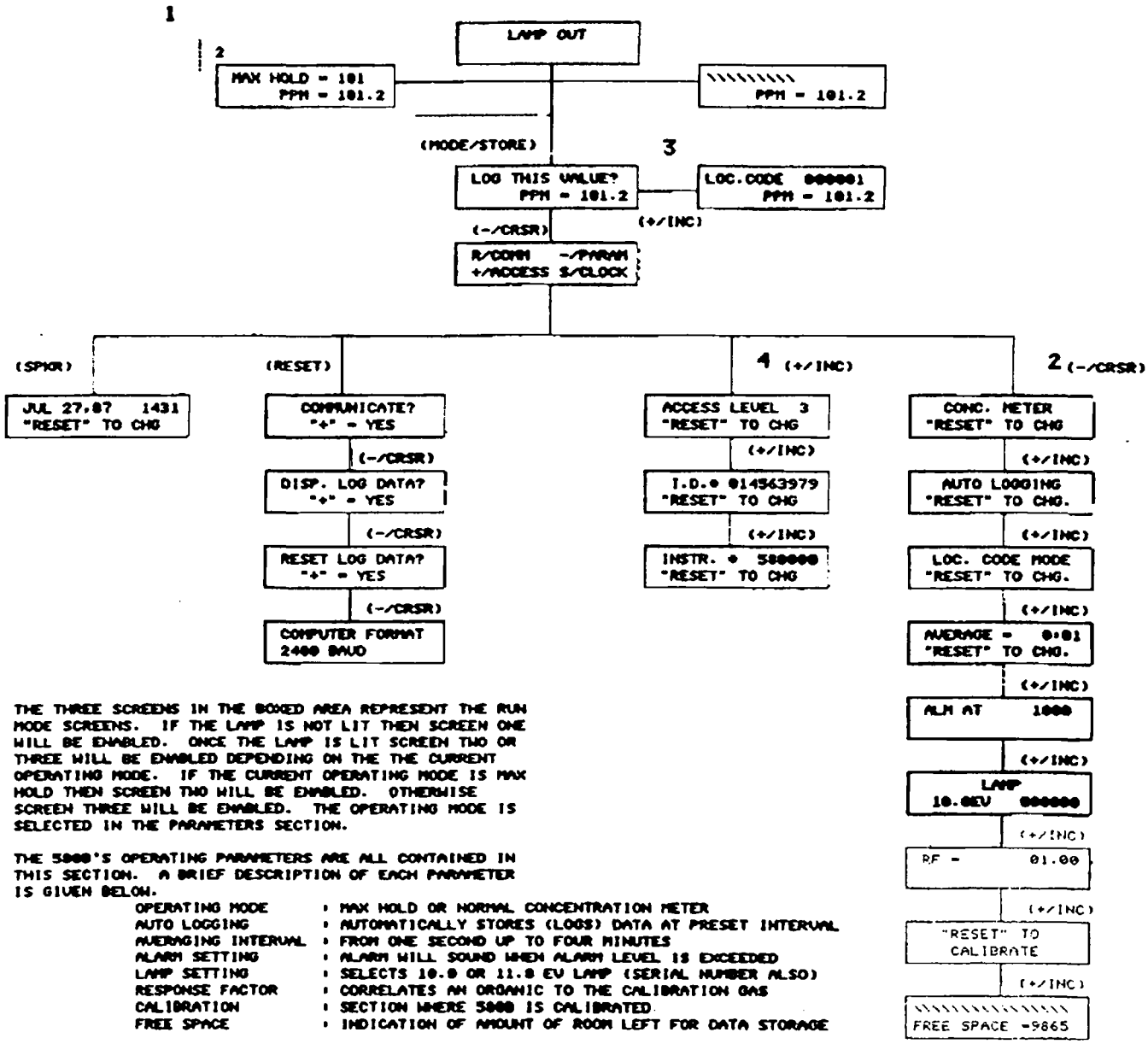
8.1 QUICK START-UP

The Quick Start-up flow chart shows each of the top level screens. The screens are ordered according to the hierarchy of the 580B software. The particular button (which advanced the 580B to the next screen) is shown in parenthesis above each screen. This flow chart does not illustrate any of the associated screens or operations (see the detailed flow chart for more in depth information).

The Quick Start-up flow chart should be fully understood before moving on to the more detailed flow chart. The best way to learn each of the flow charts is to have the 580B with you and to follow along verifying each step.

8.2 DETAILED FLOW CHART

The detailed flow chart illustrates many of the lower level screens as well as the function of buttons. Screens are shown in rectangles with the text written inside. The buttons are shown in ellipses (actually a rather flattened ellipse) with the button identifier written inside. There are a few conventions which need to be explained. The button identifiers have been abbreviated. For example the +/INC button is simply denoted as +. When two buttons need to be pressed simultaneously each identifier is shown with a slash between them. For example RESET/+ indicates that the RESET and +/INC buttons should be pressed together. Arrows indicate the direction of flow from one screen to the next.



1 THE THREE SCREENS IN THE BOXED AREA REPRESENT THE RUN MODE SCREENS. IF THE LAMP IS NOT LIT THEN SCREEN ONE WILL BE ENABLED. ONCE THE LAMP IS LIT SCREEN TWO OR THREE WILL BE ENABLED DEPENDING ON THE THE CURRENT OPERATING MODE. IF THE CURRENT OPERATING MODE IS MAX HOLD THEN SCREEN TWO WILL BE ENABLED. OTHERWISE SCREEN THREE WILL BE ENABLED. THE OPERATING MODE IS SELECTED IN THE PARAMETERS SECTION.

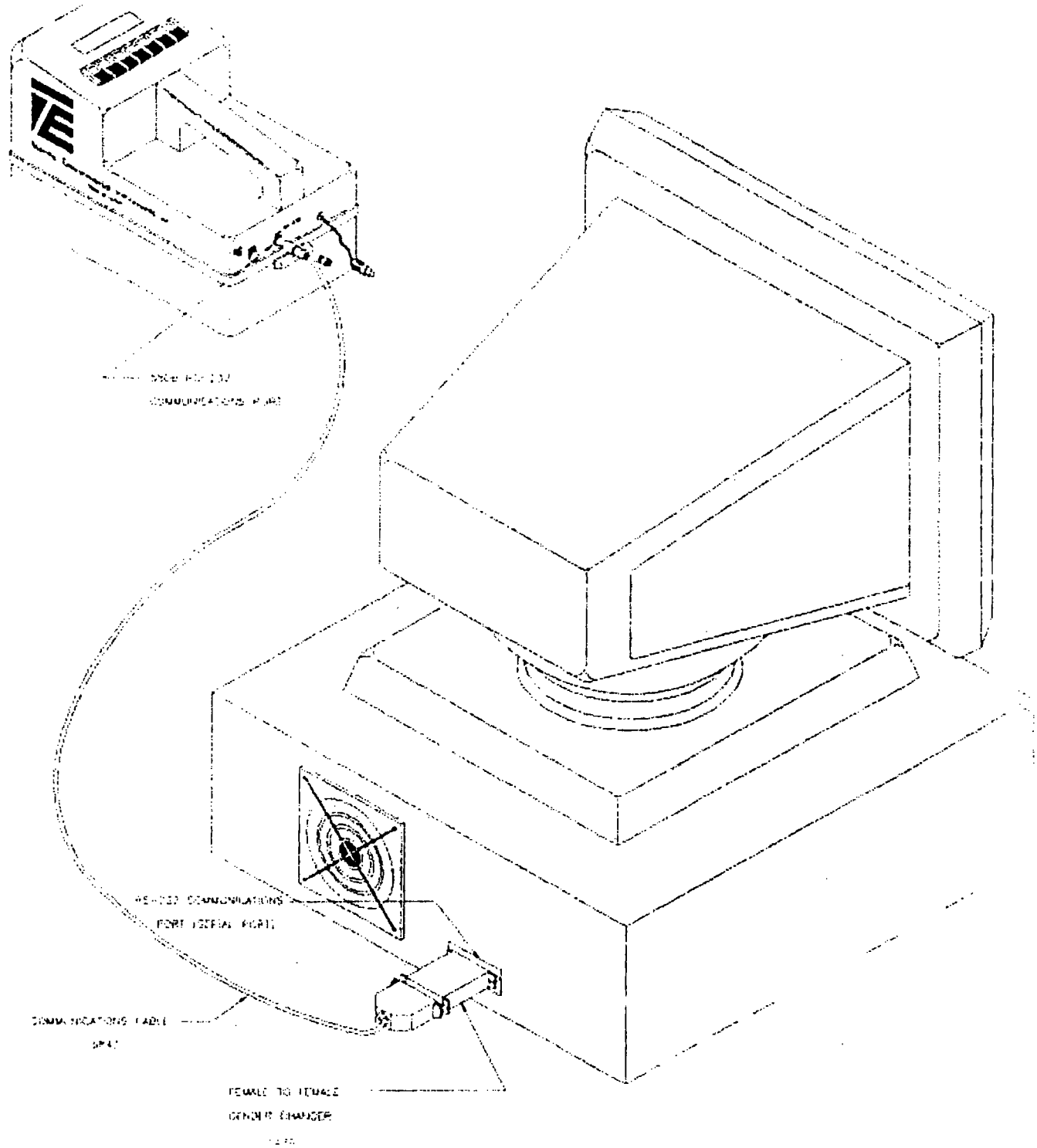
2 THE 5000'S OPERATING PARAMETERS ARE ALL CONTAINED IN THIS SECTION. A BRIEF DESCRIPTION OF EACH PARAMETER IS GIVEN BELOW.

OPERATING MODE	: MAX HOLD OR NORMAL CONCENTRATION METER
AUTO LOGGING	: AUTOMATICALLY STORES (LOGS) DATA AT PRESET INTERVAL
AVERAGING INTERVAL	: FROM ONE SECOND UP TO FOUR MINUTES
ALARM SETTING	: ALARM WILL SOUND WHEN ALARM LEVEL IS EXCEEDED
LAMP SETTING	: SELECTS 10.0 OR 11.0 EV LAMP (SERIAL NUMBER ALSO)
RESPONSE FACTOR	: CORRELATES AN ORGANIC TO THE CALIBRATION GAS
CALIBRATION	: SECTION WHERE 5000 IS CALIBRATED
FREE SPACE	: INDICATION OF AMOUNT OF ROOM LEFT FOR DATA STORAGE

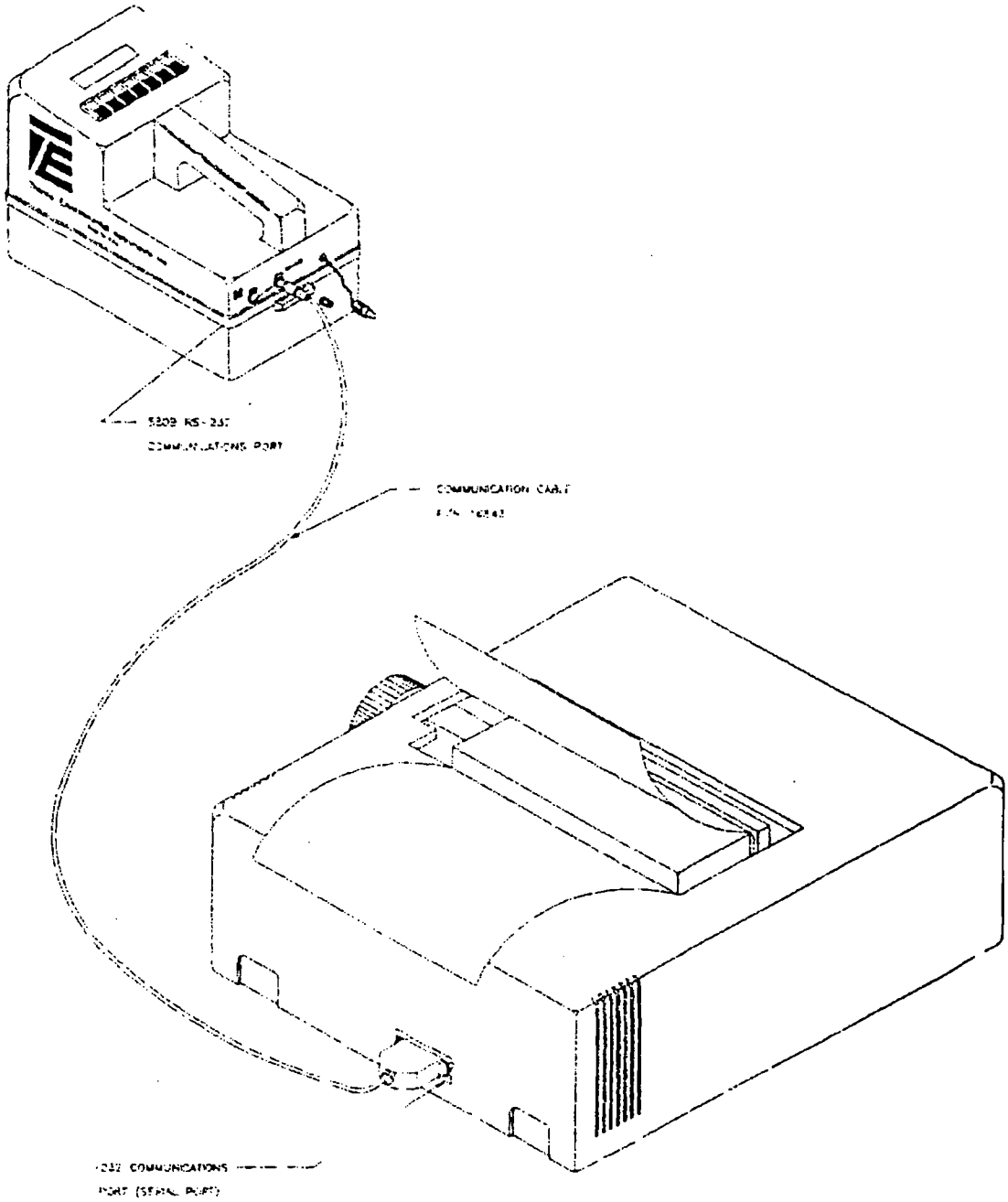
3 THESE ARE THE SCREENS USED FOR LOGGING (STORING) DATA POINTS. AFTER ENTERING THE DESIRED LOCATION CODE, SIMPLY PRESSING THE MODE/STORE SWITCH WILL LOG THE VALUE (AS WELL AS A DATE AND TIME STAMP) AND RETURN OPERATION TO THE RUN MODE.

4 THE ACCESS (SECURITY) LEVEL IS SET IN THIS SECTION. ACCESS LEVEL THREE GIVES THE OPERATOR ACCESS TO ALL OF THE 5000'S FACILITIES. LOWER ACCESS LEVEL ZERO ARE PROGRESSIVELY MORE RESTRICTIVE. ACCESS LEVEL ZERO ONLY ALLOW READING AND LOGGING OF DATA.

Figure 8.1
Quick Flow Chart



Fi
Se .al in Communi



Figu
Compu Communi ion

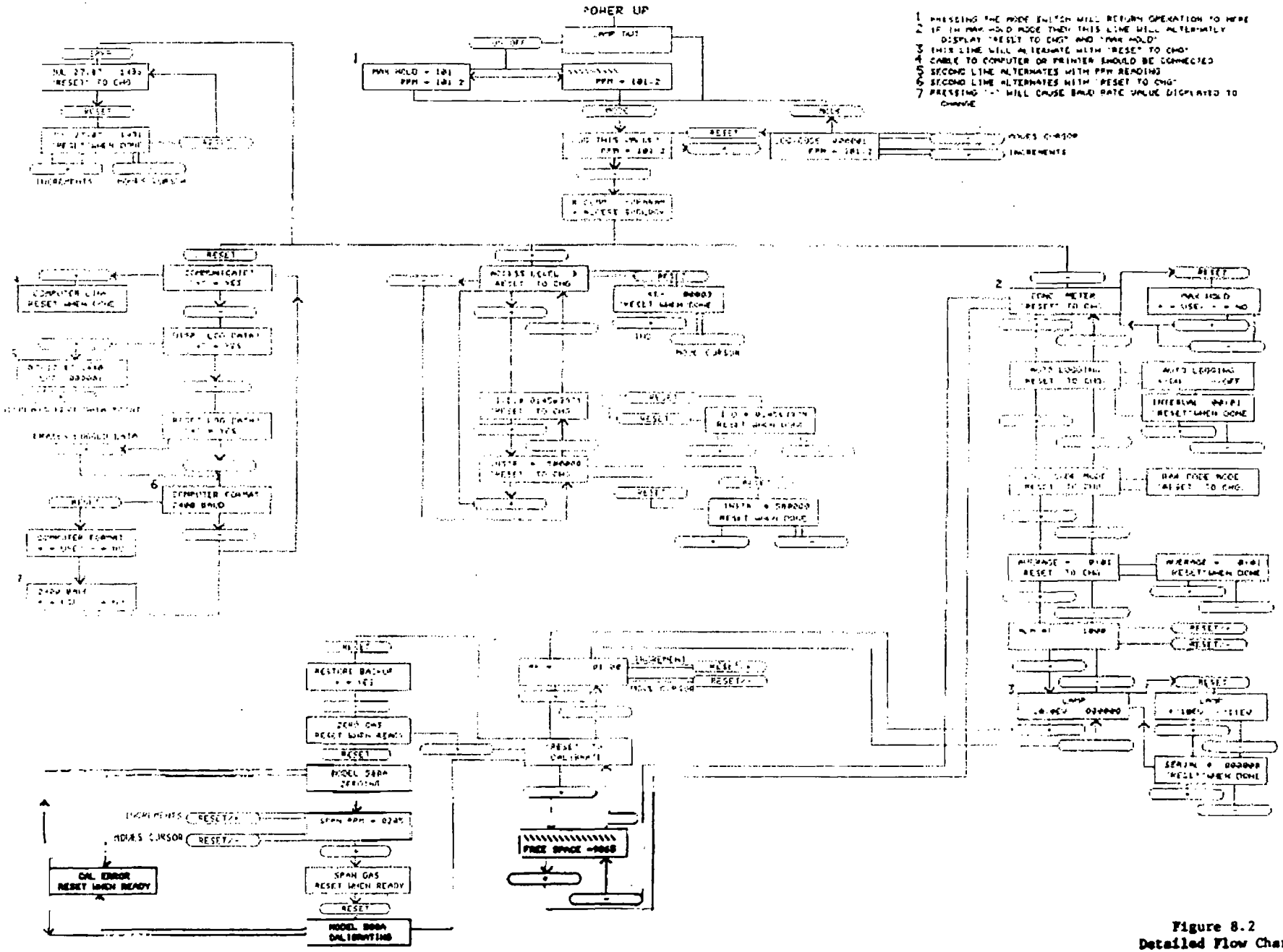


Figure 8.2
Detailed Flow Chart

APPENDIX A

COMMUNICATION

A.1 INTRODUCTION

The 580B is capable of communicating over an RS-232 link with any peripheral device which adheres to the communication protocol outlined in this document. The 580B will communicate with a peripheral device in one of two modes. While in the PRINTER mode the 580B responds to commands from its keypad and can be commanded to send characters out its RS-232 port to a peripheral device. In the COMPUTER mode the 580B responds to commands from a peripheral computer and can be commanded to send and receive data and to perform other tasks. Regardless of the mode used, the 580B sends and expects to receive data in the following format:

No Parity
1 Start Bit
8 Data Bits
1 Stop Bit
Baud Rate = 150, 300, 600, 1200, 2400, 4800 or 9600

The Baud Rate may be selected from the 580B keypad (see Section 2.7)

A.2 PRINTER MODE INTERFACE

In the PRINTER mode the 580B can be instructed to send its log data out the RS-232 port to a peripheral device such as a printer.

The 580B can be manually instructed from its keypad to output its log data. In this case the 580B sends all the log data points it has acquired thus far. The log data is saved in 580B memory and will NOT be automatically erased upon output. While in the PRINTER mode, the 580B log data file must be erased (reset) from the keypad. An example of a log data output is shown on page A-17. Notice that the 580B also sends header information which includes the following parameters: instrument number, user ID, and mode of operation. The date at the top of the header corresponds to the time when the first log data point was taken with the parameters set as shown in the header. If any of the parameters are changed and then new log data points are acquired, the 580B will send an updated header before it sends the new data points. It is also important to note that every log data point is time stamped to show when it was stored.

HARDWARE INTERFACE, PRINTER MODE

```
580B              PERIPHERAL

TxD  (B)_          )RxD
CTS  (E)(          _DTR (or "printer ready")
GND  (A)__________GND
```

The connections shown above are required before the 580B can successfully send its log data to the peripheral. An example of a cable used for PRINTER MODE communication is shown below:

SAMPLE CABLE, 580B TO HP THINKJET PRINTER

```
580B              PRINTER

TxD (B)________)RxD (3)
CTS (E)(________DTR (20)
GND (A)_________GND (1)
GND (F)_________GND (7)
```

Thinkjet connector = TRW/CINCH DB-25P plug connector

Please remember that the 580B must be placed into the PRINTER mode prior to output of log data to a printer. This is done from the 580B keypad.

HARDWARE HANDSHAKING, PRINTER MODE

The 580B will send log data out the port to a peripheral device as long as its CTS line is asserted (+V). If the peripheral has temporarily fallen behind, and consequently clears its DTR line (-V), the 580B will stop transmitting data. It will resume transmitting as soon as the peripheral reasserts (+V) its DTR line.

A.3 COMPUTER MODE INTERFACE

In the COMPUTER mode the 580B will respond to commands sent by a peripheral computer. The 580B will respond to 3 types of commands; DO, GET, and SET commands.

An example of a DO command is "DO RESET LOG (ret)" in which the 580B is instructed to reset its log which, in effect, clears all previously stored log data points.

A GET command such as "GET ALARM (ret)" allows the peripheral to change a specified parameter in the 580B to a value provided by the peripheral.

A combination of DO, SET, and GET commands allow the operator at the peripheral to perform a variety of functions needed to prepare a 580B for acquiring data.

The 580B can also be operated under "computer control". For example, the 580B can be commanded to acquire readings at specified intervals and then store the readings in a log data file.

The 580B can subsequently be commanded to send its log data to a printer, a file or the screen of the peripheral computer. This can all be accomplished through commands issued by the peripheral computer. So, effectively the 580B is under "computer control".

HARDWARE INTERFACE, COMPUTER MODE

```
580B              COMPUTER

TxD (B)___________)RxD
RxD (C)(___________TxD
CTS (E) ___________DTR
                ___DSR
GND (A)____________GND

                ___CTS
               !___RTS
```

The connections shown above are required before the peripheral computer can successfully communicate with the 580B. In addition, the 580B must be placed into COMPUTER mode. This is done from the 580B keypad.

An example of a cable used for COMPUTER MODE communication is shown below:

SAMPLE CABLE, 580B TO IBM PC

```
580B              COMPUTER

TxD (B)________)RxD  (3)
RxD (C)(________TxD  (2)
CTS (E)(________DTR (20)
            !___DSR  (6)

GND (A)________GND   7)
            !___GND   1)

             ___CTS  (5)
            !___RTS  (4)
```

If the peripheral's DTR line is asserted (+V), the 580B will look for and then respond to peripheral commands. As long as DTR remains high, the 580B will NOT perform functions such as counting, updating the display, storing log data, etc. If DTR is asserted, the 580B will display the following message:

"COMPUTER LINK"
"WAITING FOR COMM"

The 580B must be allowed 100ms between the time the peripheral asserts DTR and the time it sends the 580B its first message. If the 580B is busy communicating the display will read:

"COMPUTER LINK"
"COMMUNICATING"

When DTR is low (-V), the 580B will return to its normal mode of operation where it counts, updates the display, etc. and will NOT respond to peripheral commands.

XON/XOFF HANDSHAKING, COMPUTER MODE

If the 580B is transmitting log data and detects that an XOFF has been received, it will stop transmitting. The 580B will not resume transmission until the peripheral device sends XON. The 580B will respond to XON and XOFF characters only if it is NOT communicating with the computer (i.e., if 580B CTS is NOT asserted).

It is important to note that if the 580B receives an XOFF it will stop transmitting and will simply wait for the peripheral to send XON, it will not acquire data, update the display or perform other functions. The 580B is essentially "locked up" until it receives XON. For this reason, it would be good programming practice to send out an XON to the 580B prior to 580B/peripheral communication and afterwards also. Consequently, if an XOFF character is sent to the 580B inadvertently, the 580B will not be locked up indefinitely.

PERIPHERAL/580B COMMAND MESSAGES

A command message is a string of upper-case ASCII characters terminated by an ASCII carriage return. The carriage return may immediately follow the command or a space may separate the command and the carriage return as shown in the example below. The command messages which the 580B will accept from the peripheral are listed in TABLE A.1. The 580B will accept the messages as shown in TABLE 1 or the command portion of the message can be abbreviated as follows:

"S R F 01.00 (ret)" instead of
"SET RESPONSE FACTOR 01.00 (ret)"

Please note that the abbreviation must contain the first letter of each and every word of the command. There are some additional guidelines for abbreviating the SET OPERATING MODE commands.

If the abbreviated version of a command is sent, an ASCII blank must separate each letter of the command and must separate the command from the data. Note that the command message will contain data only if a SET command is being sent.

If the spelled-out version of a command is sent, an ASCII blank must separate each word of the command and must separate the command from the data.

Every SET command message contains a data value. The data sent as part of a SET command must conform to the formats described in TABLE A.1. It is important to note that the 580B does NOT perform error-checking on data sent as part of a SET command.

It is up to the user to insure that the data value is "reasonable" and formatted as shown in TABLE A.1.

The following are examples of valid command messages:

"SET ACCESS LEVEL 3 (ret)"
or "S A L 3 (ret)"

"SET REAL TIME 02/15/86 1723 (ret)"
or "S R T 02/15/86 1723 (ret)"

580B/PERIPHERAL RESPONSE MESSAGES

A response message is a string of upper-case ASCII characters terminated by an ASCII carriage return. The response messages which the 580B will send to the peripheral are listed in TABLE A.1. The messages which the 580B sends in response to a GET command contain data formatted as shown. The notes which follow TABLE A.1 describe the GET command response messages in more detail.

SOFTWARE HANDSHAKING, COMPUTER MODE

Every command message must be preceded by the "WAKE UP/PROCEED" sequence. This sequence begins when the peripheral sends a WAKE UP ("?") character to the 580B. The 580B must respond with a PROCEED ("!") character before the computer can send a command message. In the discussion to follow, the WAKE UP/PROCEED sequence will be referred to as (WAKE UP/PROCEED).

The peripheral sends command messages to the 580B an entire line at a time. When the 580B receives the command line it will echo the line back to the peripheral. The peripheral will examine the echo to determine if the 580B received the command correctly. If the echo was correct, the peripheral will signal the 580B with the PROCEED character. The 580B will then perform the task specified by the command message. In the discussion ahead, the command message and echo sequence will be referred to as (COMMAND/ECHO/PROCEED).

The software handshaking sequences for each of the 3 types of commands are given below:

DO COMMANDS

The handshake sequence for a DO command is as follows:

1. (WAKE UP/PROCEED)
2. (COMMANDS/ECHO/PROCEED)
3. 580B performs task
4. 580B sends PROCEED or ERR

If the 580B was able to successfully complete the task it will send a PROCEED character in step 4, otherwise it will send the error message ("ERR").

GET COMMANDS

The handshake sequence below applies to all of the GET commands with the exception of GET LOG DATA and GET CONTINUED LOG:

1. (WAKE UP/PROCEED)
2. (COMMAND/ECHO/PROCEED)
3. 580B sends data message
4. Peripheral echoes data message
5. 580B sends PROCEED or ERR

The message sent by the 580B in response to a GET command are shown in TABLE 1. When the peripheral receives the message containing the data it echoes the entire message back to the 580B. If the echo is correct the 580B will send the PROCEED character so that the peripheral knows it received the data correctly. If the echo is not correct, the 580B will send "ERR".

The GET LOG DATA and GET CONTINUED LOG commands differ from the other GET commands in that the 580B sends an indefinite number of data values. The handshake sequence for these commands is as follows:

1. (WAKE UP/PROCEED)
2. (COMMAND/ECHO/PROCEED)
3. 580B sends a log data point message
4. If message = "EOT" (end of transmission) then DONE, otherwise go on to step 5.
5. Peripheral echoes entire message
6. 580B sends PROCEED or ERR
7. Peripheral sends PROCEED
8. Go to step 3

In step 4, the 580B sends "EOT" if it has sent all the log data points available. If some time later the peripheral sends "GET CONTINUED LOG (ret)" the 580B will send any additional data points it may have acquired since the GET LOG DATA command. In step 6, the 580B will send PROCEED if the peripheral echoed the message correctly in step 5. The 580B will also increment its data buffer pointer. If however, the peripheral did <u>NOT</u> correctly echo the message in step 5, the 580B will send "ERR" in step 6 and will <u>NOT</u> increment its data buffer pointer. This means that the next time through step 3, the 580B will send the same data point again. In either case, the peripheral must send a PROCEED in step 7.

COMMANDS

handshaking sequence for a SET command is as follows:

1. (WAKE UP/PROCEED)
2. (COMMAND/ECHO/PROCEED)
3. 580B sets parameter to value
4. 580B sends PROCEED or ERR

In step 3 the 580B sets the parameter specified by the command to the value provided by the peripheral in the command message. The data value sent in the SET command message must be formatted as shown in TABLE 1. If the 580B is able to successfully set the parameter it will send the PROCEED character, otherwise it will send "ERR".

NOTE: The flowcharts shown in Figures A.1 - A.4 are included to further explain the software handshaking sequences required for successful communication between the peripheral and the 580B.

TABLE A.1
MESSAGE FORMATS

PERIPHERAL COMMAND	580B RESPONSE
DO COMMANDS	
DO END COMMUNICATIONS (ret	! (ret)
DO RESET LOG (ret)	! (ret)
GET COMMANDS	
GET ACCESS LEVEL (ret)	ACCESS LEVEL I (ret)
GET ALARM SETTING (ret)	ALARM SETTING IIII (ret)
GET CONTINUED LOG (ret)	(see notes which follow)
GET INSTRUMENT NUMBER (ret)	INSTRUMENT # IIIIII (ret)
GET LOCATION CODE (ret)	LOCATION CODE IIIIII (ret)
GET LOG DATA (ret)	(see notes which follow)
GET OPERATING MODE (ret)	OPERATING MODE: ASCII (50) (ret)
GET MAX READING (ret)	LAST MAX VALUE IIII ASCII (8) (ret)
GET RATEMETER READING (ret)	LAST CONC VALUE IIII ASCII (8) (ret)
GET REAL TIME (ret)	REAL TIME CLOCK II/II/II IIII (ret)
GET USER ID (ret)	USER I.D. # IIIIIIIII (ret)
GET RESPONSE FACTOR (ret)	RESPONSE FACTOR II.II (ret)
GET SPAN CONCENTRATION (ret)	SPAN CONCENTRATION IIII (ret)
GET VERSION NUMBER (ret)	580B VERSION 1.0 (ret)
GET LOGGING INTERVAL (ret)	I:II (ret)
SET COMMANDS	
SET ACCESS LEVEL I (ret)	! (ret)
SET ALARM SETTING IIII (ret)	! (ret)
SET INSTRUMENT NUMBER IIIIII (ret)	! (ret)
SET LOCATION CODE IIIIII (ret)	! (ret)
SET OPERATING MODE ASCII (50) (ret)	! (ret)
SET REAL TIME II/II/II/ IIII (ret)	! (ret)
SET USER ID IIIIIIIII (ret)	! (ret)
SET RESPONSE FACTOR II.II (ret)	! (ret)
SET SPAN CONCENTRATION IIII (ret)	! (ret)
SET LOGGING INTERVAL I:II (ret)	! (ret)

NOTES ON TABLE A.1

The peripheral will receive data back from the 580B in response to a GET command only. The 580B response to a DO or SET command is the PROCEED ("!") character. This is because the 580B does not actually return data but signals the peripheral with the PROCEED character if it was able to perform the task requested. If for some reason the 580B is unable to perform the task it will send an error message "ERR" rather than PROCEED.

The data values sent by the peripheral as part of a SET command message and the data received by the peripheral in response to a GET command must be formatted as shown in TABLE A.1.

The data format codes used in TABLE 1 are described below:

I	a single digit
III...II	an integer "string", the number of I's shown indicates the length of the string. Note: the "string" MUST be the length specified, use leading zeros if necessary.
ASCII (n)	an ASCII string with a maximum of n characters

Several of the command messages listed in TABLE 1 require additional explanation. These comments are listed according to the command name:

DO RESET LOG

This command instructs the 580B to clear its log data file All log data values acquired previously will be erased.

GET CONTINUED LOG

This command instructs the 580B to send any log data points acquired since the last GET LOG DATA command. The format of the 580B response will be the same as the response to the GET LOG DATA command.

GET LOG DATA

This command instructs the 580B to send all of its log data points. The log data file is saved in 580B memory and is NOT automatically erased upon output. The log data file may be erased (reset) with the DO RESET LOG command.

GET OPERATING MODE

The 580B responds to a GET OPERATING MODE command by sending a string "MODE: ", followed by an ASCII string which describes the current 580B mode of operation. The 580B responses to the

GET OPERATING MODE command are listed below:

OPERATING MODE: CONCENTRATION METER NORMAL
OPERATING MODE: CONCENTRATION METER MAX HOLD

GET MAX READING

The 580B responds to a GET MAX READING command by sending the max value as shown in TABLE A.1. After the 580B sends the max reading it resets the max value to 0.

GET REAL TIME

The 580B will return its real time as an ASCII string in the following format: "05/29/86 1422"

SET ACCESS LEVEL

The access level must be an integer in the range 0 to 3

SET INSTRUMENT NUMBER

The instrument number is a string of 6 integers. If the instrument number = 2 then the number must be represented as 000002 (i.e. leading zeros must fill in excess spaces). An example of a valid SET INSTRUMENT NUMBER command is "SET INSTRUMENT NUMBER 000002 (ret)".

SET LOCATION CODE

The location code is a string of 6 integers. If the location code = 234 then the correct SET LOCATION CODE command is "SET LOCATION CODE 000234 (ret)". (Leading zeros must fill excess spaces.)

SET OPERATING MODE

As shown in TABLE A.1, the command SET OPERATING MODE must be followed by an ASCII string which describes the mode. The list of valid SET OPERATING MODE commands along with valid abbreviations are listed below:

SET OPERATING MODE CONCENTRATION (ret)
S O M C (ret)

SET OPERATING MODE MAX HOLD (ret)
S O M M H (ret)

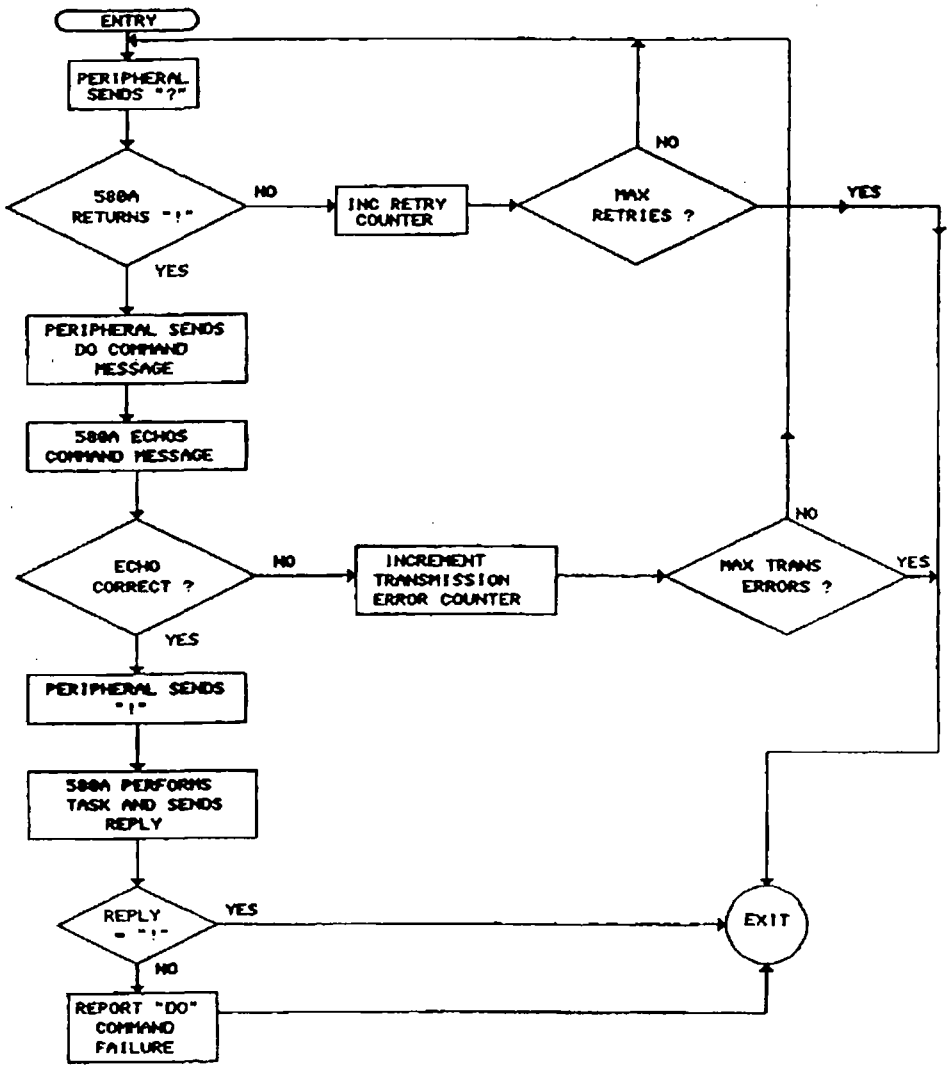


Figure A.1
Software Handshake
Do Commands

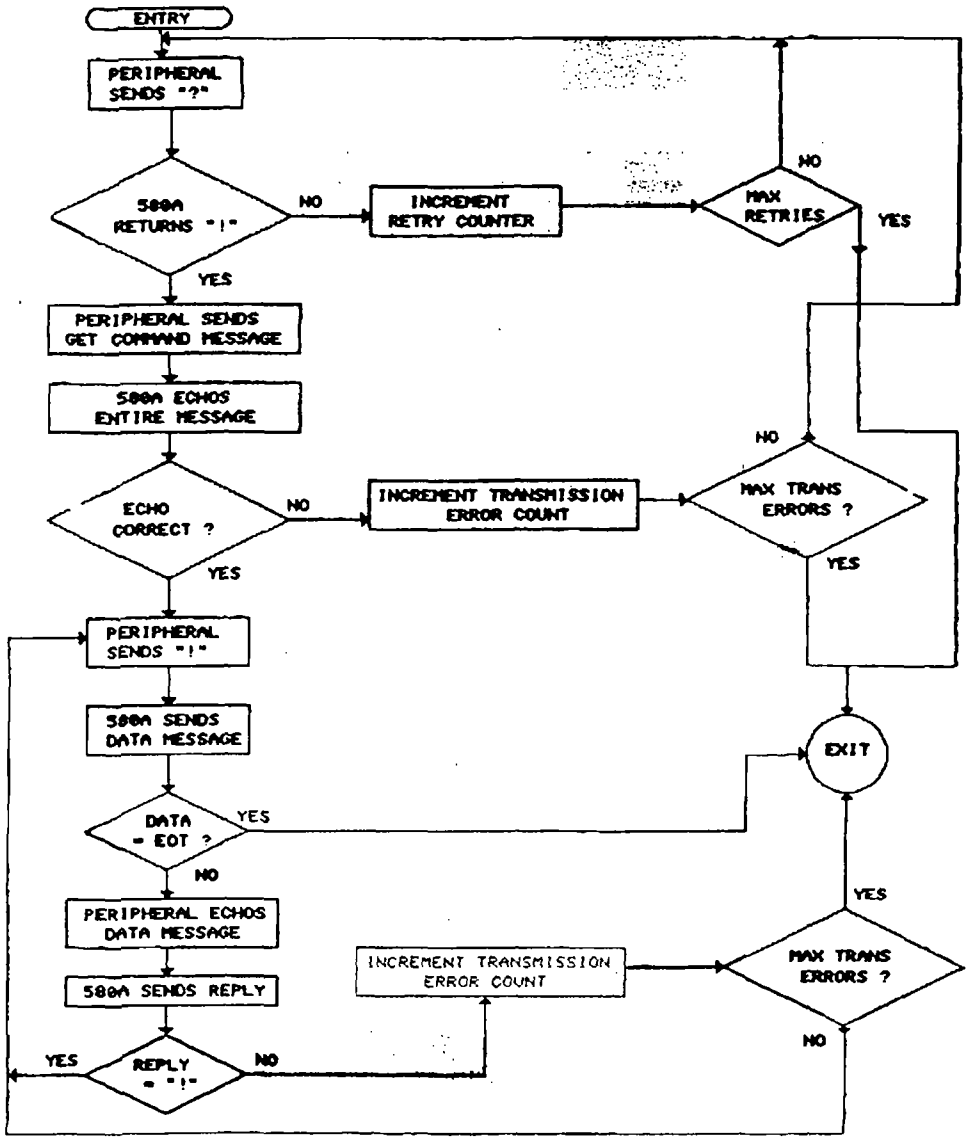


Figure A.2
Software Handshake
Get Log Data, Get Continue Log Command

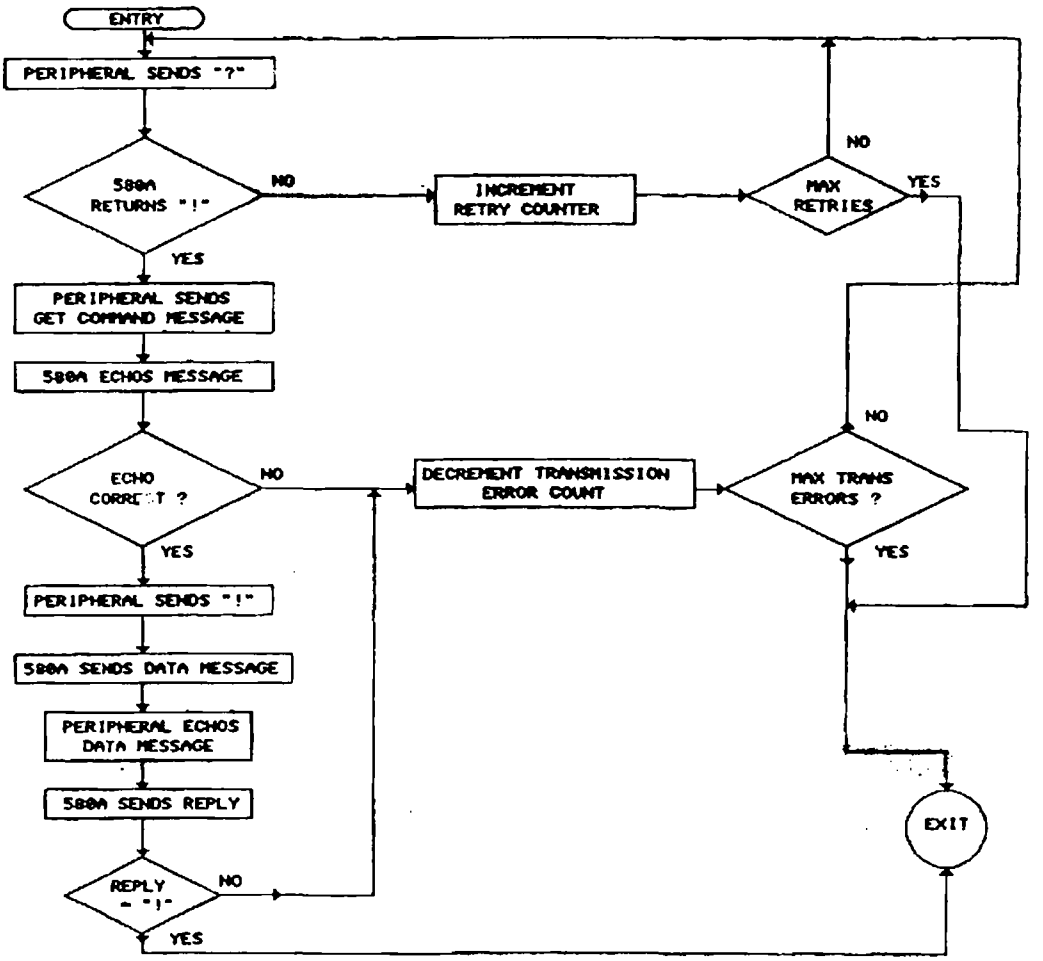


Figure A.3
Software Handshake
Get Command
(Except Get Log Data, Get Continue Log)

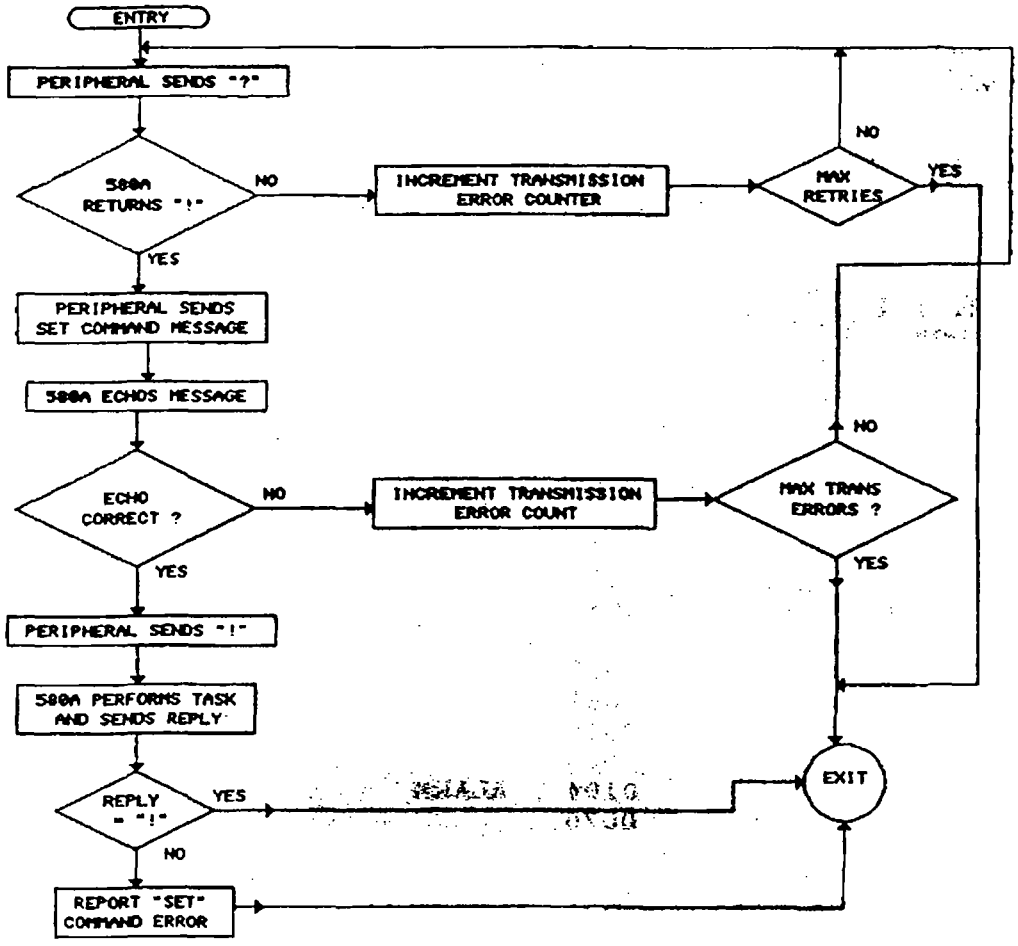


Figure A.4
Software Handshake
Set Commands

SET REAL TIME

`e format for setting the real time is as follows:

```
II/II/II IIII
 .  .  .  . .
    .  .  . .........minutes (max=59)
    .  .  ...........hours (max=23)
    .  ..............year
    ................day
    ................month
```

For example: SET REAL TIME 02/15/86 1723 (ret)
This instructs the 580B to set its real time clock to February 15, 1986 5:23 p.m.

SET USER ID

The user ID is a string of 9 integers. To set user ID = 66, use the following command "SET USER ID 000000066 (ret)" (leading zeros must fill in excess spaces).

```
580B   VER. 1.1
07/11/88 1508
INSTRUMENT #     580000
USER I.D. #      014569373
OPERATING MODE: CONC. METER, MAX HOLD

                 LOC.        PPM     STATUS
07/11/88 1508    000000      0012
07/11/88 1508    000001      0047
07/11/88 1508    000002      0000
07/11/88 1508    000003      0050
07/11/88 1508    000004      0021
07/11/88 1508    000005      0010
07/11/88 1509    000006      0061
07/11/88 1509    000007      0046
07/11/88 1509    000008      0004
07/11/88 1509    000009      0104    ALARM
07/11/88 1509    000010      0076

07/11/88 1509
INSTRUMENT #     580000
USER I.D. #      014569373
OPERATING MODE: CONC. METER

                 LOC.        PPM     STATUS
07/11/88 1509    000011      0000
07/11/88 1509    000012      0064
07/11/88 1509    000013      0052
07/11/88 1509    000014      0001
07/11/88 1509    000015      0007
07/11/88 1509    000016      0101    ALARM
```

Figure A.5
Data Log Output

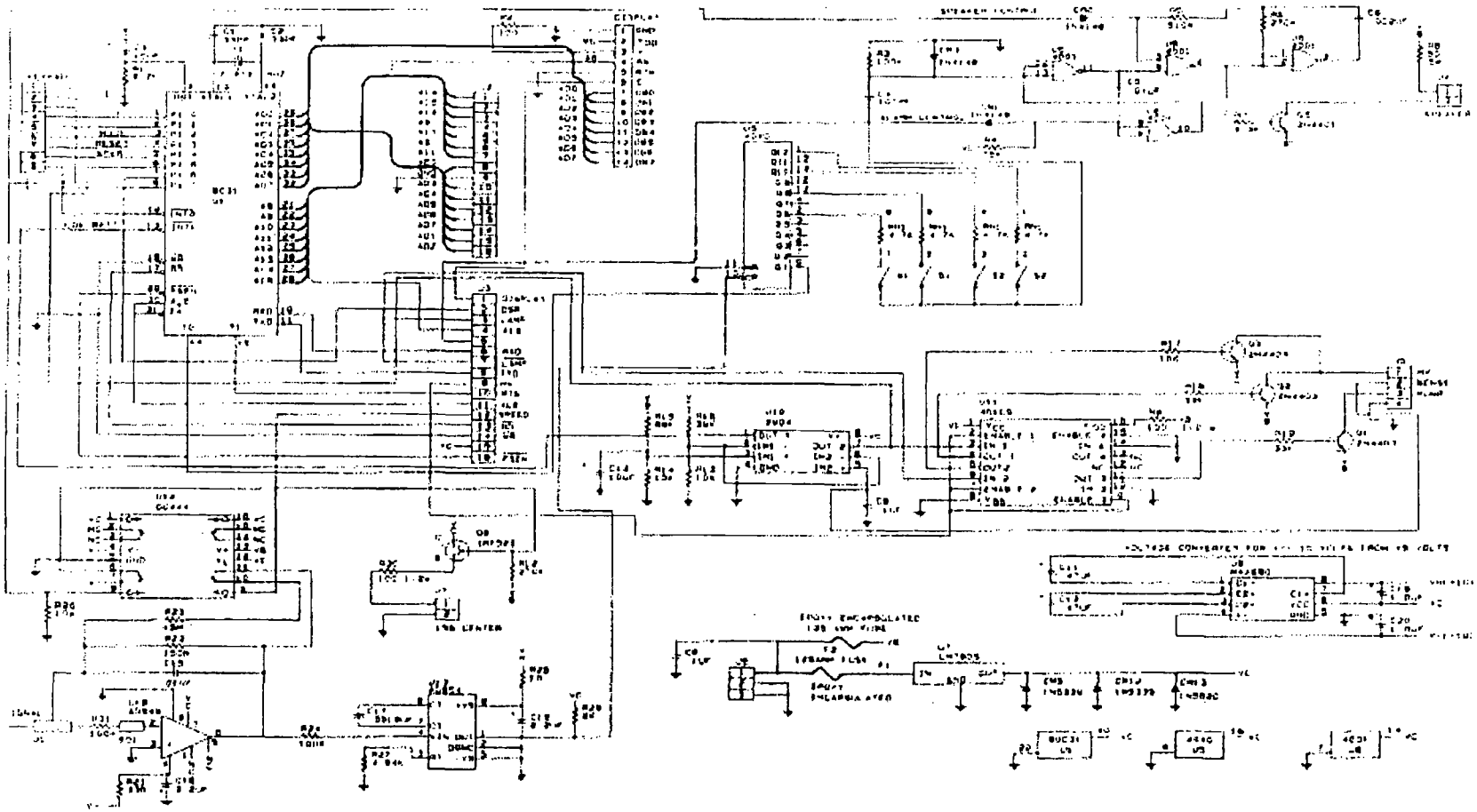


Figure B-1

Processor/Ranging Bd. Schematic

5008-9022 Rev

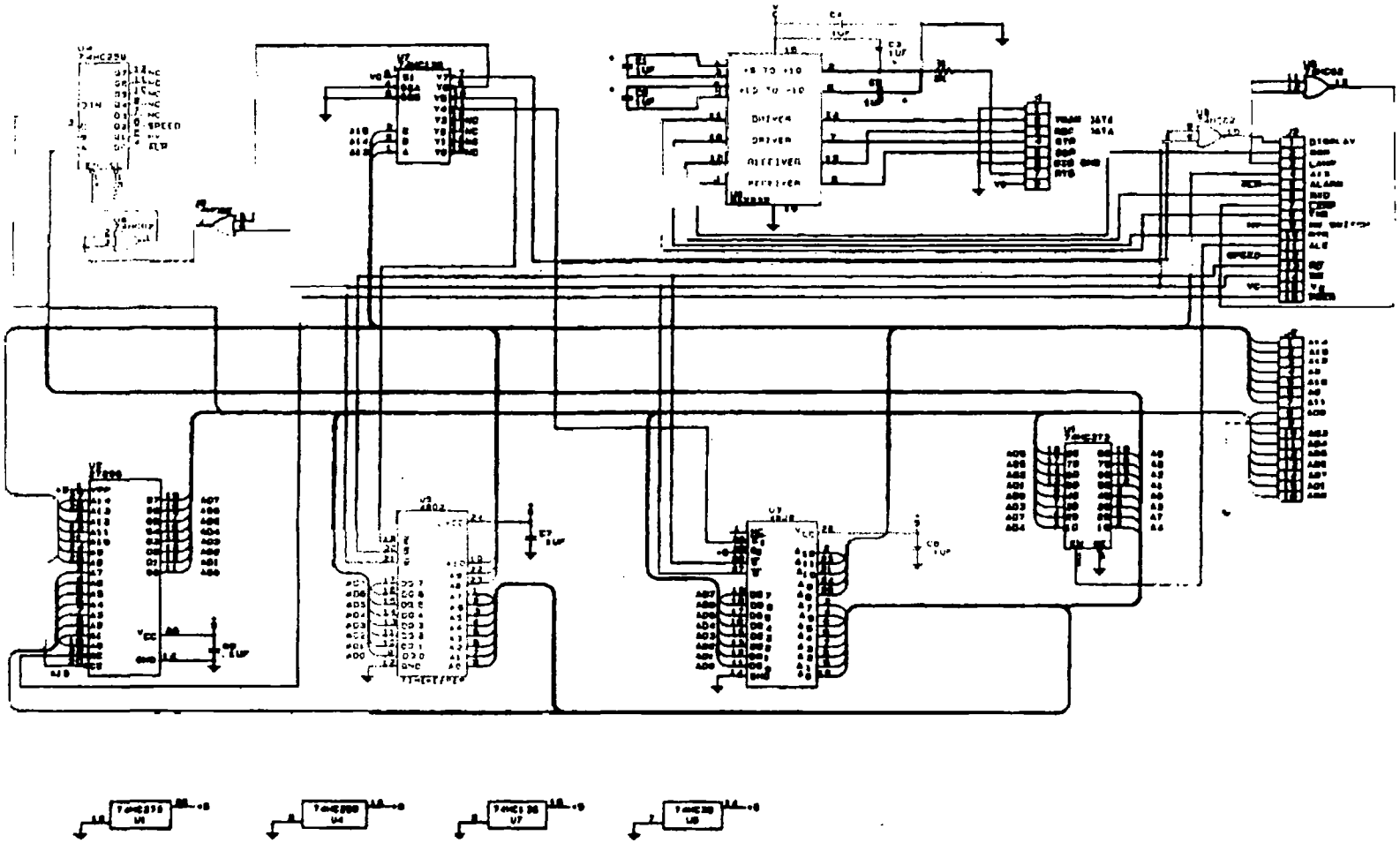
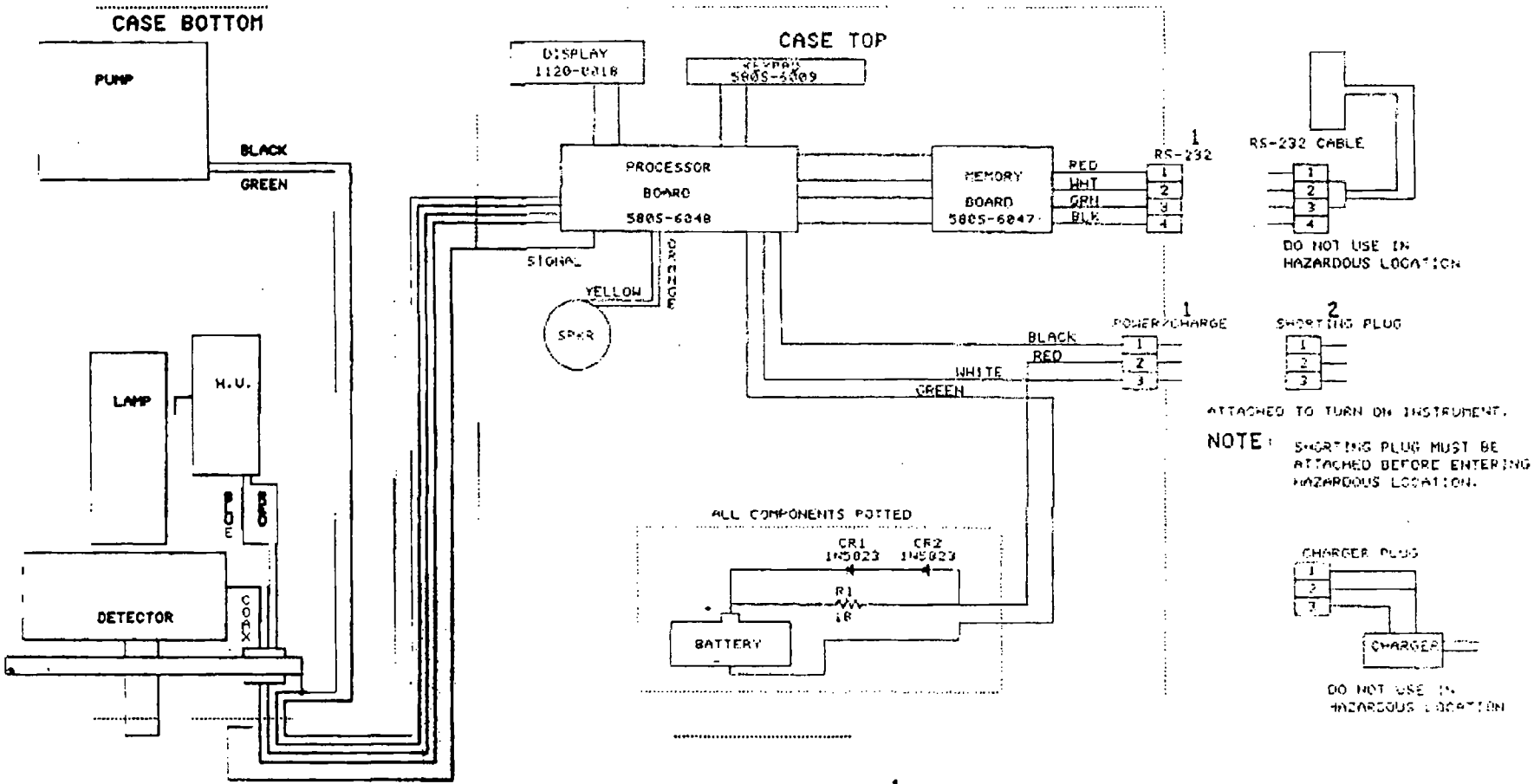


Figure B.2

Memory Board Schematic



1 CONNECTORS MOUNTED ON REAR OF CASE TOP.

2 SHORTING PLUG IS TETHERED TO PREVENT ITS LOSS.

Figure C.1
Block Diagram
C-1

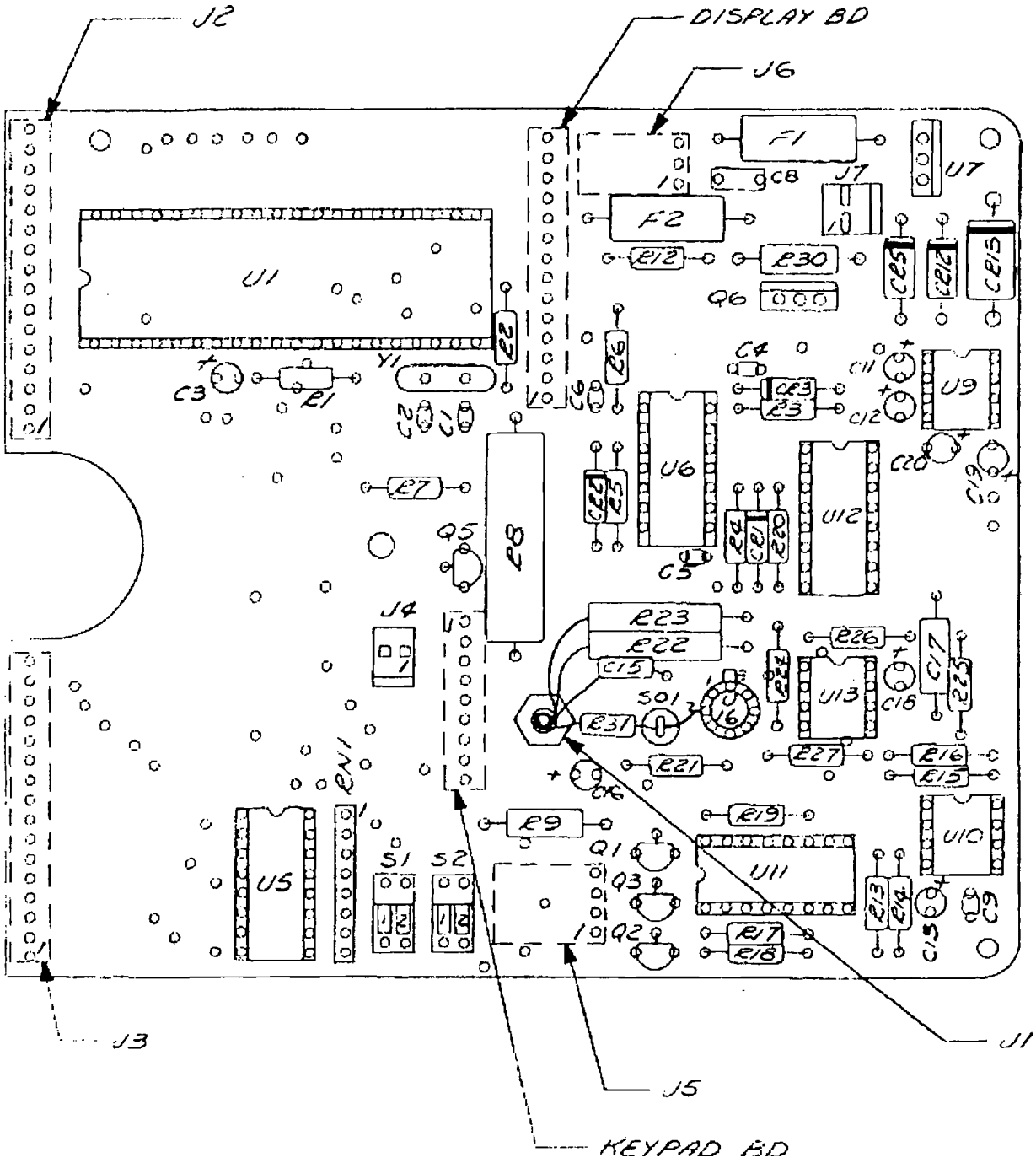


Figure D-1
Processor/Ranging Bd. Loading Drawing

BILL OF MATERIALS THERMO ENVIRONMENTAL INSTRUMENTS
580S-6048 REV. A PROCESSOR/RANGING BOARD

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	11695	U1	80C31 8 BIT MICROCONTROLLER
1	11696	U5	4040 BINARY COUNTER
1	11697	U6	4001 NOR GATE
1	11126	U7	LM7805 5 VOLT REGULATOR
1	11159	U9	MAX680 VOLTAGE CONVERTER
1	11716	U10	LM2904 DUAL OP AMP
1	11717	U11	CD40109B QUAD LEVEL SHIFTER
1	11723	U12	DG-444 ANALOG SWITCH
1	9296	U13	AD654 V/F
1	11152	U16	AD549 ELECTROMETER
2	10391	C1,2	CAPACITOR, 33PF
2	10376	C3,13	CAPACITOR, 10UF
1	5609	C4	MONOLITHIC CAPACITOR, 100PF
2	5605	C5,15	MONOLITHIC CAPACITOR, .01UF
1	10399	C6	MONOLITHIC CAPACITOR, .002UF
2	10372	C8,9	MONOLITHIC CAPACITOR, 0.1UF
2	10403	C11,12	CAPACITOR, .47UF
2	10390	C16,18	CAPACITOR, 2.2UF
1	10402	C17	POLYPROPYLENE CAP 1.8NF,5%
2	10378	C19,20	CAPACITOR, 1.0UF
1	10790	R1	RESISTOR, 8.2K
1	10847	R2	RESISTOR, 100, 1/4 W
3	10862	R3,24,31	RESISTOR, 100K
1	10928	R4	RESISTOR, 75K

BILL OF MATERIALS THERMO ENVIRONMENTAL INSTRUMENTS
580S-6048 REV. A PROCESSOR/RANGING BOARD

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	10929	R5	RESISTOR, 510K
2	10930	R6,12	RESISTOR, 270K
1	5986	R7	RESISTOR, 3,3K
1	10939	R8	RESISTOR, 50, 5W
2	10704	R9,30	RESISTOR, 100, 1/2W
4	10864	R13,14,17,20	RESISTOR, 10K
1	10938	R15	RESISTOR, 68K
1	6025	R16	RESISTOR, 39K
2	2219	R18,19	RESISTOR, 33K
1	10786	R21	RESISTOR, 330
1	10951	R22	RESISTOR, 150M, 5%
1	10952	R23	RESISTOR, 15M, 5%
1	10846	R25	RESISTOR, 10
1	10936	R26	RESISTOR, 2K
1	10865	R27	RESISTOR, 4.64K
1	11641	RN1	NETWORK, 4.7K X 6
3	11807	CR1-3	1N4148
2	11829	CR5,12	1N5339
1	11805	CR13	1N5820
1	10557	Y1	7.373 MHZ
1	10446	J1	RADIAL SMC
1	11398	J4	2 PIN AMP, .100 CENTER
1	11418	J5	4 PIN MTE

BILL OF MATERIALS THERMO ENVIRONMENTAL INSTRUMENTS
580S-6048 REV. A PROCESSOR/RANGING BOARD

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	11419	J6	3 PIN MTE
1	11405	J7	2 PIN AMP .156 CENTER
2	580S-6040	F1,2	.125 AMP FUSE ASSEMBLY
1	10422	S01	STANDOFF
2	12138	S1,2	SPST SWITCH, DUAL
3	11762	Q1-3	2N4403
1	11759	Q5	2N4401
1	11773	Q6	IRF523
1	580S-2057 REV. A		P.C. BOARD BLANK

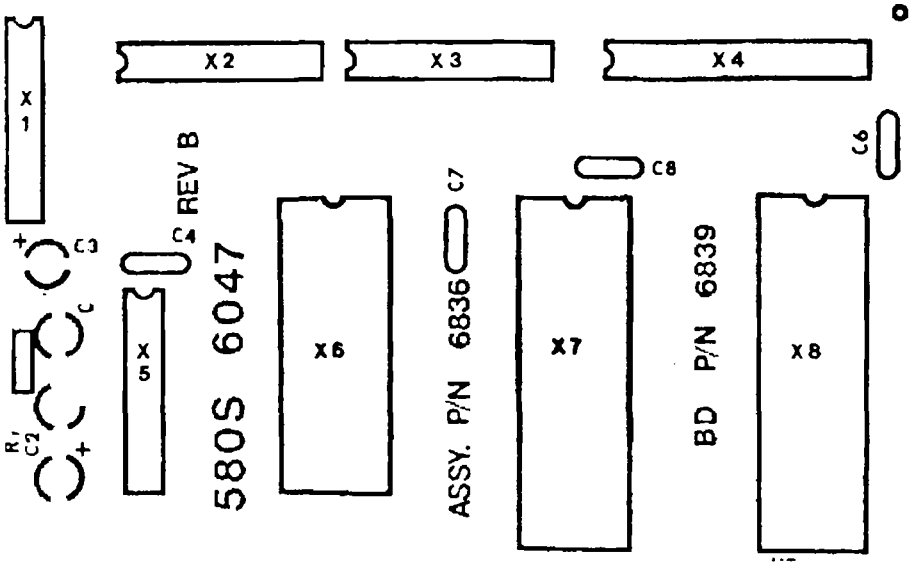
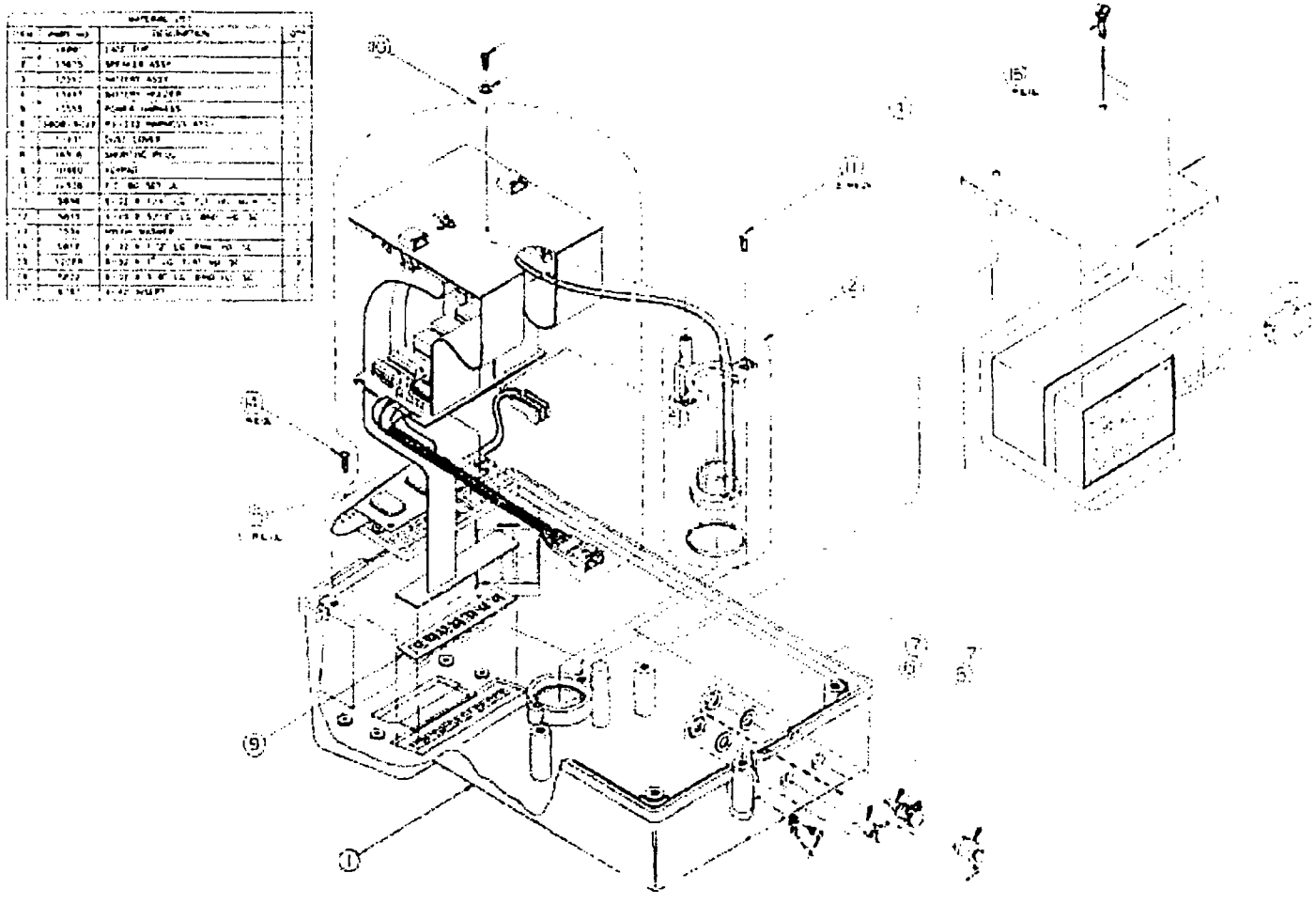


Figure D.2
Memory Board Loading Drawing

BILL OF MATERIALS THERMO ENVIRONMENTAL INSTRUMENTS
580S-6047 REV. A MEMORY BOARD

QUAN.	PART NUMBER	DESG.	DESCRIPTION
1	11689	U1	74HC373
1	11728	U2	27C256 8K EPROM
1	11687	U3	48Z08 8K X 8 BATTERY BACKED RAM
1	11688	U4	74HC259 OUTPUT PORT
1	11691	U5	48T02 2K X 8 TIMEKEEPER RAM
1	11685	U6	MAX232 RS-232 CHIP
1	11151	U7	74HC138
1	11730	U8	74HC02
4	10378	C1-3, 5	1UF CAPACITOR
4	10372	C4,6, 7,8	MONOLITHIC CAPACITOR, .1UF
1	10789	R1	RESISTOR, 3K
1	11374	X7	28 PIN SOCKET
1	580S-2056 REV. A		P.C. BOARD BLANK



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APPENDIX F
COMMON ORGANIC SOLVENTS AND GASES DATA SHEET

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM) ***
Acetaldehyde	44.05	0.788	21	10.21	
Acetamide	59.07	1.159	221	9.77	
Acetic Acid	60.05	1.049	116-117	10.37	10
Acetic Anhydride	102.1	1.10	138-117	9.88	5
Acetone	58.1	0.79	56	9.69	1000
Acetonitrile	41.1	0.79	82	12.22	40 cell
Acetophenone	120.15	1.033	202	9.27	
Acetyl Bromide	122.96	1.52	75-75	10.55	
Acetyl Chloride	78.50	1.104	52	11.02	
Acetylene	26.02	0.90		11.41	
Acrolein	56.06	0.8389	53	10.10	0.1
Acrylonitrile	53.06	0.8004	77	10.91	10
Allyl Alcohol	58.1	0.85	96-98	9.67	2
Allyl Chloride	76.5	0.94	44-46	9.9	1
Aniline	93.1	1.02	184	7.70	5
Anisole	108.13	0.9956	154	8.22	
Ammonia	17.03	gas		10.15	
Arsine	77.9	gas			
Benzaldelyde	106.12	1.053	178-185	9.53	
Benzene	78.1	0.88	80	9.25	1
Benzonitrile	103.12	1.010	188	9.71	
Benzotriflouride	146.11	1.1886	102	9.68	
Benzyl Chloride	126.6	1.10	177-181	9.14	1
Biphenyl	154.21	0.992	255		
Bromine	159.81	3.1023	58.8	10.55	
Bromobenzene	157.02	1.495	156	8.98	
1-Bromobutene	137.03	1.276	100-04	10.13	
2-Bromobutene	137.03	1.255	91	9.98	
1-Bromo-2-Chlorethene	143.42	1.723	106-07	10.63	
Bromochloromethane	129.39	1.991	68	10.77	
1-Bromo-2-Flourobenzene	175.01	1.593	150	8.99	
Bromoform	252.8	2.9	150-01	10.47	0.5
1-Bromo-2-methyl propane	137.03	1.260	90-92	10.09	
2-Bromo-2-methyl propane	137.03	1.189	72-74	9.89	
1-Bromopentane	151.05	1.218	130	10.10	
2-Bromopropane	123.00	1.354	71	10.18	
2-Bromopropene	123.00	1.310	59	10.08	
1-Bromopropene	120.98	1.413	58-63	9.30	
3-Bromopropene	120.98	1.398	70-71	9.70	
2-Bromothiophene	163.04	1.684	149-151	8.63	
M-Bromotoluene	171.04	1.4099	183.7	8.81	
O-Bromotoluene	171.04	1.431	58.60	8.79	
P-Bromotoluene	171.04	1.431	184	8.67	
1,3-Butadiene	54.1	gas	9.07		1000
Butane	58.12	gas	10.63		
	90.19	.842	9.14		

* BP - Boiling Point Degrees Centigrade
** IP - Ionization Potential
*** TWA - Time Weighted Average = Parts Per Million

CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM)***
2-Butanone	72.1	0.81	80	9.53	200
1-Butene	56.10	0.6255		9.58	
N-Butyl Acetate	116.2	0.88	124-26	10.01	150
S-Butyl Acetate	116.2	0.88	111-12	9.91	150
N-Butyl Alcohol	74.1	0.81	117.7	10.04	100
N-Butyl Amine	73.1	0.73	73	78	5
S-Butyl Amine	73.1	0.73	63	8.70	5
T-Butyl Amine	73.1	0.73	46	8.64	5
N-Butyl Benzene	134.21	0.8604	183	8.69	
S-Butyl Benzene	134.21	0.8604	173-04	8.68	
T-Butyl Benzene	134.21	0.8669	169	8.68	
N-Butyraldehyde	72.10	0.8016	75	9.86	
N-Butyric Acid	88.10	0.959	162	10.16	
N-Butyronitrile	69.10	0.7954	115-17	11.67	
Camphor	152.2	0.99	204	8.76	2 mg/m
Carbon Dioxide	44.01	gas		13.79	5000
Carbon Monoxide	28.01	gas		14.01	50
Carbon Tetrachloride	153.8	1.59	77	11.47	10
Chlorine	70.90	gas		11.48	1 cell
Chlorobenzene	112.6	1.10	132	9.07	75
Chloroform	119.4	1.48	60.5-61.5	11.37	50 cell
1-Chloro-2-Methylpropane	92.57	.883	68-69	10.66	
2-Chloro-2-Methylpropane	101.64	.851	51-52	10.61	
1-Chloropropane	78.54	.892	46-47	10.82	
2-Chloropropane	78.54	.859	34-36	10.78	
3-Chloropropane	76.53	.939	44-46	10.04	
2-Chlorothiophene	118.59	1.286	127-29	8.68	
M-Chlorotoluene	126.58	1.076	160-162	8.83	
O-Chlorotoluene	126.58	1.0826	157-159	8.83	
P-Chlorotoluene	126.58	1.0697	162	8.70	
M-Cresol	108.1	1.034	203	8.52	5 cell
O-Cresol	108.1	1.048	191	8.50	5 cell
P-Cresol	108.1	1.034	202	8.38	5 cell
Crotonaldehyde	70.09	0.853	104	9.73	2
Cumene	120.2	0.86	152-154	8.75	50
Cyanogen	52.04	0.9537		13.80	
Cyclohexane	84.2	0.81	80.7-81	9.98	300
Cyclohexane	100.2	0.96	160-161	10.0	50
Cyclohexanone	98.1	0.95	155	9.14	50
Cyclohexene	82.1	0.81	83	8.95	300
Cyclo-Octatetraene	104.15	0.925	142-43	7.99	
Cyclopentane	70.13	0.7460	50	10.53	
Cyclopentanone	84.11	1.4366	130-131	9.26	
Cyclopentene	68.12	0.744	44	9.01	
Cyclopropane	42.08	gas		9.91	
Diborane	27.68	gas		11.00	
Diazomethane	42.0	gas		9.0	0.2

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CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM)***
Dibromodiflouromethane	209.83	2.297	22-23	11.07	
1,2-Dibromoethane	187.87	2.180	131-32	9.45	
1,3-Dibromopropane	201.90	1.937	167	10.07	
Dibutylphthlate	278.3	1.04	340		5 mg/m
M-Dichlorobenzene	147.01	1.288	172-73	9.12	50
O-Dichlorobenzene	147.01	1.306	179-180	9.07	50
P-Dichlorobenzene	147.01	1.241	173	8.94	75
1,1-Dichlorethane	99.0	1.18	57	11.06	100
1,2-Dichlorethane	98.96	1.256	83	11.12	
1,2-Dichlorethylene	97.0	1.28	46-60	9.66	
Dichloromethane	84.93	1.325	39.8-40	11.35	
1,2-Dichloropropane	112.99	1.156	95-96	10.87	
1,3-Dichloropropane	112.99	1.190	120-22	10.85	
2,3-Dichloropropane	110.97	1.204	94	9.82	
N,N-Diethyl Acetamide	115.18	0.925	182-86	8.60	
Diethylamine	73.1	0.71	55	8.01	25
Diethyl Ether	74.12	0.7134	34.6	9.53	
N.N-Diethyl Formamide	101.15	0.908	176-77	8.89	
Diethyl Ketone	86.13	0.816	102	9.32	
Diethyl Sulfide	90.19	.837		8.43	
Diethyl Sulfite	138.19	1.883	158-60	9.68	
Dihydropyran	84.12	0.922	86	8.34	
Diisopropylamine	101.2	0.72	84	7.73	5
1,1-Dimethoxyethane	90.12	0.863	64	9.65	
N,N-Dimethyl Acetamide	87.12	0.937	164.5-66	8.81	[illegible]
Dimethyl Amine	45.1	0.68		8.24	
N,N-Dimethyl Aniline	122.2	0.96	193-94	7.13	
2,2-Dimethyl Butane	86.18	0.649	50	10.06	
2,3-Dimethyl Butane	86.18	0.662	50	10.02	
3,3-Dimethyl Butanone	100.16	0.801	106	9.17	
N,N-Dimethyl Formamide	73.09	0.9445	153	9.12	10
Dimethlyl Sulfide	63.13	0.846	38	8.69	
P-Dioxane	88.1	1.03	100-102	9.13	
Dipropyl Amine	101.19	0.738	105-110	7.84	
Durene	134.12	0.84	80-82	8.03	
Epichlorohydrin	92.5	1.18	115-117		5
Ethane	30.07	gas		11.65	
Ethanethiol	62.13	0.8315	35	9.29	
Ethyl Acetate	88.1	0.90	76.5-77.5	10.11	400
Ethyl Alcohol	46.1	0.80	78	10.48	1000
Ethyl Amine	45.1	0.69	19.20	8.86	10
Ethyl Benzene	106.2	0.87	136	8.76	100
Ethyl Bromide	109.0	1.45	37-40	10.29	200
Ethyl Butyl Ketone	114.2	0.82	146-49	9.02	50
Ethyl Chloride	64.52	0.9214		10.98	1000
Ethyl Disulfide	122.25	0.993	153	8.27	
Ethylene Dibromide	187.9	2.17	131-132	10.52	20
Ethylene Dichloride	99.0	1.26	83	11.32	50

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CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM)**
Ethyl Ether	74.1	0.73	34.6	9.59	400
Ethyl Formate	74.1	0.92	52-54	10.61	100
Ethyl Iodide	155.98	1.950	67-73	9.33	
Ethyl Isothiocyanate	87.15	1.003	60	9.14	
Ethyl Methyl Sulfide	76.16	0.842	66-67	8.55	
Ethyl Nitrate	75.07	0.90	112	11.22	
Ethyl Propionate	102.13	0.891	99	10.00	
Ethyl Thiocyanate	87.14	1.007		9.89	
Ethynylbenzene	102.13	0.9300	142-44	8.82	
Fluorine	37.99	gas		15.70	
Flourobenzene	96.10	1.024	85	9.20	
O-Fluorophenol	112.10	1.256	172-74	8.95	
M-Fluorotoluene	110.13	0.997	178	8.92	
O-Fluorotoluene	110.13	1.004	172-172	8.92	
P-Fluorotoluene	110.13	1.001	185	8.79	
Formaldehyde	30.03	1.083		10.87	3
Formahide	45.04	1.1334	210	10.25	
Formic Acid	46.02	1.220	110-101	11.05	
2-Furaldehyde	96.09	1.160	182	9.21	
Furan	68.07	0.9371		8.89	
Heptane	100.2	0.68	98	10.08	
2-Heptanone	114.18	0.8068	149-50	9.33	
Hexane	86.2	0.66	68-69	10.18	500
1-Hexane	84.16	0.673	64	9.46	
Hexone	100.2	0.80		9.53	
Hydrogen	2.017	gas		15.43	
Hydrogen Bromide	80.92	gas		11.62	3
Hydrogen Chloride	36.47	gas		12.74	5 cell
Hydrogen Cyanide	27.03	0.687		13.91	10
Hydrogen Flouride	20.01	gas		15.77	3
Hydrogen Iodide	127.93	gas		10.38	
Hydrogen Selenide	80.98	gas		9.88	0.05
Hydrogen Sulfide	34.08	gas		10.46	20 cell
Hydrogen Telluride	129.63	gas		9.14	
Iodine	253.81	4.93		9.28	0.1 cell
Iodobenzene	204.02	1.8384	188	8.73	
1-Iodobutene	184.02	1.617	130-31	9.21	
2-Iodobutene	184.02	1.4991	119-120	9.09	
1-Iodo-2-Methylpropane	184.02	1.599	120-21	9.18	
1-Iodopentane	198.05	1.517	154-55	9.19	
1-Iodopropane	169.99	1.743	101-02	9.26	
2-Iodopropane	169.99	1.703	88-90	9.17	
O-Iodotoluene	218.04	1.713	211	8.62	
M-Iodotoluene	218.04	1.698		8.61	
P-Odotoluene	218.04		211-5	8.50	
Isoamyl Acetate	130.2	0.88	142	9.94	
Isoamyl Alcohol	88.2	0.81	130-1	10.42	

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CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM)**
Isobutyl Amine	73.14	0.724	64-71	8.70	
Isobutyl Formate	102.13	0.885	98.4	10.46	
Isobutylene	56.11	0.5942	-6.9	9.23	
Isobutyraldehyde	72.11	0.794	63	9.74	
Isobutyric Acid	88.11	0.950	153-54	10.02	
Isoctane	114.2	0.70	98-99	17.9	
Isopentane	114.23	0.692	30	10.32	
Isoprene	68.12	0.681	34	8.85	
Isopropyl Acetate	102.1	0.87	85	9.99	250
Isopropyl Alcohol	60.1	0.79		10.16	400
Isopropyl Amine	59.1	0.69	33-34	8.72	5
Isopropyl Benzene	120.2	0.86	152-54	8.75	50
Isopropyl Ether	102.2	1.37	68-69	9.20	500
Isovaleraldehyde	86.13	0.785	90	9.71	
2,3-Lutidine	107.15	0.945	162-63	8.85	
2,4-Lutidine	107.15	0.927	159	8.85	
2,6-Lutidine	107.15	0.9252	143-45	8.85	
Malaic Anhydride	98.1	0.93	200	11.1	
Mesitylene	120.19	0.8637	162-64	8.40	
Mesityl Oxide	98.14	0.8592	129	9.08	
Methane	16.04	gas		12.98	
Methanethiol	48.11	0.96		9.44	
N-Methyl Acetamide	73.10	0.957	204-05	8.90	
Methyl Acetate	74.08	0.9279	57.5	10.27	
Methyl Acrylate	86.1	0.96	80	9.9	10
Methyl Amine	31.06	gas	48	8.97	
Methyl Bromide	95.0	gas		10.53	
2-Methyl-1-Butane	70.16	0.650	31	9.12	
3-Methyl-1-Butane	70.14	0.627	20	9.51	
3-Methyl-2-Butane	70.14	0.643		8.67	
Methyl Butyl Ketone	100.6	0.83	127	9.34	
Methyl Butyrate	102.13	0.898	102-103	10.07	
Methyl Chloride	50.5			11.28	
Methyl Cyclohexane	98.19	0.770	101	9.85	
Methyl Disulfide	94.20	1.046	109	8.46	
Methyl Ethyl Ketone	72.10	0.805	80	9.53	
Methyl Formate	60.1	1.34	34	10.815	100
2-Methyl Furan	82.10	0.827	63-66	8.39	
Methyl Iodide	142.0	2.28	41-43	9.54	5
Methyl Isobutyl Ketone	100.2	0.80	117-18	9.30	100
Methyl Isobutyrate	102.13	0.891	90	9.98	
Methyl Isopropyl Ketone	86.12	0.805	94-95	9.32	
Methyl Isothiocyanate	73.12		37-39	9.25	
Methyl Methacrylate	100.1	0.94	100	9.9	100
1-Methyl Napthalene	142.20	1.001	240-243	7.96	
2-Methyl Napthalene	142.20	1,000	241-242	7.96	
2-Methyl Pentane	86.18	0.653	62	10.12	
3-Methyl Pentane	86.18	0.664	64	10.08	
Methyl Propionate	88.11	0.915	79	10.15	

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CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM)**
Methyl Propyl Ketone	86.13	0.809	100.01	9.38	
2-Methyl Styrene	165.4	1.068	131	10.07	
Monomethyl Aniline	107.16	0.989			
Monomethyl Hydrazine	46.1	0.87			
Morpholine	87.1	1.01	129	8.88	20
Nephthalene	93.7	1.16	217.7	8.12	10
Nitric Oxide	162.2	1.01		9.25	
P-Nitroaniline	138.1				1.0
Nitrobenzene	123.1	1.21	210-211	9.92	1.0
4-Nitrobiphenyl	199.2				
P-Nitrochlorobenzene	157.6	1.52		9.96	1.0 mg/m
Nitrogen Dioxide	46.01	1.448		9.78	
Nitroethane	75.1	1.38	112	10.81	100
Nitromethane	61.0	1.13	100.8-101	11.08	100
1-Nitropropane	89.1	0.99	131-32	10.88	25
2-Nitropropane	89.1	0.98	120	10.71	25
N-Nitrosodimethylamine	74.1	1.00	153	9.07	
Nitrotoluene	137.1	1.16	225-238	11.63	5
Oxygen	31.9988	gas		12.08	
Ozone	48.00	gas		12.08	
Pentaborane	63.17	0.61		10.40	
Pentane	72.15	0.62638	35	10.35	
2,4-Pentanedione	70.13	0.6429	140.4	8.87	
1-Pentene	70.13	0.6503	29.9-30.1	9.50	
Phenetol	122.16	0.967	169-70	8.13	
Phenol	94.1	1.07	182	8.50	5
Phenyl Hydrazine	108.1	1.1	238-41	7.86	5
Phenyl Isocyanate	119.12	1.0887	162-63	8.77	
Phenyl Isothiocyanate	135.18	1.1288	221	8.52	
Phosgene	98.9	gas		11.77	0.4 mg/m
Phosphine	34.0	gas			0.3
Phosphorous Pentachloride	208.2	1.6		10.7	1 mg/m
Phosphorous Trichloride	137.3	1.57	76	10.5	
2-Picoline	93.12	0.950	128-29	9.02	
3-Picoline	93.12	0.9613	144	9.02	
4-Picoline	93.12	0.9571	145	9.04	
Propane	44.09	gas		11.07	
1-Propanethiol	76.16	0.841	67-68	9.20	
Propiolactone	72.06	1.146	162	9.70	
Propionic Acid	74.08	0.99336	141	10.24	
Propionaldehyde	58.08	0.8071	46-50	9.98	
Propionitrile	55.08	0.7818	97	11.84	
N-Propyl Acetate	102.1	0.84	120	10.04	200
Propyl Alcohol	60.10	0.804	97	10.20	
Propyl Amine	59.11	0.719	48	8.78	
Propyl Benzene	120.20	0.862	159	8.72	
Propylene	42.08	gas		8.73	
Propylene Oxide	58.08	0.859	34	10.22	

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CHEMICAL MATERIALS	F.W. (G/MOLE)	DENSITY (G/ML)	BP (°C)*	I.P. (EV)**	TWA (PPM)***
Methyl Propyl Ketone	86.13	0.809	100.01	9.38	
2-Methyl Styrene	165.4	1.068	131	10.07	
Monomethyl Aniline	107.16	0.989			
Monomethyl Hydrazine	46.1	0.87			
Morpholine	87.1	1.01	129	8.88	20
Napthalene	93.7	1.16	217.7	8.12	10
Propyl Ether	102.17	0.7360	88.90	9.27	
Propyl Formate	88.10	0.901		10.54	
Pyrene	202.3	gas		7.41	
Pyridine	79.1	0.98	115	9.32	5
Pyrrole	67.09	0.9691	131	8.20	
Styrene	104.14	9.9059	145-146	8.47	
Styrene Oxide	120.2	1.054	194	9.04	
Tetrachloroethylene	165.9	1.63	121	9.32	100
Tetrahydrofuran	72.10	0.8892	67	9.54	
Tetrahydropyran	86.13	0.8814	88	9.26	
Thiophene	84.1	1.53	84	8.86	
Toluene	93.13	0.866	111	8.82	
O-Toluidine	107.2	1.01	199-200	7.44	5
Trichloroethene	131.40	1.4649	87	9.45	
Triethylamine	101.19	1.069	88.18	7.50	
Trimethyl Amine	59.11	0.636	3-4	7.82	
2,2,4-Trimethyl Pentane	114.23	0.692	98-99	9.86	
Tripropyl Amine	143.27	0.753	155-58	7.23	
Valeraldehyder	86.13	0.8095	103	9.82	
Valeric Acid	102.13	0.939	185	10.12	
Vinyl Acetate	118	0.94	72-73	9.19	1
Vinyl Bromide	106.96	1.517	16	9.80	
Vinyl Chloride	62.5	gas		10.00	1
Water	18.016	1.00	100	12.59	
M-Xylene	106.16	0.8684	138-39	8.56	100
O-Xylene	106.16	0.8801	143-45	8.56	100
P-Xylene	106.16	0.8614	138	8.45	100

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*** TWA - Time Weighted Average = Parts Per Million

APPENDIX G

DILUTION PROBE OPERATION

(Not investigated as part of UL classified product)

G.1 GENERAL

The dilution probe is constructed of stainless steel and Teflon, with a charcoal filter mounted on the dilution inlet. The purpose of the charcoal filter is to provide hydrocarbon free air to the probe assembly so that the dilution of the incoming sample is not affected by the dilution air. The charcoal filter should be changed every 3 months to ensure proper operation, eliminating the problem of hydrocarbon breakthrough. It is easy to evaluate the performance of the charcoal, by challenging the Model 580A with hydrocarbon free air, then introducing a standard through the charcoal filter, with the inlet of the probe plugged. If there is breakthrough, a reading other than zero will be observed on the readout.

Another important part of the dilution probe is the 10 micron filter that is placed in the inlet of the probe assembly. The flow through this may reduce with time, as dirt collects on the inlet filter. This filter should be changed on a regular basis, depending upon the operator's experience and the environment in which he is working.

It is important to realize that the charcoal filter is not a totally efficient device. This does not cause a problem with the 580A, however, because the photoionization detector does not respond to ethane or methane.

TECHNICAL CONSIDERATION

Need For Dilution - The Model 580B dilution system was developed to increase the dynamic range of the Model 580A. As the instrument is manufactured, it has a workable range of 0 to 2,000 ppm. Above this upper limit, the detector is found to be non-linear. It does not absorb ethane or methane. The 580B will "lock out" for concentrations above 2,000 ppm. To meet the requirements of fugitive emission measurements as defined in EPA Method 21, there is the need to make measurements above the 2,000 ppm level. To accomplish this using a detector system that is limited by linearity, a dilution probe was developed. this probe provides a nominal 10 to 1 dilution ratio, increasing the dynamic range of the Model 580B from 2,000 to 20,000 ppm.

G.3 CALIBRATION OF THE DILUTION PROBE

The dilution probe is not factory calibrated. It has been tested and evaluated proper performance. It is the responsibility of the operator to properly calibrate the dilution probe.

The following is a simple procedure for this activity:

1. The performance of the 580B should have previously seen verified and calibrated.

2. Place the 580B in close proximity to a standard with the appropriate range. For example, if the instrument is to be used in a 5,000 ppm sampling range, then a standard of that concentration should be selected.

3. Connect the dilution probe making sure that the charcoal filter and the 10 micron filter are in place to the front of the 580B.

4. Challenge the instrument with the new standard gas and adjust the micro metering valve until a tenth of the reading is seen on the instrument readout.

5. As in the example of the 5,000 ppm standard, 500 ppm should be seen on the readout.

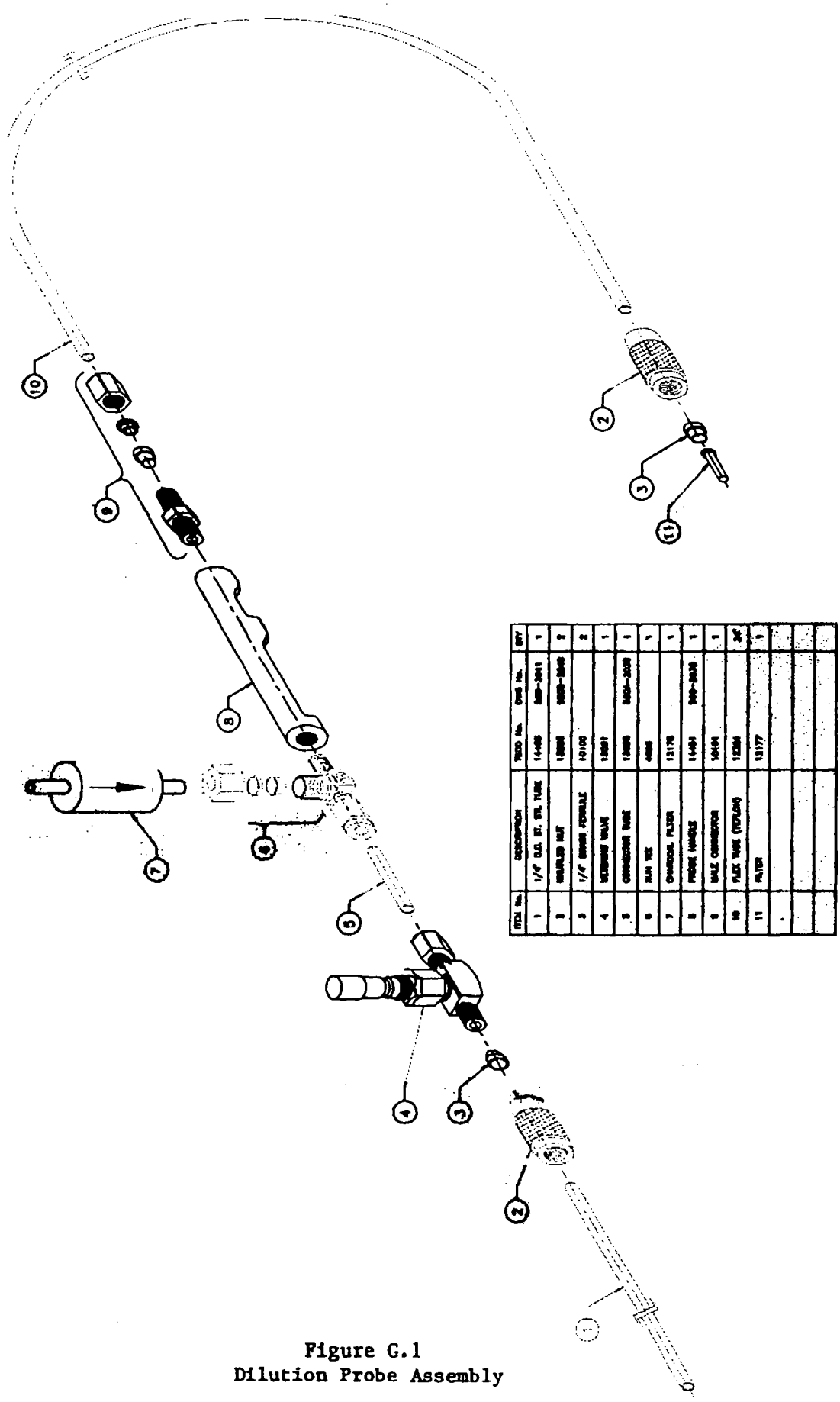
6. This is all that is required to calibrate the 580A or 580B.

   Note: It is important that both zero and span of of the 580A have been properly verified prior to initiating this procedure. It is very simple after using the dilution probe, to remove it and recheck the performance of the instrument on your low concentrator standard.

7. It should be noted that due to the environment that you are operating in, there may be a change in the back pressure of the charcoal filter and the 10 micron filter. Any changes in these over a period of time will cause a change in the split ratio of the dilution probe. Therefore, it is important to calibrate the dilution probe as regularly as you calibrate the 580A or 580B.

REPLACEMENT PARTS

1.	Inlet Probe Assembly	580A-6016
2.	Charcoal Filter	3150-0018
3.	Inlet Filter 10 Micron	3150-0017



ITEM No.	DESCRIPTION	TEDO No.	DWG No.	QTY
1	1/4" O.D. ST. STL. TUBE	14465	[illegible]	1
2	MOUNTED NUT	[illegible]	[illegible]	2
3	1/4" [illegible] FERRULE	10100		2
4	METERING VALVE	[illegible]		1
5	CONNECTOR TUBE	[illegible]	[illegible]	1
6	RUN TEE	[illegible]		1
7	CHARCOAL FILTER	12176		1
8	PROBE HANDLE	14461	[illegible]	1
9	MALE CONNECTOR	10101		1
10	FLEX TUBE (TEFLON)	12264		24"
11	FILTER	13177		1

Figure G.1
Dilution Probe Assembly

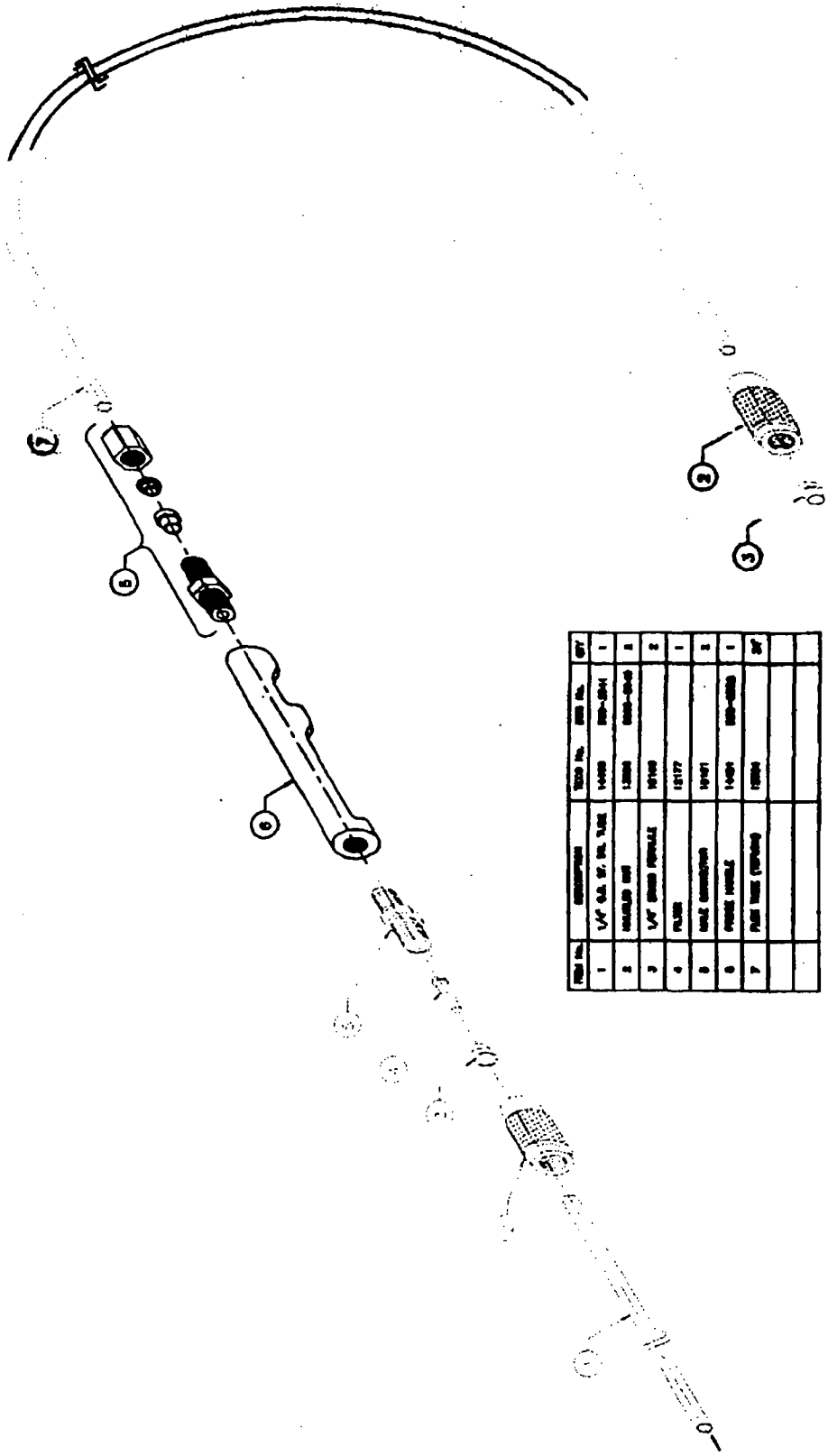


Figure H.1
Probe Extension Assembly

APPENDIX I

INSTRUCTION SHEET
OPTION 11 WATER TRAP ASSEMBLY

(Not investigated as part of the UL classified product)

INSTALLATION

The water trap assembly (16846) is to be installed on the end of the 580 sample probe. The tygon tubing included is to be placed on the syringe side of the filter then connected to the probe. Refer to the drawing below.

USE

The water trap will effectively stop water from entering the instrument. Water traps can be re-used after drying at room temperature, but the user must be cautious of possible contamination. Contaminated traps should be discarded.

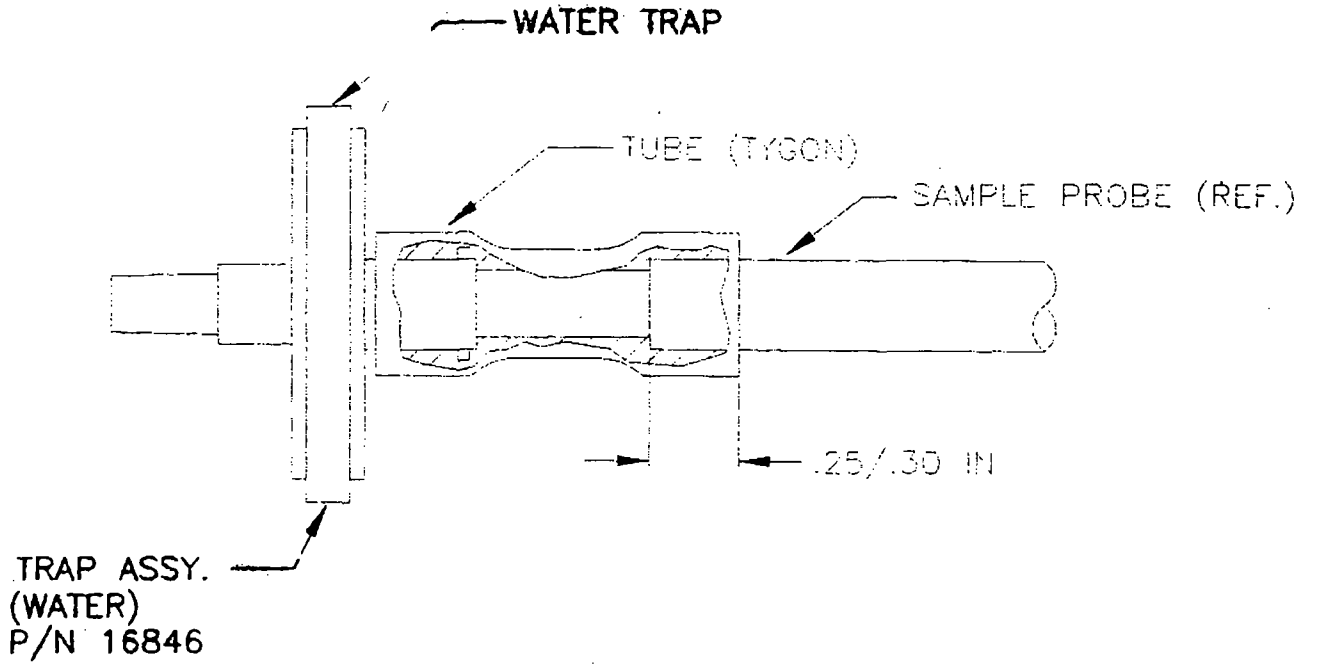


Figure I.1
Water Trap Assembly

APPENDIX J

Revised documents having an earlier revision level to the existing manual documents.

B-1	Processor Circuit	580S-9002	Sht. 1
B-2	Processor Circuit	580S-9002	Sht. 2
B-3	Memory Circuit	580S-9007	
C-1, 2, 3	Processor Board Bill of Materials	580S-6008	
	Processor Board Silkscreen	580S-6008	
	Memory Board Bill of Materials	580S-6007	
	Memory Board Silkscreen	580S-6007	

APPENDIX K

RS-232 Information Sheet

This procedure will retrieve logged data from Thermo Environmental Instruments' Model 580, and download the data into the HyperTerminal program for Windows 95 or Windows NT.

Hardware needed:

- Model 580
- Personal computer running either Win95 or WinNT with an available free serial communication port.
- RS-232 cable supplied with the Model 580

Software needed:

- HyperTerminal (supplied with Win95 and WinNT)

NOTE:
Even though this document uses HyperTerminal as the communication package, it is not necessary to use this program. HyperTerminal was chosen because it is part of the Win95 and WinNT software packages and is therefore readily available to users of these operating systems. Any communication program can be used to retrieve data from the Model 580 as long as it allows direct connections to a free communication port.

Procedure for setting up HyperTerminal for Win95 and WinNT

Click on the **HyperTerminal** folder within the **Programs/Accessories** folder in the start menu
Double Click on the icon called "HYPERTRM" or "HYPERTRM.EXE". This will execute the program and a dialog box called Connection Description should appear. In this dialog box it should say New Connection. In the edit box labeled **Name** enter *Model 580*. Then click **OK.**
Another dialog box called Phone Number should appear. The only edit box that needs to be changed is labeled **Connect Using.** From the list, selected by clicking on down arrow on the side of the edit box, pick from the *Direct to Comm* choices, the communications port you are planning to connect the Model 580 to. Then click **OK.**
A dialog box called Comm # Properties (# being the communications port you selected) should appear. These are the communications settings that should be set for communications with the Model 580.

Bits per second	9600	(Also called BAUD RATE)
Data bits	8	
Stop bits	1	
Flow Control	NONE	(Also called handshaking)

Once the above properties have been entered and set into the appropriate edit boxes, click **OK**
At this point you should have the main HyperTerminal program window on the screen. On the left side of the status bar which appears at the bottom of the screen, it should read "connected" with a timer counting up.
From the **FILE** menu select **SAVE**. This will save the properties you just entered for later use. The file will be named *Model 580* or *Model 580.ht* and can be used to start HyperTerminal by just double clicking on this file in the HyperTerminal folder.

Procedure for setting up Thermo Environmental Instruments' Model 580

To setup the Model 580 to communicate with the HyperTerminal or any other communications program see section 2.7.4 in the Manual. The Model 580 should be set to use *PRINTER FORMAT* with the baud rate set to *9600*. A basic understanding of the Model 580's menu system will be helpful.

To transfer data between HyperTerminal and the Model 580

HyperTerminal should be setup and the Model 580 should be set up and running. Before transferring the data, HyperTerminal or the communications program you are using should be set to capture the text being transmitted by the model 580.

To turn on the capture text feature in HyperTerminal

1 Select **CAPTURE TEXT** from the **TRANSFER** menu. A dialog box will appear asking for a file name to which the data will be written.
2. Enter the directory and filename in the edit box and then click **START**. The capture file is now open and ready to receive data.
3. Use the **BROWSE** button to open the appropriate file and directory into which you wish the captured data to be saved. Using the **BROWSE** feature only allows you to open an existing file and it will not let you create a new file.

Connect the communication cable between the selected communication port on the computer and the Model 580.
Once the Model 580 is setup and connected select Output Logged Data on the Model 580 and data should appear in the HyperTerminal Window. This is the logged data and even though it may scroll off screen all the data is being captured into the above capture file described above.
Once the data is transferred, close the capture text file. This is done in HyperTerminal by selecting **STOP** from the **TRANSFER/CAPTURE TEXT** menu.
This capture text file can now be printed using any text editor or imported into a spread sheet program for data analysis.

SERVICE LOCATIONS

For additional assistance, Environmental Instruments Division has service available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information.

866-282-0430 Toll Free
508-520-0430 International

Geotech P3

Bedienungsanleitung

Taschenmeßgerät MultiLine P3 pH/OXI und SET

Instruction Manual

Pocket Meter MultiLine P3 pH/OXI and SET

Bedienungsanleitungen
Instruction manuals

MultiLine P3 pH/OXI

und/*and* SET

pH/Sauerstoff -Taschenmeßgerät
pH/Oxygen Handheld Meter

MultiLine P3

pH-Einstabmeßkette mit integriertem Temperaturmeßfühler
pH Combined Electrode with Integrated Temperature Probe

SenTix 41

Sauerstoffsensor
Dissolved Oxygen Probe

CellOx 325

Luftkalibriergefäß
Air Calibration Beaker

OxiCal® - SL

BA62207/02.98/As/MultiLine P3/pHOxi-SET_1

Sicherheitshinweise

Bitte lesen Sie diese Sicherheitshinweise vor Inbetriebnahme des Gerätes aufmerksam durch!

Dieses Gerät ist gemäß IEC 1010, Sicherheitsbestimmungen für elektronische Meßgeräte, gebaut und geprüft und hat das Werk in sicherheitstechnisch einwandfreiem Zustand verlassen.

Die einwandfreie Funktion und Betriebssicherheit des Gerätes ist nur dann gewährleistet, wenn bei der Benutzung die allgemein üblichen Sicherheitsvorkehrungen sowie die speziellen Sicherheitshinweise in dieser Bedienungsanleitung beachtet werden.

- Vor dem Verbinden des Steckernetzgerätes mit dem Stromversorgungsnetz sicherstellen, daß die am Steckernetzgerät angegebene Betriebsspannung mit der Netzspannung übereinstimmt (Angabe der Bereiche der Spannungsversorgung).
- Die einwandfreie Funktion und Betriebssicherheit des Gerätes kann nur unter den klimatischen Verhältnissen, die im Kapitel "Technische Daten" in dieser Bedienungsanleitung spezifiziert sind, eingehalten werden.
- Wird das Gerät von einer kalten in eine warme Umgebung transportiert, kann durch Kondensatbildung eine Störung der Gerätefunktion eintreten. In diesem Fall muß die Angleichung der Gerätetemperatur an die Raumtemperatur vor einer erneuten Inbetriebnahme abgewartet werden.
- Das Öffnen des Gerätes, Abgleich-, Wartungs- und Reparaturarbeiten dürfen nur von einer von uns autorisierten Fachkraft ausgeführt werden.
- Wenn anzunehmen ist, daß das Gerät nicht mehr gefahrlos betrieben werden kann, so ist es außer Betrieb zu setzen und vor einer weiteren Inbetriebnahme durch Kennzeichnung zu sichern.
- Die Sicherheit des Benutzers kann durch das Gerät beeinträchtigt sein, wenn es zum Beispiel
  - sichtbare Schäden aufweist,
  - nicht mehr wie vorgeschrieben arbeitet,
  - längere Zeit unter ungeeigneten Bedingungen gelagert wurde,
  - erschwerten Transportbedingungen ausgesetzt war.
- In Zweifelsfällen sollte das Gerät grundsätzlich an den Hersteller "Wissenschaftlich-Technische-Werkstätten GmbH" zur Reparatur bzw. Wartung eingeschickt werden.

Safety guidelines

Please read these safety guidelines attentively before the instrument is put into operation!

This instrument has been built and tested acc. to the German safety regulations for electronic test instruments IEC 1010 and has left our works in a condition complying with all the requirements of technical safety.

The perfect functioning and operational safety of the instrument is only ensured if the user observes the normal safety precautions as well as the specific safety guidelines stated in the present instruction manual.

- *Before connecting the plug-in power supply unit to the electricity supply network, ensure that the operating voltage stated on the plug -in power supply unit corresponds to the mains voltage (statement of the supply voltage range).*
- *The perfect functioning and operational safety of the instrument can only be maintained under the climatic conditions specified in the "Technical data" section of this instruction manual.*
- *When the instrument is moved from cold to warm surroundings, condensate may occur and interfere with the functioning of the instrument. In such a case, the user should wait until the temperature of the instrument has adapted to the ambient temperature before using the instrument again.*
- *Opening of the instrument, adjustment, maintenance or repair must only be carried out by a suitably qualified specialist authorized by us.*
- *If there is reason to assume that the instrument can no longer be employed without a risk, it must be set aside and appropriately marked to prevent further use.*
- *The safety of the user may be endangered, e. g. if the instrument*
  - *shows visible damage,*
  - *no longer operates as specified,*
  - *has been stored over a longer period under unsuitable conditions,*
  - *has been subjected to difficult conditions during transport.*
- *If in doubt, the instrument should as a rule be sent back to the manufacturer - "Wissenschaftlich-Technische-Werkstätten GmbH" for repair or maintenance.*

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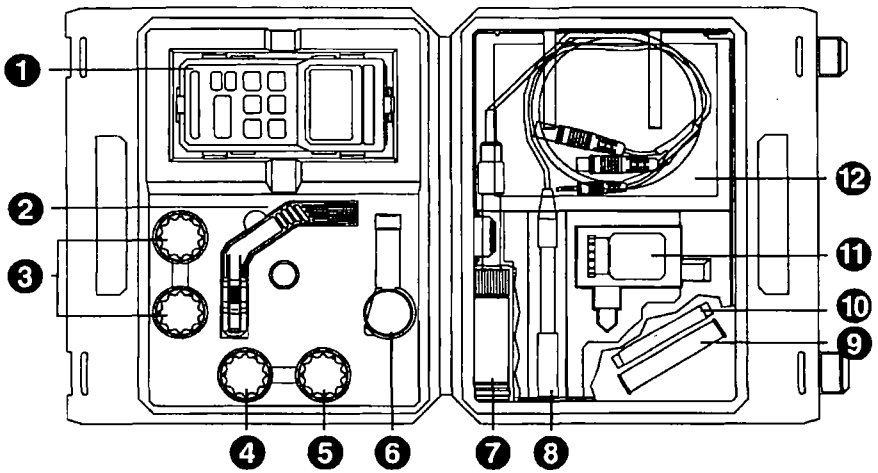
SET-Ausstattung
SET equipment



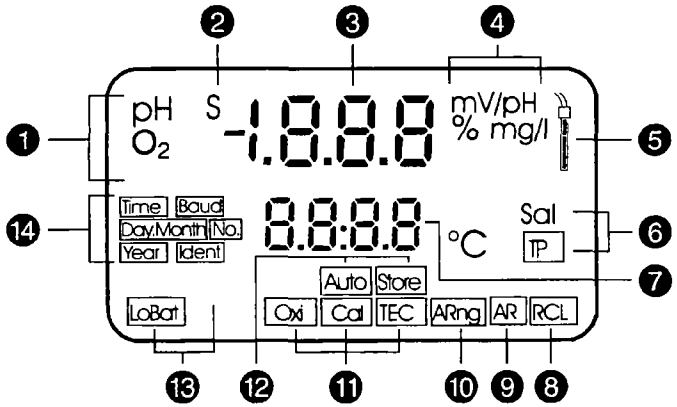
1	Meßgerät MultiLine P3 pH/OXI	*Meter MultiLine P3 pH/OXI*
2	Stativ	*Stand*
3	• pH-Pufferlösung STP 4, 50 ml • pH-Pufferlösung STP 7, 50 ml	• *pH buffer solution STP 4, 50 ml* • *pH buffer solution STP 7, 50 ml*
4	KCl Aufbewahrungslösung für Meßketten	*KCl Storing solution for electrodes*
5	Elektrolytlösung für O_2-Elektroden ELY/G	*Electrolyte solution ELY/G for O_2 electrodes*
6	Meßbecher 50 ml	*Measuring beaker 50 ml*
7	CellOx 325	*CellOx 325*
8	SenTix 41	*SenTix 41*
9	Wechselpatronen	*Exchange cartridges*
10	Schleiffolie	*Grinding foil*
11	Reinigungslösung RL-G	*Cleaning solution RL-G*
12	Bedienungsanleitung Klebeschilder - Kurzanleitung - Deutsch und Englisch	*Instruction manual* *Adhesive labels - short instruction - German and English*

pH/Sauerstoff-Taschenmeßgerät
pH/Oxygen Handheld Meter

MultiLine P3 pH/OXI

Display

Display



❶ **Meßmodus:**

pH	pH-Wert + Redoxspannung	*pH*	*pH value + redox voltage*
O_2	Sauerstoff	*O_2*	*Dissolved oxygen*

❷ **Kalibrierdaten:**
Steilheit des Sauerstoffsensors

Calibration data:
Slope of the D. O. probe

❸ **Benutzerführung und Meßwerte:**
pH, Spannung, Sauerstoffkonzentration, Sauerstoffsättigung, pH-Meßkettensteilheit, Asymmetrie, Sauerstoffsensor-Steilheit

User guidance and measured values:
pH, voltage, D. O. concentration, D. O. saturation, Slope of the pH electrode, Asymmetry, Slope of the D. O. probe

❹ **Einheiten:**

mV	Spannung/Asymmetrie	*mV*	*Voltage/Asymmetry*
mV/pH	Meßkettensteilheit	*mV/pH*	*Slope of the electrode*
%	Sauerstoffsättigung	*%*	*D. O. saturation*
mg/l	Sauerstoffkonzentration	*mg/l*	*D. O. concentration*

❺ **Kalibrierdaten:**
Sensorbewertung

Calibration data:
Probe evaluation

❻ **Status:**

Sal	Salzgehaltskorrektur aktiv	*Sal*	*Salinity correction active*
TP	Temperaturmessung aktiv	*TP*	*Temperature measurement active*
°C	Temperatur	*°C*	*Temperature*

❼ **Meßwerte und eingestellte Parameter:**
Temperatur, Salinität, Uhrzeit, Datum, Numerator, Nummer zur Meßwertidentifikation, Baudrate

Measured values and set parameters:
Temperature, Salinity, Time, Date, Numerator, Number to identify measured value, Baud rate

❽ **Status:**

RCL	Funktion "Speicher Auslesen" aktiv	*RCL*	*Function "Read-out of memory" active*

❾ **Status:**

AR	Driftkontrolle aktiv	*AR*	*Drift control active*
AR statisch	Anzeige des stabilen Meßwertes	*AR static*	*Stable measured value is displayed*
AR blinkend	Bestimmen des stabilen Meßwertes	*AR flashing*	*Stable value is being determined*

❿ **Status:**

ARng	Automatische Meßbereichswahl aktiv	*ARng*	*Automatic selection of measuring range active*

⓫ **Kalibrierverfahren:**

AutoCal TEC	für pH-Messungen	*AutoCal TEC*	*for pH measurements*
ConCal	für pH-Messungen	*ConCal*	*for pH measurements*
Oxi Cal	für Sauerstoffmessungen	*Oxi Cal*	*for D. O. measurements*

⓬ **Status:**

Store	Funktion "Manuelles Speichern" aktiv	*Store*	*Function "Manual storing" active*
Auto Store	Funktion "Automatisches Speichern" aktiv	*Auto Store*	*Function "Automatic storing" active*

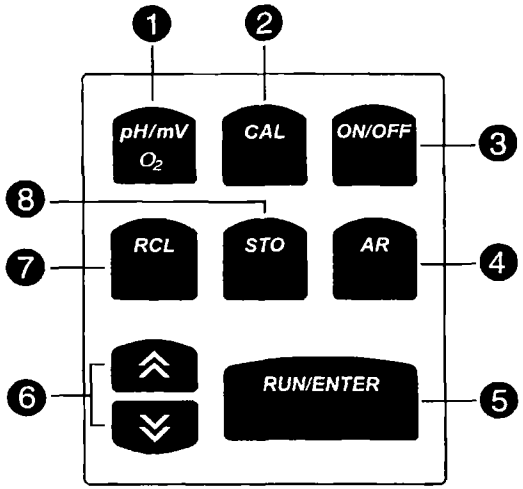
⓭ **Status:**

LoBat	Akku entladen	*LoBat*	*Rechargeable batteries discharged*

⓮ **Status:**

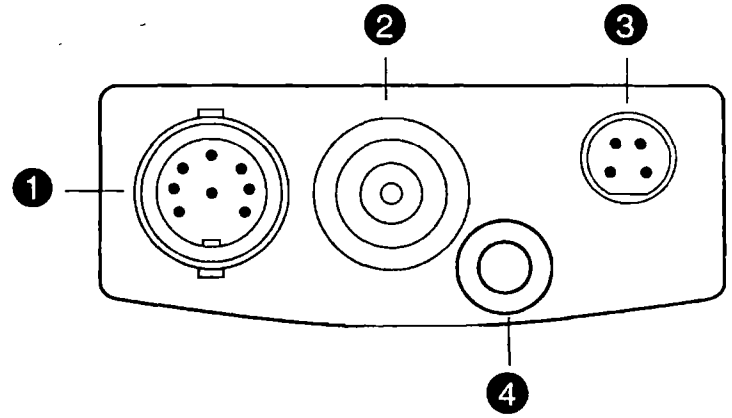
Time	Uhrzeit	*Time*	*Time*
Day, Month	Tag und Monat	*Day, Month*	*Day and month*
Year	Jahreszahl	*Year*	*Year*
Baud	Übertragungsgeschwindigkeit	*Baud*	*Transmission speed*
No.	Nummer des Meßwertspeichers	*No.*	*Number of storage location*
Ident	Nummer zur Meßwertidentifikation	*Ident*	*Number to identify measured value*

Tastatur *Keypad*



1	**Meßmodus**: pH-Wert/Spannung, Sauerstoffkonzentration / Sauerstoffsättigung, (Rollmodus)	***Measuring mode***: *pH value/voltage, D. O. concentration/ D. O. saturation, (scroll mode)*
2	Kalibrieren der jeweils eingestellten Meßgröße	*Calibration of the currently set measuring parameter*
3	Ein-/Ausschalter	*On/Off switch*
4	Ein-/Ausschalter für Driftkontrolle (AR) bei pH und O_2	*On/Off switch for drift control (AR) for pH and O_2*
5	Bestätigen von Eingaben, Starten von Messungen mit Driftkontrolle, Ausgabe von Meßwerten	*Confirmation of inputs, Start of measurements with drift control, Output of measured values*
6	Einstellen numerischer Werte, "Rollen" einer Liste, Auswahl von Einstellungen	*Setting of numerical values, "Scrolling" of a list, Selection of settings*
7	Gespeicherte Meßwerte anzeigen oder übertragen	*Displays or transmits stored measured values*
8	Meßwert speichern	*Stores measured value*

Buchsenfeld *Rear panel*



Buchse/ *Socket*	Anschluß	*Connection*
1	Sauerstoffsensor CellOx 325	*D. O. probe CellOx 325*
2	pH-Einstabmeßkette	*pH combined electrode*
3	Serielle Schnittstelle	*Serial interface*
4	Temperaturmeßfühler (in pH-Meßkette integriert)	*Temperature probe (integrated in pH electrode)*

Batterie-Betrieb

Batterie-Typ:
4 x Alkaline, AAsize, 1,5 V
Betriebsdauer: 5000 h

Battery operation

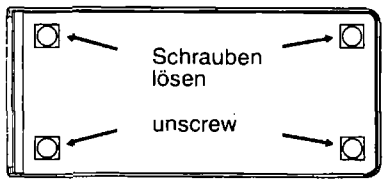
Battery type:
4 x alkaline, AAsize, 1,5 V
Operation time: 5000 hours.

Batteriewechsel

Vor dem Öffnen des Gehäuses Gerät ausschalten!

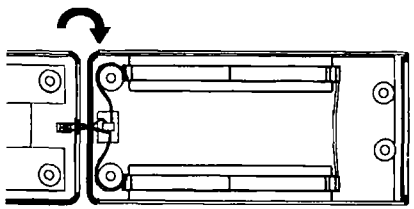
Switch off the instrument before opening!

Rückansicht:



Rear view:

Innenansicht:
Unterschale aufklappen



Interior view:
Swing open lower shell

Alle vier Batterien wechseln, Polarität beachten!
(4 MIGNON, Alkali-Mangan-Batterien)

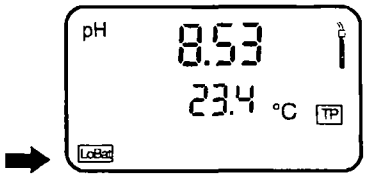
Change all four batteries, pay regard to polarity!
(4 MIGNON, alkali-manganese batteries)

Nur auslaufsichere Alkali-Mangan-Batterien verwenden.
Beim Schließen des Gerätes darauf achten, daß die umlaufende Dichtung nicht beschädigt wird!

Use leakage-free alkali-manganese batteries only.
Take care that the gasket is not damaged when the instrument is closed.

Batteriezustandsanzeige

Display indicator of battery condition



Bei Anzeige "LoBat" sind die Akkus/Batterien weitgehend entladen. Das Gerät ist maximal noch zehn Stunden funktionstüchtig.

When "LoBat" is displayed the batteries are nearly discharged. The meter is operable for no longer than another 10 hours.

– Kapazitätszustand der Akkus/Batterien prüfen und Akkus gegebenenfalls laden, bzw. Batterien tauschen.

– *Check capacity condition of the batteries and if necessary charge the rechargeable batteries, or exchange the non-rechargeable batteries respectively.*

Die **Sparschaltung** schaltet das Gerät etwa eine Stunde nach der letzten Tastenbetätigung ab.

Ausnahmen:
Schnittstellenkabel ist angeschlossen oder die Funktion "Automatisches Speichern" ist eingeschaltet.

The ***economy circuit*** switches off the meter approx. 1 hour after the last key operation.

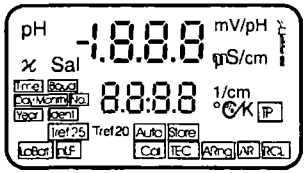
Exceptions:
Interface cable is connected or the function "Automatic storage" is switched on.

– Bei Erstinbetriebnahme bzw. nach Batteriewechsel Datum und Uhrzeit einstellen (siehe Kapitel "Konfiguration").

– *When putting the intrument into operation for the first time or after a battery exchange set date and time (see chapter "Setup").*

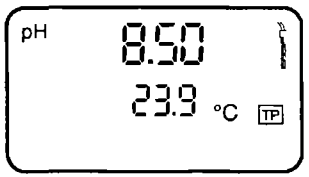
Einschalten / Display test

Switching on / Display test



Einschalten und Displaytest abwarten.

Switch meter on and wait until the display test is finished.



– Falls nach dem Displaytest eine blinkende Datumsanzeige erscheint, müssen Datum und Uhrzeit neu eingestellt werden (wie im Kapitel "Konfiguration" beschrieben).

– *If the date display indicator flashes after the display test, date and time have to be set (as described in chapter „Setup").*

– pH-Meßkette anstecken.

– *Connect pH electrode.*

Automatisches Kalibrieren

Automatic calibration

Zulässige Standardlösungen:

- WTW-Technische Pufferlösungen pH 2.00, 4.01, 7.00 oder 10.00 (bei 25°C)

Admissible standard solutions:

- *WTW technical buffer solutions pH 2.00, 4.01, 7.00 or 10.00 (at 25°C)*

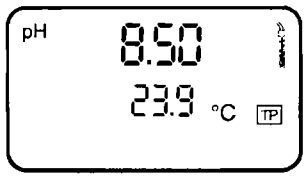
Hinweis:

Höchstmögliche Genauigkeit bei gleicher Temperatur von Standardlösungen und Meßlösungen.

Note:

Highest accuracy when the temperature of standard solutions and sample solution is the same.

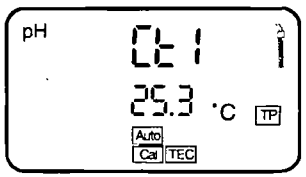
bis / *until*



Meßmodus pH/mV-Wert einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion "pH-Wert" wählen.

Set measuring mode pH/mV value.
With ⌃ or ⌄ select measuring function "pH value".

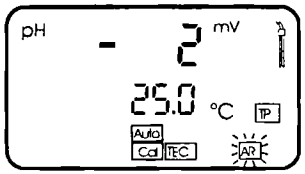
bis / *until*



– pH-Meßkette in die erste Technische Pufferlösung tauchen.

– *Immerse pH electrode into the first Technical Buffer Solution.*

RUN/ENTER

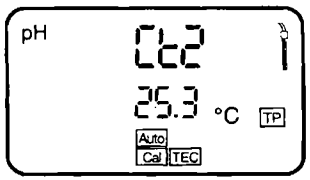


Messung starten.
AR blinkt.

Start measurement.
AR flashes.

Warten bis zur Anzeige:

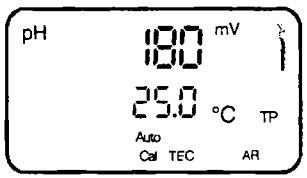
Wait until the display shows:



– pH-Meßkette spülen und in die zweite Technische Pufferlösung tauchen.

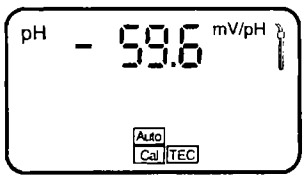
– *Rinse pH electrode and immerse into the second Technical Buffer Solution.*

RUN/ENTER



Messung starten.
AR blinkt.
Warten bis AR erlischt.

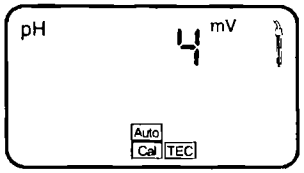
Start measurement.
AR flashes.
Wait until AR extinguishes.



Meßkettensteilheit.
Zulässiger Bereich:
-50,0 mV/pH ... -62,0 mV/pH.

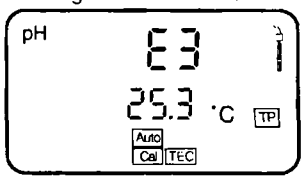
Slope of the electrode.
Admissible range:
-50.0 mV/pH ... -62.0 mV/pH.

RUN/ENTER



Offsetspannung (Asymmetrie).
Zulässiger Bereich: ± 30 mV.

Offset voltage (Asymmetry).
Admissible range: ± 30 mV.



Bei Fehlermeldung E3 siehe Kapitel "Was tun, wenn..."

When error message E3 occurs see chapter "Troubleshooting".

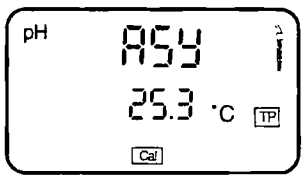
Konventionelle Zwei-Punkt-kalibrierung "ConCal"

Conventional two point calibration "ConCal"

Zulässige Standardlösungen:
Eine Pufferlösung pH 7,0 ± 0,5 und eine beliebige Pufferlösung.

Admissible standard solutions:
Buffer solution pH 7.0 ± 0.5 and a buffer solution of your choice.

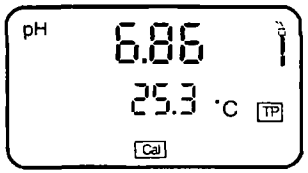
bis/*until*

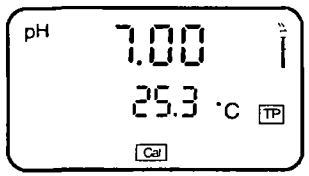


– pH-Meßkette in eine neutrale Pufferlösung tauchen.
pH-Wert der Lösung:
7.0 ± 0.5.

– *Immerse pH electrode into a neutral buffer solution.*
pH value of the solution:
7.0 ± 0.5

RUN/ENTER





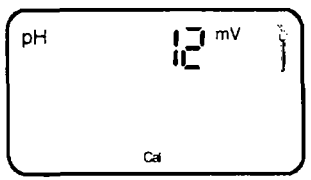
– pH-Wert der Pufferlösung einstellen.

– *Set pH value of the buffer solution.*

Temperatur der Pufferlösung beachten!

Pay attention to the temperature of the buffer solution!

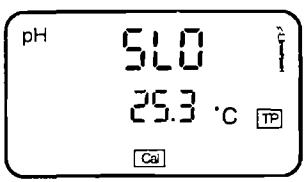
RUN/ENTER



Anzeige: Asymmetrie. Zulässiger Asymmetriebereich ± 30 mV.

Indication: Asymmetry. Admissible asymmetry range: ± 30 mV.

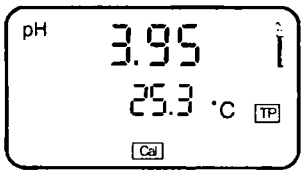
RUN/ENTER



– pH-Meßkette spülen und in die zweite Pufferlösung tauchen.

– Rinse pH electrode and immerse into the second buffer solution.

RUN/ENTER



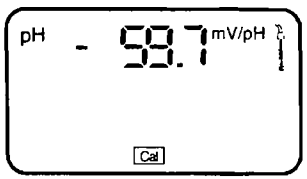
– pH-Wert der Pufferlösung einstellen.

– Set pH value of the buffer solution.

Temperatur der Pufferlösung beachten!

Pay attention to the temperature of the buffer solution.

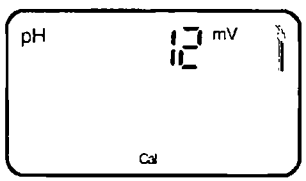
RUN/ENTER



Anzeige: Meßkettensteilheit. Zulässiger Steilheitsbereich: -50,0 mV/pH ... -62,0 mV/pH.

Indication: Slope of the electrode. Admissible slope range: -50.0 mV/pH ... - 62.0 mV/pH.

RUN/ENTER



Anzeige: Offsetspannung (Asymmetrie)

Indication: Offset voltage (Asymmetry)

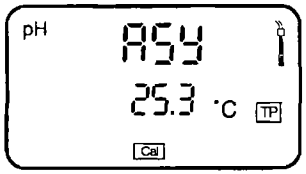
Konventionelle Ein-Punktkalibrierung "ConCal"

Conventional single point calibration "ConCal"

Zulässige Standardlösung:
probenangepaßte Standardlösung
(siehe Applikationsbericht Nr.: ...007)

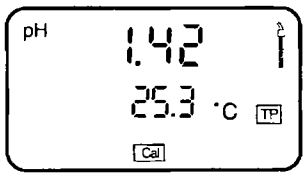
Admissible standard solution:
Standard solution suitable for the sample
(see application reports no: ...007)

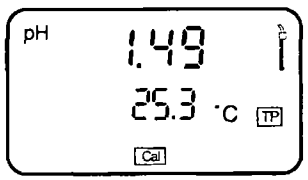
bis / until



– pH-Meßkette in die Standardlösung tauchen.

– Immerse pH electrode into the standard solution.



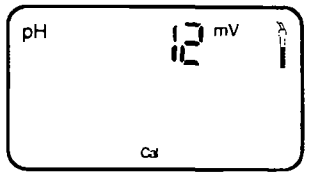


– pH-Wert der Standardlösung einstellen, z. B. 1.49.

– Set pH *value of the standard solution*, e.g. *1.49.*

Temperatur der Standardlösung beachten!

Pay attention to the temperature of the standard solution!

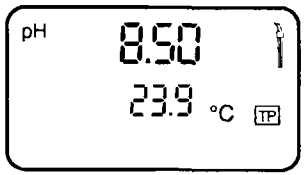


Anzeige: Offsetspannung (Asymmetrie).
Zulässiger Asymmetriebereich: ± 30 mV

Indication: Offset voltage (Asymmetry).
Admissible asymmetry range: ± 30 mV

Messen ***Measurement***

bis / *until*



Meßmodus pH-Wert/ Spannung einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion "pH-Wert" wählen.

Set measuring mode pH value / voltage.
With ⌃ or ⌄ select measuring function "pH value".

Redoxspannung
Redox voltage

– optionale Redoxmeßkette anstecken (z. B. WTW Modell Pt 4805/S7)

– *Connect redox electrode (e.g. WTW model Pt 4805/S7)*

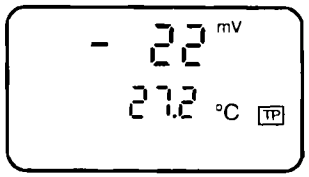
Redoxmeßkette prüfen ("Kalibrieren")

Check of the redox electrode ("Calibration")

bis / *until*

Meßmodus pH/mV-Wert einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion "mV" wählen.

Set measuring mode pH/mV value.
With ⌃ or ⌄ select measuring function "mV".



– Meßkette in Redoxpufferlösung tauchen.

– *Immerse electrode into redox buffer solution.*

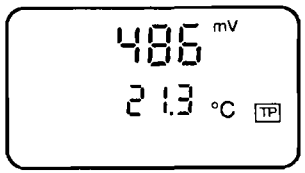
Spannungswert und Temperaturwert mit den Angaben auf der Flasche der Redoxpufferlösung vergleichen.
Bei Abweichungen größer als ± 30 mV Meßkette reinigen oder austauschen.

Compare voltage and temperature value to the data on the bottle of the redox buffer solution.
If the difference is higher than ± 30 mV clean or change the electrode.

Messen

Measurement

bis / *until*



Meßmodus pH/mV-Wert einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion "mV" wählen.

Set measuring mode pH/mV value.
With ⌃ or ⌄ select measuring function "mV".

Stabilen Meßwert abwarten, z. B. 486 mV bei 21,3 °C.

Wait for stable measured value, e. g. 486 mV at 21.3 °C.

Sauerstoffkonzentration/-sättigung
D.O.concentration/saturation

– Sauerstoffsensor CellOx 325 anstecken.

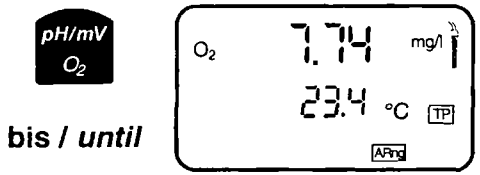
– *Connect D. O. probe CellOx 325.*

Kalibrieren

Calibration

Höchstmögliche Reproduzierbarkeit bei Kalibriertemperatur = Meßtemperatur

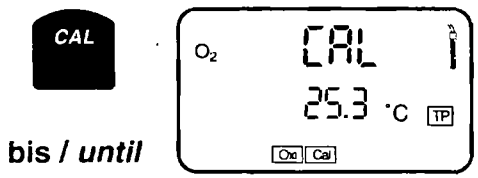
Best reproducibility when calibration temperature = measuring temperature



bis / *until*

Meßmodus Sauerstoffkonzentration/-sättigung einstellen.

Set measuring mode dissolved oxygen concentration/saturation.



bis / *until*

– Sensor in Luftkalibriergefäß stecken.

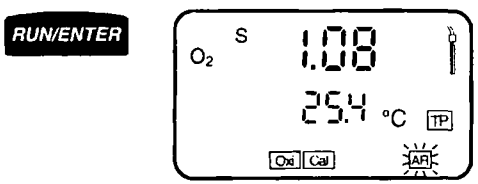
– *Place probe in air calibration beaker.*

Schwamm im Gefäß muß feucht sein (nicht naß!).

Siehe auch Bedienungsanleitung OxiCal® - SL im Anhang dieser Bedienungsanleitung.

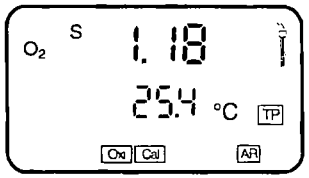
Sponge in the beaker must be moist (not wet!).

See also operation manual OxiCal® - SL in the appendix of this manual.



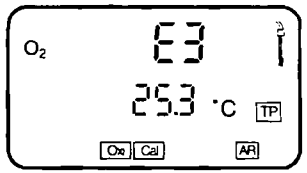
Messung starten.
AR blinkt.
Warten bis zur Anzeige:

Start measurement.
AR flashes.
Wait until the display shows:



Relative Steilheit des Sensors.
Zulässiger Bereich: 0,6 ... 1,25

Relative slope of the probe.
Admissible range: 0.6 ... 1.25

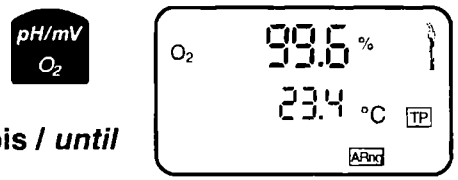


Bei Fehlermeldung E3 siehe Kapitel "Was tun wenn...".

With error message E3 see chapter "Troubleshooting"

Messen

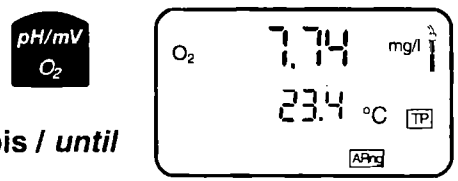
Measurement



bis / *until*

Meßmodus Sauerstoffkonzentration/-sättigung einstellen.
Mit ⌃ bzw. ⌄ wählen der Meßfunktion "Sauerstoffsättigung".

Set measuring mode dissolved oxygen concentration/saturation. With ⌃ or ⌄ select measuring function "oxygen saturation".



bis / *until*

Meßmodus Sauerstoffkonzentration/-sättigung einstellen.
Mit ⌃ bzw. ⌄ wählen der Meßfunktion "Sauerstoffkonzentration"

Set measuring mode dissolved oxygen concentration/saturation. With ⌃ or ⌄ select measuring function "oxygen concentration".

Sauerstoffkonzentration/-sättigung
D.O.concentration/saturation

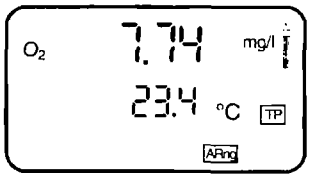
Sauerstoffkonzentrationen messen mit Salzgehaltskorrektur

Für Wasser mit einem Salzgehalt über 1 g/l die Salzgehaltskorrektur einstellen. Bei Messungen in **nicht salzbelastetem** Wasser "Sal" unbedingt **ausschalten**!

To measure oxygen concentration with salinity correction

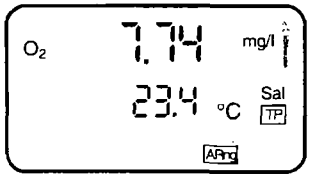
*For water with a salt content of more than 1 g/l set the salinity correction. For measurements in water that is **not salt loaded** "Sal" must be **switched off**!*

bis / *until*



Meßmodus *Sauerstoff-konzentration/-sättigung* einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion "Sauerstoffkonzentration" wählen.

Set measuring mode dissolved oxygen concentration /saturation.
With ⌃ or ⌄ select measuring function "oxygen concentration".



Salzgehaltskorrektur Ein/Ausschalten

Switching the salinity correction on/off

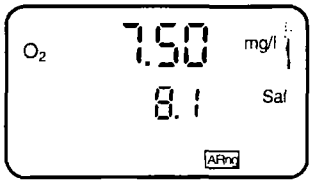
⌃ Eingeschaltet: Anzeige "Sal"
⌄ Ausgeschaltet: Keine Anzeige

⌃ switched on: display indicator "Sal"
⌄ switched off: no display indicator

Salzgehalt der Meßlösung einstellen

To set the salt content of the measuring sample

bis / *until*



Anzeige: "Sal" für Salzgehalts-korrektur.
Mit ⌃ bzw. ⌄ Salzgehalt in ‰ einstellen (Bestimmung des Salzgehaltes siehe Salinitätsmessung).

Display indicator: "Sal" for salinity correction.
With ⌃ or ⌄ set salt content in ‰ (Determination of salt content see salinity measurement).

Temperaturmessung
Temperature measurement

pH-Meßketten ohne Temperaturmeßfühler

Für die pH-Messung ist es möglich, auch andere Meßketten als die SenTix 41 zu verwenden. Da die meisten dieser Meßketten keinen oder keinen passenden Temperaturmeßfühler haben, bietet das MultiLine P3 für diese Anwendungen zwei Möglichkeiten zur Temperatureingabe:

- Manuelle Eingabe
- Nutzung des Temperaturmeßfühlers des Sauerstoffsensors.

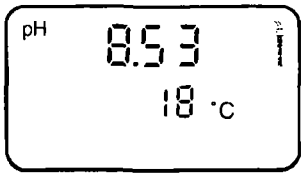
pH electrodes without temperature probe

For pH measurement it is also possible to use other electrodes than the SenTix 41. As most of these other electrodes have no or no suitable temperature probe the MultiLine P3 offers two possibilities to enter the temperature for these applications:

- *Manual input*
- *Use of the temperature probe of the oxygen probe.*

Manuelle Eingabe des Temperaturwertes

Manual input of temperature value



Meßmodus pH/mV-Wert einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion "pH-Wert" wählen.

Set measuring mode pH/mV value.
With ⌃ or ⌄ select measuring function "pH value".

Temperaturwert der Meß-lösung einstellen.

Set temperature value of sample solution.

Wert ändern:

To change the value:

Wert höher.

Value higher.

Wert niedriger.

Value lower.

Temperaturmessung / Sensorüberwachung
Temp. measurement / Probe supervision

Nutzung des Temperaturmeßfühlers des Sauerstoffsensors

Die Benutzung des Temperaturmeßfühlers bei der Konfiguration des MultiLine P3 anmelden (siehe Kapitel Konfiguration).

Nach Einstellen der pH-Meßfunktion **blinkt** nun die **Anzeige TP** und erinnert daran, daß bei der pH-Messung (Kalibrierung) der Sauerstoffsensor mit in die Lösung tauchen muß.

Use of the temperature probe of the D. O. probe

The use of the temperature probe has to be set in the setup menu of the MultiLine P3 (see chapter „Setup").

*After setting the pH measuring function **the TP display indicator flashes** to remind that the D. O. probe also has to be immersed into the solution during the pH measurement („Setup").*

Sensorsymbol

Das MultiLine P3 bewertet nach einer Kalibrierung den Zustand des kalibrierten Sensors (siehe auch Applikationsbericht Nr. ...298: „Bewertung elektrochemischer Sensoren".)

Hinweise:

- Bei pH werden Steilheit und Offsetspannung (Asymmetrie) getrennt bewertet und das jeweils schlechtere Ergebnis zur Qualitätsanzeige benutzt.
- Bei O_2 wird die Standzeit des Sensors bewertet. Die Qualität der Messung entspricht nach einer Kalibrierung immer den Spezifikationen. Die Sensorzustandsanzeige gibt lediglich einen Hinweis auf den zeitlichen Abstand bis zur nächsten erforderlichen Sensor-Regeneration (siehe Applikationsbericht Oxi ...234 in dieser Bedienungsanleitung).

Probe symbol

After a calibration the MultiLine P3 evaluates the condition of the calibrated probe (see also application report no. ...298: "Evaluation of electrochemical probes").

Notes:

- *For pH, slope and offset voltage (asymmetry) are evaluated separately. Then the worse result is used for the quality indication.*
- *For D. O. measurement the operation time of the probe is evaluated. After a calibration the quality of the measurement is always according to the specifications. The probe evaluation symbol only gives notice of when the next probe regeneration is required (see application report Oxi ...234 in this manual).*

Sensorüberwachung
Probe supervision

Bedeutung der Sensorsymbole: ***Meaning of the probe symbols:***

Anzeige *Indication*	Qualität der pH-Meßkette *Quality of pH electrode*	Steilheit O_2-Sensor *Slope of D. O. probe*
	S = –58 ... –60.5 mV/pH U_{ASY} = –10 ... +10 mV sehr gut / *excellent*	S = 0.8 ... 1.2 sehr gut / *excellent*
	S = –57 ... –58 mV/pH U_{ASY} = –15 ... +15 mV gut / *good*	S = 0.7 ... 0.8 gut / *good*
	S = –56 ... –57 mV/pH oder / *or* S = –60.5 ... –61 mV/pH U_{ASY} = –20 ... +20 mV ausreichend / *sufficient*	S = 0.6 ... 0.7 ausreichend / *sufficient*
	S = –56 ... –50 mV/pH oder / *or* S = –61 ... –62 mV/pH U_{ASY} = –30 ... –20 mV oder / *or* U_{ASY} = +20 ... +30 mV schlecht / *poor*	
E3	Kalibrierfehler / *Calibration error*	S < 0.6 oder / *or* S > 1.2

Maßnahmen bei Bewertung "schlecht" oder E3 siehe Kapitel "Was tun wenn..."

Action in case of evaluation "poor" or E3 see chapter "Troubleshooting"

Kalibrierintervall

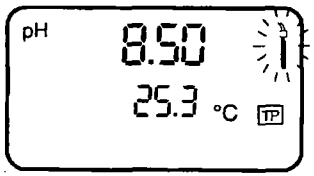
Wenn **Sensorsymbol blinkt**:
Kalibrierintervall überschritten. Meßfunktion so bald als möglich kalibrieren.

Die Sensorbewertung erfolgt nach dem Kalibrieren. Die Zuverlässigkeit des Meßgerätes hängt daher wesentlich vom Kalibrierintervall ab.
Das Ändern der Kalibrierintervallzeit ist im Kapitel "Konfiguration" beschrieben.

Calibration interval

*When **probe symbol is flashing**:*
Calibration interval has expired. Calibrate measuring function as soon as possible.

The probe evaluation is made after the calibration. The reliability of the meter, therefore, depends on the calibration interval considerably.
How to change the calibration interval is described in the chapter "Setup".



Kalibrierintervall überschritten. Messung weiterhin möglich. So bald wie möglich neu kalibrieren.

Calibration interval has expired. Measurement still possible. Calibrate as soon as possible.

Driftkontrolle AR

Die Stabilität des Meßwertes hat neben anderen Faktoren einen wesentlichen Einfluß auf die Reproduzierbarkeit des Meßwertes.
Die Driftkontrolle prüft die Stabilität des Meßsignals und bringt das stabile Meßergebnis zur Anzeige.

Drift control AR

Besides other factors, the stability of the measured value has a considerable influence on the reproducibility of the measured value.
The drift control checks the stability of the measuring signal and causes the stable measuring result to be displayed.

Kriterien

bei stets gleichen Meßbedingungen

Criteria

with unchanged measuring conditions

pH-Wert: *	besser 0,02	***pH value:*** *	*better 0.02*
Einstellzeit:	> 30 Sekunden	*Response time:*	*> 30 seconds*
Sauerstoffkonzentration: *	besser 0,05 mg/l	***D. O. concentration:***	*better 0.05 mg/l*
Einstellzeit:	> 10 Sekunden	*Response time:*	*> 10 seconds*
Sauerstoffsättigungsindex: *	besser 0,6 %	***D. O. saturation index:***	*better 0.6 %*
Einstellzeit:	> 10 Sekunden	*Response time:*	*> 10 seconds*

* theoretischer Wert für das Gerät

** theoretical value for the meter*

Kalibrieren mit Driftkontrolle

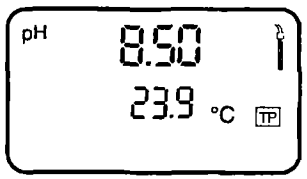
Bei Kalibrierung in den Meßfunktionen "pH-Wert", "Sauerstoffkonzentration/ -sättigung" schaltet das MultiLine P3 die Driftkontrolle automatisch ein bzw. aus.
Bei der pH-Meßfunktion ist der Abbruch der Driftkontrolle und die manuelle Übernahme durch Drücken von RUN/ENTER möglich.

Calibration with drift control

The MultiLine P4 automatically switches the drift control on or off when calibrating in the measuring functions "pH value", "dissolved oxygen concentration" or "saturation".
In the pH measuring function it is possible to cancel the drift control and to accept the value manually by pressing RUN/ENTER.

Messungen mit Driftkontrolle

Measurements with drift control

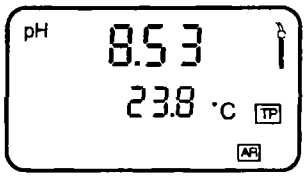


Meßmodus einstellen.
Mit ⌃ bzw. ⌄ Meßfunktion wählen.

Set measuring mode.
With ⌃ or ⌄ select measuring function.

Driftkontrolle "AR"
Drift control "AR"

AR



Driftkontrolle einschalten.
Meßwert eingefroren.

Switch on drift control.
Measured value frozen.

RUN/ENTER

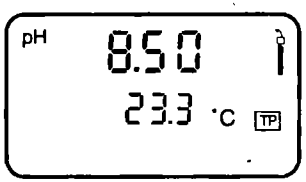
Anzeige AR blinkt.
Warten bis AR stabil.

AR display indicator flashes.
Wait until AR is stable.

Abbruch der Driftkontrolle und die manuelle Übernahme des Wertes durch Drücken von RUN/ENTER möglich.

It is possible to cancel the drift control and to accept the value manually by pressing RUN/ENTER.

AR



Driftkontrolle abschalten.

Switch off drift control.

Speichergröße: Max. 120 Meßdatensätze

Memory size: Maximum 120 measuring records

Speichern von Meßdaten ist nur während einer Messung möglich (Meßfunktion eingeschaltet).
Das MultiLine P3 speichert jeweils einen kompletten Meßdatensatz bestehend aus:

Storing measured data is only possible during measurement (measuring function switched on). The MultiLine P3 always stores a complete measuring record consisting of:

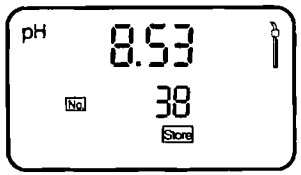
Meßwertspeicher
Data logging

- Numerator
- Datum
- Uhrzeit
- pH-Wert oder Spannungswert
- Temperaturwert (pH/mV-Meßfunktion)
- Sauerstoffsättigungs-, Sauerstoffkonzentrationswert
- Temperaturwert (O_2-Meßfunktion)
- Identnummer

- *Numerator*
- *Date*
- *Time*
- *pH value or voltage value*
- *Temperature value (pH/mV measuring function)*
- *Value for D. O. saturation, D. O. concentration*
- *Temperature value (O_2 measuring function)*
- *Identity number*

Manuelles Speichern
Manual storing

STO



Beispiel: Speichern des 38. Meßdatensatzes.

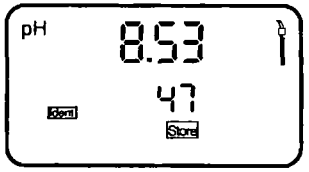
Zulässig: max. 120 Meßdatensätze.

Example: Storage of the 38th measuring record.

Admissible: max. 120 measuring records.

Meßwertspeicher
Data logging

RUN/ENTER



Letzte Identnummer (Kennzeichnung des Datensatzes).
Mit ⌃ bzw. ⌄ Ändern der Nummer.

Last identity number (designation of the record)
With ⌃ bzw. ⌄ change the number.

Mit RUN/ENTER bestätigen.

With RUN/ENTER confirm.

Bei Erscheinen der Anzeige "Sto Fu" siehe Kapitel "Speicher voll".

If "Sto Fu" is displayed see chapter „Memory full".

Automatisches Speichern
Automatic storing

RUN/ENTER + STO

Letztes Zeitintervall.
Beispiel 30 Sekunden.
Mit ⌃ oder ⌄: Ändern des Intervalls.

Last time interval.
Example 30 seconds.
With ⌃ or ⌄: Change the interval.

Mögliche Intervalle:
5 sec
30 sec
1 min
5 min
10 min
15 min
30 min
60 min

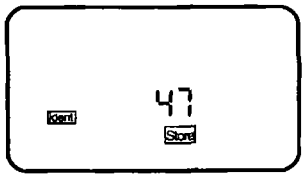
Possible intervals:
5 sec
30 sec
1 min
5 min
10 min
15 min
30 min
60 min

RUN/ENTER: Bestätigen der Einstellung.

RUN/ENTER: Confirms the setting.

Meßwertspeicher
Data logging

RUN/ENTER



Letzte Identnummer.
Eingabe einer Zahl zur Kennzeichnung des Meßwertes (z.B. für den Probenort).
Mit ⌃ oder ⌄: Ändern der Identnummer.

Last identity number.
Input of a number to designate the measured value (e. g. for the sample location).

With ⌃ or ⌄: change the identity number.

RUN/ENTER: Bestätigen der Einstellung.

RUN/ENTER: Confirms the setting

RUN/ENTER

Anzeige: Anzahl noch freier Speicherplätze.
Automatisches Speichern beginnt.
Alle Funktionen sind gesperrt.

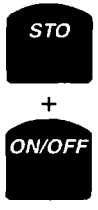
Indication: Number of storage locations that are still free.
Automatic storage is started.
All functions are blocked.

Meßwertspeicher
Data logging

Speicher löschen

Die Löschfunktion löscht **alle gespeicherten Meßdatensätze**. Kalibrierprotokolle bleiben bis zur nächsten Kalibrierung enthalten.

Gerät ausschalten, dann



Löschfunktion eingeschaltet. (Erscheint nur, wenn Daten im Speicher abgelegt sind.)

Löschvorgang bestätigen. Jede andere Taste bricht den Löschvorgang ab.

Erasure of memory

*The erasure function erases **all the stored measuring records**. Calibration protocols remain stored up to the next calibration.*

Switch meter off, then

Erasure function switched on. (Only appears when the memory contains data.)

Confirm erasure process. Any other key cancels the erasure process.

Datenübertragung
Data transmission

Die Ausgabe von Kalibrierprotokollen und Meßdatensätzen auf Drucker oder Computer erfolgt über die serielle Schnittstelle.

Serielle Schnittstelle

Seriellen Ausgang des Meßgerätes mit seriellem Anschluß PC/Drucker verbinden.

PC: Kabel AK 340/B, Best.-Nr. 902 841
Drucker: Kabel AK 325/S, Best.-Nr. 902 837

Belegung:
1 CTS
2 Steckercodierung + RxD
3 Masse
4 TxD

Verbinden von **2**, **3** und Anschluß eines PC/Drucker aktiviert die serielle Ausgabe.

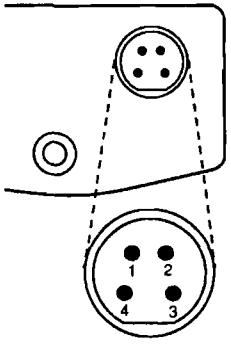
Übertragungsdaten am PC/Drucker einstellen.

Baudrate:	1200, 2400, 4800, 9600 wählbar
Parität (nur PC):	keine
Handshake:	RTS/CTS + Xon/Xoff
Datenbits (nur PC):	8
Stopbit (nur PC):	1

Sparschaltung:
Das Gerät schaltet ca. 1 h nach der letzten Tastenbetätigung automatisch ab.
Ausnahme:
Dauerbetrieb bei angeschlossenem PC oder Drucker.

Die Konfiguration der seriellen Schnittstelle (Baudrate, zeitgesteuerte Übertragung, Übertragung auf Tastendruck) entnehmen Sie dem Kapitel "Konfiguration".

Serial interface



Connect serial output of the meter to serial connection of the PC/printer.

PC: Cable AK 340/B, Order no. 902 841
Printer: Cable AK 325/S, Order no. 902 837

Connections:
1 CTS
2 Plug codification + RxD
3 Mass
4 TxD

*Connecting **2, 3** and connection of a PC/printer activates the serial output.*

Set transmission data at the PC/printer:

Baud rate:	*1200, 2400, 4800, 9600 selectat*
Parity (PC only):	*none*
Handshake:	*RTS/CTS + Xon/Xo*
Data bits (PC only):	*8*
Stop bit (PC only):	*1*

Economy circuit:
The meter automatically switches itself approx. 1 h after the last key operation.
Exception:
Continuous operation with connected P or printer.

For setup of the serial interface (Baud rate, timed transmission, transmission o keypressing) please refer to chapter "Setup".

Automatische Übertragung von Kalibrierprotokollen und Meßdatensätzen

Nach der Kalibrierung überträgt das MultiLine P3 automatisch das Kalibrierprotokoll bzw. nach Messungen mit Driftkontrolle (AR) den entsprechenden Meßdatensatz über die serielle Schnittstelle an einen angeschlossenen Drucker oder PC (siehe Kapitel "Kalibrierprotokolle").

Automatic transmission of calibration protocols and measuring records

After calibration the MultiLine P3 automatically transmits the calibration protocol or, after measurement with drift control (AR), the corresponding measuring record to a connected printer or PC via the serial interface. (See chapter "Calibration protocols")

Übertragung von Meßdatensätzen

Mögliche Einstellungen:
5 sec, 30 sec, 1 min, 5 min,
10 min, 15 min, 30 min,
60 min, OFF.

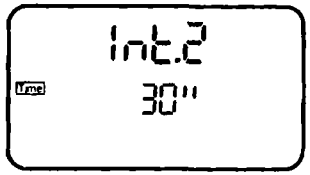
Bei eingestelltem **Int.2 = OFF**:
Übertragung eines **einzelnen** Meßdatensatzes.

Transmission of meas. records

Possible settings:
5 sec, 30 sec, 1 min, 5 min,
10 min, 15 min, 30 min,
60 min, OFF.

*When **Int.2 = OFF** is set a **single** measuring record is transmitted.*

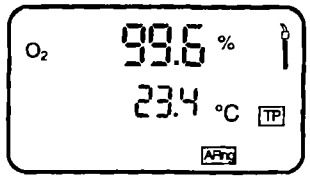
RUN/ENTER + RCL



Letztes Zeitintervall.
Beispiel 30 Sekunden.
Mit ⌃ oder ⌄ Ändern des Intervalls.

Last time interval.
Example 30 seconds.
With ⌃ or ⌄ change the interval.

RUN/ENTER



Start der Übertragung bzw. des Ausdrucks nach erstmaligem Ablauf des gewählten Zeitintervall.

Start of the transmission or printout after the selected time interval has expired for the first time.

Beispiel für zeitgesteuerte Ausgabe während des Meßbetriebes

Example for timed output during measuring operation

Datum/Uhrzeit	12.5.97	13:17	*Date/Time*
pH-Wert / Temperatur	pH 3.22	23.9 °C	*pH value / Temperature*
O_2-Sättigungswert/Temp.	110.4 %	23.8 °C	*O_2 saturation value/Temp.*
Datum/Uhrzeit	12.5.97	13:22	*Date/Time*
pH-Wert / Temperatur	pH 3.22	23.9 °C	*pH value / Temperature*
O_2-Sättigungswert/Temp.	110.4 %	23.8 °C	*O_2 saturation value/Temp.*
Datum/Uhrzeit	12.5.97	13:27	*Date/Time*
pH-Wert / Temperatur	pH 3.22	23.9 °C	*pH value / Temperature*
O_2-Sättigungswert/Temp.	110.4 %	23.8 °C	*O_2 saturation value/Temp.*

Meßdatensätze aus dem Speicher übertragen

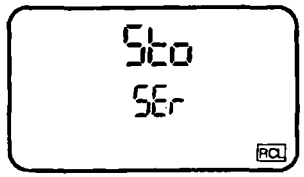
Jede Übertragung beginnt mit der Ausgabe der Kalibrierprotokolle.

Transmission of measuring records from the memory

Each transmission starts with the output of the calibration protocols.

RCL

bis / *until*



Ausgabe auf serielle Schnittstelle.

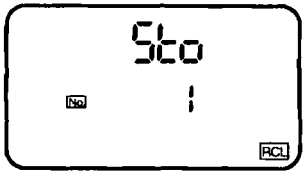
Output to serial interface.

RUN/ENTER

Start der Übertragung. Abbruch mit RUN/ENTER oder pH/mV.

Start of the transmission. Termination with RUN/ENTER or pH/mV.

Datenübertragung
Data transmission



Die Übertragung der Meßdatensätze beginnt mit dem ältesten Wert.

The transmission of the measuring records starts with the oldest value.

Die Ausgabe des Speichers ist auch bei eingestelltem Int 2 OFF möglich (nur Kabel muß angesteckt sein).
Die Ausgabe kann jederzeit (z.B. nach Ausdruck der Kalibrierprotokolle) mit pH/mV/O2 oder RUN/ENTER abgebrochen werden.

The output of the stored data is also possible if Int 2 OFF is set (but the cable must be connected).
The output can be terminated any time (e.g. after printing the calibration protocols) with pH/mV/O2 or RUN/ENTER.

s. Kalibrierprotokoll pH			*See calibration protocol pH*
s. Kalibrierprotokoll O_2	Protokoll(e) / *Protocol(s)*		*See calibration protocol O_2*
Datensatz Nummer 1	No. 1:		*Record number 1*
Speicherdatum/Uhrzeit	12.5.97	13:17	*Date/time of storage*
pH-Wert mit Temperatur	pH 3.22	23.9 °C	*pH value with temperature*
O_2-Sättigungswert/Temp.	110.4 %	23.8 °C	*O_2 saturation value/temp.*
Probenortnummer	Ident:	36	*Number of sample location*
Datensatz Nummer 2	No. 2:		*Record number 2*
Speicherdatum/Uhrzeit	12.5.97	13:20	*Date/time of storage*
pH-Wert/Temperatur	pH 3.24	21.7 °C	*pH value with temperature*
Probenortnummer	Ident:	36	*Number of sample location*
Datensatz Nummer 3	No. 3:		*Record number 3*
Speicherdatum/Uhrzeit	12.5.97	14:24	*Date/time of storage*
mV-Wert/Temperatur	+ 1210 mV	38.9 °C	*mV value with temperature*
O_2-Konzentration/Temp.	7.76 mg/l	38.9 °C	*O_2 concentration/temp.*
Probenortnummer	Ident:	87	*Number of sample location*
Datensatz Nummer 4	No. 4:		*Record number 4*
Speicherdatum/Uhrzeit	13.5.97	8:17	*Date/time of storage*
pH-Wert/manuelle Temp.	pH 7.03	18 °C	*pH value/manual temp.*
Probenortnummer	Ident:	55	*Number of sample location*
Datensatz Nummer 5	No. 5:		*Record number 5*
Speicherdatum/Uhrzeit	13.5.97	8:56	*Date/time of storage*
pH-Wert/Temperatur	pH 7.12	18,6 °C	*pH value/temperature*
(kein weiterer Sensor gesteckt)	Ident:	55	*(no other probe connected)*
Probenortnummer			*Number of sample location*

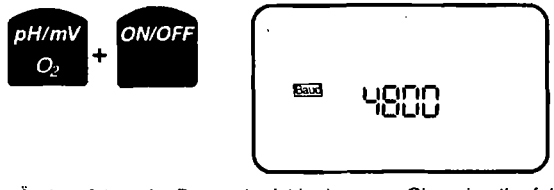
Konfiguration
Setup

Konfiguration

Einstellen der Parameter für
- Baudrate
- Datum
- Uhrzeit
- Intervallzeiten.

Setup

Setting the parameters for
- *Baud rate*
- *Date*
- *Time*
- *Interval times.*



Das Ändern folgender Parameter ist in der aufgelisteten Reihenfolge möglich (Auslieferungszustand = fett gedruckt):

Changing the following parameters is possible in the sequence listed below (Default setting = printed in bold):

Anzeige / *Display*	**Parameter / *Parameters***		**Einstellmöglichkeiten / *Setting possibilities***
Baud	Baudrate	*Baud rate*	1200, 2400, **4800**, 9600
TP USE	Temperaturmeßfühler	*Temperature probe*	pH-Meßkette / *pH electrode* (USE PH), O_2-Sensor / *D. O. probe* (USE O2)
P	Luftdruck	*Barometric pressure*	Anzeige des aktuellen Luftdruckwertes (nur wenn O_2-Sensor gesteckt ist) / *Display of the current barometric pressure (only when D. O. probe is connected)*
Time Int. 1	Intervallzeit (Speichern)	*Interval times (storage)*	**5 sec**, 30 sec, 1 min, 5 min, 10 min, 15 min, 30 min, 60 min
Time Int. 2	Intervallzeit (Übertragung)	*Interval times (transmission)*	**5 sec**, 30 sec, 1 min, 5 min, 10 min, 15 min, 30 min, 60 min oder / *or* Int 2 OFF: Übertragung blockieren / *Stop transmission*
pH Int. 3	Kal.-Intervall pH	*Cal. interval pH*	1 ... **7** ... 999 Tage / *days*
O_2 Int. 4	Kal.-Intervall O_2	*Cal. interval D. O.*	1 ... **14** ... 999 Tage / *days*
Day/Month	Datum (Tag)	*Date (day)*	**1** ... 31
Day/Month	Datum (Monat)	*Date (month)*	1 ... 12
Year	Datum (Jahr)	*Date (year)*	**1997** ... 2100
Time	Uhrzeit (Stunde)	*Time (hour)*	**0** ... 24
Time	Uhrzeit (Minute)	*Time (minute)*	**0** ... 60

⌃ oder ⌄: Ändern der Parameter — ⌃ *or* ⌄ *change the parameters*

RUN/ENTER Bestätigen des Parameters — RUN/ENTER *confirms the parameter*

RESET-Funktion

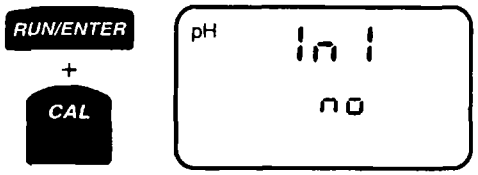
Rückstellen einzelner Meßfunktionen auf Auslieferzustand.
Erhalten bleiben auch nach einem RESET:

- Inhalt des Meßdatenspeichers
- Datum/Uhrzeit
- Kalibrierintervall (Int. 3, Int. 4)

RESET function

Resetting of single measuring functions to default condition.
Even after a RESET the following data remain stored:

- *Measured values stored in memory*
- *Date/Time*
- *Calibration interval (Int. 3, Int. 4)*



Anzeige / *Display*	Funktion	*Function*	Daten nach RESET	*Data after RESET*
pH In I	pH/mV	*pH/mV*	Meßgröße: pH Steilheit: -59,2 mV/pH Offset: 0 mV Temperatur: 25 °C manueller Kalibrier-modus: AutoCalTEC	*Parameter: pH* *Slope: -59.2 mV/pH* *Offset: 0 mV* *Temperature: 25 °C* *manual calibration mode: AutoCalTEC*
O_2 In I	Sauerstoff	*Dissolved Oxygen*	Meßgröße: Konzentration Steilheit: 1 Salzgehaltskorrektur: Aus	*Parameter: Concentration* *Slope: 1* *Salinity correction: Off*
In I	alle Konfigu-rationspara-meter (ausge-nommen Int. 3, Int. 4, Datum, Uhrzeit)	*all adjustable parameters (exception: Int. 3, Int. 4, date, time)*	Rücksetzen aller Konfi-gurationsparameter auf den Auslieferungszustand (siehe Kapitel "Konfiguration")	*Resets all adjustable parameters to the default setting (see chapter "Setup").*

Für jede Meßfunktion mit ⌃ oder ⌄ wählen:

Yes: RESET durchführen
No: RESET nicht durchführen

RUN/ENTER Bestätigen und weiter

For each measuring function select with ⌃ or ⌄:

Yes: Perform RESET
No: Do not perform RESET

RUN/ENTER *Confirms and goes on*

pH-Systemmeldungen

Systemmeldung	Ursache	Fehlerbehebung
OFL Anzeigebereich überschritten	**pH-Meßkette:** • Nicht eingetaucht • Kabel gebrochen • Elektrolytgel eingetrocknet • Luftblase vor dem Diaphragma • Luft im Diaphragma	**pH-Meßkette:** In Meßlösung tauchen Meßkette austauschen Meßkette austauschen Luftblase entfernen Luft absaugen bzw. Diaphragma benetzen
E3 Steilheit oder Asymmetrie außerhalb der zulässigen Bereiche (Steilheit: -50 ... -62 mV/pH; Asymmetrie: -30 ... +30 mV)	**pH-Meßkette:** • pH-Meßkette überaltert • Diaphragma verschmutzt • Membran verschmutzt • Feuchtigkeit im Stecker • Elektrolytlösung überaltert **Meßgerät:** • Falsches Kalibrierverfahren • Falsche Lösungstemperatur (nur ohne Temperaturmeß-fühler) • Feuchtigkeit in der Buchse **Pufferlösung:** • Ungeeignete Pufferlösungen • Zu alte Pufferlösungen • Verbrauchte Pufferlösungen	**pH-Meßkette:** pH-Meßkette austauschen Diaphragma reinigen Membran reinigen Stecker trocknen Meßkette austauschen **Meßgerät:** Richtiges Verfahren wählen Richtige Temperatur einstellen Buchse trocknen **Pufferlösung:** WTW-Technische Puffer-lösungen verwenden Haltbarkeit der Lösungen beachten. Lösungen nur einmal verwenden

Weitere Fehlermöglichkeiten - pH-Messung

Systemmeldung	Ursache	Fehlerbehebung
pH-Meßketten-spannung nicht stabil	**pH-Meßkette:** • Diaphragma verschmutzt • Membran verschmutzt **Meßlösung:** • pH-Wert nicht stabil • Temperatur nicht stabil **Meßkette + Meßlösung:** • Zu geringe Leitfähigkeit • Hohe Temperatur • Organische Flüssigkeiten	**pH-Meßkette:** Diaphragma reinigen Membran reinigen **Meßlösung:** ggf. unter Luftabschluß messen ggf. temperieren **Meßkette + Meßlösung:** Geeignete pH-Meßkette verwenden Geeignete pH-Meßkette verwenden Geeignete pH-Meßkette verwenden
Offensichtlich falsche Meßwerte	**pH-Meßkette:** • Ungeeignete pH-Meßkette • Temperaturunterschied zwischen Kalibrier- und Meßlösung zu groß • Störspannungen • Nicht geeignetes Meßverfahren	**pH-Meßkette:** Geeignete pH-Meßkette wählen Puffer- oder Meßlösungen temperieren Bei geerdeter Meßlösung keinen geerdeten PC oder Drucker anschließen Spezielle Verfahren beachten

Oxi-Systemmeldungen

Systemmeldung	Ursache	Fehlerbehebung
OFL Anzeigebereich überschritten	Kurzschluß zwischen Gold- und Bleielektrode	Sensor überprüfen, ggf. tauschen.
E3 Unzulässige Kalibrierung	• Elektrolytlösung verbraucht • Membran verschmutzt • Elektrodensystem vergiftet	Sensor regenerieren Membran reinigen Sensor regenerieren
E7 Beschädigte Membran	• Membran beschädigt • Membrankopf nicht fest genug angezogen	Sensor regenerieren Membrankopf fest anziehen

Weitere Fehlermöglichkeiten - O_2-Messung

Systemmeldung	Ursache	Fehlerbehebung
Zu kleiner Meßwert	Unzureichende Anströmung	Sensor anströmen
Zu hoher Meßwert	• Hohe Anteile gelöster Stoffe • Luftblasen prallen mit hoher Geschwindigkeit auf die Membran • Der Kohlendioxiddruck ist zu hoch > 1 Bar	Löslichkeitsfunktion durch Eingabe des Salinitäts-äquivalentes korrigieren Membran nicht direkt anströmen Keine Messung möglich

Allgemeine Systemmeldungen

Systemmeldung	Ursache	Fehlerbehebung
Gerät reagiert nicht mehr auf Tastenbetätigung	Undefinierter Betriebszustand des Prozessors z.B. nach nicht zulässiger EMV-Beaufschlagung (außerhalb der spezifizierten Bereiche).	Prozessor-Reset: Taste RCL drücken und Gerät einschalten.
LoBat	Akkus weitgehend entladen.	Akkus laden.
to	Timeout der seriellen Schnittstelle.	Angeschlossenes Gerät überprüfen.
blinkt	Eingestelltes Kalibrierintervall ist abgelaufen.	Sensor neu kalibrieren.

pH system messages

System message	*Cause*	*Action*
OFL *Indication range exceeded*	***pH electrode:*** • *Not immersed* • *Cable broken* • *Electrolytic gel dried* • *Air bubble in front of diaphragm* • *Air in diaphragm*	***pH electrode:*** *Immerse into sample solution* *Exchange electrode* *Exchange electrode* *Remove air bubble* *Suck off air or moisten diaphragm*
E3 *Slope or asymmetry outside of admissible ranges (Slope: -50 ... -62 mV/pH; Asymmetry: -30 ... +30 mV)*	***pH electrode:*** • *pH electrode too old* • *Diaphragm contaminated* • *Membrane contaminated* • *Moisture in the plug* • *Electrolyte solution too old* ***Meter:*** • *Wrong calibration procedure* • *Wrong temperature of solution (Without temperature probe only)* • *Moisture in the socket* ***Buffer solution:*** • *Unsuitable buffer solutions* • *Buffer solutions too old* • *Used up buffer solutions*	***pH electrode:*** *Exchange pH electrode* *Clean diaphragm* *Clean membrane* *Dry plug* *Exchange electrode* ***Meter:*** *Select correct procedure* *Set correct temperature* *Dry socket* ***Buffer solution:*** *Use WTW Technical buffer solutions* *Pay attention to perishability of solutions.* *Use solutions only once.*

General system messages

System message	Cause	Action
Meter does not react on keypressing	*Undefined operation state of the processor, e. g. after inadmissible EMC admission (outside the specified ranges)*	*Reset of processor: Press RCL key and switch meter on.*
LoBat	*Rechargeable batteries nearly discharged.*	*Charge rechargeable batteries.*
to	*Timeout of serial interface.*	*Check connected instrument.*
is flashing	*Set calibration interval has run out.*	*Recalibrate probe.*

Zubehör allgemein

	Modell	Best.-Nr.
Schnittstellenkabel zum Anschluß des MultiLine P3 an einen Drucker über die RS232-Schnittstelle	AK 325/S	902 837
Schnittstellenkabel zum Anschluß des MultiLine P3 an einen PC über die RS232-Schnittstelle; einschließlich Adapter 9/25 pin und Bedienungsanleitung für gängige Terminalprogramme	AK 340/B	902 841
Kommunikationspaket bestehend aus Schnittstellenkabel AK 340/B mit Adapter 9/25 pin, Multi/ACHAT II Übertragungssoftware	KOM 340	902 851
Teleskopverlängerung ausziehbare Verlängerung 1,5 - 3 m inkl. Sensorhalter SH 340 zur gleichzeitigen Aufnahme der pH-Einstabmeß-kette SenTix...und des Sauerstoffsensors CellOx 325-...	TH 340	402 802
Sensorhalter zur gleichzeitigen Aufnahme von pH-Einstabmeßkette SenTix... und des Sauerstoffsensors CellOx 325-...	SH 340	402 800
Schutzarmierung Stoßabsorbierend, gummielastisch, mit Aufstellbügel und Klemmhalterung für das Elektrodenkabel	SM 325	902 818
Köcher-Set passend zur Schutzarmierung SM 325, bestehend aus einem Elektrodenköcher pH, einem Elektrodenköcher Oxi, Haltevorrichtung und Tragegurt für den Feldeinsatz	TG/ML	902 854
Feldarmierung extrem robust und stoßfest durch gummielastische Schutzarmierung, mit integriertem Elektrodenköcher für Oxi, mit integriertem Tragegriff, zusätzlichem Elektrodenköcher pH, einschließlich Haltevorrichtung und Aufstellbügel für die Messung im Labor	FM/ML	902 855

Zubehör zur pH-Messung

	Modell	Best.-Nr.
pH Einstabmeßkette mit integriertem Temperaturmeßfühler und wasserdichtem Stecker (IP 67)		
mit Kabellänge 1 m	SenTix 41	103 635
3 m	SenTix 41-3	103 636
pH Einstabmeßkette mit wasserdichtem Stecker (IP 67)		
mit Kabellänge 1 m	SenTix 21	103 631
3 m	SenTix 21-3	103 632
Technische Pufferlösungen, 250 ml		
Puffer pH 4,01	TPL 4	108 800
Puffer pH 7,00	TPL 7	108 802
Puffer pH 10,00	TPL 10	108 804
Aufbewahrungslösung 250 ml KCl 3 mol/l	KCl-250	109 705

Zubehör zur Redox-Messung

	Modell	Best.-Nr.
Redox-Einstabmeßkette (Platin Silber/Silberchlorid) Ø 12 mm, Eintauchtiefe 120 mm,		
mit Steckkopf	Pt 4805 / S7	105 311
mit aufsteckbarem Normschiff (NS 14 / 23)	Pt 4805-NS / S7	105 411
Anschlußkabel für Meßketten mit Steckkopf	AS 7	103 614
Redox-Pufferlösung, zur Kontrolle von Redox-Meßketten U_H = 427 mV, 1 Flasche à 250 ml	RH 28	109 740
Reagenzien zum Regenerieren von Redox-Meßketten bestehend aus 10 g Aktivierungspulver und 30 g Chlorinapulver	SORT / RH	109 730

Zubehör zur Sauerstoffmessung

	Modell	Best.-Nr.
Galvanischer **Sauerstoffsensor** mit wasserdichtem Stecker (IP 67) incl. Kalibrier- und Aufbewahrungsgefäß OxiCal® - SL und Zubehörkasten mit		
Kabellänge 1,5 m	CellOx 325	201 533
3 m	CellOx 325-3	201 545
6 m	CellOx 325-6	201 546
10 m	CellOx 325-10	201 547
15 m	CellOx 325-15	201 548
20 m	CellOx 325-20	201 549
Zubehörkasten für Sauerstoffsensor CellOx 325-...	ZBK 325	202 706
Kunststoffarmierung mit Schutzkorb für Sauerstoffsensor CellOx 325 bis 20 m Kabellänge	AK 325/K	903 830
Batterierührer, notwendig für Profil- und Tiefenmessungen, nur in Verbindung mit der Kunststoffarmierung A 325/K	BR 325	203 826
Durchflußzusatz für Messungen im drucklosen Betrieb, Durchflußmenge 25 ... 65 ml/min	D 201	203 730

Zubehör zur BSB-Messung

	Modell	Best.-Nr.
Rührzusatz zur konstanten, definierten Anströmung des Sensors in Verbindung mit einem Magnetrührer	RZ 300	203 824
Magnetrührer mit konstanter Festdrehzahl im wasserdichten Edelstahlgehäuse	Oxi-Stirrer 300	203 810
Karlsruher Flasche Trichterflasche geeignet für die BSB_5-Bestimmung	KF 12	205 700
Fixierring empfohlen zur Messung in der Karlsruher Flasche	FR 19	205 712
Trichterset für die BSB_5-Bestimmung in Winkler-Flaschen mit NS 19	TS 19	205 710

General accessories

	Model	Order no.
Interface cable for connection of the MultiLine P3 to a printer via RS232 interface	AK 325/S	902 837
Interface cable for connection of the MultiLine P3 to a PC via RS232 interface, incl. adaptor 9/25 pin and operation manual for current terminal programs	AK 340/B	902 841
Communication set consisting of Interface cable AK 340/B, with adaptor 9/25 pin and transmission software Multi/ACHAT II	KOM 340	902 851
Telescopic extension 1.5 - 3 m with sensor holder for pH combined electrode SenTix... and oxygen sensor CellOx 325-...	TH 340	402 802
Probe holder for simultaneous holding of pH combined electrode SenTix... and CellOx 325-...	SH 340	402 800
Protection armouring Shock absorbent, rubber elastic, with stand and clamping holder for sensor cable	SM 325	902 818
Beaker set for protection armoring SM 325, consisting of one electrode beaker pH, one sensor beaker Oxi, holding device and carrying strap for field application	TG/ML	902 854
Field armouring extremely robust and shock-proof because of rubber elastic protection armoring, with integrated sensor beaker for Oxi, carrying handle and additional electrode beaker pH, carrying strap, including holding device and stand for measurements in the laboratory	FM/ML	902 855

Accessories for pH measurement

	Model	Order no.
pH combined electrode with integrated temperature probe and watertight plug (IP 67)		
with cable lengths 1 m	SenTix 41	103 635
3 m	SenTix 41-3	103 636
pH combined electrode with watertight plug (IP 67)		
with cable length 1 m	SenTix 21	103 631
3 m	SenTix 21-3	103 632
Technical buffer solutions, 250 ml		
Buffer pH 4.01	TPL 4	108 800
Buffer pH 7.00	TPL 7	108 802
Buffer pH 10.00	TPL 10	108 804
Storing solution 250 ml KCl 3 mol/l	KCl-250	109 705

Accessories for Redox measurement

	Model	Order no.
Redox combined electrode (Platinum Silver/Silver chloride) Ø 12 mm, immersion length 120 mm,		
with plug head	Pt 4805 / S7	105 311
with cut (NS 14 / 23)	Pt 4805-NS / S7	105 411
Connection cable for electrodes with plug head	AS 7	103 614
Redox buffer solution for control of Redox electrodes U_H = 427 mV, 1 bottle with 250 ml	RH 28	109 740
Reagents for regeneration of Redox electrodes consisting of 10 g activation powder and 30 g chlorina powder	SORT / RH	109 730

Accessories for Dissolved Oxygen measurement

	Model	Order no.
*Galvanic **oxygen sensor** with watertight plug (IP 67) incl. OxiCal® -SL calibration and storage beaker and accessory kit with cable length 1.5 m*	*CellOx 325*	*201 533*
3 m	*CellOx 325-3*	*201 545*
6 m	*CellOx 325-6*	*201 546*
10 m	*CellOx 325-10*	*201 547*
15 m	*CellOx 325-15*	*201 548*
20 m	*CellOx 325-20*	*201 549*
***Accessory kit** for CellOx oxygen sensor*	*ZBK 325*	*202 706*
***Plastic armouring** with protection hood for CellOx oxygen sensor up to 20 m cable length*	*AK 325/K*	*903 830*
***Battery stirrer,** necessary for profile and depth measurements, only in connection with plastic armoring A325/K*	*BR 325*	*203 826*
***Flow-through chamber** for measurements in pressureless systems, flow-through volume 25 ... 65 ml/min*	*D 201*	*203 730*

Accessories for BOD measurement

	Model	Order no.
***Stirring accessory** for constant flow, in combination with a magnetic stirrer*	*RZ 300*	*203 824*
***Magnetic stirrer** with constant fixed rotational speed, in watertight stainless steel housing*	*Oxi-Stirrer 300*	*203 810*
***Karlsruhe bottle** funnel bottle for BOD5 determination*	*KF 12*	*205 700*
***Fixing ring** recommended for measurement in Karlsruhe bottles*	*FR 19*	*205 712*
***Funnel set** for BOD5 determination in Winkler bottles with NS 19*	*TS 19*	*205 710*

Gehäuse		
Länge	172 mm	
Breite	80 mm	
Höhe	37 mm	
Gewicht	ca. 0,3 kg (Gerätegesamtgewicht)	
Farbe	schwarz, RAL 9005	
EMV- und VDE-Normen		
Schutzart	IP 66	IEC 529
Schutzklasse	3	IEC 1010
Klimaklasse	JVD	DIN 40040
EMV Störaussendung	Fachgrundnorm EN 50081-1 normativer Teil FCC class A	
EMV Störfestigkeit	Fachgrundnorm EN 50082-1 normativer Teil	
Betriebsbedingungen		
Betriebstemperatur	-10 bis 55 °C	
Lagertemperatur	-25 bis 65 °C Betrieb im Freien, Betauung möglich	
Relative Feuchte	Jahresmittel:	< 90 %
	30 Tage/Jahr:	<100 %
	übrige Tage:	< 80 %
Energieversorgung		
Batterien	4 x 1,5 V Batterien Typ AA,	
Laufzeit	pH	2500 h
	pH/Sauerstoff	1500 h
Datensicherung	unbegrenzt	
Uhrzeit		
Uhr	Echtzeit-Uhr	
Genauigkeit	1 min/Monat max. Abweichung	
Meßdatenspeicher		
Typ	Ringspeicher	
Anzahl	120 Meßdatensätze	
Timer für zeitgesteuertes Speichern	5 sec, 30 sec, 1 min, 5 min,10 min, 15 min, 30 min, 60 min	

Technische Daten

Serielle Schnittstelle	
Typ	RS232.C, Datenausgabe
Baudrate	einstellbar 1200, 2400, 4800, 9600 Baud
Datenbits	8
Stopbit	1
Parität	keine (None)
Handshake	RTS/CTS + X_{on}/X_{off}
Kabellänge	max. 15 m
Ausgabeformat	ASCII-Zeichenketten (IBM-Zeichensatz) Feldertrennung durch CR, LF
Timer für zeitgesteuerte Ausgabe	5 sec, 30 sec, 1 min, 10 min, 15 min, 30 min, 60 min, OFF
Anschlüsse (elektromechanische Ausführung)	
Sauerstoff	8-pol. WTW-Buchse mit Stiftkontakten mit Verriegelung (Schutzart IP 67)
pH/Spannung	Buchse nach DIN 19262 (Schutzart IP 67) in Verbindung mit SenTix-Meßkette
Temperatur	1-pol. WTW-Bananensteckerbuchse (Schutzart IP 67)
Serielle Schnittstelle	4-pol. Buchse mit Stiftkontakten
pH-Messung (zusätzlich die technischen Daten der Meßkette beachten)	
Meßbereich	-2 ... 16
Auflösung	0,01
Genauigkeit	0,01 ± 1 digit
Allgemeines	Eingangswiderstand: $>5 \cdot 10^{12}$ Ohm Eingangsstrom: $5 \cdot 10^{-13}$ A typisch $<2 \cdot 10^{-12}$ A bei 25 °C
Verwendbare Meßketten	pH-Meßketten mit Stecker nach DIN 19262 und Kettennullpunkt pH = 7.0 ± 0,5
Kalibrierverfahren	Zweipunktkalibrierung: AutoCal TEC WTW-Technische Pufferlösungen Einpunktkalibrierung: ConCal 1 oder 2-Pt Kalibrierung mit probenangepaßten Pufferlösungen
Kalibrierintervall	1 ... 999 Tage (voreingestellt 7 Tage)
Steilheitsbereich	-62 ... -50 mV/pH
Asymmetrie	-30 ... +30 mV
Redox-Messung (zusätzlich die technischen Daten der Meßkette beachten)	
Meßbereich	-1250 mV ... +1250 mV
Auflösung	1 mV
Genauigkeit	1 mV ± 1 digit
Verwendbare Meßketten	Meßketten mit Stecker nach DIN 19262

Technical data

Sauerstoff-Messung	
Sauerstoffsättigung (zusätzlich die technischen Daten des Sensors beachten)	
AutoRange = Automatische Meßbereichswahl	
Meßbereiche:	
Meßbereich 1	0 ... 199,9 %
Auflösung	0,1 %
Genauigkeit	± 0,5 % vom Meßwert ± 1 digit bei Messung im Bereich von ± 10 K um die Kalibriertemperatur
Meßbereich 2	0 ... 600 % (Obergrenze bei pO_2=1250 mbar)
Auflösung	1 %
Genauigkeit	± 0,5 % vom Meßwert ± 1 digit bei Messung im Bereich von ± 10 K um die Kalibriertemperatur
Genauigkeit der Temperaturkompensation	< 2 % bei 0 ... 40 °C
Verwendbare Sensoren	WTW-Sauerstoffsensor CellOx 325
Kalibrierverfahren	WTW-Luftkalibrierverfahren
Kalibrierintervall	1 ... 999 Tage (voreingestellt 14 Tage)
Steilheitsbereich	0,6 ... 1,25
Sauerstoffkonzentration (zusätzlich die technischen Daten des Sensors beachten	
AutoRange = Automatische Meßbereichswahl	
Meßbereiche:	
Meßbereich 1	0 ... 19,99 mg/l
Auflösung	0,01 mg/l
Genauigkeit	± 0,5 % v. Meßwert ± 1 digit bei Umgebungstemperatur 5°C ... 30 °C
Meßbereich 2	0 ... 90,0 mg/l bei 0 °C (Obergrenze bei pO_2=1250 mbar)
Auflösung	0.1 mg/l
Genauigkeit	± 0,5 % v. Meßwert ± 1 digit bei Umgebungstemperatur 5°C ... 30 °C
Genauigkeit der Temperaturkompensation	< 2 % bei 0 ... 40 °C
Salzgehaltskorrektur	0,0 ... 70,0 Sal
Luftdruckkorrektur	automatisch durch eingebauten Drucksensor im Bereich 500 ... 1100 mbar
Verwendbare Sensoren	WTW-Sauerstoffsensor CellOx 325
Kalibrierverfahren	WTW-Luftkalibrierverfahren
Kalibrierintervall	1 ... 999 Tage (voreingestellt 14 Tage)
Steilheitsbereich	0,6 ... 1,25

Prüfzertifikat EMV

SENTON
EMV-Prüfzentrum EMI/EMC-Testcenter

GUTACHTEN

über die elektromagnetische Verträglichkeit
zum Prüfbericht Nr. 52501-61125-1/-2

Prüfling:	MultiLine P4
EMV-technisch baugleich:	MultiLine P3 pH/OXI
Auftraggeber:	WTW GmbH
Prüfgrundlagen:	EN 50081-1:1992 EN 50082-1:1992

Prüfergebnis/*Testresult*:

Das geprüfte Gerät entspricht den Anforderungen der Störaussendung und der Störfestigkeit nach o. a. Prüfgrundlagen. Es wurden folgende Verträglichkeitswerte erreicht:

Störemissionen: Anforderungen nach EN 50081-1:1992
Anforderunen nach FCC part 15 subpart B limit class A

Störfestigkeit: Elektrostatische Entladungen nach IEC 801-2:1991
Luftentladung: 8 kV

Elektromagnetische Felder nach IEC 801-3:1984
27 - 500 MHz: 3 V/m

Schnelle transiente Störgrößen (Bursts) nach IEC 801-4:1988
Steckernetzteil: 1 kV
Datenleitung: 0,5 kV

[redacted] 19. Dezember 1997
Roidt Johann — Datum
Senton GmbH

Deutscher Akkreditierungs Rat DAR

SENTON GmbH · EMV-Prüfzentrum · Äußere Frühlingsstraße 45 · D-94315 Straubing · Tel. 09421/56 22-0

Housing		
Length	*172 mm*	
Width	*80 mm*	
Height	*37 mm*	
Weight	*approx. 0.3 kg (total weight of meter)*	
Color	*black, RAL 9005*	
EMC and VDE Standards		
Protection degree	*IP 66*	*IEC 529*
Protection class	*3*	*IEC 1010*
Climate class	*JVD*	*DIN 40040*
EMC Emission	*Generic standard EN 50081-1 standard part* *FCC class A*	
EMC Immunity	*Generic standard EN 50082-1 standard part*	
Operation conditions		
Operating temperature	*-10 ... 55 °C*	
Storing temperature	*-25 ... 65 °C* *Operation in the open, dew possible*	
Relative humidity	*Yearly mean:*	*< 90 %*
	30 days/year:	*<100 %*
	Other days:	*< 80 %*
Power supply		
Batteries	*Batteries: 4 x 1.5 V Typ AA*	
Working time	*pH*	*2500 h*
	pH/dissolved oxygen	*1500 h*
Data security	*unlimited*	
Time		
Clock	*Real time clock*	
Accuracy	*1 min/month max. deviation*	

Memory of measured values	
Type	*Ring store*
Quantity	*120 measuring records*
Timer for timed storing	*5 sec, 30 sec, 1 min, 5 min, 10 min, 15 min, 30 min, 60 min*
Serial interface	
Type	*RS232.C, data output*
Baud rate	*adjustable 1200, 2400, 4800, 9600 Baud*
Data bits	*8*
Stop bit	*1*
Parity	*None*
Handshake	*RTS/CTS + X_{on}/X_{off}*
Cable length	*max. 15 m*
Output format	*ASCII strings (IBM font)* *Field separation by CR, LF*
Timer for timed output	*5 sec, 30 sec, 1 min, 10 min, 15 min, 30 min, 60 min, OFF*
Connections *(electromechanical construction)*	
Dissolved oxygen	*8 pin WTW socket with pin contacts with latching device (Protection degree IP 67)*
pH/voltage	*Socket according to DIN 19262 (Protection degree IP 67) in connection with SenTix electrode*
Temperature	*1 pin WTW jack (Protection degree IP 67)*
Serial interface	*4 pin socket with pin contacts*
pH measurement	
(Pay also attention to the technical data of the electrode)	
Measuring range	*-2 ... 16*
Resolution	*0.01*
Accuracy	*0.01 ± 1 digit*
General points	*Input resistance: > 5 · 10^{12} Ohm* *Input currence: 5 · 10^{-13} A typically* *< 2 · 10^{-12} A at 25 °C*
Usable electrodes	*pH electrodes with plug according to DIN 19262 and electrode zero point pH = 7.0 ± 0.5*
Calibration procedure	*Two point calibration:* *AutoCal TEC: Technical buffer solutions* *One point calibration:* *ConCal: 1 or 2 point calibration with buffer solutions suitable for the sample*
Calibration interval	*1 ... 999 days (preset 7 days)*
Slope range	*-62 ... -50 mV/pH*
Asymmetry	*-30 ... +30 mV*
Redox measurement	
(Pay also attention to the technical data of the electrode)	
Measuring range	*-1250 mV ... +1250 mV*
Resolution	*1 mV*
Accuracy	*1 mV ± 1 digit*
Usable electrodes	*Electrodes with plug according to DIN 19262*

Oxygen measurement

Dissolved oxygen saturation measurement
(Pay also attention to the technical data of the probe)

AutoRange = Automatic selection of measuring ranges

Measuring ranges:	
Measuring range 1	*0 ... 199.9 %*
Resolution	*0.1 %*
Accuracy	*± 0.5 % of measured value ± 1 digit when measuring at calibration temperature ± 10 K*
Measuring range 2	*0 ... 600 % (upper limit at pO_2=1250 mbar)*
Resolution	*1 %*
Accuracy	*± 0.5 % of measured value ± 1 digit when measuring at calibration temperature ± 10 K*
Accuracy of temperature compensation	*< 2 % with 0 ... 40 °C*
Usable probes	*WTW D. O. probe CellOx 325*
Calibration procedure	*WTW air calibration*
Calibration interval	*1 ... 999 days (preset 14 days)*
Slope range	*0.6 ... 1.25*

D. O. concentration measurement
(Pay also attention to the technical data of the probe)

AutoRange = Automatic selection of measuring ranges

Measuring ranges:	
Measuring range 1	*0 ... 19.99 mg/l*
Resolution	*0.01 mg/l*
Accuracy	*± 0.5 % of measured value ± 1 digit with ambient temperature 5°C ... 30°C*
Measuring range 2	*0 ... 90.0 mg/l bei 0 °C (upper limit at pO_2=1250 mbar)*
Resolution	*0.1 mg/l*
Accuracy	*± 0.5 % of measured value ± 1 digit with ambient temperature 5°C ... 30 °C*
Accuracy of temperature compensation	*< 2 % with 0 ... 40 °C*
Salinity correction	*0.0 ... 70.0 SAL*
Barometric pressure correction	*automatically with built-in pressure sensor in the range 500 ... 1100 mbar*
Usable probes	*WTW D. O. probe CellOx 325*
Calibration procedure	*WTW air calibration*
Calibration interval	*1 ... 999 days (preset 14 days)*
Slope range	*0.6 ... 1.25*

Test certificate EMC

SENTON
EMV-Prüfzentrum EMI/EMC-Testcenter

CERTIFICATE

to the Electromagnetic Compatibility
to Test Report No. 52501-61125-1/-2

EUT:	MultiLine P4
Uniform EMC design:	MultiLine P3 pH/OXI
Applicant:	WTW GmbH
Regulations:	EN 50081-1:1992 EN 50082-1:1992

Testresult:

The tested sample is in compliance with the RFI requirements and the immunity requirements according to above referenced regulations.
The following severity levels have been achieved:

RFI-Emissions:	Requirements according to EN 50081-1:1992 Requirements according to FCC part 15 subpart B class limit A
Immunity:	Limit class B according to EN 55022:1987 Air discharge: 8 kV Radiated Electromagnetic Fields according to ENV 50140:1993 / ENV 50204:1995 80 - 1000 MHz: 10 V/m, ITU-Frequency: 3 V/m 900 ± 5 MHz: 10 V/m Electrical Fast Transients (Burst) according to IEC 801-:1988 Electrical Fast Transients (Burst) according to Powerline: 1 kV, Dataline: 0,5 kV Conducted Disturbances according to ENV 50141:1993 0,15 - 80 MHz: 3 Veff

Roidt Johann — Date
Senton GmbH

Deutscher Akkreditierungs Rat DAR

SENTON GmbH · EMV-Prüfzentrum · Äußere Frühlingsstraße 45 · D-94315 Straubing · Tel. 09421/55 22-0

Liste empfohlener Applikationsberichte

	Appl.-Bericht Nr.
pH-Wert	
pH-Messung im Abwasser	... 295
Einfluß der Temperatur auf die pH-Messung	... 244
Haltbarkeit von pH-Pufferlösungen	... 065
pH-Ein-Punktkalibrierung	... 007
Redoxspannung	
Redox-Messung im Abwasser	... 297
Sauerstoff	
Sauerstoffmessung im Belebungsbecken	... 064

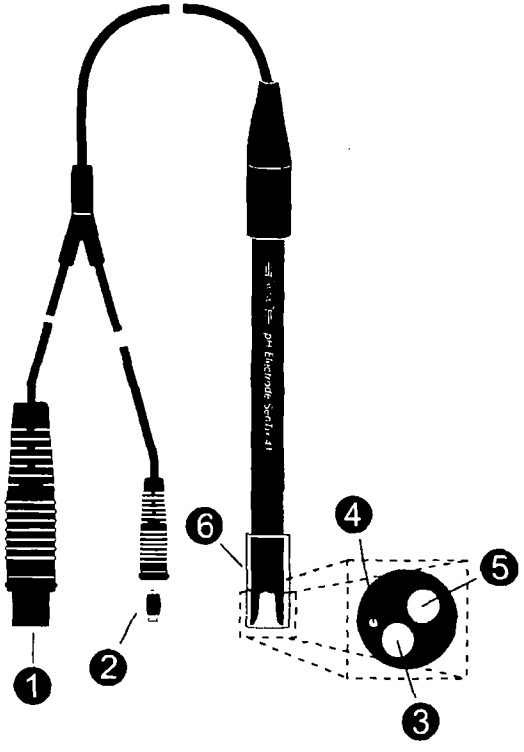
List of recommeded application reports

	Appl. report no.
pH value	
pH measurement in wastewater	*... 295*
Influence of temperature on pH measurement	*... 244*
Stability of pH buffer solutions	*... 065*
pH single point calibration	*... 007*
Redox voltage	
Redox measurement in wastewater	*... 297*
Dissolved oxygen	
Dissolved oxygen measurement in the activated sludge basin	*... 064*

pH-Einstabmeßkette mit integriertem Temperaturmeßfühler

pH combined electrode with integrated temperature probe

SenTix 41
SenTix 41-3



1. Wasserdichter Stecker der pH-Einstabmeßkette
   Watertight plug of the pH combined electrode
2. 1-poliger Bananenstecke für Temperaturmeßfühler
   1 pin banana plug for temperature probe
3. Membran der pH-Elektrode
   Membrane of the pH electrode
4. Diaphragma der Referenzelektrode
   Diaphragm of the reference electrode
5. Temperaturmeßfühler
   Temperature probe
6. Wässerungskappe mit Kaliumchlorid-Lösung (3 mol/l)
   Wetting cap with potassium chloride solution (3 mol/l)

Inbetriebnahme / *Putting into operation*

- pH-Meßkette an Meßgerät stecken.
- Wässerungskappe entfernen.
- pH-Meßkette ca. 10 min in neutraler Pufferlösung wässern.
- Nach Geräteanleitung kalibrieren.

- *Connect electrode to meter.*
- *Remove wetting cap.*
- *Soak pH electrode in neutral buffer solution for approx. 10 minutes.*
- *Calibrate according to instrument instructions.*

Bei ausgetrockneter Membran Meßkette 24 Stunden in neutraler Pufferlösung oder vorzugsweise in Kaliumchlorid-Lösung (c = 3 mol/l) wässern.

Aus der Wässerungskappe kann während des Transportes oder der Lagerung Kaliumchloridlösung austreten, wobei sich beim Austrocknen eine Kruste von Kaliumchlorid bildet. Diese Salzschicht ist ungefährlich und läßt sich mit Wasser einfach abspülen.

If the membrane has dried out, soak the pH electrode in a neutral buffer solution or, preferably, potassium chloride solution (c = 3 mol/l) for 24 hours.

Some of the potassium chloride solution may leak out of the wetting cap during transport or storage, leaving a crust of potassium chloride solution after drying. This layer of salt is harmless and can be rinsed off with water.

Empfohlene Einsatzbereiche / *Recommended areas of application*

Vor-Ort-Messung und einfache Labormessung in wäßrigen Medien. An den Grenzen und außerhalb der angegebenen Einsatzbereiche (siehe Technische Daten) kann die Haltbarkeit verkürzt sein.

At-site measurement and simple laboratory measurement in aqueous media. The durability can be shortend if using the combined pH electrode near the limits or outside the specified areas of application (see technical data).

Reinigen / *Cleaning*

Verunreinigung	Reinigungsmittel	Einwirkzeit
Wasserlösliche Verunreinigungen	Destilliertes Wasser	10 Minuten
Sonstige Verunreinigungen	Warmes, spülmittelhaltiges Wasser	10 Minuten

Impurities	*Cleaning agents*	*Contact time*
Water-soluble impurities	*Distilled water*	*10 minutes*
Other impurities	*Warm water with detergent*	*10 minutes*

Anschließend gründlich mit entionisiertem Wasser nachspülen.

Subsequently, thoroughly rinse with deionized water.

Lagern / *Storage*

Membran **stets feucht** halten.
Lagerung mit Wässerungskappe, gefüllt mit Kaliumchlorid-Lösung (c = 3 mol/l).
Nie destilliertes Wasser zur Aufbewahrung verwenden.

Aufbewahrungslage: Liegend oder stehend mit Membrane nach unten.

***Always** keep the membrane in a **moist** condition.*
Storage with wetting cap, filled with potassium chloride solution (c = 3 mol).
Never use deionized water for storage.

Storage position: Horizontal or upright with membrane at the bottom.

Wechsel der Elektrolytlösung / *Replacement of electrolytic solution*

Nicht erforderlich.

Not necessary.

Alterung

Beachten Sie bitte, daß jede pH-Meßkette einer natürlichen Alterung unterliegt, wobei die Anzeige immer träger wird und die Meßkettensteilheit allmählich abnimmt.

Unsachgemäße Lagerung, spezielle Meßmedien (z. B. sulfidhaltige, hochalkalische, proteinhaltige Medien) oder hohe Temperaturen sowie große pH- und Temperaturwechsel verkürzen die Lebensdauer erheblich.

Für durch das Meßmedium verursachte Ausfälle und bei mechanischen Beschädigungen besteht kein Garantieanspruch.

Aging

Please note that each pH electrode undergoes a natural aging process, as a result of which the reading will become increasingly slow while the slope of the pH electrode gradually decreases.

Incorrect storage, certain measurement media (e.g., sulphate-containing, highly alkaline, protein-containing media) or high temperatures as well as large pH or temperature changes will shorten the service life considerably.

The guarantee does not apply in the case of failure caused by the measurement media or mechanical damage.

Entsorgung

Verbrauchte Meßketten einschicken. WTW übernimmt die vorschriftsmäßige Entsorgung.

Disposal

Your old pH electrodes can be returned to WTW who will ensure correct disposal in compliance with the legal regulations.

Vorgang	Ergebnis	Maßnahme
Kalibrieren	Fehlermeldung (nicht kalibrierbar)	● Wässerungskappe entfernen ● Reinigen ● Steckkontakt prüfen ● Pufferlösungen überprüfen
pH-Messen in einer Lösung	Fehlermeldung (Meßbereichs-überschreitung)	● Steckkontakt DIN-Stecker prüfen
	Driftende oder instabile Meßwerte	● Reinigen ● Steckkontakt DIN-Stecker trocknen ● Meßkette nur in der vorgesehenen Lösung lagern ● Meßlösung mit zu geringer Leitfähigkeit oder sich änderndem pH-Wert
Temperatur messen	Fehlermeldung (Meßbereichs-überschreitung)	● Steckkontakte prüfen
	Driftende Werte	● Steckkontakte trocknen ● Temperaturanpassung abwarten

Process	*Result*	*Action*
Calibrating	*Error message (calibration not possible)*	● *Remove wetting cap* ● *Clean* ● *Check plug-in contact of DIN plug* ● *Check buffer solutions*
pH measurement in a solution	*Error message (overrange)*	● *Check plug-in contact of DIN plug*
	Drifting or unstable values	● *Clean* ● *Dry plug-in contact of DIN plug* ● *Only store pH electrode in the specified solution* ● *Conductivity of measurement solution too low or changing pH value*
Temperature measurement	*Error message (Exceeding of meas. range)*	● *Control plug contacts*
	Drifting values	● *Dry plug contacts* ● *Wait for temperature conformity*

Meßbedingungen	
pH-Einsatzbereich	0 ...14
Temperaturbereich	0 ...80 °C
Eintauchtiefe	min. 18 mm max. 120 mm
Kenndaten bei Auslieferung	
Steilheitsbereich	57,0 ... 60,5 mV/pH
Offsetspannung (Asymmetrie)	± 15 mV
Ansprechzeit Temperaturfühler	t_{95} < 50s t_{99} < 130s
Bezugssystem	Ag/AgCl mit Gelfüllung
Material	
Schaft	PPE
Membran	pH-Glas
Gehäuse Temperaturfühler	Glas
Abmessungen	
Schaftlänge	120 mm
Schaftdurchmesser	12 mm
Kabellänge	1 m (Sentix 41); 3 m (Sentix 41-3)
Stecker DIN 19262	Schutzart IP 66 im gesteckten Zustand

Measurement conditions	
pH range of application	*0 ...14*
Temperature range	*0 ...80 °C*
Depth of immersion	*min. 18 mm* *max. 120 mm*
Characteristic data at the time of delivery	
Range of slope	*57.0 ... 60.5 mV/pH*
Offset voltage (Asymmetry)	*± 15 mV*
Response time temperature sensor	t_{95} < *50s* t_{99} < *130s*
Reference system	*Ag/AgCl with gel filling*
Material	
Shaft	*PPE*
Membrane	*pH-glass*
Housing temperature sensor	*glass*
Dimensions	
Length of shaft	*120 mm*
Shaft diameter	*12 mm*
Length of cable	*1 m (SenTix 41); 3 m (SenTix 41-3)*
***Plug** DIN 19262*	*Type of protection IP 66 in plugged-in condition*

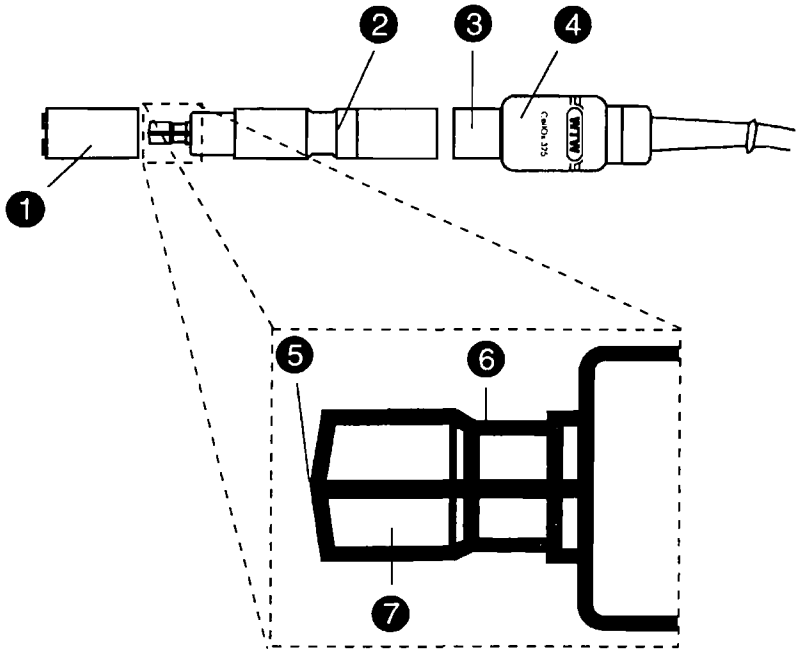
Sauerstoffsensor

Dissolved Oxygen Probe

CellOx 325

Aufbau des Sauerstoffsensors CellOx 325

Construction of the dissolved oxygen probe CellOx 325



1	Membrankopf WP 90	*Membrane head WP 90*
2	Temperaturfühler	*Temperature probe*
3	Schaft	*Shaft*
4	Abschlußkopf	*Closing head*
5	Arbeitselektrode (Goldkathode)	*Working electrode (gold cathode)*
6	Gegenelektrode (Bleianode)	*Counter electrode (lead anode)*
7	Isolator	*Isolator*

Inbetriebnahme / Meßbereitschaft

Den Sensor an das Meßgerät stecken. Der Sensor ist sofort meßbereit.
Ein Polarisieren des Sensors ist nur dann erforderlich, wenn Elektrolyt und Membran gewechselt werden.

Putting into operation / Readiness for measuremen

Connect probe to the meter. The probe is immediately ready for measurement.
It is only necessery to polarize the probe if electrolyte and membrane ar changed.

Empfohlene Einsatzbereiche

Vor-Ort-Messungen in Flüssen, Seen und Abwasser sowie BSB-Messung.

Recommended ranges of application

At site-measurement in rivers, lakes, wastewater and BOD measurement.

Kalibrieren

Kalibrierung bitte in der Bedienungsanleitung des Meßgerätes nachlesen.

Calibration

For calibration please refer to operation manual of the instrument.

Messen

Für die erforderliche Mindestanströmung sorgen, z. B.:

- Die Fließgeschwindigkeit des Gewässers reicht aus.
- Den Sensor langsam mit der Hand durch das Wasser ziehen.
- Eine Anströmhilfe am Sensor anbringen.

Measurement

Take care of necessary minimum flow, e.g.:

- *The flow velocity of the water is sufficient.*
- *Pull probe slowly by hand through th water.*
- *Attach a flow accessory to the probe*

Reinigen (Äußere Reinigung) / *Cleaning (Exterior cleaning)*

Verunreinigung	Reinigungsverfahren
Kalk	1 Minute in Essigsäure (25 %) tauchen.
Fett/Öl	mit warmen, spülmittelhaltigem Wasser spülen.

Impurity	*Cleaning procedure*
Lime	*Immerse for 1 minute into acetic acid (25 %).*
Grease/Oil	*Rinse with warm water and household cleaning solution.*

Gründlich mit entionisiertem Wasser spülen.

Rinse thoroughly with deionized water.

Lagern / *Storage*

Den Sensor im Kalibriergefäß aufbewahren.

Store the probe in the calibration beaker.

Temperatur: -5 °C bis 50 °C
Feuchtigkeit: Luft im Kalibriergefäß feucht halten
Lage: beliebig

Temperature: -5 °C ... +50 °C
Humidity: Keep air in calibration beaker moist
Position: any

Wartung / *Maintenance*

Siehe Applikationsbericht 895234 (im Anhang dieser Bedienungsanleitung):

"Regenerieren galvanischer Sauerstoffsensoren".

See application report 895234 (in the appendix of this manual):

"Regeneration of galvanic oxygen probes".

Wartungsmittel und Ersatzteile / *Maintenance and spare parts*

		Modell *Model*	Best.-Nr. *Order No.*
Austausch-Membranköpfe (3 Stück)	*Exchange membrane heads (3 pieces)*	WP 90/3	202 725
Elektrolytlösung	*Electrolyte solution*	ELY/G	205 217
Reinigungslösung für Blei-Gegenelektrode	*Cleaning solution for lead counter electrode*	RL/G	205 204
Schleiffolie	*Grinding foil*	SF 300	203 680
OxiCal®-Kalibriergefäß	*OxiCal® calibration beaker*	OxiCal®-SL	205 362
Zubehörkasten	*Accessory kit*	ZBK 325	202 706

Fehlersuche
Trouble shooting

Fehlersymptom	Mögliche Ursache	Behebung
Meßgerät zeigt 0.0 mg/l bzw. 0 % Sat O_2 an (Sensor ist an Luft)	• keine Verbindung Meßgerät-Sensor • Kabel defekt	Verbindung Meßgerät-Sensor prüfen Sensor einsenden
Sensor ist nicht kalibrierbar	• verschmutzter Membrankopf	Sensor nach Bedienungsanleitung neu befüllen, 60 Minuten warten und dann erneut kalibrieren
Sensor nach Elektrolyt- und Membrankopfwechsel immer noch nicht kalibrierbar	• Verschmutzte Elektroden bzw. Sensorvergiftung	Elektrodenreinigung
Leckanzeige erscheint	• Membrankopf nicht fest genug aufgeschraubt • Loch in der Membran	Membrankopf fest anziehen Sensor nach Bedienungsanleitung mit neuen Membrankopf bestücken
Falsche Temperaturanzeige	• Temperaturfühler defekt	Sensor einsenden
Mechanische Beschädigung des Sensors		Sensor einsenden

Error symptom	*Possible cause*	*Elimination*
Instrument displays 0.0 mg/l or 0 % Sat O_2 (probe in air)	• *No connection between meter and probe* • *Defective cable*	*Control connection between meter and probe* *Send probe to WTW*
Probe cannot be calibrated	• *Contaminated membrane head*	*Refill probe acc. to operation manual, wait 60 min. and recalibrate*
Probe cannot be calibrated even after exchange of electrolyte and membrane head	• *Contaminated electrode or probe poisoned*	*Cleaning of electrode*
Leakage is displayed	• *Membrane head hasn't been really tightened* • *Hole in the membrane*	*Screw tight membrane head* *Exchange membrane head acc. to operation manual*
Wrong temp. indication	• *Defective temperature probe*	*Send probe to WTW*
Mechanical damage of the probe		*Send probe to WTW*

Technische Daten

Meßprinzip	Membranbedeckter galvanischer Sensor
Temperaturkompensation	IMT

Meßbedingungen

Meßbereich	0 bis 50 mg/l O_2
Temperaturbereich:	0 °C bis 50 °C
Max. zulässiger Überdruck	6 bar
Eintauchtiefe	min. 6 cm max. 20 m Tiefe
Betriebslage	beliebig
Anströmung	> 3 cm/s bei 10 % Meßgenauigkeit 10 cm/s bei 5 % Meßgenauigkeit 18 cm/s bei 1 % Meßgenauigkeit
Anschlußtechnik	Kabel, Stecker: Schutzart IP67, 8-poliger Stecker Sensor: Schutzart IP68 (20 m)

Kenndaten bei Auslieferung

Nullsignal	< 0,1 % vom Sättigungswert
Ansprechzeit bei 20 °C	t_{90} (90 % der Endwertanzeige nach) < 10 sec t_{95} (95 % der Endwertanzeige nach) < 16 sec t_{99} (99 % der Endwertanzeige nach) < 60 sec
Eigenverbrauch bei 20 °C	0,008 µg h^{-1} $(mg/l)^{-1}$
Drift	ca. 3 % pro Monat im Betriebszustand
Standzeit	mindestens 6 Monate pro Elektrolytfüllung
Material	Membrankopf: POM Membran: FEP Sensorkopf: POM Thermistorgehäuse: VA-Stahl 1.4571 Schaft: POM
Abmessungen	Schaftlänge: 145 mm Schaftdurchmesser: 15,25 mm Membrandicke: 13 µm Kabellänge: 1,5 m bis 20 m

Measuring principle	*Membrane covered galvanic probe*
Temperature compensation	*IMT*

Measuring conditions

Meas. range	*0 to 50 mg/l O_2*
Temperature range	*0 °C to 50 °C*
Max. admissible overpressure	*6 bar*
Immersion depth	*min. 6 cm* *max. 20 m depth*
Operating position	*any*
Incident flow	*> 3 cm/s at 10 % meas. accuracy* *10 cm/s at 5 % meas. accuracy* *18 cm/s at 1 % meas. accuracy*
Connections	*Cable, plug: Protection degree IP67, 8pin plug* *Probe: Protection degree IP68 (20 m)*

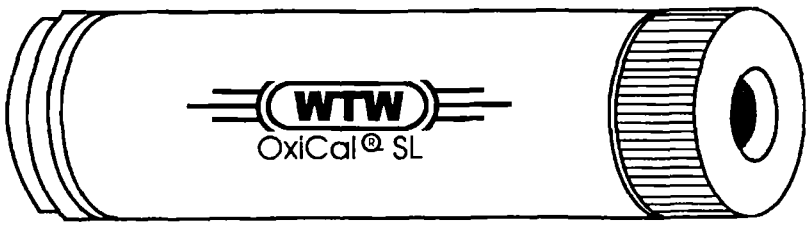
Characteristics when delivered

Zero signal	*< 0.1 % of saturation value*
Response time at 20°C	*t_{90} (90 % of indication of end value after) < 10 sec* *t_{95} (95 % of indication of end value after) < 16 sec* *t_{99} (99 % of indication of end value after) < 60 sec*
Self consumption at 20°C	*0.008 µg h^{-1} $(mg/l)^{-1}$*
Drift	*approx. 3 %/month in operation condition*
Operation time	*at least 6 months per electrolyte filling*
Material	*Membrane head POM* *Membrane FEP* *Probe head POM* *Thermistor housing VA-steel 1.4571* *Shaft POM*
Dimensions	*shaft length 145 mm* *shaft diameter 15.25 mm* *membrane thickness 13 µm* *cable length 1.5 m to 20 m*

Luftkalibriergefäß
zur Präzisionskalibrierung von WTW-Sauerstoffsensoren

Air Calibration Beaker
for precision calibration of WTW D. O. probes

OxiCal® - SL



Tips für die Kalibrierung mit dem OxiCal® - SL

Erhöhen Sie die Kalibriergenauigkeit durch **Vermeidung von starken Temperatureinflüssen** auf das OxiCal®-Gefäß!
(Einsatzbereich 15 °C bis 40 °C):
- keine direkte Sonnenbestrahlung
- keine starken Temperaturschwankungen

Bei großer Temperaturdifferenz zwischen Sensor und OxiCal®: Beschleunigen Sie den Temperaturangleich durch Eintauchen des Sensors in ein Wasserbad!

Kalibrieren Sie den Sensor **in dem Zustand in dem Sie messen** (mit oder ohne Rührzusatz RZ 300)!

Mechanische Belastung des Membrankopfes des Sensors (z.B. Abnehmen des RZ 300) **macht ein erneutes Kalibrieren notwendig.**

Notes for calibration with the OxiCal® - SL

*Increase calibration accuracy by **avoiding strong temperature influences** on the OxiCal® beaker!*
(Application range 15 °C to 40 °C):
- *no direct insolation*
- *no strong thermal fluctuations*

***With a high difference in temperature** between probe and OxiCal®: Accelerate the temperature adjustment by immersing the probe into a water bath!*

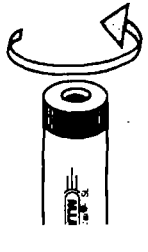
***Calibrate** the probe **in the same condition in which you measure** (with or without stirring accessory RZ 300)!*

Mechanical strain on the membrane head of the probe** (e. g. removing the RZ 300) **makes a recalibration necessary.

Kalibrierung mit dem OxiCal® - SL

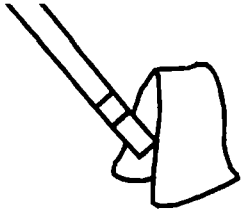
Calibration with the OxiCal® - SL

①



Drehverschluß lösen. *Loosen screw cap.*

②

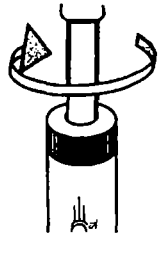


Sensor trocknen. *Dry probe.*

③

Sensor bis zum Anschlag einstecken. *Insert probe up to the stop.*

④



Drehverschluß handfest zudrehen. *Close screw cap handtight.*

⑤

Kalibrierung am Meßgerät starten (Taste "Cal" drücken). *Start calibration at the meter (Press "Cal" key).*

Wartung OxiCal® - SL / *Maintenance OxiCal® - SL*

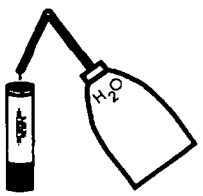
Schwamm im OxiCal®-SL muß immer **feucht** sein (nicht naß)!

***Sponge in the** OxiCal®-SL must always be **moist** (not wet)!*

①

Deckel öffnen. *Remove cap.*

②



Schwamm befeuchten. *Moisten sponge.*

③

Deckel schließen. *Close cap.*

Nr.: Oxi 895234

Regenerieren galvanischer Sauerstoffsensoren

WTW liefert die Sensoren betriebsfertig aus.

Ein Wechsel der Elektrolytlösung und des Membrankopfes ist erforderlich bei:

- **beschädigter Membran**
- **stark verschmutzter Membran**
- **verbrauchter Elektrolytlösung**

Geräte u. Zubehör

Austausch-Membranköpfe
Kathodenreiniger (Schleiffolie) SF 300
Papiertücher
Bechergläser

Reagenzien

Entionisiertes Wasser
Reinigungslösung RL/G
Elektrolytlösung ELY/G

Hinweise

Bei allen Wartungsarbeiten den Sensor vom Gerät abziehen.

Der Sensor ist nach dem Regenerieren in 30 - 50 Minuten wieder betriebsbereit.
Für Messungen in Medien mit sehr kleinen Sauerstoffkonzentrationen (< 0,5 % Sat) den Sensor mindestens 12 Stunden ruhen lassen.

Die Elektrolytlösung ELY/G ist stark alkalisch!

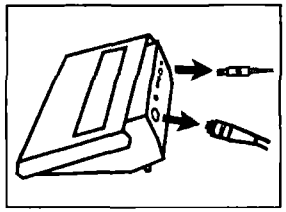
- **Sie darf nicht in die Hände von Kindern gelangen!**
- **Geeignete Schutzhandschuhe und Schutzbrille tragen!**
- **Bei Berührung mit Augen und Haut gründlich mit Wasser spülen!**
- **Bei Berührung mit den Augen Arzt konsultieren!**

Wissenschaftlich-Technische Werkstätten GmbH

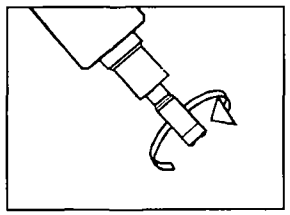
82362 Weilheim • Dr. Karl Slevogt Str. 1

Tel.: 0881/183-0 • Fax (0881) 6 25 39

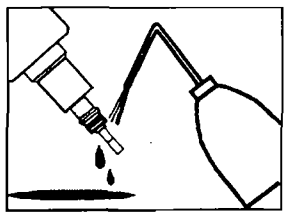
Regenerieren des Sensors



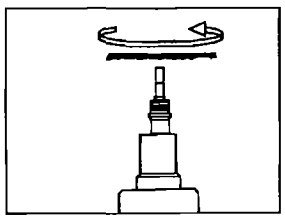
Die Stecker vom Gerät abziehen.



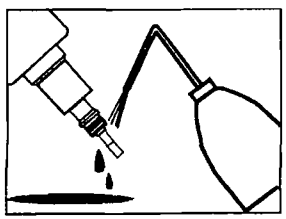
Membrankopf abschrauben.



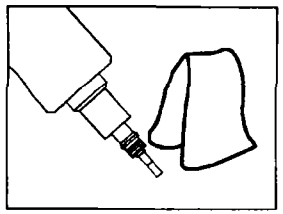
Sensorkopf mit entionisiertem Wasser spülen.



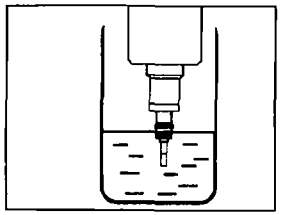
Mit Kathodenreiniger (nasser Schleiffolie) Verunreinigungen von der Kathode mit leichtem Druck abpolieren.
Kein Schleifpapier oder Glasfaserpinsel verwenden!



Sensorkopf mit entionisiertem Wasser spülen.

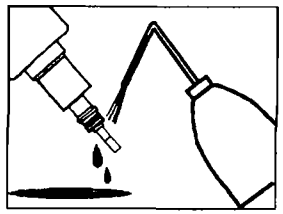


Gegenelektrode mit fusselfreiem Papiertuch abwischen und vorsic von losem weißen Belag befreien.

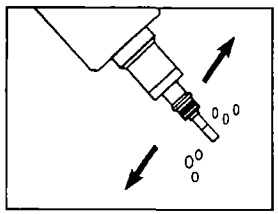


Sensorkopf bis einschließlich zur Gegenelektrode in Reinigungslös RL/G tauchen.
1 - 3 Minuten wirken lassen.

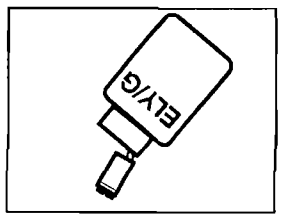
Sicherheitshinweise auf der Flasc beachten!



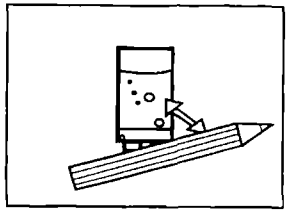
Sensorkopf mehrmals mit entionisiertem Wasser spülen.



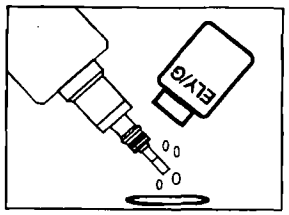
Wassertropfen vorsichtig abschütteln.



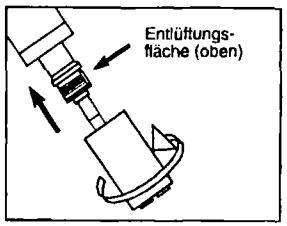
Neuen Membrankopf mit Elektroly lösung füllen.



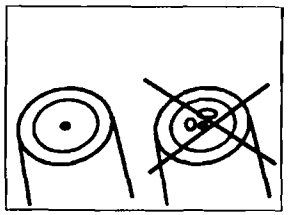
Luftblasen durch vorsichtiges Klopfen entfernen.



Sensorkopf mit Elektrolytlösung spülen.



- Membrankopf auf den Schaft schrauben.
- Sensor schräg halten. Überschüssige Elektrolytlösung drückt an der Entlüftungsfläche heraus.
- Membrankopf mit einem Papiertuch gut handfest festschrauben.



Kleine Luftblasen stören nicht.

Neubefüllung nur bei:
- Großen Luftblasen
- Luftblasen an der Goldkathode

WTW **Application report**

No.: Oxi 895234

Regeneration of galvanic oxygen sensors

WTW delivers the sensor ready to use.

An exchange of the membrane and the electrolyte solution is necessary in case of:

- damaged membrane,
- strongly contaminated membrane
- used up electrolyte solution.

Instrum. and acc.

Exchange membrane heads
Cathode cleaner SF 300
Paper towels
Beakers

Reagents

Deionized water
Cleaning solution RL/G
Electrolyte solution ELY/G

Hints

For all maintenance operation disconnect the sensor from the instrument.

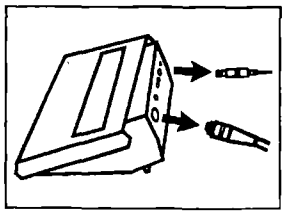
The sensor is ready for operation after regeneration in approx. 30 to 50 minutes.
For measurements in agents with very low oxygen concentrations (< 0,5 % sat), rest the sensor approx. 12 hours.

The electrolyte solution ELY/G is strongly alkaline!
- Keep out of reach of children!
- Wear suitable gloves and eye/face protection!
- After contact with eyes and skin wash immediately with plenty of water!
- In case of contact with eyes seek medical advice!

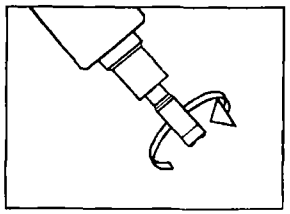
Wissenschaftlich-Technische Werkstätten GmbH

82362 Weilheim • Dr. Karl Slevogt Str. 1
Tel.: 0881/183-0 • Fax (0881) 6 25 39

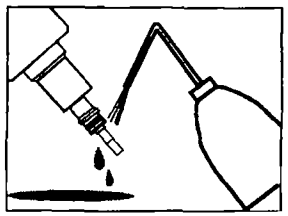
Regeneration of the oxygen sensor



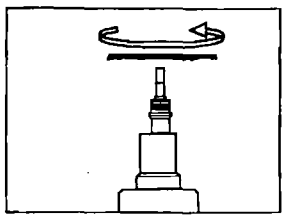
Disconnect plugs from the instrument.



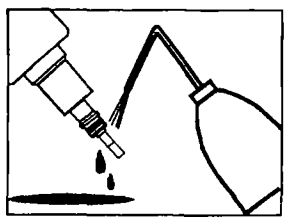
Unscrew membrane head.



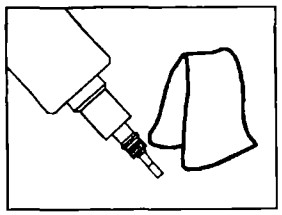
Rinse sensor head with deionized water.



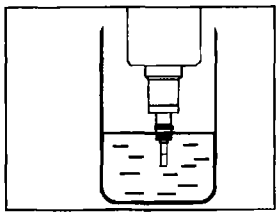
Polish impurities from the cathode with cathode cleaner (wet grinding foil) under low pressure.
Don't use grinding paper or glass fibre pen!



Rinse sensor head with deionized water.

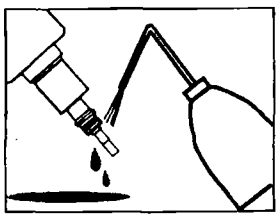


Wipe off counter electrode with fuzz free paper towel and remove careful white coating.

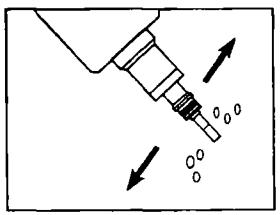


Immerse sensor head including the counter electrode into cleaning solution RL/G for 1 to 3 minutes.

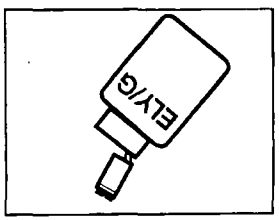
Please note the safety guideliness c the bottle!



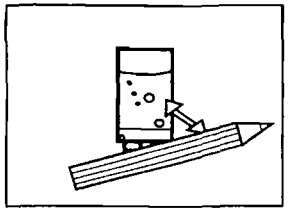
Rinse sensor head several times wi deionized water.



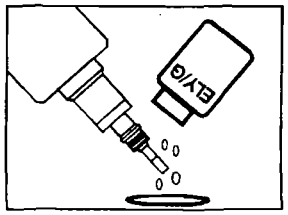
Shake carefully off water drops.



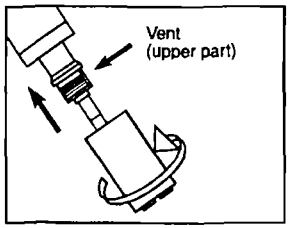
Fill a new membrane head carefully with electrolyte solution.



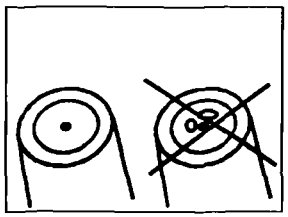
Remove existing air bubbles by careful knocking.



Rinse sensor head with electrolyte solution.



- **Screw membrane head on the shaft.**
- **Hold sensor inclined. Excessed electrolyte solution is pushed out.**
- **Screw on membrane head fingertight with a paper towel.**



Small air bubbles do not interfere.

Refilling only in case of:
- **Big air bubbles,**
- **Air bubbles at the gold cathode.**

Garantieerklärung
Warranty

Garantieerklärung

Wir übernehmen für das bezeichnete Gerät eine Garantie von 2 Jahren ab Kaufdatum.
Die Gerätegarantie erstreckt sich auf Fabrikationsfehler, die sich innerhalb der Garantiefrist herausstellen. Von der Garantie ausgeschlossen sind Komponenten, die im Zuge einer Wartung ausgetauscht werden, wie z. B. Batterien, Akkus, Lampen usw..

Der Garantieanspruch erstreckt sich auf die Wiederherstellung der Funktionsbereitschaft, nicht jedoch auf die Geltendmachung weitergehender Schadenersatzansprüche. Bei unsachgemäßer Behandlung oder bei unzulässiger Öffnung der Geräts erlischt der Garantieanspruch.

Zur Feststellung der Garantiepflicht das Gerät und den Kaufbeleg mit Kaufdatum frachtfrei bzw. postfrei einsenden.

Declaration of warranty

The designated meter is covered by a warranty of 2 years from the date of purchase. The meter warranty extends to manufacturing faults that are determined within the period of warrant. The warranty excludes components that are replaced during maintenance, such as batteries, rechargeable batteries, lamps etc.

The warranty claim extends to restoring the meter to readiness for use but not, however, to any further claims for damages. Improper handling or unauthorized opening of the meter invalidates any warranty claim.

To ascertain the warranty liability, return the meter and proof of purchase together with the date of purchase freight paid or prepaid.

Technische Kundenberatung

Bei Rückfragen wenden Sie sich bitte an den Laborfachhandel. Darüber hinaus stehen Ihnen die technischen Kundenberater im Hause WTW bzw. die technischen Außendienst-Mitarbeiter unserer WTW-Büros zur Verfügung.

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HACH Portable Turbidimeter Model 2100P

CAT. NO. 46500-88

PORTABLE TURBIDIMETER
Model 2100P
Instrument and Procedure Manual

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Rev. 1, 8/99

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CERTIFICATION

Hach Company certifies this instrument was tested thoroughly, inspected and found to meet its published specifications when it was shipped from the factory.

The Model 2100P Portable Turbidimeter has been tested and is certified as indicated to the following instrumentation standards:

Product Safety

Battery/Eliminator Power Supply Only:
120 Vac, 60 Hz, UL Listed & CSA Certified, Class 2
230 Vac, 50 Hz, VDE Approved, GS & CE marked

Immunity

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50082-1 (European Generic Immunity Standard) **per 89/336/EEC EMC:** Supporting test records with Dash Straus and Goodhue, Inc. (now Intertek Testing Services), certified compliance by Hach Company.

Standards include:
IEC 801-2 Electro-Static Discharge
IEC 801-3 Radiated RF Electro-Magnetic Fields
IEC 801-4 Electrical Fast Transients/Burst

Emissions

2100P Turbidimeter Tested with external Battery/Eliminator Power Supply:
EN 50081-1 (Emissions) **per 89/336/EEC EMC:** Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

Standards include:
EN 55022 (CISPR 22) Emissions, Class B Limits

Canadian Radio Interference-Causing Regulation, Chapter 1374, Class A: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

CERTIFICATION, continued

FCC Part 15, Class "A" Limits: Supporting test records by Amador Corp. (now TUV Product Services), certified compliance by Hach Company.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference in which case the user will be required to correct the interference at his own expense.

The following techniques of reducing interference problems are applied easily:

1. Disconnect the battery eliminator from it's power source and from the 2100P Portable Turbidimeter to verify if it is the source of the interference
2. If the battery eliminator for the 2100P Portable Turbidimeter is plugged into the same outlet as the device with which it is interfering, try another outlet.
3. Move the 2100P Portable Turbidimeter away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

SAFETY PRECAUTIONS

Please read this entire manual before unpacking, setting up, or operating this instrument. Pay particular attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

To ensure the protection provided by this equipment is not impaired, do not use or install this equipment in any manner other than that which is specified in this manual.

Use of Hazard Information

If multiple hazards exist, this manual will use the signal word (Danger, Caution, Note) corresponding to the greatest hazard.

DANGER
Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION
Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTE
Information that requires special emphasis.

Precautionary Labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed.

⚠ This symbol, if noted on the instrument, references the instruction manual for operational and/or safety information.

SPECIFICATIONS

Specifications subject to change without notice.
Operating specifications applicable at 25 °C unless noted.
Program software copyrighted by Hach Company, 1991.

Measurement Method: Ratio Nephelometric signal (90°) scatter light ratio to transmitted light

Range: 0-1000 NTU with automatic decimal point placement or manual range selection of 0-9.99, 0-99.9 and 0-1000 NTU

Accuracy: ± 2% of reading plus stray light from 0-1000 NTU

Resolution: 0.01 NTU on lowest range

Repeatability: ±1% of reading or 0.01 NTU, whichever is greater (with Gelex standards)

Response Time: 6 seconds for full step change without signal averaging in constant reading mode

Stray Light: <0.02 NTU

Standardization: StablCal™ Stabilized Formazin primary standards or Formazin primary standards

Secondary Standards: Gelex® Secondary Standards

Display: Four-digit liquid crystal; 10.16 mm (0.4 in) high digits with custom icons

Light Source: Tungsten filament lamp; lamp life typically greater than 100,000 readings

Detectors: Silicon photovoltaic

Signal Averaging: Operator selectable on or off

Sample Cells: (Height X width) 60.0 X 25 mm (2.36 X 1 in)
Borosilicate glass with screw caps, marking band and fill line

Sample Required: 15 mL (0.5 oz.)

SPECIFICATIONS, continued

Storage Temperature: -40 to 60 °C (-40 to 140 °F) (instrument only)

Operating Temperature: 0 to 50 °C (32 to 122 °F) (instrument only)

Operating Humidity Range: 0 to 90% RH noncondensing at 30 °C;
0 to 80% RH noncondensing at 40 °C;
0 to 70% RH noncondensing at 50 °C

Power Requirements: Four AA Alkaline cells or optional battery eliminator

Battery Life: Typically 300 tests with signal average mode off; 180 tests with signal average mode on

Battery Eliminator (optional):

For 120 V eliminator: CSA and UL approved for 120 VAC ±10%, 60 Hz, 6 V at 800 mA DC output

For 230 V eliminator: CE (VDE) approval pending for 230 VAC ±10%, 50 Hz, 6 V at 900 mA DC output

Enclosure: High impact ABS plastic

Dimensions: 22.2 X 9.5 X 7.9 cm (8.75 X 3.75 X 3.12 in)

Instrument Weight: 520 kg (1 lb 2.5 oz)

Shipping Weight: 3.1 kg (6 lbs 8.5 oz)

OPERATION

DANGER

Handling chemical samples, standards, and reagents can be dangerous. Review the necessary Material Safety Data Sheets and become familiar with all safety procedures before handling any chemicals.

DANGER

La manipulation des échantillons chimiques, étalons et réactifs peut être dangereuse. Lire les Fiches de Données de Sécurité des Produits (FDSP) et se familiariser avec toutes les procédures de sécurité avant de manipuler tous les produits chimiques.

PELIGRO

La manipulación de muestras químicas, estándares y reactivos puede ser peligrosa. Revise las fichas de seguridad de materiales y familiarícese con los procedimientos de seguridad antes de manipular productos químicos.

GEFAHR

Da das Arbeiten mit chemischen Proben, Standards und Reagenzien mit Gefahren verbunden ist, empfiehlt die Hach Company dem Benutzer dieser Produkte dringend, sich vor der Arbeit mit sicheren Verfahrensweisen und dem richtigen Gebrauch der Chemikalien vertraut zu machen und alle entsprechenden Materialsicherheitsdatenblätter aufmerksam zu lesen.

PERIGO

A manipulação de amostras, padrões e reagentes químicos pode ser perigosa. Reveja a folha dos dados de segurança do material e familiarize-se com todos os procedimentos de segurança antes de manipular quaisquer produtos químicos.

SECTION 1 DESCRIPTION

1.1 General Description

The Hach Model 2100P Portable Turbidimeter (*Figure 1*) measures turbidity from 0.01 to 1000 NTU in automatic range mode with automatic decimal point placement. The manual range mode measures turbidity in three ranges: 0.01 to 9.99, 10 to 99.9 and 100 to 1000 NTU. Designed primarily for field use, the microprocessor-based Model 2100P has the range, accuracy, and resolution of many laboratory instruments. The instrument operates on four AA batteries or with an optional battery eliminator. Rechargeable nickel-cadmium cells may be used, but cannot be recharged in the instrument. The instrument automatically shuts off after 5.5 minutes if no keystrokes occur (does not influence operation). If this occurs, simply turn the instrument on – the 2100P will resume operation as if the power had not been interrupted. The instrument, all standard accessories, and the optional battery eliminator may be conveniently stored in the carrying case.

Figure 1 2100P Turbidimeter and Accessories

Note: *Avoid prolonged exposure to ultraviolet light and sunlight.*

Note: *Do not hold the instrument during measurements; place the instrument on a flat, steady surface.*

1.2 Accessories

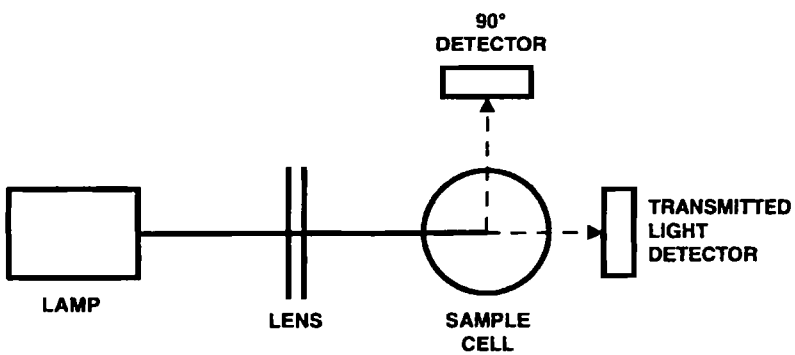
Accessories supplied with the turbidimeter include three sample cells; three Gelex Secondary Standards; one 100 mL bottle each of: <0.1-NTU, 20-NTU, 100-NTU, and 800-NTU StablCal solution; 4 AA alkaline batteries; 15 mL of silicone oil; oiling cloth; carrying case; instrument manual; and quick reference card.

1.3 Principle of Operation

The Model 2100P Portable Turbidimeter operates on the nephelometric principle of turbidity measurement. This instrument meets the design criteria specified by the United States Environmental Protection Agency, Method 180.1.

The optical system* (*Figure 2*) includes a tungsten-filament lamp, a 90° detector to monitor scattered light and a transmitted light detector. The instrument's microprocessor calculates the ratio of the signals from the 90° and transmitted light detectors. This ratio technique corrects for interferences from color and/or light absorbing materials (such as activated carbon) and compensates for fluctuations in lamp intensity, providing long-term calibration stability. The optical design also minimizes stray light, increasing measurement accuracy.

Figure 2 Ratio Optical System



* Patent number 4,198,161; other patents pending.

1.4 Preparation for Use

1.4.1 Unpacking

Remove the instrument and accessories from the shipping box and inspect them for damage that may have occurred due to rough handling or extreme weather conditions. Verify the following are present:

- Model 2100P Portable Turbidimeter
- Instrument Manual (with quick reference card)
- <0.1-NTU StablCal Solution, 100 mL
  20-NTU StablCal Solution, 100 mL
  100-NTU StablCal Solution, 100 mL
  800-NTU StablCal Solution, 100 mL
- Standardization Kit containing Gelex Secondary Standards (0-10, 0-100 and 0-1000 ranges) plus nine sample cells with caps.
- Silicone Oil, 15-mL (0.5 oz) dropping bottle
- Oiling Cloth
- Carrying Case
- Four AA alkaline batteries

If any of the items are missing or damaged, please contact the Customer Service Department, Hach Company, Loveland, Colorado. The toll-free number in the United States is 800-227-4224. International customers should contact the Hach office or authorized distributor serving your area. Refer to *REPAIR SERVICE* on page *64*

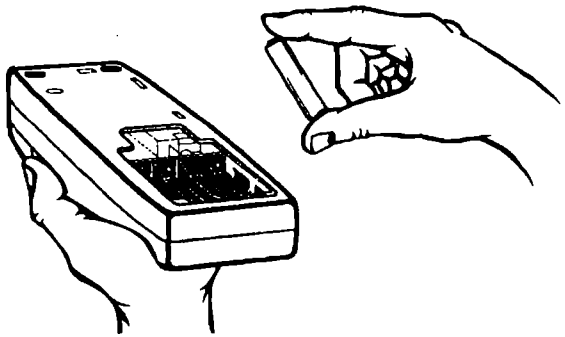
Please do not return the instrument without prior authorization from Customer Service.

1.4.2 Battery Installation

The instrument is shipped completely assembled without the batteries installed. Before use, install the four AA alkaline batteries or connect the battery eliminator (*Figure 3*). For battery operation, remove the battery compartment cover on the instrument bottom and install the

batteries. Correct battery polarity is shown on the battery holder. The instrument will not function if the batteries are not installed correctly. Reinstall the battery compartment cover.

Figure 3 Battery Installation



1.4.3 Using the Battery Eliminator and Rechargeable Batteries

For operation with the optional battery eliminator, plug the eliminator jack into the connector on the turbidimeter side. The battery eliminator may be used with or without the batteries installed. **The eliminator will not charge batteries.** Rechargeable batteries may be used in the instrument, but must be removed for recharging. See *HOW TO ORDER* on page *63* for ordering information. To prolong battery life, the instrument lamp turns on temporarily when the **READ** key is depressed. Batteries are not necessary for battery eliminator operation.

1.4.4 Calibration

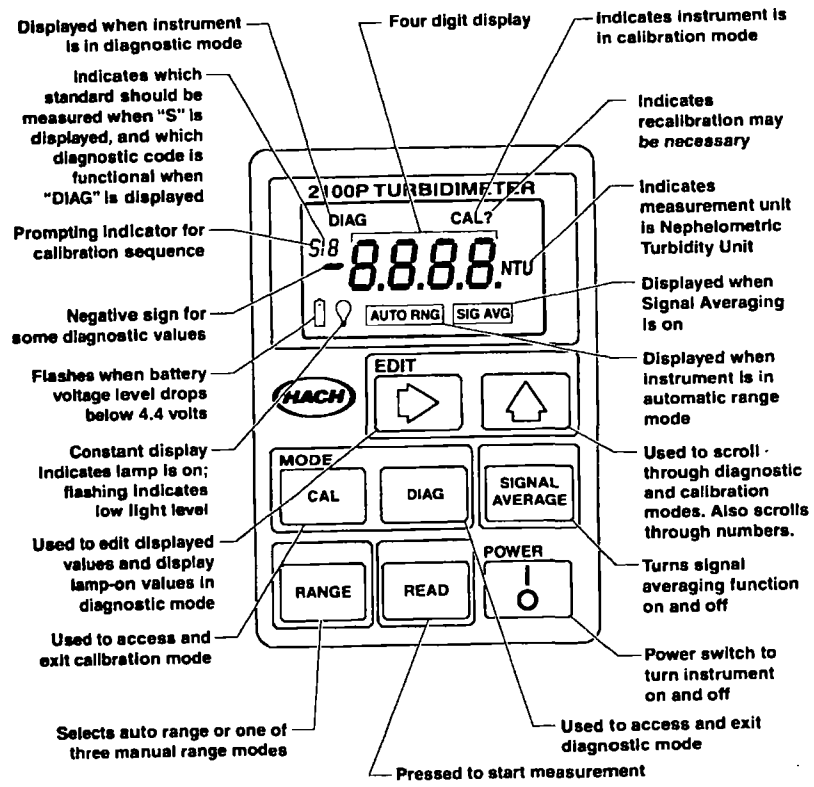
The 2100P Portable Turbidimeter is calibrated with Formazin Primary Standard at the factory and **does not require recalibration before use.** Hach recommends recalibration with formazin once every three months, or more often as experience dictates. The Gelex Secondary Standards supplied with the instrument are labelled with general ranges for application, but must be assigned values before use from formazin calibration. See *Section 3.6* on page *25* for calibration instructions.

SECTION 2 TURBIDITY MEASUREMENT

2.1 Operating Controls and Indicators

Figure 4 shows the 2100P controls and indicators. Refer to *SECTION 3* for a detailed description of each control and indicator.

Figure 4 Keyboard and Display with Descriptions



2.2 Turbidity Measurement

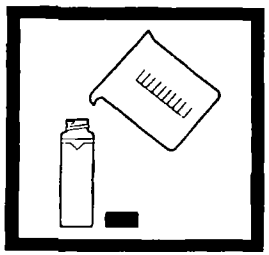
Measurements may be made with the signal average mode on or off and in manual or automatic range selection mode. Using automatic range selection is recommended. Signal averaging uses more power and should be used only when the sample causes an unstable reading. Signal averaging measures and averages ten measurements while displaying

intermediate results. The initial value is displayed after about 11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 20 seconds). After this, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When not in signal average mode, the final value is displayed after about 13 seconds.

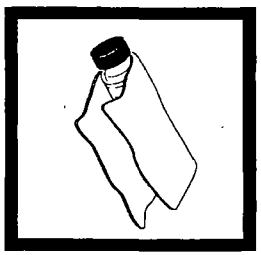
Accurate turbidity measurement depends on good measurement technique by the analyst, such as using clean sample cells in good condition and removing air bubbles (degassing). Refer to *Section 2.3* on page *10* for a detailed discussion of measurement techniques.

2.2.1 Turbidity Measurement Procedure

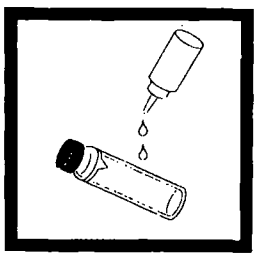


1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL), taking care to handle the sample cell by the top. Cap the cell. (See *Section 2.3* on page *10* for more information about collecting a representative sample).

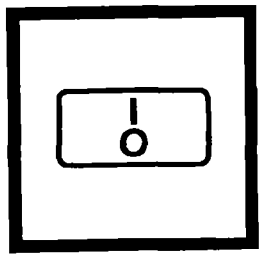
Note: *The instrument automatically shuts off after 5.5 minutes if no keystrokes occur. To resume operation, press* **I/O**.



2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.

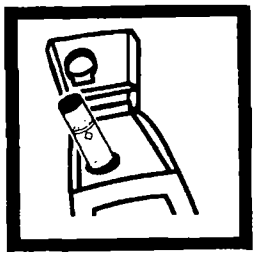


3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface.

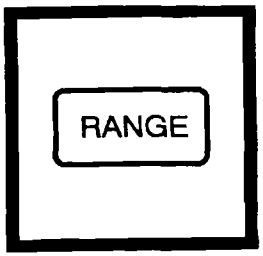


4. Press: **I/O**.

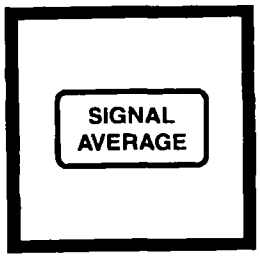
The instrument will turn on. Place the instrument on a flat, sturdy surface. Do not hold the instrument while making measurements.



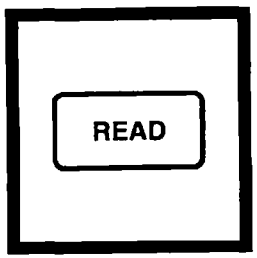
5. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. **Close the lid.**



6. Select manual or automatic range selection by pressing the **RANGE** key. The display will show **AUTO RNG** when the instrument is in automatic range selection.



7. Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show **SIG AVG** when the instrument is using signal averaging. Use signal average mode if the sample causes a noisy signal (display changes constantly).



8. Press: **READ**

The display will show **- - - - NTU**, then the turbidity in NTU. Record the turbidity after the lamp symbol turns off.

Note: *The instrument defaults to the last operating mode selected. If automatic range mode and signal averaging were used on the previous measurements, these options will automatically be selected for subsequent samples.*

2.2.2 Measurement Notes

- Always cap the sample cell to prevent spillage of sample into the instrument.
- When taking a reading, place the instrument on a level, stationary surface. It should not be held in the hand during measurement.
- Always close the sample compartment lid during measurement and storage.
- Always use clean sample cells in good condition. Dirty, scratched, or damaged cells can cause inaccurate readings.
- Do not leave a sample cell in the cell compartment for extended periods of time. This may compress the spring in the cell holder.
- Remove sample cell and batteries from instrument if the instrument is stored for extended time period (more than a month).
- Avoid operating in direct sunlight.
- Make certain cold samples do not "fog" the sample cell.
- Avoid settling of sample prior to measurement.
- Keep sample compartment lid closed to prevent dust and dirt from entering.

2.3 Measurement Techniques

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Regardless of the instrument used, measurements are more accurate, precise and repeatable if the analyst pays close attention to proper measurement techniques.

Measure samples immediately to prevent temperature changes and settling. Avoid sample dilution when possible. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes or when the sample is diluted, resulting in a non-representative sample measurement.

2.3.1 Cleaning Sample Cells

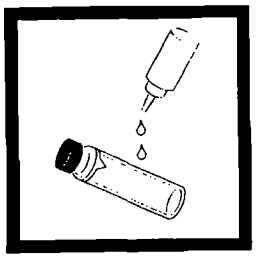
Cells must be extremely clean and free from significant scratches. The glass used to make cells is easily scratched – manufacturing cells free of minor scratches and other imperfections is difficult. However, minor imperfections are effectively masked by applying silicone oil as outlined in *Section 2.3.2*.

Clean the inside and outside of the cells by washing with laboratory detergent. Follow with multiple rinses of distilled or demineralized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path.

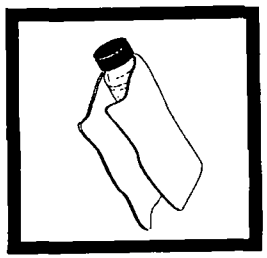
2.3.2 Applying Silicone Oil

Applying a thin coat of silicone oil will mask minor imperfections and scratches which may contribute to turbidity or stray light. Use silicone oil equivalent to Hach Cat. No. 1269-36. This silicone oil has the same refractive index as glass. When applied in a thin, uniform coat, the oil fills in and masks minor scratches and other imperfections in the glass. Apply the oil uniformly by wiping with a soft, lint-free cloth.
Avoid application of excess oil. Applying excess oil may retain dirt and contaminate the instrument's cell compartment.

1. Thoroughly clean the sample cell.



2. Apply a small bead of silicone oil from the top to the bottom of the cell-- just enough to coat the cell with a thin layer of oil.



3. Using a soft, lint-free cloth, spread the oil uniformly, then wipe off the excess so that only a thin coat of oil is left. The cell should appear nearly dry with little or no visible oil.

Note: *Soft, lint-free cloth (velvet) works well for oiling. Store the oiling cloth with the sample cells and keep it free of dirt. After a few applications of oil, the cloth will contain enough residual oil that simply wiping the cell with the oiled cloth will provide a sufficient oil coat on the sample cell. Periodically, add a small amount of oil to the sample cell surface to replenish the oil in the cloth.*

Note: *Only a thin coat of oil on the sample cells is necessary.* ***Avoid using excessive amounts of oil.***

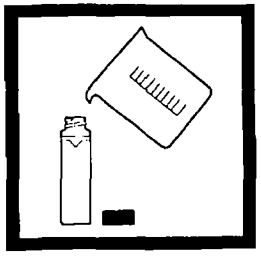
2.3.3 Orienting Sample Cells

Note: *When orienting and matching cells, it may be more efficient to use the continuous reading mode. The instrument performs continuous readings if the* **READ** *key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds. The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.*

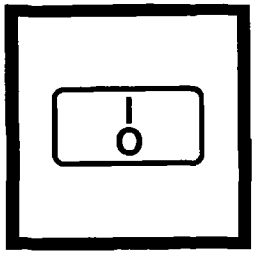
Precise measurements for very low turbidity samples require using a single cell for all measurements or optically matching the cells. Using one cell provides the best precision and repeatability. When one cell is used, an orientation mark (other than the factory-placed diamond) can be placed on the cell so it's inserted into the instrument with the same orientation each time.

2.3.3.1 Orienting a single cell

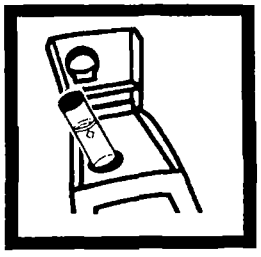
When using a single cell, make an index or orientation mark on the cell as follows:



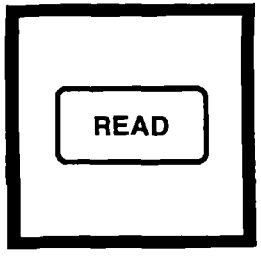
1. Fill the clean sample cell to the line with high quality water (< 0.5 NTU). Cap and wipe with lint-free cloth. Apply silicone oil. See *Section 3.6.3* on page *26* for more information about high quality water.



2. Press: **I/O** to turn the instrument on.



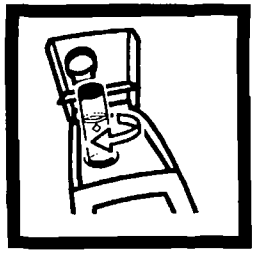
3. Insert the sample cell into the sample compartment. Close the cover.



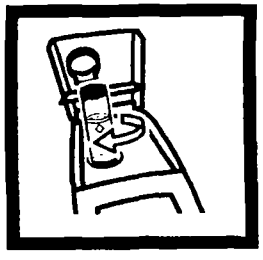
4. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*



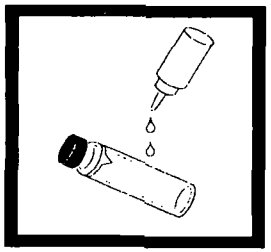
5. Remove the cell, rotate it slightly and reinsert it into the cell compartment. Close the cover, then press **READ**. Record the cell's position and the displayed reading.



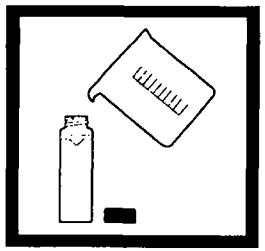
6. Repeat *step 5* until the lowest reading is displayed. Place an orientation mark on the cell's marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading. When using the cell, always place it in the instrument so the orientation mark aligns with the raised mark on the instrument.

2.3.4 Matching multiple sample cells

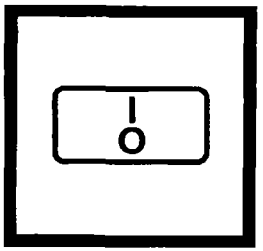
Precise measurements of very low turbidity samples require the cells be optically matched or a single cell be used for all measurements. If more than one cell is used, follow this procedure to match (index) the cells:



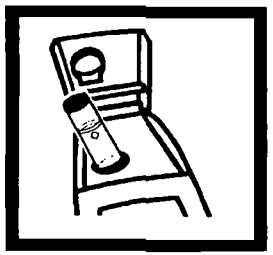
1. Clean and oil the sample cells as instructed in *Section 2.3.1* on page *11* and *Section 2.3.2* on page *11*.



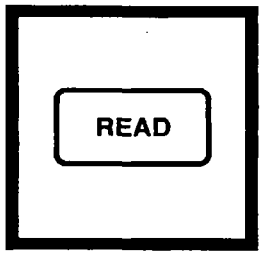
2. Fill the clean sample cells to the line with the same sample.



3. Press: **I/O** to turn the instrument on.



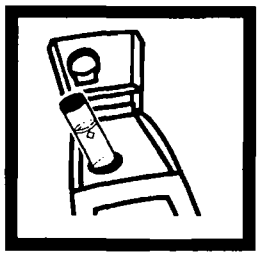
4. Insert the **first** sample cell into the sample compartment and close the cover



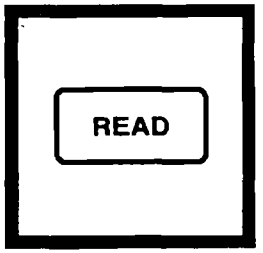
5. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading. Place an orientation mark on the cell's marking band.

Note: *This procedure may be easier if the user holds the* **READ** *key through the whole process. This allows the lamp to remain on and make continuous readings.*

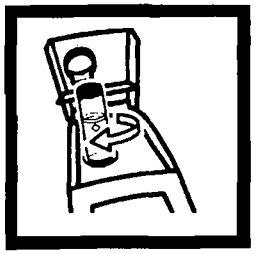


6. Insert the **second** sample cell into the cell compartment and close the cover.

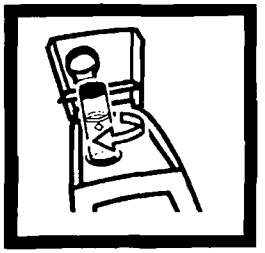


7. Press: **READ**

Record the cell's position in the cell compartment and the displayed reading.

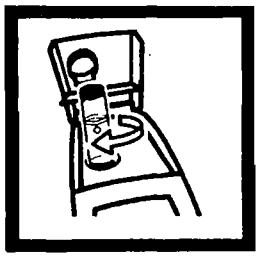


8. Remove the cell, rotate it slightly and reinsert into the cell compartment. Close the cover, then press **READ** again. Record the cell's position and the displayed reading.



9. Repeat *step 8* until the value displayed for the second cell is within 0.01 NTU (or 1%) of the value obtained for the first cell. Place an orientation mark on the second cell's marking band so it is consistently inserted in this position.

Note: *Due to variability in glass, it may not be possible to match all cells.*



10. Repeat *step 6* through *step 9* if matching other sample cells.

2.3.5 Removing Bubbles (Degassing)

Before measurement, removing air and other trapped gasses from the sample is strongly recommended, even if bubbles are not visible. Four degassing methods are commonly used:

1. applying a partial vacuum
2. adding a surfactant
3. using an ultrasonic bath
4. heating the sample

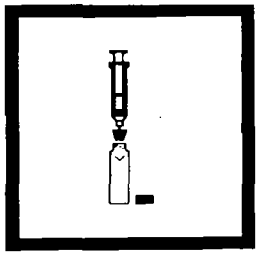
In some cases, more than one method may be necessary for effective bubble removal. For example, use of both a surfactant and ultrasonic bath may be necessary for some severe conditions. Use care with these techniques. If misused, sample turbidity can be altered.

Removing air bubbles by letting the sample stand for a period of time is not recommended. Particulates that cause turbidity may settle and the sample temperature may change. Both conditions may alter sample turbidity, resulting in measurements not representative of the original turbidity.

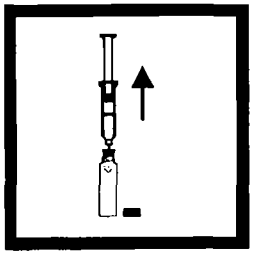
2.3.5.1 Application of vacuum

Apply a vacuum with any convenient, clean, oil-free vacuum source. The vacuum lowers the atmospheric pressure, allowing trapped bubbles to escape into the air above the sample. Vacuum works well with non-viscous samples (such as water) that don't contain volatile components. Applying vacuum to viscous, volatile-containing samples (paint resins) may cause the volatile components to come out of solution and aggravate the bubble problem.

To apply a vacuum, use a sample degassing kit equivalent to Cat No. 43975-00 (Degassing Kit) or 43975-10 (Degassing and Filtration Kit). These kits contain a syringe and rubber stopper for vacuum degassing. An electric or hand-operated pump equivalent to Cat No. 14283-00 or 14697-00, respectively, may also be used.



1. Fill a sample cell to the mark with sample. Insert a #2 single-hole rubber stopper and syringe into the cell. If using a pump, insert a piece of glass tubing into the stopper.



2. **Slowly** apply the vacuum by carefully pulling the plunger upward, then holding it. If using a hand or electric pump, connect the tubing to the vacuum pump with vacuum hose. Apply vacuum until visible gas bubbles disappear. **Slowly** release the vacuum. Remove the vacuum apparatus and cap the cell.

2.3.5.2 Adding a surfactant

Surfactants should be limited to severe problems when other degassing methods are ineffective. Surfactants change the surface tension of the water, which releases trapped gases. Hach recommends a surfactant such as Triton X-100 or the equivalent, Hach Cat No. 14096-37. Put one drop of Triton X-100 in the sample cell before adding sample.

Note: *Any turbidity contributed by surfactant addition is negligible.*

This technique is very effective when the water is super-saturated with air. However, changing the surface tension may accelerate settling of turbidity-causing particles. Mix the sample gently, but thoroughly, and analyze as soon as possible after adding the surfactant. Avoid vigorous mixing as the surfactant may foam. Rinse the sample cells thoroughly between samples to prevent surfactant accumulation.

2.3.5.3 Using an ultrasonic bath

Note: *The time necessary to expel bubbles may vary from a few seconds to a minute or more. To avoid excessive application of ultrasound, a simple procedure can be followed. First, apply ultrasound until all visible bubbles are absent. Then measure the sample turbidity. Apply ultrasound for a short time period and again measure turbidity. Continue for several repetitions, noting the treatment time and turbidity readings. If turbidity begins to increase instead of decrease, the ultrasound waves have probably started to alter the suspended particles. Note the time it takes for this to occur and record it as the maximum time limit for ultrasonic treatment.*

Ultrasonic baths effectively remove gas bubbles from most samples, especially viscous liquids. However, the ultrasonic waves which cause degassing may also alter the characteristics of the particles causing the turbidity. Turbidity depends on the size, shape, composition and refractive index of the suspended particles. Excessive ultrasound application may alter particle size and shape, thus changing sample turbidity. In some cases, ultrasound may aggravate air bubble removal by fracturing the bubbles, making degassing more difficult.

1. Fill a clean sample cell to the line with sample. Leave uncapped.
2. Immerse the cell (1/2 to 2/3 immersed) in an ultrasonic bath and allow it to stand until visible bubbles are expelled.
3. Remove the cell, cap, then thoroughly dry the cell. Apply silicone oil as directed.

2.3.5.4 Application of heat

Whenever possible, avoid using heat to degas samples because heat may change the characteristics of the suspended particles and cause volatile components to come out of solution. Gentle heating may be helpful for degassing some very viscous samples when combined with application of vacuum or ultrasound. If heat is necessary, heat the sample only until degassing occurs. The simplest technique is to prepare a warm water bath and partially immerse the filled sample cell. Use the shortest time necessary for expelling visible bubbles. Cool sample to original sample temperature before taking measurements.

2.3.6 Measuring Overrange Samples

Nephelometric turbidity measurement depends on detection of light scattered from particles suspended in the liquid. If the turbidity is very high, a significant amount of light is blocked or absorbed by the particles and only a small amount of light reaches the detector. This results in a negative interference – the measured turbidity is lower than the actual turbidity. This condition is called "going blind". A multidetector ratioing instrument, such as the Hach 2100P Turbidimeter, minimizes this effect and extends the instrument range. Highly turbid samples may also be diluted, but this should be avoided when possible since it may alter the characteristics of the suspended particles and produce erroneous results.

Light absorbing particles such as activated carbon and highly colored samples may also cause an instrument to "go blind". Dilution may not correct for these interferences. A ratioing instrument will correct for the presence of light absorbing particles and color.

2.3.7 Condensation (fogging)

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at room temperature or immersing it in a warm bath for a short period. After warming, mix the sample thoroughly before measurement. Allowing samples to warm can alter sample turbidity, so it is best to avoid warming samples before measurement when possible.

2.3.8 Calibration

Turbidimeters must be properly calibrated with a primary standard. For U.S. Environmental Protection Agency reporting under NPDES or NPDWR permits, quarterly calibration is required. If necessary, calibrate more frequently. Use secondary standards for periodic calibration checks. The frequency of calibration depends on environmental conditions (humidity, temperature) and use. Please note that Gelex standards must be assigned values after formazin calibration and before use as secondary standards. Gelex standards must be recalibrated each time the instrument is calibrated with formazin.

See *Section 3.6* on page *25* for detailed information and use of formazin and Gelex standards.

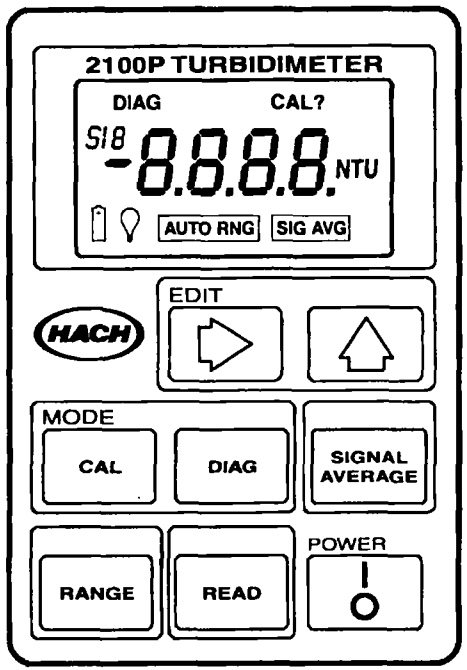
2.3.9 Representative Sampling

A representative sample accurately reflects the true condition of the water source from which the sample was taken. To ensure a representative sample, gently, but thoroughly, mix every sample before aliquots are taken. Do not allow the sample to settle.

When sampling from a tap in a distribution system or treatment plant, allow the water to run for at least five minutes before sampling. When sampling from a stream, reservoir, clarifier, or storage tank, collect at least one liter (1 quart) and thoroughly mix before measurement. If the water source is not uniform, it may be necessary to sample several locations at varying depths and combine the samples into a single, well-mixed composite sample before measurement.

SECTION 3 OPERATION

3.1 Operational Controls and Indicators



Key	Description
I O	Power key to turn instrument on and off. If no keys are pressed for 5.5 minutes, the instrument turns off automatically.
READ	Depressed to perform a measurement. To conserve battery power, the lamp turns on only when **READ** is depressed. A reading is displayed about 12 seconds after the key is depressed. During the delay, a flashing NTU is displayed. After the reading is displayed, the lamp turns off and the reading continues to be displayed. Continuous readings may be done by holding this key if **not** in the Signal Averaging mode. After the initial delay, the reading is updated every 1.2 seconds.
CAL	Used to perform a calibration or review calibration data. Also terminates a calibration or calibration review and returns to the 2100P measurement mode.

Key	Description
△	Edits a flashing digit in the calibration mode or sequences through the calibration standards (S0,S1, S2, S3) or diagnostic menu.
▷	Used to move the editing cursor to the digits being edited in the calibration mode or initiate editing of a standard value.
SIGNAL AVERAGE	Turns the signal averaging function on or off.
DIAG	Selects the diagnostic mode.
RANGE	Selects Auto Range or Manual Range (one of three manual modes).

Display Icon	Description
DIAG	Turns on after the **DIAG** is pressed to access the diagnostic mode. A number displayed under the DIAG icon (1-9) indicates which diagnostic function is active. See *Section 5.1* on page *53* for more information on diagnostic codes.
CAL	Turns on after the **CAL** key is pressed to access the calibration mode and remains on during the calibration.
CAL?	Appears after calibration if a value entered during calibration is outside an acceptable range. May indicate an operator error or possible instrument malfunction. Flashing CAL? indicates the default calibration coefficients are being used (even after a user-calibration has been done) or that no calibration data is currently stored.
S_	Displayed during calibration. The S is followed by a number to indicate which standard value is currently being edited or displayed. Flashing number is prompting user for measurement of S0, S1, S2 or S3 to establish a calibration. Steady number identifies which standard's value is being displayed.
	Flashes when the battery voltage drops to 4.4 volts as an indication to change batteries. At <4.0 volts, the instrument automatically shuts off.
	The lamp symbol is constantly on when the lamp is on and flashes after a reading if a marginal light level reaches the transmitted light detector. A flashing icon indicates the sample may be too turbid (not within measurement range) and needs dilution or the lamp needs replacing.

Display Icon	Description
SIGNAL AVERAGE	Indicates the signal averaging mode is on. The icon turns off if signal averaging is not selected.
AUTO RNG	Indicates instrument is in automatic range mode. The icon turns off when manual range mode is selected.
8888	The 4-digit display is active when the instrument is on (measurements are displayed to three digits). After the **READ** key is pressed - - - - is displayed during wait periods.
NTU	Identifies the measurement units- Nephelometric Turbidity Units. This icon is active during measurements and in the calibration mode.

3.2 Using the Read Key

To preserve battery power and prolong lamp life, the lamp turns on only after the **READ** key is pressed. Pressing the key turns the instrument lamp on; after about 12 seconds, the lamp turns off, but the measurement value continues to be displayed. After the first measurement, a four-second recovery time occurs before another measurement can be started. If **READ** is pressed during the recovery time, the display will begin flashing, but the lamp will not turn on until the full four seconds have passed. If no other key strokes occur within 5.5 minutes, the instrument turns off.

3.2.1 Continuous Reading

The instrument cannot be used in continuous read mode if the Signal Averaging mode is on.

The instrument will perform continuous readings if the **READ** key is pressed and held. As long as the key is held, the lamp remains on and the display is updated every 1.2 seconds.

3.3 Using the Signal Averaging Key

The signal averaging mode compensates for reading fluctuations caused by drifting of sample particles through the light path. Signal averaging is turned on or off by pressing the **SIGNAL AVERAGE** key. The SIG AVG icon is displayed when signal averaging is on.

Signal averaging measures and averages ten measurements while displaying intermediate results. The initial value is displayed after about

11 seconds and the display is updated every 1.2 seconds until all ten measurements are taken (about 22 seconds). After 22 seconds, the lamp turns off, but the final measured turbidity value continues to be displayed until another key is pressed.

When signal averaging is off, the instrument takes three measurements, the microprocessor averages them, then displays the average. If the **READ** key is held during measurement, the initial value is displayed in 12 seconds and is updated every 1.2 seconds as long as the **READ** key is held.

When the instrument is turned on, the instrument defaults to the signal averaging mode which was used during the last measurement.

3.4 Using the Range Selection Key

As shipped, the instrument defaults to automatic range mode. The first time the **RANGE** key is pressed, the instrument goes into manual range mode. The second, third, and fourth key strokes put the instrument in the 0.00-9.99, 10 to 99.9 or 100-1000 NTU range, respectively. Another key stroke brings the selection back to automatic range mode. When the automatic range mode is selected, the **AUTO RNG** icon is displayed. Range selection can be done any time except when a measurement or calibration is in progress.

When the instrument is turned on, the instrument defaults to the range mode and measurement range which was used during the last measurement.

3.5 Restoring the Default Calibration

To restore and use the default calibration, turn the instrument off. Press and hold **DIAG**, then press and release **I/O**. Release **DIAG** when the software version number disappears from the display. (For models with serial number less than 920300000800, **2100** disappears). This clears any user-entered calibration from memory; the 2100P will use the default calibration for measurement. **CAL?** will appear and continue to flash until a user-entered calibration is successfully completed.

For best results, a user-entered calibration should be done every three months.

3.6 Calibration

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provide long-term stability and minimize the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. However, **a formazin recalibration should be done at least once every three months,** more often if experience indicates the need. When calibration is necessary, use formazin primary standards or StablCal™ Standards to calibrate.

3.6.1 Using StablCal Stabilized Formazin Standards*

Most consistent results will be achieved with the use of StablCal Stabilized Formazin Standards. Refer to *Section 3.6.6* on page *29* for information on preparing the standards for use.

Note: *Hach StablCAL Stabilized Formazin in 20-, 100-, and 800-NTU values is packaged in convenient kits for calibration of the 2100P Turbidimeter. The kit may be ordered in 500-mL size bottles by specifying Cat. No. 26594-00 or in sealed ampules by ordering Cat. No. 26594-05. (See OPTIONAL ACCESSORIES AND REAGENTS on page 61.)*

3.6.2 Preparing Formazin Stock Solution

Dilute formazin standard solutions from a 4000 NTU stock solution equivalent to Hach Cat. No. 2461-49. The prepared stock solution is stable for up to one year when properly prepared. An alternative to purchasing the 4000 NTU stock solution is preparing a stock solution as follows:

1. Dissolve 5.000 grams of reagent grade hydrazine sulfate ($N_2H_4 \cdot H_2SO_4$) in 400 mL of distilled water.
2. Dissolve 50.000 grams of pure hexamethylenetetramine in 400 mL of distilled water.
3. Pour the two solutions into a 1000-mL volumetric flask and dilute to the mark with distilled water.

* StablCal Stabilized Formazin is USEPA Accepted when using Hach Method 8195.

4. Let the solution stand for 48 hours at 25 °C (77 °F) to develop the 4000 NTU stock suspension. The standing temperature is critical for correct formation of formazin polymers.

5. Mix the 4000 NTU suspension for at least ten minutes before use. Then it can be diluted with distilled or demineralized water to achieve a solution of the desired NTU value.

Instead of diluting a formazin stock solution, StablCAL™ Stabilized Formazin Standards may be used. Order the StablCAL Calibration Kit for the 2100P Turbidimeter, Cat.No. 26594-00 (500-mL bottles) or Cat. No. 26594-05 (sealed ampules). (See *OPTIONAL ACCESSORIES AND REAGENTS* on page *61*.)

3.6.3 Correcting for Turbidity of Dilution Water

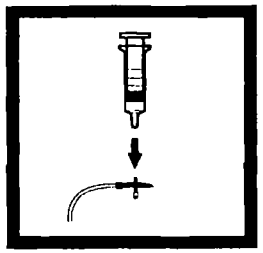
The 2100P Turbidimeter automatically compensates for turbidity contributed by dilution water when calculating the true value of the lowest formazin standard. Use high quality distilled or deionized water less than 0.5 NTU. The instrument will display E 1 after calibration if the dilution water turbidity is greater than 0.5 NTU. In this case, prepare the water as directed below.

The value of the dilution water can be arbitrarily forced to zero (see calibration procedure). This is not recommended for most applications and, if done, should be done only if the dilution water turbidity is less than 0.2 NTU.

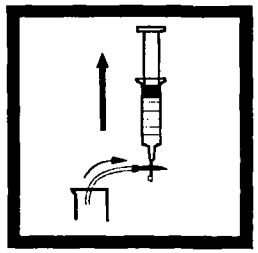
3.6.4 Preparing Dilution Water

Note: *Use the same dilution water for all dilutions and the sample blank.*

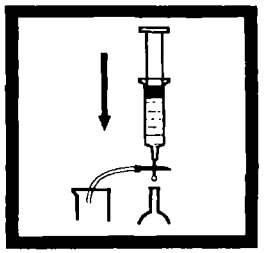
Collect at least 1000 mL of high quality dilution water (distilled, demineralized or deionized water). The 2100P Turbidimeter, as received from the factory, is precalibrated and may be used to check the dilution water turbidity. If the turbidity is greater than 0.5 NTU, filter the water with the Sample Filtration and Degassing Kit (Cat. No. 43975-10) or the equivalent. When measuring low range turbidity, clean all glassware with 1:1 hydrochloric acid and rinse several times with dilution water. If the glassware is not used immediately, use stoppers to prevent small particles from contaminating it.



1. Attach the syringe to the 3-way valve by gently twisting the square end into the syringe tip. Attach the connector, tubing and a 0.2 micron filter (clear part faces syringe) as shown. Be sure the connections are tight.



2. Fill a beaker or container with the water to be filtered. Insert the tubing into the container. Slowly draw the water into the syringe by pulling up on the syringe plunger.



3. Draw about 50 mL of sample into the syringe. Slowly push on the plunger to force the water through the filter and into a graduated cylinder or volumetric flask. Repeat Steps 2 and 3 until the desired amount of water is obtained.

Note: *As the filter clogs, it gets more difficult to push water through it. At this point, discard the filter and attach a new filter. Replacement filters are available in packages of 10 (Cat. No. 23238-10).*

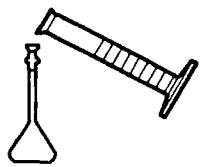
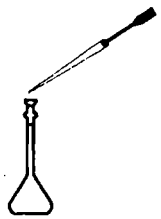
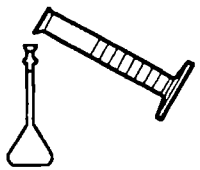
3.6.5 Preparing Formazin Dilutions (Factory recommended)

Hach Company recommends using 20, 100, and 800 NTU formazin standards for calibrating the 2100P Turbidimeter. Dilutions with other NTU values can be prepared and used (see *Section 3.6.8* on page *34*). If problems occur when using alternate solutions, use the dilutions specified here.

Prepare all formazin dilutions immediately before use and discard after calibration. The 4000 NTU solution is stable for up to a year, but dilutions deteriorate more rapidly. Use the same high quality water (turbidity <0.5 NTU) for the dilutions and the blank.

3.6.5.1 Preparing the 20, 100 and 800 NTU standards

Table 1 Formazin Standard Preparation

	Step 1	Step 2	Step 3
Standards			
20 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette* pipet, add 1.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
100 NTU	Add 100 mL of dilution water to a clean **200-mL** class A volumetric flask.	With a TenSette pipet, add 5.00 mL of well-mixed 4000 NTU Formazin stock solution to the 200-mL flask.	Dilute to the mark with dilution water. Stopper and mix.
800 NTU	Add 50 mL of dilution water to a clean **100-mL** class A volumetric flask.	With a TenSette pipet, add 20.00 mL of well-mixed 4000 NTU Formazin stock solution to the 100-mL flask.	Dilute to the mark with dilution water. Stopper and mix.

* A class A volumetric pipet may be used in place of a TenSette Pipet.

3.6.6 Preparing StablCal Stabilized Formazin Standards

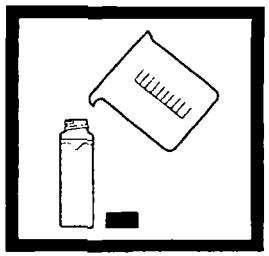
When using bulk standards that have been sitting undisturbed for longer than a month, start at *step 1*. If the standards are used on at least a weekly interval, start at *step 3*

Important Note: These instructions do not apply to <0.1 NTU StablCal Standards; <0.1NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to resuspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the bottle of StablCal 5 to 7 times.
4. Prepare the sample cell for measurement using traditional preparation techniques (oiling the sample cell and marking the cell to maintain the same orientation in the sample cell compartment) to eliminate any optical variations in the sample cell.
5. Rinse the sample cell at least one time with the standard and discard the rinse.
6. Immediately fill the sample cell with the standard. Cap the sample cell and let it stand for one minute. The standard is now ready for use in the calibration procedure.

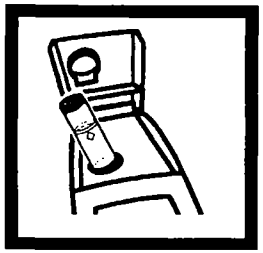
3.6.7 Calibrating the Turbidimeter

Note: *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the cell so the orientation mark placed on the cell during the matching procedure is correctly aligned. (See Section 2.3.4 on page 14 for matching sample cells).*



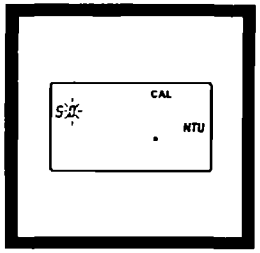
1. Rinse a clean sample cell with dilution water several times. Then fill the cell to the line (about 15 mL) with dilution water or use StablCal <0.1 NTU standard.

Note: *The same dilution water used for preparing the standards must be used in this step.*



2. Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

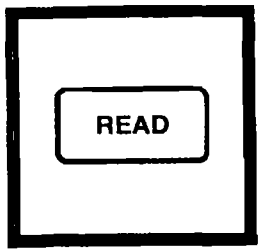
Note: *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*



3. Press: **CAL**

The **CAL** and **S0** icons will be displayed (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank (as shown). Press → to get a numerical display.

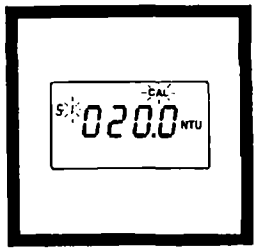
Hach Company only recommends the use of StablCal™ Stabilized Formazin or formazin standards for the calibration of Hach turbidimeters. Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinylbenzene beads or other suspensions.



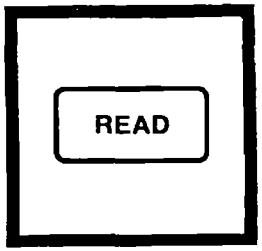
4. Press: **READ**

The instrument will count from 60 to 0, (67 to 0 if signal average is on), read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (See *Section 3.6.4* on page *26* for more dilution water information). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

Note: *The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show* **S0 NTU** *and the ↑ key must be pressed to continue with the next standard.*

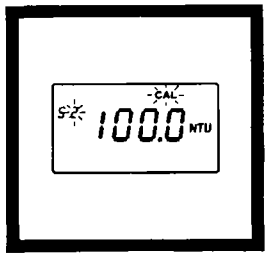


5. The display will show the **S1** (with the 1 flashing) and **20 NTU** or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 20 NTU standard or the 20 NTU StablCal standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

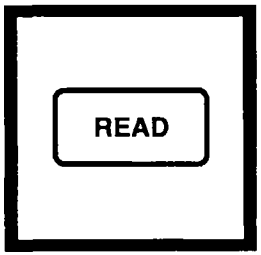


6. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

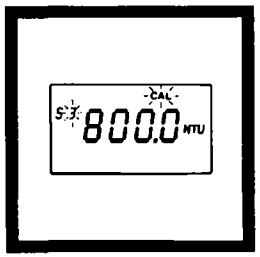


7. The display will show the **S2** (with the 2 flashing) and **100 NTU** or the value of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 100 NTU standard or the 100 NTU StablCal standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

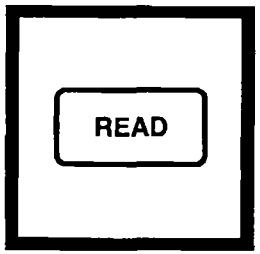


8. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then, the display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

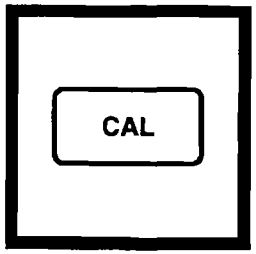


9. The display will show the **S3** (with the 3 flashing) and **800 NTU** or the value of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. After editing, fill a clean sample cell to the line with **well mixed** 800 NTU standard or the 800 NTU StablCal standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.



10. Press: **READ**

The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.



11. Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ**, **I/O**, ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

3.6.8 Preparing User-selected Formazin Dilutions

The formazin solutions should span the entire range of the instrument. Hach recommends preparing three standards:

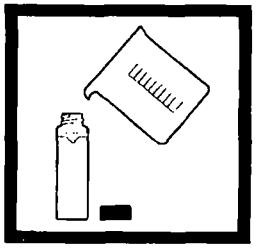
1. 10 to 30 NTU
2. 90 to 110 NTU
3. 700 to 900 NTU

The standards must have a difference of at least 60 NTU.
In addition, a blank made from the dilution water should be prepared.

Prepare the formazin standard solutions from the well mixed 4000 NTU stock solution as specified in *Section 3.6.5* on page *27* and dilution water as specified in *Section 3.6.3* and *Section 3.6.4* on page *26*. Make the standards **immediately** before use and discard them after calibration is done.

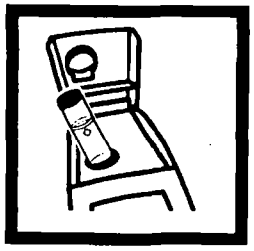
3.6.8.1 Calibrating with User-selected Standards

Note: *For best accuracy use the same sample cell or four matched sample cells for all measurements during calibration. Always insert the sample cell with the same orientation.*



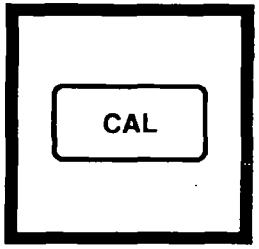
1. Fill a clean sample cell to the line (about 15 mL) with dilution water.

Note: *The same dilution water used for preparing the standards must be used in this step.*



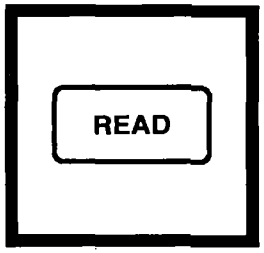
2. Insert the sample cell into the cell compartment and close the lid. Press **I/O**.

Note: *Choose signal average mode option (on or off) before pressing* **CAL** *– the* **SIGNAL AVERAGE** *key is not functional in calibration mode.*



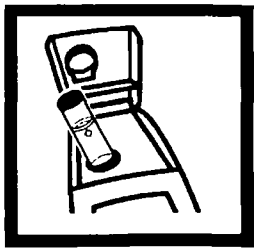
3. Press: **CAL**.

The **CAL** and **S0** icons will appear (the **0** will flash). The 4-digit display will show the value of the S0 standard for the previous calibration.

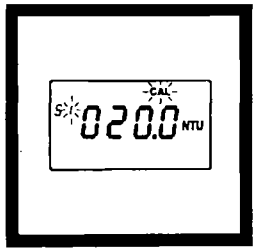


4. Press: **READ**.

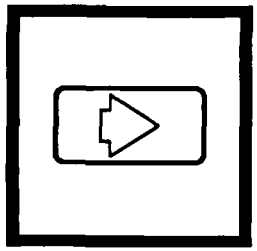
The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the blank and use it to calculate a correction factor for the lowest standard. If the dilution water is ≥0.5 NTU, **E 1** will appear (see *Section 3.6.4* on page *26* for more dilution water information).
The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



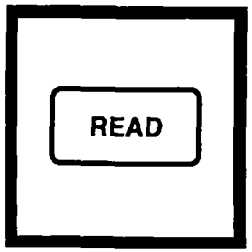
5. Thoroughly mix the 10 to 30 NTU range standard, then fill a clean sample cell to the line with the standard. Insert the sample cell into the cell compartment



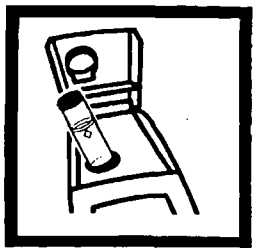
6. The display will show the **S1** icon (with the **1** flashing) and **20 NTU** or the value of the S1 standard for the previous calibration.



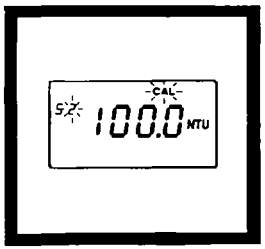
7. Edit the standard concentration by pressing →. The **1** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



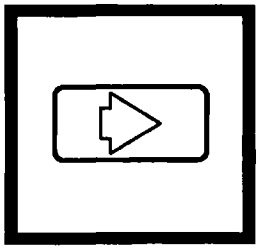
8. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment.



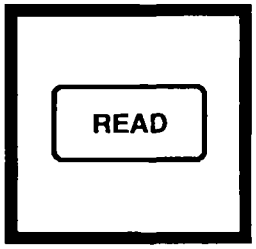
9. Thoroughly mix the 90 to 110 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



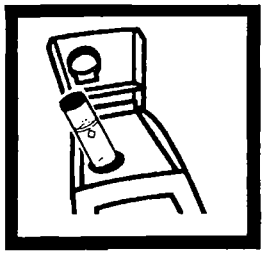
10. The display will show the **S2** icon (with the **2** flashing) and **100 NTU** or the value of the S2 standard for the previous calibration.



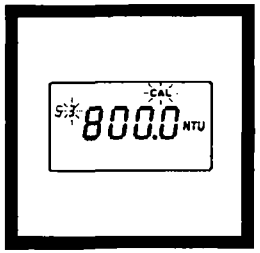
11. Edit the standard concentration by pressing →. The **2** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



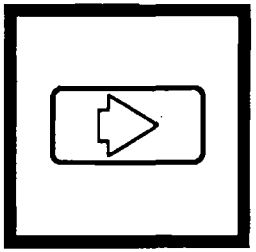
12. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Remove the sample cell from the cell compartment.



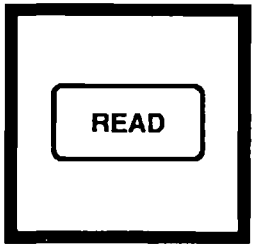
13. Thoroughly mix the 700 to 900 NTU standard, then fill a clean sample cell to the line with the standard. Insert the cell into the cell compartment.



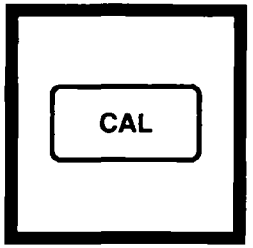
14. The display will show the **S3** icon (with the **3** flashing) and **800 NTU** or the value of the S3 standard for the previous



15. Edit the standard concentration by pressing →. The **3** will stop flashing and the left digit in the display will flash. Press ↑ to scroll the digit up to the appropriate number. Press → again to move the cursor to the next digit and edit it in the same manner.



16. When all the digits show the appropriate value, press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The instrument will increment back to **S0**. Remove the sample cell from the cell compartment.



17. Press: **CAL**.

The instrument will store the new calibration data and return the instrument to the measurement mode. It will use the new calibration to calculate turbidity for subsequent measurements.

Note: *Pressing* **CAL** *completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after* **CAL** *is pressed. If* **E 1** *or* **E 2** *appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If* **CAL?** *appears, an error may have occurred during calibration. If* **CAL?** *is flashing, the instrument is using the default calibration.*

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ**, **I/O**, ↑, and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. If the error messages recur, calibrate using the factory specified standards, *Section 3.6.5* on page *27* and *Section 3.6.7* on page *30*. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then only ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** isn't flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

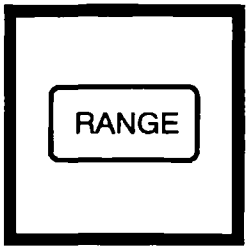
3.6.9 Using Gelex Secondary Turbidity Standards

Note: *Store Gelex standards at room temperature. Do not allow to freeze or exceed 50 °C.*

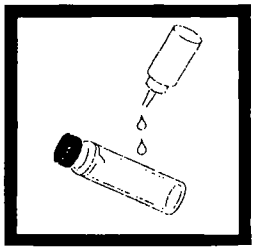
The instrument comes with Gelex Secondary Standards which are particulate suspensions similar to formazin primary standards in light scattering characteristics. NTU values on the Gelex standards indicate the range for which they should be used. Due to minor variations in glass and individual instrument optical systems, the true value of the Gelex standards must be determined against formazin in the same instrument they will be used with for later calibration checks.

3.6.9.1 Assigning Values to Gelex Standards

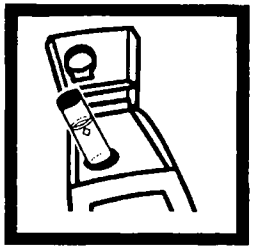
1. Calibrate the instrument with formazin.



2. Select automatic range mode using the **RANGE** key.

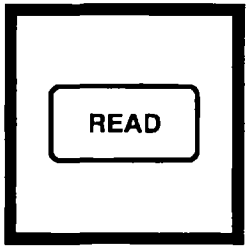


3. Thoroughly clean the outside of the Gelex vials and apply a thin coating of silicone oil.



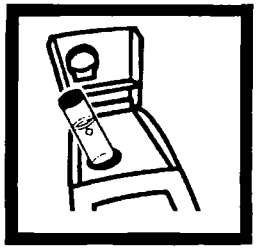
4. Place the 0-10 NTU Gelex standard in the cell compartment so the diamond on the vial aligns with the orientation mark on the instrument. Close the sample lid.

Note: *Correct cell orientation is essential to obtain accurate Gelex values. Always orient the cell so the diamond mark aligns with the orientation mark on the instrument.*



5. Press: **READ**.

Record the displayed value, remove the vial from the instrument and mark the value on the band near the top of the vial.



6. Repeat *step 3* through *step 5* for the other Gelex standards, being careful to orient the cells properly.

Re-assign with every formazin calibration

7. Re-assign values to the Gelex standards each time the instrument is calibrated with formazin.

3.6.9.2 Routine Calibration Check With Gelex Standards

The 2100P Turbidimeter does not require standardization before every measurement as some turbidimeters do. Periodically, as experience dictates, check the instrument calibration using the appropriate Gelex Secondary Standard. Be sure the Gelex standards are aligned correctly when inserting them (diamond aligns with orientation mark). If the reading is not within 5% of the previously established value, the instrument should be recalibrated with formazin primary standard (*Section 3.6.7* on page *30*).

MAINTENANCE

Some of the following manual sections contain information in the form of warnings, cautions and notes that require special attention. Read and follow these instructions carefully to avoid personal injury and damage to the instrument. Only personnel qualified to do so, should conduct the maintenance tasks described in this portion of the manual.

Certains des chapitres suivants de ce mode d'emploi contiennent des informations sous la forme d'avertissements, messages de prudence et notes qui demandent une attention particulière. Lire et suivre ces instructions attentivement pour éviter les risques de blessures des personnes et de détoriation de l'appareil. Les tâches d'entretien décrites dans cette partie du mode d'emploi doivent être seulement effectuées par le personnel qualifié pour le faire.

Algunos de los capítulos del manual que presentamos contienen muy importante información en forma de alertas, notas y precauciones a tomar. Lea y siga cuidadosamente estas instrucciones a fin de evitar accidentes personales y daños al instrumento. Las tareas de mantenimiento descritas en la presente sección deberán ser efectuadas únicamente por personas debidamente cualificadas.

Einige der folgenden Abschnitte dieses Handbuchs enthalten Informationen in Form von Warnungen, Vorsichtsmaßnahmen oder Anmerkungen, die besonders beachtet werden müssen. Lesen und befolgen Sie diese Instruktionen aufmerksam, um Verletzungen von Personen oder Schäden am Gerät zu vyyyermeiden. In diesem Abschnitt beschriebene Wartungsaufgaben dürfen nur von qualifiziertem Personal durchgeführt werden.

Algumas das seguintes secções do manual contêm informações em forma de advertências, precauções e notas que requerem especial atenção. Leia e siga atentamente as presentes instruções para evitar ferimentos pessoais e não danificar o instrumento. As tarefas de manutenção descritas nesta parte do manual só poderão ser executadas por pessoal qualificado.

SECTION 4 MAINTENANCE

4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1* on page *11* for more information about sample cell care.

4.2 Battery Replacement

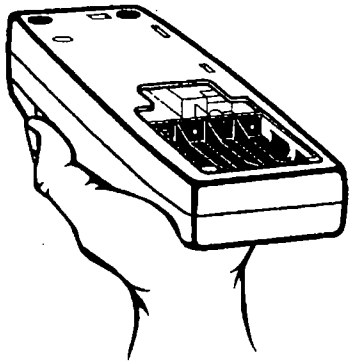
AA alkaline cells typically last for about 300 tests with the signal averaging mode off, about 180 tests if signal averaging is used. The "battery" icon flashes when battery replacement is needed. Refer to *Section 1.4.2* on page *5* for battery installation instructions. If the batteries are changed within 30 seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings.

If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

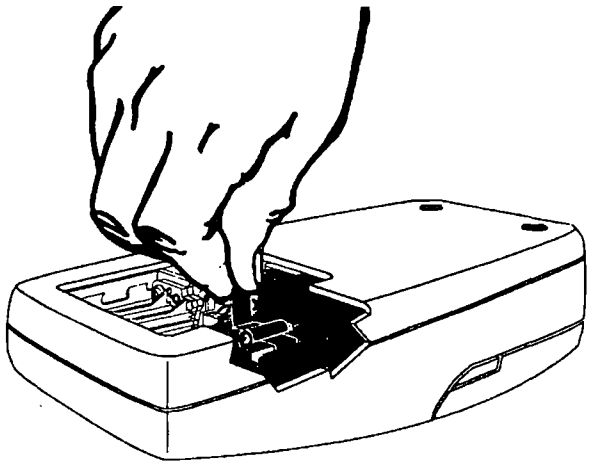
4.3 Lamp Replacement

The procedure below explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

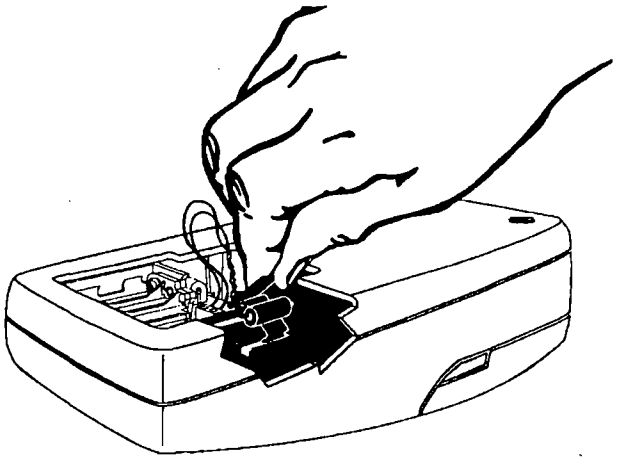
1. Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.



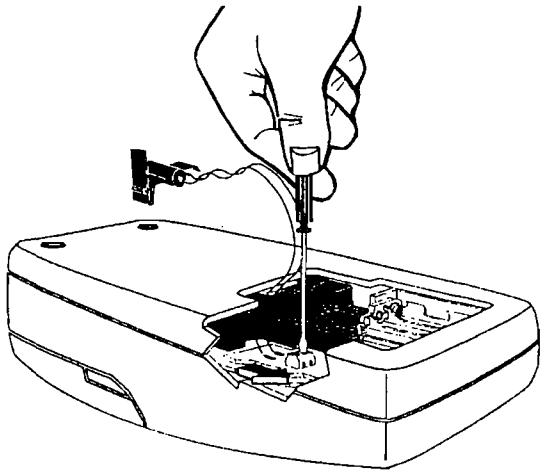
2. Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.



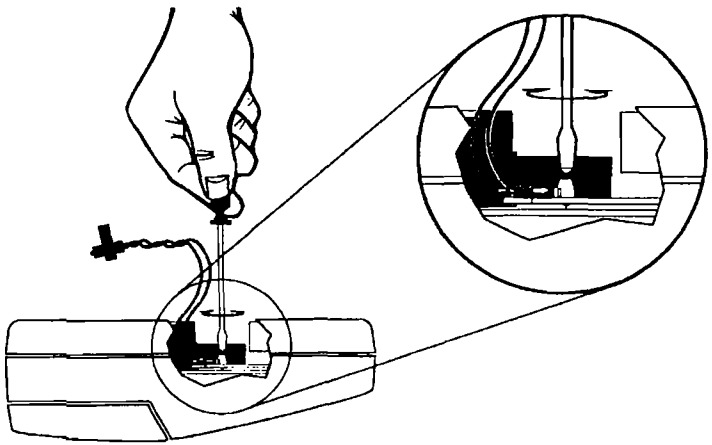
3. Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.



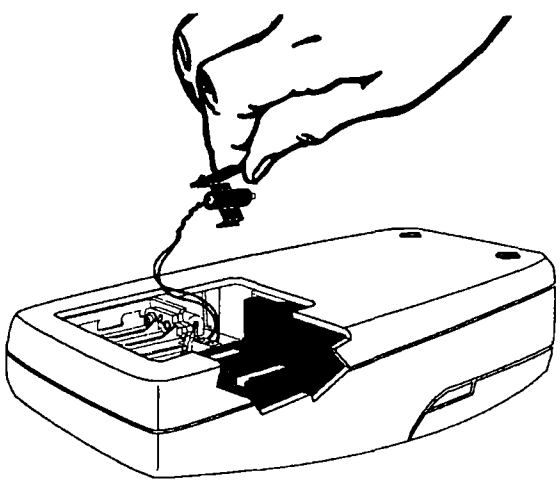
4. Back the terminal block screws **partially** out (1 to 2 turns) and remove the old lamp leads.



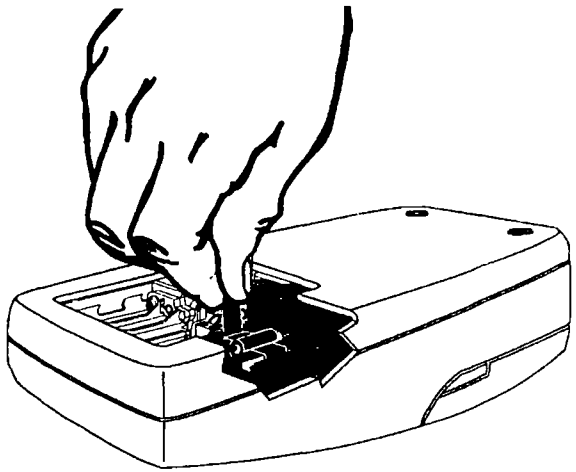
5. Gently bend the wires of the new lamp assembly into an "L" shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug on the wires to make sure they are connected to the terminal block.



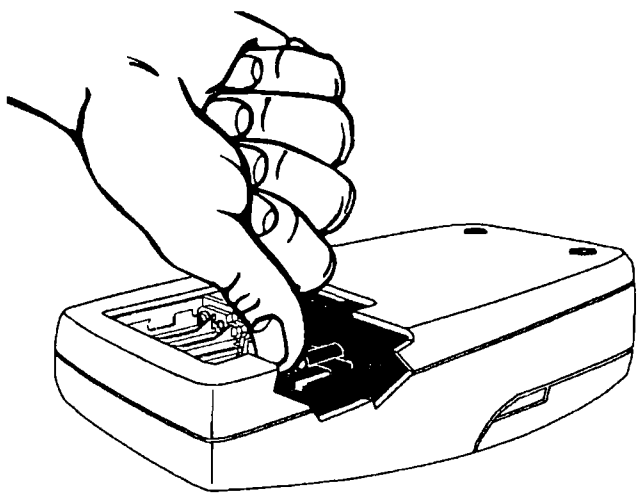
6. Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).



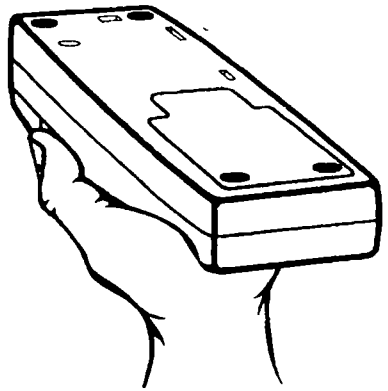
7. Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.



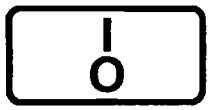
8. With your thumb, firmly slide the assembly forward until it stops. Again, push firmly against the tab to make sure the lamp is seated correctly.



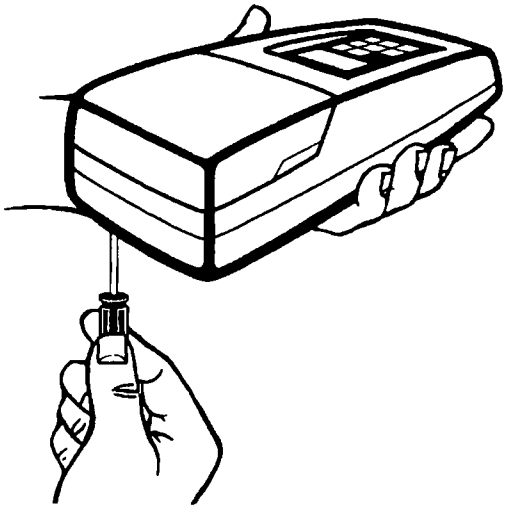
9. Replace the battery(s) and battery cover.



10. Insert the 800 NTU formazin standard into the sample cell. Press and hold **READ**. Then press **I/O**. Release the **READ** key after the software version number disappears from the display (for models with serial numbers less than 920300000800, **2100** disappears).



11. Adjust the scattered light amplifier output by inserting a small flat-bladed screwdriver into the trimpot hole (located on bottom). Adjust the display to read 2.5 ± 0.3 volts (2.0 volts for models that display **2100** when turned on).



12. Press **I/O** to exit gain adjust mode.

13. Perform a formazin calibration according to *Section 3.6.7* on page *30* or *Section 3.6.8* on page *34*.

SECTION 5 TROUBLESHOOTING

5.1 Using the Diagnostic Functions Key

Enter the diagnostic mode by pressing the **DIAG** key. Exit this mode at any time by pressing the key again. The diagnostic mode allows access to information about instrument function which may be useful for servicing and troubleshooting.

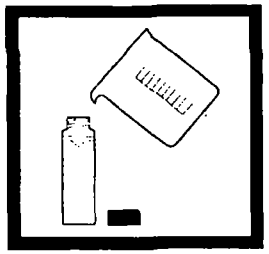
5.1.1 Basic Diagnostic Codes

The diagnostic codes are:

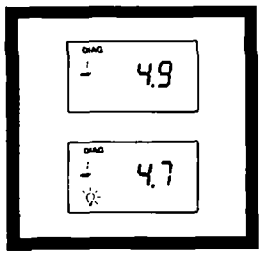
Code	Description
1	Checks the battery voltage with the lamp on, then with the lamp off. This is a dual diagnostic code.
2	Displays calibration coefficient a_0
3	Displays calibration coefficient a_1
4	Displays calibration coefficient b_0
5	Displays calibration coefficient b_1
6	Displays the lamp voltage (about 3 volts)
7	Displays the dark voltage of the transmitted light detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.
8	Displays the high gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.*
9	Displays the low gain dark voltage of the 90° detector amplifier with the lamp off and the detector amplifier voltage with the lamp on.

* Samples with turbidity >10 NTU may display - - - for the lamp-on amplifier voltage.

5.2 The Diagnostic Procedure

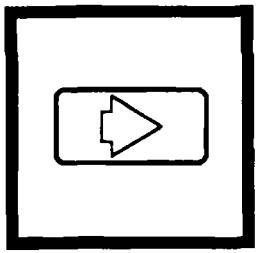


1. Fill a clean sample cell to the line with clear water, cap the cell and place it in the cell compartment. Press the **READ** key and wait until the reading is finished.

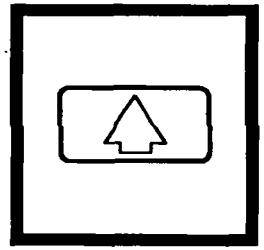


2. Press: **DIAG**

The **DIAG** icon will turn on and **1** will be displayed below the icon. The instrument will measure the battery voltage with the lamp off and display the result in volts (V). Then the lamp icon will turn on and the instrument will measure the voltage with the lamp on. The value is briefly displayed before defaulting to the lamp-off reading. To repeat the measurement, press **READ**.



3. To continuously display the lamp-on voltage, press →. The lamp icon will flash. Press → to turn the lamp icon off (the lamp is not on during this display).



4. Press the ↑ key to scroll through the other diagnostics. Each press of the key increments the digit in the small numerical display below the **DIAG** icon and the result of the diagnostic measurement is then displayed. Each press of the **READ** key updates the value. For measurements made with the lamp off and again with the lamp on, the measurement with the lamp off is displayed when the diagnostic is entered. To see the second measurement with the lamp on, press the → key (only works with diagnostic codes 1, 7, 8, & 9). The lamp icon will flash and the lamp-on measurement will be displayed in volts. Press → to turn the lamp icon off.

Note: *DIAG 8 will display ---- for the lamp-on voltage if a of >10 NTU is placed in the cell compartment.*

5.3 Other Instrument Diagnostics

5.3.1 Display Test

Pressing and holding the **I/O** key turns on all the display icons and elements so you can determine if all the elements and icons are functioning. The display test sequence will cycle as long as the key is held down.

5.4 Error Messages

Error messages indicate sample interferences and/or instrument malfunction.

5.4.1 Flashing Numeric Display

If the highest value in the range selected is flashing in the display, the sample is too turbid (or overrange) for the selected range. In automatic or manual range, **1000** flashes if the sample is over the instrument's range. In manual range mode, select the next higher range mode if **9.99** or **99.9** flashes. See *Section 2.3.6* on page *19* for measuring overrange samples. The display will stop flashing if a sample within range is inserted and read.

5.4.2 E Messages

An error message indicates either an instrument failure or an operation cannot be performed. **An error message can be cleared by pressing DIAG** (display will return to previous measurement or calibration value). The meter continues to operate as best it can. If the message occurs during a calibration, calibration can continue. If the error message occurs when a calibration is being calculated, the instrument will discard the new calibration and retain the old calibration. Error messages and corrective actions are listed below.

5.4.3 CAL?

A flashing **CAL?** appears when the instrument is using the default calibration programmed at the factory. It will appear if the analyst has erased the user-entered calibration using the procedure to restore the default calibration or after and E 4 error is cleared by pressing DIAG. Recalibrate as soon as possible when **CAL?** appears. **CAL?** (not flashing) appears when a calibration has questionable validity.

Message*	Probable Cause	Corrective Action
E1	Dilution water is ≥ 0.5 NTU.	Start calibration over with better quality dilution water or use a membrane filter to filter the water before use.
E2	Two standards have the same value or their difference is less than 60 NTU. Not all standards were read during the calibration. Standard 1 is too low (<10 NTU).	Recheck preparation of standards and repeat calibration.
E3	Low light error.	Re-read measurement. Check lamp** Check for obstructed light path. Dilution may be necessary.
E4	EEPROM malfunction.	Check sum failed. Press I/O. If E 4 reappears, call Hach service. If **CAL?** appears, recalibrate.
E5	A/D overrange.	Check for obstructed light path. Call Hach Service.
E6	A/D underrange.	Check for open lid during reading and re-read. Check for obstructed light path. If persists, call Hach Service.
E7	Light Leak.	Close lid before pressing **READ** key.
E8	Bad lamp circuit.	Reinsert lamp leads at terminal block-make sure the lead ends are not touching each other.If this fails, call Hach Service.

* Error messages 4, 5, and 6 may indicate a failure in the internal electronics.
** Check lamp by inserting a pencil or piece of paper into the cell compartment and pressing READ. Light should be visible on the inserted object.

GENERAL INFORMATION

At Hach Company, customer service is an important part of every product we make.

With that in mind, we have compiled the following information for your convenience.

REPLACEMENT PARTS & ACCESSORIES

REPLACEMENT PARTS

Description	Cat. No.
<0.1 NTU* StablCal®** Stabilized Formazin Standard, 100 mL	26597-42
20 NTU StablCal® Stabilized Formazin Standard, 100 mL	26601-42
100 NTU StablCal® Stabilized Formazin Standard, 100 mL	26602-42
800 NTU StablCal® Stabilized Formazin Standard, 100 mL	26605-42
AA Batteries, 4/pkg	19380-04
Battery Door	46005-00
Carrying Case	46506-00
Gelex® Standards, set (includes standards and 3 sample cells)	24641-05
Instrument Manual	46500-88
Lamp Assembly, with leads	46539-00
Mounting Feet, 4/pkg	41093-00
Oiling Cloth	47076-00
Sample Cells, 1 inch, with cap, 6/pkg	24347-06
Silicone Oil, 15 mL	1269-36

OPTIONAL ACCESSORIES AND REAGENTS

Deionized Water, 3.78 L	272-17
Bath, Ultrasonic, 2.8 L (0.75-gal), w/heater	24895-00
Battery Charger, 120 V	46479-00
Battery Charger, 230 V	46479-01
Battery Eliminator, 120 V	46079-00
Battery Eliminator, 230 V	46080-00
Filter, 0.2 micron, 10/pkg	23238-10
Formazin, 4000 NTU, 500 mL	2461-49
Formazin, 4000 NTU,100 mL	2461-42
Hexamethylenetetramine, 100 g	1878-26
Hexamethylenetetramine, 500 g	1878-34
Hydrazine Sulfate, 20 g	742-46
Hydrazine Sulfate, 100 g	742-26
NiCad Rechargeable Battery (4 required)	16077-00
Pipet, serologic, 1.00 mL	532-35

* <0.1 NTU StablCal® Standard is used in place of dilution water standard when performing a calibration.

** StablCal® is a registered trademark of Hach Company.

OPTIONAL ACCESSORIES AND REAGENTS, continued

Description	Cat. No.
Pipet, TenSette®*, 1-10 mL	19700-10
Pipet Tips, for 1-10 mL TenSette Pipet, 50/pkg	21997-96
Pipet Tips, for 1-10 mL TenSette Pipet, 1000/pkg	21997-28
Pipet, Volumetric, Class A, 1.00 mL	14515-35
Pipet, Volumetric, Class A, 5.00 mL	14515-37
Pump, Vacuum, Hand-Operated	14283-00
Pump, Vacuum, 115 V, 60 Hz	14697-00
Pump, Vacuum, 230 V, 50 Hz	14697-02
Sample Degassing Kit	43975-00
Sample Filtration and Degassing Kit	43975-10
StablCal® Low Level Turbidity Standards for Instrument Verification**	
0.1 NTU, 100 mL	27233-42
0.3 NTU, 100 mL	26979-43
0.5 NTU, 100 mL	26980-42
StablCal® Calibration Set for 2100P Turbidimeter	
<0.1, 20, 100, 800 NTU, 500 mL each	26594-00
<0.1, 20, 100, 800 NTU, 100 mL each	26594-10
<0.1, 20, 100, 800 NTU, sealed vials	26594-05
Triton-X Solution, 118 mL (4 oz)	14096-32
Volumetric Flask, 100 mL	14574-42
Volumetric Flask, 200 mL	14574-45

* TenSette™ is a Hach Company trademark.
** Do not use these standards for instrument calibration.

HOW TO ORDER

By Telephone:
6:30 a.m. to 5:00 p.m. MST
Monday through Friday
(800) 227-HACH
(800-227-4224)
By FAX:
(970) 669-2932

By Mail:
Hach Company
P.O. Box 389
Loveland, Colorado 80539-0389
U.S.A.
Ordering information by E-mail:
orders@hach.com

Information Required

- Hach account number (if available)
- Your name and phone number
- Purchase order number
- Brief description or model number
- Billing address
- Shipping address
- Catalog number
- Quantity

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