Quality Assurance/ Quality Control Plan

Stoughton City Landfill
Stoughton, Dane County, WI

Revision 1
April 2024

Prepared For:

Wisconsin Department of Natural Resources
101 S. Webster Street
Madison, WI 53707

Prepared By:

TRC
999 Fourier Drive, Suite 101
Madison, WI 53717

Wesley J Braga

Wesley Braga
Project Manager

Katherine Vater

Katherine Vater, P.E.
Senior Project Engineer

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1.0 Introduction

1.1 Background

The Stoughton City Landfill (SCL) is located northeast of Stoughton (near the intersection of Amundson Parkway and Skogdalen Drive), Dane County Wisconsin. The Wisconsin Department of Natural Resources (WDNR) required the landfill to be closed in 1977 and the landfill was officially closed in 1982. The State of Wisconsin, through the WDNR Remediation and Redevelopment Program, is responsible for performing inspection and monitoring activities including groundwater quality sampling of monitoring wells and monitoring for explosive gases at the landfill perimeter. TRC has completed these landfill monitoring activities for the WDNR since April 2020 following the scope of work (SOW) outlined in the December 2019 issued Request for Bid (RFB). In October 2023 the WDNR issued a new RFB providing updated details of the monitoring SOW. This QA/QC plan has been revised to reflect the SOW outlined in the 2023 RFB.

1.2 Purpose

This QA/QC Plan (Revision 1) has been prepared to support groundwater and landfill gas monitoring activities at the SCL. The purpose of the QA/QC Plan is to define technical details of sampling and data gathering methods to be used during field activities, provide details of the laboratory analytical program, and provide the specific quality assurance (QA) and quality control (QC) activities associated with the data collection.

1.3 Scope

This QA/QC Plan consists of seven sections, including:

- **Section 1** describes the background, purpose, and scope of the QA/QC Plan.
- **Section 2** describes the field sampling scope of work.
- **Section 3** covers the details of sample identification, control, and field records.
- **Section 4** describes the sampling equipment and procedures for collecting samples for field and laboratory analyses.
- **Section 5** identifies the sample handling and analytical procedures to be followed, and the specific laboratory analyses to be performed.
- **Section 6** describes management of waste materials that will be produced during the fieldwork.
- **Section 7** provides a list of references contained in the document text.

2.0 Scope of Work

TRC will perform the following field sampling program as described in the RFB dated October 2023:

- Measure depth to water and report groundwater elevations at the 12 monitoring wells included in the site monitoring program outlined in section 2.5.3 of Attachment A of the RFB and in Table 1 of this QA/QC Plan. The monitoring program will be completed in April of each year. Measurements will be collected prior to sampling to ensure a static level measurement is obtained.

- The groundwater monitoring program is summarized in Table 1. Select monitoring wells will be sampled for volatile organic compounds (VOCs) and/or dichlorodifluoromethane (DCDFM) and tetrahydrofuran (THF) per Section 2.5.3 of Attachment A of the RFB. Monitoring well samples will be analyzed by SW846 Method 8260D. In addition to the analytical samples, field indicators (pH, temperature and specific conductivity) will be collected at each sampling location.

- Perform landfill gas monitoring on a bi-monthly basis to monitor pressure, VOCs, percent methane as LEL, percent oxygen, and percent carbon dioxide at the three gas probes illustrated on the Figure included in Attachment 1 (months: February, April, June, August, October, and December).

- Perform inspections of the packer systems installed in monitoring wells MW-7I, MW-8I and MW-10I to confirm flow control systems are working properly.

- Per Section 2 of Attachment A of the RFB, perform semi-annual inspections of the following landfill site features:

  - Landfill Final Cover/Cap,
  - Stormwater Control Systems,
  - Landfill Gas Venting System,
  - Security Fence and Signage,
  - Groundwater Monitoring Wells, and
  - Gas Monitoring Probe.

The following report sections provide details of the sampling methodology and equipment to be used to perform the scope of work.

3.0 Sample Identifiers, Control, and Field Records

3.1 Sample Identifiers

Samples will be named in a manner consistent with the current sampling program, and with the existing WDNR Groundwater and Environmental Monitoring System (GEMS) database records. Samples will be assigned a unique alpha-numeric sample descriptor identifying the media type and sample location. Each sample will be labeled as follows:

> [sample type]-[sample location or QA/QC number]

The following subsections describe the sample numbering system in greater detail.

3.1.1 Sample Type

Sample type codes for the fieldwork include the following:

- GMP – gas monitoring probe
- MW – monitoring wells
- FB – field blanks
- DUP – single-blind field duplicate samples
- TB – trip blanks

3.1.2 Sample Locations

Following the convention above, samples collected from the existing monitoring wells will be labeled as identified in Table 1 and on the Figure included in Attachment 1. A groundwater sample collected from the location of MW-3D will be labeled “MW-3D”; field notes for gas data collected from point GMP-1 will be labeled “GMP-1”, and so on.

3.1.3 QA/QC Sample Numbers

Quality control samples (e.g., field blanks, trip blanks, and blind duplicates) will be numbered sequentially each event beginning with “01,” and will be recorded on the appropriate field form. For example, the complete sample identifier for the field blank collected during a monitoring event would be “FB-01”. The blind duplicate would be identified as “DUP-01”. The duplicate sample label will not include a sample time so as to not reveal the source of the duplicate. The name and location of the field duplicate sample will be recorded on the field form associated with the primary sample point.

Per the RFB, no site-specific matrix spike/matrix duplicate will be collected during the monitoring event unless additional volume is requested by the laboratory for internal QA/QC. If a sample for matrix spike/matrix spike duplicate analyses is required, the suffix of “-MS/MSD” (or separately labeled as “-MS” and “-MSD”) will be added to the sample identification number. An MS/MSD collected for a groundwater sample for MW-3D would read, “MW-3D-MS/MSD.”

3.1.4 *GEMS Database Submittal*

The analytical laboratory will prepare an electronic data deliverable (EDD) of the groundwater sampling data in a format compatible with the WDNR GEMS database. The data submittal will uniquely identify each result by the site license number (#112 through #134), the WDNR point ID, sample date, and analytical parameter. In order to prepare the GEMS submittal, the analytical laboratory will be provided with the field sampling data, and locations of the blind field duplicate samples (after the final analytical reports are prepared). The EDD will be submitted to the WDNR along with an exceedance report and a signed electronic data certification form.

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:

- 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, or
- the sample is in a designated secure area.

Sets of sample containers that are shipped together will be assigned a Chain-of-Custody form, which will travel with the sample containers to the analytical laboratory. A copy of the Chain-of-Custody form will be kept by the field team 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 the samples are not tampered with during transit, and the shipment airbill will be kept as Chain-of-Custody documentation. An example of the Chain-of-Custody form is included in Attachment 2.

3.3 Field Records

This section describes requirements and procedures for documenting field activities. All fieldwork personnel will be cognizant of the requirement that all field documentation must provide a clear, unbiased description of field activities.

Daily field activities and sampling data will be recorded on paper field forms, or electronically on a field tablet computer (or equivalent). Example forms are provided as Attachment 2. Entries into the field forms will be legibly written and will provide a clear record of field activities. Entries will be made in waterproof ink, in language that is objective, factual, and generally free of personal opinions, or terminology that might later prove unclear or ambiguous. No field notes may be destroyed or discarded, even if they are illegible, or known to contain inaccuracies. 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 by the person making the correction. The person filling out the field forms will sign and date each page and will identify the date, the time, the location on-site, the field personnel present, and the weather conditions observed.

4.0 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:

- 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 the WDNR-approved laboratory for analysis

The procedures presented in this QA/QC Plan 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 field notes. The WDNR Project Manager will be notified of deviations after the sampling event in the report documenting the results of the sampling event.

4.1 General Considerations

The following factors and procedures are general considerations to be used in planning and performing sampling. These factors and procedures will be considered with respect to the specific objectives and scope of the field investigation, as presented in this QA/QC Plan:

- 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
- Sample identification
- Transportation and shipping of samples
- Sample Chain-of-Custody

4.2 Decontamination Procedures

An appropriately-developed, executed, and documented equipment decontamination procedure is an integral and essential part of environmental site investigations. The benefits include minimizing the spread of contaminants (within a study area and from site to site), reducing the potential for worker exposure by means of contact with contaminated sampling equipment, and improved data quality and reliability.

4.2.1 Single-Use and Dedicated Sampling Equipment

To the extent practicable, single-use or dedicated sampling equipment and materials will be used for the collection of samples. The single-use materials used will be new and clean and will be placed in plastic for transport to the site. Once used, single-use equipment will be placed in plastic bags and managed as investigation-derived waste material. Dedicated equipment will remain in the wells or sealed in clean plastic bags for storage. Single-use equipment includes, but is not limited to, the following:

- Low-density polyethylene (LDPE), High-density polyethylene (HDPE), and/or silicon tubing
- Polypropylene rope
- Disposable HDPE bailers
- Waterra Valves

Dedicated and single-use equipment and materials will not require field decontamination.

4.2.2 Non-dedicated Sampling Equipment

Proper decontamination of sampling equipment is essential to minimize the possibility of cross-contamination of samples. Non-dedicated equipment used for purging monitoring wells or sampling groundwater will be cleaned before its initial use in the field and again before use at each subsequent sampling location. Equipment subject to this decontamination procedure includes, but is not limited to, the following:

- Non-dedicated submersible pumps (not expected to be needed)
- Water level indicator
- Groundwater flow through-cell
- Groundwater multi-parameter sensors
- Stainless steel bailers (not expected to be needed)

Non-dedicated sampling equipment will be decontaminated prior to its initial use on-site and in between sampling points, unless new and transported to the site in a protected and decontaminated condition. Decontamination procedures will include the following steps:

- Wash the equipment in a non-phosphate detergent.

- Rinse with potable tap water.
- Rinse with distilled water.

Field decontamination of sampling equipment may take place at the sampling location. Decontamination water will be collected in 5-gallon buckets or similar container(s) and managed as described in Section 6.

When field cleaning of sampling equipment is required, a piece of the field-cleaned equipment will be selected for collection of a field equipment blank sample at the frequency specified, and in accordance with the methods described in Section 4.6.

4.3 Groundwater Sampling

Groundwater samples from the site monitoring wells will be collected using low-flow sampling methods when possible. The following sections describe the specific equipment and methods that will be utilized to perform the scope of work. In general sampling efforts will be completed in correlation with the WDNR Groundwater Sampling Field Manual (WDNR, 1996a), Sampling Desk Reference (WDNR, 1996b), and Low stress (low flow) purging and sampling procedure for the collection of groundwater samples from monitoring wells developed by USEPA (USEPA, 1996).

4.3.1 Water Level Measurements

Depth to water measurements will be obtained on the first day of each groundwater monitoring event or within a 24-hour period (i.e., “synoptic water levels”), prior to any purging or sampling activities. Water level measurements will be collected using an electronic water level indicator. The water level indicator 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. A copy of the manufacturer’s operation and maintenance instructions is included in Attachment 3. Measurements will be taken from the established reference point marked on the casing, or if such a marking is not present, then from the high point of the well casing.

4.3.2 Well Inspection

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

- The ground surface condition around the well (grading, 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, protective cover, vented cap on well casing, presence/condition of reference point, and surface seal
- Evidence of potential contamination at the wellhead, including staining or suspicious containers

4.3.3 Groundwater Sampling Procedures – Monitoring Wells

Groundwater samples will be collected from the selected monitoring wells through low-flow sampling techniques. When sampling through low-flow methods, the pump intake will be set at the desired sampling depth, and the well will be purged at a rate that should not mobilize naturally non-mobile colloidal matter, generally does not create excessive water level drawdown, minimizes pressure changes in the purged water, and does not appreciably change the redox state of the sample. This sampling method minimizes the disturbance of the sample, thereby reducing sampling artifacts, and improves the consistency and quality of the groundwater sample results. In addition, if PFAS sampling is warranted in the future, this method is preferred as less equipment handling is required, reducing the risk of compromised samples. In general, low-flow purging and sampling methods developed by USEPA (USEPA, 2021) will be followed.

None of the site wells contain dedicated pumps so each well will be purged using a portable bladder pump, a peristaltic pump, a Waterra pump or a submersible sampling pump (e.g., Grundfos or equivalent), as appropriate depending on the well depth, depth to water, and if the well screen is completely submerged. Portable sampling pumps will be set in the well such that the pump intake is approximately 1 to 2 feet from the base of the well screen.

Each well will be pumped at a flow rate ranging from 0.1 to 1.0 liter/minute. The pumping rate for each monitoring well will be dependent on the hydraulic properties of the formation the well is screened across, and will be determined in the field to be the highest flowrate attainable without creating drawdown greater than approximately 0.1 meter, or at a minimum of 0.1 liter/minute. In the event that the well cannot produce sufficient water to limit drawdown to 0.1 meter at the lowest specified pumping rate (0.1 liter/minute), sampling will be conducted at the 0.1 liter/minute rate after field parameter measurements and the water level have stabilized as described below.

An In-Situ AquaTroll 400 (or equivalent) equipped with temperature, specific electrical conductance, and pH electrodes will be used to collect field measurements during purging to evaluate stabilization. The pump discharge will be connected to a flow through cell for the collection of field parameters. A minimum of 1-Liter of water will be purged from the well between measurements. Field parameter measurements will be considered stable when three consecutive readings are within the limits listed below:

- pH: +/- 0.1 unit
- Specific Conductivity: +/- 3%
- Temperature: +/- 0.5 degrees Celsius
- The water level drawdown is within 0.16 ft. in a 2” diameter well (or 0.04 ft. in a 4” diameter well) for every liter of water removed (or less than 10 percent of the water purged resulting from drawdown).

The wells will be sampled immediately following stabilization. The samples will be collected directly from the pump discharge after the flow-through cell has been disconnected. Final measurements of pH, temperature, specific conductance; and qualitative observations of color, odor, and sample turbidity will be recorded on the field forms. In the event that stabilization of the indicator parameters is not achieved in a reasonable amount of time (1 hour), the well may be sampled after a minimum of four well screen volumes has been removed.

If a well cannot sustain a pumping rate of 0.1 L/minute, and can be purged dry at that flow rate, the well will be purged dry and allowed to recover prior to sampling. The sample will be collected within 24 hours after purging.

Disposable HDPE or reusable stainless steel bailers may be used as a “last resort” to purge and sample wells in the event that a well cannot be successfully sampled by any other means. When wells are purged with a bailer, a minimum of four well volumes will be removed prior to sampling.

4.4 Landfill Gas Monitoring Procedures

Gas probe monitoring will be performed in the field with the portable instruments such as the Landtech GEM 2000 portable gas sensor, RAE System MiniRAE 3000 photoionization detector, and Dwyer Manometer (or equivalent). The following sampling protocol will be followed to monitor pressure, barometric pressure, methane as percent of the lower explosive limit (LEL), percent oxygen, percent carbon dioxide and volatile organic compounds (VOCs) at each of the gas probes:

- Calibrate the gas monitoring instrument (Landtech) in an area where ambient concentrations of gases of concern are not present. Calibrate the oxygen sensor to 21 percent and set the methane sensor to zero. Check the calibration of the methane sensor using appropriate concentrations of sample gas following the manufacturer's recommended procedures.
- The photoionization detector instrument will be field bump tested using two known gas concentrations; a zero air (0.0 parts per million) and Isobutylene (C_4H_8) (100 parts per million (ppm)). The measured value of the standard must be within ±10% of the true value, otherwise the instrument will be recalibrated, and bump tested.
- With the gas instrument running and zeroed, first attach a pressure gauge to the valve prior to opening the valve. Open the valve and record the highest pressure that the gauge measured. Close the valve and disconnect the gauge.
- Attach the inlet hose of the gas analysis instrument (Landtech) to the valve prior to opening the valve. Open the valve and record the highest concentration that the instrument detects and note if the concentration decreases or remains steady. Sample the gas for a minimum period of 30 seconds and a maximum of 1 minute. After analyzing the gas, close the valve prior to removing the hose of the instrument.
- Attach the inlet hose of the gas analysis instrument (Photoionization Detector) to the valve prior to opening the valve. Open the valve and record the highest concentration that the instrument detects and note if the concentration decreases or remains steady. Sample the gas for a minimum period of 30 seconds and a maximum of 1 minute. After analyzing the gas, close the valve prior to removing the hose of the instrument.

- Prior to proceeding with sampling and analyzing gas in the next probe, let the monitoring instruments purge themselves with ambient air such that it reads zero, or the reading is representative of the atmospheric air.
- If readings are recorded that differ greatly from other probes on-site, or from previous readings at a specific probe, recalibrate the monitoring instrument(s) and recheck the anomalous gas probe.
- Record all monitoring data on a field data sheet (Attachment 2).

4.5 Field Parameter Monitoring Equipment Operation, Calibration, and Maintenance

Field analytical measurements to be taken during the fieldwork program will use equipment that is suitable for the analytical method to be used and is properly calibrated. In addition to being accurate, field analyses will be conducted on a sample that is representative of the source from which it was collected. Therefore, the type of sample and the location of the sampling site are critical.

The equipment used for in-field measurement will be maintained, calibrated, and used in the field according to the procedures described in this section. The process will be documented, and the field team leader 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 QA/QC Plan, errors, equipment failures, or other problems will be recorded in the field notes and reported to the Project Manager. Corrective actions and additional notifications will be coordinated by the Project Manager.

4.5.1 Calibration Procedures

Groundwater level measurement devices will be prepared according to the appropriate manufacturer’s instructions (Attachment 3) and checked for visual damage or defects prior to use at the site. The groundwater level measuring device will be calibrated by comparing measurements adjacent to a new measuring tape graduated in hundredths of a foot. If the measuring device does not correspond to the measuring tape within 0.01 foot, the device will be replaced.

The pH and specific conductance meter will be calibrated daily in accordance with manufacturer’s instructions (Attachment 3). Calibration will include a minimum of one calibration at the beginning of each sampling day, and a calibration check will be performed at the end of each sampling day.

The Landtech meter will be calibrated once per sampling day as described in Section 4.4. Calibration information will be recorded in the field notes.

The photoionization detector instrument will be calibrated in accordance with the manufacturer’s instructions (Attachment 3). In addition, a field bump test using two known gas concentrations (a zero air (0.0 parts per million) and Isobutylene (C_4H_8)(100 parts per million)) will be completed each day of use. The measured value of the standard must be within ±10% of the true value, otherwise the instrument will be recalibrated, and tested. Calibration information will be recorded in the field notes.

4.5.2 *Operation Procedures*

The sampling meters will be operated according to the manufacturer’s instructions (Attachment 3).

4.5.3 *Maintenance Procedures*

The sampling meters will be maintained according to the manufacturer’s instructions (Attachment 3). Maintenance activities performed during the fieldwork will be recorded in the field notes.

4.6 Sampling QA Procedures

4.6.1 *General*

The sample collection procedures presented in this QA/QC Plan are designed to provide samples of the required quality for the purposes of routine groundwater monitoring. All field personnel will be required to understand the requirements of this Plan and will be trained in the use of the specified equipment and techniques. Specific site activities that will be implemented include the following:

- Convene a meeting of field personnel at the start of a specific monitoring event to review health and safety requirements, the sampling requirements of the QA/QC Plan, review the necessary equipment and decontamination requirements and use, and review the required documentation.
- Review all documentation for completeness, errors, problems, and corrective actions taken.
- Convene daily project team meetings at the start of the day to review health and safety protocol, 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 Project Manager will be notified of significant problems and, if necessary, will work with the Technical Coordinator 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.

4.6.2 *Sample Collection*

Personnel involved in the collection of samples are required to read, understand, and follow the health and safety plan and sampling procedures specified in this QA/QC Plan. Problems that may affect the quality of the sampling effort will be recorded by the field personnel most directly involved with the problem, and the Technical Coordinator will be notified and responsible for coordinating the development and implementation of corrective actions with the Project Manager.

4.6.3 *Analytical Quality Assurance Considerations*

Analytical quality assurance will be assessed through the collection of field QA/QC samples, such as blank and duplicate samples. The frequencies for collection of field duplicate, field blank, trip blank, and matrix spike/matrix spike duplicate samples are specified below:

4.6.3.1 Field Duplicates

Blind field duplicate samples, prepared by splitting a single sample into two separate sets of laboratory containers, will be used to evaluate sampling precision. Points where duplicate samples are to be collected will be selected by the field personnel and will be submitted as single-blind duplicates to the laboratory. Field duplicates will be collected at a rate of one for every 10 (or fewer) primary samples.

4.6.3.2 Field Blanks

One equipment blank will be collected as part of the sampling plan. An equipment blank (or "rinsate blanks") is generally collected from non-dedicated, non-disposable equipment used to collect groundwater samples. Field equipment blanks are analyzed to check for procedural contamination at the site that may cause sample contamination. In most cases, field equipment blanks are samples collected in the field by rinsing a piece of non-dedicated sampling equipment (e.g., steel bailers or portable sampling pumps) that has just been decontaminated with analyte-free water or other blank matrix, and then transferring this water to the proper sample bottles. The water source for the blanks will consist of deionized or distilled water from an off-site source, or from the analytical laboratory. If all equipment being utilized is disposable or dedicated, a sample will be collected from an unused single-use (disposable) piece of sampling equipment. Field equipment blanks will be collected at a frequency of one per sampling event. Equipment blanks will not be collected from dedicated field equipment.

4.6.3.3 Trip Blanks

Trip blanks will be analyzed to assess whether cross-contamination of VOCs resulting from diffusion through sample container seals may have occurred during sample shipment. Trip blanks, consisting of 40-mL VOA vials with laboratory-grade deionized water, are generated in the laboratory and will 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.

4.6.3.4 Matrix Spikes/Matrix Spike Duplicates (MSs/MSDs)

MS/MSD sample(s) will only be collected if requested by the laboratory for internal purposes as MS/MSD samples were not requested as QA/QC samples per the request for bid. 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. In conjunction with other QC data, the spikes and duplicates give information on the precision and accuracy of the analytical methods for the various sample matrices. If MS/MSD samples are collected, triple the normal sample volume, provided adequate sample volume is available will be collected. Field personnel will select the locations where MS/MSD samples are collected and will use care to select locations where adequate sample volumes are obtainable.

5.0 Sample Handling and Analysis

This section presents general sample handling and analysis protocols.

5.1 Sample Containers and Shipping

Sample containers, preservation methods, and holding times that meet USEPA standards for liquid samples intended for chemical analyses are summarized in Table 2. Sample containers are prepared by the laboratory (Test America in University Park, Illinois) and shipped directly to the TRC Madison office for transport to the site. For samples intended for VOC analysis, the sample containers will be filled completely to eliminate airspace. Samples will be kept out of direct sunlight and on ice in a metal or hard-plastic ice chest or cooler from the time the samples are collected until delivery to the laboratory.

For delivery of samples to the laboratory, the following procedures will be implemented:

1. Collect and preserve the samples as described in Table 2.
2. Place sample containers (including field duplicates, field blanks, trip blanks, and matrix spike samples(if collected) in a laboratory shipping container(s). Pack samples securely with packing material to protect sample containers from accidental breakage and from leaks or spills during shipment. PFAS and VOC sample containers will be kept in separate coolers. A trip blank will be included with each shipping container that contains VOC samples.
3. Fill shipping containers with enough ice to last the duration of the trip. Double-bag the ice to ensure sample integrity. Do not use dry ice and/or blue ice (ice packs).
4. Complete the Chain-of-Custody form as described in Section 3.2. An example form is included in Attachment 2.
5. Seal the Chain-of-Custody form in a zipper top bag and place inside the top of the cooler.
6. Seal shipping container with packaging tape, and place a custody seal (provided by the laboratory) on the shipping container prior to shipping.
7. Deliver or ship to the laboratory using an overnight shipping service or directly via a courier.

The field team leader will be responsible for the proper use of containers and preservatives.

5.2 Selection of Parameters for Analysis

The samples to be collected for this monitoring program will be analyzed for the parameters as listed in Table 1.

5.3 Laboratory Analytical Procedures

The selection of analytical procedures will reflect USEPA-approved methodology from SW-846, where applicable, as stated in Table 2. Laboratory provided analytical standard operating procedures have been included in Attachment 4.

6.0 Management of Waste Materials From Fieldwork Program

6.1 Investigative-Derived Waste

Due to PFAS detections during previous site investigations, the purge water from all site wells will be collected in 5-gallon plastic buckets, sealed with a plastic lid then labeled. Purge water will be held on site either in the buckets or a sealed container until disposal can be coordinated by TRC.

6.2 Used Personal Protective Equipment and Uncontaminated Refuse

Used personal protective equipment and other types of general uncontaminated debris or waste materials produced during the fieldwork will be collected daily in sealed plastic bags and placed in a waste dumpster at the TRC Madison office.

7.0 References

United States Environmental Protection Agency (USEPA) Region 1. 1996. Low stress (low flow) purging and sampling procedure for the collection of groundwater samples from monitoring wells. Revision 4, September 19, 2017.

Wisconsin Department of Natural Resources. 1996a. Groundwater Sampling Field Manual. September 1996.

Wisconsin Department of Natural Resources. 1996a. Groundwater Sampling Desk Reference. September 1996.

Table 1: Stoughton City Landfill Annual Monitoring Program

Well Number	GEMS ID	Well Depth (feet)(1)	Depth to Groundwater (feet)(1)	Groundwater Elevation	Field Indicators(2)	VOCs	DCDFM THF	Analytical Method
MW-3S	111	19.4	7.97					NS
MW-3D	112	73	8.02	X	X		X	SW846-8260
MW-3B	113	95	8.86					NS
MW-4S	114	15.2	5.52					NS
MW-4D	115	74	5.41	X	X		X	SW846-8260
MW-5S	116	16.6	5.50					NS
MW-5D	117	77	5.33	X	X		X	SW846-8260
MW-7S	118	15.1	3.68					NS
MW-7I	119	60	TOC	X	X		X	SW846-8260
MW-8S	121	33	TOC					NS
MW-8I	122	62.4	TOC	X	X		X	SW846-8260
MW-8B	123	39.5	TOC					NS
MW-9S	124	13.4	0.75	X	X	X	X	SW846-8260
MW-9I	125	47.2	0.76	X	X	X	X	SW846-8260
MW-9B	126	83.3	0.50	X	X	X	X	SW846-8260
MW-10S	127	16.9	3.27	X	X	X	X	SW846-8260
MW-10I	128	-	TOC	X	X	X	X	SW846-8260
MW-13S	130	16.7	4.09					NS
MW-14S	133	26.2	2.11	X	X	X	X	SW846-8260
MW-14I	134	51.2	0.96	X	X	X	X	SW846-8260
MW-14D	135	89.6	0.90					NS
MW-15S	136	16.6	4.02					NS
MW-15I	137	57.4	0.86					NS
MW-15D	138	85.9	1.05					NS

Notes:

GEMS = Groundwater and Environmental Monitoring System and is data organized by the Wisconsin Department of Natural Resources

VOCs = Volatile Organic Compounds

DCDFM = Dichlorodifluoromethane

THF = Tetrahydrofuran

Footnotes:

(1) Well depths are from the top of the casing. Depth in feet below top of well casing, based on April 2019 data. Depths may vary seasonally.

(2) Field indicators are pH, temperature, and specific conductance

Table 2: Analytical Sampling Requirements

Analytical Group[1]	Analytical and Preparation Method	Sample Volume[1]	Containers (number, size, and type)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation/ analysis)
VOC, DCDFM, and THF (Monitoring Wells)	SW-846 8260D	120 mL	(3) 40-mL glass vials, no headspace	Cool to 4 ± 2 °C HCl to pH <2	14 days

Notes:

DCDFM = Dichlorodifluoromethane

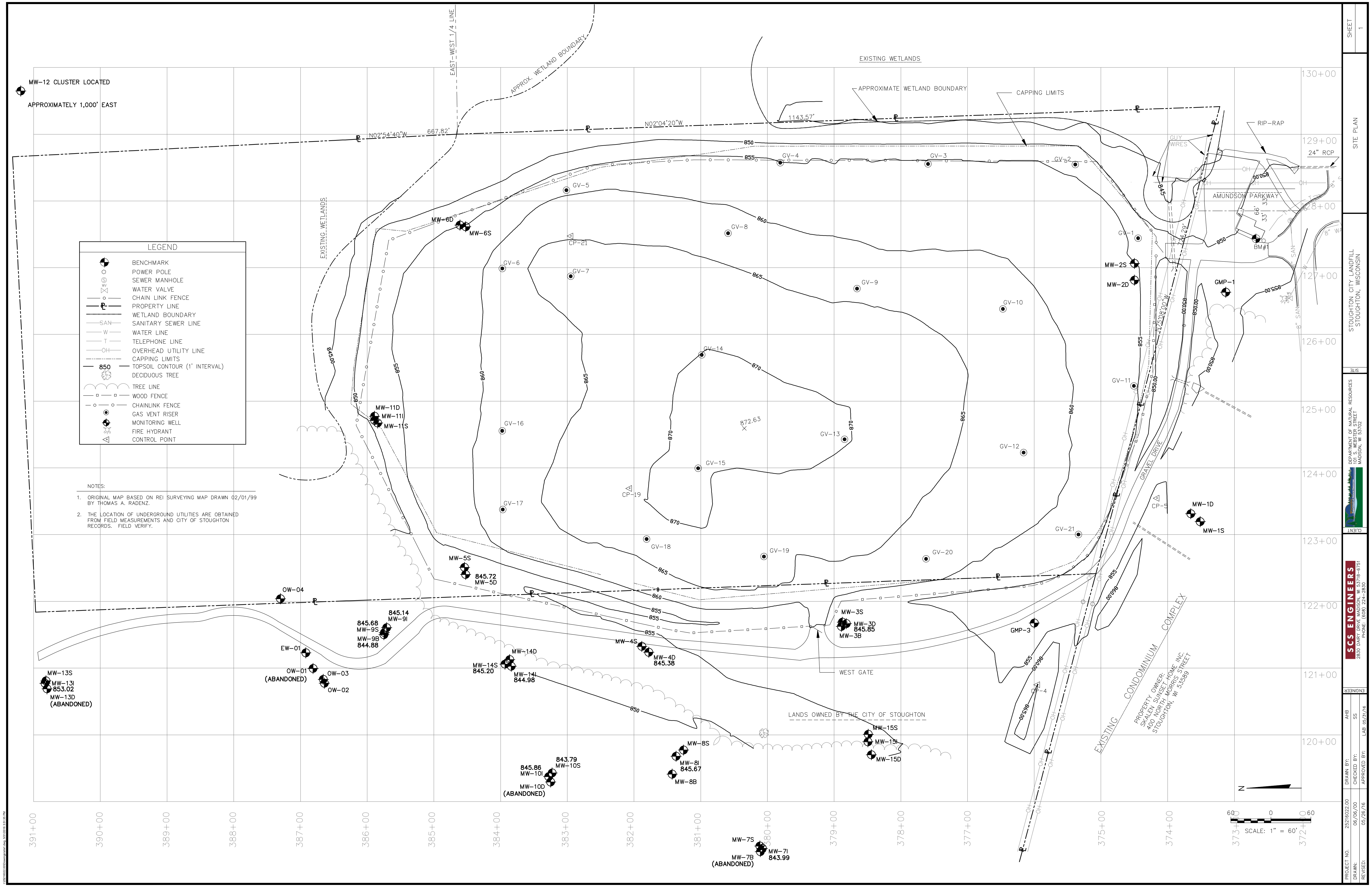
THF = Tetrahydrofuran

VOC = Volatile Organic Compounds

Footnotes:

(1) Analytical lists are included in Table 1.

Attachment 1: Site Overview Map



NOTES:

1. ORIGINAL MAP BASED ON REI SURVEYING MAP DRAWN 02/01/99 BY THOMAS A. RADENZ.
2. THE LOCATION OF UNDERGROUND UTILITIES ARE OBTAINED FROM FIELD MEASUREMENTS AND CITY OF STOUGHTON RECORDS. FIELD VERIFY.

PROJECT NO.	25216022.00	DRAWN BY:	AHB
DRAWN:	06/06/00	CHECKED BY:	SS
REVISED:	05/26/16	APPROVED BY:	LAB 05/31/16

ENGINEER

SCS ENGINEERS
2830 DAIRY DRIVE MADISON, WI 53718-6751
PHONE: (608) 224-2830

CLIENT

DEPARTMENT OF NATURAL RESOURCES
101 S. WEBSTER STREET
MADISON, WI 53702

SITE

STOUGHTON CITY LANDFILL
STOUGHTON, WISCONSIN

SITE PLAN

SHEET
1

Attachment 2: Example Forms

- TRC Field Forms
- Laboratory Analytical Chain of Custody

TRC Field Forms

PAGE _______ OF _______

PROJECT NAME: Stoughton City Landfill

PROJECT NUMBER:

PROJECT MANAGER:

SITE LOCATION: Stoughton, Wisconsin

DATES OF FIELDWORK: TO

PURPOSE OF FIELDWORK:

WORK PERFORMED BY:

SIGNED DATE

CHECKED BY DATE

REVISED 03/2008

PAGE _______ OF _______

GENERAL NOTES

PROJECT NAME: Stoughton City Landfil	DATE:	TIME ARRIVED:
PROJECT NUMBER:	AUTHOR:	TIME LEFT:

WEATHER

TEMPERATURE: ______ °F WIND: _______ MPH VISIBILITY: ________________________

WORK / SAMPLING PERFORMED

PROBLEMS ENCOUNTERED	CORRECTIVE ACTION TAKEN

COMMUNICATION

NAME	REPRESENTING	SUBJECT / COMMENTS

SIGNED DATE

CHECKED BY DATE

REVISED 03/2008

PAGE _______ OF _______

TRC

GAS MONITORING REPORT

SITE NAME: Stoughton City Landfill	DATE:
PROJECT NUMBER:	TECHNICIAN:
AS SENSOR MODEL:	FIELD CALIBRATED: YES: ______ NO: ______

WEATHER

WEATHER: ______________________ TEMPERATURE: __________ °F

SKY CONDITIONS: ______________________ WIND SPEED: ______ MPH DIR: ______

GROUND CONDITIONS: SNOW: YES NO RELATIVE HUMIDITY (%): ______________

FROZEN GROUND/FROST: YES NO DEW POINT °F ______________

VISIBILITY: ______________________ TIME: ______ BAROMETRIC PRESS (in.Hg): ______ TREND: ______

GAS READINGS

Probe/Vent Number	Time	Pressure		CH_4		O_2 (% V/V)	CO_2 (% V/V)	PID (ppm)	Comment
		+ or -	in w.c.	%LEL	% V/V				
GMP-1									
GMP-2									
GMP-3									

SIGNED DATE CHECKED BY DATE

Page: ______ of ______

PAGE _______ OF _______

WATER QUALITY METER CALIBRATION LOG

PROJECT NAME:	Stoughton City Landfil	MODEL:		SAMPLER:	
PROJECT NO.:		SERIAL #:		DATE:	-

PH METER

CALIBRATION			POST SAMPLING CALIBRATION CHECK			DATE
pH 4	pH 7	TIME	pH 4	pH 7	TIME	
☐ WITHIN RANGE	☐ WITHIN RANGE					
☐ WITHIN RANGE	☐ WITHIN RANGE					
☐ WITHIN RANGE	☐ WITHIN RANGE					
☐ WITHIN RANGE	☐ WITHIN RANGE					
☐ WITHIN RANGE	☐ WITHIN RANGE					

CONDUCTIVITY METER

CALIBRATION			POST SAMPLING CALIBRATION CHECK			DATE
STANDARD		TIME	SOLUTION CHECK	SOLUTION TEMP	TIME	
µmhos/cm	☐ WITHIN RANGE		µmhos/cm	°C		
µmhos/cm	☐ WITHIN RANGE		µmhos/cm	°C		
µmhos/cm	☐ WITHIN RANGE		µmhos/cm	°C		
µmhos/cm	☐ WITHIN RANGE		µmhos/cm	°C		
µmhos/cm	☐ WITHIN RANGE		µmhos/cm	°C		

DO METER

CALIBRATION	TIME	CALIBRATION	TIME	DATE
☐ WITHIN RANGE		☐ WITHIN RANGE		
☐ WITHIN RANGE		☐ WITHIN RANGE		
☐ WITHIN RANGE		☐ WITHIN RANGE		
☐ WITHIN RANGE		☐ WITHIN RANGE		
☐ WITHIN RANGE		☐ WITHIN RANGE		

ORP METER

		POST SAMPLING CALIBRATION CHECK			DATE
CALIBRATION	TIME	SOLUTION CHECK	SOLUTION TEMP	TIME	
☐ WITHIN RANGE		mV	°C		
☐ WITHIN RANGE		mV	°C		
☐ WITHIN RANGE		mV	°C		
☐ WITHIN RANGE		mV	°C		
☐ WITHIN RANGE		mV	°C		

TURBIDITY CALIBRATION CHECK

METER TYPE: Hach 2100P

PRE-SAMPLING CALIBRATION CHECK				POST SAMPLING CALIBRATION CHECK				DATE
GEL VALUE (NTU) 0-10	GEL VALUE (NTU) 0-100	GEL VALUE (NTU) 0-1000	TIME	GEL VALUE (NTU) 0-10	GEL VALUE (NTU) 0-100	GEL VALUE (NTU) 0-1000	TIME	

Autocal Solution Lot#:		Exp Date:	
pH 7 Soultion Lot#:		Exp Date:	
ORP Solution Lot#:		Exp Date:	

Parameters Calibrated: ☐ pH ☐ Conductivity

☐ Turbidity ☐ ORP ☐ Dissolved Oxygen

NOTES

DATE	PROBLEMS ENCOUNTERED	CORRECTIVE ACTIONS

SIGNED ____________________ DATE

Checked ____________________ DATE

REVISED 03/2008

PAGE _______ OF _______

TRC

PID FIELD CALIBRATION LOG

PROJECT NAME: Stoughton City Landfill	MODEL:
PROJECT NUMBER.:	LAMP VOLTAGE:
SAMPLER NAME:	SERIAL NO.:

PID CALIBRATION CHECK

	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:	DATE: TIME: INITIALS:
BATTERY CHECK	☐	☐	☐	☐	☐
ZERO GAS	/	/	/	/	/
SPAN GAS	/	/	/	/	/
AUDIBLE FAN MOTOR CHECK	☐	☐	☐	☐	☐
RESPONSE CHECK	☐	☐	☐	☐	☐

NOTES

PROBLEMS ENCOUNTERED	CORRECTIVE ACTION

SIGNED DATE

CHECKED DATE

REVISED 03/2008

PAGE ______ OF ______

WATER LEVEL DATA

PROJECT NAME: Stoughton City Landfil	DATE:
PROJECT NUMBER:	AUTHOR:

WELL LOCATION	TIME	REFERENCE	DEPTH TO WATER (FEET)	DEPTH TO BOTTOM (FEET)	SCREENED INTERVAL (FEET)	WATER ELEVATION
MW-3S						
MW-3D						
MW-3B						
MW-4S						
MW-4D						
MW-5S						
MW-5D						
MW-7S						
MW-7I						
MW-8S						
MW-8I						
MW-8B						
MW-9S						
MW-9I						
MW-9B						
MW-10S						
MW-10I						
MW-13S						
MW-13I						
MW-14S						
MW-14I						
MW-14D						
MW-15S						
MW-15I						
MW-15D						

SIGNED DATE

CHECKED DATE

PAGE _______ OF _______

WATER SAMPLE LOG

PROJECT NAME:	**Stoughton City Landfil**	PREPARED		CHECKED	
PROJECT NUMBER:		BY:	DATE:	BY:	DATE:

SAMPLE ID: WELL DIAMETER: ☐ 2" ☐ 4" ☐ 6" ☐ OTHER

WELL MATERIAL: ☐ PVC ☐ SS ☐ IRON ☐ ☐ OTHER

SAMPLE TYPE: ☐ GW ☐ WW ☐ SW ☐ DI ☐ LEACHATE ☐ OTHER

PURGING	TIME:	DATE:	SAMPLE	TIME:	DATE:

PURGE METHOD: ☐ PUMP ____________________ ☐ BAILER ____________________

DEPTH TO WATER: T/ PVC

DEPTH TO BOTTOM: T/ PVC

WELL VOLUME: ☐ LITERS ☐ GALLONS

VOLUME REMOVED: ☐ LITERS ☐ GALLONS

COLOR: ODOR:

TURBIDITY

☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY

DISPOSAL METHOD: ☐ GROUND ☐ DRUM ☐ OTHER

PH: SU | CONDUCTIVITY: umhos/cm

DO: mg/l | ORP: mV

TURBIDITY: NTU

☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY

TEMPERATURE: °C | OTHER: --

COLOR: | ODOR:

FILTRATE (0.45 um) ☐ YES ☐ NO

FILT COLOR: | FILT ODOR:

QC SAMPLE: ☐ MS/MSD ☐ DUP-

COMMENTS:

TIME	PURGE RATE (ML/MIN)	TEMPERATURE (°C)	CONDUCTIVITY (umhos/cm)	D.O. (mg/L)	pH (SU)	ORP (mV)	TURBIDITY (NTU)	WATER LEVEL (FEET)	CUMULATIVE PURGE VOLUME (GAL OR L)

BOTTLES FILLED | PRESERVATIVE CODES A - NONE B - HNO3 C - H2SO4 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

SHIPPING METHOD:	DATE SHIPPED:	
	SIGNATURE: ____________________	DATE SIGNED: ____________________

REVISED 03/2008

PAGE _______ OF _______

TRC

WATER SAMPLE LOG

(CONTINUED FROM PREVIOUS PAGE)

PROJECT NAME: Stoughton City Landfil	PREPARED		CHECKED	
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:

SAMPLE ID:	**START TIME:**

TIME	PURGE RATE (ML/MIN)	PH (SU)	CONDUCTIVITY (umhos/cm)	ORP (mV)	D.O. (mg/L)	TURBIDITY (NTU)	TEMPERATURE (°C)	WATER LEVEL (FEET)	CUMULATIVE PURGE VOLUME (GAL OR L)

SIGNATURE: ______________________________

DATE SIGNED: ______________________________

REVISED 03/2008

PAGE _______ OF _______

TRC

WATER SAMPLE LOG

PROJECT NAME: **Stoughton City Landfil**	PREPARED		CHECKED	
PROJECT NUMBER:	BY:	DATE:	BY:	DATE:

SAMPLE ID:

WELL DIAMETER: ☐ 2" ☐ 4" ☐ 6" ☐ OTHER

WELL MATERIAL: ☐ PVC ☐ SS ☐ IRON ☐ ☐ OTHER

SAMPLE TYPE: ☐ GW ☐ WW ☐ SW ☐ DI ☐ LEACHATE ☐ OTHER

PURGING	TIME:	DATE:

PURGE METHOD: ☐ PUMP ____________________ ☐ BAILER ____________________

DEPTH TO WATER: -- T/ PVC

DEPTH TO BOTTOM: -- T/ PVC

WELL VOLUME: -- ☐ LITERS ☑ GALLONS

WELL PURGED DRY: ☐ NO ☐ YES

VOLUME REMOVED: ☐ LITERS ☐ GALLONS

COLOR: ODOR:

TURBIDITY

☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY

DISPOSAL METHOD: ☐ GROUND ☐ DRUM ☐ OTHER

SAMPLE	TIME:	DATE:

PH: SU

CONDUCTIVITY: umhos/cm

DO: mg/l

ORP: mV

TURBIDITY: NTU

☐ NONE ☐ SLIGHT ☐ MODERATE ☐ VERY

TEMPERATURE: °C

OTHER: --

COLOR:

ODOR:

FILTRATE (0.45 um) ☐ YES ☐ NO

COLOR: FILT ODOR:

QC SAMPLE: ☐ MS/MSD ☐ DUP-

COMMENTS:

BOTTLES FILLED — PRESERVATIVE CODES A - NONE B - HNO3 C - H2SO4 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

SHIPPING METHOD:	DATE SHIPPED:	
	SIGNATURE: ____________________	DATE SIGNED: ________________

MONITORING WELL DECOMMISSIONING LOG

PROJECT NAME: Stoughton City Landfil		**MONITORING WELL ID:**	
PROJECT NUMBER: 375007	DATE:	LOCATION:	LOCATION COORDINATES: N: E:
OBSERVED BY:			
DRILLING CONTRACTOR:			
CREW CHIEF:		TOP OF CASING ELEV.: ___________	SURFACE ELEV.: ___________

PROTECTIVE COVER TYPE: ☐ STICK-UP ☐ FLUSH MOUNT ☐ TRAF. BOX ☐ OTHER _______________

PROTECTIVE COVER DIAMETER: ☐ 4" ☐ 8" ☐ 9" ☐ 10" ☐ 12" ☐ OTHER _______________

WELL MATERIAL: ☐ PVC ☐ SS ☐ IRON ☐ GALVANIZED STEEL ☐ OTHER _______________

WELL CASING DIAMETER: ☐ 1" ☐ 2" ☐ 4" ☐ 6" ☐ 8" ☐ OTHER _______________

WELL SCREEN MATERIAL: ☐ PVC ☐ SS ☐ IRON ☐ GALVANIZED STEEL ☐ OTHER _______________

WELL SCREEN LENGTH: ☐ 5-FT ☐ 10-FT ☐ UNKNOWN ☐ OTHER _______________

WELL SCREEN SLOT SIZE: ☐ 0.01" ☐ 0.02" ☐ UNKNOWN ☐ OTHER _______________

DTW: _____________ T/ PVC

DTB: _____________ T/ PVC

ABANDONMENT PROCEDURE:

NOTES:

GROUTING PROCEDURE:

GROUT TYPE:

GROUT MIX:

GROUT INTERVAL: _______ FT-BGS TO _______ FT-BGS

BENTONITE SEAL:

SEAL INTERVAL: _______ FT-BGS TO _______ FT-BGS

NOTES:

ADDITIONAL COMMENTS:

SIGNED DATE

CHECKED DATE

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PAGE _______ OF _______

TRC

WELL INSPECTION REPORT

PROJECT NAME: Stoughton City Landfil

PROJECT NO.:

SAMPLER NAME:

DATE:

WELL ID	PROTECTIVE CASING	SURFACE SEAL	DEGREE OF IMMOBILITY OF PROTECTIVE CASING	PERMANENT LEGIBLE LABELS	LOCK	WELL CAP	SEDIMENT IN WELL	REPAIRS NEEDED	COMMENT
MW-3S									
MW-3D									
MW-3B									
MW-4S									
MW-4D									
MW-5S									
MW-5D									
MW-7S									
MW-7I									
MW-8S									
MW-8I									
MW-8B									
MW-9S									
MW-9I									
MW-9B									
MW-10S									
MW-10I									
MW-13S									
MW-13I									
MW-14S									
MW-14I									
MW-14D									
MW-15S									
MW-15I									
MW-15D									

SIGNED DATE

CHECKED BY DATE

REVISED 03/2008

Laboratory Analytical Chain of Custody

Eurofins TestAmerica, Chicago
2417 Bond Street

University Park, IL 60484-3101
phone 708.534.5200 fax 708.534.5211

Chain of Custody Record

eurofins | Environment Testing TestAmerica

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc. d/b/a Eurofins TestAmerica

Client Contact
Your Company Name here
Address
City/State/Zip
(xxx) xxx-xxxx Phone
(xxx) xxx-xxxx FAX
Project Name:
Site:
P O #

Project Manager:
Email:
Tel/Fax:

Analysis Turnaround Time
☐ CALENDAR DAYS ☐ WORKING DAYS
TAT if different from Below __________
☐ 2 weeks
☐ 1 week
☐ 2 days
☐ 1 day

Site Contact:
Lab Contact:

Date:
Carrier:

COC No:
_______ of ______ COCs
TALS Project #:
Sampler:
For Lab Use Only:
Walk-in Client:
Lab Sampling:

Job / SDG No.:

Sample Identification	**Sample Date**	**Sample Time**	**Sample Type** (C=Comp, G=Grab)	**Matrix**	**# of Cont.**	**Filtered Sample (Y / N)**	**Perform MS / MSD (Y / N)**																		Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ______________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return to Client ☐ Disposal by Lab ☐ Archive for__________ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No
Custody Seal No.:
Cooler Temp. (^{o}C): Obs'd:_________ Corr'd:__________ Therm ID No.:____________

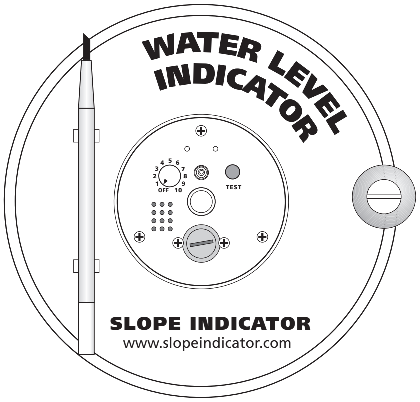
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Attachment 3: Instrument Manufacturers' Instructions/Manuals

- Slope Indicator (or equivalent) – Water Level Indicator
- In-Situ AquaTroll 400 (includes calibration and maintenance of pH, temperature, and conductivity)
- GEM-2000 Operations Manual
- Rae System MiniRAE 3000 Operations Manual
- Dwyer 475-Series Manometer

Slope Indicator (or equivalent) – Water Level Indicator

Water Level Indicator

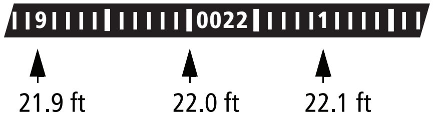


Taking Readings

1. Switch on. Set sensitivity to 5 or 6.
2. Lower probe into well. When probe touches water, light turns on and beeper sounds.
3. Read depth to water from cable mark that aligns with your reference (such as the top of the well).
4. Switch off.

Reading Cable Marks

Cable is graduated with 1/100 ft marks. White numbers are 1/10 ft. Yellow numbers are feet. Read as shown below:



Indicator Controls

On/Off/Sensitivity: The on/off switch also adjusts sensitivity. Sensitivity is set properly if beeper and light turn off immediately when probe is removed from contact with water. Use lower setting for very conductive water or to eliminate false triggering. Use higher setting for less conductive water.

Battery Test Button: Push the button to check the batteries. Light and beeper activate when batteries are good.

Replacing Batteries

The indicator uses two AA-size batteries. Press Test button to check batteries. Replace batteries if light and beeper do not activate.

1. Use coin or screwdriver to open battery holder. (¼ turn counter-clockwise)
2. Remove the two AA batteries. Insert new batteries with + terminals up, toward the cap.
3. Replace cap.

Cleaning the Indicator

Probe: Wash probe with detergent.

Reel: Wipe off the reel with a damp cloth. Do not immerse in water.

Cable: Wash the cable with a laboratory-grade detergent such as Alconox or Liquinox. Rinse with distilled water as required. Remove oily deposits with dish-washing detergent. Do not leave the cable immersed in detergent for a long time. Rinse in distilled water.

Do not use nitric acid, hydrochloric acid, MEK, Acetone, Toluene, or alcohol to clean the cable. Even short-term exposure to these substances can damage the polyurethane cable jacket.

Repairs

If your water level indicator is damaged, you can order replacement parts to fix it yourself or you can return it to the factory for repair.

To order replacement parts, please visit www.slopeindicator.com. Click on Support, then click on Water Level Indicator Parts.

To return the water level indicator to the factory for repair, contact the Slope Indicator factory for a return authorization:

Tel: 425-493-6200
Fax: 425- 493-6250
Email: solutions@slope.com

Check that the indicator is clean and dry, then package it, write the return authorization number on the outside, and send to:

Slope Indicator
12123 Harbour Reach Drive
Mukilteo, WA, USA
98275

Limited Warranty

Slope Indicator warrants all products manufactured by it to be free of defects of workmanship and material for a period of one year from the date of delivery to the customer, unless the customer is an authorized distributor of Slope Indicator products, in which case the warranty shall be for a period of one year from the date of delivery to the authorized distributor's customer. The obligation of Slope Indicator Company is hereafter limited to replacement or, at its option, repair of products returned to it with transportation charges to and from the Company paid by the customer (including prepayment of transportation charges to the Company) and which the company's examination shall disclose, to its satisfaction, were not free from such defects.

In no event shall Slope Indicator be liable for consequential or special damages, or for installation, adjustment or other expenses which may arise in connection with such products. This warranty extends only to the original customer of the company or its authorized distributor, as the case may be, and is expressly in lieu of all other warranties, express or implied, whether of merchantability or fitness for any particular purpose or use and of all other obligations and liabilities of any kind and character. Except for the warranty described on the face hereof, seller makes no warranty of merchantability or of the fitness of the goods for any purpose. There are no warranties which extend beyond the description on the face hereof.

SLOPE INDICATOR
www.slopeindicator.com

In-Situ SmarTroll
(includes calibration and maintenance of pH, temperature, and conductivity)

Aqua TROLL 400

Operator's Manual

Information subject to change without notice. In-Situ, In-Situ logo, "Water Simplified", VuLink, RDO, RuggedCable, TROLL, BaroTROLL, HydroVu, VuSitu, Baro Merge, and Win-Situ are trademarks or registered trademarks of In-Situ Inc. ©2023. All rights reserved. This product may be covered by patents identified at www.in-situ.com/patents

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In-Situ
221 East Lincoln Avenue Fort
Collins, CO 80524 U.S.A.

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For products under the requirement of WEEE directive, please contact your distributor or local In-Situ office for the proper decontamination information and take back program, which will facilitate the proper collection, treatment, recovery, recycling, and safe disposal of the device.

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Introduction

This manual is intended to describe the characteristics, operation, calibration, and maintenance of the Aqua TROLL 400 Instrument. Communication registers and programming information can be found in the Modbus and SDI-12 Reference Guide.

Scope

This manual covers the following information.
Chapter 1—Introduction
Chapter 2—Safety
Chapter 3—General Specifications
Chapter 4—Sensor Specifications
Chapter 5—Instrument Overview
Chapter 6—System Components
Chapter 7—Probe Setup
Chapter 8—Communication Settings and Sensor Calibration
Chapter 9—Controller Requirements and Connections
Chapter 10—Care and Maintenance
Chapter 11—Declaration of Conformity
Modbus registers and SDI-12 programming information can be found in the Modbus and SDI-12 Reference Guide.

Serial Number Location

The serial number is located on the large label on the instrument body. The serial number is programmed into the instrument and displayed in the control software.

Safety

Electrical Safety

Electrical installation must be performed by properly trained and qualified personnel.
After the flying leads have been properly wired to the controller, the user can safely connect the instrument to the cable using the twist-lock connector.

General Specifications

Operating temperature	-5 to 50° C (23 to 122° F)
Storage temperature	-40 to 65° C (-40 to 149° F)
Dimensions	4.7 cm (1.85 in.) OD x 26.9 cm (10.6 in.) with restrictor installed (does not include connector)
Weight	694 g (1.53 lbs)
Wetted materials	Acetal, PVC, Ceramic, FKM Fluoroelastomer, Titanium, Glass, Platinum, 316 Stainless Steel, Polycarbonate/Polymethylmethacrylate (PC/PMMA) blend, Acrylic
Environmental rating	IP68 with all sensors and cable attached. IP67 with sensors removed and cable detached.
Reading rate	1 reading every 5 seconds (no internal logging)
Power	Required: 8–36 VDC (no internal battery). Measurement current: 16 mA @ 24 VDC. Sleep current: 40 µA @ 24 VDC
Interface	In-Situ Con TROLL® PRO System; In-Situ TROLL® Link Telemetry 101 or 201 System; SCADA/PLC; and third-party data loggers, samplers, controllers, and telemetry systems.
Cable	Customizable, non-vented (absolute) RuggedCable® System is available in either Tefzel® or polyurethane.
Warranty	2 years
Notes	Specifications are subject to change without notice. Viton is a registered trademark of DuPont Performance Elastomers L.L.C.

Sensor Specifications

Level, Depth, Pressure Sensor Specifications

Accuracy	Typical ±0.1% FS @ 15° C; ±0.3% FS max. from 0 to 50° C
Range	76 m (250 ft); absolute (non-vented)
Resolution	±0.01% FS or better
Sensor Type	Fixed
Response Time	Instantaneous in thermal equilibrium
Units of Measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg Level: mm, cm, m, in, ft
Methodology	Piezoresistive; ceramic

Conductivity Sensor Specifications

Accuracy	Typical ±0.5% + 1 µS/cm; ±1% max.
Range	5 to 100,000 µS/cm
Resolution	0.1 µS/cm
Sensor Type	Fixed
Response Time	Instantaneous in thermal equilibrium
Units of Measure	Actual conductivity (µS/cm, mS/cm) Specific conductivity (µS/cm, mS/cm) Salinity (PSU) Total dissolved solids (ppt, ppm) Resistivity (Ohms-cm) Density (g/cm3)
Methodology	Std. Methods 2510 EPA 120.1

RDO (Optical Dissolved Oxygen Sensor) Specifications

Accuracy	±0.1 mg/L from 0 to 20 mg/L ±2% of reading from 20-60 mg/L
Range	0-60 mg/L
Resolution	0.01 mg/L
Sensor Type	Fixed with replaceable RDO Sensor Cap (life: 1 year typical)
Response Time	RDO X-Cap: T63<15 sec, T90<45 sec, T95<60 sec RDO Fast Cap: T63<3 sec, T90<30 sec, T95<45 sec
Units of Measure	mg/L, % saturation, ppm
Methodology	EPA-approved In-Situ Methods 1002-8-2009 1003-8-2009 1004-8-2009

ORP Sensor Specifications

Accuracy	±5.0 mV
Range	±1400 mV
Resolution	0.1 mV
Sensor Type	Replaceable pH/ORP combo sensor
Response Time	<15 sec.
Units of Measure	mV
Methodology	Std. Methods 2580

pH Sensor Specifications

Accuracy	±0.1 pH unit from 0 to 12 pH units
Range	0 to 14 pH units
Resolution	0.01 pH unit
Sensor Type	Replaceable pH/ORP combo sensor
Response Time	<15 sec., pH 7 to pH 4
Units of Measure	pH units
Methodology	Std. Methods 4500-H+ EPA 150.2

Temperature Sensor Specifications (Probe)

Accuracy	±0.1° C
Range	-5 to 50° C (23 to 122° F)
Resolution	0.01° C or better
Sensor Type	Fixed
Response Time	T90<120 sec
Units of Measure	Celsius, Fahrenheit
Methodology	EPA 170.1

Instrument Overview

Instrument Description

The Aqua TROLL 400 Instrument is a multiparameter water quality probe. The dissolved oxygen, conductivity, pressure, and temperature sensors are integrated into the instrument. The pH/ORP sensor and the RDO Sensor Cap are replaceable.

The instrument is intended for use with a PLC/SCADA system or other data-logging device. It does not include internal power or an internal data logger. The instrument provides Modbus RS485 and SDI-12 interfaces for use with an external controller.

System Components

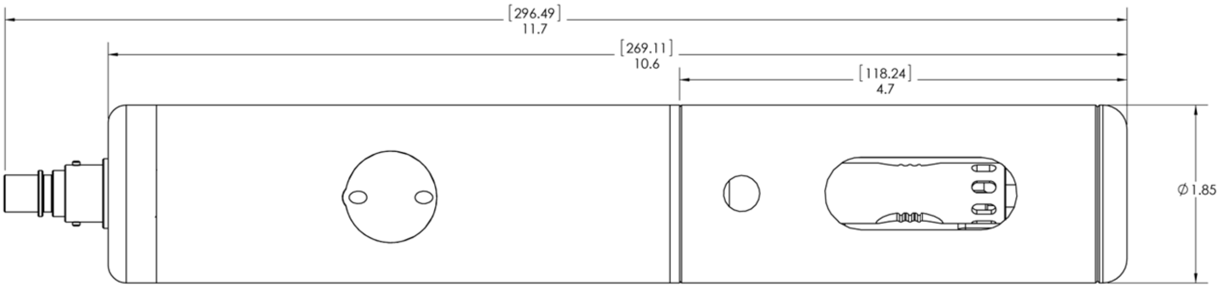
The system includes the following components.

- Integrated sensors: RDO, conductivity, pressure, and temperature
- Plug-in pH/ORP sensor
- Classic Cap, Fast Cap, or RDO-X Sensor Cap. The Fast Cap ships with the instrument.
- Stainless steel restrictor
- Calibration and storage cup and cable

Accessories purchased separately

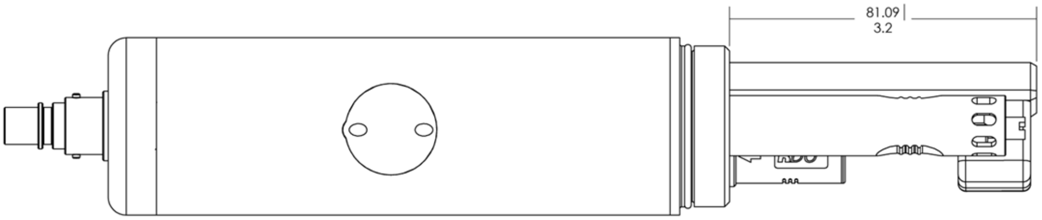
- Replacement RDO Sensor Cap
- Replacement pH/ORP sensor
- Calibration Kit (includes calibration cup, 3 sponge wafers, vented cap, and storage cap)
- Flying leads
- Maintenance kit
- Comm Kit

Probe Dimensions with Restrictor On



Total length with connector	296.49 mm (11.7 in.)
Total length without connector	269.11 mm (10.6 in.)
Restrictor length	118.24 mm (4.7 in.)
Diameter	47 mm (1.85 in.)

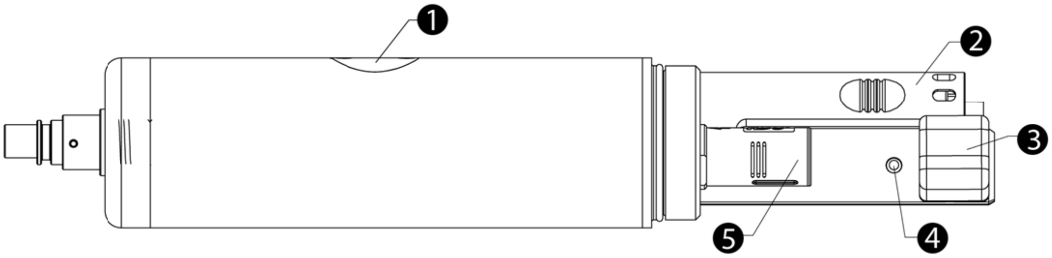
Probe Dimensions with Restrictor Off



Sensor length	81.09 mm (3.2 in.)

Sensors

Sensors include optical RDO (Rugged Dissolved Oxygen), pH/ORP, conductivity, pressure, and temperature.



1	Pressure sensor 76 m (250 ft)
2	pH/ORP sensor
3	Conductivity sensor
4	Temperature sensor
5	RDO Sensor

Cable

The cable includes a twist-lock connection to the instrument and a flying leads termination that must be wired to a controller. Cable length is customizable. Maximum length is 1,219 m (4,000 ft) for Modbus output, and 60.9 m (200 ft) for SDI-12 output.

VuSitu Mobile App

The VuSitu Mobile App is used with an Android or iOS device to calibrate the sensors and to configure the instrument settings to communicate with a process controller or data logger. See the Communication Settings and Calibration section for more details.

Win-Situ 5 Software

Win-Situ 5 Software is used on a desktop computer to calibrate the sensors and to configure the instrument settings to communicate with a process controller or data logger. See the Communication Settings and Calibration section for more details.

Probe Setup

The probe is shipped with a storage plug and protective dust caps in place.

1	Dust cap protector on the RDO Sensor. (Install the RDO Cap before deploying the instrument.)
2	pH/ORP storage plug. (Remove the storage plug and install the pH/ORP sensor before deploying the instrument.)
3	Dust cap protector on the twist-lock cable connector.

Installing the Sensors

Twist the restrictor off of the probe.

Locate the RDO Sensor Cap container and remove the cap.

Remove the dust cap from the RDO Sensor.

Align the slotted edge of the RDO cap with the flat edge of the RDO sensor. Press the cap firmly into position.

Remove the orange plug from the pH/ORP sensor port.

Use the alignment marks to properly align the pH/ORP sensor with the port connection, and press firmly into place. Push until the sensor is completely inserted into the port.

Twist the restrictor back onto the probe.

Important: Avoid touching the sensor lens and the sensing material on the top of the cap.

Important: The RDO Sensor Cap and pH/ORP sensor must be installed firmly in place to prevent water from entering the instrument.

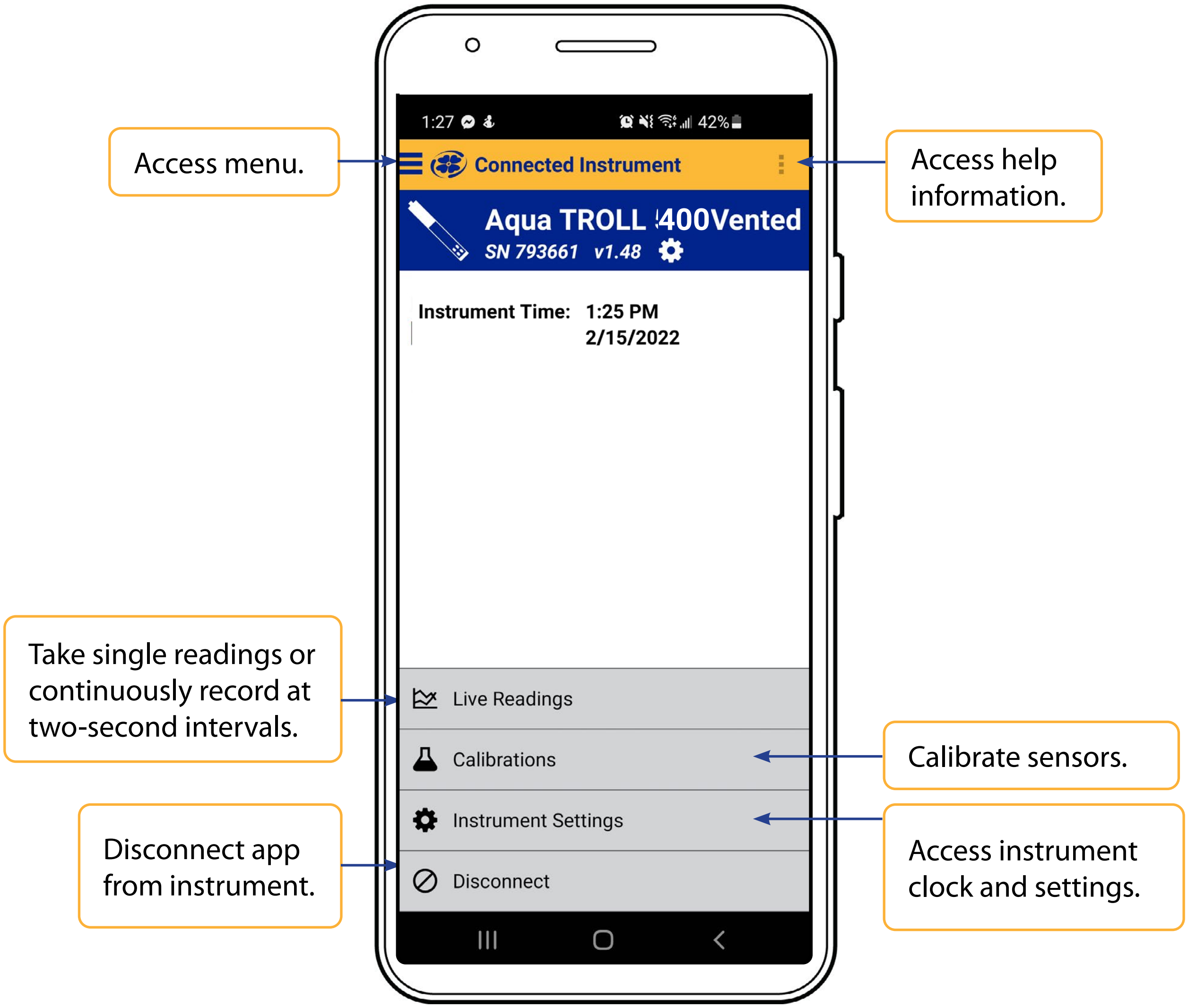
About VuSitu

VuSitu is the mobile user interface and control application for In-Situ water quality instruments. You can use VuSitu on mobile devices with Android operating system 4.4, Bluetooth 2.0 and newer. Download the latest version of the app from the Google Play Store at play.google.com.

VuSitu allows you to accomplish the following tasks:

- View live readings that update every 10 seconds
- Change parameters and units
- Set up a data log
- Record data
- Email data in spreadsheet format
- Download data to mobile device
- Transfer data from mobile device to a computer
- Organize data by Location
- Calibrate Sensors and View Reports

Connected Instrument Screen



Instrument Time: 1:25 PM 2/15/2022

Access menu.

Access help information.

Take single readings or continuously record at two-second intervals.

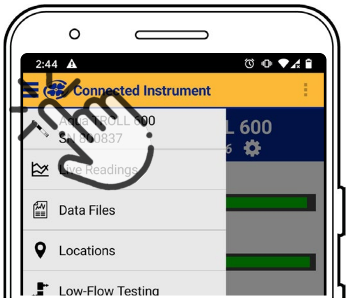
Calibrate sensors.

Disconnect app from instrument.

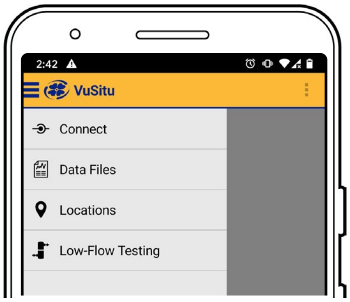
Access instrument clock and settings.

VuSitu Menu Options

The features available in the VuSitu mobile app vary slightly depending on the instrument to which it is connected.



Tap the menu icon in the upper left portion of the screen to view options.

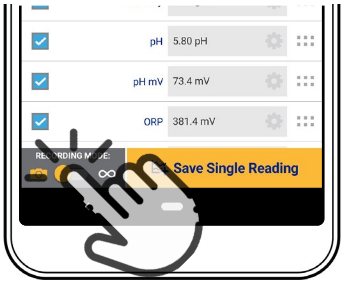


Some features aren't available when VuSitu isn't connected to an instrument.

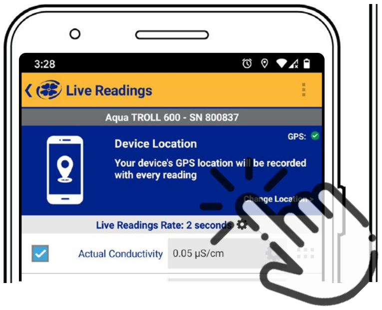
Live Readings in VuSitu

The live readings screen displays measurements taken from the instrument every two seconds. You can save these readings and share them via email or cloud storage.

Snapshot Mode

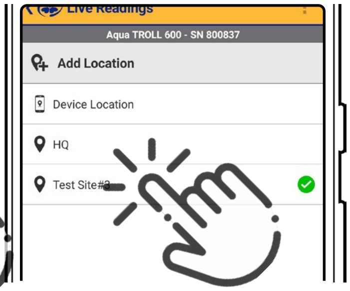


Tap the button on the bottom left to toggle between snapshot and live readings modes.

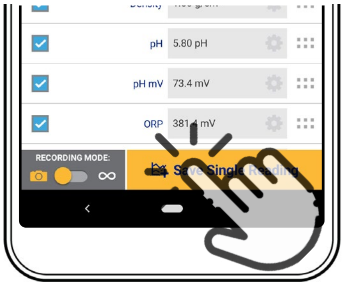


Your device's GPS location will be recorded with every reading

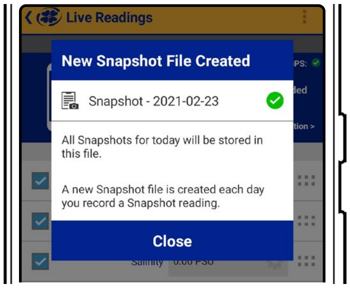
Tap **Change Location** in the top right corner to associate this data with a different location.



Choose the desired location and press **Save** in the bottom right corner of the screen.



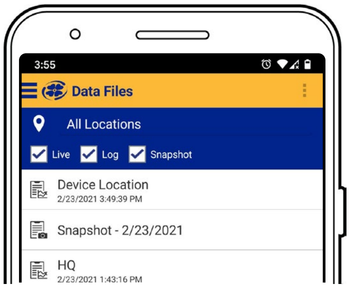
Tap **Save Single Reading** to create a snapshot.



All Snapshots for today will be stored in this file.

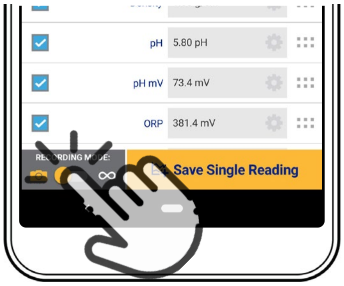
A new Snapshot file is created each day you record a Snapshot reading.

VuSitu confirms the new snapshot file.

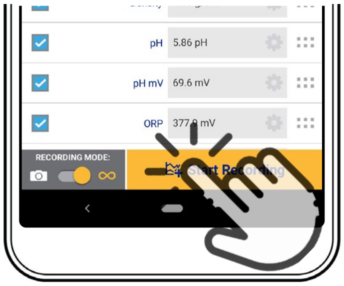


View the file from the Data Files screen.

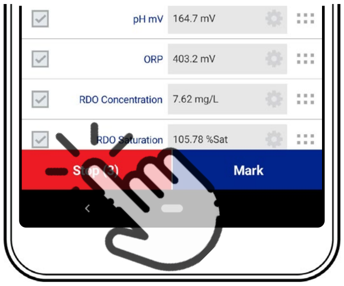
Live Readings Mode



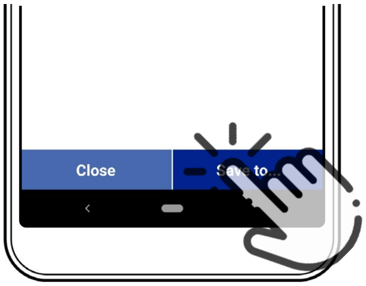
Tap the button on the bottom left to switch from snapshot mode to live readings mode.



Tap **Start Recording**. The instrument takes a reading every two seconds.



Tap **Stop** to end the recording. VuSitu displays a summary of the live readings data.

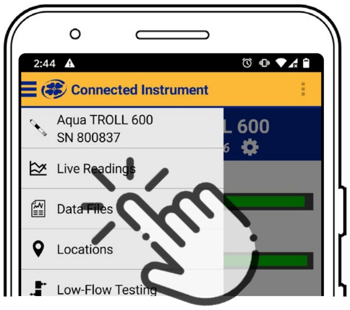


Tap **Save to** if you wish to share the Live Readings file via email or cloud storage.

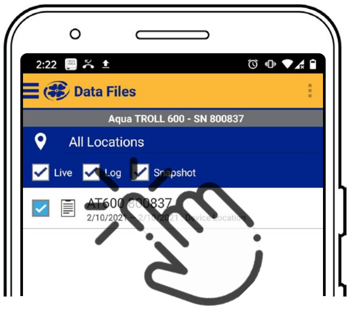
VuSitu Data

You can transfer a data file from your mobile device to a PC via Bluetooth, email it to yourself or any valid email address, or upload it to Google Drive.

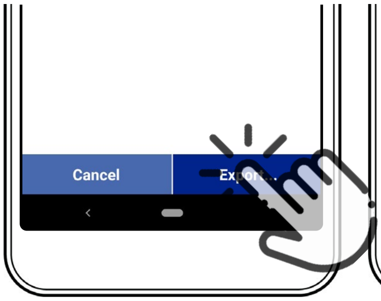
Sharing Data



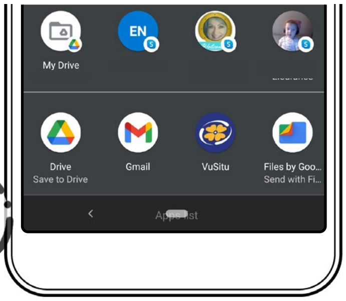
Select **Data Files** from the menu at the top left corner of the screen.



Tap and hold the name of the log you want to share.



Select **Export**.



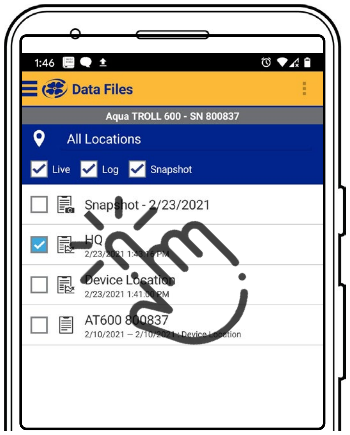
Choose email, cloud storage, or another sharing option.

To save data locally on your mobile device, export to a third-party file management app.

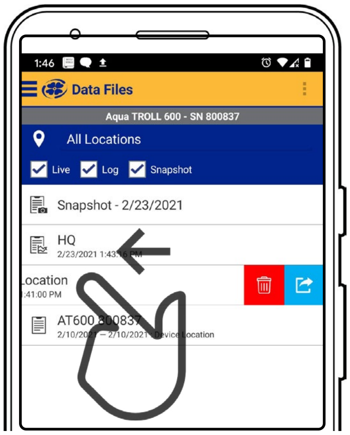
Viewing Data on a Mac or PC

You'll need to extract your files to view them. To do that on a Mac, double-click the Zip folder. On a PC, right-click on the folder and choose **Extract**. Then open your files in Excel.

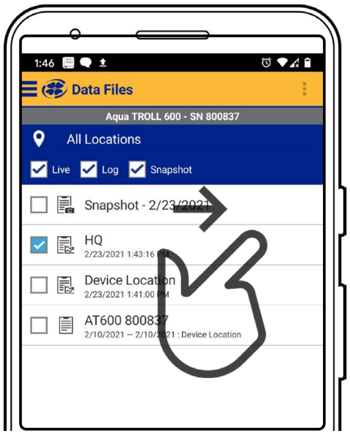
Selecting with Long-press and Swipe



Press and hold any item in a list of files. You can now select multiple files.



Press and swipe left to reveal the delete and share icons.



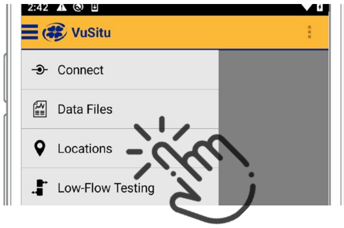
Press and swipe right to reveal the sharing icon.

VuSitu Locations

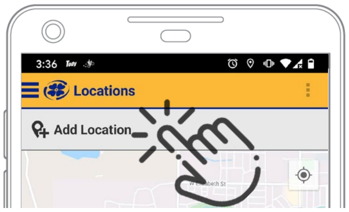
About VuSitu Locations

A VuSitu location represents the physical spot where an instrument collects data. You can create a VuSitu location for any monitoring site. If you don't create a location, your data defaults to "Device Location." Location names appear on the live readings screen, in snapshot files, and in log files.

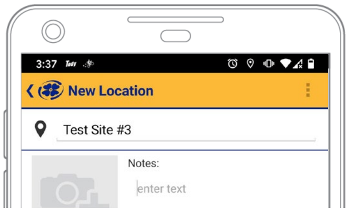
How to Create a Location



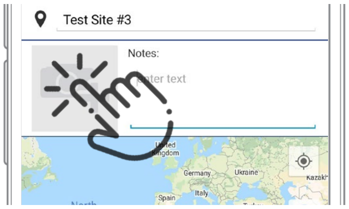
Select **Locations** from the main menu.



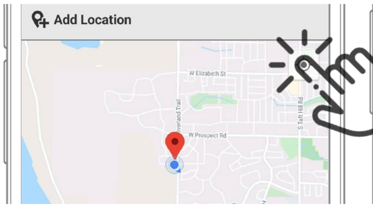
Tap **Add Location**.



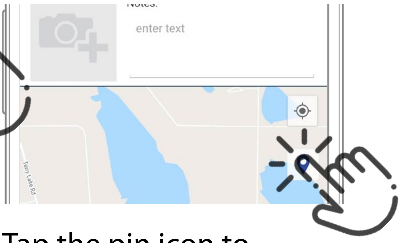
Enter a name for the location. You can also add notes.



If desired, tap the camera icon to take a photo of the new location.



To home in on your mobile device's current location, tap the button on the top right.

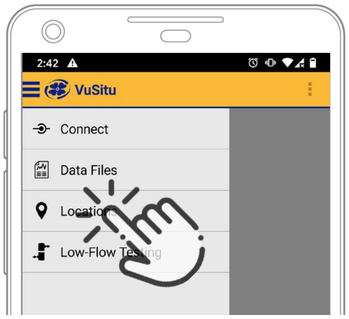


Tap the pin icon to establish the location on the map.

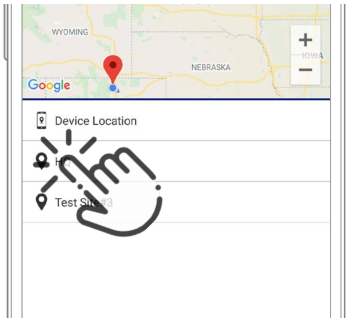
As an alternative, you can manually enter latitude and longitude values and tap **Apply**. Or, tap and hold a specific point on the map to drop a pin there.

How to Select a Location

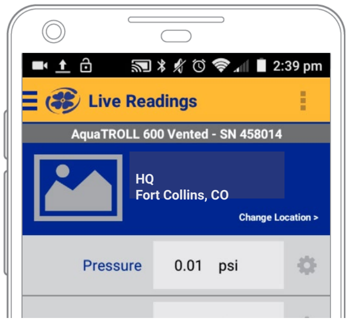
✓ Data is associated with the Location that is displayed on the Live readings screen. After you have created a Location, you must select it in order for your data to be associated with the Location.



Select **Locations** from the app menu.

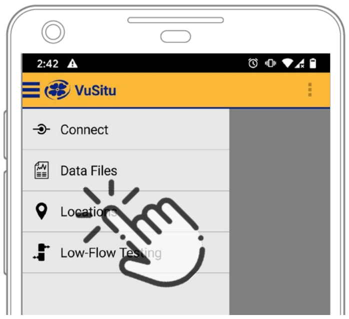


Tap a location to select it.



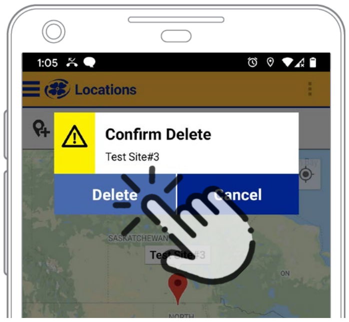
New live readings data will be associated with this location until you select another.

How to Edit or Delete a Location



Select **Locations** from the app menu.

Tap the location you wish to delete and swipe left. Tap the trash icon.



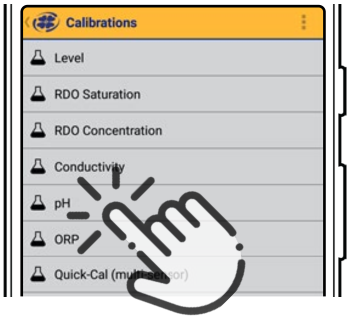
Confirm by tapping **Delete**.

Calibrating Sensors in VuSitu

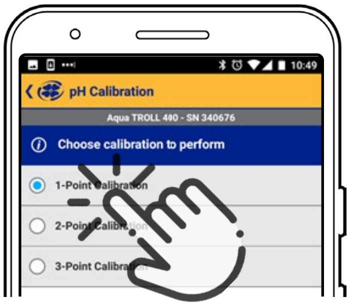
Always wear appropriate personal protective equipment and use proper laboratory technique when calibrating the sensors and operating the instrument.

Calibrating the pH Sensor

Select Calibrations from the main menu.



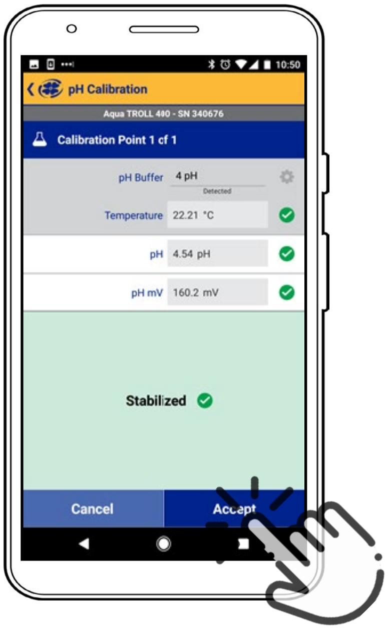
Choose the pH option.



Choose the number of calibration points to perform.

Pour pH buffer solution in the calibration cup until it reaches the fill line. Then insert the Aqua TROLL 400 into the calibration cup with the restrictor (the metal end) pointing down.

VuSitu will automatically detect the pH of your buffer solution. Allow several seconds for stabilization. When you see "Stabilized" in the green box at the bottom of the screen, click Accept.



pH Buffer 4 pH (Detected)
Temperature 22.21 °C
pH 4.54 pH
pH mV 160.2 mV

You can accept the calibration at the Nominal stage or wait for it to fully stabilize.

Calibrate the Rugged Dissolved Oxygen Sensor (1-Point)

The optical Rugged Dissolved Oxygen sensor is very stable. The factory calibration should produce readings within 3%accuracy. If you require readings with greater accuracy we recommend that you perform a 1-point, 100% water-saturated air calibration as described below.

100% Water-saturated Air Calibration

1. From the main menu, select Calibration & Settings.
2. From the Calibrations menu select RDO Saturation.
3. For a 1-point calibration, select 100% Saturation.
4. Make sure the vented cap is installed on the calibration cup and a water-saturated sponge is placed in the bottom of the cup.
5. After the calibration is stable, select Accept.
6. The calibration values are applied to the sensor and appear on screen. You can view a full calibration report for all sensors, or select Done to return to the Calibration Menu.
7. Remove the sponge from the calibration cup.

Calibrate the Rugged Dissolved Oxygen Sensor (2-Point)

We recommend that you perform the 0 % oxygen calibration only if you intend to measure dissolved oxygen at a concentration of less than 4 mg/L.

100% Water-saturated Air Calibration

1. From the main menu, select Calibration & Settings.
2. From the Calibrations menu select RDO Saturation.
3. For a 2-point calibration, select 100% and 0% Saturation.
4. Make sure the vented cap is installed on the calibration cup and a water-saturated sponge is placed in the bottom of the cup.
5. After the calibration is stable, a prompt to prepare for the next calibration point appears.

0-point Calibration

1. Remove the sponge from the calibration cup.
2. Fill the calibration cup to the fill line with sodium sulfite. Place the instrument in the calibration cup.
3. Select Next.
4. After the calibration is stable, select Accept.
5. The calibration values are applied to the sensor and appear on screen. You can view a full calibration report for all sensors, or select Done to return to the Calibration Menu.
6. Rinse the sensors and restrictor with DI water.

Calibrating the Rugged Dissolved Oxygen Sensor Using Concentration

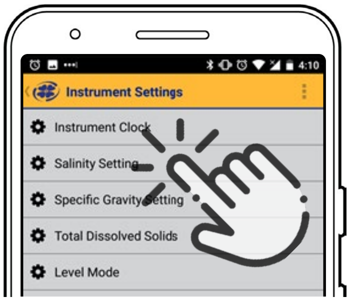
The preferred method of calibrating the RDO sensor is using the 1-point 100% Saturation calibration. However, you can also calibrate the sensor using a concentration method.

1. From the main menu, select Connected Instrument.
2. Select Calibrations.
3. Tap RDO Concentration.
4. Place the instrument in reference solution and tap Next.
5. Enter the value of the reference solution.
6. After the calibration is stable, select Accept.
7. The calibration values are applied to the sensor and appear on screen. You can view a full calibration report for all sensors, or select Done to return to the Calibration Menu.

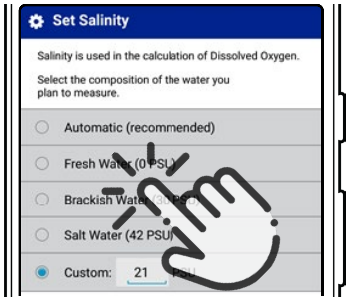
RDO Salinity Setting

The Aqua TROLL 400 includes automatic salinity compensation. This feature is active by default. To change the compensation value, follow these steps:

Select Instrument Settings from the menu at the bottom of the screen.



From the Instrument Settings menu, select Salinity Setting.



Salinity is used in the calculation of Dissolved Oxygen.

Select the composition of the water you plan to measure.

○ Automatic (recommended)
○ Fresh Water (0 PSU)
○ Brackish Water (30 PSU)
○ Salt Water (42 PSU)
● Custom: 21 PSU

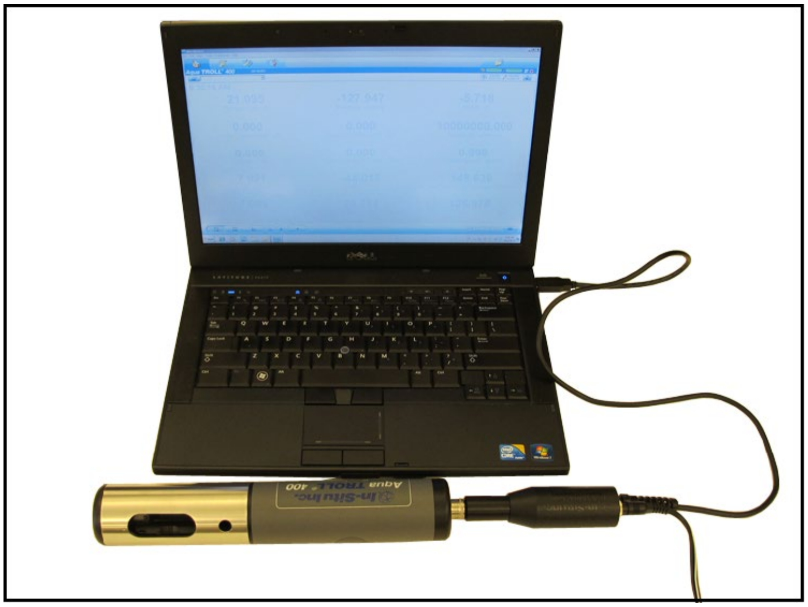
Enter your desired salinity compensation setting and press Save.

Communication Settings

Before you program the instrument to work with your PLC/SCADA system, you must set appropriate communication settings using a TROLL Com, AC/DC converter, and Win-Situ 5 Software. The software can also be used to calibrate sensors and to restore factory calibration and communication settings.

Connect the Instrument to the Computer

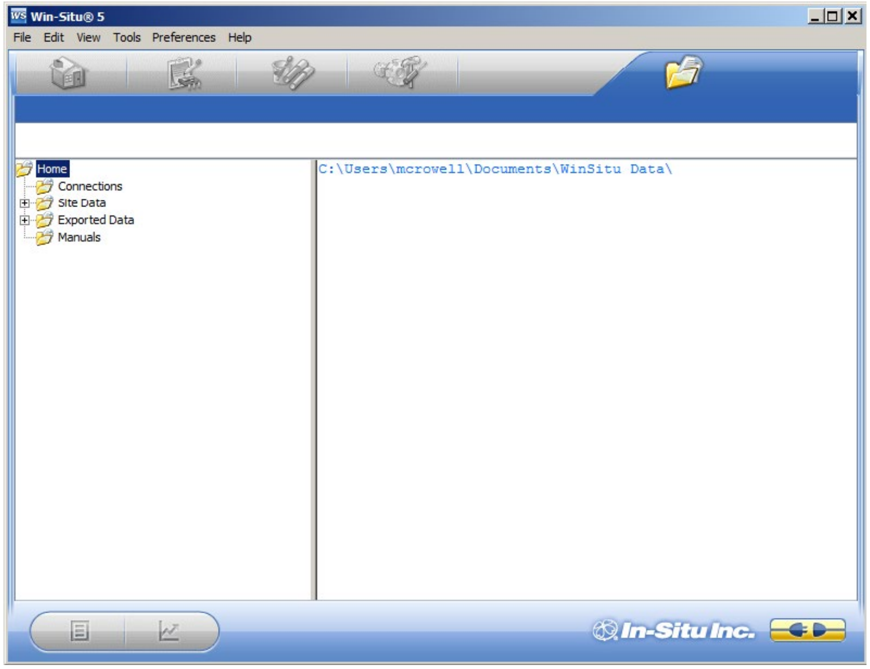
Using a direct-connect TROLL Com Communication Device, powered with an AC/DC power supply, you can connect the Aqua TROLL 400 to a computer running Win-Situ 5 Software version 5.6.22 or later.



Connect the Instrument to Win-Situ 5 Software

Install Win-Situ 5 Software from www.in-situ.com. Make sure you select the check box that installs the USB drivers. Open Win-Situ 5 Software and click the Connect button to connect to the instrument.

Data Tab

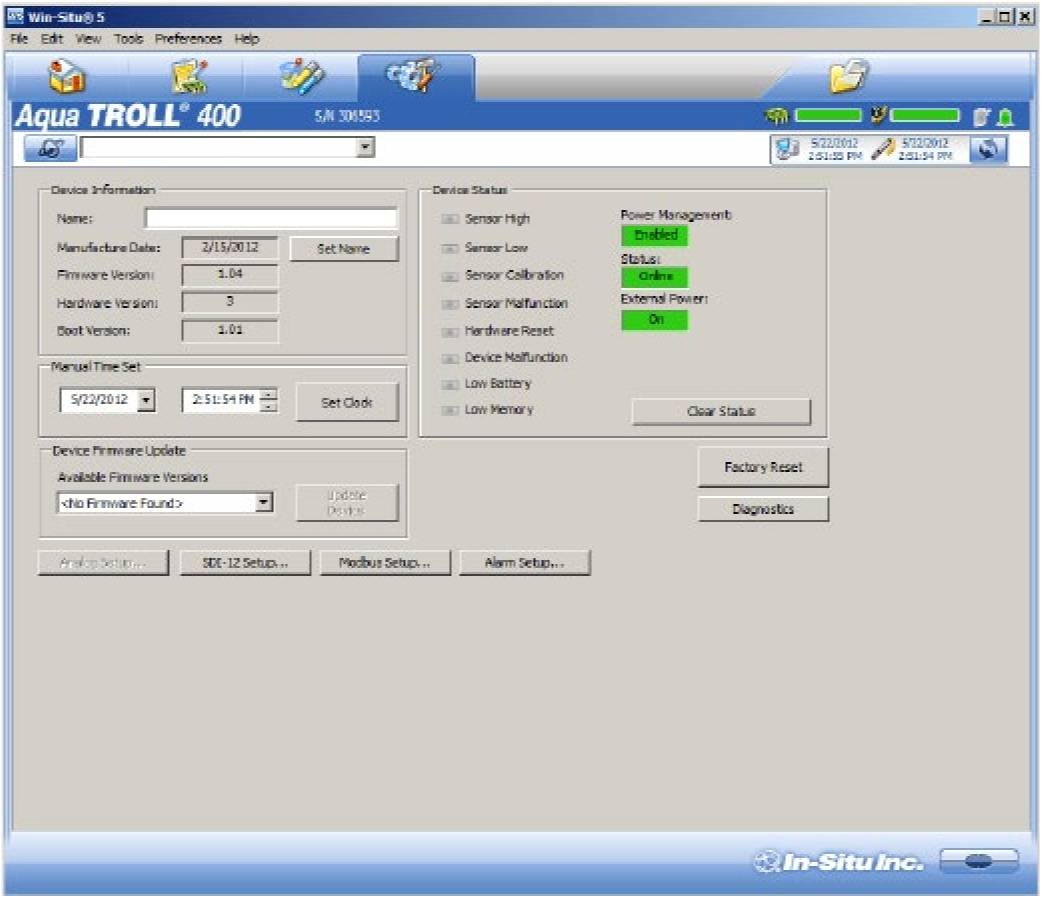


C:\Users\mcrowell\Documents\WinSitu Data\

Screen Element	Definition
	The disconnected plug indicates the instrument is not communicating with the software. Click to establish communication with a connected instrument.
	The connected plug indicates the instrument is communicating with the software. Click to disconnect the software from the instrument.
	The Home tab displays real-time readings from the instrument. When connection to the instrument is first established, the software displays one reading of all available parameters in light gray. You must click the Play button at the bottom of the screen to view real-time readings.
	The Logging tab displays a list of logs stored in the connected instrument. When you click the Logging tab, it can take a moment for the software to retrieve information from the instrument. (Not applicable for the RDO PRO-X and the Aqua TROLL 400.)
	The Sensors tab lists the sensors in the connected instrument, along with their serial numbers and the dates of factory calibration and user calibration. Use the buttons in this tab to calibrate sensors that support user calibration and configure sensors that are supported by the instrument.
	The Device Setup tab allows access to instrument information and settings such as instrument name, serial number, firmware version, communication settings, diagnostics, and factory reset options.

Set Communication Outputs

The Device Setup Tab allows you to access communication settings, instrument information and status, factory reset, diagnostics, and alarm setup. The instrument can communicate via Modbus or SDI-12 protocols. However, the instrument can use only one of the protocols at a time.



S/N 308593

5/22/2012 2:51:55 PM

5/22/2012 2:51:54 PM

Name:

Manufacture Date: 2/15/2012

Firmware Version: 1.04

Hardware Version: 3

Boot Version: 1.01

5/22/2012 2:51:54 PM

<No Firmware Found>

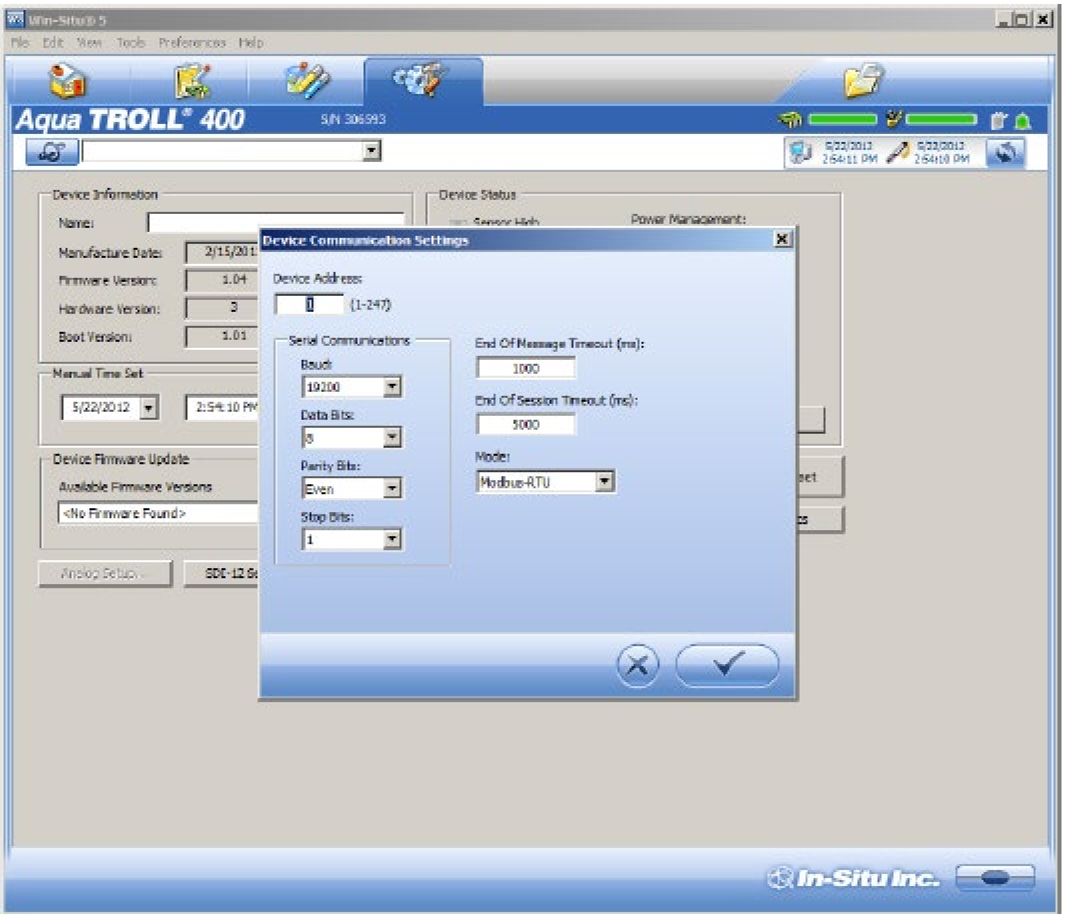
Power Management: Enabled

Status: Online

External Power: On

Modbus Setup

Click the Modbus setup button and assign instrument settings according to the requirements of your controller. For instrument Modbus registers, see the Modbus and SDI-12 Reference Guide.



Device Information

Name:
Manufacture Date: 2/15/201
Firmware Version: 1.04
Hardware Version: 3
Boot Version: 1.01

Manual Time Set

5/22/2012
2:54:10 PM

Device Firmware Update

Available Firmware Versions
<No Firmware Found>

Device Communication Settings

Device Address: 1 (1-247)

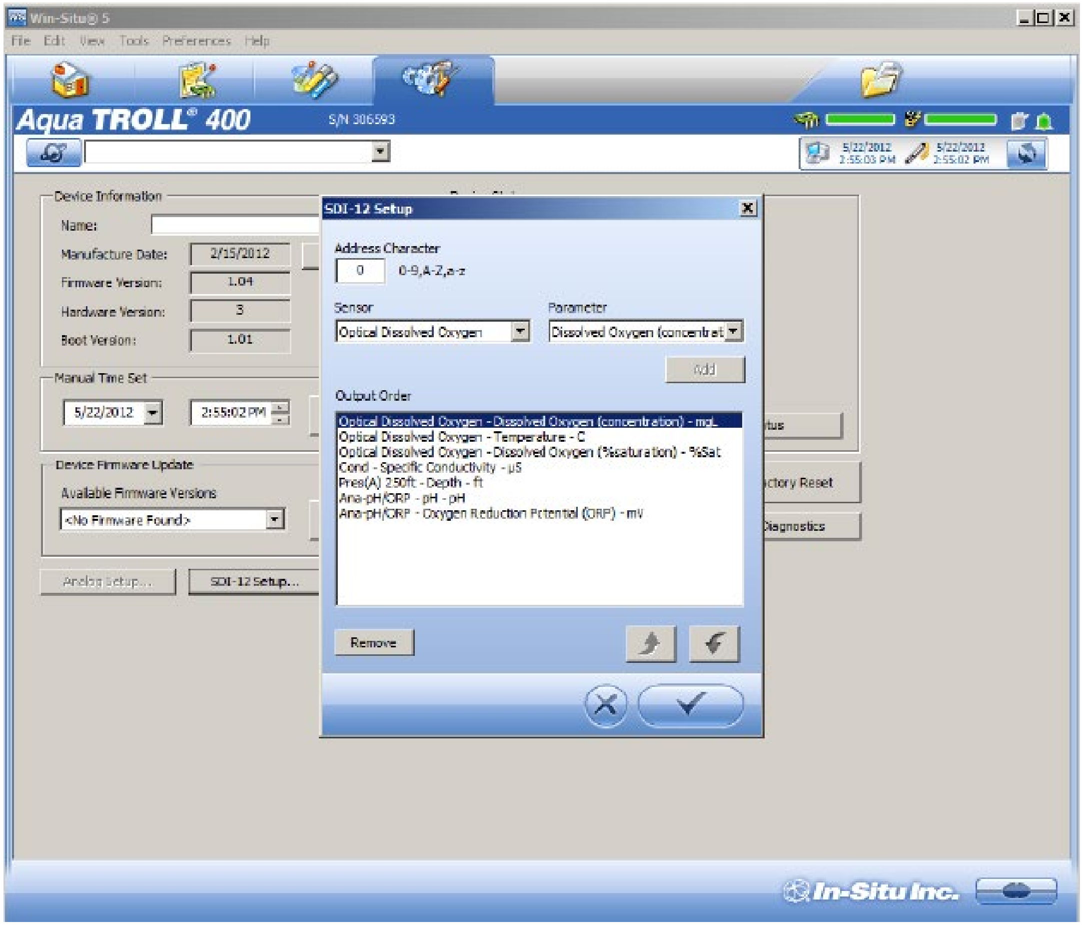
Serial Communications

Baud: 19200
Data Bits: 8
Parity Bits: Even
Stop Bits: 1

End Of Message Timeout (ms): 1000
End Of Session Timeout (ms): 5000
Mode: Modbus-RTU

SDI-12 Setup

SDI-12 setup allows you to set the instrument address, select the parameters you intend to log, and select the order in which the parameters will appear in your SCADA system or datalogger file. See the Help menu in Win-Situ 5 Software for details. To view SDI-12 programming information, see the Modbus and SDI-12 Reference Guide.



Device Information

Name:

Manufacture Date: 2/15/2012

Firmware Version: 1.04

Hardware Version: 3

Boot Version: 1.01

Manual Time Set

5/22/2012 2:55:02 PM

Device Firmware Update

Available Firmware Versions: <No Firmware Found>

SDI-12 Setup

Address Character: 0 (0-9,A-Z,a-z)

Sensor: Optical Dissolved Oxygen

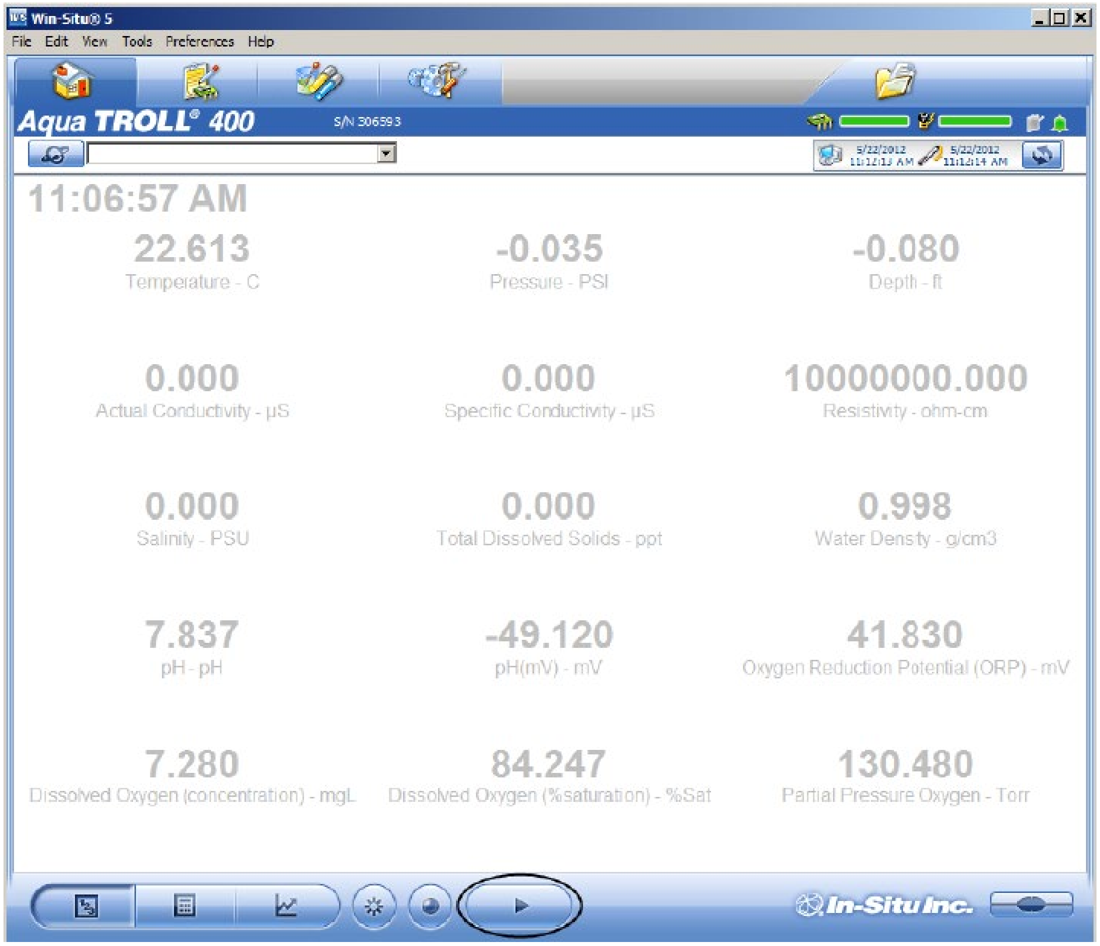
Parameter: Dissolved Oxygen (concentrat

Output Order

Optical Dissolved Oxygen - Dissolved Oxygen (concentration) - mgL
Optical Dissolved Oxygen - Temperature - C
Optical Dissolved Oxygen - Dissolved Oxygen (%saturation) - %Sat
Cond - Specific Conductivity - µS
Pres(A) 250ft - Depth - ft
Ana-pH/ORP - pH - pH
Ana-pH/ORP - Oxygen Reduction Potential (ORP) - mV

View and Record Data

The Home tab allows you to view data for the parameters that have been enabled. Gray values indicated that the instrument is not polling live data. To poll live data, click the Play button.



11:06:57 AM

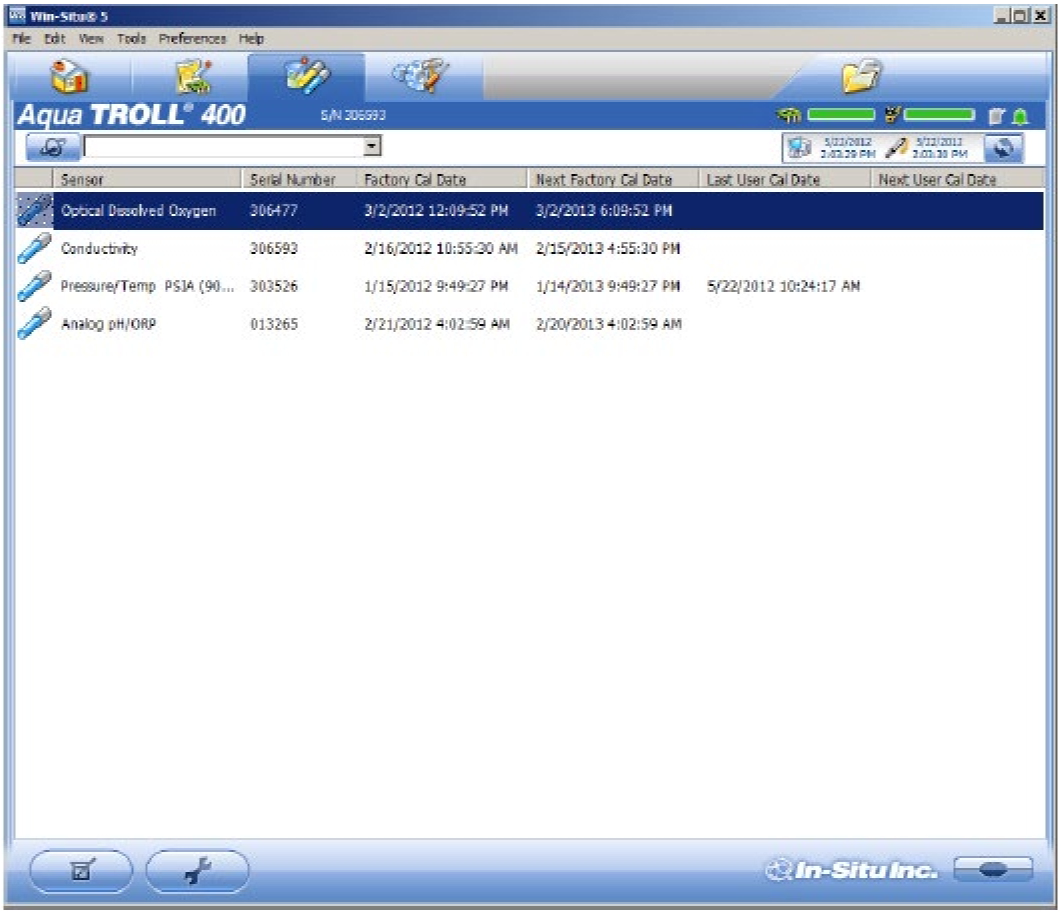
22.613 Temperature - C	-0.035 Pressure - PSI	-0.080 Depth - ft
0.000 Actual Conductivity - µS	0.000 Specific Conductivity - µS	10000000.000 Resistivity - ohm-cm
0.000 Salinity - PSU	0.000 Total Dissolved Solids - ppt	0.998 Water Density - g/cm3
7.837 pH - pH	-49.120 pH(mV) - mV	41.830 Oxygen Reduction Potential (ORP) - mV
7.280 Dissolved Oxygen (concentration) - mgL	84.247 Dissolved Oxygen (%saturation) - %Sat	130.480 Partial Pressure Oxygen - Torr

Screen Element	Definition
	The Sites button allows you to add, edit, or delete a site. (Not applicable for Aqua TROLL 400 and RDO PRO-X.)
▬ ▬	These icons allow you to view the memory and battery usage for an instrument that includes internal logging. (Not applicable for Aqua TROLL 400 and RDO PRO-X.)
🟩	This icon allows you to view the logging status for an instrument that includes internal logging. (Not applicable for Aqua TROLL 400 and RDO PRO-X.)
🔔	The Alarm icon provides additional instrument status information. Green—No alarms or warnings Yellow—One or more warnings Red—One or more alarms Move the cursor over the alarm icon to view a description. Click the Device Setup tab for detailed information on the alarm or warning. (Not applicable for Aqua TROLL 400 and RDO PRO-X.)

	System Time is displayed on the left. Device Time is displayed on the right. Clocks are updated once every two seconds. When the Device Time is displayed in red, it differs from the current System Time, and should be synchronized.
	The Time Sync button is used to write the current PC time to the instrument. If you need to set the instrument clock to a time other than the system (PC) time, use the Set Clock button on the Device Setup tab.
	Meter View shows the last known parameter values, displayed with current units and time stamp. Readings are sized to occupy the entire screen. This is the default display in the Home tab. If the type is black, the readings are updating in real time.
	List View is a running list of the most recent records. New readings are continuously added to the top of the list and old readings scroll off the bottom.
	Graph View shows a real-time trend graph of the selected parameters.
	The Snapshot button allows you to take a snapshot of the data that currently appears on screen and save it to a file. Non-logging instruments can save data as CSV files but not as WSL data files.
	The Stop button allows you to continuously record live data and save it to a file. Non-logging instruments can save data as CSV files, but not as WSL data files.
	The Play button allows you to start and stop data polling.

Calibrate and Set Up Sensors

The Sensors tab allows you to view the sensors that are available on the instrument. From this tab you can access calibration Wizards and sensor setup options. You can also view sensor serial numbers, factory calibration dates, and user calibration dates.



Sensor	Serial Number	Factory Cal Date	Next Factory Cal Date	Last User Cal Date	Next User Cal Date
Optical Dissolved Oxygen	306477	3/2/2012 12:09:52 PM	3/2/2013 6:09:52 PM		
Conductivity	306593	2/16/2012 10:55:30 AM	2/15/2013 4:55:30 PM		
Pressure/Temp PSIA (90...	303526	1/15/2012 9:49:27 PM	1/14/2013 9:49:27 PM	5/22/2012 10:24:17 AM	
Analog pH/ORP	013265	2/21/2012 4:02:59 AM	2/20/2013 4:02:59 AM		

Screen Element	**Definition**
☑	The Calibration button starts the Calibration Wizard for the selected sensor.
🔧	This button opens the setup options for the selected sensor. These options include selecting parameters, setting units, and setting sentinel values.

When you click on the sensor you want to calibrate or configure, the Calibration button and the Sensor Setup buttons become active.

Calibration Frequency Recommendations

In-Situ sensors are factory calibrated across the entire range of each sensor, and thus achieve a very high degree of accuracy and stability for extended periods of time without user calibration. In-Situ recommends inserting the instrument into a known calibration standard to check the accuracy of a sensor prior to performing any user calibration if you suspect drift, unless a user calibration is required by a standard operating procedure. Calibration requirements will vary by application and fouling conditions.

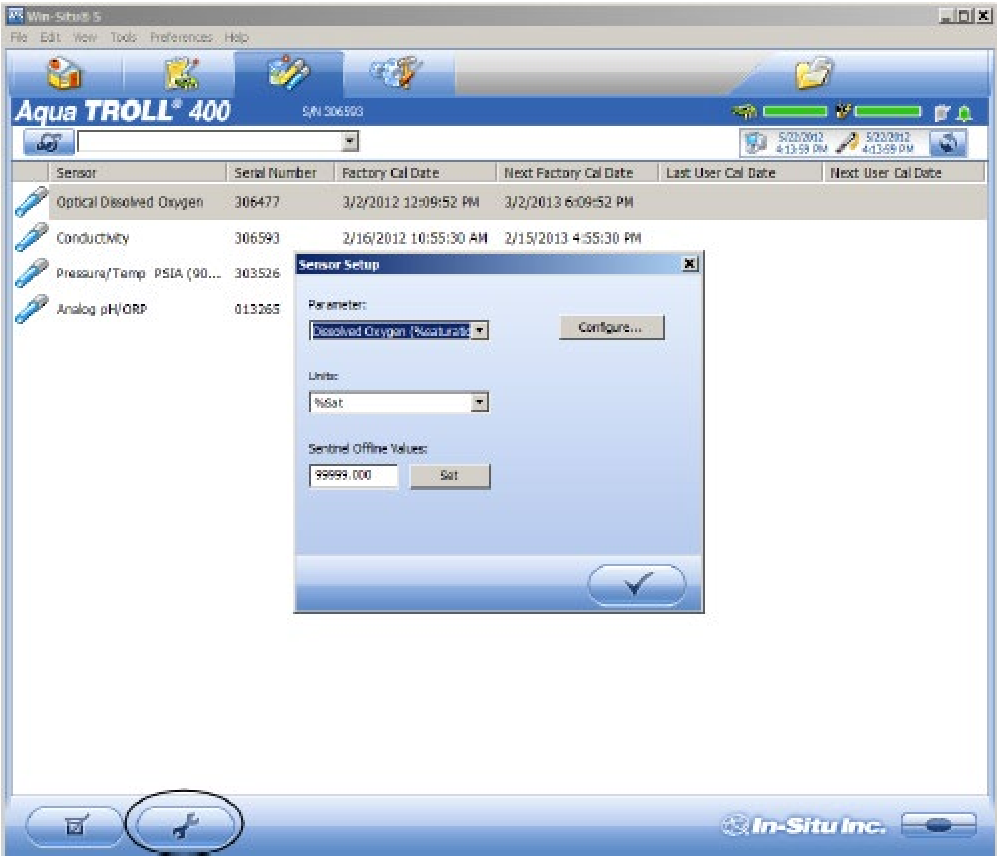
Sensor	Recommended User Calibration Frequency	Recommended Factory Calibration Frequency	Notes
Conductivity	3-6 months	12 months	K-cell value: 0.7 to 1.3
pH	4-6 weeks or as required by user protocol or site conditions	12 months	Single point: Theoretical mV ±30 mV 2- or 3-point Slope: -66 to 50 mV/pH 2- or 3-point Offset:±30mV at pH 7
ORP	4-6 weeks or as required by user protocol or site conditions	12 months	Offset: ±30 mV
RDO	12 months or as required by user protocol or site conditions	12 months	2-point Slope: 0.7 to 1.3 2-point Offset:±0.3 mg/L

Factory Calibration

Factory calibration includes a thorough cleaning, full functionality check and sensor adjustments to all applicable sensors over the entire calibrated temperature range. We recommend a factory calibration every 12 months or when the unit appears to drift significantly.

Set Parameter Units and Sentinel Values

You can set sentinel values and set units for parameters by selecting a parameter and clicking the Setup Sensor button.



Sensor	Serial Number	Factory Cal Date	Next Factory Cal Date	Last User Cal Date	Next User Cal Date
Optical Dissolved Oxygen	306477	3/2/2012 12:09:52 PM	3/2/2013 6:09:52 PM		
Conductivity	306593	2/16/2012 10:55:30 AM	2/15/2013 4:55:30 PM		
Pressure/Temp PSIA (90...	303526				
Analog pH/ORP	013265				

Parameter: Dissolved Oxygen (%saturatic

Units: %Sat

Sentinel Offline Values: 99999.000

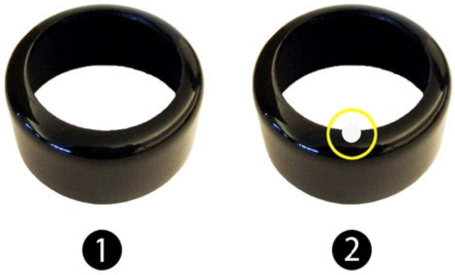
Screen Element	Purpose
Parameter	This menu lists the parameters that are available for the selected sensor.
Units	This drop-down list allows you to select units for the parameter you selected.
Sentinel Offline Value	This is a text field in which you can enter the value that you want to see in the data when a sensor is unable to communicate. After you have entered a value, click the Set button to save it.
Configure	This button becomes active when you select a parameter that includes additional configuration options. Click the Configure button to view the additional options.
Check mark	Clicking the Check mark saves the changes you have made in this screen.

RDO Sensor Calibration

The optical Rugged Dissolved Oxygen sensor is very stable. The factory calibration should produce readings within 3%accuracy. If you require readings with greater accuracy we recommend that you perform a 1-point, 100% water-saturated air calibration as described below.

Calibration 100% Oxygen Saturation

1. Place the calibration cap, with the vent hole, on the top of the calibration cup.



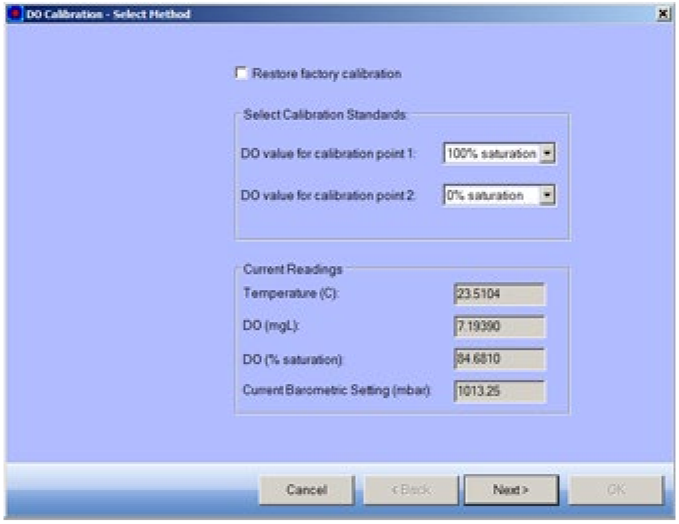
1	Storage cap
2	Calibration cap with vent hole

2. Place the sponge wafer in the bottom of the calibration cup and saturate the sponge wafer with approximately 10 mL clean water.
3. Gently dry the probe and sensing material with a paper towel. Ensure that the probe and the sensing surface are free of water and fouling.
4. Place the instrument into the calibration cup.

5. Wait 5 to 10 minutes for temperature stabilization prior to calibration.

Do not leave the instrument in the calibration cup for more than 30 minutes. This can cause condensation to form on the sensing material, providing false low readings after calibration.

6. In the software, select the Sensor Setup tab.
7. Select the RDO Dissolved Oxygen parameter.
8. Click Calibrate.
9. By default, 100% saturation is selected for the first point of the calibration. If you intend to perform a 2-point calibration, also select 0% saturation from the drop-down list. Otherwise, leave as "None."



☐ Restore factory calibration

Select Calibration Standards

DO value for calibration point 1: 100% saturation

DO value for calibration point 2: 0% saturation

Current Readings

Temperature (C): 23.5104

DO (mgL): 7.19390

DO (% saturation): 84.6810

Current Barometric Setting (mbar): 1013.25

10. Click Next.
11. Enter the barometric pressure or elevation at which the instrument will be deployed.
12. Click Next.
13. Click OK to start the calibration.
14. When the screen indicates that the calibration has reached stability, click Accept to complete the calibration, or click Cancel to return to the previous calibration.

Calibrate 0% Oxygen Saturation

We recommend that you perform the 0 % oxygen calibration only if you intend to measure dissolved oxygen at a concentration of less than 4 mg/L.

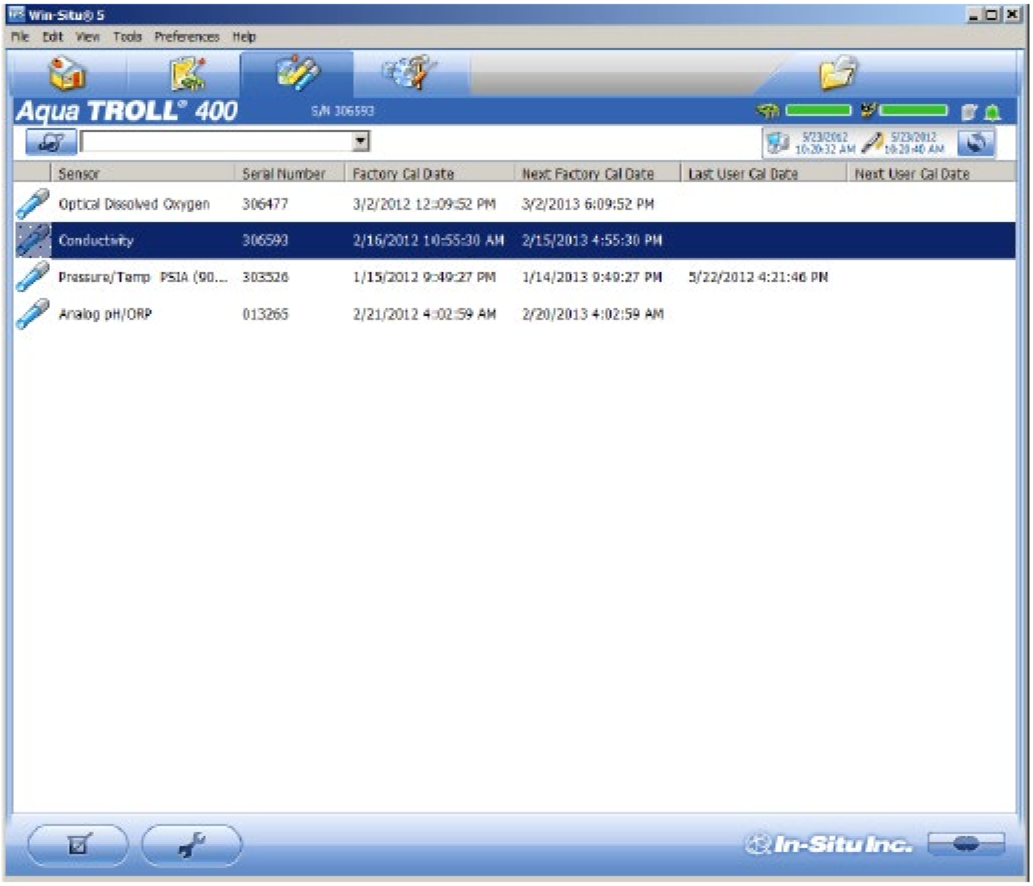
1. If you selected to perform a 2-point calibration, you are prompted to set up the solution for the second point of the calibration.
2. Remove the wet sponge from the cup.
3. Fill the calibration cup to the fill line with approximately 130 mL of fresh sodium sulfite solution.
4. Gently place the instrument in the calibration cup, taking care to not force the solution out the top of the calibration cup.

5. Completely submerge the RDO Sensor into the solution.
6. Click OK, to start the calibration.
7. When the screen indicates that the calibration has reached stability, click Accept to complete the calibration, or click Cancel to return to the previous calibration.
8. You can save or print the calibration report.
9. Click OK to complete the calibration.
10. Once calibration is complete, remove the instrument from the calibration cup and rinse both thoroughly with clean water.

Conductivity Calibration

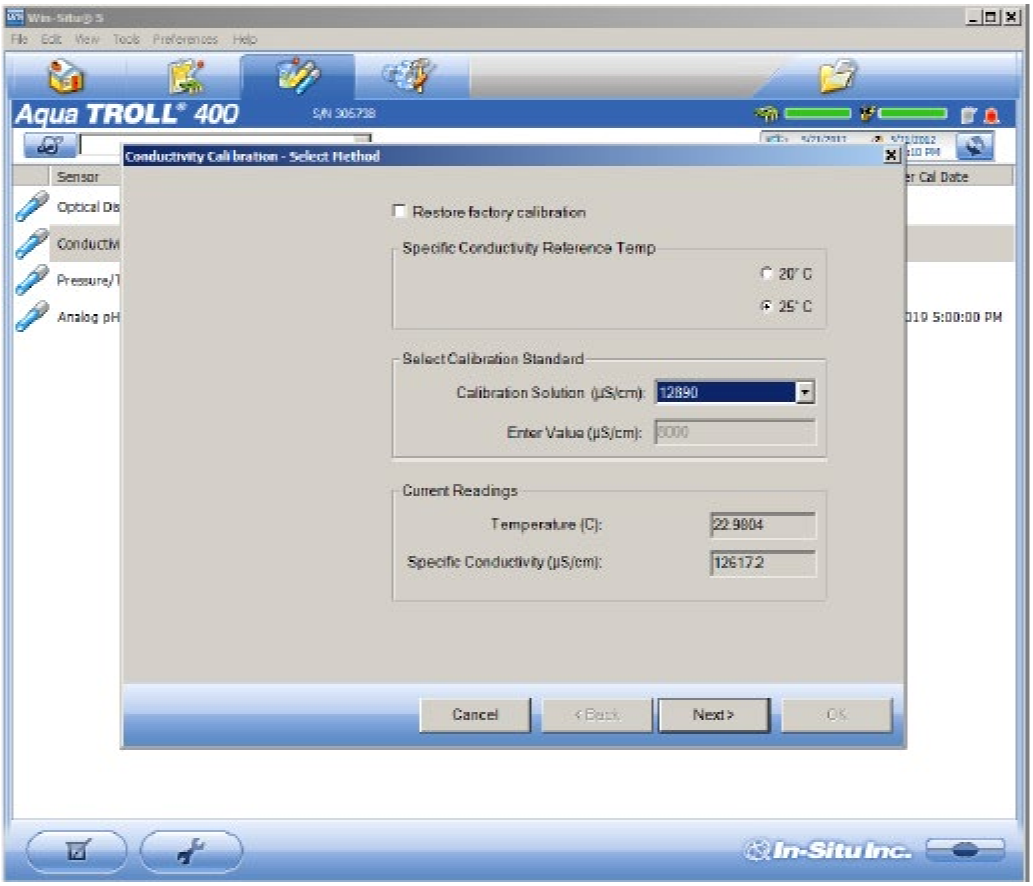
The conductivity sensor is calibrated with NIST-traceable standards at the factory, which provides a high degree of linearity across the entire operating range of 5 to 100,000 µS/cm. This sensor is capable of meeting its published specifications without requiring additional calibration by the user. Most commercially available standards can introduce a larger potential measurement error than the sensor's initial factory calibration. User calibration is recommended only if you must conform to a standard operating procedure or if the conductivity cell has undergone physical change (e.g., deposits on conductivity cell walls that cannot be removed or physical damage to the conductivity cell walls).

1. Fill the calibration cup to the fill line with approximately 130 mL of the desired calibration solution.
2. Place the instrument in the solution taking care to not force the solution out the top of the calibration cup.
3. In Win-Situ 5 Software, select the Conductivity sensor.



Sensor	Serial Number	Factory Cal Date	Next Factory Cal Date	Last User Cal Date	Next User Cal Date
Optical Dissolved Oxygen	306477	3/2/2012 12:09:52 PM	3/2/2013 6:09:52 PM		
Conductivity	306593	2/16/2012 10:55:30 AM	2/15/2013 4:55:30 PM		
Pressure/Temp PSIA (90...	303526	1/15/2012 9:49:27 PM	1/14/2013 9:49:27 PM	5/22/2012 4:21:46 PM	
Analog pH/ORP	013265	2/21/2012 4:02:59 AM	2/20/2013 4:02:59 AM		

4. Click the Calibrate button in the left corner of the screen.
5. Select either 20° C or 25° C as the reference temperature, as indicated by the reference calibration solution.



Conductivity Calibration - Select Method

☐ Restore factory calibration

Specific Conductivity Reference Temp
○ 20° C
● 25° C

Select Calibration Standard
Calibration Solution (µS/cm): 12890
Enter Value (µS/cm): 5000

Current Readings
Temperature (C): 22.9804
Specific Conductivity (µS/cm): 12617.2

6. Select the appropriate calibration standard from the drop-down list. If you select "User Defined," enter the value of the solution.
7. Click Next.
8. Place the instrument into the calibration cup and allow time for the temperature to stabilize.
9. Gently tap the sides of the calibration cup against the palm of your hand to remove any bubbles in the conductivity cell. Visually inspect to ensure that all bubbles are removed.
10. Click OK to start the calibration.
11. When the screen indicates that the calibration has reached stability, click Accept to complete the calibration, or click Cancel to return to the previous calibration.
12. You can save or print the calibration report.
13. Click OK to complete the calibration.
14. Once calibration is complete, remove the instrument from the calibration cup and rinse both thoroughly with clean water.

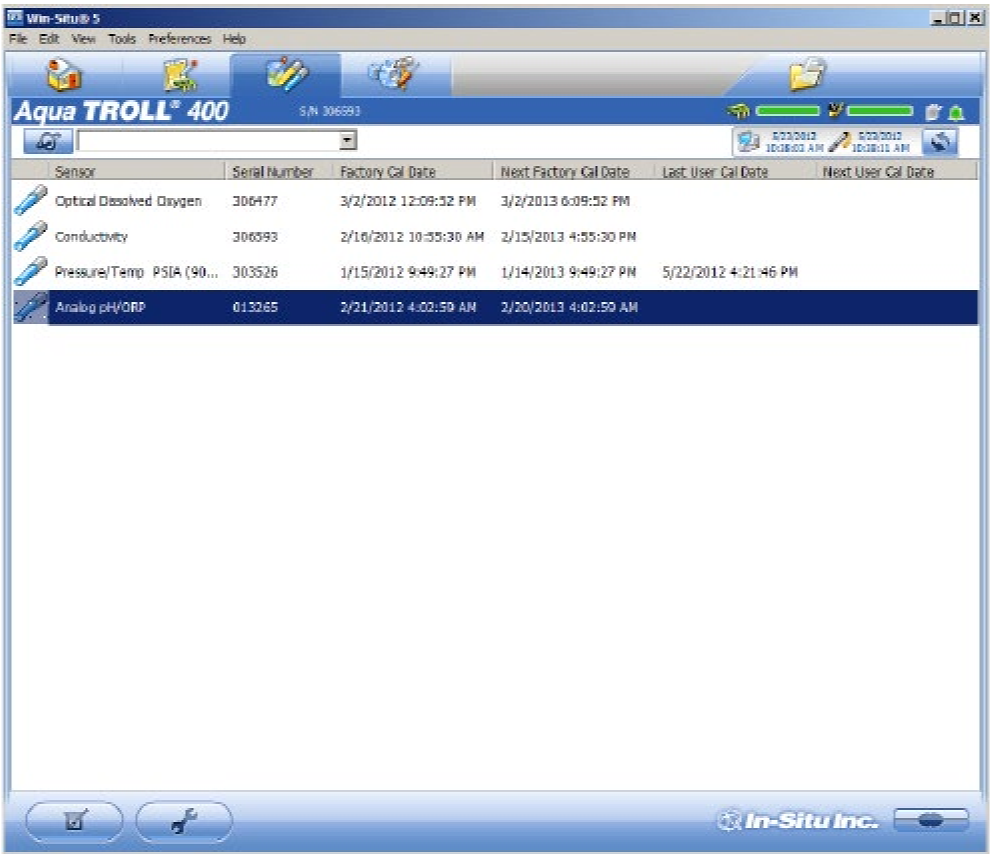
Pressure/Level

The pressure sensor has been factory calibrated with NIST standards to a greater degree of accuracy than can be achieved in nearly any alternative setting. Therefore, user calibration is not necessary for the pressure sensor if it is a gauged sensor. If you encounter significant drift in pressure sensor readings, send the instrument to the factory for service. For best results, use the pressure sensor to measure Surface Elevation or Depth to Water.

Pressure/Level

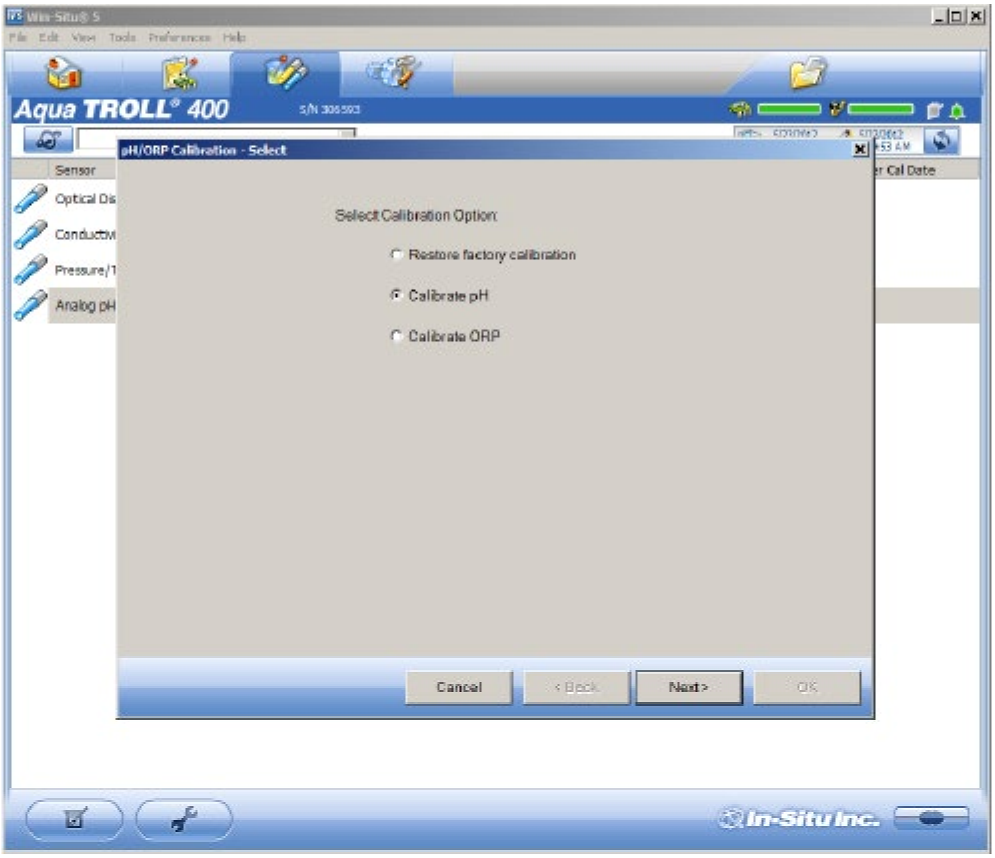
We recommend calibrating the pH/ORP sensor after you perform cleaning and maintenance or every two to six weeks.

1. Fill the calibration cup to the fill line with approximately 130 mL of the desired pH or ORP calibration solution.
2. Place the calibration cap on the instrument slightly above the restrictor, and place the instrument in the solution taking care to not force the solution out the top of the calibration cup.
3. In Win-Situ 5 Software, select the pH/ORP sensor.



Sensor	Serial Number	Factory Cal Date	Next Factory Cal Date	Last User Cal Date	Next User Cal Date
Optical Dissolved Oxygen	306477	3/2/2012 12:09:52 PM	3/2/2013 6:09:52 PM		
Conductivity	306593	2/16/2012 10:55:30 AM	2/15/2013 4:55:30 PM		
Pressure/Temp PSIA (90...	303526	1/15/2012 9:49:27 PM	1/14/2013 9:49:27 PM	5/22/2012 4:21:46 PM	
Analog pH/ORP	013265	2/21/2012 4:02:50 AM	2/20/2013 4:02:50 AM		

4. Click the Calibrate button in the left corner of the screen.



pH/ORP Calibration - Select

Select Calibration Option:

○ Restore factory calibration

● Calibrate pH

○ Calibrate ORP

5. Select either Calibrate pH or Calibrate ORP.
6. Click Next.
7. Select a value for the first calibration point. If you intend to perform a 2-point or 3-point calibration, select the appropriate values as indicated on the label of the calibration standard.
8. Click Next.
9. Place the instrument into the calibration cup and allow time for the temperature to stabilize.
10. Click OK, to start the calibration.
11. When the screen indicates that the calibration has reached stability, click Accept to complete the calibration for that calibration point, or click Cancel to return to the previous calibration.
12. Follow the Wizard to continue through the remaining calibration points.
13. You can save or print the calibration report.
14. Click OK to complete the calibration.
15. Once calibration is complete, remove the instrument from the calibration cup and rinse both thoroughly with clean water.

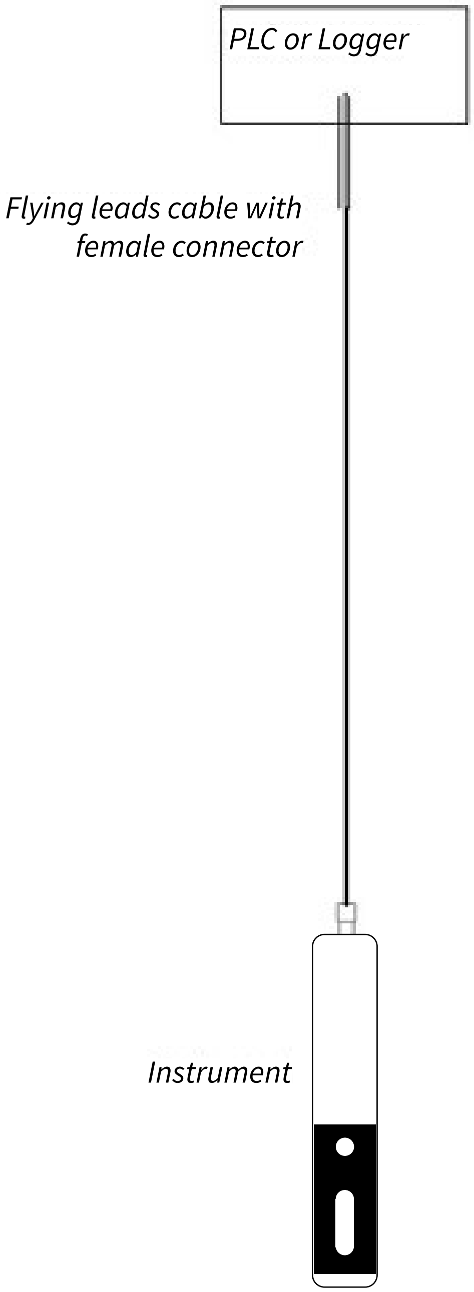
Connecting the Aqua TROLL 400 to a PLC or Data Logger

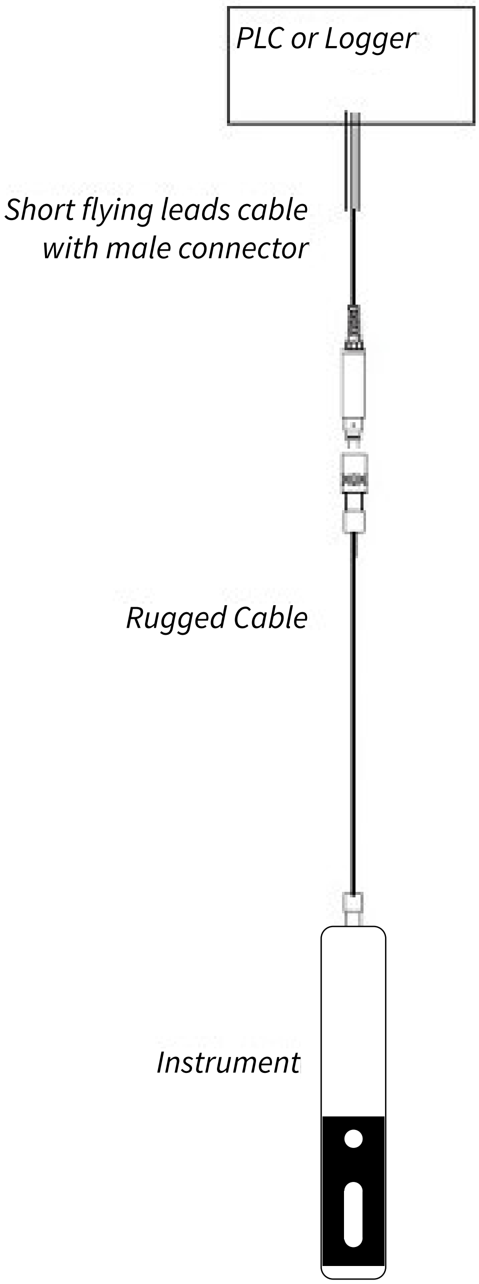
The Aqua TROLL 400 may be connected to a controller or logger for communication via:

- SDI-12
- RS485 Modbus
- RS232 Modbus (with a customer-supplied converter)

The flying leads cable has a female twist-lock connector on one end to connect with the Aqua TROLL instrument. The uphole end terminates in wires for connection to a PLC or data logger.

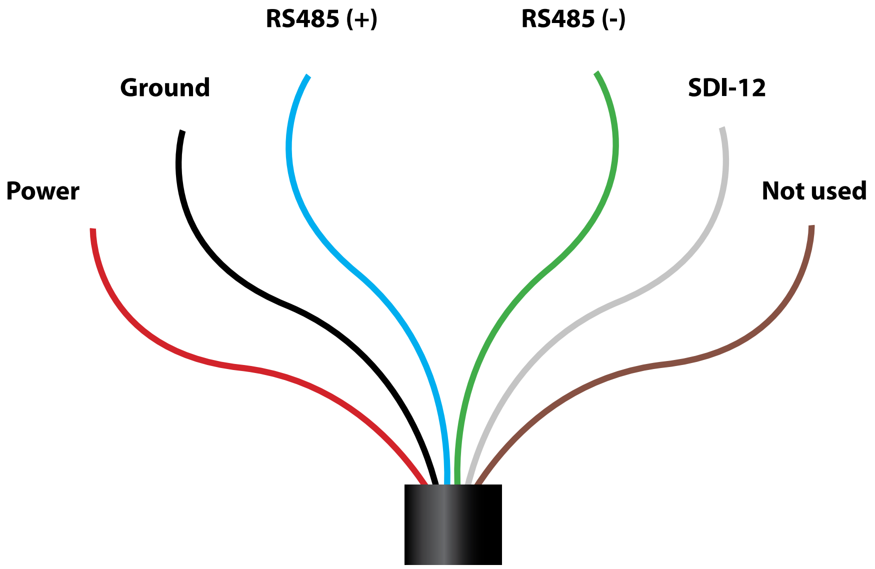
A shorter cable ending in a male twist-lock connector to connect with RuggedCable is also available.





Flying Leads Wire Diagram

✓ Refer to the diagrams on the following pages for PLC wiring diagrams. Unused leads should not be touching.



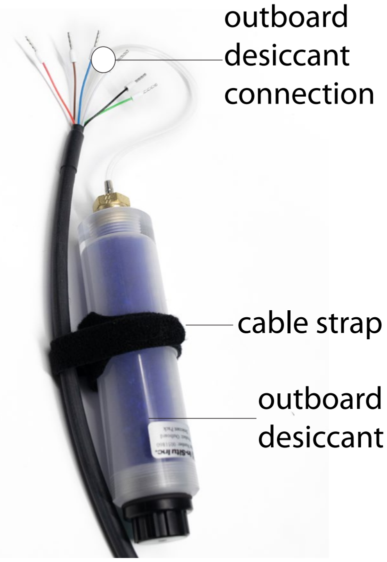
Flying Leads Cable Wire Legend

Wire Color	Signal
Red	External Power
Black	Ground
Blue	RS485 (+)
Green	RS485 (-)
White	SDI-12
Brown	Not used

Desiccant

Vented cable must be installed with outboard desiccant to protect the cable vent tube and Aqua TROLL electronics from condensation in high-humidity environments.

The desiccant is replaceable and may be may be temporarily removed from the vent tube during installation.



Power connections

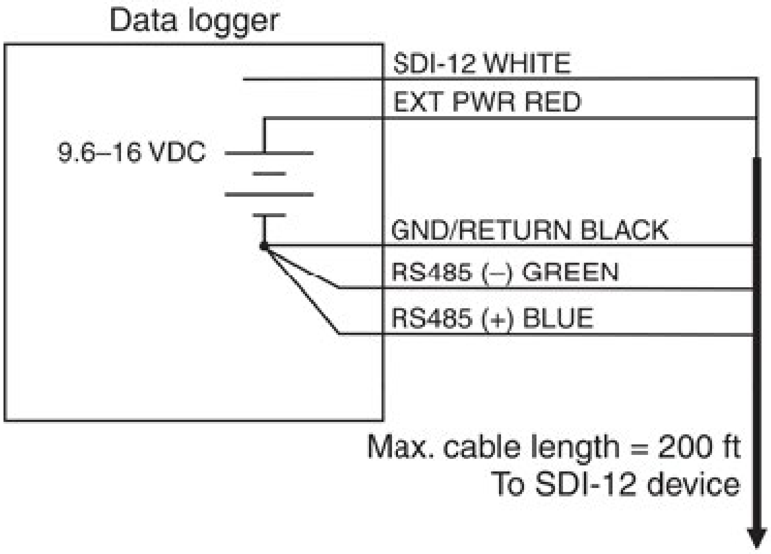
The Aqua TROLL 400 requires an external 8 to 36 VDC power source. The red wire must be connected to the positive terminal of the power source. The black wire must be connected to the negative terminal of the power source, which is often referred to as the system ground or return.

Communication modes

The device automatically switches between Modbus and SDI-12 modes depending on which of the two interfaces has activity. Modbus and SDI-12 cannot be used at the same time — whichever one is currently in use will block communication on the other.

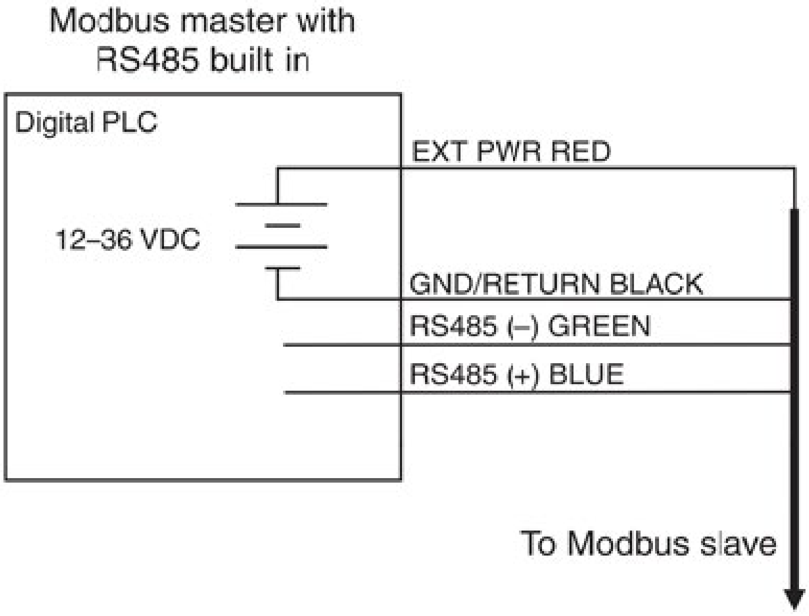
SDI-12 wiring diagram

Cable length must not exceed 60.9 m (200 ft).



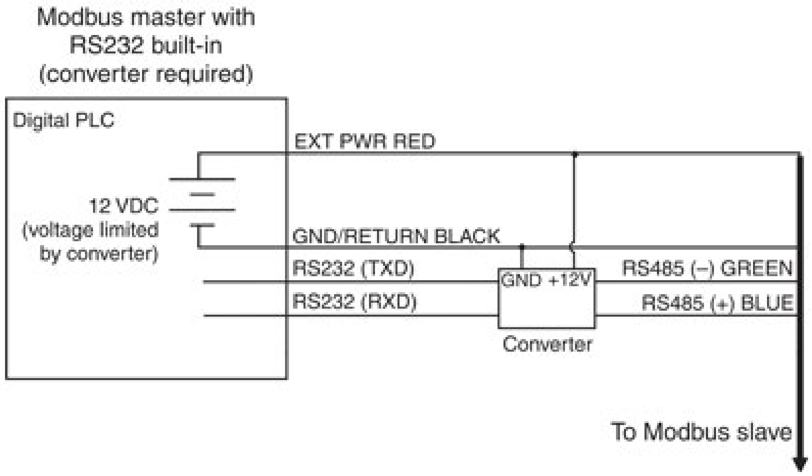
Modbus (RS485) wiring diagram

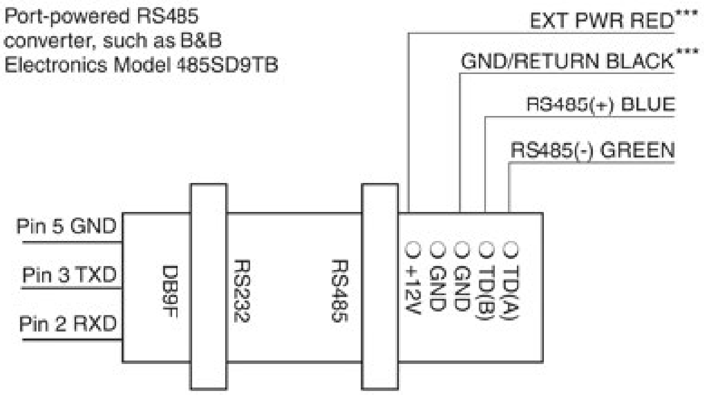
Cable length must not exceed 1,219 m (4,000 ft).



Modbus (RS232 with converter) wiring diagram

Cable length between Master and Slave must not exceed 1,219 m (4,000 ft). Cable length between Master and Converter must not exceed 6 m (20 ft).





*** Required if port power is not available

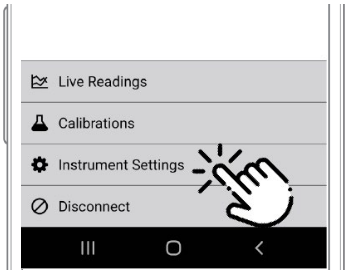
Configuring SDI-12 Settings

About SDI-12

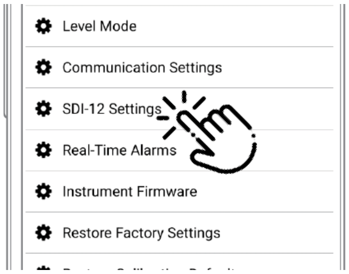
You can configure the list of SDI-12 parameters in VuSitu under **Instrument Settings.**

The Aqua TROLL 400 conforms to the general SDI-12 Standard Version 1.3. For more information about SDI-12 commands, see the SDI-12 Standard Version 1.3 document from the SDI-12 Support Group Technical Committee.

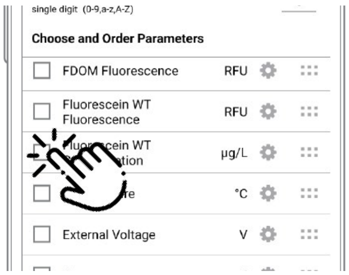
Configure SDI-12 Settings in VuSitu



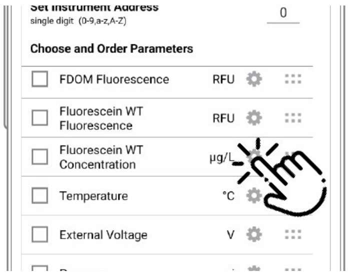
Connect to VuSitu and select **Instrument Settings.**



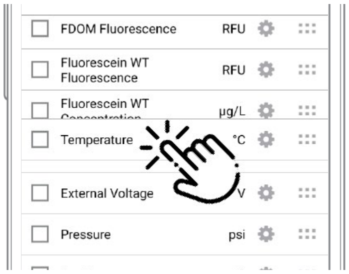
Choose **SDI-12 Settings.**



Use the checkboxes to select parameters to display.



Tap the gear icon to adjust the units for each parameter.



Drag and drop parameters to change the order.

Modbus PLC Interface

Overview

The Modbus PLC Interface is a simplified method of communicating with the Aqua TROLL 400 using the Modbus protocol. For information about the specific Modbus registers and Unit IDs for your Aqua TROLL 400, see Appendices A and B. The Aqua TROLL 400 conforms to the Modbus standard. For more information about Modbus communication, see www.modbus.org.

Setting Up Instrument

1. Connect power, and wire the instrument.
2. The setup below is using the instrument's factory default settings. Use VuSitu to reset the instrument to factory defaults if they have been changed. Take note of any changes in default units setup.

Programming the PLC

1. Set up the serial communication to match the instrument communication settings. Communication settings can be changed with the VuSitu mobile app. The default communication settings are:

Mode	Start Bit	Baud Rate	Data Bits	Parity	Stop Bit
RTU	1	19200	8	Even	1

2. Set the device address match the instrument address. The default device address is 1.
3. Set the PLC to wake-up the device by sending a carriage return (0x0D) or any Modbus command.
    a. Allow one second before sending a second command. The instrument needs this time to wake up.
    b. After the wake-up command, the next reading must be taken before the end of session timeout. If the reading interval exceeds the end of session timeout, send a new wake-up command before requesting a new reading. The default end of session timeout is 5 seconds, and may be longer if the instrument has been connected to VuSitu.
4. Select the register to read on the PLC using the information in the following sections.
    a. Some PLC devices use the register number directly in programming statements, others use register addresses, which are one less than the register number. Refer to PLC manufacturer instructions to determine which programming style to use.
    b. Each register is a holding register. Some PLCs require you to add 40000 to the register number or address. For example: 5451 would be 45451.
5. Set the type of register to: 32-bit float
    a. If asked by the PLC this is 2 registers
6. Set the byte order to: Big Endian (MSB)
    a. This should be the default and may not be configurable on all PLCs

Reading Device Information

Use the following registers to read general information about the instrument.

Holding Register Number	**Holding Register Address**	**Size (Registers)**	**Data Type**	**Description**
9001	9000	1	uint16	Device Id: 18 = Aqua TROLL 400
9002	9001	2	uint32	Serial Number
9007	9006	1	uint16	Firmware version (100 = 1.00)

Reading Parameters

Each parameter contains a block of 7 registers as shown in the table below. To read measurements for a specific parameter, look up the starting register for that parameter from the list of Parameter Numbers and Locations in Appendix A. Once you have the starting register, add the number of offset registers for additional information about the reading.

Register Offset	Size (Registers)	Mode (R/W)	Data Type	Description
0	2	R	float	The measured value from sensor
2	1	R	uint16	Data Quality ID: 0 = No errors or warnings 3 = Error reading parameter 5 = RDO Cap expired For additional errors or information, contact technical support.
3	1	R/W	uint16	Units ID for this parameter. See: Appendix B.
4	1	R	uint16	Parameter ID for this parameter. See: Appendix A.
5	2	R/W	float	Off line sentinel value: The value that's returned on error or if the parameter isn't available. The default sentinel is 0.0

For example, you can apply this information to collect a reading for Dissolved Oxygen Concentration.

From the list in Appendix A, you can find that the starting register for DO Concentration is 0038. A reading from register number 0038 (register address 0037) will return the measured value of DO Concentration.

Some PLC devices use the register number directly in programming statements, others use register addresses. Refer to PLC manufacturer instructions to determine which programming style to use.

You can use the register offsets listed in the table above to collect additional information about the reading. Adding the register offset of 2 to the starting register, you can find that register number 0040 (register address 0039) will return the Data Quality ID for the most recent DO Concentration measurement. Likewise, register number 0041 (register address 0040) will return the Units ID, which can be interpreted from Appendix B. Register number 0042 (register address 0041) will return the Parameter ID, which can be interpreted from Appendix A. Register number 0043 (register address 0042) will return the sentinel value.

The Units ID and Sentinel Value are writeable registers. Measurements can be changed to other units using the Units ID as shown in Appendix B. For example, if register number 0041 (DO Concentration Units ID) returns 117, DO Concentration is configured to report in mg/L. Looking at Appendix B, you can find that ppm is also a valid unit which can be set by writing Units ID 113 to register number 0041.

Care and Maintenance

Maintenance Schedule

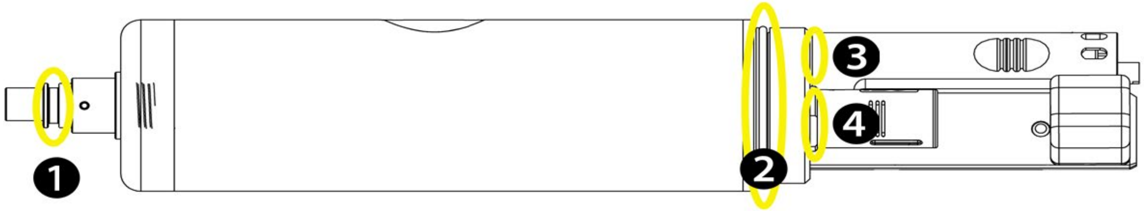
For best results, send the instrument to the manufacturer for factory calibration every 12 to 18 months.

User-Serviceable Parts

The user-serviceable parts on the instrument include the O-rings, the pH/ORP sensor, and the RDO Sensor Cap.

O-rings

The instrument has several O-rings that can be maintained by the user in order to keep moisture from entering the instrument and damaging the electronics. Apply a very thin layer of vacuum grease to new O-rings upon installation. The O-rings are located in the following areas.



1	Connector
2	Instrument housing
3	pH sensor
4	RDO Sensor

RDO Sensor Cap Replacement

The RDO Sensor Cap has a 1-year typical life (15 months of total usage) after the sensor takes its first reading, or 36 months from the date of manufacture. Follow the instructions included in the RDO Sensor Cap Replacement Kit. Replacement caps are available from In-Situ Inc. or your authorized In-Situ distributor.

pH/ORP Sensor Replacement

To replace the pH/ORP sensor or to refill the reference junction, follow the instructions in the pH/ORP Sensor Instruction Sheet that is included with the replacement sensor.

Instrument Storage

To store the probe for a week or less, place the probe in the calibration cup with at least 10 mL of clean water to maintain a moist storage environment. To store the probe for more than a week, perform the following procedure.

1. Remove the pH/ORP sensor and place the orange pH port plug into the empty pH/ORP port to prevent any humidity from entering the probe.
2. Locate the sensor storage bottle in which the pH sensor was originally shipped.
3. Open the bottle and remove the O-ring.
4. Add enough pH storage solution or pH 4 solution to cover the sensor bulb (about 10 mL).

5. Slide the O-ring onto the sensor, and then slide the bottle cap over the sensor as shown.

6. Place the sensor tip in the buffer and tighten the cap to prevent the glass bulb from drying.

Cleaning the pH/ORP Sensor

Begin with the gentlest cleaning method and continue to the other methods only if necessary. Do not directly touch or wipe the glass bulb.

To clean the pH sensor, gently rinse with cold water. If further cleaning is required, consider the nature of the debris to determine the appropriate method.

Remove Crystalline Deposits

1. Clean the sensor with warm water and mild soap.
2. Soak the sensor in 5% HCl solution for 10 to 30 minutes.
3. If deposits persist, alternate soaking in 5% HCl and 5% NaOH solutions.

Remove Oily or Greasy Residue

1. Clean the sensor with warm water and mild soap.
2. Methanol or isopropyl alcohol may be used for short soaking periods, up to 1 hour.
3. Do not soak the sensor in strong solvents, such as chlorinated solvents, ethers, or ketones, including acetone.

Remove Protein-Like Material or Slimy Film

1. Clean the sensor with warm water and mild soap.
2. Soak the sensor in 0.1M HCl solution for 10 minutes and then rinse with deionized water.

✓ After performing any of these cleaning methods, rinse the sensor with water and then soak overnight in pH 4 buffer.

Cleaning the RDO Sensor

Clean the Sensor Cap

1. Leave the cap on the sensor.
2. Rinse the sensor with clean water from a squirt bottle or spray bottle.
3. Gently wipe with a soft cloth or brush if biofouling is present.

4. If extensive fouling or mineral build-up is present, soak the RDO Cap end (while the cap is still installed on the sensor) in commercially available household vinegar for 15 minutes, then soak in deionized water for 15 minutes.

Vinegar is safe for all of the sensors on the probe including the RDO Sensor if the sensor cap is on.

5. Do not use organic solvents because they will damage the sensing material. Do not remove the cap from the sensor prior to wiping.
6. After cleaning the sensor cap, perform a 2-point calibration.

Clean the Optical Window

1. Perform this task only once per year when you replace the sensor cap.
2. Pull to remove the sensor cap.
3. Gently wipe the optical window with the supplied lens wipe.

Do not wet the interior lens area with water or any solution.

Cleaning the Conductivity Sensor

1. Before you begin, ensure that the RDO Cap and any removable sensors are in place. Rinse the conductivity sensor under running water to remove loose material.
2. Follow Cleaning Procedure 1. If debris is still present, progress to the next cleaning procedure. If the debris is removed, skip to the last step.

Cleaning Procedure 1

Avoid damaging the plastic material of the conductivity cell. Gently scrub the conductivity cell with a soft swab and mild soap such as a dilute solution of dish detergent. The probe is shipped with polyurethane foam swabs for this purpose. You can also achieve good results using a gentle back-and-forth motion with a thin cotton pipe cleaner. If debris is still present, continue to Cleaning Procedure 2. If the sensor is clean, skip to the last step.

Cleaning Procedure 2

Avoid damaging the plastic material of the conductivity cell. Gently scrub the conductivity cell with a foam swab and an aggressive soap such as Alconox cleaner. If debris is still present, continue to Cleaning Procedure 3. If the sensor is clean, skip to the last step.

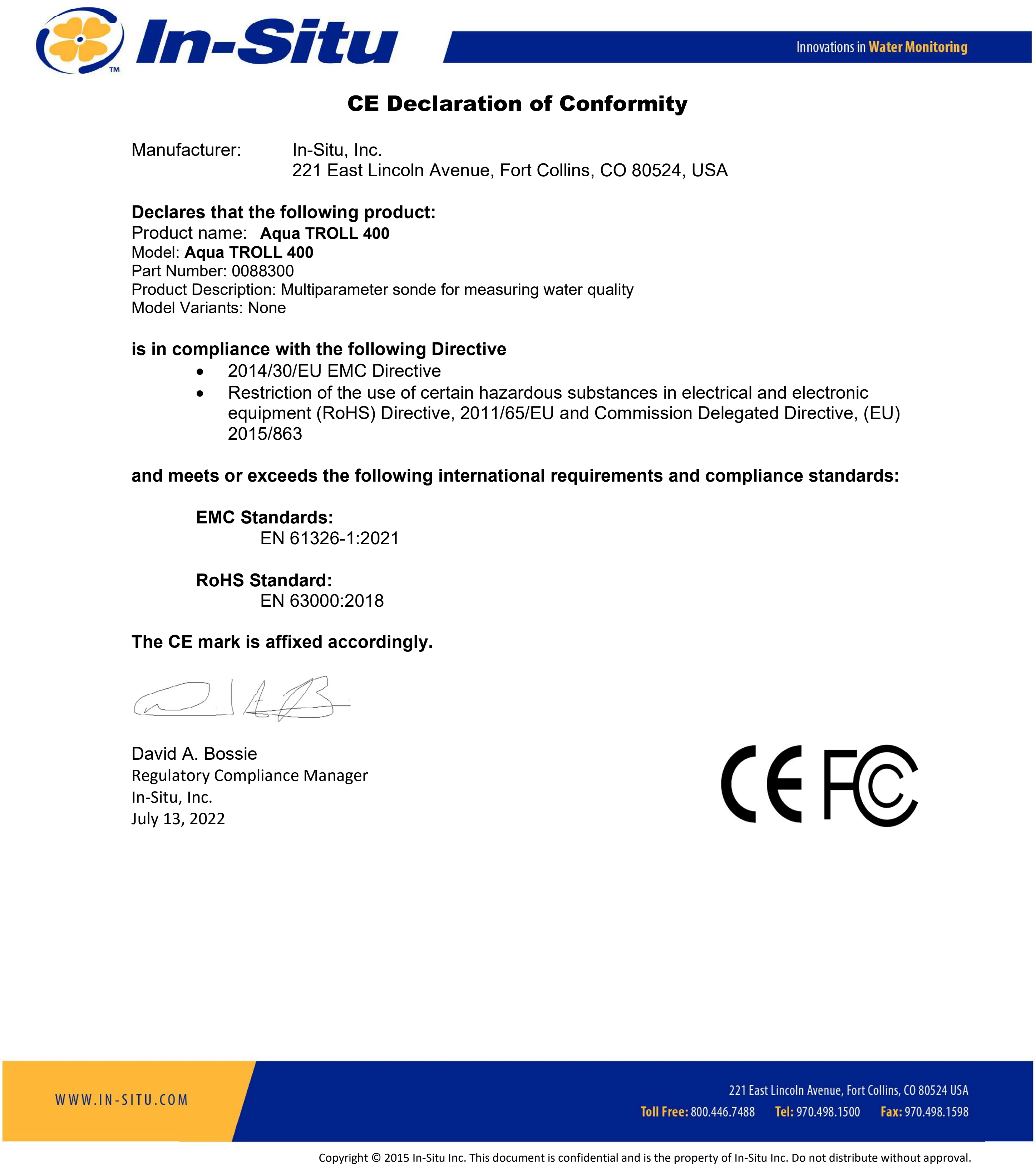
Cleaning Procedure 3

Soak the sensor with dilute acetic acid (10:1 solution) or commercially available household vinegar to pre-soften calcium deposits. Follow this with Cleaning Procedure 1 or Cleaning Procedure 2, depending on the degree of residual contamination. The probe can soak for any length of time in household vinegar. If debris is still present, continue to Cleaning Procedure 4. If the sensor is clean, skip to the last step.

Cleaning Procedure 4

Topically apply dilute phosphoric acid (< 27 %) or the consumer product LIME-A-WAY with a soft swab to remove iron or calcium deposits that remain after using Process 3. Do not allow the cleaner to be in contact with the sensor for more than 10 minutes. Rinse well with clean water and continue to the last step.
Check the sensor calibration before redeployment. Recalibrate the sensor when necessary.

Declaration of Conformity



In-Situ™
Innovations in Water Monitoring

CE Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue, Fort Collins, CO 80524, USA

Declares that the following product:
Product name: **Aqua TROLL 400**
Model: **Aqua TROLL 400**
Part Number: 0088300
Product Description: Multiparameter sonde for measuring water quality
Model Variants: None

is in compliance with the following Directive

- 2014/30/EU EMC Directive
- Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) Directive, 2011/65/EU and Commission Delegated Directive, (EU) 2015/863

and meets or exceeds the following international requirements and compliance standards:

EMC Standards:
EN 61326-1:2021

RoHS Standard:
EN 63000:2018

The CE mark is affixed accordingly.

David A. Bossie
Regulatory Compliance Manager
In-Situ, Inc.
July 13, 2022

WWW.IN-SITU.COM
221 East Lincoln Avenue, Fort Collins, CO 80524 USA
Toll Free: 800.446.7488 **Tel:** 970.498.1500 **Fax:** 970.498.1598

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In-Situ
Innovations in Water Monitoring

UKCA Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue, Fort Collins, CO 80524, USA

We declare that the performance of the following product:
Product name: Aqua TROLL 400
Model: Aqua TROLL 400
Part Number: 0088300
Product Description: Multiparameter sonde for measuring water quality.
Model Variants: None

is in compliance with the following Regulations:

- EMC Regulation 2016
- Restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) Regulation (S.I. 2012:3032)

and meets or exceeds the following British requirements and compliance standards:

- **EMC:** BS 61326-1:2021
- **RoHS:** BS 63000:2018

The UKCA mark is affixed accordingly.

David A. Bossie
Regulatory Compliance Manager
In-Situ, Inc.
July 13, 2022

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Appendix

Appendix A: Parameter Numbers and Locations

ID	Parameter Name	Holding Register Number	Holding Register Address	Default Units
1	Temperature	0046	0045	1 = °C
2	Pressure	1038	1037	17 = PSI
3	Depth	1054	1053	38 = feet
4	Level, Depth to Water (must be selected in VuSitu)	1054	1053	38 = feet
5	Level, Surface Elevation (must be selected in VuSitu)	1054	1053	38 = feet
9	Actual Conductivity	0538	0537	65 = µS/cm
10	Specific Conductivity	0546	0546	65 = µS/cm
11	Resistivity	0578	0577	81 = ohm-cm
12	Salinity	0564	0563	97 = PSU
13	Total Dissolved Solids	0570	0569	114 = ppt
14	Density of Water	0586	0585	129 = g/cm^3
17	pH	1538	1537	145 = pH
18	pH mV	1546	1545	162 = mV
19	ORP	1554	1553	162 = mV
20	Dissolved Oxygen Concentration	0038	0037	117 = mg/L
21	Dissolved Oxygen % Saturation	0054	0053	177 = % Saturation
30	Oxygen Partial Pressure	0062	0061	26 = torr

Appendix B: Unit IDs

ID	Abbreviation	Units
1	C	Celsius
2	F	Fahrenheit
Pressure, Barometric Pressure (17-32)		
17	PSI	Pounds per square inch
19	kPa	Kilopascals
20	Bar	Bars
21	mBar	Millibars
22	mmHg	Millimeters of Mercury (0 to C)
26	Torr	Torr
Distance/Length (33-48)		
33	mm	Millimeters
34	cm	Centimeters
35	m	Meters
37	in	Inches
38	ft	Feet
Conductivity (65-80)		
65	µS/cm	Microsiemens per centimeter
66	mS/cm	Millisiemens per centimeter
Resistivity (81-96)		
81	ohm-cm	Ohm-centimeters
Salinity (97-112)		
97	PSU	Practical Salinity Units
Concentration		
113	ppm	Parts per million
114	ppt	Parts per thousand
117	mg/L	Milligrams per liter
118	µg/L	Micrograms per liter
pH (145-160)		
145	pH	pH

Voltage (161-176)		
162	mV	Millivolts
Dissolved Oxygen (DO) % Saturation (177-192)		
177	% sat	Percent saturation

GEM-2000 Operations Manual

LANDTEC

GEM™2000
GEM™2000 Plus

GAS ANALYZER & EXTRACTION MONITOR

OPERATION MANUAL

For Serial Numbers less than 10,000

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For further information contact:

LANDTEC North America
850 S. Via Lata, Suite 112
Colton, CA 92324
Telephone: (800) 821-0496 or (909) 783-3636
Fax: (909) 825-0591
www.LANDTECNA.com

This manual is subject to revision without prior notice. Please periodically check our website for a newer revision.

LANDTEC Release Date: December 2, 2010
Updates to Clarify instruments are not total hydrocarbon analyzers, cross gas interference and solutions for typical interferences only.
Software, battery charger and data cable information is referenced to the equipment released at time of instrument sale (pre 2007).

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1 Introduction

LANDTEC is the premier manufacturer of products, instruments and software for landfill gas extraction and for regulatory monitoring compliance. LANDTEC has provided the landfill industry with a technologically innovative family of products for more than a decade. These products are the result of field-proven experience in design, operation and maintenance of landfills for environmental compliance.

The GEM™2000 and GEM™2000 Plus, designed by LANDTEC, are specifically for use on landfills to monitor landfill gas (LFG) extraction systems, flares and migration control systems. Both instruments sample and analyze the Methane, Carbon Dioxide and Oxygen content of LFG. The GEM™2000 Plus also samples and analyzes Carbon Monoxide and Hydrogen Sulfide. The GEM instruments are not total hydrocarbon analyzers. The readings are displayed and can be stored in the instrument or downloaded to a personal computer for reporting, analyzing and archiving.

The GEM™2000 / GEM™2000 Plus instrument is frequently shipped in an optional protective hard case with a foam interior that offers additional protection, transportation convenience and component hardware storage. When properly sealed, the hard case is watertight. The hard case is equipped with a pressure relief valve (located under the handle on the case) that is normally kept closed. If there is a change in elevation, the hard case may not open until turning the pressure relief valve equalizes internal pressure. When shipping a GEM™2000 / GEM™2000 Plus back to LANDTEC for calibration or service, always ship it in the original packaging to protect unit from damage.

Carefully unpack the contents of the GEM™2000 / GEM™2000 Plus, inspect and inventory them. The following items should be contained in your package:

- The GEM™2000 / GEM™2000 Plus instrument
- GEM™2000 / GEM™2000 Plus Operation Manual
- Registration/Warranty Card
- Soft carrying case with replaceable protective window and carrying strap
- Clear ¼" vinyl sampling hose assembly (5 ft.) with external water trap filter assembly
- Blue ¼" vinyl pressure sampling hose (5 ft.)
- Spare internal particulate filter element
- Polypropylene male connector (hose barb) connects to blue vinyl tubing
- Spare external water trap filter element
- 100-240 volt battery charger
- DataField CS software on CD-ROM
- RS-232 serial cable for computer/printer data downloading
- Temperature probe (optional)
- Hard carrying case (optional)

Complete the Registration/Warranty Card and return it to LANDTEC. The model and serial numbers are located on the back of the GEM™2000 / GEM™2000 Plus instrument.

Immediately notify shipping company if the GEM™2000 / GEM™2000 Plus **unit or accessories are damaged due to shipping.** Contact LANDTEC immediately if any items are missing.

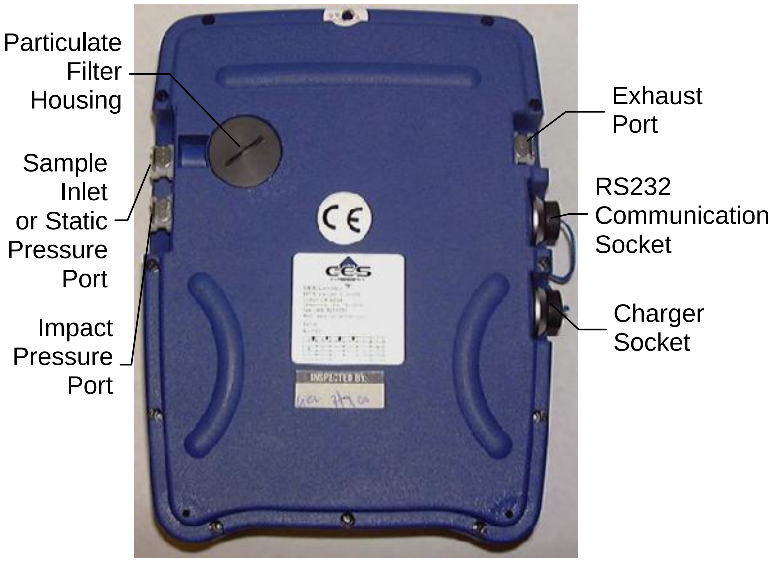
For questions regarding instrument operation and procedures, please contact LANDTEC

2 General Operational Features

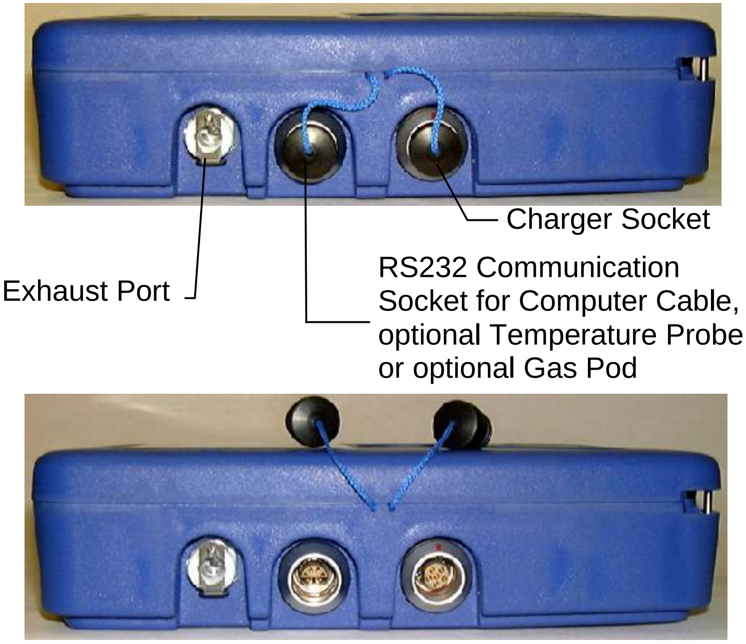
2.1 Physical Characteristics of the GEM™2000 / GEM™2000 Plus

Front View

Back View

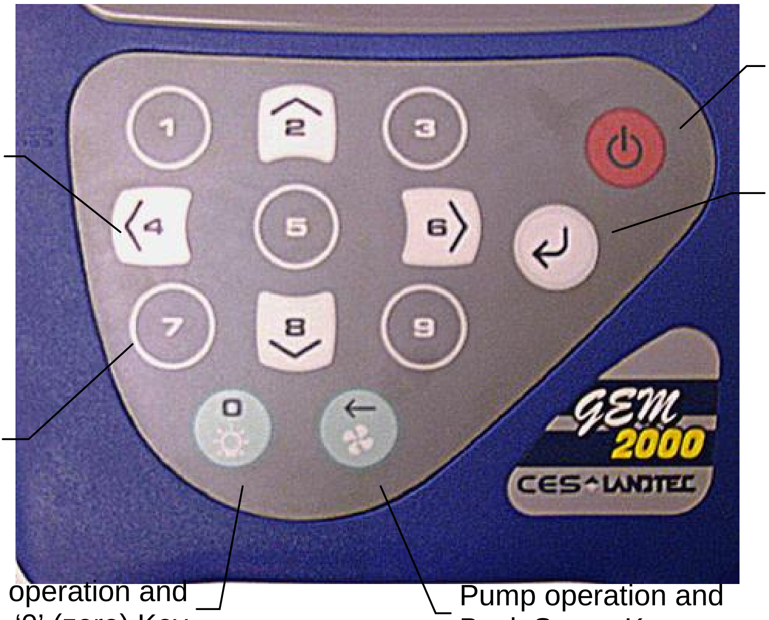


Left Side View



Right Side View

Keypad



Whenever a key is pressed the unit will emit a short ‘beep’ as an acknowledgement. This function cannot be turned off.

2.2 Turning the Instrument On/Off

When switching the instrument on, a long beep will sound, followed by the LANDTEC logo being displayed and the self-test will commence.

When switching the instrument off, the On/Off button must be held down for approximately 15 seconds, at which point a clean air purge will be carried out. If for any reason the instrument ‘locks-up’ and will not switch off, press and hold the On/Off button for 15 seconds. This will force the instrument to switch off.

2.3 Warm-up Self Test

When switched on, the instrument will perform a predetermined self-test sequence taking approximately 20 seconds, during this time many of the instrument’s functions are tested, including:

- General operation
- Pump function
- Gas flow measurement
- Calibration
- Backlight function
- Solenoid function

During the self-test, the following information is also displayed:
- Calibration due date.
- Software version.
- Lifetime guarantee covered (or not).
- Date format.
- Serial Number.
- Operating language.

Upon self-test completion, the GEM™2000 / GEM™2000 Plus should automatically enter the read gas levels screen.

2.4 Warning and Error Display

During the self-test, if any operational parameters are out of specification or the pre-programmed recommended calibration/service date has passed errors or warnings may be displayed. Only three errors/warnings can be displayed at any time. To ascertain if more errors occurred, use the ‘ė’ and ‘Ę’ key to scroll up/down the list.

2.4.1 WARNING Displayed

All warnings displayed will be prefixed by the word ‘**WARNING**‘ followed by a relevant description. Two types of warnings may be displayed.

1. General warnings that may not have an effect on the instrument’s function and those where the self-test has detected a function that is outside the usual programmed operating criteria (e.g. Battery charge low, memory nearly full, etc.).
2. Specific warnings of operational parameters that can affect the performance of the instrument (e.g. O_2 Cell out of calibration, CH_4 out of calibration, CO_2 out of calibration, etc.).

The most likely reason for the errors is either an incorrect user calibration, or sensor failure. If an incorrect user calibration has caused the warning, it should be correctable by way of returning the instrument to factory settings, zeroing or carrying out a user calibration as necessary for the relevant function.

2.4.2 ERROR Displayed

All errors displayed will be prefixed by the word ‘**ERROR**‘ followed by a number and description. The errors detected by the self-test are usually caused by a user calibration being out of specification or possibly memory corruption. This will have an effect on the functionality of the instrument and should be corrected before use (e.g. 01 - User cal data, CH_4 reading or channel out of specification, 02 - User cal data, CO_2 reading out of specification).

If any other Warnings or Errors are displayed, contact LANDTEC for further information.
LANDTEC is the ONLY authorized service center for the GEM™2000 / GEM™2000 Plus instruments in the Americas.

2.5 Storage

Do not keep the instrument in the trunk of a car or shed because it may be exposed to temperature extremes.

When not in use, instruments should be kept in a clean, dry and warm environment such as an office.

The instrument batteries should be discharged and fully charged at least once every four weeks regardless of indicated charge state. The discharge function may be carried out with the use of the Data Logging Function in GA mode of operation.

2.6 Battery/Charging

The Battery Charger IS NOT covered by the unit UL certification. Therefore, when connected to the Battery Charger, the instrument IS NOT intrinsically safe and should not be used in confined spaces.

The battery used in the GEM™2000 / GEM™2000 Plus is a Nickel Metal Hydride manufactured as an encapsulated pack from six individual cells. This type of battery is not so susceptible to “memory effects” as Nickel Cadmium batteries, although it is not recommended that the unit be given short-term charges. When the flashing LED indicates “Charging Complete”, disconnect the charger.

CES-Landtec
937 S. Via Lata, Suite 650
Colton, CA 92324
Telephone: (909) 783-3636
Fax: (909) 825-0591
Web: www.ces-landtec.com

Model: GEM2000-BC
Label - P/N 023782

The battery charger indicates when the unit is charging, charged or if there is a fault. A full charge should take approximately 2 hours. Charge the batteries until the ‘Charging Complete’ indicator is flashing.

2.7 Read Gas Levels Screen (GA mode of operation)

The read gas levels screen is also considered the normal operation screen and all operations are carried out from this starting point. The following information is displayed in various boxed sections at this time:

- Current programmed time and date.
- Current selected ID code.
- Pump status.
- Pump run time.
- Three main constituent gases – CH_4, CO_2, O_2 (in %).
- Two minor gases – CO & H_2S (GEM™2000 Plus only)
- Balance gas.
- Last read time/date (if previous data is in memory), the benefits of this are, 1 – it is easily noted if a reading has been taken/stored, 2 – the current and previous readings can be easily compared.
- External Gas Pod “Not Fitted” (displays pod type when attached).
- Peak CH_4 reading (in %) (GA mode only).
- LEL CH_4 (GA mode only).
- Current barometric pressure reading.
- Current relative pressure reading (GA mode only).
- Gas Pod or Temperature Probe reading (if connected).
- Battery Charge graph (5 segment, flashes at 20% remaining).
- Memory Usage graph (5 segment, flashes at 5% remaining).

Other options:

① Menu	Allows access to all instrument user functions.
③ Next ID	Allows the next ID to be selected (if data available).
⑦Previous Reading	Allows the previous reading of the selected ID to be viewed (if data available).
ý Store Reading	Stores the current displayed reading. (GA mode only)

2.8 Optional Gas Pods

Optional gas pods are available for use with the GEM™2000 / GEM™2000 Plus. These pods are available in seven different gases with nine different PPM ranges. Connection to the instrument is made via the data port and exhaust port. The detected PPM level is displayed in the upper right area of the gas read screen and is saved in the same manner as the other gas readings.

Gas Type	**Range (PPM)**	**Resolution (PPM)**
H_2S	0-50	0.1
	0-200	1.0
CO	0-1000	1.0
SO_2	0-20	0.1
	0-100	1.0
NO_2	0-20	0.1
CL_2	0-20	0.1
H_2	0-1000	1.0
HCN	0-100	1.0

Gas pods are intended for use as an inexpensive detection means and not for regulatory reporting purposes. If the GEM™2000, fitted with a Gas Pod, indicates the presence of the selected gas, further testing should be performed with regulatory approved instrumentation. LANDTEC recommends that field calibration be performed using the relevant gas and concentration, prior to sampling with a gas pod.

2.9 Cold Start

THIS FUNCTION SHOULD BE USED ONLY AS A LAST RESORT.
(For Gas Calibration Error Messages, confirm that Factory Setting and User Calibration is done).

A Cold Start should only be carried out to correct an instrument if no other course of action has proved successful. This function **WILL ERASE** the instrument memory entirely. After a cold start is performed the user will need to reset the instrument to factory settings, perform a field calibration and reset the internal time/date to the default settings. Please note that the time/date may only be updated through DataField software. It cannot be updated manually.

To carry out a cold start, turn the instrument on, during the self-test press and continue to hold the 'ý' key until the self-test has been completed. Upon completion of the self-test, a pass code entry screen will be displayed. At this point the 'ý' key may be released. Enter the code **12345** and press 'ý' to confirm.

After the pass-code entry has been accepted, the instrument serial number will be displayed along with the hours of operation and two options:

1 - Cold Start
0 - Continue

ONLY select option '**1'** if a Cold Start is to be carried out. Press key '**1**' to confirm this operation. The cold start menu will be displayed again, press key '**0**' to continue with normal operation.

3 General Operations Menu

The following features and functions are selectable from the main menu via key **‘① Menu**’ from the read gas levels screen. Various options are available to the user including:

3.1 Zero Transducers

This function allows the user to zero the pressure transducer(s). Upon selection, the current pressure reading is displayed. The operation will be carried out when the ‘ý’ is pressed.

3.2 Update Site Data

Allows the user to answer questions (pre-defined in DataField software) relating to the site (e.g. name of operator, weather conditions, etc.). Site Questions are different from Site Comments.

This is covered in detail in Section 6 of this manual.

3.3 Data Logging (GA mode only)

Enables the user to leave the Instrument unattended to take samples at a pre-determined time. The reading interval and pump run time may be edited prior to commencing the logging cycle. The ID code may ONLY be set in DataField communication software.

Once the logging function is activated, the instrument will carry out a 30 second ‘Warm-up’ countdown (displayed bottom right) and begin the first sample. After each sample, the unit will shut down (sleep) to conserve power if the time between the pump ending and the next sample is greater than 30 seconds.

The instrument is reactivated (awakened) during a logging cycle, the company logo will be displayed for a few seconds and the read gas levels screen will be displayed. This will initiate a 30 second countdown to the next sample being taken unless the operator stops the logging function.

If for any reason during a logging cycle the inlet port were to become blocked the Instrument will sense this as a flow fail during the ‘pump on’ time and will automatically retry until a reading can be obtained. Therefore, position the sample tubing carefully to ensure no blockage due to water/moisture can occur.

3.4 Print Data

Allows ALL the data currently stored to be printed. This may ONLY be carried out with an appropriate RS232 cable (included with new instruments & available from LANDTEC) and a printer with a serial port connection.

3.5 Adjust Contrast

The GEM™2000 automatically adjusts the screen contrast according to the ambient temperature to maintain normal viewing.

The contrast can be manually adjusted by using the ‘Y’ and ‘[’ cursor keys. The manual contrast setting is stored when the instrument is switched off.

3.6 Field Calibration

Whenever carrying out a user calibration function it is important to ensure the correct value is entered. Additionally, in the case of a zeroing function, ensure only ambient air is used and no connection is made to a probe or wellhead fitting. The calibration cylinders sold by LANDTEC have a volume of 17 liters. The regulator, sold by same, is set to 0.5 liters per minute and 15 psig maximum. A normal field calibration usually requires the gas to be running for about two minutes.

Upon selecting this option, the Field Calibration screen is displayed. A brief description of the user span calibration procedure and the current reading (row ‘**R**’) and user span calibration gas values (row ‘**S**’) are displayed.
The span gas values may be changed via the ‘③ **Edit Target Concentrations**’ option. Once this option has been selected, **all** the gas values will require entry. Each entry is to be confirmed by pressing the ‘ý’ key.

3.6.1 Zero Channels

Selected from the ‘**Field Calibration**’ - ‘ý**-Calibration Menu**’ allows the relevant reading to be zeroed. When selected, a list of the available options will be displayed, this usually includes CH_4, and O_2, also the Gas Pod (if fitted).

Supply a zero gas mixture to the instrument for the gas to be zeroed. Ensure the reading for the selected gas has settled to its lowest value before selecting the zero function. When the required option is selected, the user zero function will be carried out automatically. The operation will be carried out when the ‘ý’ key is pressed.

3.6.2 Span Channels

Spanning Channels should be carried out prior to use or when the ambient operating temperature changes greater than +/- 20 degrees. Selected from the ‘**Field Calibration**’ - ‘ý**-Calibration Menu**’, allows the relevant reading to be span calibrated (in accordance with the calibration value entered). When selected, a list of the available options will be displayed, which includes CH_4, CO_2, O_2, (CO & H_2S for the Plus) and Gas Pod (if fitted).

When the required option is selected from the list, the span calibration function will be carried out automatically. When carrying out this procedure, ensure the span calibration procedure (as outlined below) is followed:

1. Apply the relevant known certified gas concentration through the inlet port of the Instrument.
2. Wait until the current gas reading has stabilized.
3. Select the required calibration option via the ‘ý**-Calibration Menu**’.

3.6.3 Factory Settings

This will clear any user zero and span calibration data. It will also restore the pre-programmed factory settings for **ALL** channels – CH_4, CO_2, O_2 (CO & H_2S for the Plus) or Gas Pod (if fitted) and pressure transducers.

3.6.4 Last Field Cal

Displays the date the last field calibration was carried out (zero or span).

3.7 Mode of Operation

Allows changing instrument between GA mode and GEM mode of operation.

4 Taking Probe Readings (GA Mode)

LANDTEC classifies non-extraction wells as Probes when **NOT** connected to an active vacuum extraction system. Probes, (commonly known as migration probes), may be placed on the perimeter of the landfill to test for gas migration or may be placed next to a building or road to test for the presence of Methane. The GEM™2000 / GEM™2000 Plus instrument may be configured as a Gas Analyzer (GA mode) for sampling probes. To access this function from the gas read screen press '①' for menu and scroll down to **Mode of Operation**, press the 'ý' key and highlight **Landfill Gas Analyzer**, pressing the 'ý' key again will select GA mode of operation.

4.1 Preliminary Checks

Prior to going to the test site, it is good practice to ensure:

- All necessary ID codes and readings have been uploaded via DataField software.
- The time and date are correct.
- The water trap has a clean and dry filter fitted.
- The inlet-port particulate filter is clean and dry.
- A supply of spare filters is available in case of accidental water blockage or contamination.
- The battery has a good charge (minimum 25% charge, even if only a few readings are required).
- The memory has sufficient space available.
- The CH_4, CO_2, and O_2 readings have been auto-zeroed, without gas concentration present.
- Check the span calibration with a known concentration calibration gas.

Travel to the site with the analyzer in the vehicle's interior - not in the trunk or truck bed, where it may be subjected to extremes of temperature and possible shock damage. Do not place the analyzer against anything hot (e.g. gas extraction pipe, car body or in an unattended car during the summer). This may cause erroneous readings.

When moving around a site, protect the instrument from strong direct sunlight, heavy rain or wind-chill. Strong direct sunlight can raise the temperature of the instrument beyond its operating range. If this occurs, the LCD display will appear almost black and the contrast setting cannot alter the contrast.

Always use the water trap! If the water trap becomes flooded, change the filter immediately and ensure all tubes are clear before re-use.

4.2 Update Site Data

Prior to taking the readings at a particular site, the Site Data should be updated (if programmed). This is accessed via the General Menu '① **Update Site Data**'. This function removes the need for the site conditions to be recorded manually.

A series of up to five questions can be pre-programmed with the use of DataField and answered at this time. The answers to these questions are stored and appended to each reading stored thereafter, until the site data is updated for another site.

4.3 Taking Readings – With ID

For this function to be used it is essential that the relevant ID and if required, previous readings are uploaded to the Instrument. An ID **cannot** be entered from the Instrument.

1. When the read gas levels screen is displayed, option **'③ Next ID'** should be selected. A list of stored IDs is displayed for selection via the 'ė' and 'Ę' cursor keys, the 'next' ID on the list is automatically highlighted. To confirm selection, press the 'ý' key. The display may be toggled to

display any relevant ID information such as a description of the probe location, work to be carried out, etc.

2. A reminder is displayed to disconnect sample tubes, as a clean air purge will automatically remove the previous sample from the instrument. Purge time may be set via DataField (default is 30 seconds). Once the 'ý' key is pressed, purge will begin and the Read Gas Levels screen will be displayed upon completion. The purge may be aborted by pressing the '①**EXIT**' key.
3. The ID number selected and the pump runtime is displayed in the upper left corner of the read gas levels display.
4. At this point, connect the sample tube (with water trap) from the sample point to the inlet port of the instrument, ensuring the connector 'clicks' into place. Then connect the sample tube to the probe sample port. **Do not connect the sample tube to the probe port before connecting to the instrument as this will cause any pressure in the probe to dissipate and a proper pressure reading will not be taken.**
5. As soon as the connection is made, the relative/static pressure reading will be displayed. No sample is taken from the probe at this time. Once the reading stabilizes and the pump starts, the relative/static pressure reading is stored. The relative/static reading will remain displayed as the pressure last taken.
6. The pump will run for the pre-programmed time and a countdown timer will be displayed. The pump may be stopped or started at anytime by way of the '✇' (pump) key. The reading may be stored at anytime with the use of the 'ý' key. When the pump automatically stops this should be used as a prompt to store the reading.
7. Upon storing the reading, any pre-programmed questions will be displayed for response. This may require a numeric, alphanumeric selectable comment, or exclusive comment answer. A maximum of eight selectable and exclusive comments may be entered.
8. Disconnect the sample tubing from the probe and proceed to Step 1 for the next probe.

For each reading, the following information will be stored:
- ID code.
- Current time/date.
- Site data (if entered).
- All gas readings and balance (CH_4, CO_2, O_2 (, CO and H_2S for the Plus)).
- LEL CH_4.
- Barometric Pressure.
- Relative Pressure.
- Questions/comments.
- Temperature (if temperature probe is connected).
- Gas Pod (if connected).

When the instrument is switched off, a clean air purge is automatically started for a pre-determined period. This may be aborted with the use of the 'ý' key, although it is not recommended.

A tone will sound and a flashing bell will be displayed next to the appropriate gas reading value if a preset alarm condition has been exceeded.

4.4 Taking Readings – Without ID

1. From the ID list press **'⑤ Select No ID**' or, if ID information has not been uploaded to the instrument, an ID list will not be available. In either case, the ID will be displayed and stored as '**- - - - - - -**'.
9. A reminder is displayed to disconnect sample tubes, as a clean air purge will automatically remove the previous sample from the instrument. Purge time may be set via DataField (default is 30 seconds). Once 'ý' is pressed, purge will begin and the Read Gas Levels screen will be displayed upon completion. The purge may be aborted by pressing the '①**EXIT**' key.

2. At this point, connect the sample tube (with water trap) from the sample point to the inlet port of the instrument, ensuring the connector ‘clicks’ in to place.
3. Now connect the sample tube to the probe sample port. **Do not connect the sample tube to the probe port before connecting to the instrument as this will cause any pressure in the probe to dissipate and a proper pressure reading will not be taken.**
4. The pump may be started or stopped at anytime by way of the ‘✇’ (pump) key and a ‘time-on’ timer will be displayed. The pump should always be stopped using the ‘ý’ key, before storing a reading.
5. Upon storing the reading, a virtual keyboard will be displayed for any alphanumeric comments to be entered.
6. Disconnect the sample tubing from the probe and proceed from step 1 for the next probe.

Except for the ID code information, which will be stored as ‘**- - - - - - - -**‘, and probe questions, for each reading the information stored will be the same as that for a reading with an ID.

A tone will sound and a flashing bell will be displayed next to the appropriate gas reading value if a preset alarm condition has been exceeded.

4.5 Temperature Probe Reading

The GEM™2000 / GEM™2000 Plus has the facility to automatically display and record the probe temperature via an optional temperature probe (TP-100). When a temperature probe is fitted to the RS232 Communication Socket, the temperature will be displayed in the read gas levels screen and recorded with all other data. The temperature probe is part of the GEM™2000 UL certification and is therefore certified for use under the same conditions as the instrument.

4.6 Cross-Gas Effects

4.6.1 Methane, Carbon Dioxide and Oxygen

Methane is measured using dual beam infrared absorption. The Methane reading is filtered to an absorption frequency of 3.41μm (nominal). Instruments are calibrated using certified Methane mixtures and will give correct readings provided there are no other hydrocarbon gasses present within the sample (e.g. ethane, propane, butane, etc.). If there are other hydrocarbons present, the Methane reading will be higher (never lower) than the actual Methane concentration being monitored.

The extent to which the Methane reading is affected depends upon the concentration of the Methane in the sample and the concentration of the other hydrocarbons. The effect is non-linear and difficult to predict. The instrument does not read total hydrocarbons. If other hydrocarbons are present in the sample gas a filter should be used to remove them and mitigate the cross gas effects. Typically trace levels of other hydrocarbons (<100ppm) will not induce a cross gas effect and do not require filtering.

The Carbon Dioxide reading is filtered to an infrared absorption frequency of 4.29µm (nominal), the frequency specific to Carbon Dioxide. Therefore, any other gases usually found on landfill sites will not affect the Carbon Dioxide reading.

The Oxygen sensor is a galvanic cell type and suffers virtually no influence from CO_2, CO, H_2S, SO_2 or H_2, unlike many other types of Oxygen cell.

The infrared sensors will not be "poisoned" by cross gas effects. Normal operation will resume as soon as the gas sample has been purged.

Note - there has been one reported incident of a high reading due to the presence of Carbon Disulfide, which has a similar absorption frequency to Carbon Dioxide.

4.6.2 H_2S, CO and other Optional Gas Pods

The Gas Pods used to measure H_2S and CO do suffer from cross-gas effects. Such effects are not accurately specified. However, the following table may be useful as a guide. This table represents how many ppm would be read by a Gas Pod if 100ppm of the interfering gas was applied, (with no other cross-contaminates being present in the sample).

Cell	**CO**	**H_2S**	**SO_2**	**NO_2**	**CL_2**	**H_2**	**CH_4**	**CO_2**
CO	100	<3	0	<-20	0	<40	0	0
H_2S	<0.5	100	~20	~-20		~0.1	0	0

NOTE: All readings are given in parts per million (ppm). The life of an electrochemical cell is determined by exposure to gasses, typical life being one to two years. It is recommended that Gas Pods be field calibrated at regular intervals.

NOTE: Cross-gas effects can be mitigated by employing a filter for the gas not being tested. The GEM™2000 Plus has a built-in H_2S filter to protect the CO sensor.

4.7 Memory

The instrument's memory is volatile. It is maintained by a battery back-up system, which will maintain the memory while the battery is being changed.

The memory is not to be used as a permanent storage medium and any data should be transferred to a more permanent storage medium as soon as possible. An Instrument should never be stored for prolonged periods with valuable data in its memory.

Although unlikely, sudden shocks, high levels of electromagnetic interference or static discharge may cause memory corruption or loss. If this occurs, the instrument should be Cold Started and the calibration reset to factory settings before further use. **Cold starting will erase all data in the instrument including resetting the time and date to the default value**.

4.8 RF Interference

The gas sensors, especially the Methane sensor, are sensitive to RF interference.

Any device that transmits radio waves can cause your gas readings to fluctuate. Cell phones are the most common cause of the problem. You should never use your cell phone while you are taking gas readings.

5 Taking Extraction Well Readings (GEM Mode)

LANDTEC classifies gas-producing penetrations on landfills as wells when used with vacuum extraction systems and flow determining devices such as the Accu-Flo wellheads, orifice plates or pitot tubes. The GEM™2000 / GEM™2000 Plus may be configured as a Gas Extraction Monitor (GEM mode) for the purpose of sampling wells and obtaining flow measurements. To access this function from the gas read screen press ‘①’ and scroll down to **Mode of Operation**, press the ‘ý’ key and highlight **Gas Extraction Monitor**, pressing the ‘ý’ key again will select GEM mode of operation.

5.1 Preliminary Checks

Prior to going on site, it is good practice to ensure:

- All necessary ID codes and readings have been uploaded via DataField software.
- The time and date are correct.
- The water trap has a clean and dry filter fitted.
- The inlet-port particulate filter is clean and dry.
- A supply of spare filters is available in case of accidental water blockage or contamination.
- The battery has a good charge (minimum 25% charge, even if only a few readings are required).
- The memory has sufficient space available.
- The CH_4, CO_2 and O_2 readings have been auto-zeroed without gas concentration present.
- Check the span calibration with a known concentration calibration gas.

Travel to the site with the analyzer in the vehicle’s interior - not in the trunk or truck bed, where it may be subjected to extremes of temperature and possible shock damage. Do not place the analyzer against anything hot (e.g. gas extraction pipe, car body or in an unattended car during the summer). This may cause erroneous readings.

When moving around a site, protect the instrument from strong direct sunlight, heavy rain or wind-chill. Strong direct sunlight can raise the temperature of the instrument beyond its operating range. If this occurs, the LCD display will appear almost black and the contrast setting cannot alter the contrast.

Always use the water trap! If the water trap becomes flooded, change the filter immediately and ensure all tubes are clear before re-use.

5.2 Update Site Data

Prior to taking the readings at a particular site, the Site Data should be updated (if programmed). This is accessed via the General Menu ‘①’. This function removes the need for the site conditions to be recorded manually. A series of up to five questions can be pre-programmed with the use of DataField and answered at this time. The answers to these questions are stored and appended to each reading stored thereafter, until the site data is updated for another site.

5.3 Taking Gas and Flow Readings (GEM Mode)

The GEM mode of operation is designed to allow for gas flow (SCFM) and energy measurements (BTU) to be calculated at the wellhead. This function requires the use of an ID that has been uploaded from DataField software with the type of flow device defined. **Gas flow and BTU will not be calculated if this action has not been performed.**

1. When the gas read screen is displayed select **‘③ Next ID’**. A list of stored IDs will be displayed for selection via the ‘ė’ and ‘Ę’ cursor keys, the ‘next’ ID is automatically highlighted, to confirm the selection press the ‘ý’ key. The screen may be toggled to display any relevant ID information such as a description of the well location, work to be carried out, etc.

2. A reminder is displayed to disconnect sample tubes, as a clean air purge will automatically remove the previous sample from the instrument. Purge time may be set via DataField (default is 30 seconds). Once the 'ý' key is pressed, purge will begin and the Read Gas Levels screen will be displayed upon completion. The purge may be aborted by pressing the '①**EXIT**' key.
3. Connect the sample tubes (with water trap filter) to the wellhead ensuring the gas sample tube and impact pressure tubes are properly oriented. Insert the temperature probe if used.
4. Press the '✇' key to start the sample pump; a countdown timer will be displayed in the upper left area of the display. The pump may be stopped and restarted and any time by pressing the '✇' key. The pump run time is set in DataField software. Allow the gas readings to stabilize and press '⑤**Measure Flow**' key, this will store the gas level readings and display the '**PRESSURE READINGS**' screen. Note; a flashing bell will be displayed next to the appropriate gas and a beeping tone will be heard, if a preset alarm condition has been exceeded.
5. The '**PRESSURE READINGS**' screen will prompt the user to disconnect the sample tubes and allow the pressure to stabilize. Once the pressure has stabilized press 'ý **Zero Transducers**'. Press '①' to continue. **Note**; if Accu-Flo wellheads are used this zero function may be performed prior to connecting the sample tubes to the well head by selecting **'① MENU**' and highlighting '**ZERO TRANSDUCERS**'. This eliminates the need to disconnect and re-connect the sample tubes on the same wellhead.
6. If a temperature probe is not connected, the user is prompted to manually input the gas temperature, press the 'ý' key when entry is finished.
7. The gas flow and energy screen is now displayed showing all the gas level readings taken in the gas read screen as well as the level of gas flow (SCFM) and power (BTU). In addition, Adjusted, Current and Previous (if downloaded) readings are displayed so modifications may be made to the well if required.
8. Pressing 'ý **STORE**' will save the readings to memory. Then, the comments screen (if comments were loaded) will display and allow you to answer questions or select comments about the condition of the well. A total of seven comments and one exclusive comment may be stored with each ID.
9. Press '③ **NEXT ID**' and proceed to the next wellhead. An automatic purge will be performed at this time to ensure the sample has been exhausted from the instrument.

For each reading, the following information will be stored:

- ID code.
- Current time/date.
- Site data (if entered).
- All gas readings and balance gas (CH_4, CO_2, O_2 (CO & H_2S for the Plus)).
- Barometric Pressure.
- Temperature.
- Gas Pod (if connected).
- Gas flow (SCFM) and Power (BTU).
- Comments and exclusive comment.

When the Instrument is switched off, a clean air purge is automatically started for a pre-determined global period. This may be aborted by pressing the 'ý' key, although we do not recommend this action.

6 DataField CS Software

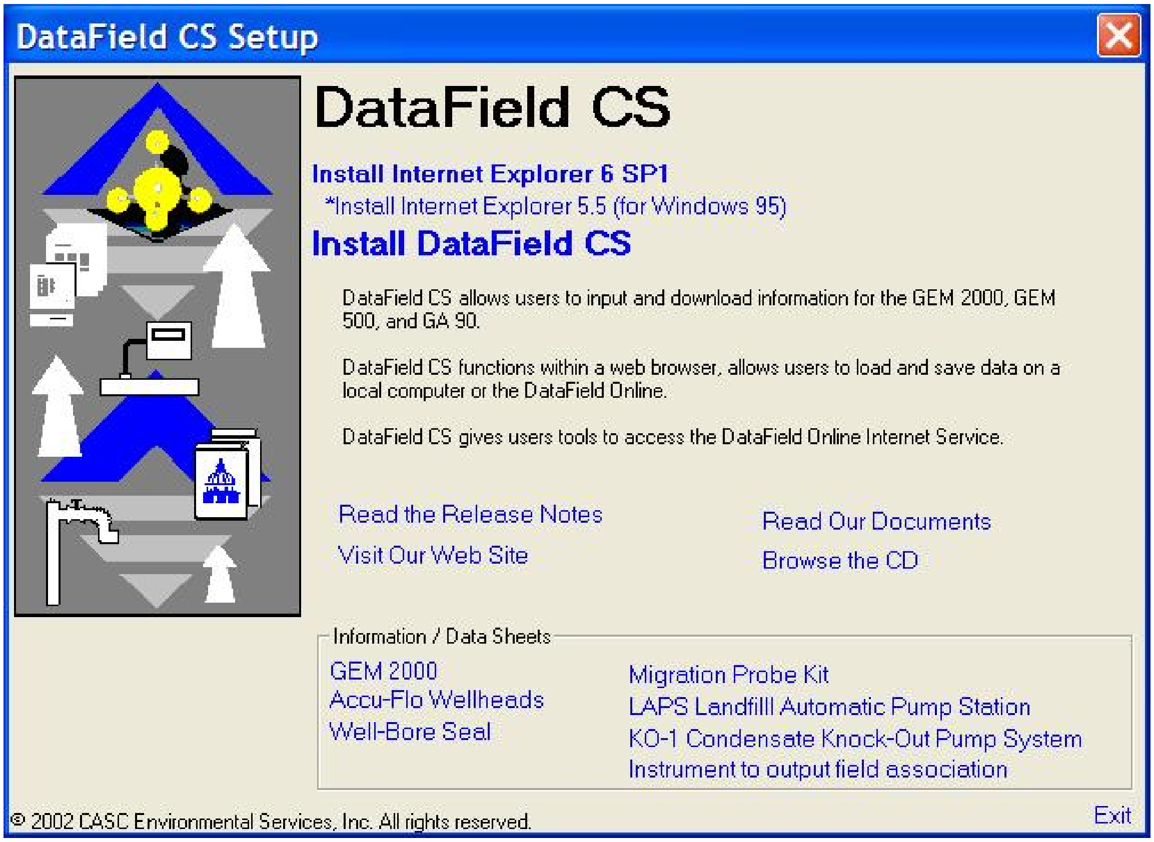
DataField CS is an integrated software program designed to communicate with the GEM™2000, Plus, GEM™2000, GEM™500 and GA-90 instruments. The software will create files used for storing gas read data, ID data, comments and instrument configuration data. The files created are significantly different from the files created with GEM_COMM or GA_COMM software and are not compatible with these versions of software.

DataField CS is browser based (Java enabled) and will operate on Windows 98/ME/NT/2000/XP operating systems. Recommended hardware requirements are:

- Pentium III 500 MHz microprocessor or equal.
- 64 MB RAM.
- 120 MB of free hard disk space.
- CDROM drive.
- Mouse or pointer system.
- Standard keyboard.
- Installed printer.

6.1 Installing DataField CS

Be sure your computer is turned on and all software programs have been properly closed. Place the program disk in the CD ROM drive and close the tray. DataField CS will self start and display the DataField CS set-up screen.*



DataField CS Setup

DataField CS

Install Internet Explorer 6 SP1

*Install Internet Explorer 5.5 (for Windows 95)

Install DataField CS

DataField CS allows users to input and download information for the GEM 2000, GEM 500, and GA 90.

DataField CS functions within a web browser, allows users to load and save data on a local computer or the DataField Online.

DataField CS gives users tools to access the DataField Online Internet Service.

Read the Release Notes

Visit Our Web Site

Read Our Documents

Browse the CD

Information / Data Sheets

GEM 2000

Accu-Flo Wellheads

Well-Bore Seal

Migration Probe Kit

LAPS Landfilll Automatic Pump Station

KO-1 Condensate Knock-Out Pump System

Instrument to output field association

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Exit

Install the Internet Explorer 6 SP1 by clicking on the corresponding link in the DataField CS set-up screen. If you are using Windows 95, install the Internet Explorer 5.5. Follow the onscreen instructions until the Internet Explorer is installed successfully.

Reboot the computer after the installation of the Internet Explorer is completed.
Re-insert CD Rom to start autorun again.
Install the DataField CS by clicking on the corresponding link in the DataField CS set-up screen. Follow the onscreen instructions.*

Other useful links on the DataField CS set-up screen:

Read the DataField CS Overview link will open a presentation with an overview of DataField CS.
Read the Release Notes link has information on the system requirements, application compatibility and other important issues.
Visit Our Web Site link will open the LANDTEC web site.
Read Our Documents link will open a new window with manuals and user guides for GEM Instruments, as well as several viewers and 3rd party tools that can be downloaded.
Browse the CD link will open a file browser.
Information / Data Sheets set of links provides information on various Landfill instruments.

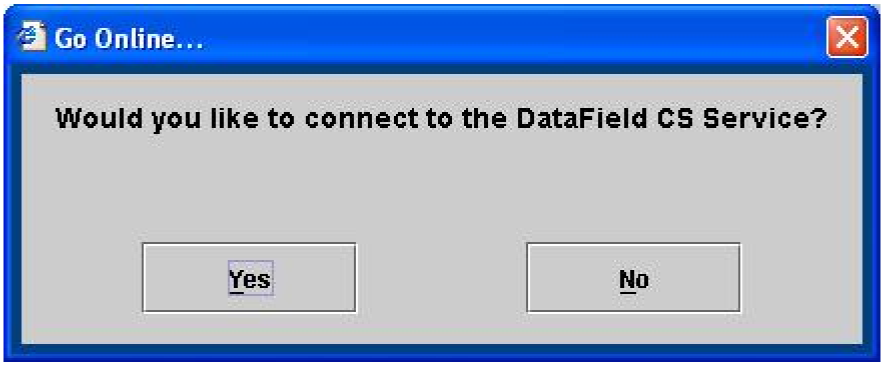
* If the DataField CS set-up screen hasn't appeared, open a file browser (ex. right-click on the Start button on your desktop and choose open) and navigate to your CD-ROM drive. Double-click on the **Autorun.exe**.

6.2 Establishing Communications

Connect the RS-232 download cable to an open COM port on your computer. Connect the other end of the RS-232 download cable to the GEM™2000 / GEM™2000 Plus data port. DataField CS has the ability to automatically scan the different COM ports on your computer to find where the instrument is connected.

Turn the instrument on, wait for the self-test function to finish. The Gas Readings screen will display, if not, then turn off the GEM and re-start the instrument. The GEM™2000 / GEM™2000 Plus must be in the Gas Reading screen in order to establish communications.

Once the instrument is in the proper communications mode, click on the Start menu then All Programs menu. Scroll to DataField and then DataField CS to initialize the software. The following screen will appear on the computer.



Would you like to connect to the DataField CS Service?

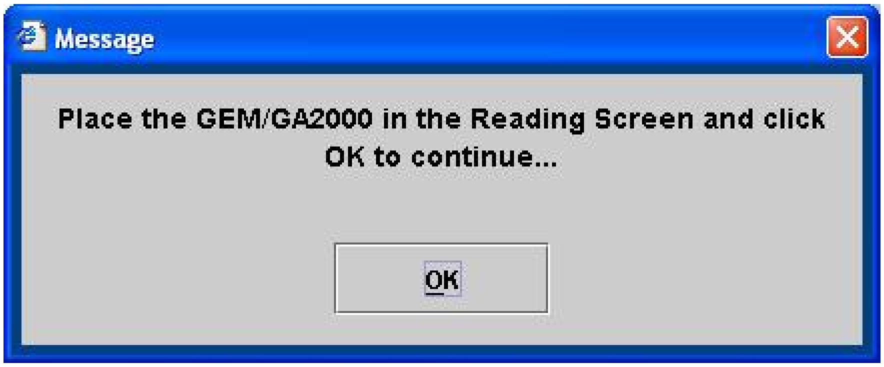
Click Yes to run DataField CS online or No to run it offline.

[Offline]DataField CS Instrument Operations

Please select an Instrument Type

19 seconds remaining...

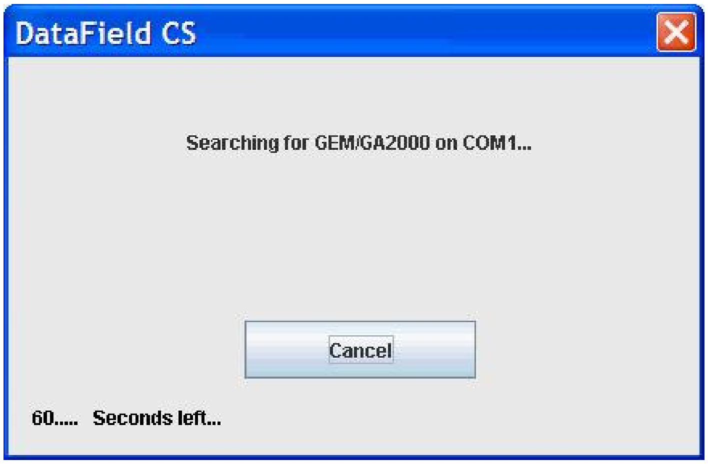
Click on the GEM/GA2000 button. You can also click on the Auto-Detect button for the DataField CS to automatically detect the instrument.



Message

Place the GEM/GA2000 in the Reading Screen and click OK to continue...

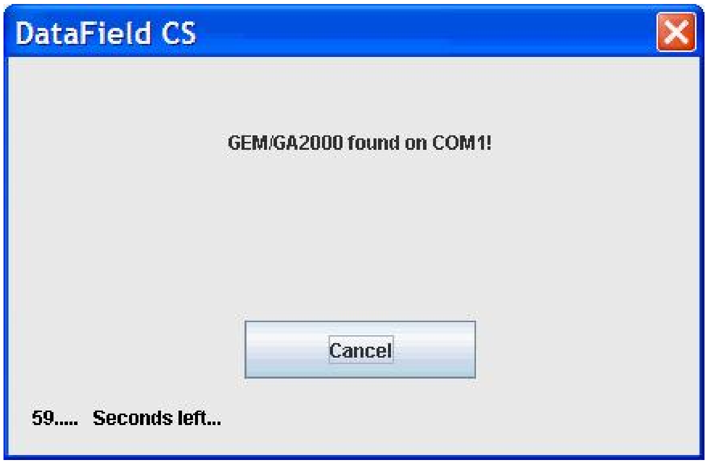
Click OK and DataField CS will automatically search for the instrument. This may take a few minutes. When the instrument is found and the communication is established, the software will display a box that indicates what type of instrument was found. If the software does not find the instrument, it will display a box that indicates that no instrument was found.



DataField CS

Searching for GEM/GA2000 on COM1...

60..... Seconds left...



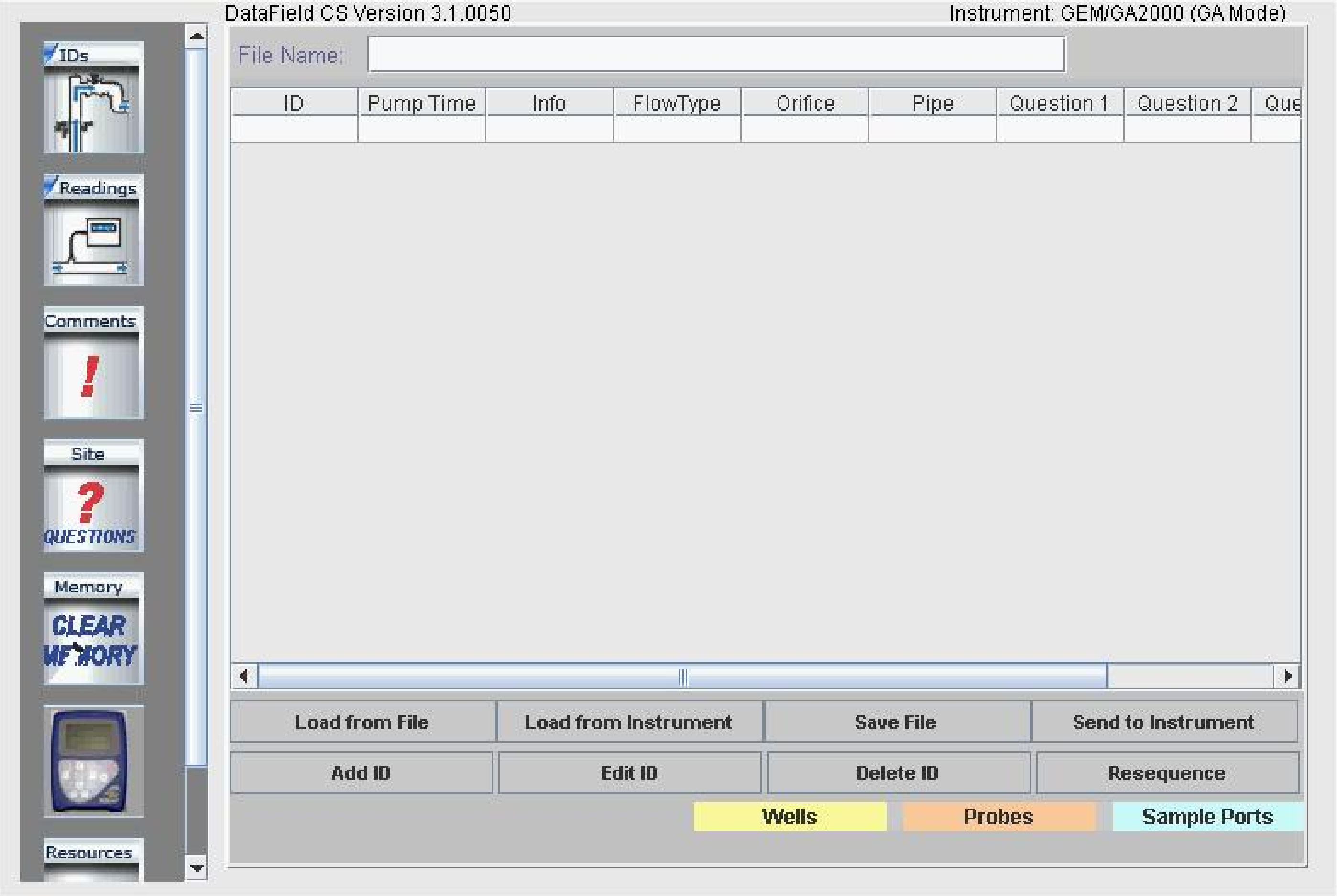
DataField CS

GEM/GA2000 found on COM1!

59..... Seconds left...

6.3 Main Screen

Once DataField CS establishes the communication with the instrument, the main software screen will appear.



Seven main categories (buttons) are listed down the left side of the screen: ID Functions, Readings, Comments, Site Questions, Clear Memory, Instrument Settings and Resource Links. Clicking on any one of the buttons will take the user to that functionality of the application.

6.4 Close the program

Clicking on the **Close** button in the top right corner of the screen will exit the program. This will close all files and exit the program.

6.5 Communications

It is not possible to change instruments and establish communications without re-starting the software.

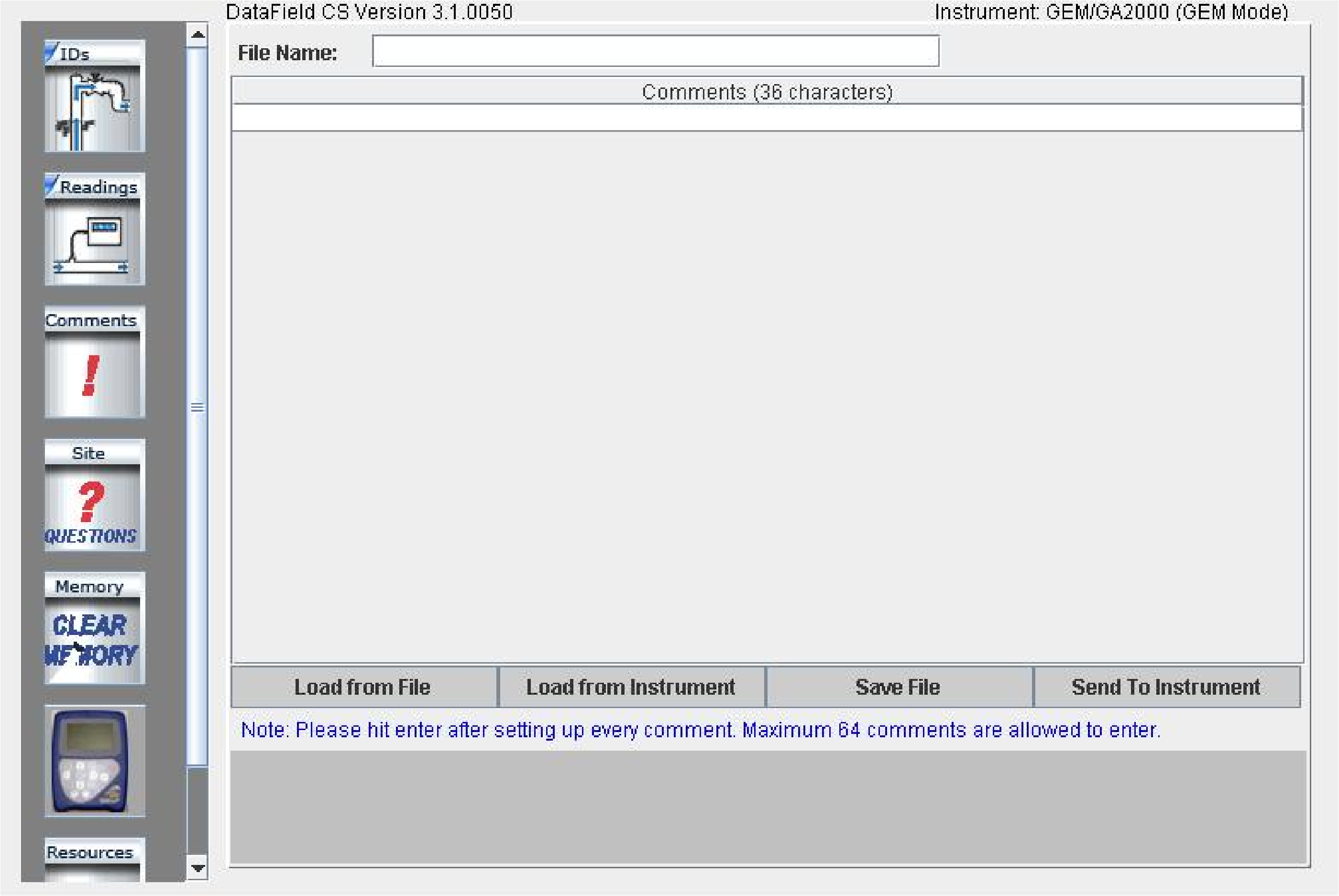
6.6 Functions

Each button has a specific function as listed below:

1. **Comments** – Allows entry of comments that may be selected for the IDs. A total of seven comments and one exclusive comment may be selected for each ID.
2. **IDs** – Used for adding new IDs, editing IDs or deleting IDs and entry of ID parameters such as pump run time, flow device, comments and questions for the ID.
3. **Readings** – Allows downloading and viewing data from instrument and uploading of previous data to the instrument.
4. **Site Questions** – DataField CS supports a total of five site questions that are answered by the technician and saved to the ID data.
5. **Clear Memory** – Allows the deletion if selective IDs, readings, comments, site questions or all memory loaded in instrument memory.
6. **Resource Links** – Allows the user to directly access information via the www.

6.6.1 Comments

DataField CS allows up to 64 comments to be created for upload to the GEM™2000. Each comment may be up to 36 characters in length and may be alphanumeric or any character on the computer keyboard. **Select Comment** or **Exclusive Comment** must be turned on for comments to be selected for that ID. See section 6.6.2. Click on the **Comments** button to open the following screen.



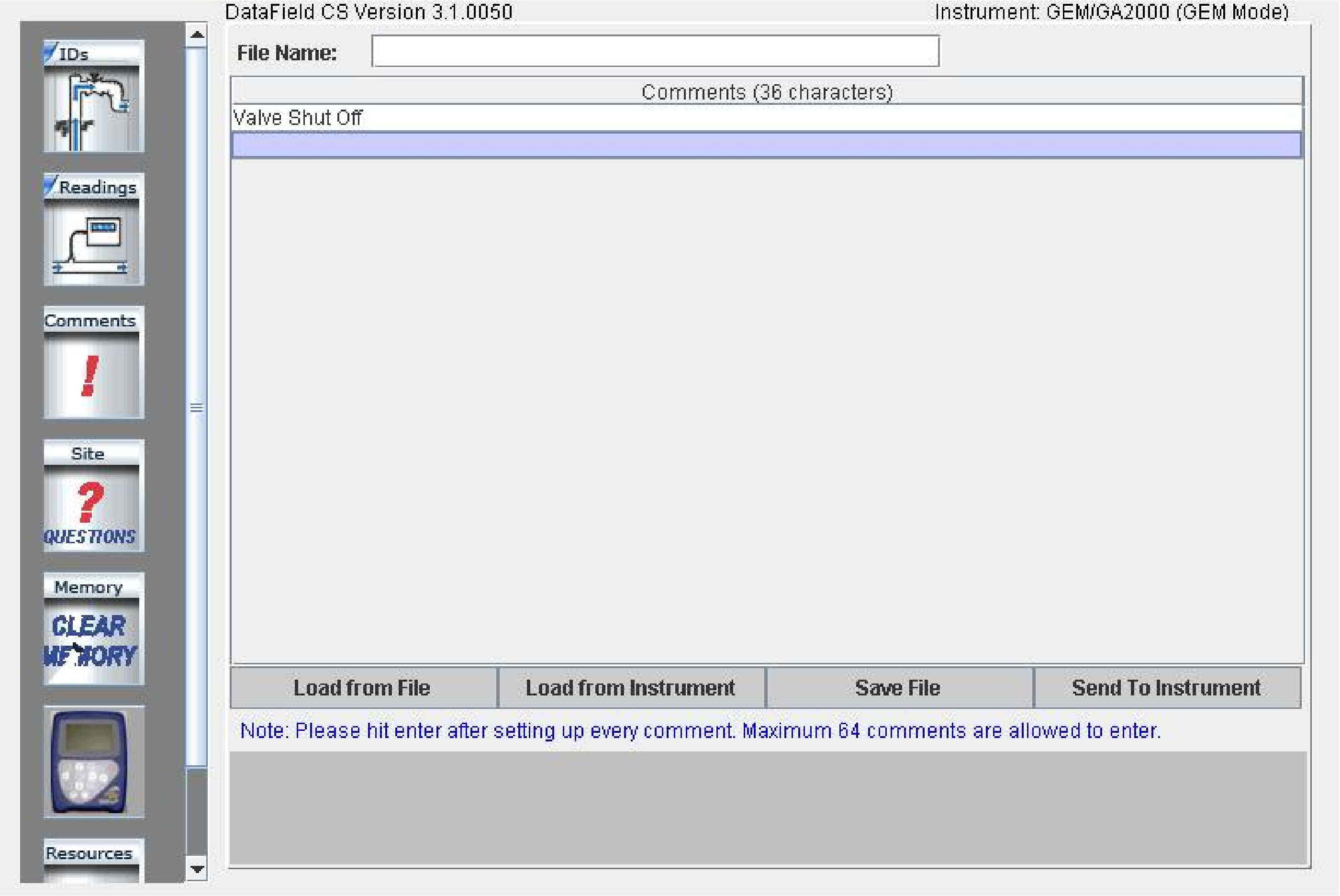
DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

File Name:

Comments (36 characters)

Note: Please hit enter after setting up every comment. Maximum 64 comments are allowed to enter.



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

File Name:

Comments (36 characters)
Valve Shut Off

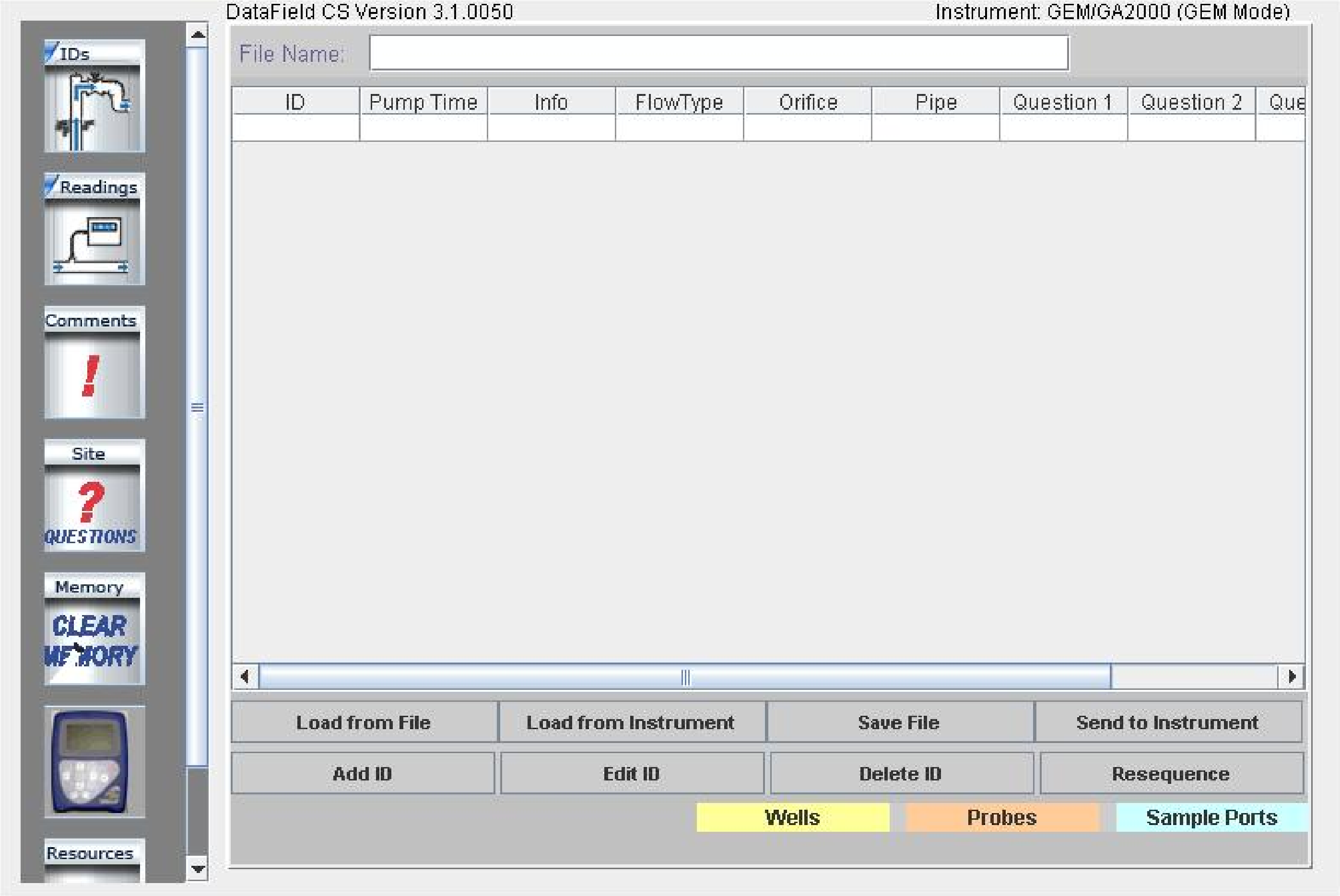
Note: Please hit enter after setting up every comment. Maximum 64 comments are allowed to enter.

Enter the comment on the comment line and press **Enter** to continue entering comments until all the desired comments have been entered. Click on **Save File** to save the data to disk and then click on **Send to Instrument** to save the comments in the instrument. To delete a comment, click on the comment to highlight the comment and press the **Delete** key on the computer keyboard to remove the highlighted comment. It is always suggested to save the comment file because of the potential size and time required to recreate the comments. Once created, the comment file may be modified and saved under a different file name at any time.

Note: Comments must be created and sent to the instrument through the software. They can not be hand input into the instrument in the field.

6.6.2 Entering IDs

From the opening screen select the **ID** button. The following screen will open:



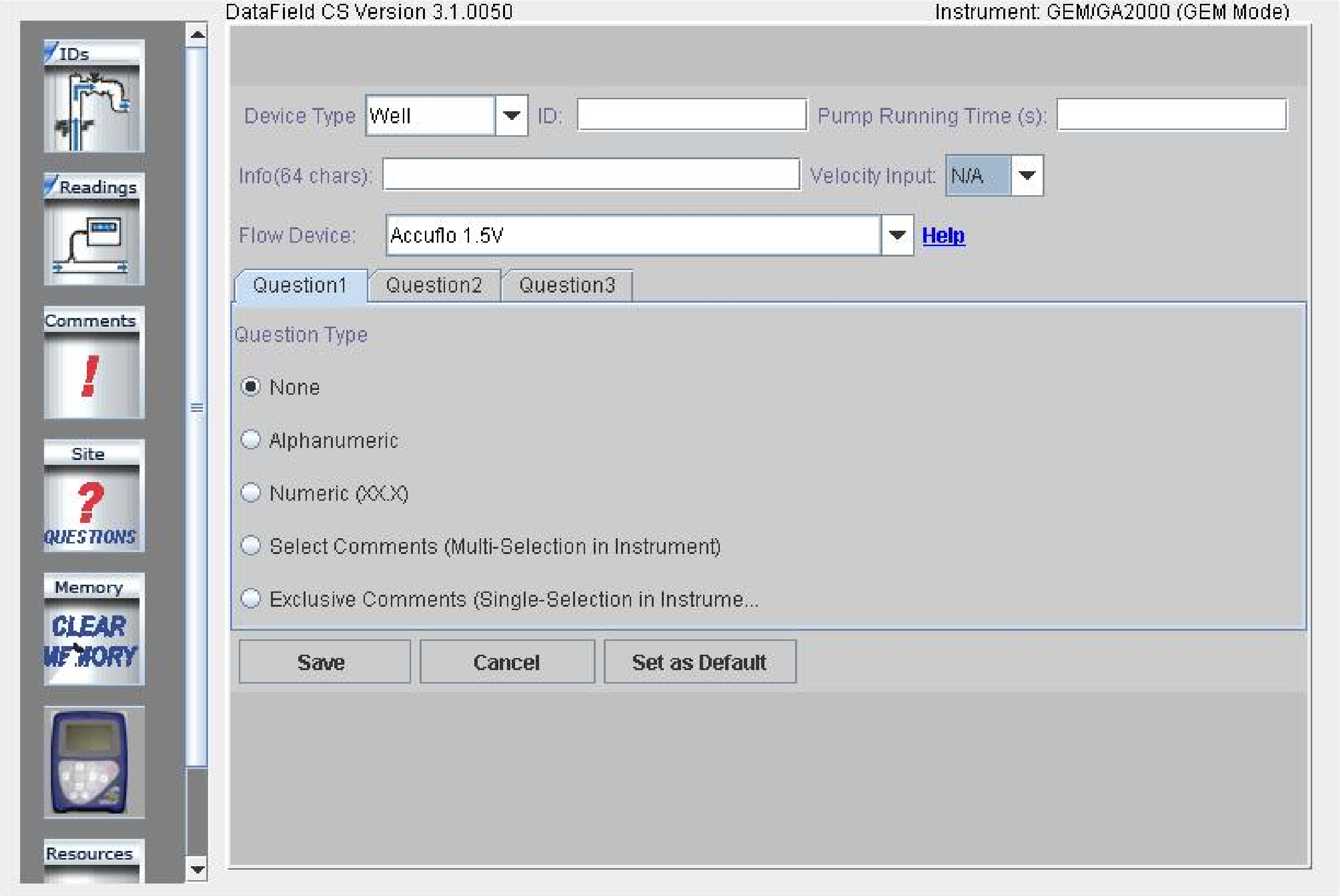
Selecting the **Save File** button will allow you to enter the name for the file you wish to save. The naming of files follows the extended naming convention for Windows (255 characters maximum, all characters allowed except \ / : * ? " < > |).

Selecting the **Load from File** button will allow a previously created file to be loaded from the computer disk drive.

Selecting the **Load from Instrument** button will allow previously loaded IDs in the instrument to be downloaded for modification such as increasing the pump run time or adding additional comments to a specific ID. CAUTION: Loading IDs from an instrument can be a dangerous practice and is not recommended if using DF online service. The possibility exists of introducing into a project IDs from another project. When the IDs are downloaded from the instrument and stored online all IDs that are present in the instrument will be stored to the current project IRRESPECTIVE of if the IDs belong to the project.

Add ID button is used for the creation of a new ID or multiple IDs that may be sent to the instrument or saved to a new file for later use.

To enter a new ID or create a new ID set, click on the **Add ID** button and the following screen will open:



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

Device Type: Well

ID:

Pump Running Time (s):

Info(64 chars):

Velocity Input: N/A

Flow Device: Accuflo 1.5V

Question Type

● None

○ Alphanumeric

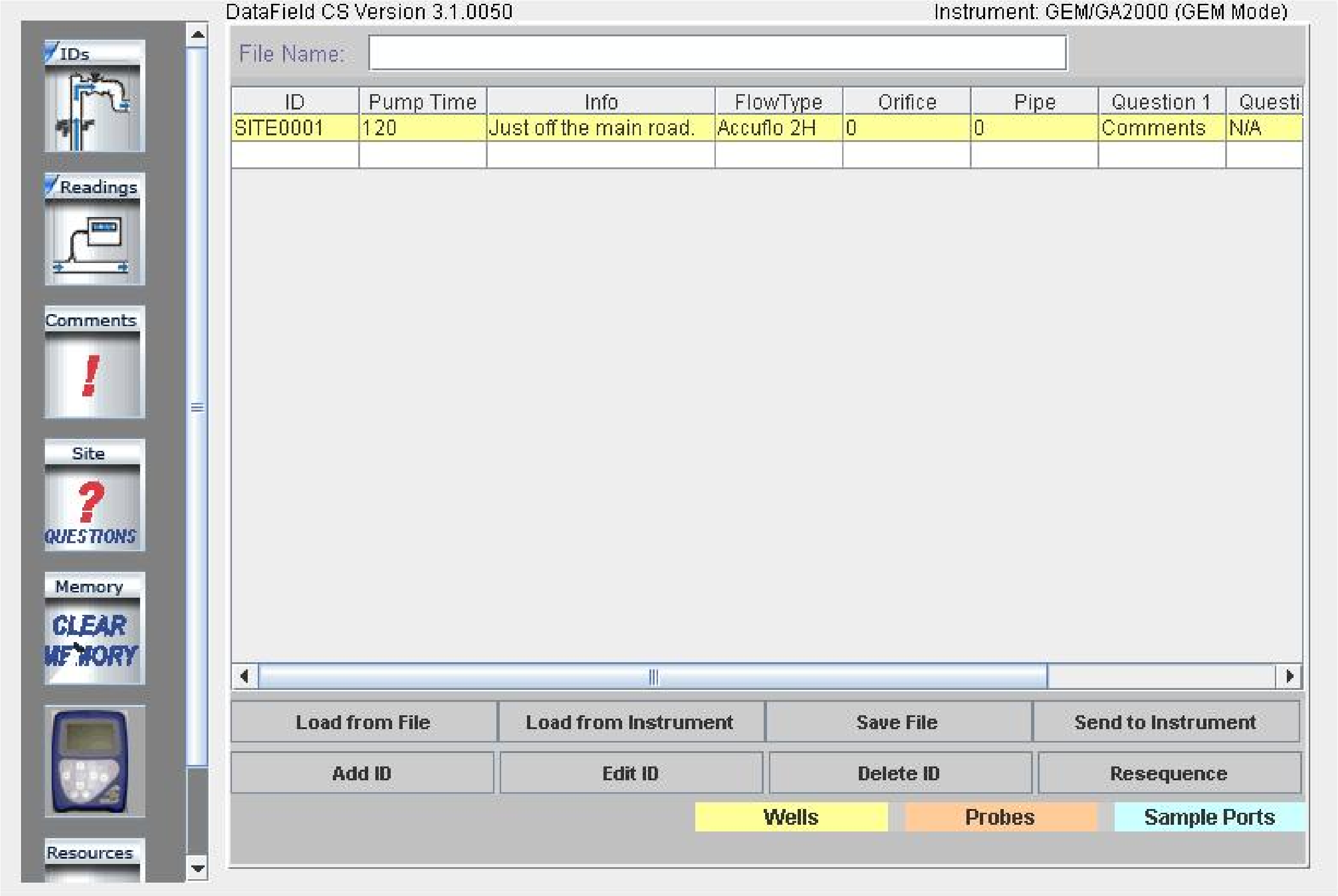
○ Numeric (XX.X)

○ Select Comments (Multi-Selection in Instrument)

○ Exclusive Comments (Single-Selection in Instrume...

Enter the Well ID in any combination of alpha or numeric characters for a maximum of eight characters. **All eight characters must be used**. Enter the pump run time in seconds (maximum of 999 seconds); pump run time must be entered in order for the pump to be turned on for gas sampling. Enter information about the well, such as its location, previous problems, etc or leave blank. Enter the type of flow device used with the well (Accu-Flo wellhead, Pitot tube, or orifice plate); user input may also be selected. If Pitot tube or orifice plate is selected, the **inside** pipe diameter and **orifice diameter** must be entered. If the pump run time and the flow device are going to be the same for multiple wells, click on **Set as Default** to lock these two values. Three questions may be asked about the well for reply by the technician at the time a sample is taken. These can take the form of alphanumeric, numeric, selected comments or exclusive comments. If none is selected then no questions will be asked for this ID. Note: **If Select Comments or Exclusive Comments is selected, Comments must be created and sent to the instrument.** See section 6.6.1.

Click on **Save** to add this ID to the editor screen seen below. If additional IDs need to be entered, simply click on **Add ID** and enter the data as before.

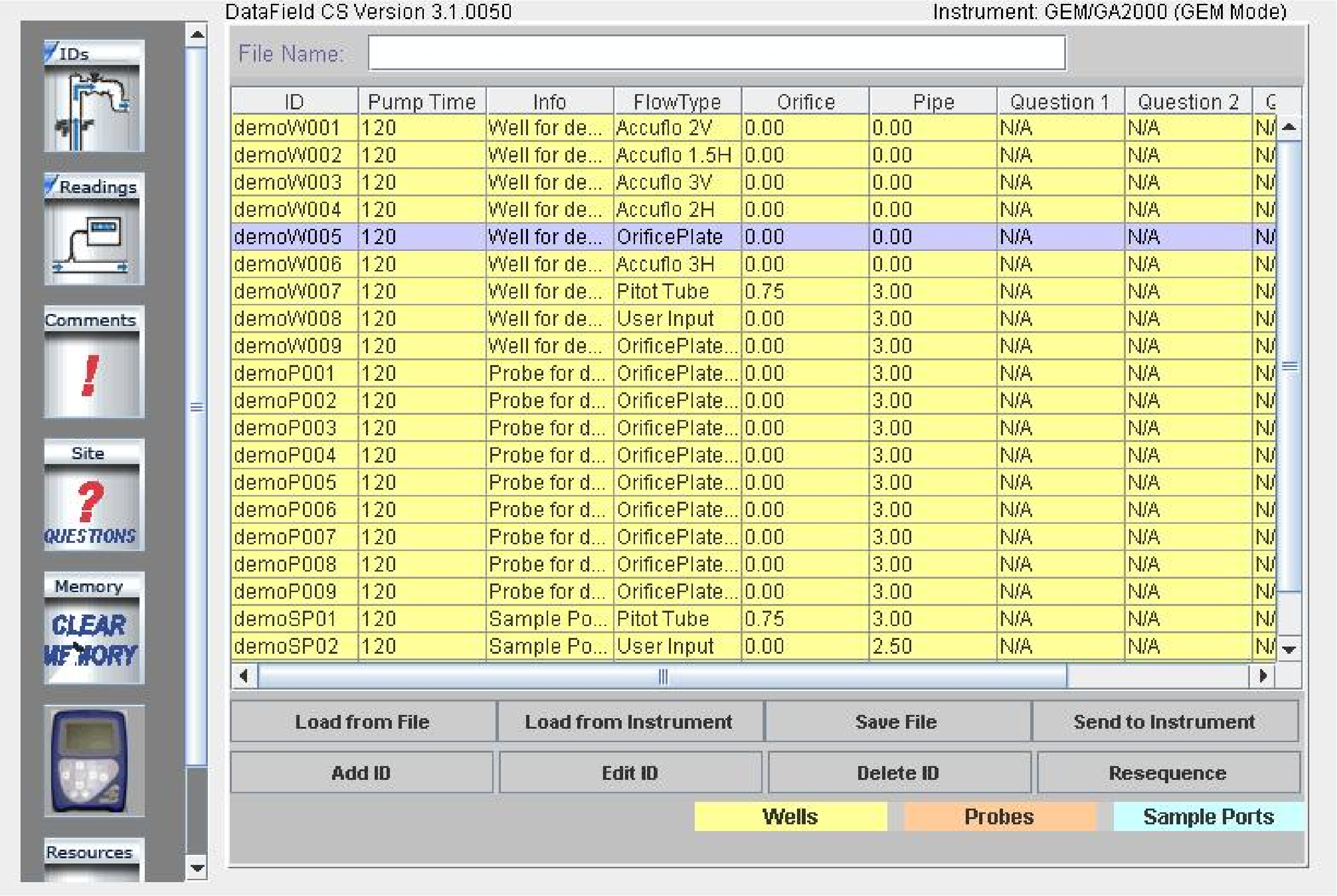


ID	Pump Time	Info	FlowType	Orifice	Pipe	Question 1	Questi
SITE0001	120	Just off the main road.	Accuflo 2H	0	0	Comments	N/A

Once all the IDs have been entered, click **Save File** button to save the ID data to a file or **Send to Instrument** button if data is to be uploaded to an instrument for field sampling.

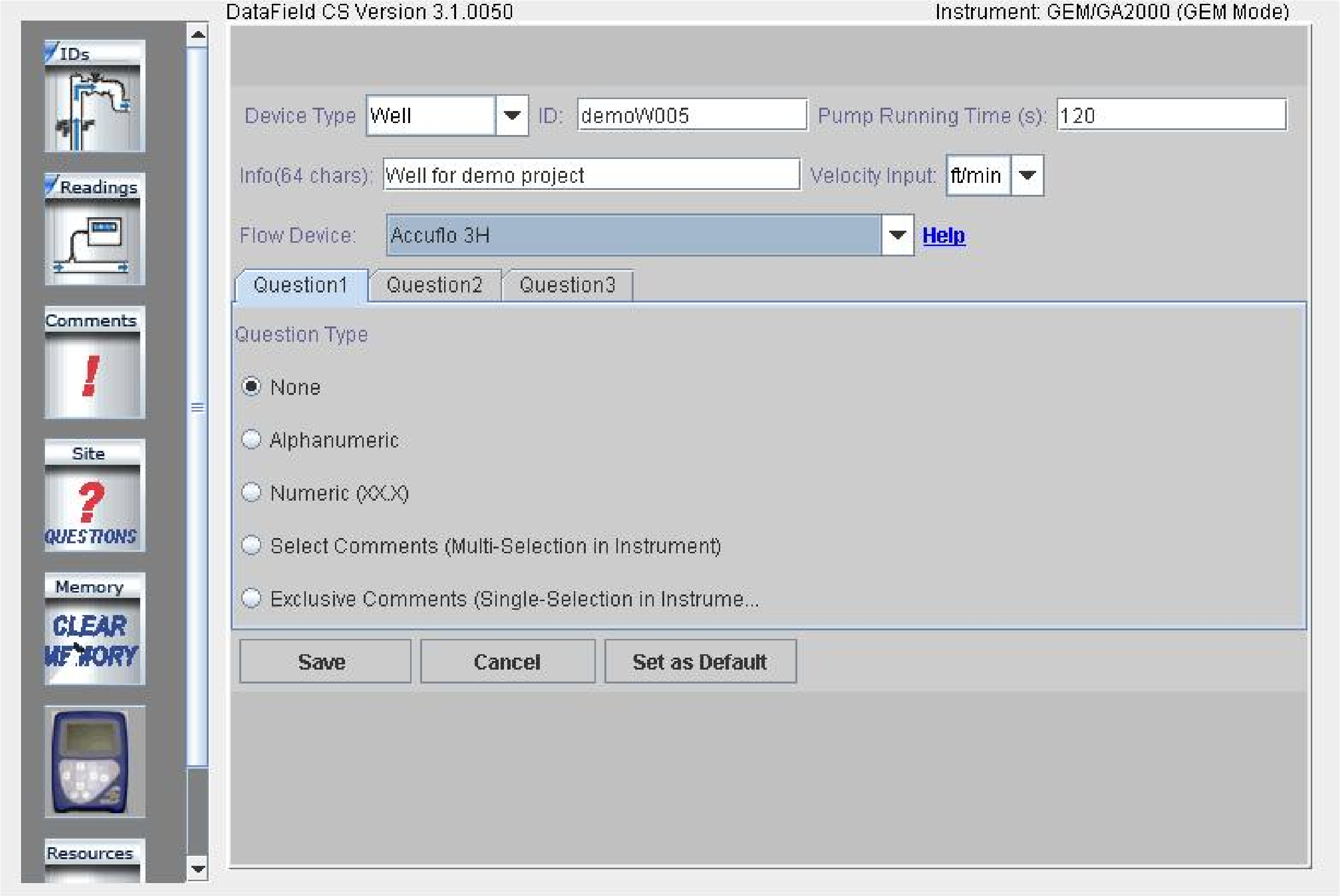
6.6.3 Editing IDs

IDs may be edited in a similar manner to entering a new ID. Click on the **ID** button. Click on the **Load from File** button if the IDs to be edited are in a saved file on disk or click on **Load from Instrument** if the IDs to be edited reside in the instrument. Once the IDs have been opened, the **ID Editor** screen will appear as shown below.



ID	Pump Time	Info	FlowType	Orifice	Pipe	Question 1	Question 2	C
demoW001	120	Well for de...	Accuflo 2V	0.00	0.00	N/A	N/A	N/
demoW002	120	Well for de...	Accuflo 1.5H	0.00	0.00	N/A	N/A	N/
demoW003	120	Well for de...	Accuflo 3V	0.00	0.00	N/A	N/A	N/
demoW004	120	Well for de...	Accuflo 2H	0.00	0.00	N/A	N/A	N/
demoW005	120	Well for de...	OrificePlate	0.00	0.00	N/A	N/A	N/
demoW006	120	Well for de...	Accuflo 3H	0.00	0.00	N/A	N/A	N/
demoW007	120	Well for de...	Pitot Tube	0.75	3.00	N/A	N/A	N/
demoW008	120	Well for de...	User Input	0.00	3.00	N/A	N/A	N/
demoW009	120	Well for de...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP001	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP002	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP003	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP004	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP005	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP006	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP007	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP008	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP009	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoSP01	120	Sample Po...	Pitot Tube	0.75	3.00	N/A	N/A	N/
demoSP02	120	Sample Po...	User Input	0.00	2.50	N/A	N/A	N/

To select an ID for editing, click on the ID to highlight the ID, and then click on the **Edit ID** button. The Edit ID screen will open and allow information for the selected ID to be changed. When finished with the changes, click on **Save** to save the edited ID to the ID list.



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

Device Type: Well

ID: demoW005

Pump Running Time (s): 120

Info(64 chars): Well for demo project

Velocity Input: ft/min

Flow Device: Accuflo 3H

Question Type

● None

○ Alphanumeric

○ Numeric (XX.X)

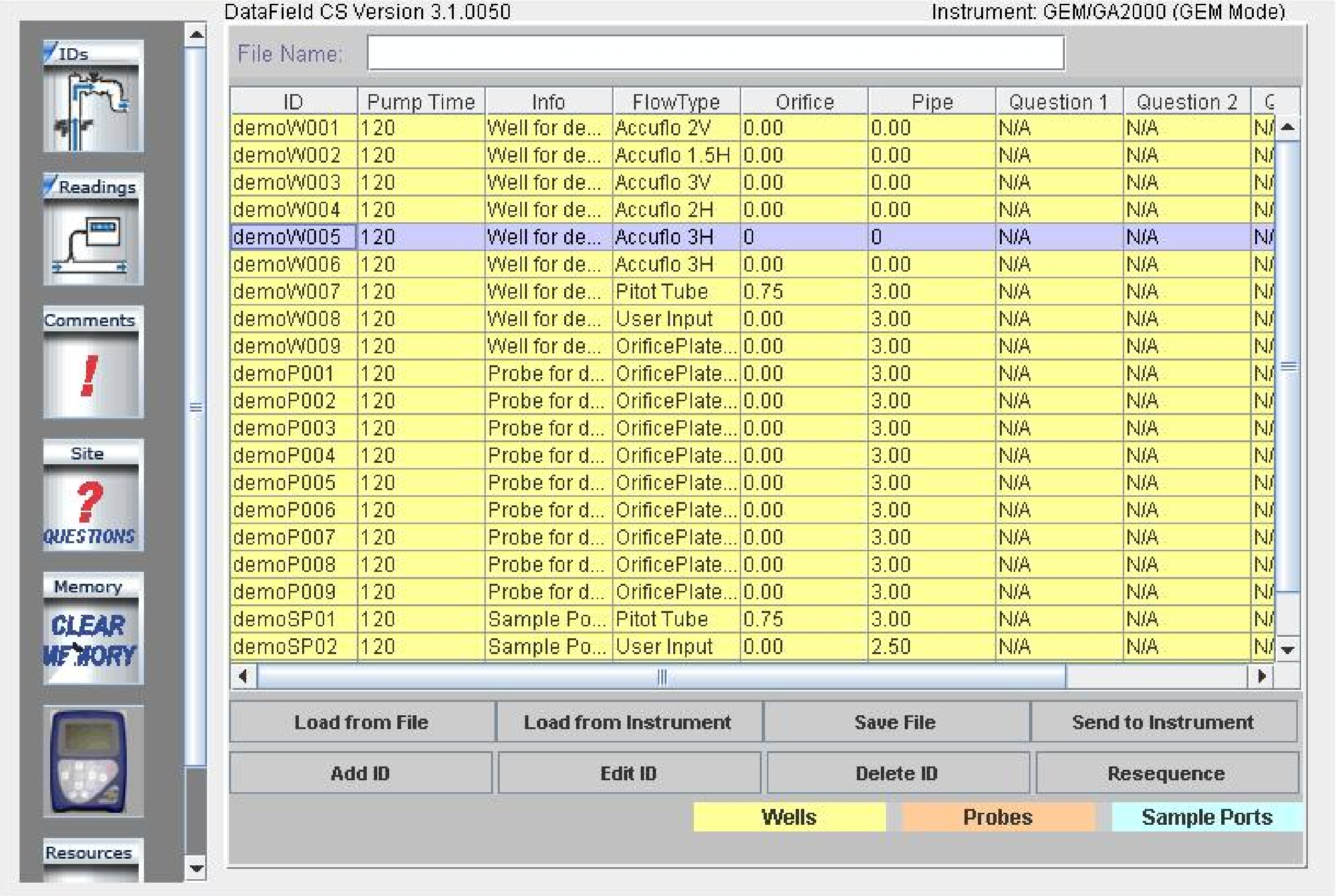
○ Select Comments (Multi-Selection in Instrument)

○ Exclusive Comments (Single-Selection in Instrume...

When editing is completed, click on **Save** to return to the previous screen. Click on **Save File** to save the edited data to disk or click on **Send to Instrument** to append the IDs to the IDs in the instrument.

Note: IDs are only appended to the unit. It is strongly recommended to erase/clear IDs from unit prior to sending new IDs to the unit. One obvious exception is in the case of loading IDs for multiple sites in an instrument.

\



DataField CS Version 3.1.0050 Instrument: GEM/GA2000 (GEM Mode)

File Name:

ID	Pump Time	Info	FlowType	Orifice	Pipe	Question 1	Question 2	
demoW001	120	Well for de...	Accuflo 2V	0.00	0.00	N/A	N/A	N/
demoW002	120	Well for de...	Accuflo 1.5H	0.00	0.00	N/A	N/A	N/
demoW003	120	Well for de...	Accuflo 3V	0.00	0.00	N/A	N/A	N/
demoW004	120	Well for de...	Accuflo 2H	0.00	0.00	N/A	N/A	N/
demoW005	120	Well for de...	Accuflo 3H	0	0	N/A	N/A	N/
demoW006	120	Well for de...	Accuflo 3H	0.00	0.00	N/A	N/A	N/
demoW007	120	Well for de...	Pitot Tube	0.75	3.00	N/A	N/A	N/
demoW008	120	Well for de...	User Input	0.00	3.00	N/A	N/A	N/
demoW009	120	Well for de...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP001	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP002	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP003	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP004	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP005	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP006	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP007	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP008	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoP009	120	Probe for d...	OrificePlate...	0.00	3.00	N/A	N/A	N/
demoSP01	120	Sample Po...	Pitot Tube	0.75	3.00	N/A	N/A	N/
demoSP02	120	Sample Po...	User Input	0.00	2.50	N/A	N/A	N/

6.6.4 Delete IDs

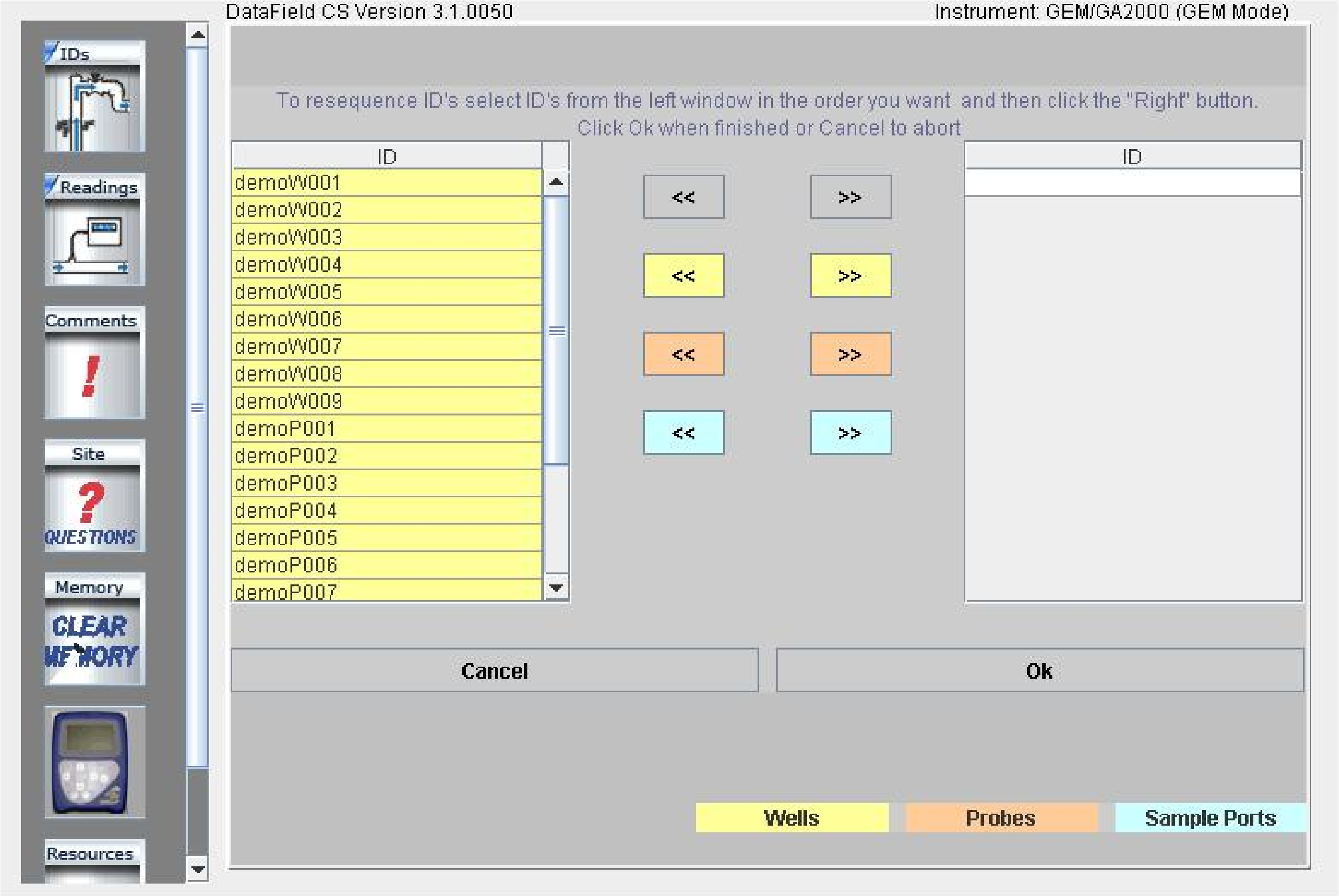
Select an ID to delete and click on it to highlight it. Click on the **Delete ID** button. A prompt will appear to verify the action. Clicking **Yes** will delete the ID. To select multiple IDs use **Ctrl** and **Shift** buttons on your keyboard. When deleting multiple IDs after clicking on the **Delete ID** button a prompt will appear: “Would you like to verify each deletion?” Clicking **No** will delete all the selected IDs. Clicking **Yes** will prompt on the deletion of each ID in the selection. In this case the deletion of some IDs in the selection can be cancelled.

Click on **Save File** to save the updated file to disk or click on **Send to Instrument** to update the instrument for field sampling.

Note: We suggest clearing the ID information from the instrument prior to uploading the revised ID list. Otherwise the new ID list will be appended to the existing list. Clearing IDs in the instrument will clear IDs in the both GEM & GA modes of operation.

6.6.5 Re-sequencing

With DataField CS it is possible to change the order of the IDs in a file to put them in the same order as they are sampled in the field. This is called **Re-sequencing**. To re-sequence an ID data set, click on the **ID** button to open the ID editor. Load the ID data set from a file or download the data set from the instrument. Click on the **Re-sequence** button to open the screen shown below.



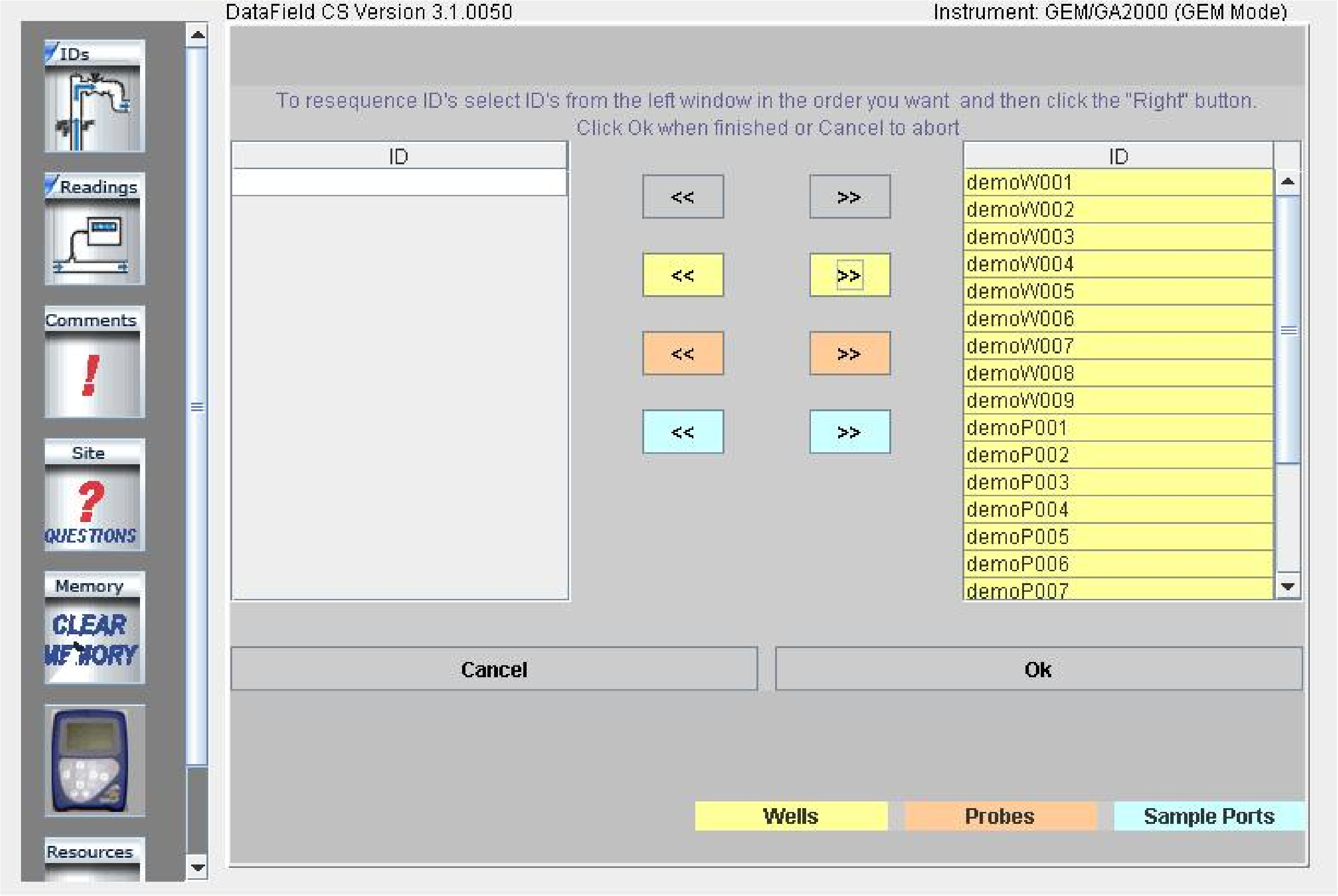
DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

To resequence ID's select ID's from the left window in the order you want and then click the "Right" button.
Click Ok when finished or Cancel to abort

ID
demoW001
demoW002
demoW003
demoW004
demoW005
demoW006
demoW007
demoW008
demoW009
demoP001
demoP002
demoP003
demoP004
demoP005
demoP006
demoP007

Select the ID from the left side window and click on the **Right** button to move ID to the right window to create the new sequence order. Repeat this process moving all IDs to the right side in the desired order.



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

To resequence ID's select ID's from the left window in the order you want and then click the "Right" button.
Click Ok when finished or Cancel to abort

ID

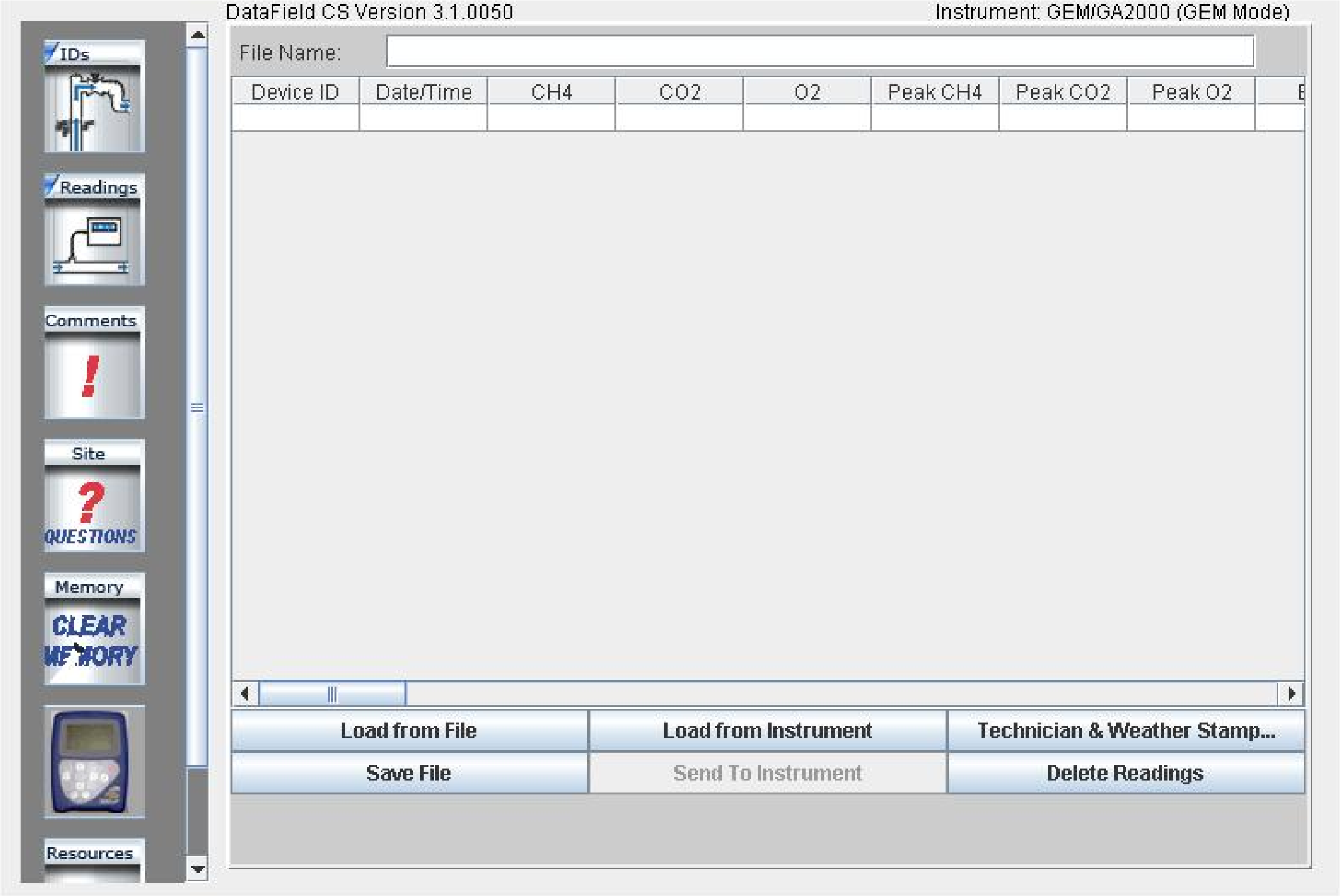
ID
demoW001
demoW002
demoW003
demoW004
demoW005
demoW006
demoW007
demoW008
demoW009
demoP001
demoP002
demoP003
demoP004
demoP005
demoP006
demoP007

Click OK when the desired new sequence is obtained, this will return you to the well ID screen. Click on the **Save File** button to save the new data set to a file on disk or click on **Send to Instrument** to upload the new data to the instrument.

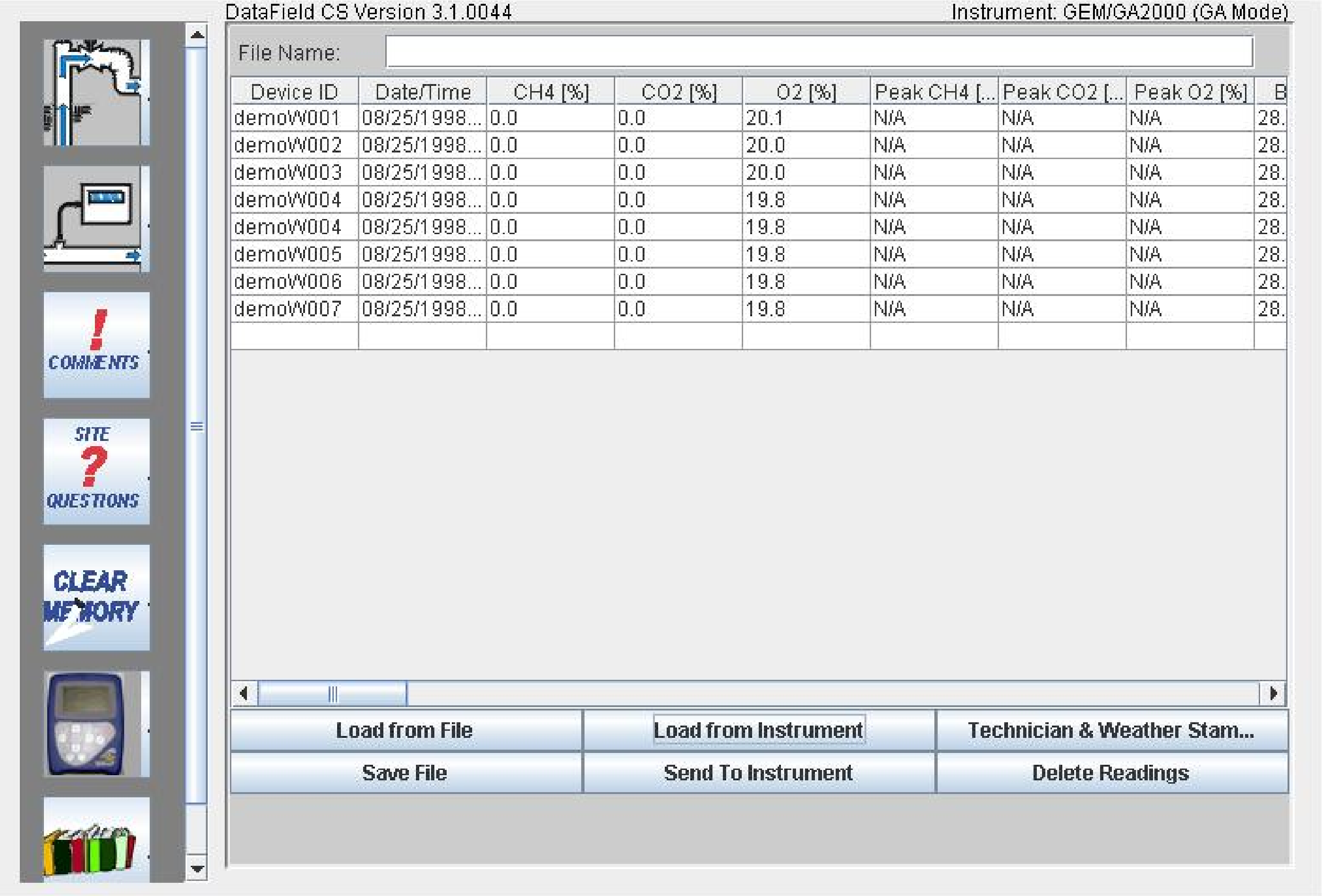
Note: It is suggested to clear ID information from the instrument prior to uploading the re-sequenced ID list. Otherwise the new ID list will be appended to the existing list. Clearing IDs in the instrument will clear IDs in the both GEM & GA modes of operation.

6.6.6 Readings

The Readings screen provides the capability to download, upload, view, save data to a file and delete individual or multiple readings from a data set. Click on the **Readings** button to open the screen shown below.



Click on **Load from File** to open a file folder of saved data on the disk drive or click on **Load from Instrument** to download data from the instrument. Either action will open the following screen. All readings should be downloaded on a daily basis. While the instrument can hold readings for an extended period of time, it is recommended to download them to a non-volatile memory device (e.g. hard drive, CD, etc.).



File Name:

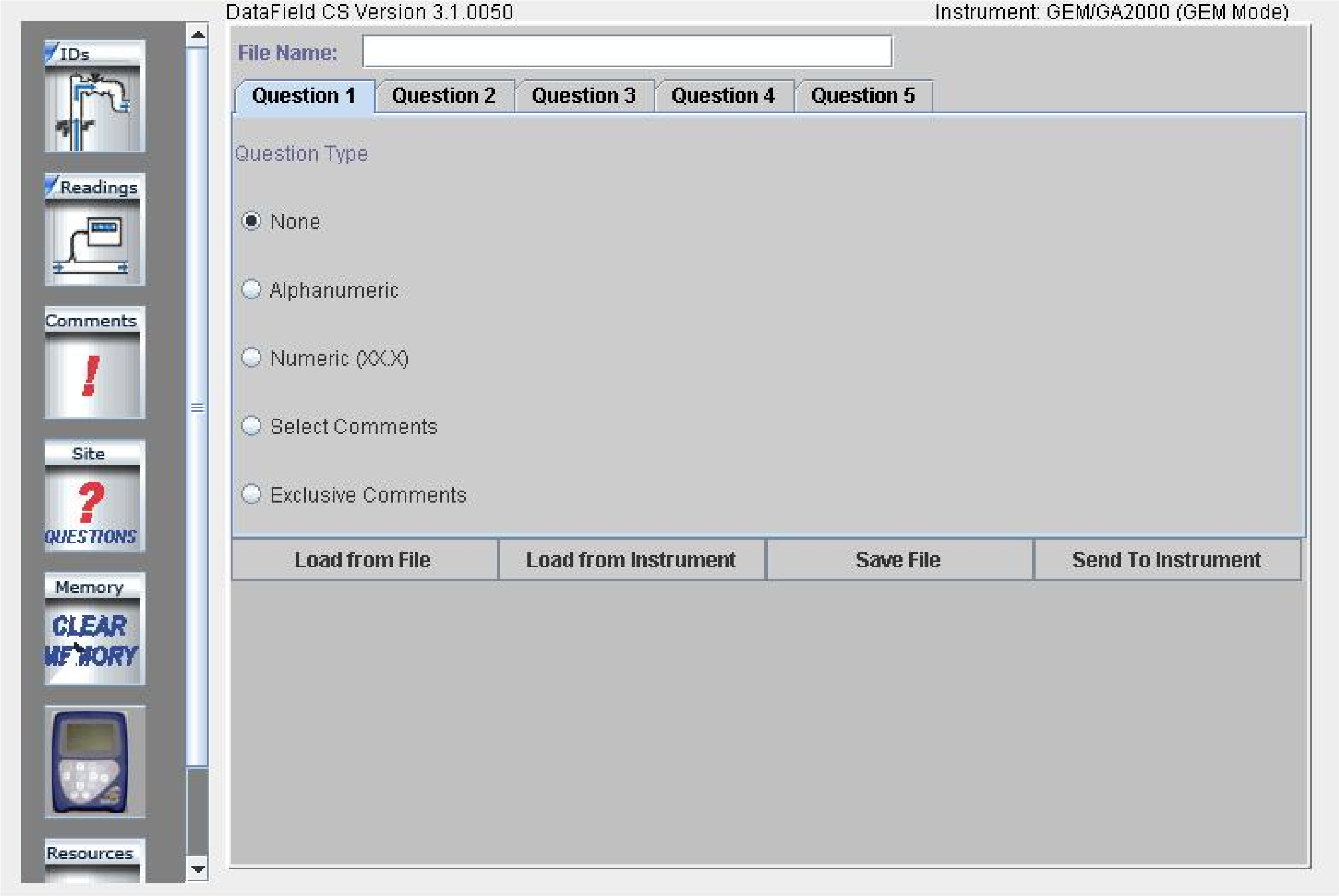
Device ID	Date/Time	CH4 [%]	CO2 [%]	O2 [%]	Peak CH4 [...	Peak CO2 [...	Peak O2 [%]	B
demoW001	08/25/1998...	0.0	0.0	20.1	N/A	N/A	N/A	28.
demoW002	08/25/1998...	0.0	0.0	20.0	N/A	N/A	N/A	28.
demoW003	08/25/1998...	0.0	0.0	20.0	N/A	N/A	N/A	28.
demoW004	08/25/1998...	0.0	0.0	19.8	N/A	N/A	N/A	28.
demoW004	08/25/1998...	0.0	0.0	19.8	N/A	N/A	N/A	28.
demoW005	08/25/1998...	0.0	0.0	19.8	N/A	N/A	N/A	28.
demoW006	08/25/1998...	0.0	0.0	19.8	N/A	N/A	N/A	28.
demoW007	08/25/1998...	0.0	0.0	19.8	N/A	N/A	N/A	28.

Once the file has been opened or data downloaded from the instrument, the readings can be either **stored online** (only with the online version) or **saved to a file** (only with the offline version). When the instrument is in the GA Mode the readings can also be **sent to the instrument**. **Send to Instrument** button will be disabled when the instrument is in the GEM Mode. The screenshot above shows the online version with the instrument in the GEM mode.

To delete a reading from the data set, click on this reading to highlight it and then click on the **Delete Readings** button. Only one reading can be deleted at a time.

6.6.7 Site Questions

DataField CS supports up to five site questions. Site questions are answered only when **Update Site Data** is selected from the GEM menu screen and appended to all IDs taken thereafter until Update Site Data is selected again. This is a useful feature if conditions change in various locations on the landfill site or for selected wells/probes. Site questions can be either alphanumeric, numeric, select comment (the technician selects the comment from a list of ten answers) or exclusive comments (the technician may select only **ONE** exclusive question from a list of 10 answers). From the opening screen, click on the **Site Questions** button to open the following screen.



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

File Name:

Question Type

● None

○ Alphanumeric

○ Numeric (XX.X)

○ Select Comments

○ Exclusive Comments

Note: Site questions must be created and sent to the instrument by the software prior to going into the field. They can not be hand inputted into the instrument in the field.

Click on the open spot, to the left of the alphanumeric category in **Question Type** to define Question 1 and type in the question.

DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

File Name:

Question Type

○ None

● Alphanumeric

○ Numeric (XX.X)

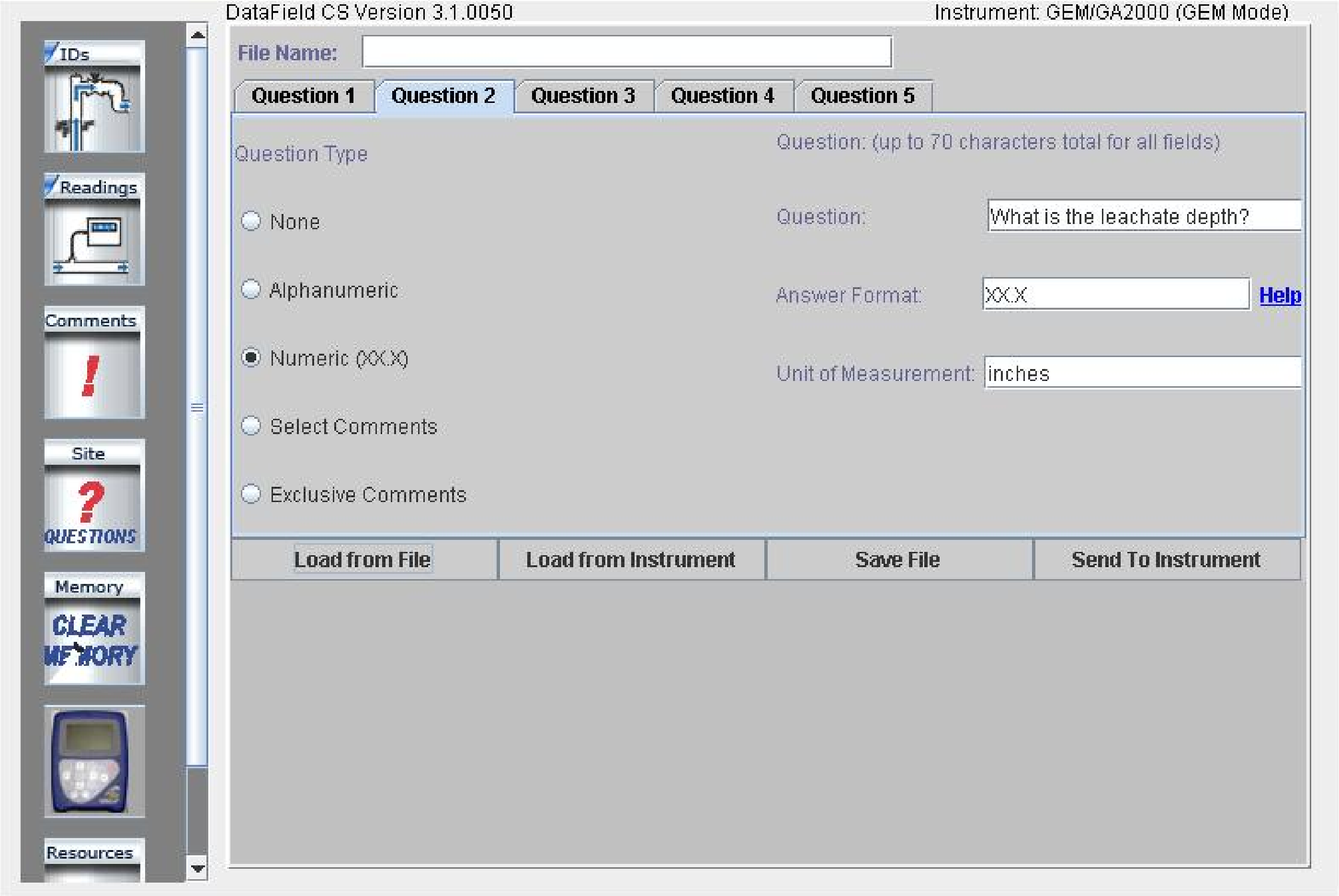
○ Select Comments

○ Exclusive Comments

Question: (up to 70 characters total for all fields)

Question: What is the wind direction?

Click on Question 2 and then select Numeric as the Question Type. Note that Answer Format and Unit of Measurement fields appear for this type of question. Answer format refers to the number of digits and decimal places required for the answer. Unit of Measurement refers to inches, feet, yards, etc. for the answer. In this example, XX.X could be equal to 20.5 inches as per the question ‘What is the leachate depth in tank?’



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

File Name:

Question Type

○ None

○ Alphanumeric

● Numeric (XX.X)

○ Select Comments

○ Exclusive Comments

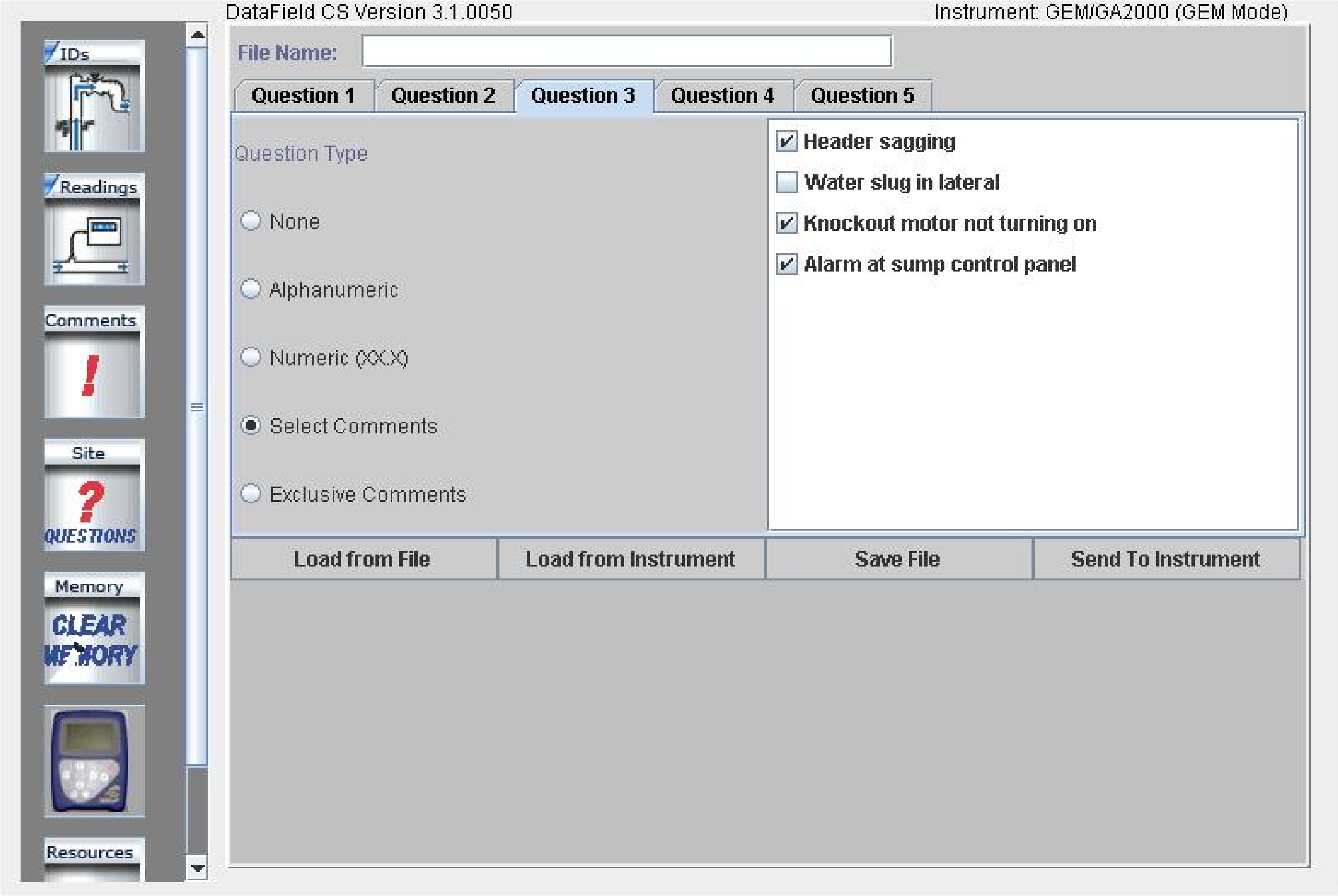
Question: (up to 70 characters total for all fields)

Question: What is the leachate depth?

Answer Format: XX.X

Unit of Measurement: inches

Comments may also be used as a site question; however, comments must be downloaded from an instrument that already has comments loaded in it. Connect the GEM™2000 / GEM™2000 Plus and be sure it is in the read gas screen. Click on Select Comments and the list of comments from the instrument will open in the window for selection. Ten comments may be selected from the list to become **Site Questions**. Click on the box to the left of the comment to select it. The operator may choose any or all of the ten comments when **Update Site Data** is selected on the instrument.



Question Type

○ None

○ Alphanumeric

○ Numeric (XX.X)

● Select Comments

○ Exclusive Comments

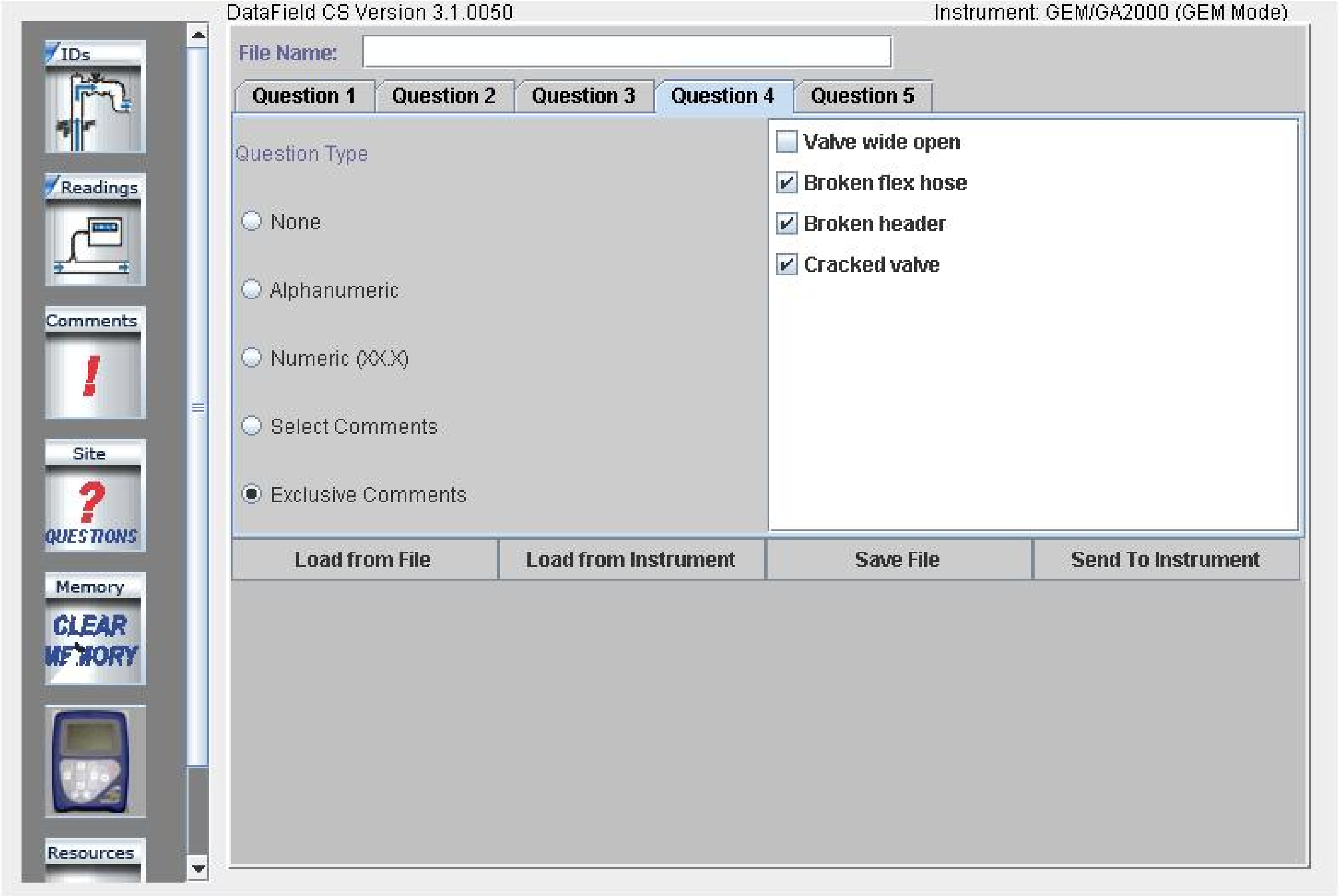
☑ Header sagging

☐ Water slug in lateral

☑ Knockout motor not turning on

☑ Alarm at sump control panel

Exclusive comments are treated in a similar manner as select comments in that they also must be downloaded from the instrument. Ten exclusive comments may be selected, however only **ONE** may be chosen by the operator to become an **Exclusive Comment.**


DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

File Name:

Question 4

Question Type

○ None
○ Alphanumeric
○ Numeric (XX.X)
○ Select Comments
● Exclusive Comments

☐ Valve wide open
☑ Broken flex hose
☑ Broken header
☑ Cracked valve

When all the desired questions have been entered, click on **Save File** to retain the information for later use and then click on **Send to Instrument** to update site data in the instrument.

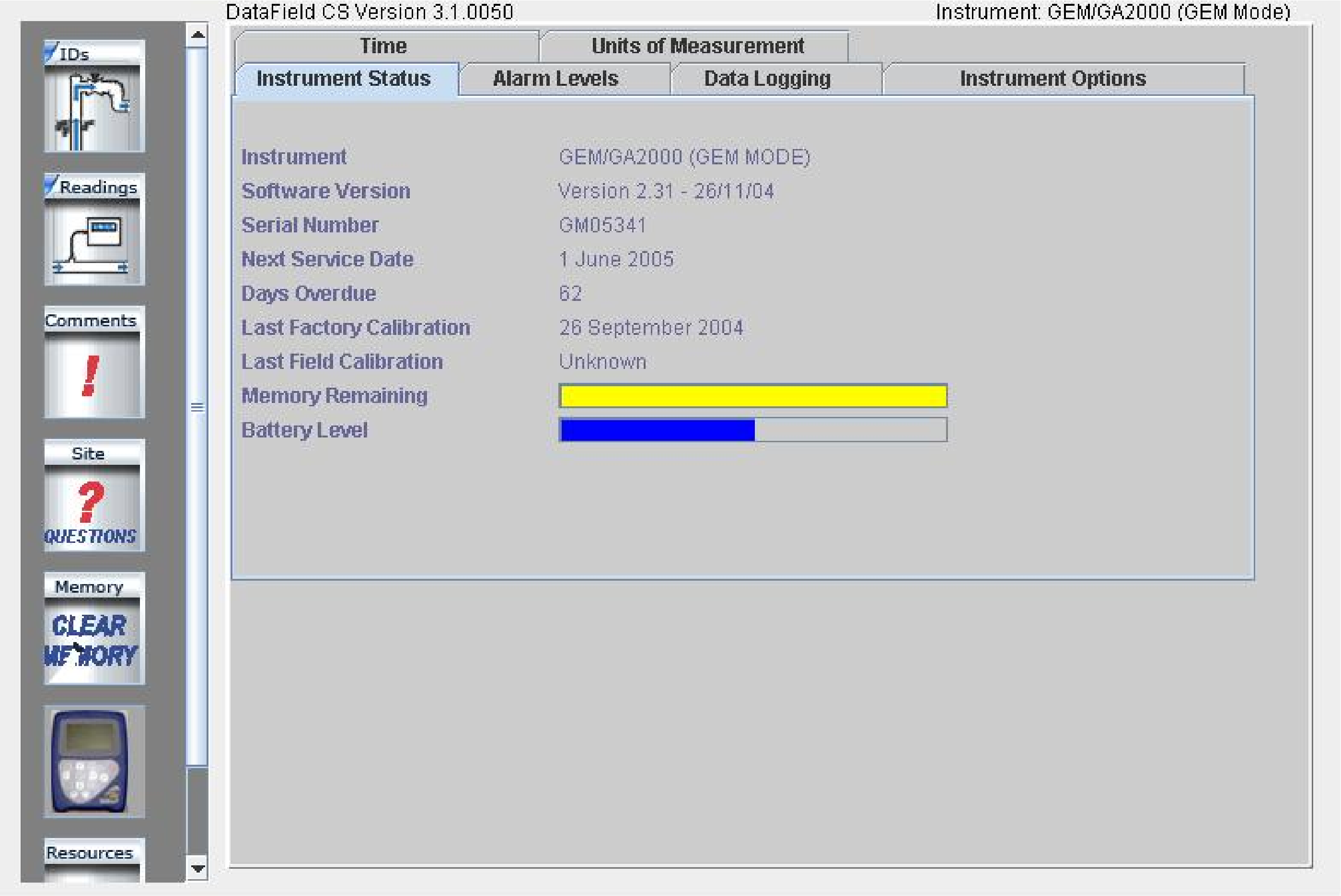
6.7 Settings

Clicking on the **Settings** button on the main screen will display the **Instrument Settings.** The Instrument settings provide the capability to set or change optional controls in the instrument, such as time/date, data logging (GA mode only), purge times, etc.

6.7.1 Instrument Settings

Set the instrument for RS-232 communications and click on the **Settings** button and the following screen will open. The software will establish communications and download the current instrument settings.

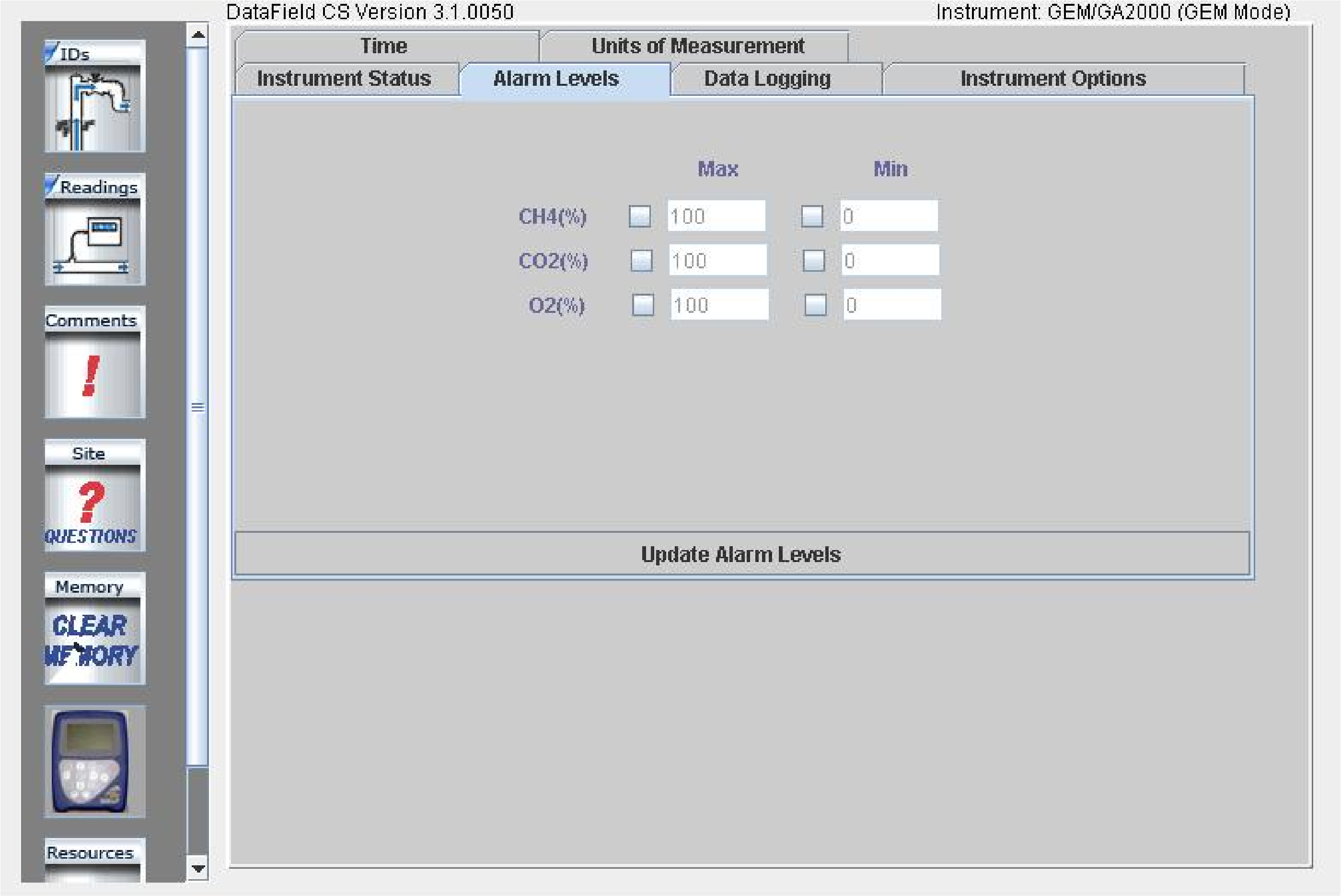
Once the current settings have been obtained, the following screen will open.



Instrument GEM/GA2000 (GEM MODE)
Software Version Version 2.31 - 26/11/04
Serial Number GM05341
Next Service Date 1 June 2005
Days Overdue 62
Last Factory Calibration 26 September 2004
Last Field Calibration Unknown
Memory Remaining
Battery Level

There are six different "Menu Cards" under instrument settings. Each card provides different information or instrument settings that may be changed to update the operation of the GEM™2000 / GEM™2000 Plus. The instrument status card will always be shown first, providing calibration and maintenance information in addition to instrument serial number and software version number.

Click on the card tab for **Alarm Levels** to open the alarm levels screen. Both a maximum alarm and a minimum alarm may be set. Note these are global settings and will be the same for all IDs entered in the instrument. Turn off the alarm by clicking off the check mark next to the gas. Click on **Update Alarm Levels** to send the new settings to the instrument.

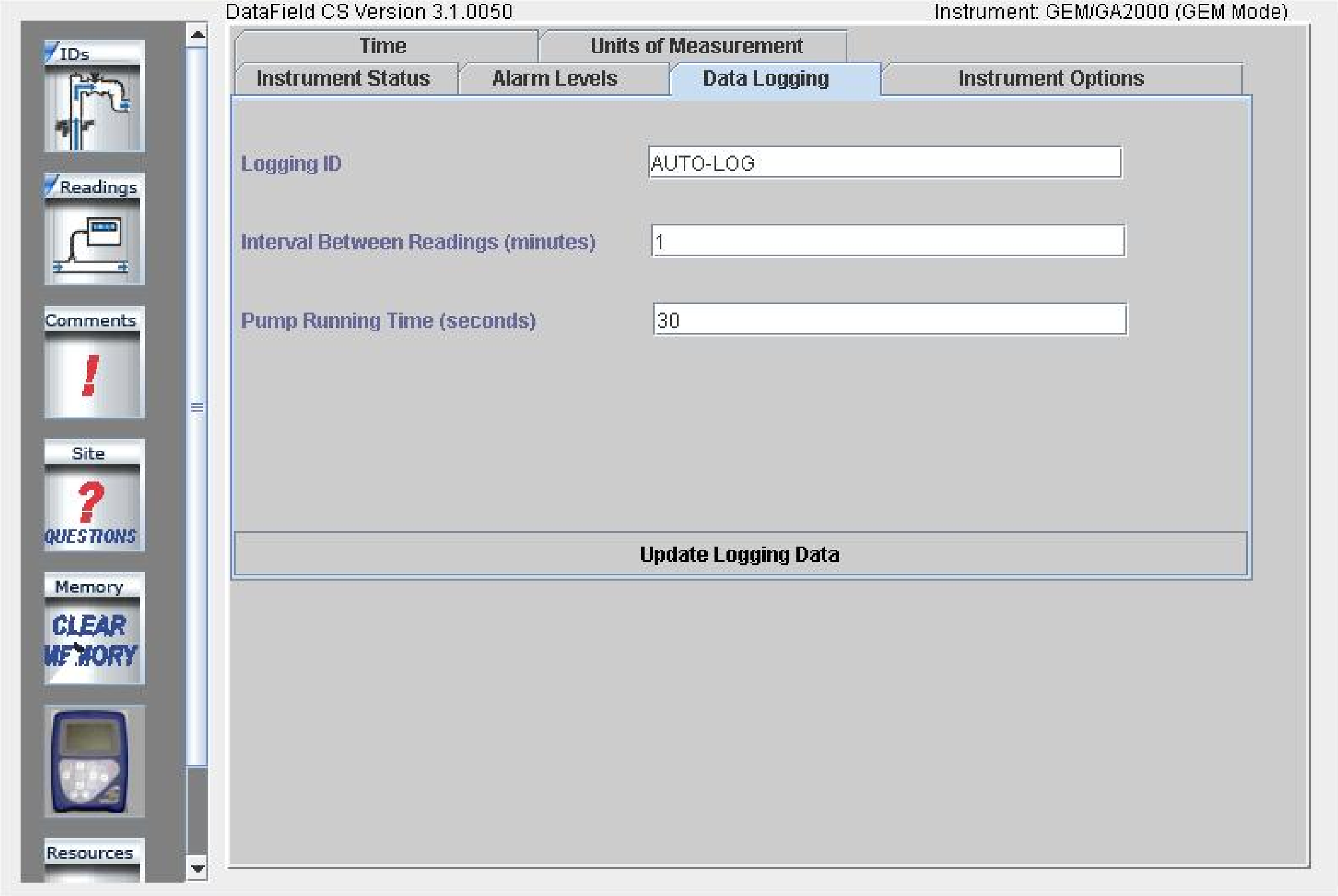


DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

		Max		Min
CH4(%)	☐	100	☐	0
CO2(%)	☐	100	☐	0
O2(%)	☐	100	☐	0

Click on the **Data Logging** card tab to open the data-logging screen. In this screen enter the Logging ID; this may be any alphanumeric combination of eight characters. Enter the interval between readings in minutes and pump run time in seconds. Click on **Update Logging Data** to send to instrument. Only one logging ID may be loaded to the instrument.


DataField CS Version 3.1.0050

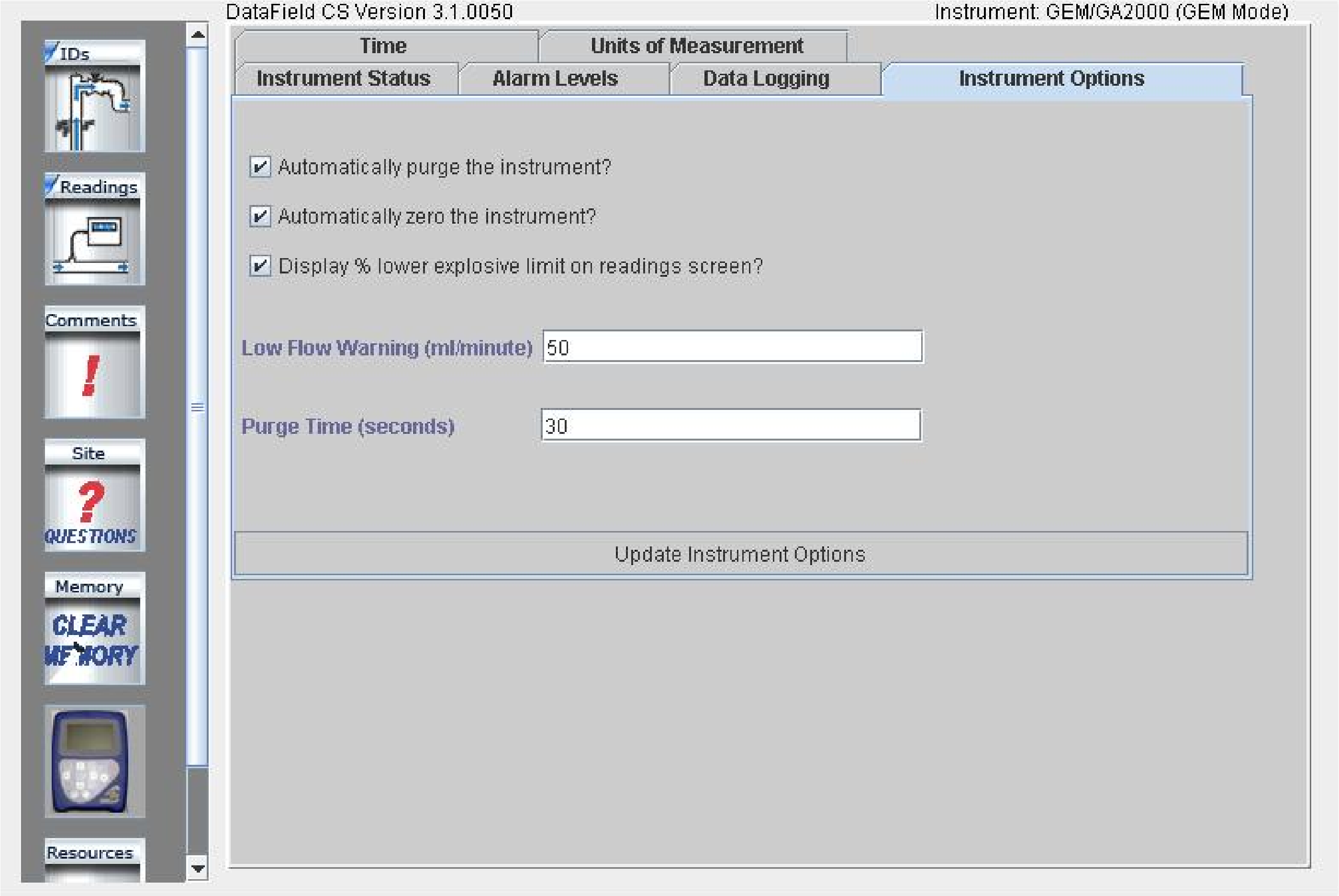
Instrument: GEM/GA2000 (GEM Mode)

Logging ID: AUTO-LOG

Interval Between Readings (minutes): 1

Pump Running Time (seconds): 30

Click on the **Instrument Options** card tab to open the instrument options screen. The settings in this screen affect different global functions of the instrument. Check the corresponding boxes in order to do the following: automatically purge the instrument during a shut down, automatically zero the instrument, display the percent lower explosive limit on readings screen. **Unchecking the last feature will disable % LEL display in both GA and GEM modes of operation**. The **Low Flow Warning** setting controls the point at which the pump is shut off due to low flow conditions. The default setting for this feature is 50 milliliters per minute but may be set to a lower number or even to zero, if sampling on high vacuum systems. The default value for the **Purge Time** is 30 seconds and may be reset to any length required. Turning off this feature is not recommended. Click on the **Update Instrument Options** button to send the new settings to the instrument.



☑ Automatically purge the instrument?

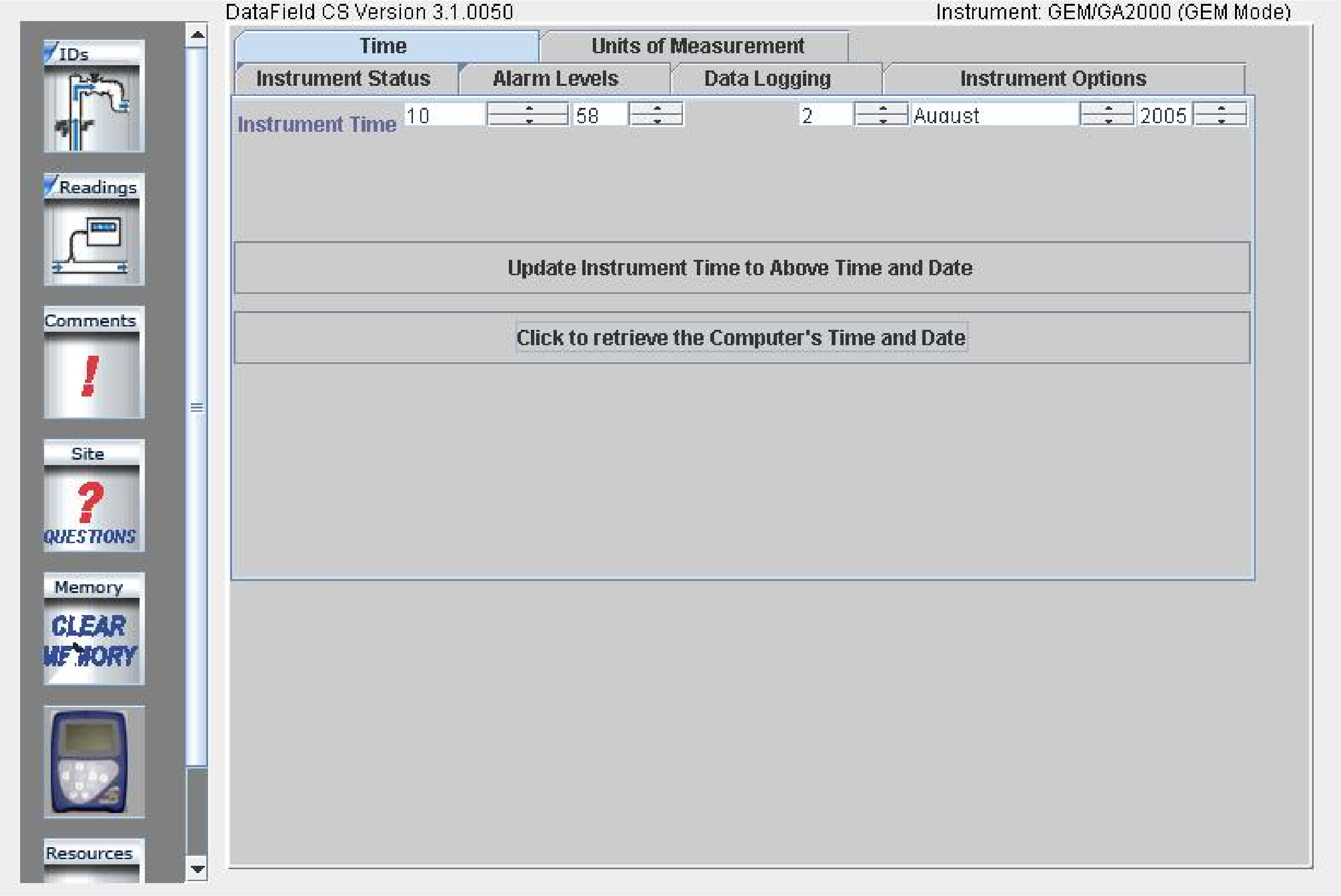
☑ Automatically zero the instrument?

☑ Display % lower explosive limit on readings screen?

Low Flow Warning (ml/minute) 50

Purge Time (seconds) 30

Click on the Time card tab to open the time and date setting screen. Time and date may be set to the computer time and date settings by clicking on the **Click to Retrieve the Computer's Time and Date** button. Manual setting of the time and date may be accomplished by clicking on the **Update Instrument Time to Above Time and Date**. Any time updates must be done through the software. The instrument time can not be manually updated in the field.



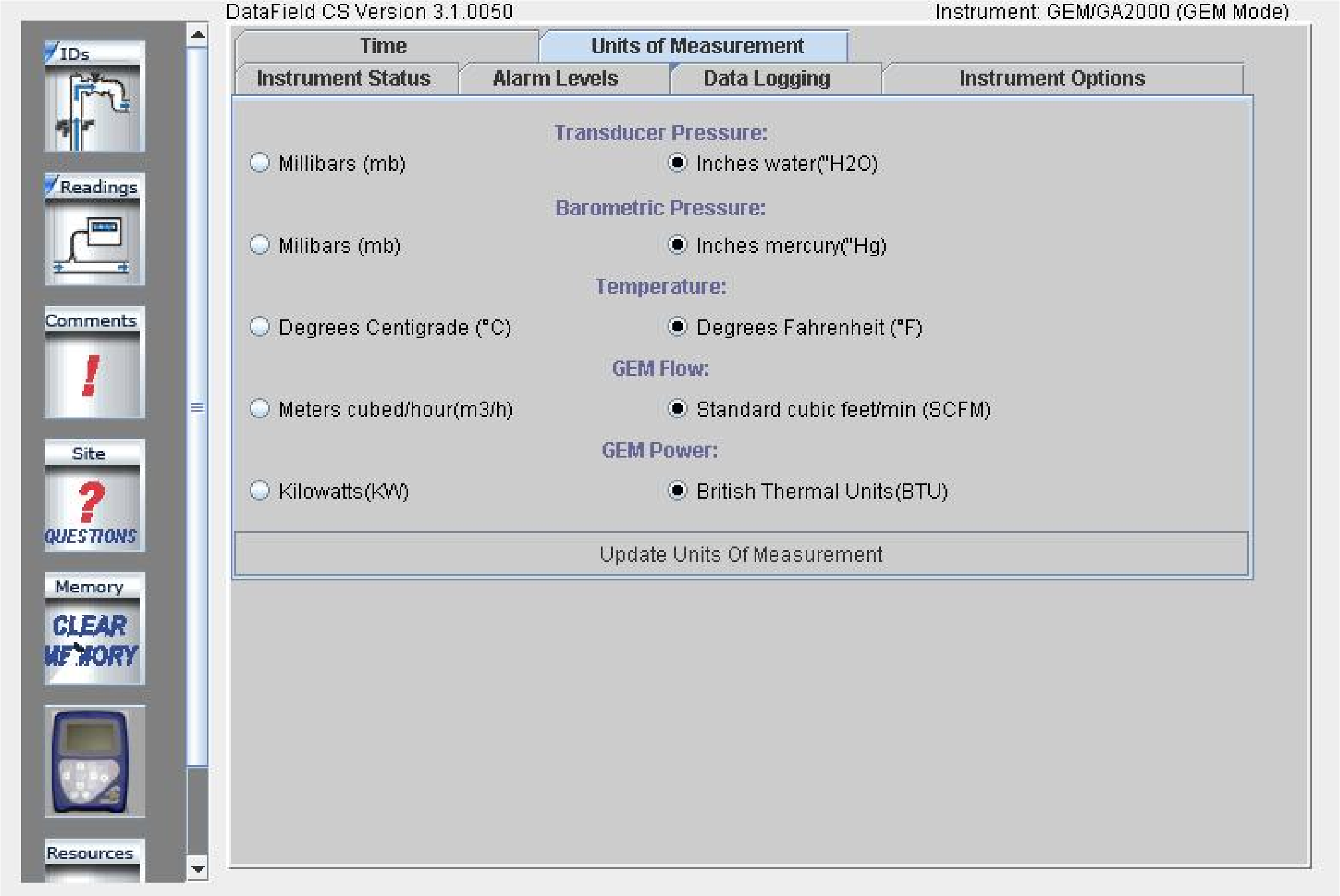
DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

Instrument Time 10 58 2 August 2005

Units of Measurement screen allows the units to be changed.

This screen is protected by the password. If you need to change the units of measurement, please contact our technical support team.



Transducer Pressure:
○ Millibars (mb) ● Inches water("H2O)

Barometric Pressure:
○ Milibars (mb) ● Inches mercury("Hg)

Temperature:
○ Degrees Centigrade (°C) ● Degrees Fahrenheit (°F)

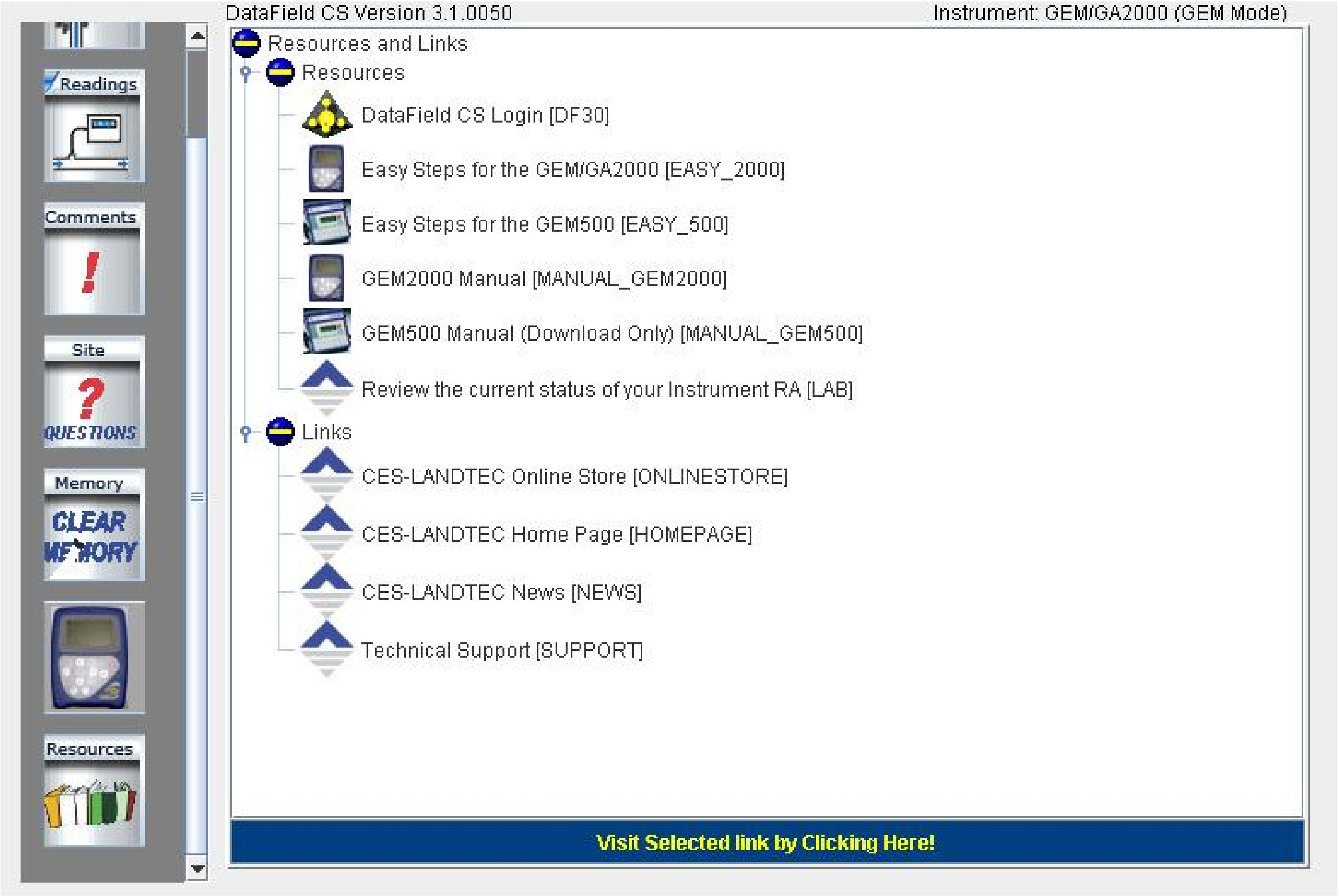
GEM Flow:
○ Meters cubed/hour(m3/h) ● Standard cubic feet/min (SCFM)

GEM Power:
○ Kilowatts(KW) ● British Thermal Units(BTU)

Note: EXTREME CAUTION should be taken if changing the Units of Measurement. All data from the instrument should be downloaded and stored in both, the GEM and the GA modes before updating the Units of Measurement. Updating Units of Measurement will erase readings from the instrument. The instrument should be turned off and restarted once the units of measurement have been updated.

6.7.2 Resource Links

Clicking on the **Resource Links** button on the main screen will display the **Resources and Links** screen.



DataField CS Version 3.1.0050

Instrument: GEM/GA2000 (GEM Mode)

- Resources and Links
  - Resources
    - DataField CS Login [DF30]
    - Easy Steps for the GEM/GA2000 [EASY_2000]
    - Easy Steps for the GEM500 [EASY_500]
    - GEM2000 Manual [MANUAL_GEM2000]
    - GEM500 Manual (Download Only) [MANUAL_GEM500]
    - Review the current status of your Instrument RA [LAB]
  - Links
    - CES-LANDTEC Online Store [ONLINESTORE]
    - CES-LANDTEC Home Page [HOMEPAGE]
    - CES-LANDTEC News [NEWS]
    - Technical Support [SUPPORT]

By clicking on the supplied link the user is taken directly to the www and the information listed.

7 Field Operations

7.1 Landfill Gas Generation

A brief overview of the theory of landfill gas generation and Methane recovery follows. Initially, when decomposable refuse is placed into a solid waste landfill, the refuse is entrained with air from the surrounding atmosphere. Through a natural process of bacterial decomposition, the Oxygen from the air is consumed and an anaerobic (Oxygen free) environment is created within the landfill. This anaerobic environment is one of several conditions necessary for the formation of Methane-CH_4.

If Oxygen is reintroduced into the landfill, those areas are returned to an aerobic (Oxygen present) state and the Methane-producing bacteria population is destroyed. A period of time must pass before the productive capacity is returned to normal. Since there is some Methane of a given quality within the landfill void space, a decline in Methane quality is only gradually apparent depending upon the size of the landfill.

Carbon Dioxide is also produced under either an aerobic or anaerobic condition. Under static conditions, the landfill gas will be composed of roughly half Methane and half Carbon Dioxide with a little Nitrogen.

As air is introduced into the landfill, the Oxygen is initially converted to Carbon Dioxide and residual Nitrogen remains. Measurement of residual Nitrogen is usually a good indicator of the anaerobic state of the landfill; however, it cannot be directly measured. It can, however, be assumed and estimated using a subtraction basis as the balance gas. Hence, the measurement of Carbon Dioxide is an intermediary step. Because Carbon Dioxide levels may fluctuate depending on the changing concentrations of the other constituent gases, Carbon Dioxide levels are not evaluated directly but are considered in light of other data.

In evaluation of residual Nitrogen, allowances must be made if there has been any air leakage into the gas collection system or if there has been serious over pull. If enough air is drawn into the landfill, not all Oxygen is converted into Carbon Dioxide and the Oxygen is apparent in the sample. It is ideal to perform routine analysis of individual wells, as well as an overall well field composite sample, by a gas chromatography. This is not always practical at every landfill.

Under some conditions there may be a small amount of hydrogen in the LFG, (about 1 percent, usually much less). This may affect field monitoring response factors, but otherwise it can be ignored.

7.2 Subsurface Fires

If very large quantities of air are introduced into the landfill, either through natural occurrence or overly aggressive operation of the LFG system, a partly unsupported subsurface combustion of the buried refuse may be initiated. Subsurface fire situations are difficult to control or extinguish once started, present health and safety hazards, and can be quite costly. Therefore, prevention by good operation of the collection system and maintenance of the landfill cover is the best course of action. The presence of Carbon Monoxide, Carbon Dioxide, and Hydrogen Sulfide are indicators of poorly supported combustion within the landfill.

7.3 Techniques for Controlling Landfill Gas

There are many techniques for controlling landfill gas extraction. These techniques represent tools, which are used together to control landfill gas. The Accu-Flo wellhead is designed to work with all of these techniques. Below is a discussion of the individual techniques, how to use them, and their limitations. Reliance on only a few of the techniques discussed can lead to misinterpretation of field data and improper operation of the well field. Later the best use of these techniques to optimize landfill gas control will be discussed.

7.3.1 Controlling by Wellhead Valve Position

Unless the valve handle is calibrated for a given flow rate, this method is unreliable. The position of the valve handle alone does not provide sufficient information about the well to control it. It is useful to note the relative position of the valve, and essential to know which valves are fully open or fully closed.

7.3.2 Controlling by Wellhead Vacuum

This technique relies on the relationship of well pressure/vacuum to flow for a given well. Reliance upon this method, however, can be misleading. This is because the square root relationship between flow and pressure is difficult to affect while performing day-to-day well field adjustments. As decomposition, moisture, and other conditions change, this method shows itself to be inadequate and imprecise.

7.3.3 Controlling by Gas Composition

This method determines Methane, Nitrogen (balance gas) and other gas composition parameters at wellheads and at recovery facilities using portable field instruments and, sometimes, analytical laboratory equipment. Complete knowledge of gas composition (i.e., major fixed gases: Methane, Carbon Dioxide, Oxygen and Nitrogen) is desirable. It is also necessary to check other gas parameters, such as Carbon Monoxide, to fully evaluate the condition of the well field. Reliance on this information can lead to improper operation of the well field. Indications of excessive extraction often do not show up right away. This method often leads to a cycle of damage to the Methane producing bacteria population and then to over-correction. This cycling of the well and producing area of the landfill is not a good practice. It leads to further misinterpretation of the condition of the well field and has a disruptive effect on the operation of the well field. The use of analytical laboratory instrumentation such as a gas chromatograph is a valuable supplementary tool to verify gas composition. This normally requires collection of samples at the wellhead and analysis at some fixed location where the equipment is located. The drawbacks of this method as a primary means of obtaining information for well field adjustment are the time expended, cost, and probably most important, responsiveness to the needs of the well field for timely adjustment. The laboratory equipment required is also very costly. Some analysis is recommended for verification of field readings from time to time. It is recommended a monthly sample of the composite gas be taken at the inlet to the flare or gas recovery facility.

7.3.4 Controlling by Flow Rate

This is a more exacting technique for determining and adjusting gas flow at individual wells. It requires using a fixed or portable flow measurement device at each wellhead to obtain the data needed to calculate volumetric (or mass) flow rates. It is normally convenient to use cubic feet per minute or per day, as a standard unit of measure for volumetric flow. It is important to distinguish between the volumetric quantity of landfill gas and the volumetric quantity of Methane extracted from each well and the landfill in total. The two variables are somewhat independent of each other and it is the total quantity of Methane extracted we are interested in. It is possible for the total quantity of landfill gas extracted to increase while the total quantity of Methane extracted decreases. To monitor this, the quantity of Methane extracted (LFG flow x percent Methane) or the quantity of BTUs recovered per hour (LFG flow x percent Methane x BTUs per cubic foot of Methane x 60 minutes per hour) can be calculated. It is conventional to measure BTUs per hour as a unit of time. There are approximately 1012 BTUs of heat per cubic foot of pure Methane (like natural gas), although this figure varies a little among reference texts.

Measuring flow is an essential part of monitoring and adjusting a well field. The well should be adjusted until the amount of Methane recovered is maximized for the long term. A greater amount of Methane or energy can usually be recovered over the short term; however, this ultimately leads to diminishing returns. This is seen in stages as increased CO_2 and gas temperature and later as increased Oxygen from well over-pull. In time, the Methane will also decline. This is the result of a portion of the landfill, usually at the surface, being driven aerobic. In this portion of the landfill, the Methane-producing bacteria will have been destroyed (due to the presence of Oxygen). With the Methane-producing capacity of the landfill reduced, the pore space in the area no longer producing may become filled with landfill gas equilibrating (moving in) from an unaffected producing area. This leaves the impression that more gas can be recovered from this area, and may lead to the operator opening the well or increasing flow.

7.4 Well field Monitoring

The frequency of LFG well field monitoring varies depending upon field requirements and conditions. Normal monitoring frequency for a complete field monitoring session with full field readings (suggested normal and abbreviated field readings list follows) will vary from typically once a month to once a week. Well field monitoring should not normally be extended beyond one month. The importance of regular, timely monitoring cannot be overemphasized.

7.5 Typical Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH_4)
- Oxygen (O_2)
- Carbon Dioxide (CO_2)
- Balance Gas (primarily Nitrogen N_2)
- Wellhead gas temperature (flowing)
- Ambient air temperature
- Static pressure (PS) (from GEM™2000 or magnehelic) or other device(anemometer/velometer)
- Velocity head (P or PT) (from GEM™2000 or pitot tube and magnehelic)
- Wellhead gas flow (from GEM™2000, or pitot tube & magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment
- Calculation of each well's LFG and Methane flow and sum total
- Observations/comments

Additionally, Carbon Monoxide (CO) or Hydrogen Sulfide (H_2S) readings may be taken if problems are suspected. Supplementary monitoring once to several times a week may be performed using an abbreviated form of field readings.

7.6 Abbreviated Field Readings

- Name of person taking readings
- Date/time of each reading
- Methane (CH_4)
- Oxygen (O_2)
- Wellhead gas temperature (flowing)
- Ambient air temperature
- Static pressure (PS) (from GEM™2000 or magnehelic)
- Velocity head (P or Pt) (from GEM™2000 or pitot tube and magnehelic)
- Wellhead gas flow (from GEM™2000, or pitot tube and magnehelic, or anemometer/velometer)
- Wellhead adjustment valve position (initial and adjusted)
- New wellhead vacuum and flow information after adjustment
- Observations/comments

Line vacuums and gas quality may be taken at key points along the main gas collection header and at subordinate branches. This helps to identify locations of poor performance, excessive pressure drop, or leakage. Perform systematic monitoring of the well field, taking and logging measurements at each wellhead and major branch junction in the collection system.

During monitoring, examine landfill and gas collection system for maintenance issues. Record needed maintenance or unusual conditions. Examples of unusual occurrences or conditions are unusual settlement, signs of subsurface fires, cracks and fissures, liquid ponding, condensate/leachate weeping from side slopes, surface emissions and hot spots, and liquid surging and blockage in the gas collection system. Field readings should be kept in a chronological log and submitted to management on a timely basis.

7.7 Well field Adjustment Criteria

There are several criteria used in well field adjustment. The primary criterion is Methane quality. Methane quality is an indicator of the healthy anaerobic state of the landfill and thus proper operation of the LFG collection system. However, a decline in the healthy productive state of the landfill is usually not immediately apparent from Methane quality. Due to this, several criteria must be considered at once.

Conditions within the landfill favor Methane production. Following are well field adjustment criteria and typical conditions for consideration:

- Methane quality (ranging from 26 percent upwards)
- pH
- Temperature
- General overall quality
- Moisture conditions
- Waste stream characteristics
- Placement chronology
- Insulation characteristics
- Oxygen quality (ranging below 1 percent, preferably less then ½ percent)
- Landfill cover porosity and depth in the proximity of the well
- Landfill construction factors including:
- Type of fill
- Size and shape of refuse mass

- Depth of fill
- Compaction
- Leachate control methods
- Seasonal, climatic, geographical, and recent weather, or other considerations, including seasonally arid or wet conditions, precipitation, drainage, groundwater
- Surrounding topography and geologic conditions
- Proximity of the well to side slopes (within 150 to 200 feet and less may require conservative operation of the well)
- Nitrogen (typically 8 to 12 percent and less)
- Temperature (between ambient and about 130 °F)
- LFG and Methane flow from the wellhead
- Design of the gas collection system
- Landfill perimeter gas migration and surface emission control, or energy recovery objectives
- Diurnal fluctuation (day to night) of atmospheric pressure

7.8 Establishing Target Flows

The goal is to establish a target flow which will likely produce the best possible Methane quality and minimum Oxygen levels while maximizing the recovery of landfill gas. Typically, small adjustments are made in flow to achieve and maintain quality objectives. The well must not be allowed to over pull. High well temperatures, (130° to 140°F and greater), are an indication of aerobic activity and, thus, well over-pull. These effects may not be immediately apparent.

Well adjustment should be made in as small an increment as possible, preferably an increment of ten percent of the existing flow or less. There may be obvious conditions when this is not appropriate, such as when first opening up a well or when serious over-pull is recognized. Every effort should be made to make adjustments and operations as smooth as possible. Dramatic adjustments, or operating while switching between a high flow mode and a well shutoff mode, should be avoided.

7.9 Well field Optimization

Every effort should be made to continuously locate and correct or eliminate conditions (e.g., gas condensate, surging and blockage, settlement, etc.), which inhibit efficient operation of the gas collection system. This allows well monitoring and adjustment to be significantly more effective.

7.10 Migration Control—Dealing with Poor Methane Quality

If Methane and Oxygen quality objectives cannot be maintained at a given well, such as a perimeter migration control well, then an attempt should be made to stabilize the well as closely as is practical, avoiding significant or rapid down trending of Methane or up trending of Oxygen.

It is not uncommon for perimeter migration control wells to be operated at less than 40 percent Methane or greater than one-percent Oxygen. It should be recognized that these wells are likely in a zone where some aerobic action is being induced, and that there is some risk of introducing or enhancing the spread of a subsurface fire. Sometimes a judicious compromise is necessary to achieve critical migration control objectives or because existing conditions do not allow otherwise. Such situations should be monitored closely.

7.11 *Well field Adjustment—Purpose and Objectives*

The objective of well field adjustment is to achieve a steady state of operation of the gas collection system by stabilizing the rate and quality of extracted LFG in order to achieve one or several goals. Typical reasons for recovery of LFG and close control of the well field are:

- Achieve and maintain effective subsurface gas migration control.
- Achieve and maintain effective surface gas emissions control.
- Assist with proper operation of control and recovery equipment.
- Avoid well “over-pull” and maintain of a healthy anaerobic state within the landfill.
- Optimize LFG recovery for energy recovery purposes.
- Control nuisance landfill gas odors.
- Prevent or control subsurface LFG fires.
- Protect structures on and near the landfill.
- Meet environmental and regulatory compliance requirements.

Well field adjustment is partly subjective and can be confusing because it involves judgment calls based on simultaneous evaluation of several variables, as well a general knowledge of site specific field conditions and historical trends. Well field evaluation and adjustment consist of a collection of techniques, which may be used, in combination, to achieve a steady state of well field operation.

8 Troubleshooting

Problem	**Corrective Action/Reason**
Unit does not turn on or operation is erratic	Battery charge is too low-recharge batteries. Unit is too hot - cool down unit and try again. Contact Factory Service.
“Flow Fail” is displayed and an audible alarm is heard	The inlet is blocked. Remove blockage and retry. The particulate filter or water trap filter needs replacing.
Readings taken are not what was expected	Unit may be out of calibration. Calibrate unit with known gas concentration. Water trap or particulate filters are clogged. Replace filter(s).
Readings swing up or down wildly as they are being taken	Cell phones and other sources of RF interference can affect Methane readings. Don’t use your cell phone while taking readings.
Unit displays***** or >>>>>	These symbols are substituted when the measured reading is out of range of the instruments capabilities in some fields or when a value needs to be entered manually such as temperature.
Oxygen reading is high on all wells	Check that the water trap housing is screwed on tight. Check or replace O-rings on the water trap and instrument inlet. Check the wellhead inset for cracks, replace O-ring on insert. Field calibrate Oxygen channel.
Unit will not download readings or an error occurs while downloading.	Verify that the communications software is the right version for the instrument being used. Check that the proper serial port is selected in the software. Contact Factory Service.
Methane and Carbon Dioxide readings drift	Perform a field calibration and check well again. Verify cal gas is flowing when regulator is turned on. Verify all connections are tight and filters are not clogged. Contact Factory Service.
Oxygen readings drift	Perform a field calibration - zero and span. Contact Factory Service.
Black screen displayed when unit turned On	Charge unit over night and try again. Unit too hot - cool down and try again. Try adjusting contrast level. Contact Factory Service.
Nothing happens when the Gas Pod is installed	Remove and re-seat the Gas Pod. Contact Factory Service.
Temperature does not update when temperature probe is installed	Check the probe fitting is fully seated. Check the probe plug is screwed together tightly. Contact Factory Service.

9 Technical Specifications

9.1 *Physical*

Weight	4.4 lbs.
Size	L 2.48” x W 7.48’’ x D 9.92”.
Case material	Anti-static ABS.
Keys	Membrane panel.
Display	Liquid Crystal Display 40 x 16 characters. Fiber optic woven backlight for low light conditions.
Filters	User replaceable integral fiber filter at inlet port and external PTFE water trap filter.

9.2 *General*

Certifications	UL Certified to Class 1, Zone 1, AEx Ib d IIa T4
Temperature measurement	With optional probe 14°F to 167°F.
Temperature accuracy	±0.4ºF (± probe accuracy).
Visual and audible alarm	User selectable CO_2, CH_4 and O_2 Min/Max levels via DataField CS software.
Communications	RS232 protocol via download lead with variable baud rate.
Relative pressure	±250 mbar from calibration pressure

9.3 *Power supply*

Battery type	Rechargeable Nickel Metal Hydride battery pack containing six 4AH cells. **Not user replaceable**. Lithium Manganese battery for data retention.
Battery life	Typical use 10 hours from fully charged condition.
Battery charger	Separate intelligent 2A battery charger powered from AC voltage supply (110-230V).
Charge time	Approximately 2 hours from complete discharge.
Alternative power	Can be powered externally for fixed-in-place applications only. Contact LANDTEC for further information.
Battery lifetime	Up to 1,000 charge/discharge cycles.

9.4 *Gas Ranges*

Detection principle	CO_2 and CH_4 by dual wavelength infrared cell with reference channel. O_2 by internal electrochemical cell.
Oxygen cell lifetime	Approximately 18 months in air.
Typical Accuracy 0 - Full Scale	**Gas** **0-5% volume** **5-15% volume** **15%-FS** **CH_4** ±0.3% ±1% ±3% (100%) **CO_2** ±0.3% ±1% ±3% (60%) **O_2** ±1% ±1% ±1% (21%)
Response time, T90	CH_4 ≤20 seconds CO_2 ≤20 seconds O_2 ≤20 seconds
Range	CH_4 0-70% to specification, 0-100% reading. CO_2 0-40% to specification, 0-100% reading. O_2 0-25%

9.5 Pump

Typical flow	300 cc/min.
Flow fail point	50 cc/min approximately.
Flow with 200 mbar vacuum	250 cc/min approximately.
Vacuum	70 inches H_20.

9.6 Operating Conditions

Operating temp range	32°F to 104°F.
Relative humidity	0-95% non-condensing.
Atmospheric pressure range	700-1200 mbar. Displayed in Inches of Mercury (5.9 – 35.4“Hg). Not corrected for sea level.
Atmospheric pressure accuracy	±5 mbar approximately.
Case seal	IP65.

9.7 Optional Gas Pods

Typical Accuracy (Subject to User calibration).	**Gas**	**0-Full Scale**
	CO	±10% FS
	H_2S	±10% FS
	SO_2	±10% FS
	NO_2	±10% FS
	CL_2	±10% FS
	H_2	±10% FS
	HCN	±10% FS
Response time, T90	CO	≤60 seconds
	H_2S	≤60 seconds
	SO_2	≤60 seconds
	NO_2	≤60 seconds
	CL_2	≤60 seconds
	H_2	≤60 seconds
	HCN	≤60 seconds
Range	CO	0-500ppm
	H_2S	0-50 or 0-200ppm
	SO_2	0-20 or 0-100ppm
	NO_2	0-20ppm
	CL_2	0-20ppm
	H_2	0-1000ppm
	HCN	0-100ppm

Rae System MiniRAE 3000 Operations Manual

MiniRAE 3000
User's Guide

RAE SYSTEMS
by Honeywell

Rev. F
February 2016
P/N 059-4020-000

FCC Information

Contains FCC ID: PI4411B or SU3RM900

The enclosed device complies with part 15 of the FCC rules. Operation is subject to the following 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.

Wireless Approval For UAE In Middle East

TRA REGISTERED No: ER36153/14 or ER36153/15
DEALER No.: HONEYWELL INTERNATIONAL MIDDLE EAST – LTD – DUBAI BR

Wireless Approval For QATAR In Middle East

ictQATAR
Type Approval Reg. No.: R-4466 or R-4635

contém o módulo wireless: RM900

ANATEL

2781-14-6496

(01)07898911288364

Este equipamento opera em caráter secundário, isto é, não tem direito a proteção contra interferência prejudicial, mesmo de estações do mesmo tipo, e não pode causar interferência a sistemas operando em caráter primário.

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Read Before Operating

This manual must be carefully read by all individuals who have or will have the responsibility of using, maintaining, or servicing this product. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions. The user should understand how to set the correct parameters and interpret the obtained results.

CAUTION!

To reduce the risk of electric shock, turn the power off before removing the instrument cover. Disconnect the battery before removing sensor module for service. Never operate the instrument when the cover is removed. Remove instrument cover and sensor module only in an area known to be non-hazardous.

Special Notes

⚠ When the instrument is taken out of the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the instrument. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

⚠ The battery of the instrument discharges slowly even if it is turned off. If the instrument has not been charged for 5 to 7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the instrument before using it. It is also recommended to fully charge the instrument for *at least 10 hours* before first use. Refer to this User Guide’s section on battery charging for more information on battery charging and replacement.

WARNINGS

STATIC HAZARD: Clean only with damp cloth.

For safety reasons, this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.

Use only RAE Systems battery packs, part numbers 059-3051-000, 059-3052-000, and 059-3054-000. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.

Do not mix old and new batteries or batteries from different manufacturers.

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service.

For maximum safety, the accuracy of the instrument should be checked by exposing it to a known concentration calibration gas before each day's use.

Do not use USB/PC communication in hazardous locations.

AVERTISSEMENT

DANGER RISQUE D'ORIGINE ELECTROSTATIQUE: Nettoyer uniquement avec un chiffon humide.

Pour des raisons de sécurité, cet équipment doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d’instructions en entier avant d’utiliser, d’entretenir ou de réparer l’équipement.

Utiliser seulement l'ensemble de batterie RAE Systems, la reference 059-3051-000 au 059-3052-000 au 059-3054-000. Cet instrument n’a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d’oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsique. Ne charger les batteries que dans emplacements désignés non-dangereuse.

Ne pas melanger les anciennes et les nouvelles batteries, ou bien encore les batteries de differents fabriquants.

La calibration de toute instruments de RAE Systems doivent être testé en exposant l’instrument a une concentration de gaz connue par une procédure diétalonnage avant de mettre en service l’instrument pour la première fois.

Pour une securite maximale, la sensibilité du l’instrument doit être verifier en exposant l’instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.

Ne pas utiliser de connection USB/PC en zone dangereuse.

Standard Contents

Instrument
Calibration Kit
Charging Cradle
AC/DC Adapter
Alkaline Battery Adapter
Data Cable
CD-ROM With User's Guide, Quick Start Guide, and related materials

General Information

The compact instrument is designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a photoionization detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas-discharge lamp. Features are:

Lightweight and Compact

- Compact, lightweight, rugged design
- Built-in sample draw pump

Dependable and Accurate

- Up to 16 hours of continuous monitoring with rechargeable battery pack
- Designed to continuously monitor VOC vapor at parts-per-million (ppm) levels

User-friendly

- Preset alarm thresholds for STEL, TWA, low- and high-level peak values.
- Audio buzzer and flashing LED display are activated when the limits are exceeded.

Datalogging Capabilities

- 260,000-point datalogging storage capacity for data download to PC

The instrument consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged case with a backlit LCD and 3 keys to provide easy user interface. It also has a built-in flashlight for operational ease in dark locations.

Physical Description

The main components of the portable VOC monitoring instrument include:

- Three keys for user to interact with the instrument: 3 operation/programming keys for normal operation or programming
- LCD display with back light for direct readout and calculated measurements
- Built-in flashlight for illuminating testing points in dark environments
- Buzzer and red LEDs for alarm signaling whenever exposures exceed preset limits
- Charge contacts for plugging directly to its charging station
- Gas entry and exit ports
- USB communication port for PC interface
- Protective rubber cover

Specifications

Size:	9.25" L x 3.6" W x 2.9" H
Weight:	28 oz with battery pack
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 3.7V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only)
	Alkaline battery holder (for 4 AA batteries)
Battery Charging:	Less than 8 hours to full charge
Operating Hours:	Up to16 hours continuous operation
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0.1 ppm to 15,000 ppm	0.1 ppm
9.8 eV	0.1 ppm to 5,000 ppm	0.1 ppm
11.7 eV	0.1 ppm to 2,000 ppm	0.1 ppm

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	10 to 2000 ppm: ±3% at calibration point.
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration:	Two-point field calibration of zero and standard reference gases
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing
Radio module:	Bluetooth (2.4GHz) or RF module (433MHz, 868MHz , 915MHz, or 2.4GHz)
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A, B, C, D Europe: ATEX (0575 Ex II 2G Ex ia IIC/IIB T4 Gb) KEMA 07 ATEX 0127 Complies with EN60079-0:2009, EN60079-11:2007

	IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0:2007, IEC 60079-11:2006 (IIC: 059-3051-000 Li-ion bat pack or 059-3054-000 NiMH bat pack; IIB: 059-3052-000 alkaline bat pack)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC R&TTE (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 30cm and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station.
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Wireless Network:	Mesh RAE Systems Dedicated Wireless Network (or WiFi network for WiFi-equipped instruments)
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE R&TTE, IEEE 802.11 b/g bands (2.4 GHz)
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Temperature:	-20º C to 50º C (-4º to 122º F)

Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

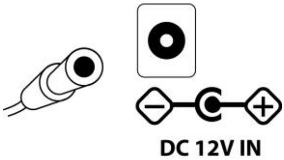
Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion battery is charged by placing the instrument in its cradle. (The battery can also be charged by placing the instrument in an AutoRAE 2 Cradle.) Contacts on the bottom of the instrument meet the cradle's contacts, transferring power without other connections.

Note: Before setting the instrument into its charging cradle, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter's barrel connector into the instrument's cradle.



2. Plug the AC/DC adapter into the wall outlet.
3. Place the instrument into the cradle, press down, and lean it back. It locks in place and the LED in the cradle glow

The instrument begins charging automatically. The "Primary" LED in the cradle blinks green to indicate charging. During charging, the diagonal lines in the battery icon on the instrument's display are animated and you see the message "Charging..."

When the instrument's battery is fully charged, the battery icon is no longer animated and shows a full battery. The message "Fully charged!" is shown. The cradle's LED glows continuously green.

Note: If you see the "Battery Charging Error" icon (a battery outline with an exclamation mark inside), check that the instrument or rechargeable battery has been set into the cradle properly. If you still receive the message, check the Troubleshooting section of this guide.

Note: If the instrument or battery has been in the cradle for more than 10 hours and you see the "Battery Charging Error" icon and a message that says, "Charging Too Long," this indicates that the battery is not reaching a full charge. Try changing the battery and make sure the contacts between the instrument (or battery) are meeting the cradle. If the message is still shown, consult your distributor or RAE Systems Technical Services.

Charging A Spare Rechargeable Battery

A rechargeable Li-ion battery can be charged when it is not inside the monitor. The charging cradle is designed to accommodate both types of charging. Contacts on the bottom of the battery meet the contacts on the cradle, transferring power without other connections, and a spring-loaded capture holds the battery in place during charging.

1. Plug the AC/DC adapter into the monitor's cradle.
2. Place the battery into the cradle, with the gold-plated contacts on top of the six matching charging pins.
3. Plug the AC/DC adapter into the wall outlet.

The battery begins charging automatically. During charging, the Secondary LED in the cradle blinks green. When charging is complete, it glows steady green.

Release the battery from the cradle by pulling it back toward the rear of the cradle and tilting it out of its slot.

Note: If you need to replace the Li-ion battery pack, replacements are available from RAE Systems. The part number is 059-3051-000.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. Remove and replace batteries only in areas known to be non-hazardous.

Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the "empty battery" icon blinks on and off once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion battery or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

Data Protection While Power Is Off

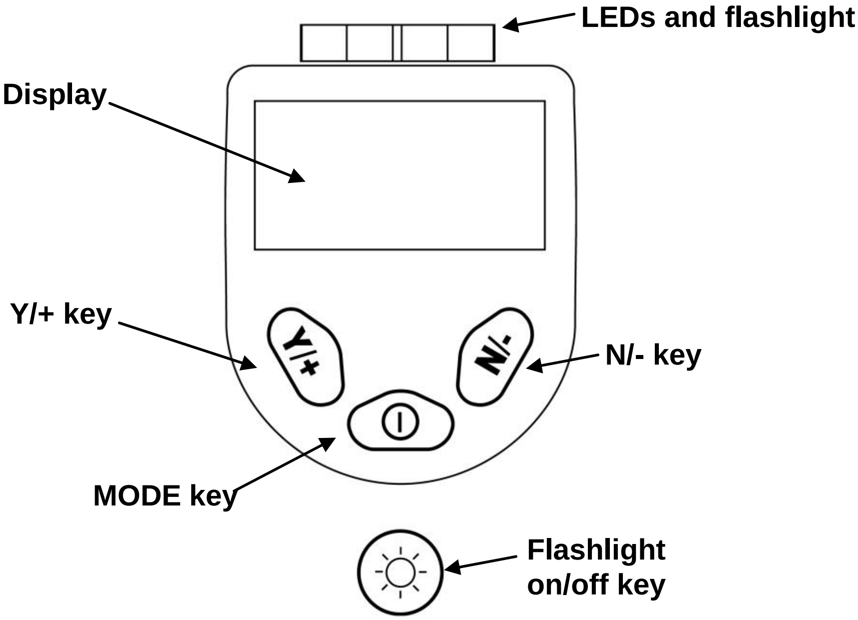
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

User Interface

The instrument's user interface consists of the display, LEDs, an alarm transducer, and four keys. The keys are:

Y/+
MODE
N/-
Flashlight on/off

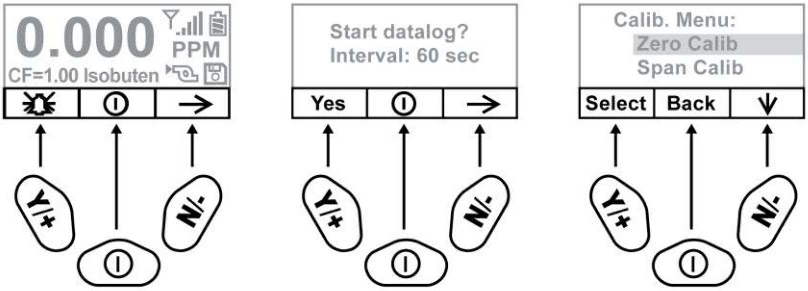
The LCD display provides visual feedback that includes the reading, time, battery condition, and other functions.



In addition to their labeled functions, the keys labeled Y/+, MODE, and N/- act as "soft keys" that control different parameters and make different selections within the instrument's menus. From menu to menu, each key controls a different parameter or makes a different selection.

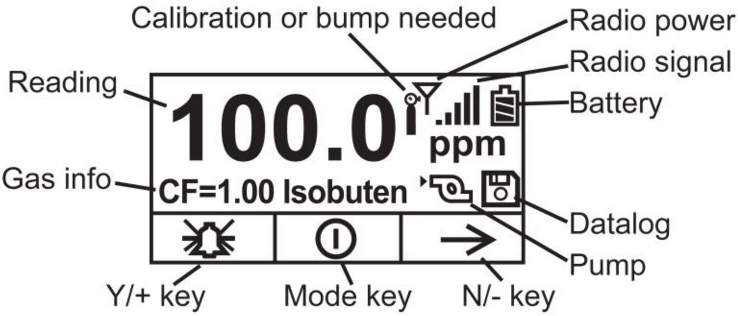
Three panes along the bottom of the display are "mapped" to the keys. These change as menus change, but at all times the left pane corresponds to the [Y/+] key, the center pane corresponds to the [MODE] key, and the right pane corresponds to the [N/-] key. Here are three examples of different menus with the relationships of the keys clearly shown:

RELATIONSHIP OF BUTTONS TO CONTROL FUNCTIONS



Display

The display shows the following information:



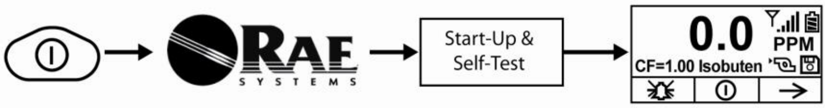
Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration or bump needed	Dark icon indicates that calibration should be performed; light icon indicates bump should be performed
Radio power	Indicates whether radio (Mesh wireless or Bluetooth) connection is on or off
Radio signal	Indicates signal strength in 5-bar bargraph
Battery	Indicates battery level in 3 bars
Pump	Indicates that pump is working
Datalog	Indicates whether datalog is on or off
Y/+	Y/+ key's function for this screen
MODE	MODE key's function for this screen
N/-	N/- key's function for this screen

Operating The Instrument

The instrument is designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real-time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment, the instrument is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, you should test the instrument and verify the calibration before the first use. After the instrument is fully charged and calibrated, it is ready for immediate operation.

Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.



The RAE Systems logo should appear first. (If the logo does not appear, there is likely a problem and you should contact your distributor or RAE Systems Technical Support.) The instrument is now operating and performs self tests. If any tests (including sensor and memory tests fail), refer to the Troubleshooting section of this guide.

Once the startup procedure is complete, the instrument shows a numerical reading screen with icons. This indicates that the instrument is fully functional and ready to use.

Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. Once the countdown stops, the instrument is off. Release the Mode key.
3. When you see "Unit off..." release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

Operating The Built-In Flashlight

The instrument has a built-in flashlight that helps you point the probe in dark places. Press the flashlight key to turn it on. Press it again to turn it off.

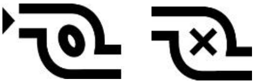
Note: Using the flashlight for extended periods shortens the battery's operating time before it needs recharging.

Pump Status

IMPORTANT!

During operation, make sure the probe inlet and the gas outlet are free of obstructions. Obstructions can cause premature wear on the pump, false readings, or pump stalling. During normal operation, the pump icon alternately shows inflow and outflow as shown here:

During duty cycling (PID lamp cleaning), the display shows these icons in alternation:



If there is a pump failure or obstruction that disrupts the pump, you will see this icon blinking on and off:

If you see this blinking icon, consult the Troubleshooting section of this guide.

Calibration Status

The instrument displays this icon if it requires calibration:

Calibration is required (and indicated by this icon) if:

- The lamp type has been changed (for example, from 10.6 eV to 9.8 eV).
- The sensor has been replaced.
- It has been 30 days or more since the instrument was last calibrated.
- If you have changed the calibration gas type without recalibrating the instrument.

Bump Status

The instrument displays this icon if it requires a bump test:

A bump test is required (and indicated by this icon) if:

- The defined period of time between bump tests has been exceeded (bump test overdue).
- The sensor has failed a previous bump test.
- The sensor(s) should be challenged on a periodic basis.

Policy Enforcement

The MiniRAE 3000 can be configured to enforce a facility/company's requirements that calibration and/or bump testing be performed at specified intervals, and to explicitly prompt the user that calibration/bump testing is required. Depending on how Policy Enforcement features are configured, the user may be required to perform a bump test or calibration prior to being able to use the instrument. That is, it can be set to not allow normal operation of the instrument unless calibration or bump testing is performed.

If the instrument has been bump tested and calibrated in compliance with the policy settings, a check-mark icon is included along the top of the MiniRAE 3000 screen:

✓

If Policy Enforcement is enabled, then after startup the MiniRAE 3000 displays a screen that informs the user that the instrument requires either a bump test or a calibration. If both are required, then they are shown in sequence.

Note: Policy enforcement features are disabled by default.

Setting Policy Enforcement

You must use ProRAE Studio II to make changes to Policy Enforcement settings. You must use an AutoRAE 2 Cradle, a MiniRAE 3000 Travel Charger, or a MiniRAE 3000 Desktop Cradle. Policy violations are captured in the datalog.

Using The Travel Charger, Desktop Charger, or AutoRAE 2 Automatic Test And Calibration System

To program a MiniRAE 3000 via an AutoRAE 2, you need ProRAE Studio II Instrument Configuration and Data Management Software, the AutoRAE 2 connected to a power source, and a USB PC communications cable.

1. Connect a USB cable between a PC with ProRAE Studio II and the AutoRAE 2 Cradle, Travel Charger, or Desktop Cradle.
2. Apply power to the AutoRAE 2 Cradle, Travel Charger, or Desktop Cradle.
3. Turn off the MiniRAE 3000 (or put the MiniRAE 3000 into AutoRAE 2 Mode or Communication Mode) and set it in the cradle.
4. Start ProRAE Studio II software on the PC.
5. Select “Administrator” and input the password (the default is “rae”).
6. Click “Detect the instruments automatically” (the magnifying glass icon with the letter “A” in it). After a few seconds, the AutoRAE 2 Cradle is found and it is shown, along with its serial number.
7. Click on the icon to highlight it, and then click “Select.”
8. In ProRAE Studio II, the instrument or AutoRAE 2 Cradle is shown, including its Serial Number, under “Online.”
9. Expand the view to show the instrument or to show the instrument in the AutoRAE 2 Cradle by clicking the “+” to the left of the image of the AutoRAE 2 Cradle.
10. Double-click on the icon representing the MiniRAE 3000.
11. Click “Setup.”
12. In the menu that now appears on the left side, click “Policy Enforcement.” It is highlighted, and the Policy Enforcement pane is shown. For “Must Calibrate” and “Must Bump,” you have the options of no enforcement or enforcement (including “Can't Bypass,” and “Can Bypass”).

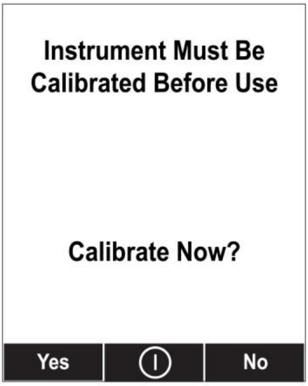
Must Calibrate. The user is prompted to calibrate the instrument when calibration is due (as set by the calibration interval). There are two programmable options:

- **Can't Bypass.** Unless calibration is performed, the instrument cannot be used, and the only option is to turn off the instrument.
- **Can Bypass.** If calibration is due but the user does not want to perform a calibration, the instrument can still be used. In this case, the instrument records that the user has bypassed the calibration requirement in a Policy Violation report.

Must Bump. The user is prompted to bump test the instrument when a bump test is due (as set by the bump test interval). There are two programmable options:

- **Can't Bypass.** Unless a bump test is performed, the instrument cannot be used, and the only option is to turn off the instrument.
- **Can Bypass.** If a bump test is due but the user does not want to perform one, the instrument can still be used. In this case, the instrument records that the user has bypassed the bump testing requirement in a Policy Violation report.

These are the screens that are shown on a MiniRAE 3000 after startup if "Can Bypass" is selected:



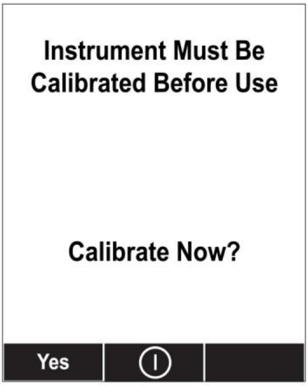
Instrument Must Be Calibrated Before Use

Calibrate Now?

Instrument Must Be Bump Tested Before Use

Bump Test Now?

If “Can’t Bypass” is selected, the display looks like this, and only allows the options of performing the test or shutting down:


Instrument Must Be
Calibrated Before Use

Calibrate Now?


Instrument Must Be
Bump Tested
Before Use

Bump Test Now?

16. Once you have made your selections in ProRAE Studio II, you must upload the changes to the instrument. Click the icon labeled “Upload all settings to the instrument.”

17. A confirmation screen is shown. Click “Yes” to perform the upload, or “No” to abort.
    Uploading takes a few seconds, and a progress bar is shown. You can abort the upload by clicking “Cancel.”

18. Exit ProRAE Studio II.

19. Press [Y/+] on the MiniRAE 3000 to exit Communication Mode.

Operating Modes

Your instrument operates in different modes, depending on the model and its factory default settings. In some cases, you can change modes using a password and using the instrument's navigation. In other cases, you must use ProRAE Studio software.

The default setting for your instrument is:

User Mode: Basic
Operation Mode: Hygiene

This is outlined in detail on page 83.

The other options, covered later in this guide, are:

User Mode: Advanced (page 86)
Operation Mode: Hygiene

User Mode: Advanced (page 90)
Operation Mode: Search

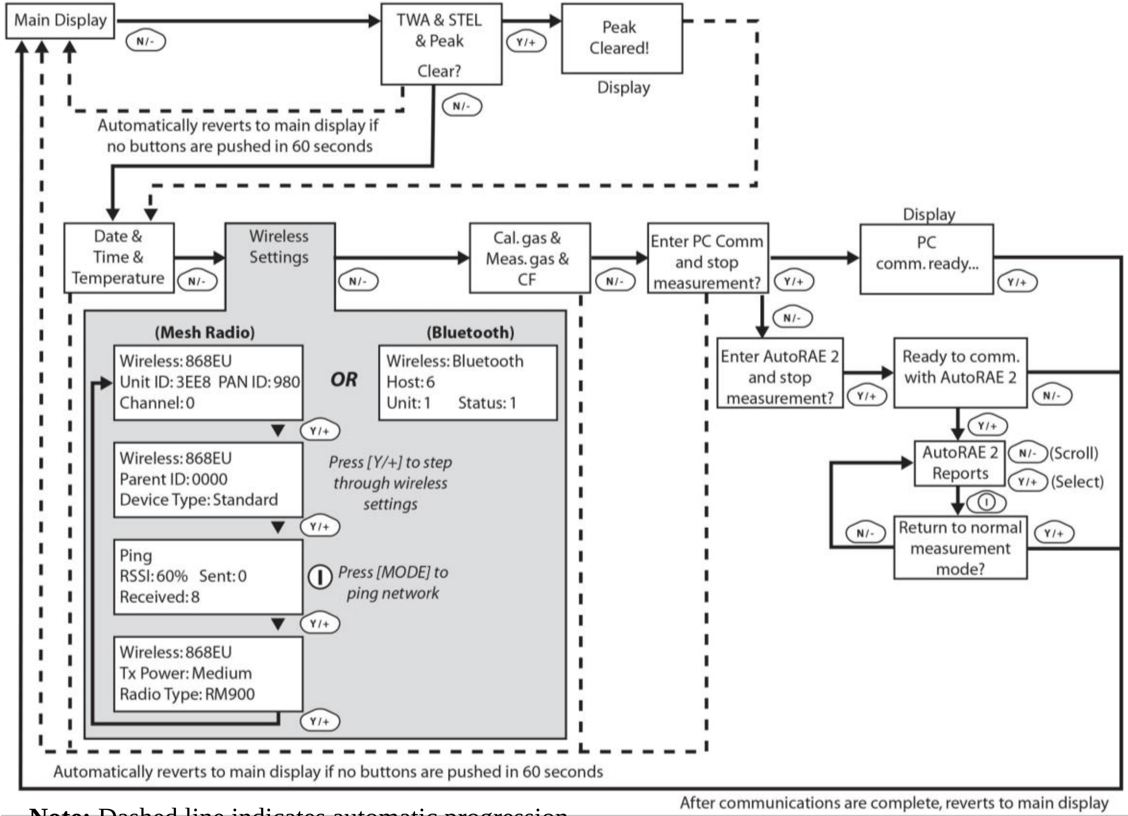
Using ProRAE Studio allows access to other options. In addition, Diagnostic Mode (page 91) is available for service technicians.

Basic User Level/Hygiene Mode (Default Settings)

The instrument is programmed to operate in Basic User Level/Hygiene Mode as its default. This gives you the most commonly needed features while requiring the fewest parameter adjustments.

Pressing [N/-] steps you from one screen to the next, and eventually return to the main display. If you do not press a key within 60 seconds after entering a display, the instrument reverts to its main display.

Note: While viewing any of these screens, you can shut off your instrument by pressing [MODE].



Note: Dashed line indicates automatic progression.

After the instrument is turned on, it runs through the start-up menu. Then the message "**Please apply zero gas…**" is displayed.

At this point, you can perform a zero air (fresh air) calibration. If the ambient air is clean, you can use that. Otherwise, use a cylinder of zero air. Refer to Zero Calibration on page 44 for a more detailed description of zero calibration.

Start zero calibration by pressing Start. You see the message "Zeroing…" followed by a 30-second countdown.

Note: You can press [MODE] to quit, bypassing the zero air calibration.

When zero calibration is complete, you see the message:

Zeroing is done!

Reading = 0.0 ppm

The instrument is now sampling and collecting data.

Note: At the Average & Peak, Date & Time & Temperature, Calibration Gas & Measurement Gas & Correction Factor, and PC Communications screens, the instrument automatically goes to the main display after 60 seconds if you do not push a key to make a selection.

Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition.

In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, or pump stall.

Alarm Signal Summary

Message	**Condition**	**Alarm Signal**
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

* Hygiene mode only. In Search mode, the number of beeps per second (1 to 7) depends upon the concentration of the sampled gas. Faster rates indicate higher concentrations.

Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas **(Isobutylene)**	**Cal Span**	**unit**	**Low**	**High**	**TWA**	**STEL**
MiniRAE 3000	100	ppm	50	100	10	25

Testing The Alarm

You can test the alarm whenever the main (Reading) display is shown. Press [Y/+], and the audible and visible alarms are tested.

Integrated Sampling Pump

The instrument includes an integrated sampling pump. This diaphragm-type pump that provides a 450 to 550 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8" inside diameter to the gas inlet port of the instrument, this pump can pull in air samples from 100' (30 m) away horizontally or vertically.

Note: In Search Mode, the pump turns on when a sample measurement is started, and turns off when the sample is manually stopped.

If liquid or other objects are pulled into the inlet port filter, the instrument detects the obstruction and immediately shuts down the pump. The alarm is activated and a flashing pump icon is displayed.

You should acknowledge the pump shutoff condition by clearing the obstruction and pressing the [Y/+] key while in the main reading display to restart the pump.

Backlight

The LCD display is equipped with an LED backlight to assist in reading the display under poor lighting conditions.

Datalogging

During datalogging, the instrument displays a disk icon to indicate that datalogging is enabled. The instrument stores the measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information is stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down- loaded at a later time to a PC.

Datalogging event

When Datalogging is enabled, measurement readings are being saved. These data are stored in "groups" or "events." A new event is created and stored each time the instrument is turned on and is set to automatic datalogging, or a configuration parameter is changed, or datalogging is interrupted. The maximum time for one event is 24 hours or 28,800 points. If an event exceeds 24 hours, a new event is automatically created. Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits are recorded.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. When transferred to a PC running ProRAE Studio, this data is arranged with a sample number, time, date, gas concentration, and other related information.

Auto/Manual/Snapshot Datalogging

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see page 63 for details).
Snapshot	Datalogs only during snapshot (single-event capture, initiated by pressing [MODE]) sampling. See page 65 for details.

Note: You can only choose one datalog type to be active at a time.

Accessories

The following accessories are included with the instrument:

- An AC Adapter (Battery Charger)
- Alkaline battery adapter
- External Filter
- Organic Vapor Zeroing kit

Hard-case kits also include these accessories:

- Calibration adapter
- Calibration regulator and Flow controller

Standard Kit & Accessories

AC Adapter (Battery Charger)

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Ne charger les batteries que dans emplacements designés non-dangereuses.

A battery charging circuit is built into the instrument cradle. It only needs a regular AC to 12 VDC adapter (wall-mount transformer, part number 500-0114-000) to charge the instrument.

To charge the battery inside the instrument:

1. Power off the instrument.
2. Connect the AC adapter to the DC jack on the instrument's cradle. If the instrument is off, it automatically turns on.
3. While charging, the display message shows "Charging." The Primary LED on the cradle flashes green when charging.
4. When the battery is fully charged, the LED changes to glowing green continuously, and the message "Fully charged" appears on the

display. If there is a charging error, the LED glows red continuously.

A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

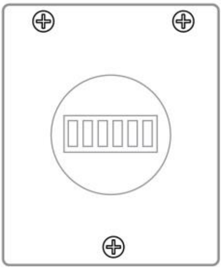
The factory-supplied battery is designed to last for 16 hours of normal operation (no alarm), for a new battery under the optimum circumstances. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), its capacity will be significantly reduced.

Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment in the adapter.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.



To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the instrument by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument. If you try to charge an alkaline batteries installed in the instrument, the instrument's display will say, "Alkaline Battery," indicating that it will not charge the alkaline batteries.

Note: When replacing alkaline batteries, dispose of old ones properly.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

External Filter

The external filter is made of PTFE (Teflon®) membrane with a 0.45 micron pore size to prevent dust or other particles from being sucked into the sensor manifold, which would cause extensive damage to the instrument. It prolongs the operating life of the sensor. To install the external filter, simply connect it to the instrument's inlet tube.

Optional Accessories

Calibration Adapter

The calibration adapter for the instrument is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the instrument and the tubing to the gas regulator on the gas bottle.

Calibration Regulator

The Calibration Regulator is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the instrument during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a demand-flow regulator or a Tedlar gas bag may be used to match the pump flow precisely.

Organic Vapor Zeroing Kit

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the instrument.

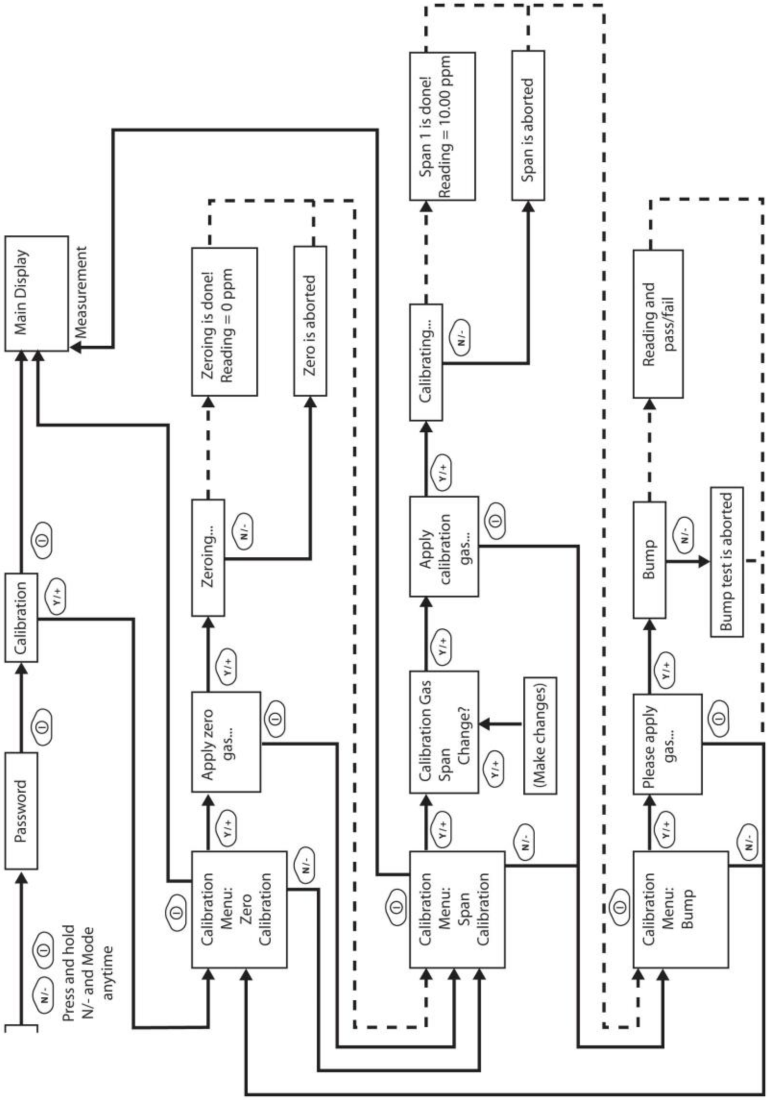
AutoRAE 2 Automatic Test & Calibration System

The AutoRAE 2 Automatic Test and Calibration System for RAE Systems portable gas monitors makes compliance with monitor test and calibration requirements as easy as pressing a button. Simply cradle the monitor and the system will take care of all calibration, testing, and recharging.

The AutoRAE 2 is a flexible, modular system that can be configured to meet your calibration requirements effectively and efficiently. An AutoRAE 2 system can be as simple as a single cradle deployed in standalone mode to calibrate one instrument at a time, or as powerful as a networked, controller-based system supporting ten monitors and five distinct calibration gas cylinders.

Standard Two-Point Calibration (Zero & Span, Optional Bump)

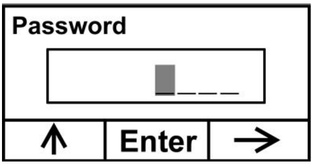
The following diagram shows the instrument's calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

Entering Calibration

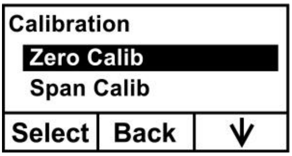
1. Press and hold [MODE] and [N/-] until you see the Password screen.



2. In Basic User Level, you do not need a password to perform calibrations. Instead of inputting a password, enter calibration by pressing [MODE].

   Note: If you inadvertently press [Y/+] and change any of the numbers, simply press [MODE] and you will be directed to the calibration menu.

The Calibration screen is now visible with Zero Calibration highlighted.



These are your options:

- Press [Y/+] to select the highlighted calibration (Zero Calib or Span Calib).
- Press [MODE] to exit calibration and return to the main display and resume measurement.
- Press [N/-] to toggle the highlighted calibration type.

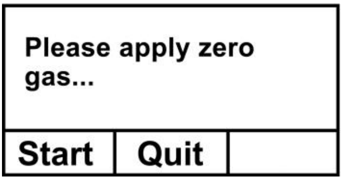
Zero (Fresh Air) Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the instrument to a "fresh" air source such as from a cylinder or Tedlar bag (optional accessory). The "fresh" air is clean, dry air without organic impurities and an oxygen value of 20.9%. If such an air cylinder is not available, any clean ambient air without detectable contaminants or a charcoal filter can be used.

At the Zero Calibration menu, you can proceed to perform a Zero calibration or bypass Zero calibration and perform a Span calibration. You may also go back to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to start calibration.
- Press [MODE] to quit and return to the main calibration display.

If you have pressed [Y/+] to enter Zero calibration, then you will see this message:



Please apply zero gas...

1. Turn on your Zero calibration gas.
2. Press [Y/+] to start calibration.

   Note: At this point, you may press [MODE] if you decide that you do not want to initiate calibration. This will take you directly to the Calibration menu, highlighted for Span calibration.

3. Zero calibration starts a 30-second countdown and displays this message:

Zeroing...

During the zeroing process, the instrument performs the Zero calibration automatically and does not require any action on your part.

Note: To abort the zeroing process at any time and proceed to Span calibration, press [N/-] at any time while zeroing is being performed. You will see a confirmation message that says "Zero aborted!" and then the Span calibration menu appears.

When Zero calibration is complete, you see this message:

Zeroing is done!
Reading = 0.0 ppm

The instrument will then show the Calibration menu on its display, with Span Calib highlighted.

Span Calibration

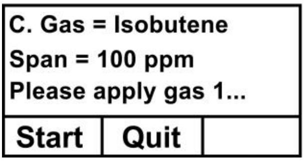
This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the instrument, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

At the Span Calibration menu, you perform a Span calibration. You may also go back to the Zero calibration menu or to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to enter Span calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

If you have pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm). You will also see this message that prompts you:



C. Gas = Isobutene
Span = 100 ppm
Please apply gas 1...

1. Turn on your span calibration gas.
2. Press [Y/+] to initiate calibration.

Note: You may press [MODE] if you decide that you do not want to initiate calibration. This will abort the span calibration and take you directly to the Calibration menu for Zero calibration.

3. Span calibration starts and displays this message:

Calibrating...

During the Span calibration process, there is a 30-second countdown and the instrument performs the Span calibration automatically. It requires no actions on your part.

Note: If you want to abort the Span calibration process, press [N/-] at any time during the process. You will see a confirmation message that says "Span is aborted!" and then the Zero calibration menu appears. You can then proceed to perform a Zero calibration, perform a Span calibration, or exit to the topmost Calibration menu.

When Span calibration is complete, you see a message similar to this (the value is an example only):

Span 1 is done!
Reading = 100.0 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

Exiting Two-Point Calibration In Basic User Level

When you are done performing calibrations, press [MODE], which corresponds with "Back" on the display. You will see the following message:

Updating settings…

The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

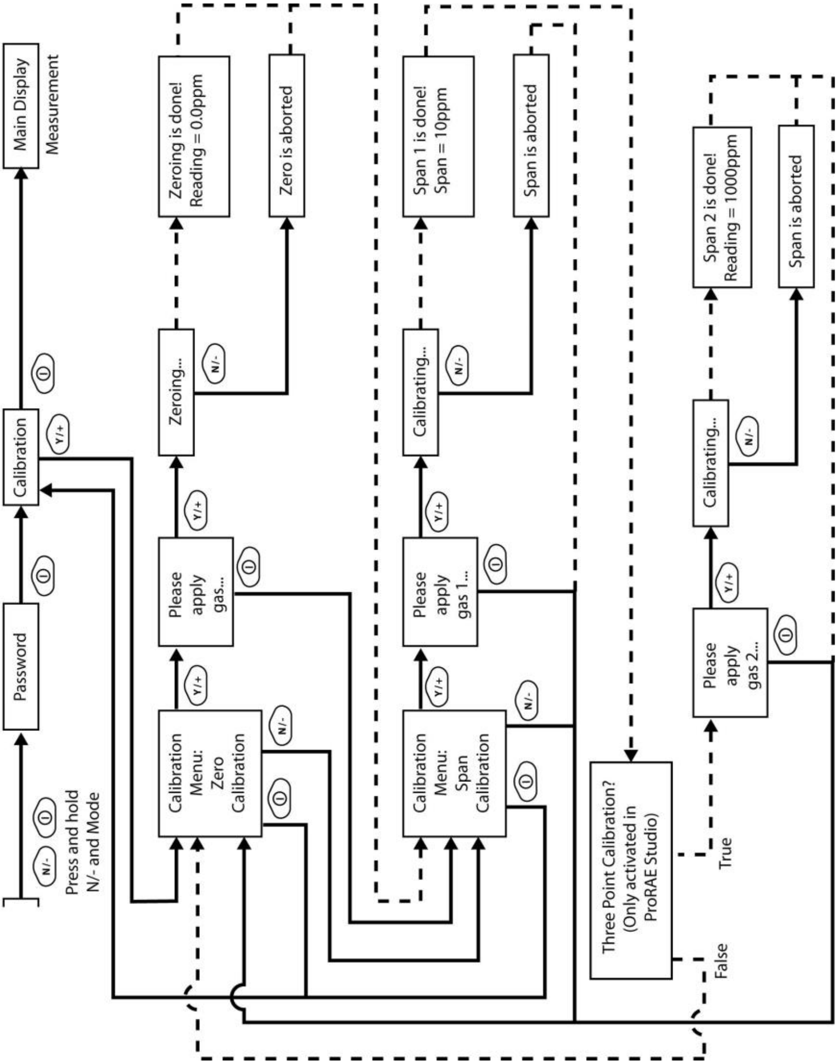
Three-Point Calibration

For enhanced accuracy, it is possible to perform a second Span calibration in addition to the Zero and Span calibrations outlined in the previous section. Your instrument first must be set to allow this third calibration. This requires using ProRAE Studio software and a PC, as well as a higher concentration of calibration gas.

Note: Once the third calibration is set, you do not need to use ProRAE Studio to allow future 3-point calibrations. Also, you can only disable 3-point calibration capability by using ProRAE Studio again.

Perform the Zero and Span calibrations. After the first Span calibration (Span 1) is completed, the display a second Span calibration (Span 2) can be performed. The process is identical to the first calibration. As in the Span 1 calibration, you may exit and return to the Zero calibration screen if you choose not to perform this calibration or to abort it.

Note: If a bump test is available, it appears after the last calibration in the menu. See "Two-Point Calibration," page 38, for details. Also, refer to page 53 for details on how to perform a bump test.



Note: Dashed line indicates automatic progression.

Span 2 Calibration

A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure.

Note: This gas should be of a higher concentration than the gas used for Span 1 calibration.

Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar bag or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the instrument, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

At the Span Calibration menu, you perform a Span calibration. You may also go back to the Zero calibration menu or to the initial Calibration menu if you want to exit calibration.

- Press [Y/+] to enter Span 2 calibration.
- Press [N/-] to skip Span calibration and return to Zero calibration.
- Press [MODE] to exit Span calibration and return to the top calibration menu.

If you have pressed [Y/+] to enter Span calibration, then you will see the name of your Span gas (the default is isobutylene) and the span value in parts per million (ppm). You will also see this message that prompts you:

Please apply gas...

4. Turn on your span calibration gas.
5. Press [Y/+] to initiate calibration.

Note: You may press [MODE] if you decide that you do not want to initiate calibration. This will take you directly to the Calibration menu for Zero calibration.

6. Span calibration starts a 30-second countdown and displays this message:

Calibrating...

During the Span calibration process, the instrument performs the Span calibration automatically and does not require any action on your part.

Note: If you want to abort the Span calibration process, press [N/-] at any time during the process. You will see a confirmation message that says "Span is aborted!" and then the Zero calibration menu will appear. You can then proceed to perform a Zero calibration, perform a Span calibration, or exit to the topmost Calibration menu.

When Span calibration is complete, you will see a message similar to this (the value shown here is for example only):

Span 2 is done!
Reading = 1000 ppm

The instrument then exits Span calibration and shows the Zero calibration menu on its display.

Note: The reading should be very close to the span gas value.

Exiting Three-Point Calibration

When you are done performing calibrations, press [MODE], which corresponds with "Back" on the display. You will see the following message:

Updating settings…

The instrument updates its settings and then returns to the main display. It begins or resumes monitoring.

Bump Test

RAE Systems recommends that a bump test be conducted prior to each day's use. The purpose of a bump test is to ensure that the instrument's sensors respond to gas and all the alarms are enabled and functional.

- The MiniRAE 3000 must be calibrated if it does not pass a bump test when a new sensor is installed, after sensor maintenance has been performed, or at least once every 180 days, depending on use and sensor exposure to poisons and contaminants.
- Calibration and bump test intervals and procedures may vary due to national legislation and company policy.

To perform a bump test (functional challenge), follow these steps:

1. Select "Bump."
2. Install the calibration adapter and connect it to a source of calibration gas.
3. Verify that the displayed calibration value meets the concentration specified on the gas cylinder.
4. Start the flow of calibration gas.
5. Press [Y/+] to start the bump test.
6. You can abort the calibration at any time during the countdown by pressing [N/-].

7. If the calibration is not aborted, the display shows reading and then tells you whether the bump test passed or failed. If the bump test failed, then it automatically advances to the Calibration screen.

Important!

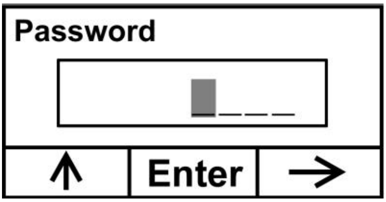
Anytime a bump test fails, you should perform a full calibration of the instrument.

Programming Mode

Programming Mode can be entered from either Hygiene Mode or Search Mode. If the current user mode is Basic, you must provide a 4-digit password to enter.

Entering Programming Mode

1. Press and hold [MODE] and [N/-] until you see the Password screen.



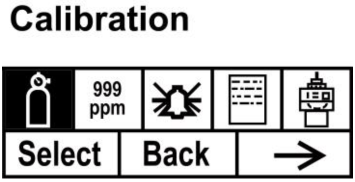
2. Input the 4-digit password:

- Increase the number from 0 through 9 by pressing [Y/+].
- Step from digit to digit using [N/-].
- Press [MODE] when you are done.

If you make a mistake, you can cycle through the digits by pressing [N/-] and then using [Y/+] to change the number in each position.

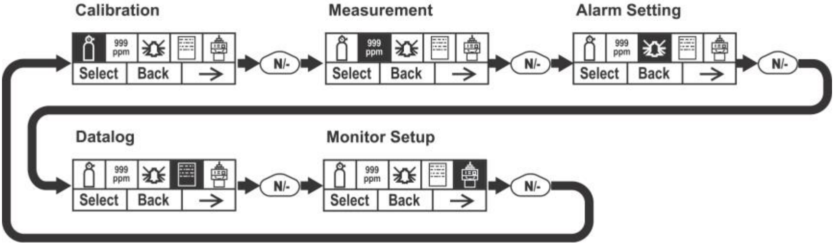
Note: The default password is 0000.

When you have successfully entered Programming Mode, you see this screen:



Note: The password can only be changed by connecting the instrument to a PC running ProRAE Studio software. Follow the instructions in ProRAE Studio to change it.

The Calibration label is shown and its icon is highlighted, but you can press [N/-] to step from one programming menu to the next, with the name of the menu shown at the top of the display and the corresponding icon highlighted. As you repeatedly press [N/-], the selection moves from left to right, and you see these screens:



Note: When you reach Monitor Setup and press [N/-], the menu cycles back to Calibration.

Programming Mode Menus

The Programming Mode allows anyone with the password to change the instrument's settings, calibrate the instrument, modify the sensor configuration, enter user information, etc. Programming Mode has five menus. Each menu includes several sub-menus to perform additional programming functions.

This table shows the menus and sub-menus:

	999 ppm			
Calibration	**Measurement**	**Alarm Setting**	**Datalog**	**Monitor Setup**
Zero Calibration	Meas. Gas	High Alarm	Clear Datalog	Radio Power
Span Calibration	Meas. Unit	Low Alarm	Interval	Op Mode
Bump		STEL Alarm	Data Selection	Site ID
		TWA Alarm	Datalog Type	User ID
		Alarm Mode		User Mode
		Buzzer & Light		Date
				Time
				Pump Duty Cycle
				Pump Speed
				Temperature Unit
				Language
				Real Time Protocol
				Power On Zero
				Unit ID
				LCD Contrast
				Lamp ID
				PAN ID
				Mesh Channel
				Mesh Interval

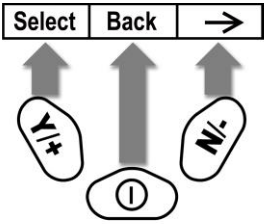
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

Exiting Programming Mode

To exit Programming Mode and return to normal operation, press [MODE] once at any of the programming menu displays. You will see "Updating Settings…" as changes are registered and the mode changes.

Navigating Programming Mode Menus

Navigating through the Programming Mode menus is easy and consistent, using a single interface format of "Select," "Back" and "Next" at the top level. The three control buttons correspond to these choices as shown:



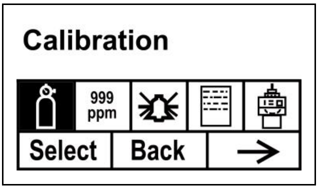
Note: Pressing [MODE] in the Programming Mode's top level causes the instrument to exit Programming Mode and return to monitoring.

The three keys perform the following functions in Programming Mode:

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Provides a "no" response to a question

Calibration

Two types of calibration are available: Zero (fresh air) and Span.



Select Zero or Span Calibration by pressing [N/+]. Once your choice is highlighted, press [Y/+].

Zero Calibration

The procedure for performing a zero calibration is covered on page 41.

Span Calibration

The procedure for performing a basic span calibration is covered on page 41.

Bump

The procedure for performing a bump calibration is covered on page 53.

A bump test can be performed either manually or using the AutoRAE 2 Automatic Test and Calibration System. When a bump test is done manually, the instrument makes a pass/fail decision based on sensor performance, but the user still has the responsibility to make sure all the alarms are enabled and functional.

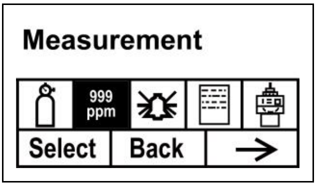
Note: Bump testing and calibration can be performed using an AutoRAE 2 Automatic Test & Calibration System. An AutoRAE 2 bump test takes care of both the sensor and alarm tests. Consult the AutoRAE 2 User's guide for details.

IMPORTANT!

If the instrument does not pass a bump test, perform a full calibration. If calibration also fails, the PID sensor or lamp may require cleaning or replacement. If the instrument repeatedly fails to calibrate, turn it off and refer it for servicing.

Measurement

The sub-menus for Measurement are Measurement Gas and Measurement Unit.



Meas. Gas

Measurement gases are organized in four lists:

- My List is a customized list of gases that you create. It contains a maximum of 10 gases and can only be built in ProRAE Studio on a PC and transferred to the instrument. **Note:** The first gas in the list is always isobutylene (it cannot be removed from the list).
- Last Ten is a list of the last ten gases used by your instrument. The list is built automatically and is only updated if the gas selected from Custom Gases or Library is not already in the Last Ten. This ensures that there is no repetition.
- Gas Library is a library that consists of all the gases found in RAE Systems' Technical Note TN-106 (available online at www.raesystems.com).
- Custom Gases are gases with user-modified parameters. Using ProRAE Studio, all parameters defining a gas can be modified,

including the name, span value(s), correction factor, and default alarm limits.

1. Scroll through each list by pressing [N/-].
2. Press [Y/+] to select one (My List, Last Ten, Gas Library, or Custom Gases).
3. Once you are in one of the categories, press [N/-] to scroll through its list of options and [Y/+] to select one. (If you press [MODE], you exit to the next submenu.)
4. Press [Y/+] to save your choice or [N/-] to undo your selection.

Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

Meas. Unit

Standard available measurement units include:

Abbreviation	Unit	MiniRAE 3000
ppm	parts per million	Yes
ppb	parts per billion	
mg/m3	milligrams per cubic meter	Yes
ug/m3	micrograms per cubic meter	

- Scroll through the list by pressing [N/-].
- Select by pressing [Y/+].
- Save your selection by pressing [Y/+] or undo your selection by pressing [N/-].

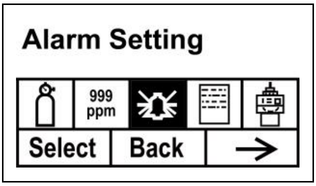
Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

Alarm Setting

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings: Low, High, TWA and STEL). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn of the alarm condition.

An alarm signal summary is shown on page 33.

In this menu, you can change the High and Low alarm limits, the STEL limit, and the TWA. Press [Y/+] to to enter the Alarm Setting menu. **Note:** All settings are shown in ppb (parts per billion), or µg/m^3 (micrograms per cubic meter), depending on your setting.



1. Scroll through the Alarm Limit sub-menu using the [N/-] key until the display shows the desired limit to be changed (High Alarm, Low Alarm, STEL Alarm, and TWA Alarm)
2. Press [Y/+] to select one of the alarm types. The display shows a flashing cursor on the left-most digit of the previously stored alarm limit.
3. Press [Y/+] to increase each digit's value.
4. Press [N/-] to advance to the next digit.
5. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

Press [MODE] when you are done.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

When all alarm types have been changed or bypassed, press [MODE] to exit to the Programming Menu.

High Alarm

You can change the High Alarm limit value. The value is typically set by the instrument to match the value for the current calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the High Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.
When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

Press [Y/+] to save the changes.
Press [N/-] to undo the changes and revert to the previous settings.

Low Alarm

You can change the Low Alarm limit value. The value is typically set by the instrument to match the value for the current calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the Low Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

STEL Alarm

You can change the STEL Alarm limit value. The value is typically set by the instrument to match the value for the calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the STEL Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

TWA Alarm

You can change the TWA (time-weighted average) Alarm limit value. The value is typically set by the instrument to match the value for the calibration gas. It is expressed in parts per billion (ppb). **Note:** The default value depends on the measurement gas.

To change the TWA Alarm value:

1. Press [Y/+] to increase each digit's value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE]. You will see two choices:

- Save
- Undo

You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Alarm Mode

There are two selectable alarm modes:

Auto Reset	When the alarm condition is no longer present, the alarm stops and automatically resets itself.
Latch	When the alarm is triggered, you can manually stop the alarm. The latched setting only controls alarms for High Alarm, Low Alarm, STEL Alarm, and TWA alarm. **Note:** To clear an alarm when the instrument is set to "Latched," press [Y/+] when the main (Reading) display is shown.

1. Press **[N/-]** to step from one alarm type to the other.
2. Press **[Y/+]** to select an alarm type.

When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Buzzer & Light

The buzzer and light alarms can be programmed to be on or off individually or in combination. Your choices are:

- Both on
- Light only
- Buzzer only
- Both off

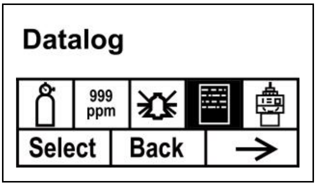
1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
3. When you have completed your selections, press [MODE].

   You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Datalog

The instrument calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.



1. Scroll through the Datalog sub-menu using the [N/-] key until the display shows the desired parameter to be changed:

   Clear Datalog
   Interval
   Data Selection
   Datalog Type

2. Press [Y/+] to make your selection. Exit by pressing [MODE] for Back.

Clear Datalog

This erases all the data stored in the datalog.

Note: Once the datalog is cleared, the data cannot be recovered.

Press [Y/+] to clear the datalog. The display asks, “Are you sure?”

- Press [Y/+] if you want to clear the datalog. When it has been cleared, the display shows “Datalog Cleared!”
- Press [N/-] if you do not want to clear the datalog.

The display changes, and you are taken to the next sub-menu, Interval.

Interval

Intervals are shown in seconds. The default value is 60 seconds. The maximum interval is 3600 seconds.

1. Press [Y/+] to increase each digit’s value.
2. Press [N/-] to advance to the next digit.
3. Again, use [Y/+] to increase the number.

Repeat this process until all numbers are entered.

When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Data Selection

Data Selection allows you to select which types of data are stored and made available when you offload your datalog to a computer via ProRAE Studio software.

You can choose any or all of three types of data (you must choose at least one):

- Average
- Maximum
- Minimum

1. Press [N/-] to step from one option to the next. The highlighter indicates your choice.
2. Press [Y/+] to toggle your selection on or off (the check box indicates "on" with an "X").
3. When you have completed your selections, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.
- Press [N/-] to undo the changes and revert to the previous settings.

Datalog Type

The instrument has three datalog types:

Auto	Default mode. Collects datalog information when the instrument is sampling.
Manual	Datalogging occurs only when the instrument's datalogging is manually started (see below for details).
Snapshot	Datalogs only during single-event capture sampling.

Note: You can only choose one datalog type to be active at a time.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].

You will see two choices: Save and Undo. You have the opportunity to register the new settings or to change your mind and revert to your previous settings.

- Press [Y/+] to save the changes.

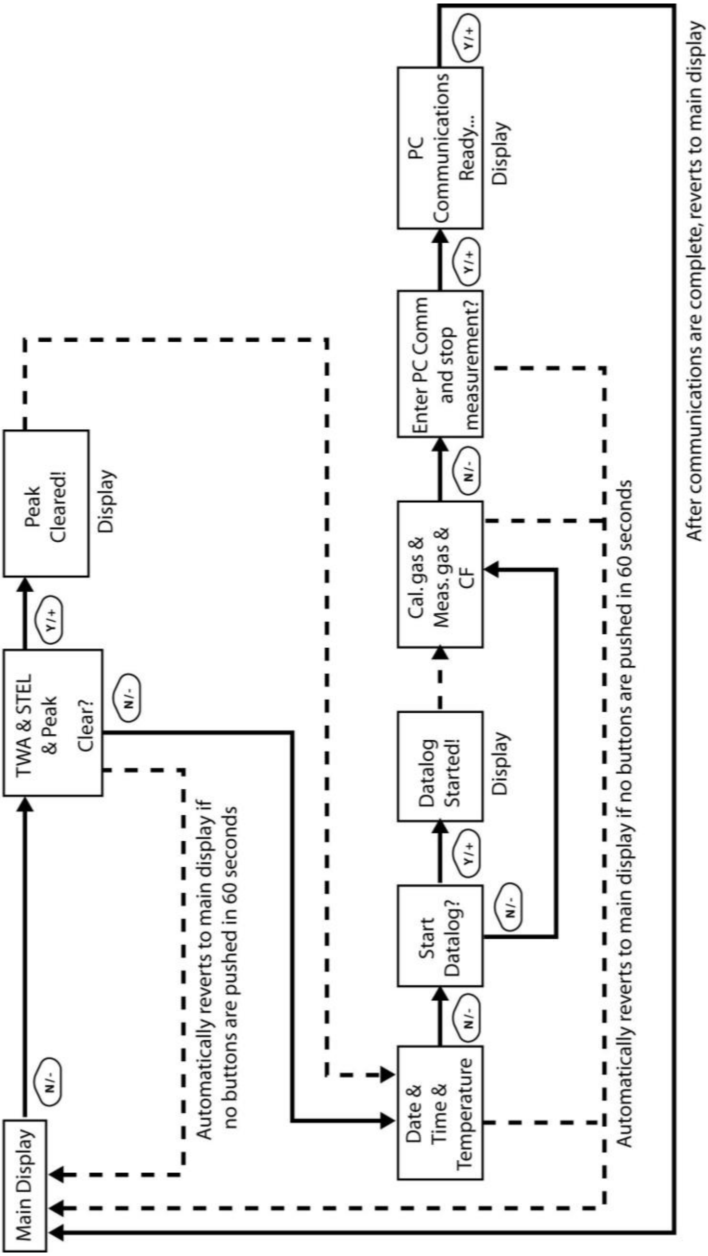
Press [N/-] to undo the changes and revert to the previous settings.

Manual Datalog

When the instrument is set to Manual Datalog, you turn datalogging on and off by stepping through the displays from the Main Display, and then pressing the keys to select datalog on/off functions.

- When you reach the screen that says "Start Datalog?" press [Y/+] to start it. You see "Datalog Started," confirming that datalogging is now on.

When you reach the screen that says "Stop Datalog?" press [Y/+] to stop it. You see "Datalog Stopped," confirming that datalogging is now off.



Note: Dashed line indicates automatic progression.

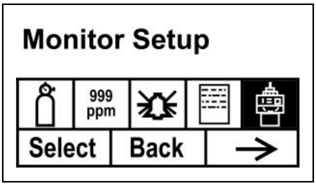
Snapshot Datalog

When the instrument is in Snapshot datalogging mode, it captures a single “snapshot” of the data at the moment of your choosing. Whenever the instrument is on and it is set to Snapshot, all you have to do is press [MODE] each time you want to capture a snapshot of the data at that instant.

When you send the data to a computer using ProRAE Studio, the data snapshots are uniquely identified by time and other parameters.

Monitor Setup

Many settings can be accessed in this menu, including setting the date and time and adjusting the pump’s on/off duty cycle.



Radio Power

The radio connection can be turned on or off.

1. Press [N/-] to step from one option to the next (on or off).
2. Press [Y/+] to make your selection (the dark circle in the “radio button” indicates that the option is selected).
3. When you have completed your selection, press [MODE].

- Press [Y/+] to accept the new radio setting (on or off).
- Press [N/-] to discard the change and move to the next sub-menu.

Op Mode

Under Monitor Setup is "Op Mode."

Press [Y/+] to select.

You see two options (one is highlighted):

Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

1. Select Hygiene or Search by pressing [N/-]. The highlighting changes from one to the other each time you press [N/-].
2. Press [Y/+] to select that mode for the instrument.
3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

Site ID

Enter an 8-digit alphanumeric/character Site ID in the programming mode. This Site ID is included in the datalog report.

1. Press [Y/+] and the display shows the current site ID. Example: "RAE00001." Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).
   Note: The last four digits must be numerals.
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

Repeat this process until all eight digits of the new site ID are entered.

Press [MODE] to exit.

If there is any change to the existing site ID, the display shows "Save?" Press [Y/+] to accept the new site ID. Press [N/-] to discard the change and move to the next sub-menu.

User ID

Enter an 8-digit alphanumeric User ID in the programming mode. This User ID is included in the datalog report.

1. Press [Y/+] and the display shows the current User ID. Example: "RAE00001." Note that the left-most digit flashes to indicate it is the selected one.
2. Press [Y/+] to step through all 26 letters (A to Z) and 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

Repeat this process until all eight digits of the new User ID are entered.

Press [MODE] to exit.

If there is any change to the existing User ID, the display shows "Save" Press [Y/+] to accept the new site ID. Press [N/-] to discard (undo) the change and move to the next sub-menu.

User Mode

The instrument has two user modes:

Basic Basic users can only see and use a basic set of functions.
Advanced Advanced users can see all screens and perform all available functions.

Note: The default value for User Mode is Basic.

To change the User Mode:

1. Press [N/-] to step from one option to the next. The highlighting changes each time you press [N/-].
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
4. Press [Y/+] to accept the new User Mode. Press [N/-] to discard the change and move to the next sub-menu.

Date

The Date is expressed as Month/Day/Year, with two digits for each.

1. Press [Y/+] and the display shows the current date. Note that the left-most digit flashes to indicate it is selected.
2. Press [Y/+] to step through all 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

Repeat this process until all six digits of the new date are entered.

Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

Time

The Time is expressed as Hours/Minutes/Seconds, with two digits for each. The time is in 24-hour (military) format.

1. Press [Y/+] and the display shows the current time. Note that the left-most digit flashes to indicate it is selected.
2. Press [Y/+] to step through all 10 numerals (0 to 9).
3. Press [N/-] to advance to the next digit. The next digit to the right flashes.

   Repeat this process until all six digits of the new time are entered.

Press [MODE] to exit.

- Press [Y/+] to save the new date.
- Press [N/-] to undo the change and move to the next sub-menu.

Pump Duty Cycle

The pump's duty cycle is the ratio of its on time to off time. The duty cycle ranges from 50% to 100% (always on), and the period is 10 seconds. Therefore, a duty cycle of 60% means that the pump is on for 6 seconds and off for four seconds. Duty cycling is employed by the instrument to clean the PID. A lower duty cycle has a greater effect on keeping the PID clean than a higher duty cycle.

Important! Pump duty cycling is interrupted when the instrument senses a gas. The pump's duty cycle is disabled when the measurement is greater than the 2ppm threshold and is re-enabled when the reading falls below 90% of the threshold (1.8 ppm).

1. Press [Y/+] to increase the value.
2. When you have completed your selection, press [MODE].
   - Press [Y/+] to save the new duty cycle value.
   - Press [N/-] to undo the change and move to the next sub-menu.

Pump Speed

The pump can operate at two speeds, high and low. Running at low speed is quieter and conserves a small amount of power. There is almost no difference in sampling accuracy.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the new temperature unit.
    - Press [N/-] to undo the change and move to the next sub-menu.

Temperature Unit

The temperature display can be switched between Fahrenheit and Celsius units.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the new temperature unit.
    - Press [N/-] to undo the change and move to the next sub-menu.

Language

English is the default language, but other languages can be selected for the instrument.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save your new language choice.
    - Press [N/-] to undo it and return to the previous language selection.

Real Time Protocol

Real Time Protocol is the setting for data transmission.

The choices are:

P2M (cable)	Point to multipoint. Data is transferred from the instrument to multiple locations using a wired connection. Default data rate: 19200 bps.
P2P (cable)	Point to point. Data is transferred only between the instrument and one other location, such as a computer. Default data rate: 9600 bps.
P2M (wireless)	Point to multipoint, wireless. Data is transferred wirelessly and can be received by multiple receivers.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the new real-time communications protocol.
    - Press [N/-] to undo the change and move to the next sub-menu.

Power On Zero

When Power On Zero is on, the instrument performs a zero calibration when it is turned on.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
3. When you have completed your selection, press [MODE].
    - Press [Y/+] to save the change.
    - Press [N/-] to discard the change and move to the next sub-menu.

Unit ID

This three-digit number keeps data separated by instrument when more than one instrument is used in a network. If multiple sensing units are attempting to communicate with the same Host, then the units must all have a different Unit ID.

1. Press [Y/+] to step through all 10 numerals (0 to 9). If you pass the numeral you want, keep pressing [Y/+]. After it counts up to 9, it starts counting up from 0 again.
2. Press [N/-] to advance to the next digit. The next digit to the right flashes.

Repeat this process until all three digits of the Unit ID are entered.

3. Press [MODE] when you are done.
    - Press [Y/+] to save the change.
    - Press [N/-] to discard the change and move to the next sub-menu.

LCD Contrast

The display's contrast can be increased or decreased from its default setting. You may not need to ever change the default setting, but sometimes you can optimize the display to suit extreme temperature and ambient brightness/darkness conditions.

- The minimum value is 20.
- The maximum value is 60.

1. Press [Y/+] to increase the value or [N/-] to decrease the value.
2. Press [MODE] to save your selection.
    - Press [Y/+] to save your new contrast value.
    - Press [N/-] to undo it and return to the previous value.

Lamp ID

The instrument must be set to the correct lamp value in order to function correctly. Always match the value that was installed in your instrument from the factory or the value of the PID lamp you are replacing.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates "on").
3. When you have completed your selection, press [MODE].

PAN ID

The MiniRAE 3000 and any other devices that you want to interconnect wirelessly must have the same PAN ID. You can set the PAN ID in the instrument or through ProRAE Studio II.

1. Press [N/-] to advance through the digits from left to right.
2. Press [Y/+] to] to advance through the numbers (1, 2, 3, etc.).
3. Press [MODE] to register your choice when you are done.

Mesh Channel

Note: For mesh radio modems operating at 868MHz, only channel 0 is available. For other frequencies, channels 1 through 10 are allowed.

1. Press [Y/+] to increase the number and [N/-] to advance to the next digit.
2. After moving to the last digit and making changes, press [MODE].
    - Press [Y/+] to save the change.
    - Press [N/-] to undo the change.

Mesh Interval

Set the time interval at which the instrument's mesh radio sends out a signal. This can range from once every 10 seconds to once every four minutes (240 seconds). The transmission frequency is user-adjustable, but a rate of at least once every 30 seconds is recommended. **Note:** Shorter intervals reduce battery life.

1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make a selection.
3. When you are done, press [MODE].

Hygiene Mode

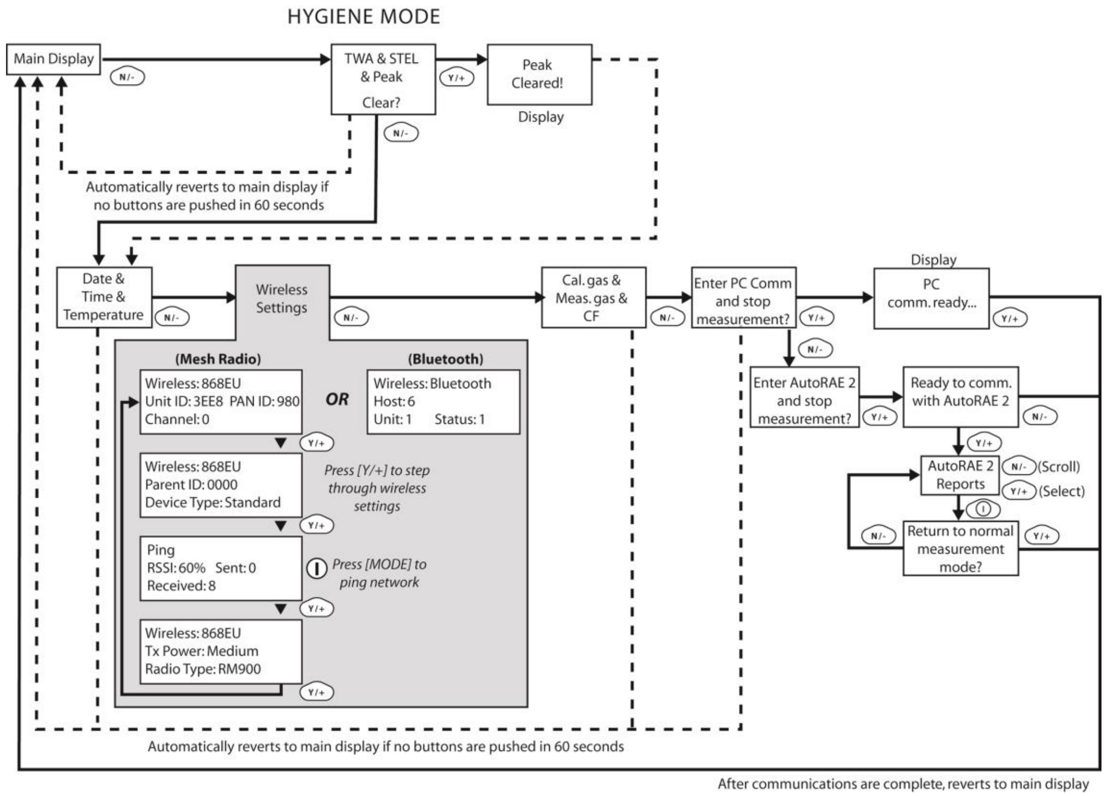
The instrument usually operates in Hygiene Mode, which provides basic functionality. However, it is possible to operate it in a second mode called Search Mode. Here are the primary differences:

Hygiene Mode: Automatic measurements, continuously running and datalogging, and calculates additional exposure values.

Search Mode: Manual start/stop of measurements and display of certain exposure values.

Basic User Level & Hygiene Mode

The default setting is navigated in the following way:



Note: Dashed line indicates automatic progression.

Pressing [N/-] steps you from screen to screen. Options include clearing the Peak value and turning on the instrument's PC Communications for data transfer to a PC.

Entering Search Mode From Hygiene Mode

In order to change the instrument's operational mode from Hygiene Mode to Search Mode, you must enter the password-protected Programming Mode:

1. Hold [MODE] and [N/-] until you see the password screen.
2. Use [Y/+] to increment to the number you want for the first digit. (If you pass by the desired number, press [Y/+] until it cycles through to 0 again. Then press [Y/+] until you reach the desired number.)
3. Press [N/-] to advance to the next digit.
4. Again press [Y/+] to increment the number.
5. Press [N/-] to advance to the next digit.

Continue the process until all four numbers of the password have been input. Then press [MODE] to proceed.

The screen changes to icons with the label "Calibration."

1. Press [N/-] to advance to "Monitor Setup."
2. Press [Y/+] to select Monitor Setup.

Under Monitor Setup, you will see "Op Mode."

Press [Y/+] to select.

You will see:

Hygiene
Search

The current mode is indicated by a dark circle within the circle in front of either Hygiene or Search.

1. Select Hygiene or Search by pressing [N/-].
2. Press [Y/+] to place the instrument into the selected mode.

3. Press [MODE] when you want to register your selection to place the instrument in the selected mode.
4. Press [Y/+] to commit the change and exit to the Monitor Setup screen, or press [N/-] to Undo (exit to the Monitor Setup screen without changing the Mode).

Advanced User Level (Hygiene Mode Or Search Mode)

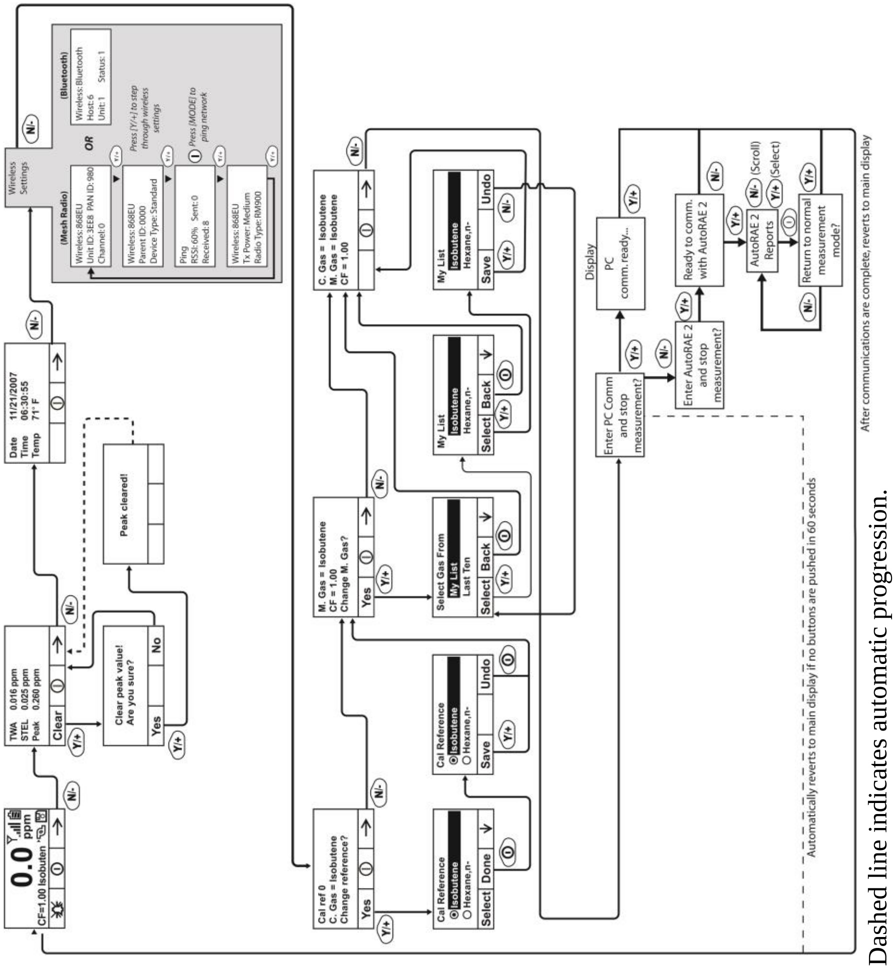
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

Advanced User Level & Hygiene Mode

With the instrument in Operation Mode: Hygiene Mode, enter User Mode: Advanced User Level (refer to the section called Monitor Mode for instructions).

Once you are in Advanced User Level and Hygiene Mode together, you can change the calibration reference and measurement gas, in addition to performing normal monitoring functions.

Pressing [N/-] progresses through the screens, while pressing [Y/+] selects options. Pressing [MODE] makes menu choices when it is shown for “Done” or “Back.” Pressing and holding [Mode] whenever the circle with a vertical line in the middle is shown activates the countdown to shutoff.

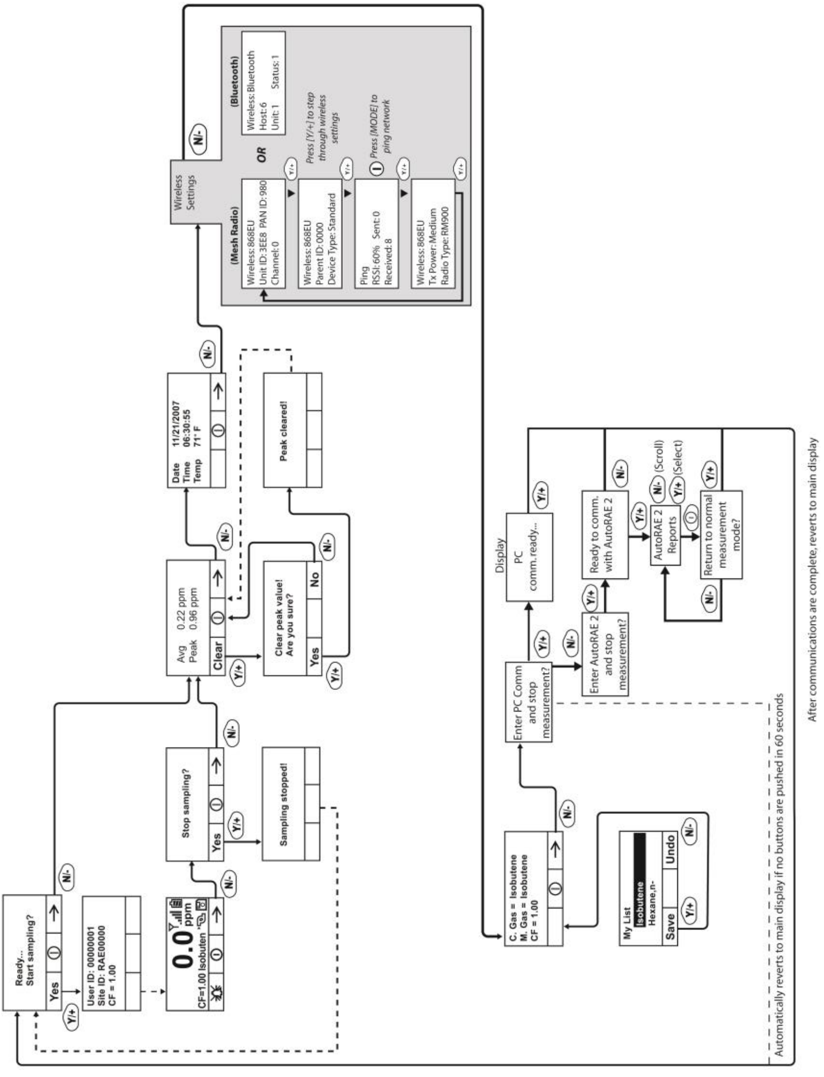


Note: Dashed line indicates automatic progression.

Basic User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Basic User Level (refer to the section called User Mode for instructions).

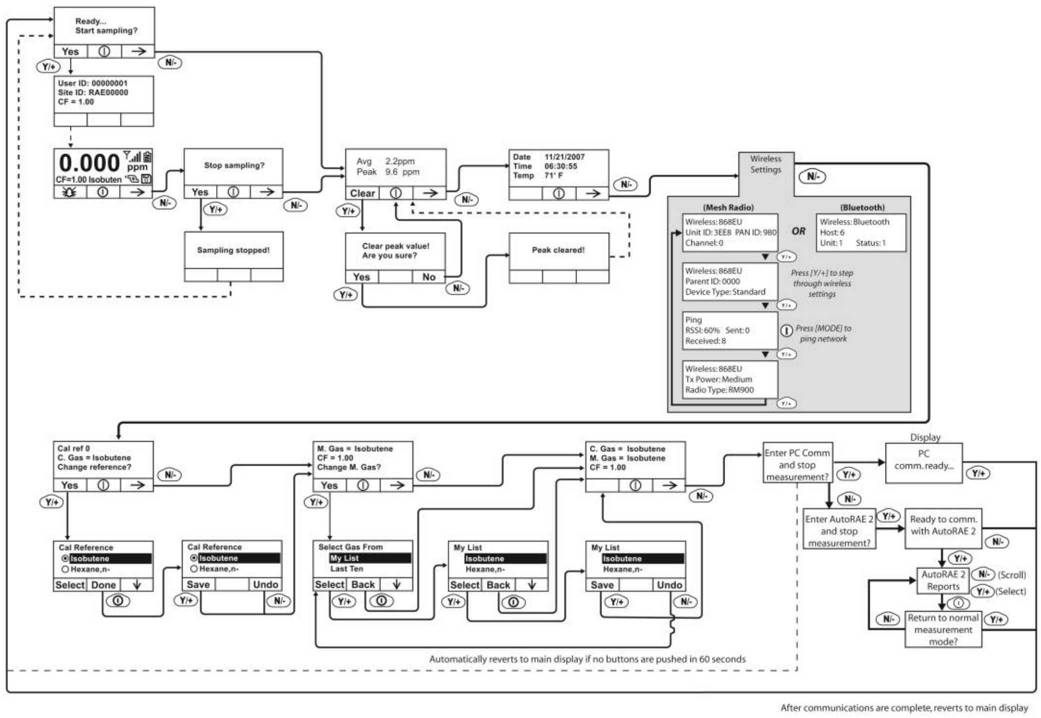
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, "Ready…Start sampling?" press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see a new screen that says, "Stop sampling?" Press [Y/+] to stop sampling. Press [N/-] if you want sampling to continue.



Note: Dashed line indicates automatic progression.

Advanced User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Advanced User Level (refer to the section called Monitor Mode for instructions). Operation is similar to Basic User Level & Sampling Mode, but now allows you to change calibration and measurement reference gases. Refer to the section on measurement gases on page 60 for more details.



Note: Dashed line indicates automatic progression.

Diagnostic Mode

IMPORTANT! Diagnostic Mode is designed for servicing and manufacturing, and therefore is not intended for everyday use, even by advanced users. It provides raw data from sensors and about settings, but only allows adjustment of pump stall parameters, which should only be changed by qualified personnel.

Note: If the instrument is turned on in Diagnostic Mode and you switch to User Mode, datalog data remains in raw count form. To change to standard readings, you must restart the instrument.

Entering Diagnostic Mode

Note: To enter Diagnostic Mode, you must begin with the instrument turned off.

Press and hold [Y/+] and [MODE] until the instrument starts.

The instrument goes through a brief startup, and then displays raw data for the PID sensor. These numbers are raw sensor readings without calibration. The instrument is now in Diagnostic Mode.

Note: In Diagnostic Mode, the pump and lamp are normally on.

You can enter Programming Mode and calibrate the instrument as usual by pressing both [MODE] and [N/-] for three seconds.

You can enter Monitoring Mode by pressing [MODE] and [Y/+] together for three seconds.

Once the instrument is started up in Diagnostic Mode, you can switch between Diagnostic Mode and Monitoring Mode by pressing and holding [MODE] and [Y/+] simultaneously for two seconds.

In Diagnostic mode, you can step through parameter screens by pressing [MODE].

Adjusting The Pump Stall Threshold

If the gas inlet is blocked but the pump does not shut down, or the pump shuts down too easily with a slight blockage, the pump stall threshold value may be set too high or too low.

Use the following steps to adjust the pump stall threshold:

Pump High

In Diagnostic Mode, press the [MODE] key until "Pump High" is displayed. The display shows the maximum, minimum, and stall values for the pump at its high speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

Pump Low

In Diagnostic Mode, press the [MODE] key until "Pump Low" is displayed. The display shows the maximum, minimum, and stall values for the pump at its low speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

Exiting Diagnostic Mode

You can exit Diagnostic Mode and go directly to Programming Mode or Monitor Mode as outlined above, or you can exit Diagnostic Mode completely.

To exit Diagnostic Mode so that it cannot be re-entered without a restart:

Shut down the instrument. When it is off, restart it by holding the [MODE] key. Diagnostic Mode cannot be entered until the instrument is restarted as outlined in "Entering Diagnostic Mode."

Transferring Data To & From A Computer

Once you have connected your instrument cradle to the PC, you can can transfer data, including a download of the datalog to the computer and updates of firmware to the instrument (should this ever be necessary).

Downloading The Datalog To A PC

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio on your PC.
4. From ProRAE Studio, select “Operation” and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. To receive the datalog in the PC, select “Downlog Datalog.”
7. When you see “Unit Information,” click OK.

During the data transfer, the display shows a progress bar.

When the transfer is done, you will see a screen with the datalog information. You can now export this datalog for other use or printing.

Uploading Firmware To The instrument From A PC

Uploading new firmware to your instrument requires connecting the instrument and PC. Follow these steps to make the connection:

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start RAEProgrammer 7000 on your PC.
4. From RAEProgrammer 7000, select "Operation" and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. Select Operation → Download Firmware.

Once communication is established, follow the instructions that accompany RAEProgrammer 7000 and the firmware to upload the new firmware to your instrument.

Note: Check for the latest updates to ProRAEProgrammer 7000 at www.raesystems.com.

Maintenance

The major maintenance items of the instrument are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

Note: Maintenance should be performed by qualified personnel only.

NOTE: The printed circuit board of the instrument is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the instrument. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

Battery Charging & Replacement

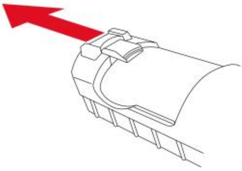
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

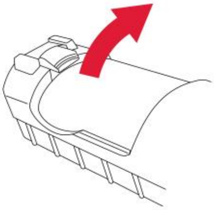
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous.

Replacing The Li-ion Battery

1. Turn off the instrument.
2. Located on the rear of the instrument is a battery tab. Slide it down to unlock the battery.



3. Remove the battery pack from the battery compartment by tilting it out.



4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment.
5. Slide the capture tab back up to its locked position.

Replacing The Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.

To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the battery compartment by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument.

Note: When replacing alkaline batteries, dispose of old ones properly.

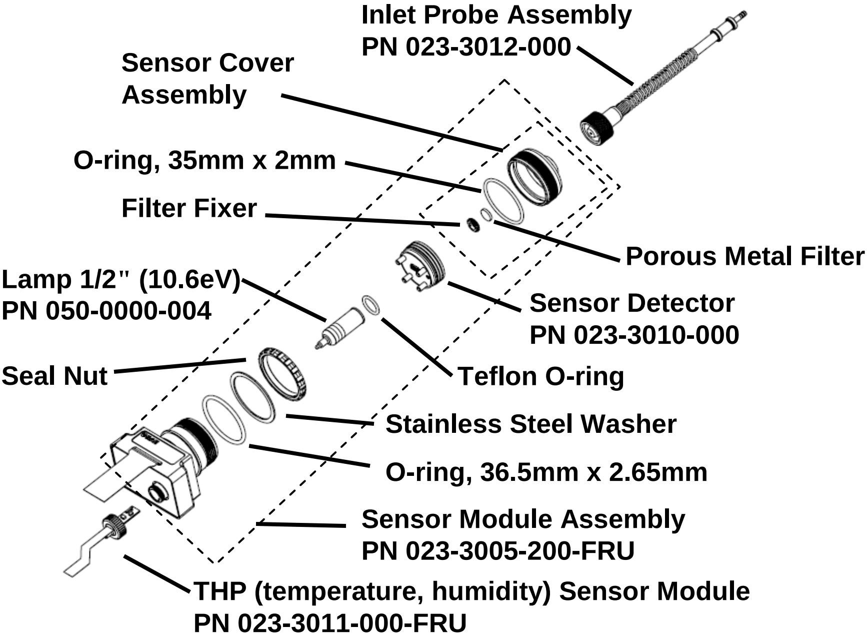
WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Sensor Components

Note: The cleaning procedure is not normally needed. Clean the PID sensor module, the lamp and the lamp housing only if:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A liquid has been sucked into the unit and damaged the unit.

Use of the external filter helps to prevent contamination of the sensor.

To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull it straight out. A slight, gentle rocking motion helps release the sensor.

Cleaning The PID Sensor

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.
Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode “fingers” should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

Cleaning The Lamp Housing Or Changing The Lamp

If the lamp does not turn on, the instrument will display an error message to indicate replacement of the lamp may be required.

1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

   CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.

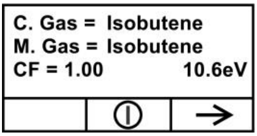
3. Reinstall the PID sensor module.

4. Tighten the Lamp Housing Cap.

Determining The Lamp Type

The monitor can accommodate three lamp values: 10.6eV (standard), 9.8eV, and 11.7eV. Always make sure you are using the correct lamp value and that the instrument is set to use that lamp.

Also, when the monitor is running, the lamp type is shown along with the calibration and measurement gas and Correction Factor:



C. Gas = Isobutene
M. Gas = Isobutene
CF = 1.00 10.6eV

Note: This screen can be accessed from the reading screen by pressing [N/-] four times.

You can manually determine the lamp type, too:

1. Turn off the instrument and remove the lamp. Now look at the serial number. The following identify the lamp type:

• 10.6eV	SN: 106 2Nxxxxx
• 9.8eV	SN: 098 2Nxxxxx
• 11.7eV	SN: 117 2Nxxxxx

Programming The Lamp ID

The correct measurement gas library is used by the instrument when you ensure that the right lamp value is programmed.

To manually select the Lamp ID:

1. Enter the Programming menu.
2. Select Monitor Setup.
3. Scroll down and select the Lamp ID sub-menu.
4. Press [N/-] to scroll down to the desired Lamp ID.
5. Press [Y/+] to select.
6. Press [MODE] to select Done.
7. Select “Save.”
8. Return to the main menu.

Recalibrate the instrument before returning it to service.

Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

If the pump is not working properly, refer the instrument to qualified service personnel for further testing and, if necessary, pump repair or replacement.

Cleaning The Instrument

Occasional cleaning with a soft cloth is recommended. Do not use detergents or chemicals.

Visually inspect the contacts at the base of the instrument, on the battery, and on the charging cradle to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Never use solvents or cleaners.

Ordering Replacement Parts

If you need replacement parts, contact your local RAE Systems distributor. A list is available online:

http://www.raesystems.com

In the U.S., you can order sensors, replacement batteries, and other accessories online at:

http://istore.raesystems.com/

Special Servicing Note

If the instrument needs to be serviced, contact either:

1. The RAE Systems distributor from whom the instrument was purchased; they will return the instrument on your behalf.

   or

2. The RAE Systems Technical Service Department. Before returning the instrument for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the instrument is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.

Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

Technical Support

To contact RAE Systems Technical Support Team:

Monday through Friday, 7:00AM to 5:00PM Pacific (US) Time
Phone (toll-free): +1 888-723-4800
Phone: +1 408-952-8461
Email: tech@raesystems.com

RAE Systems Contacts

RAE Systems by Honeywell
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Toll-Free: 888.723.4800
Fax: 408.952.8480

E-mail (technical support): RAE-tech@honeywell.com
Web Site: www.raesystems.com

WORLDWIDE SALES OFFICES

USA/Canada	1.877.723.2878
Europe	+800.333.222.44/+41.44.943.4380
Middle East	+971.4.450.5852
China	+86.10.5885.8788-3000
Asia Pacific	+852.2669.0828

Controlled Part of Manual

Intrinsic Safety:
US and Canada: Class I, Division 1, Groups A,B,C,D T4

Europe: ATEX (0575 Ex II 2G Ex ia IIC/IIB T4 Gb)
KEMA 07 ATEX 0127
Complies with EN60079-0:2009, EN60079-11:2007
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0:2007, IEC 60079-11:2006

Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)

Basic Operation

Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.

The instrument is now operating and performs self tests. Once the self tests are complete, the display shows a graph or numerical gas reading. This indicates that the instrument is fully functional and ready to use.

Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. When you see "Unit off..." release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition.

In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, pump stall, or when the datalog memory is full.

Alarm Signal Summary

Message	**Condition**	**Alarm Signal**
HIGH	Gas exceeds “High Alarm” limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics’ maximum range	3 beeps/flashes per second*
LOW	Gas exceeds “Low Alarm” limit	2 beeps/flashes per second*
TWA	Gas exceeds “TWA” limit	1 Beep/flash per second*
STEL	Gas exceeds “STEL” limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus “Lamp” message on display

Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas (Isobutylene)	**Cal Span**	**unit**	**Low**	**High**	**TWA**	**STEL**
ppbRAE 3000	10	ppm	10	25	10	25
MiniRAE 3000	100	ppm	50	100	10	25
MiniRAE Lite	100	ppm	50	100	10	25
UltraRAE 3000	100	ppm	50	100	10	25

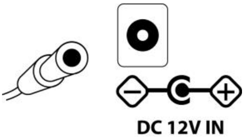
Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion/NiMH battery is charged by placing the instrument in its cradle. Contacts on the bottom of the instrument meet the cradle's contacts, transferring power without other connections.

Note: Before setting the instrument into its charging cradle, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter's barrel connector into the instrument's cradle.



2. Plug the AC/DC adapter into the wall outlet.
3. Place the instrument into the cradle, press down, and lean it back. It locks in place and the LED in the cradle glows.

Note: To release the instrument, press down and tilt the top out of the cradle and lift up.

The instrument begins charging automatically. The LED on the front of the cradle marked "Primary" blinks during charging. During charging, the diagonal lines in the battery icon on the instrument's display are animated and you see the message "Charging..."

When the instrument's battery is fully charged, the battery icon is no longer animated and shows a full battery. The message "Fully charged!" is shown and the Primary LED on the cradle glows continuously green.

Note: A spare Li-ion battery (059-3051-000) or NiMH(059-3054-000) can be charged by placing it directly in the charging port on the back of the cradle. It can be charged at the same time as the instrument. Press the battery in place, sliding it slightly toward the front of the cradle. This locks it in the cradle. To release the battery, slide it forward again and tilt it up.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. Remove and replace batteries only in areas known to be non-hazardous.

Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the battery icon blinks once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion, NiMH, or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in an area known to be non-hazardous.

Replacing Rechargeable Li-Ion or NiMH Battery

Caution: Turn off the instrument before removing or replacing the battery.

Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500).

Do not mix old and new batteries or different type batteries.

Troubleshooting

Problem	**Possible Reasons & Solutions**	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.

Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

RAE Systems by Honeywell
World Headquarters
3775 N. First St.
San Jose, CA 95134-1708 USA
Phone: 408.952.8200
Toll-Free: 888.723.4800
Fax: 408.952.8480

E-mail (technical support): RAE-tech@honeywell.com
Web Site: www.raesystems.com

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Rev. F
February 2016
P/N 059-4020-000

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SERIES 475

MANOMETER

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SPECIFICATIONS

Service: Air and compatible gases.
Wetted Materials: Consult factory.
Accuracy: ±0.5% FS, 60 to 78°F (15.6 to 25.6°C); 1.5% FS from 32 to 60°F and 78 to 104°F (0 to 15.6°C and 25.6 to 40°C).
Pressure Hysteresis: ±0.1% of FS.
Pressure Limits: See chart.
Temperature Limits: 0 to 140°F (-17.8 to 60°C).
Compensated Temperature Limits: 32 to 104°F (0 to 40°C).
Storage Temperature Limits: -4 to 176°F (-20 to 80°C).
Display: 4-digit LCD (.425 H x .234 W digits).
Power Requirements: 9 volt alkaline battery. Battery included but not connected.
Weight: 10.8 oz (306 g).
Process Connections: Two barbed connections for use with 1/8″ or 3/16″ I.D. tubing. Two compression fittings for use with 1/8″ I.D. x 1/4″ O.D. tubing (for 100 psi or higher pressure ranges).
Agency Approvals: CE, FM approved to
CLASS 1, DIV. 2 GROUPS ABCD/T4 Ta = 70°C.

Model	Pressure Ranges	Max. Pressure
475-000-FM	0 to 1.000 in w.c. (0 to .2491 kPa)	5 PSI (34.5 kPa)
475-00-FM	0 to 4.000 in w.c. (0 to 0.996 kPa)	5 PSI (34.5 kPa)
475-0-FM	0 to 10.00 in w.c. (0 to 2.491 kPa)	5 PSI (34.5 kPa)
475-1-FM	0 to 20.00 in w.c. (0 to 4.982 kPa)	10 PSI (68.9 kPa)
475-2-FM	0 to 40.00 in w.c. (0 to 9.96 kPa)	10 PSI (68.9 kPa)
475-3-FM	0 to 200.0 in w.c. (0 to 49.82 kPa)	30 PSI (207 kPa)
475-4-FM	0 to 10.00 PSI (0 to .6895 bar)	30 PSI (2.07 bar)
475-5-FM	0 to 20.00 PSI (0 to 1.379 bar)	60 PSI (4.14 bar)
475-6-FM	0 to 30.00 PSI (0 to 2.069 bar)	60 PSI (4.14 bar)
475-7-FM	0 to 100.0 PSI (0 to 6.895 bar)	150 PSI (10.3 bar)
475-8-FM	0 to 150.0 PSI (0 to 10.34 bar)	200 PSI (13.8 bar)

OPERATING INSTRUCTIONS

ON/OFF:

Press ON/OFF to turn the unit on. Press and hold ON/OFF for about 2 seconds to turn it off. Device will automatically shut off after 20 minutes if not in use.

ZERO:

Vent both pressure ports to atmosphere. Press ZERO button until the LCD displays "-----" then release it. The LCD reads 0 if the zero offset is less than 10% of FS.

UNITS:

To change units, press both ON/OFF and ZERO buttons simultaneously.

BATTERY:

Remove retaining screws on end cap at base of instrument to replace battery when LOW BAT is displayed. Use 9 V alkaline battery DURACELL® MN 1604, Energizer® 522, or Energizer® EN22.

⚠ WARNING Enclosure parts are constructed of plastic. When cleaning the exterior use a damp cloth to avoid electrostatic sparking. Enclosure parts are constructed of aluminum. Enclosure must be protected from mechanical friction and impact with iron/steel to prevent ignition capable sparks.

DWYER INSTRUMENTS, INC.
MICHIGAN CITY, IN 46360
email: info@dwyermail.com
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02-443418-10 Rev. 5

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Attachment 4: Laboratory Analytical Standard Operating Procedures

- Laboratory Handling, Transfer and Preservation of VOA Soil Samples Received in EnCoreTM Samplers for SW-846 Method 5035/5035A Low Concentration and 5030B
- Gas Chromatography Mass Spectrometry – Volatiles SW-846 Method 8260D

Laboratory Handling, Transfer and Preservation of VOA Soil Samples Received in EnCoreTM Samplers for SW-846 Method 5035/5035A Low Concentration and 5030B

TITLE: Laboratory Handling, Transfer and Preservation of VOA Soil Samples Received in EnCore™ Samplers for SW-846 Method 5035/5035A Low Concentration and 5030B

Approvals (Signature/Date):

	12/27/22		12-22-22
Pete Ficarello Supervisor, GC/MS Volatiles	Date	William Estes Analyst	Date
Terese A. Preston	12/22/22		12/28/22
Terese A. Preston Quality Assurance Manager	Date	Chris Hoham Env. Health & Safety Coor.	Date
	12/28/22		
Ray Shock, III Technical Director	Date		

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1.0 SCOPE / APPLICATION

This Standard Operating Procedure (SOP) has been written using SW-846 Methods 5035/5035A and describes the procedures for handling, transferring and preserving solid waste, soil and sediment samples for subsequent determination of volatile organic compounds when received by the laboratory in EnCore™ Disposable Samplers. The EnCore™ Sampler is a single use device which cannot be cleaned and/or reused. Samples are transferred to vials and are then suitable for analysis using preparation Methods 5035/5035A for Low Concentration volatile compounds or 5030B for High Concentration volatile compounds. This procedure also addresses issues relating to VOC samples preserved in the field using Method 5035/5035A, however, does not discuss sample collection.

Method 5035A section 1.9 states "Analyst should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is not mandatory in response to Federal testing requirements. The information contained in the method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application".

Therefore, on occasion, clients request and/or sample matrices require slight modifications to this SOP and/or method. These modifications are addressed on a case-by-case basis with the range of accuracy (i.e., MDLs, linearity check or PT sample) verified prior to implementation. Any modifications would be discussed with the project manager and a NCM would be added in TALS to the project.

Methods 5035/5035A is restricted to use by or under the supervision of trained analysts. Each analyst must demonstrate the ability to generate acceptable results with this method. Training records should be completed and filed with the QA department.

When preparing samples from the state of South Carolina Method 5035 will be followed.

1.1 Method Sensitivity

1.1.1 Method Detection Limits

Refer to the analytical SOPs.

1.1.2 Reporting Limits

Refer to the Analytical SOPs.

1.2 Summary of Method

This procedure is used when soils are sampled in the field with EnCore™ samplers and then transferred to the laboratory for preservation. It also addresses samples that are preserved in the field using ready-to-use vial and/or TerraCore Kits and transferred to the laboratory. The specific preparation procedures for sample vials depends on the expected concentration range of the sample, with separate procedures for "low" concentration soil samples (Section 7.1) and "high" concentration soil samples (Section 7.2). Low concentration soils are transferred to vials containing organic free water (OFW) without any acid preservative and frozen within 48 hours (or upon sample receipt at the laboratory). The date and time a sample preserved in OFW is placed in the freezer is documented in the preparation batch of TALs. If the time the sample is placed in the freezer exceeds 48 hours from collection, a NCM is generated documenting the sample was outside the recommended hold time.

The laboratory is reducing the number of projects accepted which require the sodium bisulfate preservation. If requested by the client or if receipt to the laboratory is known ahead of time to be outside the 48 hour time constraint, then, the soils are transferred to vials containing sodium bisulfate and water in the field which forms an acid for preserving the VOC from biodegradation. If samples are preserved at the laboratory with sodium bisulfate, an effervescence test is done to determine the presence of carbonate minerals prior to sample preservation. To ensure minimal loss of volatile constituents the sample vial is never opened prior to analysis. The surrogates, internal standards and reagent free water are added through the septum. High concentration VOC soils are transferred to vials containing methanol. After the appropriate amount of contact time the methanol is pipetted into an amber 1.5 mL screw cap vial. Aliquots of the methanol extract are diluted in water along with the internal standards and surrogates, and then purged using method 5030B.

1.3 Definitions

Refer to Section 3.0 of the Laboratory's Quality Assurance Manual (UP-QA-QAM).

2.0 INTERFERENCES

Solvents, reagents, glassware and room conditions may yield volatile organic compounds. All these materials must be demonstrated to be free from interferences under the conditions of the preparation by analyzing method blanks.

Extraction blanks should be prepared from each preservative (sodium bisulfate, OFW, and MEOH) for samples prepared in the laboratory and should be carried through the same processes as the samples to ensure that preservatives and storage procedures are free of interferences.

It is strongly recommended that an unused TerraCore Kit be used as a trip blank for samples that are prepared in the field. Clients should be encouraged to use this tool to serve as a check for interferences or contamination.

3.0 SAFETY

Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, Lab Specific Addendum to the CSM, and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coat and closed-toe, nonabsorbent shoes are a minimum.

3.1 Specific Safety Concerns or Requirements

- Take careful note of those sections marked "**CAUTION**", "**NOTE**", OR "**WARNING**".
- When the sample is added to the vial containing sodium bisulfate and organic free water, a reaction can result with pressure build-up if the sample is immediately capped. This may result in the popping of the septum cap and splashing of corrosive liquid (acid) and, under severe pressure, may burst the sample vial. If effervescence is noted, the sample vial shall not be sealed until the reaction is complete or ends. All samples demonstrating effervescence shall be prepared in organic free water with a note in TALS that the sample effervesced.

3.2 Primary Material Used

- The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material	Hazards	OSHA Exposure Limit	Signs and symptoms of exposure/Unusual Hazards
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Sodium Bisulfate	Irritant	None	Causes mild to severe irritation to the eyes. Prolonged exposure may cause burn if not flushed with water. May cause mild irritation to skin. Prolonged exposure may cause burn if not flushed with water.

4.0 EQUIPMENT AND SUPPLIES

- 40-ml, screw-cap, PTFE lined, septum-sealed glass vials
- Magnetic stir bars
- EnCore™ Extrusion Tool
- Top-loading balance capable of accurately reading to 0.01 g.
- Balance weights
- 5 g En Core™ samplers (from field in sealed containers)
- Repipet suitable for dispensing methanol
- Repipet suitable for dispensing lab pure water
- 1 gram scoop; and VOC vial rack
- Nitrile Gloves

5.0 REAGENTS AND STANDARDS

A label on any reagent bottle must contain the concentration of the reagent, name of the reagent, date prepared, expiration date and the analyst who prepared the reagent. Lot # of Methanol reagent used is recorded in the comment section of the prep batch in TALs. In addition, the Lot # of the prepared 20% Sodium Bisulfate vial is also recorded in the TALs prep batch.

5.1 Reagents

- Methanol, CH_3OH - purge and trap quality of equivalent
- Organic Free Laboratory Water (OFW)
- Sodium Bisulfate, $NaHSO_4$ - ACS grade or equivalent (Note: prepared vials from kits are used)

5.2 Quality Control (QC) Solutions

Refer to analytical SOPs.

6.0 CALIBRATION

Not Applicable.

7.0 PROCEDURE

7.1 Low Concentration Procedure

The following steps apply to the preparation vials and EnCore™ sample transfers to vials that will be analyzed for low concentration volatile compounds by the closed-system purge and trap equipment described in Method 5035/5035A.

7.1.1 Low Concentration Sample Vial Preparation

Ready-to-use sample vials and/or TerraCore Kits may be purchased from a vendor which contains the OFW water, sodium bisulfate, Methanol, magnetic stirrer and tare weighted. If not, steps described in 7.1.1 are to be followed to prepare the vials for low level method.

Note: The laboratory is reducing the number of projects accepted which require the sodium bisulfate preservation. Lab experience with Sodium Bisulfate preservation has shown a vigorous effervescence with soils high in carbonate minerals, potential acetone formation in samples with a high proportion of decayed matter, some compounds inadvertently affected by the preservation, increase loss of internal standard and surrogate responses and deterioration of GC/MS instrumentation.

7.1.1.1 Add a clean magnetic stir bar to each clean 40 mL vial. Add 5 mLs of OFW water

Note: The soil vial cannot be opened until after analysis of the sample, therefore after the samples are analyzed, the vial is opened and the pH of the sample is determined and recorded on the sample analysis sheet.

7.1.1.2 The water and preservative form an acid solution that will eliminate the majority of the biological activity in the sample, preventing biodegradation of the volatile target analytes. Seal the vial with the screw-cap septum seal.

7.1.1.3 Weigh the prepared vial to the nearest 0.01 g, record the tare weight and vial number in TALS. Record the job number, client, date, TALS prep batch, analyst initials and comments in the Sample Weight Prep Log.

If the samples were prepared in the field and the initial weight of the vial was taken before the laboratory sample login label was attached to the vial, then the weight of the sample login label must be subtracted form the final weight of the sample. To accomplish this, the analyst must do the following:

1. Obtain a label from login on a daily basis prior to weighing back sample vials.
2. Calibrate the balance daily prior to use.
3. Place the sample login label on balance and record the label weight in the 5035 Prep Logbook.
4. Tare the balance with the label on it. This will subtract out the label weight from the final weight.
5. Remove the label and proceed to weigh the sample vials and upload the weights directly into the TALs prep batch.

7.1.1.4 Since calcareous soils may react vigorously with sodium bisulfate, which could result in a loss of volatile compounds, an effervescence test will be performed on samples that are expected to effervesce. Add ~5 g to the prepared 20% sodium bisulfate vial. Observe for bubbles. If the sample effervesces, then prepare the sample in OFW and freeze instead of preparing in sodium bisulfate. A note should be made in TALS and in the Sample Weight Prep Log that the sample effervesced and was prepared in organic free water (OFW).

WARNING: When the sample is added to the vial containing sodium bisulfate and organic free water, a reaction can result with pressure build-up if the sample is immediately capped. This may result in the popping of the septum cap and splashing of corrosive liquid (acid) and, under severe pressure, may burst the sample vial. If effervescence is noted, the sample vial shall not be sealed until the reaction is complete or ends. A sample vial prepared in sodium bisulfate that effervesces should not be used for analysis. Acid solution can cause burns, therefore, protective gloves, lab coat and eye protection shall be worn during this transfer. Due to the loss of volatile compounds, all samples demonstrating effervescence shall be prepared in organic free water.

The vial is then ready for transferring the soil sample from the EnCore™ sampler into the vial as described in section 7.1.2.

7.1.2 Sample Transfer from EnCore™ to Low Concentration Vial

7.1.2.1 Within 48 hours of sample collection, the sample in the EnCore™ sampler must be transferred to the sample vial containing OFW and frozen or if required, transferred to vial containing preservative if effervescence test was negative. Line up the EnCore™ sample bags with vials and scan the respective sample # into TALS. If required, perform the effervescence test and record the results in TALS.

7.1.2.2 Attach the EnCore™ Sampler to the EnCore™ Extrusion Tool as follows: Depress the locking lever on the Extrusion Tool and place the sampler, plunger end first, into the open end of Extrusion Tool (aligning slots on sampler body with pins in Extrusion Tool). Turn the coring body clockwise until it locks into place. Then release the locking lever.

7.1.2.3 Remove the cap from the vial and then remove the cap from the EnCore™ Sampler, which was previously inserted in the Extrusion Tool. Slowly place the sample core directly over the vial (avoid sample or vial spillage), then release the soil core by pushing down on the plunger knob of the EnCore™ Extrusion Tool. Cap the vial. In TALS, record the time the sample was transferred into the vial. After the sample is safely transferred, remove and properly dispose of the EnCore™ Sampler.

If samples are received already preserved from the field in sodium bisulfate and they show evidence of effervescence (i.e., bulging septa, fizzing, hissing when auto-sampler punctures septa, etc.), the analyst shall notify the PM at once. Additionally, the analyst needs to proceed with the analysis using either Method 5030B purge & trap using an appropriate aliquot from the VOA jar or solids jar if available or in cases where the client provides both sodium bisulfate preserved sample and OFW prepared samples use the OFW and document the reason in an NCM.

7.1.2.4 Weigh the sample vial to the nearest 0.01 g and record weight in TALS. The sample is then transferred to the GC/MS VOC refrigerator if preserved in sodium bisulfate or transferred to the GC/MS VOC freezer if prepared in water.

NOTE: Because volatile organics will partition into the headspace of the vial from the aqueous solution and will be lost when the vial is opened, surrogates, matrix spikes and internal standards should be added through the septa after the vial has been capped. These standards will be introduced by the GC/MS VOC analyst or automatically by the sample introduction system, just prior to analysis. The pH of the sample will be taken after sample analysis.

In addition, since the sample weight is determined after the vial is sealed and can not be re-opened, it has been decided that any sample with a sample weight greater than 8 grams would not be properly preserved with 5mL of sodium bisulfate solution. Whenever possible the OFW vial should be used for analysis. Large sample weights and sample weights <4 grams (which result in elevated reporting limits) will be documented in a NCM and sent to the Project Manager for review. Client contact by the PM may be required to determine the best course of action when sample integrity is in question.

7.2 High Concentration Procedure

The following steps apply to the preparation vials and En Core™ sample transfer to these vials to be analyzed for High concentration volatile compounds described in Method 5030B.

7.2.1 High Concentration Sample Vial Preparation

Sample vials ready for use for the high concentration method or TerraCore Kits may be purchased from a vendor which contains the methanol preservative and tare weighted. If not, steps described in 7.2.1 are to be followed to prepare the vials.

7.2.1.1 Add 5 mLs of methanol to each vial.

NOTE: Any combination of sample weight and methanol volume may be used as long as it is demonstrates that method performance objectives can be achieved.

7.2.1.2 Seal the vial with the screw-cap septum seal and affix a label to the vials.

7.2.1.3 Weigh the prepared vial to the nearest 0.01 g, record the tare weight and the vial number in TALS. The vial is then ready for transferring the soil sample from the EnCore™ sampler into the vial as described in Section 7.2.2.

7.2.2 Sample Transfer from En Core™ Sampler to High Concentration Vial

7.2.2.1 Within 48 hours of sample collection, the sample in the EnCore™ sampler must be transferred to the sample vial containing preservative. Line up the EnCore™ sample bags with vials and scan in TALS the respective sample #.

7.2.2.2 Attach the EnCore™ Sampler to the EnCore™ Extrusion Tool as follows: Depress the locking lever on the Extrusion Tool and place the sampler, plunger end first, into the open end of Extrusion Tool (aligning slots on sampler body with pins in Extrusion Tool). Turn the coring body clockwise until it locks into place. Then release the locking lever.

7.2.2.3 Place the soil core plug into the matching vial as follows: Remove the cap from the vial and then remove the cap from the EnCore™ Sampler, which was previously inserted in the Extrusion Tool. Slowly place the sample core directly over the vial (avoid sample or vial spillage), then release the soil core by pushing down on the plunger knob of the En Core™ Extrusion Tool. Cap the vial but be careful not to spill.

(WARNING: Precautions must be taken when handling vials and samples. Methanol is flammable and should not be handled near a heat source or open flame. Protective gloves, lab coat and eye protection shall be worn during this transfer.)

In TALS, record the time the sample was transferred into the vial. After the sample is safely transferred, remove and properly dispose of the EnCore™ Sampler.

7.2.2.4 Weigh the sample vial to the nearest 0.01-g and record the weight in TALS. The sample is then transferred to the GC/MS VOC refrigerator for 24 hours. After the 24 hour contact time, draw off the methanol and put into a 1.5 mL amber vial labeled with the appropriate sample identification. Surrogates, matrix spikes and internal standards should be added by the auto-sampler or the GC/MS VOC analyst at the time of analysis.

7.2.2.5 In cases where the client requires a quick turnaround time, the 24-hour contact time can be replaced by sonicating the samples for 20 minutes and then draw off the methanol.

7.2.2.6 For samples received from the state of Wisconsin, an extraction blank (LB3) and extraction spike (LCS) will be prepared in 10 mL of methanol and 10 g of organic free (OF) sand and will be treated the same as the client samples in that batch. These QC samples will be prepared at a frequency of 1 for every group of 20 samples. These samples will be shaken for 2 minutes, sonicated for 20 minutes and allowed to settle before the methanol extract can be transferred to the 1.5 mL extraction vial. In addition, Wisconsin requires that all soil samples that arrive at the laboratory without methanol, that have not been stored properly, must be rejected. Refer to SOP UP-GV-GRO, Section 7.2, Table 2 and Table 3 for additional discussion and specific instructions for preparing Wisconsin samples.

7.3 Quality Control Checks

Refer to the analytical SOP.

7.4 Sample Preservation and Storage

The hold time for the extraction of volatile organic compounds from soils and sediments is 14 days from the date of sampling. The samples must be transferred from the EnCore™ Sampler to the preservatives or freeze the OFW vial within 48 hours after collection. The date and time a sample preserved in OFW is placed in the freezer is documented in preparation batch of TALs. If the time the sample is placed in the freezer exceeds 48 hours from collection, a NCM is generated documenting the sample was outside the recommended hold time. Preserved samples must be stored at 4 ± 2°C prior to analysis. Samples in OFW must be frozen at -10 to -20°C. Frozen samples must be allowed to come to room temperature before analysis.

7.5 Calibration / Standardization

Not Applicable.

7.6 Preventive Maintenance

- Balances should be cleaned and checked for levelness prior to each use. Class "S" weights must be weighed and documented each day the balance is used. Refer to the Balance Calibration Logbook for the weights and control limits.
- Consult your section manager or supervisor if the weights are out of acceptable limits. Do not use the balance until the situation is back in control.

7.7 Documentation

All sample transfer information must be carefully documented in TALS. Record the job number, client, date, prep batch numbers, analyst initials and comments in the prep batch in TALS. All problems and/or deviations from normal procedures must be documented, the section manager or supervisor should be notified and if the situation warrants it, a Nonconformance Memo (NCM) may need to be initiated.

8.0 QUALITY CONTROL

8.1 QC Summary

Refer to the analytical SOP (UP-MV-8260).

8.2 Corrective Actions

All problems and/or deviations from the normal procedure must be documented in the Prep Batch and in the comment section in TALS. The section manager or supervisor should be notified and a NCM may need to be initiated.

9.0 DATA ANALYSIS AND CALCULATIONS

Not Applicable.

10.0 POLLUTION CONTROL

It is Eurofins policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”

10.1 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to UP-WM-001.

The following waste streams are produced when this method is carried out.

- Residual samples waste containing Methanol. This residual sample waste containing methanol will be turned into the Waste technician for disposal in the “Flammable Vials” wastestream.

11.0 METHOD PERFORMANCE CRITERIA

Refer to Sections 1, 6, 7 and 8.

12.0 REFERENCES

Refer to Section 1.

13.0 ATTACHMENTS

Attachment A: Example: EnCore™ GC/MS and GC VOA Sample Weight Prep Log
Attachment B: Example: Batch Data
Attachment C: Recommended Sampling Instructions for the Field Preservation of VOCs using the Terra Core® Kit
Attachment D: Method 5035A Table A-1 Recommended VOC Sample Preservation Techniques and Holding Times

14.0 REVISION HISTORY

- Revision 21 updated on 12/22/22
- Annual Review
- No Changes

Attachment A.

Example: EnCore^{TM} GC/MS and GC VOA Sample Weight Prep Log (011-001)

Eurofins Chicago

GC/MS and GC Volatile: Sample Weight Prep Log

Page: ____________

Balance #: ____________	Balance #: ____________	Balance #: ____________	Balance #: ____________
Date & Time: ____________	Date & Time: ____________	Date & Time: ____________	Date & Time: ____________
Label Weight: ____________	Label Weight: ____________	Label Weight: ____________	Label Weight: ____________
Analyst Initials: ____________	Analyst Initials: ____________	Analyst Initials: ____________	Analyst Initials: ____________

Job #	**Client**	**Date**	**5035_P Batch**	**5035_M Batch**	**Prep Type**	**Comments (# of vials)** **FW = Frozen Water;** **AP = Acid Preserved;** **MeOH =Methanol Preserved**	**Analyst Innitials**	**Reviewed (Check)**
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			
			NCM _______	NCM _______	Lab Prep______ Field Prep_____ 5030 Prep_____			

(011-001)

Attachment B.

Example: Batch Data
(012-001 to 012-002)

GC/MS VOA Worksheet

Batch Number: 500-690883
Method: 5035
Analyst: Estes, William R

Date Open: Dec 13 2022 1:40PM
Batch End:

Lab ID	Client ID	Method Chain	Basis	Tare Weight	Vial and Sample weight	Initial weight/volume of sample	Final weight/volume of sample
500-227075-D-1	B-1			30.35 g	35.0551 g	4.7051 g	5 mL
500-227075-D-2	B-3			30.47 g	36.5151 g	6.0451 g	5 mL
500-227081-A-1	B1 (5-7.5)	5035A_FM, 8260B	T	+028.305 g	33.6052 g	5.3002 g	5 mL
500-227081-A-2	B2 (5-7.5)	5035A_FM, 8260B	T	+028.170 g	32.5769 g	4.4069 g	5 mL
500-227081-A-3	B3 (3-5)	5035A_FM, 8260B	T	+027.832 g	32.6525 g	4.8205 g	5 mL
500-227081-A-4	B4 (5-7.5)	5035A_FM, 8260B	T	+028.234 g	32.7599 g	4.5259 g	5 mL
500-227081-A-5	B5 (5-7.5)	5035A_FM, 8260B	T	+028.023 g	32.4746 g	4.4516 g	5 mL
500-227110-D-2	GRE-SIDW-1DW1-0-2 21219	5035A_FM, 8260D	T	+028.125 g	32.5777 g	4.4527 g	5 mL
500-227112-D-1	SC-1	5035A_FM, 8260B	T	+028.084 g	34.8577 g	6.7737 g	5 mL
500-227113-D-1	BC-1	5035A_FM, 8260B	T	+028.163 g	33.9219 g	5.7589 g	5 mL
500-227133-D-1	KWCC	5035A_FM, 8260B	T	+028.646 g	35.0431 g	6.3971 g	5 mL
500-227156-C-1	SBS-2 (8.0-10)	5035A_FM, 8260B	T	+028.128 g	34.4981 g	6.3701 g	5 mL
500-227156-C-2	SBS-1 (6-7.5)	5035A_FM, 8260B	T	+028.063 g	34.9055 g	6.8425 g	5 mL
500-227156-C-3	SBS-4 (3.5-5.0)	5035A_FM, 8260B	T	+028.482 g	34.8883 g	6.4063 g	5 mL
500-227156-C-4	SBS-3 (8.5-10)	5035A_FM, 8260B	T	+028.091 g	34.8754 g	6.7844 g	5 mL
500-227156-C-5	SBD-2 (3.5-5)	5035A_FM, 8260B	T	+028.348 g	34.3805 g	6.0325 g	5 mL

Balance ID: C-1952

(012-001)

GC/MS VOA Worksheet

Batch Number: 500-690883
Method: 5035
Analyst: Estes, William R

Date Open: Dec 13 2022 1:40PM
Batch End:

Lab ID	Client ID	Method Chain	Basis	Analysis comment	Comments
500-227075-D-1	B-1			MeOH	
500-227075-D-2	B-3			MeOH	
500-227081-A-1	B1 (5-7.5)	5035A_FM, 8260B	T	MeOH	
500-227081-A-2	B2 (5-7.5)	5035A_FM, 8260B	T	MeOH	
500-227081-A-3	B3 (3-5)	5035A_FM, 8260B	T	MeOH	
500-227081-A-4	B4 (5-7.5)	5035A_FM, 8260B	T	MeOH	
500-227081-A-5	B5 (5-7.5)	5035A_FM, 8260B	T	MeOH	
500-227110-D-2	GRE-SIDW-1DW1-0-2 21219	5035A_FM, 8260D	T	MeOH	
500-227112-D-1	SC-1	5035A_FM, 8260B	T	MeOH	
500-227113-D-1	BC-1	5035A_FM, 8260B	T	MeOH	
500-227133-D-1	KWCC	5035A_FM, 8260B	T	MeOH	
500-227156-C-1	SBS-2 (8.0-10)	5035A_FM, 8260B	T	MeOH	
500-227156-C-2	SBS-1 (6-7.5)	5035A_FM, 8260B	T	MeOH	
500-227156-C-3	SBS-4 (3.5-5.0)	5035A_FM, 8260B	T	MeOH	
500-227156-C-4	SBS-3 (8.5-10)	5035A_FM, 8260B	T	MeOH	
500-227156-C-5	SBD-2 (3.5-5)	5035A_FM, 8260B	T	MeOH	

(012-002)

Attachment C:

Recommended Sampling Instructions for the Field Preservation of VOCs using the Terra Core® Kit (CHI-22-08-041)

(013-001 thru 013-002)

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Recommended Sampling Instructions for the Field Preservation of VOCs using the Terra Core® Kit

One of two kits will be provided:

Full Kit – contains 1 vial with sodium bisulfate, 2 vials with water, 1 vial with methanol, 1 2oz jar, 1 Terra Core® sampler.

48 HOUR HOLDING TIME

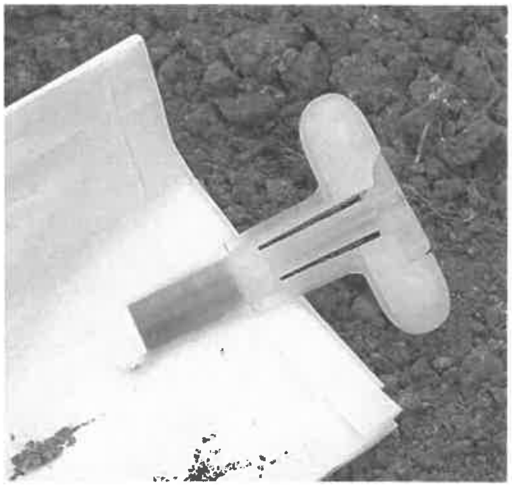
Methanol Kit – contains 1 vial with methanol, 1 2oz jar, 1 Terra Core® sampler. This kit is primarily used for BTEX only analyses where low reporting limits are not a concern.

With proper use, the Terra Core® sampler is designed to collect approximately 5 grams of soil. Improper use may result in significantly lower or higher sample weights which may affect the validity of the final results.

The Terra Core® sampler is a single use device (once per sample location). It should not be cleaned and/or reused.

SAMPLING

Step 1
Have ready a 40ml glass vial containing the appropriate preservative. With the plunger seated in the handle, push the Terra Core® into freshly exposed soil until the sample chamber is filled. The resulting sample plug will be approximately 2 cm in length and 5 grams.



Step 2
Wipe all soil or debris from the outside of the Terra Core® sampler. The soil plug should be flush with the mouth of the sampler. Remove any excess soil that extends beyond the mouth of the sampler.

(013-001)

Step 3
Rotate the plunger that was seated in the handle top 90° until it is aligned with the slots in the body. Place the mouth of the sampler into the 40ml VOA vial containing the appropriate preservative and extrude the sample by pushing the plunger down. Quickly place the lid back on the 40ml vial. **Note:** When capping the 40ml VOA vial, be sure to remove any soil or debris from the top and/or threads of the vial.

Step 4
Repeat this process until all vials contain one extruded plug.

Step 5
The 2oz jar is used for percent solids determination. This jar should be filled with sample using any appropriate technique. The Terra Core® sampler does not need to be used.

Please note that all sample vials have been pre-weighed so the laboratory can determine how much sample has been added. Do NOT add any additional sample labels or tape to the vials as this will make the final calculated sample weight incorrect.

HOLDING TIMES

EPA method SW846 5035a allows for the collection of samples in water with preservation by freezing within 48 hours of collection. Eurofins Chicago will use the two water vials as the primary analysis samples as long as the samples are frozen within holding time. Please return the samples promptly so the 48 hour holding time can be met.

Eurofins Chicago will use the sodium bisulfate preserved sample vial (14 day holding time) in cases where the samples can not be returned within 48 hours. These analyses, however, often exhibit matrix interferences due to the acid preservation.

The methanol preserved sample has a 14 day holding time. This sample is typically used for high concentration dilutions.

Reference: En Novative Technologies, Inc. CHI-22-08-041/D-12/22

(013 - 002)

Attachment D:

Method 5035A Table A-1
Recommended VOC Sample Preservation Techniques and Holding Times
(014-001 to 014-003)

Table A.1
Recommended VOC Sample Preservation Techniques and Holding Times

Sample Matrix	Preservative	Holding Time	Comment
Aqueous Samples With No Residual Chlorine Present	Cool to 4 ± 2°C.	7 days	If MTBE and other fuel oxygenate ethers are present and a high temperature sample preparative method is to be used, do not acid preserve the samples. If aromatic and biologically active compounds are analytes of interest, acid preservation is necessary and the holding time is extended to 14 days.
Aqueous Samples With No Residual Chlorine Present	Cool to 4 ± 2°C and adjust pH to less than 2 with HCl or solid $NaHSO_4$.	14 days[1]	Reactive compounds such as 2-chloroethylvinyl ether readily break down under acidic conditions. If these types of compounds are analytes of interest, collect a second set of samples without acid preservatives and analyze as soon as possible.
Aqueous Samples With Residual Chlorine Present	Collect sample in a pre-preserved container containing either 25 mg ascorbic acid or 3 mg of sodium thiosulfate per 40-mL of chlorinated sample volume containing less than 5 mg/L of residual chlorine. Cool to 4 ± 2°C.	7 days	Samples containing greater than 5 mg/L of residual chlorine may require additional amounts of dechlorinating agents. If MTBE and other fuel oxygenate ethers are present and a high temperature sample preparative method is to be used, do not acid preserve the samples. If aromatic and biologically active compounds are analytes of interest, acid preservation is necessary and the holding time is extended to 14 days.
Aqueous Samples With Residual Chlorine Present	Collect sample in a pre-preserved container containing either 25 mg ascorbic acid or 3 mg of sodium thiosulfate per 40-mL of chlorinated sample volume containing less than 5 mg/L of residual chlorine. Cool to 4 ± 2°C and adjust pH to less than 2 with HCl or solid $NaHSO_4$	14 days[1]	Samples containing greater than 5 mg/L of residual chlorine may require additional amounts of dechlorinating agents. Reactive compounds such as 2-chloroethylvinyl ether readily break down under acidic conditions. If these types of compounds are analytes of interest, collect a second set of samples without acid preservatives and analyze as soon as possible. Caution: never add acid preservative directly to a dechlorinating agent prior to sample collection.
Solid Samples[2]	Sample is extruded into an empty sealed vial and frozen on-site to < -7°C.	14 days[1]	Sample vials should not be frozen below -20°C due to potential problems with vial seals and the loss of constituents upon sample thawing.

(014-001)

Table A.1 (Continued)

Sample Matrix	Preservative	Holding Time[1]	Comment
Solid Samples[2]	Sample is extruded into an empty sealed vial and cooled to 4 ± 2°C for no more than 48 hours then frozen to < -7°C upon laboratory receipt.	14 days[1]	Analysis must be completed within 48 hours if samples are not frozen prior to the expiration of the 48 hour period. Sample vials should not be frozen below -20°C due to potential problems with vial seals and the loss of constituents upon sample thawing.
	Sample is extruded into an empty sealed vial and cooled to 4 ± 2°C for no more than 48 hours then preserved with methanol upon laboratory receipt.	14 days[1]	Analysis must be completed within 48 hours if samples are not preserved with methanol prior to the expiration of the 48 hour period.
	Sample is extruded into an empty sealed vial and cooled to 4 ± 2°C.	48 hours	
	Cool to 4 ± 2°C the coring tool used as a transport device	48 hours	The holding time may be extended to 14 days if the sample is extruded to a sealed vial and either frozen to < -7°C or chemically preserved. Coring tools should not be frozen below -20°C due to potential problems with tool seals and the loss of constituents upon sample thawing.
	Freeze to < -7°C the coring tool used as a transport device	48 hours	The holding time may be extended to 14 days if the sample is extruded to a sealed vial and either frozen to < -7°C or chemically preserved. Coring tools should not be frozen below -20°C due to potential problems with tool seals and the loss of constituents upon sample thawing.
	Sample is extruded into a vial containing reagent water and frozen on-site to < -7°C.	14 days[1]	Sample vials should not be frozen below - 20°C due to potential problems with vial seals and the loss of constituents upon sample thawing.
	Sample is extruded into a vial containing reagent water and cooled to 4 ± 2°C for 48 hours or less then frozen to < -7°C upon laboratory receipt.	14 days[1]	Analysis must be completed within 48 hours if samples are not frozen prior to the expiration of the 48 hour period. Sample vials should not be frozen below -20°C due to potential problems with vial seals and the loss of constituents upon sample thawing.

(014-002)

Table A.1 (Continued)

Sample Matrix	Preservative	Holding Time[1]	Comment
Solid Samples[2]	Sample is extruded into a vial containing reagent water and 1 g $NaHSO_4$ and cooled to 4 ± 2°C.	14 days[1]	Reactive compounds such as 2-chloroethylvinyl ether readily break down under acidic conditions. If these types of compounds are analytes of interest, collect a second set of samples without acid preservatives and analyze as soon as possible.
	Sample is extruded into a vial containing methanol and cooled to 4 ± 2°C.	14 days[1]	Additional methanol extract storage time beyond 14 days may be acceptable if the desired VOC constituent stability can be demonstrated from appropriate performance data.

[1] A longer holding time may be appropriate if it can be demonstrated that the reported VOC concentrations are not adversely affected from preservation, storage and analyses performed outside the recommended holding times.

[2] For biologically active soils, immediate chemical or freezing preservation is necessary due to the rapid loss of BTEX compounds within the first 48 hours of sample collection.

(014-003)

Gas Chromatography Mass Spectrometry – Volatiles
SW-846 Method 8260D

TITLE: Gas Chromatography Mass Spectrometry - Volatiles SW-846 Method 8260D

Approvals (Signature/Date):

4/2/24
Pete Ficarello Date
GC/MS VOA, Supervisor

4/2/24
Chris Hoham Date
Env. Health & Safety Coor.

Nicole Berg 4/2/24
Nicole Berg Date
Quality Assurance Manager

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1.0 SCOPE / APPLICATION

To outline the guidelines for the analysis of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (GC/MS) using SW-846 Methods 8260D and 8000D as references. The preparation of all volatile samples is based on Methods 8000D and 5030B. Method 5035 is covered by a separate SOP (UP-SP-5035), but can also be found in this SOP.

On occasion, clients request slight modifications to this SOP. These modifications are addressed on a case-by-case basis with the range of accuracy (i.e., MDLs, linearity check or PT sample) verified prior to implementation. Any modifications would be written into a Quality Assurance Plan (QAP), authorized via laboratory signature approval, and mentioned in the data package's case narrative.

1.1 Method Sensitivity

1.1.1 Method Detection Limits

The method detection limit (MDL), referred to as the detection limit (DL) in NELAC documents, is the lowest concentration that can be detected for a given analytical method and sample matrix with 99% confidence that the analyte is present. The MDL is determined according to Appendix B of 40 CFR 136, “Guidelines Establishing Test Procedures for the Analysis of Pollutants” with additional details are provided in the Eurofins Corporate SOP, *NDSC-US-TS-SOP42091, Detection & Quantitation Limits* and the Eurofins Chicago SOP, *UP-QA-017, Method Detection Limit Studies.* MDLs reflect a calculated (statistical) value determined under ideal laboratory conditions in a clean matrix, and may not be achievable in all environmental matrices. The laboratory maintains MDL studies for analyses performed; the MDL study will be performed and verified on an annual basis, verifying the lower limit of Quantitation (LLOQ) for the method.

1.1.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory shall confirm that it can properly operate the method. A demonstration of capability is performed whenever there is a change in instrument type, method or personnel. An Initial Demonstration of Capability (IDOC) must be thoroughly documented and approved by the Department Manager/Supervisor and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in the QA Department and in the Analyst Training files. For additional details on the demonstration of capability procedures followed, refer to the laboratory SOP, *UP-QA-QAM, Quality Assurance Manual, Sections 19.4.2 and 19.4.3.*

1.1.3 Reporting Limits (LLOQ)

Reporting Limits (LLOQ) are defined as the lowest concentration of an analyte determined by a given method in a given matrix that the laboratory feels can be reported with acceptable quantitative error or client requirements, values specified by the EPA methods or other project and client requirements. The laboratory maintains reporting limits that are higher than the MDL. Wherever possible, reporting is limited to values approximately 3-5x the respective MDL to ensure confidence in the value reported.

Table 1 defines the reporting limits and analyte list for SW-846 Method 8260D.

1.1.4 Definitions

Refer to Section 3.0 of the Laboratory's Quality Assurance Manual (UP-QA-QAM).

1.2 Summary of Method

This method is used to determine volatile organic compounds in a variety of matrices. It is applicable to water, soil, sediment, sludge and waste drum samples.

This method can be used to quantify most volatile organic compounds that have a boiling point less than 200ºF. It is also limited to those compounds that elute as sharp peaks from a capillary column. A listing of applicable compounds and their characteristic ions appears in Table 1.

A portion of sample, measured into a sample vessel, is purged with an inert gas. The volatile compounds are transferred to a trap, containing retarding materials. The trap is then backflushed with the inert gas and rapidly heated to effectively transfer the compounds to the GC column. The GC oven is then temperature ramped to separate the compounds and introduce them to the source. The mass filter separates the ions, which are then detected by the analyzer. The data system then provides qualitative and quantitative information concerning the sample.

Instrument calibration occurs about every 12-hours, or prior to analysis. Instrument maintenance is performed as needed or daily basis.

2.0 INTERFERENCES

2.1 External interferences can be caused by contaminants from sample containers, preparative glassware and reagents, syringes and columns and manifest themselves as high background and/or discrete peaks. Some contaminants are also introduced through the sample vial seal and/or instrument sample connections. Proper glassware preparation including rinsing of all volumetric glassware with methanol/water, the rinsing of syringes with water, the baking of both for a minimum of 30 minutes, and proper sample handling and instrument maintenance should eliminate these sources. The rinse water bottles that are filled with Milli-Q water will be rinsed with Methanol on a monthly basis or more frequently as needed to prevent biologic growth within the bottles. A laboratory method blank (MB) is analyzed prior to any analysis to show absence of any contaminants. Reagent (Milli-Q) water sampled in the lab and carried through all field operations is also analyzed to show absence of contaminants from field sampling.

2.2 Carryover is also another source of contamination. Any time a high-level sample is analyzed, the next sample in the batch is checked for carryover. If carryover is suspected, that sample is re-analyzed. If the carryover is excessive and continues into the next samples, the batch is aborted/paused, the column and trap baked, and/or blanks analyzed until all contamination is absent. If further response is required (i.e., trap replacement), it is documented in the maintenance logbook. Refer to Section 7.4 for information on preventive maintenance.

2.3 Internal interferences can be purged from the sample with the target compounds and appear as elevated baselines or distinct peaks. Internal interferences most often manifest themselves as low/high recoveries of surrogate/matrix spike compounds. Matrix interferences vary from sample to sample.

2.4 The volatile lab must be free of solvents. All analytes must be less than their RLs or < 3X the RL for Acetone and Methlyene Chloride. It is recommended that the volatile lab is under positive pressure in order to reduce lab contamination, however, intermittent low levels of acetone and methylene chloride may occasionally be detected. Refer to Section 8.2 (Corrective Action) for clarification for blank contamination.

3.0 SAFETY

Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual, Lab Specific Addendum to the CSM, and this document. This procedure may involve hazardous material, operations and equipment. This SOP does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of the method to follow appropriate safety, waste disposal and health practices under the assumption that all samples and reagents are potentially hazardous. Safety glasses, gloves, lab coat and closed-toe, nonabsorbent shoes are a minimum.

3.1 Specific Safety Concerns or Requirements

- The GC contains zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.
- There are areas of high voltage in the gas chromatograph. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.
- All employees will adhere to the practices and policies in the Eurofins Corporate Safety Manual (CSM) and will read the SDS's for the materials used in this method before handling or using the material.

3.2 Primary Materials Used

The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the SDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the SDS for each material before using it for the first time or when there are major changes to the SDS.

Material	Hazards	Exposure Limit[1]	Signs and symptoms of exposure
Methanol (MeOH)	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Sodium Bisulfate	Irritant	None	Causes mild to severe irritation to the eyes. Prolonged exposure may cause burn if not flushed with water. May cause mild irritation to skin. Prolonged exposure may cause burn if not flushed with water.

[1] – Exposure limit refers to the OSHA regulatory exposure limit.

4.0 EQUIPMENT AND SUPPLIES

4.1 Current Hardware/Software

- 6 Agilent 6890 GC interfaced with a 5973 MSD. Equipped with DB-624 column.
- 2 Agilent 6890 GC interfaced with a 5975 MSD. Equipped with DB-624 column
- 1 Agilent 7890 GC interfaced with a 5975 MSD. Equipped with DB-624 column
- 1 Agilent 7890 GC interfaced with a 5977 MSD. Equipped with DB-624 column.
- 2 Agilent 7890 GC interfaced with a 8860 MSD. Equipped with DB-624 column
- 2 Tekmar 3000 concentrators and 5 O.I. Eclipse 4660 concentrators in connection to 7 Archon Autosamplers.
- 2 O.I. Eclipse 4760 concentrators in connection to 2 O.I. 4100 Autosampler.
- 3 Encon Evolution concentrator with 3 EST Centurion Autosampler.
- 9-Agilent Chemstations and 3-Mass Hunter

The GC/MS has a temperature programmable chromatograph interfaced with a mass-selective detector capable of scanning from 35 – 260 amu every second or less using 70 volts of electron energy in the electron ionization mode. The system is capable of producing an acceptable spectrum of bromofluorobenzene when 50 ng is analyzed.

4.2 Data System

Agilent ChemStation/MassHunter software is loaded onto a PC. The PC is connected to both the GC/MS and local intranet. The ChemStation/Masshunter software runs the equipment and collects data for transmission to the data analysis software, Chrom. The software allows plotting specific masses versus time or scan numbers (Extracted Ion Current Profile-EICP) and integration of that abundance. The system also stores the data. The system contains the latest NBS Library.

4.3 Data File Name/ Batch Directory Assignment

Tune, standard, blank, and laboratory control sample (LCS) data files should be uniquely identified. A common practice is designated by specific letters unique to each instrument in conjunction with the appropriate month and day (example : 3b0318 = instrument #3, first 12 hour BFB tune, March 18). When a worklist is made in Chrom, a unique Chrom ID# is assigned to each file which aids in the transfer of data from chemstation to Chrom.

4.4 Miscellaneous

- assorted syringes (10, 25, 50, 100, 500 and 1000 µL)
- 5 mL luer-lock gas-tight syringes
- top-loading balance, capable of weighing to ± 0.1 g, stainless steel spatula
- assorted Teflon-lined screw-capped vials (1.5-2.0 mL, 3.5-5.0 mL)
- cleaned 40 mL vials w/Teflon-lined screw-caps
- assorted volumetrics (10 mL, 20 mL, 25 mL, 50 mL and 100 mL)

Note: The Gas-tight Syringes are color coded and disposed of quarterly

5.0 REAGENTS AND STANDARDS

The majority of the calibration standards are EPA certified, A2LA or second lot verified by the standard vendor in situations where suitable SRMs (Standard Reference Material) were available. For those compounds where standards must be made from neat material (due to instability) or some non-routine compounds, **where available**, a second-source is purchased and used in the LCS to verify the standard

Each time a new initial calibration is required, new standards are prepared and the standards are verified against a second-lot LCS (ICV-Initial Calibration Verification standard) prior to any sample analysis. This holds for all routine compounds and those available as second-source material in the LCS (see page 11 for list of compounds and venders).

All neat standards received are entered into TALs (LIMS). A label is printed from TALs and placed on the bottle. All neat standards are then stored according to manufacturer's recommended storage conditions. The standard is issued a unique ID# [i.e., Neat Standards Reference Number (NSRN)] which is used to track all standards as they are used as is or in preparation of stock/working solutions. The format of the standards in TALs (LIMS) will prevent working or intermediate level solutions from being used past the expiration date of the neat or stock solutions. Lot # of Methanol reagent used should be recorded in the comment section of the prep batch in TALs. In addition, the preparation of the 20% Sodium Bisulfate should be recorded in TALs.

Upon opening a purchased standard, all contents are transferred to Teflon-lined screw-capped vials. The standard is issued another unique ID# [i.e., SRN (Standard Reference Number)] which can be traced back to the parent ID# (i.e., NSRN with the date of receipt, date of opening, and the supplier).

5.1.1 Reagent Water (Milli-Q)

1-Liter of water is continuously purged with pre-purified nitrogen. The reagent water is routinely demonstrated to be interference-free. All compounds are < EQL or 3x EQL for methylene chloride and acetone.

5.1.2 Methanol (MeOH)

All new lot numbers of P & T Methanol are analyzed and verified to be free of contaminants. An updated solvent lot approval spreadsheet is received via email as new lots are approved. This information is also available on the Eurofins TANET Oasis Web-Site that can be accessed by all analysts.

5.2 Surrogate Spiking Solution for Initial calibration

Surrogates are purchased as custom mix solutions from Restek in 5.0 mL ampules. The following surrogates are used:

Compound	***Concentration***
4-Bromofluorobenzene	2500 ppm
1,2-Dichloroethane-d_4	2500 ppm
Toluene-d_8	2500 ppm
Dibromofluoromethane	2500 ppm

- Life of Standard: 1-year unopened or manufacturers expiration; once opened, they are used for a period of 3 months or until used.

- Storage Requirements: Stored in a freezer at ~ –10˚C in the dark and kept for a period of 1-year unopened or manufacturers expiration. *

Working Surrogate mix are prepared using the custom mix above and diluting to 50 ppm as follows:

Custom Mix	Volume (µL)	MeOH	Concentration
2500 ppm Surrogate Mix	40	Dilute to 2mL	50 ppm each component

- Life of Standard: Working SS solutions have an expiration date of 2-weeks.

5.3 Internal Standard Spiking Solutions for Initial calibration-Low level soils

Internal standards are purchased as custom mix solutions from Restek (or equivalent) in 5.0 mL ampules. The following internal standards are used:

Compound	*Concentration*
Fluorobenzene	250 ppm
Chlorobenzene-d_5	250 ppm
1,4-Dichlorobenzene-d_4	250 ppm
Tert-Butyl-Alcohol-d9	5000 ppm
1,4-Dioxane-d8	5000 ppm

1 µL injected into 5 mL of water/sample results in 50/1000 ppb internal standard concentrations.

- Life of Standard: Working IS solutions have an expiration date of 2-weeks.

5.3.1 Internal Standard Spiking Solutions for Initial calibration-waters and high level

Custom Mix	Volume (µL)	MeOH	Concentration
250/5000 ppm IS	4000	Dilute to 20mL	50/1000 ppm each component

- 5 µL injected into 5 mL water
- Working IS/SS solutions have an expiration date of 2-weeks.

5.4 Internal Standard/Surrogate Spiking Solutions

Internal Standards/Surrogate mix are purchased as a custom mix solution from Restek (or equivalent) in 5.0 mL ampules. The following internal/surrogate standards are used:

Compound	*Concentration*
Fluorobenzene	250 ppm
Chlorobenzene-d_5	250 ppm
1,4-Dichlorobenzene-d_4	250 ppm
tert-butyl-alcohol-d9	5000 ppm
1,4-Dioxane-d8	5000 ppm
4-Bromofluorobenzene	250 ppm
1,2-Dichloroethane-d_4	250 ppm
Toluene-d_8	250 ppm
Dibromofluoromethane	250 ppm

- Life of Standard: 1-year unopened or manufacturers expiration; once opened, they are used for a period of 3 months or until used.
- Storage Requirements: Stored in a freezer at ~ –10°C in the dark and kept for a period of 1-year unopened or manufacturers expiration. *

5.4.1 Internal Standard/Surrogate Spiking Solutions for waters and high level soils

Working Internal Standard/Surrogate mix are prepared using the custom mix above and diluting to 50/1000 ppm as follows:

Custom Mix	Volume (µL)	MeOH	Concentration
250/5000 ppm IS/SS Mix	4000	Dilute to 20mL	50/1000 ppm each component

5 µL injected into 5 mL of water/sample results in 50/1000 ppb internal standard/surrogate concentrations.

- The mixture is transferred to and stored in 1.5-2.0 mL Teflon-lined screw-capped vials at ~ –10 °C in the dark. The transfer is entered into TALs (LIMS). The standard issued is another unique ID# [i.e., SRN (Standard Reference Number)] which can be traced back to the parent ID# (i.e., NSRN with the date of receipt, date of opening, and the supplier).
- Life of Standard: Working IS/SS solutions have an expiration date of 2-weeks.

5.4.2 Internal Standard/Surrogate Spiking Solutions for low level soils

Internal Standards/Surrogate mix are purchased as a custom mix solution from Restek in 5.0 mL ampules. The following internal/surrogate standards are used:

Compound	*Concentration*
Fluorobenzene	250 ppm
Chlorobenzene-d_5	250 ppm
1,4-Dichlorobenzene-d_4	250 ppm
tert-butyl-alcohol-d9	5000 ppm
1,4-Dioxane-d8	5000 ppm
4-Bromofluorobenzene	250 ppm
1,2-Dichloroethane-d_4	250 ppm
Toluene-d_8	250 ppm
Dibromofluoromethane	250 ppm

- 1 µL injected into 5 mL of water/sample results in 50/1000 ppb internal standard concentrations.
- Life of Standard: Working IS solutions have an expiration date of 2-weeks.

5.4.3 Stock Purgeable Standards

These are obtained as custom mixes from Restek. The contents of each solution and concentration appear on the previous page. Upon opening, all contents are transferred to 1.5-2.0 mLTeflon-lined screw-capped vials. Listed are compounds in the EPA TCL and includes compounds done on a regular basis. Other standards, if needed, are either purchased as neat solutions or neat standards from Supelco, Chem Service or other certified supplier. See appropriate entries in TALs (LIMS).

* If the stock solution has manufacturers’ expiration date, that is assigned. If the date is not evident, 1-year is assigned to un-opened ampules. This is applicable for all “neat” standards. See Table 3 for list of analytes

5.4.3.1 Main 8260 Mix

The 8260/624 Mega Working Standard is prepared as follows:

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260List1/Std#1 MegaMix (2000-62,500ug/mL)	80	Dilute to 2 mL	100-2500 ppm

5.4.3.2 Gases

The 8260/624 Gas Working Standard is a prepared as follows:

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260 List1/Std#3 Gases 2500ug/mL	80	Dilute to 2 mL	100 ppm each component

5.4.3.3 Additional Compounds

The 8260/624 Ketone Working Standards is prepared as follows:

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260 List1/Std#2 Ketones 12,500ug/mL	16	Dilute to 2 mL	100 ppm each component

The 2-CEVE and Vinyl Acetate Working Standards is prepared as follows:

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260List1/Std#4 2-CEVE 2,500 ug/mL	80	Dilute to 2 mL	100 ppm each component
8260List1/Std#6 Vinyl Acetate 5,000ug/mL	40		

The Acrolein Working Standards is prepared as follows:

Stock Compound/Mix	Volume (µL)	Water	Concentration
8260List 1/Std#5 Acrolein 20,000ug/mL	400	Dilute to 2 mL	4000 ppm each component

5.4.3.7 8260B List 2 Standards

The Appendix IX and extra compounds are prepared as follows:

Compound / TCL Mix	Volume (µL)	MeOH	Concentration
8260 Polar Additions	80	Diluted to 2mLs	100/1000/4000 ppm
Ethanol	80		

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
Methylnaphthalenes 2,500 ug/mL	80	Dilute to 2 mL	100 ppm each component
Pentachlorethane 2,500 ug/mL	80		

Stock Compound/Mix	**Volume (µL)**	**MeOH**	**Concentration**
List 2/STD #6 2,500 ug/mL	80	Dilute to 2 mL	100/200/1000/2500 ppm
List 2/STD #7 Additions STD 2500-5000ug/mL	80		

Compound / TCL Mix	**Volume (µL)**	**Water**	**Concentration**
8260 List2/Std3 Cyclohexanone (25,000ug/mL)	800	Diluted to 2mLs	10,000 ppm

Compound / TCL Mix	**Volume (µL)**	**Water**	**Concentration**
2-Ethyltoluene (1,000ug/ml)	200	Diluted to 2mLs	100 ppm

Compound / TCL Mix	**Volume (µL)**	**Water**	**Concentration**
2,3-Dichloro-1-propene (1,000ug/mL)	200	Diluted to 2mLs	100 ppm

- Life of Standard: Unopened ampules are assigned the manufacturer's expiration date or 1 year from receipt. Working solutions have an expiration date of 1-week (Gases, 2-CEVE, Vinyl Acetate, and Acrolein) and 2-weeks for all others.
- Storage Requirements: These mixtures are stored in 1.5-2.0 mL Teflon-lined screw-capped vials at ~ –10°C in the dark.

NOTE: All standard 'recipes' are listed here in this SOP for guidelines for standard preparation. These 'recipes' are subject to change. The standards listed here are standards that are regularly used. Some clients may request other compounds not listed here. Those compounds will be evaluated for accuracy via this method and analyzed for on a project basis.

5.4.3.8 Low Level Standard

A low level standard is prepared by making a 1/10 dilution of the stock standards of each of the above (nitriles and acrolein included). This standard is used to prepare the low points in the initial calibration. The low level standard may contain the Main 8260 Mix, gases, nitriles and acrolein, and any other required standard. A low-level standard for the Appendix IX compounds is also prepared separately due to duplication of some compounds.

A low level surrogate solutions is also prepared by a 1/10 dilution of the working for low points in the water curve. The calibration levels may vary with the compounds. See recipes in the calibration section for the levels. The low point in the calibrations is based on each compounds reporting limit.

All solutions are stored in a 1.5-2.0 mL Teflon-lined screw-capped vials at –10°C in the dark. All standard preparation is recorded in the TALs (LIMS) system. Solutions are prepared every 2-weeks (1-week for the gases, 3-days for Acrolein).

5.5 Stock Spike Solution

The spike compounds are obtained as solutions from a different source from Restek in 1.5-2.0 mL ampules. These are listed on the previous page. A different analyst than the one who prepared the calibration solutions usually prepares spike solutions. These are stored according to manufacturer's recommended storage conditions. Neat standards are kept for a period of 1-year un-opened or the manufacturer’s expiration date. Once opened, the stock may be used for 3-months. See Table 3 for list of analytes in MegaMix. Verification standards (ICV/LCS) must have different lot numbers.

The spike solutions are prepared as follows:

5.5.1 VOC Spike

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260List1/Std#1.sec MegaMix (2000-62,500 ug/mL)	40	Dilute to 2 mL	50-1250

5.5.2 Gas Spike

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260 List1/Std#3.sec Gases 2000ug/mL	40	Dilute to 2 mL	50 ppm each component

5.5.3 Additional Spike Compound Mix

The 8260/624 Ketone Working Spike is prepared as follows:

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260List1/Std#2.sec Ketones 10,000ug/mL	8	Dilute to 2 mL	50 ppm each component

The 2-CEVE and Vinyl Acetate Working Standards is prepared as follows:

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
8260List1/Std#4.sec 2-CEVE 2,000 ug/mL	40	Dilute to 2 mL	50 ppm each component
8260List1/Std#6.sec Vinyl Acetate 4,000 ug/mL	20		

The Acrolein Working Standards is prepared as follows:

Stock Compound/Mix	Volume (µL)	Water	Concentration
8260 List1/Std#5.sec Acrolein 20,000 ug/mL	100	1 mL	2000 ppm each component

5.5.4 List 2 Spikes

Compound / TCL Mix	Volume (µL)	MeOH	Concentration
8260 Polar Additions	40	Diluted to 2mL	50/500/2000 ppm
Ethanol	40		

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
Methylnaphthalenes spike 2,500ug/mL	40	Dilute to 2 mL	50 ppm each component
Pentachlorethane spike 2,500 ug/mL	40		

Stock Compound/Mix	Volume (µL)	MeOH	Concentration
List 2/STD #6.sec 2,500 ug/mL	40	Dilute to 2 mL	50/100/500/1250 ppm
List 2/STD #7.sec Additions STD 2500-5000ug/mL	40		

Compound / TCL Mix	Volume (µL)	Water	Concentration
8260 List2/Std3.sec Cyclohexanone (25,000ug/mL)	200	Diluted to 1mL	5,000 ppm

Compound / TCL Mix	Volume (µL)	Water	Concentration
2-Ethyltoluene Spike 2-Ethyltoluene (1,000ug/mL)	50	Diluted to 1mL	50 ppm

Compound / TCL Mix	Volume (µL)	Water	Concentration
2,3-Dichloro-1-propene Spike 2,3-Dichloro-1-propene (1,000ug/mL)	50	Diluted to 1mL	50 ppm

For waters, addition of 5 µL of each solution results in most spike compounds at 50 ppb.
For soils, addition of 5 µL of each solution results in most compounds at 50 ppb.

These solutions are stored at ~ -10˚C in several 1.5-2.0 mL Teflon-lined screw-capped vials. All standard preparation is recorded in the TALs (LIMS) system. Working matrix spike solutions have a 2-week/1-week (Gases, 2-CEVE, Vinyl Acetate and Acrolein) expiration date. See above for label information.

5.6 Stock BFB Solution

The BFB standard is purchased as a neat solution from Supelco (or equivalent).

Stock	Amount	MeOH	Concentration
2000 ppm BFB	25 µL	Dilute to 2 mL	25 ppm

- Life of Standard: This stock can be kept for a period of 1-year until opening. Once opened, it is used for a period of 6-months.
- Storage Requirements: The standard is stored at ~ –10ºC in the dark

Addition of 2 µL to 5 mL results in a concentration of 50 ng/5 mL.
All preparation is recorded in the TALs (LIMS) system. All labels are completed as above.

NOTE: Intermediate and Working Solutions are never assigned an expiration date exceeding the expiration date of the neat/stock standards/solutions.

6.0 CALIBRATION

Before an instrument is used as a measuring device, the instrument response to known reference materials must be determined. The manner in which various instruments are calibrated depends on the particular type of instrument and its intended use. All sample measurements must be made within the calibration range of the instrument. Preparation of all reference materials used for calibration is documented.

6.1 PFTBA Tune

The instrument is first tuned with PFTBA. This tuning might not be necessary if BFB is already acceptable.

The ion abundances in the PFTBA are best monitored near the temperature of analysis of BFB. Enter the Tune Wizard software in Chemsation, and have instrument perform a BFB tune or a BFB Atune. PFTBA tuning abundances generally should meet the following ratios as a guidance.

Mass	Relative Abundance
69	100%
131	40-60%
219	50-70%

These will vary with the MS. Mass 219 is usually 10% greater than mass 131. If necessary, adjust the amu gain for peak shape and high-end isotope resolution. An **overall** peak-width of 0.500 to 0.550 is desirable. Instrument can also be manually tuned by adusting electron multiplier (EM), ion focus, and repeller. See Chemstation instruction for further details on instrument tuning.

Again, these adjustments and relative abundances may not guarantee that BFB will meet requirements, but is a good place to start. Each Chemstation software will have Tune trace activated, as well as a saved copy of modified tune file.

6.2 BFB Analysis

Once the instrument is tuned, 50 ng of 4-Bromofluorobenzene must meet criteria. Per method 8260D, this BFB analysis must occur before any instrument calibration. The BFB does not need to be performed daily, unless instrument conditions have changed (the PFTBA ratios have been adjusted), or if requested by a project specific QAPP. The mass spectrum must meet the following criteria:

Mass	Ion Abundance
95	50-200% of mass 174
96	5 - 9% of mass 95
173	<2% of mass 174
174	50-200% of mass 95
175	5 - 9% of mass 174
176	95-105% of mass 174
177	5 - 10% of mass 176

Eurofins procedure requires the following:

BFB evaluations must be set up to look at the apex ± 1 scan and average the three scans. Background correction is required prior to the start of the peak but no more than 20 scans before. Background subtraction cannot include any discrete peak. The peak apex might not be picked correctly by software, so user can determine apex peak and average scan. Additionally, a single scan (apex only) can also be used for evaluation, with background subtraction still required.

6.3 Description of Initial Calibration

An initial calibration are completed:

- as needed – continuing calibration can not be met
- after a source cleaning and/or column change or any time a major repair or change has occurred with the instrument that affects calibration where a new calibration is indicated.

Confirm that the GC/MSD is stable and equilibrated. If at all possible, allow the instrument to equilibrate overnight at all operating temperatures if the source/column has been cleaned/changed. Prior to beginning initial calibration it is a good idea to:

- check the background of air/water levels and base ion by scanning for appropriate ions and also visually inspecting the spectrum scan for any other possible and undesirable background.
- recheck the multiplier settings, after a source is cleaned the EM can most often be dropped.

6.4 Initial Calibration

Each calibration standard is analyzed according to one of the methods in Attachment 1. These are examples. The actual number of points in the calibration is determined by the calibration and acceptance criteria in TALS.

Allow standards to come to ambient temperature.

When running in soil mode, fill ten 5-mL luer-lock gas-tight syringes with reagent water to overflowing. Replace the plunger and invert. Adjust to 5-mL confirming the absence of any air bubbles. Pull back slightly on the plunger to allow addition of standards. Following the guides found in the Attachment 1, add the appropriate amount of standards and methanol. When running in water mode, fill ten 50 mL volumetric flasks slightly below line to allow addition of standards.

Immediately add the standards to a clean 40-mL vial. Following the method parameters outlined in Attachment 1, analyze the 50 ppb standard. A normal standard will appear very similar to the ones in Figures 1 and 2. Quantitate the standard against the appropriate method file. Sufficient areas for the first internal standard will vary somewhat between instruments. Acceptable areas should be based on maintaining sufficient sensitivity for poor responders without saturating the detector at the upper end of the calibration range. Too low an area will almost guarantee poor/unsatisfactory responses of low-response compounds and too high an area will result in saturation of some compounds at higher levels, resulting in false low response factors at high concentrations.

It is helpful to analyze a medium level standard first and assess the areas before continuing with the low/high level standards.

Response factors are calculated by the data system as follows:

$$RF = \frac{A_X \times Q_S}{A_S \times Q_X}$$

Where:
A_x = ion abundance for analyte
A_s = ion abundance for its internal standard
Q_s = concentration of its internal standard
Q_x = concentration of analyte
(Response Factors have no units)
The appropriate quant ion must be in the method file. A listing of the target compounds with their appropriate internal standards appears in Attachment 2. Confirm the presence of all targets and the

separation of non-co-eluting compounds. Note the response factors for the gasses. If necessary, prepare new standards.

If adjustments to the acquisition parameters are necessary, make them and re-analyze the 50 ppb standard.

The entire initial calibration shall be analyzed. If a point is found to be invalid due to an injection or instrument problem confined to that run, than the point may be repeated once only. If that point fails again a new ICAL must be performed. Removal of points for individual analytes from levels other than the highest or lowest level is not permitted in any event. However, an entire level of calibration may be entirely removed if it is determined to be a misinjection or prepared incorrectly. Unused or replaced standards must have a clear explanation of why they were not used or why they were replaced.

When a standard is analyzed and processed as part of the initial calibration the RF's are automatically updated in the daily method. After all initial calibration standards are processed, checked and confirmed as being accurate and passing method criteria, the initial calibration is locked and set as the most recent. This ensures that the correct initial calibration is used for each ensuing continuing calibration check. A hardcopy of the calibration report is generated. All method criteria are assessed for compliance. Confirm that:

1) The RSD should be $\leq$ 20% for each target analyte.
2) Table 2 contains minimum RFs that may be used as guidance in determining whether the system is behaving properly and as a check to see if calibration standards are prepared correctly. Because the minimum RFs in Table 2 were determined using specific ions and instrument conditions that may vary, it is neither expected nor required that all analytes meet these minimum RFs. The information in this table is provided as guidance only.

Calibration curves are evaluated following the set up in TALS. For all compounds in the initial calibration with a %RSD > 20%, calibration curves of area ratio versus concentration using a first order regression curve of the calibration curve points will be performed. Weighted linear curves may be used. A minimum correlation criteria should be met (R^2) $\geq$ 0.990).

Note: The state of South Carolina does not allow the use of quadratic curves, therefore, in those cases, only the weighted linear option is allowed. If the %RSD criteria are not met, only the linear regression model will be used. The state of Wisconsin will only allow the use of quadratic curves if verification is performed at two spiking levels. The CCVL will be used for this purpose.

Method 8000B/8260D specifies a minimum coefficient of determination (R^2) of 0.990. The methods also specify a minimum of 5 calibration points for a linear model and a minimum of 6 calibration points for a higher order regression. The laboratory, in order to meet requirements, will analyze a minimum number of points to satisfy both. All efforts will be made to meet the minimum COD of 0.990. However, there are some compounds that historically present a problem meeting this requirement (See attachment 9 for a list of poor purgers). These compounds are usually those listed in the analyte table of Method 8260B with qualifying remarks. Many of these have various known issues that would effect reproducibility (i.e., Acetone qualifier pp = poor purger). These typically include many of the Appendix IX compounds as well. The laboratory will take minimal action for these compounds.

The preparation instructions noted above will be modified to include the necessary calibration levels. These instructions are for guidance only and may change as needed.

The BFB tune, and all standard raw data are filed. Each instrument has its own initial calibration.

Each time a new initial calibration is required, the standards are verified against a second-lot number LCS (ICV-Initial Calibration Verification standard) prior to any sample analysis. This holds for all routine compounds and those available as second-source material in the LCS (see page 11 for list of compounds). The ICV must meet 30%D for all compounds or corrective action must be taken. Some client's require 20%D. For South Carolina, all compounds must meet 30%D unless there are compounds identified as poor purgers in the SOP. The poor purgers should still meet 40%D. South Carolina does not allow the use of marginal exceedances. Multiple ICV's without documented corrective action or valid reason for doing so, is not acceptable.

NOTE: The actual number of points in the calibration and the low point in the calibration may vary with client and project need. Clients may have additional requirements, which would be covered in a client-specific or regulatory/agency QAPP.

6.5 Daily or Continuing Calibration

Continuing calibration occurs prior to analysis.

If time remains after the initial calibration, and the 50 ppb standard meets continuing calibration criteria, samples can be analyzed up to the 12-hour tune limit. The samples are quantitated against the average RF or appropriate as per method. See later sections describing calculations.

NOTE: (BFB) Tune check are only required prior to ICAL. They are not required before CCV unless required by a QAPP or the instrument tuning parameters have changed since previous acceptable BFB. In the absence of BFB, CCV needs to be analyzed every 12 hours.

Continuing calibration criteria- (CCV)

Limit for target analytes is 20%D. Due to the large numbers of compounds that may be analyzed by this method, it is expected that some compounds will fail to meet the criterion. If the criterion is not met (i.e., greater than ±20%D or drift), for more than 20% of the compounds included in the ICAL (or more than 20% of those that will be reported), corrective action should be taken. In cases where compounds fail low with CCV meeting criteria, a low level standard (CCVL) will be analyzed at or below the reporting limit that level to confirm the analyte could be qualitatively identified.

All efforts will be made to ensure 20% rules and CCVL sensitivity is met. Deviations from these guidelines due to method defined poor performing analytes outlined in Section 1.1 of 8260D will be narrated with NCM.

- Table 2 contains minimum RFs that may be used as guidance in determining whether the system is behaving properly and as a check to see if calibration standards are prepared correctly. Because the minimum RFs in Table 2 were determined using specific ions and instrument conditions that may vary, it is neither expected nor required that all analytes meet these minimum RFs. The information in this table is provided as guidance only.

If continuing calibration can not be met, corrective action must be taken. Multiple CCV's without documented corrective action or valid reason for doing so is not acceptable. Since a CCV can fail for many reasons it is important to determine why it failed or where the problem originated (reagents, autosampler, concentrator, GC, Mass spectrometer). If corrective actions are unsuccessful, a new calibration is required.

If the initial CCV fails method criteria, try and determine why it failed:

- need new standards?
- Manual tune needs adjusting?
- Carry-over issues?
- Low or high internal standard responses?

Take appropriate actions to correct the problem. Document corrective actions on the corrective action/qualification report. Re-analyze the CCV. If the second CCV fails method criteria, compare the two standards:

- Did corrective action help?
- Are there any trends between the two standards?
- Baseline rise or ghost peaks?
- Any indication of leak or gas contamination?
- Does further maintenance need to be performed?
  - Autosampler
    - replace needle?
    - Check flows and temperatures
  - Concentrator
    - Change trap?
    - Check flows and temperatures
  - GC
    - liner/seal need to be replaced or cleaned?
    - Check flows/temperatures
  - Mass spectrometer
    - Instrument need to be cleaned?
    - Mutltiplier and filaments stable?

TNI standard EL-V1M4-2016-Rev2.0 Module 4 Section 1.7.1.2.f.ii states the following:

"If the continuing instrument calibration verification results obtained are outside the established acceptance criteria, the following steps shall be taken:

If the cause for the calibration verification failure is not identifiable or has impacted other samples, then corrective action shall be performed and documented. Prior to analyzing samples, the laboratory shall demonstrate acceptable performance after corrective action with calibration verification or a new initial calibration shall be performed."

All internal standard areas and retention times are assessed immediately after calibration. Areas and times compared to the mid point of the initial calibration. Internal standard areas should not deviate by a factor of two or the retention times should not deviate by > 30 s. If the situation occurs, appropriate action is taken and the standard re-analyzed. All corrective action and return to control are documented in the Corrective Action section in the analysis logbook for the appropriate instrument.

7.0 PROCEDURE

7.1 Quality Control Checks

Quality Control is accomplished through:
1) daily tuning and calibration checks and
2) preparation QC traceable through individual batches.

7.1.1 Initial Calibration

PFTBA		
BFB TUNE	Prior to Initial Cal	*limits in Section 6.2
200 \		
150 |		
100 |		
50 |	Initial Cal need dependent on situation.	*limits in Section 6.4
20 |		
5 |		
2 |		
1 |		
0.50 |		
0.25 /		

NOTE: As stated, the actual number of points in the calibration and the low point in the calibration may vary with client and project need. Minimum number of points, 3rd Edition SW-846 may be 6 or 7 depending on matrix. Other clients may have additional requirements, which would be covered in a client-specific QAPP. Surrogate may be calibrated with either a single, mid-range concentration or with a multiple point calibration.

7.1.2 Method Blank (MB)

Prior to any analysis, the reagent water and the instrument must be shown to be free of interference's and target compounds.

A 5 mL portion of reagent water is analyzed using one of the methods in Attachment 1. Internal Standards (IS), Surrogates (SS) and methanol will be added prior to analysis. Initial concentrations of both surrogate and internal standard solutions shall be such that "sample concentrations" of the analytes conform to the method and surrogate tables provided in this SOP. All target compounds must be less than the quantitation limit (See Section 2.0). Once the MB analysis is complete and acceptable, analysis can proceed.

7.1.3 Daily Analysis

BFB	Prior to ICAL only	* See above calibration
Daily Calibration Standard	Prior to samples	* See Section 6.5

Prep QC	Frequency
MB	Prior to analysis
LCS[1]	1 per analysis batch
MS/MSDs[2]	at least 1 set in 20
Surrogates	every blank, sample and QC Sample
Samples *	

<u>*Any given 12-hour period contains a standard, blank and LCS. Preparation QC is at a 5% frequency. Instrumental controls are outlined above and further discussed in the procedure section.</u>

[1] LCS Duplicate (LCSD) is performed when insufficient sample is available for an MS/MSD.
[2] The sample selection for MS/MSD, if not specified by the client on the chain-of-custody, is rotated among client samples so that various matrix problems may be noted and/or addressed.

7.2 Sample Preservation and Storage

Sample containers, preservation techniques and holding times may vary and are dependent on sample matrix, method of choice, regulatory compliance and/or specific contract or client requests. Listed below are the holding times and the references that include container and preservation requirements for compliance with the Resource Conservation and Recovery Act (RCRA).

Matrix	SW-846
Soils – 5030B	14-days
Unpreserved Soils – 5035A	48 hrs
Preserved soils 5035A	14-days
Preserved – waters	14-days
Preserved waters (pH 4-5 S.U.) Acrolein and Acrylonitrile only*	7-days
Non-preserved - waters	7-days
Non-preserved –Method 624 waters (Acrolein only)	3 days
Non-preserved SC waters (Acrolein and Acrylonitrile only)	3 days

All samples received for volatile analysis are refrigerated upon receipt at 4 ± 2°C. Refrigeration is the only preservative for 5030 soil samples, while 5035 soils can be preserved with sodium bisulfate, methanol or frozen. Water samples are preserved with 3 drops of 36% HCl to a pH <2. Water samples marked as un-preserved are analyzed within 7-days.

Water samples which are labeled as “Preserved” are analyzed within 14-days, if however, the pH of the sample is not <2 when verified at the time the sample is screened all efforts should be made to analyze the sample within the 7 day unpreserved holding time. If past the 7 day holding time for non-preserved samples, then an “H” flag will be applied to the data and/or NCM will be written.

*Note: Acrolein and Acrylonitrile samples must be preserved to a pH 4-5 S.U. and analyzed within 7 days of collection unless the site sampling plan or project specific QAPP specify otherwise.

7.3 Sample Preparation / Screening /Analysis

Once the samples are logged into the TALs (LIMS) database upon receipt, a paperwork trail is initiated. The Supervisor or Analyst prints and prepares the necessary information (Sample Tracking Sheets) and places it in the appropriate file bin in the GC/MS VOA lab. The analysts take this information and subsequently screen the associated samples. Samples are screened by MSD prior to analysis. The actual screening procedures vary due to sample appearance, sample matrix, client history and analytical method. Once the samples are screened, the paperwork is transferred to a second file appropriately labeled. This file contains information about samples that have been screened but need to be reviewed. Once screened, an ‘X’ is placed on top of the vial, indicating both that the sample has been screened, and that the particular vial can not be used for subsequent analysis. The screened analysis can be reviewed on screen or hard-copy, as all screening data is collected and stored on the data system as with all GC/MS analyses. Upon review, the analyst makes decisions concerning the screen and indicates if an initial dilution is required. This information is physically recorded on the paperwork. Once reviewed, the paperwork is then placed in appropriate files that are broken down by matrix and method. The samples are now ready to be analyzed.

7.3.1 Waters

Allow samples and standards to come to ambient temperature. Observe all vials of sample and confirm the absence of any air bubbles. If a vial has an air bubble do not use that vial and notify the Supervisor of the situation. If air bubbles are present in all VOA vials for a particular sample then the PM will be notified and an NCM will be written. Make sure the vial used for screening is properly marked and do not use this vial for analysis.

When running in soil mode, remove the plunger from a 5 mL luer-lock gas-tight syringe and fill to near over-flowing. Replace the plunger. The pH of all samples is verified at time of analysis and the actual estimated pH is written on the sample tracking sheets. pH checks and verification of hold-times are documented on the review form. Samples lacking preservation may be noted in the case narrative. Invert the syringe, and adjust the volume to 5 mL. Confirm the absence of all air bubbles. Pull plunger back slightly for the addition of IS, SS and Methanol.

Add IS, SS and methanol to the 5 mL syringe. Initial concentrations of both internal standard and surrogate solutions shall be such that “sample concentrations” of the analytes conform to the method and surrogate tables provided in this SOP. Immediately add the sample to a clean 40 mL vial to analyze the sample.

When running in water mode, put full client sample directly on instrument. Also put on any dilutions ensuring 40 mL vial has no headspace. pH for these samples will be checked after analysis.

Load all samples, including all batch QC prepped in the same sequence and manner as the samples, following the procedure above. After the batch is loaded, replace all samples and standards back in storage. Appropriate documentation is made on the ICOC page.

If a dilution is required as indicated from the screening results, the following guidelines are followed. If the dilution is > 1/100 (250 µL of sample) an initial dilution is made into a volumetric flask. If serial dilutions are required, no less than 1 mL is taken for further dilutions. The final sample aliquot taken for analysis from the volumetric is no less than 250 µL. If the dilution is < 1/100, the appropriate sample amount is added directly to the 5 mL syringe.

Opened sample vials are used only once unless: (a) any necessary dilutions/reruns are done the same day or (b) there are no other vials for that sample. If an open vial has to be used, then an NCM will be written explaining the reason.

7.3.2 Soils (Low Level-5030)

As some clients still request method 5030, low level soils are still being analyzed as indicated below.

Before weighing any samples, check the balance using the appropriate class weights. Record the actual weights in the Balance Logbook. If a problem is noted, contact the QA department.

Allow samples and standards to come to ambient temperature.

Weigh out 5 grams of the sample into a clean 40-mL vial. Add 5-mL reagent water into vial. IS/SS will be added though the septum. The autosampler will add an additional 10-mL of reagent water. Initial concentrations of both surrogate and internal standard solutions shall be such that “sample concentrations” of the analytes conform to the method and surrogate tables provided in this SOP. Using the methods described in Attachment 1, analyze the sample. All soil samples are analyzed with a heated purge (40°C).

After the batch is loaded, including all batch QC prepped in the same sequence and manner as the samples, replace all samples and standards to their appropriate storage location. Documentation is made on the ICOC page.

Any sample that based on screening results/historical data has shown to contain high concentrations of compounds is analyzed at an initial dilution. Any sample that after the initial run contains targets above the calibration range is diluted to accurately quantitate those compounds. If an initial analysis over-diluted the given sample it is re-analyzed as a low level soil. If the low-level analysis contains compounds above the calibration range, and the same compounds are within range in the dilution, both sets of data may be reported to the client.

If a 1/2 or 1/5 dilution is required, 2.5g/1.0g of sample is weighed into the purge vessel.

7.3.3 Medium-Level Soil Extracts (High Level-5030)

If a larger dilution is required, a 5030 medium-level soil extract is prepared as follows. Five grams of sample is weighed into a tarred vial. Five 5-mL of MeOH is added to the vial and the vial sealed. After the 24-48 hour contact time, the MeOH portion is decanted and stored in a 1-1.5 mL Teflon-lined screw-capped vial for storage. A portion of the extract (100 µL maximum) is taken for analysis. ISS and SSS will be added prior to analysis. Initial concentrations of both surrogate and internal standard solutions shall be such that “sample concentrations” of the analytes conform to the method and surrogate tables provided in this SOP. Serial dilutions, if needed, are made from the extract and appropriate amounts taken for analysis.

If the sample upon which a medium-level prep as been performed also required an MS/MSD, the appropriate amount of MS solution is also added.

All samples prepared in this manner will be analyzed against a medium-level soil curve. The standards, blanks and LCS samples will contain 100 µL MeOH. The curve will be at ambient temperature.
NOTE: Some soils are analyzed initially at low levels due to increasing client requests for lower reporting limits. The same samples may then require large dilutions to bring compounds into the calibration range of the instrument. Some compounds, most notably the ketones, have very different responses when heated versus non-heated, despite the sample matrix. Traditionally, the lab heats soils. Therefore, the match between original analyses and methanol extraction dilutions for compounds such as these may not appear to correlate.

Dilution	Sample Weight	Vol. MeOH (1/2.5) Extract
1/2	2.5 grams	---
1/5	1.0 gram	---
1/50	5 grams / 5 mL	100 µL
1/250	5 grams / 5 mL	20 µL
1/500	5 grams / 5 mL	10 µL

Using those parameters in Attachment 1, analyze all samples in the batch.

Sample vials/jars are only used once unless: (a) any dilutions/reruns are analyzed the same day or (b) there is only one jar for analysis.

7.3.4 Method 5035

NOTE: ICAL Standards are prepared with 5 mL milli-Q water.

Samples for low level VOA soil analysis may be received at the lab in one of three manners: First, as replicate 5 gram core samples in 40 mL vials containing organic free water and frozen within 48 hours of collection. Secondly, as replicate 5 gram core samples in 40 mL vials containing a Sodium Bisulfate preservative solution (refer to USP-5035 for collection/preservation). Thirdly, unpreserved 5 gram core samples may be received in Encore containers. These core samples must be placed in organic free water and frozen within 48-hours of collection. This time requirement is currently under review by appropriate regulatory agencies and may be extended beyond the 48-hours. Until such time, the laboratory will endeavor to “fix” the sample cores in preservative within 48-hours of collection. The laboratory may receive replicate 5 gram soil cores to be used for reanalysis if needed.

In addition to low level samples, an additional soil aliquot should be received for use as a screen and possible use as a mid-level extraction/analysis. This additional core must also be fixed in MeOH within 48-hours of collection. The amount of MeOH added must closely correspond to a soil to solvent ratio of 1:1. Eurofins may adjust the methanol levels of any sample prepared in the laboratory from TerraCore® plugs with a corresponding 1:1 ratio of MeOH to soil. Any sample prepared in the field and fixed in methanol prior to arrival to the laboratory will not be adjusted but an NCM will document the discrepancies. Though not specified in the method, Eurofins will pursue a goal of removing the MeOH from the soil within 24-48 hours after the initial extraction. A portion of the MeOH be removed and placed in a 1.5 - 2.0 mL Teflon-lined screw-capped vial for storage. This time limit should standardize the amount of time the MeOH comes in contact with the sample.

MeOH extracts of soils will be analyzed as stated above at ambient-temperature against a medium-level soil initial calibration. All surrogate and internal standard solutions will be added at time of analysis.

Low level soils will be analyzed using the Closed Purge and Trap Auto Sampler System. Surrogate and internal standard solutions will be added at the time of analysis through the septum by either a small gauge (10uL) syringe or automatically by the Archon autosampler. Initial concentrations of both surrogate and internal standard solutions shall be such that “sample concentrations” of the analytes conform to the method and the spike and surrogate tables provided in this SOP. The concentration of the solution and amounts spiked may vary depending on the precision obtained with a given solution/volume combination. However, the final concentrations of such compounds in the samples will follow the same guidelines as previously stated in this SOP for all other samples.

As with the internal standard and surrogate, all QC spike solutions must also be added to the closed sample container. This is accomplished by the addition of the spike solutions through the septum with a small gauge (10 μL) syringe just prior to the sample being placed on the instrument for analysis.

7.3.5 Drum/Waste Samples

- Non-MeOH Miscible
- MeOH Miscible

These samples are normally treated as medium level soils or waste dilutions. Waste dilutions normally consist of 5 grams of sample to 5 mL of MeOH. If the sample is non-miscible with methanol, mix and sonicate the sample for 20 minutes and allow sample to separate. Draw off the methanol into a screw top vial. Use a portion of this methanol extract to screen. Continue to analyze the sample as high a high level methanol extract at a dilution based on the screening result.

If the sample is miscible with methanol, notify the PM and provide a detailed description of sample matrix and any matrix issues. The sample will automatically be given a 1:2 dilution factor, as a result of its miscibility with the methanol. Screen the sample and continue to analyze by the high level methanol extract procedure based on the screening results. Both ISS and SSS are added prior to analysis. The laboratory can also pre-spike the surrogates and spike compounds if client-specified to do so. In many cases, due to the high level dilutions required, the surrogates and matrix spike compounds may be diluted out. Therefore, unless specifically instructed, both solutions will be added at the time of analysis.

Drum/waste samples that are biphasic in nature require a discussion with the PM and client in order to determine how the samples will be prepared and analyzed (one phase, both phases?). The preparation and analysis of the sample will be documented.

7.4 Preventive Maintenance

Instrumental maintenance can be categorized as daily and "as required". Required maintenance may be performed for a variety of reasons. Certain trouble-flags will indicate what maintenance procedures may be required. A description of the situation, actions taken and follow-up must be documented in the instrument maintenance logbook on the day of maintenance and initialed / dated**.** Maintenance logs are to be peer reviewed by a qualified analyst other than the analyst who recorded the maintenance in the logbook. The maintenance logs should be reviewed on a monthly basis.

7.4.1 Daily Maintenance

The most routinely performed maintenance includes:

- Purge-line or sample transfer line rinses within the concentrator and vial autosampler
- Analysis of blanks after high level samples
- GC oven bake after high level samples

The Corrective Action/Qualification Report for GC/MS VOA is used to document that the instrument Preventive Maintenance as described in this SOP has been performed.

7.4.2 "As Required"

Most maintenance is done on an "as needed" basis, is operator determined and can be categorized as GC, Concentrator, or MS related.

7.4.2.1 GC Related

- change column; condition new column
- check helium flow rate
- change gas cylinders and moisture trap
- Replace line

7.4.2.2 MS Related

- clean source/rods and anything associated with that activity
- replace electron multiplier
- change filaments

7.4.2.3 Concentrator Related

- change transfer line; clean transfer line
- replace trap; condition new trap
- run 20 ug/L Bromoform standard to check for formation of Chloromethane and Bromomethane.
- refurbish Concentrator
- check purge pressure and flow rate
- analysis of position blanks after high-level samples
- change bulk head fitting

7.4.2.4 Autosampler Related

- change sparge needle
- change pencil filters
- flush standard pickups
- calibrate standard valve
- run vial position calibration
- clean transfer rods
- oil bearings

7.5 Documentation/Tracking of Sample Analyses

7.5.1 The GC/MS VOA lab employs several forms that serve both a tracking and review function. The Sample Tracking Sheet is filled out for each job. It contains information the analyst needs as for method, QC requirements, special reporting requirements, screening results, methanol lot # etc.., in addition for space to track the analysis of every single sample in the job and the outcome of that analysis.

7.5.2 All samples logged into the department appear on back-logs ordered by both Hold Time and Due Date. The back-logs are utilized by the analysts when making decisions as to methods and analyses that are needed for the day. As samples are analyzed and reviewed, the back-logs are updated to reflect those samples completely analyzed, those requiring dilutions and re-analyses.

7.5.3 An instrument sequence log is printed, reviewed, signed and bound in a log daily for each instrument.

7.6 Archival of Data

Data will be available on the local server for at least 1 year. No data is removed from the system until it has been archived on at least one full back up and a number of differential back-ups.

Data is transferred to servers after each sample run. The servers are backed up to a local backup server each night. The local backup server is backed-up off-site daily. Data can be restored from the backup server. Back-ups are the responsibility of Eurofins Corporate IT.

8.0 QUALITY CONTROL

8.1 QC Summary

The department will review the quality controls as follows:

8.1.1 Method Blank (MB) / Laboratory Control Standard (LCS)

At least one MB and LCS will be included in each laboratory batch. Regardless of the matrix being processed, the LCS and MB will be in an aqueous media.

The MB will be examined to determine if contamination is being introduced in the laboratory. The LCS will be examined to determine accuracy and precision.

8.1.2 Accuracy

Accuracy will be measured by the percent recovery (%R) of the LCS. Method 8260B refers to Method 8000 for guidance on initial demonstration performance criteria. Guidelines for LCS/LCSD and MS/MSD accuracy limits can also be found in Method 8000. The laboratory's current in-house statistical limits are accessible in TALS. The number of compounds being used for bench level control and the accuracy limits assigned to those compounds may vary with client, QAP, project, or state certifications. This information is transmitted to the bench via method, sample or login notes in TALs or with an NCM, and indicated on one of the forms used at the bench. In-house generated limits are subject to change.

8.1.3 Precision

Precision will be measured by the reproducibility of the LCS and will be calculated as Relative Percent Difference (RPD). Current limits are accessible in TALS. RPD's are not used to assess bench level Corrective Action.

8.1.4 Surrogates

Surrogate Compounds will be added to every sample to measure performance of the analysis. In-house statistical limits are accessible in TALS. Guidelines for the generation of statistical surrogate limits can be found in Method 8000. As with LCS samples, surrogate recovery limits may vary with client, QAP or project and the information transmitted to the bench in the same manner.

8.1.5 QC Charting/Generation of Statistical Limits

Precision and accuracy are monitored using LCS data. Review of QC Charts and generation of in-house statistical criteria, including surrogate limits, is completed on an annual basis. Additional data may be added at QA/QC discretion during the year for other purposes. Spike levels are 50 ppb. Only routine compounds are spiked and should be representative of the whole. Non-routine compounds are not part of the spiking solutions. Other limitations (availability of second source) may also prevent adding these to spiking solutions.

8.2 Corrective Actions

Listed below are the steps to be taken when an out-of-control situation occurs. The analyst must address the following issues as described below in the individual sections.

- demonstrate that all of the problems creating the out-of-control situation were addressed;
- document the problem and the action that was taken to correct the problem;
- document that an in-control situation has been achieved; and
- receive approval (signature) of the supervisor, project manager, QC personnel or other qualified personnel prior to release of data associated with the problem.

Corrective Actions are documented on the Corrective Action/Qualification Report included in the instrument logbook. In addition, a sample tracking form, specific to a unique job, is attached to the sample tracking documentation. The corrective action/qualification report and sample tracking form are used to note all out-of-control events, the actions taken to try and correct the problem, the return to control.

Discussed below are the suggested and required courses of action when an out-of-control situation has occurred.

8.2.1 BFB Criteria

If BFB criteria can not be met, determine if the source of the problem is instrumental or tune related. Inspect overall sensitivity, possible excessive background, the proportionality of the masses, relative abundances of the target masses. If it seems tune-related, adjust the tune parameters in Manual Tune slightly, until acceptance is achieved. If the problem seems instrumental, perform suggested trouble-shooting to locate and correct the problem (Suggestions can be found in most of the manuals). NO analysis can proceed until criteria are met. Corrective action for BFB analysis is documented on the corrective action/qualification report in the logbook.

8.2.2 Initial Calibration

If initial calibration can not be met, determine if the problem is analytical or instrumental. Some suggested questions to ask would be:

- Were the standards prepared correctly?
- Was the proper amount analyzed?
- Check the chromatogram - did something happen on one or two analyses; i.e., a leak
- Check the response factors - is one concentration level very high or low? re-analyze
- How old are the standards?

All calibration criteria must be met (Section 6.4). If the ICAL does not meet specified criteria, at minimum, the appropriate levels must be re-analyzed. If necessary, new standards should be prepared and the levels re-analyzed. During analysis of an initial calibration, documentation of the re-analyses of specific levels is required. See previous section outlining CA for minimum COD values as well. Refer to the Eurofins Corporate Policy for Calibration Curves and the Selection of Calibration Points (NDSC-QA-QP44940) for further guidance.

8.2.3 ICV/Continuing Calibration

If continuing calibration can not be met, determine if the problem is analytical or instrumental. Some suggestions:

- Check the chromatography

- Is overall sensitivity low?
- Excessive background?
- How old is the standard?
- Need a new ICAL?
- Has the tune shifted?

Compare the relative abundances of 69, 131 and 219 from that day's manual tune to those on the day the initial calibration was analyzed. Slight adjustments to the tune may bring the standard in. Certain compounds will help indicate what the problem is.

All calibration criteria must be met (Section 6.5). If the ICV/CCAL does not meet specified criteria, at minimum the standard should be re-analyzed. A new standard may be prepared and then re-analyzed. If necessary, a new ICAL must be run. All corrective action taken for CCAL's must be recorded on the corrective action/qualification report and included in the logbook. Multiple ICV/CCVs without documented corrective action or valid reason for doing so, is not acceptable.

8.2.4 Method Blank (MB)

If the MB is/appears to be contaminated, re-analyze. If contamination is still present, the problem may be in one of the common elements, such as the trap, transfer line, port valve or column. Baking the trap/column and running position blanks may be necessary. If contamination has occurred beyond that, and maintenance is required (i.e., replace trap) it is documented in the Maintenance logbook. All corrective action taken for Method Blanks must be recorded on the corrective action/qualification report and included in the logbook. Under extenuating circumstances, if analysis continues, qualification must be made as to the positive hits above the RL for the compounds in question. Any associated samples analyzed in the tune must be noted. Any samples containing positive hits must be noted. IF, the samples containing positive hits can not be re-analyzed (i.e., past hold-time), the positive hits are flagged with "B" and the situation and data noted and qualified in a case narrative and/or Non-Conformance Memo (NCM). Methylene Chloride and Acetone are known lab contaminants; therefore intermittent low levels of these compounds may occasionally occur. Acetone and Methylene Chloride must be less than 3X the reporting limit. Any positive detects in the samples should be re-analyzed. If the samples can not be re-analyzed then the positive hits must be flagged with a "B" flag and the situation must be documented in a NCM.

8.2.5 Surrogates

All surrogate recoveries are calculated. If ANY surrogates are outside limits in the MB, it must be re-analyzed. Analyses CAN NOT proceed until an in-control situation is demonstrated. Re-analyze the blank. If surrogates are still out, the instrument may need to be re-tuned (BFB) and/or another calibration standard analyzed. If the problem persists, further maintenance action may be required (i.e., trap replacement, clean instrument).

Before pursuing other measures, check to be sure that:

- calculations are correct
- concentrations of the surrogates in the spiking solution are correct
- the correct amount of ISS/SSS solution was added
- ISS/SSS areas are reasonable

If any surrogates in a sample are outside limits, check the above first. A sample with a high surrogate recovery and results below the reporting limit may be reported. Samples that have results above the reporting limit that has a surrogate outside control limits must be re-analyzed. The re-analysis can take the form of a dilution, if there is reasonable expectation that a high concentration of a target compound is causing a matrix effect. If the surrogate(s) is/are still outside limits, a matrix effect is demonstrated and both reports are submitted. Depending on the client, the best result may be reported and the other result narrated. If all surrogates are in-control on the re-analysis, only the second analysis is reported.

Every effort is made to complete the re-analysis within hold-time. If this is impossible (i.e., capacity hold-times preclude re-analyses within hold-time), both reports may be submitted. This is documented in the narrative.

If the sample with the out-of-control surrogates is the same sample on which the MS and MSD were performed, and the pattern is duplicated, then re-analysis is NOT required. Documentation of the similarities is required.

Surrogate corrective action is documented on the sample tracking form for samples.

8.2.6 Laboratory Control Sample (LCS)

As specified in Section 8.1.2, the number of compounds and the limits used to assess accuracy vary with client, QAP, project etc. The in-house generated limits are accessible in TALS. In-house limits are subject to change. The need and course of corrective action varies with the number of compounds being used for bench control and positive detected of compounds outside limits. The LCS limits are based on the mean recovery +/- 3 standard deviations; therefore, it is statistically quite likely that there will be exceedances of the limits for a few analytes when a large number of compounds are included in the LCS. Therefore a number of individual analytes are allowed to exceed the LCS control limit before the LCS as a whole is considered to have failed. The control limit for a marginal exceedance is mean +/- 4 standard deviations which results in a larger range of +/- 10% outside the in-house generated limits.

Number of analytes in LCS	Number of marginal exceedances allowed
> 90	5
71-90	4
51-70	3
31-50	2
11-30	1
< 11	0

- For QAP's specifying five compounds-- All five compounds must be within limits for analysis to proceed. The LCS samples may be re-analyzed. New spike solutions may be prepared. Or new standards or CCAL's may be analyzed. All corrective action and return to control must be documented at the time on the corrective action/qualification report and included in the logbook. The actual limits used for the five compounds may be QAP-specific (usually those listed in the table in the appendix) or in-house generated by matrix and method. In either case, the above corrective action and required documentation apply.

- For full list spikes, all recoveries are assessed, although no immediate corrective action may be required if within the marginal excedance. If the recoveries are low, in general another LCS may be re-analyzed. The spike solution and standard may be verified for correct concentrations. However, no corrective action is absolutely required by the bench unless an error is discovered. The recoveries may or may not be documented in a NCM, however, they are noted on the review form.

- Although not strictly required to take immediate corrective action, the purpose of the full-spike is two-fold in that the bench should use it as an indicator of the status of the calibration standards, instrument conditions etc.., as well as a tool for data interpretation. Therefore, in keeping with good lab practice, the situation should be noted and assessed and any corrective action deemed necessary should be taken within a reasonable amount of time (Example: High recoveries on gases => new calibration standard may be needed).

- For samples that originate in the state of South Carolina, all compounds in the LCS must recover between 70-130% unless the compounds are identified as poor purgers in the SOP. The recoveries for the poor purgers should be within 60-140%. Note: South Carolina does not allow for the use of marginal exceedances. If the sample results are non-detect and the LCS recovery is above the 130% upper control limit for an analyte (140% for poor purgers), the analyst will contact the PM to obtain client approval to report the data with narration. If approval is not obtained, re-analysis of all associated samples will be performed.

8.2.7 Matrix Spikes (MS)

As specified in Section 8.1.2, the number of compounds and the limits used to assess accuracy vary with client, QAP, project, state certifications etc. In-house generated limits are accessible in TALS. In-house limits are subject to change. The need and course of corrective action varies with the number of compounds being used for bench control and recoveries of same compounds in the associated LCS samples. The following guidelines are used:

(1) QAP’s etc., specifying 5 compounds.

- ALL 5 compounds are assessed. If recoveries are outside limits, the LCS is reviewed for those compounds. If the recoveries are within limits in the associated LCS samples, no further action is required. See above section concerning LCS corrective action for further information and action required for recoveries outside limits in LCS samples.

- The actual limits used for the five compounds may be QAP-specific (usually those listed in the table in the appendix) or in-house generated by matrix and method. In either case, corrective action and required documentation apply.

- For all other compounds in the full-list spike, all recoveries are assessed, although no immediate corrective action may be required. The affected compounds may be compared to the same compounds in the associated LCS samples. See the above section for further information and action required for these compounds in the LCS samples. The recoveries may or may not be documented in the Job narrative, however, they are noted on the review form. The recoveries of the “un-controlled” compounds may be used for data interpretation.

8.2.8 Internal Standard Policy

The response of each internal standard in each sample, blank, and MS/MSD must be within 50% to 200% of its respective response in the mid-point calibration standard.

Situations requiring re-analyses:

- Any IS of interest outside limits will be re-analyzed.
- Any sample that has a positive hit associated with any internal standard outside limits will be re-analyzed.

Situations NOT requiring re-analyses:

- If there is historical evidence that shows a repeated pattern for a certain client and site, and this can be documented by reviewing past projects, the samples do not have to be re-analyzed. The supervisor will approve this decision. The situation must also be addressed in a NCM and/or case narrative.
- If the failing internal standard is not associated with the reported analytes in the sample, the sample will not be reanalyzed.
- Corrective action for internal standard areas for samples is documented on the sample tracking form.

Any sample showing retention times outside windows will be re-analyzed. This is documented in the appropriate manner as in the preceding paragraph.

9.0 DATA ANALYSIS AND CALCULATIONS

9.1 Computer Data Production/Reduction

The Chrom software produces a Total Ion Chromatogram, header, quant report and background subtracted spectra. For those clients requiring it, a 5 tentatively identified compound (TIC) search is also performed. The data system will produce an integration listing and tentative identification of each hit found at the selected percentage of the largest peak present.

9.1.1 Quantitation of Target Compounds

Quantitation of the target compounds is performed by the data system can be accomplished as follows:

WATERs:

$$\text{Concentration}\left(\frac{\text{mg}}{\text{L}}\right) = \frac{[A_x \times I_s]}{[A_{is} \times RF]} \times DF$$

Where:
A_x = area of characteristic ion for target
I_s = concentration of internal standard (ng)
A_{is} = area of characteristic ion for int. std.
RF = response factor for target
DF = dilution factor (if any)

SOILs:

$$\text{Concentration}\left(\frac{\text{mg}}{\text{Kg}}\right) = \frac{[A_x \times I_s]}{[A_{is} \times RF \times D]} \times DF$$

Where:
All variables are equal and
D = (100 - % moisture in sample/100) or 1 for wet weight. (As in the case of drum samples)

The target methods all contain calculations for waters and soils that allow automatic processing and calculations of concentrations to be completed. The user may enter some variables (Dilution Factor) and others are imported from LIMS. Sample prep info for VOA’s is entered directly into LIMS. The sample volume is considered to be "constant" for calculation purposes. Less sample volume (in the case of waters) and soil weight (in the case of soils) are taken into account in the dilution factor entered by the user. For medium-level soils and waste/drum type samples medium level calculations are needed and actual weights are brought into LIMS.

NOTE: As noted previously, weights are recorded to 0.1 gram. It is SOP to weigh out 5.0 grams (or as appropriate for the dilution), however, to keep data entry and calculations simple. The same holds true for all water volumes.

SOILs_High Level Methanol:

SW-846 8000C, Section 11.10.5 states the following:

Solid samples with a significant moisture content (>10%), designated for volatile organic analysis, that are extracted prior to analysis in a water miscible solvent such as methanol are diluted by the total volume of the solvent/water mixture. The total mixture volume can only be calculated based on the sample moisture present as determined by the % moisture determination. This total volume is then expressed as V_t in the sample concentration calculations provided. Therefore, in order to report results for volatiles analysis of samples containing significant moisture content on an "as received" basis, the calculated concentration needs to be corrected using the total solvent/water mixture volume represented as V_t. The total solvent/water volume is calculated as follows:

μL solvent/water V_t = [mL of solvent + ((%moisture/100) x g of sample)] x 1000 μL/mL

$$Dry\ Weight\ Concentration\left(\frac{\mu g}{KG}\right) = \frac{\frac{(X_s)(V_t)(D)}{W_s}}{\left(\frac{\%Solid}{100}\right)}$$

Where:

X_s	= Calculated concentration of the analyte (ng/μL) in the sample.
V_t	= Total volume of the concentrated extract (μL)
D	= Dilution Factor
W_s	= Weight of the sample extracted or purged (g)

Generally, it is recommended that the calculated concentrations of volatile organics samples that are solvent extracted in a water-miscible solvent/water dilution effect for situations when the sample moisture content is greater than 10%. The potential under reporting of volatile concentrations is more pronounced as the percent moisture content increases.

9.1.2 Accuracy:

$$\%R = \frac{A_T \times A_0}{A_F} \times 100$$

Where:

A_T = Total amount recovered in fortified sample
A_0 = Amount recovered in unfortified sample
A_F = Amount added to sample

9.1.3 Precision:

$$\%D = \frac{|B_1 - B_2|}{B_1} \times 100$$

$$RDP = \frac{|B_1 - B_2|}{\frac{B_1 + B_2}{2}} \times 100$$

Where:
B_1 = %Recovery MS (or LCS)
B_2 = %Recovered MSD (or LCS)

9.1.4 Modifications for 8260D quantitation

9.1.4.1 Initial Calibration Criteria

Methods 8000B/8260D require the use of linear regression calibration curves for those compounds exceeding 20%.

The following equations apply:

Linear Regression: $y = a_0 + a_1 * x$
Weighted Linear Regression: $y = a_1 * x + a_0$

Where: $x = Area_{UNK}/Area_{ISTD}$
$y = Amount_{UNK}/Amount_{ISTD}$
a_1 = slope
a_0 = y-intercept

The equation for weighted linear regression follows the linear regression but introduces a weighting factor for the slope and y-intercept. The User manually enters the weighting factor into the method as: 1/Amt or $1/Amt^2$

Once the $Amount_{UNK}$ is solved, the value is adjusted for total solids, dilution factors etc.., to calculate a final concentration.

The quantitation of compounds using linear regressions curve as performed automatically by the Chrom software has been confirmed to be accurate.

Method 8000B/8260D specifies a minimum COD(R^2). The corrective action regarding an initial calibration for method 8260D as it relates to the 0.990 correlation coefficient acceptance criteria is outlined. When a compound has a correlation coefficient less than 0.990, the occurrence is documented by the analyst in the Corrective Action section of the instrument’s logbook. Any corrective action or data qualification is also documented on the corrective action/qualification report and included with the logbook. All corrective actions taken may include those listed below.

Samples may be analyzed against an initial calibration that have compounds with a correlation coefficient less than 0.990 and the corrective actions taken may also include some but not all of the following:

- The data for these samples may be reported without qualification if the compounds with a correlation coefficient less than 0.990 are not detected in the sample; therefore no further corrective action is required.
- If a compound is detected in the sample that has a correlation coefficient less than 0.990, the samples may be reanalyzed against an initial calibration with an acceptable correlation coefficient and only the reanalysis will be reported on the sample. If this reanalysis occurs beyond analysis hold times then both analyses on the sample will be reported.
- If a compound is detected in the sample that has a correlation coefficient less than 0.990, the decision to reanalyze or to reported the data without further corrective action is made on a case by case basis with the approval of the supervisor, the project manager and the client. The sample results may require qualification for this compound on the report and will be addressed in the case narrative.

9.1.4.2 Continuing Calibration Check

Prior to sample analysis a 50 ppb calibration check is completed. All minimum RF's must meet same limits. All target analytes must be less than 20% Drift as calculated below; the analysts may verify %DIFF and only calculate those that are close. (Error may only be made in favor of tighter control).

$$\%\mathrm{Drift} = \frac{C_i \times C_C}{C_i} \times 100$$

Where:
Ci = standard conc. (10/50)
Cc = measured conc. in cal check

9.1.5 Quantitation of TICs (Tentatively Identified Compounds)

Quantitation of TICs is performed by the Chrom processing software. The formulas above for waters and soils can be used with the following modifications. A_x and A_{is} should be taken from the total ion integration listing accompanying the TIC report produced by the data system. The nearest non-interfered with internal standard should be used. The RF is assumed to be one (1). The concentration is therefore an estimate and is flagged as such with a "J". Any TIC also found in the MB is flagged with a "JB". Any TIC identified with a CAS number is also flagged with an "N", indicating that the ID was based on the mass spectra. The operator should visually confirm that the integration is correct. If not, the peak in question must be manually integrated. The Chrom data system automatically calculates the actual concentration of the TIC's, including dilutions and total solids, once that information is retrieved from TALs (LIMS).

9.2 Operator Data Reduction/Review

The operator does on-screen review of all data and

- makes judgments concerning the "realness" of those target compounds found and
- makes judgments concerning the identification of the tentatively identified compounds
- modifies the output to produce a data package reflective of those decisions

9.2.1 Initial Review

The GC/MS VOA area uses three types of corrective action documentation. The first consists of the Corrective Action/Qualification Report that is filled out daily with each tune of samples. This form contains a comment section to report out-of-control situations, corrective action and return-to-control for documenting problems related to general QC: tune, ICAL, ICV, CCAL, internal standard areas from CCAL to ICAL, LCS and qualification of data. It is attached to the worklist and bound in the logbook. The second are the sample tracking forms that refer to a single job. These are used to record events, corrective actions and final actions for surrogates, internal standard areas, carry-over situations, dilutions, analyses past tune time, MS/MSD data, etc., for each sample in the batch. These forms are attached to the other sample documentation that accompanies the job through analysis. The third form of documentation is in non-conformance memos which can be for internal use or incorporated into the narrative. All forms of documentation may be used during initial review of the data. See Section 8.2 of this SOP for details on Corrective Action.

All data is initially reviewed on-screen. The review is both a QC review and a general review as described below.

- The MB contains no interferences or target compounds at the RL.
- ALL surrogates are in control in the blank. Surrogate limits are accessible in TALS;
- ALL surrogates in samples are in control;
- LCS recoveries meet the limits are accessible in TALS. See Section 8.2 concerning compounds and limits for LCS samples. In-house limits have been generated and are in use.
- Internal standard areas and retention times are checked and meet guidelines.. Additional guidelines can be found in Section 8.2.
- The sample does not require any further dilutions or analysis at a more concentrated level. Dilutions are made to keep the target in the upper half of the calibration range. The MS and MSD are never diluted to get spiked or non-spiked compounds within range, as this would reduce the matrix affect assessment.
- Visually confirm complete integration for any large and/or saturated target compounds.
- The sample does not require re-analysis for any other reason (i.e., leak, analysis past tune time, ISTD areas low, etc.).
- DRC Checker has been run and all issues addressed and acknowledged.

9.2.2 Identification of Targets

The following guidelines are used in the positive identification of target compounds.

1. "elution of component at the same relative retention time as the standard component."

The elution times should compare within +- 30 s. The standard must be run on the same 12 hour period as the sample. If co-eluting analytes interfere with the comparisons of retention times, other ions characteristic to that compound can be used to confirm relative retention times.

2. "correspondence of the sample component and standard component mass spectrum." Comparisons of sample spectra to standard spectra must be made using standard spectra obtained from the GC/MS system.

All ions present in the standard spectrum at a 10% relative intensity (most abundant ion being 100%) should be present in the sample.

The relative intensities of the above ions should agree within ±20%, between the standard and sample. If an ion is 50% intensity in the standard the corresponding ion must be between 30 and 70% in the sample.

Ions >10% in the sample but not present in the standard should be considered and accounted for.

3. Operator judgment. If a compound can not be verified by the above, but in the operators technical judgment the ID is correct, it is reported as such.

Once all positive identification is made, the file is modified to reflect these decisions. At this time TIC's may also be reviewed and name. In each case where the file has been edited or manual integrations have taken place the operator must identify, initial and date the changes on the hardcopy (if such is generated).

9.2.3 Manual Integration Policy

In each case where the file has been edited or manual integrations have been performed the operator must identify in Chrom the reason for the change. The following guidelines apply:

- Manual integrations should be consistent between all files integrated.
- Manual integrations should not be performed to meet QC criteria.
- Manual integrations are automatically flagged with an 'M' on the raw data.
- Excessive manual integrations may reflect an instrumental or methodological problem that should be addressed.
- Manual integrations shall follow the Eurofins Corporate SOP for Manual Integrations (NDSC-QA-SOP43862) – Attachment 8). Example integrations and documentation are provided within this attachment.

Manual integrations are most often performed for the following reasons:

- Assignment of correct peak that was mis-identified by the data system.
- Incomplete auto-integration due to high level of target compound detected.
- Incomplete auto-integration due to background interference.
- Incorrect auto-integration due to co-elution or near co-elution of compounds.
- Missed peaks.

9.2.4 Identification of TICs

In general, up to as many as 5 non-target compounds are tentatively identified by the data system and operator. Compounds with responses >10% of the nearest ISTD are identified. The data system provides the operator with a SUB ADC C sample spectrum, spectra of the first three matches and a listing of two other possibilities. Molecular formulas, molecular weights and CAS #'s are included. The following guidelines are used:

Relative intensities of major ions in the reference spectrum should be present in the sample (ions >10%).

- Relative ions should agree within ±20%;
- Molecular ions in the reference should be in the samples;
- Review the possibility of background and/or co-eluting compounds for those ions present in the sample but not in the standard;
- If ions are present in the sample but not in the standard, review the possibility of the presence of background or co-eluting compounds;
- If ions are present in the standard but not in the sample, review the possibility that the ions were subtracted out because they are also common to the background or co-eluting compounds;
- In the event no valid interpretation can be made, the compound is called "unknown".
- Interpretation can be often narrowed down to a class of compounds, molecular formula or weight.

9.3 Final Review

9.3.1 Once (a) the analysis is determined to be acceptable and (b) the initial review and data reduction has occurred and (c) the analyst has entered sample prep info into TALs (LIMS), the following steps occur. The sample prep information, client ID information and some data applicable to fields in the forms is retrieved from TALs.

9.3.2 All necessary forms are then generated using the TALs. The package is then assembled and ready for the first review. For level 2 data reports and similar deliverables other data may be generated for review purposes. In these cases, final packages with raw data and forms are not generated. Review of all reports and associated data is required regardless of data deliverable level.

9.3.3 Analytical data goes through a 200% review cycle. As results are generated, analysts review their work to ensure that the results generated meet QC requirements and relevant EPA methodologies. The analyst transfers the data into TALs in the Analyst Desktop module. Where non-compliance is observed, the analyst creates Non-Conformance Memos (NCMs) in TALs. Flags and data qualifiers can be method, project, program or QAPP specific. The analyst is documented as the initial reviewer in TALS and sets the batch status in TALs to 2nd level. The peer/supervisor review of the data is conducted by another individual who has been trained on the review process or by the department supervisor. This secondary review is documented on the data review checklist, making any necessary corrections to the data or additions to the NCMs as necessary. The batch is then set to lab complete. Any Spectra and all manual integrations are reviewed. For the organic instruments, manual integrations may also be electronically reviewed utilizing auditing software to help ensure compliance to the ethics and manual integration policies. The raw data, including the checklist, instrument print-outs, and manual entries, and electronic files are retained for easy retrieval in accordance with the laboratory's record and retention policy outlined in the SOP, *UP-QA-QAM, Section 16.*

Examples of items included in the above reviews are as follows:

- QC data are outside the specified control limits for accuracy and precision
- Unusual detection limit changes are observed
- Samples having unusually high results
- Samples exceeding a known regulatory limit
- Raw data indicating some type of contamination or poor technique
- Inconsistent peak integration (if applicable)
- Transcription errors
- Results outside of calibration range

Note: The complete analysis scheme can be summarized below (Section 7.1.1 & 7.1.2) and in Attachment 3. The entire sample tracking system can be summarized in Attachment 3.

10.0 POLLUTION CONTROL

It is Eurofins policy to evaluate each method and look for opportunities to minimize waste generated (i.e., examine recycling options, ordering chemicals based on quantity needed, preparation of reagents based on anticipated usage and reagent stability). Employees must abide by the policies in section 13 of the Corporate Safety Manual for "Waste Management and Pollution Prevention."

10.1 Waste Management

Waste management practices are conducted consistent with all applicable rules and regulations. Excess reagents, samples and method process wastes are disposed of in an accepted manner. Waste description rules and land disposal restrictions are followed. Waste disposal procedures are incorporated by reference to UP-WM-001.

The following waste streams are produced when this method is carried out.
- Methanol Waste from this procedure will enter the ‘Flammable Vials’ wastestream.
- Laboratory generated solid and aqueous waste water remaining from this method is to be disposed of in the carboys labeled Waste Water or Solid Waste.
- All expired standards are to be turned over to the waste technicians or the EHSC for disposal.

11.0 METHOD PERFORMANCE CRITERIA

Refer to Sections 1, 6, 7 and 8.

12.0 REFERENCES

Refer to Section 1.0

13.0 ATTACHMENTS

Table 1.	Characteristic Mass for Purgeable Organics Compounds
Table 2.	Guidance Response Factors (RFs) criteria from EPA contract laboratory program
Table 3.	Purgeable Calibration and Verification (ICV) Standards
Attachment 1.	Example: Initial Calibration Guides; Instrument Parameters
Attachment 2.	Example: Target and Internal Standards
Attachment 3.	Example: Analysis and Sample Tracking Flowcharts
Attachment 4.	List of Poor Purging or Poorly Performing Compounds

14.0 REVISION HISTORY

- Revision 06, was updated on 4/2/24
- External Audit Response
- Section 1.1.1 Updated corporate SOP
- Sections 4.1 and 4.2 updated with current equipment/hardware
- Section 4.4 Syringe shelf life specified
- Section 5.3 internal standards updated
- Section 5.4 there were 2 listed, corrected numbering
- Sections 6.1 and 6.2 PFTBA and BFB Tune procedures revised
- Sections 6.4 and 6.5 adapted for soil and water conditions
- Section 7.1.1 Add surrogate may be calibrated with single point
- Throughout removed reference to Table 1, removed attachment
- Section 7.3.1 Add instructions for non-manual prep
- Added Nitrogen initial calibration guides to attachment 1 Reformatted Table 2 and combined and moved tables from sections 5.4.2 and 5.4.8 to table 3
- Removed Form 6 from attachment 2, removed references and attachment 3 (Sample Run Log; Corrective Action/Qualification Report; GC/MS VOA Maintenance Logbook; Sample Tracking Sheet; GC/MS VOA-ICOC Form), 4 (Continuing Calibration Evaluation and Acceptance Criteria (CCVIS)); and 6 (Initial Calibration Verification and Acceptance Criteria (ICV)), Corporate SOP attachments removed

Table 1.
Characteristic Mass (m/z) for Purgeable Organic Compounds

Analyte	Primary Characteristic Ion	Secondary Characteristic Ion
Dichlorodifluoromethane	85	87
Chloromethane	50	52
Vinyl Chloride	62	64
Butadiene	39	54
Bromomethane	94	96
Chloroethane	64	66
Dichlorofluoromethane	67	69
Tichlorofluoromethane	101	103
Ethanol	45	46
Ethyl Ether	59	74, 45
Acrolein	56	55, 58
1,1-Dichloroethene	96	61, 98
Trichlorotrifluoromethane	101	103, 151
Acetone	43	58
Iodomethane	142	127, 141
Carbon Disulfide	76	78
Isopropyl alcohol	45	59
Acetonitrile	41	40, 39
3-Chloro-1-propene	76	41, 39
Methyl Acetate	43	74
Methylene Chloride	84	49, 51
TBA-d9 (IS)	65	46
2-Methyl-2-propanol (TBA)	59	57, 41
Acrylonitrile	53	52, 51
trans-1,2-Dichloroethene	96	61, 98
Methyl-tert-butyl ether	73	57, 45
Hexane	57	56, 86
1,1-Dichloroethane	63	65, 83
Vinyl Acetate	43	86
Isopropyl Ether	45	43, 87
2-Chloro-1,3-butadiene	53	88
Tert-butyl-ethyl-ether	59	87, 57
2,2-Dichloropropane	77	97
cis-1,2-Dichloroethene	96	61, 98
2-Butanone	43	57, 72
Ethyl acetate	43	45, 61
Propionitrile	54	55, 40
Methacrylonitrile	41	39, 67
Chlorobromomethane	128	49, 130
Tetrahydrofuran	42	71, 72
Chloroform	83	85
Dibromofluoromethane(SS)	113	111, 192

Analyte	Primary Characteristic Ion	Secondary Characteristic Ion
1,1,1-Trichloroethane	97	99, 61
Cyclohexane	56	69, 84
1,1-Dichloropropene	75	110, 77
Carbon Tetrachloride	117	119, 121
Isobutyl alcohol	43	41, 42
1,2-Dichloroethane-d4 (SS)	65	102
Benzene	78	77
1,2-Dichloroethane	62	64, 100
Isooctane	57	41, 56
Tert-amyl methyl ether	73	55, 87
n-Heptane	43	57, 71
Fluorobenzene (IS)	96	77
n-Butanol	56	43, 41
Trichloroethene	130	95, 97
Ethyl acrylate	55	56
Methylcyclohexane	83	98
1,2-Dichloropropane	63	65
2,3-Dichloro-1-propene	75	77, 110
1,4-Dioxane-d8 (IS)	96	64
Methyl methacrylate	41	69, 39
Dibromomethane	93	95, 174
1,4-Dioxane	88	58
Dichlorobromomethane	83	85
2-Nitropropane	43	41, 39
2-Chloroethyl vinyl ether	63	65, 106
cis-1,3-Dichloropropene	75	77, 49
4-Methyl-2-pentanone	43	58, 100
Toluene-d8 (SS)	98	100
Toluene	92	91
trans-1,3-Dichloropropene	75	77, 49
Ethyl methacrylate	69	41, 99
1,1,2-Trichloroethane	97	83, 85
Tetrachloroethene	166	164, 129
1,3-Dichloropropane	76	78
2-Hexanone	43	58, 57
n-Butyl acetate	43	56, 73
Chlorodibromomethane	129	127
Ethylene Dibromide	107	109, 188
Chlorobenzene-d5 (IS)	117	119
Chlorobenzene	112	114
1-Chlorohexane	91	55, 56
1,1,1,2-Tetrachloroethane	131	133, 119
Ethylbenzene	106	91
m & p-Xylene	91	106, 77

Analyte	Primary Characteristic Ion	Secondary Characteristic Ion
o-Xylene	91	106
Styrene	104	78
Bromoform	173	171, 175
Isopropylbenzene	105	120
Cyclohexanone	55	69, 42
4-Bromofluorobenzene (SS)	95	174, 176
Bromobenzene	156	77, 158
1,1,2,2-Tetrachloroethane	83	85, 131
1,2,3-Trichloropropane	75	110, 77
trans-1,4-Dichloro-2-butadiene	53	88, 124
n-Propylbenzene	91	120
2-Chlorotoluene	91	126
1,3,5-Trimethylbenzene	105	120
4-Chlorotoluene	91	126
tert-Butylbenzene	119	91, 134
2-Ethyltoluene	105	120
Pentachloroethane	167	117, 165
1,2,4-Trimethylbenzene	105	134
sec-Butylbenzene	105	134
1,3-Dichlorobenzene	146	111, 148
4-Isopropyltoluene	119	134, 91
1,4-Dichlorobenzene-d4 (IS)	152	150, 115
1,4-Dichlorobenzene	146	111, 148
1,2,3-Trimethylbenzene	105	120, 77
Benyl Chloride	126	91, 65
1,2-Dichlorobenzene	146	111, 148
n-Butylbenzene	91	92, 134
1,2-Dichlorobenzene	146	111, 148
1,2-Dibromo-3-chloropropane	75	155, 157
1,3,5-Trichlorobenzene	180	182, 145
1,2,4-Trichlorobenzene	180	182, 145
Hexachlorobutadiene	225	223, 227
Naphthalene	128	129
1,2,3-Trichlorobenzene	180	182, 145
2-Methylnaphthalene	142	141, 143
1-Methylnaphthalene	142	141, 115

***NOTE:** The primary and secondary ions listed here are taken directly from SW-846 Method 8260. The laboratory uses secondary ions in the cases of Ethanonl, Ethylbenzene, Toluene, 1,1,2-Trichloroethane, Trichloroethene, 1,2,3-Trichloropropane and Xylenes due to interferences.

Table 2.

Guidance Response Factors (RFs) Criteria From EPA Contract Laboratory Program

Analyte	RF	Analyte	RF
Dichlorodifluoromethane	0.01	1,2-Dichloropropane	0.2
Chloromethane	0.01	Dichlorobromomethane	0.3
Vinyl Chloride	0.01	cis-1,3-Dichloropropene	0.3
Bromomethane	0.01	4-Methyl-2-pentanone	0.03
Chloroethane	0.01	Toluene	0.3
Tichlorofluoromethane	0.01	trans-1,3-Dichloropropene	0.3
1,1-Dichloroethene	0.06	1,1,2-Trichloroethane	0.2
Trichlorotrifluoromethane	0.05	Tetrachloroethene	0.1
Acetone	0.01	2-Hexanone	0.01
Carbon Disulfide	0.1	Chlorodibromomethane	0.2
Methyl Acetate	0.01	Ethylene Dibromide	0.2
Methylene Chloride	0.01	Chlorobenzene	0.4
trans-1,2-Dichloroethene	0.1	Ethylbenzene	0.4
Methyl-tert-butyl ether	0.1	m & p-Xylene	0.2
1,1-Dichloroethane	0.3	o-Xylene	0.2
cis-1,2-Dichloroethene	0.2	Styrene	0.2
2-Butanone	0.01	Bromoform	0.1
Chlorobromomethane	0.1	Isopropylbenzene	0.4
Chloroform	0.3	1,1,2,2-Tetrachloroethane	0.2
1,1,1-Trichloroethane	0.05	1,3-Dichlorobenzene	0.5
Cyclohexane	0.01	1,4-Dichlorobenzene	0.6
Carbon Tetrachloride	0.1	1,2-Dichlorobenzene	0.6
Benzene	0.2	1,2-Dibromo-3-chloropropane	0.01
1,2-Dichloroethane	0.07	1,2,4-Trichlorobenzene	0.4
Trichloroethene	0.2	1,2,3-Trichlorobenzene	0.4
Methylcyclohexane	0.05		

Table 3.
Purgeable Calibration and Verification (ICV) Standards

8260 List 1/Std #1 Mega Mix.sec
2,500 ug/mL in MeOH
1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2-Trichlorotrifluoroethane

1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1-Dichloroethane
1,1-Dichloroethylene
1,1-Dichloropropylene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane

1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene

1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,4-Dichlorobenzene

2,2-Dichloropropane
2-Chlorotoluene
4-Chlorotoluene
4-Isopropyltoluene
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Carbon tetrachloride
Chlorobenzene
Chloroform
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropylene
Dibromomethane
Dibromochloromethane
Dichloromethane
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene

m-Xylene & p-Xylene
n-Butylbenzene
Diethyl ether (Ethyl Ether)
Tert-Butanol (TBA) (25,000)
Iodomethane
Allyl Chloride (3-Chloroprene)
Tetrahydrofuran (5,000)
n-Heptane
n-Propylbenzene
Methyl-tert-butyl ether
Naphthalene

o-Xylene
sec-Butylbenzene
Styrene
tert-Butylbenzene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene

trans-1,3-Dichloropropylene
Trichloroethylene

Methyl Acetate (5000)
Acrylonitrile (25,000)
n-Hexane
Isobutanol (62,500)
Carbon Disulfide
Methylcyclohexane
1,4-Dioxane (50,000)
Ethyl methacrylate
Trans-14-dichlor-2-butene
Cyclohexane

8260 List1/Std#3 Gases.sec
2,500 ug/mL in MeOH
1,3-Butadiene
Dichlorofluoromethane (CFC-21)
Chloroethane (ethyl chloride)
Methyl Bromide (Bromomethane)
Methyl chloride (Chloromethane)
Trichlorofluoromethane (CFC-11)
Dichlorodifluoromethane
Vinyl chloride

8260 List1/Std#2 Ketones.sec
12,500 ug/mL in MeOH
Acetone
2-Hexanone
Methyl ethyl ketone (2-Butanone)
4- Methyl-2-pentanone (MIBK)

8260 List1/Std#6 Vinyl Acetate.sec
5,000 ug/mL in MeOH
Vinyl Acetate

8260 list1/Std#4 2-CEVE.sec
2,500 ug/mL in MeOH
2-Chloroethyl vinyl ether

8260 Ethanol Std.sec
100,000 ug/mL in MeOH
Ethanol

8260List 1/Std#5 Acrolein.sec
20,000 ug/mL in H2O
Acrolein

8260 List3/Std#1 Polar Additions.sec
2,500 ug/mL in MeOH

Acetonitrile (25,000)
Diisopropyl ether (DIPE)
Ethyl-tert-butyl ether (ETBE)
Proprionitrile (25,000)
Tert-Amyl methyl ether (TAME)
Tert-Amyl alcohol (25,000)

8260 List2/Std#2 Pentachloroethane.sec
2,500 ug/mL in MeOH
Pentachloroethane

8260 List2/Std#3 Cyclohexanone
25,000 ug/mL in H2O
Cyclohexanone

8260 List2/Std#5 Methylnaphthalenes.sec
2,500 ug/mL in MeOH
1-Methylnaphthalene
2-Methylnaphthalene

8260 List2/Std#6.sec
2,500 ug/mL in MeOH
2-Propanol (isopropanol) (25,000)
Chloroprene(2-chloro-1,3butadiene)
Methacrylonitrile (25,000)
1-Butanol (62,500)
2-Nitropropane (5,000)
1,2,3-Trimethylbenzene
Benyl Chloride
1,3,5-Trichlorobenzene
2,2,4-Trimethylpentane (isooctane)
1-Chlorohexane

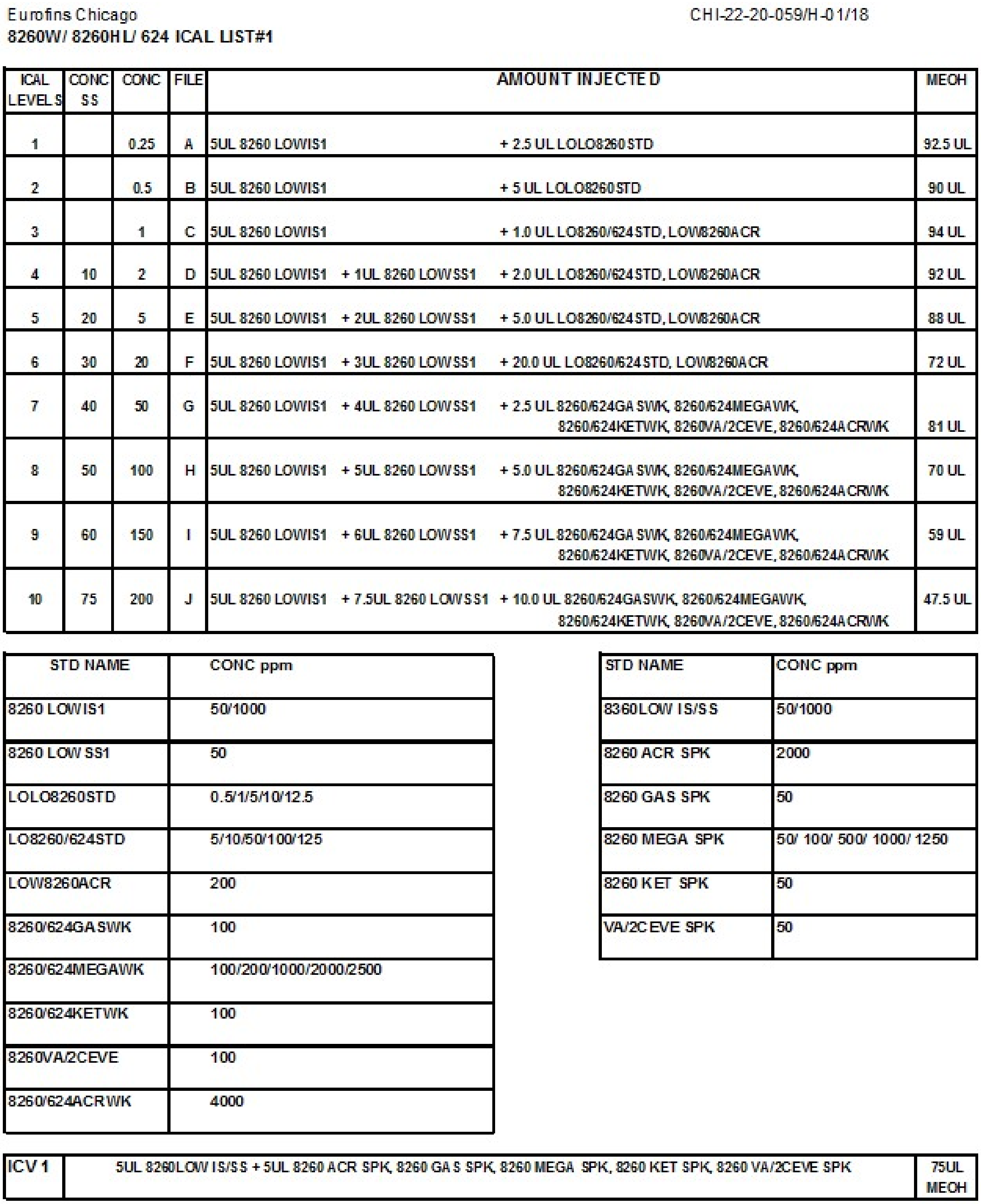
8260 List2/Std#7.sec
2,500 ug/mL in MeOH
Ethyl Acetate (5,000)
Ethyl acrylate
Methyl methacrylate (5,000)
Butyl Acetate

2,3-Dichloro-1-propene.sec
1,000 ug/mL in MeOH
2,3-Dichloro-1-propene

2,Ethyltoluene.sec
1,000 ug/mL in MeOH
2-Ethyltoluene

Attachment 1.

Example: Initial Calibration Guides, Instrument Parameters



Eurofins Chicago
8260W/ 8260HL/ 624 ICAL LIST#1

CHI-22-20-059/H-01/18

ICAL LEVELS	CONC SS	CONC	FILE	AMOUNT INJECTED	MEOH
1		0.25	A	5UL 8260 LOWIS1 + 2.5 UL LOLO8260STD	92.5 UL
2		0.5	B	5UL 8260 LOWIS1 + 5 UL LOLO8260STD	90 UL
3		1	C	5UL 8260 LOWIS1 + 1.0 UL LO8260/624STD, LOW8260ACR	94 UL
4	10	2	D	5UL 8260 LOWIS1 + 1UL 8260 LOW SS1 + 2.0 UL LO8260/624STD, LOW8260ACR	92 UL
5	20	5	E	5UL 8260 LOWIS1 + 2UL 8260 LOW SS1 + 5.0 UL LO8260/624STD, LOW8260ACR	88 UL
6	30	20	F	5UL 8260 LOWIS1 + 3UL 8260 LOW SS1 + 20.0 UL LO8260/624STD, LOW8260ACR	72 UL
7	40	50	G	5UL 8260 LOWIS1 + 4UL 8260 LOW SS1 + 2.5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	81 UL
8	50	100	H	5UL 8260 LOWIS1 + 5UL 8260 LOW SS1 + 5.0 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	70 UL
9	60	150	I	5UL 8260 LOWIS1 + 6UL 8260 LOW SS1 + 7.5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	59 UL
10	75	200	J	5UL 8260 LOWIS1 + 7.5UL 8260 LOW SS1 + 10.0 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	47.5 UL

STD NAME	CONC ppm
8260 LOWIS1	50/1000
8260 LOW SS1	50
LOLO8260STD	0.5/1/5/10/12.5
LO8260/624STD	5/10/50/100/125
LOW8260ACR	200
8260/624GASWK	100
8260/624MEGAWK	100/200/1000/2000/2500
8260/624KETWK	100
8260VA/2CEVE	100
8260/624ACRWK	4000

STD NAME	CONC ppm
8360LOW IS/SS	50/1000
8260 ACR SPK	2000
8260 GAS SPK	50
8260 MEGA SPK	50/ 100/ 500/ 1000/ 1250
8260 KET SPK	50
VA/2CEVE SPK	50

ICV 1	5UL 8260LOW IS/SS + 5UL 8260 ACR SPK, 8260 GAS SPK, 8260 MEGA SPK, 8260 KET SPK, 8260 VA/2CEVE SPK	75UL MEOH

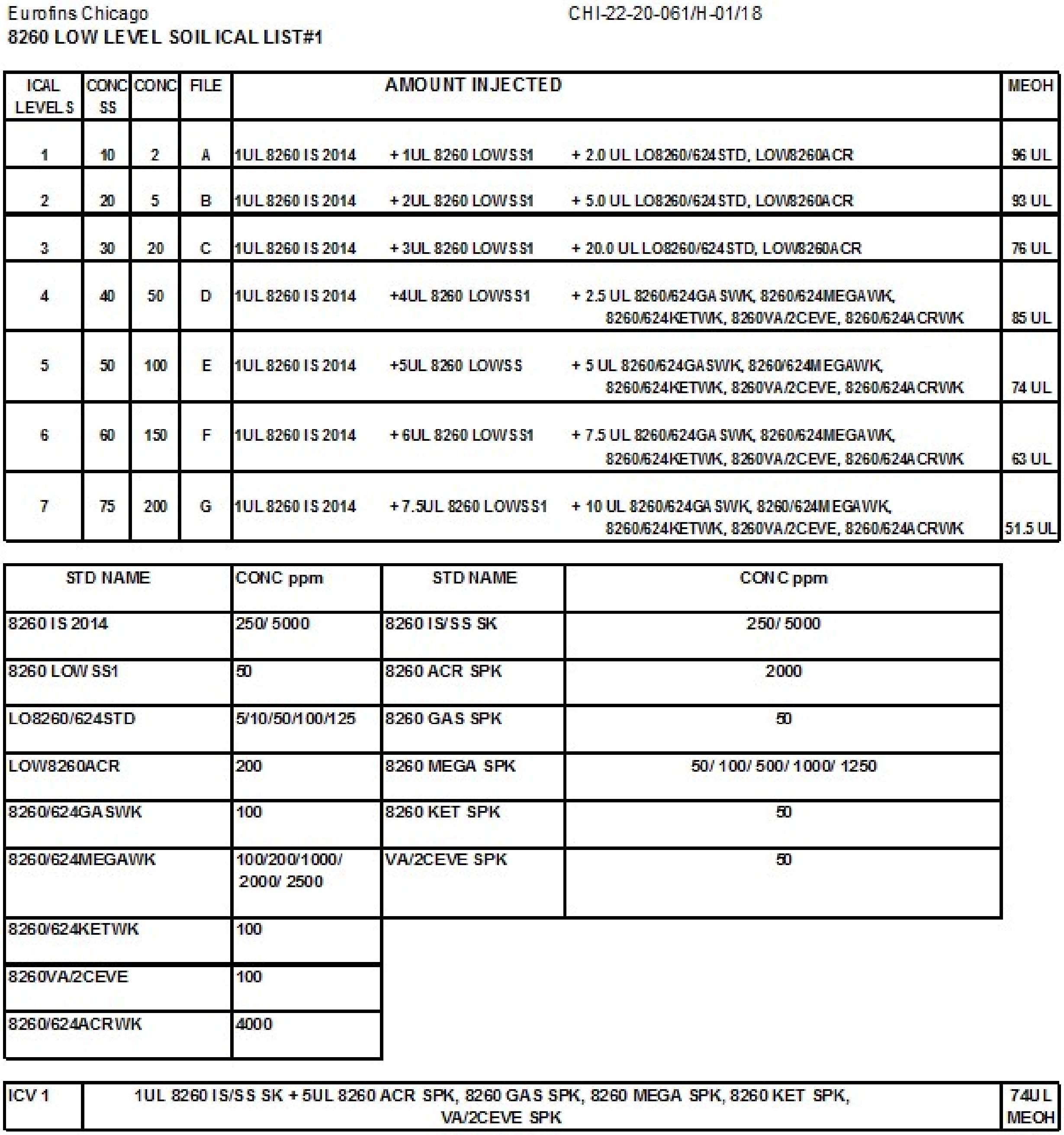
Eurofins Chicago
8260W/ 8260HL/ 624 ICAL LIST#2

CHI-22-20-060/H-01/18

ICAL LEVELS	CONC	FILE	AMOUNT INJECTED	MEOH
3	1	C	5UL LOWIS1 + 1UL LO8260APIX, LOWCYCHXWK	94UL
4	2	D	5UL LOWIS1 + 2UL LO8260APIX, LOWCYCHXWK	93UL
5	5	E	5UL LOWIS1 + 5UL LOAPIX, LOWCYCHXWK	90UL
6	20	F	5UL LOWIS1 + 20UL LO8260APIX, LOWCYCHXWK	75
7	50	G	5UL LOWIS1 + 2.5UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	82.5UL
8	100	H	5UL LOWIS1 + 5UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	70UL
9	150	I	5UL LOWIS1 +7.5UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	57.5UL
10	200	J	5UL LOWIS1 + 10UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	45UL

STD NAME	CONC PPM	STD NAME	CONC PPM
8260 LOWIS1	50/1000	8260LOW IS/SS	50/100
LO8260APIX	5/10/50/125/200	CYCLOHEX SPK	5000
	5	2ETTOL SPK	50
		2,3DCLP SPK	50
LOWCYCHXWK	500	POLARADDSSPK	50/ 500/ 2000
		8260 ADDS SPK	50/100/ 500/ 1250
		STD2 SPK	50
8260ADDS 2016	100/ 200/1000/ 2500		
8260/624STD2	100		
8260POLR ADDS	100/ 1000/ 4000		
8260CYCHXWK	10000		
8260 23DCL WK	100		
2ETTOL WK STD	100		

ICV 2	5UL 8260LOW IS/SS + 5UL CYCLOHEX SPK, 2ETTOL SPK, 2,3DCLP SPK, POLRADDSSPK, 8260 ADDS SPK, STD 2 SPK	65UL MEOH



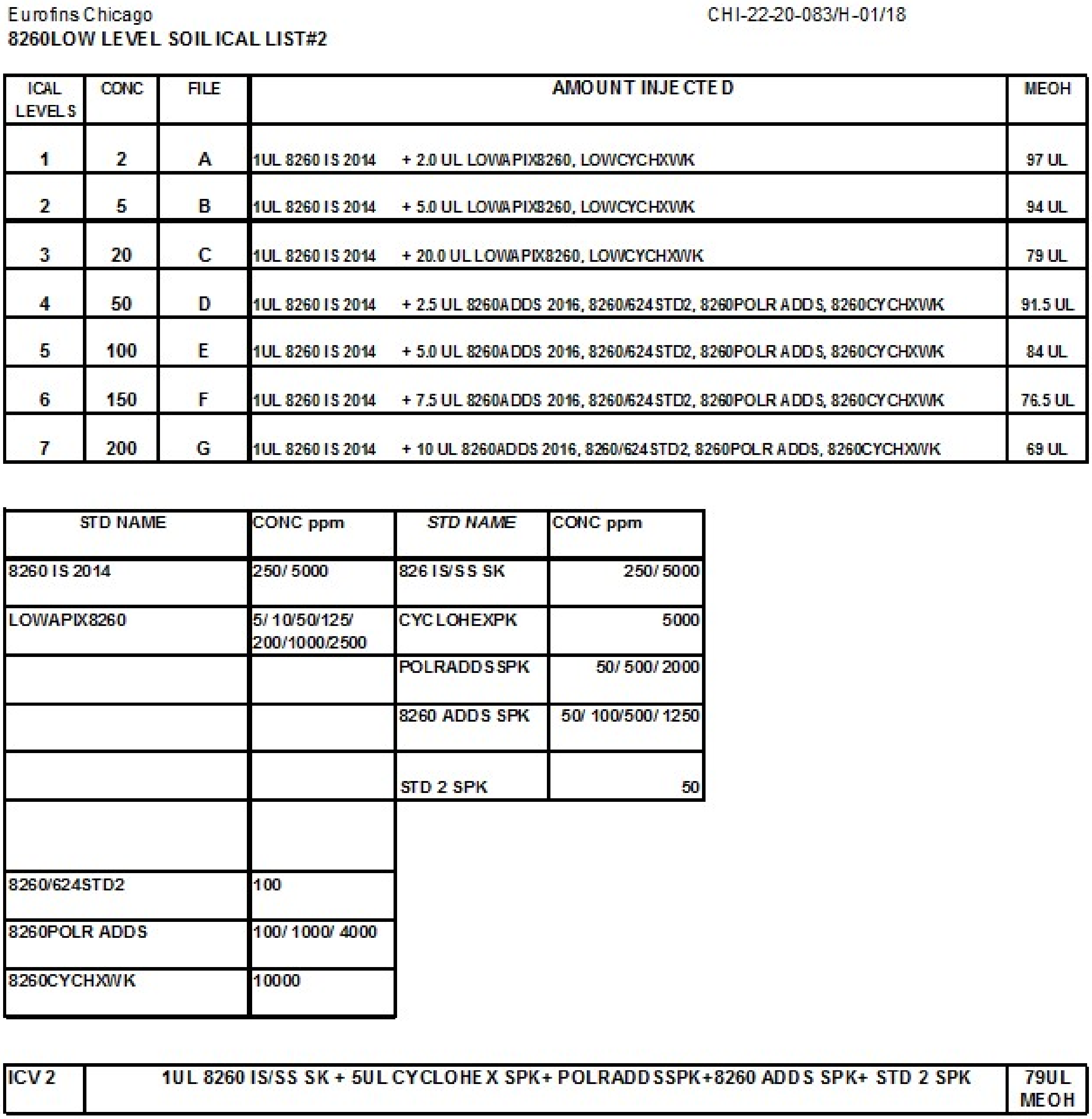
Eurofins Chicago CHI-22-20-061/H-01/18

8260 LOW LEVEL SOIL ICAL LIST#1

ICAL LEVELS	CONC SS	CONC	FILE	AMOUNT INJECTED			MEOH
1	10	2	A	1UL 8260 IS 2014	+ 1UL 8260 LOWSS1	+ 2.0 UL LO8260/624STD, LOW8260ACR	96 UL
2	20	5	B	1UL 8260 IS 2014	+ 2UL 8260 LOWSS1	+ 5.0 UL LO8260/624STD, LOW8260ACR	93 UL
3	30	20	C	1UL 8260 IS 2014	+ 3UL 8260 LOWSS1	+ 20.0 UL LO8260/624STD, LOW8260ACR	76 UL
4	40	50	D	1UL 8260 IS 2014	+4UL 8260 LOWSS1	+ 2.5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	85 UL
5	50	100	E	1UL 8260 IS 2014	+5UL 8260 LOWSS	+ 5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	74 UL
6	60	150	F	1UL 8260 IS 2014	+ 6UL 8260 LOWSS1	+ 7.5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	63 UL
7	75	200	G	1UL 8260 IS 2014	+ 7.5UL 8260 LOWSS1	+ 10 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	51.5 UL

STD NAME	CONC ppm	STD NAME	CONC ppm
8260 IS 2014	250/ 5000	8260 IS/SS SK	250/ 5000
8260 LOW SS1	50	8260 ACR SPK	2000
LO8260/624STD	5/10/50/100/125	8260 GAS SPK	50
LOW8260ACR	200	8260 MEGA SPK	50/ 100/ 500/ 1000/ 1250
8260/624GASWK	100	8260 KET SPK	50
8260/624MEGAWK	100/200/1000/ 2000/ 2500	VA/2CEVE SPK	50
8260/624KETWK	100		
8260VA/2CEVE	100		
8260/624ACRWK	4000		

ICV 1	1UL 8260 IS/SS SK + 5UL 8260 ACR SPK, 8260 GAS SPK, 8260 MEGA SPK, 8260 KET SPK, VA/2CEVE SPK	74UL MEOH



Eurofins Chicago CHI-22-20-083/H-01/18

8260LOW LEVEL SOIL ICAL LIST#2

ICAL LEVELS	CONC	FILE	AMOUNT INJECTED	MEOH
1	2	A	1UL 8260 IS 2014 + 2.0 UL LOWAPIX8260, LOWCYCHXWK	97 UL
2	5	B	1UL 8260 IS 2014 + 5.0 UL LOWAPIX8260, LOWCYCHXWK	94 UL
3	20	C	1UL 8260 IS 2014 + 20.0 UL LOWAPIX8260, LOWCYCHXWK	79 UL
4	50	D	1UL 8260 IS 2014 + 2.5 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	91.5 UL
5	100	E	1UL 8260 IS 2014 + 5.0 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	84 UL
6	150	F	1UL 8260 IS 2014 + 7.5 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	76.5 UL
7	200	G	1UL 8260 IS 2014 + 10 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	69 UL

STD NAME	CONC ppm	*STD NAME*	CONC ppm
8260 IS 2014	250/ 5000	826 IS/SS SK	250/ 5000
LOWAPIX8260	5/ 10/50/125/ 200/1000/2500	CYCLOHEXPK	5000
		POLRADDSSPK	50/ 500/ 2000
		8260 ADDS SPK	50/ 100/500/ 1250
		STD 2 SPK	50
8260/624STD2	100		
8260POLR ADDS	100/ 1000/ 4000		
8260CYCHXWK	10000		

ICV 2	1UL 8260 IS/SS SK + 5UL CYCLOHEX SPK+ POLRADDSSPK+8260 ADDS SPK+ STD 2 SPK	79UL MEOH

Eurofins Chicago CHI-22-20-059/H-01/18

8260W/ 8260HL/ 624 ICAL LIST#1 NITROGEN

ICAL LEVELS	CONC SS	CONC	FILE	AMOUNT INJECTED	MEOH
1		0.25	A	5UL 8260 LOWIS1 + 2.5 UL LOLO8260STD	92.5 UL
2	10	0.5	B	5UL 8260 LOWIS1 + 1UL 8260 LOWSS1 + 5 UL LOLO8260STD	89 UL
3	20	1	C	5UL 8260 LOWIS1 + 2UL 8260 LOWSS1 + 1.0 UL LO8260/624STD, LOW8260ACR	92 UL
5	30	5	D	5UL 8260 LOWIS1 + 3UL 8260 LOWSS1 + 5.0 UL LO8260/624STD, LOW8260ACR	87 UL
6	40	20	E	5UL 8260 LOWIS1 + 4UL 8260 LOWSS1 + 20.0 UL LO8260/624STD, LOW8260ACR	82 UL
7	50	40	F	5UL 8260 LOWIS1 + 5UL 8260 LOWSS1 + 2.0 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	82 UL
8	60	70	G	5UL 8260 LOWIS1 + 6UL 8260 LOWSS1 + 3.5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	75 UL
9	75	100	H	5UL 8260 LOWIS1 + 7.5UL 8260 LOWSS1 + 5.0 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	67.5 UL

STD NAME	CONC ppm
8260 LOWIS1	50/1000
8260 LOW SS1	50
LOLO8260STD	0.5/1/5/10/12.5
LO8260/624STD	5/10/50/100/125
LOW8260ACR	200
8260/624GASWK	100
8260/624MEGAWK	100/200/1000/2000/2500
8260/624KETWK	100
8260VA/2CEVE	100
8260/624ACRWK	4000

STD NAME	CONC ppm
8360LOW IS/SS	50/1000
8260 ACR SPK	2000
8260 GAS SPK	50
8260 MEGA SPK	50/ 100/ 500/ 1000/ 1250
8260 KET SPK	50
VA/2CEVE SPK	50

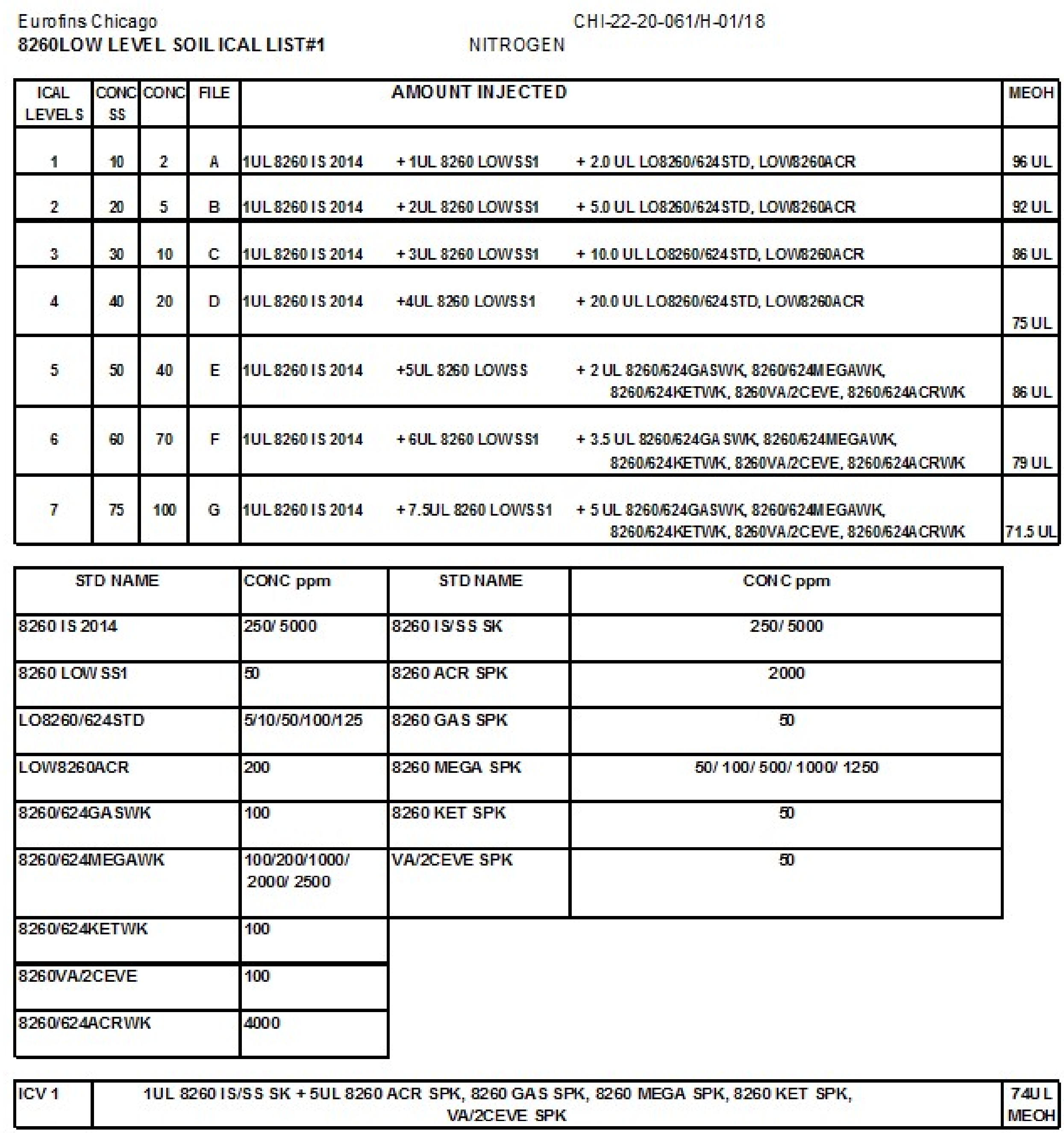
ICV 1	5UL 8260LOW IS/SS + 5UL 8260 ACR SPK, 8260 GAS SPK, 8260 MEGA SPK, 8260 KET SPK, 8260 VA/2CEVE SPK	75UL MEOH

Eurofins Chicago CHI-22-20-060/H-01/18
8260W/ 8260HL/ 624 ICAL LIST#2 NITROGEN

ICAL LEVELS	CONC	FILE	AMOUNT INJECTED	MEOH
3	1	C	5UL LOWIS1 + 1UL LO8260APIX, LOWCYCHXWK	94UL
4	5	D	5UL LOWIS1 + 5UL LO8260APIX, LOWCYCHXWK	90UL
5	20	E	5UL LOWIS1 + 20UL LOAPIX, LOWCYCHXWK	75UL
6	40	F	5UL LOWIS1 + 2.0UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	85UL
7	70	G	5UL LOWIS1 + 3.5UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	77.5UL
8	100	H	5UL LOWIS1 + 5UL 8260 POLR ADDS,8260ADDS 2016, 8260/624STD2 2ETTOL WK STD,8260 23DCP WK, 8260CYCHXWK	70UL

STD NAME	CONC PPM	STD NAME	CONC PPM
8260 LOWIS1	50/1000	8260LOW IS/SS	50/100
LO8260APIX	5/10/50/125/200	CYCLOHEX SPK	5000
	5	2ETTOL SPK	50
		2,3DCLP SPK	50
LOWCYCHXWK	500	POLARADDSSPK	50/ 500/ 2000
		8260 ADDS SPK	50/100/ 500/ 1250
		STD2 SPK	50
8260ADDS 2016	100/ 200/1000/ 2500		
8260/624STD2	100		
8260POLR ADDS	100/ 1000/ 4000		
8260CYCHXWK	10000		
8260 23DCL WK	100		
2ETTOL WK STD	100		

ICV 2	5UL 8260LOW IS/SS + 5UL CYCLOHEX SPK, 2ETTOL SPK, 2,3DCLP SPK, POLRADDSSPK, 8260 ADDS SPK, STD2 SPK	65UL MEOH



Eurofins Chicago   CHI-22-20-061/H-01/18

8260LOW LEVEL SOIL ICAL LIST#1   NITROGEN

ICAL LEVELS	CONC SS	CONC	FILE	AMOUNT INJECTED	MEOH
1	10	2	A	1UL 8260 IS 2014 + 1UL 8260 LOWSS1 + 2.0 UL LO8260/624STD, LOW8260ACR	96 UL
2	20	5	B	1UL 8260 IS 2014 + 2UL 8260 LOWSS1 + 5.0 UL LO8260/624STD, LOW8260ACR	92 UL
3	30	10	C	1UL 8260 IS 2014 + 3UL 8260 LOWSS1 + 10.0 UL LO8260/624STD, LOW8260ACR	86 UL
4	40	20	D	1UL 8260 IS 2014 +4UL 8260 LOWSS1 + 20.0 UL LO8260/624STD, LOW8260ACR	75 UL
5	50	40	E	1UL 8260 IS 2014 +5UL 8260 LOWSS + 2 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	86 UL
6	60	70	F	1UL 8260 IS 2014 + 6UL 8260 LOWSS1 + 3.5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	79 UL
7	75	100	G	1UL 8260 IS 2014 + 7.5UL 8260 LOWSS1 + 5 UL 8260/624GASWK, 8260/624MEGAWK, 8260/624KETWK, 8260VA/2CEVE, 8260/624ACRWK	71.5 UL

STD NAME	CONC ppm	STD NAME	CONC ppm
8260 IS 2014	250/ 5000	8260 IS/SS SK	250/ 5000
8260 LOW SS1	50	8260 ACR SPK	2000
LO8260/624STD	5/10/50/100/125	8260 GAS SPK	50
LOW8260ACR	200	8260 MEGA SPK	50/ 100/ 500/ 1000/ 1250
8260/624GASWK	100	8260 KET SPK	50
8260/624MEGAWK	100/200/1000/ 2000/ 2500	VA/2CEVE SPK	50
8260/624KETWK	100		
8260VA/2CEVE	100		
8260/624ACRWK	4000		

ICV 1	1UL 8260 IS/SS SK + 5UL 8260 ACR SPK, 8260 GAS SPK, 8260 MEGA SPK, 8260 KET SPK, VA/2CEVE SPK	74UL MEOH

Eurofins Chicago CHI-22-20-083/H-01/18
8260LOW LEVEL SOIL ICAL LIST#2 nitrogen

ICAL LEVELS	CONC	FILE	AMOUNT INJECTED	MEOH
1	2	A	1UL 8260 IS 2014 + 2.0 UL LOW8260APIX, LOWCYCHXWK	97 UL
2	5	B	1UL 8260 IS 2014 + 5.0 UL LOW8260APIX, LOWCYCHXWK	94 UL
3	10	C	1UL 8260 IS 2014 + 10.0 UL LOW8260APIX, LOWCYCHXWK	89 UL
4	20	D	1UL 8260 IS 2014 + 20.0 UL LOW8260APIX, LOWCYCHXWK	79 UL
5	40	E	1UL 8260 IS 2014 + 2.0 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	93 UL
6	70	F	1UL 8260 IS 2014 + 3.5 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	88.5 UL
7	100	G	1UL 8260 IS 2014 + 5 UL 8260ADDS 2016, 8260/624STD2, 8260POLR ADDS, 8260CYCHXWK	84 UL

STD NAME	CONC ppm	*STD NAME*	CONC ppm
8260 IS 2014	250/ 5000	8260 IS/SS SK	250/ 5000
LOW8260APIX	5/ 10/50/125/ 1000/2500/4000	CYCLOHEXPK	5000
		POLRADDSSPK	50/ 500/ 2000
		8260 ADDS SPK	50/ 100/500/ 1250
LOWCYCHXWK	500	STD 2 SPK	50
8260ADDS 2016	100/ 200/1000/ 2500		
8260/624STD2	100		
8260POLR ADDS	100/ 1000/ 4000		
8260CYCHXWK	10000		

ICV 2	1UL 8260 IS/SS SK + 5UL CYCLOHEX SPK+ POLRADDSSPK+8260 ADDS SPK+ STD 2 SPK	79UL MEOH

Example: Instrument Parameters for 5973 / 5975 / 5977

GC Oven Parameters

Initial Temperature = 35°C
Initial Time = 1.0 minutes
Aux Temperature = 250°C

Ramp Rate

Ramp 1 – 10°C/min. to 120°C
Ramp 2 – 24°C/min. to 220°C Hold 2 minutes

Run Time = 13.33 min.

Inlet Pressure Program

Mode=split
Gas = Helium
Column length = 25 m
Column Diameter = 0.25 mm
Constant flow = 1.0 mL/min
Injection port temp. = 250°C
Split ratio = 80:1
Gas saver = off

Scan Parameters

Mass Range = 35-260
Threshold = 100
Scans/sec = 6
EM Voltage = 1938
Solvent Delay = 0.8 min. (scan start time): before the elution of the first compound.
Run Time (scan stop time): until after the elution of last compound.

Concentrator Conditions

Trap Temp. Prior to Purge	< 35
Desorb Preheat	250
Desorb	190
Bake	21
Purge Time	11 min
Desorb	0.5 - 2 min (inst. dependent)
Bake Time	7 min

Approximate Vacuums

~5 x 10^{-6} torr

Example Autosampler Conditions

Transfer Line Temp	110°C
Soil Valve	95°C
Purge Pressure	25 psi
Purge Flow	~ 40 ml/min
Purge Time	11 min
Desorb	0.5 -2 min
SamplePre-heat(soils)	40°C ~ 2 min

Attachment 2.

Example: Target and Internal Standards

Fluorobenzene	**TBA-d9**	**1,4-Dioxane-d8**	**Chlorobenzene-d5**	**1,4-Dichlorobenzene-d4**
Acetone Acetonitrile Acrolein Acrylonitrile Benzne Bromochloromethane Bromomethane Butadiene 2-Butanone Carbon disulfide Carbon Tetrachloride 2-Chloro-1,3-butadiene Chloroethane Chloroform Chloromethane 3-Chloro-1-propene Cyclohexane Dibromofluoromethane (surr) Dibromomethane Dichlorobromomethane Dichlorodifluoromethane 1,1-Dichloroethane 1,2-Dichloroethane 1,2-Dichloroethane-d4 (surr) 1,1-Dichloroethene 1,2-Dichloroethane (total) cis-1,2-Dichloroethene trans-1,2-Dichloroethene Dichlorofluoromethane 1,1-Dichloropropene 1,2-Dichloropropane 2,2-Dichloropropane Ethyl Acetate Ethyl Acrylate Ethyl Ether Hexane Iodomethane Isopropyl ether Methacrylonitrile Methyl Acetate Methylcyclohexane Methylene chloride Methyl methacrylate Methyl-tert-butyl ether n-Heptane Propionitrile Tert-amyl methyl ether Tert-butyl ethyl ether Tetrahydrofuran 1,1,1-Trichloroethane Trichloroethene Trichlorofluoromethane 1,1,2-Trichloro-1,2,2-trifluoroethane Vinyl acetate Vinyl Chloride Isooctane 2,3-Dichloro-1-propane	Ethanol Isobutyl alcohol Isopropyl alcohol 2-Methyl-2-propanol (TBA) n-Butanol	1,4-Dioxane	Bromoform 2-Chloroethyl vinyl ether Chlorodibromomethane Chlorobenzene 1-Chlorohexane cis-1,3-Dichloropropene 1,3-Dichloropropane Ethylbenzene Ethylene dibromide Ethyl methacrylate 2-Hexanone 4-Methyl-2-pentanone n-Butyl acetate 2-Nitropropane Styrene 1,1,1,2-Tetrachloroethane Tetrachloroethene Toluene Toluene-d8 (surrogate) trans-1,3-Dichloropropene 1,1,2-Trichloroethane m,p-Xylene o-Xylene Xylene (total)	Benzyl chloride Bromobenzene Bromofluorobenzene (surrogate) n-Butylbenzene sec-Butylbenzene tert-Butylbenzene 2-Chlorotoluene 4-Chlorotoluene Cyclohexanone 1,2-Dibromo-3-chloropropane 1,2-Dichlorobenzene 1,3-Dichlorobenzene 1,4-Dichlorobenzene Hexachlorobutadiene Isopropyl benzene p-Isopropyltoluene 2-Methylnaphthalene Naphthalene Pentachloroethane n-Propylbenzene trans-1,4-Dichloro-2-butene 1,1,2,2-Tetrachloroethane 1,2,3-Trichlorobenzene 1,2,4-Trichlorobenzene 1,3,5-Trichlorobenzene 1,2,3-Trichloropropane Trimethylbenzene (total) 1,2,3-Trimethylbenzene 1,2,4-Trimethylbenzene 1,3,5-Trimethylbenzene 2-Ethyltoluene 1-Methylnaphthalene

Attachment 3.

Example: Analysis and SampleTracking Flowcharts

Analysis Scheme Flowchart

(Terms defined in the Section 9)

```
           PFTBA
            |
            |
            |
           BFB  (Form 5)
           /  \  Every 12 hours
          /     \
         /        \
Initial Calibration--------Continuing Calibration
  (Form 6)                    (Form 7)
                      Every 12 hours
                           |
                           |
                          \|/
                        Analysis
                           |
                           |
                          \|/
             Computer Data Production/Reduction
                           |
                           |
                          \|/
              Operator Data Review/Reduction
                    (Form 1,2,3,4,5)
                           |
                           |
                          \|/
               Final Review/Data Submission
                           |
                           |
                          \|/
                  Report Generation
```

Sample Tracking Flowchart

```
                         Sample Receipt
                          |  \
                          |    \
                         Log-In     VOA Refrigerator
                           |            |
                          COC           |
                           |            |
                       Computer         |
                           |            |
                           |            |
                           |            |
                         Backlog        |
                           |            |
                           |          /
                           |        /
                           |      /
                           |    /
                          VOAs
                           |
                           |
                             INPUT
                           |
            Sample Tracking Board, Sample Tracking Sheets
                           |
                            Analysis
                                 |
    OUTPUT: COC, Analysis Logbook, Sample
                  Data, Tune, Calibration, QC, Narrative/NCM
                    __________|__________
· Operator Review/Data Reduction           · Archival (Automated scheduled back-ups)
· Data Package w/ Review Form, CN     · Data purged off system
· 1st 100% Review
· Submission/Final Review
           |
          REPORT GENERATION
                  · Data Package, Misc Files scanned
```

Attachment 4.

List of Poor Purging or Poorly Performing Compounds

Acetone	Ethyl Acetate
Acetonitrile	2-Hexanone
Acrolein	Isobutyl Alcohol
Acrylonitrile	Methacrylonitrile
Bromomethane	Methyl Acetate
n-Butanol	4-Methyl-2-pentanone
2-Butanone (MEK)	2-Nitropropane
Carbon Disulfide	Propionitrile
Chloroethane	Tetrahydrafuran
2-Chloroethylvinyl ether	Trans-1,4-dichloro-2-butene
Chloromethane	1,1,2-Trichloro-1,2,2-trifluoromethane
Dichlorodifluoromethane	Trichlorofluoromethane
1,2-Dibromo-3-chloropropane	Vinyl Acetate
Ethyl Acetate	Isopropyl alcohol
Ethanol	2-Methyl-2-propanol
1,4-Dioxane	