Work Plan

Additional Monitoring Well Installations and Groundwater Treatment, Lakewood Towne Center, Lakewood, Washington

Prepared for
Kite Realty Group

Prepared by
Herrera Environmental Consultants, Inc.

HERRERA
Science + Planning + Design

Work Plan

Additional Monitoring Well Installations and Groundwater Treatment, Lakewood Towne Center, Lakewood, Washington

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1. INTRODUCTION

Previous site investigations and groundwater monitoring within the northwest portion of the Lakewood Towne Center (Site) indicate a dry cleaner solvent, perchloroethylene (PCE) and its breakdown products (aka daughter products) trichloroethylene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC) and several related halogenated volatile organic compounds (HVOCs), were detected in groundwater across the Site. Since 2021, groundwater monitoring has shown a significant decreasing trend in contaminant concentrations at the six existing wells at the site. Concentrations of nearly all HVOC chemicals of concern (COCs) except VC have dropped below their respective Model Toxics Control Act (MTCA) cleanup levels (CULs). In 2021 and 2022, the VC concentrations detected in groundwater in monitoring well MW-1S exceeded the MTCA Method A CUL. This Work Plan describes additional investigation activities planned to further characterize the nature and extent of residual VC in groundwater, and describes the proposed groundwater treatment to reduce the concentration of residual VC in groundwater below the CUL.

1.1. General Site Information

Lakewood Towne Center is located at 5731 Main Street Southwest in Lakewood, Washington (Figure 1). The Site is located in the northwest corner of the shopping center from 5815 to 6111 Lakewood Towne Center Boulevard Southwest (Figure 2). The commercial shopping center complex has undergone multiple renovations and redevelopment since the area was originally developed in the 1950’s and currently includes multiple parcels owned by Kite Realty Group (KRG).

1.1.1. Site Identification and Contact Information

Site investigation and cleanup activities are being reviewed by the Washington State Department of Ecology (Ecology) under the Voluntary Cleanup Program (VCP Site number SW1801). Ecology is tracking the status of site investigation and cleanup activities as follows:

- Facility Site Identification Number: 7922231
- Cleanup Site Identification Number: 421

Site contact information:

Kite Realty Group
30 South Meridian Street, Suite 1100
Indianapolis, Indiana 46204
Sara Abdelrahman: sabdelrahman@kiterealty.com (253) 319-2354

Ecology VCP Program Manager:

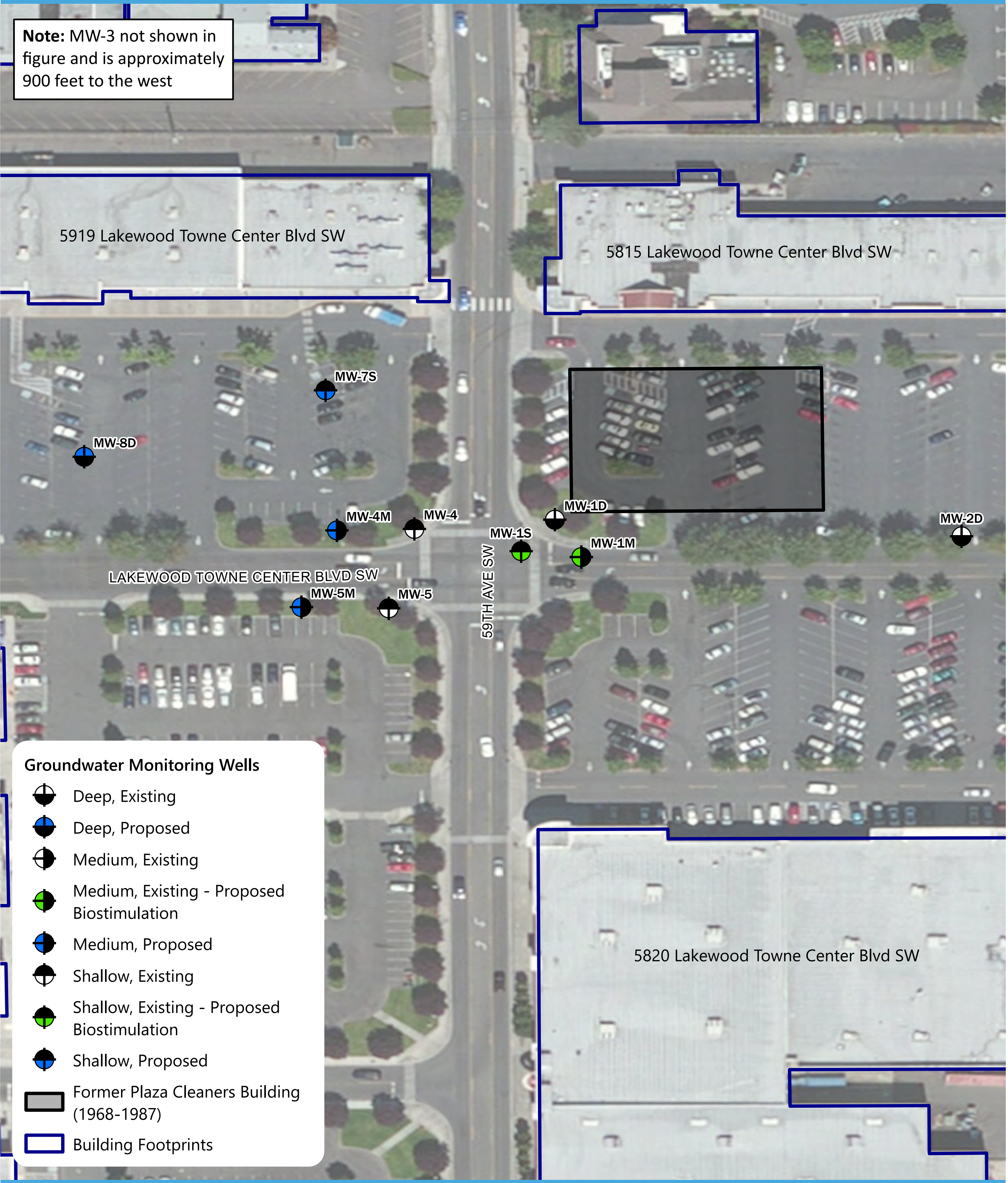
Joseph Hunt, LHG: johu461@ECY.WA.GOV (360) 489-5347

Figure 1.
Vicinity Map.

Author: bBagniewski Date: 9/27/2023 File Path: K:\Projects\Y2021\21-07668-000\Pro\Lakewood_Towne_Center_Monitoring\Lakewood_Towne_Center_Monitoring.aprx\Fig1_Vicinity

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: WSDOT, Pierce County, Esri Clarity (Imagery, 2022)

Figure 2.
Site Map and Proposed Groundwater Monitoring Locations.



Note: MW-3 not shown in figure and is approximately 900 feet to the west

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: Pierce County, Microsoft, Esri Imagery (2022)

Author: bBagniewski Date: 10/2/2023 File Path: K:\Projects\Y2021\21-07668-000\Pro\Lakewood_Towne_Center_Monitoring\Lakewood_Towne_Center_Monitoring.aprx\Fig2_SiteMap

1.1.2. Site Description

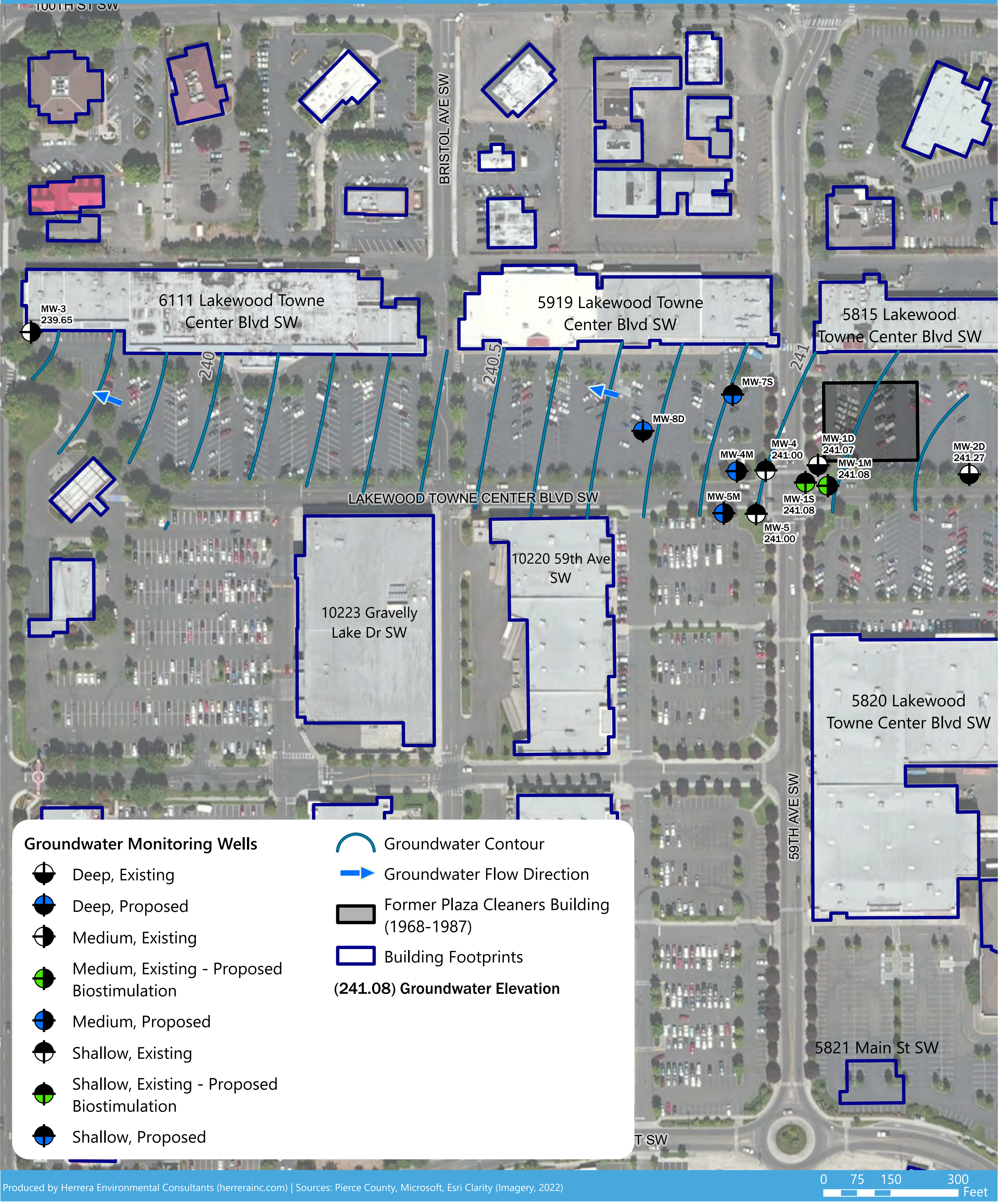
The Site is located within the Lakewood Towne Center shopping complex located in Pierce County in Lakewood, Washington. The shopping complex is centrally located at 5731 Main Street Southwest with Gravelly Lake Drive Southwest to the west, 100th Street Southwest to the north, and Main Street Southwest to the south (Figure 1). The Site investigation and groundwater monitoring activities described in this Work Plan are focused on the northwest portion of the complex along Lakewood Towne Center Boulevard Southwest, from the area south of 5815 to 6111 Lakewood Town Center Boulevard Southwest, including the northern portion of 10220 59th Avenue Southwest (Figure 3). The Site includes portion of the following parcels in Pierce County (Pierce County 2023):

- The northwest portion of Parcel Number 4002240010
- Parcel Number 4002240100
- The northern portion of Parcel Number 4002240090
- The northern portion of Parcel Number 4002240030

The Site is situated within the northwest quarter of Sectiont 2, Township 19, Range 02 east of the Willamette Meridian in Pierce County, Washington (Pierce County 2023). The Site is centered at latitude 47° 09′ 51″ North and longitude 122° 31′ 02″ West on land that is flat with a surface elevation of approximately 260 feet above mean sea level (msl) (Google 2022).

The Site is zoned within the city of Lakewood as the part of the Central Business District with areas beyond zoned as public, residential, or mixed residential (City of Lakewood 2023).

Figure 3. Lakewood Towne Center Groundwater Contour Map - August 11, 2023.



Author: bBagniewski Date: 9/27/2023 File Path: K:\Projects\Y2021\21-07668-000\Pro\Lakewood_Towne_Center_Monitoring\Lakewood_Towne_Center_Monitoring.aprx\Fig3_GW_Contour

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: Pierce County, Microsoft, Esri Clarity (Imagery, 2022)

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2. SITE USE

The Site is located within a retail shopping complex developed with single-story buildings and asphalt paved parking and driveway areas. Business and parking area perimeters are improved with landscaping and middle-aged trees.

2.1. Geology and Hydrogeology

2.1.1. Geologic Setting

Most of central Pierce County and the associated Lakewood Mall property are located on an extensive upland glacial drift plain. The drift plain originated from glacial and glaciofluvial processes associated with the Vashon glaciation. The drift plain is dotted with small lakes and swamps occupying depressions called kettles. Kettles were formed by melting blocks of glacial ice buried in the drift. The plain is bounded on the west by Puget Sound and extends east to the foothills of the Cascade Mountain range. Major drainages incising the drift plain include the Puyallup River to the north and to the east and the Nisqually River to the south.

The general stratigraphy in central Pierce County and in the vicinity of the subject site consists of a series of Pleistocene age glacial and nonglacial sediments overlying Tertiary bedrock at a depth of about 2,000 feet below ground surface (Hall and Othberg 1974). Surficial soils encountered onsite during previous field investigations and nearby environmental investigations consist of openwork coarse sand and gravel with cobbles and trace amounts of silt. This gravel unit is called the Steilacoom gravels, representing a facies of recessional outwash as a result of deltas formed in proglacial lakes (Walters and Kimmel 1968). Based on several gravel pit mines identified in the area, the thickness of Steilacoom gravels in the vicinity of the subject site can vary between 20 to 60 feet. Underlying the Steilacoom gravels is a very dense glacial till deposit, known as the Vashon till, consisting of impermeable sandy silt with variable amounts of gravel and clay.

The area topography is relatively flat to slightly hummocky at an elevation of 260 feet above mean sea level. Based on historical information, the mall was developed on a marsh that had occupied the east-central portion of the property. A layer of peat reportedly exists beneath the Site based on information gathered for development of Lakewood Mall II (Nastansky 2000).

2.1.2. Site Geology

Soils encountered at the site generally consisted of grayish brown to olive brown sandy gravel with variable amounts of cobbles and trace amounts of silt overlying an impermeable till layer. The gravel deposit is similar in lithology to those described for the Steilacoom gravel formation, and the till layer is similar to those described for Vashon glacial till. Fill material, generally consisting of slightly silty sand to sandy gravel with concrete chunks, brick fragments, and other debris, was generally encountered across the Site to approximate depths ranging from 2 to 14 feet. During previous investigations, the Steilacoom gravel deposit was encountered in borings starting beneath the asphalt pavement or fill layer. The base of the Steilacoom gravel unit was reached in the two deep well borings, MW-1d and MW-2d, and well boring MW-3 at maximum depths of 48, 57.5, and 28 feet below ground surface (bgs), respectively (Herrera 2001). The till encountered in these borings generally consisted of very dense, olive brown silty sand with variable amounts of clay and gravel; the base of the till layer was not reached.

2.1.3. Site Hydrogeology

The Lakewood Mall property and vicinity has a poorly developed surface drainage system, due to high infiltration capacity of the gravelly soil and the level topography. Aquifers are recharged primarily by precipitation in this area, with an average annual precipitation of approximately 38 inches. Prior to development of the mall in 1957, the marsh drained into Ponce de Leon Creek to the west, which eventually drains into Lake Steilacoom located 0.5 miles west of the mall property. The marsh and creek were diverted and tightlined into a stormwater drainage system beneath the property during the development of Villa Plaza shopping center and later the Lakewood Mall II complex, which continues to discharge into Ponce de Leon Creek (Nastansky 2000). During the previous Phase II investigations, groundwater appeared to seep into the stormwater drainage system, based on observations of running water in some of the drains and water levels measured in nearby probe borings. Groundwater also was observed seeping in an open-bottom storm drain/catch basin located in the far eastern portion of the site. No other continuously flowing streams or surface water channels in or out of the mall property and surrounding area were observed during Phase II investigations.

The water bearing zone at the site is located within the Steilacoom gravel unit, confined by the consolidated Vashon till layer beneath it. Monitoring wells across the northwest portion of the site have well screens spanning the upper (shallow), middle (medium), and deeper (deep) portions of the water bearing zone. Shallow wells have well screens in the top portion of the water bearing zone down to approximately 2.5 feet bgs, medium wells have well screens in the middle 7.5 to 12 feet of the water bearing zone, and deep wells have well screens in the bottom 32 to 46 feet of the water bearing zone.

The groundwater at the site is encountered from approximately 11.6 feet bgs at the eastern portion of the Site in MW-2D to 18.1 feet bgs at the western portion of the Site in MW-3. In general, groundwater flows to the west/west-northwest across the northwestern portion of the site. The hydraulic gradient ranges from approximately 0.0011 to 0.0017 feet per feet across the site (Figure 3).

In general, groundwater across the northwest portion of the site is the shallowest at monitoring well MW-2D and the deepest in MW-3 with an average difference of 2.2 feet between the highest and lowest groundwater points. Groundwater generally flows to the west with little seasonal variability to the west-northwest and west-southwest.

3. PREVIOUS INVESTIGATIONS

Soil and water quality at the site have been characterized through efforts by Herrera since early 2000, including a Phase I Environmental Site Assessment (ESA) in May 2000, a Phase II ESA in February 2001, a limited Phase II Environmental Site Investigation in June 2002 and May 2003, and subsequent groundwater monitoring events through 2022.

3.1. Site Environmental History – Summary

The Sisters of Visitation, a Catholic school for girls, owned the site from 1918 through 1954 prior to the development of the Villa Plaza shopping center. Before the Sisters owned the property, the site was in a rural area and had not been used for commercial or industrial purposes. A park-like setting surrounding a wetland marsh occupied the east-central portion of the property prior to the development of the Villa Plaza shopping center. Based on historical records, the original mall was developed in modules, beginning in the western half of the property with the development of the former Villa Plaza shopping center in 1957. The modules were designated as the North, West, South, and East Concourses, each comprised of multiple buildings and tenant lease spaces. In 1989, the East Concourse was mostly demolished and an enclosed mall was built in the east-central portion of the property. Businesses located in the mall over the years included gasoline stations, automotive repair shops, dry cleaning facilities, and printing, film developing, and paint retailers (Herrera 2000).

3.2. Summary of Previous Investigations and Data

This section summarizes site investigations previously completed from 1998 through 2022 to characterize the nature and extent of COCs in soil and groundwater at the Site and adjacent properties (see Table 1 below). Data tables summarizing the laboratory analytical results for groundwater samples collected during the previous investigations are present in Appendix A.

Soil and groundwater data from the previous investigations were compared to MTCA Method A CULs where applicable, and the most conservative Method B CULs when no Method A CUL is applicable (Ecology, . Groundwater monitoring well locations are depicted on Figures 2 and 3 and described in Appendix A Table 1. Chemical analytical results for groundwater samples collected during previous investigations are summarized in Appendix A Table 2.

Since the Lakewood Towne Center site characterization project began in the summer of 2000, Herrera has prepared the following reports:

Table 1. Site Investigations 1998 through 2022.

Date	Deliverables
May 2000	Phase I Environmental Site Assessment
February 2001	Phase II Environmental Site Assessment
March 2001	Groundwater Quarterly Status Report (first quarter)
June 2001	Groundwater Quarterly Status Report (second quarter)
September 2001	Groundwater Quarterly Status Report (third quarter)
January 2002	Groundwater Monitoring Annual Summary Report (fourth quarter and first year summary)
February 2002	Updated Phase I Environmental Site Assessment
March 2002	Groundwater Quarterly Status Report (fifth quarter)
June 2002	Limited Phase II Site Investigation and Groundwater Quarterly Status Report (sixth quarter)
October 2002	Groundwater Quarterly Status Report (seventh quarter)
January 2003	Groundwater Monitoring Annual Summary Report (eighth quarter and second year summary)
April 2003	Groundwater Quarterly Status Report (ninth quarter)
August 2003	Groundwater Quarterly Status Report (tenth quarter)
August 2006	August 2006 Groundwater Quality Status Report
February 2007	February 2007 Groundwater Quality Status Report
September 2007	September 2007 Groundwater Quality Status Report
April 2008	March 2008 Groundwater Quality Status Report
November 2008	September 2008 Groundwater Quality Status Report
October 2009	September 2009 Groundwater Quality Status Report
June 2010	May 2010 Groundwater Quality Status Report
December 2010	November 2010 Groundwater Quality Status Report
June 2011	May 2011 Groundwater Quality Status Report
December 2011	November 2011 Groundwater Quality Status Report
June 2012	May 2012 Groundwater Quality Status Report
November 2012	November 2012 Groundwater Quality Status Report
August 2021	August 2021 Groundwater Quality Status Report
August 2022	August 2022 Groundwater Status Update

3.3. Detail of Previous Investigations

3.3.1. 1999 Phase II Environmental Site Assessment – Hillmann Environmental Company

In December 1998 and January 1999, Hillmann Environmental Company (Hillmann) of Seattle, Washington conducted a Phase II Environmental Site Assessment (ESA) near the tenant space at Building N1, tenant space #3 to determine whether soil and groundwater had been impacted by potential releases of hazardous substances from Villa One Hour Cleaners (Hillmann 1998, 1999). PCE was detected in soil collected from inside the dry cleaner facility above the MTCA Method A CUL (0.5 mg/kg) at a concentration of 0.99 mg/kg, approximately 1.5 feet below the concrete floor slab. However, PCE was not detected above the laboratory reporting limit or was detected below the MTCA CULs in soil and groundwater samples collected from the two soil borings drilled behind the facility.

As a follow-up investigation, 10 roundwater samples were collected using the push probe sampling method at locations adjacent to the dry cleaning facility in the alley to the north and in the planting strip to the west. All 10 samples were found to be below laboratory detection limits for diesel-range petroleum hydrocarbons, including a sample co-located with the earlier Phase II study that had contained elevated total petroleum hydrocarbon (TPH) levels. A determination was made that the TPH plume detected in their earlier study no longer existed in the area, either because groundwater flow direction had changed or because the contamination had naturally attenuated.

3.3.2. February 2001 – Phase II Environmental Site Assessment

Beginning in late May to September 2000, Herrera conducted a Phase II ESA at the Site (Herrera 2001), including two follow-up investigations. A total of 34 probe locations were drilled and sampled in phases and 7 groundwater monitoring wells were installed. Soil and groundwater samples from four probe borings (P18 through P21) in particular identified a source area of dry cleaning solvent in the septic tank and drain field system area at the location of the former Plaza Cleaners that operated from 1968-1987.

The seven groundwater monitoring wells were installed in the following locations (Figure 2, Appendix A Table 1):

- MW-1S (shallow), MW-1M (medium depth), and MW-1D (deep) in the source area;
- MW-2D (deep) upgradient of the source area;
- MW-3 (shallow) at the northwest corner of the former mall complex, approximately 1,300 feet downgradient of the source area;
- MW-4 (shallow) immediately downgradient of the source area; and
- MW-5 (shallow) immediately downgradient of the source area.

During the Phase II ESA, soil and groundwater samples were analyzed for residual petroleum hydrocarbons, volatile organic compounds, and metals potentially associated with underground storage tanks and septic tanks used by automotive repair shops, gasoline stations, and commercial businesses including dry cleaning, film developing, printing, and paint retailers. Results of the 2001 Phase II ESA indicated shallow groundwater at the Lakewood Mall had been impacted by dry cleaning solvent releases of PCE, primarily from the north-central part of the Site where Plaza Cleaners operated from 1968 – 1987.

Soil samples from the identified source area were submitted for laboratory analysis and were non-detect for PCE and its breakdown products. Groundwater sample results indicated PCE and its biodegradation by-products exceeded MTCA CULs in groundwater across a lateral area approximately 150 feet by 250 feet and were vertically limited to upper portion the water table. Concentrations of PCE were detected in groundwater below the MTCA Method A CUL downgradient of the north-central portion of the Site, across the northwest quadrant of the Site. Field screening of soil samples did not indicate the presence of VOCs.

3.3.3. June 2002 – Limited Phase II Site Investigation

Herrera performed a limited Phase II site investigation in the Spring of 2002 to address the potential for contamination associated with dry clear activities at the northwest corner and other portions of the mall property as reported in the 1999 Phase II ESA (Herrera 2002; Hillman 1999). Villa One Hour Cleaners, operated an onsite dry-cleaning facility in the space at 6111 Lakewood Towne Center Boulevard Southwest, Suite O (Building N1, tenant space #3) from 1992 until February 2003. During the June 2002 investigation, sampling of groundwater from monitoring well MW-3 and a soil boring (SB-3) indicated detections of PCE and two associated breakdown products in groundwater below their applicable CULs. The low detections of CVOCs in groundwater at and around MW-3 during the investigation were determined to have potentially originated either from upgradient at the original identified source area near MW-1S or from the cleaners operating in Building N1.

3.3.4. May 2003 – Limited Phase II Site Investigation

In May 2003, Herrera performed a limited Phase II site investigation to confirm the presence of PCE contaminated soil found during the June 2002 investigation beneath the tenant space occupied by Villa One Hour Cleaners, located at 6111 Lakewood Towne Center Boulevard Southwest, Suite O (Building N1, tenant space #3) (Herrera 2003). Dry cleaning equipment was operated within the east-central portion of the tenant space including an enclosed aboveground storage tank that contained dry cleaning solvents from 1992 until February 2003. Villa One Hour Cleaners operated as a drop off/pickup service at this location, with dry cleaning operations occurring at an offsite facility beginning in March 2003.

A release of dry-cleaning solvent (PCE) was identified in soil collected beneath the floor slab inside the tenant space #3 at Building N1, as evidenced by low level contamination found in the sample from 2.5 feet below the floor slab at SB-4 and a hand auger soil sample collected 1.5 feet below the floor slab during a previous investigation. Boring SB-4 was installed near the former dry cleaning operation area, and a hand auger sample was also collected near the same area. Sample SB4-2.5 had a PCE concentration (0.0020 mg/kg) below the MTCA Method A CUL (0.05 mg/kg). PCE was detected above the Method A CUL at 0.99 mg/kg from the previous 1.5-foot depth sample from the hand auger borehole. No HVOCs, including PCE, were detected above the laboratory practical quantitation limits (PQLs) in soil collected from the 10-foot depth interval at SB-4. Because detections of PCE detected beneath the tenant space #3 at Building N1 were limited to vadose zone soil and well above the capillary fringe zone of the groundwater, it was determined PCE contaminated soil directly beneath the tenant space was not likely to be attributing to CVOCs in groundwater at and near MW-3.

3.3.5. October 2003 – Brown & Caldwell Groundwater Injection Treatment

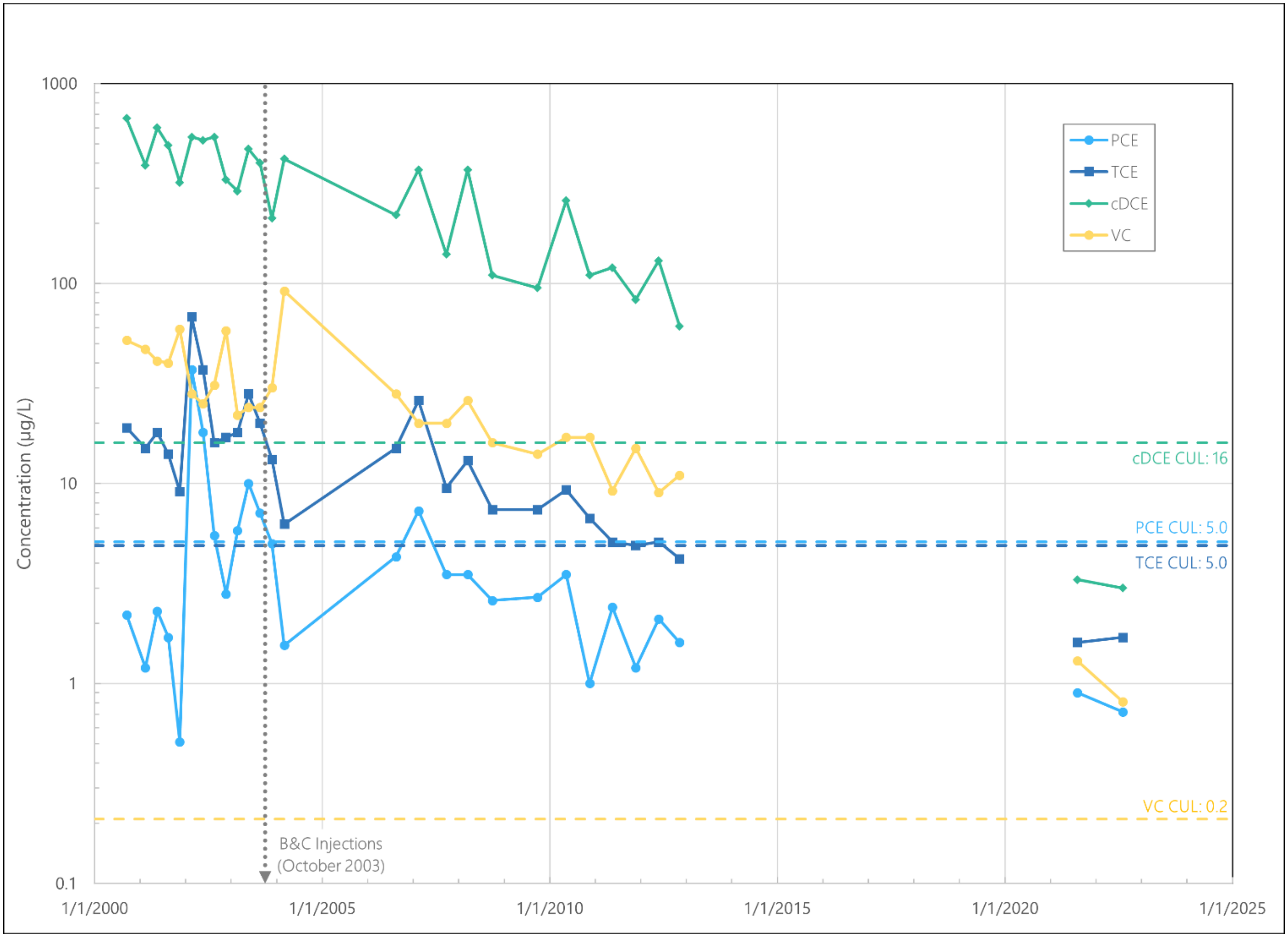
In October 2003, Brown & Caldwell (B&C) was contracted by MBK Northwest Inc. (property owner of the former mall site at the time) to inject hydrogen release compound (HRC) at six shallow boring locations in the vicinity and upgradient of MW-1s to promote biodegradation of PCE (B&C 2004). Within a month following treatment, PCE, TCE, and cDCE concentrations declined and VC increased at MW-1s, indicating local biodegradation was tking place. Further evidence of biodegradation is provided in samples collected 3 months later, with increased concentrations of biological breakdown products cDCE and VC. Samples collected over the next 9 years after the biodegradation treatment indicated PCE concentrations at MW-1S below the MTCA Method A CUL of 5 micrograms per liter (µg/L), except for the sample collected in February 2007, where PCE was detected slightly above the CUL. Approximately 6 months following treatment, concentrations of PCE breakdown products returned to pretreatment levels and have slowly declined since mid-2007 (Appendix A Table 2, Figure 4).

3.3.6. 2000 to Current – Groundwater Sampling

Quarterly, semi-annual, and/or annual groundwater sampling have been performed at the Site since September 2000 (Appendix A Table 2). CVOCs including PCE, and its breakdown compounds TCE, cDCE, and VC have been detected in groundwater samples in the northwest portion of the Site above applicable MTCA CULs. Additional HVOCs including trans-1,2-dichloroethene (tDCE), 1,1-dichloroethene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), 1,3-dichlorobenzene (1,3-DCB), 1,4-dichlorbenzene (1,4-DCB), and chloroform have also been detected in groundwater samples at the site below their applicable CULs.

Sampling results from the annual groundwater sampling events in 2021 and 2022 indicate VC in groundwater from monitoring well MW-1S, located in the northeast portion of the Site, is the only VOC detected above its CUL in groundwater. In general, concentrations of VC in groundwater at MW-1S have been decreasing since 2004. No other VOCs have been detected in groundwater samples above their applicable CULs at the Site since 2012 (Appendix A Table 2, Figure 4).

Figure 4. CVOCs in MW-1S.



4. GROUNDWATER TREATMENT WORK PLAN

This section describes the procedures and scope of work Herrera will perform to provide groundwater treatment at the Site. Prior to groundwater treatment, four new monitoring wells will be installed and sampled to further characterize the nature and extent of contamination present in soil and groundwater. Groundwater sampling results will be used to support or modify the proposed groundwater treatment plan aimed at reducing concentrations of vinyl chloride in groundwater at the Site.

As described in Sectiont 4.4.1, two soil samples from each boring will be collected and submitted for lab analysis for VOCs. This includes one soil sample from 0 to 10 feet bgs and one soil sample near the bottom of each boring. Sample collection intervals for lab analysis will be adjusted in the field depending on observations of potential soil contamination, such as odors, staining, sheen, or elevated PID readings. A total of eight soil samples, plus one field duplicate will be analyzed for HVOCs.

4.1. Preliminary Conceptual Site Model

The preliminary conceptual site model (CSM) for the site is based on previous investigation data collected from 2000 to 2022. The data indicates that PCE, a dry-cleaner solvent, and associated HVOCs have been detected in groundwater in the north-central portion of the Site, migrating to the west from the main source area near the former Plaza Cleaners (1968-1987) location.

Contaminants of concern found in groundwater at the Lakewood Towne center site since monitoring began in 2000 include: PCE, TCE, cDCE, tDCE, 1,1-DCE, 1,1-DCA, 1,3-DCB, VC, and chloroform. Groundwater sample results indicate that groundwater concentrations of PCE and associated HVOCs detected above applicable cleanup levels have been restricted to the shallow portion of the groundwater and are generally decreasing. Results of the 2021 and 2022 annual groundwater sampling event indicate all HVOCs previously detected in groundwater above applicable CULs have decreased to below CULs, with the exception of VC in groundwater from MW-1S, which was detected in 2021 and 2022 at continuingly decreasing concentrations 1.3 µg/L and 0.81 µg/L, respectively (Appendix A, Table 2, Figure 4).

Groundwater at the Site is not used and will not be used in the future as a drinking water source. There is no indication that any vadose zone soil contamination in the source area of the Site is contributing to leaching of HVOCs to the underlying saturated zone soils and/or groundwater. Decreasing concentrations of HVOCs in groundwater also indicate there is no residual source area contamination contributing to the groundwater plume.

Herrera will update and refine the CSM if needed following analysis of the groundwater samples collected after the supplemental monitoring well installation and baseline groundwater sampling event.

4.2. Site Cleanup Levels for Groundwater and Soil

An evaluation of site cleanup levels for groundwater and soil was performed based on the conceptual model described above for the purpose of screening existing Site data and to identify appropriate analytical methods and detection limits for the Sampling and Analysis Plan (SAP). The evaluation considered potentially applicable cleanup levels based on Site use, contaminant transport pathways, and potential receptors.

4.3. Data Gaps

Based on the historical and recent HVOC analytical results relative to the existing well network, Ecology requested additional groundwater delineation beyond the existing groundwater monitoring wells before proceeding with the proposed groundwater treatment. Ecology suggested that installing intermediate zone (medium depth) wells at or downgradient of shallow wells MW-4 and MW-5 would allow assessment of whether temporal reductions in HVOC concentrations in well MW-1S were truly due to intrinsic biodegradation or to vertical contaminant migration of HVOC between these wells as negatively buoyant dissolved fractions or as yet undetected DNAPL (J. Hunt, personal communication).

Figure 2 provides a site map depicting the locations of two additional intermediate zone wells MW-4M and MW-5M, an additional shallow well MW-7S to track potential flow from the source area toward the northwest, and a deep well MW-8D to better define the downgradient edge of the plume.

Based on the results of sampling the existing and four proposed wells, deeper wells may need to be installed if HVOC are detected above MTCA cleanup levels in intermediate zone groundwater. Knowledge of the more complete vertical groundwater contaminant profile would then help inform if adjustments are needed to the planned groundwater treatment regimen that would lead to more effective overall results.

4.4. Overview of Planned Field Activities

This section provides an overview of the planned field activities to be completed with the overall objective of reducing residual concentrations of VC in groundwater in the vicinity of monitoring well MW-1S at the Site. Table 2 presents a summary of the sampling and analysis plan. The SAP in Appendix B provides a complete description of field method and sampling procedures to be employed, and includes a Quality Assurance Project Plan (QAPP) to ensure the investigation data are defensible and usable for their intended purpose. A site-specific Health and Safety Plan (HASP) to guide the field work is included in Appendix C. Figure 2 depicts the proposed investigation sampling locations.

The specific goals of the tasks described herein are as follows:

- Update the conceptual site model (CSM) with updated groundwater contour data and evaluate the lateral and vertical extents of the contaminant plume with additional monitoring wells.

- Coordinate with Ecology to verify that groundwater monitoring wells at the site are registered with Ecology and obtain the Underground Injection Control (UIC) permit for groundwater treatment.
- Perform in situ chemical oxidation (ISCO) groundwater injection treatment to break down VC and related contaminants.
- Monitor and evaluate the effects of groundwater injection treatment performed in the vicinity of MW-1S and MW-1M.

4.4.1. Monitoring Well Installation

A drilling subcontractor will complete four soil borings with monitoring well installations using a hollow-stem auger drill rig. Shallow depth monitoring well MW-7S will be installed downgradient to the northwest of the source area and approximately 16 feet bgs. The well screen for MW-7S will be within the upper portion of the water column. Medium depth monitoring wells MW-4M and MW-5M will be installed adjacent to existing shallow wells MW-4 and MW-5, respectively, to approximately 30 feet bgs. The well screens for MW-4M and MW-5M will be within the approximate middle of the water column. Deep monitoring well MW-8D will be installed downgradient of the source area and approximately 55 feet bgs. The well screen for MW-8D will be at the bottom of the water column within the Steilacoom gravel layer, directly above the Vashon till layer.

Soil samples will be collected from each boring every 5 feet using an 18-inch, split spoon sampler. The soil will be visually inspected for staining and classified in accordance with the Unified Soil Classification System (USCS; ASTM International [ASTM] D2488-09), and a PID instrument will be used to screen soil for VOCs. Two soil samples from each boring will be collected and submitted for lab analysis for VOCs. One soil sample from 0 to 10 feet bgs and one soil sample near the bottom of each boring will be collected. Sample collection intervals for lab analysis will be adjusted in the field depending on observations of potential soil contamination, such as odors, staining, sheen, or elevated PID readings. A total of 8 soil samples, plus one field duplicate will be analyzed for HVOCs.

Following soil sample collection, a monitoring well will be installed in each boring. Monitoring wells will be developed with a submersible pump and allowed to equilibrate with the surrounding formation prior to collecting groundwater samples.

4.4.2. Baseline Groundwater Sampling

One round of baseline groundwater sampling, including the new monitoring wells, will be performed prior to commencing groundwater treatment activities. Herrera will collect static water levels from the 11 monitoring wells at the Site to evaluate the groundwater flow direction. Herrera will also collect groundwater samples from 10 monitoring wells at the Site, excluding MW-3. All groundwater samples will be analyzed for HVOCs, including PCE and its breakdown products (CVOCs). Geochemical parameters including total organic carbon (TOC), total sulfate, dissolved iron and manganese, total nitrogen, and total phosphorus will be analyzed in samples from source area wells MW-1S and MW-1M.

As described in Sectiont 5.1, the results of the baseline groundwater sampling will be discussed with the Ecology VCP site manager and used to evaluate the proposed groundwater treatment and monitoring described in this Work Plan.

4.4.3. Underground Injection Control Permit

After Ecology review of this Work Plan and receiving Notice to Proceed with the proposed groundwater treatment and monitoring, Herrera will apply for an Underground Injection Control (UIC) permit from Ecology. The UIC permit must be obtained 60 days in advance of the groundwater treatment. In addition, because the Site is located within two well head protection areas, Herrera will submit a copy of the Work Plan to the Lakewood Water District and the Fircrest Water Protection Area and request letters from both stating that they have been notified of the planned treatment.

4.4.4. Proposed Groundwater Treatment

Appendix D includes the vinyl chloride remediation proposal designed by Tersus Environmental to address residual low concentrations of vinyl chloride at the Site (Tersus 2022). The groundwater treatment consists of in situ chemical oxidation (ISCO) remediation and will be performed in the field by Holocene Drilling (Holocene) and overseen by Herrera. The treatment includes injecting modulated TersOx Liquid and nutrients into existing shallow and medium monitoring wells MW-1S (shallow) and MW-1M (medium) to accelerate the aerobic degradation of HVOCs. The injections to be performed at the two monitoring wells will include 250 pounds (26 gallons) of TersOx Liquid, 12.5 pounds of TersOx Nutrients, and 2.5 gallons of TersOx Modulator.

Groundwater sampling will occur one, three, and six months following the treatment and injection activities, to evaluate the efficacy of the treatment. Sampling parameters will include:

- Field parameters: dissolved oxygen, oxidation-reduction potential, pH, temperature, and conductivity.
- Geochemical parameters (MW-1S and MW-1M only): total nitrogen, total organic carbon, total phosphorous, dissolved iron, sulfate, and manganese. Samples for geochemical parameters will be collected during the baseline sampling event and subsequent three quarterly sampling events.
- HVOCs

If a decline in contamination concentrations does not occur, Tersus and Herrera, in consultation with KRG and Ecology, will evaluate supplemental treatment options.

4.4.5. Post-Injection Groundwater Monitoring

Following the baseline sampling event and subsequent groundwater treatment, groundwater monitoring will occur for six quarterly events to monitor and evaluate the impacts of the proposed groundwater treatment. Post-injection groundwater monitoring will begin approximately one month following groundwater treatment activities. During each quarterly sampling event, Herrera will collect static water levels from the 11 monitoring wells and will collect groundwater samples from 10 monitoring wells at the Site, excluding MW-3. All groundwater samples will be analyzed for HVOCs, including PCE and its breakdown products (CVOCs). Geochemical parameters including total organic carbon (TOC), total sulfate, dissolved iron and manganese, total nitrogen, and total phosphorus will be analyzed for from source area wells MW-1S and MW-1M for the first three quarters of post-injection groundwater sampling.

5. REPORTING AND SCHEDULE

5.1. Reporting

5.1.1. Baseline Groundwater Monitoring Memorandum

Following installation of the four new monitoring wells and the subsequent baseline groundwater sampling event, Herrera will prepare a brief technical memorandum (memo) detailing the following:

1. The field events associated with the installation and development of four new monitoring wells.
2. The field events and laboratory analytical results associated with the baseline sampling of 10 monitoring wells at the site. The memo will include a table summarizing all historic groundwater data for the Site, a site map and groundwater contour map, a discussion of the horizontal and vertical distribution of HVOCs in groundwater, and a discussion of whether the groundwater treatment plan described in this Work Plan and included in Appendix D should be modified.

The memo describing the baseline groundwater sampling will be submitted to Ecology to request an Opinion Letter regarding the work proposed under the Work Plan before proceeding with treatment and additional groundwater monitoring.

5.1.2. Quarterly Groundwater Monitoring Evaluations

Following the groundwater treatment, Herrera will conduct quarterly groundwater monitoring and provide the results of each monitoring event including field notes and laboratory reports to Tersus to evaluate how well the treatment is progressing. Tersus will prepare a baseline sampling evaluation after the first quarterly groundwater monitoring event, progress reports after the second and third monitoring events, and a final report after the fourth monitoring event.

5.1.3. Final Groundwater Monitoring Memorandum

Herrera will provide one technical memo following the seventh and final quarterly groundwater monitoring event that summarizes the groundwater treatment methods and all groundwater monitoring results, including data tables and groundwater contour maps, for submittal to KRG and Ecology. The memo will include a data quality assurance review of all analytical data, a table summarizing previous and recent groundwater data collected at the Site, one groundwater contour map for the final event, Site figures depicting the contaminants detected, conclusions, and recommendations.

5.2. Schedule

The overall project schedule is provided in Table 2.

Table 2. Lakewood Towne Center Schedule.

Task	Task Name	Start	End
1	Groundwater Treatment and Well Installation[a]	2/1/2024	2/15/2024
2	Groundwater Monitoring and Reporting[a]	3/1/2023	9/30/2025
	7 Quarterly Events Planned[a]	2023: November	
		2024: March, June, September, December	
		2025: March, June	
3	Ecology VCP Coordination	2/1/2023	12/2/2024
4	Project Management	2/1/2023	12/2/2024
5	Work Plan	8/1/2023	11/1/2023
6	Monitoring Well Installation and Baseline Groundwater Monitoring	11/1/2023	1/1/2024
	Submit Tech Memo to Ecology	12/15/2023	1/1/2024
7	Additional VCP Coordination and PM	8/1/2023	12/31/2025
8	Groundwater Monitoring at New Wells	11/1/2023	6/30/2025

[a] Task 1 start date dependent on Ecology approval of Work Plan and Tech Memo under Task 5 and 6.
Task 2 quarterly groundwater events will start after Ecology reviews tech memo with initial monitoring results under Task 6.

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APPENDIX A

Data Tables

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Table A-1. Well Completion Details for Lakewood Towne Center Site.

Location Name	Location Description	Date Installed	Easting	Northing	Top of Ground Surface Elevation (feet)	Top of Casing Elevation (feet)	Depth to Bottom (ft btoc)	Well Screen				
								Length (feet)	ft btoc		Elevation (feet)	
									Top	Bottom	Top	Bottom
MW-1S	Sidewalk, NE corner of 59th Ave SW and Lakewood Town Center Blvd SW	7/18/2000	1,139,096.2	674,274.0	255.1	254.0	15.1	5	10.1	15.1	243.9	238.9
MW-1M	Sidewalk, NE corner of 59th Ave SW and Lakewood Town Center Blvd SW	July 2000	1,139,101.5	674,272.8	255.0	254.1	24.8	2.5	22.3	24.8	231.8	229.3
MW-1D	Sidewalk, NE corner of 59th Ave SW and Lakewood Town Center Blvd SW	7/17/2000	1,139,102.1	674,279.1	255.3	254.2	48.2	2.5	45.7	48.2	208.5	206.0
MW-2D	Parking lot, NE corner of 59th Ave SW and Lakewood Town Center Blvd SW	7/18/2000	1,139,326.0	674,268.9	253.2	252.9	57.3	2.5	54.8	57.3	198.1	195.6
MW-3	Parking lot, NE corner of Gravelly Lake Dr SW and Lakewood Towne Center Blvd SW	7/18/2000	1,137,905.0	674,521.5	258.0	257.7	28.0	2.5	25.5	28.0	232.2	229.7
MW-4	Sidewalk, NW corner of 59th Ave SW and Lakewood Town Center Blvd SW	July 2000	1,139,016.4	674,282.8	256.2	255.5	16.6	5	11.6	16.6	243.9	238.9
MW-4M	Adjacent to MW-4	Proposed	–	–	–	–	30.0	2.5	27.5	30.0	–	–
MW-5	Sidewalk, SW corner of 59th Ave SW and Lakewood Town Center Blvd SW	July 2000	1,139,000.4	674,218.0	256.3	255.1	16.4	5	11.4	16.4	243.7	238.7
MW-5M	Adjacent to MW-5	Proposed	–	–	–	–	30.0	2.5	27.5	30.0	–	–
MW-7S	Downgradient of MW-1S, parking lot south of 5919 Lakewood Towne Center Blvd SW	Proposed	–	–	–	–	15.0	2.5	12.5	15.0	–	–
MW-8D	Downgradient of MW-1S, parking lot south of 5919 Lakewood Towne Center Blvd SW	Proposed	–	–	–	–	50.0	2.5	47.5	50.0	–	–

Survey data provided by Sitts and Hill Engineers, Inc of Tacoma, WA, August 11, 2023.

Survey data is relative to NAVD88.

ft btoc = feet below top of casing.

– = Proposed well. Survey data not available.

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	Sample Date	PCE	TCE	cDCE	tDCE	1,1-DCE	1,1-DCA	Vinyl Chloride	1,3-DCB	1,4-DCB	Chloroform
	MTCA CUL	***5*** [a]	***5*** [a]	***16*** [b]	***160*** [b]	***400*** [b]	***7.7*** [b]	***0.2*** [a]	**–**	***8.1*** [b]	***1.4*** [b]
Shallow Monitoring Wells											
MW-1S (243.9 to 238.9)	09/15/00	**2.2**	**19**	**670**	**14**	**0.76**	**6.1**	**52**	ND (0.20)	**0.25**	**1.3**
	02/12/01	**1.2**	**15**	**390**	**8.2**	**0.37**	**3.1**	**47**	ND (0.20)	ND (0.20)	ND (0.20)
	05/17/01	**2.3**	**18**	**600**	**10**	**0.64**	**5.5**	**41**	ND (0.20)	**0.3**	ND (0.20)
	08/15/01	**1.7**	**14**	**490**	**8.3**	**0.56**	**4.2**	**40**	ND (0.20)	ND (0.20)	ND (0.20)
	11/15/01	**0.51**	**9.1**	**320**	**6.4**	**0.47**	**2.3**	**59**	ND (0.20)	**0.21**	ND (0.20)
	02/20/02	**37**	**68**	**540**	**7.2**	**0.83**	**3.1**	**28**	ND (0.20)	**0.35**	ND (0.20)
	05/20/02	**18**	**37**	**520**	**8.3**	**0.61**	**2.3**	**25**	ND (0.20)	**0.32**	ND (0.20)
	08/19/02	**5.5**	**16**	**540**	**7.3**	ND (2.0)	ND (2.0)	**31**	ND (2.0)	ND (2.0)	ND (2.0)
	11/20/02	**2.8**	**17**	**330**	**8.5**	**1**	ND (0.20)	**58**	ND (0.20)	ND (0.20)	ND (0.20)
	02/20/03	**5.8**	**18**	**290**	**3.6**	ND (2.0)	ND (2.0)	**22**	ND (2.0)	ND (2.0)	ND (2.0)
	05/21/03	**10**	**28**	**470**	**6.7**	**0.55**	ND (0.20)	**24**	ND (0.20)	**0.23**	ND (0.20)
	08/21/03	**7.1**	**20**	**400**	**6.6**	ND (2.0)	ND (2.0)	**24**	ND (2.0)	ND (2.0)	ND (2.0)
	11/26/03 (B&C)	ND (5.0)	**13.2**	**212**	ND (5.0)	ND (5.0)	ND (5.0)	**30.1**	ND (5.0)	ND (5.0)	ND (5.0)
	03/03/04 (B&C)	**1.55**	**6.26**	**420**	**6.77**	ND (1.0)	**1.44**	**91.8**	ND (1.0)	ND (1.0)	ND (1.0)
	08/16/06	**4.3**	**15**	**220**	**2.9**	ND (2.0)	ND (2.0)	**28**	ND (2.0)	ND (2.0)	ND (2.0)
	02/14/07	**7.3**	**26**	**370**	**3.9**	ND (2.0)	ND (2.0)	**20**	ND (2.0)	ND (2.0)	ND (2.0)
	09/24/07	**3.5**	**9.5**	**140**	**2.4**	ND (1.0)	ND (1.0)	**20**	ND (1.0)	ND (1.0)	ND (1.0)
	03/13/08	**3.5**	**13**	**370**	**3.7**	ND (2.0)	ND (2.0)	**26**	ND (2.0)	ND (2.0)	ND (2.0)
	09/26/08	**2.6**	**7.4**	**110**	**1.4**	ND (0.40)	ND (0.40)	**16**	ND (0.40)	ND (0.40)	ND (0.40)
	09/24/09	**2.7**	**7.4**	**95**	**1.3**	ND (0.40)	ND (0.40)	**14**	ND (0.40)	ND (0.40)	ND (0.40)
	05/12/10	**3.5**	**9.3**	**260**	**2.8**	ND (2.0)	ND (2.0)	**17**	ND (2.0)	ND (2.0)	ND (2.0)
	11/18/10	ND (1.0)	**6.7**	**110**	**1.6**	ND (1.0)	ND (1.0)	**17**	ND (1.0)	ND (1.0)	ND (1.0)
	05/19/11	**2.4**	**5.1**	**120**	**1.5**	ND (1.0)	ND (1.0)	**9.2**	ND (1.0)	ND (1.0)	ND (1.0)
	11/22/11	**1.2**	**4.9**	**83**	**1.2**	ND (1.0)	ND (1.0)	**15**	ND (1.0)	ND (1.0)	ND (1.0)

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	Sample Date	PCE	TCE	cDCE	tDCE	1,1-DCE	1,1-DCA	Vinyl Chloride	1,3-DCB	1,4-DCB	Chloroform
	MTCA CUL	***5*** [a]	***5*** [a]	***16*** [b]	***160*** [b]	***400*** [b]	***7.7*** [b]	***0.2*** [a]	**–**	***8.1*** [b]	***1.4*** [b]
MW-1S (continued)	05/24/12	**2.1**	**5.1**	**130**	**1.4**	ND (0.20)	**0.22**	**9**	ND (0.20)	ND (0.20)	ND (0.20)
	11/08/12	**1.6**	**4.2**	**61**	**0.88**	ND (0.40)	ND (0.40)	**11**	ND (0.40)	ND (0.40)	ND (0.40)
	08/04/21	**0.9**	**1.6**	**3.3**	ND (0.20)	ND (0.20)	ND (0.20)	**1.3**	ND (0.20)	ND (0.20)	ND (0.20)
	08/03/22	**0.72**	**1.7**	**3**	ND (0.20)	ND (0.20)	ND (0.20)	**0.81**	ND (0.20)	ND (0.20)	ND (0.20)
MW-4 (243.9 to 238.9)	09/15/00	**1.6**	**4.9**	**120**	**2.8**	ND (0.20)	**1**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/12/01	**1**	**2.3**	**48**	**0.9**	ND (0.20)	**0.22**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/17/01	**1**	**3.4**	**100**	**1.6**	ND (0.20)	**1**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/15/01	**0.97**	**2.9**	**70**	**1.1**	ND (0.20)	**0.68**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/15/01	**0.99**	**1.6**	**35**	**0.57**	ND (0.20)	**0.29**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/20/02	**9.8**	**18**	**110**	**1.3**	ND (0.20)	**0.71**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/20/02	**3.8**	**6.6**	**65**	**0.9**	ND (0.20)	**0.32**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/19/02	**2.4**	**4.2**	**77**	**1.7**	ND (0.40)	ND (0.40)	ND (0.40)	ND (0.40)	ND (0.40)	ND (0.40)
	11/21/02	**1.6**	**3.7**	**38**	**0.99**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/20/03	**1.5**	**3.1**	**36**	**0.48**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/21/03	**2.4**	**4.7**	**65**	**0.97**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/21/03	**1.8**	**3.8**	**54**	**0.78**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/26/03 (B&C)	**1.73**	**2**	**24.8**	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
	03/03/04 (B&C)	**2.09**	**4.07**	**75**	**0.88**	ND (0.20)	**0.21**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/16/06	**1.4**	**2.7**	**33**	**0.56**	ND (0.20)	**0.21**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/14/07	**1.4**	**3.7**	**49**	**0.43**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/07	**1.1**	**2.1**	**23**	**0.28**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/13/08	**1.1**	**2.6**	**52**	**0.51**	ND (0.20)	ND (0.20)	ND (0.20)	**0.28**	ND (0.20)	ND (0.20)
	09/26/08	**0.84**	**1.3**	**14**	**0.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/09	**1**	**2**	**23**	**0.25**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/12/10	**0.98**	**1.8**	**37**	**0.34**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	**Sample Date**	**PCE**	**TCE**	**cDCE**	**tDCE**	**1,1-DCE**	**1,1-DCA**	**Vinyl Chloride**	**1,3-DCB**	**1,4-DCB**	**Chloroform**
	MTCA CUL	***5***[a]	***5***[a]	***16***[b]	***160***[b]	***400***[b]	***7.7***[b]	***0.2***[a]	**–**	***8.1***[b]	***1.4***[b]
MW-4	11/18/10	**0.66**	**0.89**	**12**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
(continued)	05/19/11	**0.86**	**1.3**	**24**	**0.26**	ND (0.20)	ND (0.20)	ND (0.20)	**0.32**	ND (0.20)	ND (0.20)
	11/22/11	**0.71**	**0.73**	**9.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/24/12	**0.7**	**1.1**	**23**	**0.21**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/08/12	**0.73**	**0.75**	**9.8**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/04/21	**0.36**	**0.21**	**0.33**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/03/22	**0.39**	**0.24**	**0.31**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
MW-5	09/15/00	**1.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
(243.7 to 238.7)	02/12/01	**0.7**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/17/01	**0.62**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/15/01	**0.88**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/15/01	**0.9**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/20/02	**0.44**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/20/02	**0.39**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/19/02	**0.71**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/21/02	**0.86**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/20/03	**0.62**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/21/03	**0.52**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/21/03	**0.89**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/26/03 (B&C)	**0.86**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/03/04 (B&C)	**0.55**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/17/06	**0.66**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/14/07	**0.34**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/07	**0.69**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/13/08	**0.33**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.33**	ND (0.20)	ND (0.20)

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	Sample Date	PCE	TCE	cDCE	tDCE	1,1-DCE	1,1-DCA	Vinyl Chloride	1,3-DCB	1,4-DCB	Chloroform
MTCA CUL		***5*** [a]	***5*** [a]	***16*** [b]	***160*** [b]	***400*** [b]	***7.7*** [b]	***0.2*** [a]	**–**	***8.1*** [b]	***1.4*** [b]
MW-5 (continued)	09/26/08	**0.67**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.21**
	09/24/09	**0.6**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/12/10	**0.28**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/18/10	**0.22**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/19/11	**0.29**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.25**	ND (0.20)	ND (0.20)
	11/22/11	**0.43**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.22**
	05/24/12	**0.27**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.20**
	11/08/12	**0.44**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/04/21	**0.33**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/03/22	**0.31**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
Medium Monitoring Wells											
MW-1M (231.8 to 229.3)	07/21/00	**0.8**	**0.45**	**5**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/15/01	**0.87**	ND (0.20)	**0.95**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/20/02	**0.69**	**0.24**	**0.93**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/26/03 (B&C)	**1.91**	**0.52**	**2.74**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/16/06	**0.65**	**0.25**	**1.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/14/07	**0.76**	**0.89**	**6**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/07	**0.6**	ND (0.20)	**0.45**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/13/08	**0.6**	**0.39**	**5.9**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.32**	ND (0.20)	ND (0.20)
	09/26/08	**0.49**	ND (0.20)	**0.41**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/09	**0.63**	ND (0.20)	**0.5**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/12/10	**0.43**	ND (0.20)	**2.4**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/18/10	**0.55**	ND (0.20)	**0.68**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/19/11	**0.38**	ND (0.20)	**1.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.26**	ND (0.20)	ND (0.20)
	11/22/11	**0.42**	ND (0.20)	**0.26**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	Sample Date	PCE	TCE	cDCE	tDCE	1,1-DCE	1,1-DCA	Vinyl Chloride	1,3-DCB	1,4-DCB	Chloroform
	MTCA CUL	***5***[a]	***5***[a]	***16***[b]	***160***[b]	***400***[b]	***7.7***[b]	***0.2***[a]	**–**	***8.1***[b]	***1.4***[b]
MW-1M (continued)	05/24/12	**0.36**	ND (0.20)	**0.82**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/08/12	**0.63**	ND (0.20)	**0.24**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/04/21	**0.32**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/03/22	**0.29**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
MW-3 (232.2 to 229.7)	07/21/00	**0.69**	ND (0.20)	**1.1**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/12/01 (B&C)	**0.66**	ND (0.20)	**0.23**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/17/01 (B&C)	**0.64**	ND (0.20)	**1.3**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/15/01	**0.66**	ND (0.20)	**0.88**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/15/01	**0.57**	ND (0.20)	**0.73**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/20/02	**0.66**	**0.31**	**1.3**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/20/02	**0.52**	ND (0.20)	**0.93**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/19/02	**0.57**	ND (0.20)	**0.79**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/20/02	**0.57**	ND (0.20)	**0.84**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.37**
	02/20/03	**0.68**	ND (0.20)	**1.1**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/21/03	**0.5**	ND (0.20)	**0.91**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/21/03	**0.54**	ND (0.20)	**0.69**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/26/03 (B&C)	**0.87**	ND (0.20)	**1.05**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/03/04 (B&C)	**0.6**	ND (0.20)	**1.03**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
Deep Monitoring Wells											
MW-1d (208.5 to 206.0)	07/21/00	**0.5**	ND (0.20)	**0.29**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/15/01	**0.64**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/20/02	**0.52**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/26/03 (B&C)	**0.7**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/16/06	**0.32**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	**Sample Date**	**PCE**	**TCE**	**cDCE**	**tDCE**	**1,1-DCE**	**1,1-DCA**	**Vinyl Chloride**	**1,3-DCB**	**1,4-DCB**	**Chloroform**
	MTCA CUL	***5*** [a]	***5*** [a]	***16*** [b]	***160*** [b]	***400*** [b]	***7.7*** [b]	***0.2*** [a]	**–**	***8.1*** [b]	***1.4*** [b]
MW-1D (continued)	02/14/07	**0.24**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/07	**0.37**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/13/08	**0.24**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.29**	ND (0.20)	ND (0.20)
	09/26/08	**0.32**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.22**
	09/24/09	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/12/10	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/18/10	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/19/11	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.28**	ND (0.20)	**0.27**
	11/22/11	**0.24**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/24/12	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.21**
	11/08/12	**0.31**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.2**
	08/04/21	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/03/22	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
MW-2D (198.1 to 195.6)	07/21/00	**0.73**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/16/01	**1.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/21/02	**1.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/26/03 (B&C)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/17/06	**4.5**	**0.28**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	02/14/07	**0.78**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/07	**0.45**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	03/13/08	**0.39**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	0.29	ND (0.20)	ND (0.20)
	09/26/08	**0.41**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	09/24/09	**2.2**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/12/10	**0.41**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/18/10	**0.71**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)

Table A-2. HVOC Results for Groundwater Samples Collected at the Lakewood Towne Center Site.

Well Location	Sample Date	PCE	TCE	cDCE	tDCE	1,1-DCE	1,1-DCA	Vinyl Chloride	1,3-DCB	1,4-DCB	Chloroform
	MTCA CUL	***5*** [*a*]	***5*** [*a*]	***16*** [*b*]	***160*** [*b*]	***400*** [*b*]	***7.7*** [*b*]	***0.2*** [*a*]	**–**	***8.1*** [*b*]	***1.4*** [*b*]
MW-2D (continued)	05/19/11	**0.45**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	**0.41**	ND (0.20)	ND (0.20)
	11/22/11	**0.61**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	05/24/12	**0.36**	ND (0.20)	ND (0.50)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	11/08/12	**0.53**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/04/21	**0.54**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
	08/03/22	**0.6**	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)

a = MTCA Method A Cleanup Level for Groundwater from WAC 173-340 Table 720-1.

b = MTCA Method B Cleanup Level for Groundwater for Noncancer or Cancer, whichever is lower, from Department of Ecology Master CLARC tables, August 2023.

Sample results are shown in micrograms per liter (µg/L).

The monitoring well screened elevations are shown in parentheses under the well location. Elevation is relative to NAVD88.

Samples were collected by Herrera Environmental Consultants, unless otherwise indicated.

B&C = Samples collected by Brown and Caldwell.

ND = Not detected. Laboratory reporting limit (RL) is shown in parentheses.

Values shown in **bold** were detected above the laboratory RL.

Values shown in **bold and shaded** were detected above the applicable Cleanup Level.

PCE = Tetrachloroethylene

TCE = Trichloroethylene

cDCE = cis-1,2-Dichloroethene

tDCE = trans-1,2-Dichloroethene

1,1-DCE = 1,1-Dichloroethene

1,1-DCA = 1,1-Dichloroethane

1,4-DCB = 1,4-Dichlorobenzene

1,3-DCB = 1,3-Dichlorobenzene

– = Not available.

APPENDIX B

Sampling and Analysis Plan

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Draft
Sampling and Analysis Plan

Additional Monitoring Well Installations and Groundwater Treatment, Lakewood Towne Center, Lakewood, Washington

Prepared for
Kite Realty Group

Prepared by
Herrera Environmental Consultants, Inc.

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Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will print correctly when duplexed.

Sampling and Analysis Plan

Additional Monitoring Well Installations and Groundwater Treatment, Lakewood Towne Center, Lakewood, Washington

Prepared for
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1. INTRODUCTION

This Sampling and Analysis Plan (SAP) describes the methodology for additional characterization of groundwater and soil at the Lakewood Towne Center Site in Lakewood, Washington. This SAP includes a Quality Assurance Project Plan (QAPP) and provides the overall study design, team responsibilities, project phases, sample collection methods, chemical analysis, quality assurance methods, and data reporting requirements.

Lakewood Towne Center is located at 5731 Main Street Southwest in Lakewood, Washington (Figure 1). The Site, where sampling activities covered under this SAP will occur, is located in the northwest corner of the shopping center from 5815 to 6111 Lakewood Towne Center Boulevard Southwest (Figure 2). The commercial shopping center complex has undergone multiple renovations and redevelopment since the area was originally developed in the 1950's and currently includes multiple parcels managed by Kite Realty Group (KRG). Soil and water quality have been characterized at the Site by Herrera Environmental Consultants (Herrera) since early 2000, however some data gaps remain. This SAP is designed to close those data gaps by obtaining additional data via sampling of soils, installing new groundwater monitoring wells, and collection additional groundwater samples.

The goal of this SAP is to document procedures to be used for sample collection, field analysis, laboratory analysis, and data analysis to ensure high quality, scientifically defensible results. This document includes the following sections:

- Project Background
- Project Team and Responsibilities
- Data Collection and Sample Handling Methods
- Laboratory Methods
- Quality Assurance and Quality Control Methods
- Reporting.

Refer to the main text of the Work Plan for additional information regarding the site geology and hydrogeology, and environmental history.

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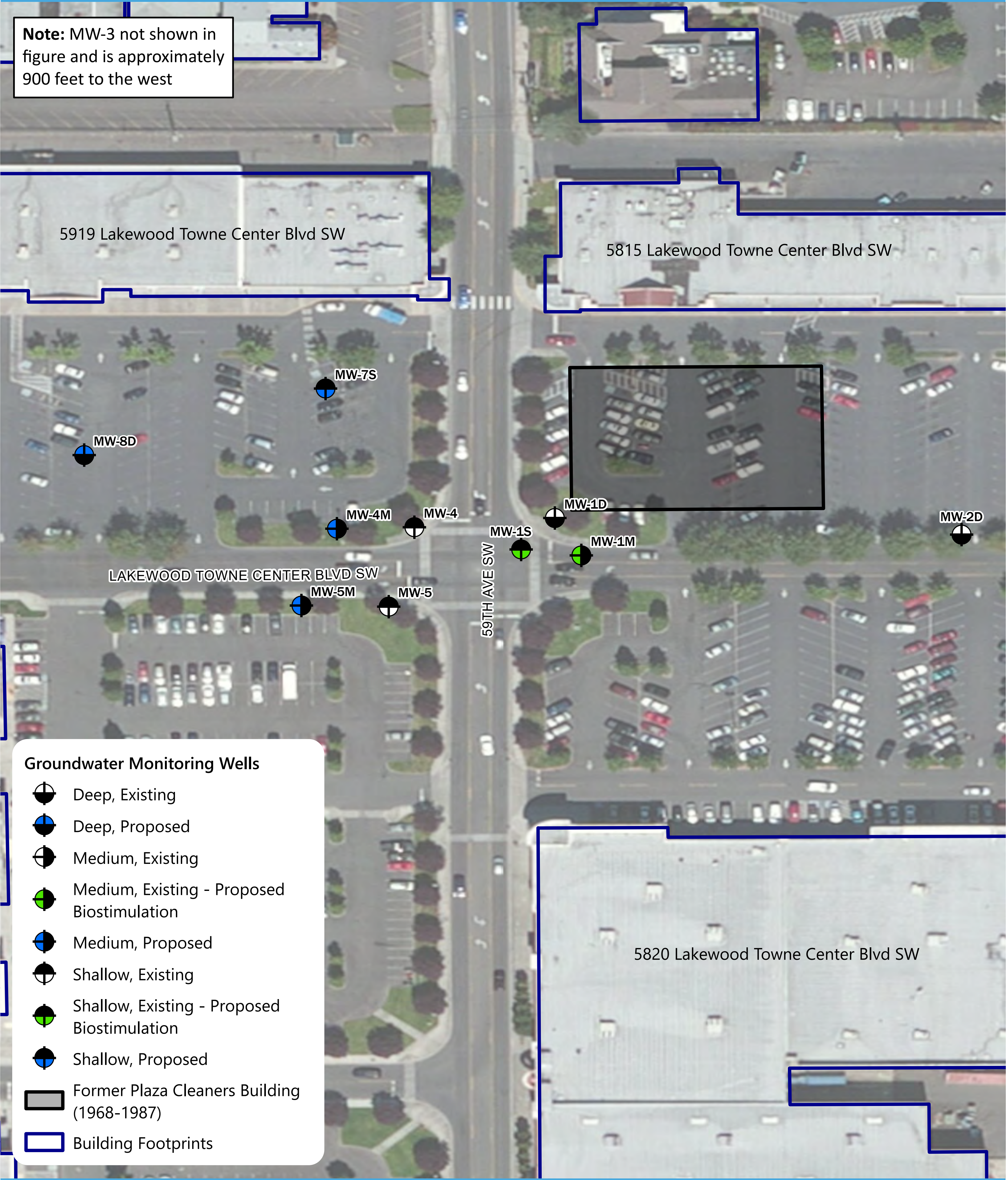
Figure 1.
Vicinity Map.

Author: bBagniewski Date: 9/27/2023 File Path: K:\Projects\Y2021\21-07668-000\Pro\Lakewood_Towne_Center_Monitoring\Lakewood_Towne_Center_Monitoring.aprx\Fig1_Vicinity

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: WSDOT, Pierce County, Esri Clarity (Imagery, 2022)

Figure 2.
Site Map and Proposed Groundwater Monitoring Locations.



Note: MW-3 not shown in figure and is approximately 900 feet to the west

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: Pierce County, Microsoft, Esri Imagery (2022)

Author: bBagniewski Date: 10/2/2023 File Path: K:\Projects\Y2021\21-07668-000\Pro\Lakewood_Towne_Center_Monitoring\Lakewood_Towne_Center_Monitoring.aprx\Fig2_SiteMap

2. PROJECT BACKGROUND

Refer to Section 3 – Previous Investigations in the Work Plan for project background information.

3. PROJECT TEAM AND RESPONSIBILITIES

Activities for the monitoring well installation, groundwater sampling, and groundwater treatment will include: (1) project planning and agency coordination, (2) field sample collection, (3) laboratory preparation and analysis, (4) data evaluation and quality assurance/quality control (QA/QC) review, and (5) a draft and final data report. Initial staffing and responsibilities are outlined below that may change through the course of the project.

3.1. Project Planning and Coordination

The KRG Project Manager and Technical Lead will be Ms. Sara Abdelrahman. The Project Manager is responsible for all technical aspects of the contract and coordinates the contract administration. The Project Manager ensures the technical requirements of the contract are met, monitors contract performance and maintains communication with the Consultant. Ms. Abdelrahman will also review the regulatory requirements with the Consultant to ensure that they are met. She also will assist in technical matters related to the sampling plan and program and will provide review comments to the Consultant.

KRG Project Manager and Technical Lead

Ms. Sara Abdelrahman
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The consultant, Herrera Environmental Consultants, Inc. (Herrera), is responsible for SAP preparation, field sampling, and reporting. George Iftner will serve as the Consultant Project Manager for Herrera, and will be responsible for coordinating project activities and submitting deliverables to KRG. Any significant deviation from the approved sampling plan will be discussed and coordinated with the KRG Project Manager. He will also serve as the Principal Investigator for Herrera and will be responsible for the overall quality control of the project.

Mr. Iftner will direct the field sampling program. He will conduct field collection of soil, groundwater and seep, surface water, and sediment grab samples, coordinate drilling and equipment logistics, ensure conformance to the sampling and handling requirements, maintain the field log, and schedule personnel and subcontractor services. Mr. Iftner will also serve as the Site Safety Officer. A drilling contractor will be responsible for completing HSA borings, well completions and facilitating the collection of soil samples.

Consultant Project Manager/Principal Investigator

Mr. George Iftner
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Mr. Rob Zisette of Herrera will serve as the Quality Control Supervisor for Herrera and will be responsible for overall quality control of all project activities. Rob Zisette will also serve as the Data Quality Control Manager to provide laboratory coordination, QA/QC oversight of analytical laboratory procedures, data review and management coordination, and assurance that reported data are valid and usable in accordance with this SAP.

Quality Control Supervisor

Mr. Rob Zisette
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Mr. Jess Brown of Herrera will serve as the Data Quality Reviewer to provide EPA Level 2 validation and QA1 validation (for sediment samples) in accordance with the SAP objectives and procedures.

Data Quality Reviewer

Mr. Jess Brown
24 NW 2nd Avenue
Seattle, WA 97209
503.228.4301
jbrown@herrerainc.com

Mr. David Baumeister of OnSite Environmental, Inc., in Redmond, Washington, will serve as the Analytical Laboratory Project Manager, and will be responsible for the testing and reporting of all conventional and chemical analytes.

Analytical Laboratory Project Manager

David Baumeister
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4. SAMPLING PLAN

This section describes the monitoring well installation, baseline groundwater sampling, and subsequent quarterly groundwater sampling events at the Site. The following field activities and associated soil and groundwater sampling for laboratory analysis will be performed:

- Four new groundwater monitoring wells will be installed downgradient of the source area near MW-1S. MW-4M and MW-5M will each be installed to a depth of 30 feet below ground surface (bgs), MW-7S will be installed to 15-feet bgs, and MW-8D will be installed to 50-feet bgs. Two soil samples will be collected from each boring, including one from the 0- to 10-foot depth interval in the vadose zone and one from the bottom of the boring.
- Seven rounds of quarterly water levels will be recorded at the 11 monitoring wells located on the site.
- Seven rounds of quarterly groundwater samples will be collected from 10 monitoring wells located on the site, excluding MW-3.

The proposed monitoring well locations and screened depths have been selected to determine the lateral and vertical extent of contamination in groundwater at the site. New monitoring wells will be surveyed after installation.

Table 4-1 provides a summary of the sample locations, sample types, sample numbers, and analytical requirements.

Table 4-1 Samples to be Collected at Lakewood Towne Center.

Sampling Location	Sample Type	Maximum Number of Samples	Analytical Requirements
Soil borings for MW-4M, MW-5M, MW-7S, MW-8D	Soil sample	9: Two samples from each of 4 borings plus 1 field duplicate	Halogenated VOCs (including PCE and daughter products)
Groundwater monitoring wells MW-1S, MW-1M, MW-1D, MW-2D, MW-4, MW-4M, MW-5, MW-5M, MW-7S, MW-8D	Groundwater sample	77 Samples: One from each of 10 wells x 7 events (70) plus 1 duplicate per event	Halogenated VOCs (including PCE and daughter products)
Groundwater monitoring wells MW-1S, MW-1M	Groundwater sample	8: One from each of 2 wells x baseline plus 3 events (8)	TOC, Sulfate, Fe and Mn (Dissolved), N and P (Total)

VOCs = Volatile organic compounds

PCE = Perchloroethylene

TOC = Total organic carbon

Fe, Mn = Iron, manganese

N, P = Nitrogen, phosphorus

4.1. Field Work and Sample Collection Methods

Monitoring well installation and soil and groundwater sample collection methods are described in the following subsections and the proposed sampling locations are depicted on Figure 2. Soil and groundwater types, containers, holding times, preservation, and storage requirements are summarized in Table 4-2.

Table 4-2. Summary of Data Quality Objectives, Sample Containers, Preservation, and Holding Times for Lakewood Towne Center.

Parameter	Units	Reporting Limits	Accuracy (%)	Precision (%)	Method Number	Bottle/ Preservative	Maximum Holding Time
Soil							
HVOCs	µg/kg	1.0-5.0	52-132	31	EPA Method 8260D	1 x Glass Jar 2 x 40 mL GV with stir bar Cool to 4°C	48 hours to preserve, 14 days to analyze
Groundwater							
HVOCs	µg/L	0.020-5.0	52-132	31	EPA Method 8260D	3 x 40 mL GV/HCl Cool to 4°C	14 days to analyze
Total Organic Carbon	mg/L	1.0	86-127	13	SM 5310B/ EPA 9060A	1 x 250 mL HDPE/HCl Cool to 4°C	28 days to analyze
Sulfate	mg/L	5.0	73-127	10	ASTM D516-11	1 x 250 mL HDPE/HCl Cool to 4°C	28 days to analyze
Iron (dissolved)	µg/L	56	75-125	20	EPA 200.7	1x 500 mL HDPE/HNO3 Cool to 4°C	6 months to analyze
Manganese (dissolved)	µg/L	11	75-125	20	EPA 200.8	1x 500 mL HDPE/HNO3 Cool to 4°C	6 months to analyze
Total Nitrogen	mg/L	0.25	83-117	25	EPA 351.2/ SM 4500-Norg	1 x 250 mL HDPE/H2SO4 Cool to 4°C	28 days to analyze
Total Phosphorus	mg/L	0.010	81-114	17	EPA 365.1	1x 250 mL HDPE/H2SO4 Cool to 4°C	28 days to analyze

HVOCs = Halogenated volatile organic compounds

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

mg/L = milligrams per liter

mL = milliliter

GV = Glass VOA

HDPE = high density polyethylene

HCl = Hydrochloric acid preservative (lab provided)

HNO3 = Nitric acid preservative (lab provided)

H2SO4 = Sulfuric acid preservative (lab provided)

4.1.1. Monitoring Well Surveying

Prior to installing new monitoring wells, the ground elevation and top of well casing at all seven existing monitoring wells (MW-1S, MW-1M, MW-1D, MW-2D, MW-3, MW-4, and MW-5) will be surveyed by a licensed surveyor, Sitts & Hill Engineers, Inc. (Sitts & Hill), of Tacoma, Washington. At the same time, Herrera will collect one round of static groundwater levels from all existing wells.

4.1.2. Pre-Drilling Activities

Prior to commencing drilling activities, a public underground utility one-call will be performed, and public utilities will be marked by utility companies with underground utilities in the area of the proposed drilling locations. A private utility locate service will also be retained to locate utilities at each proposed boring location.

4.1.3. Soil Sample Collection from HSA Borings

The four new monitoring wells will be installed with a hollow-stem auger (HSA) drill rig equipped with 4 inch inside diameter augers. Shallow depth monitoring well MW-7S will be installed downgradient of the source area and approximately 16 feet below ground surface (bgs). MW-7S will be screened within the upper portion of the water column within the Steilacoom gravel layer. Medium depth monitoring wells MW-4M and MW-5M will be installed adjacent to existing shallow wells MW-4 and MW-5, respectively, to approximately 30 feet bgs. MW-4M and MW-5M will be screened within the approximate middle of the water column within the Steilacoom gravel layer. Deep monitoring well MW-8D will be installed downgradient of the source area and approximately 55 feet bgs. MW-8D will be screened at the bottom of the water column within the Steilacoom gravel layer, directly above the Vashon till layer.

Soil samples will be collected from each boring every 5 feet using an 18-inch, split spoon sampler. The soil will be visually inspected for staining and classified in accordance with the Unified Soil Classification System (USCS; ASTM International [ASTM] D2488-09), and a PID instrument will be used to screen soil for VOCs (see calibration manual in Attachment A). Two soil samples from each boring will be collected and submitted for lab analysis for VOCs. One sample from 0 to 10 feet bgs and one sample near the bottom of each boring will be collected. Sample collection intervals for lab analysis will be adjusted in the field depending on observations of potential soil contamination, such as odors, staining, sheen, or elevated PID readings. Each sample will be uniquely labeled, denoting a unique sample identification location and depth, date and time sampled, and the sample site. Soil samples will be placed directly into a chilled cooler for storage prior to delivery to the analytical laboratory. Pre-weighted sample vials will be filled to comply with EPA Method 5035A for sample collection for VOC analysis. Following soil sample collection, a monitoring well will be installed in each boring.

4.1.4. Monitoring Well Installation and Development

Monitoring wells will be constructed with 2-inch Schedule 40 PVC. Wells will be constructed with 2.5 foot long 0.020-inch slotted screens and the top of each well casing will consist of blank 2 inch PVC pipe. Each well will be completed at the ground surface with a flush-mounted steel monument sealed in concrete. The new wells will be surveyed by Sitts & Hill after installation.

Following installation, new monitoring wells will be developed with a submersible pump. Groundwater will be removed from each monitoring well across the screened interval until suspended solids (sand and silt) are reduced and the water removed from the well is generally of clear quality.

4.1.5. Groundwater Sample Collection

Following the installation of the four new monitoring wells (MW-4M, MW-5M, MW-7S, and MW-8), Herrera will collect up to seven rounds of quarterly groundwater samples from ten onsite wells, excluding MW-3. General procedures for collecting groundwater samples from monitoring wells will be as follows:

- Remove the well monument cover and inspect the condition of the well and surrounding area. Note observations in the field notebook or on the well sampling log. Unlock and remove the well casing plug.
- Using an electric water level indicator, measure the depth to groundwater to the nearest 0.01 foot. Record date, time, and measurements in the field notebook or on the well sampling log.
- Place clean 0.25-inch polyethylene tubing into the well within the center of the screened zone to draw water from the formation.
- Connect the tubing to the peristaltic pump and begin purging at a low flow rate, less than one liter per minute. Drawdown should not exceed 0.33 foot and should approximate the estimated well recovery rate.
- Purge one tubing volume of water from the well and then begin recording water quality indicator parameters, including pH, specific conductance, dissolved oxygen, oxidation-reduction potential (ORP), and temperature at 5-minute intervals using a multi-meter (see Attachment A for multi-meter user manual). The water level and flow rate will also be monitored at 5-minute intervals. Record all measurements on the well sampling log.
- When drawdown, flow rate, and the parameters have stabilized after three successive readings, the sample may be collected.
    - Sample stabilization criteria are as follows: ±0.1 for pH, ±3 percent for specific conductance, and ±0.3 milligrams per liter for dissolved oxygen. ORP may not stabilize during purging.
- If well stabilization does not occur, increase the flow rate to approximately one gallon per minute and purge three volumes of water from the well. Record field parameters after removing each volume of water. Sample collection may occur upon removing three volumes from the well, assuming the indicator parameters have stabilized. Sample collection may occur regardless of indicator parameter stabilization when five well volumes have been removed.
- Following purging, fill the laboratory approved sample containers using the peristaltic pump.
- Securely cap, label, and place sample containers into a chilled cooler for storage prior to delivery to the laboratory.
- Record the date and time of sample collection on the chain-of-custody form.
- Replace the well casing plug, lock, and well monument cover.

4.1.6. Groundwater Treatment

As described in Section 4.4.3 of the Work Plan, groundwater treatment will consist of in-situ chemical oxidation (ISCO) designed by Tersus Environmental (Tersus 2022). The treatment will be implemented by Holocene Drilling (Holocene) and overseen by Herrera to address low concentrations of VC in groundwater above the MTCA CUL. Modulated TersOx Liquid™ and nutrients will be injected into existing shallow and medium monitoring wells MW-1S and MW-1M, respectively, to accelerate the aerobic degradation of VC. If a decline in contamination concentrations does not occur, Tersus and Herrera will evaluate supplemental treatment options.

4.1.7. Sample Identification

The following sample identification codes will be used for project samples:

- Soil samples will be identified using the monitoring well location ID for the soil boring followed by the depth the sample was collected from. For example: MW-4M-2 reflects the sample collected from soil boring MW-4M from the 2-foot interval.
- Groundwater samples will be identified using the monitoring well location ID, such as MW-4M.

4.1.8. Sample Storage and Delivery

All sample containers will be stored in insulated coolers and preserved by cooling with ice or frozen gel-packs. Maximum sample holding and extraction times will be strictly adhered to by field personnel and the analytical laboratories. Sample containers may be placed in plastic bubble-pack bags or wrapped in bubble pack and secured with packaging tape.

Samples for chemical analyses will be hand-carried to the analytical laboratory at the completion of each sampling event and accompanied by the chain-of-custody record, which identifies the cooler contents. The chain-of-custody form will be signed by the individual relinquishing samples to the laboratory.

4.1.9. Field Documentation

A complete record of field activities will be maintained. Documentation necessary to meet QA objectives for this Project include field notes and field forms, sample container labels, and chain-of-custody forms. The field documentation will provide descriptions of all sampling activities, sampling personnel, and weather conditions, and will record all modifications, decisions, and/or corrective actions to the study design and procedures. In addition, photographs of the grab samples will be included in the field documentation.

4.1.10. Field Logbooks

Sampling activities will be documented in a dedicated field notebook. The notebook will be labeled with the project name, project identification number, dates of field activities, and the name and phone number of the project manager. All relevant activities will be recorded in the field notebook during the sample collection period. Entries into the field notebook will be made in permanent ink. Corrections will be made by placing a single line through the original entry and the initials of the person entering the correction. At a minimum, information in the field notebook will include:

- Date and atmospheric weather conditions
- Activities to be performed
- Name(s) of sampling personnel
- General condition of sampling area
- Start and stop times of work
- Any unusual events or occurrences
- Description of soil profile.

Field logbooks are intended to provide sufficient data and observations to enable participants to reconstruct events that occur during Project field activities. Entries should be factual, detailed, and objective. Unless restricted by weather conditions, all original data recorded in field logbooks and on sample identification labels, chain-of-custody records, and field forms will be written in waterproof ink. If an error is made, the individual responsible may make corrections simply by crossing out the error and entering the correct information. The erroneous information should not be obliterated. All corrections must be initialed and dated. All documentation, including voided entries, must be maintained within Project files.

4.1.11. Chain-of-Custody Procedures

Samples will be retained at all times in the field crew's custody until samples are delivered to the laboratory by Herrera personnel. Chain-of-custody forms will be initiated at the time of sample collection to ensure that all collected samples are properly documented and traceable through storage, transport, and analysis. Information tracked by the chain-of-custody records will include sample identification, date and time of sample collection and receipt, and analyses required. When all line items on the form are completed or when the samples are relinquished, the sample collection custodian will sign and date the form, list the time, and confirm the completeness of all descriptive information contained on the form. Each individual who subsequently assumes responsibility for the samples will sign and date the chain-of-custody form.

The field chain-of-custody terminates when the laboratory receives the samples. The field sample custodian should retain a copy of the completed, signed chain-of-custody form(s) for Project files. Upon receipt of samples at the laboratories, the shipping container seal will be broken and the receiver will record the condition of the samples. The laboratories will maintain chain-of-custody internally to track handling and final disposition of all samples.

4.2. Equipment Decontamination Procedures

Decontamination will be performed on all sampling equipment potentially exposed to contaminated soil between sampling locations. All sampling equipment will be decontaminated prior to entry in the field. Chemical-resistant gloves worn during sample collection will be changed between each sample location.

Decontamination of groundwater sampling equipment is only required for the water level indicator and will follow the same decontamination procedure for soil sampling equipment (below). Clean, dedicated polyethylene tubing will be used during groundwater sample collection.

4.2.1. Soil Sampling Equipment Decontamination

The following decontamination procedure will be used for soil sampling equipment:

- Rinse with tap water
- Scrub with water and Liquinox detergent
- Rise with tap water
- Rinse with deionized water.

4.3. Waste Disposal

4.3.1. Disposal of Incidental Trash

Incidental trash generated during this investigation (including discarded nitrile gloves, used Ziploc® bags, paper towels) will be placed in plastic trash bags and disposed of as solid waste.

4.3.2. Disposal of Soil Cuttings and Investigation-Derived Water

Soil cuttings will be placed into 55-gallon drums. Decontamination solutions, rinse water, and purge water will be placed into 55-gallon drums. Soil and water drums will be stored in the storage room on the backside of the building located at 5815 Lakewood Towne Center Boulevard, and disposal in appropriately permitted facilities will be arranged by Herrera pending analytical results.

4.4. Laboratory Analyses

Mr. David Baumeister of OnSite Environmental, Inc. (OnSite), in Redmond, Washington, will serve as the Analytical Laboratory Project Manager, and will be responsible for the testing and reporting of all conventional and chemical analytes. The analytical laboratory will handle and analyze the submitted samples in accordance with EPA-approved methods. The analytical laboratory report and QA/QC results will be included as appendices in the final data report.

Analytical Laboratory Project Manager

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425-883-3881
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4.5. QA/QC Management

Rob Zisette of Herrera will serve as the Consultant Quality Control Supervisor for Herrera and will be responsible for overall quality control of all project activities. Rob Zisette will also serve as the Data Quality Control Manager to provide laboratory coordination, QA/QC oversight of analytical laboratory procedures, data review and management coordination, and assurance that reported data are valid and usable in accordance with this SAP. George Iftner of Herrera will be responsible for QA/QC management of the field sampling, sample processing, and reporting elements of the project. The KRG Project Manager will be notified immediately of any activities that vary from the written SAP. Mr. Jess Brown of Herrera will serve as the Data Quality Reviewer to provide EPA Level 2 validation in accordance with the SAP procedures.

4.6. Reporting

Herrera will prepare data tables and figures for all data collected, describe the field investigation work and any deviations from the SAP, and summarize and analyze the results within a technical memorandum (memo, Section 7). The memo will also include an analysis of the data collected and updates to the Conceptual Site Model (CSM). All laboratory data and a data validation memo will be included as an attachment to the memo. The technical memo and associated data validation memo will cover all of the following:

- Field sampling methods, including a summary of sampling and laboratory analysis, and QA/QC procedures
- Any deviations from the SAP
- Sample locations depicted in figures and tables
- Laboratory analyses conducted for each sample
- Chemistry results with both laboratory and data validation qualifiers
- A summary of QA/QC data, including data validation results
- Interpretation and comparison of results to CULs in tabular format.

5. LABORATORY METHODS

All chemical analytical testing procedures used in this Project will be performed in accordance with EPA-approved methods. Laboratory analysis will be performed by OnSite, a Washington Department of Ecology accredited laboratory, for all analytical methods to be used for this Project and has instituted internal QA/QC plans accordingly. Analyses will be required to conform to accepted standard methods and internal QA/QC checks prior to final approval.

5.1. Analytical Methods

Soil and groundwater samples will be submitted to OnSite for chemical analyses. The specific analyses and conventional parameters to be measured, analytical methods, and target reporting limits (RLs) are presented in Table 4-2. Actual sample RLs may vary due to analytical dilutions, percent solids, sample volumes used for analysis, and matrix interferences.

5.1.1. Detection Limits and Sample Analysis Scenarios

The samples collected for characterization will be analyzed for the parameters listed in Table 4-2. Laboratory RLs for all COCs are below applicable CULs.

5.1.2. Holding Times

All samples for chemical testing will be maintained at the laboratory at appropriate temperatures and will be analyzed prior to the expiration time specific in Table 4-2.

5.1.3. Quality Assurance/Quality Control

The chemistry QA/QC procedures summarized in Table 5-1 will be conducted to ensure data quality and usability for groundwater and soil characterization.

Table 5-1. Quality Assurance Requirements and Anticipated Number of Samples.

Parameter	Number of Samples	Laboratory Method Blanks[a]	Laboratory Control Standard[a]	Matrix Spike[a]	Lab Duplicates[a]	Field Duplicates	Trip Blanks
Soil							
HVOCs	8	1	1	1	1	0	1
Groundwater							
HVOCs	70	7	7	7	7	7	7
Total Organic Carbon	8	4	4	4	4	4	0
Sulfate, Fe, Mn (dissolved)	8	4	4	4	4	4	0
Total Nitrogen	8	4	4	4	4	4	0
Total Phosphorus	8	4	4	4	4	4	0

[a] Laboratory quality assurance samples will be analyzed with each batch of samples submitted to the laboratory for analysis. A laboratory batch will consist of no more than 20 samples.

HVOCs = Halogenated volatile organic compounds

Fe, Mn = Iron, Manganese

5.2. Analytical Laboratory Written Report

Any data qualifiers applied will include descriptions at the time the preliminary data are submitted. Missing information or data not yet reported by the lab will be identified as such. Reports from the chemistry analytical laboratory for this program will be accompanied by sufficient backup data and QC results to enable independent reviewers to evaluate the quality of the data results. Analytical data will be reported in the units specified by the laboratory RLs listed in Table 4-2.

The analytical laboratory deliverables will include the following:

- Case narrative (including any problems encountered, protocol modifications, and/or corrective actions taken)
- Laboratory data qualifiers and a summary of qualifier definitions
- MDLs and RLs for each result
- Sample analytical and QA/QC results with units
- Appropriate method references for all analytical, preparatory, and cleanup methods used during analyses
- Any protocol deviations from the approved sampling plan
- Surrogate recovery results and control limits
- Matrix spike/matrix spike duplicate (MS/MSD) results and control limits
- Laboratory duplicate/triplicate results and control limits

- Method blank and instrument blank results
- Sample custody records (including original chain-of-custody forms)
- Analytical results in an electronic data delivery format.

5.3. Independent Data Validation

All chemistry and conventional parameter data generated as part of this investigation will undergo an EPA Level 2B quality assurance review by Herrera. An EPA Level 2B review represents a level of quality assurance review acceptable for most contaminated site and sediment investigations conducted under MTCA. If data quality concerns are noted, the laboratory will be contacted; and the data will be reanalyzed, qualified, and/or discussed in a data validation checklist. The data validation memorandum will be included as an attachment to the data report.

The analytical laboratory will provide EPA Level 4 chemistry data packages that will allow for the examination of the complete analytical process from calculation of instrument and MDLs, RLs, final dilution volumes, sample size, and wet-to-dry ratios to quantification of calibration compounds and all analytes detected in blanks and environmental samples.

6. QUALITY ASSURANCE AND QUALITY CONTROL METHODS

The purpose of Project QA/QC is to provide confidence in the data results through a system of quality control performance checks with respect to data collection methods, laboratory analysis, data reporting, and appropriate corrective actions to achieve compliance with established performance and data quality criteria. This section presents the QA/QC procedures to ensure that the investigation data are defensible and usable for their intended purpose.

6.1. Measurements of Data Quality

The tolerable limits for the data reported by the laboratory will be measured through precision, accuracy, representativeness, completeness, and comparability. Acceptance criteria for COCs are presented in Table 4-2.

6.1.1. Precision

Precision is a measure of mutual agreement among individual measurements of the same property under prescribed conditions. Precision will be assessed by the analysis of lab duplicates (for conventional parameters and metals) and matrix spike / matrix duplicates (MS/MSDs) (for organics) performed on select samples to determine the reproducibility of the measurements. The relative percent difference (RPD for duplicates) will be compared to the precision objectives listed in Table 4-2.

6.1.2. Accuracy

Accuracy is the degree of agreement of a measurement (or an average of multiple measurements), with an accepted reference or true value, usually expressed as the difference between the two values (measured-true), the difference as a percentage of the true value, or as a ratio. Accuracy is a measure of the bias in the system and is expressed as the percent recovery of spiked (matrix or surrogate spike) samples. Accuracy objectives for the percent recovery of matrix spike samples are listed in Table 4-2. Laboratory control will be analyzed with each batch of samples as a further assessment of analytical accuracy in the absence of matrix effects.

6.1.3. Representativeness

Representativeness expresses the degree to which data accurately and precisely represent an actual condition or characteristic at a particular sampling point. Representativeness is achieved by collecting samples representative of the matrix at the time of collection. Representativeness can be evaluated using replicate samples, additional sampling locations, and blanks.

6.1.4. Completeness

Completeness refers to the number of valid (i.e., not rejected) data points (i.e., all individual parameter results) achieved divided by the total number of data points expected. For this Project, completeness objectives have been established at 95 percent.

6.1.5. Comparability

Comparability is based on the use of established EPA-approved methods for the analysis of the selected parameters. The quantification of the analytical parameters is based on published methods, supplemented with well-documented procedures used in the laboratory to ensure reproducibility of the data.

6.2. QA/QC Samples for Chemical Analysis

Field and laboratory QA/QC samples will be used to evaluate the data precision, accuracy, representativeness, and comparability of the analytical results.

6.2.1. Field QA/QC Samples

6.2.1.1. Field Duplicates

One field duplicate sample will be collected during soil sampling activities. One field duplicate sample will be collected during each groundwater sampling event. Field duplicate results are used to assess the combined precision of the sample collection process and laboratory analysis. Each field duplicate will be designated for the same analyses as the original sample and will be submitted to the laboratory blind with no indication of the associated sample.

6.2.1.2. Trip Blank

One trip blank will be submitted and analyzed for VOCs during each groundwater sampling event. The laboratory will provide a 40 milliliter vial with deionized and micro-filtered pure water that will be stored in the ice cooler with the samples and submitted for laboratory analysis along with the project samples.

6.2.2. Laboratory QA/QC Samples

Laboratory QA/QC samples will consist of method blanks, lab duplicates, MS/MSD pairs, and surrogate compounds. The results of these laboratory QA/QC samples will provide information on the accuracy and precision of the chemical analysis, and will be used to verify that the measured concentrations are acceptable. The specific laboratory QA/QC samples to be analyzed are provided in Table 5-1 which will be analyzed for every 20 samples submitted or for each analytical batch of samples.

7. REPORTING

Refer to Section 5 of the Work Plan main text for a discussion of the planned reporting and schedule for the project.

8. REFERENCES

Tersus. 2022. Vinyl Chloride Remediation Proposal for Lakewood Towne Center Site. Prepared for Herrera Environmental Consultants, Inc. of Seattle, Washington. Tersus Environmental of Wake Forest, North Carolina. November 1, 2022.

ATTACHMENT A

Field Instrument Calibration and Maintenance References

HERRERA
Science + Planning + Design

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MiniRAE 3000
User's Guide

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.

Contents

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.

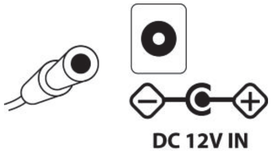
Charging The Battery

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

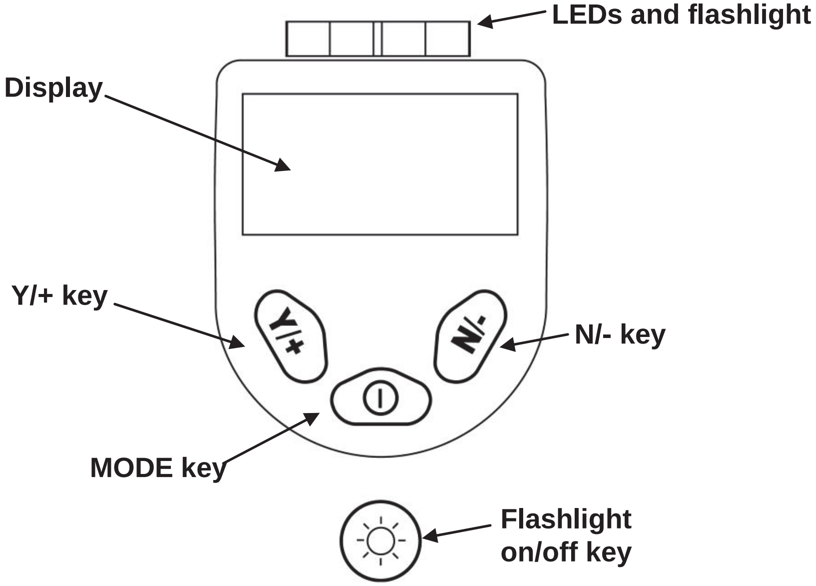
When the instrument is turned off, all the current real-time data including last measured values are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost.

User Interface

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

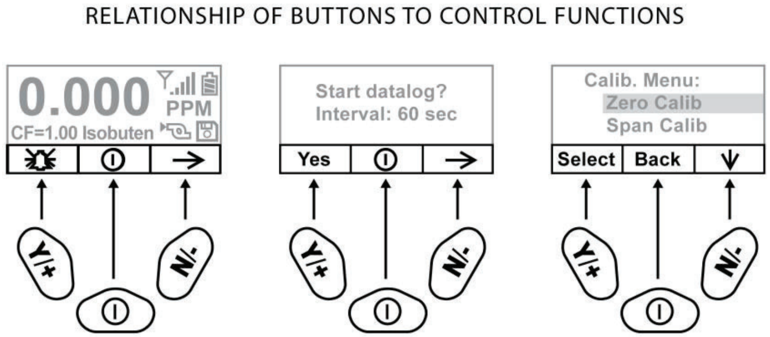
Y/+
MODE
N/-
Flashlight on/off

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



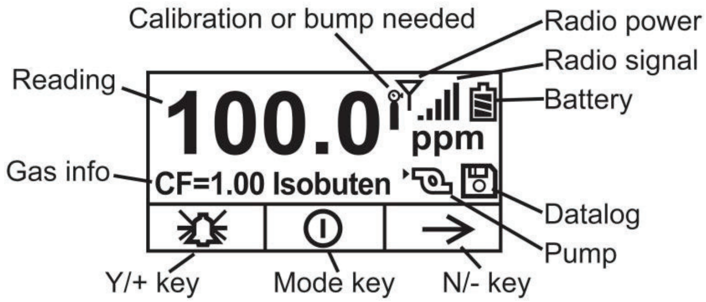
In addition to their labeled functions, the keys labeled Y/+, MODE, and N/- act as "soft keys" that control different parameters and make different selections within the instrument's menus. From menu to menu, each key controls a different parameter or makes a different selection.

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:



Display

The display shows the following information:



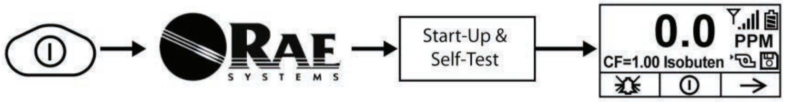
Gas info	Tells the Correction Factor and type of calibration gas
Reading	Concentration of gas as measured by the instrument
Calibration or bump needed	Dark icon indicates that calibration should be performed; light icon indicates bump should be performed
Radio power	Indicates whether radio (Mesh wireless 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”).

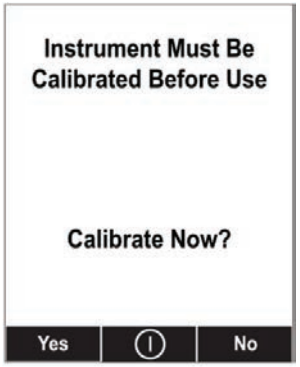
Must Calibrate. The user is prompted to calibrate the instrument when calibration is due (as set by the calibration interval). There are two programmable options:

- **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:

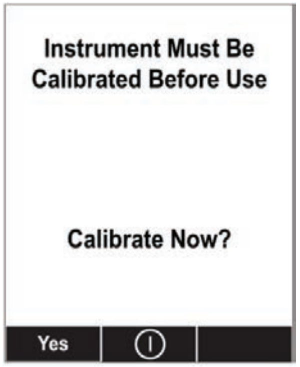

Instrument Must Be Calibrated Before Use

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

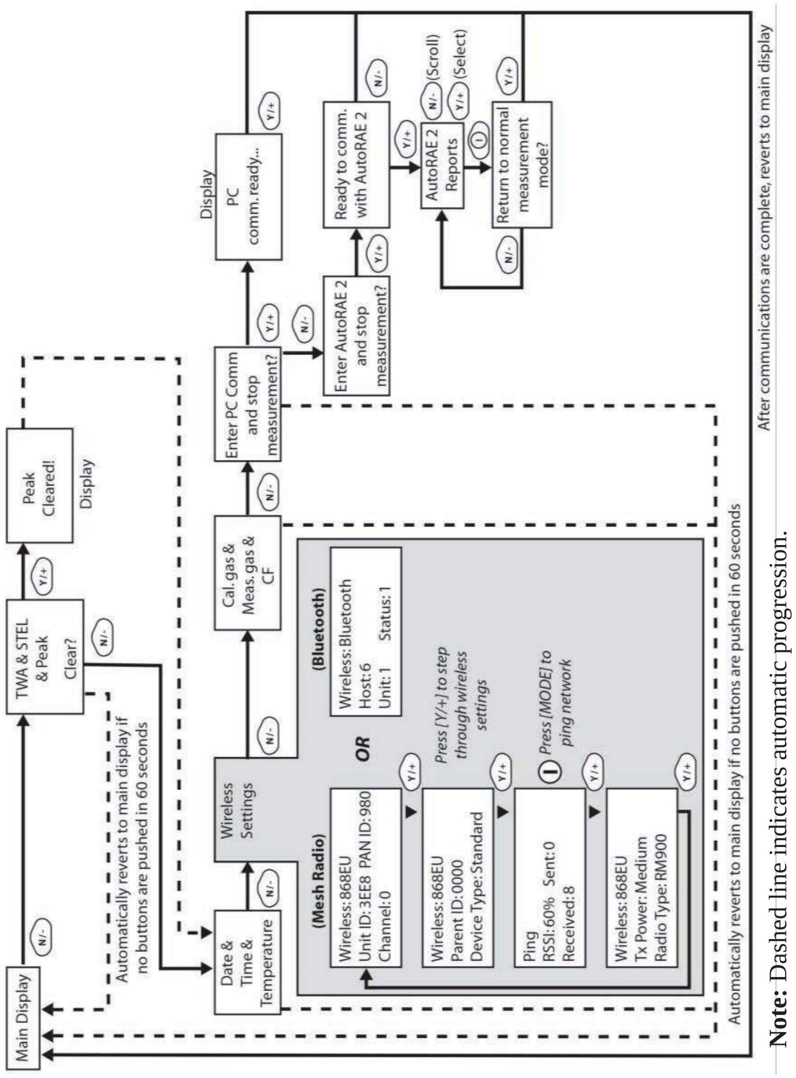
Using ProRAE Studio allows access to other options. In addition, Diagnostic Mode (page 91) is available for service technicians.

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.

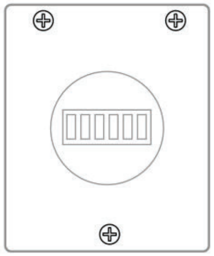
A completely discharged instrument can be charged to full capacity within 8 hours. Batteries drain slowly even if an instrument is off. Therefore, if the instrument has been in storage or has not been charged for several days or longer, check the charge before using it.

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.

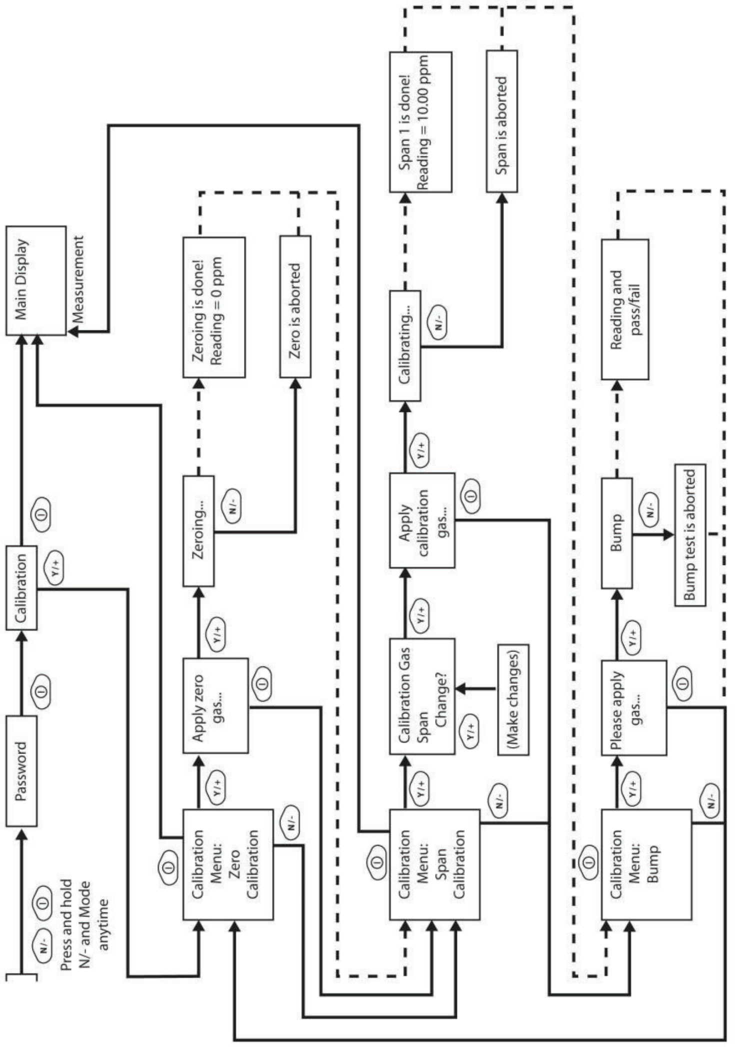
AutoRAE 2 Automatic Test & Calibration System

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)

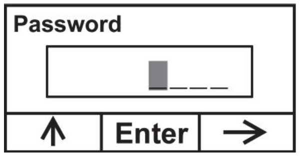
The following diagram shows the instrument’s calibrations in Basic/Hygiene mode.



Note: Dashed line indicates automatic progression.

Entering Calibration

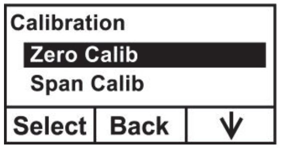
1. Press and hold [MODE] and [N/-] until you see the Password screen.



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.

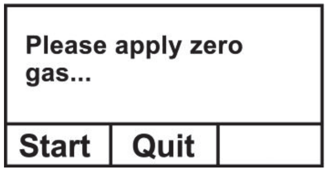
Zero (Fresh Air) Calibration

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

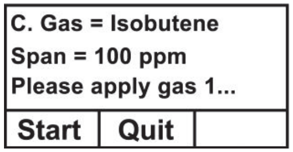
This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only 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.

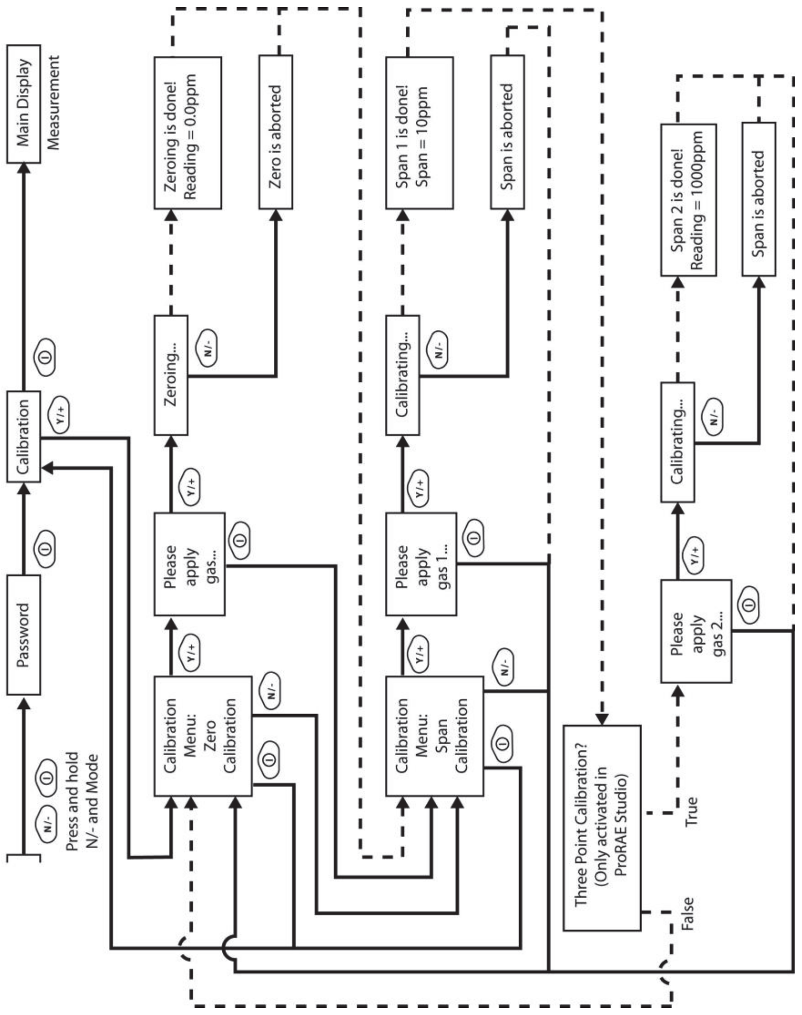
Three-Point Calibration

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!

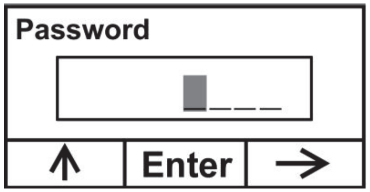
Anytime a bump test fails, you should perform a full calibration of the instrument.

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.



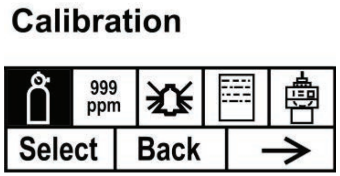
2. Input the 4-digit password:

- 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.

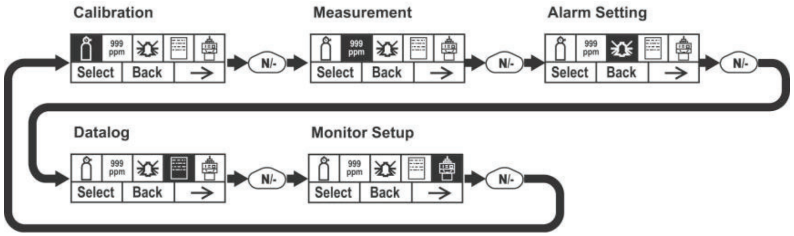
Note: The default password is 0000.

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

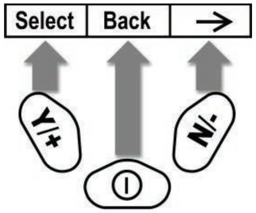
Once you enter Programming Mode, the LCD displays the first menu, Calibration. Each subsequent menu is accessed by pressing [N/-] repeatedly until the desired menu is displayed. To enter a sub-menu of a menu, press [Y/+].

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:



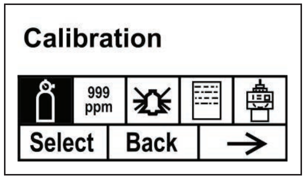
Note: Pressing [MODE] in the Programming Mode's top level causes the instrument to exit Programming Mode and return to monitoring.

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.

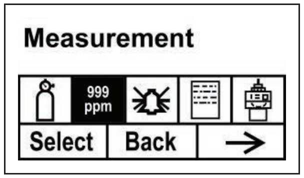
Note: Bump testing and calibration can be performed using an AutoRAE 2 Automatic Test & Calibration System. An AutoRAE 2 bump test takes care of both the sensor and alarm tests. Consult the AutoRAE 2 User's guide for details.

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/-].

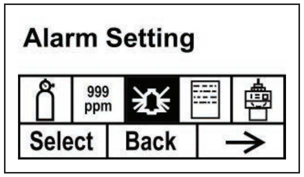
Leave the sub-menu and return to the Programming Mode menus by pressing [MODE].

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

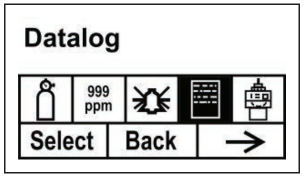
1. Press [N/-] to step from one option to the next.
2. Press [Y/+] to make your selection (the dark circle in the "radio button" indicates your selection).
3. When you have completed your selections, press [MODE].

   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.

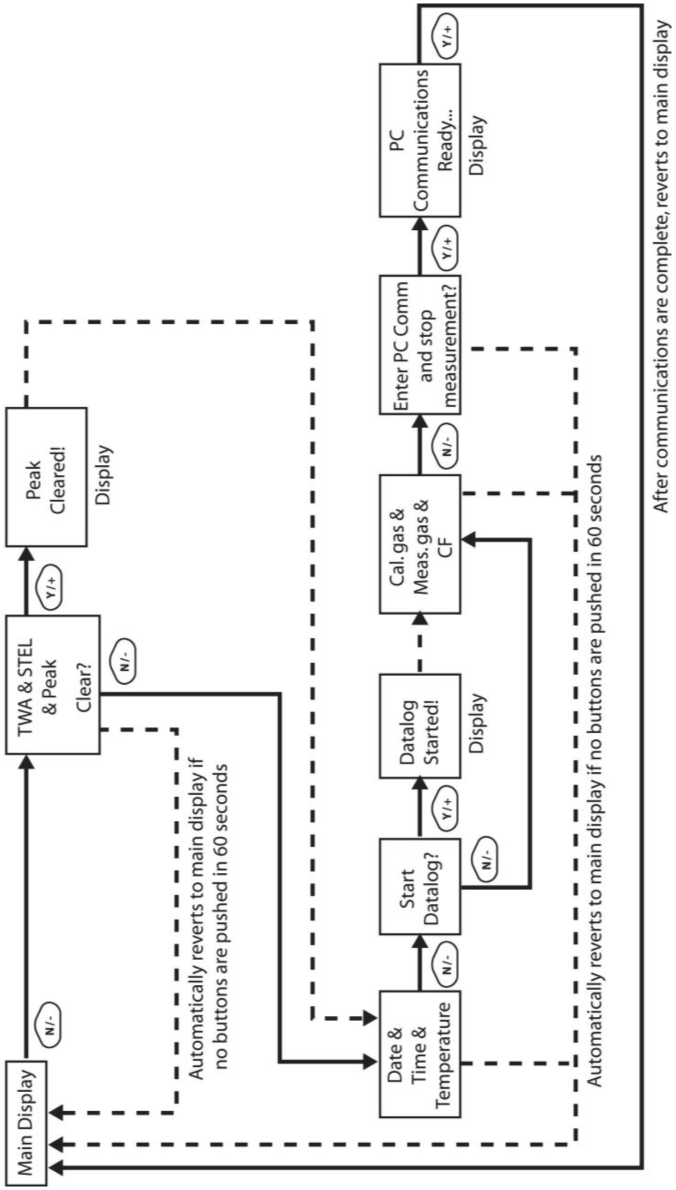
Press [N/-] to undo the changes and revert to the previous settings.

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.

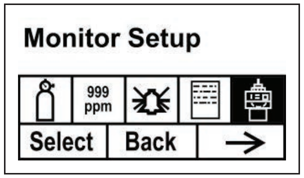
Snapshot Datalog

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].

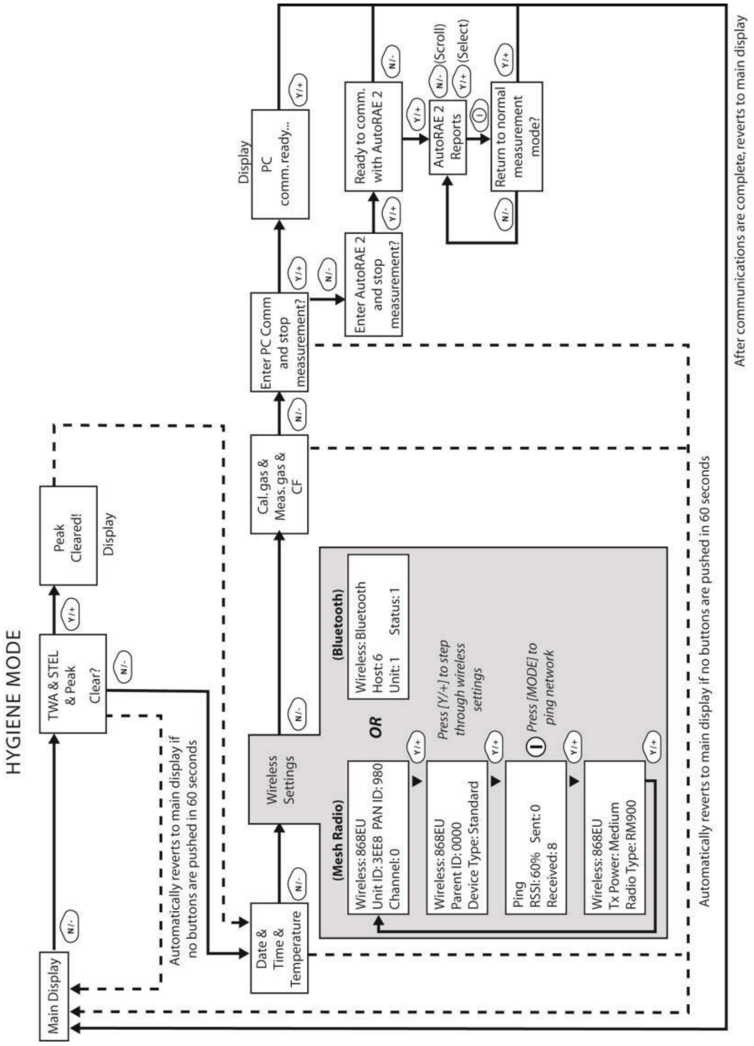
Hygiene Mode

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)

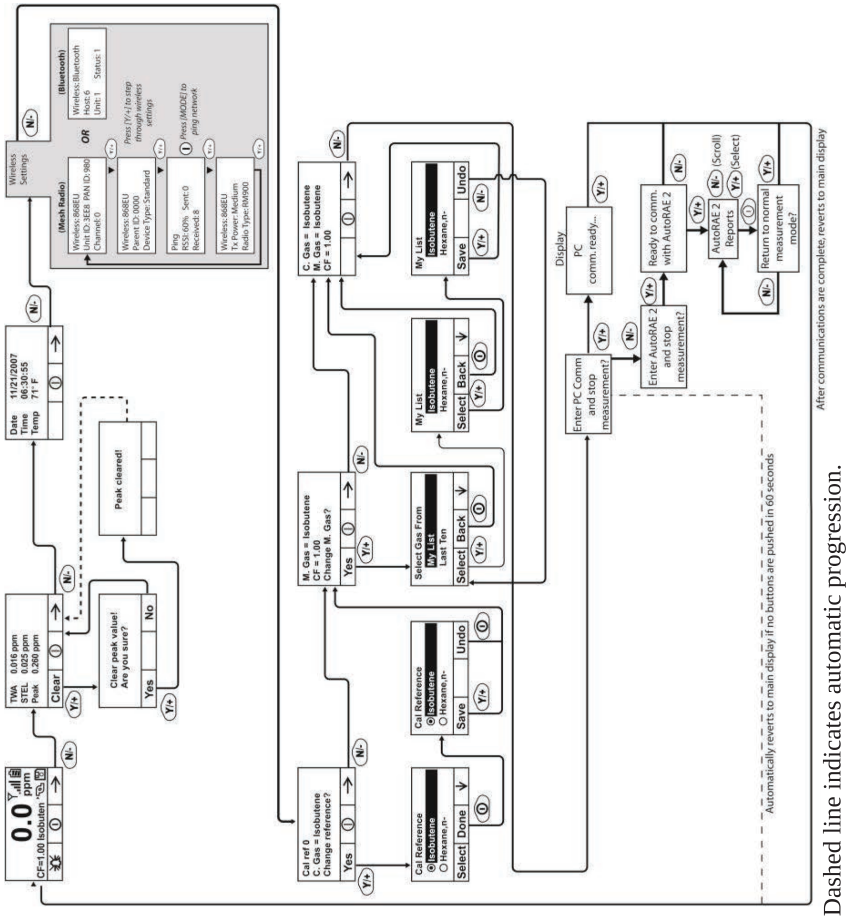
The User Mode called Advanced User Level allows a greater number of parameters to be changed than Basic User Level. It can be used with either of the Operation Modes, Hygiene Mode or Search Mode.

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.

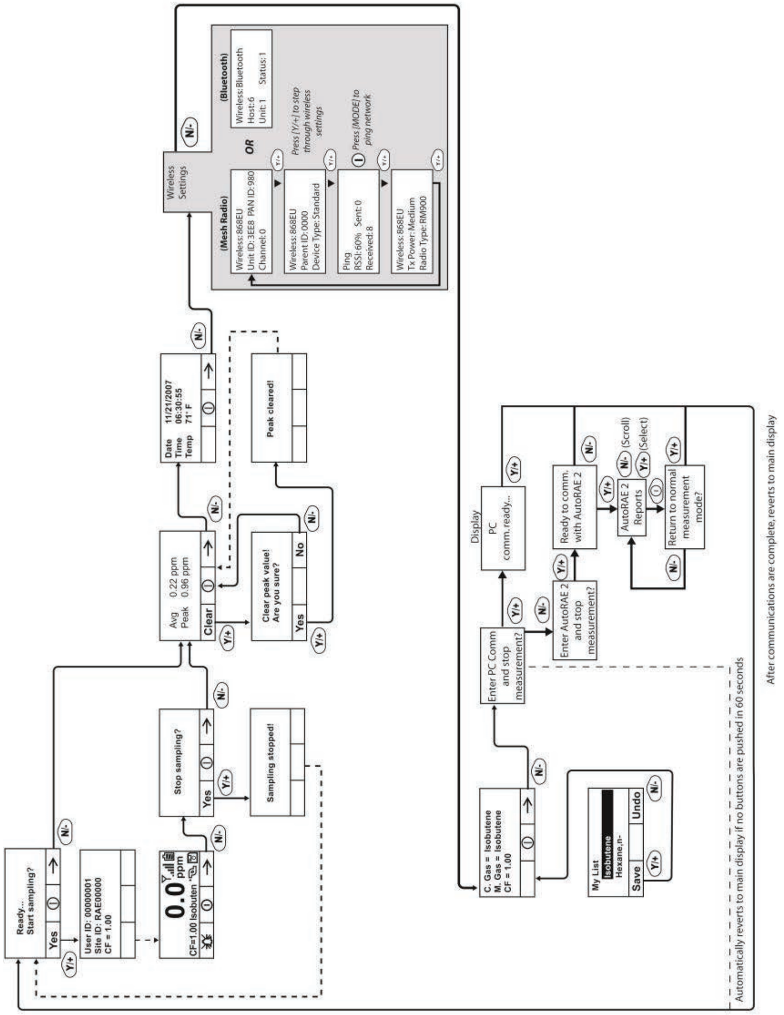


Note: Dashed line indicates automatic progression.

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).

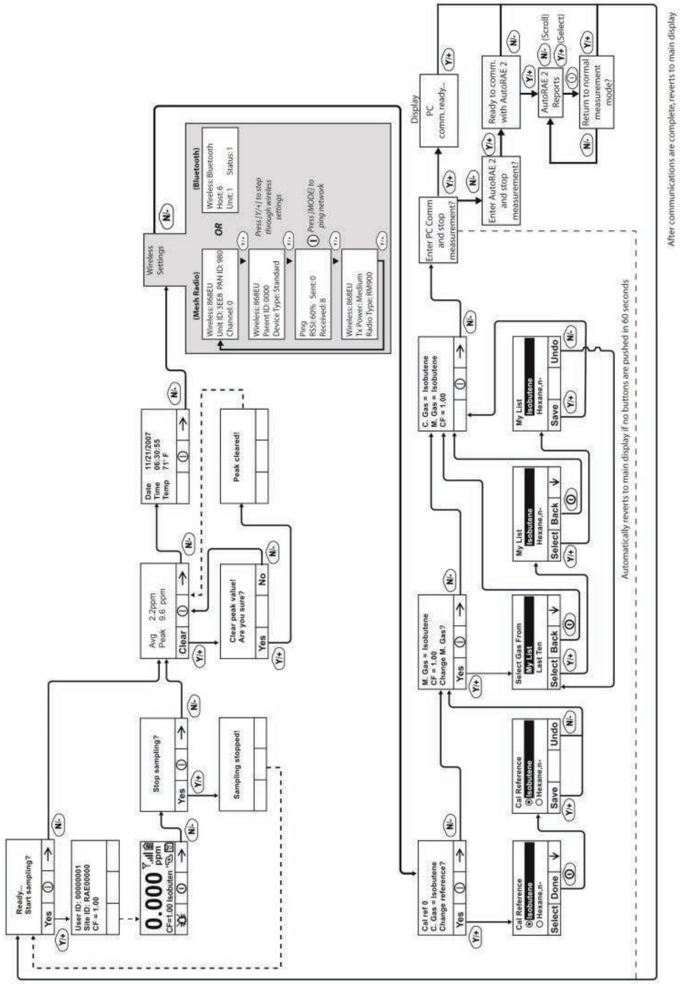
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, "Ready…Start sampling?" press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see 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

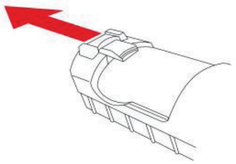
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

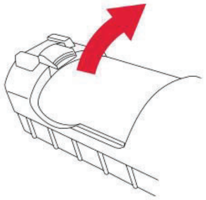
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. **Remove and replace battery only in areas known to be non-hazardous.**

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.

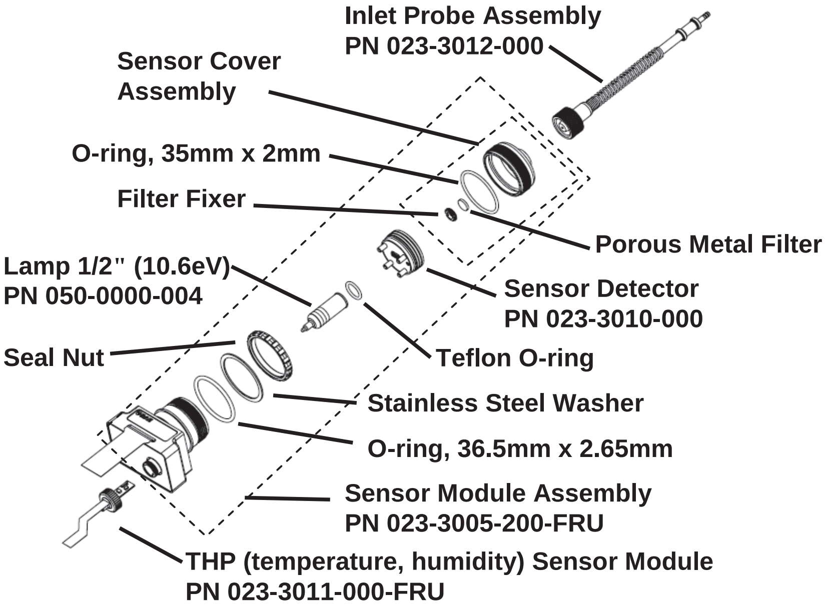
WARNING!

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.

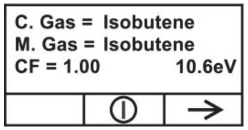
   CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

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

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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

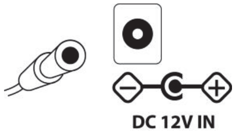
Charging The Battery

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

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February 2016
P/N 059-4020-000

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xylem
Let's Solve Water

USER MANUAL
ITEM# 626973-01REF
REVISION H

ProDIGITAL User Manual

PROFESSIONAL SERIES DIGITAL HANDHELD METERS

a xylem brand

ProDIGITAL

Thank you for purchasing a YSI Professional Series Digital handheld meter. This manual covers setup, operation, and functionality of the ProDIGITAL handhelds which include the ProDSS, ProSwap and ProSolo.

ProDIGITAL Handheld features include:

- Digital smart probes that are automatically recognized by the instrument when connected
- Waterproof (IP-67) case
- Long-life rechargeable lithium-ion battery pack
- Color display and backlit keypad
- User-selectable cable options
- USB connectivity
- Global Positioning System (GPS) (optional on ProDSS and ProSwap)
- Depth sensor (optional on 1-port and 4-port cables)
- Large memory with extensive site list capabilities
- Rugged enclosure with rubber over-molded case and miltary-spec (MS) connectors
- KorDSS data management software included with each instrument (Please see Installation Instructions)

Safety Information

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all precautionary statements. Failure to do so could result in serious injury to the operator or damage to the equipment. Do not use or install this equipment in any manner other than that specified in this manual.

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Precautionary Symbols

NOTE: *Information that requires special emphasis*

NOTICE: Indicates a situation which, if not avoided, may cause damage to the instrument

⚠ **CAUTION:** Indicates a potentially hazardous situation that may result in minor or moderate injury

⚠ **WARNING:** Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury

Product Components

Carefully unpack the instrument and accessories and inspect for damage. If any parts or materials are damaged, contact YSI Customer Service at 800-897-4151 (+1 937 767-7241) or the authorized YSI distributor from whom the instrument was purchased.

TABLE OF CONTENTS

THIS IS AN
INTERACTIVE DOCUMENT

When viewing this document as an Adobe™ PDF, hovering your cursor over certain phrases will bring up the finger-point icon. Clicking elements of the Table of Contents, website URLs, or references to certain sections will take you automatically to those locations.

1. Introduction

1.1 Battery Use and Battery Life

ProSeries Digital handhelds use a rechargeable lithium-ion (Li-Ion) battery pack as a power source. The battery comes pre-installed in the handheld and ships at less than 50% full capacity. Battery life depends on use, enabled parameters, LCD brightness, and GPS use.

A new battery, that has been fully charged, is expected to last for the following durations at 25°C, with Sampling set to Auto, Backlight set to Auto, and GPS enabled:

- ProDIGITAL handheld only - 48 hours
- ProDSS with fully loaded 4-port cable assembly and 25% LCD brightness - 20 hours

To increase battery life, enable manual sampling mode (Sampling). Manual sampling mode powers the sensor(s) on to take a measurement and then powers down to conserve battery life.

As with all lithium-ion batteires, battery life will decline over time and use. This decay should be expected. For the long-term health of the battery, a larger discharge is better than a small dishcharge between recharges.

1.2 Charging the Battery Pack

A USB cable is included with the handheld to charge the instrument battery pack and connect the instrument to a PC. The battery pack can be charged from the AC power adapter, directly from a computer USB connection or from an external, portable USB battery pack (sold separately, see Accessories).

Plug the USB connector into the AC power adapter, computer USB connector or external USB battery pack, then plug the micro USB connector into the handheld (Figure 1).

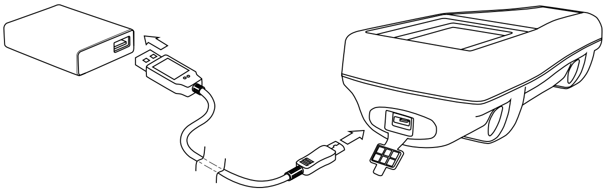


Figure 1 Connecting the handheld to AC power supply

⚠ **WARNING:** Charge the battery pack in an open area away from flammable materials, liquids, and surfaces. Do not charge or handle a battery pack that is hot to the touch. Failure to follow the safety warnings and precautions can result in personal injury and/or instrument damage not covered under warranty. Read Rechargeable Lithium-Ion battery pack safety warnings and precautions.

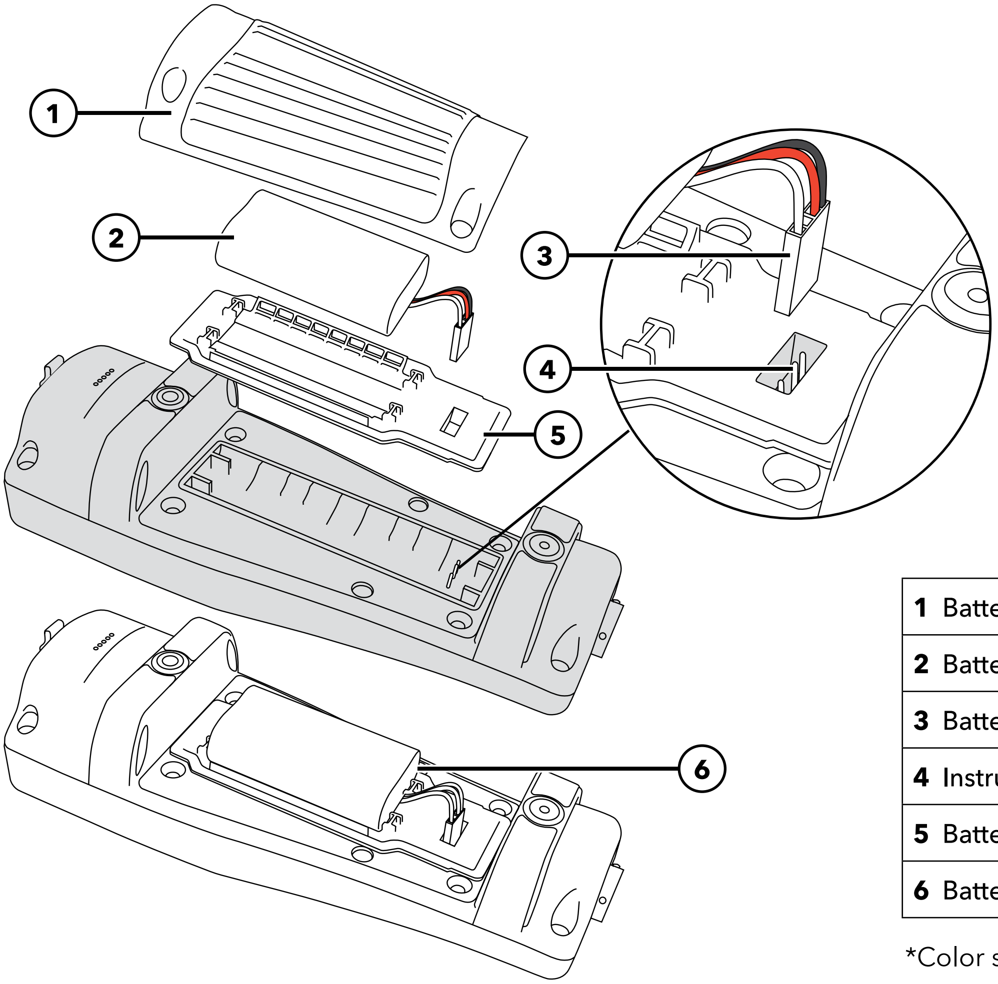
For the handheld to recognize that it is using AC power, you must start charging the handheld while it is turned on. After the instrument recognizes it is being charged, it can be turned off to finish charging.

AC Charging	DC Charging
9 hr	14 hr

1.3 Battery Replacement

1. Remove the battery pack cover by unscrewing (counter-clockwise) the four screws with a flat or Phillips head screwdriver (Figure 2). The retaining screws are captured into the battery pack cover and are not removable.
2. If replacing an existing battery pack, remove the Li-Ion battery pack and rubber battery pack cradle. With two fingers, grasp the battery pack connector and pull the connector straight up to disconnect and remove. Properly dispose of the old battery pack (See Battery Disposal).
3. Inspect the replacement battery pack and battery pack cradle for damage. Contact YSI technical support if there is any damage.
4. Correctly align and seat the battery pack cradle and battery pack into the instrument.
5. Align the battery pack connector wire terminals with the three instrument pins, then connect the battery pack to the instrument. Make sure that the three wire terminal connectors and three instrument pins are correctly aligned before connecting the battery pack connector. Incorrect installation can damage the battery pack connectors or instrument pins.
6. Install the battery pack cover, then hand tighten the cover screws with a screwdriver. DO NOT use any power tools. Make sure that the cover sealing surface is correctly aligned and free of any contamination or damage.

NOTICE: The battery cover does NOT need to make a compressed seal. Overtightening the cover screws can damage the battery cover and the handheld.



1	Battery pack cover
2	Battery pack
3	Battery pack connector*
4	Instrument pin connectors
5	Battery pack cradle
6	Battery pack cradle installed

*Color shown for reference

Figure 2 Battery replacement

1.4 Connect the Handheld to the Cable Assembly

The cable connectors are keyed for positive mating and to prevent connector damage (Figure 3). The handheld retains its IP-67 waterproof rating when the cable is disconnected. However, the connectors are not wet-mateable and should be clean and dry before connecting.

Align the keys on the cable connector with the slots on the handheld connector. Push together firmly, then twist the outer ring clockwise until it locks into place.

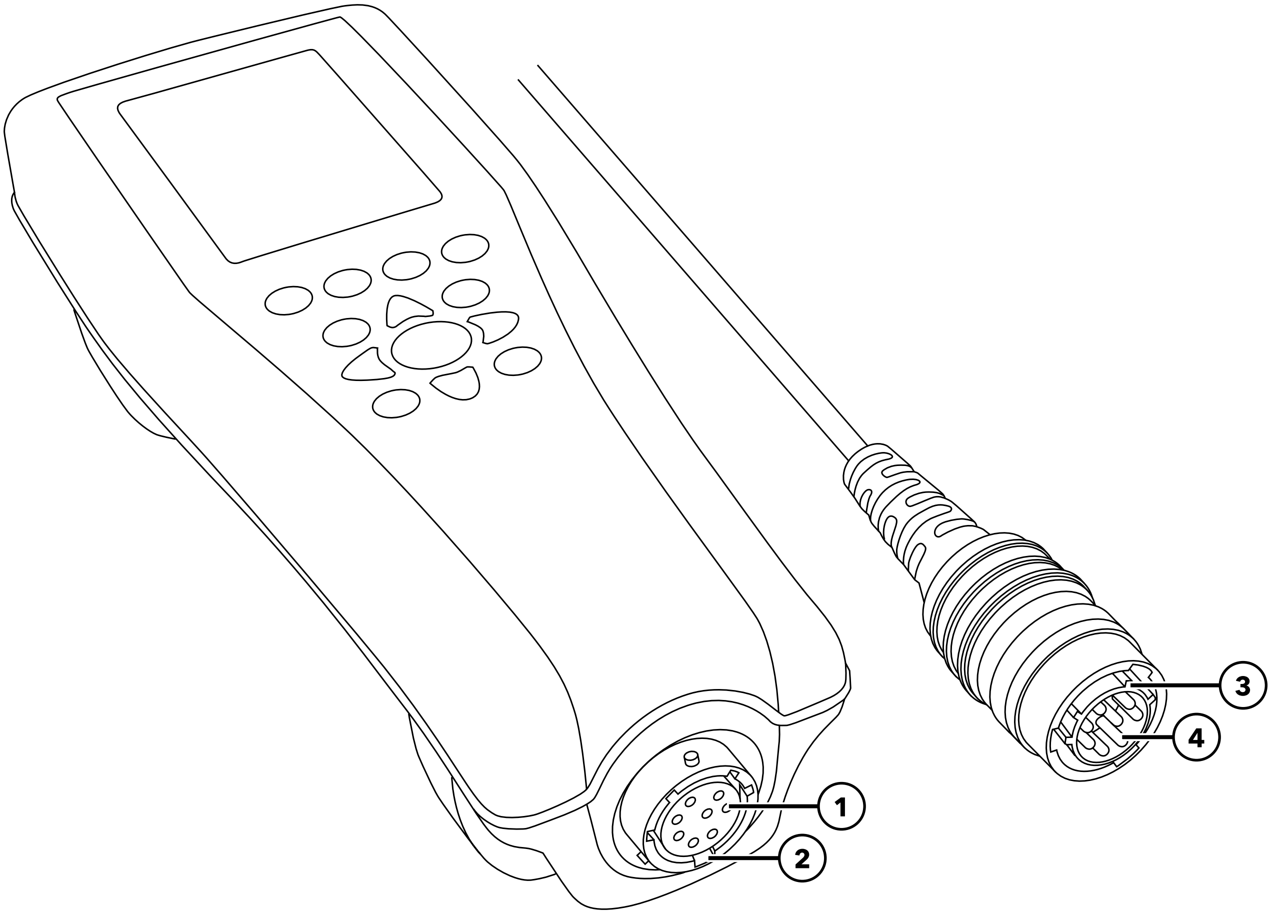


Figure 3 Keyed connectors

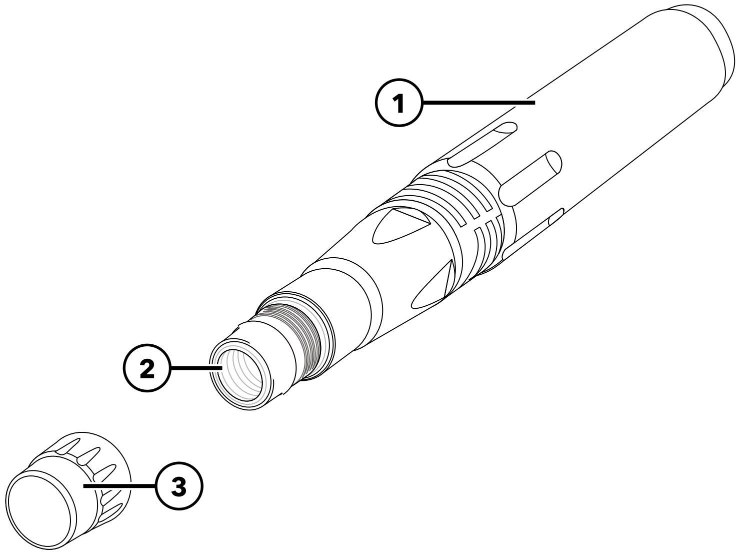
1 Handheld female connector	**3** Keyed area of connector
2 Slotted area of connector	**4** Cable male connector

1.5 Cable Assemblies with Integrated Sensors

Probe assemblies like the **ODO/CT**, **ODO/T**, and **ProOBOD** feature integral sensors — this means that these sensors cannot be removed from the probe and cable. Sensor caps on the ODO/CT and ODO/T are user-replaceable and need to be changed out about once per year.

> ***NOTE:*** *Each ODO cable assembly and sensor cap includes an instruction sheet with important information unique and specific to each individual sensing cap. These are important because they include calibration coefficients needed for proper setup.*

> ***NOTE:*** *A new cable/probe assembly already has a sensor cap installed and the sensor cap coefficients are preloaded into the probe at the factory.*



1	Probe
2	Sensor
3	Sensor Cap

Figure 4 ODO probe and cable assembly

Preparing the Probe and Sensor

1. Remove the metal probe guard from the probe by turning it counterclockwise.
2. Remove the red storage cap which, contains a moist sponge, from the end of the probe by pulling it straight off the sensor. Save this to use later for long-term storage.
3. Reinstall the probe guard by sliding it carefully over the sensor and then threading it onto the cable assembly with a clockwise rotation.

⚠ **CAUTION:** It is important to always store your sensor in a moist environment so the sensor cap does not dry out. A grey calibration/storage sleeve is shipped with your cable assembly for an easy storage option. Simply moisten the sponge with a small amount of clean water and slide the sleeve over the probe guard to create a moist atmosphere for the sensor.

1.6 Cable Assemblies with 1 or 4 Ports

ProSwap 1-port cables support user-replaceable sensors. The single port is universal and will allow any ProDSS smart sensor to be connected. These cables include a built-in thermistor which eliminates the need to always connect a conductivity/temperature sensor.

ProDSS 4-port cables feature user-replaceable sensors. The ports on the bulkhead are universal, meaning that you can install any sensor into any port. A conductivity/temperature sensor must be installed for accurate measurement of all parameters except turbidity and TSS.

Bulkhead ports are numbered (Figure 5), so if multiple sensors of the same type are installed, the port number will be added to the Run screen display to clarify the measurement value of each sensor.

NOTICE: The bulkhead ports and sensor connectors are not wet-mateable. Make sure that the sensor connectors and bulkhead ports are clean and dry before sensor installation.

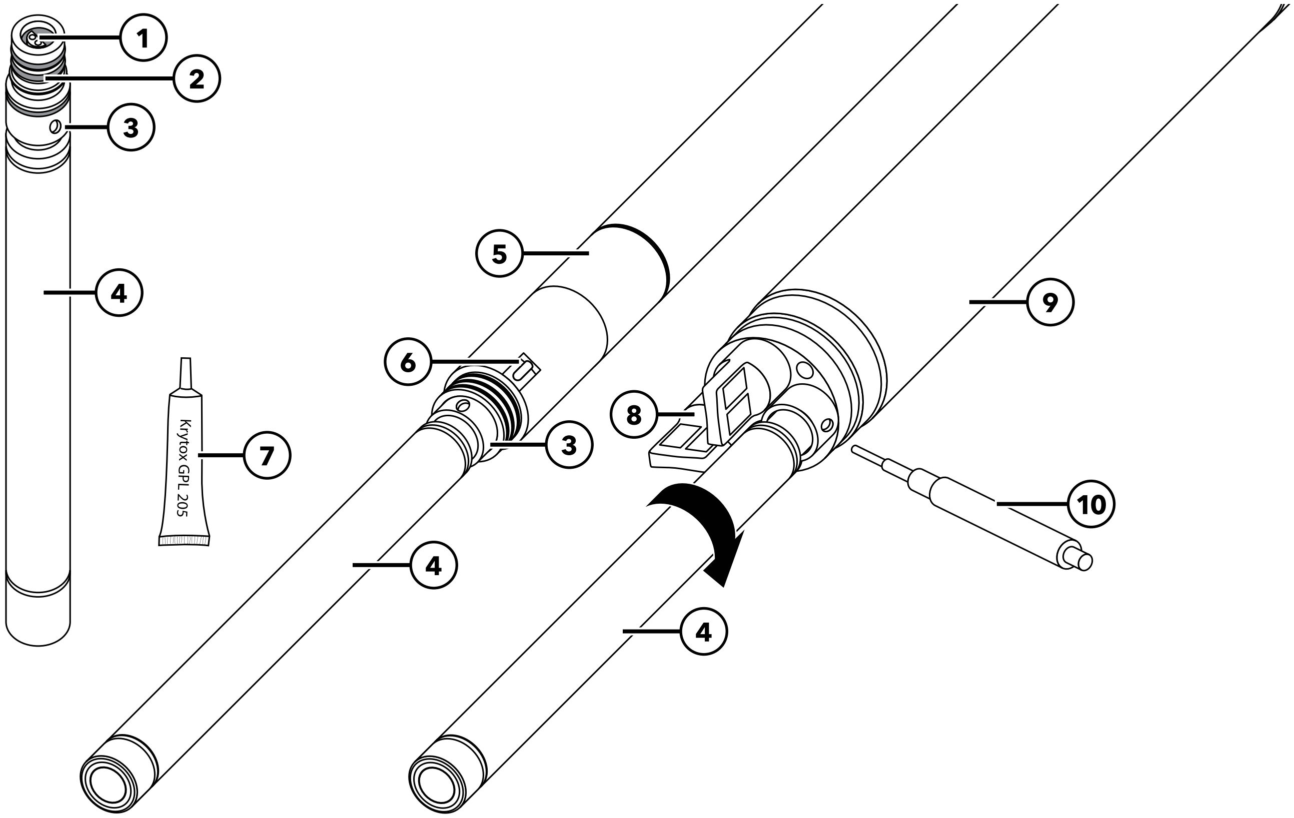


Figure 5 Sensor installation (1- and 4-port cables)

1 Sensor port	**6** Thermistor
2 O-ring	**7** O-ring lubricant
3 Sensor retaining nut	**8** Port plug
4 Sensor	**9** 4-port bulkhead
5 1-port bulkhead	**10** Sensor installation/removal tool

Sensor Installation

1. Remove the port cover shipped with the cable. This cover can be kept to protect the bulkhead ports from contamination during long-term storage.
2. Inspect each bulkhead port for contamination. If the port is dirty or wet, clean it with compressed air.
3. Apply a thin coat of o-ring lubricant to the sensor o-rings. Wipe off excess o-ring grease with a lint-free cloth.
4. Carefully align the sensor and bulkhead connectors by inserting the sensor into the port then gently rotating the sensor until the connectors align. Once aligned, push the sensor toward the bulkhead until the sensor seats in the port.
5. Carefully finger-tighten the retaining nut clockwise. If any resistance is felt, loosen the retaining nut completely to prevent cross-threading.
6. Use the sensor installation/removal tool to tighten the retaining nut clockwise until snug, about a ¼ to ½ additional turn of the retaining nut. Be careful not to over-tighten the retaining nut.

NOTICE: Incorrect installation or over-tightening can cause damage to the sensor or bulkhead that is not covered by the warranty.

Sensor Removal

To remove a sensor, insert the sensor installation/removal tool into the retaining nut, then rotate the retaining nut counterclockwise to loosen. After the retaining nut has been completely unscrewed from the bulkhead, pull the sensor straight out of the port and place it on a clean surface. Install a port plug if not reinstalling a sensor in the exposed port. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

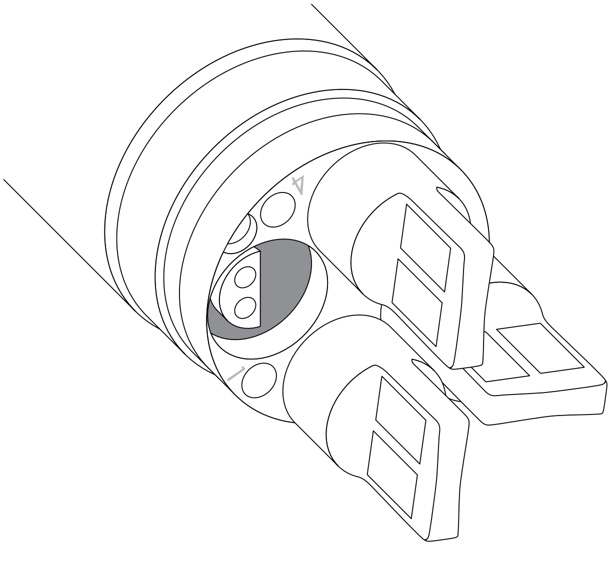


Figure 6 Sensor port plugs and port numbering (4-port cables)

Port plugs

Port plugs and a tube of o-ring lubricant are included in the maintenance kit that ships with all 1-port and 4-port cables.

Installation

1. Apply a thin coat of o-ring lubricant to the o-rings on the plug port.
2. Remove any excess lubricant from the o-rings and port plug with a lint-free cloth.
3. Insert the port plug into the empty port and press until firmly seated.
4. Finger-tighten the port plug clockwise to install. If necessary, use the sensor installation tool to make sure that the plug is fully seated into the port. The o-rings will not be visible if a port plug is correctly installed. Do not over-tighten the port plug.

NOTICE: Do not submerge the bulkhead without a sensor or port plug installed in all ports.

Sensor Guard and Weight Installation

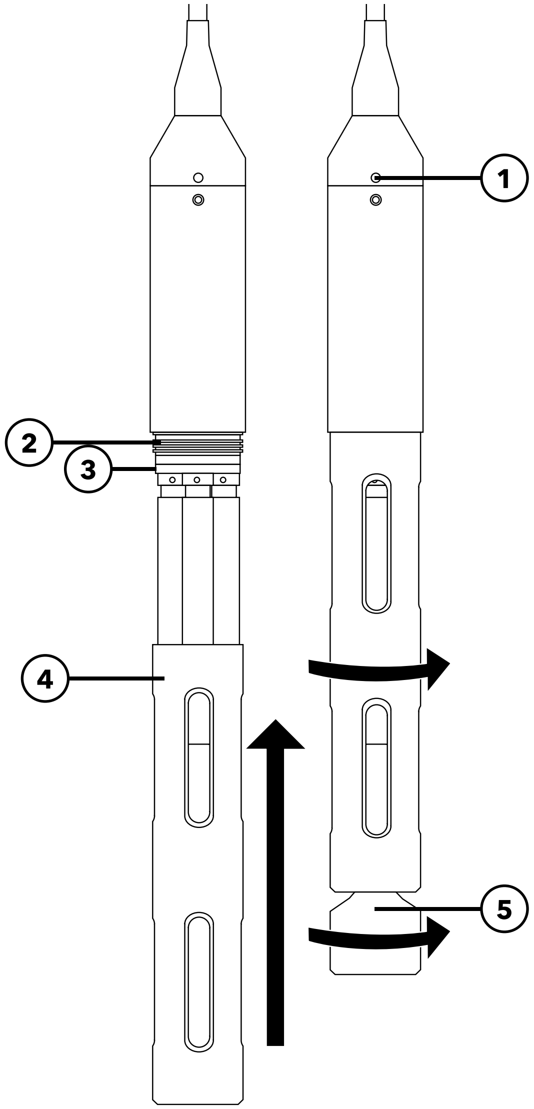


Figure 7 Sensor guard and weight installation on a 4-port cable assembly

1. Carefully slide the sensor guard over the bulkhead and attached sensors/port plugs. Push the sensor guard toward the bulkhead until the sensor guard threads align with the bulkhead threads.
2. Carefully hand-tighten the sensor guard clockwise. If any resistance is felt, loosen the sensor guard completely to prevent cross-threading. Incorrect installation may cause damage to the sensor guard or bulkhead that is not covered by the warranty.

1	Depth sensor (if equipped)
2	Bulkhead threads
3	Bulkhead
4	Sensor guard
5	Weight

Sensor Guard Weights

To help stabilize the sensors when profiling at deeper depths, a sensor guard weight is supplied with 1-port and 4-port assemblies 10 meters and longer. To attach the weight, carefully hand-tighten it clockwise on to the bottom of the sensor guard (Figure 7). If any resistance is felt, loosen the sensor guard weight completely to prevent cross-threading.

The bottom of the weight is threaded so that additional weights can be added if needed. YSI recommends installing no more than 5 lbs of weight on ProDIGITAL cables. See Accessories.

NOTE: *Do not have any weights installed on the sensor guard when calibrating using the calibration cup.*

2. Operation

2.1 Keypad and Navigation

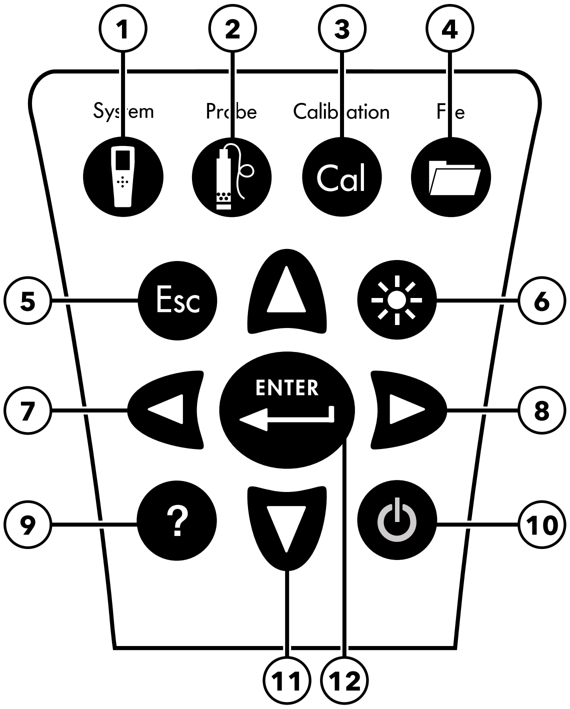


Figure 8 Keypad description

1	**System:** Opens the system menu. Use to adjust system settings.	7	**Left arrow key:** Navigate left in an alpha/numeric entry screen. Push to return to previous menu in all screens except alpha/numeric entry. On the Run screen, push to show graphical representations of the displayed measurements.
2	**Probe:** Opens the sensor menu. Use to setup sensors, change the units shown, select the sensor averaging mode, and turn on/off Auto Stable and GPS.	8	**Right arrow key:** Navigate right in an alpha/numeric entry screen. On the Run screen, push to show graphical representations of the displayed measurements. In the View Data screen, push to view additional parameters in the data set.
3	**Calibrate:** Opens the calibration menu. Use to calibrate sensors or restore default calibration.	9	**Help:** Shows context sensitive help.
4	**File:** Opens the file menu. Use to view logged data and calibration files, backup data to a USB stick, and delete data.	10	**ON/OFF:** Turn on or turn off the instrument.
5	**Exit/Escape key:** Exits to the Run screen. When in an alpha/numeric entry screen, returns to previous menu.	11	**Up/Down arrow keys:** Scroll through menus or enter numbers and letters.
6	**Backlight:** Turns the keypad backlight on or off for use in low light conditions.	12	**Enter key:** Push to confirm selections. On the Run screen, push to log a single data point or start continuous data logging.

2.2 Startup

Push the On/Off (⏻) key to turn on the handheld. If the handheld does not turn on, make sure that the battery is charged. Push and hold the ⏻ key for 1.5 seconds to turn the handheld off.

2.3 Navigation

The handheld contains menus to change user-defined options, functions, and parameters. Use the arrow keys (▲ and ▼) to highlight different options within menus and sub-menus, then push the Enter (ENTER ↵) key to select the option. Push the left arrow (◀) key to return to the previous menu.

Push the Exit/Escape (Esc) key to return to the Run screen. To enable or disable an option, highlight the option, then push the ENTER ↵ key. Enabled functions appear as a circle with a dot (◉) or a box with a check mark (☑). Disabled functions appear as a circle only (○) or an empty box (☐).

Alpha/Numeric Entry

When required, an alpha/numeric entry screen will be shown. Use the arrow keys to highlight a specific character and push the ENTER ↵ key to select it for entry. When finished entering information, highlight **ENTER**, then push the ENTER ↵ key to save the entry (Figure 9).

NOTE: *When in an alpha/numeric screen, the ◀ key is for alpha/numeric navigation only. Push the* Esc *key to cancel and return to the previous menu.*

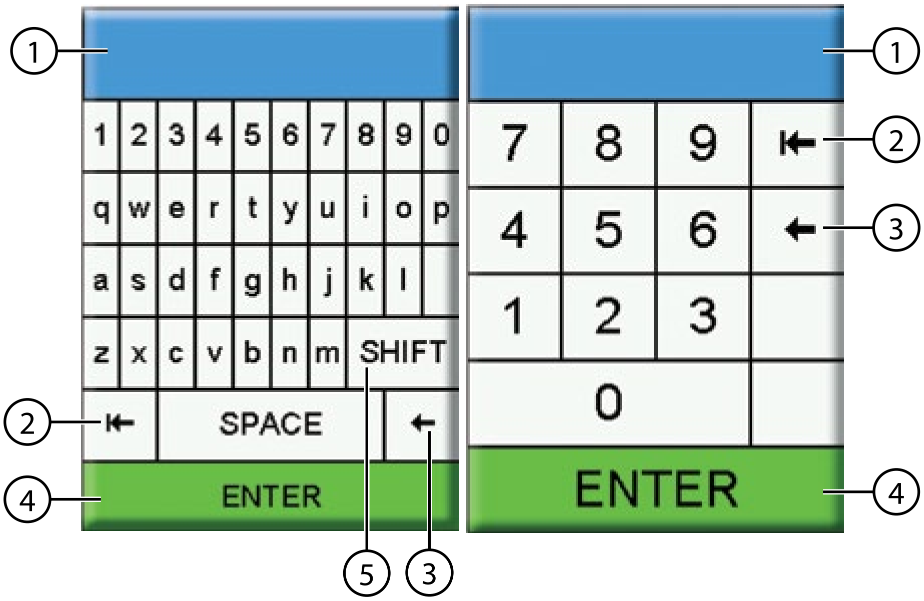


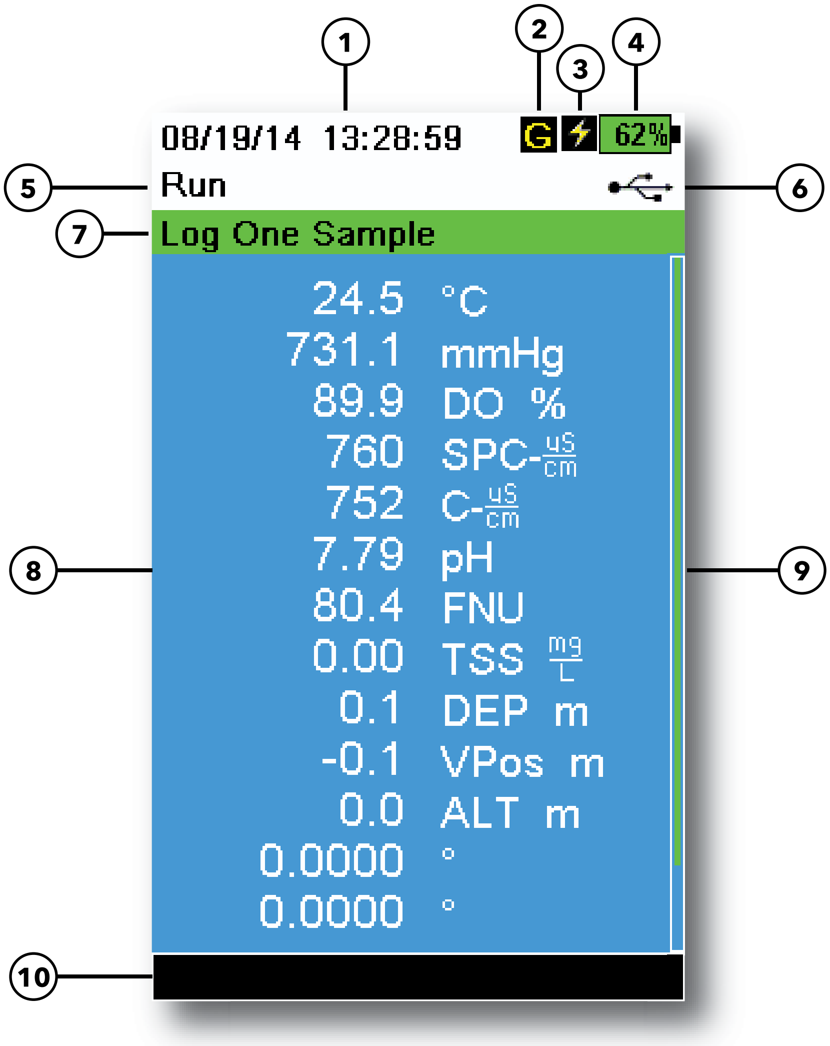
Figure 9 Alpha/numeric and numeric entry screens

1	User entry field
2	Delete entire entry
3	Backspace
4	Enter (highlighted selection)
5	Upper/lowercase

2.4 Main Display Description

The main display (Run screen) shows the current measurements and units as defined in the Sensor Display menu. If more measurements are selected than can be displayed on the Run screen, a scroll bar will be shown. Use the ▲ and ▼ arrow keys to view the additional measurements (Figure 10).

The message area shows status messages, error messages, and information about selected functions.



08/19/14 13:28:59

Run

Log One Sample

24.5 °C
731.1 mmHg
89.9 DO %
760 SPC-$\frac{uS}{cm}$
752 C-$\frac{uS}{cm}$
7.79 pH
80.4 FNU
0.00 TSS $\frac{mg}{L}$
0.1 DEP m
-0.1 VPos m
0.0 ALT m
0.0000 °
0.0000 °

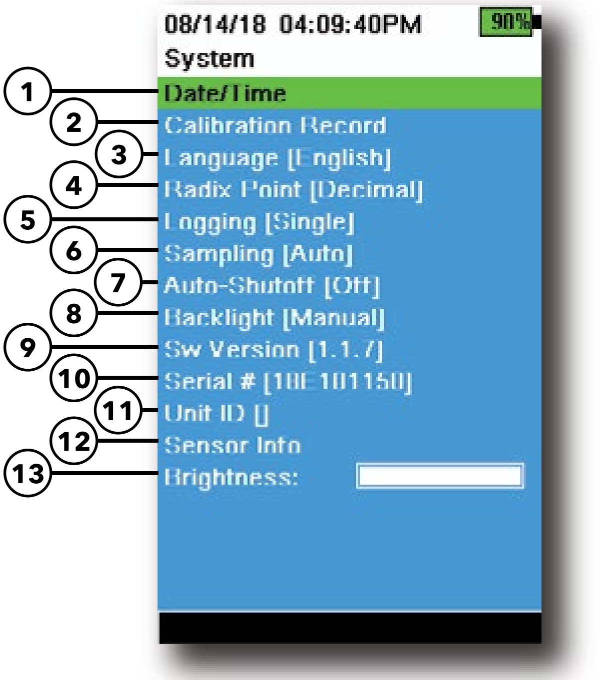
Figure 10 Main display example

1	Date/Time	**6**	USB/PC connection indicator
2	GPS signal indicator	**7**	Log or sampling (update measurements) prompt on Run screen (single or continuous)
3	Battery charging indicator	**8**	Displayed measurements
4	Battery charge %	**9**	Scroll bar
5	Current screen/menu	**10**	Message area

2.5 System Menu

Push the System (▮) key to view and adjust instrument settings. Highlight a sub-menu then push the ENTER key to view the sub-menu options (Figure 11).

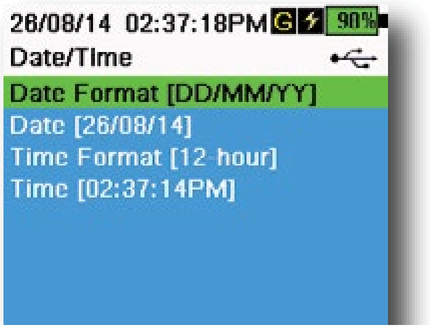
Pre-defined or user-selected options are noted within brackets (**[ ]**).



08/14/18 04:09:40PM 90%
System
Date/Time
Calibration Record
Language [English]
Radix Point [Decimal]
Logging [Single]
Sampling [Auto]
Auto-Shutoff [Off]
Backlight [Manual]
Sw Version [1.1.7]
Serial # [18E101150]
Unit ID []
Sensor Info
Brightness:

Figure 11 System menu

1	Set the Date and Time
2	Change the user-defined Calibration Options
3	Change the instrument Language settings
4	Change the Radix Point
5	Change the Logging options
6	Change the Sampling options
7	Set the handheld Auto-Shutoff time
8	Set the Backlight mode
9	View the Software Version
10	View the handheld Serial Number
11	View and adjust the Unit ID
12	View the Sensor specific information
13	Adjust the display Brightness



26/08/14 02:37:18PM 90%
Date/Time
Date Format [DD/MM/YY]
Date [26/08/14]
Time Format [12 hour]
Time [02:37:14PM]

Figure 12 Date/Time

Date/Time

▮ → **Date/Time**

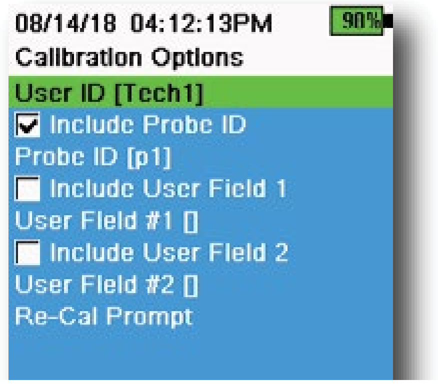
For accurate logging and calibration data, correctly set the date and time options (Figure 12). Select any of the following options to set the Date/Time.

Date/Time options:

- Set YY/MM/DD, MM/DD/YY, DD/MM/YY or YY/DD/MM date format
- Set the correct date
- Select 12 or 24 hour time format
- Set the correct time

Calibration Record

Detailed sensor calibration information is stored for later review. The instrument's internal memory can save up to 400 individual calibration records. After 400 records, the instrument will overwrite previously stored calibration records, starting with the oldest. To prevent the permanent loss of calibration records, periodically download the calibration files to a computer using the KorDSS software.



08/14/18 04:12:13PM 90%
Calibration Options
User ID [Tech1]
☑ Include Probe ID
Probe ID [p1]
☐ Include User Field 1
User Field #1 []
☐ Include User Field 2
User Field #2 []
Re-Cal Prompt

Figure 13 Calibration Options

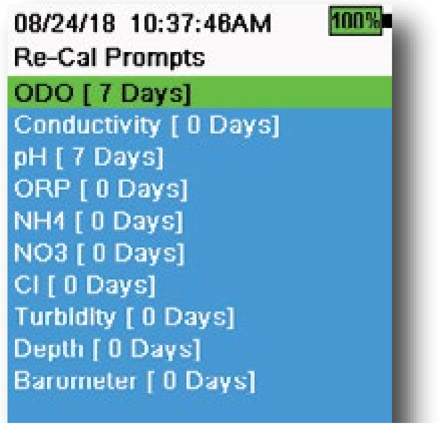
Calibration Options

▮ → **Calibration Record** → **Options**

User ID, Probe ID, or User Field #1 or 2 can be user-defined for positive calibration file identification of:

- The person calibrating the instrument
- The sensor/cable serial number used during calibration (or other, user-defined Probe ID)
- Other user-specific identification (User Field #1 and #2) (Figure 13)

> ***NOTE:*** *User Field can be used to describe the condition of the probe. For example, new sensor or new ODO cap.*



08/24/18 10:37:46AM 100%
Re-Cal Prompts
ODO [7 Days]
Conductivity [0 Days]
pH [7 Days]
ORP [0 Days]
NH4 [0 Days]
NO3 [0 Days]
Cl [0 Days]
Turbidity [0 Days]
Depth [0 Days]
Barometer [0 Days]

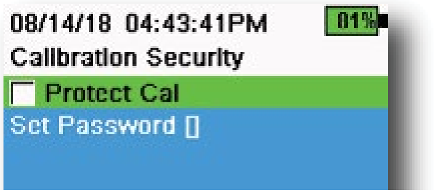
Figure 14 Re-Cal Prompts

Re-Cal Prompts

▮ → **Calibration Record** → **Options** → **Re-Cal Prompts**

Re-Cal Prompts provide a reminder to recalibrate a probe in the user-defined number of days (Figure 14). Select the desired sensor Re-Cal prompt, then enter the desired number of days before the Re-Cal prompt occurs. This reminder will be provided when the instrument is powered on and will reoccur every day until the sensor is re-calibrated.

Set the sensor value to zero (0) days (default) to turn off Re-Cal prompts.



08/14/18 04:43:41PM 01%
Calibration Security
☐ Protect Cal
Set Password []

Figure 15 Calibration Security

Calibration Security

→ **Calibration Record** → **Security**

The Calibration menu can be password protected to prevent accidental or unauthorized sensor calibration (Figure 15).

1. From the Calibration Record menu, select **Security**, then enter the default password “ysi123”.
2. Select **Set Password** [ ] and change the default password.
3. Select the **Protect Cal** check box to password protect the Calibration menu.

NOTE: *Write down and keep the password in a safe place. Contact YSI Technical Support if you lose the password (Technical support).*

05/20/18 08:43:04AM 93%
Language
● English
○ Español
○ Français
○ Deutsch
○ Italiano
○ Português
○ Norsk
○ 日本語
○ 中國傳統
○ 中国简体
○ 한국어
○ ไทย

Figure 16 Language

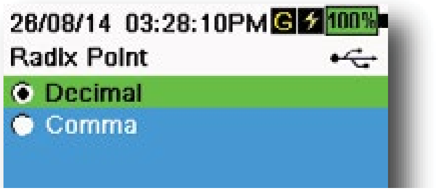
Language

→ **Language**

The instrument is shipped with English enabled. If a different language is desired and selected, the handheld will take approximately 10 to 20 seconds to enable the new language (during the first installation only).

Optional languages:

- Spanish
- French
- German
- Italian
- Portuguese
- Norwegian
- Japanese
- Simplified Chinese
- Traditional Chinese
- Korean
- Thai



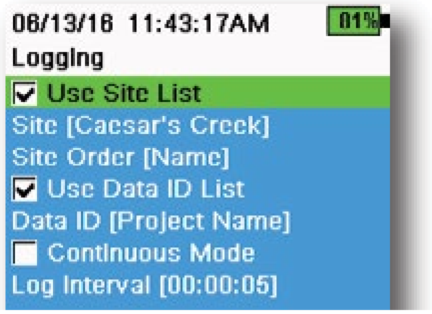
28/08/14 03:28:10PM 100%
Radix Point
● Decimal
○ Comma

Figure 17 Radix Point

Radix Point

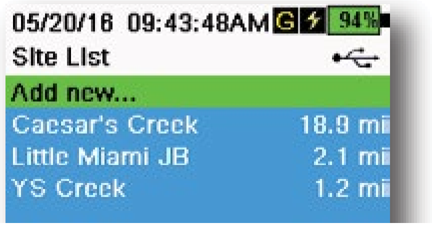
→ **Radix Point**

The radix point can be changed to display a comma or a decimal in numeric displays (*e.g.* 1.00 becomes 1,00 when Comma is selected) (Figure 17).



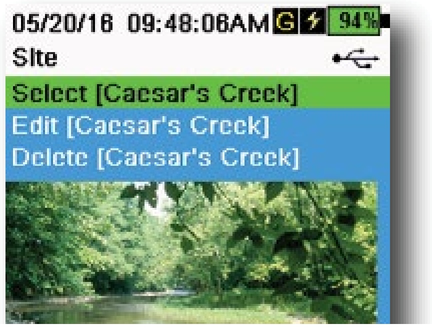
06/13/16 11:43:17AM 91%
Logging
☑ Use Site List
Site [Caesar's Creek]
Site Order [Name]
☑ Use Data ID List
Data ID [Project Name]
☐ Continuous Mode
Log Interval [00:00:05]

Figure 18 Logging



05/20/16 09:43:48AM 94%
Site List
Add new...
Caesar's Creek 18.9 mi
Little Miami JB 2.1 mi
YS Creek 1.2 mi

Figure 19 Site List



05/20/16 09:48:06AM 94%
Site
Select [Caesar's Creek]
Edit [Caesar's Creek]
Delete [Caesar's Creek]

Figure 20 Site

Logging

→ **Logging**

The handheld can add a user-defined Site and/or Data ID to a data record if these functions are enabled under the Logging menu. A check mark in the box next to these features indicates they are enabled (Figure 17).

After selecting **Site** [ ] or **Data ID** [ ], the Site List or Data ID List will be shown (Figure 19). New entries can be created by choosing **Add new...**

If the handheld has a GPS signal, the current GPS coordinates will be auto-populated when creating a new site. If the handheld does not have a built-in GPS, the coordinates and altitude can be entered manually.

Sites can be listed in order of Name (*i.e.* alphanumeric order) or Distance from the current position (Figure 19).

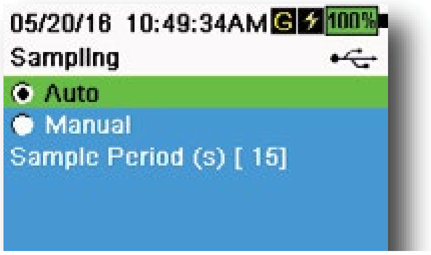
Choose an entry from the Site List or Data ID List to **Select**, **Edit**, or **Delete** (Figure 20). When selected, data recorded will be tagged with the specific site and/or data ID.

> ***NOTE:*** *The Manage Sites menu in KorDSS Software can be used to send a picture of the Site to the instrument.*

Continuous Mode (Interval logging): Select the Continuous Mode check box and enter the user-defined Log Interval (in hours:minutes:seconds) to log samples continuously at the specified time interval. The Run screen will display **Start Logging...** when in Continuous Mode. Press ENTER to begin logging.

One sample logging: Clear the Continuous Mode check box. The Run screen will display **Log One Sample**. A sample will be logged each time the ENTER key is pushed when in the Run screen.

> ***NOTE:*** *An option to change Site and/or Data ID (if enabled) appears once ENTER is pressed to begin logging.*



05/20/16 10:49:34AM G 100%

Sampling

● Auto

○ Manual

Sample Period (s) [15]

Figure 21 Sampling

Sampling

→ **Sampling**

Auto sampling mode continuously updates measurements on the display (Figure 21).

When in Manual mode, the instrument will take measurements for the duration of the user-defined Sample Period (in seconds) then “lock” or hold the readings on the display. The default sample period is 50 seconds, and can be adjusted from 15 to 60 seconds. Manual mode helps conserve battery power.

Once the measurements are locked, push the ENTER key to log the held data, or the Esc key and then the ENTER key to take a new measurement.

> ***NOTE:*** *When both Continuous Logging Mode and Manual Sampling mode are enabled, the handheld will power the sensors on and take measurements for 15 seconds before logging a data set.*

Auto-Shutoff

→ **Auto-Shutoff**

To conserve battery power, auto-shutoff powers off the instrument after a user-defined time period (in minutes). The auto-shutoff time can be adjusted from 1 to 255 minutes. Set to 0 (zero) to disable Auto-Shutoff.

Backlight

→ **Backlight**

In Automatic mode, the instrument display will dim 60 seconds after the last key was pushed. Once any key is pushed, the instrument display will return to the user-defined brightness setting and the keypad backlight will turn on. The screen will dim and the keypad backlight will turn off after another 60 seconds of inactivity.

In manual mode, the instrument display remains at the user-defined brightness and the keypad backlight is turned on and off by the Backlight key. Setting the backlight to manual mode is recommended for bright conditions.

Software (Sw) Version

▮ → **Sw Version**

Sw Version shows the instrument's software version number. The latest instrument software and update instructions are available at YSI.com. Instrument software can be updated through the KorDSS Software under the **Instrument and Sensors** tab.

Serial

▮ → **Serial #**

Serial # shows the serial number of the handheld instrument. Note the serial number when contacting YSI support.

Unit ID

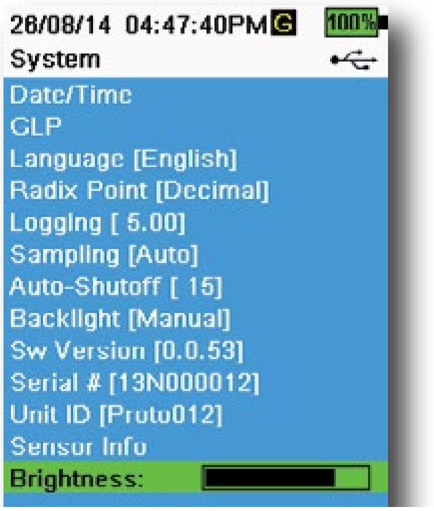
▮ → **Unit ID**

Users can set a custom Unit ID. The Unit ID identifies the instrument in KorDSS Software.

Sensor Info

▮ → **Sensor Info**

Sensor info shows measurement data, and hardware/software information for each component of the system: instrument, sensor, and bulkhead. Use the ▲ and ▼ arrow keys to scroll through the components.



26/08/14 04:47:40PM G 100%

System

Date/Time

GLP

Language [English]

Radix Point [Decimal]

Logging [5.00]

Sampling [Auto]

Auto-Shutoff [15]

Backlight [Manual]

Sw Version [0.0.53]

Serial # [13N000012]

Unit ID [Proto012]

Sensor Info

Brightness:

Figure 22 Display Brightness

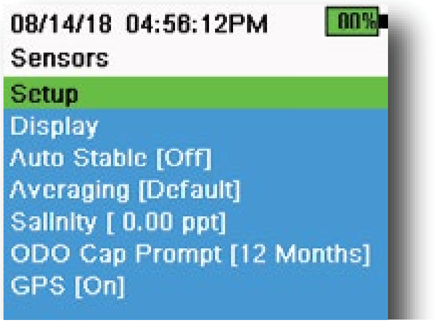
Brightness

▮ → **Brightness**

The screen brightness can be adjusted to accommodate lighting conditions and to conserve battery power (Figure 22). Use the ◀ and ▶ arrow keys to adjust the screen brightness.

2.6 Sensor Menu

Use the Probe ( ) key to access the Sensor menu and change sensor settings (if applicable), enable the measurement units displayed on the Run screen, set Auto Stable parameters, change the sensor averaging mode, and if equipped, turn on/off GPS.



08/14/18 04:56:12PM 00%

Sensors

Setup

Display

Auto Stable [Off]

Averaging [Default]

Salinity [0.00 ppt]

ODO Cap Prompt [12 Months]

GPS [On]

Figure 23 Probe (Sensor) menu

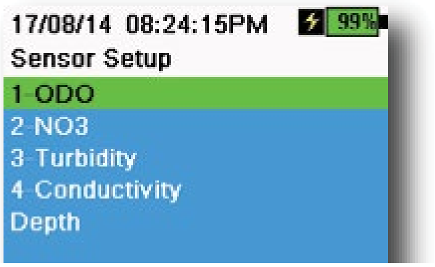
Push the key to access the sensor menu (Figure 23). Highlight a sub-menu then push the ENTER key to view sub-menu options.

Pre-defined or user-selected sensor settings are noted within brackets (**[]**).

Sensor Setup

→ **Setup**

The Sensor Setup menu will show all sensors connected to the instrument (Figure 24). If a sensor is connected but is not listed on the Sensor Setup menu (**<None>** displayed), check the sensor and cable connections.



17/08/14 08:24:15PM 99%

Sensor Setup

1 ODO

2 NO3

3 Turbidity

4 Conductivity

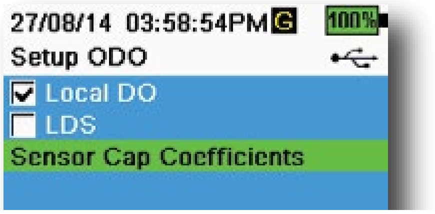
Depth

Figure 24 Sensor Setup

Setup ODO

→ **Setup** → **ODO**

Local DO: Enable or disable localized DO% measurements. When enabled, the calibration value is set to 100% regardless of altitude or barometric pressure. When enabled, an L will be shown next to DO% on the run screen. DO mg/L measurements are unaffected when Local DO is enabled (Figure 25).



27/08/14 03:58:54PM G 100%

Setup ODO

☑ Local DO

☐ LDS

Sensor Cap Coefficients

Figure 25 Setup ODO

LDS: Last Digit Supression (LDS) rounds the DO value to the nearest tenth, *e.g.* 8.27 mg/L becomes 8.3 mg/L.

Sensor Cap Coefficients: The sensor cap coefficients must be updated after sensor cap replacement. Update the sensor cap coefficients using the coefficient sheet provided with the new sensor cap. Once updated, the coefficients are saved to the ODO sensor and do not need to be re-entered.

> ***NOTE:*** *The coefficients stay with the sensor even when used with different handheld meters.*

Setup Turbidity

→ **Setup** → **Turbidity**


02/09/14 01:32:58PM 96%
TSS Coefficients
C1 [0.000000]
C2 [0.000000]
C3 [0.000000]
C4 [0.000000]
C5 [0.000000]
C6 [0.000000]
Update Coefficients

Figure 26 TSS coefficients

TSS Coefficients: Total Suspended Solids (TSS) can be measured if correlation coefficients are calculated in KorDSS.

To obtain these coefficients, collect turbidity data at the sampling site with corresponding grab samples. Analyze the samples in a lab to determine a true TSS measurement (mg/L). At least 2 and up to 6 value pairs of turbidity and TSS measurements can be used.

Correlation data must be collected for each unique sampling site, as this correlation is site-specific.

In KorDSS Software, enter the field-obtained turbidity measurements and the corresponding lab-obtained TSS measurements in the Instrument and Sensors menu. Coefficients can then calculated with KorDSS and sent to the sensor.

> ***NOTE:*** *Although correlation coefficients can be entered directly into the handheld (Figure 26), only KorDSS Software can calculate the coefficients.*

Setup pH

→ **Setup** → **pH**

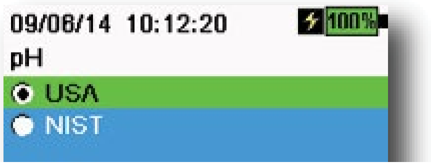

09/06/14 10:12:20 100%
pH
● USA
○ NIST

Figure 27 Setup pH

Select USA auto-buffer recognition (4.00, 7.00, and 10.00) or NIST auto-buffer recognition (4.01, 6.86, and 9.18) (Figure 27). Calibration values are automatically compensated for temperature for both buffer sets.

Setup Conductivity

→ **Setup** → **Conductivity**

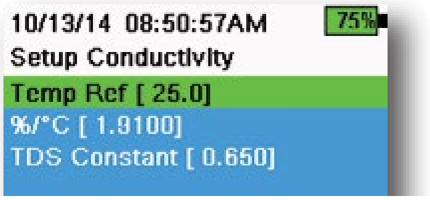

10/13/14 08:50:57AM 75%
Setup Conductivity
Temp Ref [25.0]
%/°C [1.9100]
TDS Constant [0.650]

Figure 28 Setup Conductivity

Temp Ref: Reference temperature is used to calculate temperature compensated specific conductance. All specific conductance values are compensated to the Temp Ref temperature. The default value is 25°C (Figure 28). Enter a new value between 15.00°C and 25.00°C.

%/°C (Percent per degree Celsius): The temperature coefficient is used to calculate temperature compensated specific conductance. The default is 1.91% based on KCl standards. Enter a new value between 0 and 4%.

TDS Constant: This is a multiplier used to calculate an estimated Total Dissolved Solids (TDS) value from conductivity. The multiplier is used to convert specific conductance in mS/cm to TDS in g/L. The default value is 0.65. Enter a new value between 0 and 0.99.

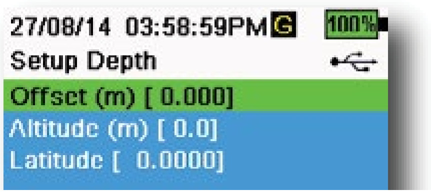
Setup Conductivity *(continued)*

The TDS multiplier is highly dependent on the nature of the ionic species present in the water sample. To be assured of moderate accuracy for the conversion, you must determine a multiplier for the water at your sampling site. Use the following procedure to determine the multiplier for a specific sample:

1. Determine the specific conductance of a water sample from the site.
2. Filter a portion of water from the site.
3. Carefully measure a volume of the filtered water. Completely evaporate to yield a dry solid.
4. Accurately weigh the remaining solid.
5. Divide the weight of the solid (in grams) by the volume of water used (in liters) to yield the TDS value in g/L for the site.
6. Divide the TDS value in g/L by the specific conductance of the water in mS/cm to yield the conversion multiplier.

NOTE: *If the nature of the ionic species at the site changes between sampling studies, the TDS values will be in error. TDS cannot be calculated accurately from specific conductance unless the make-up of the chemical species in the water remains constant.*

Setup Depth


27/08/14 03:58:59PM

Setup Depth

Offset (m) [0.000]

Altitude (m) [0.0]

Latitude [0.0000]

Figure 28 Setup Depth

→ **Setup** → **Depth**

Cable assemblies with a depth sensor in the bulkhead can measure virtual vented depth. The virtual vented depth measurement allows for real time compensation for atmospheric pressure using the handheld's barometer.

Depth offset: Depth offset can be used if referencing water elevation against a known value. If a depth offset is entered (in meters), the output value will shift by the value of the offset (Figure 29).

A common offset entered by the user is the depth sensor location relative to the rest of the WQ sensors. This value is 18.6 cm on the 1-port cable and 27.2 cm on the 4-port cable. (Figure 30).

Altitude/Latitude: To compensate for atmospheric pressure based on elevation and gravitational pull, enter the local altitude in meters relative to sea level and latitude in degrees where the instrument is sampling.

Latitude effect: Varying latitudes can cause up to a 200 mm change in depth from equator to pole.

Altitude effect: A 100 m change in altitutde causes a 1.08 mm of change to the depth readings.

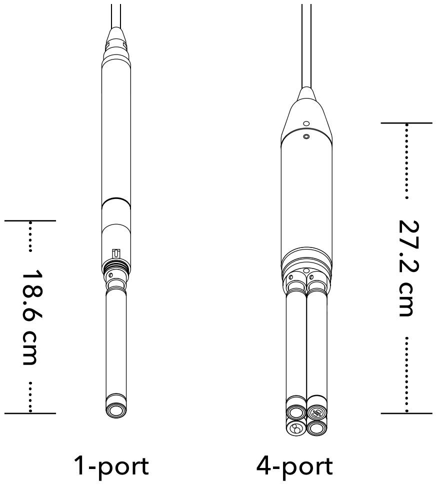


Figure 30 Distance of depth sensor to WQ sensors

Figure 31 Sensor Display

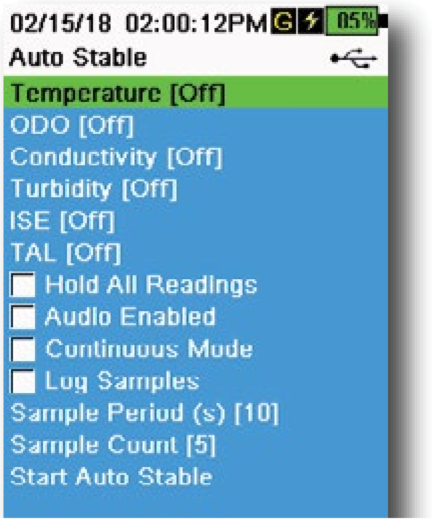
Sensor Display

→ **Display** (Figure 31)

The Sensor Display menu determines the parameters and units that are shown on the Run screen (Figure 10). The Run screen will only show measurements for sensors that are attached to the cable bulkhead.

If more measurements are selected than can be displayed on one screen, a scroll bar will be shown. Use the ▲ and ▼ keys to scroll through the measurements.

> ***NOTE:*** *For depth profiling, enable Vertical Position under Depth Display to view the real-time position of the depth sensor in the water column. This is helpful in profiling applications to ensure the depth sensor is lowered to the desired depth without waiting for the depth data to stabilize.*



02/15/18 02:00:12PM

Auto Stable

Temperature [Off]

ODO [Off]

Conductivity [Off]

Turbidity [Off]

ISE [Off]

TAL [Off]

☐ Hold All Readings

☐ Audio Enabled

☐ Continuous Mode

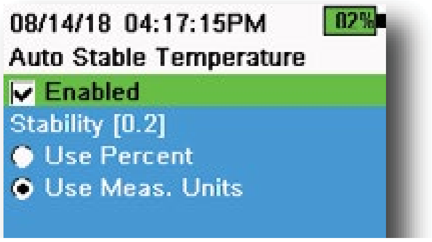
☐ Log Samples

Sample Period (s) [10]

Sample Count [5]

Start Auto Stable

Figure 32 Auto Stable



08/14/18 04:17:15PM

Auto Stable Temperature

☑ Enabled

Stability [0.2]

○ Use Percent

● Use Meas. Units

Figure 33 Auto Stable stability threshold

Auto Stable

→ **Auto Stable**

Auto Stable indicates when a measurement is stable. Sensors with Auto Stable enabled will have $\overset{A}{s}$ flash beside the measurement on the Run screen.

$\overset{A}{s}$ will flash green when the measurement is stable.

Select a sensor to enable or disable Auto Stable (Figure 32). Then set the stability threshold parameters.

The Auto Stable stability threshold can be set by percent of measurement or in the units of measurement selected in the Sensor Display menu. Enter the stability value, then select **Use Percent** or **Use Meas. Units** (Figure 33).

This threshold is used to compare the last reading with the previous. The smaller the number entered in % or units, the longer it will take for the instrument to reach the auto stable criteria.

Example: For temperature in °C, if Measurement Units threshold is set to 0.2 and the temperature reading changes by more than 0.2 degrees, $\overset{A}{s}$ will continue to be red until the reading does not change by more than 0.2°C over the defined sample period and sample count.

Hold All Readings: After all sensors have reached their stability criteria, the measurements will be held or 'locked' on the display. If disabled, the sensor measurements will continue to change in real time.

Audio Enabled: An audio alert will sound when stability is reached.

Auto Stable *(continued)*

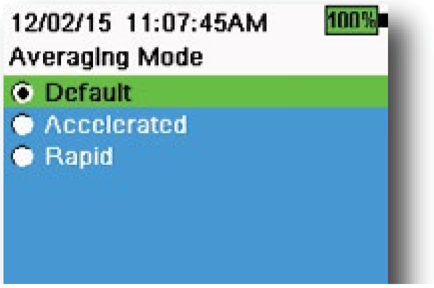
Continuous Mode: The handheld will continuously check sensor values against the stability criteria even after the sample period and sample count have been met.

Log Samples: Logs the sample/s defined by the Sample Period to memory.

Sample Period: Time interval between samples that are used to determine stability. Set the interval in seconds (1 to 900).

Sample Count: Number of consecutive samples required for stability (1 to 10).

Select Start Auto Stable to enable.


12/02/15 11:07:45AM

Averaging Mode

● Default

○ Accelerated

○ Rapid

Figure 34 Averaging

Averaging

→ **Averaging** (Figure 34)

The averaging mode determines how the handheld will filter data. A smaller time frame for the rolling average window allows changes in the sensor's measurements to be more quickly observed, while a larger rolling window provides more stable measurement readings and a smooth result. Each averaging mode will decrease the time span of the rolling window if a large change in the sensor measurement is detected, allowing the handheld to adapt when an event occurs.

The **Default** mode provides optimum averaging for all sensors. This mode has up to 40 seconds of averaging on the sensors to curb spikes and outliers, resulting in more stable data.

In **Accelerated** mode, changes in sensor measurements are more quickly observed than default (approximately 10 seconds of averaging). This mode is recommended when the sensors are moving through the water, such as during profiling studies and most spot sampling applications.

> ***NOTE:*** *For profiling applications, enable Vertical Position under Depth Display to view unfiltered depth measurements. This helps to ensure the depth sensor is lowered to the desired depth without waiting for the averaged measurement.*

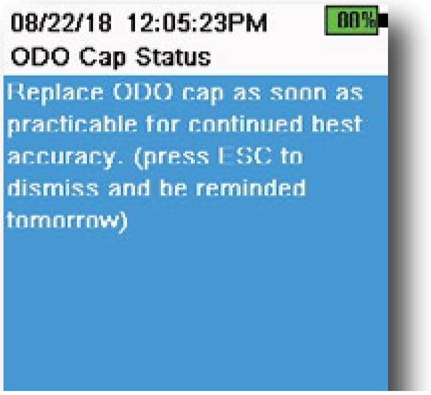
In **Rapid** mode, sensor response is very fast (approximately 2 seconds of averaging), but the instrument will never settle on a single steady number. This mode is recommended when the sensors are moving quickly through the water, such as rapid profiling and towed applications.

Salinity

→ **Salinity**

Salinity is determined by calculations derived from the conductivity and temperature sensors.

When a conductivity sensor is installed, the instrument will automatically use the salinity measurement for DO and "As Measured" will be displayed. If no conductivity sensor is installed (*e.g.* ODO/T cable assembly used), the salinity value will be user-selectable.



08/22/18 12:05:23PM

ODO Cap Status

Replace ODO cap as soon as practicable for continued best accuracy. (press ESC to dismiss and be reminded tomorrow)

Figure 35 ODO Cap Status

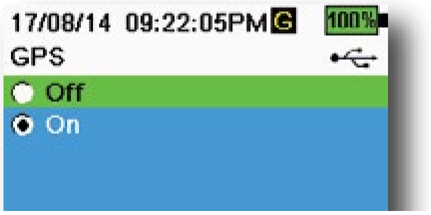
ODO Cap Prompt

→ **ODO Cap Prompt**

The handheld can remind users when it is time to replace the ODO Cap based on a user-defined interval (Figure 35). To set the reminder, select ODO Cap Prompt and **input a number in months**. YSI recommends enabling this setting to match the warranty period of the ODO Cap:

- ProDSS ODO Sensor Cap [SKU: 626890] = **12** months
- ODO Extended Warranty Sensor Cap [SKU: 627180] = **24** months

The handheld will automatically recognize the last time the ODO Sensor Cap coefficients were updated and alert the user when the Cap is due for replacement. To disable the prompt, simply enter **0** for the number of months.



17/08/14 09:22:05PM G

GPS

○ Off

● On

Figure 36 GPS

GPS (Optional)

→ **GPS**

Some handhelds feature a built-in GPS. GPS turns the handheld Global Positioning System On or Off. The G symbol is shown when a GPS signal is received (Figure 36).

When enabled, the GPS coordinates will be saved with the Calibration Record and logged data. Note that the battery will drain more rapidly when GPS is enabled than when it is not enabled.

NOTE: *GPS data will be most accurate when there is a clear line of sight to satellites. It may be difficult for the handheld to receive a good GPS signal when under canopy or indoors.*

2.7 Calibration Menu

Push the Calibrate (Cal) key to access the Calibration menu (Figure 37). Highlight a sub-menu then push the ENTER key to view sub-menu options. Pre-defined or user-selected parameters are noted within brackets (**[ ]**). Refer to the Calibration section for sensor specific calibration procedures.

> ***NOTE:*** *User ID, Probe ID, and User Field #1 and #2 can be enabled in the* ***Calibration Settings*** *under the System menu.*

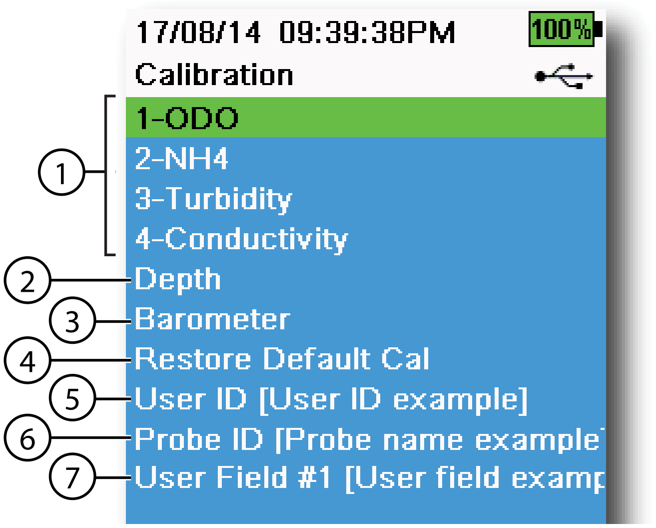


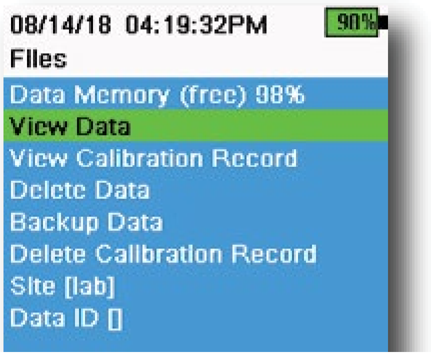
Figure 37 Calibration menu

1 Sensors connected	**5** User ID
2 Optional Depth sensor calibration	**6** Probe ID
3 Barometer calibration	**7** User Field #1
4 Restore Default Calibration - restores specified sensor to factory default	

2.8 Files Menu

Push the File ( ) key to access the Files menu (Figure 38). Highlight a sub-menu then push the key to view sub-menu options.

Use the Files menu to view, delete or backup logged data or the calibration file. Data can be filtered by a specific date and time range and by user-created Site and Data ID lists.

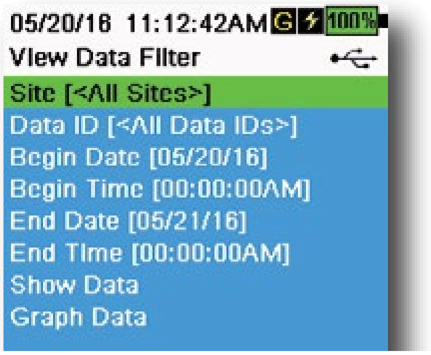


08/14/18 04:19:32PM 90%
Files
Data Memory (free) 98%
View Data
View Calibration Record
Delete Data
Backup Data
Delete Calibration Record
Site [lab]
Data ID []

Figure 38 Files menu

Data Memory: (free) % shows the remaining memory available. Download or delete data to free available internal memory.

The Site List and/or Data ID List can be seen by selecting **Site [ ]** or **Data ID [ ]**. To enable the use of Site and/or Data ID when logging data, select **Logging** under the System menu.



05/20/16 11:12:42AM 100%
View Data Filter
Site [<All Sites>]
Data ID [<All Data IDs>]
Begin Date [05/20/16]
Begin Time [00:00:00AM]
End Date [05/21/16]
End Time [00:00:00AM]
Show Data
Graph Data

Figure 39 View Data Filter

View Data Filter

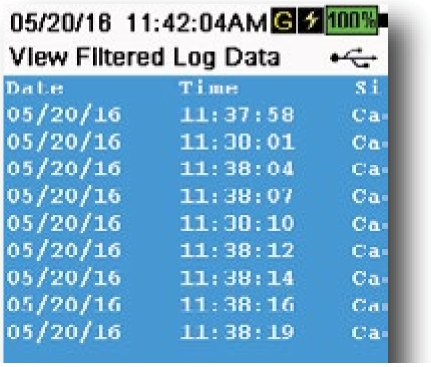
→ **View Data**

Enter the desired filter criteria, then select **Show Data** or **Graph Data** to view the tabular or graphical data. If necessary, use the arrow keys to scroll through the data (Figure 39 and Figure 40).

Site: View data from one site or all sites.

Data ID: View data from one ID or all IDs.

Begin/End: View data within specific date and time ranges.



05/20/16 11:42:04AM 100%
View Filtered Log Data

```
Date        Time      Si
05/20/16    11:37:58  Ca
05/20/16    11:30:01  Ca
05/20/16    11:38:04  Ca
05/20/16    11:38:07  Ca
05/20/16    11:30:10  Ca
05/20/16    11:38:12  Ca
05/20/16    11:38:14  Ca
05/20/16    11:38:16  Ca
05/20/16    11:38:19  Ca
```

Figure 40 View Filtered Log Data

08/14/18 04:20:18PM 90%
View Calibration Record
Calibrate ODO
Date: [MM/DD/YY] 08/12/18
Time: 02:00:25PM
Sensor Type: ODO/T
Sensor: 18N000001
Sw Version: 3.1.2
Method: DO Air Cal
Cal Value: 96.6 DO %
Pre Cal Value: 93.3 DO %
Sensor Value: 90.2
ODO Gain: 1.035855
Barometer: 734.5 mmHg
Temperature: 22.7 Ref °C
User ID:
Probe ID:
Calibrate Status: Calibrated

Figure 41 View GLP

View Calibration Record

→ **View Calibration Record**

Select **View Calibration Record** to show the stored sensor calibrations (Figure 41).

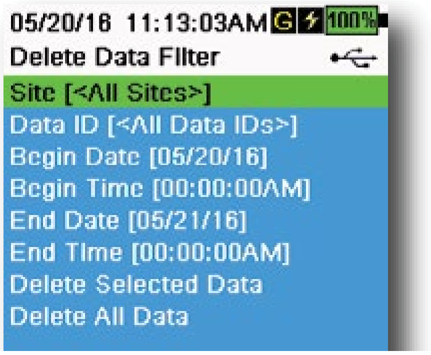
Use the arrow keys to scroll through the calibration file data.

Calibration Information

Information in each calibration record:

- Sensor calibrated
- Date/time stamp
- Sensor ID
- Sensor serial #
- Sensor software version
- User ID (optional)
- Probe ID (optional)
- User Fields #1 and #2 (optional)
- Calibration status
- Calibration value
- Temperature

Depending on the parameter, a calibration record may include additional information such as the Conductivity cell constant, ODO gain, ORP offset, and pH slope.



05/20/16 11:13:03AM G 100%
Delete Data Filter
Site [<All Sites>]
Data ID [<All Data IDs>]
Begin Date [05/20/16]
Begin Time [00:00:00AM]
End Date [05/21/16]
End Time [00:00:00AM]
Delete Selected Data
Delete All Data

Figure 42 Delete Data Filter

Delete Data

→ **Delete Data**

Enter the desired filter criteria, then select **Delete Selected Data** to *permanently* delete the data (Figure 42).

Select **Delete All Data** to permanently delete all logged data from the handheld.

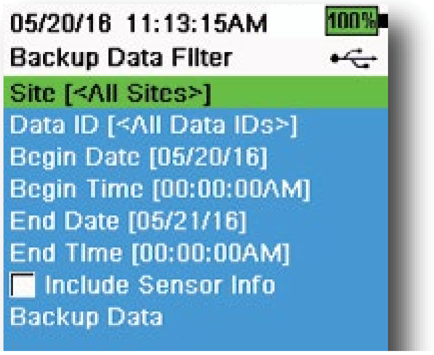

05/20/18 11:13:15AM 100%
Backup Data Filter
Site [<All Sites>]
Data ID [<All Data IDs>]
Begin Date [05/20/16]
Begin Time [00:00:00AM]
End Date [05/21/16]
End Time [00:00:00AM]
☐ Include Sensor Info
Backup Data

Figure 43 Backup Data

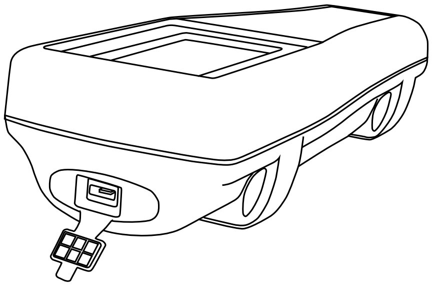


Figure 44 Micro USB female connector

Backup Data

→ **Backup Data**

This function allows you to backup logged data to a flash drive based on Site, Data ID, and log date (Figure 43). A USB female to micro USB male adapter is included with new instruments for this data backup.

> ***NOTE:*** *The USB storage device must be formatted as FAT32, not NTFS or exFAT. The handheld will only support FAT32.*

If the box next to "**Include Sensor Info**" is checked, each data set will be sent to a flash drive as a separate file with sensor serial number and sensor software information included. If the box is not checked (default), all data sets will be sent in a single backup file with no sensor serial number or sensor software information.

> ***NOTE:*** *It is suggested to send data to the USB flash drive as a single file (i.e. box is not checked) unless this sensor information is needed. This makes importing the data much faster and easier.*

Once the filter settings are configured, select **Backup Data** to send the data to a flash drive. The data is exported in a CSV file.

If the data backup is not successful, ensure the correct filter criteria are selected and the USB connection indicator can be seen at the top of the screen (Figure 10).

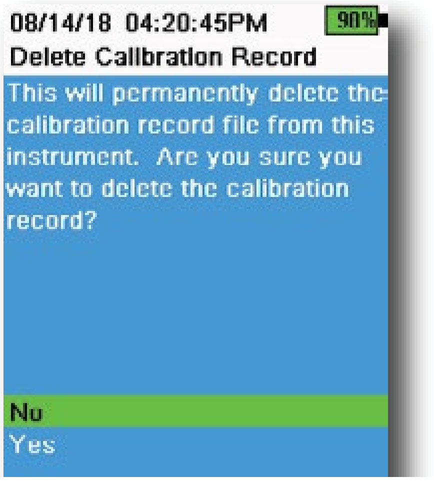

08/14/18 04:20:45PM 90%
Delete Calibration Record
This will permanently delete the calibration record file from this instrument. Are you sure you want to delete the calibration record?
No
Yes

Figure 45 Delete Calibration Record

Delete Calibration Record

→ **Delete Calibration Record**

To permanently delete the Calibration Record file from the instrument, select **Yes**, then push the ENTER key (Figure 45).

2.9 Taking Measurements

For the highest accuracy, calibrate the sensor(s) before taking measurements.

1. Create Site and Data ID lists for logged data (if applicable).
2. Set the logging method (single or interval).
3. Set the Auto Stable parameters (if applicable).
4. Verify that the sensors and/or port plugs are correctly installed in all bulkhead ports.
5. Install the probe guard.
6. Insert the probe into the sample. Make sure the probe is fully submerged.
7. Move the probe in the sample to release any air bubbles and to provide a fresh sample to the sensors.
8. Wait for the sensor/s to stabilize in the sample.
9. On the main run screen, press ENTER to begin logging (single or interval) (See Logging).

   NOTE: *An option to change Site and/or Data ID (if enabled) appears once* ENTER *is pressed to begin logging.*

10. To stop continuous logging, simply press ENTER key again.

3. Calibration

ProDIGITAL sensors (except temperature) require periodic calibration. Calibration procedures follow the same basic steps with variations for specific parameters. Before calibration, adjust *Calibration Record* settings under the **System** menu if applicable to user requirements. Set up sensor options, settings, and coefficients as applicable.

3.1 Calibration Setup

Make sure the calibration cup, sensor guard, and all sensors are clean. YSI strongly recommends installing the sensor guard before placing the sensors into the calibration cup.

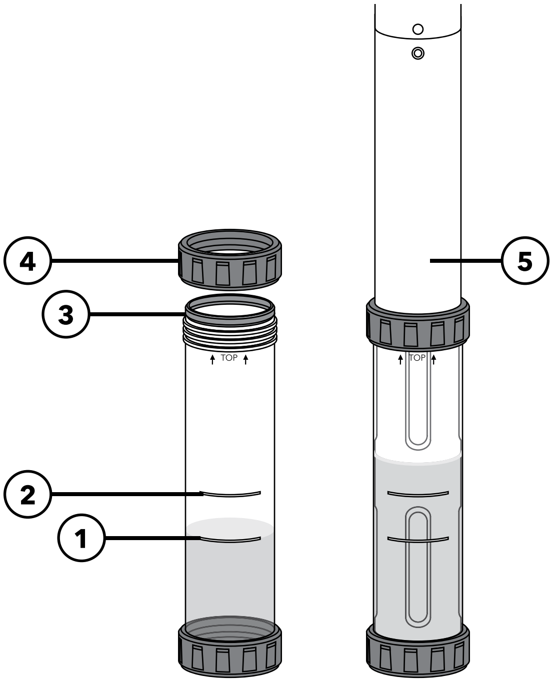
For highest data accuracy, thoroughly rinse the calibration cup and sensors with a small amount of the calibration standard for the sensor to be calibrated. Discard the rinse standard, and proceed with a fresh standard.

Be careful to avoid cross-contamination with other standards between calibrations by thoroughly rinsing with DI water and drying the calibration cup and sensors.

Ensure the calibration cup gasket is correctly seated. Loosely install the retaining nut on the cup. Slide the calibration cup over the sensors and sensor guard and tighten the retaining nut (Figure 46).

For cables and probes without dedicated calibration cups, please use the included graduated cylinder or a clean conatainer large enough to submerge the sensors. When calibrating the 1-port cable assembly, please ensure the built-in thermistor is fully submerged in the calibration solution.

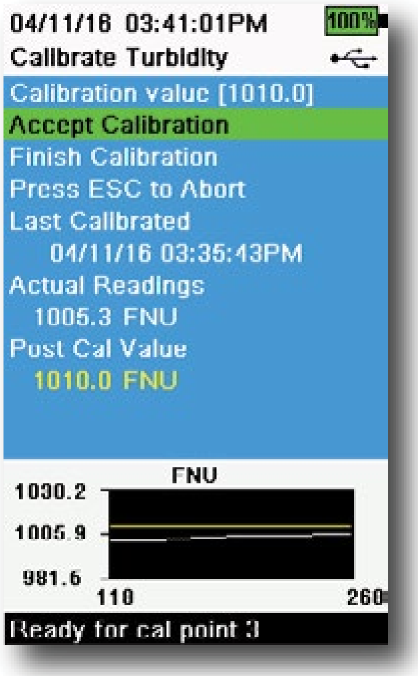
Calibration Cup Installation for 4-Port Cable Assemblies



1	Fill line one (for all calibration solutions except for conductivity)
2	Fill line two (for conductivity calibration solution)
3	Gasket
4	Retaining nut
5	Calibration cup installed

It takes 170 mL of solution to fill the calibration cup to line 1, while it takes 225 mL to fill to line 2.

Figure 46 Calibration cup standard volume (4-port cable)



04/11/16 03:41:01PM

Calibrate Turbidity

Calibration value [1010.0]

Accept Calibration

Finish Calibration

Press ESC to Abort

Last Calibrated

04/11/16 03:35:43PM

Actual Readings

1005.3 FNU

Post Cal Value

1010.0 FNU

Ready for cal point 3

Figure 47 Layout of calibration screen

Calibration Screen Layout

The calibration screen has the same basic layout for each parameter (Figure 47).

Calibration value: This is the value the sensor will be calibrated to. The Yellow Line on the graph corresponds to this value.

Accept Calibration: Select this to calibrate the sensor to the calibration value.

Finish Calibration: This option is only available with multi-point calibrations (*i.e.* pH, ISE, turbidity, PC, PE, and chlorophyll). Finishes the calibration by applying previously accepted points.

Press ESC to Abort: Press the ESC key to leave the calibration. The sensor will not be calibrated to any points. The last successful calibration will be used.

Last Calibrated: View the date and time of the last successful sensor calibration.

Actual Readings: This shows the current measurement value on the Run screen. The White Line on the graph corresponds to this value. Observe the White Line to ensure the measurement is stable before choosing Accept Calibration.

Post Cal Value: This is the same as the calibration value. This will be the measurement value in the current solution after the calibration is finished.

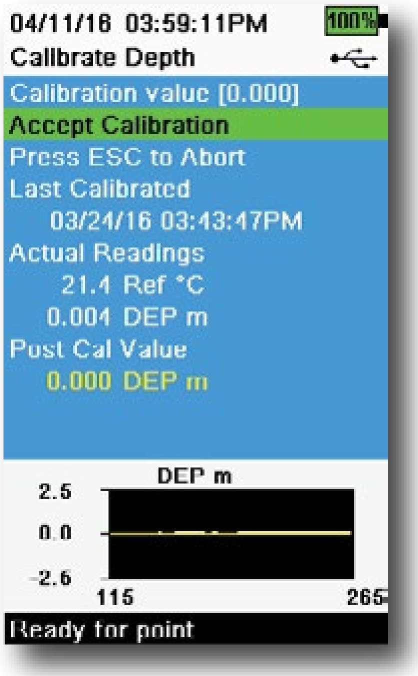
3.2 Depth

NOTE: *This calibration option is available only if your bulkhead is equipped with a depth sensor.*

Depth is calculated from the pressure exerted by the water column minus atmospheric pressure. Factors influencing depth measurement include barometric pressure, water density, and temperature. Calibration in the atmosphere "zeros" the sensor with respect to the local barometric pressure.

YSI recommends calibrating depth at the location of measurement. A change in barometric pressure will result in a zero shift unless the transducer is recalibrated to the new pressure.

If applicable, enter the depth offset to set the depth measurement to something other than zero. Enter the altitude and latitude of your sampling location to increase the accuracy of your depth measurement.



04/11/16 03:59:11PM 100%

Calibrate Depth

Calibration value [0.000]

Accept Calibration

Press ESC to Abort

Last Calibrated

03/24/16 03:43:47PM

Actual Readings

21.4 Ref °C

0.004 DEP m

Post Cal Value

0.000 DEP m

Ready for point

Figure 48 Calibrate Depth

Depth Calibration

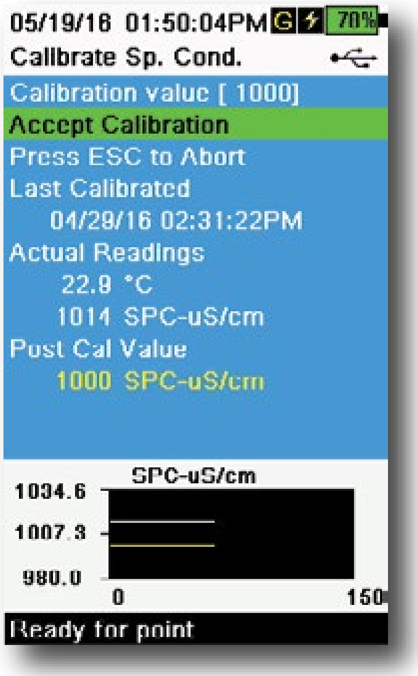
1. Make sure that the depth sensor is clean and dry in air, not immersed in any solution. For best results, keep the bulkhead still and in one position while calibrating.
2. Push the Cal key, then select **Depth**. The **Calibration Value** is set to 0.000 and should not be changed for air calibrations, even if using an offset.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 48).

If the depth offset is used, the depth measurement will be adjusted after calibration.

3.3 Conductivity

The conductivity/temperature sensor can measure and calculate conductivity, specific conductance (temperature compensated conductivity), salinity, non-linear function (nLF) conductivity, TDS, resistivity, and density. Calibration is only available for specific conductance, conductivity, and salinity. Calibrating one of these options automatically calibrates the other conductivity/temperature parameters listed above. For both ease of use and accuracy, YSI recommends calibrating specific conductance.

Select the appropriate calibration standard for the conductivity of the sampling environment. Standards at least 1 mS/cm (1000 µs/cm) are recommended for the greatest stability. For fresh water applications, calibrate to 1,000. For salt water applications, calibrate to 50,000 µS.



05/19/16 01:50:04PM G ⚡ 70%
Calibrate Sp. Cond.
Calibration value [1000]
Accept Calibration
Press ESC to Abort
Last Calibrated
04/28/16 02:31:22PM
Actual Readings
22.9 °C
1014 SPC-uS/cm
Post Cal Value
1000 SPC-uS/cm

Ready for point

Figure 49 Calibrate specific conductance

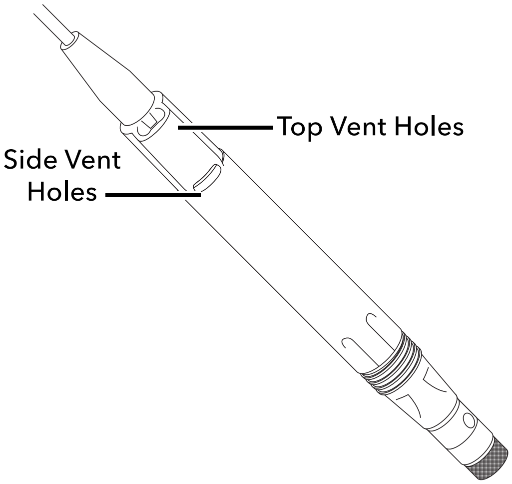


Figure 50 ODO/CT Cable Assembly

Conductivity Calibration

1. Make sure the conductivity sensor is clean prior to calibration. If necessary, clean the conductivity cell with the supplied soft brush.
2. Place the correct amount of conductivity standard into a clean and dry or pre-rinsed calibration cup.
3. Carefully immerse the sensors into the solution. Make sure the solution is above the vent holes on the side of the conductivity sensor.

   If using the ODO/CT assembly, ensure the vent holes at the top of the sensor are completely immersed and the solution level is at least 1 cm higher than the top vent holes (Figure 50). A graduated cylinder is included with ODO/CT cable assemblies for the purpose of calibrating conductivity.

   For 4-port cable assemblies, fill the calibration cup to the second line with fresh calibration standard. It takes 225 mL of solution to fill to line 2.
4. Gently rotate and/or move the sensor up and down to remove any bubbles from the conductivity cell. Allow at least 40 seconds for temperature equilibration before proceeding.
5. Push the Cal key, select **Conductivity**, then select **Specific Conductance**.
6. Select **Calibration value** then enter the calibration value of the standard used. Note the measurement units the instrument is reporting and calibrating and be sure to enter in the correct calibration value for the units being used. For example, 10,000 µS = 10 mS. Make sure that the units are correct and match the units displayed on the handheld.
7. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 49). "Calibration successful!" will be displayed in the message area.

(continued on next page)

Conductivity Calibration *(continued)*

8. Rinse the sensor in clean water then dry.

   NOTE: *If the data is not stabilized after 40 seconds, gently rotate the sensor or remove/reinstall the calibration cup to make sure that no air bubbles are in the conductivity cell.*

   If you get calibration error messages, check for proper sensor immersion, verify the calibration solutions is fresh, the correct value has been entered into the handheld, and/or try cleaning the sensor.

3.4 Barometer

The barometer is factory calibrated and should rarely need to be recalibrated. The barometer is used for DO calibration, %Local measurements, and for virtual vented depth measurements. Verify that the barometer is accurately reading "true" barometric pressure and recalibrate as necessary.

Laboratory barometer readings are usually "true" (uncorrected) values of air pressure and can be used "as is" for barometer calibration. Weather service readings are usually not "true", *i.e.* they are corrected to sea level and cannot be used until they are "uncorrected". Use this approximate formula:

True BP in mmHg=[Corrected BP in mmHg] - [2.5* (Local altitude in ft. above sea level/100)]
Example:
Corrected BP = 759 mmHg
Local altitude above sea level = 978 ft
True BP = 759 mmHg - [2.5*(978ft/100)] = 734.55 mmHg

Barometer Calibration

1. Push the Cal key, then select **Barometer**.
2. Select **Calibration value** then enter the correct "true" barometric pressure.

   NOTE: *The measurement units during calibration are dictated by what is enabled in the sensor setup menu. Be sure to enter in the correct units.*

- BP in mmHg=25.4 x BP inHg
- BP in mmHg=0.750062 x BP mb
- BP in mmHg=51.7149 x BP psi
- BP in mmHg=7.50062 x BP kPa
- BP in mmHg=760 x BP atm

3. Select **Accept Calibration** (Figure 51). "Calibration successful!" will be displayed in the message area.

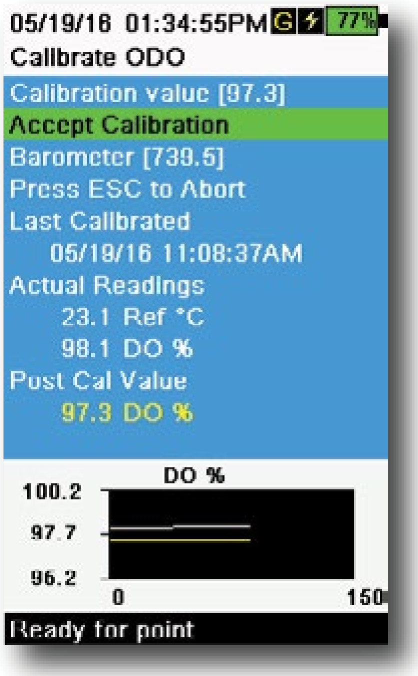

04/11/16 04:00:49PM
100%
Calibrate Barometer
Calibration value [732.0]
Accept Calibration
Press ESC to Abort
Last Calibrated
01/11/16 09:44:53AM
Actual Readings
21.7 °C
732.0 mmHg
Post Cal Value
732.0 mmHg
Ready for point

Figure 51 Calibrate Barometer

3.5 Dissolved Oxygen

ODO calibration requires the current "true" barometric pressure. Make sure that the barometer is reading accurately prior to ODO calibration.

Calibrating in DO% or DO% local automatically calibrates the mg/L and ppm measurement. There is no reason to calibrate both parameters. For both ease of use and accuracy, we recommend that you calibrate DO% or DO% Local and not mg/L.



05/19/16 01:34:55PM G ⚡ 77%
Calibrate ODO
Calibration value [97.3]
Accept Calibration
Barometer [739.5]
Press ESC to Abort
Last Calibrated
05/19/16 11:08:37AM
Actual Readings
23.1 Ref °C
98.1 DO %
Post Cal Value
97.3 DO %

Ready for point

Figure 52 Calibrate ODO %

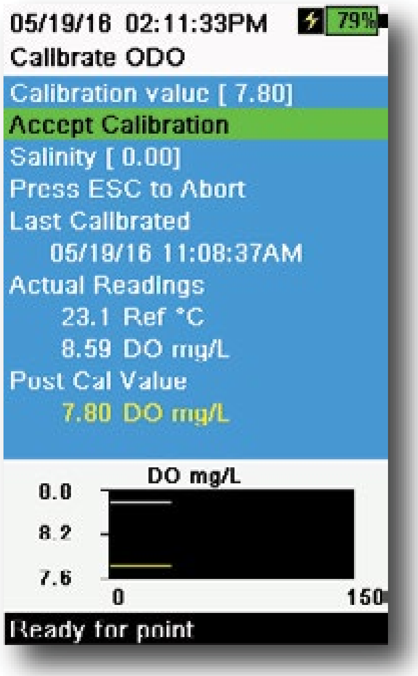
ODO% and ODO% Local - Water Saturated Air Calibration

1. Place a small amount of clean water (5 mL) in the calibration cup or a wet sponge into the calibration sleeve (for ODO/T and ODO/CT probes and 1-port cable assemblies).
2. Make sure there are no water droplets on the ODO sensor cap or temperature sensor.
3. Attach the probe guard and carefully slide into the calibration cup. Make sure a seal is not created around the probe. Atmospheric venting is required for accurate calibration.
4. Turn the instrument on and wait approximately 5 to 15 minutes for the air in the storage container to be completely saturated with water.
5. Push the Cal key, then select **ODO.** Select **DO%**.
6. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 52). "Calibration successful!" will be displayed in the message area.

NOTE: *If you see a calibration error message, verify the barometer reading and inspect the sensor cap. Clean and/or replace the sensor cap as needed.*

ODO mg/L Calibration

1. Place the ODO and conductivity/temperature sensor into a water sample that has been titrated by the Winkler method to determine the dissolved oxygen concentration in mg/L.
2. Push the Cal key, then select **ODO**. Select **DO mg/L**.
3. Select **Calibration value.**
4. Enter the dissolved oxygen concentration of the sample in mg/L.
5. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 53). "Calibration successful!" will be displayed in the message area.
6. Rinse the bulkhead and sensors in clean water then dry.


05/19/16 02:11:33PM 79%
Calibrate ODO
Calibration value [7.80]
Accept Calibration
Salinity [0.00]
Press ESC to Abort
Last Calibrated
05/19/16 11:08:37AM
Actual Readings
23.1 Ref °C
8.59 DO mg/L
Post Cal Value
7.80 DO mg/L

Ready for point

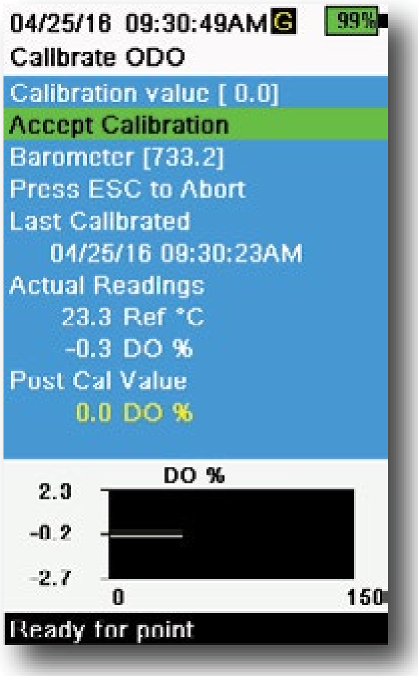
Figure 53 Calibrate ODO mg/L

ODO Zero Point Calibration

1. Place the ODO and Conductivity/Temperature sensors in a solution of zero DO.

   NOTE: *A zero DO solution can be made by dissolving approximately 8-10 grams of sodium sulfite into 500 mL of tap water. Mix the solution thoroughly. It may take the solution 60 minutes to be oxygen-free.*

2. Push the Cal key, then select **ODO**. Select **Zero**.
3. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration** (Figure 54). "Calibration successful!" will be displayed in the message area.
4. Thoroughly rinse the bulkhead and sensors in clean water then dry.
5. Perform a ODO % water-saturated air calibration after performing a zero point calibration.


04/25/16 09:30:49AM G 99%
Calibrate ODO
Calibration value [0.0]
Accept Calibration
Barometer [733.2]
Press ESC to Abort
Last Calibrated
04/25/16 09:30:23AM
Actual Readings
23.3 Ref °C
-0.3 DO %
Post Cal Value
0.0 DO %

Ready for point

Figure 54 Calibrate ODO zero point

3.6 Turbidity

Standards

For best results, YSI recommends the following standards for turbidity calibration:

Calibration Point	Standard Value
1	0 FNU [SKU: 608000]
2	12.4 FNU [SKU: 607200] or 124 FNU [SKU: 607300]
3	1010 FNU [SKU: 607400]

Other standards may be acceptable as long as they have been prepared according to details in Standard Methods for the Treatment of Water and Wastewater (Section 2130 B). These standards include:

- YSI Certified AMCO-AEPA polymer-based standards (see above)
- Hach StablCal™ standards in various NTU denominations
- Dilutions of 4000 NTU formazin concentrate purchased from Hach
- Other formazin standards prepared according to the Standard Methods

The use of standards other than those mentioned above will result in calibration errors and inaccurate field readings. It is important to use the same type of standard for all calibration points; do not mix formazin and polymer-based standards for different points in a multi-point calibration.

When using an alternative standard (non-YSI), calibration can be completed using the following limits:

	Min	Max	Unit
1st Calibration Point	0.0	1.0	FNU or NTU
2nd Calibration Point	5.0	200	FNU or NTU
3rd Calibration Point	400	4000	FNU or NTU

04/11/16 03:39:31PM

Calibrate Turbidity

Calibration value [124.0]

Last Calibrated
04/11/16 03:35:43PM

Actual Readings
123.8 FNU

Post Cal Value
124.0 FNU

Ready for cal point 2

Figure 55 Calibrate Turbidity

Turbidity Calibration 2-Point

Turbidity calibrations, more than most other paramters, are susceptible to interference from contamination. It is critical for calibrations to be performed with very clean sensors, guards, and cups.

> ***NOTE:*** *Calibration standards should not be re-used.*

1. Fill the calibration cup to the appropriate level with 0 FNU standard (deionized water may be used as a substitute). The sensor guard must be installed to ensure an accurate calibration. Make sure the guard is intalled and immerse the probe in the zero standard.
2. Push the Cal key, then select **Turbidity**.
3. Select **Calibration Value** and enter 0.00.
4. Make sure there are no air bubbles on the turbidity sensor lens. If present, lightly tap the guard against the cup to dislodge any bubbles. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), and then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
5. Discard the used standard, and rinse the probe, guard, and calibration cup with a small amount of the next calibration point standard. Discard the rinse standard.
6. Fill the calibration cup to the appropriate level with fresh standard for the second calibration point. Immerse the probe in the standard.
7. Select **Calibration Value** and enter the value of the second calibration standard.
8. Make sure there are no air bubbles on the turbidity sensor lens. Observe the actual measurement readings for stability, and then select **Accept Calibration** (Figure 55). "Ready for cal point 3" will be displayed in the message area.
9. Select **Finish Calibration** to complete a 2-point calibration or continue for the 3-point calibration.

Repeat steps 5 through 8 for a 3-point calibration. "Calibration successful!" will be displayed in the message area. After calibration, rinse with water and dry the probe.

3.7 Total Algae

TAL Sensors

YSI offers two Total Algae (TAL) sensor options. Both are dual-channel fluorescence sensors.

The channels on the TAL-PC sensor refer to two independent data sets: one results from a blue excitation beam that excites the chlorophyll a (Chl) molecule and the second results from an orange excitation beam that excites the phycocyanin (PC) accessory pigment. TAL-PC sensors are typically selected for monitoring freshwater cyanobacteria.

The TAL-PE sensor is similar in having a chlorophyll channel, but utilizes a slightly blueshifted beam that excites the pigment phycoerythrin (PE). TAL-PE sensors are typically selected for monitoring marine cyanobacteria.

TAL Units

The TAL sensors report data in RFU and µg/L of pigment (Chl, PC or PE) units. YSI recommends reporting in Relative Fluorescence Units (RFU).

RFU is used to set sensor output relative to a stable secondary standard, Rhodamine WT dye. This allows users to calibrate sensors identically so that results from sensor to sensor can be compared. Calibration with Rhodamine WT also enables users to monitor for sensor drift and external factors such as biofouling or declining sensor optical performance over time as the LEDs age.

The excellent linearity of RFU, once the channels are calibrated with Rhodamine WT, translates to the best accuracy of measurements. For example, a chlorophyll reading of 100 units will represent twice the pigment detected by the sensor than with a chlorophyll reading of 50 units. This high linearity (R2>0.9999) doesn't always hold for µg/L of pigment since that unit was derived from laboratory monocultures, and an environmental algal population can behave quite differently. This is also why the TAL sensors and in situ monitoring should not be regarded as a perfect replacement for other methods such as pigment extractions and cell counting.

The µg/L output generates an estimate of pigment concentration that is based upon correlations built with sensor outputs and extractions of pigments from laboratory-grown blue-green algae. Synonymous with parts per billion (ppb), µg/L is still commonly used by regulatory agencies, but has the drawback that it is very dependent upon the composition of the algal population, the time of day, the physiological health of the algae, and a number of other environmental factors. Thus, users are advised to do their own check of our correlation with a population of algae relevant to their own sites, as described below.

A 2-point RFU calibration is advised to be performed first. Next, with samples collected from the site of interest, measure both RFU and µg/L with the sensor(s). Observing careful handling and preservation of the samples, as soon as possible extract the pigments from the samples, using standardized methods to determine the µg/L in each sample. The extraction data may be used to assess how RFU and µg/L delivered by the sensor compare with the µg/L of pigment that would be predicted by RFU from the sensor. The user's requirements can guide the decision as to whether RFU or µg/L is the best unit to read from the sensor for any specific application.

TAL Raw values can only be seen under Sensor info in the System menu and are unaffected by user calibrations. These values range from 0-100, representing the percent of full scale that the sensor detects in a sample, and are used for diagnostic purposes.

Rhodamine WT Dye Solution Preparation

Rhodamine WT dye solution must be used when completing a 2-point calibration. Purchase Rhodamine WT as a 2.5% solution to follow the procedure below. Kingscote Chemicals (Miamisburg, OH, 1-800-394-0678) has historically had a 2.5% solution (item #106023) that works well with this procedure. Note that there are many types of Rhodamine—make sure Rhodamine **WT** is selected. If a 2.5% solution cannot be obtained commercially, prepare it from a solid or from another concentration of a liquid solution to a 2.5% final concentration, or adjust the dilutions below accordingly. It should be stored in the refrigerator when not in use.

For PC and chlorophyll channel calibrations, a 0.625 mg/L solution of Rhodamine WT should be prepared. For PE channel calibration, a 0.025 mg/L solution of Rhodamine WT should be prepared. The steps below describe one procedure to prepare these solutions.

1. *For any TAL sensor calibration, prepare a 125 mg/L solution of Rhodamine WT.* Transfer 5.0 mL of the 2.5% Rhodamine WT solution into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water and mix well to produce a solution that is approximately 125 mg/L of Rhodamine WT. Transfer to a storage bottle and retain it for future use.

   *This solution can be stored in the refrigerator (4°C). Its degradation will depend upon light exposure and repeated warming cycles, but solutions used 1-2 times a year can be stored for up to two years. Users should implement their own procedures to safeguard against degradation.

2. *For PC and chlorophyll channel calibrations, prepare a 0.625 mg/L solution of Rhodamine WT.* Transfer 5.0 mL of the 125 mg/L solution prepared in step one into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water. Mix well to obtain a solution that is 0.625 mg/L of Rhodamine WT. Use this solution within 24 hours of preparation and discard it after use.
3. *For PE channel calibration, prepare a 0.025 mg/L solution of Rhodamine WT.* Transfer 0.2 mL of the 125 mg/L solution prepared in step one into a 1000 mL volumetric flask. Fill the flask to the volumetric mark with deionized or distilled water. Mix well to obtain a solution that is 0.025 mg/L of Rhodamine WT. Use this solution within 24 hours of preparation and discard it after use.

In addition to preparing the Rhodamine solution(s), it is also necessary to determine temperature-compensated calibration values for solutions. In general, fluorescence is inversely related with temperature. Measure the temperature of the Rhodamine solution(s) and use the temperature of the solution at the time of calibration to select the compensated solution concentrations, in either RFU (recommended) or µg/L pigment equivalents, from the table below.

As an example, assume that you will calibrate the chlorophyll channel in RFU, and that the temperature measured in the 0.625 mg/L Rhodamine WT solution is 22°C. The first standard value entered will be 0, and the second standard value will be 16.4 (see table on page 41). Likewise, if you intend to use the default µg/L unit when calibrating chlorophyll, the second standard value would be 66 in this example. Using the same 0.625 mg/L Rhodamine WT solution to calibrate the PC channel will yield a second standard value of 16.0 RFU or 16 µg/L. These values will be entered when performing a 2-point calibration.

Rhodamine WT Dye Solution Preparation *(continued)*

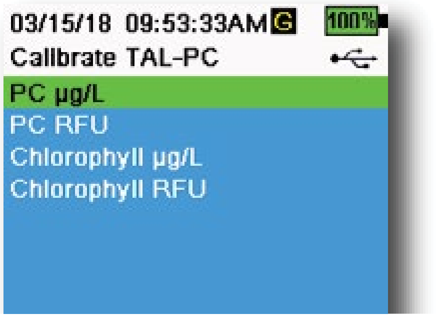
	Chlorophyll		Phycocyanin		Phycoerythrin	
Temp (°C)	RFU	µg/L	RFU	µg/L	RFU	µg/L
30	14.0	56.5	11.4	11.4	37.3	104.0
28	14.6	58.7	13.1	13.1	39.1	109.0
26	15.2	61.3	14.1	14.1	41.0	115.0
24	15.8	63.5	15.0	15.0	43.0	120.0
22	16.4	66	16.0	16.0	45.0	126.0
20	17.0	68.4	17.1	17.1	47.0	132.0
18	17.6	70.8	17.5	17.5	49.2	138.0
16	18.3	73.5	19.1	19.1	51.4	144.0
14	18.9	76	20.1	20.1	53.6	150.0
12	19.5	78.6	21.2	21.2	55.9	157.0
10	20.2	81.2	22.2	22.2	58.2	163.0
8	20.8	83.8	22.6	22.6	60.6	170.0

TAL Calibration

A 1- or 2-point calibration can be completed for all channels on the TAL-PC and TAL-PE sensors.

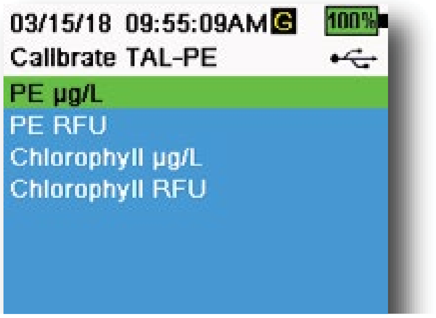
A 1-point calibration, typically completed in clear deionized or distilled water, is simply a re-zeroing of the sensor. This calibration does not reset the second point entered during the previous 2-point calibration. The consequence is that error will be alleviated at and near zero, but more error can accumulate in the measurement the farther away from zero the measured value is. The amount of error is dependent upon how much the second point drifts, which is not always equivalent to how much the zero point drifts.

For many users, especially those with sites where pigment is rarely detected and values are at or near zero most of the time, the far-from-zero accumulation of error is a non-issue. For others, it is best to perform a 2-point calibration using a Rhodamine WT solution.



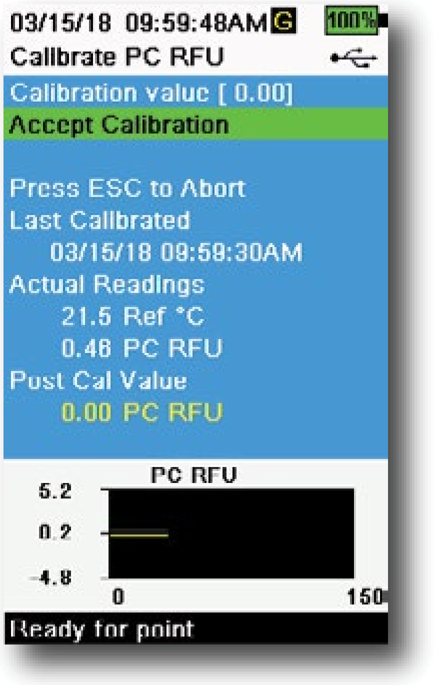
03/15/18 09:53:33AM
Calibrate TAL-PC
PC µg/L
PC RFU
Chlorophyll µg/L
Chlorophyll RFU

Figure 56 TAL-PC Calibration Options



03/15/18 09:55:09AM
Calibrate TAL-PE
PE µg/L
PE RFU
Chlorophyll µg/L
Chlorophyll RFU

Figure 57 TAL-PE Calibration Options



03/15/18 09:59:48AM
Calibrate PC RFU
Calibration value [0.00]
Accept Calibration
Press ESC to Abort
Last Calibrated
03/15/18 09:59:30AM
Actual Readings
21.5 Ref °C
0.48 PC RFU
Post Cal Value
0.00 PC RFU
Ready for point

Figure 58 Calibrate PC RFU

PE, PC and Chlorophyll Calibration 2-Point

Each channel of the sensor must be calibrated independently. Calibration of the chlorophyll channel does not set the calibration for the PC channel or the PE channel. In addition, calibrating in RFU for a channel does not automatically calibrate the µg/L measurement for the same channel. The following calibration procedure must be performed for each channel and each unit the user would like to display.

1. Fill the calibration cup to the appropriate level with deionized water (0 standard). Immerse the probe in the standard. Make sure the sensor guard is installed.
2. Push the Cal key, then select either **TAL-PC** or **TAL-PE**, depending on the sensor to be calibrated.
3. Select the channel and units to be calibrated. Options for the TAL-PC sensor are shown in Figure 56, while options for the TAL-PE sensor are shown in Figure 57.
4. Select **Calibration Value** and enter 0.00.
5. Make sure there are no air bubbles on the sensor lens. If present, lightly tap the guard against the cup to dislodge any bubbles. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), and then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
6. Discard the used water, and rinse the probe, guard, and calibration cup with a small amount of the standard for calibration point #2. Discard the rinse standard.

   NOTE: *For standard #2, use the 0.625 mg/L Rhodamine WT solution when calibrating chlorophyll (RFU or µg/L) on either TAL sensor, or when completing a PC (RFU or µg/L) calibration on a TAL-PC sensor. Use the 0.025 mg/L Rhodamine WT solution when completing a PE (RFU or µg/L) calibration on a TAL-PE sensor.*

7. Fill the calibration cup to the appropriate level with fresh standard #2. Immerse the sensors in the second calibration standard.
8. Observe the temperature reading on the calibration display (Figure 58). Use the table in the Rhodamine WT dye solution preparation section to identify the appropriate value for the calibration standard.
9. Select **Calibration Value** and enter the value of the second calibration standard.
10. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration**. The procedure will automatically finish after calibrating using the second standard.

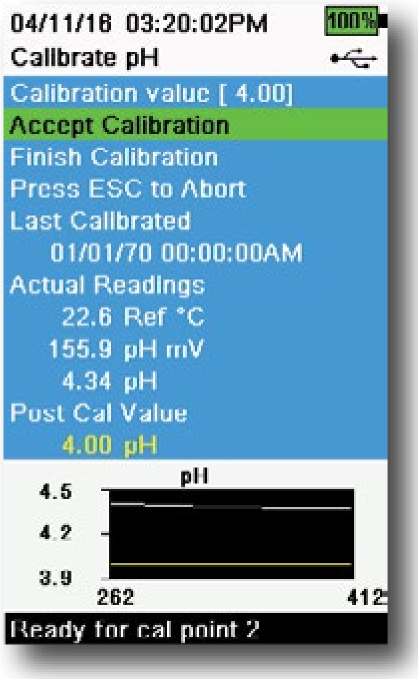
3.8 pH/ORP

Observe the pH mV readings during calibration to understand the condition and response of the pH sensor. In buffer 7, pH mVs should be between -50 and +50. In pH4 buffer, the mV reading should be 165 to 180 mV higher than the reading in pH 7 buffer. In pH 10 buffer, the mV reading should be 165 to 180 mV lower than the reading in pH 7 buffer. The theoretically ideal slope is -59 mV/pH unit.

1-Point
While a 1-point pH calibration is possible, this calibration procedure adjusts only the pH offset and leaves the previously determined slope unaltered. This should only be performed if you are adjusting a previous 2-point or 3-point calibration.

2-point
Perform a 2-point pH calibration if the pH of the media to be monitored is known to be either basic or acidic. In this procedure, the pH sensor is calibrated with a pH 7 buffer and a pH 10 or pH 4 buffer depending upon the pH range you anticipate for your water to be sampled.

3-point
Perform a 3-point pH calibration to assure maximum accuracy when the pH of the environmental water cannot be anticipated or fluctuates above and below pH 7. In this procedure, the pH sensor is calibrated with pH 7, pH 10, and pH 4 buffer solutions.



04/11/16 03:20:02PM

Calibrate pH

Calibration value [4.00]

Last Calibrated
01/01/70 00:00:00AM

Actual Readings
22.6 Ref °C
155.9 pH mV
4.34 pH

Post Cal Value
4.00 pH

Ready for cal point 2

Figure 59 Calibrate pH 2- or 3-point

pH Calibration 3-Point

1. Always start the calibration with pH 7 buffer. Fill the calibration cup to the appropriate level with pH 7 buffer solution.
2. With the probe guard installed, carefully immerse the probe into the buffer solution. Make sure both the pH sensor and temperature sensor are submerged.
3. Push the Cal key; then select **pH** or **pH/ORP**.
4. The **Calibration value** will automatically be adjusted based on the selected buffer and temperature. Alternatively, the Calibration value can be manually entered..
5. Wait for the pH mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.
6. Select **Accept Calibration** and press the ENTER key. "Ready for cal point 2" will be displayed in the message area.
7. Rinse the probe and calibration cup. Fill to the appropriate level with either pH 10 or pH 4 buffer solution; it doesn't matter which one comes next.
8. Immerse the probe into the buffer solution. The **Calibration value** will automatically be adjusted based on the selected buffer and temperature.
9. Wait for the pH mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.
10. Select **Accept Calibration** and press the ENTER key. "Ready for cal point 3" will be displayed in the message area.

pH Calibration 3-Point *(continued)*

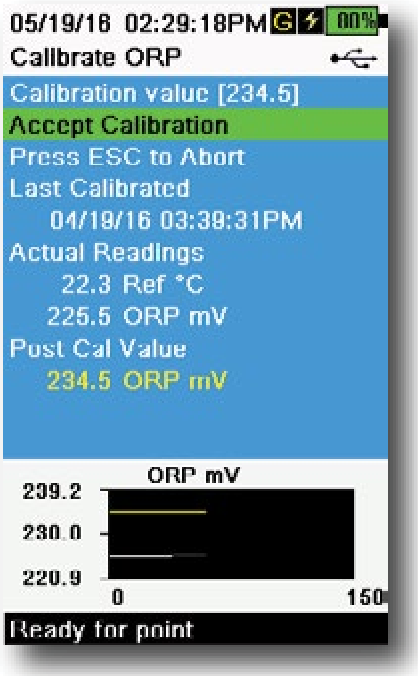
NOTE: *For 2-Point calibrations, select Accept Calibration before selecting Finish Calibration.*

11. Rinse the probe and calibration cup. Fill to the appropriate level with the final buffer solution.

12. Immerse the probe into the buffer solution. The **Calibration value** will automatically be adjusted based on the selected buffer and temperature.

13. Wait for the pH mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.

14. Select **Accept Calibration** and press the ENTER key. The procedure will automatically finish after calibrating the third point.



05/19/16 02:29:18PM

Calibrate ORP

Calibration value [234.5]

Accept Calibration

Press ESC to Abort

Last Calibrated

04/19/16 03:38:31PM

Actual Readings

22.3 Ref °C

225.5 ORP mV

Post Cal Value

234.5 ORP mV

Ready for point

Figure 60 Calibrate ORP

ORP Calibration

1. Obtain a premixed standard solution that is approved for use with Ag/AgCl ORP sensors or prepare a standard with a known oxidation reduction potential (ORP) value. Zobell solution is recommended.
2. With the probe guard installed, carefully immerse the probe into the standard solution. Make sure both the ORP sensor and temperature sensor are submerged.
3. Push the Cal key, then select **pH/ORP**, then **ORP**.
4. If using YSI Zobell solution, the **Calibration value** will automatically be adjusted based on the temperature. Otherwise, refer to the table included with the standard solution and enter the mV value that corresponds to the temperature of the solution.
5. Wait for the ORP mV and temperature readings to stabilize; the white line on the graph should be flat for about 40 seconds.
6. Select **Accept Calibration** and press the ENTER key. "Calibration successful!" will be displayed in the message area.

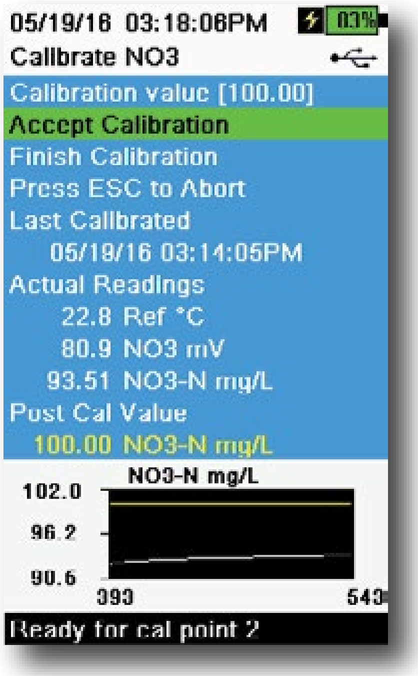
3.9

ISEs

Ammonium, Nitrate, & Chloride

YSI recommends a 2-point calibration for ISEs. For best results, use standards that differ by 2 orders of magnitude:

- 1 mg/L and 100 mg/L for Ammonium and Nitrate
- 10 mg/L and 1,000 mg/L for Chloride



05/19/16 03:18:06PM 83%

Calibrate NO3

Calibration value [100.00]

Accept Calibration

Finish Calibration

Press ESC to Abort

Last Calibrated

05/19/16 03:14:05PM

Actual Readings

22.8 Ref °C

80.9 NO3 mV

93.51 NO3-N mg/L

Post Cal Value

100.00 NO3-N mg/L

Ready for cal point 2

Figure 61 Calibrate ISE

ISE Calibration

1. Fill the calibration cup to the appropriate level standard for calibration point #1. Immerse the probe in the standard.
2. Push the Cal key, then select the applicable ISE sensor.
3. Select **Calibration value** and enter the value that corresponds to the first calibration standard.
4. Observe the actual measurement readings for stability (white line on graph shows no significant change for 40 seconds), then select **Accept Calibration**. "Ready for cal point 2" will be displayed in the message area.
5. Discard the used standard and rinse the probe and calibration cup with a small amount of the next calibration point standard. Discard the rinse standard.
6. Fill the calibration cup to the appropriate level with fresh standard for the second calibration point. Immerse the probe in the standard.
7. Select **Calibration value** and enter the value of the second calibration standard.
8. Observe the actual measurement readings for stability, and then select **Accept Calibration** (Figure 61). "Ready for cal point 3" will be displayed in the message area.
9. Select **Finish Calibration** to complete a 2-point calibration.

Optimal mV for ISE calibration

Ammonium mV values

- NH_4 1 mg/L = 0 mV +/- 20 mV (new sensor only)
- NH_4 100 mg/L = 90 to 130 mV greater than the mV reading in the 1 mg/L standard
- The mV span between 1 mg/L and 100 mg/L values should be approximately 90 to 130 mV. The slope should be 45 to 65 mV per decade of ammonium concentration in mg/L

Nitrate mV values

- NO_3 1 mg/L = 200 mV +/- 20 mV (new sensor only)
- NO_3 100 mg/L = 90 to 130 mV less than the mV reading in the 1 mg/L mV standard
- The mV span between 1 mg/L and 100 mg/L values should be approximately 90 to 130 mV. The slope should be -45 to -65 mV per decade of nitrate concentration in mg/L

Chloride mV values

- Cl 10 mg/L = 225 mV +/- 20 mV (new sensor only)
- Cl 1,000 mg/L = 80 to 130 mV < 10 mg/L mV value
- The mV span between 10 mg/L and 1000 mg/L values should be approximately 80 to 130 mV. The slope should be -40 to -65 mV per decade of chloride concentration in mg/L

Chilled Third Calibration Point

The chilled 3-point calibration is recommended if there is a large temperature variation during sampling or when the temperature of the media cannot be anticipated. The highest concentration solution and one of the lower concentration solutions should be at ambient temperature. The other lower concentration solution should be chilled to less than 10°C to prior calibration point.

1. Discard the used standard and rinse the probe and calibration cup with a small amount of the next calibration point standard. Discard the rinse standard.
2. Fill the calibration cup to the appropriate level with fresh standard for the third calibration point. Immerse the probe in the standard.
3. Select **Calibration value** and enter the value of the third calibration standard.
4. Observe the actual measurement readings for stability, and then select **Accept Calibration**. "Calibration successful!" will be displayed in the message area.

Preparing Standards

We recommend using YSI calibration solutions whenever possible. However, qualified users can follow these recipes to prepare their own standards.

⚠ **CAUTION:** Some of the chemicals required for these solutions could be hazardous under some conditions; therefore, the standards should only be prepared by qualified chemists in laboratories where proper safety precautions are possible. It is the responsibility of the user to obtain and study the MSDS for each chemical and to follow the required instructions with regard to handling and disposal of these chemicals.

Ammonium Standards

You will need:

- Solid ammonium chloride or a certified 100 mg/L NH_4^+-N from a supplier
- Lithium acetate dihydrate
- Concentrated hydrochloric acid
- High purity water
- A good quality analytical balance
- A 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL and 10 mL of solution
- And a 1000 mL glass or plastic storage vessels

⚠ **CAUTION:** Hydrochloric acid is highly corrosive and toxic and should therefore be handled with extreme care in a well-ventilated fume hood. The equivalent amount of a less-hazardous, more dilute sample of the acid may be used if preferred.

100 mg/L Standard

1. Accurately weigh 0.3817 g of ammonium chloride and transfer quantitatively into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water to the flask. Swirl to dissolve all of the reagents and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity. Alternatively, 100 mL of certified 100 mg/L NH_4^+-N standard can be used in place of the solid ammonium chloride.

Ammonium Standards *(continued)*

1 mg/L Standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 2.6 g of lithium acetate dihydrate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.
4. Add 3 drops of concentrated hydrochloric acid to the bottle, then seal and agitate to assure homogeneity.

Other concentrations can be made by altering the amount of ammonium chloride. All other ingredient concentrations should remain unchanged.

Nitrate Standards

You will need:

- Solid potassium nitrate or a certified 1000 mg/l NO_3-N from a supplier
- Magnesium sulfate, high purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- Accurate volumetric measuring devices for 100 mL, 10 mL and 1 mL of solution
- And 1000 mL glass or plastic storage vessels

100 mg/L standard

1. Accurately weigh 0.7222 g of anhydrous potassium nitrate and transfer quantitatively into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of water to the flask. Swirl to dissolve all of the reagents, and then dilute to the volumetric mark with distilled or deionized water.
3. Mix well by repeated inversion and then transfer the 100 mg/L standard to a storage bottle.
4. Rinse the flask extensively with water prior to its use in the preparation of the 1 mg/l standard. Alternatively, 100 mL of certified 1000 mg/L NO_3-N standard can be used in place of the solid potassium nitrate.

1 mg/L standard

1. Accurately measure 10.0 mL of the above 100 mg/L standard solution into a 1000 mL volumetric flask. Add 1.0 g of anhydrous magnesium sulfate to the flask.
2. Add approximately 500 mL of distilled or deionized water. Swirl to dissolve the solid reagents, and then dilute to the volumetric mark with water.
3. Mix well by repeated inversion and then transfer the 1 mg/L standard to a storage bottle.

Other concentrations can be made by altering the amount of potassium nitrate. All other ingredient concentrations should remain unchanged.

Chloride Standards

You will need:

- Solid sodium chloride or a certified 1000 mg/L chloride solution from a supplier
- Magnesium sulfate
- High-purity water
- A good quality analytical balance
- 1000 mL volumetric flask
- An accurate 10 mL measuring devices
- And 1000 mL glass or plastic storage vessels

1000 mg/L Standard

1. Accurately weigh 1.655 grams of anhydrous sodium chloride and transfer into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water to the flask, swirl to dissolve all of the reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 1000 mg/L standard to a storage bottle.
5. Rinse the flask extensively with water prior to its use in the preparation of the 10 mg/L standard. Alternatively, simply add 0.5 grams of magnesium sulfate to a liter of a 1000 mg/L chloride standard from a certified supplier.

10 mg/L Standard

1. Accurately measure 10 mL of the above 1000 mg/L standard solution into a 1000 mL volumetric flask.
2. Add 0.5 grams of anhydrous magnesium sulfate to the flask.
3. Add 500 mL of water, swirl to dissolve the solid reagents, then dilute to the volumetric mark with water.
4. Mix well by repeated inversion, then transfer the 10 mg/L standard to a storage bottle.

4. Maintenance and Storage

Follow all maintenance and storage procedures in this section. Incorrect or unapproved maintenance and/or storage can cause handheld, sensor or cable damage not covered by the warranty.

Storage terms are defined as follows:

Short-term Storage = Less than 4 weeks

Short-term storage is appropriate when the handheld, cables, and sensors will be used at regular intervals (daily, weekly, etc.).

Long-term Storage = More than 4 weeks

During long periods of inactivity, such as the "off-season" for environmental monitoring, the instrument, sensors, and cables should be placed in long-term storage.

YSI recommends cleaning and maintenance before long-term storage.

4.1 ProDIGITAL Handheld

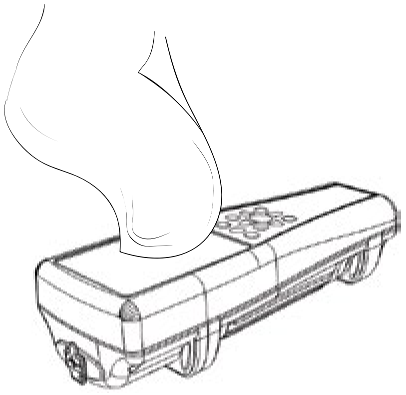


Figure 62 Handheld cleaning

Wipe the keypad, screen, and case with a cloth dampened with a mild solution of clean water and dish soap (Figure 62). Optimal storage temperature of the handheld instrument is 0-45°C. The battery pack permanently loses capacity at a faster rate when above 45°C.

Short-term Storage:

Assure that the handheld instrument is powered off, and store it in a temperature-controlled, secure location. Ideally all ports should be covered to prevent dust, water, or other contamination.

Long-term Storage:

In addition ot the short-term storage guidelines above, remove the battery pack to prevent any damage from possible battery leaks. Reinstall the battery cover. Store the battery pack in a dry place ideally around 25°C.

4.2 1-Port and 4-Port Bulkheads

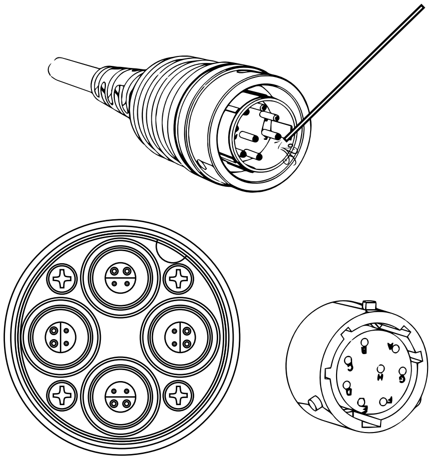


Figure 63 Cable, bulkhead, connector maintenance

Wipe the cable and bulkhead with a cloth dampened with a mild solution of clean water and dish soap. Make sure sensors or port plugs are installed so the bulkhead ports do not get wet when cleaning. Exposure to water can cause damage or corrosion to the bulkhead connectors not covered by the warranty.

For short-term storage, YSI recommends leaving the sensors installed on the bulkhead. The ODO, pH, and pH/ORP sensors must be kept in a moist air environment; therefore, place a small amount of water (5-10 mL) in the calibration cup and tighten the retaining nut to seal the storage chamber.

For long-term storage, YSI recommends uninstalling the sensors from the bulkhead and following each sensor's respective long-term storage instructions. Inspect the bulkhead ports and cable connectors for contamination. If dirty or wet, clean it with compressed air (Figure 63). Install the cap that protected the bulkhead during initial shipment. Alternatively, install the bulkhead port plugs.

4.3 Sensor Guard

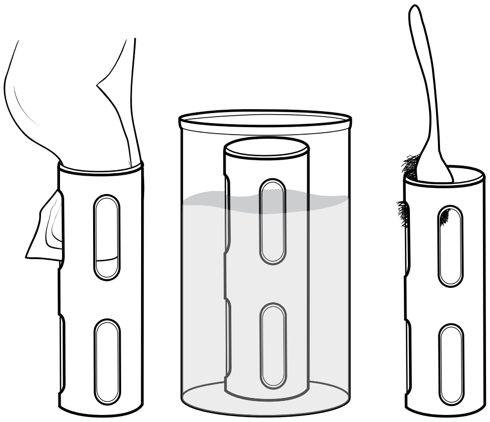


Figure 64 Sensor guard maintenance

Remove light bio-fouling with a cloth soaked in a mild solution of clean water and dish soap. Soak in vinegar to remove hard growth and deposits. Use a plastic scrub brush to remove any remaining bio-fouling. Rinse the sensor guard with clean water (Figure 64).

NOTICE: Do not sand or polish the guard. Removal of the guard coating can affect some sensor readings.

4.4 Depth Sensor

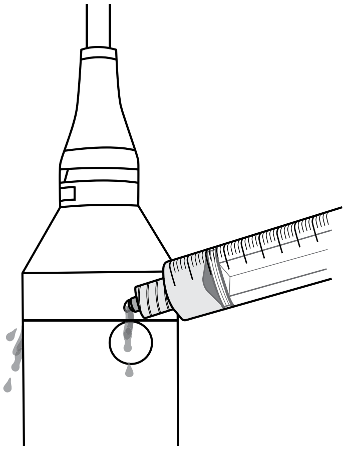


Figure 65 Depth sensor flush

The depth sensor should be flushed after each use. Fill the syringe (included with the maintenance kit) with clean water and gently push water through the ports located on the bulkhead. Flush until clean water flows from the opposite depth port (Figure 65).

The sensor can be stored wet or dry. For long-term storage, YSI recommends storing the sensor dry.

NOTICE: Do not insert objects into the depth ports. Damage to the depth transducer from incorrect cleaning is not covered by the warranty.

4.5 Temperature Sensor

To ensure optimal performance, it is important to keep the temperature sensor free of any deposits. Rinse the thermistor after each use. If deposits have formed, use mild soapy water and a soft bristle cleaning brush. The ProDSS smart sensor can be stored wet or dry.

However, if you're using the **ODO/T** or **ODO/CT** cable assembly, the sensor must be stored in a moist enviornment. A grey storage sleeve is shipped with the cable for an easy storage option. Simply moisten the sponge with a small amount of clean water and slide the sleeve over the probe guard to create a moist atmosphere for the sensor.

4.6 Conductivity Sensor

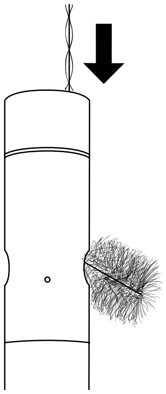


Figure 66 Channel brush

The conductivity channels should be cleaned after each use. Dip the sensor's cleaning brush (included with the maintenance kit) in clean water, insert the brush at the top of the channels, and sweep the channels 15 to 20 times (Figure 66).

If deposits have formed on the electrodes, use a mild solution of dish soap and water to brush the channels. For heavy deposits, soak the sensor in white vinegar, then scrub with the cleaning brush. Rinse the channels with clean water following the sweepings or soak.

The ProDSS sensor can be stored wet or dry. For long-term storage, YSI recommends storing the sensor dry.

However, if you're using the **ODO/CT** cable assembly, the sensor must be stored in a moist enviornment.

4.7 Optical Dissolved Oxygen Sensor

The ODO sensor should be kept clean since some types of fouling may consume oxygen which could affect the dissolved oxygen measurements.

To clean the sensor cap, gently wipe away any fouling with a lens cleaning tissue that has been moistened with water to prevent scratches (Figure 67). Do not clean the ODO sensor with organic solvents as they may damage the cap.

To minimize sensor drift, always store the ODO sensor in a wet or water-saturated air environment.

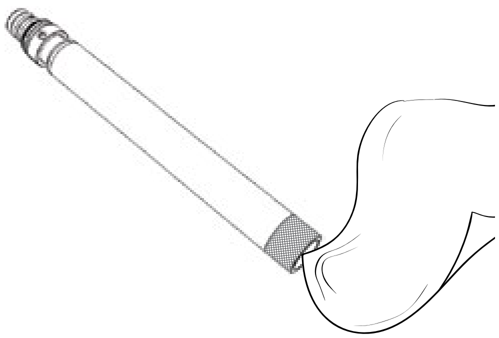


Figure 67 Wiping the ODO sensor window

Short-term Storage:

Store the ODO sensor in a moist air environment. A storage sleeve with a wet sponge or the calibration cup with a small amount of water is recommended (Figure 68).

This is true for both ProDSS sensors and the ODO cables assemblies.

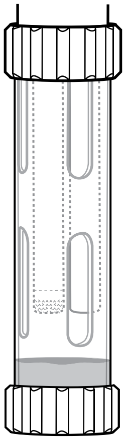


Figure 68 ODO short-term storage

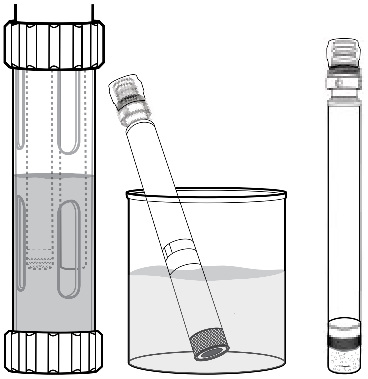


Figure 69 ODO long-term storage

Long-term Storage:

- **Method 1:** Submerge the sensing end of the sensor in a container of distilled or deionized water. Periodically check the level of the water to make sure that it does not evaporate.
- **Method 2:** Wet the sponge located in the cap originally included with the ODO sensor, then install on sensing end of the ODO sensor. Replace the sponge if it becomes dirty.

For ProDSS ODO sensors, the sensor can be left on the 4-port bulkhead or removed for long-term storage (Figure 69).

For ODO cable assemblies, the sensor must be stored in a moist enviornment. A grey storage sleeve is shipped with the cable for an easy storage option. Simply moisten the sponge with a small amount of clean water and slide the sleeve over the probe guard to create a moist atmosphere for the sensor.

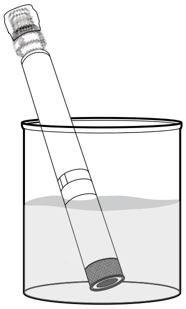


Figure 70 ODO rehydration

ODO Sensor Rehydration

If the ODO sensor has accidentally been left dry for longer than 8 hours, it must be rehydrated. To rehydrate, soak the ODO sensor in room temperature tap water for approximately 24 hours. After the soak, calibrate the sensor (Figure 70).

ODO Sensor Cap

Optical DO sensor caps are warrantied for either 12 or 24 months depending on the model:

- ProDSS ODO Sensor Cap [SKU: 626890] = **12** months
- ODO Extended Warranty Sensor Cap [SKU: 627180] = **24** months

Depending on usage and storage practices, the cap may last longer than its warranty period.

As the ODO sensor caps ages, deterioration of the dye layer can reduce measurement stability and response time. Periodically inspect the sensor cap for damage and large scratches in the dye layer. Replace the cap when readings become unstable and cleaning the cap and DO recalibration do not remedy the symptoms.

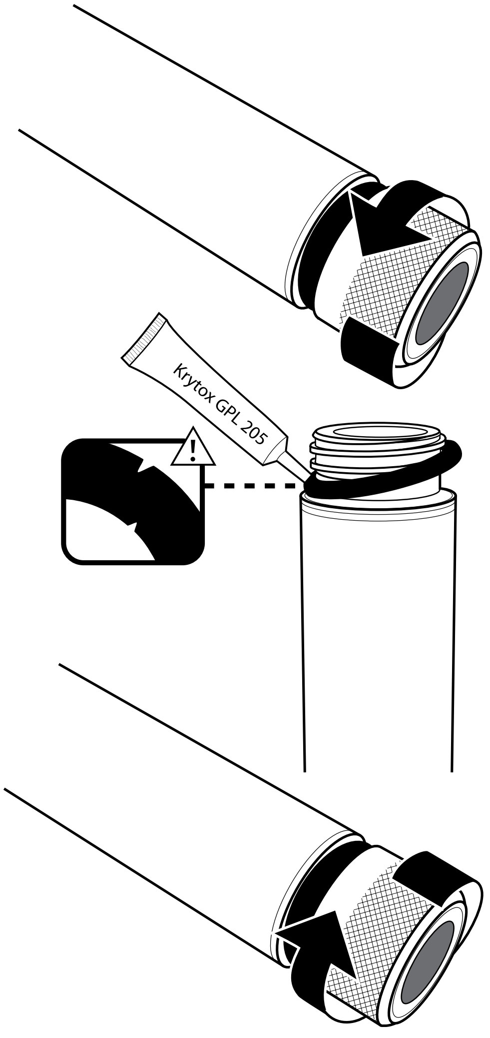


Figure 71 ODO cap replacement

ODO Sensor Cap Replacement

The instruction sheet shipped with the replacement ODO sensor cap includes the calibration coefficients specific to that sensor cap. Make sure to save the ODO sensor cap instruction sheet in case you need to reload the calibration coefficients.

1. Remove the old sensor cap assembly from the probe by grasping the probe body with one hand and rotating the sensor cap counterclockwise until it is completely free. Do not use any tools for this procedure.
2. Carefully remove the o-ring by pinching it with your fingers and rolling it up. Do not use any tools to remove the o-ring. Clean the area of any debris with a lens cleaning tissue.
3. Install the new o-ring that is included with the replacement sensor cap.
4. Apply a thin coat of o-ring lubricant (included with the new cap) to the installed o-ring. Remove any excess o-ring lubricant with a lens cleaning tissue. Be careful to avoid contact with the sensor lens.
5. Inspect the sensor lens for any moisture or debris. If necessary, wipe the lens carefully with a non-abrasive, lint-free cloth to prevent scratches. Do not use organic solvents to clean the ODO sensor lens.
6. Remove the new sensor cap from its hydrated container and dry the inside cavity of the sensor cap with lens cleaning tissue. Make sure the cavity is completely dry before proceeding with the installation.
7. Using clockwise motion, thread the new sensor cap onto the probe assembly until it is finger-tight. The o-ring should be compressed between the sensor cap and probe. Do not over-tighten the sensor cap and do not use any tools for the installation process.
8. After installing the new sensor cap, store the sensor in either water or in the water-saturated air storage chamber.

NOTE: *Be sure to update the ODO Sensor Cap Coefficients after replacement.*

Updating the ODO Sensor Cap Coefficients

After installing a new sensor cap, connect the probe to the handheld and turn the instrument on. Locate the Calibration Code Label on the ODO Sensor Cap Instruction Sheet. This contains the calibration codes for this particular sensor cap. Follow the procedures below to enter the new calibration coefficients into the instrument.

1. Push the key to access the Sensor menu, then select **Setup**, then **ODO**.
2. Select **Sensor Cap Coefficients**.
3. Highlight each coefficient in turn (K1 through KC) and use the numeric entry screen to enter the corresponding new coefficient from the Calibration Code Label. Push the ENTER key after each entry and then proceed to the next K selection.
4. After all the new coefficients have been entered, select **Update Sensor Cap Coefficients**.
5. A message will appear warning that you will be overwriting the current sensor cap coefficients and you should confirm that you wish to carry out this action. Select **Yes** to confirm the new coefficients.

After updating the Coefficients, the Serial # in the Sensor Cap menu will be updated automatically based on your entries.

If errors are made in entering the Sensor Cap Coefficients, the instrument will block the update and an error message will appear on the display. If you see this error message, re-enter the coefficients and check them carefully.

NOTE: *After entering the sensor cap coefficients, the ODO sensor must be calibrated.*

4.8 Turbidity & Total Algae Sensors

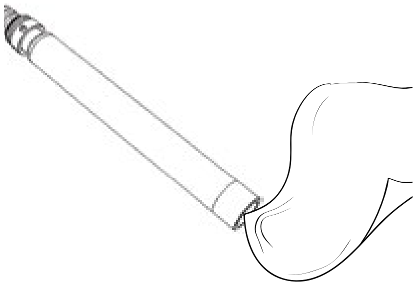


Figure 72 Wiping the sensor window

Clean the sensing window with a non-abrasive, lint-free cloth (Figure 72). If necessary, use mild soapy water.

The sensor can be stored wet or dry. For long-term storage, YSI recommends storing the sensor dry. Install the shipping cap or sensor guard to prevent scratches or damage to the optical sensing window.

4.9 pH/ORP Sensor

The pH and pH/ORP sensors are shipped with their tips in a storage bottle containing potassium chloride (KCl) solution. Keep this bottle for long-term storage.

Periodic maintenance is necessary to clear contamination from the sensing elements. Contaminants on the bulb and/or junction can slow sensor response time. Clean the sensors when deposits, bio-fouling or other contamination appears on the glass or when the sensor response time is noticeably slow. There are several methods to clean and restore the sensor depending on the severity of fouling or contamination.

Cleaning Methods

Standard Rinse

Rinse the sensor with tap water each time it is brought in from the field. This is generally recommended for most sensors and use cases to clear mild contamination.

If contaminants remain or the sensor exhibits a slow response time, continue with advanced cleaning.

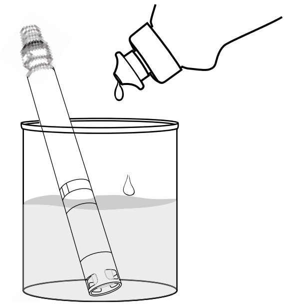


Figure 73 Cleaning the pH and pH/ORP sensor with dish soap

Advanced Cleaning

For moderate contamination or slow response after advanced rinsing, remove the sensor from the bulkhead and perform the following steps:

1. Remove any foreign matter from the sensor tip. If necessary, use a moistened cotton swab to carefully remove foreign material from the glass bulb and junction. Be careful to avoid direct contact with the glass bulb. The bulbs are fragile and will break if pressed with sufficient force.
2. Soak for 10 minutes in a mild solution of clean water and dish soap (Figure 73). Rinse the sensor with tap water and inspect.

If contaminants are removed, attach the sensor to the bulkhead and test the response time.

If contaminants remain or response time does not improve, continue to the hydrochloric acid (HCl) soak.

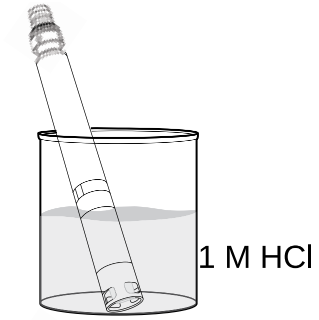


Figure 74 Cleaning the pH and pH/ORP sensor with hydrochloric acid

Acid Soak

For heavy contamination or slow response after advanced cleaning, remove the sensor from the bulkhead and perform the following steps:

1. Soak the sensor for 30 to 60 minutes in one molar (1 M) HCl (Figure 74). HCl reagent can be purchased from most chemical or laboratory distributors. To prevent injury, carefully follow the HCl manufacturer's instructions. If HCl is not available, soak in white vinegar.
2. After soaking, thoroughly rinse the sensor with tap water. Then soak the sensor in clean tap water for 60 minutes, stirring occasionally. Finally, rinse the sensor once again with tap water.

Attach the sensor to the bulkhead and test the response time. If response time does not improve or biological contamination of the reference junction is suspected, continue to the chlorine bleach soak.

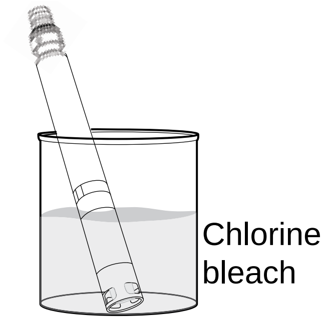


Figure 75 Cleaning the pH and pH/ORP sensor with chlorine bleach

Bleach Cleanse

If biological contamination of the reference junction is suspected or if good response is not restored by the previous methods, remove the sensor from the bulkhead and perform the following steps:

1. Soak the sensor for 60 minutes in a 1:1 dilution of chlorine bleach and tap water.
2. After soaking, thoroughly rinse the sensor with tap water. Then soak the sensor in clean tap water for 60 minutes. Finally, rinse the sensor once again with tap water.

Attach the sensor to the bulkhead and test the response time. If response time does not improve the sensor may be nearing the end of its useful life.

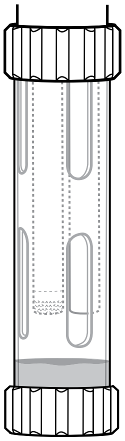


Figure 76 pH and pH/ORP short-term storage

Short-term Storage:

When in regular field use, the pH-pH/ORP sensors should remain on the bulkhead with the calibration/storage cup installed. Place a small amount of tap or surface water in the cup prior to storage or transport. The probes should be kept in this water-saturated air chamber between uses; not submerged (Figure 76). Make sure the storage cup makes a tight connection to prevent evaporation.

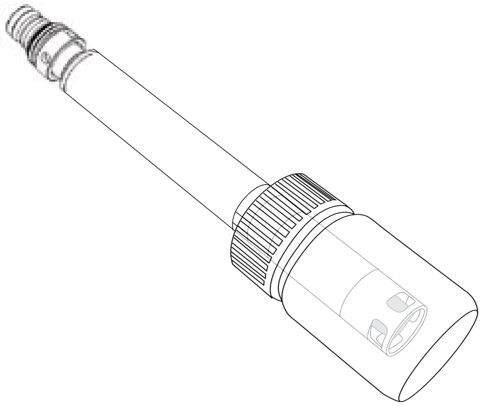


Figure 77 pH and pH/ORP long-term storage

Long-term Storage:

Remove the sensor from the bulkhead and plug the bulkhead port. Insert the sensor tip into the storage bottle and solution that were originally supplied with the sensor (Figure 77). The storage bottle features an open cap and o-ring to form a tight seal around the sensor tip; the solution contains KCl with potassium phthalate and a preservative. If this original solution is not available, one can prepare a 2 M KCl solution or use pH 4 buffer as an alternative, though these solutions should be monitored for microbial growth and replaced if growth is apparent. Other sensors and system components should not be stored in or exposed to these pH buffers for long periods of time.

NOTICE: Do NOT let the sensor dry out. Do NOT store the sensor in distilled or deionized water. Either of these will radically shorten the lifespan of the sensor module and void its warranty.

Sensor Module

The pH and pH/ORP sensors feature user-replaceable sensor modules. These modules contain a reference solution that depletes over time. The warranty period for both of these modules is 12 months:

- Replacement pH Module [SKU: 626963] = **12** months
- Replacement pH/ORP Module [SKU: 626964] = **12** months

Depending on usage and storage practices, the module may last longer than its warranty period. Replace the module if the sensor exhibits a slow response time after trying all the cleaning methods listed above.

4.10 ISE Sensor

ISE sensors are shipped with their tips in a storage bottle. Keep this bottle for long-term storage.

Do not let the ISE sensor reference electrode junctions dry out. Clean the sensors when deposits, bio-fouling or other contamination appears on the membrane.

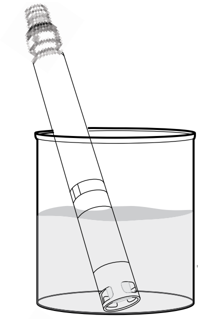


Figure 78 Soaking the ammonium or nitrate ISE sensor

Ammonium and Nitrate Sensor Maintenance

1. Carefully clean the ammonium or nitrate sensor by rinsing with DI water followed by soaking in the high standard calibration solution.
2. Carefully dab the sensor dry with a clean, lint-free cloth.

NOTICE: The ion-selective membranes are very fragile. Do not use coarse material (*e.g.* paper towels) to clean the membranes or permanent damage to the sensor can occur. The only exception is fine emery cloth on the chloride sensor.

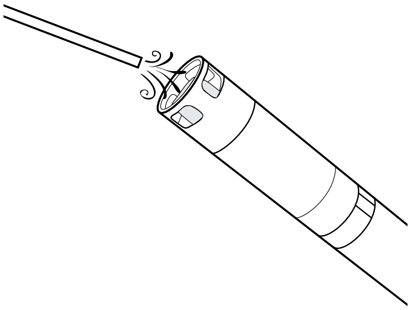


Figure 79 Rinsing the chloride sensor

Chloride Sensor Maintenance

1. Carefully clean the chloride sensor by carefully polishing with fine emery paper in a circular motion to remove deposits or discoloration.
2. Carefully rinse with DI water to remove any debris.

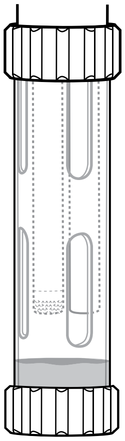


Figure 80 ISE short-term storage

Short-term Storage:

When in regular field use, ISEs should remain on the bulkhead with the calibration/storage cup installed. Place a small amount of tap or surface water in the cup prior to storage or transport. The probes should be kept in this water-saturated air chamber between uses; not submerged. Make sure the storage cup makes a tight connection to prevent evaporation (Figure 80).

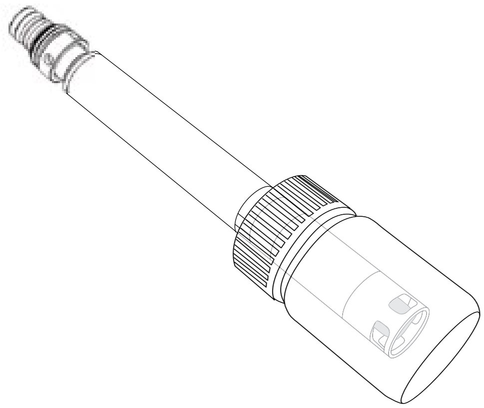


Figure 81 ISE long-term storage

Long-term Storage:

Remove the sensor from the bulkhead and plug the bulkhead port. Insert the sensor tip into the storage bottle with a small amount of high-calibration solution or tap water. The sensor tip should not be submerged. The storage bottle features an open cap and o-ring to form a tight seal around the sensor tip (Figure 81).

> **NOTICE:** Do NOT let the sensor dry out. Do NOT store the ISE sensor in conductivity standard, pH buffer, or salt water. Either of these will radically shorten the lifespan or kill the sensor module and void its warranty.

Rehydrating the Reference Junction

If an ISE module has been allowed to dry, soak the sensor for several hours (preferably overnight) in the sensor's high-calibration solution. If the sensor is irreparably damaged, the sensor module must be replaced.

Sensor Module

Ammonium, chloride and nitrate sensors feature user-replaceable sensor modules. These modules contain a reference solution that depletes over time. The warranty period for ISE modules is 6 months:

- Replacement Nitrate Module [SKU: 626965] = **6** months
- Replacement Ammonium Module [SKU: 626966] = **6** months
- Replacement Chloride Module [SKU: 626967] = **6** months

Depending on usage and storage practices, the module may last longer than its warranty period. When it is time, perform a sensor module replacement in a clean, dry laboratory environment.

4.11 ProDSS Sensor Module Replacement

Sensor modules for pH, pH/ORP, nitrate, ammonium, and chloride all require periodic replacement. Perform a sensor module replacement in a clean, dry laboratory environment. Remove the sensor from the bulkhead and perform the following steps:

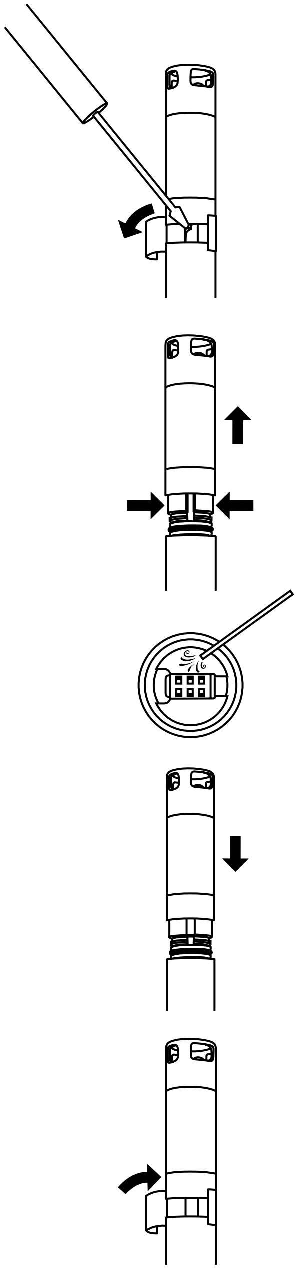


Figure 82 Sensor module replacement

Module Replacement

1. Peel off and discard the sticker that covers the junction of the sensor body and the module (Figure 82).
2. With a small, flat-blade screwdriver, carefully remove the square rubber plug from the gap in the hard plastic ring at the base of the sensor module.
3. Using two fingers, squeeze the sensor module's hard plastic ring so that it compresses the gap left by the rubber plug.
4. While squeezing, steadily pull the sensor module straight from the sensor body, rocking slightly if necessary. Do not keep the used o-rings as they are unusable after removal from the sensor body. Discard the old sensor module.
5. Inspect the sensor connector port for debris or moisture. If detected, remove it with lint-free cloth or a light blast of compressed air.
6. The new sensor module comes with two o-rings installed and pre-lubricated. Visually inspect the o-rings for nicks, tears, contaminants or particles. Replace any damaged o-rings.

   NOTICE: If a sensor module is removed for any reason, the o-rings must be replaced.

7. Align the prongs on the base of the sensor module with the slots in the sensor body. The sensor module is keyed to insert in only one orientation. Push the sensor module firmly into position until it clicks. Wipe any excess o-ring lubricant from the assembled components.
8. Wrap the junction of the sensor module and sensor body with the new sticker included in the sensor module kit. The sticker helps keep the sensor module junction clean and retain the rubber plug throughout deployment.
9. Write the replacement date on the sticker.

***NOTE:** Be sure to calibrate the sensor after module replacement.*

5. KorDSS Software

5.1 Introduction

KorDSS Software and drivers require permissions for successful installation. Administrative privileges may be necessary for a business or networked PC. Contact your organization's IT department for admin privileges.

System Requirements

Supported 32 bit (x86) and 64 bit (x64) Microsoft Operating Systems:

- Microsoft Windows 7 Home Basic SP1
- Microsoft Windows 7 Home Premium SP1
- Microsoft Windows 7 Professional SP1
- Microsoft Windows 7 Enterprise SP1
- Microsoft Windows 7 Ultimate SP1
- Microsoft Windows 8 Home Basic
- Microsoft Windows 8 Home Premium
- Microsoft Windows 8 Professional
- Microsoft Windows 8 Enterprise
- Microsoft Windows 8.1 Basic
- Microsoft Windows 8.1 Professional
- Microsoft Windows 8.1 Enterprise
- Microsoft Windows 10 Home
- Microsoft Windows 10 Professional
- Microsoft Windows 10 Enterprise
- Microsoft Windows 10 Education

Ram Memory Requirement:

- Minimum of 2 GB of RAM installed

Hard Disk Free Space:

- Minimum of 500 MB of free hard drive space

Internet Access Required to Support:

- Software and device updates, software licensing

5.2 Installing the Driver and Software

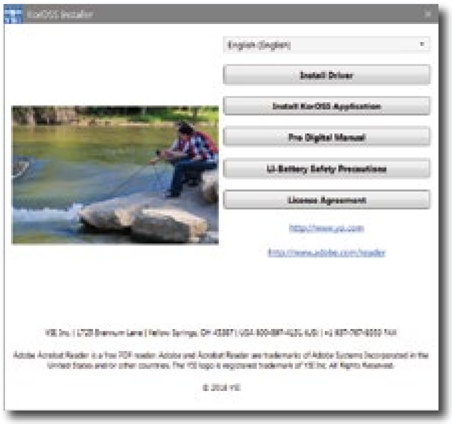


Figure 83 KorDSS Installer

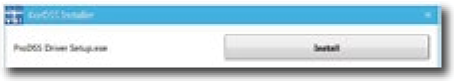
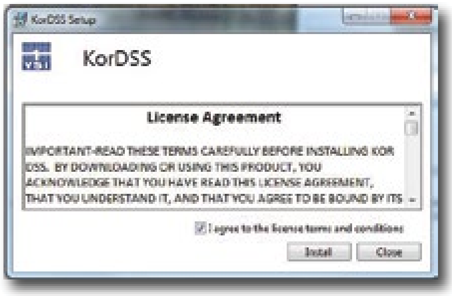


Figure 84 ProDSS Driver Installer

Figure 85 Back button



IMPORTANT-READ THESE TERMS CAREFULLY BEFORE INSTALLING KOR DSS. BY DOWNLOADING OR USING THIS PRODUCT, YOU ACKNOWLEDGE THAT YOU HAVE READ THIS LICENSE AGREEMENT, THAT YOU UNDERSTAND IT, AND THAT YOU AGREE TO BE BOUND BY ITS

Figure 86 KorDSS license agreement

Setup Successful

Figure 87 Launch KorDSS

Follow these steps to complete the installation process and establish connection to the handheld:

> ***NOTE:*** *Be sure to install the driver* ***before*** *connecting the handheld to your PC for the first time.*

1. Insert the supplied USB flash drive into a USB port on your computer.
2. Depending on the PC operating system and system settings, the KorDSS Installer may appear. If it does not appear, open the flash drive in Windows Explorer and double-click **Start.exe** to start the installer. Figure 83 shows how the installer will appear once it starts.
3. On the KorDSS Installer, click **Install Driver**. Then choose to Install the driver on the screens that follow (Figure 84).
4. After the driver has installed, choose to go **Back** to the KorDSS Installer (Figure 85) .
5. On the KorDSS Installer, click **Install KorDSS Application**. A license agreement will appear (Figure 86).
6. You may be asked if you want to allow a program from an unknown publisher to make changes on the computer. If so, select **Yes**.
7. After successful installation of KorDSS, click **Launch** to start the program (Figure 87).
8. Connect the handheld meter to the PC with the supplied USB cable.
9. Power on the handheld and click **Connect** when it appears under the **Instrument Connection Panel**; there may be a short delay before it appears in the software.

6. Accessories

6.1 Ordering

Telephone: 800 897 4151 (USA)
+1 937 767 7241 (Globally) Monday through Friday
8:00 AM to 5:00 ET
Fax: +1 937 767 9353 (orders)
Email: info@ysi.com
Mail: YSI Incorporated 1725 Brannum Lane
Yellow Springs, OH 45387 USA
Web: Visit YSI.com to order replacement parts, accessories, and calibration stolutions.

When placing an order please have the following available:

1. YSI account number (if available)
2. Name and phone number
3. Purchase Order or Credit Card number
4. Model Number or brief description
5. Billing and shipping addresses
6. Quantity

ProDIGITAL Handhelds

YSI Item #	Description
626650	ProSolo handheld, no GPS, not compatible with ProSwap 1-port or ProDSS 4-port cable assemblies
626700-1	ProSwap handheld, no GPS, not compatible with ProDSS 4-port cable assemblies
626700-2	ProSwap handheld with GPS, not compatible with ProDSS 4-port cable assemblies
626870-1	ProDSS handheld, no GPS
626870-2	ProDSS handheld with GPS

ProDIGITAL Probe Assemblies

NOTE: *The ODO and OBOD sensor caps come pre-installed on the following probe assemblies, with calibration coefficients of the sensor cap pre-loaded into the probe at the factory.*

YSI Item #	Description
	Optical Dissolved Oxygen and Temperature Probes
627200-1	ODO/T Probe Assembly, 1m
627200-4	ODO/T Probe Assembly, 4m
627200-10	ODO/T Probe Assembly, 10m
627200-20	ODO/T Probe Assembly, 20m
627200-30	ODO/T Probe Assembly, 30m
627200-50	ODO/T Probe Assembly, 50m
627200-100	ODO/T Probe Assembly, 100m
	Optical Dissolved Oxygen, Conductivity, and Temperature Probes
627150-1	ODO/CT Probe Assembly, 1m
627150-4	ODO/CT Probe Assembly, 4m
627150-10	ODO/CT Probe Assembly, 10m
627150-20	ODO/CT Probe Assembly, 20m
627150-30	ODO/CT Probe Assembly, 30m
627150-50	ODO/CT Probe Assembly, 50m
627150-100	ODO/CT Probe Assembly, 100m
	Self-Stirring Optical Biochemical Oxygen Demand Probes
626400	ProOBOD probe assembly (lab BOD probe); U.S./Japanese version with power supply
626401	ProOBOD probe assembly (lab BOD probe); International version with power supply

ProSwap 1-Port Cable Assemblies (No Sensors Included)

YSI Item #	Description
626750-1	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 1m
626750-4	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 4m
626750-10	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 10m
626750-20	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 20m
626750-30	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 30m
626750-50	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 40m
626750-100	ProSwap 1-port cable assembly with integral temperature sensor, no depth, 100m
626760-1	ProSwap 1-port cable assembly with integral temperature sensor, shallow depth, 1m
626760-4	ProSwap 1-port cable assembly with integral temperature sensor, shallow depth, 4m
626760-10	ProSwap 1-port cable assembly with integral temperature sensor, shallow depth, 10m
626770-20	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 20m
626770-30	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 30m
626770-50	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 50m
626770-100	ProSwap 1-port cable assembly with integral temperature sensor, medium depth, 100m

ProDSS 4-Port Cable Assemblies (No Sensors Included)

YSI Item #	Description
626909-1	ProDSS 4-port cable assembly, no depth, 1m
626909-4	ProDSS 4-port cable assembly, no depth, 4m
626909-10	ProDSS 4-port cable assembly, no depth, 10m
626909-20	ProDSS 4-port cable assembly, no depth, 20
626909-30	ProDSS 4-port cable assembly, no depth, 30m
626909-40	ProDSS 4-port cable assembly, no depth, 40m
626909-50	ProDSS 4-port cable assembly, no depth, 50m
626909-60	ProDSS 4-port cable assembly, no depth, 60m
626909-70	ProDSS 4-port cable assembly, no depth, 70m
626909-80	ProDSS 4-port cable assembly, no depth, 80m
626909-90	ProDSS 4-port cable assembly, no depth, 90m
626909-100	ProDSS 4-port cable assembly, no depth, 100m
626910-1	ProDSS 4-port cable assembly, with depth, 1m
626910-4	ProDSS 4-port cable assembly, with depth, 4m
626910-10	ProDSS 4-port cable assembly, with depth, 10m
626911-20	ProDSS 4-port cable assembly, with depth, 20m
626911-30	ProDSS4-port cable assembly, with depth, 30m
626911-40	ProDSS 4-port cable assembly, with depth, 40m
626911-50	ProDSS 4-port cable assembly, with depth, 50m
626911-60	ProDSS 4-port cable assembly, with depth, 60m
626911-70	ProDSS 4-port cable assembly, with depth, 70m
626911-80	ProDSS 4-port cable assembly, with depth, 80m
626911-90	ProDSS 4-port cable assembly, with depth, 90m
626911-100	ProDSS 4-port cable assembly, with depth, 100m

ProDSS Sensors (for 1-Port and 4-Port Cable Assemblies)

YSI Item #	Description
626900	Optical dissolved oxygen sensor
626902	Conductivity and temperature sensor
626901	Turbidity sensor
626903	pH sensor with module
626904	pH/ORP sensor with module
626906	Ammonium sensor with module
626905	Nitrate sensor with module
626907	Chloride sensor with module
626210	Total algae sensor, PC
626211	Total algae sensor, PE

Replacement Sensor Modules and ODO Sensor Caps

YSI Item #	Description
626890	Replacement ProDSS Optical Dissolved Oxygen sensor cap (for 626900 smart sensor)
626482	Replacement ProOBOD Optical Dissolved Oxygen sensor cap (for 626400 or 626401 lab probes)
627180	Replacement ODO Extended Warranty Sensor Cap (only compatible with ODO/T and ODO/CT probe assemblies)
626963	Replacement ProDSS pH sensor module
626964	Replacement ProDSS pH/ORP sensor module
626966	Replacement ProDSS Ammonium sensor module
626965	Replacement ProDSS Nitrate sensor module
626967	Replacement ProDSS Chloride sensor module

Calibration Standards

YSI Item #	Description
065270	Conductivity standard, 1000 µmhos/cm (quart, glass); ideal for fresh water
065272	Conductivity standard, 10000 µmhos/cm (quart, glass); ideal for brackish water
065274	Conductivity standard, 100000 µmhos/cm (quart, glass); ideal for supersaturated sea water
060907	Conductivity standard, 1000 µmhos/cm (box of 8 individual pints, plastic); ideal for fresh water
060906	Conductivity standard, 1413 µmhos/cm, ±1%, 0.01 M KCl (box of 8 individual pints, plastic)
060911	Conductivity standard, 10000 µmhos/cm (box of 8 individual pints, plastic); ideal for brackish water
060660	Conductivity standard, 50000 µmhos/cm (box of 8 individual pints, plastic); ideal for sea water
061320	ORP (mV) standard, Zobell solution, powder - needs hydrated (125 mL bottle, plastic)
061321	ORP (mV) standard, Zobell solution, powder - needs hydrated (250 mL bottle, plastic)
061322	ORP (mV) standard, Zobell solution, powder - needs hydrated (500 mL bottle, plastic)
003821	pH 4 buffer (box of 6 individual pints, plastic); ideal for storage solution for pH sensor
003822	pH 7 buffer (box of 6 individual pints, plastic)
003823	pH 10 buffer (box of 6 individual pints, plastic)
603824	Assorted case of pH 4, 7, and 10 buffers (2 individual pints of each buffer, plastic)
005580	Confidence solution to verify conductivity, pH and ORP system (box of 6 individual 475 mL bottles, plastic). ***Note:*** *Not for calibration*
003841	Ammonium standard, 1 mg/L (500 mL, plastic)
003842	Ammonium standard, 10 mg/L (500 mL, plastic)
003843	Ammonium standard, 100 mg/L (500 mL, plastic)
003885	Nitrate standard, 1 mg/L (500 mL, plastic)
003886	Nitrate standard, 10 mg/L (500 mL, plastic)
003887	Nitrate standard, 100 mg/L (500 mL, plastic)
608000	Turbidity standard, 0 FNU (1 gallon, plastic)
607200	Turbidity standard, 12.4 FNU (1 gallon, plastic)
607300	Turbidity standard, 124 FNU (1 gallon, plastic)
607400	Turbidity standard, 1010 FNU (1 gallon, plastic)

ProDIGITAL Accessories

YSI Item #	Description
626946	Large, hard-sided carrying case (Fits ProDSS 4-port cables 10, 20, and 30 meters in length, cable management kit, handheld, and accessories)
603075	Large, soft-sided carrying case
626945	Small, hard-sided carrying case (Fits ProDSS 4-port cables 1 and 4 meters in length, handheld, flow cell, and accessories)
599080	Flow cell for ProDSS 4-port cables
603076	Flow cell for ODO/CT cables (requires single port adapter; 603078)
603078	Adapter required for ODO/CT flow cell (603076)
603056	Flow cell mounting spike
063507	Tripod (screws into back of meter)
063517	Ultra clamp (screws into back of meter)
603070	Shoulder strap
603069	Belt clip (screws into back of meter)
626942	USB car charger
626943	Small external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged handheld battery to about 50%)
626944	Large external Li-Ion rechargeable battery pack (Typical performance: will charge a completely discharged battery to full charge, plus have power to charge a second battery to 20%)
626940	AC charger (USA). Includes power supply and USB cable (included with handheld)
626941	AC charger (international). Includes power supply, USB cable and outlet adapters (included with handheld)
626846	Replacement Lithium-ion battery pack
626969	USB flash drive (included with handheld)
626991	Cable for charging and PC connection (included as part of 626940 and 626941)
626992	Cable for connection to USB drive (included with handheld)
626990	ProDSS maintenance kit (included with all ProDSS 4-port cables): • 3 port plugs • 1 tube of o-ring lubricant • 1 brush • 1 syringe • 1 sensor installation/removal tool • O-rings (6)
626919	Sensor guard for 4-port ProDSS cable assembly (included with all 4-port cables)
599786	Calibration/storage cup for 4-port ProDSS cable assembly (included with all 4-port ProDSS cables)
627195	Calibration cup for ODO/CT cable assembly (included with all ODO/CT cables)
603062	Cable management kit (included with **ProDSS 4-port cables** 10, 20, and 30-meters long; **ODO/CT cables** 4, 10, 20, and 30-meters long; and **ODO/T cables** 4, 10, 20, and 30-meters long)
626918	1 lb weight (included with ProDSS 4-port cables 10-meters and longer)
605978	4.9 oz weight

7. Safety and Support

7.1 Rechargeable Lithium-Ion Battery Pack

Safety Warnings and Precautions

⚠ **CAUTION:** Failure to follow the safety warnings and precautions can result in fire, personal injury and/or equipment damage not covered under warranty.

⚠ **CAUTION:** If the internal battery fluid comes into contact with skin, wash the affected area(s) with soap and water immediately. If it comes into contact with your eye(s), flush them with generous amounts of water for 15 minutes and seek immediate medical attention.

⚠ **CAUTION:** Always keep batteries away from children.

⚠ **WARNING:** In the unlikely event a lithium-ion battery catches fire, **DO NOT** attempt to put the fire out with water, use a Class A, B or C fire extinguisher.

Do:

- Store the battery pack in a cool, dry, ventilated area.
- Store the battery pack in a non-conductive and fireproof container.
- Store the battery pack at approximately 50% of the capacity.
- Disconnect the battery pack when not in use and for long-term storage.
- Follow applicable laws and regulations for transporting and shipping of batteries.
- *Immediately discontinue* use of the battery pack if, while using, charging or storing the battery pack:
  - Emits an unusual smell
  - Feel hot
  - Changes color
  - Changes shape
  - Appears abnormal in any other way.

Battery Pack General Precautions:

- **DO NOT** put the battery in fire or heat the battery.
- **DO NOT** connect the positive and the negative terminal of the battery to each other with any metal object (*e.g.* wire).
- **DO NOT** carry or store the battery pack with neckaces, hairpins or other metal objects.
- **DO NOT** carry or store the battery pack with hazardous or combustible materials.
- **DO NOT** pierce the battery pack with nails, strike with a hammer, step on or otherwise subject the battery pack to strong impacts or shocks.
- **DO NOT** solder directly onto the battery pack.
- **DO NOT** expose the battery pack to water or salt water or allow it to get wet.
- **DO NOT** disassemble or modify the battery pack. The battery contains safety and protection devices that, if damaged, can cause the battery to generate heat, rupture or ignite.
- **DO NOT** place the battery pack on or near fires, stoves or other high-temperature locations.
- **DO NOT** place the battery pack in direct sunlight or extreme temperatures for extended periods of time or store the battery pack inside cars in hot weather. Doing so may cause the battery pack to generate heat, rupture or ignite. Using the battery pack in this manner may also result in a loss of performance and a shortened life expectancy.
- **DO NOT** place the battery pack in microwave ovens, high-pressure containers or on induction cookware.
- **DO NOT** ship damaged or potentially defective batteries to YSI or any of our authorized service centers unless instructed otherwise. All federal and international shipping laws should be consulted prior to shipping lithium-ion batteries.

Charging/Discharging/Handling the Battery Pack

⚠ **WARNING:** Failure to follow the battery pack charging/discharging instructions can cause the battery to become hot, rupture or ignite and cause serious injury and/or equipment damage.

⚠ **WARNING:** Only charge the battery using charging devices designed specifically for the ProDIGITAL handheld by YSI. Use of unapproved chargers can result in battery failure and potentially serious injury to the user.

If at any time the battery pack becomes damaged, hot or begins to balloon or swell, discontinue charging (or discharging) immediately. Quickly and safely disconnect the charger. Then place the battery pack and/or charger in a safe, open area way from flammable materials. After one hour of observation, remove the battery pack from service. **DO NOT** continue to handle, attempt to use or ship the battery.

Damaged or swollen batteries can be unstable and very hot. **DO NOT** touch batteries until they have cooled. In the event of a fire use a Class A, B, or C fire extinguisher. **DO NOT** use water.

- **DO NOT** attach the battery pack to a power supply plug or directly to a car's cigarette lighter.
- **DO NOT** place the battery pack in or near fire or into direct extended exposure to sunlight. When the battery pack becomes hot, the built-in safety equipment is activated, preventing the battery pack from charging further. Heating the battery pack can destroy the safety equipment and cause additional heating, breaking or ignition.
- **DO NOT** leave the battery pack unattended while charging.

NOTICE: The ambient temperature range over which the battery pack can be discharged is -20°C to 60°C (-4°F to 140°F). Use of the battery pack outside of this temperature range may damage the performance of the battery pack or may reduce its life expectancy.

- **DO NOT** discharge the battery pack using any device except for a ProDIGITAL handheld. When the battery pack is used in other devices it may damage the performance of the battery or reduce its life expectancy. Use of a non-approved device to discharge the battery pack can cause an abnormal current to flow, resulting in the battery pack to become hot, rupture or ignite and cause serious injury.
- **DO NOT** leave the battery pack unattended while discharging.

Battery Disposal

When the battery pack is worn out, insulate the terminals with adhesive tape or similar materials before disposal. Dispose of the battery pack in the manner required by your city, county, state or country. For details on recycling lithium-ion batteries, please contact a government recycling agency, your waste-disposal service or visit reputable online recycling sources such as www.batteryrecycling.com.

This product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

For more information about where you can drop off your waste equipment for recycling, please contact your local city office, or your local waste disposal service. **DO NOT ship batteries to YSI or a YSI authorized service center unless instructed to do otherwise.**

Contact YSI Technical Support at (937) 767-7241 if you have additional questions.

7.2 Service Information

YSI has authorized service centers throughout the United States and Internationally. For the nearest service center information, please visit ysi.com and click ‘Support’ or contact YSI Technical Support directly at 800-897-4151 (+1 937-767-7241).

When returning a product for service, include the Product Return form with cleaning certification. The form must be completely filled out for a YSI Service Center to accept the instrument for service. The form may be downloaded from YSI.com.

7.3 Technical Support

Telephone: 800 897 4151 (USA)
+1 937 767 7241 (Globally) Monday through Friday, 8:00 AM to 5:00 ET
Fax: +1 937 767 9353 (orders)
Email: info@ysi.com
Mail: YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Internet: YSI.com

7.4 Declaration of Conformity

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for the listed European Council Directive(s) and carries the CE mark accordingly.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	ProDSS, ProSwap, ProSolo
Conforms to the following:	
Directives:	EMC 2004/108/EC RoHS 2011/65/EU WEEE 2012/19/EU
Harmonized Standards:	EN61326-1:2013 (IEC 61326-1:2012) IEC 61000-3-2:2005 +A1:2008+A2:2009 IEC 61000-3-3:2008
Supplementary Information:	All performance met the operation criteria as follows: 1. ESD, IEC 61000-4-2:2008 2. Radiated Immunity, IEC 61000-4-3:2006 +A1:2007+A2:2010 3. Electrical Fast Transient (EFT), IEC 61000-4-4:2004 +A1:2010 4. Immunity to Surge, IEC 61000-4-5:2005 5. Radio Frequency, Continuous Conducted Immunity, IEC61000-4-6:2008 6. IEC 61000-4-8:2009 7. IEC 61000-4-11:2004
Authorized EU Representative	Xylem Analytics UK Ltd Unit 2 Focal Point, Lacerta Court, Works Road Letchworth, Hertfordshire, SG6 1FJ UK

Gregory W. Popp

Signed: Gregory Popp
Title: Quality Manager

Date: March 10, 2020

The undersigned hereby declares on behalf of the named manufacturer under our sole responsibility that the listed product conforms to the requirements for electrical equipment under US FCC Part 15 and ICES-003 for unintentional radiators.

Manufacturer:	YSI Incorporated 1725 Brannum Lane Yellow Springs, OH 45387 USA
Product Name:	Professional Digital Sampling System Instrument
Model Numbers	
Instrument/Accessory:	ProDSS non-GPS (626870-1) / ProDSS GPS (626870-2), ProSwap non-GPS (XXX), ProSwap GPS (XXX), ProSolo (626650)
Probe/Cable Assemblies:	626909-1, 626909-4, 626909-10, 626909-20, 626909-30, 626909-40, 626909-50, 626909-60, 626909-70, 626909-80, 626909-90, 626909-100, 626910-1, 626910-4, 626910-10, 626911-20, 626911-30, 626911-40, 626911-50, 626911-60, 626911-70, 626911-80, 626911-90, 626911-100 626750-1, 626750-4, 626750-10, 626750-20, 626750-30, 626750-50, 626750-100 626760-1, 626760-4, 626760-4 626770-20, 626770-30, 626770-50, 626770-100, 627200-1, 62700-4, 627200-10, 627200-20, 627200-30, 627200-50, 627200-100 627150-1, 627150-4, 627150-10, 627150-20, 627150-30, 627150-50, 627150-100 626250-1, 626250-4, 626250-10, 626250-20, 626250-30, 626250-40, 626250-50, 626250-60, 626250-70, 626250-80, 626250-90, 626250-100 626400, 626401
Sensors:	626900, 626902, 626901, 626903, 626904, 626906, 626905, 626907, 626210, 626211
Conforms to the following:	
Standards:	• FCC 47 CFR Part 15-2008, Subpart B, Class B, Radio Frequency Devices • ICES-003:2004, Digital Apparatus
Supplementary Information:	Tested using ANSI C63.4-2003 (excluding sections 4.1, 5.2, 5.7, 9, and 14)

Gregory W. Popp

Signed: Gregory Popp　　Date: March 10, 2020
Title: Quality Manager

7.5 Warranty

The YSI Professional Series Digital (ProDIGITAL) handheld meters are warranted for three (3) years from date of purchase by the end user against defects in materials and workmanship. Digital sensors and cables (ProSwap 1-port, ProDSS 4-port, ODO/CT, ODO/T, and ProOBOD) are warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. The ODO Extended Warranty Sensor Cap (627180) for the ODO/T and ODO/CT cable assemblies is warranted for two (2) years from date of purchase by the end user against defects in material and workmanship. ProDSS pH and pH/ORP sensor modules, optical ODO sensor caps (all but the 627180 cap previously mentioned), and Li-Ion battery pack are warranted for one (1) year from date of purchase by the end user against defects in material and workmanship; ProDSS ISE sensor modules (ammonium, nitrate, and chloride) are warranted for 6 months. ProDIGITAL systems (instrument, cables & sensors) are warranted for 1 year (excluding sensor modules) from date of purchase by the end user against defects in material and workmanship when purchased by rental agencies for rental purposes. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio at +1 937 767-7241, 800-897-4151 or visit www.YSI.com (Support tab) for a Product Return Form. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

LIMITATION OF WARRANTY

This Warranty does not apply to any YSI product damage or failure caused by:

1. Failure to install, operate or use the product in accordance with YSI's written instructions;
2. Abuse or misuse of the product;
3. Failure to maintain the product in accordance with YSI's written instructions or standard industry procedure;
4. Any improper repairs to the product;
5. Use by you of defective or improper components or parts in servicing or repairing the product;
6. Modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI's LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

8. Appendices

8.1

Appendix A
DO% Calibration Values

Calibration Value	Pressure			
D.O. %	**in Hg**	**mmHg**	**kPa**	**mbar**
101%	30.22	767.6	102.34	1023.38
100%	29.92	760.0	101.33	1013.25
99%	29.62	752.4	100.31	1003.12
98%	29.32	744.8	99.30	992.99
97%	29.02	737.2	98.29	982.85
96%	28.72	729.6	97.27	972.72
95%	28.43	722.0	96.26	962.59
94%	28.13	714.4	95.25	952.46
93%	27.83	706.8	94.23	942.32
92%	27.53	699.2	93.22	932.19
91%	27.23	691.6	92.21	922.06
90%	26.93	684.0	91.19	911.93
89%	26.63	676.4	90.18	901.79
88%	26.33	668.8	89.17	891.66
87%	26.03	661.2	88.15	881.53
86%	25.73	653.6	87.14	871.40
85%	25.43	646.0	86.13	861.26
84%	25.13	638.4	85.11	851.13
83%	24.83	630.8	84.10	841.00
82%	24.54	623.2	83.09	830.87
81%	24.24	615.6	82.07	820.73
80%	23.94	608.0	81.06	810.60
79%	23.64	600.4	80.05	800.47
78%	23.34	592.8	79.03	790.34
77%	23.04	585.2	78.02	780.20
76%	22.74	577.6	77.01	770.07
75%	22.44	570.0	75.99	759.94
74%	22.14	562.4	74.98	749.81
73%	21.84	554.8	73.97	739.67
72%	21.54	547.2	72.95	729.54

8.2 Appendix B

Oxygen Solubility Table

Solubility of oxygen in mg/L in water exposed to water-xaturated air at 760 mm Hg pressure.

Salinity = Measure of quantity of dissolved salts in water.

Chlorinity = Measure of chloride content, by mass, of water.

S(0/00) = 1.80655 x Chlorinity (0/00)

Temp °C	**Chlorinity : 0** **Salinity: 0**	**5.0 ppt** **9.0 ppt**	**10.0 ppt** **18.1 ppt**	**15.0 ppt** **27.1 ppt**	**20.0 ppt** **36.1 ppt**	**25.0 ppt** **45.2 ppt**
0.0	14.62	13.73	12.89	12.10	11.36	10.66
1.0	14.22	13.36	12.55	11.78	11.07	10.39
2.0	13.83	13.00	12.22	11.48	10.79	10.14
3.0	13.46	12.66	11.91	11.20	10.53	9.90
4.0	13.11	12.34	11.61	10.92	10.27	9.66
5.0	12.77	12.02	11.32	10.66	10.03	9.44
6.0	12.45	11.73	11.05	10.40	9.80	9.23
7.0	12.14	11.44	10.78	10.16	9.58	9.02
8.0	11.84	11.17	10.53	9.93	9.36	8.83
9.0	11.56	10.91	10.29	9.71	9.16	8.64
10.0	11.29	10.66	10.06	9.49	8.96	8.45
11.0	11.03	10.42	9.84	9.29	8.77	8.28
12.0	10.78	10.18	9.62	9.09	8.59	8.11
13.0	10.54	9.96	9.42	8.90	8.41	7.95
14.0	10.31	9.75	9.22	8.72	8.24	7.79
15.0	10.08	9.54	9.03	8.54	8.08	7.64
16.0	9.87	9.34	8.84	8.37	7.92	7.50
17.0	9.67	9.15	8.67	8.21	7.77	7.36
18.0	9.47	8.97	8.50	8.05	7.62	7.22
19.0	9.28	8.79	8.33	7.90	7.48	7.09
20.0	9.09	8.62	8.17	7.75	7.35	6.96
21.0	8.92	8.46	8.02	7.61	7.21	6.84
22.0	8.74	8.30	7.87	7.47	7.09	6.72
23.0	8.58	8.14	7.73	7.34	6.96	6.61
24.0	8.42	7.99	7.59	7.21	6.84	6.50
25.0	8.26	7.85	7.46	7.08	6.72	6.39
26.0	8.11	7.71	7.33	6.96	6.62	6.28
27.0	7.97	7.58	7.20	6.85	6.51	6.18
28.0	7.83	7.44	7.08	6.73	6.40	6.09
29.0	7.69	7.32	6.93	6.62	6.30	5.99
30.0	7.56	7.19	6.85	6.51	6.20	5.90
31.0	7.43	7.07	6.73	6.41	6.10	5.81
32.0	7.31	6.96	6.62	6.31	6.01	5.72

Temp °C	**Chlorinity : 0** **Salinity: 0**	**5.0 ppt** **9.0 ppt**	**10.0 ppt** **18.1 ppt**	**15.0 ppt** **27.1 ppt**	**20.0 ppt** **36.1 ppt**	**25.0 ppt** **45.2 ppt**
33.0	7.18	6.84	6.52	6.21	5.91	5.63
34.0	7.07	6.73	6.42	6.11	5.82	5.55
35.0	6.95	6.62	6.31	6.02	5.73	5.46
36.0	6.84	6.52	6.22	5.93	5.65	5.38
37.0	6.73	6.42	6.12	5.84	5.56	5.31
38.0	6.62	6.32	6.03	5.75	5.48	5.23
39.0	6.52	6.22	5.98	5.66	5.40	5.15
40.0	6.41	6.12	5.84	5.58	5.32	5.08
41.0	6.31	6.03	5.75	5.49	5.24	5.01
42.0	6.21	5.93	5.67	5.41	5.17	4.93
43.0	6.12	5.84	5.58	5.33	5.09	4.86
44.0	6.02	5.75	5.50	5.25	5.02	4.79
45.0	5.93	5.67	5.41	5.17	4.94	4.72

Xylem |'zīləm|

1) The tissue in plants that brings water upward from the roots;

2) a leading global water technology company.

We’re a global team unified in a common purpose: creating advanced technology solutions to the world’s water challenges. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. Our products and services move, treat, analyze, monitor and return water to the environment, in public utility, industrial, residential and commercial building services settings. Xylem also provides a leading portfolio of smart metering, network technologies and advanced analytics solutions for water, electric and gas utilities. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise with a strong focus on developing comprehensive, sustainable solutions.

For more information on how Xylem can help you, go to www.xylem.com

ProDIGITAL USER MANUAL 626973-01REF

Who’s
Minding
the Planet?®

xylem
Let’s Solve Water

YSI, a Xylem brand
1725 Brannum Lane
Yellow Springs, OH 45387
☎ +1.937.767.7241
✉ info@ysi.com
YSI.com

YSI.com/ProDIGITAL

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APPENDIX C

Health and Safety Plan

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Draft

Site-Specific Health and Safety Plan

Lakewood Towne Center, Lakewood, WA

Prepared for
Kite Realty Group

Prepared by
Herrera Environmental Consultants, Inc.

HERRERA
Science + Planning + Design

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will print correctly when duplexed.

Site-Specific Health and Safety Plan

Lakewood Towne Center, Lakewood, WA

Prepared for
Kite Realty Group
Indianapolis, IN

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206-441-9080

DRAFT
October 2, 2023

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HEALTH AND SAFETY PLAN REVIEW AND APPROVAL

Client:	Kite Realty Group	Site Name: Lakewood Towne Center
Project Name:	Lakewood Towne Center Groundwater Treatment – Phase 2	Project No.: 21-07668-003
Start Date:	November 1, 2023	End Date: September 2025
Plan Expiration Date:	December 31, 2025	

The following individuals have reviewed this Health and Safety Plan (HASP) and have approved its use for the dates specified.

Liza Holtz		
Plan Completed by	Signature	Date
George Iftner		
Project Manager	Signature	Date
Rob Zisette		
Corporate Health and Safety Officer	Signature	Date
Shannon McKernan		
Site Health and Safety Officer	Signature	Date

This HASP is based on federal (29 Code of Federal Regulations [CFR] Part 1910.120) and state (Chapter 296-843-120 Washington Administration Code [WAC]) regulations, which address practices conducted at sites associated with hazardous substances. This HASP is applicable only to employees of Herrera Environmental Consultants, Inc. Consultants, subconsultants, and contractors other than Herrera working at this jobsite are responsible for the health and safety of their own employees and are required to develop their own HASP. Other contractor personnel, who provide site-specific information, may review this HASP; however, Herrera Environmental Consultants, Inc. assumes no responsibility or liability for the use of this document by other parties.

Due to the potentially hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury at this site. The health and safety guidelines in this HASP were prepared specifically for this site based on site conditions, purposes, dates, and personnel specified, and must be amended if these conditions change. This HASP should not be used on any other site without prior research by trained health and safety specialists.

Contents

Attachments

ABBREVIATIONS AND ACRONYMS

ACGIH	American Council of Governmental Industrial Hygienists
cDCE	cis-1,2-dichloroethene
CFR	Code of Federal Regulations
7CPR	cardiopulmonary resuscitation
CUL	cleanup level
CVOCs	chlorinated volatile organic compounds
HASP	health and safety plan
HAZWOP	Hazardous Waste Operations
Herrera	Herrera Environmental Consultants, Inc.
HVOC	halogenated volatile organic compounds
IDLH	immediately dangerous to life and health
ISCO	in-situ chemical oxidation
LFC	lowest feasible concentration
LOP	levels of protection
MTCA	Model Toxics Control Act
NIOSH	National Institute of Occupational Safety and Health
LTC	Lakewood Towne Center
OSHA	Occupational Safety and Health Administration
PCE	perchloroethylene
PEL	permissible exposure limit
PID	photoionization detector
PPE	personal protective equipment
ppm	parts per million
REL	recommended exposure limit
SCBA	self-contained breathing apparatus
SDS	Safety Data Sheet
SHSO	site health and safety officer
STEL	short-term exposure limit

TCE	trichloroethylene
TLV	threshold limit value
TWA	time weighted average
VC	Vinyl chloride
WAC	Washington Administrative Code

INTRODUCTION

This site-specific health and safety plan (HASP) applies to field work associated with activities at the Lakewood Towne Center (LTC), a site with documented releases of hazardous substance(s) to the environment. Herrera Environmental Consultants, Inc. (Herrera) expects employees, for company-approved field work or personal use, will follow safety procedures and regulations set forth in this safety plan.

Safety Policy

Herrera's Safety Policy is that health and safety of the staff is of paramount importance. Activities performed under potentially hazardous conditions shall be acknowledged and planned to mitigate personal injury. Herrera's Safety Policy shall apply during company-approved field work only.

Site Description and Scope of Work

The LTC Site is owned by Kite Realty Group and located in parking lots and streets surrounding the intersection of Lakewood Towne Center Boulevard Southwest and Fifty-Ninth Avenue Southwest in Lakewood, Washington. The groundwater monitoring wells are situated around the footprint of the former Plaza Cleaners Building, which operated from 1968 to 1987.

Since July 2000, monitoring and analytical results from quarterly, semi-annual, and annual sampling events indicate that a dry cleaner solvent, perchloroethylene (PCE) and its daughter products trichloroethylene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC) and several related halogenated volatile organic compounds (HVOCs), have been detected in groundwater across the northwest portion of the site. The main source was identified by the presence of elevated PCE and its daughter products, collectively known as chlorinated volatile organic compounds (CVOCs) in shallow groundwater.

August 2021 and August 2022 groundwater monitoring showed a significant decreasing trend in contaminant concentrations at the existing six wells at the site. These results indicate that biodegradation is ongoing and concentrations of nearly all HVOC chemicals of concern (COCs) except VC have dropped below their respective Model Toxics Control Act (MTCA) cleanup levels (CULs). The VC concentrations detected in groundwater at MW-1S in 2021 and 2022 exceeded the MTCA Method A CUL.

The scope of work is to additional well installation, baseline groundwater monitoring, planned groundwater treatment, and performance groundwater monitoring to reduce the concentrations of HVOCs at the Lakewood Towne Center project site. The site is currently a parking lot for a shopping center on property owned by Kite Realty Group. In-situ chemical oxidations (ISCO) groundwater injection will use a hollow-stem auger drill rig will be used to collect soil and groundwater samples at 6 locations for geotechnical and environmental data collection.

Detailed Description of Specific Tasks Planned

List each separate task in order of progression:

Task	Task Description
Task 1	Monitoring well installation and development
Task 2	Groundwater treatment
Task 3	Groundwater sample collection

Potential Hazards Associated With Field Tasks

Potential Chemical Hazards

- Contaminants associated with contaminated soils and groundwater.

Potential Physical Hazards

- Slips, trips, and falls
- Heavy equipment (drill rig)
- Environmental conditions (rain, snow, cold, sun, heat, low visibility, plants, wildlife)
- Hand hazards (pinch hazards)

Potential Biological Hazards

- Biting or tinging insects such as spiders, bees, or wasps.

Initial Site Entry

- Has this been performed by Herrera?

  Yes: ☒ No: ☐

Herrera staff have experience working at Lakewood Towne Center.

Traffic Control

- Does field work require traffic control around the work area, using barricades, traffic signs, and other traffic control devices?

Yes: ☐ No: ☒

- Is a city/county/state road use permit required?

  Yes: ☐ No: ☒

- Is a traffic control plan required with the road use permit?

  Yes: ☐ No: ☒

Interior Work and Confined Spaces

- Will any field work be done inside an enclosure, building, or confined space?

  Yes: ☐ No: ☒

Sewers or Other Areas of Potentially Containing Explosive Gases or Vapors

- Will any field work be done in sewers or other areas containing explosive gas/vapors?

  Yes: ☐ No: ☒

LFG could potentially be encountered during drilling or follow-up LFG monitoring.

Hazardous Materials

- Will any hazardous materials (chemicals) be used on site (including decontamination)?

  Yes: ☒ No: ☐

- Will any field work be done on a site with known or suspected release of hazardous materials?

  Yes: ☒ No: ☐

Contaminated soil and groundwater with PCE and related HVOCs has been confirmed at the former Plaza Cleaners dry cleaning site.

Site Status

- Site Status: Occupied?

  Yes: ☒ No: ☐

Site Control and Security

- Any site access requirements and special considerations?

  Yes: ☐ No: ☒

- Work will be done in daylight hours?

  Yes: ☒ No: ☐

- Barricades, fencing, or other equipment to be used to mark the perimeter of the site?

  Yes: ☐ No: ☒

- Require work area security (on- and off-hours) to be used?

  Yes: ☐ No: ☒

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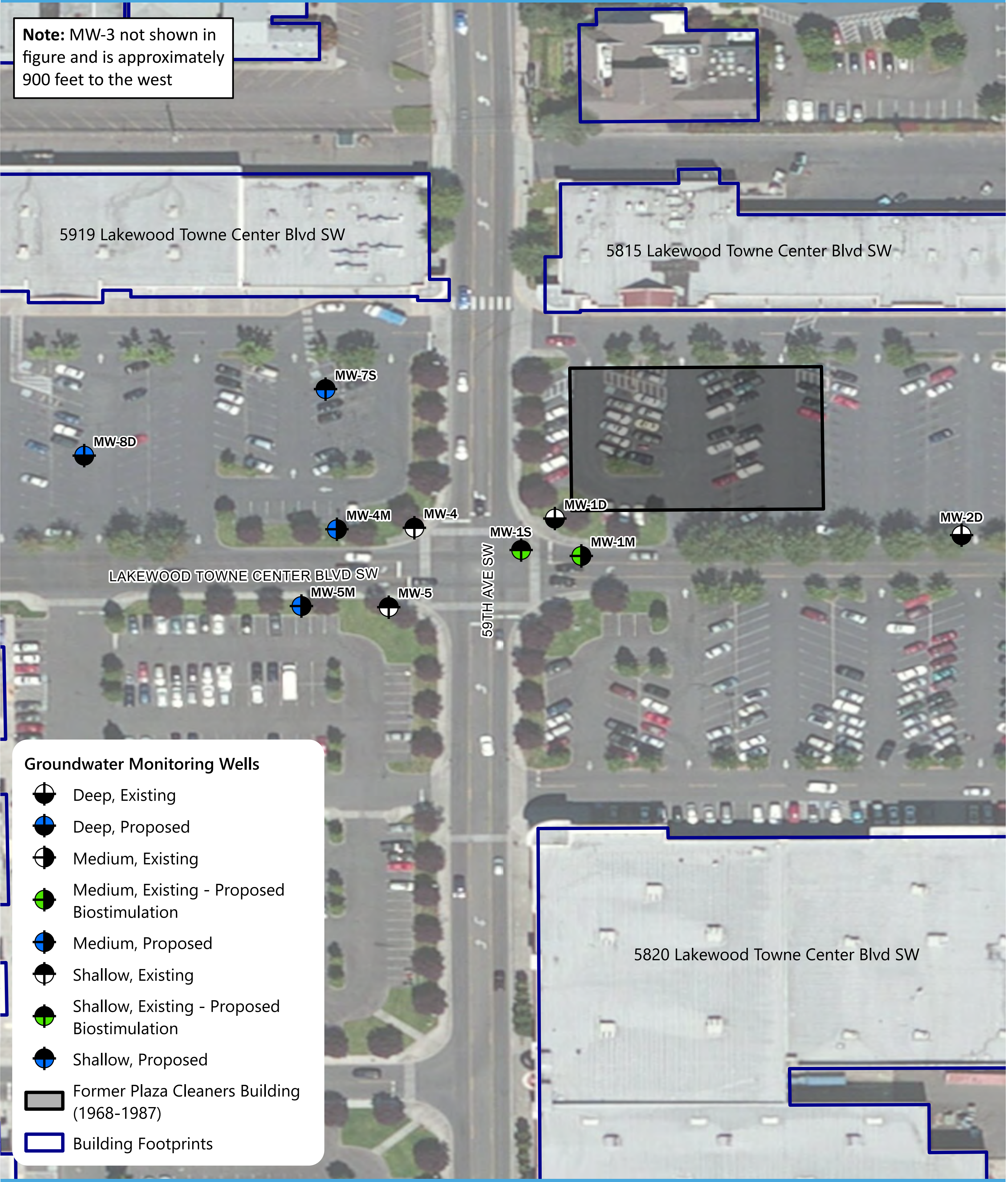
Science + Planning + Design

Site Map and Proposed Groundwater Monitoring Locations.



Author: bBagniewski Date: 10/2/2023 File Path: K:\Projects\Y2021\21-07668-000\Pro\Lakewood_Towne_Center_Monitoring\Lakewood_Towne_Center_Monitoring.aprx\Fig2_SiteMap

Produced by Herrera Environmental Consultants (herrerainc.com) | Sources: Pierce County, Microsoft, Esri Imagery (2022)

LOCAL EMERGENCY AND PROJECT TELEPHONE NUMBERS

Site Address and Phone Number

Site Address:	5731 Main Street Southwest in Lakewood, Washington
Site Phone Number:	NA

Local Emergency Phone Numbers

Agency	Name	Telephone Number
Hospital	St. Clare Specialty Center	253.426.6341
Police / Fire	City of Seattle	911

Project Personnel Phone Numbers

Role	Name	Telephone Number
Site Health and Safety Officer	Shannon McKernan	206.787.8238 office/ 813.777.7575 mobile
Project Manager	George Iftner	206.787.8210 office/206.697.0312 mobile
Principal-in-Charge	Phil Coughlan	206.787.8242 office/ 253.686.1910 mobile
Site Contact	Sara Abdelrahman	253.229.9966
Client Contact / Project Manager	Sara Abdelrahman	253.229.9966
Corporate Health and Safety Officer	George Iftner	206.787.8210 office/ 206.697.0312 mobile

EMERGENCY ROUTES

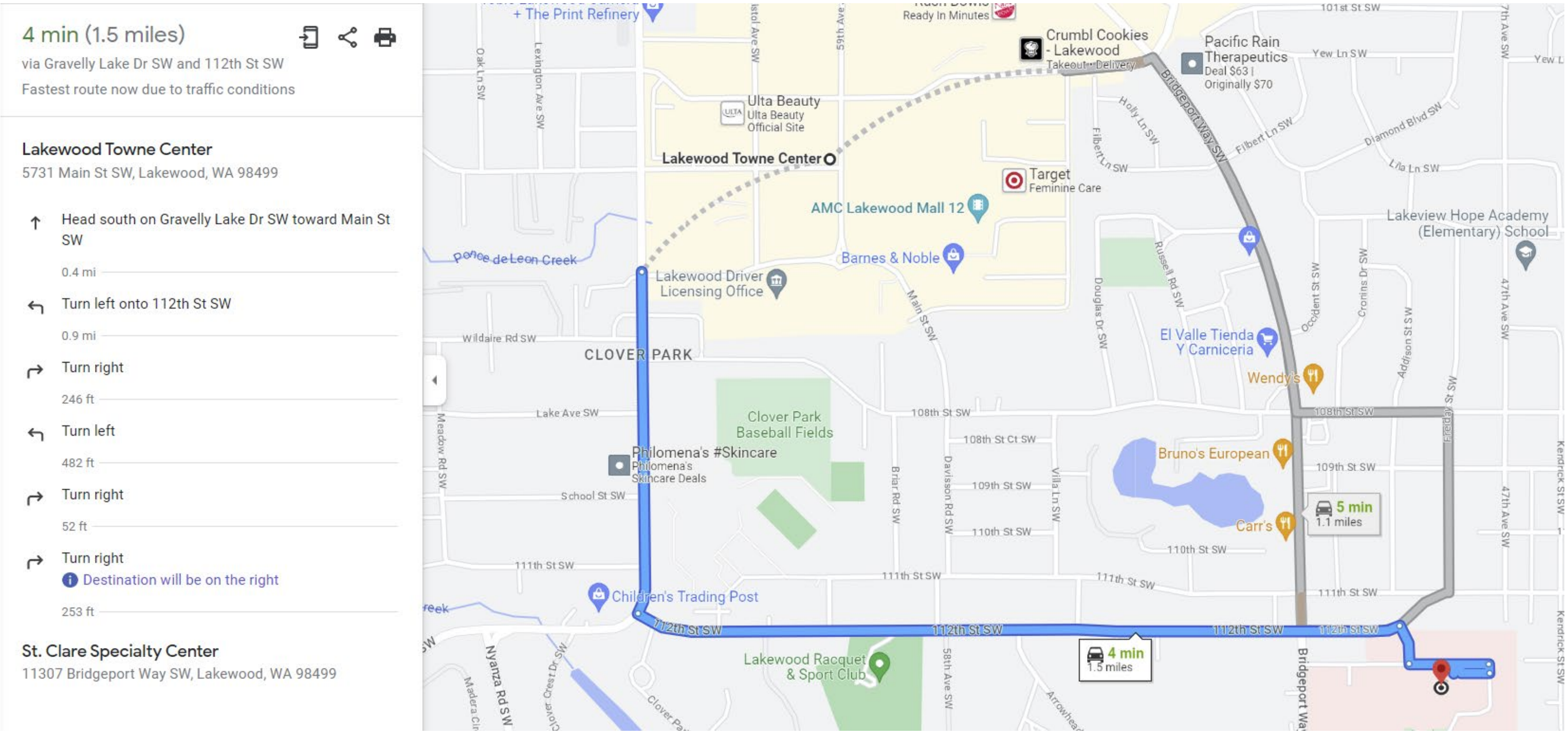
Prior to field work, conduct a drive-by from the work area to the hospital to check for any obstacles (i.e., road closure due to construction, etc.) and change the emergency route(s) to the hospital accordingly.

Hospital Name:	St. Clare Specialty Center
Hospital Address:	11307 Bridgeport Way SW, Lakewood, WA 98499
Hospital Phone Number:	253.426.6341

Refer to the following page for the route to the Hospital.

HOSPITAL LOCATION AND ROUTE MAP

St. Clare Specialty Center – 11307 Bridgeport Way SW, Lakewood, WA 98499



4 min (1.5 miles)

via Gravelly Lake Dr SW and 112th St SW

Fastest route now due to traffic conditions

Lakewood Towne Center

5731 Main St SW, Lakewood, WA 98499

- ↑ Head south on Gravelly Lake Dr SW toward Main St SW
  0.4 mi
- ↰ Turn left onto 112th St SW
  0.9 mi
- ↱ Turn right
  246 ft
- ↰ Turn left
  482 ft
- ↱ Turn right
  52 ft
- ↱ Turn right
  ⓘ Destination will be on the right
  253 ft

St. Clare Specialty Center

11307 Bridgeport Way SW, Lakewood, WA 98499

EMERGENCY RESPONSE PLAN

Injury or Exposure

If an injury or exposure occurs, take the following actions:

- Get first aid for the person immediately.
- Notify the Site Health and Safety Officer (SHSO). The SHSO is responsible for immediately notifying the Project Manager and preparing and submitting an Injury/Exposure Report (Attachment 1) to the Corporate Health and Safety Officer within 24 hours, as well as notifying the employee's supervisor and Principal-in-Charge. If a subcontractor employee is injured, the Subcontractor Field Supervisor will also complete an injury/exposure investigation and submit a copy to the Corporate Health and Safety Officer as well.
- The SHSO will assume charge during a medical emergency.

Site Incident

If an incident (e.g., theft, car accident, property damage) occurs, take the following action:

- Notify the SHSO immediately. The SHSO is responsible for immediately notifying the Project Manager and preparing and submitting a Site Incident Report (Attachment 1) to the Corporate Health and Safety Officer within 24 hours.

GENERAL SITE REQUIREMENTS AND BACKGROUND INFORMATION

HASP Organization and Responsibilities

Key Personnel

Principal-in-Charge	Phil Coughlan
Corporate Health and Safety Officer	George Iftner
Herrera Project Manager	George Iftner
Herrera Site Health and Safety Officer	Shannon McKernan
Herrera Field Personnel	George Iftner
Client Project Manager	Sara Abdelrahman

Principal-in-Charge

The Principal-in-Charge provides a point of contact if the Project Manager cannot be accessed during emergency situations.

Project Manager

The Project Manager provides technical support to the SHSO for health and safety decision-making. Prior to beginning onsite work, the Project Manager will ensure that employee training and medical clearance is current and up-to-date, and that site-specific safety and health concerns, have been addressed prior to field work. It is the responsibility of the Project Manager or designate to take reasonable steps to verify the following:

- Employee training is current and up-to-date
- Each participant is informed of the known risks and physical requirements
- Each participant is shown where remote communication devices are kept (e.g., mobile phones, radios)
- Each participant has read this HASP
- Has determined what safety clothing and equipment is appropriate for this project
- Company and personal equipment taken into the field is thoroughly checked for safety and in good working condition by a qualified person before it is used

- Each participant is instructed in field safety, wearing of safety clothing (e.g., chemical resistant personal protective equipment (PPE), high-visibility reflective clothing, etc.), and safe use of equipment
- Site-specific health and safety concerns (including but not limited to: known or suspected chemical hazards, etc.) have been addressed prior to field work

Site Health and Safety Officer

The SHSO shall be responsible for coordinating emergency response measures during this project. Workers shall report to the SHSO in the event of an emergency. Within 24 hours of the end of fieldwork, the SHSO will submit the completed (signed) HASP to the Corporate Health and Safety Officer.

The SHSO will oversee the overall HASP. The SHSO has the authority to stop work or prohibit any personnel from working on the site at any time for not complying with any aspect of the HASP.

Field Lead

Depending on the activity (i.e., installation, monitoring, sampling, demobilization), one member of the field team will be designated as Field Lead for each field task. The Field Lead is responsible for preventing unauthorized entry onto the site, ensuring all appropriate equipment is available and ready for use, and knowing who is on site while activities are occurring.

Subcontractor Field Supervisor

If a subcontractor is required to perform Herrera's portion of the work, the Subcontractor Field Supervisor is responsible for implementing health and safety for the subcontractor's own employees.

Onsite Personnel

Persons on the site have responsibility for their own health and safety, as well as assisting others in carrying out the HASP. Any person observed to be in violation of the HASP should be assisted in complying with the HASP, or reported to the Project Manager, the SHSO, or the Subcontractor Field Supervisor.

Any site personnel may shut down field activities if there is a real or perceived immediate danger to life or health.

Minimum Training, Immunization, and Medical Surveillance Requirements for Site Personnel

Training

Field workers have received health and safety training required by Occupational Safety and Health Administration (OSHA) (29 Code of Federal Regulations [CFR] 1910.120) and Washington State Division of Occupational Safety and Health (Chapter 296-843-200 WAC), including some of the following:

- 40 hours Hazardous Waste Operations training (HAZWOP)
- 8 hours Annual HAZWOP Refresher training
- First Aid and cardiopulmonary resuscitation (CPR) training
- Annual Respirator Fit Testing
- Hazard Communication Training Related to Biological Hazards in Sewer Work
- Annual Medical Clearance

Copies of applicable personnel training certifications are presented in Attachment 2.

Medical Surveillance

The Herrera medical surveillance program is described in the corporate HASP. In summary, Herrera employees potentially exposed to hazardous substances or health hazards for 30 days or more a year will participate in the program. The medical surveillance program includes a determination of fitness for each individual to work in hazardous environments, including use of various levels of PPE. Medical examinations are conducted on a regular basis (usually annually) and each person's condition reviewed at that time. The Corporate Health and Safety Officer maintains medical records in a designated file and are available for review by each affected employee.

Immunizations

In accordance with recommendations provided by the United States Centers for Disease Control regarding immunizations for wastewater workers, Tetanus/Diphtheria (Td) immunizations shall be administered to field personnel prior to field work potentially associated with wastewater.

GENERAL FIELD SAFETY

The SHSO is responsible for establishing and coordinating procedures for evacuation of onsite personnel, including non-Herrera personnel, prior to commencement of work. This plan will be reviewed at the site safety meeting conducted at the beginning of the first day of work (and at subsequent site safety meetings as warranted by changing conditions and addition of new site workers). A Daily Tailgate Health and Safety Meeting Form is to be completed and signed by personnel who attended the site safety meetings (see Attachment 3).

In the event of a potential emergency, as determined by any onsite worker, the SHSO will be notified and site personnel assembled at an area designated during the site safety meeting. The Project Manager, with the aid of the SHSO and other site workers, will decide the appropriate response depending onsite conditions.

General Field Safety Requirements

- Prior to working on site, a general inspection of hazards will be made by the SHSO. SHSO is responsible for preventing unauthorized entry onto the site and for knowing who is onsite.
- Onsite field personnel must have a mobile phone capable of connecting to an emergency contact (i.e., Herrera office, local emergency service).
- Designate at least one vehicle for emergency use.
- High-visibility reflective safety vests, shirt, or jacket that is fluorescent yellow-green, orange-red, or red in color; sturdy boots; and hard hats will be worn.

Work Limitations and Restrictions

- No eating or drinking is allowed in the work area.
- No smoking or lighting of matches or lighters is allowed in the work area.
- No rings, watches, bracelets, necklaces, or other jewelry that could trap chemical or biological contamination or get caught in moving equipment.
- If respiratory protection is required, no facial hair present that would interfere with respirator fit.
- Employees will use the “buddy system,” which requires at least two people, at all times while working in Level C PPE, when there is potential for contact with leachate or a LFG release, or working around heavy equipment.

HAZARD IDENTIFICATION

Hazards may exist in multiple forms on the site and shall be classified among three general categories: chemical, physical, and biological. The following list is meant to convey the general hazard classes that may be encountered on the site. Herrera's COVID-19 Field and Shared Equipment Safety Plan is provided

	Chemical Hazards		Physical Hazards		Biological Hazards
	Asbestos	X	Motor Vehicle Driving		Coliform Bacteria
	Flammable Liquids/Gases		Heavy Equipment Operations		Wastewater
	Metals	X	Drilling Rigs		Hospital Waste
	Polychlorinated Biphenyl		Heavy Lifting	X	Stinging/Poisonous Insects
	Pesticides/Herbicides	X	Slips, Trips, or Falls		Bacterial/Viral Agents
	Petroleum Hydrocarbons		Confined Space Entry		Rodents/Vermin
X	Volatiles	X	Electrical Hazards		Large Predatory Animals
	Semi-Volatiles		Explosives		Poisonous Snakes
	Toxic Liquids/Gases		Radioactive Isotopes		
	Dioxins/Furans	X	Traffic Hazards		
	Oxygen Deficiency		Water Hazards		

Potential Chemical Hazards

Chemical hazards will be evaluated both by visual examination of site conditions, as well as by use of monitoring equipment. Visual indications of potential chemical hazards include evidence of dead or dying vegetation, dead animals, discolored vegetation, or soil. Monitoring equipment to be used is discussed in under General Procedures for Air Monitoring section.

Sampling at Lakewood Towne Center has the potential for exposure to VOCs in soil and/or groundwater related to the historic release of dry cleaning solvent at the Site. In addition, groundwater treatment chemicals including nutrients and stabilized hydrogen peroxide that will be injected into two wells are also recognized chemical hazards staff should be aware of. Attachment 5 provides the SDS sheets for the groundwater treatment chemicals and nutrients to be used at the Site including:

- TersOx™ Liquid, Hydrogen Peroxide (34.5%)(harmful if swallowed, causes serious eye damage, and may cause respiratory irritation if inhaled)
- TersOx™ Nutrients-QR (may cause skin and eye irritation and may be harmful if inhaled)
- TersOx™ Modulator (causes severe skin burns and eye damage and may cause respiratory irritation)

All groundwater treatment work including injection of the treatment chemicals and nutrients will be performed by the drilling subcontractor operating under their own health and safety plan. Herrera will share this safety plan and attached SDS sheets with the drilling subcontractor for information purposes only and to aid in their development of their health and safety plan. Herrera staff will observe the work from a safe distance of approximately 50 feet away and will not enter the immediate work area surrounding the drill rig.

Regulatory Action Levels

The following table provides information regarding the relative toxicity of chemicals that may be found at the site based on established state or federal cleanup levels.

Volatiles		
Chemical	**Matrix**	**Regulatory Action Level[a]**
Tetrachloroethylene; (perchloroethylene – PCE)	Air	300 ppm
Trichloroethylene (TCE)		NA
Vinyl chloride		NA

Notes:

[a] References for regulatory action levels are NIOSH Pocket Guide to Chemical Hazards 2006; NIOSH short term exposure limit (STEL) and Washington Department of Labor and Industries Permissible Exposure Limits (PELs).

Exposure Pathways and Permissible Exposure Limits

The following is a list of potential exposure pathways, and the PELs and time weighted averages (TWAs) for chemical and biological hazards that may be encountered on the site. The potential exposure pathways are not limited to those listed. Acute systems of exposure along with odor thresholds and descriptions are given when that information is known. Odor thresholds are not exact and vary with susceptibility or sensitivity involved and will be discussed in the daily safety briefing.

Predominant Potential Site Chemical Hazards

Chemical (or Class)	Exposure Limits (TWA)			Other Pertinent Limits	Warning Properties/ Description	Routes of Exposure Or Irritation	Acute Health Effects	Chronic Health Effects/Target Organs
	OSHA PEL	NIOSH REL	STEL					
Tetrachloroethylene; (perchloroethylene – PCE)	100 ppm	LFC Carcinogenic	300 ppm	IDLH = 150 ppm Carcinogenic CEILING (OSHA) = 200 ppm; 300 ppm (5 min. max. peak in any 3 hrs.)	Colorless liquid with a mild chloroform-like odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, nose, throat, respiratory system; nauseous, flush face and neck; vertigo, dizziness, incoordination, headache, drowsiness, skin redness	Carcinogen A3 – Eyes, skin, respiratory system, liver, kidneys, central nervous system, (liver tumors)
Trichloroethylene (TCE)	100 ppm	LFC Carcinogenic	NA	IDLH = 1,000 ppm Carcinogenic CEILING (OSHA) = 200 ppm; 300 ppm (5 min. max. peak in any 2 hrs.)	Colorless liquid with a chloroform-like odor	Inhalation, absorption, ingestion, skin and/or eye contact	Irritated eyes, skin; headache, vertigo, visual disturbance, weakness, exhaustion, dizziness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmias, paresthesia	Carcinogen A3 – Eyes, skin, respiratory system, heart, liver, central nervous system (liver, kidney cancer)
Vinyl chloride	1 ppm	LFC Carcinogenic	NA	Carcinogenic CEILING (OSHA) = 5 ppm (15 min.)	Colorless liquid or gas with a pleasant odor at high concentrations	Inhalation, skin and/or eye contact (liquid)	Weakness, exhaustion, abdominal pain, gastrointestinal bleeding, pallor or cyanosis of extremities, frostbite (liquid)	Carcinogen A1 – Enlarged liver, central nervous system, respiratory system, lymphatic system (liver cancer)

PEL-TWA = Permissible Exposure Limit-Time Weighted Average (8 hours).
REL-TWA = Recommended exposure limit – time weighted average.
TLV-TWA = Threshold Limit Value-Time Weighted Average (8 hours).
STEL = Short Term Exposure Limit (15 minutes).
IDLH = Immediately Dangerous to Life or Health.
LFC = Lowest feasible concentration (no-effect exposure)
CEILING = Ceiling Limit (not to be exceeded, even instantaneously).
NIOSH = National Institute of Occupational Safety and Health

Carcinogenicity Status (ACGIH)
A1 - Confirmed human carcinogen

References:
ACGIH Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. 93-94.
NIOSH Pocket Guide to Chemical Hazards, U.S. Dept. of Health and Human Services, September 2005.
NIOSH Safety and Health Topic: Focus on Coal Mining – Safety Hazards, Health Hazards, and Mine Rescue, 2006.

General Procedures for Air Monitoring

Ambient air monitoring equipment will be used as a general survey tool to indicate the presence of potential airborne contamination. Air monitoring will be used periodically during installation of new monitoring wells. The following air monitoring equipment will be used during sampling:

- **Photoionization detector (PID)** – Monitors the presence of ionizable volatile organic vapors (not including methane) by measuring relative concentrations in parts per million (ppm). The PID features a 10.8 eV lamp and is calibrated daily using 100 ppm isobutylene calibration gas. Used for characterizing sample media and for determining whether volatile organic vapors present in the breathing zone at sample locations.

Air monitoring equipment shall be operated according to manufacturer's instructions and applied to site decision-making according to Herrera's standard operating procedures. Air monitoring will be recorded on the Air Monitoring Equipment Calibration/Check Log and Air Monitoring Log (Attachment 6).

The action levels for chemical monitoring are listed in the following table. These action levels are general guidelines derived from the United States Environmental Protection Agency emergency response action levels and are minimum action levels to be observed during field work.

Action Level Table for Chemical Monitoring

Monitoring Instrument	Chemical (or Class)	Action Level		Monitoring Frequency/ Location	Level For Respirator* Use	Level For Work Stoppage
☒ PID	Volatile organics	**Unknown vapors:** Background to 1 ppm above background: Level D 1 to 5 ppm above background (short-term exposure anticipated): Level C 5 to 500 ppm above background: Level B	**Contaminant-Specific:**	Conduct initial monitoring at the beginning of task activities, during sampling manhole 44, or if conditions change (e.g., increase in ambient temperature, visual observation of suspect contaminant, detection of suspect odors). Monitor breathing zone at least 15 minutes or less if PID alarm sound, indicating ionizable volatile organic vapors above background levels or ppm	≥5 ppm in breathing zone (continuous exposure)	5 ppm in breathing zone 50 ppm (in Level C PPE) NA in Level B PPE

* Respirator is full face with combination cartridges.

See Attachment 6 for complete Air Monitoring Equipment Calibration/Check Log and Air Monitoring Log.

Potential Physical Hazards

Potential physical hazards that may be encountered at the site and hazard control measures are summarized in the table below.

"X" If Applicable	Hazards	Hazard Control Measures
X	Motor Vehicle Driving	● Drive defensively. ● If you need to place or receive a phone call, pull off the road to a safe location and stop the vehicle before using your cell phone. Allow voicemail to handle your calls. ● Be aware of weather and road conditions when driving (i.e., heavy rain, snow; large puddles in roadway, black ice). ● Driver and passengers must wear seatbelts.
X	Slips, Trips, Falls	● Be aware of obstacles, such as cords, tools, and other equipment that may be present on the ground in the work area. ● Identify and mark areas that are potentially slippery (e.g., wet or oily surfaces) with spray paint or flagging and walk around them. ● Use handholds. ● Wear boots with good traction.
X	Drilling (i.e., hollow-stem auger, push probe, etc.)	● Identify/locate underground utilities prior to drilling activities. Complete Utility Clearance Log (Attachment 2). ● Wear hard hat, steel-toe boots, and noise protection. ● Maintain line of sight between drillers and field personnel.
	Confined Space	● Ensure compliance with 29 CFR 1910.146. ● Complete a confined space entry form. ● Attach permit for confined space entry. ● **Note: no confined space entries will be performed during this work by Herrera personnel**
	Oxygen Deficiency	● Monitor oxygen level in work zone. ● Do not enter area if oxygen level is less than 19.5 percent. ● Use self-contained breathing apparatus (SCBA) if area has less than 19.5 percent oxygen.

Potential Biological Hazards

There is a potential for encounters with stinging/poisonous insects while in the field. This hazard will be discussed during the daily tailgate safety meeting to determine if any workers onsite have known allergies to stinging insects and emergency medical attention will be sought, as necessary.

PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

Level of Protection

- **Level B**: SCBA or supplied-air respirator with an escape bottle, chemically resistant suit.
- **Level C**: Full-face air-purifying respirator with organic vapor and acid gas cartridges, chemically resistant PPE.
- **Level D**: No respiratory protection. Safety glasses, hard hat, sturdy boots, long-sleeved shirt and pants. Hearing protection, gloves (an inner disposable nitrile glove and outer chemical resistant glove), and other PPE as required.

To protect workers from potential contaminants in sample media, protective clothing will be worn during sampling activities, including Tyvek coveralls, protective eyewear, and chemical resistant boots and gloves. Protective clothing will be discarded or decontaminated between uses.

The following levels of protection (LOPs) have been selected for each work task based on an evaluation of the potential or known hazards, the routes of potential hazard, and performance specifications of the PPE. Onsite monitoring results and other information obtained from onsite activities will be used to modify LOPs and PPE as necessary to ensure sufficient personnel protection.

Work Task Number	D	C	B	Modifications Allowed
1, 2, and 3	X	-	-	No

Note: Use “X” for initial levels of protection. Use “(X)” to indicate LOPs that may be used as site conditions warrant.

Personal Protective Equipment

Personnel who perform work on site will be minimally required to meet the protective clothing and safety equipment requirements for Level D (minimum required PPE for Level D in the following table is marked by an “*”). Level D status will apply to fieldwork on the site unless the trigger mechanism(s) to Level C or B are activated. Previous work at MH44 indicates PPE and full-face respirators with combination cartridges will be required during sampling activities. The SHSO must notify the Corporate Health and Safety Officer prior to work if Level “C” or “B” is warranted.

PPE	Task 1	Task 2	Task 3
Safety glasses/goggles[a]	X	X	X
Cotton coveralls/long-sleeved shirt and pants[a]	X	X	X
Rain gear or Tyvek suit for splash protection			
Hard hat (required at all construction sites) [a]	X	X	
Steel-toed safety boots (as per ANSI Z41) [a]	X	X	X
Work gloves[a]	X		
Neoprene safety boots (as per ANSI Z41			
Solvex or nitrile gloves (for sample handling)	X	X	X
Ear plugs/muffs	X	X	
Reflective safety vest	X	X	X

[a] Represents minimum required PPE for Level D work.

Safety Equipment

The safety equipment in the following table that is marked by an "X" indicates safety equipment needed for each work task.

Safety Equipment	Tasks 1 and 2	Task 3
First-aid kit[a]	X	X
Emergency eye wash[a]	X	X
Fire extinguisher (Class A, B, C) [a]	X	X
Photoionization detector[a]	X	

[a] Represents minimum required safety equipment.

DECONTAMINATION

Following are the decontamination procedures that will be employed to prevent contamination of personnel and to prevent cross contamination of sampling equipment during the collection of samples.

Personnel Decontamination

Decon Solutions:	Hand sanitizer
Decon Method:	Remove rain gear; remove and dispose of gloves; wash hands and face with hand sanitizer and wipe dry with paper towel.
Exposure Monitoring:	None
Level of Protection:	D
Location:	Support zone

Some of the personnel protective clothing that may be used, such as Tyvek suits and gloves, are disposable and no decontamination required following use.

Sampling Equipment Decontamination

A decontamination station shall be set up daily during sampling activities. The location of the decontamination station may vary based on the location of sampling activities. Bucket used for sample collection and flow measurement will be decontaminated. The station shall include one or more of the following items:

- Hand sanitizer for hands and face after disposable gloves and rain gear is removed.
- A bucket or tub with a Liquinox soap/water solution and a brush for scrubbing boots, rain gear, gloves, and other non-disposable PPE
- A second bucket or tub filled with tap or deionized water for rinsing
- Sprayer with potable water used for final rinse.

WASTE CHARACTERISTICS

Waste Generation

Waste Anticipated:

Yes: ☒ No: ☐

Waste Type	Description	Quantity	Packaging Requirements
Solid	-	-	
Liquid	-	-	
Sludge	-	-	
Incidental	Used disposable gloves, paper towels	1 bag	Plastic trash bag
Other	-	-	

TRAINING, IMMUNIZATION, AND MEDICAL CLEARANCE

Following is a summary of training, immunization, and/or medical clearance information for personnel who will perform work on the site. Copies of personnel training certificates are presented in Attachment 2.

1. Name: Shannon McKernan	Title: Field Personnel and Field Lead	Approved personal protection level: B
Field Responsibilities:	Tasks 1, 2, and 3	

Training	Dates (Month/Year)
Current 8-Hour Refresher	July 12, 2023
40-Hour Hazardous Waste	March 17, 2017
Supervisor	May 20, 2020
First Aid; CPR	November 2013

2. Name: Katie Jerauld	Title: Field Personnel	Approved personal protection level: B
Field Responsibilities:	Tasks 1, 2, and 3	

Training	Dates (Month/Year)
Current 8-Hour Refresher	October 2023 (scheduled)
40-Hour Hazardous Waste	August 2022
Supervisor	NA
First Aid; CPR	May 2017

3. Name: George Iftner	Title: Field Personnel	Approved personal protection level: B
Field Responsibilities:	Tasks 1, 2, and 3	

Training	Dates (Month/Year)
Current 8-Hour Refresher	October 2023 (scheduled)
40-Hour Hazardous Waste	April 19, 1998
Supervisor	April 19, 2002
First Aid; CPR	September 12, 2019

HEALTH AND SAFETY PLAN — ACKNOWLEDGEMENT AND AGREEMENT FORM

The following field personnel have read this HASP and understand the potential and actual hazards present on the site and shall abide by its strictures.

Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date
Name	Signature	Company	Date

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ATTACHMENT 1

Injury/Exposure Report and Site Incident Report

HERRERA

INJURY/EXPOSURE REPORT

(Attach additional documentation as necessary.)

Date of Incident: ____ Case No. ____ Time of Day ____

Employee Name ____ Date of Birth ____

Home Address ____ Phone No. ____

Sex Male ____ Female ____ Age ____ Job Title ____ Social Security No. ____

Office Location ____ Date of Hire ____

Where did incident occur? (include address) ____

On employer's premises? Yes ____ No ____ Project Name/No. ____

What was employee doing when incident occurred? (be specific) ____

How did the incident occur? (describe fully) ____

What steps could be taken to prevent such an incident? ____

Object or substance that directly caused incident? ____

Describe the injury or exposure ____

Part of body affected ____

Name and address of physician ____

If hospitalized, name and address of hospital ____

Loss of one or more days of work? Yes ____ No ____ If yes, date last worked ____

Has employee returned to work? Yes ____ No ____ If yes, date returned ____

Did employee die? Yes ____ No ____ If yes, date ____

Completed by (print) ____
(Supervisor or Site Health & Safety Officer)

Employee signature ____

Date ____

Signature ____

Date

PIC Signature ____

Date

This report must be completed by the employee's supervisor or Site Health and Safety Officer immediately upon learning of the incident. The completed report must be reviewed and signed by the Principal-in-Charge and transmitted to Corporate Health and Safety Officer within 24 hours of the incident, even if employee is not available to review and sign. Employee or employee's doctor must submit a copy of the doctor's report to Corporate Health and Safety Officer within 24 hours of the initial exam and any subsequent exams. For field injuries, submit a copy of the Health and Safety Plan.

HERRERA

SITE INCIDENT REPORT

(Attach additional documentation as necessary.)

Date of Incident: ______________________________ Time of Incident: ____________________

Location of Incident: ____

Project Name: ________________________________ Project No.: _________________________

Type of Incident* (check those that apply):

_____ "Near Miss"
_____ Underground Property Damage
_____ Aboveground Property Damage
_____ Theft
_____ Other (describe) ____
_____ Vehicle Accident
_____ Fire
_____ Evacuation
_____ Regulatory Agency Inspection or Violation

*Submit copy of Health and Safety Plan and attachments for field-related incidents.

Description of Incident: ____

Cause of Incident: ____

Action Taken: ____

Future Corrective Action: ____

Estimated Amount of Damage: ____

Investigator Name	Signature	Date
Principal-in-Charge	Signature	Date

cc: Site Health and Safety Officer, Corporate Health and Safety Officer, and Human Resources within 24 hours of incident.

ATTACHMENT 2

Personnel Training Certificates

LONGLEAF
WILDERNESS
MEDICINE

September 12, 2019

Dear George -

Congratulations on completing a **16-Hour Wilderness First Aid Course** with Longleaf Wilderness Medicine!

Course Number:	Herrera-WFA234
Course Location:	Seattle, WA
Issue Date:	September 12, 2019
Expiration Date:	September 12, 2021

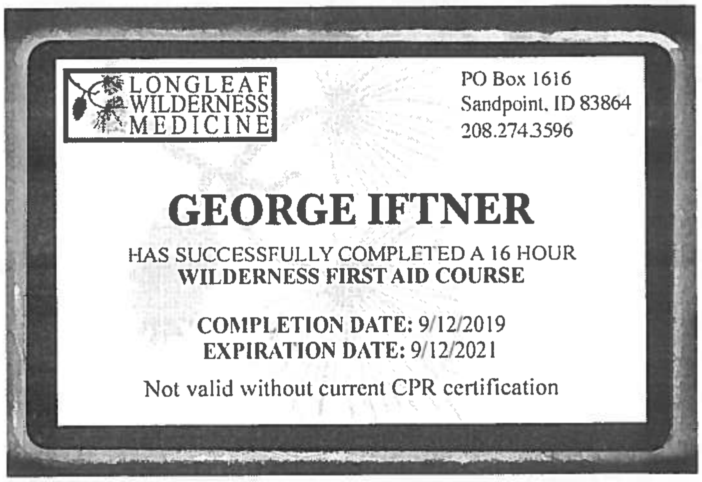
If you have any questions that arise after class, please do not hesitate to get in contact with us. We love to hear from our alumni! If you do lose your card, you can order a new one through the online store on our website.

Thank you again for choosing Longleaf Wilderness Medicine! We hope to see you in another class in the future.

All our best,

LWM Staff

Longleaf Wilderness Medicine
www.longleafmedical.com
208.274.3596



LONGLEAF
WILDERNESS
MEDICINE

PO Box 1616
Sandpoint, ID 83864
208.274.3596

GEORGE IFTNER

HAS SUCCESSFULLY COMPLETED A 16 HOUR
WILDERNESS FIRST AID COURSE

COMPLETION DATE: 9/12/2019
EXPIRATION DATE: 9/12/2021

Not valid without current CPR certification

NATIONAL
ENVIRONMENTAL
TRAINERS

A TPC COMPANY

Certificate of Completion

George Iftner

has satisfactorily passed an exam and completed an 8-hour annual refresher training course entitled

HAZWOPER 8 Hour Refresher (Engineers & Scientists) - 1910.120 (e)

meeting the requirements identified in Title 29 CFR 1910.120.

Completion Date: 04/06/2022

Certificate Number: 312580

Amy Bonilla

Amy Bonilla
Vice President

Paul Colangelo
Training Facilitator

www.natlenvtrainers.com
info@natlentrainers.com
750 W Lake Cook Rd, Suite 350
Buffalo Grove, IL 60089
1-888-877-7130

Certificate of Completion

This is to certify that

George C Iftner

has satisfactorily completed
8 hours of supervisor training in

Hazardous Waste Operations And Emergency Response

to comply with the training requirements of
OSHA 29 CFR 1910.120 and WAC 296-62-30415

Certificate Number 1002061

Philippa Murphy
Training Administration

ARGUS PACIFIC
SAFETY • TRAINING • INDUSTRIAL HYGIENE

Apr 19, 2002
Date(s) of Training

Argus Pacific, Inc. • 1900 W. Nickerson • Suite 315 • Seattle, Washington • 98119 • (206) 285.3373 • fax (206) 285.3927

IESMC, Inc.

Industrial/Environmental Safety Management Consulting, Inc.

P.O. Box 331, Crystal Lake, IL 60039-0331
815-455-1762 Fax: 815-455-1780

Certifies that

George Iftner

has been awarded this certificate for successfully completing

40 Hour Hazardous Incident Response Operations EPA (165.5) Training in accordance with 29 CFR 1910.120 and in Cooperation with the U.S. EPA OFFICE OF EMERGENCY AND REMEDIAL RESPONSE

Conducted on April 19, 1998

Certification #: 0498HW100142

April 19, 1998
Date

2.1 CEU

James C. Meldrum
James C. Meldrum, Founder, CEI

Certificate of Completion

This is to certify that

George Iftner

has satisfactorily completed
2 hours of refresher training in

Confined Space Entry

to comply with the training requirements of
WAC 296-809 and OSHA 29 CFR 1910.146.

Certificate Number 1024796

Susan N. Moss
Instructor

ARGUS PACIFIC
SAFETY • TRAINING • INDUSTRIAL HYGIENE

Dec 8, 2006
Date(s) of Training

Argus Pacific, Inc. • 1900 W Nickerson • Suite 315 • Seattle, Washington • 98119 • (206) 285.3373 • fax (206) 285.3927

Certificate of Completion

This is to certify that

Shannon E. McKernan

has satisfactorily completed
40 hours of training in

Hazardous Waste Operations and Emergency Response

to comply with the training requirements of
OSHA 29 CFR 1910.120, WAC 296-843 & WAC 296-824

Certificate Number 161675

Instructor

ARGUS PACIFIC
TRAINING•CONSULTING
A Terracon COMPANY

Mar 13 - 17, 2017
Date(s) of Training
Annual Refresher Required by: Mar 17, 2018

ARGUS PACIFIC, INC / 1900 WEST NICKERSON ST, SUITE 315 / SEATTLE, WASHINGTON 98119 / 206.285.3373 / ARGUSPACIFIC.COM

Certificate of Completion

This certifies that

Shannon E. McKernan

has successfully completed

8 Hour HAZWOPER Refresher Training

Refresher certification does NOT necessarily indicate initial 24 or 40 Hour HAZWOPER certification

In Accordance w/Federal OSHA Regulation 29 CFR 1910.120(e) & (p)

And all State OSHA/EPA Regulations as well including 29 CFR 1926.65 for Construction.

This course (Version 3) is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) (Accreditation # 044).

Safety Unlimited, Inc., Provider #5660170-2, is accredited by the International Association for Continuing Education and Training (IACET) and is accredited to issue the IACET CEU. As an IACET Accredited Provider, Safety Unlimited, Inc. offers CEUs for its programs that qualify under the ANSI/IACET Standard. Safety Unlimited, Inc. is authorized by IACET to offer 0.8 CEUs for this program.

Julius P. Griggs
Julius P. Griggs
Instructor #892

2307125480245
Certificate Number

7/12/2023
Issue Date

ACCREDITED
IACET
PROVIDER

Scan this code or visit safetyunlimited.com/v to verify certificate.

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley,CA 93063
(855) 784-2677 or 805 306-8027
https://www.safetyunlimited.com

Proof of initial certification and subsequent refresher training is NOT required to take refresher training

Certificate of Completion

This certifies that

Shannon McKernan

has successfully completed

8 Hour HAZWOPER Supervisor Training

This certificate does not in itself indicate initial 24 or 40 Hour HAZWOPER Training

In Accordance With Federal OSHA Regulation 29 CFR 1910.120(e)(4)

And all State OSHA/EPA Regulations as well including 29 CFR 1926.65 for Construction.

This course is approved for 8 Contact Hours (0.8 CEUs) of continuing education per the California Department of Public Health for Registered Environmental Health Specialist (REHS) (Accreditation # 044)

Safety Unlimited, Inc., Provider #5660170-2, is accredited by the International Association for Continuing Education and Training (IACET) and is accredited to issue the IACET CEU. As an IACET Accredited Provider, Safety Unlimited, Inc. offers CEUs for its programs that qualify under the ANSI/IACET Standard. Safety Unlimited, Inc. is authorized by IACET to offer 0.8 CEUs for this program.

Julius P. Griggs	2005204279748	5/20/2020
Julius P. Griggs Instructor #892	Certificate Number	Issue Date

ACCREDITED IACET PROVIDER

Scan this code or visit safetyunlimited.com/v to verify certificate.

SAFETY UNLIMITED, Inc.
OSHA Compliant Safety Training Since 1993

2139 Tapo St., Suite 228 Simi Valley,CA 93063
(855) 784-2677 or 805 306-8027
https://www.safetyunlimited.com

Annual Refresher Training NOT Required

Certificate of Completion

This is to certify that

Katie S. Jerauld

has satisfactorily completed
40 hours of training in

Hazardous Waste Operations and Emergency Response

to comply with the training requirements of
OSHA 29 CFR 1910.120 & WAC 296-843

PPE Levels: A, B, C, D

185981
Certificate Number

ARGUS PACIFIC
TRAINING • CONSULTING
A Terracon COMPANY

Aug 15 - 19, 2022 Expires in 1 year.
Date(s) of Training

Exam Score: N/A
(if applicable)

Tracy Greene

Instructor: Tracy Greene

ARGUS PACIFIC, INC / 21905 64th AVE W, SUITE 100 / MOUNTLAKE TERRACE, WASHINGTON 98043 / 206.285.3373 / ARGUSPACIFIC.COM

AGC Education Foundation

Katie Jerauld

Successfully Completed:

Construction Stormwater Best Management Practices Field Training

and is hereby a

Certified Erosion & Sediment Control Lead

Certification Date: 11/29/2022 Expiration Date: 11/29/2025

ID # **EF8184854** www.constructionfoundation.org

ATTACHMENT 3

Daily Tailgate Health and Safety Meeting Form

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DAILY TAILGATE SAFETY MEETING FORM

First Date of Activity: ________________ Time: ________________ Site Locations: ____________________________

1. ☐ Discussed activities planned for the day
2. ☐ Individual activities are clear to each crew member
3. ☐ Physical hazards discussed
   - a. ☐ Heat stress
   - b. ☐ Cold stress
   - c. ☐ Slip, trip, and fall hazards
   - d. ☐ Water hazards (streams, boats)
   - e. ☐ Traffic hazards
   - f. ☐ Remote, forested, or hazardous areas
   - g. ☐ Heavy equipment
   - h. ☐ Other:
4. ☐ Biological hazards discussed
   - a. ☐ Stinging insect allergies
   - b. ☐ Other:
5. ☐ Personal protective equipment (PPE) discussed
   - a. ☐ Head protection (hard hat)
   - b. ☐ Eye protection (safety glasses must have side shields)
   - c. ☐ Hearing protection (at all times when working in or around traffic, heavy equipment)
   - d. ☐ Foot protection (steel toes and shanks for work boots)
   - e. ☐ Splash protection (solvent rinse)
   - f ☐ Gloves
     - i. ☐ Environmental conditions (cold)
     - ii. ☐ Protection against cross-contamination (disposal after each use)
     - iii. ☐ Physical hazard (cut, puncture, and abrasion)
6. ☐ Decontamination procedures discussed
   - a. ☐ PPE equipment (rain gear, waders)
   - b. ☐ Sampling equipment
7. ☐ Emergency procedures discussed
   - a. ☐ Route to hospital from site locations(s) above
   - b. ☐ Evacuation procedures
   - c. ☐ Cellular phone, map to hospital, first aid kit, and eyewash with Site Health and Safety Officer/Field Lead
8. ☐ Special conditions/procedures
   - a. ☐ Escort required
   - b. ☐ Locked gates, permits, passes, etc.
9. ☐ Questions/concerns addressed
10. ☐ Other:

Meeting attended by (sign and date for each day of work on site; **USE BACK IF ADDITIONAL SPACE IS REQUIRED**):

(Print Name)	(Signature)	(Date)

Meeting conducted by: ______________________________ (Title) ____________________________

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ATTACHMENT 4

COVID-19 Field and Shared Equipment Safety Plan

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HERRERA ENVIRONMENTAL CONSULTANTS
COVID-19 FIELD AND SHARED EQUIPMENT SAFETY PLAN
UPDATED SEPTEMBER 2023

The purpose of this document is to act as a contagion safety guide to augment Herrera's Corporate Health and Safety Plan and Site-Specific Health and Safety Plans in response to the COVID-19 virus outbreak. Herrera's guidance is for all employees to follow State Mandates and Orders and the current CDC guidelines throughout all Herrera office and work site locations, including travel to and from those locations. The guidelines can be accessed at the following link: <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/index.html>.

The following guidelines have been prepared to be compliant with the CDC guidelines and to protect our staff, their families, our clients, and the communities in which we work. Herrera is requiring staff to adhere to those guidelines as well as additional guidelines specific to our work.

This safety plan is to be followed for all projects. If this plan has been modified to include project-specific requirements, then include the following information:

- Project name/number:
- Revision date:

Vaccinations

The CDC recommends everyone stay up to date with COVID-19 vaccines for their age group. Herrera staff are considered up to date with COVID-19 vaccines if they have completed a COVID-19 primary series and received the most recent booster dose recommend for them by the CDC. If you have completed your primary series, but are not yet eligible for a booster, you are also considered up to date. Booster recommendations can be accessed at the following link: Stay Up to Date with COVID-19 Vaccines Including Boosters | CDC.

COVID-19 Symptoms and Reducing Transmission Among Employees

Staff should be aware that COVID-19 symptoms may appear 2-14 days after exposure and may include:

- Fever
- Cough
- Shortness of breath

Other symptoms may include chills, muscle pain, headache, sore throat, congestion or runny nose, and new loss of taste or smell. People have a wide range of symptoms – ranging from mild to severe illness. See the CDC website for a full list of possible symptoms: <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>.

Employees who develop cold/flu/COVID-19 like symptoms at work should immediately be isolated from other workers and go home. Employees should stay home, get tested as soon as possible, and monitor symptoms. If you test negative and still have symptoms, it is recommended you stay home. If you must come to work for field work, notify field staff and wear a KN-95 mask in case you test positive later.

When to Get Tested for COVID-19

Herrera staff should get tested if any of the following apply:

- If you have symptoms, test immediately.
- If you were exposed to COVID-19 and do not have symptoms, wait at least 5 full days after your exposure before testing. If you test too early, you may be more likely to get an inaccurate result.
- If you are in certain high-risk settings, you may need to test as part of a screening testing program.
- Consider testing before contact with someone at high risk for severe COVID-19: <https://www.cdc.gov/coronavirus/2019-ncov/your-health/risks-getting-very-sick.html>.

Isolation and Precautions for People with COVID-19

The following actions should be followed if an employee tests positive for COVID-19 (even without symptoms):

- Isolate from others regardless of vaccination status.
    - Stay home for at least 5 days and isolate from others in your home.
        - If you have no symptoms, Day 0 is the day you were tested (not the day you received your positive test), and Day 1 is the first full day following the day you were tested.
        - If you have symptoms, Day 0 of isolation is the day of symptom onset regardless of when you tested positive. Day 1 is the first full day after your symptoms started.
    - End isolation based on how serious your COVID-19 symptoms were.

    - If you had no symptoms, you may end isolation after day 5
    - If you had symptoms and your symptoms are improving, you may end isolation after day 5 if you are fever-free for 24 hours
        - If your symptoms are not improving, continue to isolate until your symptoms improv and you are fever-free for 24 hours
    - If you had symptoms and experienced shortness of breath or difficulty breathing, you need to isolate through day 10.
    - If you were hospitalized or have a weakened immune system you need to isolate through day 10 and consult your doctor before ending isolation.
- Wear a high-quality mask through day 10 if you must be around others at home and work.
    - You may remove your mask before day 10 if you received two sequential negative antigen tests 48 hours apart.

What to Do If You Have Been Exposed

If you were exposed to someone with COVID-19, you may have been infected with the virus. Employees should follow the guidance below for 10 a full days, regardless of vaccination status or previous infection. A person can still develop COVID-19 up to 10 days after they have been exposed. Day 0 is the day of last exposure. Day 1 is the first full day after last exposure.

1. Wear a high-quality mask (e.g., KN-95) or respirator as soon as you find out you were exposed. Wear the mask any time you around others indoors.
2. If you must conduct field work outdoors, wear a high-quality mask any time you are around others.
3. Watch for symptoms
    a. If you develop symptoms, isolate immediately, get tested, and stay home until you know the result. If your test is positive, follow the *isolation recommendations* above.
4. Take extra precautions if you will be around people who are more likely to get very sick form COVID-19.
5. Get tested at least 5 full days after your last exposure even if you do not develop symptoms. If you test too early, you may be more likely to get an inaccurate result. Follow the CDC's specific testing recommendations if you have had COVID-19 within 90 days of exposure: https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/testing.html#choosing-a-test

a. If you test negative, continue wearing a high-quality mask when around others at home or indoors in public.

b. If you test positive, isolate immediately and follow the guidance above.

Face Coverings

Face coverings include masks and respirators. Each provides a different level of protection depending on the type and how it is used. Loosely woven products provide the least protection, layered finely woven products offer more protection, well-fitting disposable surgical masks and KN95s offer even more protection, and well-fitting NIOSH-approved respirators (including N95s) offer the highest level of protection. Herrera employees must undergo medical clearance (via a physical by a licensed physician) and be fit tested in order to wear a respirator or N95 mask. Whatever product you choose, it should provide a good fit (i.e., fitting closely on the face without any gaps along the edges or around the nose) and be comfortable enough when worn properly so that you can keep it on when you need to.

- Currently, the CDC does not require face coverings but recommends wearing a mask or respirator under the following conditions: When the COVID-19 community levels where you live are medium and high (COVID-19 by County | CDC):
    - Wear a high-quality face covering when indoors in public if you are at high risk of getting very sick.
    - If you have household or social contact with someone at high risk for getting very sick, consider wearing a high-quality mask when indoors with them.
    - When the COVID-19 community level is high:
        - Wear a high-quality face covering
- If you are sick or caring for someone who is sick with COVID-19.
- If you were exposed to someone with COVID-19, wear a high-quality mask when indoors around others for 10 days, testing, and monitoring yourself for symptoms.
- If you have a weakened immune system
- When it is not practical to say away from a person with COVID-19.
- While traveling or working in public transportation settings (such as airplanes, trains, buses, ferries).
- Work indoors in correctional facilities, homeless shelters, schools, public transportation, and certain health care settings, including doctor’s offices, long-term care, and hospitals.

Personal Hygiene

- Wash your hands often with soap and water for at least 20 seconds, especially after you have been in a public place, or after blowing your nose, coughing, or sneezing, and always before eating.
- If soap and water are not readily available, use a hand sanitizer that contains at least 60% alcohol. Cover all surfaces of your hands and rub them together until they feel dry.
- Hand sanitizer is available in each Herrera office, in each company vehicle, and in the equipment storage rooms.
- Avoid touching your eyes, nose, and mouth with unwashed hands.
- If you must cough, cover your cough with a tissue and dispose of in the trash. If a tissue is not available, cough into your elbow.
- Use designated personal protective equipment (PPE) for all field work as required in a Site-Specific Health and Safety Plan.

Vehicle Use and Hygiene

- Upon entering a vehicle, wipe down all surfaces that you will be touching with a fresh disinfectant wipe stored in each vehicle. One wipe will suffice for all surfaces. If wipes are not present, replenish vehicle with wipes from office or storage room supplies.
- Use a disinfectant wipe to clean any gas pump handle or credit card reader before and after use (again you should only need one wipe).
- Once you are done with a field vehicle, again wipe down all contacted surfaces with a disinfectant wipe.

Equipment Use and Hygiene

- Wipe down frequently touched surfaces on all shared equipment (e.g., GPS, laptops, iPads, hand tools, etc.) with a disinfectant wipe prior to picking up at the office or loading into a field vehicle or personal vehicle for the day.
- Proceed with additional decontamination procedures as required by project-specific protocols after wiping down gear with disinfectant wipes.
- Upon returning equipment:
    - Wipe down frequently touched surfaces on all field gear with disinfectant wipes.

    - Deep clean dirty areas prior to disinfecting them.

- Plug in any equipment that needs to charge and then wipe down the plugs and touched surfaces.

- Use nitrile gloves and work gloves as much as possible in the field.

Staff are instructed to review these guidelines and respond by email to Human Resources confirming they have read and will abide by these guidelines (jmcinerney@herrerainc.com). Your email response is acknowledgement that you have received, read, understood, and will implement these guidelines.

ATTACHMENT 5

Air Monitoring Equipment Calibration/ Check Log and Air Monitoring Log

AIR MONITORING EQUIPMENT CALIBRATION/CHECK LOG

Project Name: ____________________

Project Number: ____________________

Date	Instrument/ Model No.	Serial No.	Battery Check OK?	Zero Adjust OK?	Calibration Gas (ppm)	Reading (ppm)	Performed By	Comments

AIR MONITORING LOG

Project Name: ______________________________

Project Number: ______________________________

Date	Time	Location	Source Area/ Breathing Zone	Instrument	Concentrations/ Units	Sampled By	Comments

ATTACHMENT 6

Safety Data Sheets

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SAFETY DATA SHEET
TersOx™ Liquid

Creation Date: 2/14/2019
Revision Date: 6/1/2023
Version 1.3
SDS # 15A

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product Identifier

Product Name: TersOx™ Liquid, Hydrogen Peroxide (34.5%)

1.2 Recommended Use of the Chemical

Product Use: Bleaching agent, Oxidizing agent, Cosmetics, and Water treatment.

1.3 Details of the Supplier

Supplier

Tersus Environmental, LLC
1116 Colonial Club Rd
Wake Forest, NC 27587
Phone: +1-919-453-5577
Email: info@tersusenv.com

1.5 Emergency Telephone Number

For leak, fire, spill or accident emergencies, call:

+1-919-453-5577 (Tersus Office Hours, 8:00 AM to 5:00 PM Eastern)
+1-800-424-9300 (Chemtrec 24 Hour Service – Emergency Only)

2. HAZARD IDENTIFICATION

2.1 Classification

2.1.1 Physical hazards	Oxidizing liquids	Category 2, H272
2.1.2 Health hazards	Acute toxicity, oral	Category 4, H302
	Skin corrosion/irritation	Category 1A, H315
	Serious eye damage/eye irritation	Category 1, H318
	Specific target organ toxicity (single exposure)	Category 3, H335
	Chromic aquatic toxicity	Category 3, H412

2.2 Label Elements

2.3 Signal Word

Danger

2.4 Hazard Statement

May intensify fire; oxidizer. Harmful if swallowed. Causes serious eye damage.
May cause respiratory irritation. Harmful to aquatic life with long lasting effects.
H272 : May intensify fire; oxidizer.
H302 : Harmful if swallowed.
H318 : Causes serious eye damage.
H335 : May cause respiratory irritation.
H412 : Harmful to aquatic life with long lasting effects.

2.5 Precautionary Statement

2.5.1 Prevention: Keep away from heat. Keep/Store away from clothing and other combustible materials. Take any precaution to avoid mixing with combustibles. Wash thoroughly after handling. Do not eat, drink, or smoke when using this product. Wear eye protection/face protection. Wear protective gloves/eye protection/face protection.
P210 : Keep away from heat.
P220 : Keep/Store away from clothing/ combustible materials.
P221 : Take any precaution to avoid mixing with combustibles.
P261 : Avoid breathing gas/mist/vapours/spray.
P264 : Wash skin thoroughly after handling.
P270 : Do not eat, drink or smoke when using this product.
P271 : Use only outdoors or in a well-ventilated area.
P273 : Avoid release to the environment.
P280 : Wear protective gloves/ eye protection/ face protection.

2.5.2 Response: If swallowed: Call a poison center/doctor if you feel unwell. Rinse mouth. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center/doctor. In case of fire: Use appropriate media to extinguish.

P301 + P312: IF SWALLOWED: Call a POISON CENTER or doctor/ physician if you feel unwell.
P304 + P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338: IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310: Immediately call a POISON CENTER or doctor/ physician.
P330: Rinse mouth.
P370 + P378: In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.

2.5.3 Storage: Store away from incompatible materials.

P403 + P233: Store in a well-ventilated place. Keep container tightly closed.
P405: Store locked up.

2.5.4 Disposal: Dispose of contents/container in accordance with local/regional/national/international regulations.

P501: Dispose of contents/ container to an approved waste disposal plant.

2.6 Hazard(s) not Otherwise Classified (HNOC): If swallowed: May cause: gastrointestinal symptoms, ulceration, burns, accumulation of fluid in the lungs which may be delayed for several hours. (Severity of effects depends on extent of exposure)

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Formula H_2O_2

Chemical Name	Identification Number (CAS-No.)	Concentration (%)	GHS Classification**
Hydrogen Peroxide	7722-84-1	34.5	H272, H302, H318, H335, H412
Water	7732-18-5	65.5	Not classified

Occupational exposure limits, if available, are listed in Section 8.

4. FIRST AID MEASURES

4.1 Eye Contact Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Seek immediate medical attention/advice.

4.2 Skin Contact Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for further treatment advice. Wash clothing before reuse. Thoroughly clean shoes before reuse.

4.3 Inhalation Move to fresh air. If person is not breathing, contact emergency medical services, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.

4.4 Ingestion If swallowed, DO NOT induce vomiting unless directed to do so by medical personnel. Get medical attention immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person. Rinse mouth.

4.5 Important Symptoms and Effects (Acute and Delayed) Hydrogen peroxide irritates the respiratory system and, if inhaled, may cause inflammation and pulmonary edema. The effects may not be immediate. Overexposure symptoms are coughing, giddiness and sore throat. In case of accidental ingestion, necrosis may result from mucous membrane burns (mouth, esophagus, and stomach). Oxygen rapid release may cause stomach swelling and hemorrhaging, which may produce major, or even fatal, injury to organs if a large amount has been ingested. In case of skin contact, may cause burns, erythema, blisters or even necrosis.

4.6 Indication of Medical Attention and Special Treatment Needed (If Necessary) Hydrogen peroxide at these concentrations is a strong oxidant. Direct contact with the eye is likely to cause corneal damage especially if not washed immediately. Careful ophthalmologic evaluation is recommended, and the possibility of local corticosteroid therapy should be considered. Because of the likelihood of corrosive effects on the gastrointestinal tract after ingestion, and the unlikelihood of systemic effects, attempts at evacuating the stomach via emesis induction or gastric lavage should be avoided. There is a remote possibility, however, that a nasogastric or orogastric tube may be required for the reduction of severe distension due to gas formation.

4.7 General Information	Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse.
4.8 Notes to Physician	Exposure to material may cause delayed lung injury resulting in pulmonary edema and pneumonitis. Exposed individuals should be monitored for 72 hours after exposure for the onset of delayed respiratory symptoms.

5. FIRE-FIGHTING MEASURES

5.1 Suitable Extinguishing Media	Water spray, water fog. Do not use any other substance.
5.2 Specific Hazards Arising from the Chemical	In closed unventilated containers, there is the risk of rupture due to the increased pressure from decomposition. Contact with combustible material may cause fire.
5.3 Hazardous Combustion Products	On decomposition product releases oxygen which may intensify fire.
5.4 Explosion data	Explosive when mixed with combustible material. Avoid breathing fumes from fire exposed material.
5.4.1 Sensitivity to Mechanical Impact	Not sensitive.
5.4.2 Sensitivity to Static Discharge	Not sensitive.
5.5 Protective Equipment and Precautions for Firefighters	Use water spray to cool fire exposed surfaces and protect personnel. Move containers from the fire area if you can do it without risk. Fire fighters and others who may be exposed to products of combustion should wear full firefighting turn out gear (full Bunker Gear) and self-contained breathing apparatus (pressure demand / NIOSH approved or equivalent).
5.6 Firefighter Advice	Oxidizing material in case of major fire and large quantities: Evacuate area. Fight fire remotely due to the risk of explosion. Decomposition will release oxygen, which will intensify a fire. Cool closed containers exposed to fire with water spray. Closed containers of this material may explode when subjected to heat from surrounding fire. Do not allow run-off from firefighting to enter drains or water courses. Firefighting equipment should be thoroughly decontaminated after use.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal Precautions	Avoid contact with skin, eyes, and clothing. Wear personal protective equipment. Isolate and post spill area. Keep people away from and upwind of spill/leak. Eliminate all sources of ignition and remove combustible materials.
6.2 Additional Information	Combustible materials exposed to hydrogen peroxide should be immediately submerged in or rinsed with large amounts of water to ensure that all hydrogen peroxide is removed. Residual hydrogen

peroxide that can dry (upon evaporation hydrogen peroxide can concentrate) on organic materials such as paper, fabrics, cotton, leather, wood, or other combustibles can cause the material to ignite and result in fire. Avoid contact with cellulose, paper, sawdust, or similar substances. Risk of self-ignition or promotion of fires. Contain and collect spillage with non-combustible absorbent material such as clean sand, earth, diatomaceous earth or non-acidic clay and place into suitable properly labeled containers for prompt disposal. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Consult a regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits.

6.3 Environmental Precautions

Prevent undiluted spillage from entering sewers, basements, or watercourses.

6.4 Methods for Containment

Dike to collect large liquid spills. Stop leak and contain spill if this can be done safely. Small spillage: Dilute with large quantities of water.

6.5 Methods for Cleaning Up

Flush area with flooding quantities of water. Hydrogen peroxide may be decomposed by adding sodium metabisulfite or sodium sulfite after diluting to about 5%.

7. HANDLING AND STORAGE

7.1 Handling Practices

Do not taste or swallow. Do not get in eyes, on skin, or on clothing. Avoid breathing vapor or mist. Keep/Store away from clothing/ combustible materials. Keep away from heat, sparks, and flames. Wear personal protective equipment. Reference to other sections. Never return unused hydrogen peroxide to original container. Use only with adequate ventilation. Contamination may cause decomposition and generation of oxygen gas which could result in high pressures and possible container rupture. Empty drums should be triple rinsed with water before discarding. Utensils used for handling hydrogen peroxide should only be made of glass, stainless steel, aluminum, or plastic. Pipes and equipment should be passivated before first use. DO NOT CUT, DRILL, GRIND, OR WELD ON OR NEAR THIS CONTAINER. Use only in well-ventilated areas. Hydrogen peroxide should be stored only in vented containers and transferred only in a prescribed manner. Observe all labeled safeguards until the container is cleaned, reconditioned or destroyed.

7.2 Safe Storage

Keep containers in cool areas out of direct sunlight and away from combustibles. Provide mechanical general and/or local exhaust ventilation to prevent release of vapor or mist into work environment. Containers must be vented. Keep/store only in original container. Storerooms or warehouses should be made of non-combustible materials with impermeable floors. Store in tightly closed container. Store in cool, dry, well-ventilated area away from sources of ignition such as flame, sparks, and static electricity. Store out of direct sunlight in a cool well-ventilated place. Store away from combustibles and incompatible materials. In case of release, spillage should flow to safe area. Containers should be visually inspected on a regular basis to detect any abnormalities (swollen drums, increases in temperature, etc.). Refer to National Fire Protection Association (NFPA) 430, Code for the Storage of Solid and Liquid Oxidizers.

7.3 Incompatible Materials Combustible materials. Copper alloys, galvanized iron. Strong reducing agents. Heavy metals. Iron. Copper alloys. Contact with metals, metallic oxides, alkalis, reducing agents and organic matter (such as alcohols or terpenes) may produce self-accelerated thermal decomposition.

8. EXPOSURE CONTROL / PERSONAL PROTECTION

8.1 Control parameters

Exposure guidelines, ingredients with workplace control parameters.

Chemical name	ACGIH TLV	OSHA PEL	NIOSH	Mexico
Hydrogen peroxide 7722-84-1	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3	IDLH: 75 ppm TWA: 1 ppm TWA: 1.4 mg/m^3	Mexico: TWA 1 ppm Mexico: TWA 1.5 mg/m^3 Mexico: STEL 2 ppm Mexico: STEL 3 mg/m^3
Chemical name	**British Columbia**	**Quebec**	**Ontario TWAEV**	**Alberta**
Hydrogen peroxide 7722-84-1	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3	TWA: 1 ppm	TWA: 1 ppm TWA: 1.4 mg/m^3

8.2 Appropriate Engineering Controls

8.2.1 Appropriate Engineering Controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Provide eyewash station.

8.3 Individual Protection Measures

8.3.1 Eye/Face Protection Where there is potential for eye contact, wear a face shield, chemical goggles, and have eye flushing equipment immediately available.

8.3.2 Skin Protection (Hands) Wear appropriate chemical resistant gloves. Suitable gloves can be recommended by the glove supplier. Be aware that the liquid may penetrate the gloves. Frequent change is advisable.

8.3.3 Skin Protection (Body) Wear appropriate chemical resistant protective clothing and chemical resistant gloves to prevent skin contact. When handling this material, gloves of the following type(s) should be worn: Neoprene, Polyvinylchloride, Impervious butyl rubber gloves. Wear a face shield, chemical goggles, and chemical resistant clothing such as an approved splash protective suit made of SBR Rubber, PVC, Gore-Tex or a HAZMAT Splash Protective Suit (Level A, B, or C) when splashing may occur (such as connecting/disconnecting, mechanical first break). For foot protection, wear boots made of NBR, PVC, polyurethane, or neoprene. Overboots made of Latex or PVC, as well as firefighter boots or specialized HAZMAT boots are also permitted. DO NOT wear any form of boot or overboots made of nylon or nylon blends. DO NOT use cotton, wool, or leather, as these materials react RAPIDLY with higher concentrations of hydrogen peroxide. Rinse immediately if skin is contaminated. Remove contaminated clothing and shoes immediately. Thoroughly rinse the outside of gloves and protective clothing with water prior to removal. Completely submerge hydrogen peroxide contaminated clothing or other materials in water prior to drying. Residual hydrogen peroxide, if allowed to dry on materials such as paper, fabrics, cotton, leather, wood, or other combustibles can cause the material to ignite and result in a fire. Clean protective equipment before reuse. Provide a safety shower at any location where skin contact can occur. Wash thoroughly after handling.

8.3.4 Respiratory Protection

Avoid breathing vapor or mist. Where airborne exposure is likely or airborne exposure limits are exceeded (if applicable, see above), use NIOSH approved respiratory protection equipment appropriate to the material and/or its components. Full facepiece equipment is recommended and, if used, replaces the need for face shield and/or chemical goggles. Consult respirator manufacturer to determine appropriate type equipment for a given application. Observe respirator use limitations specified by NIOSH or the manufacturer. For emergency and other conditions where there may be a potential for significant exposure or where exposure limit may be significantly exceeded, use an approved full face positive-pressure, self-contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply. Respiratory protection programs must comply with 29 CFR § 1910.134.

8.3.5 General Hygiene Considerations

Keep from contact with clothing and other combustible materials. Remove and wash contaminated clothing promptly. Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on Basic Physical and Chemical Properties

Appearance	Clear, colorless liquid
Physical State	Liquid
Color	Colorless
Odor	Pungent
Odor threshold	Not applicable
pH	Not applicable.
Freezing point	-33°C (-27°F)
Boiling Point/Range	108°C
Flash point	Not flammable
Evaporation Rate	> 1 (n-butyl acetate=1)
Flammability (solid, gas)	Not flammable
Flammability Limit in Air	Not applicable
Upper flammability limit:	Not applicable

Lower flammability limit:	Not applicable
Vapor pressure	24 mm Hg @ 20°C
Vapor density	Not determined.
Relative Vapor density	1.0
Density	1.13 g/cm³ @ 20ºC
Autoignition temperature	Not combustible
Molecular weight	34.01 g/mol
Bulk density	Not applicable

10. STABILITY AND REACTIVITY

10.1 Reactivity	Greatly increases the burning rate of combustible materials.
10.2 Chemical Stability	Material is stable under normal conditions.
10.3 Possibility of Hazardous Reactions	No dangerous reaction known under conditions of normal use.
10.4 Conditions to Avoid	Material decomposes with the potential to produce a rupture of unvented closed containers.
10.5 Incompatible Materials	Metals, Organic materials, Reducing agents, Metallic oxides, Dusts, Combustible materials (e.g., wood, sawdust), Alkaline materials.
10.6 Hazardous Decomposition Products	This material decomposes if contaminated, causing fire and possible explosions. Oxygen can be liberated at temperatures above ambient.

11. TOXICOLOGICAL INFORMATION

11.1 Information on Likely Routes of Exposure

11.1.1 Inhalation	Prolonged inhalation may be harmful.
11.1.2 Skin Contact	No adverse effects due to skin contact are expected.
11.1.3 Eye Contact	Causes serious eye damage.
11.1.4 Ingestion	Harmful if swallowed.
11.1.5 Symptoms related to the Physical, Chemical and Toxicological Characteristics	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result.

11.2 Information on Toxicological Effects

11.2.1 Acute Toxicity	Harmful if swallowed.
11.2.2 Skin Irritation	Prolonged skin contact may cause temporary irritation.
11.2.3 Serious Eye Damage	Causes serious eye damage.
11.2.4 Respiratory Sensitization	Not a respiratory sensitizer.
11.2.5 Skin Sensitization	This product is not expected to cause skin sensitization.
11.2.6 Germ cell Mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

11.2.7 Carcinogenicity	Chronic drinking water administration to rat and mouse / affected organ(s): Gastro-intestinal tract / signs: Increased incidence of tumors was reported. Classified by the International Agency for Research on Cancer as: Group 3: Unclassifiable as to carcinogenicity in humans.
11.2.8 OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)	Not listed.
11.2.9vReproductive toxicity	This product is not expected to cause reproductive or developmental effects.
11.2.10 Specific Target Organ Toxicity – Single / Repeated Exposure	Not classified.
11.2.11 Aspiration Hazard	Not an aspiration hazard.
11.2.12 Chronic Effects	Prolonged inhalation may be harmful.

12. ECOLOGICAL INFORMATION

12.1 Ecotoxicity Effects

Active Ingredient	Duration	Species	Value	Units
Hydrogen peroxide	96 h LC50	Fish Pimephales promelas	16.4	mg/L
Hydrogen peroxide	72 h LC50	Fish Leuciscus idus	35	mg/L
Hydrogen peroxide	48 h EC50	Daphnia pulex	2.4	mg/L
Hydrogen peroxide	24 h EC50	Daphnia magna	7.7	mg/L
Hydrogen peroxide	72 h EC50	Algae Skeletonema costatum	1.38	mg/L
Hydrogen peroxide	21 d NOEC	Daphnia magna	0.63	mg/L

12.2 Persistence and Degradability

Hydrogen peroxide in the aquatic environment is subject to various reduction or oxidation processes and decomposes into water and oxygen. Hydrogen peroxide half-life in freshwater ranged from 8 hours to 20 days, in air from 10 - 20 hours, and in soils from minutes to hours depending upon microbiological activity and metal contamination. Readily biodegradable. (0.02 d) biodegradation 99%.

12.3 Bioaccumulation

Material may have some potential to bioaccumulate but will likely degrade in most environments before accumulation can occur.

12.4 Mobility

Will likely be mobile in the environment due to its water solubility but will likely degrade over time.

12.5 Other Adverse Effects

Decomposes into oxygen and water. No adverse effects.

13. DISPOSAL CONSIDERATIONS

13.1 Disposal Instructions	Dilution with water is the preferred method of disposal. Dispose

of in accordance with federal, state and local regulations. Consult a regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinent environmental permits.

13.2 Local Disposal Regulations Dispose in accordance with all applicable regulations.

13.3 Hazardous Waste Code The waste code should be assigned in discussion between the user, the producer, and the waste disposal company.

13.4 Waste from Residues/Unused Products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner.

13.5 Contaminated Packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. TRANSPORTATION INFORMATION

14.1 DOT

UN/ID no: 2014
Proper Shipping Name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION
Hazard class: 5.1
Subsidiary class: 8
Packing Group: II
Marine pollutant: No
ERG Number: 140

14.2 TDG

UN/ID no: UN 2014
Proper Shipping Name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION
Hazard class: 5.1
Subsidiary class: 8
Packing Group: II

14.3 ICAO/IATA Air regulation permit shipment of Hydrogen Peroxide (<=40%) in non-vented containers for Air Cargo Only aircraft, as well as for Passenger and Cargo aircraft. IATA air regulations state that venting of packages containing oxidizing substances is not permitted for air transport.

14.4 IMDG/IMO

UN/ID no: UN 2014
Proper Shipping Name: HYDROGEN PEROXIDE, AQUEOUS SOLUTION
Hazard class: 5.1
Subsidiary Hazard Class: 8
Packing Group: II
Marine pollutant: No

14.5 OTHER INFORMATION Protect from physical damage. Keep drums in upright position. Drums should not be stacked in transit. Do not store drums on wooden pallets.

15. REGULATORY INFORMATION

15.1 U.S. Federal Regulations

SARA Title III – Section 302 Extremely Hazardous Chemicals:
Chemical Name : HYDROGEN PEROXIDE
CAS-No.: 7722-84-1
SARA Reportable Quantities: 1000 lbs
SARA Threshold Planning Quantity: 1000 lbs

15.2 SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

15.3 SARA 311/312 Hazard Categories

Acute health hazard	Yes
Chronic health hazard	No
Fire hazard	Yes
Sudden release of pressure hazard	No
Reactive Hazard	Yes

15.4 Clean Water Act

This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

15.5 CERCLA

Chemical Name	Hazardous Substances RQs	Extremely Hazardous Substances RQs	SARA RQ
Hydrogen peroxide 7722-84-1		1,000 lbs.	

Hydrogen Peroxide RQ is for concentrations of > 52% only

15.6 Other Federal Regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List
Not regulated.
Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)
Not regulated.
Safe Drinking Water Act (SDWA)
Not regulated.
Food and Drug Administration (FDA)
Total food additive
Direct food additive
GRAS food additive

15.7 US State Regulations

15.7.1 US. California Controlled Substances. CA Department of Justice (California Health and Safety Code Section 11100)
Not listed.

15.7.2 US. Massachusetts RTK - Substance List
Hydrogen peroxide (CAS 7722-84-1)

15.7.3 US. New Jersey Worker and Community Right-to-Know Act
Hydrogen peroxide (CAS 7722-84-1)

15.7.4 US. Pennsylvania Worker and Community Right-to-Know Law
Hydrogen peroxide (CAS 7722-84-1)

15.7.5 US. Rhode Island RTK
Hydrogen peroxide (CAS 7722-84-1)

15.7.6 California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

15.8 International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia Australian	Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe European	Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. OTHER INFORMATION

NFPA	Health Hazards 3	Flammability 0	Stability 1	Special Hazards OX
HMIS	Health Hazards 3	Flammability 0	Physical hazard 1	Special precautions H

16.1 NFPA/HMIS Ratings Legend
Severe = 4; Serious = 3; Moderate = 2; Slight = 1; Minimal = 0
Special Hazards: OX = Oxidizer
Protection = H (Safety goggles, gloves, apron, the use of supplied air or SCBA respirator is required in lieu of a vapor cartridge respirator)

16.2 Uniform Fire Code Oxidizer Class 2—Liquid

16.3 H-Statements referred in Section 2 and 3

H272: May intensify fire; oxidizer.
H302: Harmful if swallowed.
H318: Causes serious eye damage.
H335: May cause respiratory irritation.
H412: Harmful to aquatic life with long lasting effects.

Disclaimer: The information contained in this Safety Data Sheet (SDS), as of the issue date, is believed to be true and correct. However, the accuracy or completeness of this information and any recommendations or suggestions are made without warranty, express or implied, or guarantee. Tersus Environmental, LLC urges each customer or recipient of this SDS to study it carefully and consult appropriate expertise, as necessary or appropriate, to become aware of and understand the data contained in this SDS and any hazards associated with the product. Regulatory requirements are subject to change and may differ between various locations. It is the buyer's/user's responsibility to ensure that his activities comply with all federal, state, provincial or local laws. Since we cannot control the application, use or processing of the product, we do not accept responsibility. Therefore, it is the buyer's/user's duty to determine the conditions necessary for the safe use of this product and ensure that the intended use of the product will not infringe any party's intellectual property right. The information presented here pertains only to the product as shipped.

All recommendations for the use of our products, whether given by us, orally or to be implied from data or lab tests results by us, are based on the current state of our knowledge at the time those recommendations are made. When additional information is obtained, these recommendations may be updated. They may also be influenced by circumstances outside our control. Notwithstanding such recommendation the user is responsible for ensuring that the product supplied by us is suitable for the process or purpose he/she intends to use it.

Due to the proliferation of sources for information such as manufacturer specific SDSs, we are not and cannot be responsible for SDSs obtained from any source other than ourselves. If you have obtained an SDS from another source or if you are not sure that the SDS you have is current, please contact us for the most current version.

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End of Safety Data Sheet

SAFETY DATA SHEET
TersOx™ Nutrients-QR

Revision date: 2019-06-14
Version 1.0

1. PRODUCT AND COMPANY IDENTIFICATION

Product Identifier

Product Name: TersOx™ Nutrients-QR

Synonyms: Water soluble nitrogen and phosphorus nutrient salt supplement for microbial process

Product Form: Mixture

Recommended use of the chemical and restrictions on use

Recommended Use: For use in stimulating biological activity in soils and sludges
Remediation of contaminated groundwater and soils

Restrictions on Use: Use as recommended by the label

Details of the supplier and of the safety data sheet

Supplier
Tersus Environmental, LLC
1116 Colonial Club Rd
Wake Forest, NC 27587
Phone: +1-919-453-5577
Email: info@tersusenv.com

Contact Person
David F. Alden
Phone: +1-919-453-5577 x2002
Email: david.alden@tersusenv.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:

+1-919-453-5577 (Tersus Office Hours, 8:00 AM to 5:00 PM Eastern)
+1-800-424-9300 (Chemtrec 24 Hour Service – Emergency Only)
+1-703-527-3887 (Chemtrec Outside United States 24 Hour Service – Emergency Only)
+1-919-638-7892 Gary M. Birk (Outside office hours)

2. HAZARD IDENTIFICATION

Relevant identified uses of the substance or mixture

Hazard Classification	Category	H-statement
Skin irritant	2	H315
Eye irritant	2A	H319
Acute toxicity – Inhalation	4	H332
Specific Target Organ Toxicity – Repeated	2	H371
Mutagenicity	2	H341

Label elements

Hazard Pictograms

Hazard Statements

Causes skin irritation (H315)
Causes serious eye irritation (H319)
Harmful if inhaled (H332)
May cause damage to lungs through prolonged or repeated exposure to inhalation of Urea: Known to cause emphysema (H371)
Urea – suspected of causing genetic defects (H341)

Precautionary statements

P201 – Obtain special instructions before use.
P202 – Do not handle until all safety precautions have been read and understood.
P260 – Do not breathe dust.
P264 – Wash thoroughly after handling.
P270 – Do not eat, drink or smoke when using this product.
P271 – Use only outdoors or in a well-ventilated area.
P280 – Wear protective gloves, clothing, eye, and face protection.
P302 + P352 – IF ON SKIN: Wash with soap and plenty of water.
P304 + P340 – IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305 + P351 + P338 – IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P311 + P313 – IF exposed or concerned: Call a POISON CENTER or doctor and get medical advice/attention.
P312 – Call a POISON CENTER or doctor if you feel unwell.
P332 + P313 – If skin irritation occurs: Get medical advice/attention.
P337 + P313 – If eye irritation persists: Get medical advice/attention.
P362 + P364 – Take off contaminated clothing and wash it before reuse.
P405 – Store locked up.
P501 – Dispose of contents/container in accordance with local, regional, and federal regulations.

Further information

Persons who have a compromised immune system or a history of severe allergic response should avoid contact and/or breathing dust or mist from product handling or manufacturing processes.

Other hazards

None known.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Formula Mixture

Hazardous components

Chemical Name	Concentration (%)	CAS Number
Urea	<75	57-13-6
Diammonium Phosphate	<25	7783-28-0
Tricalcium Phosphate	<1	1306-06-5

Synonyms are provided in Section 1.
Occupational exposure limits, if available, are listed in Section 8.

4. FIRST AID MEASURES

General Information	Check the vital functions. If unconscious place in recovery position and seek medical advice. In case of respiratory arrest, administer artificial respiration. Cardiac arrest: perform resuscitation. Victim conscious with labored breathing: half-seated. Victim in shock: on his back with legs slightly raised. Vomiting: prevent asphyxia/aspiration pneumonia. Prevent cooling by covering the victim (no warming up). Keep watching the victim. Give psychological aid. Keep the victim calm, avoid physical strain. Take victim to a doctor if irritation persists. Remove affected person from source of contamination.
Eye Contact	Product is a severe eye irritant. Direct contact with eyes must be avoided. In case of contact with eyes, flush eyes with low pressure water for at least 15 minutes. If irritation persists, seek medical attention.
Skin Contact	Product may cause slight irritation. Prolonged or repeated direct contact with skin may cause reddening, itching and inflammation. In case of contact with skin, wash skin with soap and water. Remove contaminated clothing and wash. If irritation persists, consult a physician.
Inhalation	May cause sensitization by inhalation in hypersensitive individuals, irritation of respiratory tract, or physical interference with breathing. Avoid inappropriate handling which may result in dust generation. If inhaled, remove from contaminated area to fresh air. Initiate CPR if victim has stopped breathing. Administer oxygen if victim has difficulty breathing. Report situation. Seek medical attention if allergic response or difficulty breathing is exhibited. No incidences of health effects from dust inhalation have been reported.
Ingestion	Ingestion of material may cause gastric disturbance including irritation, nausea, vomiting, and diarrhea. If swallowed, rinse mouth and throat with tap water. Consult a physician if symptoms exist.
Most important symptoms and effects, both acute and delayed	Most important symptoms/effects, acute and delayed: A single dose of 100 g has been reported to cause mild central nervous system depression, e.g. drowsiness and slow reflexes. Sensitization (shortness of breath, wheezing, and labored coughing) take individual to emergency room.
Indication of any immediate medical attention and special treatment needed	If exposed or concerned, get medical advice and attention.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media	Dry chemical, carbon dioxide, chemical foam or water (all common agents as appropriate to surrounding fire – this material burns with difficulty).

Specific Hazards Arising from the chemical or mixture	Avoid mixtures with strong acids (nitric or perchloric) which may create explosive mixture.
Special Fire Fighting Procedures	Irritating toxic substances may be emitted on thermal decomposition. Exposed firefighters should wear self-contained breathing apparatus and protective clothing. Cool containers exposed to flames with water until well after the fire is out. Use water spray to reduce vapors. If risk of water pollution occurs, notify appropriate authorities. Avoid water in straight hose stream; will scatter and spread fire. Keep upwind. Do not inhale explosion and combustion gases. Collect contaminated fire extinguishing water separately. This must not be discharged into drains. Cool containers exposed to flames with water until well after the fire is out. Use water spray to reduce vapors. If risk of water pollution occurs, notify appropriate authorities. Avoid water in straight hose stream; will scatter and spread fire. Wear positive-pressure, self-contained breathing apparatus (SCBA) and chemical protective clothing.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions	Provide enough ventilation. Advice for emergency responders: protective equipment see Section 8. Wear protective clothing as described in Section 8 of this safety data sheet. Do not smoke or use open fire or other sources of ignition. Contact with walking surface may result in formation of slippery film/falling hazard.
First Aid:	In case of contact with skin, wash with soap and water. If symptoms occur, seek medical attention. In case of contact with eyes, rinse with plenty of water for at least 15 minutes and see an eye specialist if irritation persists. In case of inhalation, remove to fresh air. In case of ingestion, drink water. If symptoms occur, seek medical assistance.
Environmental Precautions	Do not discharge into drains, sewers or watercourses or onto the ground. Inform the relevant authorities if this occurs. Spilled product should be removed immediately to avoid formation of dust. Contain spill, sweep up avoiding airborne dust. Provide enough ventilation. Recover product for reuse if possible. Avoid contamination of waterways and (if large quantity) vegetation.
Methods for Containment and Clean Up	Spilled product should be removed immediately to avoid formation of dust. Contain spill, sweep up avoiding airborne dust. Provide enough ventilation. Recover product for reuse if possible. Avoid contamination of waterways and (if large quantity) vegetation. Absorb in non-combustible material, vermiculite, dry sand or earth and place into containers.

7. HANDLING AND STORAGE

Precautions for safe handling	Avoid creating dust. Adequately ventilate when handling this product. Provide eyewash capability. Contain with applicable regulations. Avoid contact with eyes. Avoid inhalation of vapors and spray/mist. Remove contaminated clothing immediately. Clean contaminated objects and areas thoroughly observing environmental regulations. Keep away from sources of ignition – No smoking. Handle in accordance with good industrial hygiene and safety procedures. Discharge into the environment must be avoided. Keep container

	tightly closed. Either local exhaust or general room ventilation is usually required.
Hygiene measures	Handle in accordance with good industrial hygiene and safety procedures. Use good personal hygiene practices.
Conditions for safe storage, including any incompatibilities	Avoid mixtures with strong acids (nitric or perchloric) which may create explosive mixture.

8. EXPOSRE CONTROL / PERSONAL PROTECTION

Control parameters

Exposure guidelines, ingredients with workplace control parameters.

Name	CAS-No	TLV (ACGIH)	PEL (OSHA)
Urea	57-13-6	10mg/m3 {3}*	15mg/m3 {5}*
Diammonium phosphate	7783-28-0	10mg/m3 {3}*	15mg/m3 {5}*
Tricalcium phosphate	1306-06-5	10mg/m3 {3}*	15mg/m3 {5}*

* Specific limits not set for these chemicals. Limits are shown for Particles Not Otherwise Regulated (PNOR) or Particles Not Otherwise Classified (PNOC). First number is for total dust second number { } is for respirable dust.

Exposure Control

Protective equipment

Appropriate engineering controls	Provide adequate general and local exhaust ventilation. Observe any occupational exposure limits for the product or ingredients. Do not allow uncontrolled discharge of product into the environment.
Eye/face protection	The following protection should be worn: Safety glasses with shields, chemical splash goggles or face shield.
Respiratory protection	Dust mask or respirator for particle removal (NIOSH)
Hand protection	Neoprene. Vinyl, Rubber (natural, latex), Butyl rubber. Wear protective gloves made of the following material: Chemical-resistant, impervious gloves complying with an approved standard should be worn if a risk assessment indicates skin contact is possible. Polyvinyl chloride (PVC). Manufactured/tested in accordance with EN 374, Avoid the following conditions: Polyvinyl alcohol (PVA).
Other skin and body protection	Wear appropriate clothing to prevent any possibility of skin contact.
Hygiene measures	Wash promptly if skin becomes contaminated. Wash hands at the end of each work shift and before eating, smoking and using the toilet. When using do not eat, drink or smoke.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	White granular solid
Odor	Mild ammonia odor
Odor threshold	Information Not Available
pH	7 – 10 (10% sol)
Melting point /Freezing Point	130 °C
Initial Boiling point and boiling point range	Does Not Apply
Flash Point	Does Not Apply
Evaporation rate	Does Not Apply
Flammability (solid; gas)	Information Not Available
Upper/lower flammability or explosive limits	Does Not Apply
Vapor pressure	Low
Vapor density	Does Not Apply
Relative density	Information Not Available
Solubility (ies)	100g / 100mL in water
Partition coefficient: n-octanol/water	Does Not Apply
Initial Boiling point and boiling point range	Does Not Apply
Auto-ignition temperature	Information Not Available
Decomposition temperature	Information Not Available
Viscosity	Does Not Apply
Other Physical/Chemical Properties	Specific Gravity at 25°C – 1.3

10. STABILITY AND REACTIVITY

Reactivity	Stable under normal conditions and use.
Chemical stability	Information not available
Possibility of hazardous reactions	Information not available
Conditions to avoid	Avoid mixtures with strong acids (nitric or perchloric) which may create explosive mixture, extreme heat.
Incompatible materials	Strong alkalis, active metals (aluminum, magnesium), ammonia, inorganic materials. Strong oxidizers, chlorine compounds.
Hazardous decomposition products	Information not available
Hazardous Polymerization	Information not available

11. TOXICOLOGICAL INFORMATION

Acute Toxicity

Acute toxicity	(low) LD50 > 1000 mg/kg body weight
Skin Corrosion/Irritation	Dust may cause slight skin irritation, prolonged or repeated direct skin contact may cause reddening, itching and inflammation.
Serious Eye Damage/Irritation	Dust may cause severe irritation.
Respiratory or Skin Sensitization	Dust may cause irritation or allergy in susceptible individuals.

	May cause respiratory allergy in susceptible individuals: sensitization (shortness of breath, wheezing, and labored coughing) take individual to emergency room.
Ingestion	May cause severe gastric disturbances, sore throat.
Germ Cell Mutagenicity	Information Not Available
Carcinogenicity	Information Not Available
Reproductive Toxicity	Information Not Available
Specific Target Organ Toxicity – Single Exposure	Information Not Available
Specific Organ Toxicity – Repeated Exposure	Information Not Available
Aspiration Hazard	Information Not Available
General Remarks	Information Not Available

12. ECOLOGICAL INFORMATION

Chemical Fate Information
Product is readily biodegradable in wastewater treatment systems.

Biodegradability
Readily degradable.

Excess product in waterways may encourage eutrophication.

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	Dispose according to federal, state and local laws. Dispose of waste to licensed waste disposal site in accordance with the requirements of the local Waste Authority. Waste is suitable for incineration.

14. TRANSPORTATION INFORMATION

UN Number	Mixture not classified as Hazardous according to Regulation (EC) 1272/2008.
UN Proper Shipping Name	n/a
Transport Hazard Class	n/a
Packing Group (if applicable)	n/a
Environmental Hazards	n/a
Special Precautions for User	n/a
Transport in Bulk According to Annex II of MARPOL 73/78 and the IBC Code	n/a
DOT Proper Shipping Name	Chemicals not otherwise indexed (NOI) non-hazardous.

15. REGULATORY INFORMATION

All ingredients used are listed on the USEPA TSCA Inventory list.

Ingredients are not listed in: Reportable Quantity (49CFR 172.101), SARA Title III Section 302/313 (Extremely Hazardous Substance List/ Toxic Chemicals), RCRA Hazardous Waste, California Proposition 65, State Right to Know Laws (Connecticut, Florida, Illinois, Louisiana, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island)

16. OTHER INFORMATION

Mixture classified as not dangerous according to Regulation (EC) 1272/2008.

Observe employment restrictions for people.
Product is not listed with IARC, NTP, ACGIH or OSHA as a carcinogen.

Components not precisely identified are proprietary or non-hazardous. All chemical ingredients appear on the EPA TSCA inventory.

The information contained in this Safety Data Sheet, as of the issue date, is believed to be true and correct. However, the accuracy or completeness of this information and any recommendations or suggestions are made without warranty or guarantee. Since the conditions of use are beyond the control of our company, it is the responsibility of the user to determine the conditions of safe use of this product. The information in this sheet does not represent analytical specifications; for this information contact Tersus Environmental.

Disclaimer: This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. All recommendations for the use of our products, weather given by us, orally or to be implied from data or lab tests results by us, are based on the current state of our knowledge at the time those recommendations are made. When additional information is obtained, these recommendations may be updated. They may also be influenced by circumstances outside our control. Notwithstanding, such recommendation the user is responsible that the product as supplied by us is suitable to the process or purpose he intends to use it. The user of the product is solely responsible for compliance with all laws and regulations applying to the use of this product. Since we cannot control the application, use or processing of the product, we do not accept responsibility. Therefore, the user should assure that the intended use of the product will not infringe in any party's intellectual property right.

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End of Safety Data Sheet

SAFETY DATA SHEET
TersOx™ Modulator

Revision date: 2019-06-10
Version 1.0

1. PRODUCT AND COMPANY IDENTIFICATION

Product Identifier

Product Name: TersOx™ Modulator

Synonyms: None

Product Form: Mixture (Proprietary Blend)

Recommended use of the chemical and restrictions on use

Recommended Use:	For use in stimulating biological activity in soils and sludges Remediation of contaminated groundwater and soils
Restrictions on Use:	Use as recommended by the label

Details of the supplier and of the safety data sheet

Supplier
Tersus Environmental, LLC
1116 Colonial Club Rd
Wake Forest, NC 27587
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Email: info@tersusenv.com

Contact Person
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Email: david.alden@tersusenv.com

Emergency telephone number

For leak, fire, spill or accident emergencies, call:

+1-919-453-5577 (Tersus Office Hours, 8:00 AM to 5:00 PM Eastern)
+1-800-424-9300 (Chemtrec 24 Hour Service – Emergency Only)
+1-703-527-3887 (Chemtrec Outside United States 24 Hour Service – Emergency Only)
+1-919-638-7892 Gary M. Birk (Outside office hours)

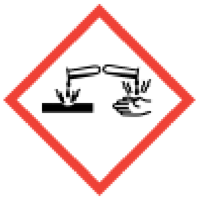
2. HAZARD IDENTIFICATION

Classification of the substance or mixture

White or transparent crystalline powder. Noncombustible. At very high temperatures, Sulfur dioxide, sulfur trioxide and ammonia may be generated. No known chronic hazards. None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA, or ACGIH as a carcinogen.

Label elements

Hazard Pictograms



Signal word Danger

Hazard Statement(s):

H290 May be corrosive to metals.
H314 Causes severe skin burns and eye damage.
H335 May cause respiratory irritation.

Eye contact may cause eye corrosion with corneal or conjunctival ulceration. Skin contact may cause skin irritation with discomfort or rash. Higher or prolonged skin irritation may cause burns or ulceration. Inhalation may cause irritation of the respiratory passages with cough, difficulty in breathing and bronchial irritation. Ingestion may cause irritation of the gastrointestinal tract with abdominal pain, nausea, vomiting, diarrhea, and abnormal kidney function. Ingestion may also cause corrosion of mucous membranes with stomach discomfort, nausea, and prostration. Individuals with preexisting diseases of the skin, kidneys, or reproductive system may have increased susceptibility to the toxicity of excessive exposure.

Precautionary statements - Prevention

P234 Keep only in original container.
P260 Do not breathe mist / vapors / spray.
P264 Wash hands thoroughly after handling.
P271 Use only outdoors or in a well-ventilated area.
P280 Wear protective gloves / protective clothing / eye protection / face protection.

Acute Toxicity Inhalation 4-hour LC50: 7.7 mg/L in rats
Oral LD50: 4,240 mg/kg in rats

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information

The mixture is a skin and eye corrosive but is not a skin sensitizer in animals. Toxic effects described in animals from a single exposure by inhalation include body weight losses, ocular and nasal discharges and other nonspecific effects. Repeated inhalation exposures produced liver, spleen, and thymus changes and gastrointestinal tract alterations. By ingestion, the administration of single high oral doses produced severe gastrointestinal tract irritation, liver damage, increased kidney weights, and the formation of dosing in cats produced weight and appetite loss, depression, vomiting, coma, convulsions, kidney failure due to calcium oxalate deposition, and death. Dogs given similar and higher doses exhibited no toxic effects. Long-term dosing in male and female rats exhibited no toxic effects.

At a high dietary level, a reduced number of off-spring were observed in rats, but this effect occurred only at a maternally toxic dose. In a developmental toxicity study, fetal abnormalities were indicated in rats orally dosed during gestation with Synergist at levels that also produced maternal toxicity. The mixture does not produce genetic damage in bacteria cell cultures.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical Formula Mixture

Hazardous components

Chemical Name	Concentration (%)	CAS Number
Acid	25 -75	Proprietary
Salt	25 -75	Proprietary

Occupational exposure limits, if available, are listed in Section 8.

4. FIRST AID MEASURES

General Information In all cases of doubt, or when symptoms persist, seek medical attention.

Never give anything by mouth to an unconscious person.

Eye Contact Product is a severe eye irritant. Direct contact with eyes must be avoided. In case of contact with eyes, flush eyes with low pressure water for at least 15 minutes. If irritation persists, seek medical attention.

Skin Contact Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse.

Inhalation Remove to fresh air, keep patient warm and at rest. If breathing is irregular or stopped, give artificial respiration. If unconscious place in the recovery position and obtain immediate medical attention. Give nothing by mouth.

Ingestion If large quantities of this material are swallowed obtain immediate medical attention. Keep at rest. Do NOT induce vomiting.

Most important symptoms and effects, both acute and delayed No information available.

Indication of any immediate medical attention and special treatment needed Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable Extinguishing Media This material is compatible with all extinguishing media.

Unsuitable extinguishing media None

Specific Hazards Arising from the chemical or mixture See Section 2 for information on hazards when this material is present in the area of a fire.

Special Fire Fighting Procedures	Evacuate all non-essential personnel. Wear protective clothing and self-contained breathing apparatus. Remain upwind of fire to avoid hazardous vapors and decomposition products. Use water spray to cool fire-exposed containers.

6. ACCIDENTAL RELEASE MEASURES

Personal Precautions	Put on appropriate personal protective equipment (see Section 8).
Environmental Precautions	Sinks and mixes with water. No adverse effects known.
Methods for Containment and Clean Up	For large spill cleanup: Keep unnecessary people away; isolate hazard area and deny entry. Do not touch walk through spilled material. Neutralize spills with lime or soda ash. Flush spill area with plenty of water. Observe environmental regulations.

7. HANDLING AND STORAGE

Precautions for safe handling	Avoid breathing dust. Promptly clean up spills.
Hygiene measures	Handle in accordance with good industrial hygiene and safety procedures. Use good personal hygiene practices.
Conditions for safe storage, including any incompatibilities	Keep containers closed and protected from extremes of temperature and humidity during storage. Recommended storage conditions 68-110°F and 55-87% relative humidity. **Chemical Stability:** Stable **Decomposition:** Will not occur **Polymerization:** Will not occur **Incompatible materials:** Hazardous reaction in aqueous solution may occur with chlorine, hypochlorous acid, hypochlorites, cyanides, nitric acid, or sulfides.

8. EXPOSRE CONTROL / PERSONAL PROTECTION

Control parameters
Exposure guidelines, ingredients with workplace control parameters.

Exposure Guidelines (Exposure Limits)
TersOx Modulator PEL (OSHA) None established TLV (ACGIH) None Established

Potential Health Effects
This compound may cause burns and ulceration of the eyes and is a severe skin irritant. Prolonged exposure may cause skin burns and ulceration. Inhalation may cause nose, throat, and lung irritation. Ingestion may cause burns and/or perforation of the gastrointestinal tract.
Gross overexposure may result in death.

Human Health Effects
Eye contact may cause eye corrosion with corneal or conjunctival ulceration. Skin contact may cause skin irritation with discomfort or rash. Higher or prolonged skin irritation may cause burns or ulceration. Inhalation may cause irritation of the respiratory passages with cough, difficulty in breathing and bronchial irritation. Ingestion may cause irritation of the gastrointestinal tract with abdominal pain, nausea, vomiting, diarrhea, and abnormal kidney function. Ingestion may also cause corrosion of mucous membranes with

stomach discomfort, nausea, and prostration. Individuals with preexisting diseases of the skin, kidneys, or reproductive system may have increased susceptibility to the toxicity of excessive exposure.

Carcinogenicity Information
None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA, or ACGIH as a carcinogen.

Exposure Control
Protective equipment

Appropriate engineering controls	Provide adequate general and local exhaust ventilation. Observe any occupational exposure limits for the product or ingredients. Do not allow uncontrolled discharge of product into the environment.
Eye/face protection	The following protection should be worn: Safety glasses with shields, chemical splash goggles or face shield.
Respiratory protection	Provide workers with NIOSH approved respirators in accordance with requirements of 29 CFR 1910. 134 for level of exposure incurred.
Hand protection	Neoprene. Vinyl, Rubber (natural, latex), Butyl rubber. Wear protective gloves made of the following material: Chemical-resistant, impervious gloves complying with an approved standard should be worn if a risk assessment indicates skin contact is possible. Polyvinyl chloride (PVC). Manufactured/tested in accordance with EN 374, Avoid the following conditions: Polyvinyl alcohol (PVA).
Other skin and body protection	Wear appropriate clothing to prevent any possibility of skin contact.
Hygiene measures	Wash promptly if skin becomes contaminated. Wash hands at the end of each work shift and before eating, smoking and using the toilet. When using do not eat, drink or smoke.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	White-yellow Solid, granular to fine powder
Odor	Slight
Odor threshold	Not determined
pH	1.18 @ 25°C (77°F)
Melting point / freezing point	Not Measured
Initial boiling point and boiling range	209°C
Flash Point	Not Measured
Evaporation rate (Ether = 1)	Not Measured
Flammability (solid, gas)	Not Applicable
Upper/lower flammability or explosive limits	**Lower Explosive Limit:** Not Measured **Upper Explosive Limit:** Not Measured

Vapor pressure (Pa)	Not Measured
Vapor Density	Not Measured
Specific Gravity	2.126 g/cm^3
Solubility in Water	Miscible
Partition coefficient n-octanol/water (Log K_{OW})	Not Measured
Auto-ignition temperature	Not Measured
Decomposition temperature	Not Measured
Viscosity (cSt)	Not Measured
Bulk Density	Not Measured

10. STABILITY AND REACTIVITY

Reactivity	Information not available
Chemical stability	Stable under normal circumstances.
Possibility of hazardous reactions	Information not available
Conditions to avoid	Extreme temperature and direct sunlight.
Incompatible materials	Hazardous reaction in aqueous solution may occur with chlorine, hypochlorous acid, hypochlorites, cyanides, nitric acid, or sulfides.
Hazardous decomposition products	At very high temperatures, magnesium oxide, sulfur dioxide and sulfur trioxide may be generated.
Hazardous Polymerization	Information not available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Ingredient	Oral LD50, mg/kg	Skin LD50, mg/kg	Inhalation Vapor LC50, mg/L/4hr	Inhalation Dust/Mist LC50, mg/L/4hr	Inhalation Gas LC50, ppm
TersOx™ Modulator	4,240	No data available	7.7 mg/l	No data available	No data available

Note: When no route specific LD50 data is available for an acute toxin, the converted acute toxicity point estimate was used in the calculation of the product's ATE (Acute Toxicity Estimate).

Classification	Category	Hazard Description
Acute toxicity (oral)	---	Not Applicable
Acute toxicity (dermal)	---	Not Applicable
Acute toxicity (inhalation)	---	Not Applicable
Skin corrosion/irritation	---	Not Applicable
Serious eye damage/irritation	---	Not Applicable
Respiratory sensitization	---	Not Applicable
Skin sensitization	---	Not Applicable
Germ cell mutagenicity	---	Not Applicable
Carcinogenicity	---	Not Applicable

Reproductive toxicity	---	Not Applicable
STOT-single exposure	---	Not Applicable
STOT-repeated exposure	---	Not Applicable
Aspiration hazard	---	Not Applicable

12. ECOLOGICAL INFORMATION

Toxicity

No additional information provided for this product. See Section 3 for chemical specific data.

Aquatic Ecotoxicity
Aquatic Toxicity - Slight
24-48-hour LC50, bluegill sunfish: 93mg/L
96-hour LC50, fathead minnows: 164 mg/L
These data indicate that TersOx™ Modulator has slight aquatic toxicity.

Persistence and degradability
Readily biodegradable. After 7 days, 89.6% is biodegraded (closed bottle test).

Bioaccumulative potential
Material does not bioaccumulate.

Mobility in soil
No available information

Results of PBT and vPvB assessment
No available information

Other adverse effects
No data available.

13. DISPOSAL CONSIDERATIONS

Waste Disposal Methods	This material, as supplied, is a hazardous waste according to federal regulations (40 CFR 261). Dispose of in accordance with local regulations.
US EPA Waste Number	The waste code should be assigned in discussion between the user and the waste disposal company.
Contaminated Packaging	Empty remaining contents. Empty containers should be taken to an approved waste handling site for recycling or disposal. Do not reuse container

14. TRANSPORTATION INFORMATION

Transport information
NFPA, NPCA-HMIS: NPCA - Rating: Health 1; Flammability 0; Reactivity 1; Personal Protection F

DOT

Hazardous materials descriptions and proper shipping names: Corrosive solid, acidic, inorganic, n.o.s.

UN/NA ID: UN3260

PG: III

Symbol: G

Class: 8

15. REGULATORY INFORMATION

International Inventories

TSCA	
DSL/NDSL	
EINECS/ELINCS	
ENCS	
IENSC	
KECL	Does not comply
PICCS	
AICS	

Legend:

TSCA	United States Toxic Substance Control Act Section 8(b) Inventory
DSL/NDSL	Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS	European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS	Japan Existing and New Chemical substances
IECSC	China Inventory of existing Chemical Substances
KECL	Korean Existing and Evaluated Chemical Substances
PICCS	Philippines Inventory of Chemicals and chemical Substances
AICS	Australian Inventory of chemical Substances

US Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

SARA 311-312 Hazard Categories

Acute health hazard	No
Chronic health Hazard	No
Fire Hazard	No
Sudden release of pressure hazard	No
Reactive Hazard	No

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response compensation and Liability Act (CERCLA) (40 CFR 302) of the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals.

US State Right-to-know regulations
None

16. OTHER INFORMATION

NFPA (National Fire Protection Association) - Classification

Health	1
Flammability	0
Instability or Reactivity	0
Physical and Chemical Properties	-

HMIS (Hazardous Materials Identification System (Paint & Coating)) - Classification

Health	1 slight
Flammability	0 minimal
Physical Hazards	0 minimal
PPE	Determined by User; dependent on local conditions

Key or legend to abbreviations and acronyms used in the safety data sheet

PEL	Permissible exposure limit
TWA	8-hour, time-weighted average
ACGIH	American Conference of Governmental Industrial Hygienists
OSHA	Occupational Safety and Health Administration
NTP	National Toxicology Program
IARC	International Agency for Research on Cancer
NIOSH	National Institute for Occupational Safety and Health

Disclaimer: This information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. All recommendations for the use of our products, weather given by us, orally or to be implied from data or lab tests results by us, are based on the current state of our knowledge at the time those recommendations are made. When additional information is obtained, these recommendations may be updated. They may also be influenced by circumstances outside our control. Notwithstanding, such recommendation the user is responsible that the product as supplied by us is suitable to the process or purpose he intends to use it. The user of the product is solely responsible for compliance with all laws and regulations applying to the use of this product. Since we cannot control the application, use or processing of the product, we do not accept responsibility. Therefore, the user should assure that the intended use of the product will not infringe in any party's intellectual property right.

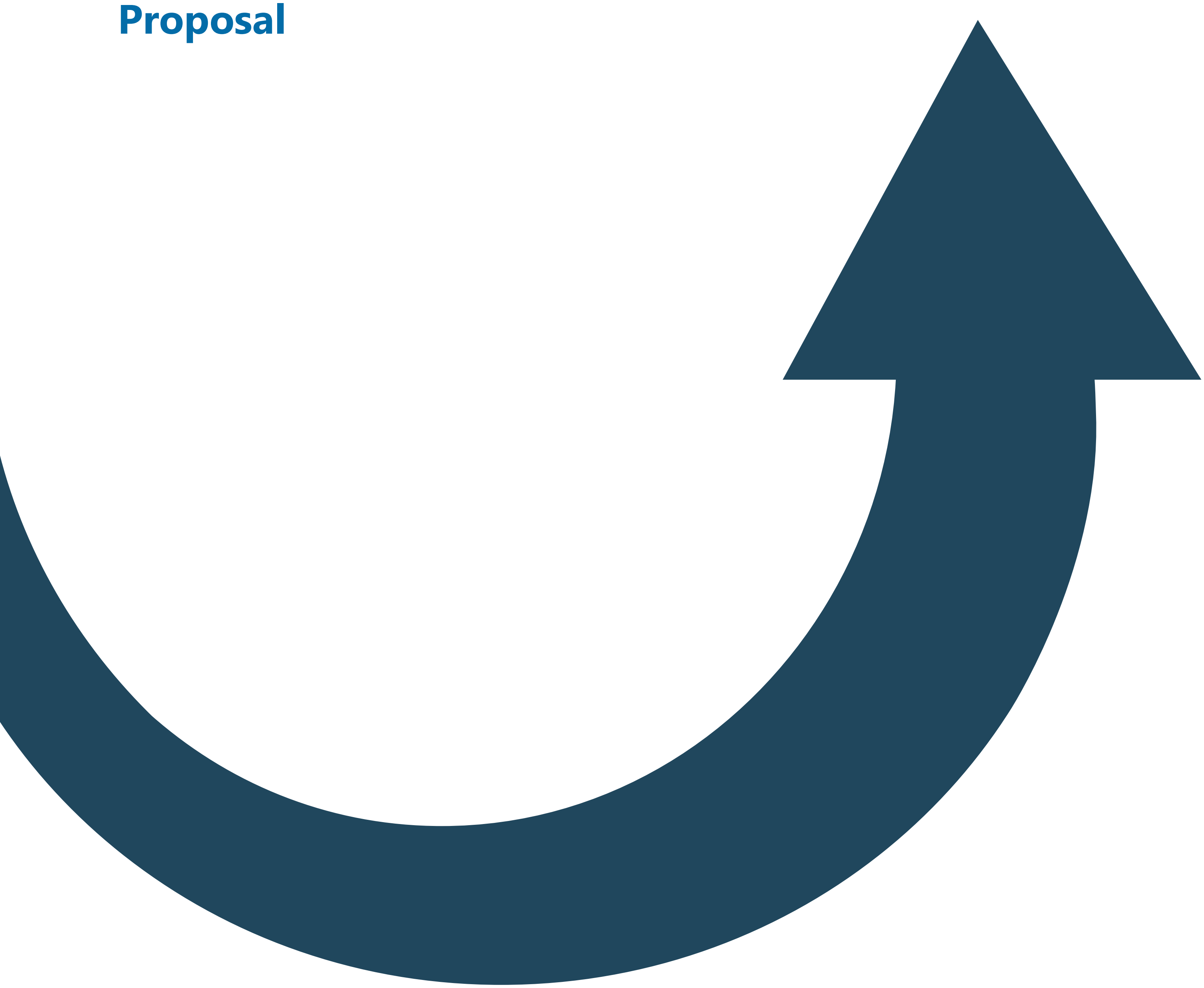
919.453.5577 • info@tersusenv.com • tersus.com

TersOx is a Trademark of Tersus Environmental, LLC

End of Safety Data Sheet

APPENDIX D

Tersus Environmental Vinyl Chloride Remediation Proposal



HERRERA
Science + Planning + Design

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Tersus Environmental, LLC

Vinyl Chloride Remediation Proposal for:
Lakewood Towne Center Site

Prepared For:

George Iftner
Associate Scientist, LG, CPESG
Herrera Environmental Consultants
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Phone: 206.787.8210
giftner@herrerainc.com

Tersus Proposal No. Q21-3649
November 1, 2022

1116 Colonial Club Road
Wake Forest, NC 27587
Ph: 919.453.5577 • info@tersusenv.com
tersusenv.com

November 1, 2022

George Iftner
Herrera Environmental Consultants
2200 6th Avenue, Suite 1100, Seattle, WA 98121

Reference: **Vinyl Chloride Remediation Proposal**
Lakewood Towne Center Site in 5731 Main St. Southwest, Lakewood, WA
Tersus Proposal No. Q21-3649

Dear George:

We appreciate Herrera Environmental Consultants' interest in Tersus Environmental, LLC (Tersus). Please find enclosed our preliminary analysis and cost estimate for your project located at the 5731 Main St. Southwest, Lakewood, WA.

Tersus has prepared this proposal based on the information provided regarding site conditions and project approach. Tersus reserves the right to refine our proposal and estimate, as new information is made available.

Should you have any questions or need additional information regarding this quotation, please contact us at 919.453.5577. Thank you for the opportunity to present this proposal. We look forward to supporting you on this project.

Best regards,

Tersus Environmental, LLC

Table of Contents

Disclaimer and Notice of Confidentiality

This proposal by Tersus Environmental, LLC includes data that shall not be disclosed outside Herrera Environmental Consultants or its client and shall not be duplicated, used, or disclosed—in whole or in part—for any purpose other than to evaluate this proposal. If, however, a contract is awarded to this offeror as a result of—or in connection with—the submission of this data, Herrera Environmental Consultants and its client shall have the right to duplicate, use, or disclose the data to the extent provided in the resulting contract. This restriction does not limit Herrera Environmental Consultants' or its client's right to use information contained in this data if it is obtained from another source without restriction. The data subject to this restriction are identified at the bottom of each page as: "Use or disclosure of data contained on this sheet is subject to the restriction on page i of this proposal."

About Tersus Environmental

We research, develop, and commercialize innovative soil and groundwater remediation solutions through university and professional relationships to meet the advancing technological requirements at contaminated sites. Our proven technologies help our clients reduce uncertainty, minimize risks, and achieve cost-effective results.

We have a passion for supporting our clients by delivering outstanding Customer Service every day. Not focused on a single technology, Tersus Environmental offers the right solution for your site-specific needs. We look forward to helping you develop the optimally cost-effective, remediation approach.

Company Information

- Small Business
- NAICS: 562910 (750 employees)
- EIN: 27-4634147
- CAGE Code: 70SW7
- DUNS: 03-778-7719
- Current SAM Registration

Soil and Groundwater Remediation of:

- Chlorinated Solvents
- Petroleum Hydrocarbons
- Pesticides
- Metals

Vinyl Chloride Remediation Proposal for Lakewood Towne Center Site

Background

Herrera Environmental Consultants (client) requested a remediation approach to address residual vinyl chloride at a site impacted by tetrachloroethylene and daughter products at a site in 5731 Main St. Southwest, Lakewood, WA.

Tersus Scope

Tersus will aid in the accomplishment of the following goals:

- Suggest products and associated cost to address constituents of concern.
- Assist with a performance monitoring plan and associated support and provide associated costs

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Preliminary assessment

Based on contaminant concentrations, Tersus suggests the client considers an ISCO approach to address low concentrations of vinyl chloride. Should concentrations persist or rebound is observed, Tersus suggest a second biostimulation (aerobic co-metabolic) stage.

Remediation Approach

1. The two-step sequence is based on assumptions in MW-1S and MW-1M (medium).

Table 1 and Figure 1:

2. Inject a slug of Modulated TersOx Liquid and nutrients in two wells MW-1S and MW-1M (medium).
3. Table 1. Assumed Treatment Area Properties

	Design ROI	thickness	Pore Volume @ 30% porosity	Injection Volume
	ft	ft	gal	gal
MW-1S	7.5	5	2,000	1,250
MW-1M	7.5	5	2,000	1,250
Sum:		10	4,000	2,500

4. Evaluate results after 1, 3 and 6 months.
5. Should contaminants persist, evaluate alternative options such as a second injection or an alternative. Potential alterative option includes the install gas-diffusion devices to sustain aerobic conditions and a co-substrate to allow aerobic co-metabolic destruction pathways of cis-DCE and VC.

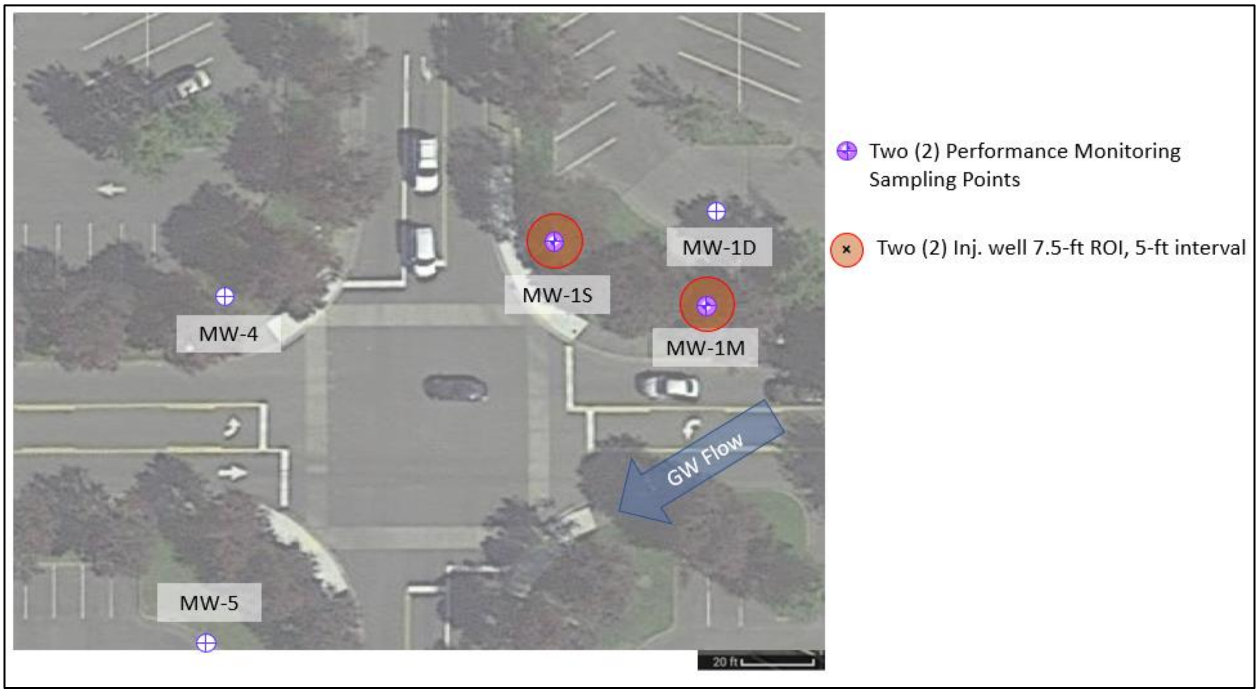

Figure 1

ISCO Calculations

Table 2. Chemical Demand

	TersOx Nutrients-QR (0.8 g/L)	**TersOx Liquid (5.3 g/L H_2O_2)**	**TersOx Modulator3**	**Injection Volume**
	lbs	**lbs**	**lbs**	**gal (balance water)**
MW-1S	12.5	250 (26 gal)	2.5 gal	1,250
MW-1M	12.5	250 (26 gal)	2.5 gal	1,250
Total:	**25** **(1 pail)**	**500** **(1 drum)**	**5 gal** **(1 pail)**	2,500

Baseline Testing and Performance Monitoring

This proposal also presents a scope of work for Tersus, in collaboration with our scientific advisors and client, to review site reports and field data provided by client which will be collected before and after potential injections to assess injection performance and contaminant fate. Data sources include historical data, field, geochemical and cVOC data, along with molecular diagnostic tools (MDT) such as qPCR data and compound specific isotope analysis (CSIA).

1. Are key microbial targets responding to biostimulation efforts?

Monitoring wells:

Tersus suggests that Herrera Environmental Consultants consider sampling two monitoring wells in the vicinity of the two wells to be treated, MW-1S and MW-1M (medium).

Sampling parameters:

- Field parameters: DO, ORP, pH, Temp, Cond.
- Geochemical parameters: TKN, total P, Iron, Sulfate, manganese
- HVOC (Constituents of concern)

Sampling frequency:

- Baseline sampling
- 1-2 months Post first injection
- 2-3 months
- 3-6 months

Reporting:

- Email-based status for baseline and progress reports.
- One final report to include all sampling events. This report should be able to address efficiency of the treatment and propose timely adjustments.

Summary

Chemical demand per injection event	Unit	Qty
TersOx Liquid	500-lb drums	1
TersOx Modulator3	5-gal pail	1
TersOx Nutrients-QR	25-lb Pail	1

Laboratory Analysis	Qty	Baseline	Rd 1	Rd 2	Rd 3	Total
DO, ORP, pH, Temp, Cond. VOCs (CoC), TOC, Sulfate, dissolved iron, manganese, Total Nitrogen, Total Phosphorous	2	1	1	1	1	8
Baseline Analysis	3	1				3
Progress reports	3		1	1		6
Final report	4				1	4

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Remedial Tasks Ownership

	Tersus Scope	Shared Scope	Scope by Client/Others
Design, Work Plans, Permits:			
Work Plan	☐	☐	■
Health and Safety Plan	☐	☐	■
Regulatory Negotiations and Client Interface	☐	☐	■
field technician cost for sampling events	☐	☐	■
Other Lab costs, additional GW parameters	☐	■	■
Site preparation (access, permits, roads, etc.)	☐	☐	■
Well Installation	☐	☐	■
Injection Event	☐	☐	■
Chemicals	■	☐	☐
Data interpretation Support	☐	■	☐

Fees and Costs

We propose to provide our services on a unit price basis. Costing to provide the amendments, bioaugmentation culture, and performance monitoring is attached.

Engagement

A copy of our Terms and Conditions of Sale is available at the following link https://www.tersusenv.com/agreement_for_services and is incorporated as a part of this Quotation. If you agree that the above adequately sets forth your understanding of our mutual responsibilities, please indicate your acceptance of our proposal by signing and returning the agreement to our office.

If you elect to accept our proposal by issuing a purchase order, then please reference this proposal number and date. Your purchase order will be an acceptance of our Agreement for Services and an authorization to proceed with the performance of our services. Unless otherwise agreed in writing signed by Tersus, any and all services provided to Client pursuant to the acceptance of a proposal by Tersus, a written contract, a purchase order, or other evidence of an agreement between Tersus and Client where a copy of our Agreement for Services has been provided in advance to Client, shall be deemed to be controlled by our Agreement for Services and incorporated into any other among the parties, whether or not contrary terms are included in a purchase order or other document provided by Client.

Information and Suggestions Provided by Tersus

The information and suggestions provided herein are furnished to help Herrera Environmental Consultants evaluate the feasibility of using our technologies at your site, without charge, as a complimentary service and is therefore given on the express understanding and agreement of the recipient that they are given without warranty (expressed or implied) or liability of any kind. Product sheets, brochures, instructions, technical advice, suggested recommendations by our staff, or other information provided by Tersus Environmental, LLC and/or the Companies we represent is provided as guidelines for the convenience of recipient only and should not be construed as substitute for appropriate engineering and geologic design.

References

Aelion, C.M., Höhener, P., Hunkeler, D., Aravena, R. Environmental Isotopes in Biodegradation and Bioremediation. 2009. CRC Press. 464 Pages, 1st Edition. ISBN 9781566706612.

Tersus Point of Contact

YOUR PRIMARY CONTACTS

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Project Administrator
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Scientific Advisory Team

Gary M. Birk, P.E.
Managing Partner at Tersus Environmental
Gary Birk is a founder and Managing Partner for Tersus Environmental. He has a bachelor's degree in chemical engineering from North Carolina State University and holds registrations as a Professional Engineer in NC, VA, and FL. Well-known for his contributions to *in situ* anaerobic groundwater remediation, he has worked on enhanced reductive dechlorination projects in North America, Europe, Asia, and Africa.

Daniel Bouchard, Ph.D.
Research and Development Isotopic Tools and Scientific Advisor
Daniel provides support for the isotope assessment, including support to develop the application strategy at the site, interpretation of results and reporting. He holds a Bachelor and Master of Science (Soil Science) and a PhD (Hydrogeology). He has applied stable isotopic analyses on contaminated sites to better understand the origin and fate of contaminants in the environment for over 18 years so far. He contributed to the development of the isotopic tools to assess the efficiency of in situ treatment of groundwater contaminated by petroleum hydrocarbons and to determine the source of contaminants in gaseous phase (soil air, indoor air) for historical investigation purposes.