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PROCEDURE

MEASUREMENT OF
GROUNDWATER FIELD PARAMETERS

Procedure No.RMRS/OPS-PRO.108
Revision 0
Date effective: 12/21/98

APPROVED: _____ 12-15-98
Manager, Water Operations/Waste Operations Division — Date

USE CATEGORY 2

TABLE OF CONTENTS

1.0 PURPOSE

This document contains guidelines for measuring certain chemical and physical parameters during the collection of groundwater samples and the development and redevelopment of groundwater monitoring wells at the Rocky Flats Environmental Technology Site (RFETS). Data collected in the field are referred to as field parameters. These data supplement the corresponding laboratory results for groundwater samples or, in the case of well development and redevelopment, provide an indication of the effectiveness of development procedures.

2.0 SCOPE

This document, which supercedes Procedure No. GW.05, constitutes a Standard Operating Procedure (SOP) that applies to all Rocky Mountain Remediation Services (RMRS) personnel and subcontractors conducting groundwater-related work at the RFETS. This SOP describes the procedures that will be used for the measurement of specific field parameters. The parameters currently required are pH, specific conductivity, temperature, turbidity, and alkalinity.

Measurements of field parameters in groundwater have consistently been conducted using instruments manufactured by the Hach Company. These procedures, although generally applicable to the use of these instruments, can be applied to other instruments.

Occasionally modifications may be made requiring the measurement of additional field parameters. If these requirements are sitewide, measurement of the additional field parameters will be described in an addendum to this SOP. If the added parameters are for a specific project, or on an otherwise limited scale, they will be described in project-specific work plans rather than as additions to this SOP.

3.0 REQUIREMENTS

The following sections identify the personnel qualifications and equipment for measuring groundwater field parameters.

3.1 Personnel Qualifications

Personnel performing these procedures are required to have completed the initial 40-hour OSHA classroom training that meets Department of Labor Regulation 29 CFR 1910.120(e)(3)(i), and must maintain a current training status by completing the appropriate 8-hour OSHA refresher courses. Personnel must also have read and signed the appropriate Health and Safety Plan(s).

Prior to engaging in groundwater sampling and measurement of field parameters, personnel are required to have a complete understanding of the procedures described within this and other related SOPs and receive specific training regarding these procedures if necessary.

3.2 Equipment

The following is a list of basic equipment typically required when measuring field parameters. Additional equipment may be required in less typical applications, and will be specified in the project-specific work plan or other appropriate document.

- Well sampling equipment (see SOP PRO.113)

- pH probe, meter, and standard buffer solutions
- Specific conductivity probe, meter, and standard solution
- Turbidity meter (turbidimeter)
- Alkalinity solution and pH table
- Reagent and graduated cylinder or bottle for the measurement of the solution
- Several clean beakers (typically 100 ml to 250 ml in volume)
- Decontamination equipment and supplies
- Health and safety equipment and supplies

For wells with dedicated pumps the following additional equipment is required to pump and sample the well:

- Portable air compressor
- Pump control unit
- Solomat Sonde and Data Logger, or equivalent continuous sampler instruments (can be optional since parameters can be taken on recovered water with the equipment listed above)
- One to two liter graduated cylinder

Some of the meters listed above (pH and specific conductivity) may be multipurpose units that can also be used for temperature measurements. In addition, alternatives to listed meters may be used, such as a spectrophotometer for the measurement of turbidity rather than a turbidimeter. Substitutions such as these are acceptable so long as the substituted equipment is designed to perform the required measurement (as documented in the equipment's instruction manual and manufacturers specifications), and can meet the required detection limits.

4.0 INSTRUCTIONS

Field parameters are routinely measured when groundwater monitoring wells (and, on occasion, piezometers and well points) are purged, sampled, developed, or redeveloped. Procedures for performing these tasks are presented in SOPs PRO.113, Groundwater Sampling, and PRO.106, Well Development.

Several of the parameters that must be measured are physically or chemically unstable and must be tested either in the borehole using a probe (*in situ*) or immediately after collection using a field test kit or instrument (EPA 1986). Unstable parameters include pH, temperature, and alkalinity. Although the specific conductivity of a substance is relatively stable, it is recommended that this characteristic also be measured in the field. Most instruments measuring pH and conductivity require temperature compensation; therefore, the temperature of the samples should be measured at the time pH and conductivity is measured.

The standardization/calibration of *in situ* monitoring equipment, portable and laboratory meters and probes, and field test kits will be completed according to the manufacturer's specifications, and at the minimum frequency specified in Table 108-1 of this SOP, unless the appropriate work plans or the manufactures instructions state otherwise. Instruments meeting the acceptance criteria specified in Table 108-1, or more stringent criteria specified in the work plans, are acceptable for use in the field. Instruments not meeting the specified criteria must be calibrated prior to each use so that the acceptance criteria are met. Any change in these frequencies or criteria to lower frequencies or less stringent criteria must be approved by the RMRS project manager prior to being implemented.

Instruments and instrument components will be maintained and cleaned in accordance with the manufacturers' recommendations, and will be inspected during field activities and routine calibration and standardization

procedures. Damaged instruments or components will be removed from service and professionally repaired or replaced.

Solutions used for standardizing, calibrating, or titrating will be checked prior to use in the field to determine if the expiration dates have been exceeded. Any expired solutions will be replaced with new solutions.

TABLE 108-1. Calibration/standardization frequencies and minimum acceptance criteria for field parameter measurements.*

Parameter	Frequency	Minimum Procedure	Acceptance Criteria
Temperature	Weekly	Standardize	± 1.0°C**
pH	Daily	Calibrate	Standard Value ± 0.2 pH units
Specific Conductivity	Daily	Calibrate	Standard Value ± 10%
Turbidity	Each well	Zero Instrument	0 FTUs / Standard Value ± 10%
Total Alkalinity	For each new lot of titrant	Standardize	Standard Value ± 10%

* Standards from equipment manufactures recommendations and RFETS requirements.

** Temperature difference between measured value and that reported by a NIST-calibrated thermometer or thermometer calibrated against a NIST-traceable thermometer.

Samples for field parameter measurements will be collected according to SOP PRO.113, Groundwater Sampling. Chemical-resistant gloves will be worn when measuring field parameters, and will be changed between locations. All measurements will be recorded on the appropriate forms, which are contained in SOP PRO.113, Groundwater Sampling, or (for developing/redeveloping activities) SOP PRO.106, Well Development.

4.1 Temperature

Temperature measurements can be made with a high quality mercury-filled thermometer or thermistor having an analog or digital readout that has been standardized weekly by comparison with a thermometer calibrated against a National Institute of Standards and Technology (NIST)-calibrated thermometer. All temperature-measuring devices will be scaled to indicate degrees Celsius (°C) in increments of 1°C or less as appropriate to meet data quality objectives. Mercury thermometers will be of the Teflon®-coated safety type. Thermometers will be transported in protective cases to prevent breakage.

The Hach pH meters currently in use at RFETS are routinely used for temperature measurements (displayed digitally) taken concurrently with the pH of water samples immediately after sample recovery. The probe is standardized weekly against a NIST calibrated thermometer as specified in Table 108-1.

Standardization will be verified weekly and will consist of comparing the temperature measured with the field instrument against the temperature measured by a NIST-traceable thermometer, preferably within the temperature range that is typical of that of groundwater. If the results of this verification vary by more than 1.0°C, the field

thermometer or thermistor will be removed from service. Thermometers and thermistors that cannot be calibrated within the variance criteria will be replaced.

4.1.1 *Temperature Measurement using a Thermometer*

The following procedure will be used when collecting temperature measurements using a thermometer

- A mercury filled standardized thermometer will be used.
- Standardize the field thermometer at least weekly to the criteria specified in Table 108-1. If the acceptance criteria specified are not met, replace the thermometer so that the criteria are met.
- The thermometer will be inspected before each field trip to ensure that there are neither cracks in the glass nor air spaces or bubbles in the mercury.
- A portion of the ground water will be transferred to a beaker previously rinsed with distilled water and acclimated with groundwater. The thermometer will be inserted into the sample collection container, and the sample will be swirled. The temperature reading will be taken when the mercury column stabilizes.
- The temperature will be recorded on the field logsheet to the nearest ± 0.1°C.
- The thermometer will be decontaminated in accordance with SOP FO.3, General Equipment Decontamination, blotted dry, and stored in a protective case.
- Liquids and materials from decontamination operations will be handled in accordance with SOP PRO.112, Handling of Decontamination Water and Wash Water.

4.1.2 *Temperature Measurement using a pH or Other Meter*

The following procedures will be followed when performing temperature measurements using a Hach One pH meter (model 43800-00) or equivalent type meter:

- Standardize the probe at least weekly to the criteria specified in Table 108-1. If the acceptance criteria specified are not met, replace the probe and/or meter,as necessary, so that the criteria are met.
- A portion of the ground water will be transferred to a beaker previously rinsed with distilled water and acclimated with groundwater. The probe will be inserted into the sample collection container, and the sample will be swirled. The temperature reading will be taken when the digital readout stabilizes.
- The temperature will be recorded on the field logsheet to the nearest ± 0.1°C.
- Upon completing all pH measurements at a location, the probe will be rinsed thoroughly with distilled or deionized water, blotted dry, and stored in accordance with the manufactures recommendations.
- Liquids and materials from decontamination operations will be handled in accordance with SOP PRO.112, Handling of Decontamination Water and Wash Water.

4.2 pH

This procedure describes the method that will be used to measure pH in the field using a Hach One pH meter (model 43800-00) or equivalent type hand-held, portable pH meter. In all cases, the manufacturer's instructions will be followed for calibration and use. All pH meters used for field measurements will be temperature compensating.

The following procedures will be followed when performing pH measurements:

- Meters will be calibrated daily prior to the start of field activities following the manufacturer's instructions. The appropriate calibration mode will be used with buffers of pH 7 and pH 10.
- Before each field activity, the meter will be checked for damage to the probe and for weak batteries in accordance with manufacturer's recommendations.
- Calibration will be verified immediately before beginning measurement activities at each location. Verification will consist of recording the instrument reading of a pH 7 standard solution.
- The probe will be rinsed with distilled or deionized water and blotted dry.
- A clean sample beaker will be rinsed with a small volume of sample groundwater to acclimate the beaker to the groundwater.
- An appropriate volume of groundwater (100 ml or so) will be poured into the acclimated beaker. The probe tip will be immersed in this water, swirled gently, and the pH measured following the manufacturer's instructions. Care will be taken to minimize surface disturbance of the sample while stirring.
- The pH will be read and recorded to the nearest ± 0.01 pH unit. The temperature will also be recorded.
- If the first measurement of groundwater produces a reading closer to a different standard solution rather than the pH 7 used to field calibrate the instrument, then the field personnel may want to consider repeating the calibration verification using a different standard solution (pH 4 or 10 instead of pH 7).
- If a number of pH measurements are to occur at the same location over a short period of time, the probe tip may be placed in a second clean beaker containing distilled, deionized, or groundwater from the location (between sampling events) for the duration of the sampling period.
- Upon completing all pH measurements at a location, the probe will be rinsed thoroughly with distilled or deionized water, blotted dry, and stored in accordance with the manufacturer's recommendations.
- Sampling tools, instruments, and equipment will be protected from extraneous sources of contamination and will be decontaminated after use as specified in SOPOPS-PRO.127, General Equipment Decontamination, or according to the manufacturer's instructions.
- Calibration will be verified at the end of each workday. Verification will consist of recording the instrument reading of a pH 7 standard solution. If the instrument reading varies from the standard by more than ± 0.2 pH units, the instrument will be checked for a malfunction. If the variance continues for

two consecutive days, the frequency of calibration of that instrument will be increased. Calibration will then be performed prior to use at each site. If the instrument cannot be calibrated to the minimum acceptance criteria it will be taken out of service for repair or replacement.

4.3 Specific Conductivity

Conductivity, also referred to as conductance, is the reciprocal of resistance and is therefore often reported in units of reciprocal ohms, or "mhos." The international system of units, the siemen (S), will be used to report conductivity for RFETS groundwater programs. Because most groundwater has a specific conductivity much less than 1 siemen, data will be reported in either microsiemens (μS)/cm or millisiemens (mS)/cm.

If the pH probe being used employs electrolyte-dispensing technology, the conductivity measurement will be made prior to pH measurement or on a different volume of sample water.

This procedure describes the method to be used to measure specific conductivity in the field using a Hach Conductivity/TDS Meter (model 44600) or equivalent type conductivity meter. In all cases, the manufacturer's instructions will be followed for calibration and use of the conductivity meter. Conductivity meters used for field measurements will be temperature compensating. This will allow for the recording of specific conductivity measurements directly from the meter. Meters will also have adjustable readings that will allow for accurate calibration to a known standard.

- The meter will be calibrated at the start of each day prior to any field activities. Calibration will be performed according to manufacturer's instructions and the guidance given in Table 108-1. All instrument ranges will be calibrated with a single standard solution. A sodium chloride standard solution having a conductivity of 1000 μS/cm is generally appropriate.

- Before each field activity, the meter will be checked for damage to the probe and for weak batteries in accordance with manufacturer's recommendations.

The following procedures will be followed when performing field conductivity measurements:

- Calibration will be verified immediately before beginning measurement activities at each location. Verification will consist of recording the instrument reading of a 1000 μS /cm standard solution.

- The probe will be thoroughly rinsed with distilled or deionized water and blotted dry.

- A clean sample beaker will be rinsed with a small volume of sample groundwater to acclimate the beaker to the groundwater.

- The beaker will be filled with a volume of groundwater sufficient to immerse the probe 1 inch below the surface of the sample. The probe will be gently agitated vertically and swirled to dislodge any trapped air bubbles and the reading will be allowed to stabilize.

- The temperature (from pH meter) and temperature-compensated conductivity reading will be recorded on the field form.

- If a number of conductivity measurements are to occur at the same location over a short period of time, the probe tip may be placed in a second clean beaker containing distilled, deionized, or groundwater from the location (between sampling events) for the duration of the sampling period.

- The probe will be rinsed thoroughly with distilled or deionized water, blotted dry, and stored in accordance with the manufacturer's recommendations.

- Sampling tools, instruments, and equipment will be protected from extraneous sources of contamination and will be decontaminated after use as specified in SOP PRO.127, General Equipment Decontamination and/or the manufacturer's instructions.

- Calibration will be verified at the end of each workday. Verification will consist of recording the instrument reading of a standard solution of the same conductivity as that used to calibrate the meter prior to beginning the day's activities. If the instrument reading varies by more than 10 percent of the standard, the instrument will be checked for malfunction. If the variance continues for two consecutive days, the calibration frequency for that instrument will be increased. Calibration will then be performed prior to each sampling event. If the instrument cannot be calibrated to the minimum acceptance criteria it will be taken out of service for repair or replacement.

4.4 Turbidity

Turbidity may be measured with a turbidity meter (turbidimeter) or by other equipment or methods designed to measure this property. This procedure describes the measurement of turbidity using the Hach DR20000 spectrophotometer absorption method that is currently being used for most wells at RFETS. The turbidity test measures an optical property of a water sample that results from the scattering and absorbing of light by particulate matter that may be present within the sample. The amount of turbidity registered is dependent on such variables as the size, shape, and refractive properties of the particles.

The sample is contained within a clear sample cell that is inserted into a light-shielded enclosure within the meter. Because this method of determining turbidity is based upon light transmitted through the sample, it is important that sample cells be kept clean and undamaged. Sample cells, which are used in matched pairs, must be replaced if one is scratched, cracked, or permanently discolored.

Regardless of the instrument being used, it will be calibrated according to the methods and frequency suggested in the manufacturer's instructions. The DR2000 may be calibrated using formazin standards, and the readings are in terms of formazin turbidity units (FTU).

The following procedures will be followed when performing turbidity measurements using the Hach DR2000 spectrophotometer:

- Sample cells will be inspected prior to each use. Defective cells will not be used.

- Enter the stored program number for turbidity; press "750 Read/Enter." The display will show "Dial nm to 450."

- Rotate the wave length dial until the small display shows "450 nm."

- Press "Read/Enter." The display will show "FTU Turbidity."

- Place a prepared blank (a clean, permanently sealed glass sample cell filled with 25 ml of deionized water) into the cell holder and close the light shield.

- Press "zero" and the display will show "wait" and then "0. FTU Turbidity".

- Fill a beaker with an appropriate volume of sample water and swirl the water gently to keep any particulate matter suspended. Transfer a sample to a clean sample cell, place into the cell holder, and close the light shield .
- Press "Read/Enter" and the display will show "wait" and the result in FTUs will then be displayed.

- After all turbidity measurements have been completed, the sample cell will be decontaminated, blotted dry, and stored in accordance with the manufacturer's recommendations.

The stored program has been calibrated using a standard polymer solution called formazin. Standard formazin solutions for checking the spectrophotometer accuracy can be prepared following the manufacture's instructions.

4.5 Total Alkalinity

Total alkalinity, which may be defined as the ability of a water to neutralize acid, is expressed as ppm $CaCO_3$. This section describes the procedure that will be followed in order to measure total alkalinity in the field using an ORION Total Alkalinity Test Kit and Hach One pH meter. The ORION test kit includes a reagent composed of several acids and a conversion wheel. After the pH of a solution is recorded, the reagent is added to a fresh aliquot of solution, and the pH is recorded again. Using the conversion wheel, the new pH is converted to total alkalinity as ppm $CaCO_3$.

Total alkalinity will be measured once, upon the completion of purging activities. The procedure for determining total alkalinity is as follows:

- The pH meter will be calibrated as described in Subsection 4.2. Once each week, verification of proper alkalinity measurement will be performed using a standard of known alkalinity and following the manufacturer's instructions. If the verification measurement varies by more than 10 percent, the total alkalinity reagent will be replaced.

- After determining the pH of the sample of interest, collect a fresh 100 mL of sample in a clean beaker.

- Add 10 mL of Total Alkalinity Reagent to the sample and stir well using the pH probe.

- Measure and record the resulting pH of the sample as described in Subsection 4.2.

- Using the gray side of the Total Alkalinity Conversion Wheel, find the resulting pH value. Record the corresponding total alkalinity of the sample.

- If the alkalinity is off scale, the pH will be recorded and the alkalinity measurement will be repeated using a fresh sample. This time, 10 ml of sample and 10 ml of reagent will be added to 90 ml of distilled or deionized water. This mixture will be stirred and the pH measured as above. The conversion wheel will be consulted to determine the alkalinity of the mixture. This value will be recorded, then multiplied by ten to determine the total alkalinity, which will also be recorded.

- Upon completion of all alkalinity measurements, the probe will be thoroughly rinsed with distilled or deionized water blotted dry, and stored in accordance with the manufacturer's recommendations.

- Sampling tools, instruments, and equipment will be protected from extraneous sources of contamination (i.e., non-groundwater) and will be decontaminated after use as specified in SOP PRO.127, General Equipment Decontamination.

5.0 USE OF SOLOMAT TO MEASURE PARAMETERS

Numerous monitoring wells at RFETS are equipped with down-hole pumps. These pumps are used to purge the well and collect the required water samples through "micropurging" procedures. Groundwater field parameters at these monitoring wells will typically be measured using a Solomat water quality monitoring system, which consists of a data logger (Model WP4007) and sonde (Model 803PS). The sonde houses probes capable of measuring temperature, pH, conductivity, turbidity, and other parameters not currently measured at RFETS. A variety of different pumps, sondes, flow cells, and probes are available. All operate on essentially the same principles, and the calibration, standardization, cleaning, decontamination, and storage and maintenance of the Solomat or any equivalent system shall be conducted in accordance with the manufacturer's instructions.

The procedures that follow are specific to the Solomat system.

5.1 Calibration/Standardization

The frequencies of calibration/standardization and the minimum acceptance criteria presented in Table 108-1 shall be maintained unless the manufacturer's instructions dictate otherwise. Any change in these frequencies or criteria to lower frequencies or less stringent criteria must be approved by the RMRS project manager prior to being implemented. During periods of use, the Solomat system shall be calibrated daily and standardized weekly. In order to track instrument drift, calibration shall be performed before taking the instrument out in the field, and checked upon returning from the field. The readings taken upon returning from the field are recorded only without resetting the instrument.

Calibration of the system follows a two-stage procedure and employs a calibration cup. The respective chambers of the cup are filled with the appropriate calibration solutions up to the internal marks on the chambers (about half way). Individual chambers are marked with the appropriate parameter(s). Markings are defined as follows: pH-ISE- NH_4 refers to pH, ion-specific electrode, and ammonium; TURB refers to turbidity; and µS refers to conductivity. In the first stage of calibration, only the pH-ISE- NH_4 and TURB chambers are filled. In the second stage, the pH-ISE- NH_4, TURB, and µS chambers are filled.

- All three of the pH suite chambers will be filled every time a calibration is performed, because the system uses all three to calculate the pH.

- The Solomat system reports turbidity in nephelemetric turbidity units (NTUs) instead of in formazin turbidity units (FTUs).

The following steps describe the calibration process.

1. Fill the "pH-ISE-NH_4" calibration cup chambers with pH 7 standard solution and the "TURB" chamber with distilled water. These solutions are used to calibrate the low-range values.

2. Remove the storage cup and storage teats from the sonde and respective probes. If the sonde has not been used for a period of time, it will be rinsed with distilled water before being inserted into the calibration cup.

3. Place the sonde in the calibration cup and turn the system on by pushing the Shift and On/Off buttons simultaneously.If the system is operating normally, the screen will display a series of numbers, including the date and time; it will then cycle through the channels corresponding to the parameters being measured. Depending on the setting, each channel/parameter reading should appear on the screen in sequence for between 4 and 8 seconds. (The 4-8 seconds can be adjusted.) Each channel can be set to display any of the parameters. In the following example the channels are set as follows:
   Channel 1 = Temperature (in degrees centigrade)
   Channel 2 = pH (in ISO pH units)
   Channel 3 = Conductivity (in microSiemens (µS); depending on the range, the unit may measure in milliSiemens (mS))
   Channel 4 = Turbidity (in NTU's)
   Channel 8 = Battery life (in mV; 4.0 represents a full charge)

4. Record the "low" values for the pH and turbidity on the log sheet. Adjust the values as necessary. (Note: the data logger connects to the probe at the B-socket on the logger.)

5. Turn off the logger and remove the sonde from the calibration cup. Rinse the sonde and the cup with distilled water. Dry the cup and prepare it for calibrations of the "high" range values of pH and turbidity, as well as conductivity and temperature.

6. Fill the pH- ISE-NH_4 chamber with pH 10 standard solution. Fill the conductivity chamber with 1000 µS/cm standard solution, which will also fill the temperature chamber. Fill the turbidity chamber with 100 NTU standard solution. If a lower pH is anticipated, the Solomat can be standardized and calibrated using pH standard solutions of 4 (high range) and pH 7 (low range). The pH 7 solution is always considered low range in the calibration process.

7. Insert the sonde in the calibration cup and turn on the data logger. Record the temperature, pH (high range), conductivity, and turbidity (high range) values on the data sheet.

8. Turn off the data logger and remove the sonde from the calibration cup. Rinse the sonde and the cup with distilled water. Dry the cup. Replace the teats on the probes and the storage cup on the sonde. Disconnect the sonde from the data logger. Assuming the Solomat readings are within acceptable ranges, as defined by Table 108-1, it is now ready for field use and should be returned to its carrying case.

If any of the readings for the calibration solutions fall outside of the acceptance criteria in Table 108-1, it is acceptable to reset the Solomat system using the calibration solutions already in the cup. If it becomes necessary to switch to different calibration solutions, the Solomat can be restandardized to accept the new solutions.

If the values of any of the parameters (pH, conductivity, turbidity) fall outside the acceptance limits presented in Table 108-1, the Solomat can be recalibrated in the following manner. (Note: temperature is set at the factory

and cannot be adjusted by the user.) Although the procedure described below is the same for all three parameters, only pH is discussed below by way of example. If a calibration gives an unacceptable reading, both the high and low calibration ranges shall be reset.

Assume that a pH standard of 7.0 gives a reading of 6.79, which is unacceptable according to Table108-1. The sonde is still immersed in the calibration cup and the data logger is turned on (step 5 above; for clarity, the following steps will be independently numbered).

1. Press and hold the SHIFT and TSS NTU/CAL/6 keys simultaneously for 1-2 seconds.

2. The Solomat screen will begin flashing "CAL".

3. The screen will automatically switch to a particular channel (i.e., Ch. 1, 2, 3, 4 or 8 will appear over "CHAN=").

4. Enter the number of the channel to be calibrated: 2=pH, 3=conductivity, and 4=Turbidity (1=Temperature and 8=battery condition, neither of which shall be calibrated).

5. Push ENTER/YES.

6. Two numbers will appear. The upper number represents the value the Solomat is currently detecting (6.79 in this example). The lower number is the value to which the Solomat is calibrated (7.00 in this example). By pressing the ENTER/YES key, the unit will be recalibrated to pH=7.00. (If, instead, the high range of pH was being recalibrated using a pH=10.00 solution in the calibration cup, the NO/> key would be pressed. This action would bypass the low range calibration and set up the high range calibration. The screen would then show two numbers, the upper being the current reading for the calibration cup and the lower the 10.00 calibration setting. To recalibrate to the high value solution, the ENTER/YES key would be pressed.)

7. After the ENTER/YES key has been pressed, the data logger will return to its usual cycling from one parameter value to the next on the screen.

- If another parameter is to be recalibrated, the SHIFT and TSS NTU/CAL/6 keys shall again be pressed, and the appropriate channel shall be selected.

- To recalibrate to the high range (e.g., pH 10.00) while the low range solution (e.g., pH 7.00) is in the calibration cup, the Solomat must be turned off, solutions in the cup must be changed, and the calibration process must be restarted.

5.2 Field Measurements

Remove the Solomat sonde and data logger from the carrying case. Remove the storage cup from the sonde and the storage teats from the individual probes. Attach the Solomat sampling cup firmly onto the sonde. The sampling cup has two interchangeable tubing couplings: one directs water into the sample chamber, the other directs water out to the purge receptacle.

Connect the Solomat sonde wiring coupling to the data logger at the B-socket. Place the sonde in a safe position, either on the ground or hung from a support attached to the well casing. If possible, the sonde should be positioned

in the shade. Place the data logger next to the pump control box. For convenience, a table may be used to support the logger and control box.

Connect the pump airline to the well. From the well casing, connect the 3/8 inch outflow tubing to one side of the sampling cup of the Solomat sonde. The opposing side of the Solomat cup is connected through tubing to the purge bucket (a 2L graduated cylinder). Use a short piece of flexible tubing to complete the connection between the end of the outflow tubing and the graduated cylinder. With the pump and Solomat in place, well purging and water quality measurement can begin. (See SOP PRO.113 for instructions on purging wells.)

Turn on the pump. Adjust the pump mechanism so that water flows gently from the well into the sample chamber (with minimal turbulence). Hold the Solomat sonde horizontal with the inflow line down and the outflow line up until all the probes are immersed in water and the air is purged from the sample chamber. When the chamber is completely filled with water, return the sonde to a vertical position.

Once the sample cup has filled with water and a steady flow through the cup has been established, turn on the data logger and record the various parameters on the sample log sheet. This sheet includes sections pertaining to the Solomat and water quality parameters and to pump operation. Purging and measuring parameters should continue as per SOP PRO.113, Groundwater Sampling.

After completing the purge cycle but before the Solomat sonde has been disconnected or the data logger has been turned off, collect an aliquot of water and perform a total alkalinity measurement as described in Section 4.5. Parameters will also be taken if dissolved metals and/or uranium isotope samples are to be taken.

Upon completion of the purge cycle and alkalinity measurement, and collection of the dissolved metals, and/or uranium isotope samples, if required, disconnect the Solomat sonde from the well. The tubing used to direct water from the well casing to the Solomat sampling cup may continue to be used during the sampling activities by turning the water line valve so the pumped water exits through the sample tubing rather than the solomat.

Rinse the Solomat sonde and probes thoroughly with distilled water. Decontaminate the sample cup and tubing (if removed) as per SOP PRO.127, General Equipment Decontamination. Replace the teats on the sonde probes and then attach the storage cup. Make sure that the teats and cup are moist. The sonde, data logger and sample cup shall then be replaced in the case.

6.0 RECORDS

All records of field measurements will be recorded on the appropriate forms contained in SOP PRO.113, Groundwater Sampling, or PRO.106, Well Development.

All instrument calibrations, standardizations, and calibration/standardization verifications will be recorded on a calibration/standardization log or in a bound field notebook kept specifically for each instrument. Records will be maintained in a locked filing cabinet or locked room and will be reviewed periodically by the project or program QA/QC officer.

7.0 REFERENCES

7.1 Source References

The following references were reviewed in order to write this procedure:

U.S. Environmental Protection Agency (EPA), December 1987, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

U.S. Environmental Protection Agency (EPA), 1987, *Data Quality Objective for Remedial Activities Development Process*, EPA/540/G-87/003.

Hach Company, 1988, *Hach DR/2000 Spectrophotometer Handbook*. Loveland, Colorado.

Hach Company, 1989, *Hach Water Analysis Handbook*. Loveland, Colorado.

Environmental Protection Agency (EPA), September 1986, *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, ,OSWER-9950.1.

Standard Methods for the Examination of Water and Wastewater, 16th Edition. 1985, Method 212.

U.S. Department of Energy (DOE), 1987, *The Environmental Survey Manual*, DOE/EH-0053. Appendix E, "Field Protocols and Guidance."

7.2.1 Internal References

Related SOPs cross-referenced by this SOP are as follows:

- SOP OPS-PRO.127, General Equipment Decontamination
- SOP OPS-PRO.112, Handling of Decontamination Water and Wash Water
- SOP OPS-PRO.106, Well Development
- SOP OPS-PRO.113, Groundwater Sampling
- SOP FO.13, Containerizing, Preserving, Handling, and Shipping Soil and Water Samples