

Groundwater Sampling Field Manual



PUBL-DG-038 96

Produced by the Wisconsin Department of Natural Resources
Bureau of Drinking Water and Groundwater
September 1996

Groundwater Sampling Field Manual

PUBL-DG-038 96

Produced by the Wisconsin Department of Natural Resources
Bureau of Drinking Water and Groundwater
September 1996

Author

Steve Karklins

Editor

Jordana Lenon

ACKNOWLEDGEMENTS

The author would like to express his sincere gratitude to the groundwater professionals who reviewed this document and the accompanying Desk Reference in their draft forms. A special thanks is extended to the many reviewers with the Wisconsin Department of Natural Resources, Michael Barcelona with the National Center for Integrated Bioremediation Research and Development, along with technical staff from several environmental consulting firms including Northern Lakes Services, STS Consultants, Natural Resources Technology, John Robinson & Associates, RUST E&I, Dames & Moore, Montgomery Watson, and RMT.

DISCLAIMER

The mention of trade names or commercial products in this document does not constitute an endorsement or recommendation by the Wisconsin Department of Natural Resources. Also, while this document and the accompanying Desk Reference include brief mention of health and safety issues, neither document adequately addresses all health and safety issues and requirements. Both documents should be supplemented with other appropriate references, requirements and training on health and safety.

ADDITIONAL COPIES

Additional copies of this document titled **Groundwater Sampling Field Manual, Stock # 1729**, and the accompanying document titled **Groundwater Sampling Desk Reference, Stock # 1728**, may be purchased from Wisconsin Department of Administration, Document Sales Unit. Call Document Sales at (608) 266-3358 or TTY (608) 264-8499 for pricing information (business hours 7:45 am to 4:30 pm).

Credit card orders using either VISA or MASTERCARD may be placed by calling the following numbers:

Long Distance:	1-800-362-7253
Local:	(608) 264-9419

Orders for the documents may be prepaid either with cash, money order, or check made payable to the Department of Administration and mailed to the following address:

Wisconsin Department of Administration
Document Sales Unit
202 South Thornton Avenue
P.O. Box 7840
Madison, WI 53707-7840

GROUNDWATER SAMPLING FIELD MANUAL

1.0 INTRODUCTION	1
1.1 PURPOSE AND USE OF THIS FIELD MANUAL.....	1
1.2 PRELIMINARY SITE DATA.....	1
1.3 VADOSE ZONE SOIL-WATER MONITORING.....	1
2.0 SAMPLING PROCEDURES FOR MONITORING WELLS	2
2.1 PRE-FIELD CHECKLISTS AND DOCUMENTATION	2
Pre-field Checklists.....	2
Documentation of the Sampling Event.....	2
2.2 MEASURING STATIC WATER LEVEL	2
Electronic Water Level Indicator.....	3
Popper.....	3
Indicator Substance.....	4
Alternative Methods.....	4
Calculating Groundwater Elevation.....	4
2.3 MEASURING AND SAMPLING IMMISCIBLE LAYERS	5
Measuring the Thickness of Immiscible Layers.....	5
Sampling Immiscible Layer > 1 foot Thick in Well.....	5
Sampling Immiscible Layer < 1 foot Thick in Well.....	6
2.4 PURGING AND SAMPLING PROCEDURES	6
Wells that do NOT Purge Dry.....	7
Wells that Purge Dry.....	12
Alternative Methods.....	13
2.5 SAMPLE COLLECTION	14
Sample Collection and Filling Procedures.....	14
Volatile Organic Compounds (VOCs).....	15
Semi-volatiles and Pesticides.....	16
Inorganics.....	16
Other Sample Parameters.....	16
2.6 FIELD WATER QUALITY MEASUREMENTS	17
Temperature.....	17
Specific Conductance.....	17
pH.....	18
Turbidity.....	19
Dissolved Oxygen.....	19
Color.....	20
Odor.....	20
Eh (Oxidation-reduction potential).....	20
Other Water Quality Measurements.....	20
2.7 SAMPLE FILTRATION	21
Filtration Procedures.....	21
Alternative Methods.....	23
2.8 SAMPLE PRESERVATION AND HANDLING	24
Sample Preservation.....	24
Checking and Adjusting the pH of a Preserved Sample.....	24

	Sample Handling and Storage.....	25
2.9	QUALITY ASSURANCE/QUALITY CONTROL.....	25
	Quality Control Samples.....	26
	Equipment Decontamination.....	27
	Sample Tracking, Security and Chain of Custody Procedures.....	28
3.0	SAMPLING PROCEDURES FOR WATER SUPPLY WELLS.....	30
3.1	PRE-FIELD CHECKLISTS AND DOCUMENTATION.....	30
	Pre-field Checklists.....	30
	Documentation of the Sampling Event.....	30
3.2	INITIAL PROCEDURES.....	31
	Coordination with the Well Owner/Operator.....	31
	Initial Coliform Bacteria Testing.....	31
	Wisconsin Unique Well Number (WUWN) Labeling Procedures.....	31
3.3	MEASURING WATER LEVEL, CASING DEPTH AND TOTAL WELL DEPTH.....	32
	Disinfection Procedures for Equipment.....	32
	Measuring Water Level.....	33
	Measuring Well Casing Depth.....	33
	Measuring Total Well Depth.....	33
	Disinfection of Well after Measurements.....	34
	Post Disinfection Coliform Bacteria Testing Procedures.....	35
3.4	WELL PURGING.....	36
	Large Water Supply Systems.....	36
	Small Water Supply Systems.....	36
3.5	FIELD WATER QUALITY MEASUREMENTS.....	36
3.6	SAMPLE FILTRATION.....	36
3.7	SAMPLE COLLECTION, PRESERVATION, AND HANDLING.....	37
	Bacteriological Sampling.....	37
	Other Sample Parameters.....	38
3.8	QUALITY ASSURANCE/QUALITY CONTROL.....	38

APPENDIX A MONITORING WELLS

Checklists

Pre-field Work Procedures Checklist - Monitoring Wells
Equipment Checklist - Monitoring Well Sampling

Documentation Sheets and Forms

Well Specific Field Sheet - Monitoring Wells
Field Procedures Documentation
Chain of Custody Form for the LUST Program (Form 4400-151)

APPENDIX B WATER SUPPLY WELLS

Checklists

Pre-field Work Procedures Checklist - Water Supply Wells
Equipment Checklist - Water Supply Well Sampling

Documentation Sheets and Forms

Well Specific Field Sheet - Water Supply Wells
Field Procedures Documentation
Groundwater Monitoring Inventory Form (Form 330-67 Rev. 12-92)
Chain of Custody Form

APPENDIX C REFERENCE MATERIALS

Sample Containers, Preservation and Holding Time Requirements
Chain of Custody for Samples Requiring Strict Custody
Potential for a Substance for Volatilizing from a Water Sample
Equivalency and Conversion Tables


1.0 INTRODUCTION

1.1 PURPOSE AND USE OF THIS FIELD MANUAL

This field manual provides you with easy-to-use, WDNR-recommended procedures for consistently collecting quality, representative groundwater samples and measurements.

Before going out in the field, you should develop a sampling plan and a QA/QC plan. All sampling personnel should read these plans. The *Groundwater Sampling Desk Reference, PUBL-DG-037-96 REV*, contains detailed information on creating such plans. Consistently follow the procedures and protocols specified in these plans *throughout a project's life. Always* clearly document any deviations from them, including reasons for the deviations.

Most sections of this manual contain an "Alternative Methods" subsection to help you consider alternative procedures and equipment not covered in this manual. This manual contains commonly used equipment and procedures and is not intended to limit your choice of procedures and equipment to use for a specific site or project. Therefore, WDNR will allow alternative procedures as long as they provide scientifically valid and legally defensible groundwater data.

This manual uses the  iconic symbol to highlight key points to follow for all procedural options. This manual also uses "Note", "Important note", "Caution", and "Tip" to highlight important points that apply to a specific subsection or procedural option (e.g., coated tapes).

1.2 PRELIMINARY SITE DATA

Instructions on collecting subsurface stratigraphy data and preliminary screening discrete-depth groundwater samples are beyond this field manual's scope. Refer to Section 2.0 of the *Groundwater Sampling Desk Reference* for a more detailed discussion on the collection, use and limitations of such data. In addition, refer to the instructions and specifications provided by the manufacturer of your sampling and monitoring equipment.

1.3 VADOSE ZONE SOIL-WATER MONITORING

Instructions on vadose zone soil-water sampling and monitoring are beyond this field manual's scope. Refer to Section 5.0 of the *Groundwater Sampling Desk Reference* for a more detailed discussion on the collection, use and limitations of such data. In addition, refer to the instructions and specifications provided by the manufacturer of your sampling and monitoring equipment.

2.0 SAMPLING PROCEDURES FOR MONITORING WELLS

2.1 PRE-FIELD CHECKLISTS AND DOCUMENTATION

Pre-field Checklists (Included in Appendix A)



Go through the following two checklists before heading out to the field. You may modify these checklists to meet specific project needs.

1. Pre-field Work Procedures Checklist - Monitoring Wells.
2. Equipment Checklist - Monitoring Well Sampling.

Documentation of the Sampling Event

1. **Sampling Plan.** The sampling plan documents the equipment and procedures you use during a sampling event. *Document any deviations* from the sampling plan; use the "Field Procedures Documentation" sheet included in Appendix A. Or, create your own form to record deviations.
2. **Well-Specific Field Sheet - Monitoring Wells (Appendix A)** Document well, purging and sampling information, measurements, etc., on this sheet. Or, customize your own data sheet.
3. **Field Procedures Documentation (Appendix A).** If a sampling plan is not available, you may use the "Field Procedures Documentation" sheet included in Appendix A. Customize this sheet as necessary.
4. **Chain of Custody Form (Appendix A).** Document the possession of groundwater samples collected by filling out a chain of custody form. Use this form to document each time the samples change possession. Refer to the "Chain of Custody for Samples Requiring Strict Custody" instruction included in Appendix C when collecting enforcement samples.

2.2 MEASURING STATIC WATER LEVEL

-  Measure the static water level for a well *before* purging, sampling or inserting any other instrument or device into a well's water column.
-  Collect water level measurements from all site wells within a reasonably short time, preferably the same day.

- ☞ Collect measurements in the order of least contaminated to most contaminated wells (if known). Decontaminate the measuring device between each well.
- ☞ Read water level measurements to the nearest 0.01 foot from a permanently-marked spot on the well (e.g., top of casing or reference elevation).
- ☞ When possible, use one measuring device for all site wells. If using more than one measuring instrument, check the calibration of both instruments against the same well to ensure that they provide the same water level measurements.
- ☞ After removing a *water/air tight well cap* (e.g., flush mounted well), allow the water level in the well to stabilize. This may be especially important for wells screened in silt and clay (low permeability) formations. Take several measurements to ensure that the water level has stabilized.
- ☞ Bring along records of previous water level measurements taken on the well.

Electronic Water Level Indicator

1. Lower the decontaminated probe or electrode into the well until the instrument indicates that you've reached the water column.
2. Slowly raise and lower the probe or electrode in and out of the water column until you are satisfied that the instrument is providing a reliable water level reading. If necessary, adjust the instrument's sensitivity according to the manufacturer's instructions.
3. Read the measurement on the cable or tape to the nearest 0.01 foot against the top of casing or reference elevation on the well. Record this measurement as "depth to water."

Popper

1. Lower the decontaminated popper and tape into the well until you hear a "pop," indicating that you've reached the water column.
2. Raise and lower the popper, listening for a repeating "pop" sound. Continue doing this until you are satisfied that you have a reliable reading.
3. Read the measurement on the tape to the nearest 0.01 foot against the top of casing or reference elevation on the well. Record this measurement as "depth to water."
4. You can also use the popper to measure the *well depth* by lowering the popper and tape through the water column until the tape becomes slack. Slowly pull the tape up until it just becomes taut again. Read the tape against the top of casing or reference elevation on the well and record this measurement as "depth to well bottom."

MONITORING WELLS

Caution! Deep wells, water table wells, high noise areas and floating products in wells may make it difficult to hear the "pop" and collect a reliable "depth to water" reading. Some individuals can "feel" the water surface without hearing a pop; however, if you are not confident you are collecting a reliable reading, use another measuring method.

Indicator Substance

Important Note: If you use a tape coated with an indicator substance, you **must ensure** that the indicator substance will not contaminate the well or subsequent samples collected from that well. If you have any doubt, choose another water level measurement method.

1. Coat at least 2 feet of the end of the tape.
2. Lower the coated tape into the well until you hear or feel the tape reach the water column. Lower the tape a few inches into the water and wait at least five seconds.
3. Without moving the tape, read and record the tape measurement to the nearest 0.01 foot against the top of casing or reference elevation on the well.
4. Withdraw the tape from the well and record the measurement where the wetted and dry portions of the tape intersect.
5. Subtract the measurements (Step 3 minus Step 4). Record this measurement as "depth to water."

Alternative Methods

Alternative water level measuring devices or methods are acceptable if they (1) are consistently accurate to ± 0.01 foot; (2) do not affect the integrity and chemistry of groundwater samples; (3) do not affect the groundwater geochemistry or well materials; and (4) can be thoroughly decontaminated between wells. Document the type of alternative device or alternative method used. Include this information in the sampling plan and groundwater data reports generated for the site or project. Follow the manufacturer's instructions for the instrument's use and its limitations.

Refer to the *Groundwater Sampling Desk Reference* regarding procedures for using transducers, air-line or bubble tubes, float methods or ultrasonic methods for measuring depth to water in a well.

Calculating Groundwater Elevation

After obtaining depth to water measurements, subtract the "depth to water" from the "top of casing or reference elevation" and record this data as "groundwater elevation."

2.3 MEASURING AND SAMPLING IMMISCIBLE LAYERS

- ☞ Measure and sample light non-aqueous phase liquid (LNAPL) and dense non-aqueous phase liquid (DNAPL) layers *before* purging a well.
- ☞ Disposable equipment (e.g., disposable bailers or disposable peristaltic pump tubing) is recommended because equipment decontamination may be quite difficult.
- ☞ A single or double check valve bailer works well for LNAPL collection and double check valve bailer works well for DNAPL collection. Peristaltic pumps may also be effective.

Measuring the Thickness of Immiscible Layers

- 1a. Measure LNAPL thickness with either an LNAPL/water interface probe or a weighted tape coated with a water and LNAPL-sensitive substance to distinguish between the air/LNAPL and LNAPL/water interfaces.
- 1b. You may also measure DNAPL thickness with an interface probe.

Sampling Immiscible Layer > 1 foot Thick in Well

Sampling LNAPLs

1. Slowly lower the bailer into the LNAPL, but not into the water, and then bring the LNAPL sample to the surface.
2. If both water and LNAPL are present in the bailer, allow the liquids to separate, then drain the water into a waste container.
3. Fill the sample containers with the remaining LNAPL.

Sampling DNAPLs

1. Slowly lower a double check valve bailer to the bottom of the well and allow it to fill with the DNAPL. *Slowly* raise the bailer out of the water column.
2. Drain any sediment-laden DNAPL or water into a waste container.
3. Fill the sample containers with the remaining DNAPL.

Sampling Immiscible Layer < 1 foot Thick in Well

Note: A *top-filling* stainless steel bailer or weighted top-filling bailer usually works best. Most bottom emptying bailers can be temporarily sealed at the bottom.

Sampling LNAPLs

1. Use the apparent LNAPL thickness and depth to water sample measurements to determine how far to lower the top of the bailer into the well. Slowly lower the bailer until *its top* is in the upper half of the LNAPL's thickness. Allow the bailer to fill with the LNAPL.
2. After a few seconds, raise the bailer out of the well. If both water and LNAPL are present, allow the liquids to separate, then drain the water into a waste container.
3. Fill the sample containers with the LNAPL remaining in the bailer.

Sampling DNAPLs

1. Use the same procedures just described for DNAPLs in layers thicker than 1 foot.

2.4 PURGING AND SAMPLING PROCEDURES

The *goal of purging* is either to remove stagnant water from the well or prevent stagnant water from entering samples as you are collecting them. Stagnant water does not represent groundwater.

The *goal of sampling* is to collect unaltered samples that represent the physical and chemical composition of groundwater.

- ☞ Purge and sample wells in order of least-to-most contaminated. (This is not necessary if you use dedicated or disposable equipment.) If you do not know this order, sample the upgradient wells first, then the furthest down-gradient or side-gradient wells, and finally the wells closest to, but down-gradient of the most contaminated area.
- ☞ Wait at least one week before sampling a newly-constructed and developed well; waiting a month or more may be appropriate for wells constructed in silt or clay.
- ☞ When using a bailer, purge and sample **SLOWLY AND CAREFULLY** Use a bottom-emptying device to decant samples from the bailer.
- ☞ Do *not* use cotton or cloth rope or line; use stainless steel cord, Teflon[®]-coated cord, nylon, or equivalent cord that can be decontaminated between each well. Or, use disposable rope or line.
- ☞ Decontaminate all equipment and accessories between use in each well. Store and transport all equipment in clean containers.

- ☞ Place a clean plastic sheet or other protective covering around the base of the well to prevent the equipment from contacting the ground. If you do not use a protective covering, ensure that your equipment does not touch the ground or a contaminated surface.

Wells that do NOT Purge Dry

This section applies to wells that take less than ~ 1 hour for their water levels to recover, or nearly so, after they have been purged.

The following purging and sampling procedures are recommended for wells that do not purge dry. The first procedure (A) consistently yields the *highest level of data quality*. The last procedure (C) may yield a *lower level of data quality*.

- A. Low-flow Purging < 1 L/min (0.26 gpm), Low-flow Sampling < 300 ml/min (0.3 L/min or 0.1 gpm) and Monitoring Indicator Parameters for Stability in a Closed Flow-through Cell
1. SLOWLY lower the pump to the *middle* of the well's screened area. (A dedicated system is recommended.) Securely fasten the power cable and sample tubing at the top of the well. Connect the power source, controller box, gas source, etc., to the pumping equipment.
 2. Connect the sample tubing to the water entry point of the closed flow-through cell.

Closed Flow-Through Cell

Air pockets may exist in the upper neck of each port hole that has a probe inserted into it – this is not a problem. Just make sure the probe's sensors are completely submerged in water during use.

Avoid exposing the flow-through cell to extreme heat and sun in the summer and freezing temperatures in the winter.

3. Set up and calibrate all indicator parameter instruments and place each probe into its respective port of the closed flow-through cell.
4. Set the pump controller to the desired purging rate (i.e., < 1 L/min). **Do not** use a valve to reduce the flow from a pump; valves can cause an "orifice" effect that can cause sample agitation and alteration.
5. Record the "purging time start," and start purging the well at a rate of 1 L/min or less. During purging, the water level in the well should not decrease significantly and should stabilize after purging for a few minutes. If the water level continues to decline while purging, decrease the purging rate if possible. Record the "purging flow rate" as an average. Use a graduated beaker, cylinder, calibrated bucket or other device to measure the flow rate while purging and sampling.
- 6a. Purge the well until you have taken at least three consecutive readings, spaced ~ 2 minutes

MONITORING WELLS

or ~ 0.5 well volumes or more apart, are within the following ranges for the following indicator parameters:

Dissolved Oxygen	± 0.2 mg/L
Specific Conductance	± 5.0 µmhos/cm for values < 1000 µmhos/cm ± 10.0 µmhos/cm for values > 1000 µmhos/cm
pH	± 0.1 pH units
Temperature	± 0.1 °C
Turbidity	< 5 NTUs (Required if metals samples will not be filtered. Recommended if sorptive compounds or elements are collected. Optional , but recommended, if other compounds or elements are collected).
Eh (<i>optional</i>)	± 30 mv

Stable dissolved oxygen, specific conductance and turbidity readings are considered the most reliable parameters for indicating that stagnant water has been replaced by formation water. You may adjust the ± ranges and which indicator parameters you use to indicate that stagnant water has been replaced by formation water to reflect site-specific data, geochemistry, and hydrogeologic conditions.

Turbidity stabilization and NTU readings below 5 are required if you will not be filtering metals samples. In addition, monitor turbidity stabilization when collecting sorptive, hydrophobic, or high octanol-water partition coefficient (K_{ow}) compounds or elements.

OR

- 6b. Purge the well until the readings for indicator parameters listed above (or well-specific indicator parameters) vary within ±10% over three or more consecutive readings, spaced ~2 minutes or ~ 0.5 well volumes or more apart.
 7. Record the final three stable readings for each indicator parameter on the "Well Specific Field Sheet - Monitoring Wells" (Appendix A). Or, use your own customized data sheet. Record indicator parameter data measured before stabilization on graph paper. Or, customize your own data sheet.
 8. Record the "volume purged," "purging time stop," "purged dry (Y/N)," and any problems purging.
 9. Collect samples as described under Section 2.5. Record "sample flow rate" as an average, "time sample collected," and any other pertinent information related to the sampling event.
- B. Purging FOUR Well Volumes with a Standard pump and Sampling with a Pump or Grab Sampler
1. SLOWLY lower the pump to the *middle* of the screened area of the well. Securely fasten

the power cable and sample tubing. Connect the power source, controller box, gas source, etc., to the pumping equipment.

2. Use **Equation 1** or **Table 1** (see the following this section) to calculate the number of gallons to remove *four* well volumes from the well. Record this data as "four well volumes."
- 3a. Using a **pump** to *purge and sample* the well: Record the "purging time start" and start purging the well. Minimize well drawdown; it should stabilize before sampling. If the water level continues to decline during purging, try using a lower purging rate. Use a graduated beaker, cylinder, calibrated bucket or other device to calculate the flow rate while purging and sampling.
- 3b. Using a **pump** to *purge* the well and then using a **grab sampler** to *sample* the well: Record the "purging time start" and start purging the well with the pump's inlet at the *top* of the water column. As you are purging *slowly lower the pump* so that, after four well volumes are purged, the pump's inlet is near the bottom of the well (within ~ 1 foot). **Important note:** Before collecting samples with a grab sampler, you must lower the pump while purging the well, thus removing any stagnant water before collecting samples.
4. Record "purging flow rate" as an average, "volume purged," "purging time stop," "purged dry (Y/N)," and any problems purging.
- 5a. If you use a **pump** to collect samples, the sampling flow rate should be as low as possible, and preferably less than the purging flow rate.
- 5b. If you use a **grab sampler**, try not to disturb the samples. If you use a bailer, use a bottom-emptying device to decant your samples.
6. Collect samples as described under Section 2.5. Record "sample flow rate" as an average, "time sample collected," and any other pertinent information related to the sampling event.

C. Purging FOUR Well Volumes with a Bailer and then Sampling with a Bailer or Other Grab Sampler

1. Use **Equation 1** or **Table 1** (see the following section) to calculate the number of gallons needed for removing *four* well volumes. Record this data as "four well volumes."
2. Record the "purging time start." Lower and raise a decontaminated bailer in and out of the water column *very slowly* and purge four well volumes.

Tip! To hasten purging and sampling with a bailer, tie an overhand knot, string or other easily-removable marker to the rope or cable just short of the well's depth to

MONITORING WELLS

water. You can then rapidly lower the bailer into the well to just above the water column, then ***gently and slowly*** lower it into, then out of the water column.

3. Use a calibrated bucket or other device to keep track of the volume of water you remove. Purge four well volumes.
4. Record "volume purged," "purging time stop," "purged dry (Y/N)," and any problems purging.
5. Sample the well by ***slowly and gently*** lowering the bailer until it is submerged and in the middle of the well screen. Do not allow the bailer to contact the bottom of the well. ***Very slowly and carefully*** raise the bailer out of the water column and to the surface. Do not bang it against the side of the well (typical of the "helicoptering" technique).
6. Collect samples as described under Section 2.5. Use of a bottom-emptying device to decant samples from a bailer. Record "time sample collected" and any other pertinent information related to the sampling event.

EQUATION 1
Volume to be Purged from a Monitoring Well

$$V = p \times (D/2)^2 \times H \times 4 \times 7.48 \text{ gallons/ft}^3$$

Where: **V** = Total purge volumes (i.e., four well volumes in gallons)
p = Pi (3.1416)
D = Inside diameter of well casing (feet)
H = Feet of water in well (depth to well bottom minus depth to water)

TABLE 1
Four Well Volumes of Water (in gallons) per One-Foot Section of Well Casing

Nominal casing or pipe size (inch)	Well casing or pipe schedule	Actual inside diameter of well casing (inch)	Four well volumes per one foot of water in well
1	40	1.05	0.18
1	80	0.96	0.15
1.25	40	1.38	0.31
1.25	80	1.28	0.27
1.5	40	1.61	0.42
1.5	80	1.50	0.37
2	5	2.25	0.82
2	40	2.07	0.70
2	80	1.94	0.61
3	40	3.07	1.54
3	80	2.90	1.37
4	5	4.33	3.07
4	40	4.03	2.65
4	80	3.83	2.39

How to calculate four well volumes using Table 1

- Step 1: Measure the actual inside diameter of the well casing - find on column three of chart. You may also use the nominal pipe size and schedule in lieu of a measurement.
- Step 2: Calculate feet of water in the well casing (depth to well bottom minus depth to water).
- Step 3: Multiply step 2 by the applicable value in column four. For example, you have a 2-inch, schedule 40 casing that measures 2.07 inside diameter and you have 20 feet of water (step 2) in the well. Multiply 20 feet by 0.70 (column 4) = 14 gallons; therefore, you must purge 14 gallons from the well before collecting

MONITORING WELLS

samples.

To Convert: Gallons to liters, multiply gallons by 3.785
Liters to gallons, multiply liters by 0.2642
Milliliters to gallons, multiply milliliters by 0.0002642
Feet to meters, multiply feet by 0.3048
Centimeters to feet, multiply centimeters by 0.03281

Wells that Purge Dry

This section applies to wells that take ~ 1 or more hours to recover, or nearly so, after they have been purged dry, or nearly so.

A. Low-flow Purging and Sampling in a WATER TABLE WELL (water level intersects the well screen)

1. Slowly lower the pump to the *lower portion* of the screened area of the well but without setting it at the very bottom of the well. Secure the power cable and sample tubing. A dedicated system is recommended over a portable system.
2. Record the "purging time start" and start purging the well at < 300 ml/min or <0.1 gpm. Purge until drawdown reaches the top of the pump or until the pump runs dry, then shut the pump off immediately! (**Caution!** Some pumps can be damaged by running them dry - follow the manufacturer's instructions.) Record the "purging flow rate" as an average.

Note: A pressure transducer or electric water level indicator can assist in determining when drawdown reaches the top of the pump. If you use an electric water level indicator, lower the probe tip to the well pump and turn the instrument on before pumping. Start pumping, then shut off the pump when the water level indicator shuts off.

3. Allow the well to recover, or nearly so. If time permits, purge the well a second time and allow the water to recover again before sampling. To save time, purge a well the first time, move on to the next well and purge it, then come back to the first well to purge it again before sampling. (With portable equipment - decontaminate first.) Record "volume purged," "purging time stop," "purged dry (Y)," and any problems purging.
4. Collect samples as described under Section 2.5. (Collect samples within 24 hours of purging, if possible.) Record "sampling flow rate" as an average, "time sample collected," and any other pertinent information related to the sampling event.

B. Low-flow Purging and Sampling in a PIEZOMETER (water level is above the top of well screen)

1. SLOWLY lower the pump to the *lower portion* of the screened area of the well but do not set the pump on the very bottom of the well. Secure the power cable and sample tubing at the top of the well. A dedicated system is recommended over a portable system.
2. Record the "purging time start" and start purging the well at <300 ml/min or <0.1 gpm. Purge the well until the water level is just below the top of the well screen. (Use a pressure transducer, water level indicator or similar method.) Shut off the pump and

MONITORING WELLS

record the "purging flow rate" as an average, "volume purged," "purging time (stop)," "purged dry (Y)," and any problems purging.

3. Allow the well to recover, or nearly so, then begin collecting samples as described under Section 2.5. (Collect samples within 24 hours of purging, if possible.) If the water level in the well reaches the top of the screen before all samples are collected, shut off the pump, allow the well to recover again, then resume collecting the rest of the samples. Record "sample flow rate" as an average, "time samples collected," and any other pertinent information related to the sampling event.

C. Purging and Sampling with a BAILER, or other grab sampler, in a Water Table Well or Piezometer

1. Record "purging time start" and bail the well dry, or nearly so. Take extra care to purge the well very slowly and very gently. Do not allow the bailer to contact the bottom of the well.
2. Allow the well to recover, or nearly so. If time permits, purge the well dry, or nearly so, a second time. Record "volume purged," "purging time stop," "well purged dry (Y)," and any problems purging.
3. Collect samples as described under Section 2.5, within 24 hours of well recovery, if possible. Use a bottom-emptying device to decant samples from the bailer. Record "time sample collected" and any other pertinent information related to the sampling event.

Alternative Methods

Alternative purging and sampling methods and equipment are acceptable if they provide representative groundwater samples. Your purging and sampling method and your equipment must not adversely affect sample integrity, chemistry, temperature and turbidity. In addition, alternative equipment must have minimal or no effect on groundwater geochemistry, aquifer permeability and well materials. Equipment materials must minimize sorption and leaching. Use the equipment in a manner that minimally alters the groundwater samples. If you meet these conditions, WDNR pre-approval is not required; however, verbal or written approval from WDNR is recommended before you use alternative purging and sampling equipment or procedures.

Document and describe any alternative equipment and procedures you use to purge a well and collect samples. Include this information in the sampling plan and groundwater data reports you generate for a site or project.

2.5 SAMPLE COLLECTION

Sample Collection and Filling Procedures

- ☞ Take in-field water quality measurements before *or immediately* after sample collection. (See Section 2.6.)
- ☞ Open only one sample container or one set of sample containers immediately before filling. Preserve samples within 15 minutes of collection and immediately place on ice.
- ☞ Minimize the contact of extraneous contamination with sample containers and equipment. Common extraneous contaminants include perfumes, cosmetics, bug spray, sun tan lotion, Sharpie[®], spray lubricants (e.g., WD-40[®]) and engine fumes. Sample up wind or remove extraneous contaminants before opening containers and collecting samples.
- ☞ Use waterproof labels. Write on them with a permanent, waterproof marking device (e.g., grease pencil). Labels should include:
 - ✓ A unique sample number and WUWN (if applicable).
 - ✓ Site/project name or other identifier.
 - ✓ Date and time sample collected.
 - ✓ Sample collectors initials.
 - ✓ Type of preservation added and analysis required.
- ☞ Appendix C includes a table that indicates a substance's potential to volatilize from a water sample during sample collection. Use extra caution when collecting samples that have a "medium" or "high" potential to volatalize from water.
- ☞ Remember to keep complete and accurate records. Record all field information before proceeding to the next well.

Order of Filling Sample Containers

Collect sample parameters in the following order:

1. Unfiltered samples for in-field water quality measurements. (This is not necessary if you take down-well or closed flow-through cell measurements.)
2. Volatile organic compounds (VOCs).
3. Non-filtered, non-preserved (e.g., sulfate, total chromium VI, mercury, semi- and non-volatiles, pesticides, PCBs).
4. Non-filtered, preserved (e.g., nitrogen series [ammonia, nitrates, nitrites, etc.], phenolics, total phosphorous, total metals, cyanide, total organic carbon).
5. Filtered, non-preserved (e.g., dissolved chromium VI).
6. Filtered, preserved immediately (e.g., dissolved metals)
7. Miscellaneous parameters.

MONITORING WELLS

Note: Collect sulfate samples before sulfuric acid preserved samples (e.g., nitrogen series). Collect nitrogen series samples before nitric acid preserved samples (e.g., boron, dissolved metals).

Procedures for Filling Sample Containers

Note: If a sample container already has preservative in it before you fill it (common for VOC vials), do not rinse the container before filling and take care to minimize sample overflow that may dilute the preservative.

1. Tip the sample container at a slight angle and allow a slow steady stream of water to run down its inner wall. Hold the sampling discharge tube close to the sample container but do not touch it.
2. Immediately after filling a sample container, if not already done, add any required preservative (filter first, if required), replace the cap, add the label, and place the sample in a plastic bag (optional) on ice in a cooler.
3. Record the "time sample collected." To avoid confusion, you may wish to record sample collection time in military time (e.g., 1300 instead of 1:00 pm, 1845 instead of 6:45 pm, etc.,)

Volatile Organic Compounds (VOCs)

Note: Do *not* filter VOC or other organic samples. Turn off any nearby gasoline engines or sample up wind of any engine exhaust. Remember to store one trip blank per cooler when collecting volatile (VOCs, GRO, and PVOCs) samples. Store empty VOC containers on ice to help you reduce VOC volatilization when you fill them.

1. If a laboratory hasn't already done so, add sufficient preservation to the container.
2. Tip the container at a slight angle and allow a slow, steady stream of water to run down its inner wall.
3. Fill the sample container until the water forms a positive meniscus at the brim, then immediately replace the cap.
4. Invert the sample container and tap it lightly to check for bubbles. If bubbles are present, fill a new sample container (containing preservative) and check for bubbles the same way. If bubbles are unavoidable, collect numerous samples and save those with the least amount of bubbles. Do not try to reopen and add more water to samples that have bubbles.

Refill a *used* container only if you again add sufficient preservative *and* refill it with water from the same well, to avoid cross-contamination between samples.

5. Label the sample, place it in a plastic bag (optional), then immediately place it on ice in a cooler. Record the "time sample collected."

Semi-volatiles and Pesticides

When collecting semi-volatiles and pesticides, unless project objectives or regulations require otherwise, use similar, but less rigorous, procedures as those described for collecting VOC samples. Use the same equipment decontamination and storage procedures you use for collecting VOC samples.

When collecting semi-volatiles and pesticides, the type of sample container, volume and preservative may be quite different than that required for VOC samples. In addition, leave approximately ½ inch of air space when filling sample bottles to allow for expansion. Otherwise, the bottles may break.

Note: The number of sample bottles required depends on the number of different extraction, clean-up, analytical methods and quality control (QC) needed for the project. Remember that laboratories are required to duplicate and spike samples at a set frequency. Collecting insufficient sample volumes may result in higher detection limits, because sample volume must be reduced to accommodate QC requirements.

Inorganics

Inorganic samples (e.g., dissolved metals) are quite susceptible to aeration, oxidation, precipitation, coprecipitation, extraneous contamination and cross-contamination during sampling, filtering and handling. Therefore, take extra care to avoid sample aeration before filtering (if required) and preserving. Unless WDNR requires or approves otherwise *field filter* inorganic samples and *preserve immediately* after collection. Refer to Section 2.7 regarding filtering procedures.

Other Sample Parameters

Other sample parameters subject to rapid change (by aeration and subsequent changes in redox state, or addition or loss of dissolved gasses) once groundwater is removed from a well include: chromium VI, pH, Eh, oxygen, inorganic carbon, alkalinity, TOC, ammonium, nitrate/nitrite, sulfide, cyanide, molybdenum, mercury, selenium, dissolved iron (ferrous iron - Fe^{2+}), manganese, zinc, cadmium, lead, vanadium, arsenic and phosphate. Take precautions to avoid altering these parameters during sampling. Add preservative, if required, *immediately* and place on ice in a cooler.

For those interested in monitoring indicators of biodegradation that may be occurring in groundwater at a site, use a field test kit (e.g., colorimetric), sensor probe or other field test (e.g., portable gas chromatogram) to quantify pH, dissolved oxygen, nitrate, sulfate, ferrous iron, redox potential and manganese *in the field* immediately after sample collection. In addition, alkalinity, methane and carbon dioxide should be measured in the field immediately after collection, or less preferably, in the laboratory.

Contact a qualified laboratory for specific directions on collecting, preserving and handling samples not discussed in this manual.

2.6 FIELD WATER QUALITY MEASUREMENTS

- ☞ Use a closed flow-through cell. Or, you can use a down well measuring probe; however, well water must be flowing past the probe during measurements (i.e., the probe is near the pump's inlet during purging or is lowered and raised in the screened portion of the well).
- ☞ If you do not use a closed flow-through cell or a down-well probe, take in-field measurements immediately, or less preferably, within 30 minutes of collection.
- ☞ Avoid exposing instruments and samples to extreme heat or cold.
- ☞ Specific conductance, pH, dissolved oxygen and Eh can change rapidly due to aeration, oxidation and the loss or gain of dissolved gasses as you remove groundwater from a well. Minimize atmospheric contact with the sample.

Following are procedures for '*but of the well*' (i.e., closed flow-through cell or sample bottle) water quality measurements. Your equipment's operation manual may deviate from guidelines provided here. Follow the manufacturer's instructions for your instrument and familiarize yourself with the methodology in the most recent version of *Standard Methods for the Examination of Water and Wastewater*.

Temperature

1. Place the thermometer or probe into a closed flow-through cell or sample bottle and allow the purge water to continuously flow past the thermometer or probe. If you use a sample bottle, allow the water to overflow while measuring temperature.
2. Allow the thermometer or probe to equilibrate with the water for a minute or more, then record the temperature. Do not remove the thermometer or probe from the water when taking the reading.
3. Decontaminate the thermometer or probe and store properly.

Specific Conductance (conductivity and electric conductance)

Note: Measure specific conductance *before* pH (unless using a flow-through cell). In addition, as specific conductance is a temperature sensitive measurement, adjust readings to 25°C.

1. Calibrate the conductivity instrument and probe against a standard potassium chloride (KCl) solution. Do this in the field, or less preferably, in the laboratory. Calibrate the instrument

- according to the manufacturer's instructions. Recalibrate at least daily; more often is recommended and prudent. Record calibration data.
2. If required, set the instrument to the anticipated range for measurement (e.g. 100 $\mu\text{mhos/cm}$).
 - 3a. If your instrument *automatically compensates for temperature*, record the measurement as "field specific conductance at 25°C." Don't forget to multiply the measurement by the range at which the instrument is set.
 - 3b. If your instrument *does not automatically compensate for temperature*, measure the temperature of the sample and set the instrument's temperature dial to the sample temperature. Record the measurement as the "field specific conductance at 25°C." Don't forget to multiply the measurement by the range at which the instrument is set.
 - 3c. If your instrument cannot compensate for temperature, apply a correction factor as specified in the manufacturer's instructions or by using the following formula:

$$\text{specific conductance @ 25}^\circ\text{C} = \frac{\text{sample conductivity } (\mu\text{mhos/cm})}{1 + 0.0191x (\text{sample temp. in } ^\circ\text{C} - 25)}$$

Note: Conductivity meters that do not automatically correct readings to 25°C usually include a conversion table or chart for correcting data to 25°C.

4. Decontaminate the electrode and store properly.

Note: Most problems related to collecting poor conductivity data include: weak batteries; fouling of the electrode (chemical cleaning may be necessary); insufficient submersion of the probe into the sample; allowing the probe to touch the container walls; improper or no instrument calibration; not allowing the probe to equalize with the sample temperature; and improperly or not converting readings to 25°C.

pH

1. Calibrate the pH instrument with pH buffer solutions that span the range of expected groundwater pH values. Two fresh pH buffer solutions (7.00 and 4.00 or 7.00 and 10.00) having temperatures within 5°C of the groundwater samples are required for instrument calibration. Properly fill the probe with a salt solution, if required. Follow the manufacturer's instructions for the procedures and frequency of instrument calibration. Calibrate the instrument at least daily; more often is recommended and prudent. Record calibration data.
 - 2a. Place the calibrated pH probe into a closed flow-through cell and allow the purge water to continuously flow past the probe.
 - 2b. If you measure pH from a sample container, fill a container for this measurement *only*. Do not insert a pH probe into a sample that will later be analyzed for other parameters.
 3. Allow the pH probe to equilibrate with the water for a minute or more, then record pH. Do not
-

MONITORING WELLS

remove the pH probe from the water while taking the reading. Read pH measurements to the nearest 0.1 pH units.

4. Rinse the pH probe with reagent grade water and store in the buffer solution or as recommended by the equipment's manufacturer.

Turbidity

Measure the turbidity of a sample the same day you collect it, preferably in the field immediately after collection.

If you cannot measure sample turbidity soon after collection, you may store samples in the dark for up to 24 hours before measuring turbidity. Shake the sample vigorously before measuring. *Standard Methods for the Examination of Water and Wastewater* discusses interferences and procedures for measuring turbidity.

- 1a. Use a turbidity meter according to the manufacturer's instructions. Read turbidity to the nearest 0.1 Nephelometric Turbidity Unit (NTU) and record your measurement. In addition, provide this measurement to the laboratory if any well samples will be analyzed for metals.
- 1b. When you do not use a turbidity meter, describe the turbidity (e.g., slight, moderate) and record your observations or have a laboratory determine sample turbidity within 24 hours of sample collection.

Dissolved Oxygen

You can measure dissolved oxygen (DO) with an electrometric method (dissolved oxygen meter), colorimetric method, the Winkler method, or with the iodometric method. (See most recent version of *Standard Methods for the Examination of Water and Wastewater*) Dissolved oxygen meters usually require calibration before use and a visual check of the probe to verify that the membrane is not damaged.

To function properly, most DO probes require that water continuously flow past the membrane while measurements are being taken. Therefore, for down-well measurements of DO after purging a well, use either a DO probe equipped with a stirring rod or, less preferably, slowly raise and lower the probe in the water column while taking readings. If you use a DO probe on a water sample removed from the well, either use a probe equipped with a stirring rod or, while purging the well, allow the purge water to overflow from the sample container while taking DO readings.

If your DO meter is not responding as expected or is very sluggish, you may need to change the probe's membrane; follow the manufacturer's instructions for doing this. Lowering a probe into a deep well may also result in sluggish performance because signal strength weakens with cable distance.

Color

1. Note the color against a white background. If filtering is required, note the color *after* filtering. Document whether you noted sample color for a filtered or nonfiltered sample.
2. Describe the color by common descriptors (e.g., light gray), or use an industry-recognized and standardized color description method (e.g., a color comparison disk for water). Record your observations.

Odor

Important Note: WDNR neither requires nor advocates smelling groundwater samples.

- 1a. If you do not know the type and approximate concentration of substances in a sample, **do not** attempt to smell it. Record sample odor only if you notice it unintentionally.
- 1b. If the type and concentration of substances are known and below safe values as established by Occupational Safety and Health Association (OSHA) or the National Institute for Occupational Safety and Health (NIOSH) *Pocket Guide to Chemical Hazards*, carefully wave your hand over the sample and note any distinct odor. Do not "stick your nose" in the sample to check for odor. Record any noticeable odor (e.g., pungent, solvent).

Eh (Oxidation-reduction potential)

Eh is usually measured with a noble metal (e.g., platinum) and a reference electrode system using a pH meter that reads millivolts. Take field measurements of Eh in an air-tight flow-through cell or similar air-tight device. Read Eh measurements to the nearest 10 millivolts (mV).

Follow the equipment manufacturer's instructions and refer to the most recent version of *Standard Methods for the Examination of Water and Wastewater*

Other Water Quality Measurements

Other water quality measurements that may change physically and chemically soon after collection include dissolved carbon dioxide and alkalinity. These parameters are best measured in-field and immediately after collection. Follow the equipment manufacturer's instructions and the most recent version of *Standard Methods for the Examination of Water and Wastewater* for measuring these parameters.

2.7 SAMPLE FILTRATION

- ☞ WDNR *strongly recommends* direct, in-line filtering of samples. It is fast, simple and greatly reduces sample alteration. Direct, in-line filtering means that you attach the filter *directly* to a pump's discharge line or to the discharge tube of a grab sampler (e.g., bailer). If you place a sample into any type of container or transfer vessel before filtering, any filtering that follows is not direct, in-line filtering.
- ☞ If you do not use direct, in-line filtration, filter samples *immediately* after collection, document when you filtered the samples.
- ☞ Use a 0.45 micron pore size filter membrane for filtering. If possible, rinse or flush the filter membrane and filtering device with a minimum of 0.5 liters (500 mls) of reagent grade water before use.
- ☞ Avoid applying high pressure (>50 psi) when filtering samples. For silt-laden or turbid samples, try using a pre-filter (e.g., glass microfiber), a filter membrane of larger diameter or larger surface area, or a slower pumping rate or bailing technique. If high turbidity is a recurring problem, the well may need to be redeveloped or rehabilitated.
- ☞ If possible, allow 150 mls or so of sample to pass through the filtering device before filling sample containers. If possible, rinse sample containers once with filtrate.

Filtration Procedures

IMPORTANT: *Immediately* after or during collection, *field filter* samples collected for metals analyses. There are three exceptions:

- 1) Total metals results are required. This requirement may be in a Wastewater permit, administrative rule, sampling contract or other requirement or agreement.
 - 2) WDNR grants a verbal or written approval to the responsible party, or its representative, allowing unfiltered metal sample results.
 - 3) Low-flow sampling procedures are used, three consecutive in-field turbidity readings (spaced ~2 minutes or ~ 0.5 well volumes or more apart) are all 5 NTUs or less *and* WDNR grants verbal or written approval to the responsible party, or its representative, allowing unfiltered metal sample results.
- A. Low-flow Purging and Sampling, NO FILTRATION and Three Consecutive Turbidity Readings of 5 NTUs or less

This procedure involves purging a well at 1 L/min (0.26 gpm) or less and sampling the well at 300 ml/min (0.3 L/min or 0.1 gpm) or less. The sample does not require filtering if low-flow sampling procedures are used, three consecutive in-field turbidity readings (spaced ~2 minutes or

~ 0.5 well volumes or more apart) are all 5 NTUs or less **and** WDNR grants verbal or written approval to the responsible party, or its representative, allowing unfiltered metal sample results. Record that the samples were not filtered and that they have turbidity readings of 5 NTUs or less.

Under this scenario, purging and sampling rates should be at or less than natural flow conditions existing in the aquifer. Low turbidity values (<5 NTUs) for the sample should reflect the naturally mobile colloids and particulates moving through the groundwater.

B. Low-flow Purging and Sampling, and Direct, In-line Filtration

1. After completing well purging as described under Section 2.4, reduce the pumping rate as low as possible to deliver a slow discharge. Do not use a valve to reduce the flow rate.
2. Attach the direct, in-line filter **directly** to the pump's discharge line. (If applicable, remove the sample tubing from the flow-through cell first.)
3. Discard the first 150 mls or so of filtered sample. Collect the subsequent filtered samples into appropriate sample containers.
4. Immediately preserve the samples, replace the cap, label the samples, and place them on ice in a cooler.
5. Record "sample field filtered (Y)" and the "time samples filtered." Dispose of the used in-line filter - **do not** reuse it.

C. Purging and Sampling with a Bailer and Direct, In-line Filtration

1. Purge and sample the well as described under Section 2.4.
2. Connect the direct, in-line filter to the bailer as described by the manufacturer's instructions. Pressure-fed systems are recommended over gravity-fed systems.
3. If the bailer's volume allows, discard the first 150 mls or so of filtered sample. Collect the subsequent filtered samples into appropriate sample containers.
4. Immediately preserve the samples, replace the cap, label the samples and place them on ice in a cooler.
5. Record "sample field filtered (Y)" and the "time samples filtered." Dispose of the used in-line filter - **do not** reuse it.

D. Sample Transfer and Pressure Filtration: Field Filtering Immediately After Sample Collection

Note: Use positive pressure filtration rather than vacuum filtration, which causes excessive sample aeration and agitation.

- 1a. If you use a **self-contained filtering device**, gently pour the sample (preferably directly

MONITORING WELLS

from the pump's or grab sampler's discharge line) directly into the self-contained device fitted with a disposable filter membrane. Attach the pressure line to the device.

- 1b. If you use a **transfer vessel**, gently pour the sample (preferably directly from the pump's or grab sampler's discharge line) into the transfer vessel. Set up the reusable filtering device with a disposable filter membrane or use a disposable, in-line filter in conjunction with the transfer vessel.

Note: Some laboratories may recommend a dilute nitric acid/reagent grade water rinse of the filtering equipment (i.e., described in "1a" and "1b") to prevent extraneous contamination of filtered samples.

2. If you have sufficient sample volume, discard the first 150 mls or so of filtered sample. Collect the rest of the filtered sample into appropriate sample containers.
3. Immediately preserve the samples, replace the cap, label the samples and place them on ice in a cooler. Record "time samples filtered" and "samples field filtered (Y)."
4. Dispose of the used filter membrane **-do not** reuse it. Decontaminate the transfer vessel and filtering device and store for later use.

E. Sample Transfer and Filtration: Field Filtering NOT Done Immediately or Sample is Filtered Later in a Laboratory

Unless the parameters being collected are not subject to change during sample storage (e.g., changes in dissolved gas content, pH, Eh, redox potential, and dissolved/solid phases), filter samples in the field **immediately** after collection. If a sample is not subject to change and is held for extended periods of time, filtering may be done later. Record the filtering place, time and method.

Alternative Methods

Alternative filtration techniques are acceptable if you use a 0.45 micron pore size filter membrane that is nonsorptive and does not leach contaminants into the sample. The materials and operation of the filtering device must have little or no physical or chemical effect on the sample being filtered. Follow the manufacturer's instructions for proper use.

Document and describe the device, membrane and procedure used for filtering. This information must appear in your sampling plan and groundwater data reports for a site or project.

2.8 SAMPLE PRESERVATION AND HANDLING

Sample Preservation

Appendix C includes sample preservation for a variety of compounds and parameters. You may add preservative to sample bottles before or immediately after sample collection. (Filter the sample, if required, before adding preservative.) If you add preservative to a container before adding the sample, take care to minimize sample overflow that may dilute the preservative.

Checking and Adjusting the pH of a Preserved Sample

Note: Do **not** check the pH of VOC samples.

When using a pH meter to check the pH of a preserved sample, follow these procedures:

1. If applicable, check and fill the reference electrode with solution as recommended by the instrument's manufacturer.
2. Calibrate the instrument according to the manufacturer's instruction. Two fresh pH buffer solutions (7.00 and 4.00 *or* 7.00 and 10.00) having temperatures within 5°C of the groundwater samples are typically required for instrument calibration.
3. Pour a small portion of the preserved sample into a separate container. Immerse the electrode into the separate container and wait for the reading to stabilize. Do not swirl or stir the electrode while taking the reading unless recommended by the manufacturer.
- 4a. If sample pH needs adjustment, add additional preservative to the original sample and repeat Step 3.
- 4b. If sample pH is acceptable, dispose of the separate sample (**do not** pour it back into the original sample container), replace the lid on the original sample and place it on ice in a cooler.
5. Rinse the electrode with reagent grade water and store the electrode in the buffer solution or as recommended by the manufacturer.

When using pH paper to check the pH of a preserved sample, follow these procedures:

1. Gently tip the sample container on its side to wet the inside of the lid and remove the lid.
2. Touch the pH paper to the droplets inside the lid and read the pH. **Do not** put the pH paper directly into the sample container. Compare the color of the pH paper to color-pH provided by the manufacturer.
- 3a. If sample pH needs adjustment, add additional preservative to the sample, rinse the container lid with reagent grade water, replace the container lid and repeat Steps 1 and 2.

- 3b. If sample pH is acceptable, rinse the container lid with reagent grade water, shake the lid to remove any excess water and replace the lid.

Sample Handling and Storage

After samples are collected, filtered (if required), labeled and preserved (if required), they must be placed *immediately* on ice. Keep samples at or below 4°C, but above freezing throughout storage, handling and shipping. Make sure there is enough ice for the duration of sample storage and transport. WDNR *discourages* using frozen cold packs (e.g., "blue ice"). If you do use them, place a temperature blank in the cooler so the laboratory can document the temperature of the samples when they arrive.

Breakable sample containers (e.g., glass VOC vials) should be separated by bubble wrap, foam, ice, etc. At least a portion of each container must contact the ice, otherwise the protective layer (e.g., bubble wrap) may insulate the sample from the cooling effects of the ice. Placing samples in a plastic bag can help minimize the chance of cross-contamination among samples should a container break.

2.9 QUALITY ASSURANCE/QUALITY CONTROL

- ☞ Field QA/QC efforts must match the data quality objectives established or required for the project and sampling event.
- ☞ Remember that QA/QC procedures and samples are not optional. Each WDNR program may have different QA/QC requirements. Check WDNR program guidance or contact a WDNR project manager for details.
- ☞ All QA/QC samples must be collected, handled and processed in *the same exact manner* as the other analytical samples being collected. Make sure the laboratory receives sufficient sample volumes or additional containers to perform required QC procedures.
- ☞ All purging, sampling and decontamination wastewaters and materials must be stored, handled and disposed of properly. Contact your WDNR project manager or WDNR program for details.

Quality Control Samples

Trip Blank

Include one trip blank per cooler if collecting volatiles (i.e., VOCs, GRO, or PVOCs).

Prepare trip blanks with laboratory *reagent grade water*. **Do not** prepare them with water (even if distilled or deionized) purchased at a store; there is no guarantee that store-bought water is free of contamination. Trip blanks must be analyzed by the same laboratory that is analyzing the volatile samples. The trip blanks should not be opened until they are analyzed.

WDNR typically requires one trip blank per vehicle and one trip blank per cooler. Store, transport and ship all volatile samples in one cooler to minimize the number of trip blanks.

Note: If holding times permit, trip blanks do not need to be analyzed if VOC, GRO and PVOOC compounds are not detected *in any* of the groundwater samples. The holding time for a trip blank begins when groundwater samples are being collected.

Field Blank (field rinsate blank, decontamination blank, equipment blank)

Collect one field blank for every 10 samples or less collected. Decontaminate the sampling equipment for the field blank the same way you do when collecting other samples. After decontaminating the sampling device (e.g., bailer or pump), fill it with laboratory *reagent grade water*, then collect a sample of the reagent grade water - this is your field blank. Collect the field blank from equipment used in a site's most contaminated well, if possible. The field blank should be analyzed for the same parameters as the samples. Field blanks are **not** required if you use dedicated sampling equipment ("permanently" left in the well) or disposable sampling equipment.

Field Duplicate

Collect one field duplicate for every 10 samples or less collected. Collect the field duplicate from the most contaminated well, if possible. The field duplicate should be analyzed for the same parameters as the samples. When using a grab sampler (e.g., bailer), collect the duplicate from the same bailer of water as the original sample is collected, bailer volume permitting.

Field Split Samples

Typically not required. Collect the sample from the well, filter if required, and dispense into two or more containers. Preserve the samples if required and send them to separate

MONITORING WELLS

laboratories for analysis. The samples must be analyzed by identical laboratory analytical methods to be comparable.

Sequential Samples

Typically not required. Sequential samples are taken from the same well during the same sampling event but are collected with different equipment or procedures. These samples can be used to detect variability in analytical results caused by different sampling equipment or procedures.

Equipment Decontamination

Check with your laboratory for recommended equipment cleaning solutions and procedures for each analyte you are sampling. Collection of inorganic compounds may necessitate a dilute acid equipment rinse first. Collection of organic compounds may require a pesticide grade isopropanol, acetone, methanol or hexane equipment rinse. If you use pesticide grade hexane, take extra safety precautions because hexane is quite flammable. Use your professional judgment to decide which of the following procedures to use:

Minimum Decontamination Procedures

1. Disassemble the equipment if possible. Use a weak non-phosphate detergent (e.g., Alquinox[®], Liquinox[®]) and water solution, and scrub the equipment inside and out. Visually inspect the equipment to ensure no visible contamination is present.

Note: If welfare or indicator parameters (Table 2 and 3, respectively, of ch. NR 140), or non-sorptive elements or compounds are the only contaminants to come in contact with the equipment, Step 1 may not be necessary. Consult with WDNR staff if you are uncertain.

2. Thoroughly rinse the equipment with organic-free tap water. Reassemble the equipment, if applicable.
3. Store and transport the equipment in clean plastic, aluminum foil, or a container that will protect the equipment from extraneous contamination.

More Rigorous Decontamination Procedures

1. Wash equipment with a non-phosphate detergent solution and scrub with an inert brush. For internal mechanisms and tubing, circulate the detergent solution through the equipment.
2. Thoroughly rinse the equipment with organic-free tap water.
- 3a. For **organic** (e.g., VOCs) sample collection, rinse equipment with an organic desorbing

agent (e.g., pesticide grade isopropanol, acetone, methanol or hexane).

- 3b. For *inorganic* sample collection, rinse equipment with inorganic desorbing agent (e.g., dilute [0.1 Normal] reagent grade hydrochloric acid or nitric acid solution). For stainless steel and low-carbon steel, a more dilute hydrochloric acid solution (1 percent) is recommended.

Note: If you use organic or inorganic desorbing agents, check with your laboratory regarding potential analytical interferences caused by desorbing agents and their proper use and disposal.

4. Rinse the equipment with organic-free tap water only if you are using *inorganic* desorbing agent.
5. Rinse with laboratory reagent grade water. If practical, allow the equipment to air dry before its next use or storage.
6. Store and transport the equipment in clean plastic, aluminum foil or a container that will protect it from extraneous contamination.

Other decontamination methods such as high pressure steam cleaning, hot-water power wash, ultrasonic cleaning and other methods decontaminate most equipment satisfactorily. Refer to the manufacturer's instructions for use.

Note: Dedicated sampling equipment ("permanently" left in the well) significantly reduces the need for equipment decontamination. Sampling equipment used in wells containing free product should be dedicated (suspended above the water column) or disposable.

Sample Tracking, Security and Chain of Custody Procedures

Sample tracking, security and chain of custody procedures provide a legal record of sample transport, possession and handling.

Sample Identification

Use waterproof labels or a similar method to identify each sample container. Use a permanent waterproof marker. Avoid placing labels on container lids; however, if you do place a label on a lid, make sure it's attached to the container as well. Labels should include the following information:

- ✓ a unique sample number and WUWN (if applicable)
- ✓ site/project name
- ✓ date and time sample collected
- ✓ sample collectors initials
- ✓ preservation and analysis required

Sample Seals

Some sampling protocols require sample seals. Affix the seal to the sample container so that it has to be broken to open the container. Write your initials, the date and time on the seal.

Shipping Custody Seal

Use tape or a lock to seal the container for shipping. If you use tape, write your signature, the date and time on the tape.

Chain of Custody Record

Complete a chain of custody (COC) record for each sampling event. Each time the samples change possession, whoever relinquishes and whoever receives the samples must sign, date and time the chain of custody form.

Note: If you place the chain of custody record in a sealed shipper, you do not need to have the commercial courier (e.g., UPS) sign, date and time the record; however, the courier should have a record of when he or she picked up the samples and where they were sent.

Appendix A includes an example chain of custody form. Check with the WDNR program, WDNR project manager, and the laboratory for more specific chain of custody procedures or forms required. Appendix C contains "Chain of Custody for Samples Requiring Strict Custody" when collecting enforcement samples.

3.0 SAMPLING PROCEDURES FOR WATER SUPPLY WELLS

Important note: This section addresses the collection and measurement of *raw, untreated groundwater samples* from water supply wells. Ch. NR 809 and SDWA compliance monitoring and sampling are beyond this manual's scope and intent; contact a WDNR water supply specialist or investigator when collecting these samples.

3.1 PRE-FIELD CHECKLISTS AND DOCUMENTATION

Pre-field Checklists (Included in Appendix B)

Go through the following two checklists before heading out to the field. You can modify these checklists to meet specific project needs.

1. Pre-field Work Procedures Checklist - Water Supply Wells.
2. Equipment Checklist - Water Supply Well Sampling.

Documentation of the Sampling Event

1. **Sampling Plan.** The sampling plan documents equipment and procedures used during a sampling event. All sampling personnel must read it before heading out to the field and must bring it to each sampling event. Any deviations from the sampling plan must be documented on the "Field Procedures Documentation" sheet included in Appendix B, or on a customized documentation sheet.
2. **Well-Specific Field Sheet - Water Supply Wells (Appendix B)** Document well information, purging and sampling information, measurements, etc., on this sheet or customize your own data sheet.
3. **Field Procedures Documentation (Appendix B).** If a sampling plan is not available, you can use the "Field Procedures Documentation" sheet included in Appendix B. Customize this sheet to meet specific needs.
4. **Groundwater Monitoring Inventory Form (Appendix B).** Complete this form if a well has not previously been monitored. This form documents information about the well so it can be entered into WDNR's computerized data base.
5. **Assigning a Wisconsin Unique Well Number (WUWN).** All public and private water supply wells must be documented with a WUWN. Each well must have *only one* WUWN. Refer to Section 3.2 for WUWN private well labeling procedures.

6. **Chain of Custody Form (Appendix B).** Document the possession of samples collected from water supply wells by completing a chain of custody form and documenting each time the samples change possession.

3.2 INITIAL PROCEDURES

Coordination with the Well Owner/Operator

1. Call the well owner/operator at least 24 hours before you plan to collect measurements and samples from the well. If you are sampling a private or domestic well, call the well owner at least one week in advance. Briefly explain to the well owner what you plan to do and why. Explain your procedures for measuring the water level, well casing depth and total well depth, and for collecting any samples.
2. If the well owner/operator allows you to perform these measurements, ask if it is all right to add chlorine or an alternative disinfectant to the well after taking the measurements. Explain to the owner why disinfection is essential and what disinfection technique you plan to use. If the owner rejects having the well disinfected, do not take measurements on the well. If obtaining measurements is crucial, ask an appropriate WDNR representative in the Bureau of Drinking Water and Groundwater to talk to the well owner to further explain the necessity of the measurements and that the well will be properly disinfected afterwards.
3. If the well owner/operator allows measurements and disinfection of the well, ask the well owner/operator to use a minimal amount of water in the morning/afternoon before your arrival, so the water level in the well recovers before being measured.
4. Before collecting any water level, well casing depth or well depth measurements, ask the well owner to turn off the pump to avoid an electrical hazard and to prevent the pump from starting when you are collecting measurements.

Initial Coliform Bacteria Testing

Before performing *any* tasks on the well, collect a water sample for coliform bacteria analysis using sampling procedures described under Section 3.7.

Wisconsin Unique Well Number (WUWN) Labeling Procedures

1. Determine if the well already has a WUWN - this is *absolutely* necessary to ensure that each well has *only one* WUWN assigned to it! WDNR water supply specialists/investigators at WDNR regional offices can tell you which water supply wells already have a WUWN - ask them for the most up-to-date list.
2. Determine which type of WUWN label is needed for the private well (i.e., printronic, blank, and preprinted labels). If you are uncertain which label is required, refer to the *Groundwater*

Sampling Desk Reference or contact a WDNR regional office water supply specialist/investigator. If you assign a WUWN to a private well, you must fill out a "Groundwater Monitoring Inventory Form" (Form 330-67 Rev. 12-92), and send it to the Bureau of Drinking Water and Groundwater, P.O. Box 7921, Madison, WI 53707-7921.

3. If the well owner consents to it, you should place WUWN labels on the well's fuse box and sampling tap. Attach one of the WUWN labels to the home's main electric fuse box. Attach a second label to the pipe next to the sampling tap located **before** the pressure tank. Wipe the pipe as clean and dry as possible and wrap duct tape around the pipe to provide a dry surface to affix the label. Attach the label horizontally to the duct tape.

Note: While public water supply wells have WUWNs assigned to them, they normally do **not** have WUWN labels placed on them unless requested by the public water utility, in which case a specialized label is provided. Contact the Bureau of Drinking Water and Groundwater in Madison for further details.

3.3 MEASURING WATER LEVEL, CASING DEPTH AND TOTAL WELL DEPTH

- ☞ Measure the water level, well casing depth, and total well depth only after receiving training from someone experienced in the proper procedures. If the well has a pitless adaptor, it may be impossible to collect these measurements.
- ☞ If available, use a well construction log to obtain well casing depth and total well depth information. If this information is not available, you may need to remove the well's pump, if the well owner permits, before measuring well casing depth or total well depth. Use **extreme care** so as not to damage or contaminate the well or pump. A licensed well driller, arranged for far in advance, should remove and replace the pump.
- ☞ Before taking any well measurements, ask the well owner/operator to turn off the pump. This is for your own personal safety and to protect the pump from damage as equipment is lowered into the well. Make sure the well and wiring are not damaged during measuring and sampling.

Disinfection Procedures for Equipment

Important Note: Before placing **any** equipment into a water supply well, potable or non-potable, properly disinfect the equipment.

WATER SUPPLY WELLS

1. Disinfect all equipment before and after placing it into the well to prevent the introduction of coliform bacteria, iron bacteria, or any other source of contamination.
2. Rinse all equipment parts inside and out that will enter the well (e.g., steel tape, water level indicator, weighted magnet, etc.). Rinse with a dilute chlorine solution, about 50 ppm, i.e., about 2 capfuls of liquid chlorine bleach to 1 gallon of water. The liquid chlorine bleach must not contain any additives such as "fresh scent." You may also use dry calcium hypochlorite granules to make the chlorine solution.
3. If there are no inside parts that may become contaminated, you may use a clean cloth or paper towels soaked in a dilute chlorine solution to sterilize your equipment. Do not reuse the towels.
4. Place disinfected equipment on a clean cloth or on plastic, not on bare ground.

Measuring Water Level

Note: Refer to Section 2.2 when using an electric water level indicator, popper or coated tape to measure the static water level in a well.

1. Take a series of water level measurements to determine if the well is still recovering. If at least three consecutive readings separated by a minute or more are within ± 0.01 foot, then use this as your reading. Record the reading and method used to collect this measurement. Disinfect the equipment.
2. If you are taking water level measurements to determine groundwater elevations, mark the side of the casing where the water level is measured to provide a marking point for surveying.

Measuring Well Casing Depth

1. Use a weighted magnet that is strong enough to cling to the steel casing but will also slide down it. The tape or cable should be calibrated and marked to tenths of a foot.
2. Lower the disinfected magnet, which is attached to a marked disinfected cable, along the steel casing until the magnet slips off the end of the casing.
3. Measure the length of the steel casing to its top. Repeat this process until you are satisfied you have a reliable reading.
4. Record this measurement and the method used for collecting it. Disinfect the equipment and store properly.

Measuring Total Well Depth

1. Measure the total well depth with a weighted synthetic tape or cord (~~not~~ cotton or cloth) calibrated and marked to tenths of a foot. Any tape or cord used must have very little or no stretch under tension.
2. Lower the disinfected weighted tape or cord through the water column until it becomes slack. Slowly pull the tape or cord until it just becomes taut.
3. Read the tape against the top of the well casing to the nearest 0.1 foot and record the measurement. Disinfect the equipment and store properly.

Disinfection of Well after Measurements

Properly disinfect the well after taking any measurements. While there are no formal standards for proper concentrations of the chlorine disinfection solution, a 50 ppm chlorine solution should be adequate for chlorinating wells as a preventive assurance method.

After Water Level Measurements

1. Pour one cup of full-strength liquid chlorine bleach or drop three to five HTH tablets down the well to disinfect 20 feet of standing water in a 6-inch diameter well. Re-seal the well.
2. Allow the solution to remain in the well at least 30 minutes, although at least 8 hours is recommended.
3. Tell the well owner/user to run all taps until the chlorine odor and taste disappear (usually less than one hour).

After Well Casing and Total Well Depth Measurements

If you are measuring only the well casing depth, the amount of 50 ppm chlorine solution you need to displace the affected portion of the well will depend upon how far you lower the magnet into the water. If measuring total well depth, disinfect the entire well by displacing all water out of the well. The total amount of 50 ppm chlorine solution to add will depend upon the diameter, depth, and amount of water in the well. For a 50 ppm chlorine solution made from common household bleach (approx. 5 percent available chlorine as sodium hypochlorite):

Add about 1 gallon of bleach (no additives) to 1,000 gallons of water or about 1 pint of bleach to 125 gallons of water.

For a 50 ppm chlorine solution made from dry calcium hypochlorite (approx. 70 percent available chlorine):

Add about 1 pound (approx. 16 oz.) of dry hypochlorite to 1,000 gallons of water or about 0.1 pounds (approx. 2 oz.) to 100 gallons of water.

Approximate amount of chlorine solution (CS) to displace the water in a well:

WATER SUPPLY WELLS

2" diameter well	Add 2 gallons of CS per 10 feet of well water
4" diameter well	Add 7 gallons of CS per 10 feet of well water
6" diameter well	Add 15 gallons of CS per 10 feet of well water
8" diameter well	Add 25 gallons of CS per 10 feet of well water

1. Mix the appropriate amount of chlorine solution for the volume of water to be displaced.
2. Pour the entire chlorine solution, in a circular motion, down the well's inside casing, pump equipment and wiring. Reseal the well.
3. Activate the well pump and turn on all taps, both hot and cold, until you detect a bleach smell at each tap, then shutoff all taps. To save energy, turn off the hot water heater.
4. Allow the chlorine solution to remain in the well and piping at least 8 to 12 hours, preferably 24 hours, to ensure that the well and piping are thoroughly disinfected.
5. After at least 8 hours, tell the well owner to flush the well and piping system free of the chlorine solution.

Discharge of Chlorinated Water

Unfortunately, there really is no good place to discharge the chlorine solution that comes out of the well and faucets. Do not discharge the solution directly to a lake, stream, wetland, lawn, garden, sanitary or storm sewer. Large quantities of chlorine may disrupt a septic system. Discharge the pumped water to an area that will not harm fish or sensitive plants.


Probably the best place to discharge the chlorine solution is onto a driveway or other paved area, preferably on a hot, sunny day so the solution can evaporate. Discharging the chlorinated solution to a ditch may also be appropriate.

Post Disinfection Coliform Bacteria Testing Procedures

After the system is ***completely*** free of any chlorine smell and taste, and after waiting several days to a week, collect a second coliform bacteria sample (refer to Section 3.7) from the same tap as the first sample. Properly-trained well owners, WDNR staff, local health staff or special consultants may collect the sample. When collecting post-disinfection coliform samples, you may need to use a thiosulfate sample bottle since a chlorine residual may remain in the well.

If either the initial coliform test or the post disinfection coliform test is ***positive*** for bacteria, ***immediately*** contact a WDNR drinking water specialist/investigator for further instructions.

3.4 WELL PURGING

-  Draw a diagram of where you purge the well and collect samples.

Large Water Supply Systems (i.e., public water supplies with distribution systems)

1. Purge and collect samples from a sample tap or faucet near the pump and ahead of treatment, storage or pressure systems.
2. Make sure the pump is activated, that water is flowing from the tap for at least five minutes and that the water is cold before you collect any samples.

Small Water Supply Systems (i.e., private water supply and distribution systems)

1. Purge and collect samples from a sample tap as close to the well's pump as possible, before the water passes through any softener, heater, storage or pressure system, or tank. Document if you cannot collect a sample located before a water heater or treatment system.
2. If possible, remove any aerators, filters or other devices from the tap before collecting any samples. If you must collect the sample from an outside tap, remove any hoses first.
- 3a. If you collect samples from a tap located **before** the pressure tank, first make sure the pump is activated and allow the water to run from the tap for at least two minutes – until the water is cold or for one full pump cycle.
- 3b. If you collect samples from a tap located **after** the pressure tank, first allow the water to run from the tap for at least five minutes – until the water is cold or for one full pump cycle. Run the water until the pressure tank and pump cycle the water two or three times. Document that you've collected samples from a tap located after the pressure tank.

3.5 FIELD WATER QUALITY MEASUREMENTS

Take in-field water quality measurements on unfiltered water supply well samples according to the procedures in Section 2.6.

3.6 SAMPLE FILTRATION

Do **not** filter groundwater samples from water supply wells.

3.7 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

Collect, preserve and handle water supply samples according to the procedures, where applicable, described in Sections 2.5 and 2.8. Collection of bacteriological samples are an exception; those procedures are described in this section.

Procedural exception when collecting VOCs from water supply wells:

If the sampling tap has an aerator, filter or other device, remove it. Run the water for at least two minutes, until cold. Reduce the water flow to a thin stream, then collect the VOC samples as described in Section 2.5.

Bacteriological Sampling

Select a sampling faucet least likely to provide an erroneous "unsafe" test result due to bacteriological contamination originating from the faucet. Use the following criteria to select a faucet:

- Choose cold-water faucets only.
 - Choose a faucet **not** connected to the building's water softener.
 - Avoid swing faucets.
 - Choose a smooth-end faucet over a threaded-end faucet, if possible.
 - Never sample from a flexible hose.
 - Never sample a drinking fountain.
 - Never sample a faucet that cannot be thoroughly flamed, such as a dripping faucet, outside hose bibb with an unremovable vacuum breaker, a faucet with an unremovable aerator, a plastic bathroom fixture, or a metal fixture with external plastic or rubber inserts (sometimes on the bottom of the fixture).
 - Avoid faucets that cannot deliver a smooth stream of water.
 - Avoid faucets that are seldom used.
 - Never sample a fire hydrant.
1. Remove the aerator and any washers.
 2. Run water from the faucet to determine if it can deliver a smooth stream of water.
 3. Flame the faucet for at least 15 seconds. Use a propane or butane torch. **Do not** use a candle, cigarette lighter, rolled newspaper, etc. Flame the outside and inside of the faucet. The flame must come into direct contact with the inside of the faucet. If possible, look at the inside surface of the faucet – if it is still wet, keep flaming.
 4. **Do not** touch the faucet after it has been flamed.
 5. Before collecting a sample, run the water for at least three minutes. Turn the faucet on so it delivers a smooth steady stream of water with minimal splashing. The flow rate should be high enough to deliver a smooth stream of water but low enough to permit the filling of sample bottles without turning the valve down before sampling.
Rule of thumb: The longer the water runs from the faucet, the greater your chance

for collecting a representative sample.

6. Do *not* readjust the flow rate before collecting samples. Fill the sample bottles $\frac{3}{4}$ full. This provides space for the laboratory to shake the sample to ensure uniform sample quality.
7. Replace the sample cap tightly! Place the sample container in a clean, unused sealable plastic bag to minimize exposure to any extraneous contamination during storage and transport. Bacteriological samples usually have to be analyzed soon after collection (within 30 hours of their collection for samples sent to the SLOH).

Important note: If you *eventhink or suspect* that a sample may have become accidentally contaminated, throw it out and collect a new sample following Steps 1 to 7.

Other Sample Parameters

Make sure you have the appropriate sample bottles as required by your laboratory and that they are pre-cleaned as appropriate for the parameters you are analyzing. Follow your laboratory's instructions for sample collection.

If you are unfamiliar with proper sampling procedures or need to know from which sample taps to collect other parameters (e.g., inorganic, radiological, total trihalomethanes [TTHM], etc.), ask a WDNR representative in the Water Supply program for instructions.

3.8 QUALITY ASSURANCE/QUALITY CONTROL

Refer to and follow the procedures described in Section 2.9. Appendix B includes an example chain of custody form you may use when collecting water supply well samples.

APPENDIX A

MONITORING WELLS

Checklists

- Pre-field Work Procedures Checklist - Monitoring Wells
- Equipment Checklist - Monitoring Well Sampling

Documentation Sheets and Forms

- Well Specific Field Sheet (WSFS) - Monitoring Wells
 - Groundwater Sampling Field Procedures Documentation
 - Chain of Custody Form for the LUST Program
(Form 4400-151)
- * Master copies of the above forms are also located in the plastic sheet protector at the back of this manual. Please keep these masters and copy as needed.

PRE-FIELD WORK PROCEDURES CHECKLIST - MONITORING WELLS

All the following procedures may not be necessary for each sampling event. Use those procedures applicable to your sampling plan or customize this list.

LOGISTICS

- ___ Arrange for site access with the land/home/facility owner and tenants.
- ___ Locate the nearest post office, UPS office, Fedex drop off spot, etc., if you will need to ship the samples from the field. (UPS has a 70 lb. restriction per container.)

LABORATORY ARRANGEMENTS

- ___ Select a qualified laboratory to perform the sample analysis. Check that the laboratory (and subcontracted lab) is certified to perform the required analysis.
- ___ Make sure you have sufficient numbers, types, and volumes of sample containers **get extras!** Remember QA/QC sample containers and trip blanks.
- ___ Discuss sample preservation, holding time, shipping requirements, and QA/QC expectations with the laboratory.
- ___ Inform the laboratory of the date and number of samples you will send.
- ___ Familiarize yourself with chain of custody and other sample tracking procedures.

SITE HISTORY

- ___ Review past water quality data or SAP to determine the well sampling order.

EQUIPMENT AND FIELD PREPARATION

- ___ Review the sampling and analysis plan (SAP) and QA/QC plan.
- ___ Organize equipment (Equipment Checklist - Monitoring Well Sampling).
- ___ Check that equipment is in good working condition:
 - ✓ Test and recharge/replace batteries as necessary.
 - ✓ Test the equipment with tap water or calibration standards.
 - ✓ Inspect the equipment for defects, loose bolts, frayed wiring, etc.
 - ✓ Check the instruments' ability to calibrate and function properly.
- ___ Check that all equipment is properly decontaminated and stored for transport.
- ___ Fill out the Well Specific Field Sheet (WSFS) as much as possible before heading out to the field.

HEALTH AND SAFETY EQUIPMENT AND PREPARATION

- ___ If required, prepare and follow a health and safety plan (HSP).
- ___ Inform sub-contractors and other site personnel of contaminants and site hazards.

EQUIPMENT CHECKLIST - MONITORING WELL SAMPLING

All the following items may not be necessary for each sampling event. Check those items applicable to your sampling plan or customize this list.

GENERAL AND LOGISTICS

- ___ Permission/notification to land/home owner/tenant
- ___ Directions to the site and site access roads/site access keys
- ___ Contact names, addresses and phone numbers
- ___ Site map showing well locations, keys for well locks
- ___ Calculator and/or purge volume conversion tables
- ___ _____

DOCUMENTATION AND REFERENCE MATERIALS

- ___ *Groundwater Sampling Field Manual*
- ___ Sampling and analysis plan (SAP), QA/QC plan, and health and safety plan (HSP)
- ___ Well Specific Field Sheet (WSFS) and Field Procedures Documentation sheet
- ___ Well and boring logs
- ___ Field note book and waterproof pens
- ___ Clipboard with waterproof cover
- ___ Chain of custody forms and other sample tracking forms
- ___ Camera and film
- ___ _____

PURGING AND SAMPLING EQUIPMENT

- ___ Plastic sheet or equivalent ground cover
- ___ Purging pump or bailer and accessories (inert material)
- ___ Sampling pump or bailer and accessories (inert material)
- ___ Pump or bailer rope/cable (no cotton or cloth) and tripod
- ___ Pump sample tubing (inert material)
- ___ Pump power supply, air compressor, inert gas, etc.
- ___ Calibrated buckets or similar device for purge water
- ___ Waterproof grease markers or pens (SharpiesTM are a potential source of VOCs)
- ___ Sample containers (provided by lab) -**bring extra**, and water proof labels/tags
- ___ QA/QC sample bottles (VOC trip blanks filled by lab)
- ___ Sample transfer containers and wide mouth funnel
- ___ Filtering apparatus and all accessories
- ___ Filter membranes (0.45 micron) and pre-filters, or
- ___ Disposable in-line filters
- ___ 55 gallon drums for wastewater and drum labels
- ___ _____

FIELD MEASUREMENTS AND EQUIPMENT

- ___ Water level measuring instrument (0.01 foot increments) and backup device
 - ___ Thermometer or temperature instrument
 - ___ Conductivity meter and calibration standards (KCl)
 - ___ pH meter, buffer solutions (pH 4, 7 and 10) and beakers
 - ___ Dissolved oxygen meter and membrane replacement kit and/or Eh meter
 - ___ Turbidity meter
 - ___ All meters fully charged and operational; spare batteries
 - ___ Closed flow through cell
 - ___ Squirt bottles filled with reagent grade water
-

DECONTAMINATION EQUIPMENT

- ___ Non-phosphate cleaner and scrub brushes
 - ___ Wash and rinse tubs or buckets and wastewater containers
 - ___ Laboratory reagent grade water (two gallons/well usually sufficient)
 - ___ Clean containers to transport equipment
-

SAMPLE PRESERVATION AND SHIPPING

- ___ Sample preservatives, transfer pipettes and pH paper
 - ___ Coolers sufficiently large to hold all samples, including QA/QC samples
 - ___ Crushed or cubed ice (frozen cold packs discouraged, need temp. blank)
 - ___ Bubble wrap, Ziplock™ bags or equivalent to protect sample containers
 - ___ Strapping tape, postage, Fedex or UPS shipping labels, COC forms, etc.,
-

TOOLS AND MISCELLANEOUS

- ___ Extra locks, keys for wells, flashlight, raingear, etc.
 - ___ Propane torch for frozen locks and bolt cutters for corroded locks
 - ___ Adjustable wrench, screw drivers, hammer, scissors, knife, duct tape, etc.
 - ___ Plastic garbage bags for contaminated waste
 - ___ Bailer retrieval device (e.g., weighted hook)
 - ___ Drum bung wrench and racket socket set (typ. 15/16" socket for 55 gallon drums)
-

PERSONAL PROTECTIVE EQUIPMENT

- ___ Respirators and cartridges (compatible for contaminants)
 - ___ Safety glasses and/or splash shield
 - ___ Inner and outer gloves (compatible for contaminants)
 - ___ Hard hat and steel toed boots
 - ___ Air monitoring equipment
 - ___ First aid kit and eye wash kit
-

WELL SPECIFIC FIELD SHEET - MONITORING WELLS (Sheet ____ of ____)

Facility/Project Name: _____ Date: _____

Section/Grid or Address: _____

License or Permit #: _____

Weather today and past weeks (precipitation): _____

Persons Sampling: _____

Well Name					
DNR Well ID No.					
Wis. Unique Well No. (WUWN)					
Damage to Well? (Y/N)					
Top of Casing or Reference Elevation (MSL)					
Depth to Water (to 0.01 ft)					
Groundwater Elevation (MSL)					
Depth to Well Bottom (ft)					
4 Well Volumes (gal. or liters)					
Purging Device; dedicated (D) or portable (PT)					
Purge Device Intake Depth (ft)					
Purging Time (start - stop)					
Average Purging Flow Rate (gpm or L/min)					
Volume Purged (gal. or liters)					
Purged Dry? (Y/N)					
Problems Purging? (Y/N)					
Sampling Device (D or PT)					
Sampler Intake Depth (ft)					
Average Sampling Flow Rate (gpm or L/min)					
Time Sample Collected					
Preservative (e.g., HCL)					
Field Temperature (°C)					
Field Specific Conductance					

Time Measured					
Well Name					
Field pH (standard units)					
Time Measured					
Turbidity (NTUs or describe)					
Time Measured					
Dissolved Oxygen (mg/l)					
Time Measured					
Eh - redox potential (mv)					
Time Measured					
Color (describe - grey, etc)					
Odor (describe - pungent, etc)					
Sample Field Filtered? (Y/N)					
Time Samples Filtered					
Well Capped & Locked? (Y/N)					

Comments (Discuss well damage, purging or sampling problems, deviations from sampling plan, etc.):

Sheet Completed by _____ Date _____

wsfs_3.fm

GROUNDWATER SAMPLING FIELD PROCEDURES DOCUMENTATION

Facility/Project Name: _____ Date: _____

Section/Grid Location or Address: _____

Facility Type: _____ License/Permit #: _____

DNR Regulatory Program: _____

Weather (temp., cloudiness, bar. pres., wind): _____

Persons Sampling and Title: _____

Water Level Equipment (type, model): _____

Purging Equipment (type, model, material): _____

Purging Method (4 well vol. or stabilization): _____

How Purge Volume Measured? (eg., calibrated bucket): _____

Sample Collection Equipment (type, model, material): _____

Method of Sample Withdrawal (bottom emptying device, low flow): _____

Type of Transfer Containers: _____

Filtering Equipment (type, material): _____

Filter Membrane (type, pore size): _____

When Were Samples Sent to Lab? _____

What Lab Were the Samples Sent to? _____

Were Enforcement Samples Sent? _____

How Were Samples Kept Cool (ice, other)? _____

Equipment Decontamination Procedures? _____

Decontamination Water Disposal? _____

pH Meter (type, model): _____

Person calibrating: _____

Frequency calibrated: _____

Calibration procedures (buffers used): _____

Problems with meter: _____

Conductivity Meter (type, model): _____

fpd.fm

(This page left blank)

APPENDIX B

WATER SUPPLY WELLS

Checklists

- Pre-field Work Procedures Checklist - Water Supply Wells
- Equipment Checklist - Water Supply Well Sampling

Documentation Sheets and Forms

- Well Specific Field Sheet (WSFS) - Water Supply Wells
- Groundwater Sampling Field Procedures Documentation
- Groundwater Monitoring Inventory Form
(Form 330-67 Rev. 12-92)
- Chain of Custody Form

* Master copies of the above forms are also located in the plastic sheet protector at the back of this manual. Please keep these masters and copy as needed.

PRE-FIELD WORK PROCEDURES CHECKLIST - WATER SUPPLY WELLS

All the following procedures may not be necessary for each sampling event. Use those procedures applicable to your sampling protocol or customize this list.

LOGISTICS

- ___ Contact the well owner to confirm the location, sampling date and time, and to discuss any site access issues.
- ___ Determine if the well has been inventoried. If not, obtain a WDNR well inventory number (Wisconsin Unique Well Number - WUWN).
- ___ Locate the nearest post office, UPS office, Fedex drop off spot, etc., if you will need to ship samples from the field. (UPS has a 70 lb. restriction per container.)

LABORATORY ARRANGEMENTS

- ___ Select a qualified laboratory to perform the sample analysis. Check that the laboratory (and subcontracted lab) is certified to perform the required sample analysis.
- ___ Make sure you have sufficient numbers, types, and volumes of sample containers needed ~~get extras!~~ Remember QA/QC sample containers and trip blanks.
- ___ Discuss sample preservation, holding time, shipping requirements, and QA/QC expectations with the laboratory.
- ___ Inform the lab of the date and number of samples you will send.
- ___ Familiarize yourself with chain of custody and other sample tracking procedures.

SITE HISTORY

- ___ Review past water quality data to determine the well sampling order.
- ___ Review the site hydrogeology and information available on the well.

EQUIPMENT AND FIELD PREPARATION

- ___ Organize equipment (Equipment Checklist - Water Supply Well Sampling).
- ___ Check that equipment is in good working condition:
 - ✓ Test and recharge/replace batteries as necessary.
 - ✓ Test equipment with tap water or calibration standards.
 - ✓ Inspect the equipment for defects, loose bolts, frayed wiring, etc.
 - ✓ Check the instruments' ability to calibrate and function properly.
- ___ Check that all the equipment is properly decontaminated and stored for transport.

HEALTH AND SAFETY EQUIPMENT AND PREPARATION

- ___ If required, prepare and follow a safety and health plan (SHP).
- ___ Inform sub-contractors and other site personnel of contaminants and site hazards.

EQUIPMENT CHECKLIST - WATER SUPPLY WELL SAMPLING

All the following items may not be necessary for each sampling event.

GENERAL AND LOGISTICS

- ___ Permission/notification to well owner and site access keys
- ___ Directions to the site, access roads and location of wells
- ___ Contact names, addresses and phone numbers
- ___ _____

DOCUMENTATION AND REFERENCE MATERIALS

- ___ *Groundwater Sampling Procedures Field Manual* sampling plan & QA/QC plan
- ___ Field note book, waterproof pens and clipboard
- ___ Inventory sheets or field data sheets
- ___ Chain of custody forms and other sample tracking forms
- ___ _____

EQUIPMENT AND SUPPLIES

- ___ Thermometer or temperature instrument
- ___ Conductivity meter and calibration standards (KCl)
- ___ pH meter, buffer solutions (pH 4, 7 and 10) and beakers
- ___ All meters and equipment fully charged/operational; spare batteries
- ___ Reagent grade water, gloves, ground cloth
- ___ Paper towels or disposable clean rags
- ___ Inert plastic bags to transport pump sample tubing, etc.
- ___ _____

PURGING AND SAMPLING

- ___ Special tap connection(s) and sampling tube for inaccessible sample taps
- ___ Calibrated buckets or similar device for purge water
- ___ Waterproof grease markers (SharpiesTM are a potential source of VOCs)
- ___ Sample containers (provided by lab) **bring extra** and waterproof labels/tags
- ___ QA/QC sample bottles (VOC trip blanks filled by lab)
- ___ _____

PRESERVATION AND SHIPPING

- ___ Sample preservatives, transfer pipettes and coolers with ice
- ___ Bubble wrap, ZiplockTM bags or equivalent to protect sample containers
- ___ Strapping tape, postage, Fedex or UPS shipping labels, etc

TOOLS AND MISCELLANEOUS

- ___ Flashlight and first aid kit
- ___ Adjustable wrench, screw drivers, hammer, scissors, knife, duct tape, etc.
- ___ _____

equip_ws.fm

WELL SPECIFIC FIELD SHEET - WATER SUPPLY WELLS

Name of Well Owner: _____ Date: _____

Section/Grid or Address: _____

License or Permit #: _____

Weather Conditions (temp, rain): _____

Person(s) Sampling: _____

Well verified on well construction report? _____

Does well have a WUWN and what is it? _____

Depth to water in well to nearest 0.1 feet¹ _____

Depth to bottom of well casing¹ _____

Depth to bottom of well¹ _____

Location of tap used for purging (before or after pressure tank) _____

Length of time well purged (minutes) _____

Location of tap used for collecting the samples (before or after pressure tank) _____

Time sample collected _____

Field temperature (°C) _____

Field Specific Conductance @ 25°C _____ Time _____

Field pH (standard units) _____ Time _____

Color (describe) _____

Odor (describe) _____

Turbidity (NTUs or describe) _____

Comments (problems, procedures): _____

¹ Describe how measured in comments

GROUNDWATER SAMPLING FIELD PROCEDURES DOCUMENTATION

Facility/Project Name: _____ Date: _____

Section/Grid Location or Address: _____

Facility Type: _____ License/Permit #: _____

DNR Regulatory Program: _____

Weather (temp., cloudiness, bar. pres., wind): _____

Persons Sampling and Title: _____

Water Level Equipment (type, model): _____

Purging Equipment (type, model, material): _____

Purging Method (4 well vol. or stabilization): _____

How Purge Volume Measured? (eg., calibrated bucket): _____

Sample Collection Equipment (type, model, material): _____

Method of Sample Withdrawal (bottom emptying device, low flow): _____

Type of Transfer Containers: _____

Filtering Equipment (type, material): _____

Filter Membrane (type, pore size): _____

When Were Samples Sent to Lab? _____

What Lab Were the Samples Sent to? _____

Were Enforcement Samples Sent? _____

How Were Samples Kept Cool (ice, other)? _____

Equipment Decontamination Procedures? _____

Decontamination Water Disposal? _____

pH Meter (type, model): _____

Person calibrating: _____

Frequency calibrated: _____

Calibration procedures (buffers used): _____

Problems with meter: _____

Conductivity Meter (type, model): _____

Person calibrating: _____

Frequency calibrated: _____

Calibration procedures: _____

Problems with meter: _____

Wisconsin Unique Well Number <input type="text"/> <input type="checkbox"/> Add <input type="checkbox"/> Change		
Inventory Completed By (Last Name, First, MI)	Date	With
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> DNR <input type="checkbox"/> _____

Facility Name _____ Facility ID # _____
 Local Well ID _____
 High Cap Well # _____

Primary Contact Name (Last, First, MI)		<input type="checkbox"/> Owner <input type="checkbox"/> Driller <input type="checkbox"/> Operator <input type="checkbox"/> Business <input type="checkbox"/> Occupant <input type="checkbox"/> Facility <input type="checkbox"/> Consultant <input type="checkbox"/> Sampler <input type="checkbox"/> Manager <input type="checkbox"/> Other <input type="checkbox"/> Contractor	
Telephone Number ()			
Mailing Address			
City	State		Zip Code
Other Contact Name (Last, First, MI)			

Telephone Number ()		<input type="checkbox"/> Owner <input type="checkbox"/> Driller <input type="checkbox"/> Operator <input type="checkbox"/> Business <input type="checkbox"/> Occupant <input type="checkbox"/> Facility <input type="checkbox"/> Consultant <input type="checkbox"/> Sampler <input type="checkbox"/> Manager <input type="checkbox"/> Other <input type="checkbox"/> Contractor	
Mailing Address			
City	State		Zip Code

Well Location			(X) 1/4 1/4 Sec.
<input type="checkbox"/> Town <input type="checkbox"/> City <input type="checkbox"/> Village	Fire # (If avail.)	County	<div style="text-align: center;"> <p>Location</p> </div>
Grid or Street Address or Road (If avail.)		Govt. Lot # _____	
		OR _____ 1/4 of _____ 1/4 of Section _____	
Subdivision Name	Lot	Block	
		T _____; R _____ <input type="checkbox"/> E <input type="checkbox"/> W	

Construction Type		OR Latitude _____ Deg. _____ Min. _____ Sec. Longitude _____
<input type="checkbox"/> Drilled <input type="checkbox"/> Driven Point <input type="checkbox"/> Jetted	<input type="checkbox"/> Dug <input type="checkbox"/> Spring <input type="checkbox"/> Other	
Construction Date	Land Surface Elevation _____ ft. MSL	
<input type="text"/>	Number of Wells on Property _____	
Constructor	Well Use <input type="checkbox"/> Private Potable <input type="checkbox"/> Priv. Non-Potable <input type="checkbox"/> Monitoring Well	
	<input type="checkbox"/> Community-Municipal <input type="checkbox"/> Community OTM <input type="checkbox"/> Non Transient Non-Com. <input type="checkbox"/> Transient Non-Com.	

Source of Well Data			Well Status
<input type="checkbox"/> Well Report <input type="checkbox"/> Owner/Occupant <input type="checkbox"/> Other*			
Depth From Land Surface To:	Casing Diameter	Water Bearing Formation	
Bedrock _____ ft. Well Bottom _____ ft. Static Water _____ ft. Casing Bottom _____ ft.	_____ in.	<input type="checkbox"/> Sandstone <input type="checkbox"/> Unconsolidated <input type="checkbox"/> Limestone <input type="checkbox"/> Shale <input type="checkbox"/> Crystalline	
			<input type="checkbox"/> Active Use <input type="checkbox"/> Inactive <input type="checkbox"/> Perm Filled

Comments: eg. Reason for inventory, Samples taken, Directions to property, Details of well location on property.

*For "Other", enter a description in the comment area if needed.

Instructions

1. All wells sampled by DNR employees must be inventoried and assigned a Wisconsin Unique Well ID in the Depamenes data system. Use this form to create a new inventory record or to change an existing record for a well. Use a separate form, for each well.
2. Mandatory fields are indicated by shadowing and MUST be completed or your form will not be entered into the computer system. Fill in all applicable portions of the form as completely as possible.
3. If the well is being inventoried for the first time, check the 'add' box in the upper right corner of the form. If there is a change to existing information, check the 'change' box in the upper right corner and then fill in the Wisconsin Unique Well Number and ONLY THE INFORMATION THAT NEEDS TO BE CHANGED.

If the form is filled out by DNR staff, check the DNR box. If the person completing this inventory form is associated with another agency; fill in the agency acronym letters.

4. For a private well, the primary contact should be the well owner or the resident occupant of the property served by the well, if the owner or occupant is known.
5. Check only ONE contact @ code box for each contact name. Check the one that is the most relevant if more than one applies. If the well owner is the occupant, check 'Owner' as the contact @. Check the facility or business box ONLY if there is not person to contact,
6. Wells should be located as precisely as possible. If the well is located by Public Land Survey, record the T, R, S, 1/4 1/4 section. If the well is located by latitude and longitude, record the location to the nearest second. If the well is located in a government lot, record the latitude and longitude as well as the government lot number.
7. Check only ONE box in the Well Use section. If a spring is being inventoried, check Spring under Construction Type in addition to the well use box.

8. County Codes and Names:

1. Adams	19. Florence	37. Marathon	55. Rusk
2. Ashland	20. Fond Du Lac	38. Marinette	56. St. Croix
3. Barron	21. Forest	39. Marquette	57. Sauk
4. Bayfield	22. Grant	40. Menominee	58. Sawyer
5. Brown	23. Green	41. Milwaukee	59. Shawano
6. Buffalo	24. Green Lake	42. Monroe	60. Sheboygan
7. Burnett	25. Iowa	43. Oconto	61. Taylor
8. Calumet	26. Iron	44. Oneida	62. Trempealeau
9. Chippewa	27. Jackson	45. Outagamie	63. Vernon
10. Clark	28. Jefferson	46. Ozaukee	64. Vilas
11. Columbia	29. Juneau	47. Pepin	65. Walworth
12. Crawford	30. Kenosha	48. Pierce	66. Washburn
13. Dane	31. Kewaunee	49. Polk	67. Washington
14. Dodge	32. La Crosse	50. Portage	68. Waukesha
15. Door	33. Lafayette	51. Price	69. Waupaca
16. Douglas	34. Langlade	52. Racine	70. Waushara
17. Dunn	35. Lincoln	53. Richland	71. Winnebago
18. Eau Claire	36. Manitowoc	54. Rock	72. Wood

9. **Return this form to the DNR Bureau of Water Supply, Box 7921, Madison, WI 53707, unless you are part of a special sampling program and have been instructed to return the form elsewhere.**

(Page left blank)

APPENDIX C

REFERENCE MATERIALS

- Sample Containers, Preservation and Holding Time Requirements
- Chain of Custody Procedures for Enforcement Samples
- Potential of a Substance for Volatilizing from a Water Sample
- Equivalency and Conversion Tables

Sample Containers, Preservation and Holding Time Requirements

<u>Parameter</u>	<u>Volume³</u> <u>(ml)</u>	<u>Container¹</u>	<u>Preservation²</u>	<u>Holding</u> <u>Time</u>
Alkalinity (CaCO ₃)	200	G,P	Cool 4°C	14 days
BOD - 5 Day	500 - 1000	G,P	Cool 4°C	48 hrs
BOD - Long Term	500	G,P	Cool 4°C	24 hrs
Boron	50 - 100	P	HNO ₃ pH<2 Cool 4°C	28 days
Chemical Oxygen Demand (COD)	50 - 250	G,P	H ₂ SO ₄ pH<2 Cool 4°C	28 days
Chloride	100 - 200	G,P	Cool 4°C	28 days
Chloride - I.C. ⁴	25	G,P	Cool 4°C	28 days
Color	50 - 500	G,P	Cool 4°C	48 hrs
Corrosivity	1000		Cool 4°C	
Cyanide - Total ⁶	1000	G,P	NaOH pH>12 Cool 4°C	14 days
Cyanide - Amendable to chlorination ⁶	1000	G,P	NaOH pH>12 ⁶ Cool 4°C	14 days
Fluoride	250 - 300	G,P	Cool 4°C	28 days
Metals - dissolved (except mercury & Cr ⁺⁶)	250 - 1000 ⁵	P	Filter immed. HNO ₃ pH<2 Cool 4°C	180 days
Hexavalent Chromium (Cr ⁺⁶)	50 - 100	P	Cool 4°C	24 hrs
Mercury - dissolved	500 ⁵	P or Teflon [®]	Filter immed. HNO ₃ pH<2 Cool 4°C	28 days

<u>Parameter</u>	<u>Volume³</u> <u>(ml)</u>	<u>Container¹</u>	<u>Preservation²</u>	<u>Holding</u> <u>Time</u>
NITROGEN				
Ammonia	500	G,P	H ₂ SO ₄ pH<2 Cool 4°C	28 days
Nitrate + Nitrite	100 - 200	G,P	H ₂ SO ₄ pH<2 Cool 4°C	28 days
Nitrate/Nitrite (Drinking water only)	100	G,P	Cool 4°C	48 hrs
Nitrate - I.C. ⁴	60	G,P	Cool 4°C	48 hrs
Nitrite - I.C. ⁴	60	G,P	Cool 4°C	48 hrs
Total Kjeldahl	500	G,P	H ₂ SO ₄ pH<2 Cool 4°C	28 days
Oil & Grease	2000	G only widemouth	H ₂ SO ₄ pH<2 Cool 4°C	28 days
Pesticides & PCBs	Consult Laboratory	G amber/TLS	Cool 4°C	7 days to extraction
pH	25	G,P	None	immed. & on-site
Phenolics	1000 ⁵	G only/TLS	H ₂ SO ₄ pH<2 Cool 4°C	28 days
PHOSPHOROUS				
Dissolved (soluble)	50 - 250	G,P	Filter, H ₂ SO ₄ Cool 4°C	28 days
Total	50 - 250	G,P	H ₂ SO ₄ pH<2 Cool 4°C	28 days
RESIDUE				
Dissolved Filterable	100	G,P	Cool 4°C	48 hrs
Total & Total Volatile	100	G,P	Cool 4°C	7 days
Semi-volatiles	2 liters	G amber/TLS	Cool 4°C to extract	7 days
Silica - dissolved	50 - 100	P only	Cool 4°C	28 days

Specific Conductance	100	G,P	Cool 4°C	28 days
<u>Parameter</u>	<u>Volume³ (ml)</u>	<u>Container¹</u>	<u>Preservation²</u>	<u>Holding Time</u>
Sulfate	50 - 100	G,P	Cool 4°C	28 days
Sulfide	100 - 625 ⁵	G,P	2 ml 2 N zinc acetate and NaOH ph>9 Cool 4°C	7 days
Sulfite	100 - 625 ⁵	G,P	Add EDTA Cool 4°C	immed.
Surfactants (MBAS)	250	G,P	Cool 4°C	48 hrs
Turbidity	100 - 250	G,P	Cool 4°C store in dark	48 hrs
Volatile Organics (VOCs)	2 to 4 40 ml vials	G vials/TLS	HCL pH<2 No headspace Cool 4°C	14 days

ABBREVIATIONS and ENDNOTES:

G Glass bottle (typically borosilicate)
P Plastic bottle (typically polypropylene, polyethylene or PVC)
TLS Teflon[®] lined septa

¹ In many cases, Teflon[®] and stainless steel containers (except for metals) are acceptable. For metals, polyethylene with a polypropylene cap (no liner) is preferred - a dilute nitric acid rinse may be recommended by some laboratories.

² Preserve samples immediately after collection. Consult the laboratory for volumes of preservative required per sample. Verify the pH of the sample (except VOCs).

³ Volume listed may not include quality control (QC) volume required by laboratory (except those volumes that include a number 5 superscript). Check with the laboratory if unsure of the laboratories QC volume requirements.

⁴ Ion chromatography (IC) analysis only. Ion chromatography is not universally available at certified laboratories and may require special arrangements.

⁵ Volume includes quality control (QC) effort required by laboratories.

⁶ Cyanide samples containing residual chlorine should be treated with 0.6 grams ascorbic acid/L of sample at the time of collection. Sulfide will interfere with the cyanide test and must be removed before the pH is adjusted. Contact the laboratory for special instructions for collecting samples containing sulfide.

para-tbl.fm

Chain of Custody for Samples Requiring Strict Custody

To be admissible as evidence, sample results must be traceable back through their collection, storage, handling, shipment and analysis so that the court is satisfied how the sample results submitted as evidence were collected, transferred and claimed. This is accomplished by a written record documenting the sample identity from collection to introduction as evidence.

Field records identifying sampling personnel, equipment, collection, storage and transfer techniques, and field conditions are required. The sample collector is responsible for maintaining sample custody and integrity until the samples are transferred via a dated and signed chain of custody form to a carrier or are personally delivered and transferred directly to the laboratory.

A sample is in custody if it is:

1. In physical possession, or
2. In view, after being in physical possession, or
3. Secured so that no one can tamper with it.

The courts have accepted two degrees of chain of custody. The first, described below, involves physical possession of the sample from collection to laboratory possession. With this chain of custody method, the sample collector or other person to which sample possession was transferred to delivers the samples to the laboratory. The second chain of custody method is by shipping the samples through a mail carrier. Mail carriers may not assume any liability or responsibility for compromised sample integrity during shipping (e.g., broken samples and/or containers, ice melting in cooler, etc.).

In both cases, a written record must be transferred with the samples. However, when using the second method described above, the sample collector fills out a chain of custody record, seals it in a shipping container, and mails it by a carrier to the laboratory. Upon arrival, a pre-determined laboratory custodian receives the samples, notes the shippers condition (whether sealed or unsealed), each sample container's condition (broken samples, ice present in cooler, etc.), and assumes custody of the samples by signing and dating the chain of custody record. The laboratory maintains possession of the chain of custody record until the sample analysis is complete and then sends the analytical results, along with the chain of custody record, to the sample collector or other pre-designated receiver of the analytical results and chain of custody records.

For routing surveillance samples, the second chain of custody method should suffice. If enforcement action may occur based on the type of samples and/or regulatory programs or agencies involved, the first chain of custody method involving the sample collector physically delivering and transferring possession of the samples to the laboratory is recommended.

Field Chain of Custody Procedures

1. Limit sample collection and handling to as few people as possible. If sample transfers are necessary, use signed receipts of possession. The chain of custody record must accompany the samples. Keep a copy of the chain of custody record for your own records.

2. If the samples are known or suspected of being hazardous, give a receipt for each sample collected to the property or facility owner (s. 144.69, Wis. stats.). The property or facility owner may request split samples.
3. If the samples are known or suspected of being hazardous (e.g., explosion or corrosion hazard), special shipping procedures may be required by the mail carrier. Check with the mail carrier for restrictions and procedures.
4. Follow the Quality Assurance/Quality Control procedures discussed in Section 2.9 of this manual and in the *Groundwater Sampling Desk Reference Manual*.
5. Record field measurements and other important data in a bound field note book, on field measurement data sheets provided by WDNR, or on modified data sheets that meet site-specific needs. For legal purposes, indelible ink should be used for recording all data and errors in field records should be crossed out with one line and initialed.
6. Complete appropriate laboratory tracking forms and attach them to the chain of custody record. Complete these forms in indelible ink.
7. When required or applicable, document with photographs sample locations, pollution sources, violations, etc. If possible, use cameras that print the date the photos were taken.
8. Maintain physical possession and sample integrity of the collected samples until they are properly transferred to the laboratory custodian or the mail carrier.
9. Obtain a sample possession transfer receipt (a copy of the dated and signed chain of custody record) after transferring possession of the samples to the laboratory custodian or the mail carrier.

Sample Security When Strict Custody Procedures are Necessary

Use the following procedures when securing and transferring possession of strict custody samples:

1. Use sample seals. Tape the sample container so that the tape must be cut or ripped to open the container. Use nylon-reinforced tape or other tape that cannot be tampered with without being noticed upon receipt. Sign and date the tape across the top.
2. Using an indelible permanent marker or ink, write the following information on the security tape, writing across the overlapping ends:
 - a. Name of the sample collector(s), date, time, well number, facility name, etc., where the samples were collected.
 - b. Write the words "**Strict Custody Requirements**," or similar language indicating that sample security is critical.
 - c. Write "To be opened by _____ personnel only." In the blank, specify water chemistry unit, pesticide and organic chemistry unit, water microbiological unit, or

other appropriate personnel.

- d. If all the samples are organic, specify "organic." If they are all inorganic, specify "inorganic." If the samples are a combination of both or others, specify accordingly.

By overlapping and writing over the edges of the security tape, it will be possible to detect if someone has tampered with the sample container. If someone were to remove the tape and then reseal it, it would be difficult to seamlessly realign the writing.

Do not use sealing wax to seal the tape. Sealing wax is brittle and will chip and break during normal use. This gives the appearance of tampering even when none has occurred.

Sample containers labeled "Strict Custody Requirements," or with similar language, must be locked up by the laboratory upon receipt and not removed from the locked refrigerator until ready to be analyzed. The laboratory will hold all strict custody samples until notified otherwise. When the case is resolved, either by trial or stipulation, the enforcement specialist should notify the laboratory that the samples associated with the case may be discarded or destroyed.

Potential of a Substance for Volatilizing from a Water Sample

<u>Substance</u>	<u>CAS Number</u>	<u>Henry's Law Constant (atm-m³/mole)</u>	<u>Potential for Volatilizing from Water</u>
Acenaphthylene	208-96-8	1.1 x 10 ⁻⁵	Low
Acetone	67-64-1	3.9 x 10 ⁻⁵	Low
Aldicarb	116-06-3	1.4 x 10 ⁻⁹	Low
Ammonia	7664-41-7	3.2 x 10 ⁻⁴	Moderate
Anthracene	120-12-7	6.5 x 10 ⁻⁵	Low
Atrazine	1912-24-9	2.6 x 10 ⁻¹³	Low
Benzene	71-43-2	5.6 x 10 ⁻³	High
Benzo(a)pyrene	50-32-8	1.1 x 10 ⁻⁴	Moderate
Benzo(b)fluoranthene	205-99-2	1.1 x 10 ⁻⁴	Moderate
Bromodichloromethane	75-27-4	1.6 x 10 ⁻³	High
Bromoform	75-25-2	5.5 x 10 ⁻⁴	Moderate
Bromomethane	74-83-9	6.2 x 10 ⁻³	High
Carbaryl	63-25-2	4.4 x 10 ⁻⁹	Low
Carbofuran	1563-66-2	9.2 x 10 ⁻⁵	Low
Carbon tetrachloride	56-23-5	3.0 x 10 ⁻²	High
Carbon disulfide	75-15-0	3.0 x 10 ⁻²	High
Chlordane	57-74-9	4.9 x 10 ⁻⁵	Low
Chloroethane	75-00-3	6.2 x 10 ⁻⁴	Moderate
Chloroform	67-66-3	2.7 x 10 ⁻³	High
Chloromethane	74-87-3	8.8 x 10 ⁻³	High
Chrysene	218-01-9	9.5 x 10 ⁻⁵	Low
1,2-Dibromoethane (EDB)	106-93-4	6.7 x 10 ⁻⁴	Moderate
Dibromochloromethane	124-48-1	8.7 x 10 ⁻⁴	Moderate
1,2-Dibromo-3-chloropropane	96-12-8	1.5 x 10 ⁻⁴	Moderate
Dibutyl phthalate	84-74-2	1.8 x 10 ⁻⁶	Low
Dicamba	1918-00-9	7.9 x 10 ⁻⁹	Low
1,2-Dichlorobenzene	95-50-1	1.9 x 10 ⁻³	High
1,3-Dichlorobenzene	541-73-1	3.3 x 10 ⁻³	High
1,4-Dichlorobenzene	106-46-7	2.4 x 10 ⁻³	High
Dichlorodifluoromethane	75-71-8	3.4 x 10 ⁻¹	High
1,1-Dichloroethane	75-34-3	5.6 x 10 ⁻³	High

<u>Substance</u>	<u>CAS Number</u>	<u>Henry's Law Constant (atm-m³/mole)</u>	<u>Potential for Volatilizing from Water</u>
1,2-Dichloroethane	107-06-2	9.8 x 10 ⁻⁴	Moderate
1,2-Dichloroethylene (cis)	156-59-2	4.1 x 10 ⁻³	High
1,2-Dichloroethylene (trans)	156-60-5	9.4 x 10 ⁻³	High
1,1-Dichloroethylene	75-35-4	2.6 x 10 ⁻²	High
2,4-Dichlorophenoxyacetic acid	94-75-7	1.0 x 10 ⁻⁸	Low
1,2-Dichloropropane	78-87-5	2.8 x 10 ⁻³	High
1,3-Dichloropropene (cis/trans)	542-75-6	1.8 x 10 ⁻²	High
Di (2-ethylhexyl) phthalate	117-81-7	3.6 x 10 ⁻⁷	Low
Dimethoate	60-51-5	6.2 x 10 ⁻¹¹	Low
2,4-Dinitrotoluene	121-14-2	1.3 x 10 ⁻⁷	Low
2,6-Dinitrotoluene	606-20-2	7.5 x 10 ⁻⁷	Low
Dinoseb	88-85-7	4.6 x 10 ⁻⁷	Low
Dioxins	1746-01-6	5.6 x 10 ⁻³	High
Endrin	72-20-8	7.5 x 10 ⁻⁶	Low
Ethylbenzene	100-41-4	8.4 x 10 ⁻³	High
Fluoranthene	206-44-0	6.5 x 10 ⁻⁶	Low
Fluorene	86-73-7	1.0 x 10 ⁻⁴	Moderate
Fluoride	16984-48-8	6.0 x 10 ⁻⁸	Low
Fluorotrichloromethane (freon 11)	75-69-4	9.7 x 10 ⁻²	High
Formaldehyde	50-00-0	1.7 x 10 ⁻⁷	Low
Heptachlor	76-44-8	1.1 x 10 ⁻³	High
Heptachlor epoxide	1024-57-3	3.2 x 10 ⁻⁵	Low
Hexachlorobenzene	118-74-1	1.3 x 10 ⁻³	High
Lindane	58-89-9	1.4 x 10 ⁻⁵	Low
Mercury	7439-97-6	1.1 x 10 ⁻²	High
Methanol	67-56-1	4.5 x 10 ⁻⁶	Low
Methoxychlor	72-43-5	1.6 x 10 ⁻⁵	Low
Methyl isobutyl ketone	108-10-1	1.4 x 10 ⁻⁴	Moderate
Methyl ethyl ketone (MEK)	78-93-3	2.7 x 10 ⁻⁵	Low
Methylene chloride	75-09-2	2.0 x 10 ⁻³	High
Monochlorobenzene	108-90-7	3.8 x 10 ⁻³	High
n-Hexane	110-54-3	1.4 x 10 ⁻²	High
Naphthalene	91-20-3	4.8 x 10 ⁻⁴	Moderate

<u>Substance</u>	<u>CAS Number</u>	<u>Henry's Law Constant (atm-m³/mole)</u>	<u>Potential for Volatilizing from Water</u>
Pentachlorophenol	87-86-5	2.4 x 10 ⁻⁶	Low
Phenol	108-95-2	3.3 x 10 ⁻⁷	Low
Polychlorinated biphenyls	1336-36-3	1.1 x 10 ⁻³	High
Pyrene	129-00-0	1.1 x 10 ⁻⁵	Low
Pyridine	110-86-1	8.9 x 10 ⁻⁶	Low
Simazine	122-34-9	2.7 x 10 ⁻⁹	Low
Styrene	100-42-5	2.8 x 10 ⁻³	High
1,1,1,2-Tetrachloroethane	630-20-6	2.4 x 10 ⁻³	High
1,1,2,2-Tetrachloroethane	79-34-5	4.6 x 10 ⁻⁴	Moderate
Tetrachloroethylene	127-18-4	1.8 x 10 ⁻²	High
Toluene	108-88-3	6.6 x 10 ⁻³	High
Toxaphene	8001-35-2	6.6 x 10 ⁻⁶	Low
1,2,4-Trichlorobenzene	120-82-1	1.4 x 10 ⁻³	High
1,1,1-Trichloroethane	71-55-6	1.7 x 10 ⁻²	High
1,1,2-Trichloroethane	79-00-5	9.1 x 10 ⁻⁴	Moderate
1,2,3-Trichloropropane	96-18-4	3.4 x 10 ⁻⁴	Moderate
Trichloroethylene	79-01-6	1.0 x 10 ⁻²	High
2,4,5-Trichlorophenoxy- propionic acid (2,4,5-TP)	93-72-1	8.7 x 10 ⁻⁹	Low
Trifluralin	1582-09-8	2.6 x 10 ⁻⁵	Low
1,2,4-Trimethylbenzene	95-63-6	5.6 x 10 ⁻³	High
Vinyl chloride	75-01-4	2.7 x 10 ⁻²	High
Xylene (mixed o-, m-, and p-)	1330-20-7	7.0 x 10 ⁻³	High

CAS Number: Chemical Abstract Service (CAS) registry numbers are unique numbers assigned to a chemical substance and are widely used in scientific publications.

Note: Most metals (exception - mercury) and inorganics are not susceptible to volatilizing from a groundwater sample under normal sampling conditions and temperatures.

(Sources: USEPA Superfund Chemical Data Matrix [SCDM] March 1993 data tables. U.S. Environmental Protection Agency (EPA). 1990. *Basics of Pump-and-Treat Ground-Water Remediation Technology* U.S. Environmental Protection Agency, Washington, D.C. EPA/600/8-90/003.)

henryalb.tb2

Equivalency and Conversion Tables

Volume Equivalents

unit	cc	in ³	liters	Quarts	Gals	ft ³
cc	1	.06102	.001	.00106	.00026	.00004
in ³	16.387	1	.01639	.01732	.00433	.00058
Pints	473.18	28.875	.47318	.5	.125	.01671
liters	1000	61.023	1	1.0567	.26417	.03531
Quarts	946.36	57.75	.94636	1	.25	.03342
Gallons	3785.4	231	3.7854	4	1	.13368
ft ³	28317.0	1728	28.317	29.922	7.4805	1
meter ³	100000	61023.4	1000	908.08	227.02	35.314

Equivalent Pumping Rate Table

Milliliters per Minute (ml/min)	Liters per Minute (L/min)	Gallons per Minute (gpm)
100	0.1	0.026
200	0.2	0.05
300	0.3	0.08
400	0.4	0.11
500	0.5	0.13
600	0.6	0.16
700	0.7	0.18
800	0.8	0.21
900	0.9	0.24
1000	1	0.26
2000	2	0.53
3000	3	0.79
4000	4	1.06
5000	5	1.32

Conversion formulas for rates not included in this table:

Liters per minute X 0.26417 = gallons per minute

Gallons per minute X 3.7854 = liters per minute

Length

To Convert From	To	Multiply By
inches	centimeters	2.540
inches	feet	0.0833
feet	meters	0.3048
feet	miles	0.0001894
meters	miles	6.214×10^{-4}
meters	yards	1.094

1 meter = 10 decimeters = 100 centimeters = 1000 millimeters

Volume

To Convert From	To	Multiply By
cubic centimeters	cubic inches	0.06102
cubic inches	cubic feet	0.00058
cubic inches	liters	0.01639
cubic inches	gallons	0.00433
liters	gallons	0.14546
gallons	cubic feet	0.13368

1 liter = 1 cubic decimeter = 10 deciliters = 100 centiliters = 1000 milliliters = 1000 cubic centimeters

Water attributes

Cubic foot

7.48 gallons
 28,317 milliliters
 28.317 liters
 62.428 lbs

Gallon

231 cubic inches
 3,785 milliliters
 3.785 liters
 8.345 lbs

Liter

0.2642 gallons
61 cubic inches
2.205 lbs

Cubic meter

1,000 liters
264.2 gallons
22.045 lbs