



U. S. EPA ENVIRONMENTAL RESPONSE TEAM

STANDARD OPERATING PROCEDURES

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MONITOR WELL DEVELOPMENT

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1.0 SCOPE AND APPLICATION

The purpose of this standard operating procedure (SOP) is to provide an overview of monitor well development practices. The purpose of monitor well development is to ensure removal of fine grained sediments (fines) from the vicinity of the well screen. This allows the water to flow freely from the formation into the well, and also reduces the turbidity of the water during sampling. The most common well development methods are: surging, jetting, overpumping, and bailing.

Surging involves raising and lowering a surge block or surge plunger inside the well. The resulting surging motion forces water into the formation and loosens sediment, pulled from the formation into the well. Occasionally, sediments must be removed from the well with a sand bailer to prevent sand locking of the surge block. This method may cause the sand pack around the screen to be displaced to a degree that damages its value as a filtering medium. Channels or voids may form near the screen if the filter pack sloughs away during surging (Keel and Boating, 1987).

Surging with compressed air is done by injecting a sudden charge of compressed air into the well with an air line so that water is forced through the well screen. The air is then turned off so that the water column falls back into the well and the process is repeated. Periodically, the air line is pulled up into a pipe string (educator) and water is pumped from the well using air as the lifting medium (air-lift pumping). The process is repeated until the well is sediment free. Method variations include leaving the air line in the pipe string at all times or using the well casing as the educator pipe.

Jetting involves lowering a small diameter pipe into the well and injecting a high velocity horizontal stream of water or air through the pipe into the screen openings. This method is especially effective at breaking down filter cakes developed during mud rotary drilling. Simultaneous air-lift pumping is usually used to remove fines.

Overpumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible, and then allowing the well to recharge to the original level. This process is repeated until sediment-free water is produced.

Bailing includes the use of a simple manually operated check-valve bailer to remove water from the well. The bailing method, like other methods, should be repeated until sediment free water is produced. Bailing may be the method of choice in a shallow well or well that recharges slowly.

These are standard (i.e., typically applicable) operating procedures which may be varied or changed as required, dependent on site conditions, equipment limitations or limitations imposed by the procedure. In all instances, the ultimate procedures employed should be documented and associated with a final report.

Mention of trade names or commercial products does not constitute United States Environmental Protection



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Agency (U.S. EPA) endorsement or recommendation for use.

2.0 METHOD SUMMARY

After installation, development of a well should occur as soon as it is practical. It should not occur any sooner than 48 hours after grouting is completed, especially if a vigorous well development method (i.e. surging) is being used. If a less vigorous method (i.e. bailing) is used, it may be initiated shortly after installation. The method used for development should not interfere with the setting of the well seal.

Several activities must take place prior to well development. First, open the monitor well, take initial measurements (i.e., head space air monitoring readings, water level, total depth of the well) and record results in the site logbook. Develop the well by the appropriate method to accommodate site conditions and project objectives. Continue until the development water is clear and free of sediments, or until parameters such as pH, temperature, and specific conductivity stabilize. Containerize all purge water from wells with known or suspected contamination. Record final measurements in the site logbook. Decontaminate equipment as appropriate prior to use in the next well.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The following problems may be associated with well development:

1. Overpumping is not as vigorous as surging and jetting, and is probably the most desirable method for monitor well development. The possibility of disturbing the filter pack is greatest with surging and jetting well development methods.
2. The introduction of external water or air by jetting may alter the hydro chemistry of the aquifer.
3. Surging with air may produce "air locking" in some formations, preventing water from flowing into the well.
4. The use of surge blocks in formations containing clay may cause plugging of the screen.
5. Small (2-inch nominal diameter) submersible pumps that will fit in 2-inch diameter well casing are especially susceptible to clogging if used in well development applications.
6. Chemicals/reagents used during the decontamination of drilling equipment may complicate well development.



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5.0 EQUIPMENT/APPARATUS

The type of equipment used for well development is dependent on the diameter of the well and the development method. For example, the diameter of most submersible pumps is too large to fit into a two-inch inner diameter (I.D.) well, and other development methods should be used. Obtaining the highest possible yield is not usually an objective in developing monitor wells and vigorous development is not always necessary. Many monitor wells are constructed in fine-grained formations that would not normally be considered aquifers. Specifications for the drilling contract should include the necessary well development equipment (air compressors, pumps, air lines, surge blocks, generators).

6.0 REAGENTS

The use of chemicals in developing wells that will be used to monitor groundwater quality should be avoided if possible; however, polyphosphates (a dispersing agent), acids, or disinfectants are often used in general well development. Polyphosphates should not be used in thinly bedded sequences of sands and clays. The use of decontamination solutions may also be necessary. If decontamination of equipment is required at a well, refer to Environmental Response Team/Response Engineering and Analytical Contract (ERT/REAC) SOP #2006, *Sampling Equipment Decontamination* and the site specific work plan.

7.0 PROCEDURES

7.1 Preparation

1. Coordinate site access and obtain keys to well locks.
2. Obtain information on each well to be developed (i.e., drilling method, well diameter, well depth, screened interval, anticipated contaminants).
3. Obtain a water level meter, a depth sounder, air monitoring instruments, materials for decontamination, and water quality instrumentation capable of measuring, at a minimum, pH, specific conductivity, temperature, and turbidity. Dissolved oxygen (DO) and salinity are also useful parameters.
4. Assemble containers for temporary storage of water produced during well development. Containers must be structurally sound, compatible with anticipated contaminants, and easy to manage in the field. The use of truck-mounted or roll-off tanks may be necessary in some cases; alternately, a portable water treatment unit (i.e., activated carbon) may be used to decontaminate the purge water.

7.2 Operation



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Development should be performed as soon as it is practical after the well is installed, but no sooner than 48 hours after well completion.

1. Assemble necessary equipment on a plastic sheet surrounding the well.
2. Record pertinent information in the site or personal logbook (personnel, time, location ID, etc.).
3. Open monitor well, take air monitor reading at the top of casing and in the breathing zone as appropriate.
4. Measure depth to water and the total depth of the monitor well. Calculate the water column volume of the well (Equation 1, Section 8.0).
5. Begin development and measure the initial pH, temperature, turbidity, and specific conductivity of the water and record in the site logbook. Note the initial color, clarity, and odor of the water.
6. Continue to develop the well and periodically measure the water quality parameters indicated in step 5 (above). Depending on project objectives and available time, development should proceed until these water quality parameters stabilize, or until the water has a turbidity of less than 50 nephelometric turbidity units (NTUs).
7. All water produced by development of contaminated or suspected contaminated wells must be containerized or treated. Each container must be clearly labeled with the location ID, date collected, and sampling contractor. Determination of the appropriate disposal method will be based on the analytical results from each well.
8. No water shall be added to the well to assist development without prior approval by the appropriate U.S. EPA ERT Work Assignment Manager (WAM) and/or appropriate state personnel. In some cases, small amounts of potable water may be added to help develop a poor yielding well. It is essential that at least five times the amount of water injected must be recovered from the well in order to assure that all injected water is removed from the formation.
9. Note the final water quality parameters in the site or personal logbook along with the following data:
 - C Well designation (location ID)
 - C Date(s) of well installation
 - C Date(s) and time of well development



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- C Static water level before and after development
- C Quantity of water removed, and initial and completion time
- C Type and capacity of pump or bailer used
- C Description of well development techniques

7.3 Post-Operation

1. Decontaminate all equipment;
2. Secure holding tanks or containers of development water;
3. Review analytical results and determine the appropriate water disposal method. Actual disposal of the purge water is generally carried out by the On-Scene Coordinator (OSC).

8.0 CALCULATIONS

To calculate the volume of water in the well, the following equation is used:

$$\text{Well Volume (V)} = Br^2 h \text{ (cf)} \quad [\text{Equation 1}]$$

where:

- B** = pi (3.14)
- r** = radius of monitoring well in feet (ft)
- h** = height of the water column in ft. [This may be determined by subtracting the depth to water from the total depth of the well as measured from the same reference point.]
- cf** = conversion factor in gallons per cubic foot (gal/ft^3) = 7.48 gal/ft^3 . [In this equation, 7.48 gal/ft^3 is the necessary conversion factor.]

Monitor well diameters are typically 2-, 3-, 4-, or 6-inches. A number of standard conversion factors can be used to simplify the above equation using the diameter of the monitor well. The volume, in gallons per linear foot, for various standard monitor well diameters can be calculated as follows:

where:

$$V \text{ (gal/ft)} = Br^2 \text{ (cf)} \quad [\text{Equation 2}]$$

- B** = pi
- r** = radius of monitoring well (feet)
- cf** = conversion factor (7.48 gal/ft^3)



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For example, a two inch diameter well, the volume per linear foot can be calculated as follows:

$$\begin{aligned} V \text{ (gal/ft)} &= \mathbf{B r^2 \text{ (cf)}} \quad \text{[Equation 2]} \\ &= \mathbf{3.14 (1/12 \text{ ft})}^2 \mathbf{7.48 \text{ gal/ft}^3} \\ &= \mathbf{0.1631 \text{ gal/ft}} \end{aligned}$$

NOTE: The diameter must be converted to the radius in feet as follows:

$$\frac{\text{Well Diameter (inches)}}{12} \times 0.5 = \text{Well Radius (feet)} \quad \text{[Equation 3]}$$

The volume in gallons/feet for the common size monitor wells are as follows:

Well diameter (inches)	2	3	4	6
Volume (gal/ft)	0.1631	0.3670	0.6524	1.4680

If you utilize the volumes for the common size wells above, Equation 1 is modified as follows:
where:

$$\text{Well volume} = (h)(f) \quad \text{[Equation 4]}$$

$$\begin{aligned} h &= \text{height of water column (feet)} \\ f &= \text{the volume in gal/ft calculated from Equation 2} \end{aligned}$$

9.0 QUALITY ASSURANCE/QUALITY CONTROL

There are no specific quality assurance activities, which apply to the implementation of these procedures. However, the following general quality assurance/quality control (QA/QC) procedures apply:

1. All data must be documented in site and/or personal logbooks.
2. All instrumentation must be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities must occur prior to sampling/operation and must be documented.

10.0 DATA VALIDATION

This section is not applicable to this SOP.

11.0 HEALTH AND SAFETY



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When working with potentially hazardous materials, follow U.S. EPA, Occupational Safety and Health (OSHA), and corporate health and safety practices.

12.0 REFERENCES

Driscoll, F. G. 1986. "Development of Water Wells." In: *Groundwater and Wells*. Second Edition. Chapter 15. Johnson Filtration Division, St. Paul, Minnesota. p. 497-533.

Freeze, Allan R. and John A. Cherry. 1979. *Groundwater*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 1: Conceptualizations". *Groundwater*, 25(3):300-313.

Keel, J.F. and Kwasi Boating. 1987. "Monitoring Well Installation, Purging, and Sampling Techniques - Part 2: Case Histories". *Groundwater*, 25(4):427-439.

13.0 APPENDICES

This section is not applicable to this SOP.