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Environment & Remediation Support Services

Standard Operating Procedure

for **PUMPING TESTS**

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1.0 PURPOSE AND SCOPE

The purpose of this procedure is to describe the process for performing pumping tests to determine the hydraulic properties of water-bearing geologic materials at the Environment & Remediation Support Services (ERSS) Division of the Los Alamos National Laboratory (LANL or Laboratory).

2.0 BACKGROUND AND PRECAUTIONS

2.1 Background

This procedure is used in conjunction with an approved Integrated Work Document (IWD). Also, consult the IWD for information on and use of all Personal Protective Equipment (PPE).

A pumping test is a controlled field procedure to determine the hydraulic properties of water bearing geologic units. Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, the storage coefficient (S) for confined aquifers, and the vertical hydraulic conductivity of confining layers. Also, the occurrence and position of recharge or impermeable boundaries can be identified. These parameters can be determined by graphical solutions and computerized programs.

Pumping tests consist of two phases: 1) an initial pumping phase resulting in water level drawdown; and 2) a recovery phase after the pump has been turned off. Water level monitoring is conducted throughout both of these phases.

2.2 Precautions

Pumping tests are generally carried out by monitoring the water level over time in the pumping well and in each observation well (if available) while the pumping well is being discharged at a constant rate. Such tests provide results that are more representative of aquifer characteristics than those obtained by other methods. They can also be used to determine the hydraulics of secondary aquifer flow. However, pumping tests require a greater degree of labor activity and expense than other methods and may not always be justified for all levels of investigation.

Refer to the site-specific work plan for the duration of the pumping test, the location of the observation well, and the data to be collected. Collection of measurements and documentation of data will be performed.

3.0 EQUIPMENT AND TOOLS

- Water pressure transducers;
- Electronic data logger;
- Electric water level indicator (if transducer method is not used);
- Manufacturer's operating manuals for equipment selected above;
- Weighted tapes with plopper (plumb bob);
- Steel tape (graduated in hundredths of a foot);
- Stopwatch or watch with a second hand;
- Tape measure (graduated in tenths of a foot);
- Semi log graph paper (if required);
- Laptop computer;
- Waterproof ink pen;
- Thermometer;
- Appropriate references;
- Calculator;
- Barometer or recording barograph (for tests conducted in confined aquifers);
- Pumping/recovery test data forms;
- Groundwater elevation forms;
- Daily activity logs;
- Any PPE listed or required in the site-specific health and safety plan (SSHASP); and
- Any additional supplies listed in associated procedures, as needed.

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4.0 STEP-BY-STEP PROCESS DESCRIPTION

4.1 Pre-Operation Activities

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|---------------|-----|--|
| Field Team | 1. | Ensure permission to discharge is obtained (an NPDES Permit may be required) or that a containment system is available for collecting the water that will be pumped during the test.
[NOTE: This is especially important for wells that may produce contaminated water.] |
| | 2. | Confirm from the site drilling crew that well installation is complete and that the equipment necessary to conduct the pumping test is deployed.
[NOTE: All wells should be properly developed before testing.] |
| | 3. | Obtain the pumping test equipment, appropriate operating manuals, and information on equipment modifications necessary to conduct a pumping test. |
| | 4. | Check the equipment for proper functioning. |
| Drilling Crew | 5. | Install a submersible or turbine pump. |
| | 6. | Install a flow meter in the discharge line of the pumping well to accurately measure and monitor the volume of discharge. |
| | 7. | Install sufficient pipe to transport the discharge from the pumping well away from the area to prevent infiltration of extracted water into the pumped zone. |
| | 8. | Install a gate valve along with a pressure regulator on the discharge pipe to control the pumping rate. |
| | 9. | Place an outlet near the well head, but past the totalizer and flow meters, for water quality monitoring and sampling. |
| Field Team | 10. | Ensure all gauges, transducers, flow meters, and other equipment used in conducting pumping tests are properly calibrated before use. |
| | 11. | Perform any on-site zero adjustment or calibration and document those procedures. |
| | 12. | Monitor and record water levels at the test site for about one (1) week before performing the test using a continuous recording device.
[NOTE: These records establish the barometric efficiency of the aquifer. The records also help determine if the aquifer is experiencing an increase or decrease in head over time that may be caused by recharge or pumping in the nearby area or by diurnal variations.] |

4.2 Pumping and Recovery Test Operations

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|------------|----|---|
| Field Team | 1. | Manually measure static water levels in the test well and any observation well(s) using a water level meter when all equipment has been deployed. |
| | 2. | Read and record the totalizer value from the in-line flow meter prior to turning on the pump. |
| | 3. | Initiate pumping at a specified discharge rate and immediately begin time series water level measurements in the test and observation wells at a predetermined time zero. |
| | 4. | Measure all depths to water from a designated reference marker point (measuring point). |
| | 5. | Continue to monitor water levels during recovery phase of the test. |
| | 6. | Connect the pressure transducer to a lap top computer to monitor drawdown and recovery changes in real time. |
| | 7. | Record barometric pressure during the test.
[NOTE: The barometric data, as well as projected pre-test water level trends, may be applied as corrections to water level readings so that the reduced data are representative of the hydraulic response in the aquifer to pumping from the test well.] |

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- Field Team (Continued)
- Plot the log of time versus drawdown for the most distant observation well to determine the adequacy of data.
[NOTE: When the plot becomes a straight line on the semi-log graph paper, enough data has been collected. Ideally, the straight line should continue over at least one log cycle.]

4.3 Test Completion

- Field Team
- Maintain water level monitoring while water recovers in the test and observation well(s) after the pump has been shut off.
 - Continue monitoring for a period of time equal to one-half that of the pumping portion of the test or until the water in these wells has stabilized at level that approach their pre-test static values.
 - Read and record the totalizer value from the in-line flow meter after the pump is turned off.
 - Cease monitoring when full recovery has been reached, or nearly so, in the test and observation well(s).
[NOTE: The pumping test is complete.]
 - Begin post-operation procedures.

4.4 Documentation

- Field Team
- Store all data internally or on computer diskettes or tape when electronic pressure transducers and data loggers are used to monitor the pumping test.
 - Use a lap top in the field to view data and assure the equipment is working properly.
 - Transfer the information directly to the main computer to analyze it.
 - Take measurements manually and record in a field notebook to verify the data recorded by the data logger.
 - Record all manually collected data in a field notebook.
 - Transfer appropriate data onto the Pumping/Recovery Test Data form (see Attachments 1 and 2).

4.5 Post-Operation Activities

- Field Team
- Proceed as follows if electronic data logger is used:
 - stop the logging sequence; and
 - save memory and disconnect battery at the end of the day's activities.
 - Decontaminate the water level device, transducer(s), and cable(s).

4.6 Records

- Field Team Leader
- Submit the following records generated by this procedure to the Records Processing Facility:
 - Completed Pumping/Recovery Test Data form;
 - Completed Water Level Elevation Data Sheet form; and
 - Daily Activity Log.

5.0 PROCESS FLOW CHART

Flow chart is to be included at a later date.

6.0 ATTACHMENTS

Attachment 1: 5039-1 Pumping/Recovery Test Data Sheet (1 page)

Attachment 2: 5039-2 Pumping/Recovery Test Data Sheet Completion Guidelines (2 pages)

7.0 REVISION HISTORY

Author: Rick Haacker

Revision No. Enter current revision number, beginning with Rev.0	Effective Date DCC inserts effective date for revision	Description of Changes List specific changes made since the previous revision	Type of Change Technical (T) or Editorial (E)
0.0	02/09/07	Reformatted and renumbered, supersedes SOP-07.04	E

[Using a CRYPTOCARD, click here to record "self-study" training to this procedure.](#)

If you do not possess a CRYPTOCARD or encounter problems, contact the EP Directorate Training Specialist.

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ATTACHMENT 2: PUMPING/RECOVERY TEST DATA SHEET COMPLETION GUIDELINES

5039-2 Pumping/Recovery Test Data Sheet Completion Guidelines	Records Use only 
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Use an indelible dark ink pen. Make an entry in each blank. Where there is no data entry, enter UNK for Unknown, NA for Not Applicable, or ND for Not Done. To change an entry, draw a single line through it, add the correct information above it, and date and initial the change. For all Water Level Elevation Data Sheet forms, complete the information listed below.

Item	Instruction(s)
Header Information	
1.	Test location – record Technical Area, canyon, well field where the activity is being performed.
2.	Pumped well – well in which stress is induced; also, test well.
3.	Observation well(s) – well(s) located at some distance for the test well to be monitored; one or more observation wells may be monitored.
4.	Sheet number – number all the sheets that are used for this activity.
5.	Source of data below – specify the well from which the data recorded on the form came (pumped well, observation well 1, 2, etc.).
6.	Measured distance from test well to observation well (ft.) – measure and record this distance to the nearest tenth of a foot.
7.	Measuring point – describe the physical reference mark from which all manual water level measurements are made (e.g., TOC, top of casing). Also, give the distance above ground surface of measuring point (ft).
8.	Test started – record date, time when pumping began (i.e., time zero), and pre-test static depth to water (DTW) to the nearest hundredth of a foot.
9.	Test ended – record date, time, and final DTW measurement at the end of the pumping portion of the test (i.e., when the pump was turned off and when the recovery portion of the test begins).
10.	Initial and final flow meter readings (gal.) – record readings in gallons made from the in-line flow meter immediately prior to the time the pump is turned on and after the pump has been turned off.
11.	Pump capacity – record pump type, model, and capacity in horsepower.
12.	Range of pumping rates (gpm) – low and high discharge rates over course of test; check frequently.
13.	Average pumping rate (gpm) – record the average flow rate in gallons per minute over the course of the pumping period; divide the total gallons pumped by the total elapsed time of pumping.
14.	Test conducted by – print name and position title; then sign.
15.	Weather and other comments – record all other conditions pertinent to the sample collection in this section on the daily activity log form.

ATTACHMENT 2: PUMPING/RECOVERY TEST DATA SHEET COMPLETION GUIDELINES

5039-2 Pumping/Recovery Test Data Sheet Completion Guidelines	Records Use only 
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Pumping Test

1.	Date and time (date/hr/min) – day and time of water level measurement during the pumping portion of the test using the suggested format: DD-MMM-YY (e.g., 01-JAN-06) and the 24-hour clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2.	Elapsed time (min) – cumulative time of measurement, to the nearest minute, since time zero (i.e., when the pump was turned on).
3.	Depth to water (ft) – DTW to the nearest hundredth of a foot in the well monitored.
4.	Pumping Rate (gpm) – flow rate in gallons per minute measured from the in-line flow meter. <i>This column is applicable only for the form used to record test well data.</i>

Recovery Test

1.	Date and time (date/hr/min) – day and time of water level measurement during the recovery portion of the test using the suggested format: DD-MMM-YY (e.g., 01-JAN-06) and the 24-hour clock time (0837 for 8:37 a.m. and 1912 for 7:12 p.m.).
2.	Elapsed time (min) – time of measurement, to the closest minute, since time zero (i.e., when the pump was turned on).
3.	Depth to water (ft) – DTW to the nearest hundredth of a foot corresponding to the water level measurement in the test or observation well.