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Los Alamos NATIONAL LABORATORY EST.1943

Environment & Remediation Support Services

Standard Operating Procedure

for **MONITORING WELL AND BOREHOLE ABANDONMENT**

APPROVAL SIGNATURES:

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1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes the process for monitoring well and borehole abandonment within the Environmental Programs (EP) Directorate-Environment & Remediation Support Services (ERSS) at Los Alamos National Laboratory (LANL or the Laboratory).

This SOP is consistent with acceptable practice for monitoring well and borehole abandonment under the Resource Conservation and Recovery Act (RCRA) and the American Society for Testing and Materials (ASTM) and complies with applicable requirements of the State of New Mexico's Office of the State Engineer's 19.27.4 New Mexico Administrative Code (NMAC) (Rules and Regulations Governing Well Drillers Licensing; Construction, Repair and Plugging of Wells) and Section X.D of the Compliance Order on Consent (Consent Order) signed by the New Mexico Environment Department (NMED), the U.S. Department of Energy (DOE), and the Regents of the University of California on March 1, 2005.

2.0 BACKGROUND AND PRECAUTIONS

2.1 Background

This SOP is a mandatory document and shall be implemented within EP-ERSS when conducting monitoring well and borehole abandonment.

A properly abandoned monitoring well or borehole ensures that no surface water or contamination threatens previously uncontaminated zones as a result of the well or borehole installation.

The purpose of groundwater monitoring wells is to intercept water-bearing strata. These wells are regulated by the Office of the State Engineer.

Boreholes that do not intercept water-bearing strata are not governed by the Office of the State Engineer.

2.2 Precautions

Use this procedure in conjunction with an approved Integrated Work Document (IWD) and/or Site Specific Health and Safety Plan (SSHASP). Use all Personal Protective Equipment (PPE) as required by the IWD/SSHASP.

3.0 EQUIPMENT AND TOOLS

The following equipment and supplies may be needed to properly execute the instructions in this SOP:

- Drill rig or wireline rig and accompanying equipment;
- Casing perforator and/or cut-off tool;
- Cement;
- Tremie pipe;
- Water;
- Grout pump with mechanical mixing ability;
- Bentonite (powder, pellets, or granular, depending on the specific need); and
- Any additional supplies listed in associated procedures and equipment specified in associated SOPs and the IWD/SSHASP.

4.0 STEP-BY-STEP PROCESS DESCRIPTION

4.1 Preliminary Work for Monitoring Well and Borehole Abandonment

Project Leader	1.	Using EP-ERSS-SOP-5022, Management of ER Project Waste, determine the requirements for the proper disposal of all materials removed from a monitoring well or borehole as part of abandonment.
	2.	***Submit a plan (or verify a plan has been submitted) for plugging and abandoning the monitoring well or borehole to the Office of the State Engineer.***
	3.	***Verify that the plan has been approved by the Office of the State Engineer prior to authorizing any field work on the monitoring well or borehole abandonment project.***
	4.	Inspect and evaluate the conditions and construction details of the monitoring well, before it is plugged and abandoned, by doing the following: • Sound the well (its depth measured with a weighted line or other appropriate method) immediately before it is plugged, to make sure that it contains no obstructions that could interfere with filling and sealing; and • Use video logging or other geophysics (e.g., natural gamma detector) to document down-hole conditions, where appropriate.

4.2 Methods and Requirements for Abandonment of Monitoring Wells and Boreholes

Project Leader	1.	Where possible and practical, remove all material from within the original monitoring well or borehole, including the well casing, filter pack, annular seal and/or sampling system, as appropriate. [NOTE: Material in the monitoring well or borehole may be removed by means of over-drilling with a hollow-stem auger.]
	2.	If the casing, sampling media, filter pack and annular seal materials cannot, or should not, be removed, leave these materials in place. [NOTE: The casing left in place should be perforated or punctured to allow the proper placement of sealing materials, and should be cut approximately 1 foot to 2 feet below the surface.
	3.	Control and dispose of all project waste in accordance with the requirements identified in Step 4.1.1 and EP-ERSS-SOP-5022, Management of ER Project Waste.
	4.	Whenever work is interrupted by such events as overnight shutdown, inclement weather, or other delays, cover the monitoring well or borehole opening, and any associated excavations, at the surface. [NOTE: This is to ensure public safety, and to prevent the entry of foreign material, water, or contaminants.]

Project Leader (Continued)	5.	Verify that the cover is held in place, or weighted down, in such a manner that it cannot be easily removed, except by equipment or tools.
	6.	Document the activities associated with all cover removals or installations in the project notebook, in accordance with EP-ERSS-SOP-5009, Notebook Documentation for Environmental Restoration Technical Activities, and include the following information: • The name of the person who installed or removed the cover; • The time of cover installation or removal; • The type of cover; and • The method used to secure the cover.
4.3 Place the Plugging Material in the Monitoring Well or Borehole to be Abandoned		
Project Leader	1.	Select an appropriate plugging material from the allowable materials in Section 4.4 of this procedure.
	2.	Ensure all materials used to seal and plug monitoring wells and boreholes for abandonment are the same as those specified in the abandonment plan approved by the Office of the State Engineer.
	3.	Place an appropriate selection of plugging or sealing material from the bottom of the borehole to within two (2) feet of the ground surface. [NOTE: Alternatively, consistent with 19.27.4 NMAC, drill cuttings or other clean native fill may be placed from the bottom of the borehole to within ten (10) feet of the ground surface, followed by one of the above materials to within two (2) feet of the ground surface.]
	4.	Seal the final two (2) feet of the borehole with a Portland Type I, Type II or Type I/II cement, thoroughly mixed with two (2) to five (5)% by weight of bentonite.
	5.	Ensure that only concrete is used for the surface pad.
	6.	Use the following process to plug and abandon monitoring wells and boreholes in urban areas and within portions of technical areas, if future site excavation is possible at the location of the abandoned monitoring well or borehole: • End the upper surface of the sealing material at a depth of five (5) feet below ground surface; • If the well casing was not extracted during the abandonment and sealing operations, excavate a hole around the well casing to a depth of five (5) feet below ground surface, after sealing operations have been completed, and the sealing material has adequately set and cured; • Remove the exposed well casing by cutting the casing at the bottom of the excavation; and • Backfill and compact the excavation with clean, native soil, or other suitable material.

Project Leader (Continued)	7.	Verify that the volume of the sealing and fill material, placed during abandonment operations, equals or exceeds the volume to be filled and sealed.
	8.	Using this information, verify that the monitoring well or borehole has been properly plugged and abandoned, and that no jamming or bridging of the fill or sealing material has occurred.
	9.	Document the volume calculated for the monitoring well or borehole, and the volume of the sealing and fill material used, in the project notebook, in accordance with EP-ERSS-SOP-5009, Notebook Documentation for Environmental Restoration Technical Activities.

4.4 Allowable Sealing and Plugging Materials for Abandonment of Monitoring Wells and Boreholes

Project Leader	1.	Ensure that sealing material used for plugging monitoring wells and boreholes, consists of cement slurry, bentonite-based plugging material, or other material approved by the State Engineer, as required by 19.27.4 NMAC. [NOTE: Do not use "Used" drilling mud for sealing purposes.]
	2.	Sealing material used for abandoning monitoring wells and boreholes shall consist of one of the following: • Cement, with a 2%- to 5%-by-weight bentonite mixture; • High-solids, bentonite grout; or • Bentonite clay.
	3.	Determine the quality of the water source used for sealing mixtures. [NOTE: The water used to prepare the sealing mixture shall meet the following requirements: • Water should be of potable-water quality; • Water shall be compatible with the type of sealing material used; • Water should be free of petroleum, and petroleum products; and • Water should be free of suspended matter.
	4.	Document approval of the water source in the Project notebook.
	5.	Ensure that cement used in sealing mixtures meets the requirements of ASTM C150-92, "Standard Specification for Portland Cement," including the latest revisions thereof.
	6.	Select and specify use of one of the following types of Portland cement, available under ASTM C150-92 for general construction, from the following: • Type I—General purpose. Similar to American Petroleum Institute (API) Class A; • Type II—Moderate resistance to sulfate. Lower heat of hydration than Type I. This is similar to API Class B; • Type I/II—General purpose, mixture of Types I and II; and • Neat Cement—For Types I and II Portland cement, neat cement will be mixed at a ratio of one 94 pound sack of Portland cement to five (5) to eight (8) gallons of clean water.]

Project Leader (Continued)	7.	Ensure that cement grout, used for monitoring well and borehole sealing and abandonment, has a mixture of 2% to 5% by weight bentonite powder added. [NOTE: The bentonite will be dry-mixed before hydration, and additional water may be required.]
	8.	Variations from the 2% to 5% mixture range for bentonite shall be approved and documented by the Project Leader.
	9.	Ensure that cement-based sealing materials are mixed thoroughly by machine, to provide uniformity, and to ensure that no lumps exist before pumping. [NOTE: In some specific cases, the cement-based grout may be mixed by hand. Curing accelerators may be used for temporary and short-term surface casing seals. Typical accelerators are calcium chloride, sodium chloride, aluminum powder, or gypsum. The use of accelerators requires approval and documentation by the Project Leader.]
	10.	Ensure the field project procedures include the following requirements for bentonite: • Only pure montmorillonite is an acceptable clay for bentonite annular seals; • Do not use bentonite clay seals where structural strength of the seal is required or where it will dry. [NOTE: Bentonite clay in gel or slurry form has some of the advantages of cement-based sealing material. A disadvantage is that the clay can sometimes separate from the clay-water mixture. Although many types of clay mixtures are available, none has sealing properties comparable with bentonite clay. Bentonite expands significantly in volume when hydrated. Bentonite seals may have a tendency to dry, shrink, and crack where subsurface moisture levels are low. Bentonite clay seals can be adversely affected by subsurface chemical conditions, as can cement-based materials.]; • Do not use bentonite clay as a sealing material if roots from trees and other deep-rooted plants might invade and disrupt the seal and/or damage the well casing. [NOTE: Roots can grow into a bentonite seal in some surrounding soil and vegetation conditions.]; • Do not use bentonite-based sealing material for sealing intervals of fractured rock or sealing intervals of highly unstable, unconsolidated material that could collapse and displace the sealing material; and • Bentonite clay should not be used as a sealing material where flowing water might erode it.
	11.	Prepare bentonite clay products used for sealing material in monitoring wells and borehole abandonment by following the specific manufacturer's specifications for the product[s] selected.
	12.	Use only commercially prepared, powdered, granulated, pelletized, or chipped/crushed bentonite, comprised of sodium montmorillonite, for annular seals. [NOTE: The largest dimension of bentonite pellets or chips will be less than 1/5 the radial thickness of the annular space into which they are placed.]

Project Leader (Continued)	13.	Add a sufficient amount of water to bentonite to allow proper hydration (consult specific manufacturer specifications). [NOTE: Bentonite slurry preparations normally require from 30 to 60 minutes to adequately hydrate. Actual hydration time is a function of site conditions and the form of bentonite used. Finely divided forms of bentonite generally require less time for hydration, if properly mixed.]
	14.	Where a short section of annular space is to be sealed, dry bentonite pellets or chips may be placed directly into the annular space.
	15.	Verify bridging has not occurred during the placement of bentonite seal material.
	16.	Complete Monitoring Well and Borehole Abandonment Information Form (see Attachment 1).
	17.	Attach the original "as completed" drawings and/or the Borehole/Well Completion Information Form from EP-ERSS-SOP-5032, Well Construction.

4.5 Records

Project Leader	1.	Submit the following records generated by this procedure to the Records Processing Facility: • Completed Attachment 1, including any attached supplemental information; and • Project notebook entries.

5.0 PROCESS FLOW CHART

Will be included at a later date.

6.0 ATTACHMENTS

Attachment 1: 5034-1 Monitoring Well and Borehole Abandonment Information Form (1 page)

7.0 REVISION HISTORY

Author: Danny Katzman

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	2/9/07	New document number, reformatted and renumbered. Supersedes SOP-05.03.	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 ERSS training specialist.

ATTACHMENT 1: MONITORING WELL AND BOREHOLE ABANDONMENT INFORMATION

5034-1 **Monitoring Well and Borehole Abandonment Information**	Records Use only Los Alamos NATIONAL LABORATORY EST.1943

Date/Time:	**Sheet _____ of _____**
Technical Area:	**Focus Area (if applicable, or other location details):**
Borehole ID:	**Well Type (monitoring, etc.):**
Site Work Plan:	
Depth from Surface to Bottom of Hole:	
Grout Depth/Location:	
Bentonite Depth/Location:	
Other Fill Material Depth/Location:	
Surface Construction:	
Grout/Backfill Composition:	
Additional Comments/Details:	
Attach "Borehole/Well Completion Information Form" or the original "as-completed" drawings for the abandoned hole.	