LA-UR-10-3956
July 2010
EP2010-0273

Plugging and Abandonment Summary Report for Test Well 4

Prepared by the Environmental Programs Directorate

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EXECUTIVE SUMMARY

This report describes the methods Los Alamos National Laboratory used to plug and abandon groundwater-monitoring Test Well 4 (TW-4). The well is located on the south rim of Acid Canyon in Los Alamos, New Mexico.

TW-4 was plugged and abandoned in accordance with direction from the New Mexico Environment Department.

Plugging and abandonment activities at TW-4 occurred from April 6, 2010, to May 4, 2010, using a pump hoist rig. The 2-in. pump column that was part of the well's sampling system was removed. The 6-in. internal casing string was then removed from the borehole, along with polyvinyl chloride (PVC) tubing and pump electrical cable that were stuck in the casing. No attempt was made to remove the well screen, submersible pump, additional PVC tubing and pump cable, or the additional casing strings that were installed in the borehole.

TW-4 was grouted to 2 ft below ground surface on May 3, 2010. The well screen, borehole, and remaining casing were plugged and abandoned with 3/8-in. bentonite chips and Portland Type I/II/V cement via tremie pipe. After the screen, open borehole, and casing were plugged, the annular spaces between the remaining casing strings were plugged with 3/8-in. bentonite chips on May 4, 2010.

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Acronyms and Abbreviations

bgl	below ground level
bgs	below ground surface
Consent Order	Compliance Order on Consent
DTW	depth to water
GPS	global positioning system
I.D.	inside diameter
LANL	Los Alamos National Laboratory
NAD	North American Datum, 1983
NMED	New Mexico Environment Department
OSE	Office of the State Engineer (New Mexico)
PVC	polyvinyl chloride
TD	total depth
TW	test well

1.0 INTRODUCTION

This report summarizes the methods Los Alamos National Laboratory (LANL or the Laboratory) used to plug and abandon groundwater-monitoring Test Well 4 (TW-4). Well abandonment was consistent with the requirements and guidelines in Sections IV.B.1.b.v and X.D, Well Abandonment, of the Compliance Order on Consent (the Consent Order). Additionally, the plugging and abandonment procedures complied with 19.27.4 New Mexico Administrative Code Rules and Regulations Governing Well Driller Licensing; Construction, Repair and Plugging of Wells. The following documents helped guide the implementation of the scope of work for the TW-4 plugging and abandonment project: "Work Plan to Plug and Abandon Test Well 4" (LANL 2010, 109088) and "Field Work Plan to Plug and Abandon Test Well TW-4" (TerranearPMC 2010, 109123). Additionally, a plugging plan was filed with the New Mexico Office of the State Engineer (OSE).

2.0 BACKGROUND

TW-4 is located on the south rim of Acid Canyon in Los Alamos, New Mexico (Figure 2.0-1). TW-4 was installed in 1950 to monitor the water in the regional aquifer in the vicinity of the former Technical Area 45 wastewater treatment plant (Purtymun and Swanton 1998, 099096).

2.1 Well History

TW-4 was completed to 1205 ft below ground surface (bgs), with a 6-in.-diameter, 10-ft slotted-screen section swaged into the bottom of a 6-in.-inside diameter (I.D.) steel casing string. The 6-in. casing extended from 0 to 1195 ft bgs. The surface casing consists of 16-in.-I.D. steel casing from ground surface to 109 ft bgs. A 12-in.-I.D. steel casing string was installed from ground surface to 288 ft bgs, and a 10-in.-I.D. steel casing string was installed from ground surface to 633 ft bgs. Completion notes indicate that TW-4 did not have an annular seal around the 10-in., 12-in., or 16-in. casing. In addition, TW-4 did not have an annular seal or a filter pack around the screen (Purtymun and Swanton 1998, 099096). Drilling and installation of the test well were performed using a cable tool rig.

In 2006, an initial attempt was made by the U.S. Department of Energy and their contractor to plug and abandon TW-4. The subcontractor began pump removal operations; after removing approximately 80 ft of pump discharge pipe, electrical cable, and polyvinyl chloride (PVC) tubing, the PVC transducer tube parted and was dropped downhole. This resulted in the pump being stuck downhole and the contractor being unable to retrieve the pump with the equipment on-site. The wellhead was secure and no further work was performed until the 2010 abandonment effort.

Before plugging and abandonment, a groundwater-level measurement at TW-4 of 1168 ft bgs was recorded on video on April 15, 2010. The well construction diagram for the test well prior to plugging and abandonment is presented in Figure 2.0-2.

2.2 Rationale for Plugging and Abandonment

The New Mexico Environment Department (NMED) directed that TW-4 be abandoned because the construction techniques and materials did not meet current requirements for groundwater monitoring wells.

3.0 SCOPE OF ACTIVITIES

The plugging and abandonment approach, logging activities, and abandonment activities for TW-4 are presented below.

3.1 Plug and Abandonment Design and Approach

The abandonment approach implemented at TW-4 included removing the internal 6-in. casing string to expose the lowermost formation and to backfill the open borehole with sealing materials. The additional 10-in., 12-in., and 16-in. casing strings were sealed with hydrated bentonite chips and neat Portland Type I/II/V cement.

3.2 Borehole Logging

Video and geophysical logs were run in TW-4 before well abandonment. The Laboratory's camera trailer and logging equipment were used to complete the logging.

3.2.1 Video Logging

A downhole video log was run in TW-4 on April 15, 2010, after the 6-in. casing string was removed from the borehole. The log was run to document borehole conditions and measure static water level before plugging and abandonment.

The video log obtained from TW-4 is presented in Appendix A on DVD.

3.2.2 Geophysical Logging

Natural gamma ray and induction logging were conducted on April 15, 2010, before plugging and abandonment activities to verify casing string lengths and assess lithologic contacts. Electronic files of the geophysical logs are included in Appendix B on the CD included with this report.

3.3 Plugging and Abandonment

Plugging and abandonment activities included mobilization, pump column and casing removal, pressure-grouting/sealing, and demobilization. All activities were performed following appropriate standard operating procedures and Laboratory-approved health and safety documents. TW-4 was plugged and abandoned in accordance with the NMED-approved work plan and the New Mexico OSE plugging plan. The OSE plugging record is attached as Appendix C.

3.3.1 Field Activities

A Pulstar (P100000) pump hoist was mobilized to TW-4 on April 6, 2010. Following a field management, operations, and verification review that included inspection of heavy equipment, an attempt was made to remove the 2-in. pump column that was a part of the well's sampling system. On April 7, the pump column was raised approximately 4 ft with 20,000 lb of pull-back force. Because of the tension on the pump column, likely caused by the submersible pump's dragging electrical cable and/or broken PVC tubing against the well casing, 950 gal. of water and 6 gal. of EZ-MUD (drilling additive) were poured down the 6-in. well casing. From April 8 to April 9, the 2-in. drop pipe was removed from the well (approximately 1092 ft). The submersible pump was not attached to the bottom of the drop pipe.

After the 2-in. drop pipe was removed from the well, an attempt was made to remove the 6-in.-I.D. steel casing that extended from ground surface to 1195 ft bgs and 6-in.-I.D. well screen that extended from 1195 to 1205 ft bgs. From April 13 to April 15, the entire 6-in.-I.D. steel casing string was removed from the borehole. Approximately 400 ft of pump electrical cable and 700 ft of PVC tubing that had been stuck in the 6-in. casing were also removed. No attempt was made to fish out the submersible sampling pump, additional PVC tubing and pump cable, or the 6-in. well screen from the bottom of the borehole. No attempts were made to remove the 16-in., 12-in., or 10-in. casing strings. On April 15, before plugging and abandoning the borehole, Laboratory personnel ran video, gamma, and induction logs.

From April 21 to May 3, the 6-in.-I.D. well screen, 10-in. open borehole, and 10-in.-I.D. steel casing were sealed from 1205 ft bgs (total depth of well) to 49 ft bgs with approximately 955.7 ft^3 of 3/8-in. bentonite chips. The volume and type of abandonment materials used to abandon TW-4 are presented in Table 3.3-1.

On May 3, approximately 26.8 ft^3 of cement grout was used to plug the 10-in. steel casing from 49 to 2 ft bgs. Approximately 53.6 ft^3 of 3/8-in. bentonite chips was used to plug the annular spaces (up to 2 ft bgs) between the 16-in. and 12-in. casing strings and the 12-in. and 10-in. casing strings. The tops of the 16-in., 12-in., and 10-in. casing strings were cut at 2 ft bgs. Figure 3.3-1 shows the final well configuration after plugging and abandonment.

Observations made at the well indicated the borehole diameter was larger than had been documented in available well completion records. The video log and documented observations in the field indicated that the 6-in. casing string was set in a large-diameter borehole (typical for cable-tool drilling). The theoretical volumes calculated to fill the boreholes were generally less than the actual volumes that were used, which supports these observations.

Bentonite chips were poured from the ground surface between the three casing strings (10-in, 12-in, 16-in). The actual volume used to fill the annular space of the outer casing strings was about 35% less than the calculated volume. However, that volume, in combination with the concrete surface seal and the bentonite seal in the borehole, should protect surface water from entering the borehole.

3.3.2 Completion

The well was cement-grouted to 2 ft bgs, and a 2-ft × 2-ft × 2-ft (deep) concrete surface pad was installed. A brass survey marker was installed in the pad, and it will be surveyed in accordance with Section IX.B.2.f of the Consent Order.

4.0 POSTABANDONMENT ACTIVITIES

Postabandonment activities are described below.

4.1 Well Site Restoration

Plugging and abandonment activities at TW-4 required only minimal restoration efforts to return the site to pre–plugging and abandonment conditions.

4.2 Waste Management

Contact waste was generated during the plugging and abandonment of well TW-4. Laboratory personnel removed the concrete surface pad at the former well site. Contact waste included the discharge pipe,

electrical cabling, PVC tubing, and 6-in. well casing, as well as the cutoff surface casings. All waste will be recycled or disposed by the Laboratory in accordance with the "Waste Characterization Strategy Form for Plug and Abandonment of LANL Wells" (LANL 2009, 106892).

5.0 DEVIATIONS FROM PLANNED ACTIVITIES

Plugging and abandonment at TW-4 was performed as specified in the "Field Work Plan to Plug and Abandon Test Well TW-4," (TerranearPMC 2010, 109123).

6.0 SUMMARY

TW-4 was plugged and abandoned in accordance with the NMED-approved work plan. Before abandonment activities, all aboveground appurtenances were removed, and the pump column was removed from the well. The innermost 6-in. casing string was removed, and the borehole was abandoned using hydrated bentonite chips. The 10-in., 12-in., and 16-in. casing strings that remained in the borehole were abandoned using hydrated bentonite chips, Portland Type I/II/V cement, and municipal water.

7.0 REFERENCES AND MAP DATA SOURCES

7.1 References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

LANL (Los Alamos National Laboratory), June 16, 2009. "Waste Characterization Strategy Form for Plug and Abandonment of LANL Wells," Los Alamos, New Mexico. (LANL 2009, 106892)

LANL (Los Alamos National Laboratory), March 2010. "Work Plan to Plug and Abandon Test Well 4," Los Alamos National Laboratory document LA-UR-10-1423, Los Alamos, New Mexico. (LANL 2010, 109088)

Purtymun, W.D., and A.S. Swanton, February 5, 1998. "Engineering, Geology, and Construction Data of Twenty-Five Test Holes and Test Wells on and Adjacent to the Pajarito Plateau," draft, Los Alamos National Laboratory, Los Alamos, New Mexico. (Purtymun and Swanton 1998, 099096)

TerranearPMC, April 2010. "Field Work Plan to Plug and Abandon Test Well TW-4," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (TerranearPMC 2010, 109123)

7.2 Map Data Sources

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2009-0283; June 4, 2009.

Hypsography, 100 and 20 Foot Contour Interval; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program; 1991.

Los Alamos Structures; County of Los Alamos, Information Services; as published 29 October 2007.

Los Alamos Streets; County of Los Alamos, Information Services; as published 16 May 2006.

Figure 2.0-1 Location of well TW-4

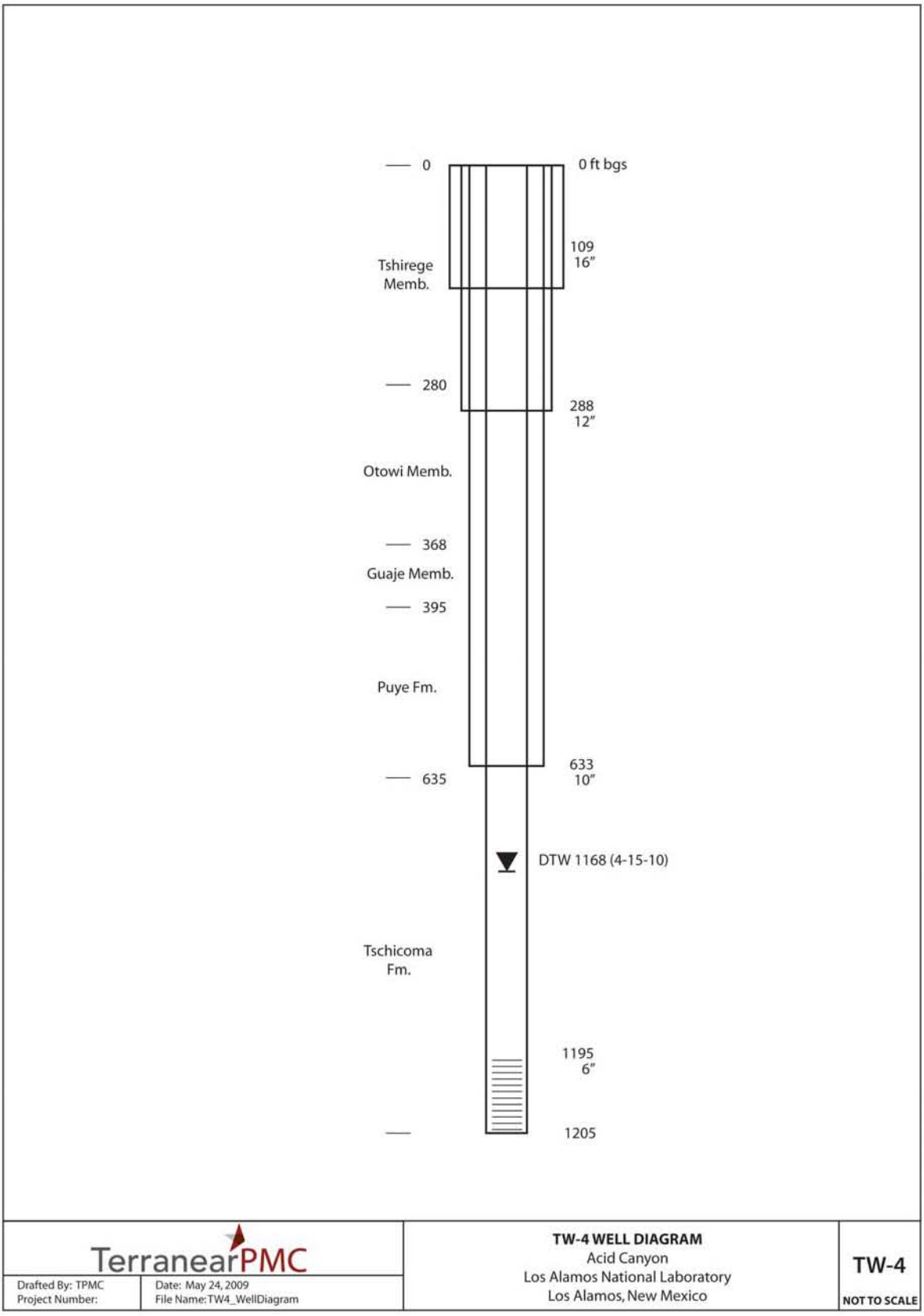

Figure 2.0-2 TW-4 well construction diagram

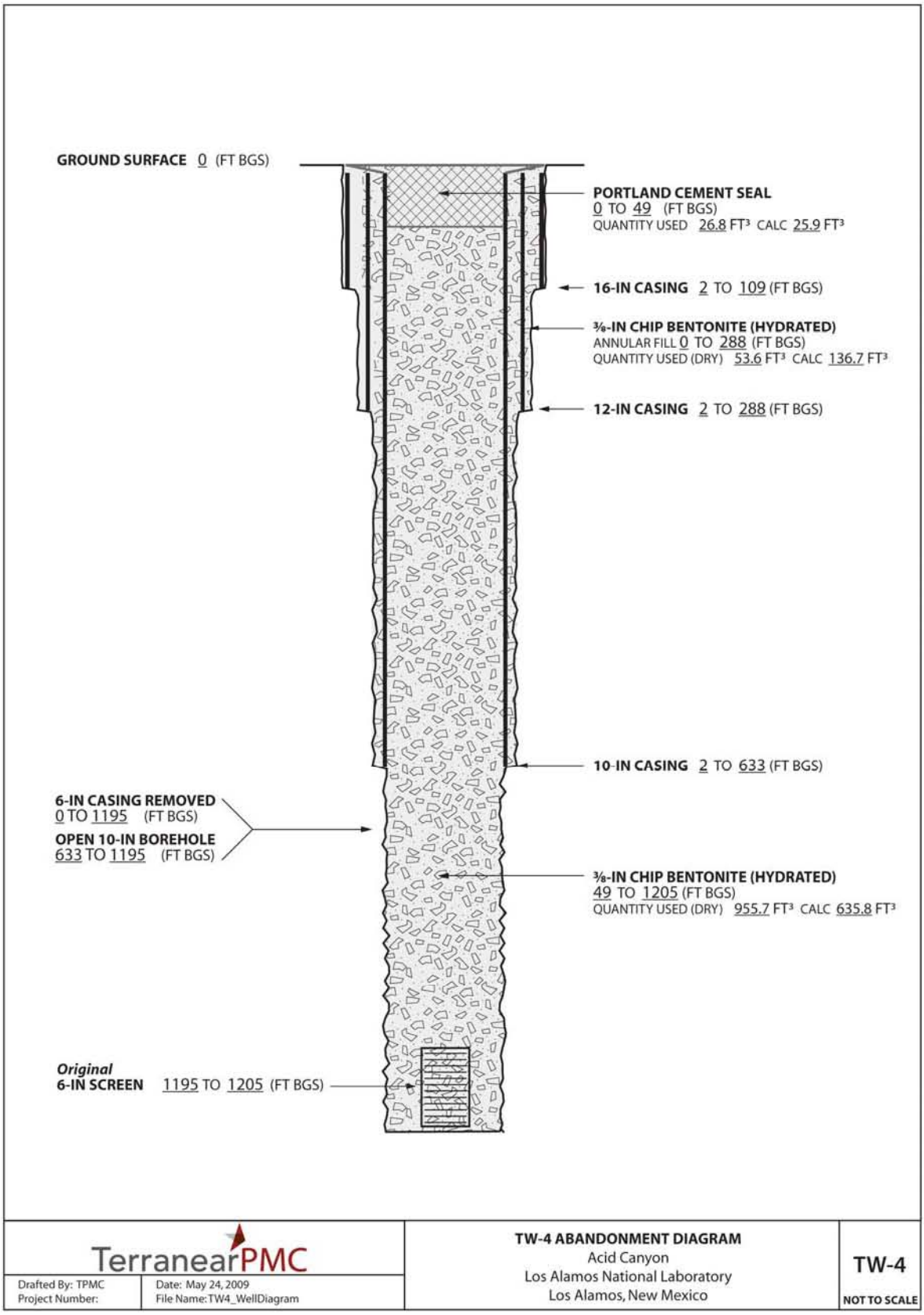

Figure 3.3-1 TW-4 well abandonment diagram

Table 3.3-1
Quantity and Materials Used to Plug and Abandon TW-4

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II/V Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume[a] (ft^3)	Actual Volume (ft^3)
4/21/10	1205.0–1144.7	n/a[b]	1500	6850	33.2	91.8
4/23/10	1144.7–1067.0	n/a	6400	4750	42.7	63.7
4/24/10	1067.0–1012.2	n/a	4500	5250	30.1	70.4
4/25/10	1012.2–971.0	n/a	4000	4500	22.7	60.3
4/26/10	971.0–945.3	n/a	2000	2750	14.1	36.9
4/27/10	945.3–903.3	n/a	8000	5200	23.1	69.7
4/28/10	903.3–830.0	n/a	5000	5250	40.3	70.4
4/29/10	830.0–766.0	n/a	7000	6750	35.2	90.5
4/30/10	766.0–689.5	n/a	7000	7500	42.1	100.5
5/1/10	689.5–504.2	n/a	3800	7500	101.9	100.5
5/3/10	504.2–49.0	n/a	2000	15,000	250.4	201.0
5/3/10	49.0–2.0	1504	160	n/a	25.9	26.8
5/3/10	Annular spaces	n/a	500	4000	86.8[c]	56.0[c]
Totals		**1504**	**51,860**	**75,300**	**798.4**	**1036.1**

[a] Calculated volumes are based on the following dimensions: 2–1205 ft bgs is 10-in. borehole/casing.

[b] n/a = Not applicable.

[c] Calculated volumes for annular spaces are based on the annular space between the 16-in. and 12-in. casing strings (0–109 ft bgs) and the annular space between the 12-in. and 10-in. casing string (0–288 ft bgs).

Appendix A

Video Log of TW-4
(on DVD included with this document)

Appendix B

Geophysical Logs
(on CD included with this document)

Appendix C

New Mexico Office of the State Engineer Plugging Record

PLUGGING RECORD

NOTE: A Well Plugging Plan of Operations shall be approved by the State Engineer prior to plugging - 19.27.4 NMAC

I. GENERAL / WELL OWNERSHIP:

State Engineer Well Number: Test Well (TW)-4

Well owner: U.S. Department of Energy/Los Alamos National Laboratory Phone No.: 505-667-5931

Mailing address: P.O. Box 1663

City: Los Alamos State: New Mexico Zip code: 87545

II. WELL PLUGGING INFORMATION:

1) Name of well drilling company that plugged well: Boart Longyear

2) New Mexico Well Driller License No.: WD-1664 Expiration Date: 1/31/2011

3) Well plugging activities were supervised by the following well driller(s)/rig supervisor(s): Terranear PMC, LLC

4) Date well plugging began: April 7, 2010 Date well plugging concluded: May 4, 2010

5) GPS Well Location (BRASS CAP): East: 483783.9
North: 1777618.0

Well coordinates are New Mexico State Plane Grid Coordinates, Central Zone (North American Datum, 1983[NAD 1983]).

6) Depth of well confirmed at initiation of plugging as: 1205.0 ft below ground level (bgl), by the following manner: manual tag

7) Static water level measured at initiation of plugging: 1168 ft bgl

8) Date well plugging plan of operations was approved by the State Engineer: April 19, 2010

9) Were all plugging activities consistent with an approved plugging plan? Yes If not, please describe differences between the approved plugging plan and the well as it was plugged (attach additional pages as needed):

SUMMARY: The 2-in. pump column was removed from the well. The entire 6-in. well casing was removed from surface to 1195 ft bgs, including approximately 400 ft of pump electrical cable and 700 ft of PVC tubing that had been stuck in the 6-in. casing. No attempt was made to fish out the submersible sampling pump, additional PVC tubing and pump cable, or the 6-in. well screen in the bottom of the borehole. Hydrated bentonite chips were used to plug the 6-in. screen, 10-in. open borehole, and 10-in. casing from 1205 ft bgs (TD) to 49 ft bgs. Portland Type I/II/V cement was used to plug the 10-in. casing from 49 to 2 ft bgs. Hydrated bentonite chips were used to plug the annular spaces between the 16-in. and 12-in. casing strings and the 12-in. and 10-in. casing strings. The 16-in., 12-in., and 10-in. casings were left in place and were not perforated. The casing strings left in place terminate at the following depths: 10-in. at 633 ft bgs, 12-in. at 288 ft bgs, and 16-in. at 109 ft bgs. All three casings were cut off at 2 ft bgs A 2-ft X 2-ft X 2-ft (deep) concrete surface pad has been installed at ground surface with a brass survey marker.

10) Log of Plugging Activities - Label vertical scale with depths, and indicate separate plugging intervals with horizontal lines as necessary to illustrate material or methodology changes. Attach additional pages if necessary.

For each interval plugged, describe within the following columns:

Depth (ft bgl)	Plugging Material Used (include any additives used)	Volume of Material Placed (gallons)	Theoretical Volume of Borehole/ Casing (gallons)	Placement Method (tremie pipe, other)	Comments ("casing perforated first", "open annular space also plugged", etc.)
2.0	**Portland Type I/II/V Cement**	**200.5 gallons**	**193.7 gallons**	**Tremie pipe**	**10-in. casing sealed from 2 to 49 ft bgs.**
49.0	**3/8-in. Hydrated Bentonite Chips (annular spaces)**	**400.9 gallons (annular spaces)**	**1022.5 gallons (annular spaces)**	**Tremie pipe**	**16-in., 12-in., and 10-in. open annular spaces also plugged.**
	3/8-in. Hydrated Bentonite Chips	**7148.6 gallons**	**4755.8 gallons**	**Tremie pipe**	**6-in casing removed from surface to 1195 ft bgs.** **10-in. casing sealed from 49 to 633 ft bgs.** **10-in. open borehole sealed from 633 to 1195 ft bgs.** **6-in. screen sealed from 1195 to 1205 ft bgs.**
1205.0					

MULTIPLY		BY		AND OBTAIN
cubic feet	x	7.4805	=	gallons
cubic yards	x	201.97	=	gallons

III. SIGNATURE:

I, Mark Everett , say that I am familiar with the rules of the Office of the State Engineer pertaining to the plugging of wells and that each and all of the statements in this Plugging Record and attachments are true to the best of my knowledge and belief.

Original with signature on file at the NMOSE

Signature of Well Driller Date