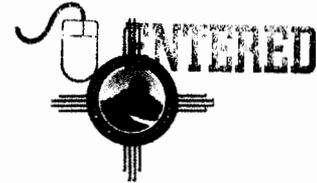




Environmental Programs
P.O. Box 1663, MS M991
Los Alamos, New Mexico 87545
(505) 606-2337/FAX (505) 665-1812



National Nuclear Security Administration
Los Alamos Field Office, MS A316
Environmental Projects Office
Los Alamos, New Mexico 87544
(505) 667-4255/FAX (505) 606-2132

Date: **MAR 28 2013**
Refer To: EP2013-0055

John Kieling, Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

Subject: Submittal of the Plugging and Abandonment Summary Report for Boreholes 49-10046, 49-10047, 49-10048, Coreholes CH-1, CH-3, CH-4, Test Holes TH-4, TBM-1, TBM-2, and Layne Western Well

Dear Mr. Kieling:

Enclosed please find two hard copies with electronic files of the Plugging and Abandonment Summary Report for Boreholes 49-10046, 49-10047, 49-10048, Coreholes CH-1, CH-3, CH-4, Test Holes TH-4, TBM-1, TBM-2, and Layne Western Well. This work was completed per the Notice of Approval with Modifications Work Plans to Plug and Abandon Wells and Boreholes at Los Alamos National Laboratory, dated March 9, 2011.

Twenty-three of the 30 wells described in the above-referenced report (plus TW-3) have now been plugged and abandoned. One more well, Sigma Mesa well, is being plugged and abandoned in calendar year 2013, and the summary report will be submitted no later than March 2014. The remaining 6 Technical Area 46 distillation wells described in the work plan (although only 4 were later confirmed in the field) will not be plugged and abandoned because the current facility operators plan to resume stable isotope operations in the near future.

In the report on the Sigma Mesa well due in March 2014, Los Alamos National Laboratory will propose a prioritization for select additional wells to be plugged and abandoned over the following 3-yr period.



If you have any questions, please contact Ted Ball at (505) 665-3996 (tedball@lanl.gov) or Woody Woodworth at (505) 665-5820 (lance.woodworth@nnsa.doe.gov).

Sincerely,



Jeff Mousseau, Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,



Peter Maggiore, Assistant Manager
Environmental Projects Office
Los Alamos Field Office

JM/PM/CD/TB:vt

Enclosures: Two hard copies with electronic files – Plugging and Abandonment Summary Report for Boreholes 49-10046, 49-10047, 49-10048, Coreholes CH-1, CH-3, CH-4, Test Holes TH-4, TBM-1, TBM-2, and Layne Western Well (LA-UR-13-22140)

Cy: (w/enc.)
Woody Woodworth, DOE-NA-00-LA, MS A316
Ted Ball, EP-CAP, MS J590
Public Reading Room (hard copy)
RPF (electronic copy)

Cy: (Letter and CD and/or DVD)
Laurie King, EPA Region 6, Dallas, TX
Steve Yanicak, NMED-DOE-OB, MS M894
Mark Everett ET-EI (w/ MS Word files on CD)
Wendy Staples, EP-BPS, MS M992

Cy: (w/o enc.)
Tom Skibitski, NMED-Resource Protection (date-stamped letter emailed)
lasomailbox@nnsa.doe.gov (date-stamped letter emailed)
Annette Russell, DOE-NA-00-LA (date-stamped letter emailed)
David Rhodes, DOE-NA-00-LA (date-stamped letter emailed)
Craig Douglass, EP-CAP (date-stamped letter emailed)
Jeff Mousseau, ADEP (date-stamped letter emailed)

LA-UR-13-22140
March 2013
EP2013-0055

**Plugging and Abandonment
Summary Report for Boreholes
49-10046, 49-10047, 49-10048,
Coreholes CH-1, CH-3, CH-4,
Test Holes TH-4, TBM-1, TBM-2,
and Layne Western Well**

Prepared by the Environmental Programs Directorate

Los Alamos National Laboratory, operated by Los Alamos National Security, LLC, for the U.S. Department of Energy under Contract No. DE-AC52-06NA25396, has prepared this document pursuant to the Compliance Order on Consent, signed March 1, 2005. The Compliance Order on Consent contains requirements for the investigation and cleanup, including corrective action, of contamination at Los Alamos National Laboratory. The U.S. government has rights to use, reproduce, and distribute this document. The public may copy and use this document without charge, provided that this notice and any statement of authorship are reproduced on all copies.

Plugging and Abandonment Summary Report for Boreholes 49-10046, 49-10047, 49-10048, Coreholes CH-1, CH-3, CH-4, Test Holes TH-4, TBM-1, TBM-2, and Layne Western Well

March 2013

Responsible project manager:

Ted Ball		Project Manager	Environmental Programs	3/26/13
Printed Name	Signature	Title	Organization	Date

Responsible LANS representative:

Jeff Mousseau		Associate Director	Environmental Programs	3/27/13
Printed Name	Signature	Title	Organization	Date

Responsible DOE representative:

Peter Maggiore		Assistant Manager	DOE-NA-00-LA	03/28/2013
Printed Name	Signature	Title	Organization	Date

EXECUTIVE SUMMARY

This report details the methods Los Alamos National Laboratory (LANL or the Laboratory) used to plug and abandon boreholes 49-10046, 49-10047, 49-10048, coreholes (CH) 1, CH-3, CH-4, test holes (TH) 4, TBM-1, TBM-2, and the Layne Western well. Plugging and abandonment activities occurred from February 14 to February 28, 2013. Before the holes and wells were abandoned, all above- and belowground appurtenances were removed. The Layne Western well was video and gamma-ray logged from ground surface to 107.5 ft below ground surface (bgs) in 2012. Water-level measurements and the total depths of the boreholes, coreholes, test holes, and well were verified using a water-level meter before the holes and well were abandoned.

Boreholes 49-10046, 49-10047, 49-10048, CH-1, CH-3, CH-4, and TH-4 were plugged and abandoned without the use of an auger rig or pump hoist. Boreholes 49-10046, 49-10047, 49-10048, CH-1, CH-3, and CH-4 were plugged with Portland Type I/II cement and municipal water. TH-4 was plugged with hydrated bentonite chips and Portland Type I/II cement. A CME-75 auger rig and ancillary equipment were used during plugging and abandonment activities at TBM-1 and TBM-2. TBM-1 and TBM-2 were reamed to remove polyvinyl chloride casing and well construction material. The boreholes were plugged with Portland Type I/II cement. A pump hoist rig was used during plugging and abandonment activities at the Layne Western well. An attempt was made to remove the well casing from the well using hydraulic casing jacks assisted by the pump hoist (used to power the jacks only due to overhead powerlines). The Layne Western well was plugged with hydrated bentonite chips and Portland Type I/II cement.

The boreholes, coreholes, test holes, and well were cement-grouted to approximately 2 ft bgs, and a small concrete surface plug was installed near ground surface with an aluminum survey marker. The surface completion was surveyed in accordance with Section IX.B.2.f of the Compliance Order on Consent.

CONTENTS

1.0 INTRODUCTION 1

2.0 BACKGROUND 1

2.1 Boreholes 49-10046, 49-10047, and 49-10048..... 2

2.2 CH-1, CH-3, and CH-4..... 2

2.3 TH-4 3

2.4 TBM-1 and TBM-2 3

2.5 Layne Western Well..... 3

3.0 PLUGGING AND ABANDONMENT 4

3.1 Boreholes 49-10046, 49-10047, and 49-10048..... 4

3.2 CH-1, CH-3, and CH-4..... 5

3.3 TH-4 5

3.4 TBM-1 and TBM-2 6

3.5 Layne Western Well..... 6

4.0 SURFACE COMPLETION 6

4.1 Geodetic Survey 7

5.0 POST-ABANDONMENT ACTIVITIES 7

5.1 Site Restoration 7

5.2 Waste Management..... 7

6.0 DEVIATIONS FROM PLANNED ACTIVITIES 7

7.0 SUMMARY 8

8.0 REFERENCES AND MAP DATA SOURCES 8

8.1 References 8

8.2 Map Data Sources for Plugging and Abandonment Report Location Map 9

Figures

Figure 1.0-1 Location of Plugged and Abandoned Boreholes 49-10046, 49-10047, 49-10048, Coreholes CH-1, CH-3, CH-4, Test Holes TH-4, TBM-1, TBM-2, and the Layne Western Well..... 11

Figure 2.1-1 Borehole 49-10046 construction diagram 12

Figure 2.1-2 Borehole 49-10047 construction diagram 13

Figure 2.1-3 Borehole 49-10048 construction diagram 14

Figure 2.2-1 CH-1 construction diagram 15

Figure 2.2-2 CH-3 construction diagram 16

Figure 2.2-3 CH-4 construction diagram 17

Figure 2.3-1 TH-4 construction diagram..... 18

Figure 2.4-1 TBM-1 construction diagram 19

Figure 2.4-2 TBM-2 construction diagram 20

Figure 2.5-1 Layne Western Well construction diagram 21

Figure 3.1-1 Borehole 49-10046 abandonment diagram 22

Figure 3.1-2	Borehole 49-10047 abandonment diagram	23
Figure 3.1-3	Borehole 49-10048 abandonment diagram	24
Figure 3.2-1	CH-1 abandonment diagram.....	25
Figure 3.2-2	CH-3 abandonment diagram.....	26
Figure 3.2-3	CH-4 abandonment diagram.....	27
Figure 3.3-1	TH-4 abandonment diagram	28
Figure 3.4-1	TBM-1 abandonment diagram	29
Figure 3.4-2	TBM-2 abandonment diagram	30
Figure 3.5-1	Layne Western Well abandonment diagram.....	31

Tables

Table 3.1-1	Quantity and Materials Used to Plug and Abandon Borehole 49-10046	33
Table 3.1-2	Quantity and Materials Used to Plug and Abandon Borehole 49-10047	33
Table 3.1-3	Quantity and Materials Used to Plug and Abandon Borehole 49-10048	33
Table 3.2-1	Quantity and Materials Used to Plug and Abandon CH-1	33
Table 3.2-2	Quantity and Materials Used to Plug and Abandon CH-3	34
Table 3.2-3	Quantity and Materials Used to Plug and Abandon CH-4	34
Table 3.3-1	Quantity and Materials Used to Plug and Abandon Test Hole TH-4	34
Table 3.4-1	Quantity and Materials Used to Plug and Abandon TBM-1	34
Table 3.4-2	Quantity and Materials Used to Plug and Abandon TBM-2	35
Table 3.5-1	Quantity and Materials Used to Plug and Abandon Layne Western Well	35
Table 4.1-1	Survey Coordinates of Aluminum Pin Embedded in Surface Pad	35

Appendix

Appendix A	Video Log of Layne Western Well (on DVD included with this document)
Appendix B	Gamma Log of Layne Western Well (on CD included with this document)

Acronyms and Abbreviations

ags	above ground surface
amsl	above mean sea level
bgs	below ground surface
CH	corehole
Consent Order	Compliance Order on Consent
I.D.	inside diameter
LANL	Los Alamos National Laboratory
NES	nuclear environmental site
NMED	New Mexico Environment Department
O.D.	outside diameter
OSE	Office of the State Engineer
PVC	polyvinyl chloride
RPF	Records Processing Facility
TA	technical area
TH	test hole

1.0 INTRODUCTION

This report summarizes the methods Los Alamos National Laboratory (LANL or the Laboratory) used to plug and abandon boreholes 49-10046, 49-10047, 49-10048, coreholes (CH) 1, CH-3, CH-4, Test Holes (TH) 4, TBM-1, TBM-2, and the Layne Western Well. The boreholes, coreholes, test holes, and well are located in and around Los Alamos County, New Mexico, as shown in Figure 1.0-1. The boreholes, coreholes, test holes, and well were plugged and abandoned with direction from NMED and in accordance with the Laboratory's "Work Plans to Plug and Abandon Wells and Boreholes at Los Alamos National Laboratory" (LANL 2010, 111131), and NMED's "Notice of Approval with Modifications Work Plans to Plug and Abandon Wells and Boreholes at Los Alamos National Laboratory (NMED 2011, 201231).

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 plugging and abandonment project: "Work Plans to Plug and Abandon Wells and Boreholes at Los Alamos National Laboratory" (LANL 2010, 111131) and the "Field Implementation Plan to Plug and Abandon Boreholes 49-10046, 49-10047, 49-10048, Core Holes CH-1, CH-3, CH-4, Test Holes TH-4, TBM-1, TBM-2, and Layne Western Well" (TerranearPMC 2012, 238466). A plugging plan of operations was filed for the Layne Western Well with the New Mexico Office of the State Engineer (OSE).

2.0 BACKGROUND

This section describes the location, construction, and conditions of each borehole, corehole, test hole, and well before plugging and abandonment activities.

All plugging and abandonment tasks within the Technical Area 49 (TA-49) nuclear environmental site (NES) were completed in compliance with the December 2010 "Documented Safety Analysis for the Nuclear Environmental Sites at Los Alamos National Laboratory," and the December 2010 "Technical Safety Requirements for the Nuclear Environmental Sites at Los Alamos National Laboratory, Revision 4." Specifically, no vehicles or equipment were driven across or parked on the NES surface. Foot traffic was restricted to defined access routes and was limited to required travel to and from the boreholes and coreholes that were abandoned. No materials were staged within the NES boundary. In addition, only authorized personnel required for performing the job tasks were allowed within the NES boundary. This restriction ensured that the integrity of the Inventory Isolation System (essentially, the soil overburden) was maintained and was not adversely altered or modified.

Grouting of the boreholes and coreholes located within the NES was performed using a diaphragm pump, air compressor, various hoses, and a spool of 1.25-in.-diameter poly tubing. The diaphragm pump, air compressor, and hoses remained outside the NES fence, and the poly tube was run through the fence to the boreholes and coreholes. The poly tube was inserted into the boreholes and coreholes and used as a tremie pipe to pump cement from the bottom up to ensure the holes were completely filled. The poly tubing was either retracted as the hole was filled or was cut off and grouted in place.

After the boreholes and coreholes were cemented, the pump and hoses were flushed through with water to remove residual cement. Cement washout water was initially containerized in drums that were later discharged to the ground in a designated cement washout area outside the NES fence.

Equipment that contacted the ground surface within the NES was decontaminated with Fantastik. Equipment removed from the NES and personnel exiting the NES were swiped for a radiological survey by a radiological control technician, per the radiological work permit.

2.1 Boreholes 49-10046, 49-10047, and 49-10048

Boreholes 49-10046, 49-10047, and 49-10048 are located at TA-49 inside the NES boundary.

Boreholes 49-10046, 49-10047, and 49-10048 were installed in 2000 as shallow cased neutron logging holes for moisture monitoring at Area 2 shafts at TA-49 (LANL 2008, 102215). The boreholes were 2 in. in diameter with aluminum casing installed to total depth. The top of the boreholes were completed with an 18-in. × 18-in. × 6-in.-thick concrete pad (approximate). The ground surface around the boreholes was covered with a steel mesh gopher barrier.

Preabandonment Conditions

The total depth of borehole 49-10046 was measured to 14.1 ft below ground surface (bgs) with no water present on February 19, 2013. Total depth and lack of water were verified with a water-level meter.

The total depth of borehole 49-10047 was measured to 11.5 ft bgs with no water present on February 19, 2013. Total depth and lack of water were verified with a water-level meter.

The total depth of borehole 49-10048 was measured to 12.2 ft bgs with no water present on February 19, 2013. Total depth and lack of water were verified with a water-level meter.

Figures 2.1-1, 2.1-2, and 2.1-3 are well construction diagrams depicting the construction details and preabandonment conditions of boreholes 49-10046, 49-10047, and 49-10048, respectively.

2.2 CH-1, CH-3, and CH-4

CH-1 and CH-4 are located at TA-49 inside the NES boundary, and CH-3 is located outside the TA-49 NES boundary.

CH-1 was cored in 1959 to 501 ft bgs, CH-3 was cored in 1960 to 300 ft bgs, and CH-4 was cored in 1960 to 303 ft bgs. The coreholes were installed to determine some of the physical and hydrologic properties of the tuff (Purtymun 1995, 045344). The 4.5-in.-diameter coreholes were dry (LANL 2008, 102215). A 2-in.-inside diameter (I.D.) galvanized pipe was installed in the coreholes to total depth and cemented in place (Purtymun 1995, 045344). The surface completions were 2-ft × 3-ft × 12-in.-thick concrete pads (approximate). An approximately 5-ft-high galvanized riser was threaded into a coupling that was flush with the top of the concrete pad. Each of the coreholes had a rotary vent installed on the top of the riser.

Preabandonment Conditions

The total depth of CH-1 was measured to 491.3 ft bgs with no water present on February 15, 2013. Total depth and lack of water were verified with a water-level meter.

The total depth of CH-3 was measured to 300.3 ft bgs with no water present on February 14, 2013. Total depth and lack of water were verified with a water-level meter.

The total depth of CH-4 was measured to 304.5 ft bgs with no water present on February 14, 2013. Total depth and lack of water were verified with a water-level meter.

Figures 2.2-1, 2.2-2, and 2.2-3 are well construction diagrams that depict the construction details and preabandonment conditions of CH-1, CH-3, and CH-4, respectively.

2.3 TH-4

Test hole TH-4 is located at TA-49 inside the NES boundary.

TH-4 was installed in 1980 to 123 ft bgs for neutron moisture logging in Area 2 at TA-49. The dry borehole was 5-in. in diameter. A 4-in.-I.D. polyvinyl chloride (PVC) surface casing was installed from approximately 3 ft bgs to 2 ft above ground surface (ags). The surface casing was not cemented in place, and no concrete pad or other surface completion was installed at ground surface.

Preabandonment Conditions

The total depth of TH-4 was measured to 88.1 ft bgs with no water present on February 19, 2013. Total depth and lack of water were verified with a water-level meter.

Figure 2.3-1 is a well construction diagram that depicts the construction details and preabandonment conditions of TH-4.

2.4 TBM-1 and TBM-2

Test holes TBM-1 and TBM-2 are located at TA-49 outside the NES boundary.

TBM-1 and TBM-2 were barometric measurement holes that were drilled immediately next to one another at TA-49 in 1993. TBM-1 was drilled to 139 ft bgs, and TBM-2 was drilled to 64 ft bgs (Purtymun 1995, 045344). The 7.25-in.-diameter test holes were dry.

Three 0.5-in.-diameter PVC casings were installed in TBM-1 with 1-ft screened intervals at 19 ft bgs, 79 ft bgs, and 124 ft bgs, respectively (each 0.5-in.-diameter casing had one screened interval). Sand was placed around each screened zone, with cement above and below, and the intervals between the screens were filled with drill cuttings.

A 4-in.-I.D. PVC pipe was installed in TBM-2 to 40 ft bgs with a biaxial tiltmeter at the bottom to measure tuff deformation. The annulus, open borehole beneath the pipe, and PVC pipe were filled with sand.

Preabandonment Conditions

Figures 2.4-1 and 2.4-2 are well construction diagrams that depict the construction details and preabandonment conditions of TBM-1 and TBM-2, respectively.

2.5 Layne Western Well

The Layne Western well is located in Guaje Canyon a few miles north of the Laboratory boundary.

The Layne Western well was installed in 1950 to 157 ft bgs to supply water for the drilling of the Guaje well field (Purtymun and Swanton 1998, 099096). The depth to water in 1960 was 105 ft bgs. The borehole was approximately 10-in. in diameter, and the well was constructed as follows:

- 0–0.3 ft bgs: 9-in. surface casing
- 0–127 ft bgs: 8-in. casing (Purtymun and Swanton 1998, 099096)

- 127–147 ft bgs: 8-in. screen
- 147–157 ft bgs: open borehole

Preabandonment Conditions

A video and a gamma-ray log were collected using Laboratory's camera trailer and logging equipment on February 28, 2012. The well was filled with sediment/fill to approximately 107.5 ft bgs, and no water was present. The outer casing was 9 in. I.D. with little to no annulus between it and the 8-in.-I.D. casing. The total depth of the well was measured to 106.8 ft bgs with no water present on February 27, 2013. Total depth and absence of water were verified with a water-level meter.

The video log collected is presented in Appendix A (on DVD). The gamma log is presented in Appendix B (on CD).

Figure 2.5-1 is a well construction diagram that depicts the construction details and pre-abandonment conditions of the Layne Western well.

3.0 PLUGGING AND ABANDONMENT

Plugging and abandonment activities included mobilization, casing removal, perforating, pressure-grouting/sealing, and demobilization. All activities were performed following appropriate standard operating procedures and Laboratory-approved health and safety documents. The boreholes, coreholes, test holes, and well were plugged and abandoned in accordance with NMED-approved work plans. The Layne Western well was plugged and abandoned in accordance with a New Mexico OSE plugging plan.

3.1 Boreholes 49-10046, 49-10047, and 49-10048

Plugging and abandonment activities at boreholes 49-10046, 49-10047, and 49-10048 occurred between February 19 and February 20, 2013. Boreholes 49-10046, 49-10047, and 49-10048 were abandoned by cutting the 2-in. aluminum casing as flush as practicable with the top of the concrete pad. Approximately 6 ft of 1.25-in.-I.D. poly tubing was inserted into the well casings. Neat cement was mixed outside the NES fence and pumped through the poly tubing. The same poly tube was used for all three boreholes and grouted in place at TH-4. Final surface completions were conducted on February 20, 2013.

Borehole 49-10046

Borehole 49-10046 was plugged with approximately 0.2 ft³ of neat cement grout from 14.1 ft bgs (total depth) to 2.0 ft bgs. The volume and type of abandonment materials used to abandon borehole 49-10046 are presented in Table 3.1-1. The final borehole configuration is shown in Figure 3.1-1.

Borehole 49-10047

Borehole 49-10047 was plugged with approximately 0.2 ft³ of neat cement grout from 11.5 ft bgs (total depth) to 2.0 ft bgs. The volume and type of abandonment materials used to abandon borehole 49-10047 are presented in Table 3.1-2. The final borehole configuration is shown in Figure 3.1-2.

Borehole 49-10048

Borehole 49-10048 was plugged with approximately 0.2 ft³ of neat cement grout from 12.2 ft bgs (total depth) to 2.0 ft bgs. The volume and type of abandonment materials used to abandon borehole 49-10048 are presented in Table 3.1-3. The final borehole configuration is shown in Figure 3.1-3.

3.2 CH-1, CH-3, and CH-4

CH-1

Plugging and abandonment activities at CH-1 occurred between February 15 and February 20, 2013. The 2-in. galvanized riser pipe (with rotary vent) was unthreaded from the coupling at the top of the existing concrete surface completion pad. Approximately 515 ft of 1.25-in.-I.D. poly tubing was run through the NES fence and inserted into the 2-in.-I.D. galvanized casing to 440 ft bgs. The neat cement was mixed outside the NES fence and pumped through the poly tubing. CH-1 was plugged with approximately 20.1 ft³ of neat cement grout from 491.3 (total depth) to 2.0 ft bgs. Approximately twice the calculated volume of cement was required to complete the abandonment. The poly tubing was cut off and grouted in place from 2 to 442 ft bgs. The final surface completion activities were conducted on February 20, 2013. The volume and type of abandonment materials used to abandon CH-1 are presented in Table 3.2-1. The final borehole configuration is shown in Figure 3.2-1.

CH-3

Plugging and abandonment activities at CH-3 occurred between February 14 and February 20, 2013. The 2-in. galvanized riser pipe (with rotary vent) was unthreaded from the coupling at the top of the existing concrete surface completion pad. The 1.25-in.-I.D. poly tubing was inserted into the 2-in.-I.D. galvanized casing to 250 ft bgs. The neat cement was mixed and pumped through the poly tubing. CH-3 was plugged with approximately 6.7 ft³ of neat cement grout from 300.3 (total depth) to 2.0 ft bgs. The poly tubing was retracted approximately 75 ft from the casing during cement emplacement and was cut off and grouted in place from 2 to 177 ft bgs. The final surface completion activities were conducted on February 20, 2013. The volume and type of abandonment materials used to abandon CH-3 are presented in Table 3.2-2. The final borehole configuration is shown in Figure 3.2-2.

CH-4

Plugging and abandonment activities at CH-4 occurred between February 15 and February 20, 2013. The 2-in. galvanized riser pipe (with rotary vent) was unthreaded from the coupling at the top of the existing concrete surface completion pad. Approximately 350 ft of 1.25-in.-I.D. poly tubing was run through the NES fence and inserted into the 2-in.-I.D. galvanized casing to 252 ft bgs. The neat cement was mixed outside the NES fence and pumped through the poly tubing. CH-4 was plugged with approximately 6.7 ft³ of neat cement grout from 304.5 (total depth) to 2.0 ft bgs. The poly tubing was cut off and grouted in place from 2 to 252 ft bgs. The final surface completion activities were conducted on February 20, 2013. The volume and type of abandonment materials used to abandon CH-4 are presented in Table 3.2-3. The final borehole configuration is shown in Figure 3.2-3.

3.3 TH-4

Plugging and abandonment activities at TH-4 occurred between February 19 and February 20, 2013. TH-4 was plugged from 88.1 (total depth) to 8.8 ft bgs, with approximately 10.7 ft³ of 3/8-in. hydrated bentonite chips. The 6-ft piece of poly tube used to cement boreholes 49-10046, 49-10047, and 49-10048 was also used to plug TH-4 with approximately 2.0 ft³ of neat cement grout from 8.8 to 2.0 ft bgs. The poly tubing was grouted in place from 2 to 8 ft bgs. The 4-in.-diameter surface casing was cut off and removed at ground surface. The final surface completion activities were conducted on February 20, 2013. The volume and type of abandonment materials used to abandon TH-4 are presented in Table 3.3-1. The final borehole configuration is shown in Figure 3.3-1.

3.4 TBM-1 and TBM-2

TBM-1

Plugging and abandonment activities at TBM-1 occurred between February 19 and February 20, 2013, using a CME-75 auger rig and ancillary equipment. The 0.5-in.-diameter PVC casings and sand/cement backfill were overdrilled with 7.25-in.-outside diameter (O.D.) hollow stem augers to 124.0 ft bgs. TBM-1 was plugged with approximately 58.8 ft³ of neat cement grout from 124.0 (total depth) to 2.0 ft bgs. The final surface completion activities were conducted on February 20, 2013. The volume and type of abandonment materials used to abandon TBM-1 are presented in Table 3.4-1. The final borehole configuration is shown in Figure 3.4-1.

TBM-2

Plugging and abandonment activities at TBM-2 occurred on February 20, 2013, using a CME-75 auger rig and ancillary equipment. The 4-in.-I.D. PVC casing and backfill were overdrilled with 7.25-in. augers to 39.0 ft bgs. TBM-2 was plugged with approximately 20.1 ft³ of neat cement grout from 39.0 (total depth) to 2.0 ft bgs. The final surface completion activities were conducted the same afternoon. The volume and type of abandonment materials used to abandon TBM-2 are presented in Table 3.4-2. The final borehole configuration is shown in Figure 3.4-2.

3.5 Layne Western Well

Plugging and abandonment activities at the Layne Western well occurred between February 27 and February 28, 2013. The 9-in.-I.D. outer surface casing (approximately 0.5-ft length) was removed by hand. An attempt was made to remove the 8-in.-I.D. well casing from the borehole using hydraulic casing jacks powered by a pump hoist rig (used to power the jacks only). The pump hoist was placed a safe distance from the borehole because of the presence of overhead powerlines, and the tower was not raised. The 8-in.-I.D. well casing parted at 10.2 ft bgs at a casing joint during the attempt to remove the well casing. Approximately 10.4 ft of well casing was removed from the borehole after neat cement grout was emplaced from TD to 10.0 ft bgs. Approximately 49.5 ft³ of neat cement grout was placed from 106.8 (total depth) to 7.5 ft bgs.

A large void was encountered from 4 to 7.5 ft bgs. Approximately 7.4 ft³ of 3/8-in. hydrated bentonite chips were used to plug the void from 7.5 to 4.0 ft bgs. The remaining borehole was plugged with 0.8 ft³ of neat cement grout from 4.0 to 2.0 ft bgs. The final surface completion activities were conducted on February 28, 2013. The volume and type of abandonment materials used to abandon the Layne Western well are presented in Table 3.5-1. The final borehole configuration is shown in Figure 3.5-1.

4.0 SURFACE COMPLETION

The boreholes, coreholes, test holes, and well were cement-grouted to approximately 2 ft bgs. Concrete surface plugs were mounded slightly abovegrade and were slightly larger than the borehole diameter at TH-4, TBM-1, TBM-2, and the Layne Western well. Concrete surface plugs were installed at boreholes 49-10046, 49-10047, 49-10048 and at CH-1, CH-3, and CH-4. Aluminum survey markers were installed in the plugs and were surveyed in accordance with Section IX.B.2.f of the Consent Order.

4.1 Geodetic Survey

Geodetic surveys were conducted on the surface completions (Table 4.1-1) with a Topcon GRS-1 GPS using an external antenna. The survey data collected conform to Laboratory Information Architecture project standards IA-CB02, "GIS Horizontal Spatial Reference System," and IA-D802, "Geospatial Positioning Accuracy Standard for A/E/C and Facility Management." All coordinates are expressed relative to the New Mexico State Plane Coordinate System Central Zone (NAD 83); elevation is expressed relative to feet above mean sea level (amsl) using the National Geodetic Vertical Datum of 1929. The survey point was the aluminum pin placed in the concrete pad/plug.

5.0 POST-ABANDONMENT ACTIVITIES

Post-abandonment activities are described below.

5.1 Site Restoration

Plugging and abandonment activities at the boreholes, coreholes, test holes, and wells required only minimal restoration efforts to return the sites to preplugging and preabandonment conditions.

5.2 Waste Management

Waste generated from the plugging and abandonment project included drill cuttings and contact waste. All waste streams produced during plugging and abandonment activities were sampled in accordance with "Waste Characterization Strategy Form for Plug and Abandonment (P&A) of LANL Wells" (LANL 2008, 103916). Cuttings produced during drilling will be disposed of as industrial or low-level waste at an authorized facility after a review of associated analytical results per the waste characterization strategy form and EP-DIR-SOP-10012, Characterization of Environmental Programs Waste. Characterization of contact waste will be based upon acceptable knowledge from historical site data per Laboratory Procedure P930-1, LANL Waste Acceptance Criteria.

6.0 DEVIATIONS FROM PLANNED ACTIVITIES

TH-4

The 4-in. PVC surface casing at TH-4 was to be removed from the borehole. Instead, the casing was cut off at the ground surface and removed so as not to disturb the NES Inventory Isolation System.

TBM-2

The plan at TBM-2 was to fill the PVC casing with cement from 40 to 20 ft bgs, then overdrill the PVC casing and backfill from surface to 20 ft bgs. However, the PVC casing was found to be filled with silica sand backfill to just below the ground surface. The PVC casing and sand backfill were overdrilled to approximately 40 ft bgs, and the borehole was plugged from 40 ft bgs to the surface.

The plugging and abandoning of the remaining wells was performed as specified in the scope of work and the field implementation plan.

7.0 SUMMARY

Boreholes 49-10046, 49-10047, 49-10048, CH-1, CH-3, CH-4, TH-4, TBM-1, TBM-2, and the Layne Western well were plugged and abandoned in accordance with the NMED-approved work plans. Before abandonment activities, all above- and belowground appurtenances were removed.

Boreholes 49-10046, 49-10047, 49-10048, CH-1, CH-3, CH-4, and TH-4 were plugged and abandoned without the use of an auger rig or pump hoist. The boreholes and coreholes were plugged with Portland Type I/II cement and municipal water. TH-4 was plugged with hydrated bentonite chips and Portland Type I/II cement and municipal water.

A CME-75 auger rig and ancillary equipment were used during plugging and abandonment activities at TBM-1 and TBM-2. TBM-1 and TBM-2 were reamed to remove PVC casing and well-construction materials. The boreholes were plugged with Portland Type I/II cement and municipal water.

A pump hoist rig was used during plugging and abandonment activities at the Layne Western well. The partial casing string was removed from the well during plugging and abandonment with hydrated bentonite chips and Portland Type I/II cement and municipal water.

8.0 REFERENCES AND MAP DATA SOURCES

8.1 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), January 2008. "Investigation Work Plan for Sites at Technical Area 49 Outside the Nuclear Environmental Site Boundary, Revision 1," Los Alamos National Laboratory document LA-UR-08-0449, Los Alamos, New Mexico. (LANL 2008, 102215)

LANL (Los Alamos National Laboratory), October 2008. "Waste Characterization Strategy Form for the R 38, R-41, R-44, R-45, and R-46 Regional Groundwater Well Installation and Corehole Drilling," Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2008, 103916)

LANL (Los Alamos National Laboratory), November 2010. "Work Plans to Plug and Abandon Wells and Boreholes at Los Alamos National Laboratory," Los Alamos National Laboratory document LA-UR-10-6972, Los Alamos, New Mexico. (LANL 2010, 111131)

NMED (New Mexico Environment Department), March 9, 2011. "Notice of Approval with Modifications, Work Plans to Plug and Abandon Wells and Boreholes at Los Alamos National Laboratory," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 201231)

Purtymun, W.D., January 1995. "Geologic and Hydrologic Records of Observation Wells, Test Holes, Test Wells, Supply Wells, Springs, and Surface Water Stations in the Los Alamos Area," Los Alamos National Laboratory report LA-12883-MS, Los Alamos, New Mexico. (Purtymun 1995, 045344)

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, December 2012. "Field Implementation Plan to Plug and Abandon Boreholes 49-10046, 49-10047, 49-10048, Coreholes CH-1, CH-3, CH-4, Test Hole TH-4, TBM-1, TBM-2, and Layne Western Well," plan prepared for Los Alamos National Laboratory, Los Alamos, New Mexico. (TerranearPMC 2012, 238466)

8.2 Map Data Sources for Plugging and Abandonment Report Location Map

Point Feature Locations of the Environmental Restoration Project Database; Los Alamos National Laboratory, Waste and Environmental Services Division, EP2008-0109; 12 April 2010.

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

Surface Drainages, 1991; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0591; 1:24,000 Scale Data; Unknown publication date.

Paved Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Dirt Road Arcs; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Structures; Los Alamos National Laboratory, KSL Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 28 May 2009.

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Division; 4 December 2009.

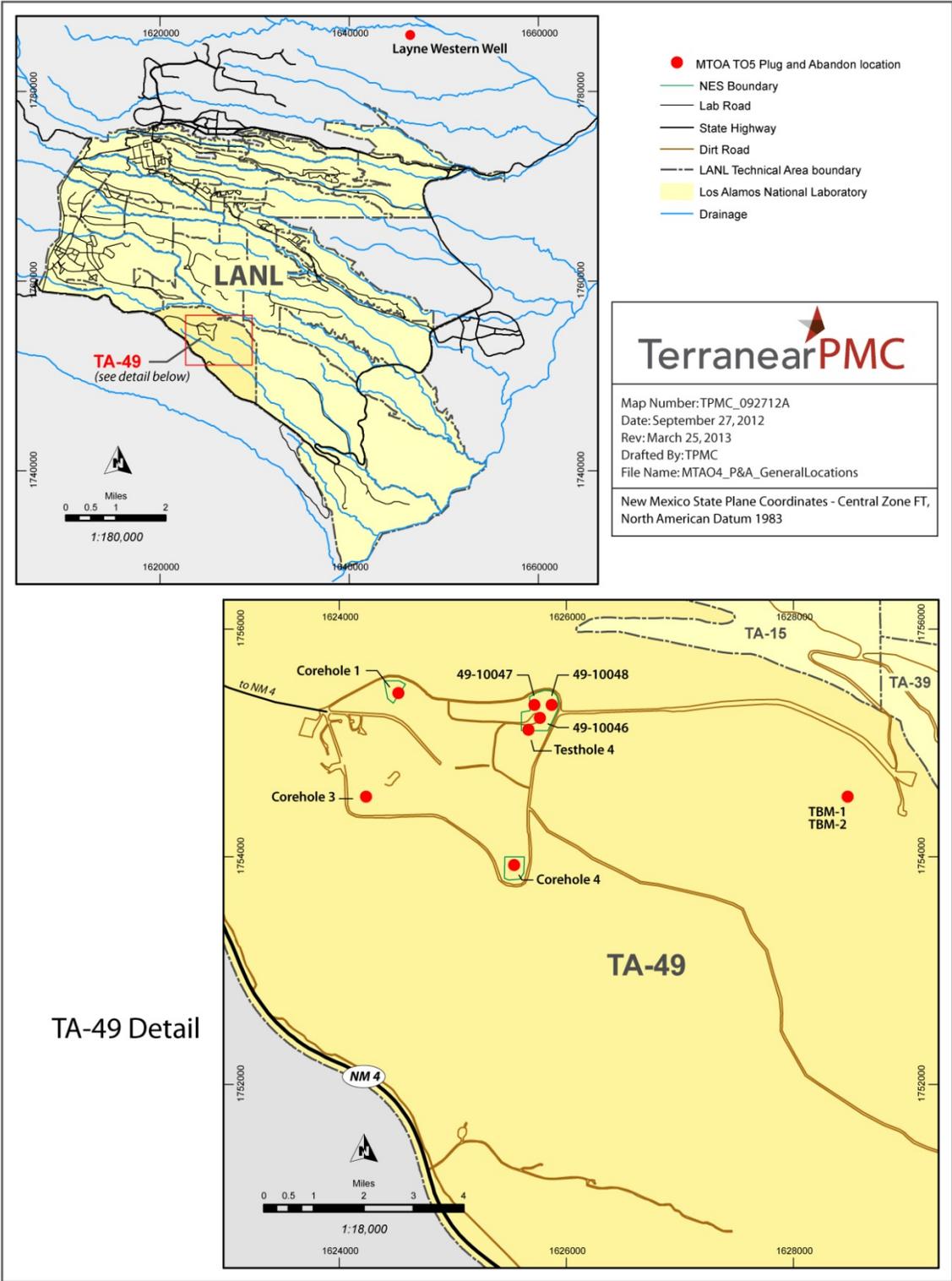


Figure 1.0-1 Location of plugged and abandoned boreholes 49-10046, 49-10047, 49-10048, coreholes CH-1, CH-3, CH-4, test holes TH-4, TBM-1, TBM-2, and the Layne Western well

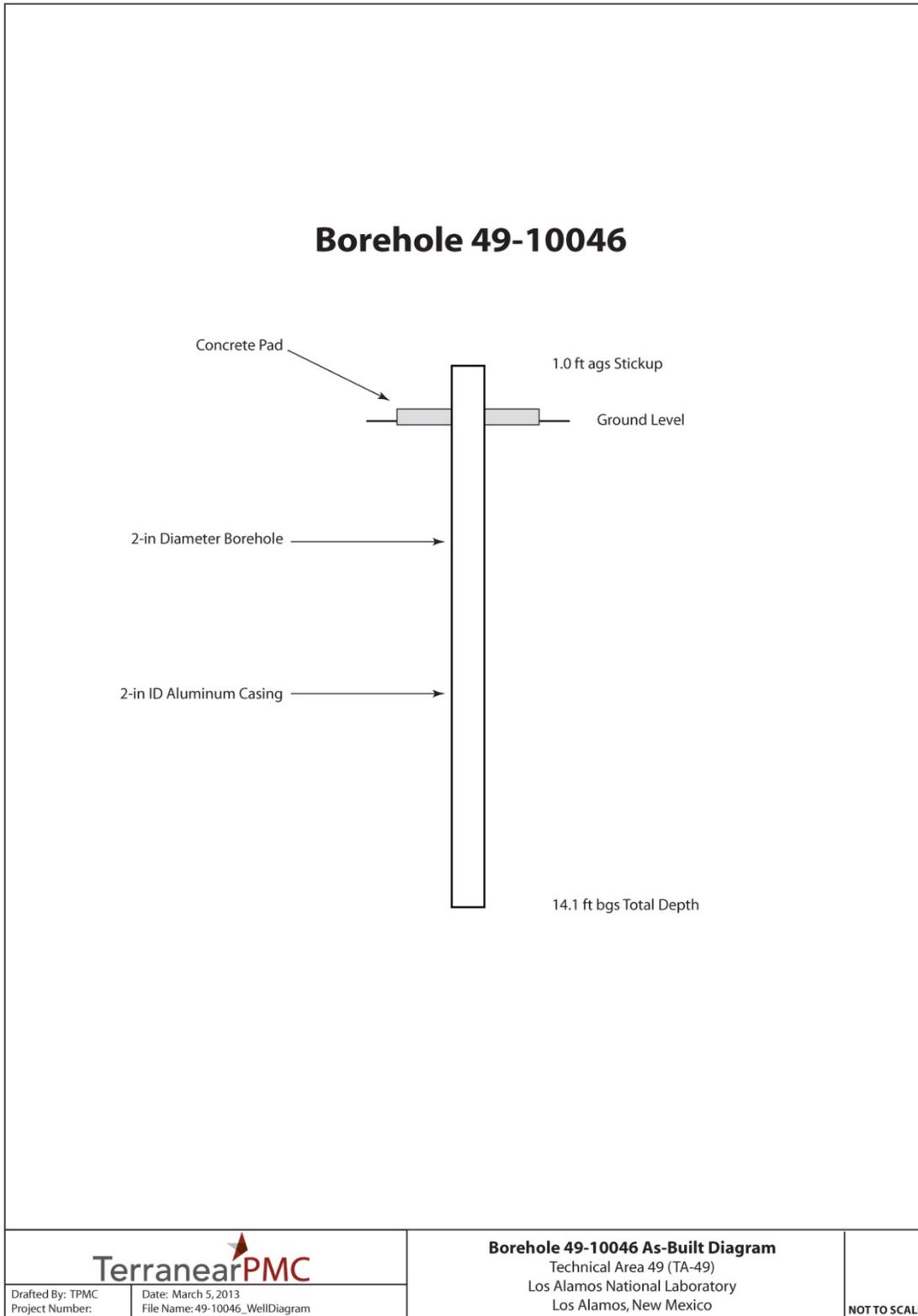


Figure 2.1-1 Borehole 49-10046 construction diagram

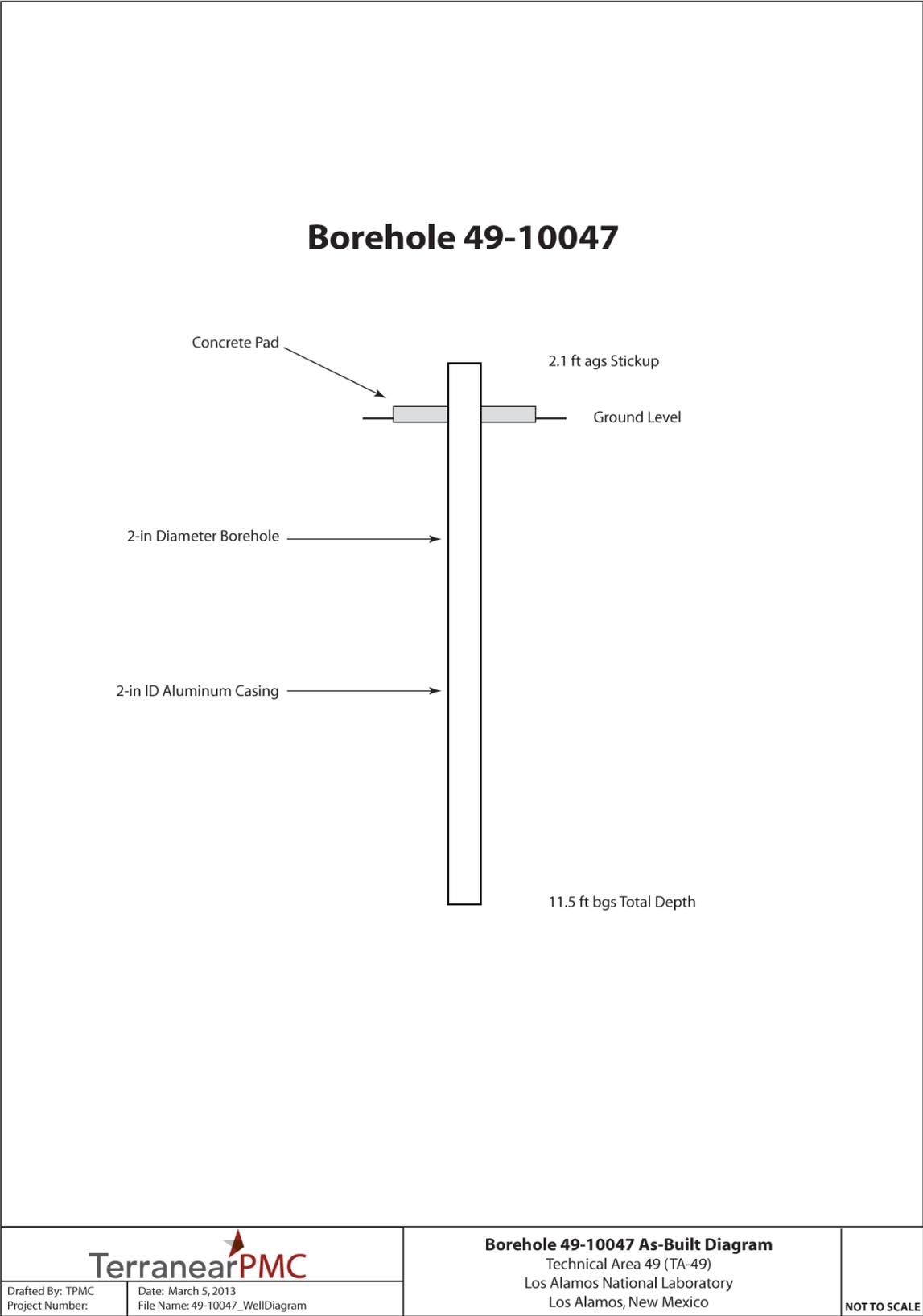


Figure 2.1-2 Borehole 49-10047 construction diagram

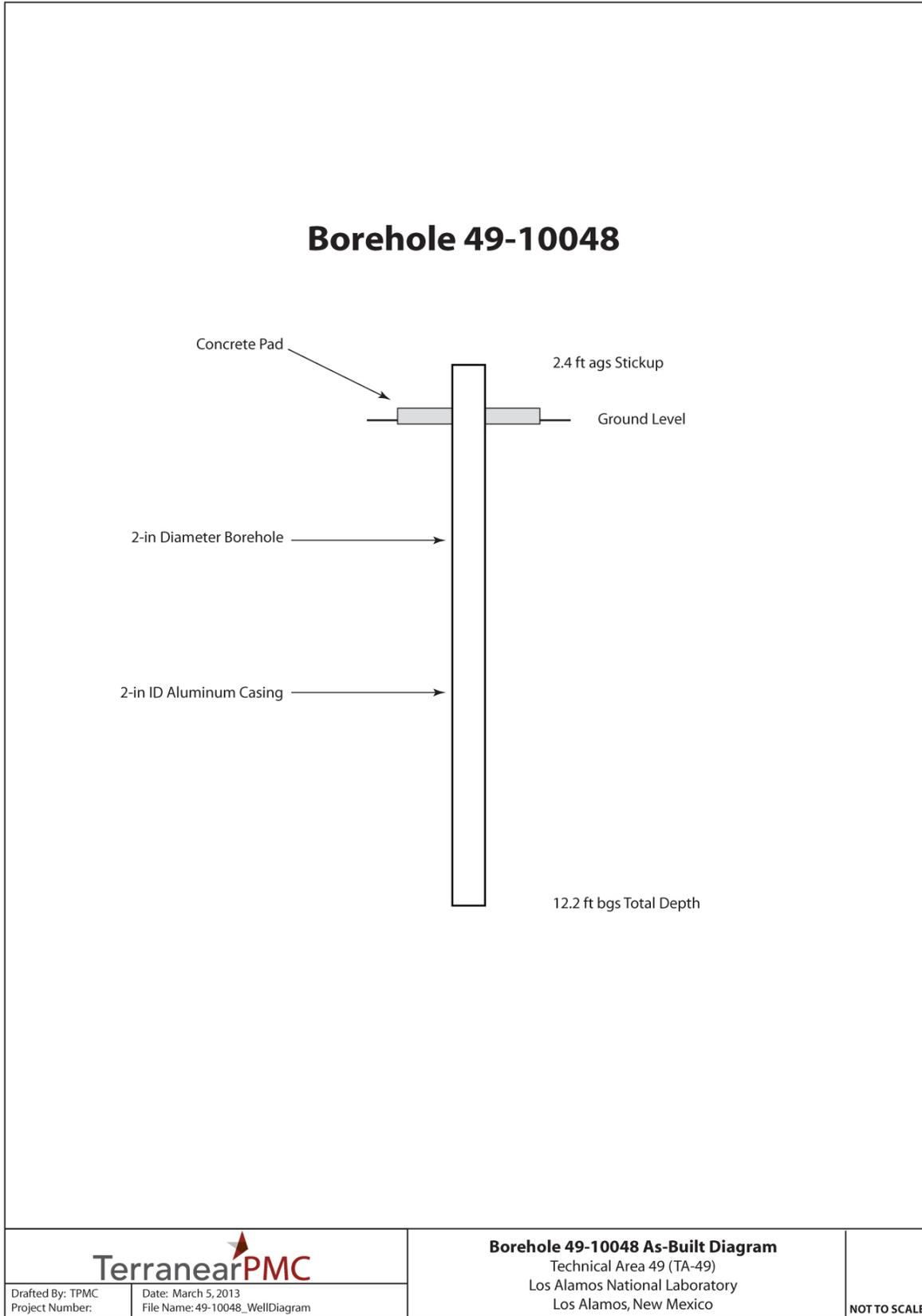


Figure 2.1-3 Borehole 49-10048 construction diagram

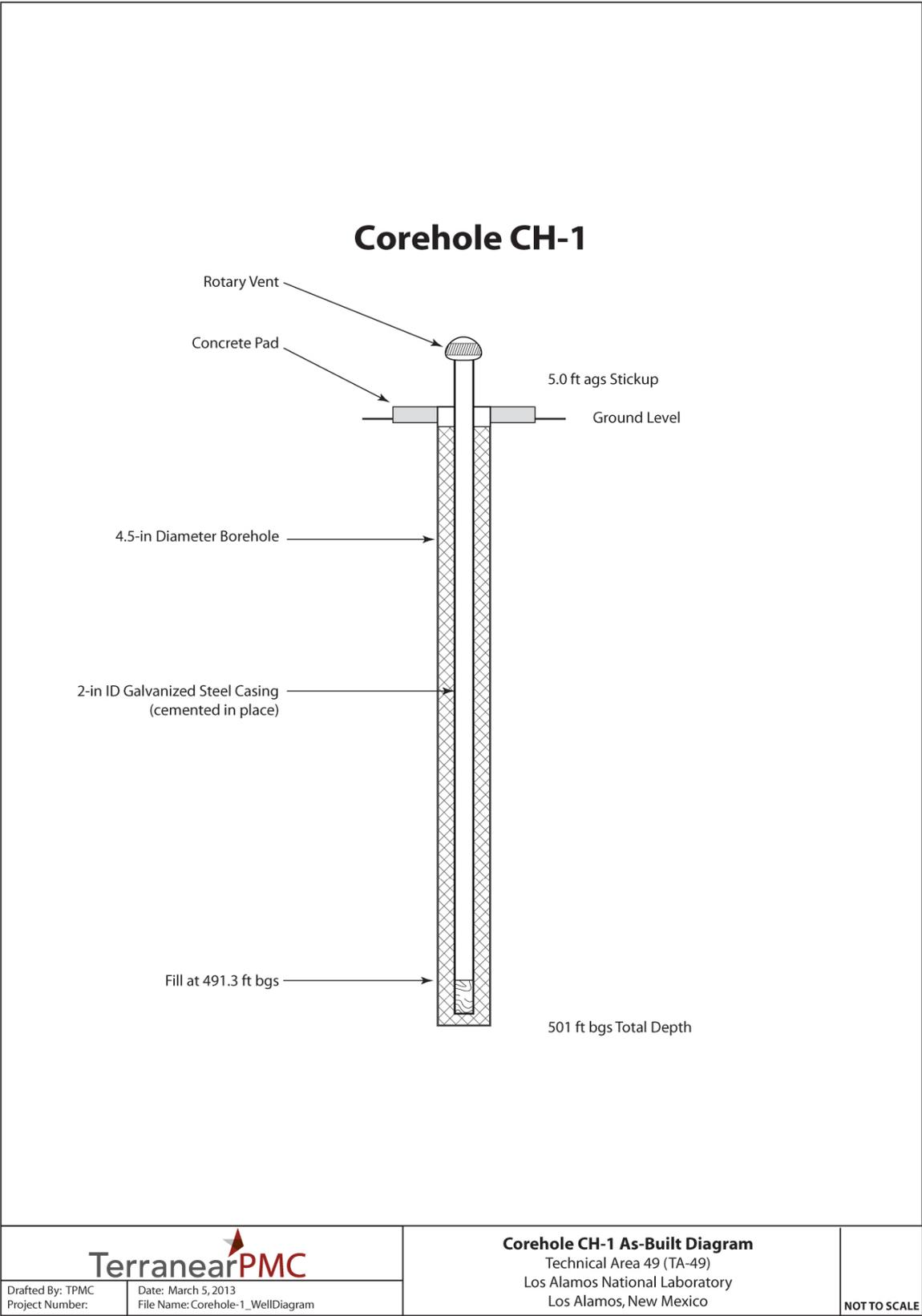


Figure 2.2-1 CH-1 construction diagram

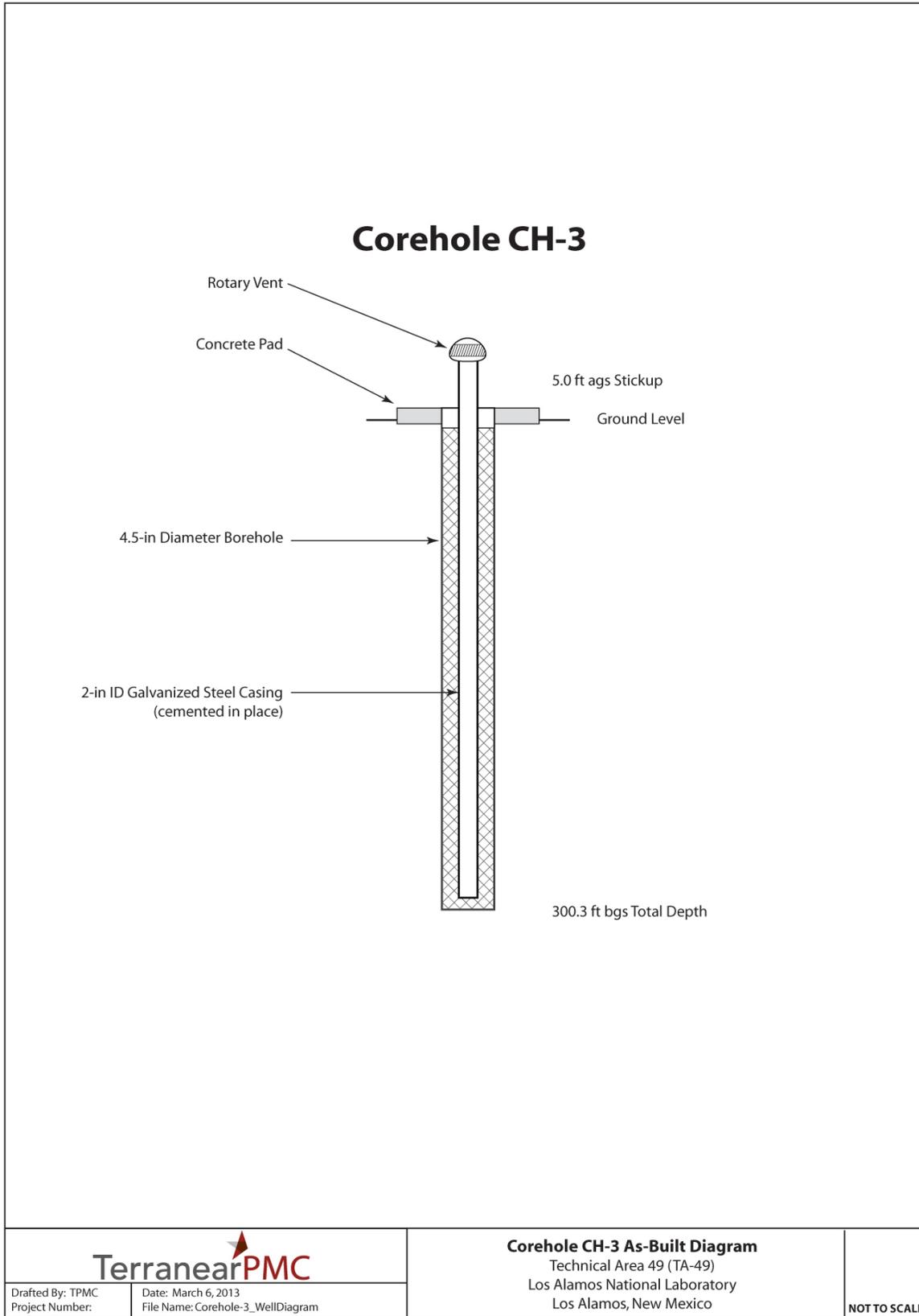
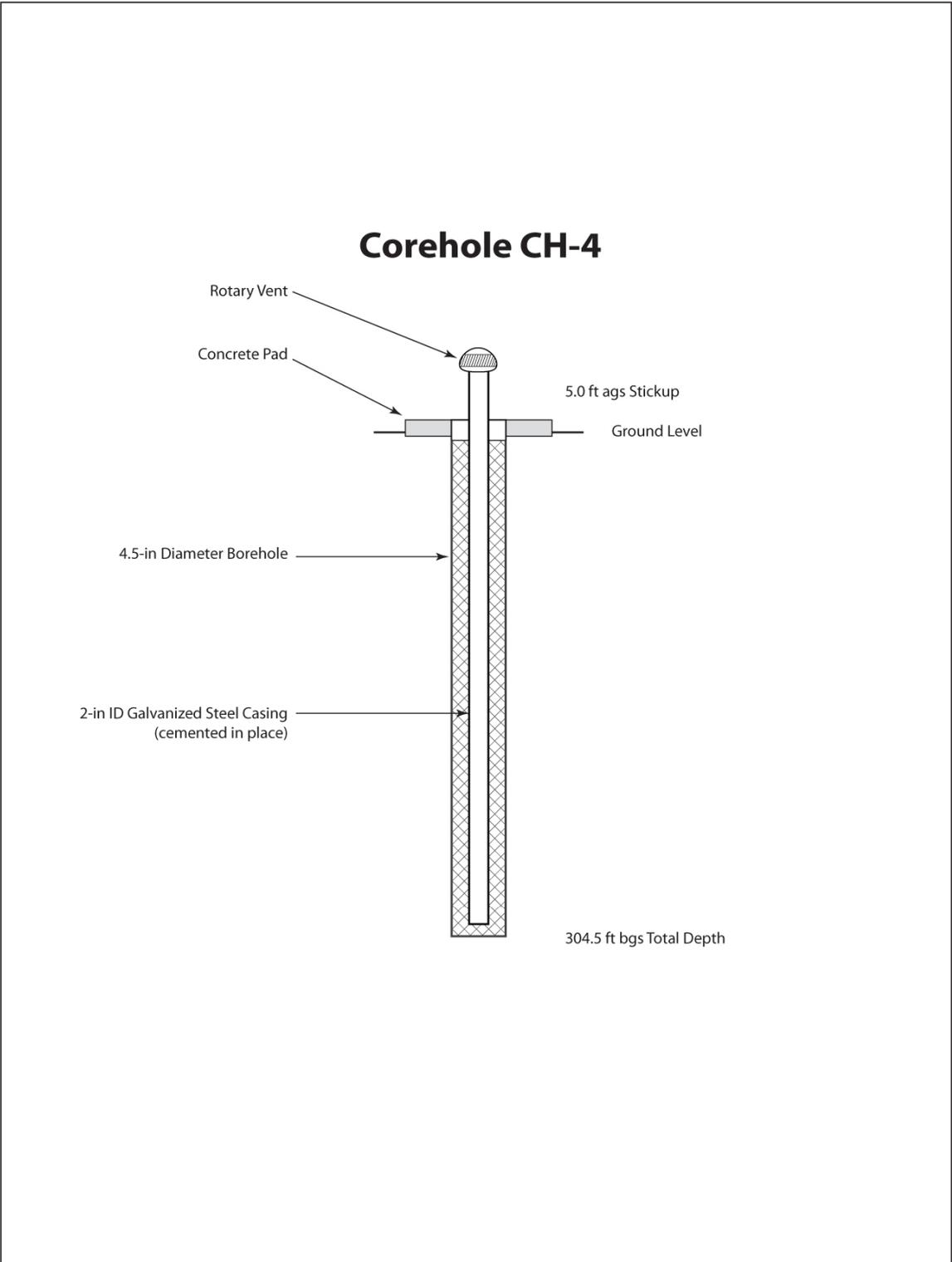


Figure 2.2-2 CH-3 construction diagram



		Corehole CH-4 As-Built Diagram Technical Area 49 (TA-49) Los Alamos National Laboratory Los Alamos, New Mexico	NOT TO SCALE
Drafted By: TPMC Project Number:	Date: March 6, 2013 File Name: Corehole-4_WellDiagram		

Figure 2.2-3 CH-4 construction diagram

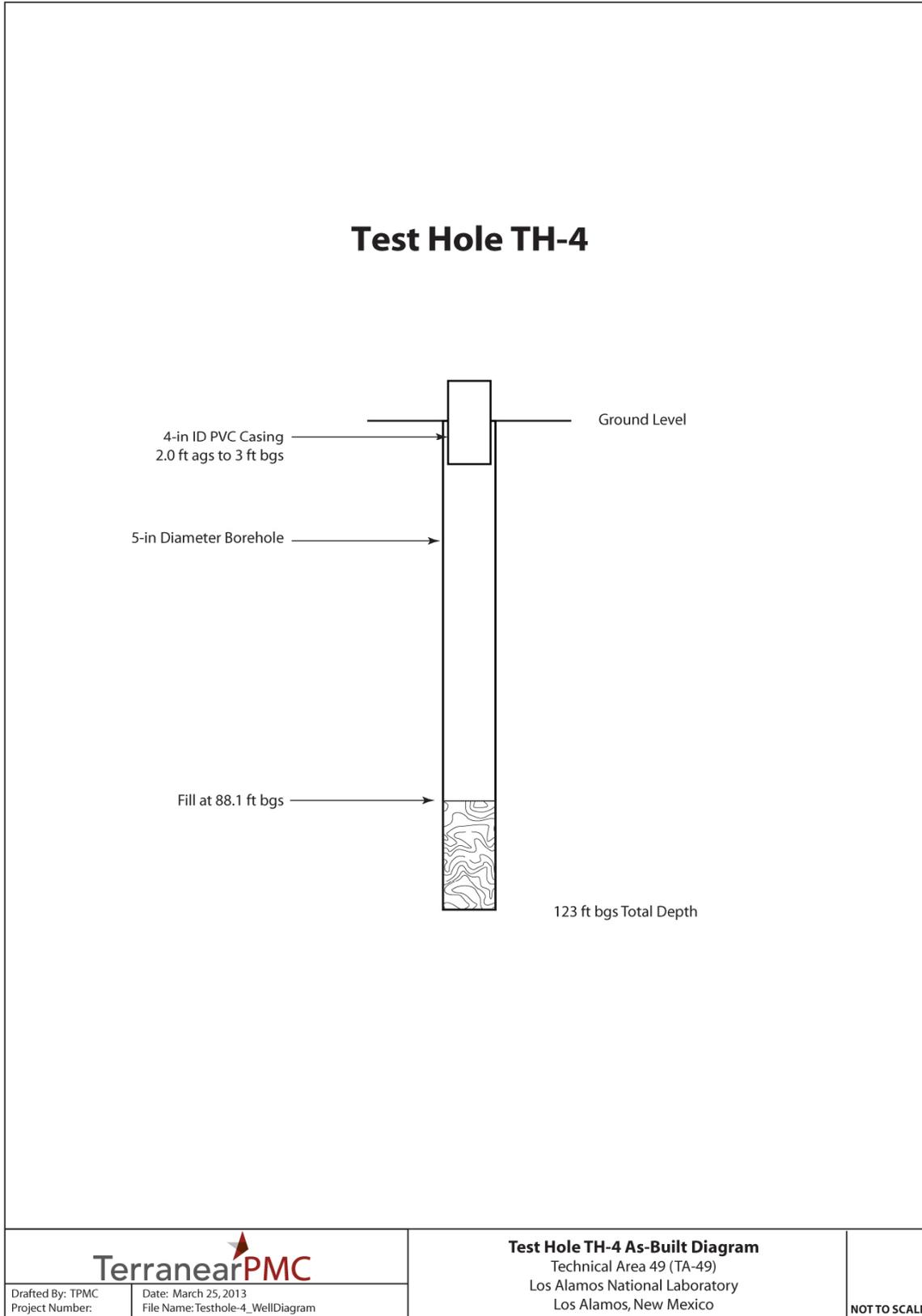


Figure 2.3-1 TH-4 construction diagram

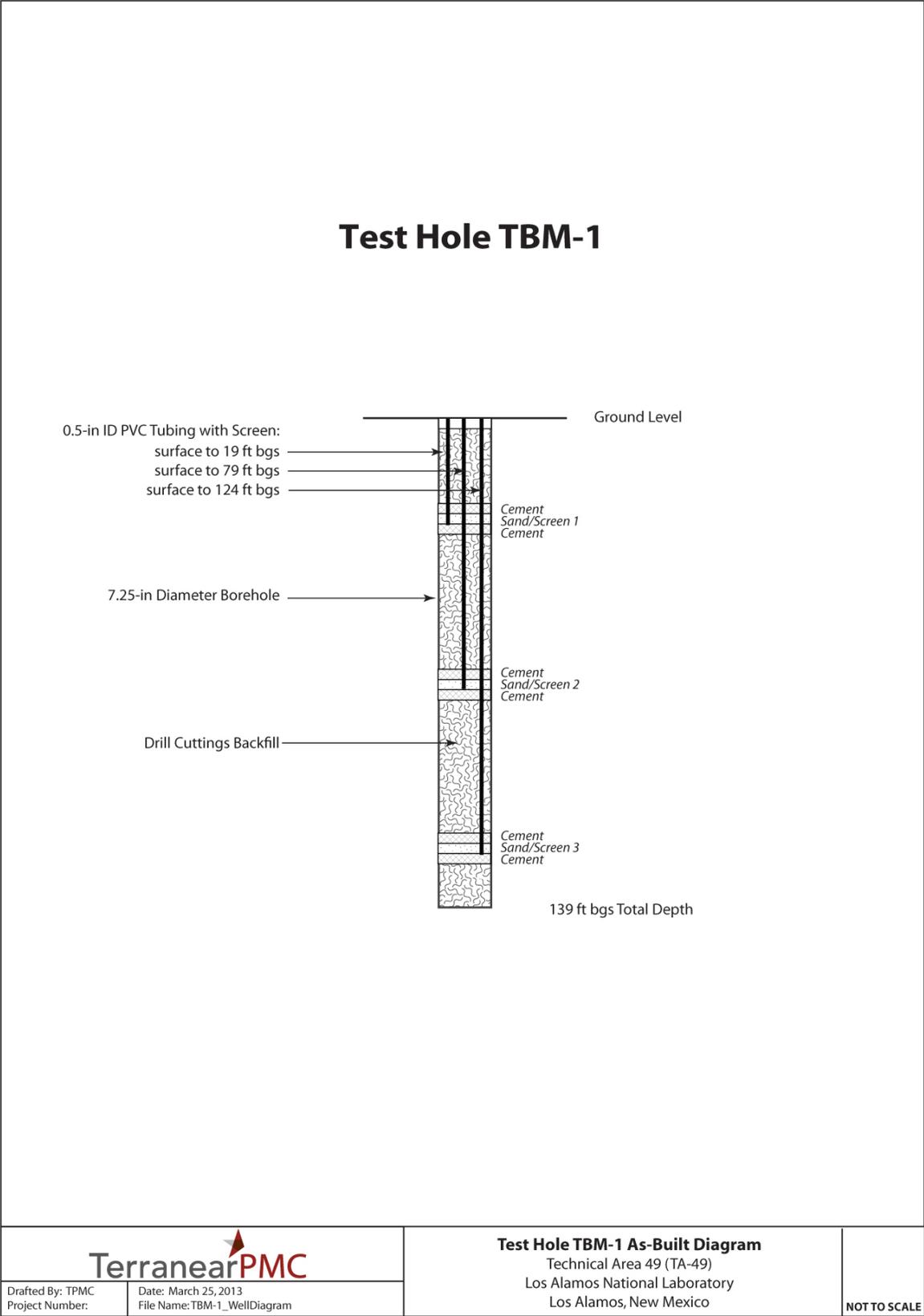
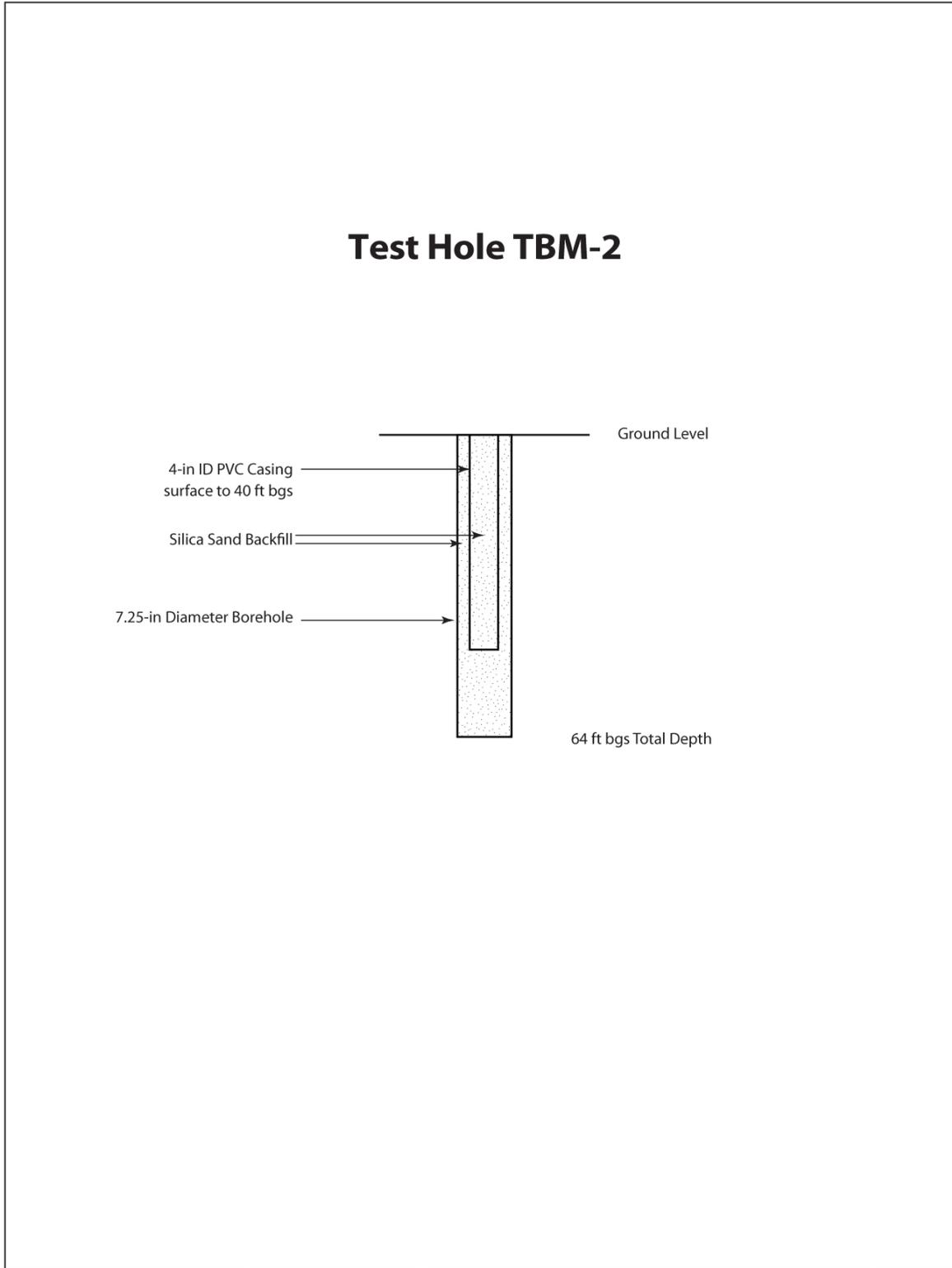
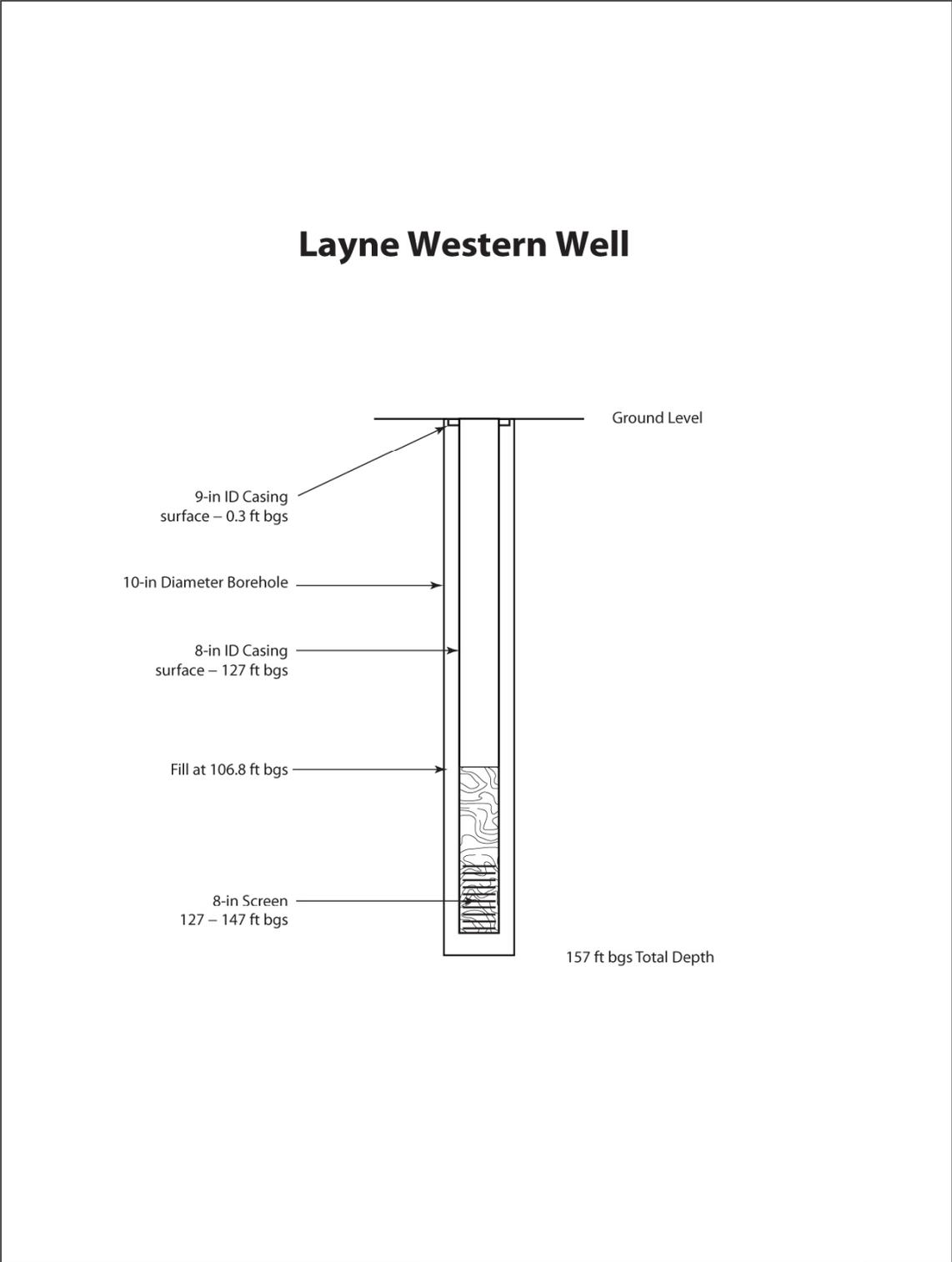


Figure 2.4-1 TBM-1 construction diagram



		Test Hole TBM-2 As-Built Diagram Technical Area 49 (TA-49) Los Alamos National Laboratory Los Alamos, New Mexico	NOT TO SCALE
Drafted By: TPMC Project Number:	Date: March 25, 2013 File Name: TBM-2_WellDiagram		

Figure 2.4-2 TBM-2 construction diagram



		Layne Western Well As-Built Diagram Lower Guaje Canyon Los Alamos National Laboratory Los Alamos, New Mexico	NOT TO SCALE
Drafted By: TPMC Project Number:	Date: March 12, 2013 File Name: LayneWestern_WellDiagram		

Figure 2.5-1 Layne Western well construction diagram

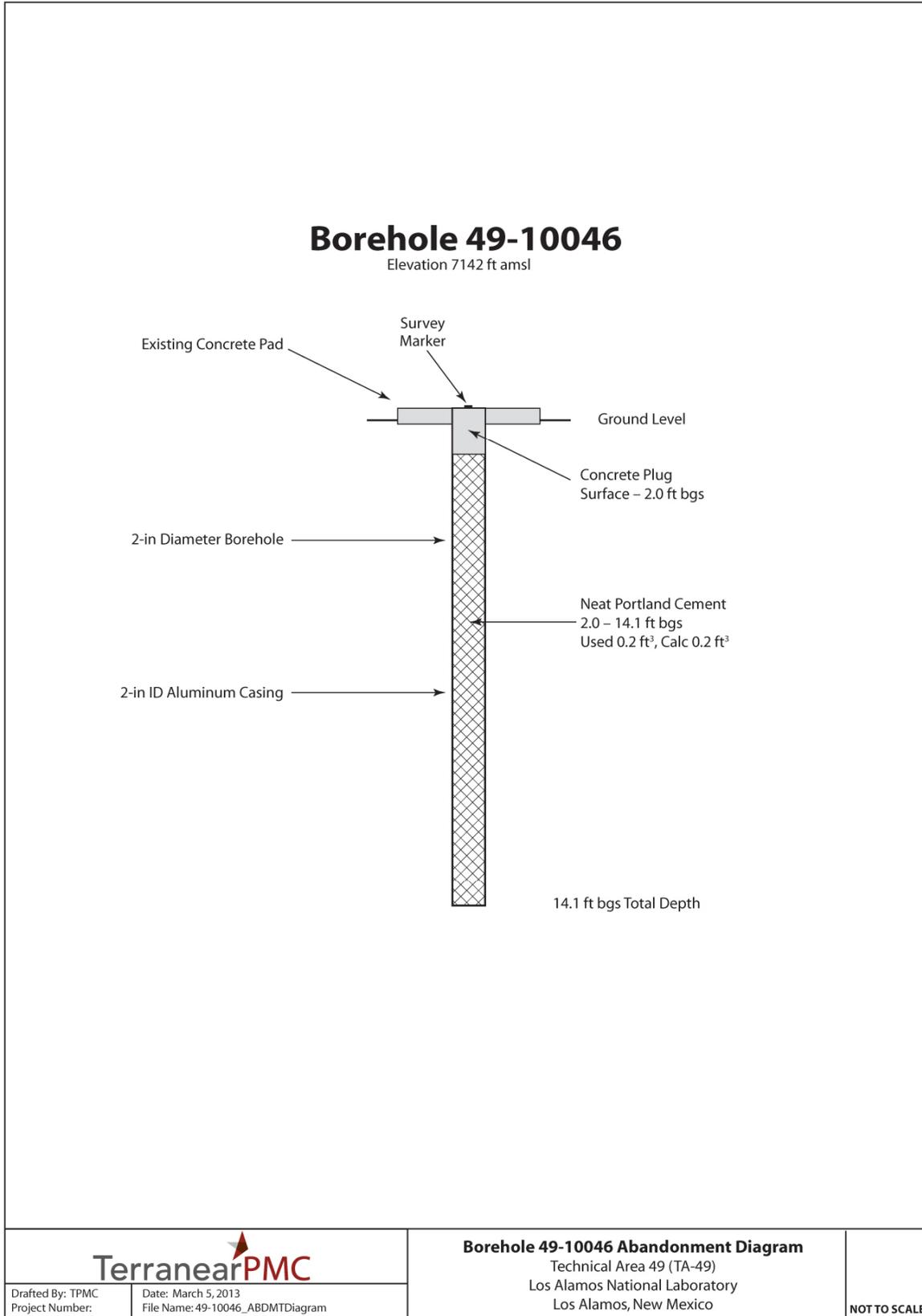


Figure 3.1-1 Borehole 49-10046 abandonment diagram

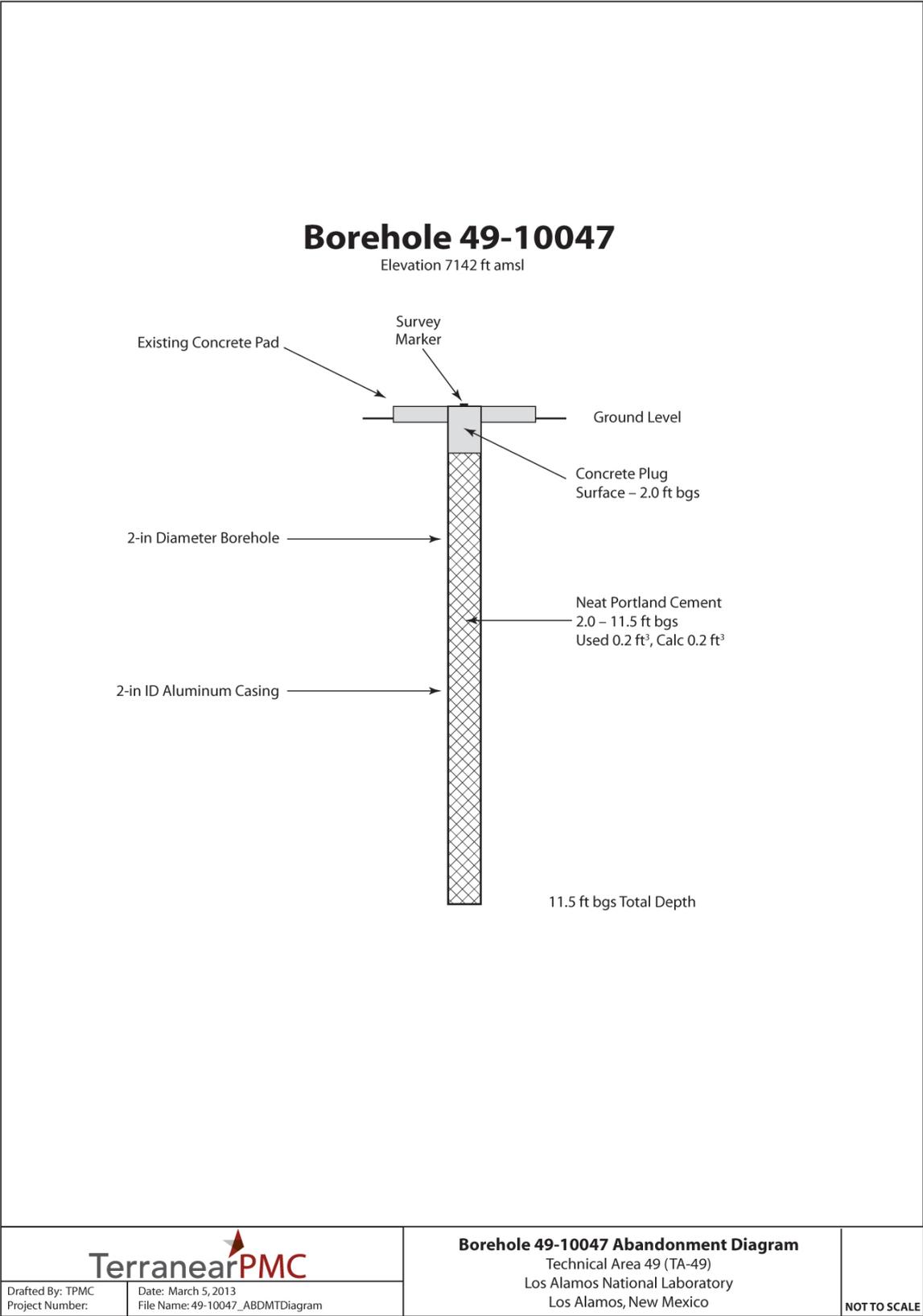


Figure 3.1-2 Borehole 49-10047 abandonment diagram

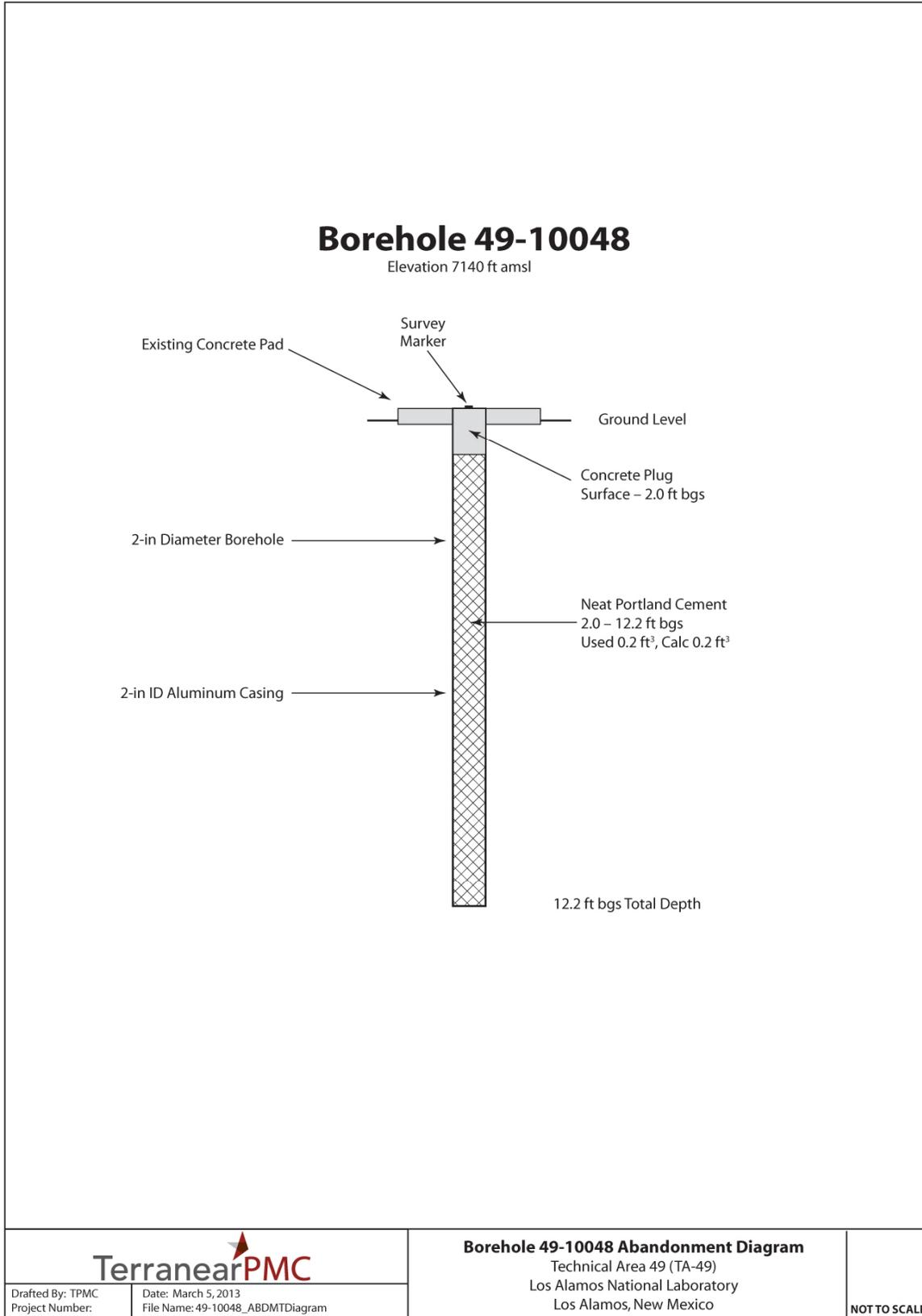
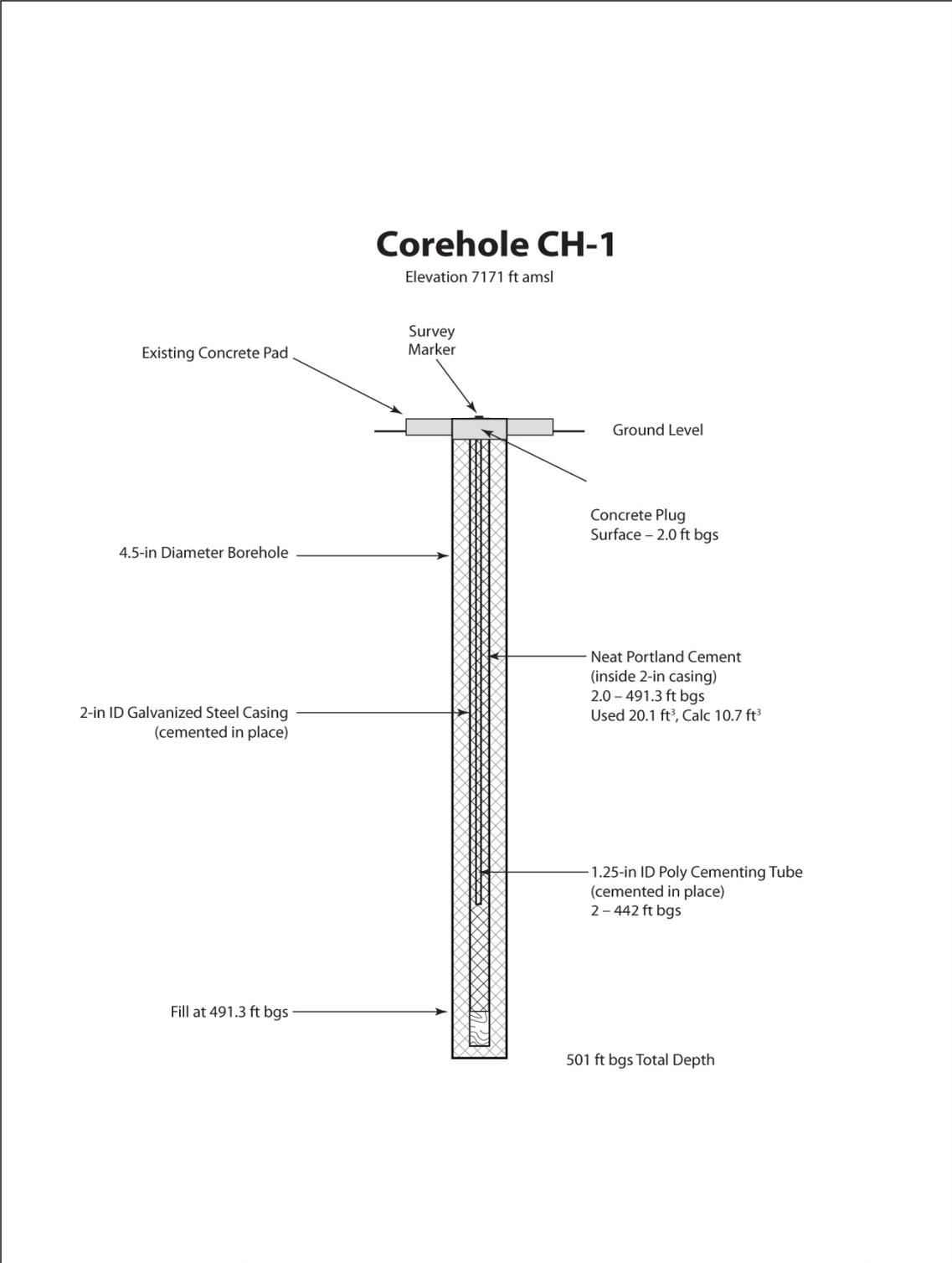


Figure 3.1-3 Borehole 49-10048 abandonment diagram



		Corehole CH-1 Abandonment Diagram Technical Area 49 (TA-49) Los Alamos National Laboratory Los Alamos, New Mexico	NOT TO SCALE
Drafted By: TPMC Project Number:	Date: March 25, 2013 File Name: Corehole-1_ABDMTDiagram		

Figure 3.2-1 CH-1 abandonment diagram

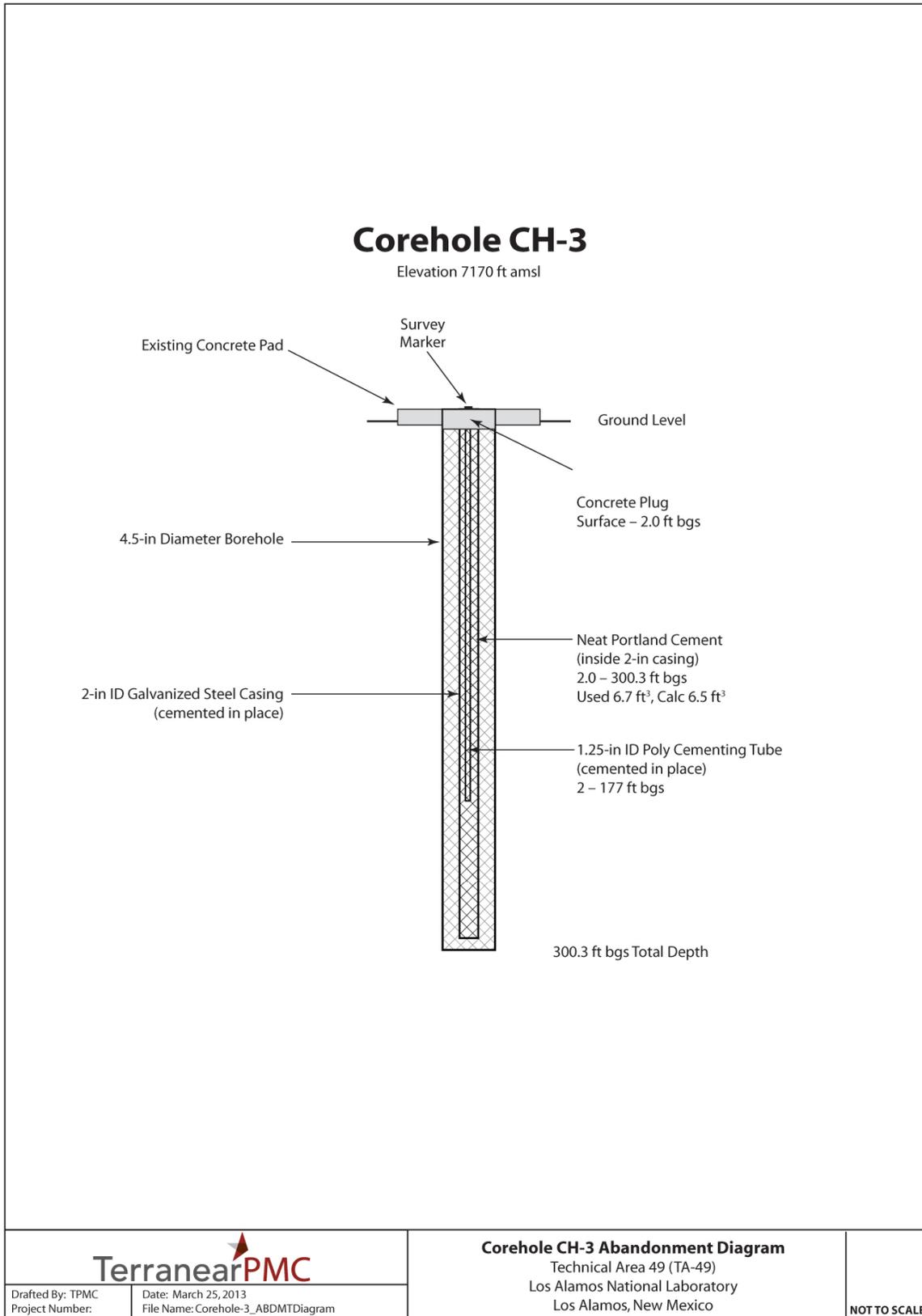


Figure 3.2-2 CH-3 abandonment diagram

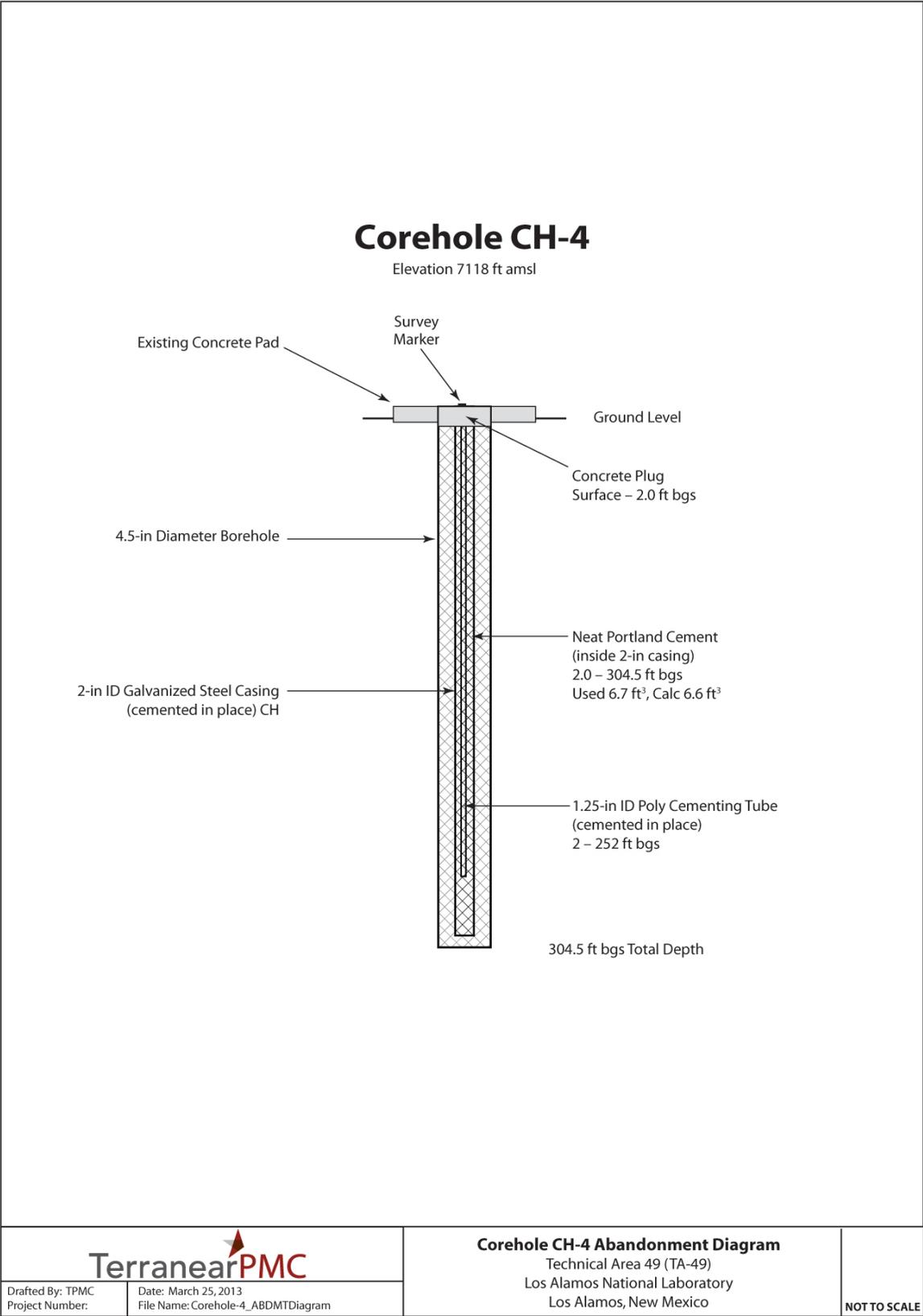


Figure 3.2-3 CH-4 abandonment diagram

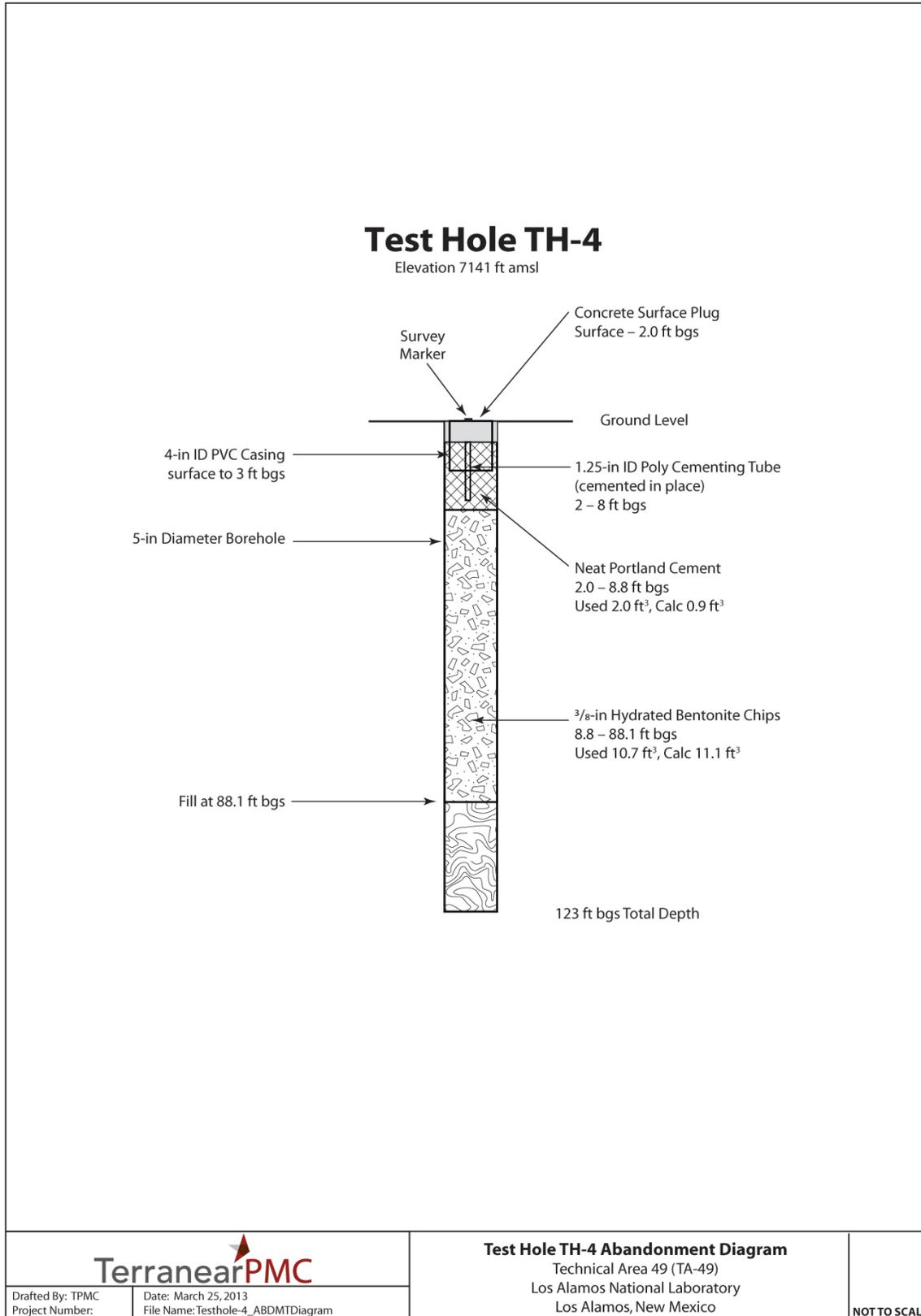


Figure 3.3-1 TH-4 abandonment diagram

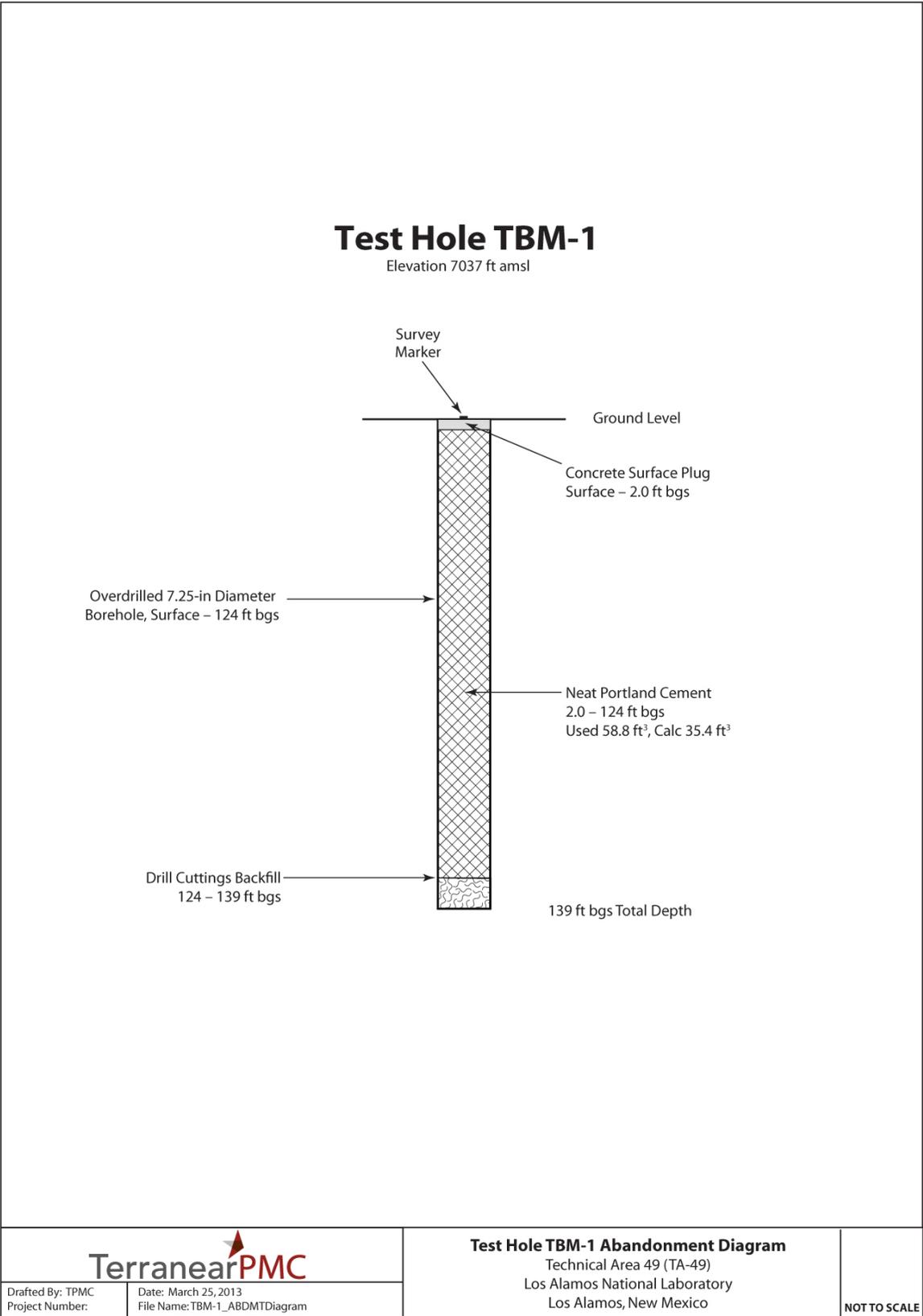


Figure 3.4-1 TBM-1 abandonment diagram

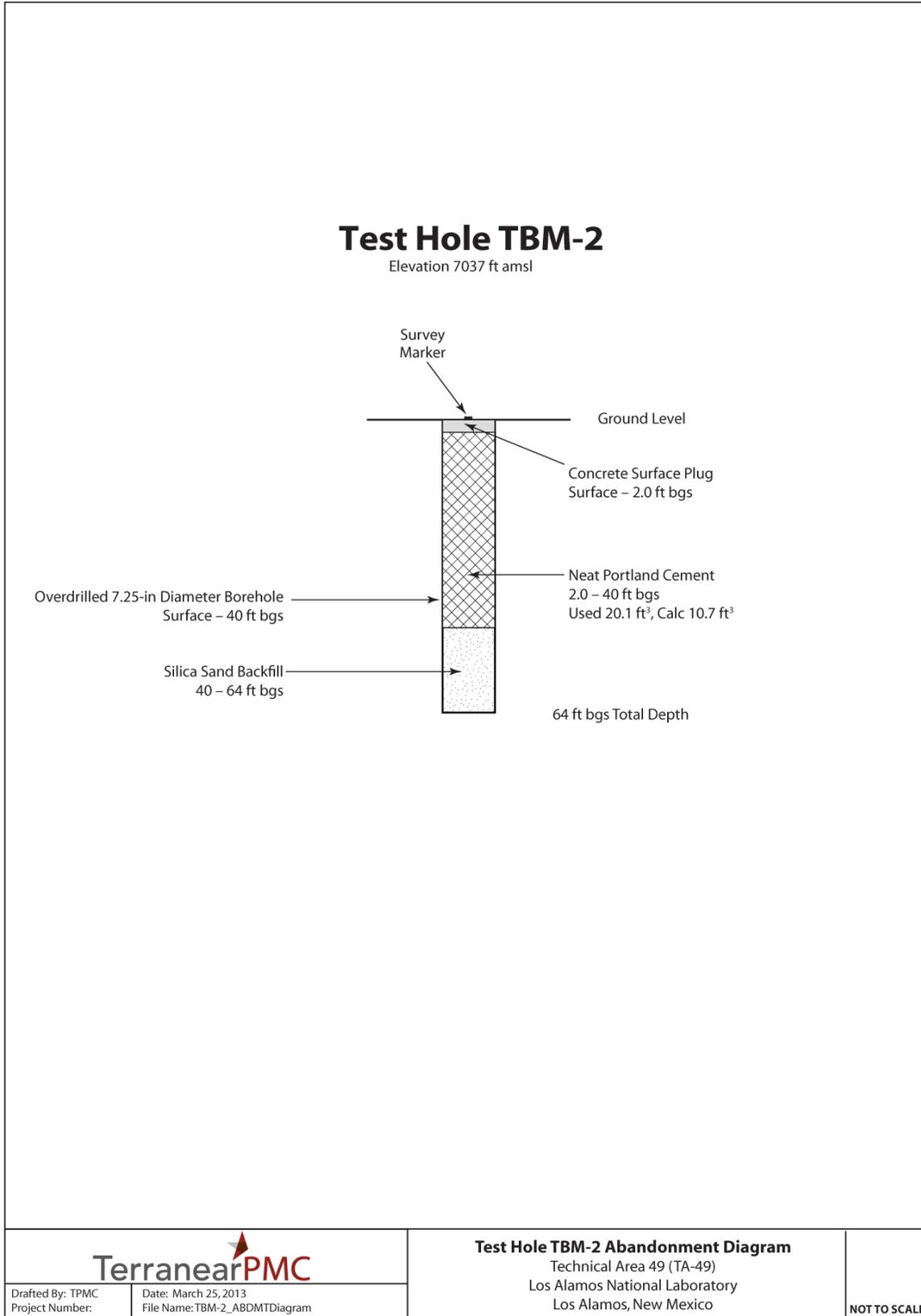


Figure 3.4-2 TBM-2 abandonment diagram

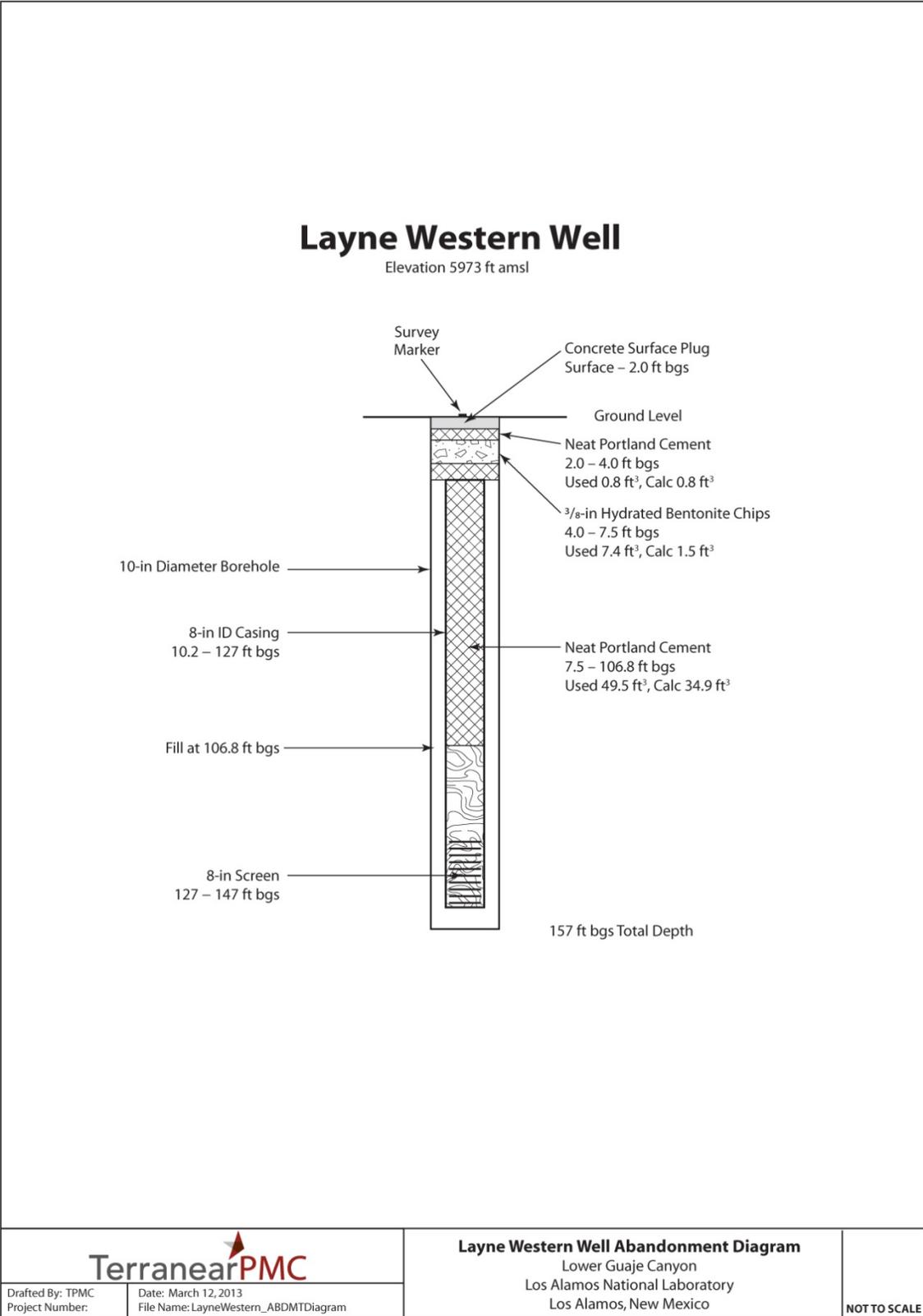


Figure 3.5-1 Layne Western Well abandonment diagram

**Table 3.1-1
Quantity and Materials Used to Plug and Abandon Borehole 49-10046**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/19/13	14.1–2.0	16	1	0	0.2	0.2
Total		16	1	0	0.2	0.2

**Table 3.1-2
Quantity and Materials Used to Plug and Abandon Borehole 49-10047**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/19/13	11.5–2.0	16	1	0	0.2	0.2
Total		16	1	0	0.2	0.2

**Table 3.1-3
Quantity and Materials Used to Plug and Abandon Borehole 49-10048**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/19/13	12.2–2.0	16	1	0	0.2	0.2
Total		16	1	0	0.2	0.2

**Table 3.2-1
Quantity and Materials Used to Plug and Abandon CH-1**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/15/13	491.3–2.0	1504	110	0	10.7	20.1
Total		1504	110	0	10.7	20.1

**Table 3.2-2
Quantity and Materials Used to Plug and Abandon CH-3**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/14/13	300.3–2.0	517	35	0	6.5	6.7
Total		517	35	0	6.5	6.7

**Table 3.2-3
Quantity and Materials Used to Plug and Abandon CH-4**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/15/13	304.5–2.0	517	35	0	6.6	6.7
Total		517	35	0	6.6	6.7

**Table 3.3-1
Quantity and Materials Used to Plug and Abandon Test Hole TH-4**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/19/13	88.1–8.8	0	200	800	11.1	10.7
2/19/13	8.8–2.0	141	9	0	0.9	2.0
Total		141	209	800	12.0	12.7

**Table 3.4-1
Quantity and Materials Used to Plug and Abandon TBM-1**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/20/13	124.0–2.0	2820	270	0	35.4	58.8
Total		2820	270	0	35.4	58.8

**Table 3.4-2
Quantity and Materials Used to Plug and Abandon TBM-2**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/20/13	39.0–2.0	846	81	0	10.7	20.1
Total		846	81	0	10.7	20.1

**Table 3.5-1
Quantity and Materials Used to Plug and Abandon Layne Western Well**

Date	Depth Interval (ft bgs bottom to top)	Quantity Portland Type I/II Used (lb)	Quantity Municipal Water Used (gal.)	Quantity 3/8-in. Bentonite Used (lb)	Calculated Volume (ft ³)	Actual Volume (ft ³)
2/28/13	106.8–7.5	3478	222	0	34.9	49.5
2/28/13	7.5–4.0	0	20	550	1.5	7.4
2/28/13	4.0–2.0	12	4	0	0.8	0.8
Total		3490	246	550	37.2	57.7

**Table 4.1-1
Survey Coordinates of Aluminum Pin Embedded in Surface Pad**

Identification	Northing	Easting	Elevation
49-10046	1755325.26	1625807.59	7142.5
49-10047	1755366.99	1625796.41	7142.8
49-10048	1755353.57	1625877.65	7140.4
CH-1	1755475.98	1624472.71	7171.9
CH-3	1754490.72	1624197.38	7170.7
CH-4	1753894.94	1625536.40	7118.2
TH-4	1755171.61	1625667.06	7141.4
TBM-1	1754595.57	1628546.59	7037.9
TBM-2	1754596.89	1628553.39	7037.2
Layne Western Well	1783496.26	1656285.62	5973.9

Appendix A

*Video Log of Layne Western Well
(on DVD included with this document)*

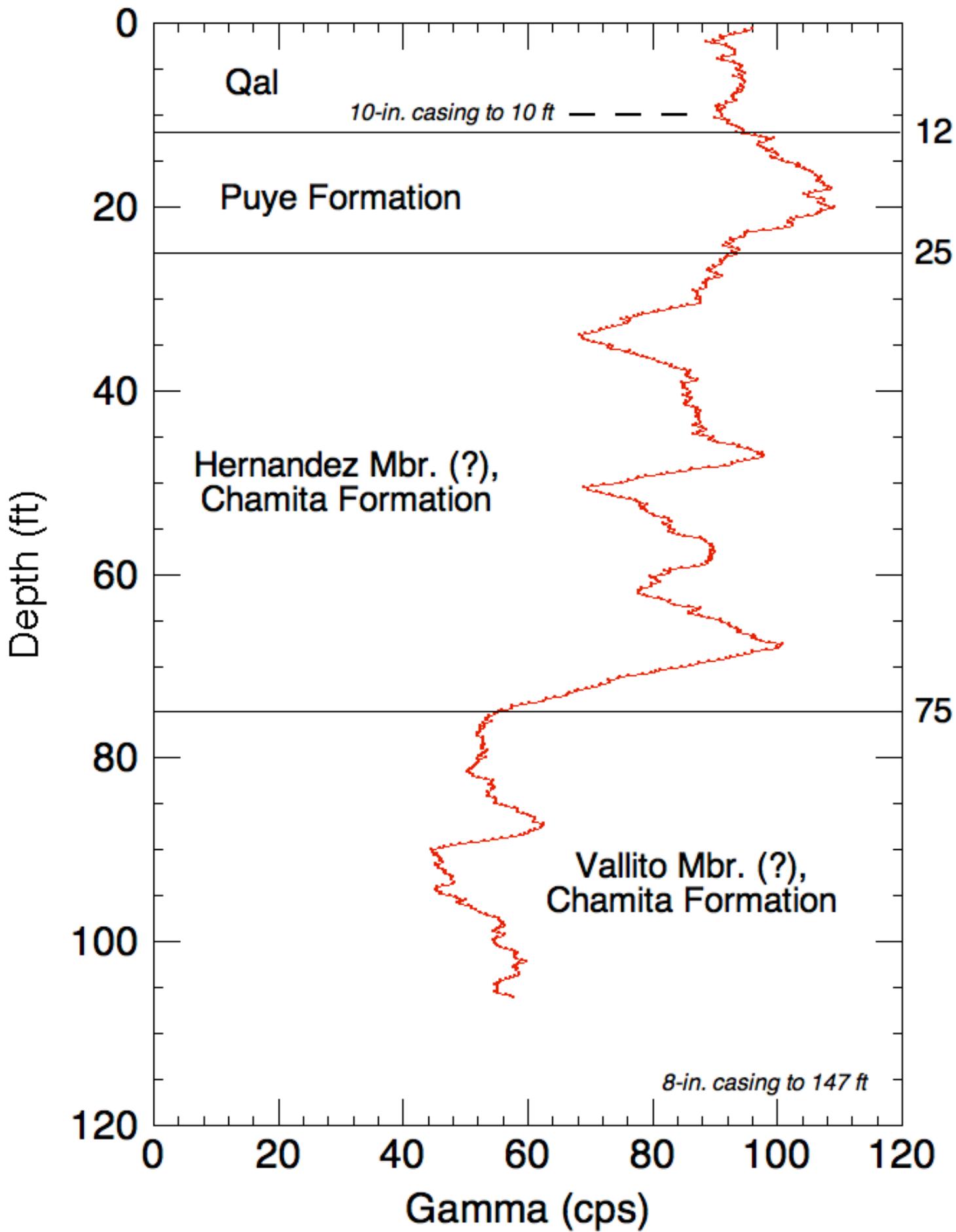
***TO VIEW THE VIDEO
THAT ACCOMPANIES
THIS DOCUMENT,
PLEASE CALL THE
HAZARDOUS WASTE
BUREAU AT 505-476-6000
TO MAKE AN
APPOINTMENT***

Appendix B

*Gamma Log of Layne Western Well
(on CD included with this document)*

Layne Western Well

(elev. 5871 ft)



~VERSION INFORMATION

VERS .2.0 :CWLS LOG ASCII STANDARD-VERSION 2.0
WRAP .NO :ONE LINE PER DEPTH STEP

~WELL INFORMATION

STRT .FT 107.743 :START DEPTH
STOP .FT -1.01706 :STOP DEPTH
STEP .FT -0.16404 :STEP
NULL . -999.25 :NULL VALUE
COMP . :COMPANY
WELL . :WELL
FLD . :FIELD
LOC . :LOCATION
PROV . N/A :PROVINCE
SRVC . N/A :SERVICE COMPANY
DATE . Feb. 28, 20 :DATE
UWI . N/A :UNIQUE WELL ID

~CURVE INFORMATION

DEPT .FT :DEPTH
GAMM .CPS :Gamma

~PARAMETER INFORMATION

ELEV . :ELEVATION
STE . :STE
DENS . :DENSITY
CASI . :CASING TO1
OPER . :OPERATING RIG TIME
WGT1 . :WGT1
CASI . :CASING SIZE1
CASI . :CASING TO2
WGT2 . :WGT2
CASI . :CASING SIZE2
WELL . Layne Wes :WELL ID
CASI . :CASING TO3
K.B. . :K.B.
WGT3 . :WGT3
TYPE . :TYPE LOG
CASI . :CASING SIZE3
CASI . :CASING TO4
SALI . :SALINITY
TITL . :TITLE
WGT4 . :WGT4
TOP . :TOP LOGGED INTERVAL
CASI . :CASING SIZE4
WITN . :WITNESSED BY
CASI . :CASING TO5
DRIL . :DRILLING MEAS. FROM

WGT5	.	:WGT5
CASI	.	:CASING SIZE5
CTY	.	:CTY
WGT6	.	:WGT6
CASI	.	:CASING SIZE6
MAX.	.	:MAX. REC. TEMP.
D.F.	.	:D.F.
CASI	.	:CASING TO6
OTHE	.	:OTHER SERVICES
BIT1	.	:BIT1
DEPT	.	:DEPTH-DRILLER
BIT2	.	:BIT2
RUN	.	:RUN No
RUN1	.	:RUN1
BIT3	.	:BIT3
RUN2	.	:RUN2
PERM	.	:PERMANENT DATUM
TWP	.	:TWP
BIT4	.	:BIT4
LOG	.	:LOG MEAS. FROM
BIT	.	:BIT FROM1
RUN3	.	:RUN3
BIT5	.	:BIT5
CASI	.	:CASING FROM1
TYPE	.	:TYPE FLUID IN HOLE
RUN4	.	:RUN4
FLD	.	:FLD
BIT6	.	:BIT6
BIT	.	:BIT TO1
CASI	.	:CASING FROM2
BIT	.	:BIT FROM2
CO	.	:CO
RGE	.	:RGE
BIT	.	:BIT TO2
DEPT	.	:DEPTH-LOGGER
CASI	.	:CASING FROM3
BIT	.	:BIT FROM3
RUN5	.	:RUN5
SEC	.	:SEC
BIT	.	:BIT TO3
G.L.	.	:G.L.
CASI	.	:CASING FROM4
BIT	.	:BIT FROM4
RUN6	.	:RUN6
BIT	.	:BIT TO4

BTM . :BTM LOGGED INTERVAL
 CASI . :CASING FROM5
 BIT . :BIT FROM5
 STAT . :STATE
 BIT . :BIT TO5
 LEVE . :LEVEL
 CASI . :CASING FROM6
 BIT . :BIT FROM6
 COUN . :COUNTRY
 RECO . :RECORDED BY
 FILI . :FILING No
 BIT . :BIT TO6
 ~OTHER
 ~A

Natural Gamma (CPS)

107.743	65.9922
107.579	66.2734
107.415	62.2246
107.251	73.2852
107.087	63.5293
106.923	47.3945
106.759	61.5293
106.594	55.3984
106.43	62.1797
106.266	50.7227
106.102	54.7422
105.938	71.2695
105.774	58.9395
105.61	49.166
105.446	58.3613
105.282	54.1777
105.118	50.7637
104.954	59.291
104.79	48.0723
104.626	52.3066
104.462	48.7188
104.298	53.3926
104.134	51.2891
103.97	35.2344
103.806	64.1953
103.642	70.6211
103.478	48.3223
103.314	61.1797
103.15	56.541
102.986	49.8691

102.822	63.1582
102.657	61.834
102.493	74.0273
102.329	78.0898
102.165	63.6055
102.001	73.9531
101.837	65.6758
101.673	53.1641
101.509	49.25
101.345	52.5273
101.181	38.957
101.017	53.3223
100.853	59.7188
100.689	58.0625
100.525	59.4648
100.361	48.9551
100.197	51.7305
100.033	43.7754
99.8688	60.4219
99.7047	58.4531
99.5407	57.0918
99.3766	57.002
99.2126	52.0938
99.0486	53.9746
98.8845	57.1816
98.7205	55.4277
98.5564	68.1016
98.3924	58.5566
98.2283	48.1895
98.0643	61.6797
97.9003	56.8457
97.7362	59.0332
97.5722	55.8926
97.4081	42.1465
97.2441	40.0391
97.0801	67.9922
96.916	52.8359
96.752	62.8613
96.5879	59.1758
96.4239	47.7012
96.2598	62.0234
96.0958	51.002
95.9318	50.957
95.7677	53.9102
95.6037	37.6074

95.4396	31.0566
95.2756	52.1934
95.1115	49.0352
94.9475	43.8945
94.7835	34.3164
94.6194	60.4473
94.4554	47.3555
94.2913	32.5957
94.1273	45.8574
93.9633	51.1406
93.7992	56.8105
93.6352	41.959
93.4711	45.8984
93.3071	44.9727
93.143	26.1143
92.979	51.8613
92.815	46.125
92.6509	46.1367
92.4869	54.2148
92.3228	57.6211
92.1588	55.7207
91.9948	65.8242
91.8307	57.5449
91.6667	35.375
91.5026	45.4609
91.3386	40.4844
91.1745	48.6152
91.0105	33.4844
90.8465	29.8984
90.6824	48.1563
90.5184	41.9551
90.3543	41.6309
90.1903	44.8691
90.0262	35.0586
89.8622	46.4805
89.6982	50.1426
89.5341	38.5117
89.3701	53.6973
89.206	42.2988
89.042	46.2539
88.878	41.6895
88.7139	67.9414
88.5499	52.2188
88.3858	49.9785
88.2218	68.0859

88.0577	59.3242
87.8937	62.4043
87.7297	78.9922
87.5656	70.3203
87.4016	74.0977
87.2375	78.9648
87.0735	70.7109
86.9094	75.5391
86.7454	75.2188
86.5814	50.3027
86.4173	60.0508
86.2533	51.6855
86.0892	55.0723
85.9252	71.4648
85.7612	48.168
85.5971	49.7988
85.4331	41.6133
85.269	38.2109
85.105	55.2148
84.9409	50.2949
84.7769	54.5645
84.6129	47.9219
84.4488	46.4805
84.2848	60.7891
84.1207	71.0664
83.9567	71.1406
83.7927	70.1602
83.6286	43.9629
83.4646	59.0957
83.3005	53.6113
83.1365	51.8281
82.9724	60.4844
82.8084	55.1914
82.6444	46.9082
82.4803	48.3633
82.3163	51.8945
82.1522	48.4551
81.9882	39.957
81.8241	49.7715
81.6601	66.6211
81.4961	48.1289
81.332	39.7949
81.168	55.2207
81.0039	44.9824
80.8399	66.9727

80.6759	46.9883
80.5118	46.7461
80.3478	51.0313
80.1837	44.3203
80.0197	49.6914
79.8556	41.8379
79.6916	60.8301
79.5276	63.3848
79.3635	66.1055
79.1995	51.166
79.0354	54.4551
78.8714	56.0215
78.7073	52.0996
78.5433	34.8691
78.3793	79.8047
78.2152	40.875
78.0512	58.7441
77.8871	42.4004
77.7231	65.5781
77.5591	48.9902
77.395	47.2676
77.231	53.9453
77.0669	43.5879
76.9029	58.377
76.7388	42.5703
76.5748	47.0371
76.4108	44.0742
76.2467	60.0957
76.0827	60.5313
75.9186	49.4082
75.7546	49.5586
75.5906	56.6348
75.4265	66.0117
75.2625	48.4785
75.0984	51.5469
74.9344	65.832
74.7703	53.7988
74.6063	54.5879
74.4423	69.4258
74.2782	50.4824
74.1142	47.2773
73.9501	57.0566
73.7861	52.125
73.622	62.1543
73.458	58.6074
73.294	57.5137

73.1299	58.7148
72.9659	77.0977
72.8018	58.4805
72.6378	63.3066
72.4738	80.1055
72.3097	78.3164
72.1457	100.461
71.9816	80.4492
71.8176	75.3164
71.6535	90.2695
71.4895	70.5156
71.3255	57.4668
71.1614	74.9141
70.9974	79.7578
70.8333	79.6133
70.6693	67.5703
70.5052	78.9609
70.3412	59.623
70.1772	88.0586
70.0131	58.0469
69.8491	56.2402
69.685	92.8438
69.521	78.5898
69.357	87.3906
69.1929	115.57
69.0289	105.652
68.8648	93.9961
68.7008	117
68.5367	115.621
68.3727	111.707
68.2087	121.316
68.0446	98.4258
67.8806	87.9141
67.7165	110.027
67.5525	107.055
67.3885	93.0625
67.2244	91.832
67.0604	101.77
66.8963	83.3398
66.7323	90.3867
66.5682	103.047
66.4042	98.9297
66.2402	87.082
66.0761	94.2813
65.9121	88.1484
65.748	73.8242
65.584	75.1289

65.4199	80.3672
65.2559	104.586
65.0919	123.895
64.9278	108.254
64.7638	65.2461
64.5997	109.418
64.4357	77.9297
64.2717	106.992
64.1076	88.4609
63.9436	88.4258
63.7795	91.4648
63.6155	75.1445
63.4514	79.8594
63.2874	89.8711
63.1234	61.9648
62.9593	74.9883
62.7953	76.7539
62.6312	63.5605
62.4672	88.7266
62.3031	86.4609
62.1391	91.8945
61.9751	88.8867
61.811	63.793
61.647	76.4492
61.4829	88.7813
61.3189	70.9844
61.1549	80.2656
60.9908	66.5977
60.8268	69.7227
60.6627	77.1289
60.4987	70.8555
60.3346	89.4727
60.1706	78.9727
60.0066	89.2969
59.8425	88.5273
59.6785	96.8633
59.5144	75.3594
59.3504	73.0664
59.1864	91.9883
59.0223	80.3203
58.8583	81.668
58.6942	79.168
58.5302	85.3789
58.3661	101.918
58.2021	102.211
58.0381	72.1523
57.874	90.707

57.71	117.695
57.5459	110.512
57.3819	91.6406
57.2178	97.4375
57.0538	66.0938
56.8898	99.5273
56.7257	91.3086
56.5617	76.9492
56.3976	99.6172
56.2336	92.8984
56.0696	72.4141
55.9055	87.3711
55.7415	79.3164
55.5774	89.1172
55.4134	80.4531
55.2493	68.8164
55.0853	92.1563
54.9213	81.9961
54.7572	97.2305
54.5932	63.5332
54.4291	83.6797
54.2651	67.0703
54.101	88.7344
53.937	73.4688
53.773	85.1133
53.6089	85.6289
53.4449	83.9883
53.2808	85.9609
53.1168	79.582
52.9528	83.5039
52.7887	84.5703
52.6247	102.926
52.4606	76.3789
52.2966	82.2617
52.1325	75.9414
51.9685	46.2988
51.8045	60.8438
51.6404	72.1328
51.4764	78.8867
51.3123	84.4922
51.1483	72.3438
50.9843	68.543
50.8202	92.3789
50.6562	63.8574
50.4921	63.5078
50.3281	82.2422
50.164	65.3398

50	52.1016
49.836	56.8555
49.6719	72.0703
49.5079	55.2988
49.3438	70.4258
49.1798	73.7227
49.0157	73.9375
48.8517	66.7578
48.6877	106.418
48.5236	87.2461
48.3596	114.688
48.1955	100.738
48.0315	104.629
47.8675	92.1172
47.7034	96.6445
47.5394	122.031
47.3753	111.277
47.2113	104.758
47.0472	100.387
46.8832	87.668
46.7192	119.52
46.5551	108.648
46.3911	81.8281
46.227	71.9453
46.063	73.8125
45.8989	92.1016
45.7349	102.188
45.5709	107.238
45.4068	71.5547
45.2428	85.0977
45.0787	99.9727
44.9147	76.7148
44.7507	90.1719
44.5866	71.4453
44.4226	100.051
44.2585	73.5117
44.0945	69.3906
43.9304	102.941
43.7664	85.8008
43.6024	107.422
43.4383	94.9102
43.2743	86.5625
43.1102	72.1875
42.9462	95.7109
42.7822	80.9688
42.6181	94.1133
42.4541	85.6016

42.29	97.0469
42.126	78.8242
41.9619	77.1016
41.7979	100.293
41.6339	94.0664
41.4698	76.8633
41.3058	82.0547
41.1417	83.5625
40.9777	93.4063
40.8136	68.3203
40.6496	86.5313
40.4856	86.793
40.3215	90.4023
40.1575	91.7695
39.9934	71.8789
39.8294	81.0742
39.6654	82.9727
39.5013	90.5313
39.3373	96.2227
39.1732	97.2344
39.0092	71.5625
38.8451	81.9063
38.6811	91.7813
38.5171	89.4922
38.353	90.7031
38.189	80.8359
38.0249	78.7266
37.8609	78.9453
37.6968	88.75
37.5328	80.8008
37.3688	117.75
37.2047	93.7422
37.0407	62.2324
36.8766	80.5313
36.7126	84.9961
36.5486	80.2773
36.3845	80.3164
36.2205	90.3828
36.0564	70.1602
35.8924	67.2148
35.7283	76.9023
35.5643	78.6875
35.4003	63.5918
35.2362	66.0859
35.0722	74.5156
34.9081	68.4531
34.7441	65.8711

34.5801	59.2598
34.416	66.6094
34.252	62.7129
34.0879	95.0391
33.9239	55.0527
33.7598	81.7852
33.5958	79.3555
33.4318	70.6367
33.2677	53.7539
33.1037	58.9063
32.9396	60.5898
32.7756	72.3242
32.6115	65.8242
32.4475	69.0352
32.2835	65.3203
32.1194	98.832
31.9554	86.9297
31.7913	93.6602
31.6273	76.9688
31.4633	88.4805
31.2992	85.2227
31.1352	97.0078
30.9711	80.625
30.8071	67.2969
30.643	67.5313
30.479	74.8984
30.315	104.953
30.1509	96.7656
29.9869	84.5586
29.8228	90.7891
29.6588	76.2852
29.4947	96.2305
29.3307	77.293
29.1667	101.543
29.0026	85.4336
28.8386	110.68
28.6745	100.855
28.5105	82.8438
28.3465	82.793
28.1824	90.5586
28.0184	77.4063
27.8543	85.7852
27.6903	90.5664
27.5262	71.7422
27.3622	90.1484
27.1982	86.9414
27.0341	77.375

26.8701	104.176
26.706	86.8711
26.542	97.3359
26.378	88.5469
26.2139	87.4219
26.0499	115.438
25.8858	98.6953
25.7218	90.5898
25.5577	78.5352
25.3937	88.9609
25.2297	94.2852
25.0656	89.1406
24.9016	99.5898
24.7375	88.4492
24.5735	104.172
24.4094	80.8477
24.2454	89.2656
24.0814	86.8008
23.9173	93.918
23.7533	95.0898
23.5892	106.355
23.4252	93.3633
23.2612	83.6602
23.0971	117.793
22.9331	86.0273
22.769	66.4336
22.605	89.8984
22.4409	115.715
22.2769	83.0313
22.1129	99.1758
21.9488	78.3828
21.7848	96.6836
21.6207	123.063
21.4567	115.664
21.2927	86.2656
21.1286	115.117
20.9646	132.859
20.8005	139.039
20.6365	109.617
20.4724	118.75
20.3084	94.2461
20.1444	93.9961
19.9803	92.0664
19.8163	104.047
19.6522	105.926
19.4882	108.316
19.3241	104.695

19.1601	117.098
18.9961	119.246
18.832	96.9414
18.668	96.7656
18.5039	105.359
18.3399	113.141
18.1759	93.0938
18.0118	94.9297
17.8478	105.113
17.6837	115.313
17.5197	119.074
17.3556	95.9375
17.1916	109.254
17.0276	106.793
16.8635	114.211
16.6995	112.984
16.5354	131.008
16.3714	115.777
16.2073	97.2461
16.0433	95.8398
15.8793	102.594
15.7152	112.117
15.5512	100.242
15.3871	109.133
15.2231	92.5195
15.0591	110.941
14.895	97.5313
14.731	82.4414
14.5669	85.4492
14.4029	90.3594
14.2388	111.73
14.0748	91.7188
13.9108	108.746
13.7467	102.086
13.5827	74.9805
13.4186	93.6758
13.2546	113.57
13.0906	93.6133
12.9265	114.328
12.7625	118.344
12.5984	91.9336
12.4344	97.7773
12.2703	83.8281
12.1063	118.508
11.9423	79.2461
11.7782	84.4141
11.6142	104.008

11.4501	101.617
11.2861	102.691
11.122	87.2266
10.958	116.402
10.794	68.707
10.6299	70.625
10.4659	77.0898
10.3018	70.4297
10.1378	97.168
9.97375	90.8359
9.80971	102.488
9.64567	86.6992
9.48163	96.6602
9.31758	105.105
9.15354	94.5195
8.9895	102.879
8.82546	68.4141
8.66142	84.9766
8.49737	100.207
8.33333	85.0469
8.16929	100.039
8.00525	94.1953
7.84121	99.6602
7.67716	114.184
7.51312	85.4766
7.34908	80.4453
7.18504	91.6719
7.021	79.8789
6.85695	100.805
6.69291	88.2461
6.52887	89.7188
6.36483	99.3047
6.20079	91.9766
6.03674	103.633
5.8727	113.676
5.70866	106.852
5.54462	91.8164
5.38058	87.1289
5.21653	75.2266
5.05249	98.2422
4.88845	97.9102
4.72441	96.4414
4.56037	90.043
4.39632	100.438
4.23228	82.3828
4.06824	105.238
3.9042	103.563

3.74016	81.543
3.57611	63.3086
3.41207	96.4102
3.24803	101.719
3.08399	95.7109
2.91995	88.9141
2.7559	77.1797
2.59186	99.5039
2.42782	77.8125
2.26378	90.7461
2.09974	106.406
1.93569	92.1602
1.77165	112.105
1.60761	97.5977
1.44357	97.3711
1.27953	90.6484
1.11548	77.4336
0.951442	90.5508
0.7874	81.8086
0.623358	70.1914
0.459316	71.5352
0.295274	106.602
0.131232	99.5781
-0.03281	83.7617
-0.19685	102.004
-0.36089	128.484
-0.52494	102.977
-0.68898	117.844
-0.85302	94.2578
-1.01706	102.109