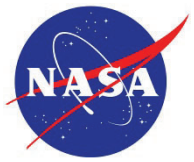
National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
White Sands Test Facility
P.O. Box 20
Las Cruces, NM 88004-0020



February 1, 2022

Reply to Attn of: RE-22-017

New Mexico Environment Department
Attn: Rick Shean, Bureau Chief
Hazardous Waste Bureau
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Subject: NASA WSTF Work Plan for Drilling and Installation of Monitoring Well 600C-002-GW and Abandonment of PL-6

On March 30, 2017, NASA submitted the *Detections of NDMA and TCE in WSTF Groundwater Monitoring Wells BLM-30, PL-5, PL-6, PL-7, PL-8, PL-10, ST-5, WW-3*. On October 4, 2017, NMED approved the report with modifications, which included a requirement for NASA to replace monitoring well PL-6 due to the absence of bentonite seals between monitoring zones. NASA plans to install new well 600C-002-GW adjacent to the location of existing well PL-6. A printed drilling work plan for new groundwater monitoring well 600C-002-GW, which includes information on the plugging and abandonment of existing well PL-6, is included as Enclosure 1. Enclosure 2 provides a CD-ROM of the drilling work plan.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions or comments concerning this submittal, please contact Antonette Doherty of my staff at 575-202-5406.

TIMOTHY DAVIS
Digitally signed by TIMOTHY DAVIS
Date: 2022.02.01 08:10:55 -07'00'

Timothy J. Davis
Chief, Environmental Office

2 Enclosures

cc:
Mr. Gabriel Acevedo
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505

Work Plan for Abandonment of NASA WSTF Well PL-6 and Replacement with Monitoring Well 600C-002-GW

Introduction and Background	On March 29, 2016, the New Mexico Environment Department (NMED) approved the National Aeronautics and Space Administration (NASA) White Sands Test Facility (WSTF) Periodic Monitoring Report for the Fourth Quarter of 2015. In the approval letter, NMED expressed concerns for periodic detections of N-nitrosodimethylamine (NDMA) at various sampling intervals in sentinel wells WW-3, PL-6, PL-7, PL-8, PL-10, and BLM-30 during 2015. NMED directed NASA to submit a work plan for the conversion of Westbay®[1] multiport sampling systems in wells WW-3, PL-5, PL-6, PL-7, PL-8, PL-10, ST-5, and BLM-30 to purgeable sampling systems no later than March 31, 2017 (NMED, 2017). On March 30, 2017, NASA submitted the *Detections of NDMA and TCE in WSTF Groundwater Monitoring Wells BLM-30, PL-5, PL-6, PL-7, PL-8, PL-10, ST-5, WW-3* (NASA, 2017), which recommended additional evaluation of chemical analytical data before converting the Westbay sampling systems in these wells to purgeable systems. NMED approved the report with modifications (NMED, 2017) that included both a requirement to complete the data representativeness evaluation and direction to replace monitoring wells PL-5 and PL-6 because of inadequate seals between monitoring zones in these wells. This work plan is provided in accordance with NMED direction that requires the submittal of a work plan for the abandonment and replacement of NASA WSTF (Figure 1) groundwater monitoring well PL-6 (NMED, 2017). NMED directed NASA to abandon and replace the well, which is located within the southern Jornada del Muerto Basin alluvial aquifer west of the WSTF Plume Front Treatment System (PFTS; Figure 2). This document includes only the abandonment and replacement of PL-6, as all other wells listed above have been addressed in previously submitted work plans.
Plugging and Abandonment of Well PL-6	NASA will plug and abandon existing groundwater monitoring well PL-6 in accordance with WSTF Hazardous Waste Permit (Permit) Attachment 19 (Section 19.4; NMED, 2009) and 19.27.4.30 New Mexico Administrative Code (NMAC). Well PL-6, completed in June 1991, is equipped with 14-inch (in.) steel surface casing that extends to a depth of 16.5 feet (ft) below ground surface (bgs). The 12 ¼-in. diameter borehole extends from surface casing to a total depth of 1,920 ft bgs. The conventional portion of the monitoring well consists of 4-in. stainless-steel casing that extends from ground surface to 1,860 ft bgs. The abandonment of PL-6 requires NASA to first remove the 1.5-in. diameter Westbay sampling system from the 4-in. stainless-steel well casing. Removal will be completed by Westbay representatives, who will use specialized equipment to perforate the inflatable packers and oversee the removal of the polyvinyl chloride (PVC) sampling system from the stainless-steel casing (Figure 3). Every effort will be made to remove as much of the PVC sampling system as possible with Westbay extraction methods. Should a portion of the sampling system be unable to be removed, the remaining material will be pushed to the bottom of the stainless-steel casing, compressing it as much as reasonably possible. The remaining material will then be pressure grouted in place during well abandonment. If this is

[1] Westbay® is a registered trademark of Nova Metrix Ground Monitoring (Canada) Ltd.

	necessary, the plan will be made in consultation with NMED and the drilling subcontractor. The stainless-steel casing is cemented to approximately 300 ft bgs, which makes over drilling and removal of the casing infeasible. Following removal of the Westbay sampling system, NASA plans to plug the well by pressure grouting each of the existing screened intervals in the stainless-steel casing (Figure 3). Pressure grouting will be completed by using a tremie pipe with a packer affixed near the bottom to inject grout under pressure into each of the nine screened intervals. After each of the screened intervals is grouted, the tremie pipe and packer will be raised above the next screen, the packer will be inflated above the screen to isolate that screened interval, and grout will be pumped in to fill that interval. Pressure grouting will be completed from the bottom of the well to the surface. Any discharge of fluids will be managed in accordance with the Waste Characterization and Management section of this work plan. The steel surface casing will be cut at least 6 in. bgs, and a concrete cap will be emplaced over the borehole. A brass cap will be placed in the concrete surface completion and all pertinent well information will be stamped into the brass cap. NASA will prepare a well plugging plan for well PL-6 and submit the plan to the New Mexico Office of the State Engineer (NMOSE) in accordance with 19.27.4.30 NMAC. The well drilling contractor will provide NASA and NMOSE with the required completed well plugging record. NASA will in turn provide NMED with a copy of the completed well plugging record.
Primary Purpose	NASA proposes to plug and abandon existing monitoring well PL-6 (Figure 3) and install replacement monitoring well 600C-002-GW adjacent to the abandoned well. Well 600C-002-GW is expected to be completed as nested three-zone conventional monitoring wells installed within a single borehole (Figure 4). Target screened intervals in the replacement well approximately mirror three monitoring zones within current monitoring well PL-6 at 545 ft, 790 ft, and 980 ft. The placement of the screened intervals within the well will be refined during drilling and/or follow-on borehole logging.
Hydrogeologic and Geochemical Objectives	The primary objective of the proposed monitoring well is to roughly mirror three groundwater monitoring zones in existing well PL-6, which is identified as a Plume Front monitoring well in the NASA Groundwater Monitoring Plan (GMP; NASA, 2021). NDMA has been sporadically detected in multiple monitoring zones (NASA, 2017) and requires additional characterization. Sampling zones in replacement well 600C-002-GW will be used to monitor the shallow, intermediate, and deep levels within the aquifer, providing analytical data for evaluation of the marginal area of the groundwater contamination plume. Analytical results from 600C-002-GW will be used to supplement data collected from other wells within the WSTF groundwater monitoring system and be used to evaluate the effectiveness of the PFTS.
Conceptual Model	The original location of well PL-6 was chosen to provide vertical delineation of the alluvial aquifer west of the Western Boundary Fault Zone (WBFZ) and to support characterization of the WSTF groundwater contaminant plume. Replacement well 600C-002-GW will continue to serve that role in the WSTF groundwater assessment program. In addition to providing analytical data concerning the marginal area of the WSTF groundwater plume, well 600C-002-GW will also provide water level data that will be used to interpret PFTS plume capture effectiveness. Information collected from

	the new well will be incorporated into the WSTF conceptual groundwater model when appropriate. Well PL-6 includes nine monitoring ports that range in depth from 545 to 1,815 ft bgs, though the three lowest monitoring zones at 1,485, 1,645, and 1,815 ft bgs have been inaccessible since 2011. Existing Westbay well PL-6 was completed within the Santa Fe Alluvium, with only the lowermost 100 ft penetrating andesite lava (Figure 5). All monitoring zones are completed within the basin Tertiary to Quaternary Santa Fe Group alluvium, which is generally characterized as an unconsolidated to semi-consolidated, poorly to moderately sorted, pebbly polygenetic conglomerate. Limestone and igneous clasts in the conglomerate originate from the San Andres Mountains, located to the east of WSTF. Clay lenses are also present and likely represent fine grain sediments of the distal portion of buried coalescent alluvial fan deposits. Figure 5 provides details on the lithology at well PL-6. Replacement well 600C-002-GW will be located approximately 50 ft to the northeast of existing well PL-6. Well 600C-002-GW will be completed in the alluvial basin-fill and is expected to have similar lithology to that encountered at comparable depths in the existing well. Aquifer conditions at the proposed location are expected to be unconfined. The groundwater flow direction in the area is generally west-southwest. Based on recent measurements at well PL-6, NASA expects to encounter groundwater at approximately 465 ft bgs.
Drilling Approach	NASA will drill and install monitoring well 600C-002-GW in accordance with the requirements of Permit Attachment 19 (NMED, 2009). The well is expected to be installed using mud rotary drilling. NASA expects to advance a 16.5-in. borehole to approximately 1,000 ft bgs to allow for the installation of a monitoring well with three sampling zones (Figure 4). The first sampling zone target depth is roughly 80 ft below static groundwater level, a second sampling zone will be located near or at the bottom extent of the conceptualized plume, and the third sampling zone target depth will be deeper than the conceptualized plume depth. **Mud Rotary Drilling** Mud rotary is a standard drilling method used when encountering challenging subsurface lithologies such as those in WSTF alluvium expected at the 600C-002-GW location, and is the preferred drilling method for this borehole installation. The Santa Fe alluvium is continuously saturated after the water table is reached, thus the identification of discrete water bearing zones that would lead NASA to prefer air rotary methods is not of concern. Conventional mud rotary drilling circulates drilling mud down through the drill pipe, which is then returned back up the borehole. Reverse mud rotary drilling circulates mud down the borehole and back up through the drill pipe. The drilling mud stabilizes the borehole wall, cools the drill bit, and carries the drill cuttings up to the surface. NASA recognizes that drilling mud has the potential to adversely affect the hydrologic properties of the aquifer immediately surrounding the borehole. It is expected that the high conductivity alluvium at the location of 600C-002-GW will yield significant volumes of groundwater during well development, which will facilitate effective drilling mud development from the aquifer. If required, the appropriate mud dispersion agents will be utilized to aid in the removal of residual drilling mud during

	borehole/well development. NASA will also consult with groundwater monitoring well drilling experts to evaluate the use of tracer dyes in drilling mud. Adding tracer dyes to the drilling mud would allow for real-time monitoring during well development to ensure that residual mud components are removed from the formation prior to installation of the dedicated sampling systems within the well casing. It is expected that drilling fluid additives and dispersants would be certified to National Sanitation Foundation Standard 60 or other applicable standards.
Potential Groundwater Occurrence and Detection	The top of regional groundwater is expected to occur at a depth of approximately 465 ft bgs. However, the exact depth to water is uncertain as a result of variability within the alluvial stratigraphy and the potential influence from operation of the PFTS.
Lithological Sampling	Lithological samples will be collected directly from the drilling mud discharge location, or from the solid's separation unit (shaker table), if utilized, on 10-ft centers, at a minimum. Drill cuttings may be collected using a stainless-steel hand-held screen placed in the flow of the discharged mud, by placing a shovel in the mud discharge trench to intercept cuttings, or other method selected by the field geologist, as appropriate. Cuttings samples will be archived for future reference.
Groundwater Screening and Characterization Sampling	Based on groundwater monitoring performed at existing well PL-6, the aquifer at the proposed 600C-002-GW location is not expected to be within the WSTF groundwater contaminant plume. Following well development and sampling system installation, groundwater characterization samples will be collected from all three sampling zones of the completed well. Samples will be collected for the analysis of volatile organic compounds by the current revision of SW-846 Method 8260, semi-volatile organic compounds by the current revision of SW-846 Method 8270C, NDMA by Modified Environmental Protection Agency (EPA) Method 607M, or an acceptable low-level analytical method, and a variety of metals by the most effective laboratory-selected analytical method. Samples will be collected and managed in accordance with the WSTF GMP (NASA, 2021).
Geophysical Logging	A complete suite of open borehole geophysical logs will be performed as a single event to aid in the selection of potential monitoring zones. Open borehole geophysical logging will be performed by a qualified geophysical contractor, and is expected to include gamma, neutron porosity, formation resistivity, spontaneous potential logs, and caliper logs/borehole deviation logs.
Well Completion	Well 600C-002-GW will be constructed in accordance with the requirements stated in Section 19.3.2 of the Permit (NMED, 2009) with three strings of nominal 4.5 in. Schedule 120 PVC casing and screen, which allows for the use of a 4-in. diameter downhole pump for well development. Three monitoring zones are planned in the well. The uppermost screened interval will be located between 500 and 600 ft bgs to effectively monitor the groundwater contaminants near the WSTF Plume Front and the effectiveness of the PFTS. The intermediate screened interval is expected to be located between 750 and 850 ft bgs to support the evaluation of contamination at depth and to monitor potential migration at the base of the conceptualized groundwater plume. The deepest monitoring zone will be located between 900 and 1,000 ft bgs to provide evaluation of the deep alluvial aquifer. Ten-foot length 0.020-in. slotted Schedule 120 PVC screens will be positioned at depths indicated as favorable monitoring zones in accordance with field screening of borehole lithology and borehole geophysical logs.

	The annular seal for the screened sampling zones will be comprised of bentonite chips or pellets bracketing each screened interval with bentonite grout between screened intervals. The general well construction configuration is presented in Figure 4 and is subject to change dependent on conditions encountered in the field or by recommendations made by the drilling contractor. NASA will prepare a final well construction diagram for the well for NMED review and approval immediately prior to well installation. Annular materials will be emplaced using a minimum 1.5-in. inner diameter tremie pipe. A 10/20 or similar silica sand filter pack will be placed to a height of 2 ft above and below each monitoring screen. Three feet of fine silica sand, such as 20/40 or similar, will be used to grade from the sand pack to a 10-ft bentonite seal composed of hydrated bentonite chips or pellets. Intervals between the individual bentonite seals will be comprised of bentonite grout with at least 30% solids. The upper 10 ft of the borehole and well pad will be completed with Type II Portland cement. Figure 4 provides a diagram of the preliminary well design with annular materials.
Well Development	The well will be developed in accordance with the requirements of Attachment 19 (Section 19.3.5) of the Permit (NMED, 2009). Drilling contractor personnel will operate equipment used to develop the well under the supervision of Environmental contractor personnel. It is anticipated that initial development for each sampling zone may consist of jetting (to facilitate mud removal following mud rotary), mechanical bailing, swabbing, pumping using a submersible pump, and the use of a mud dispersant. During development activities, Environmental contractor personnel will monitor discharged development water for parameters that will include pH, specific conductance (conductivity), temperature, and turbidity. Well development will be considered complete when measured water quality parameters are relatively stable (vary less than 10%) and turbidity is below 5 nephelometric turbidity units. Each screened interval will be developed to ensure the well will yield representative groundwater samples from that depth of the formation. Following well development, NASA expects to install a dedicated low-flow bladder pump in each PVC well casing, with pump intakes located at or slightly above the midpoint of each screened interval.
Hydraulic Testing and Groundwater Sampling	Hydraulic testing will be considered during the development of monitoring well 600C-002-GW. Additional information such as drawdown and specific capacity will be recorded if this testing is conducted. Groundwater sampling following installation and development of the well will be performed using dedicated low-flow bladder pumps. Groundwater samples will be collected and managed as described in the WSTF GMP (NASA, 2021).
Waste Characterization and Management	Information related to the characterization, management, and disposition of waste generated during this project is provided in this section. Waste characterization is conducted in accordance with Section II.C.2 (Waste Characterization) and Attachment 12 (Waste Analysis Plan) of the Permit (NMED, 2009). All waste will be properly managed and disposed of in accordance with NASA procedures and state and federal regulations. The waste streams that will be generated during the plugging and abandonment of PL-6, and the drilling and installation of groundwater monitoring well 600C-002-GW include: • **Westbay system.** PL-6 is located outside the defined extent of the WSTF groundwater plume. Components of the Westbay sampling system and

groundwater removed from well PL-6 are not contaminated and will be characterized as non-hazardous solid waste.

- **Drill cuttings.** Drill cuttings are defined as soil cuttings or rock fragments present in borehole drilling returns. Groundwater analytical results from PL-6 indicate 600C-002-GW will be located outside of the defined extent of the WSTF groundwater plume. Drill cuttings will be characterized as nonhazardous environmental media.

- **Drilling fluids.** Drilling fluids generated during drilling are impacted with added non-chlorinated native water from the WSTF potable water supply wells, related drilling fluid additives such as bentonite or foam, and uncontaminated groundwater. Drilling fluids are characterized as nonhazardous solid waste.

- **Groundwater.** Groundwater produced from the aquifer outside of the WSTF groundwater contaminant plume is non-hazardous.

- **Decontamination fluids.** Decontamination fluids such as water and soap solutions used to wash and decontaminate equipment generated during drilling above the water table or at locations outside of the WSTF groundwater contaminant plume are non-hazardous solid waste.

- **Contact waste.** Contact waste, or debris, such as used disposable sampling equipment, personal protective equipment, plastic sheeting, and other debris generated during drilling above the water table or at locations outside of the WSTF groundwater contaminant plume is non-hazardous solid waste. Debris that may have come into contact with petroleum-based oils or fuels will be managed as hazardous waste.

The EPA has established through the "contained-in policy" that groundwater, and other environmental media, is not solid waste but is subject to regulation as if it were hazardous waste when it contains listed waste (EPA, 1991). Previous analytical results indicate that groundwater at well PL-6 is not contaminated with WSTF contaminants of concern. As a result, groundwater and materials that contact groundwater at the PL-6/600C-002-GW location are not subject to regulation as hazardous waste.

Westbay sampling system components removed will be removed and disposed of solid waste in an appropriate landfill. Metal components will be recycled. PVC fragments may be generated during the well plugging and abandonment process. They will be separated from any fluid generated from the well and will be managed as nonhazardous solid waste for disposal at a RCRA Subtitle D landfill.

Drill cuttings and drilling fluids generated during Westbay casing removal at well PL-6 and drilling of replacement well 600C-002-GW will not exhibit the characteristics of a hazardous waste or contain listed hazardous waste. Drill cuttings and fluids will be managed in earthen pits lined with plastic sheeting at the drill site and will be left in place following installation.

Groundwater generated during drilling, development, and purging will be managed in the same earthen pits used for drill cuttings management. A notice of intent to discharge will be submitted to the NMED Ground Water Quality Bureau in accordance with 20.6.2.1201 NMAC describing the anticipated discharge character and volume.

	Produced water will be allowed to evaporate following project completion, at which point residual drill cuttings will be managed as previously described. Because the groundwater is not contaminated at this location, contact waste is not designated as hazardous waste. It will be collected at the end of each working shift and transferred to an appropriate nonhazardous solid waste container. Debris that may have come into contact with petroleum-based oils or fuels will be managed as hazardous waste in accordance with 40 CFR 262.17 at an existing WSTF Central Accumulation Area.
Schedule	It is anticipated that drilling of proposed well 600C-002-GW will commence following NMED approval of this work plan. The anticipated schedule for completing wells is as follows: • Eight to 10 weeks for project and procurement planning, well site preparation, and drilling contractor scheduling. • Six to eight weeks for contractor mobilization, removal of the Westbay sampling system from well PL-6, plugging and abandonment of well PL-6, installation of the 600C-002-GW borehole, and nested conventional well installation in 600C-002-GW borehole. Additional time may be required during drilling if unexpected field or geological conditions slow the drilling process. • Six to eight weeks for well development fieldwork, sampling system design and procurement, and sampling system installation. • Eight to 12 weeks for groundwater sampling, data validation and verification, and preparation of the well completion report. The well completion report will be submitted to the NMED in accordance with Attachment 19 of the Permit (NMED, 2009).
References	EPA (Environmental Protection Agency). (1991, March 26). N.t. (EPA Publication Number RO 11593). Washington, DC. Retrieved from https://yosemite.epa.gov/osw/rcra.nsf/ NASA Johnson Space Center White Sands Test Facility. (2017, March 30). *Detections of NDMA and TCE in WSTF Groundwater Monitoring Wells BLM-30, PL-5, PL-6, PL-7, PL-8, PL-10, ST-5, and WW-3.* Las Cruces, NM. NASA Johnson Space Center White Sands Test Facility. (2021, April 19). *NASA WSTF Groundwater Monitoring Plan Update for 2021*. Las Cruces, NM. NMED Hazardous Waste Bureau. (2009, November 3). *Hazardous Waste Permit No. NM8800019434* (modified December 2019). Santa Fe, NM. NMED Ground Water Quality Bureau. (2011, March). *Monitoring Well Construction and Abandonment Guidelines.* Revision 1.1. Santa Fe. NM.

	NMED Hazardous Waste Bureau. (2017, October 4). *Approval with Modifications Detections of NDMA (N-Nitrosodimethylamine) and TCE (Trichloroethylene) In WSTF Groundwater Monitoring Wells BLM-30, PL-5, PL-6, PL-7, PL-8, PL-10, ST-5, and WW-3*. Santa Fe, NM. Notice of Intent to Discharge, Water Quality Control Commission, 20.6.2.1201 NMAC (12-21-2018). Well Drilling – Non-Artesian (Unconfined) Well Requirements, Office of the State Engineer, 19.27.4.30 NMAC (6-30-2017).

Figures

Figure 1 **WSTF Location Map**

(SEE NEXT PAGE)

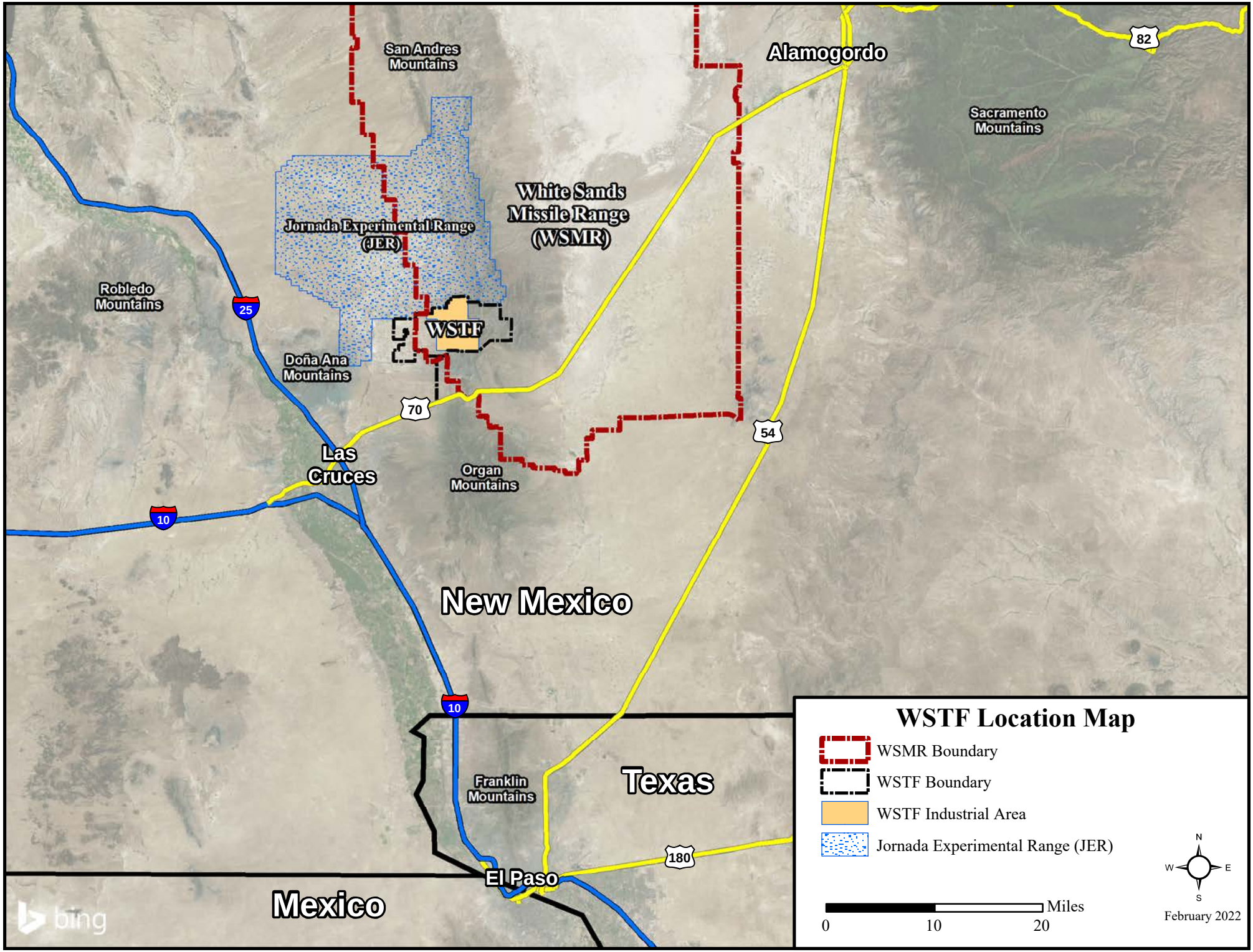

San Andres Mountains
Alamogordo
82
Sacramento Mountains
White Sands Missile Range (WSMR)
Jornada Experimental Range (JER)
Robledo Mountains
25
WSTF
Doña Ana Mountains
70
54
Las Cruces
Organ Mountains
10
New Mexico
10
Franklin Mountains
Texas
180
El Paso
Mexico
bing
WSTF Location Map
WSMR Boundary
WSTF Boundary
WSTF Industrial Area
Jornada Experimental Range (JER)
N
W
E
S
Miles
0
10
20
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Figure 2 **Proposed Location for 600C-002-GW**

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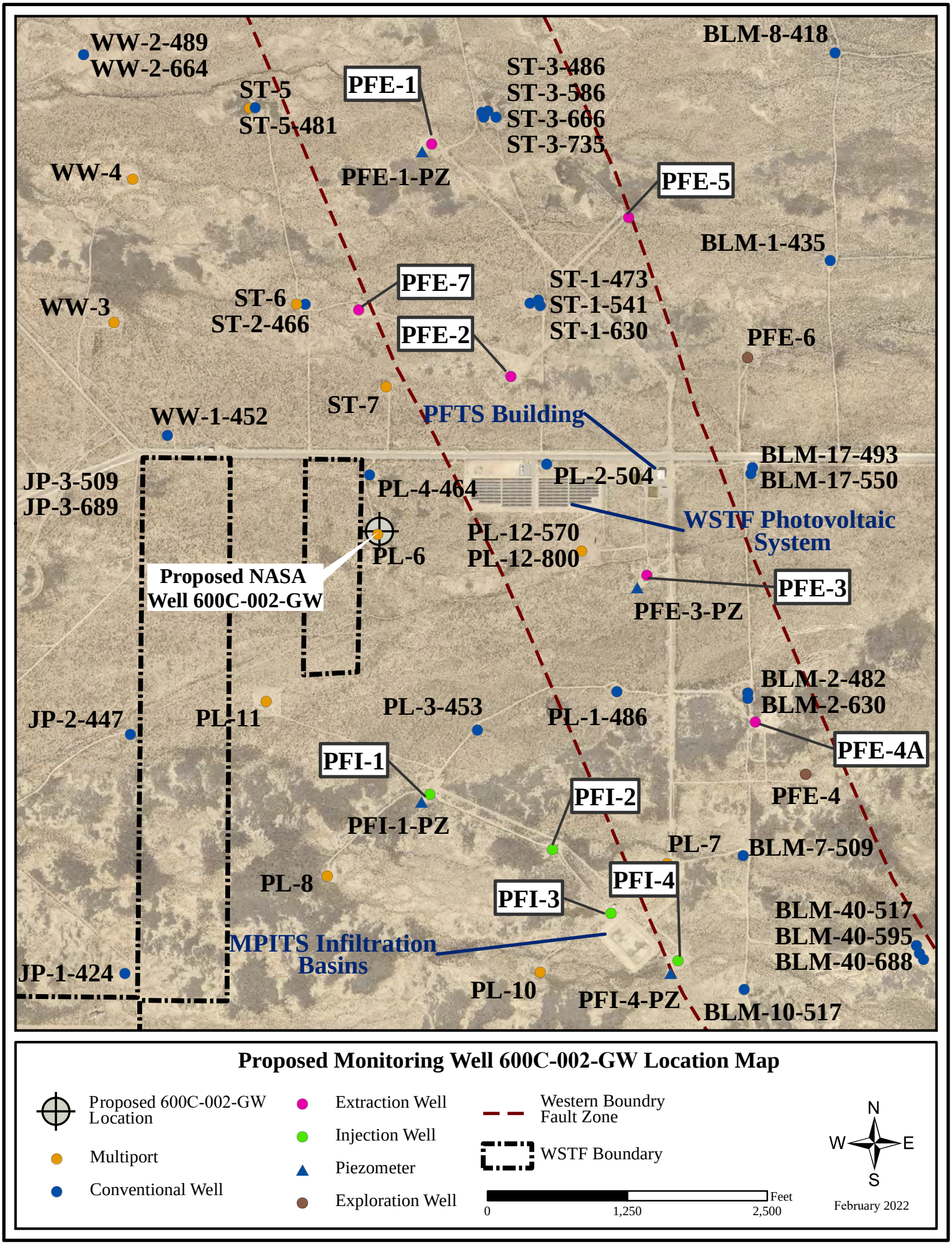


Proposed Monitoring Well 600C-002-GW Location Map

- Proposed 600C-002-GW Location
- Multiport
- Conventional Well
- Extraction Well
- Injection Well
- Piezometer
- Exploration Well
- Western Boundry Fault Zone
- WSTF Boundary

0 1,250 2,500 Feet

N W E S

February 2022

Figure 3 **PL-6 Well Completion Diagram**

(SEE NEXT PAGE)

WELL COMPLETION DIAGRAM

RETROFIT WESTBAY® MONITORING WELL

JSC - White Sands Test Facility, Las Cruces, New Mexico, USA

Location ID: **PL-6** Site ID: **NASA-WSTF, Doña Ana County, NM**

Township and Range: **SE 1/4 NE 1/4 NW 1/4 Sec. 5, T21S, R3E**
NM State Plane Coordinates (NAD 83 in meters): **168127.74N 461544.34E**
Elevation (Brass Cap): **1366.84 m AMSL**
Elevation (Top of Casing): **1367.27 m AMSL**
Drilling Contractor: **Beylik Drilling Company**
Driller: **T. Grossi, C. Jenkins, J. Jenkins, G. Welts**
Total Depth of Borehole (bgs): **1,920' (585.22 m)**
Borehole Diameter: **24" 0 - 16.5'; 12 1/4" 16.5 - 1,920'**
Depth to Bedrock (bgs): **Not Reached**
Depth to Groundwater: **412.82' (125.83 m) TOC (6/10/91)**
Total Depth Surface Casing (bgs): **16.5' (5.03 m)**
Diameter and Type Surface Casing: **14" OD Steel**
Date(s) Well Installed: **CW = 1/8/91 - 1/14/91; WB = 6/10/91 - 6/13/91**
Date(s) Well Developed: **CW = 1/15/91 - 6/6/91; WB = Not Recorded**

Field Representative(s): **See list in Annular/Borehole Descriptions.**
Total Depth Well Casing(s) (bgs): **CW=1,860' (566.93 m); WB=1,840' (560.83 m)**
Type of Casing(s): **CW = Stainless Steel; WB = MP 38 PVC**
Diameter Well Casing(s): **4" ID, 4.5" OD (CW) / 1.5" ID, 1.9" OD (WB)**
Casing Schedule: **10 (CW)**
CW Screened Zone(s) (bgs): **10' Zones (top): 540.1' (164.62 m); 720' (219.46 m); 910' (277.37 m); 1,030' (313.94 m); 1,190' 362.71 m); 1,330' (405.38 m); 1,480.1 (451.13 m); 1,640' (499.87 m);**
WB Sampling Port(s) (bgs): **545' (166.12 m); 725' (220.98 m); 915' (278.89 m); 1,035' (315.47 m); 1,195' (364.24 m); 1,335' (406.91 m) 1,485' (452.63 m); 1,645' (501.40 m); 1,815' (553.49 m)**
WB Packer Zone(s) (bgs): **See Diagram**
CW Zones (cont.): and 1,809.9' (551.66 m)
Comments: **CW = Conventional Well WB = Westbay®**

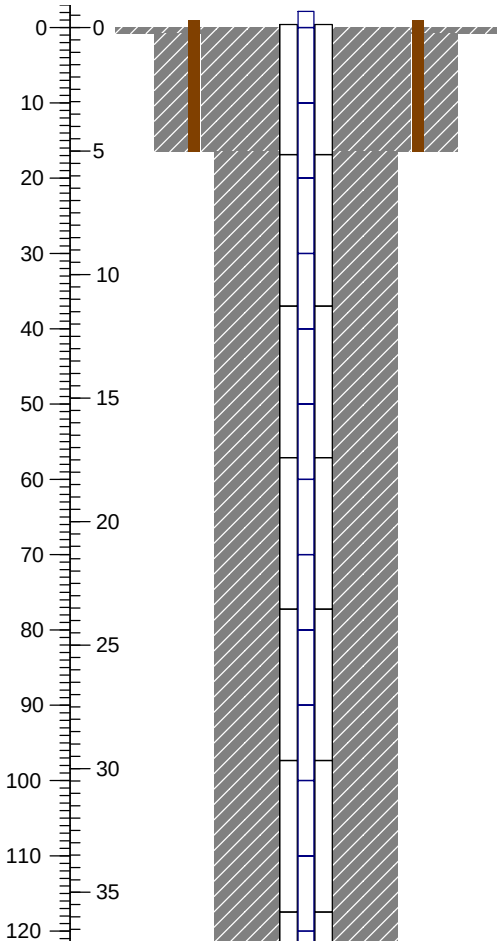
Casing Explanation:

- Surface Casing — **14" OD Steel**
- Conventional Casing — **4" ID Stainless Steel**
- Conventional Screen — **4" ID Stainless Steel 0.020"-Slot**
- Conventional End Cap — **4" ID Stainless Steel**
- **Steel Welded Centralizers**
- Water Table
- **1.5" ID Westbay® MP 38 Casing**
- **1.5" ID Westbay® MP 38 End Cap**
- Measurement Port (MP)
- MP with Filter Sock
- Packer
- Mechanical Pumping Port (PP)
- Magnetic Collar

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 8/20 Sand/ Bentonite Mix
- Slough
- 1/8 Gravel
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Westbay® Well Stick-Up = ~2.1' (0.651 m)
Conventional Well Stick-Up = ~0.41' (~0.12 m). Original stick-up measured at installation was 13.43', immediately cut to present level 1/8/91. Joints welded together.

Surface Casing Stick-Up = ~1' (~0.3 m)(Exact Stick-Up Not Measured or Surveyed)
Well completed with ~3' x ~3' cement pad, barrier posts, and locking steel well cap surrounding the casings above ground surface
14" OD Steel Surface Casing Depth = 16.5' (5.03 m)

All regular couplings are reinforced with stainless steel bands 0 - 320' (0 - 97.54 m)

Annular/Borehole Descriptions
All depths listed are bgs

Top of Cement Grout (Neat Cement with 5% Bentonite) = 0'

24" Borehole Cemented to 16.5' (5.03 m)

Field Representatives: M. Canavan, G. Contaldo, P. Egan, S. Huber, J. Kirby, D. Menzie, E. Morse, J. Rogers, M. Sanders, C. Werden

Surface Casing
14" OD Steel
Conventional Casing
4" ID Stainless Steel
Conventional Screen
4" ID Stainless Steel
0.020"-Slot
Conventional End Cap
4" ID Stainless Steel
Steel Welded Centralizers

Water Table

Casing Explanation:

1.5" ID Westbay® MP 38 Casing
1.5" ID Westbay® MP 38 End Cap
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Packer

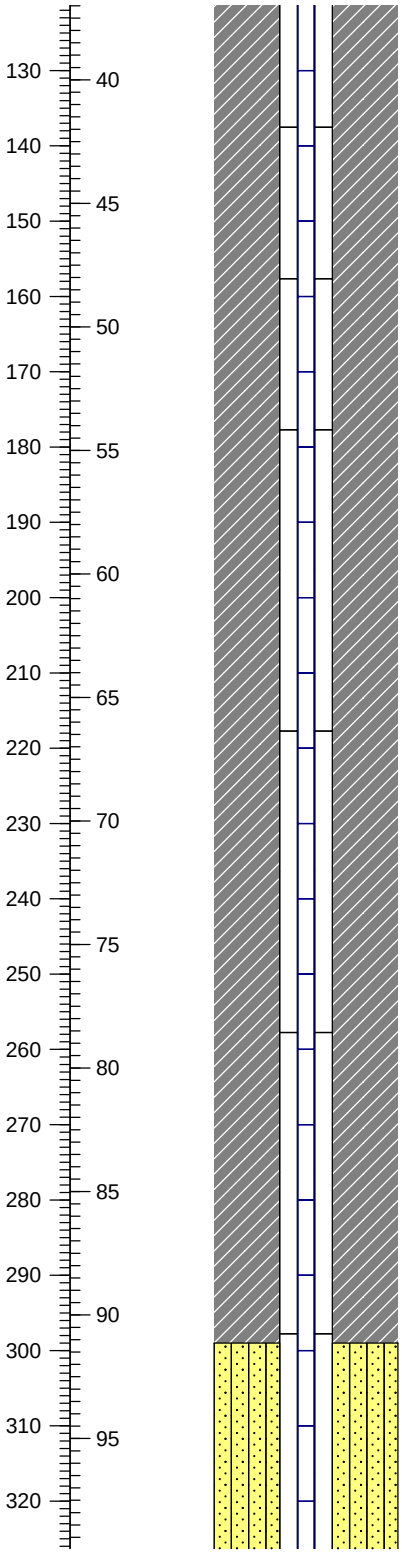
Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
8/20 Sand/ Bentonite Mix
Slough
1/8 Gravel
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters

Well Descriptions
All depths listed are bgs (unless noted)

Annular/Borehole Descriptions
All depths listed are bgs



Top of 8/20 Sand/Bentonite Benseal Mix = 299' (91.1 m)

Casing Explanation:

- Surface Casing — **14" OD Steel**
- Conventional Casing — **4" ID Stainless Steel**
- Conventional Screen — **4" ID Stainless Steel 0.020"-Slot**
- Conventional End Cap — **4" ID Stainless Steel**
- **Steel Welded Centralizers**
- Water Table
- **1.5" ID Westbay® MP 38 Casing**
- **1.5" ID Westbay® MP 38 End Cap**
- Measurement Port (MP)
- MP with Filter Sock
- Mechanical Pumping Port (PP)
- Magnetic Collar
- Packer

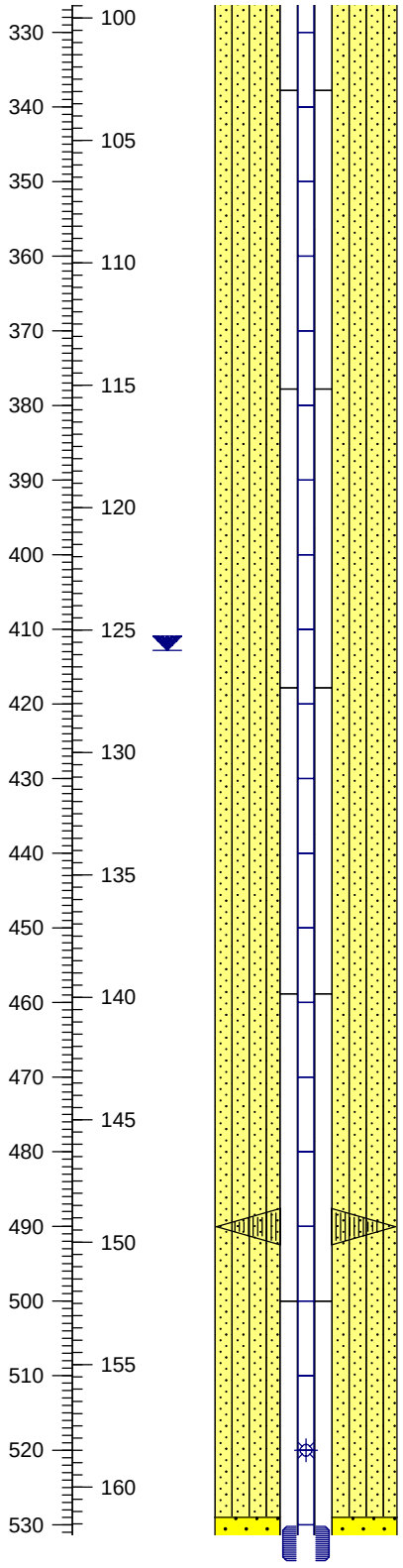
Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 8/20 Sand/ Bentonite Mix
- Slough
- 1/8 Gravel
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters

Well Descriptions
All depths listed are bgs (unless noted)

Annular/Borehole Descriptions
All depths listed are bgs



Water Table = 412.82' (125.83 m) TOC (measured 6/10/91, just prior to Westbay® well casing installation)

Three steel centralizers welded to casing 10' above bottom of joint = ~490.04' (~149.36 m)

MP Depth = 520' (158.50 m)

Packer Depth = 530'-535' (161.54-163.07 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 540.1' (164.62 m)

Top of 8/20 Sand = 529' (161.2 m)

Casing Explanation:

- Surface Casing — **14" OD Steel**
- Conventional Casing — **4" ID Stainless Steel**
- Conventional Screen — **4" ID Stainless Steel 0.020"-Slot**
- Conventional End Cap — **4" ID Stainless Steel**
- **Steel Welded Centralizers**
- Water Table
- **1.5" ID Westbay® MP 38 Casing**
- **1.5" ID Westbay® MP 38 End Cap**
- Measurement Port (MP)
- MP with Filter Sock
- Mechanical Pumping Port (PP)
- Magnetic Collar
- Packer

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 8/20 Sand/ Bentonite Mix
- Slough
- 1/8 Gravel
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters

	Well Descriptions All depths listed are bgs (unless noted)	Annular/Borehole Descriptions All depths listed are bgs
540 / 165	Magnetic Collar Depth = 544.6' (165.99 m)(0.4' above sampling MP)	
550 / 170	Sampling MP Depth (with Filter Sock) = 545' (166.12 m) PP Depth = 550' (167.64 m) Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 550.1' (167.67 m)	Top of 8/20 Sand/Bentonite Benseal Mix = 560' (170.7 m)
560 / 170	Cage centralizer installed at joint (~10' below screen) = ~559.95' (~170.67 m) Packer Depth = 555'-560' (169.16-170.69 m) MP Depth = 570' (173.74 m)	
570 / 175		
580 / 180		
590 / 180		
600 / 185		
610 / 185		
620 / 190		
630 / 190		
640 / 195		
650 / 200		
660 / 200		
670 / 205		
680 / 205		
690 / 210		
700 / 215	Packer Depth = 710'-715' (216.41-217.93 m) Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 720.0' (219.46 m)	Top of 8/20 Sand = 714' (217.6 m)
710 / 215		
720 / 220	Magnetic Collar Depth = 724.6' (220.86 m)(0.4' above sampling MP) Sampling MP Depth (with Filter Sock) = 725' (220.98 m) PP Depth = 730' (222.50 m)	
730 / 220		

Surface Casing
14" OD Steel
Conventional Casing
4" ID Stainless Steel
Conventional Screen
4" ID Stainless Steel
0.020"-Slot
Conventional End Cap
4" ID Stainless Steel
Steel Welded Centralizers

Water Table

Casing Explanation:

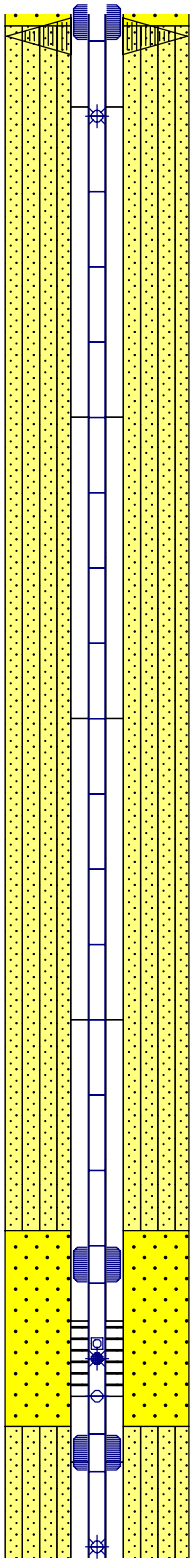
1.5" ID Westbay® MP 38 Casing
1.5" ID Westbay® MP 38 End Cap
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Packer

Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
8/20 Sand/ Bentonite Mix
Slough
1/8 Gravel
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters

740	225
750	230
760	
770	235
780	
790	240
800	
810	245
820	250
830	
840	255
850	
860	260
870	265
880	
890	270
900	275
910	
920	280
930	
940	285



Well Descriptions
All depths listed are bgs (unless noted)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 730.0' (222.50 m)

Cage centralizer installed in middle of 20' joint (~10' below screen) = ~739.37' (~225.36 m)

Packer Depth = 735'-740' (224.03-225.55 m)

MP Depth = 750' (228.60 m)

Packer Depth = 900'-905' (274.32-275.84 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 910.0' (277.37 m)

Magnetic Collar Depth = 914.6' (278.77 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 915' (278.89 m)

PP Depth = 920' (280.42 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 920.0' (280.42 m)

Annular/Borehole Descriptions
All depths listed are bgs

Top of 8/20 Sand/Bentonite Benseal Mix = 738' (224.9 m)

Top of 8/20 Sand = 898' (273.7 m)

Top of 8/20 Sand/Bentonite Benseal Mix = 924' (281.6 m)

Surface Casing
14" OD Steel
Conventional Casing
4" ID Stainless Steel
Conventional Screen
4" ID Stainless Steel
0.020"-Slot
Conventional End Cap
4" ID Stainless Steel
Steel Welded Centralizers

Water Table

Casing Explanation:

1.5" ID Westbay® MP 38 Casing
1.5" ID Westbay® MP 38 End Cap
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Packer

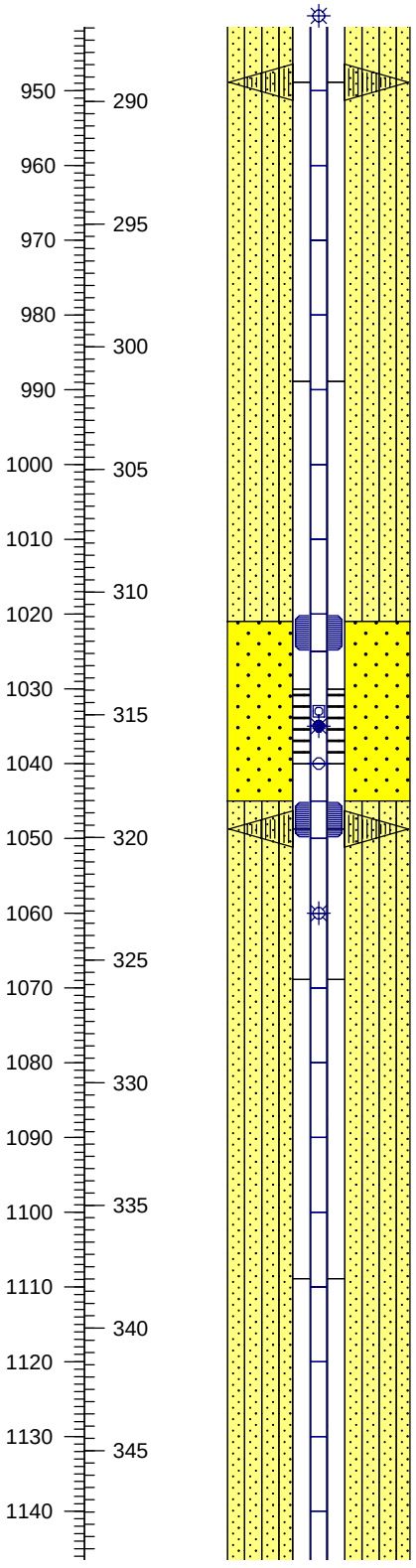
Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
8/20 Sand/ Bentonite Mix
Slough
1/8 Gravel
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters

Well Descriptions
All depths listed are bgs (unless noted)

Annular/Borehole Descriptions
All depths listed are bgs



Packer Depth = 925'-930' (281.94-283.46 m)

MP Depth = 940' (286.51 m)

Three steel centralizers welded to casing at joint (~30' below screen) = ~948.87' (~289.22 m)

Packer Depth = 1,020'-1,025' (310.90-312.42 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,030.0' (313.94 m)

Top of 8/20 Sand = 1,021' (311.2 m)

Magnetic Collar Depth = 1,034.6' (315.35 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 1,035' (315.47m)

PP Depth = 1,040' (316.99 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,040.0' (316.99 m)

Top of 8/20 Sand/Bentonite Benseal Mix = 1,045' (318.5 m)

Cage centralizer installed at joint (~10' below screen) = ~1,048.75' (~319.66 m)

Packer Depth = 1,045'-1,050' (318.52-320.04 m)

MP Depth = 1,060' (323.09 m)

Surface Casing
14" OD Steel
Conventional Casing
4" ID Stainless Steel
Conventional Screen
4" ID Stainless Steel
0.020"-Slot
Conventional End Cap
4" ID Stainless Steel
Steel Welded Centralizers

Water Table

Casing Explanation:

1.5" ID Westbay® MP 38 Casing
1.5" ID Westbay® MP 38 End Cap
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Packer

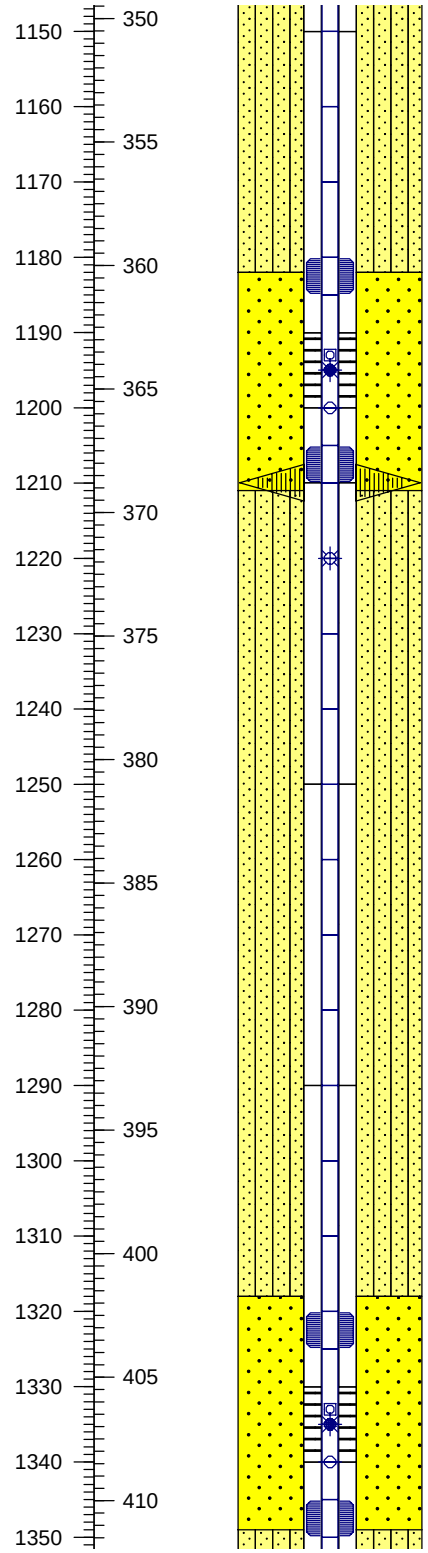
Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
8/20 Sand/ Bentonite Mix
Slough
1/8 Gravel
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters

Well Descriptions
All depths listed are bgs (unless noted)

Annular/Borehole Descriptions
All depths listed are bgs



Packer Depth = 1,180'-1,185' (359.66-361.19 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,190.0' (362.71 m)

Top of 8/20 Sand = 1,182' (360.3 m)

Magnetic Collar Depth = 1,194.6' (364.11 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 1,195' (364.24 m)

PP Depth = 1,200' (365.76 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,200.0' (365.76 m)

Top of 8/20 Sand/Bentonite Benseal Mix = 1,211' (369.1 m)

Cage centralizer installed at joint (~10' below screen) = ~1,209.96' (~368.80 m)

Packer Depth = 1,205'-1,210' (367.28-368.81 m)

MP Depth = 1,220' (372.93371.86 m)

Packer Depth = 1,320'-1,325' (402.34-403.86 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,330.0' (405.38 m)

Top of 8/20 Sand = 1,318' (401.7 m)

Magnetic Collar Depth = 1,334.6' (406.79 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 1,335' (406.91 m)

PP Depth = 1,340' (408.43 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,340.0' (408.43 m)

Top of 8/20 Sand/Bentonite Benseal

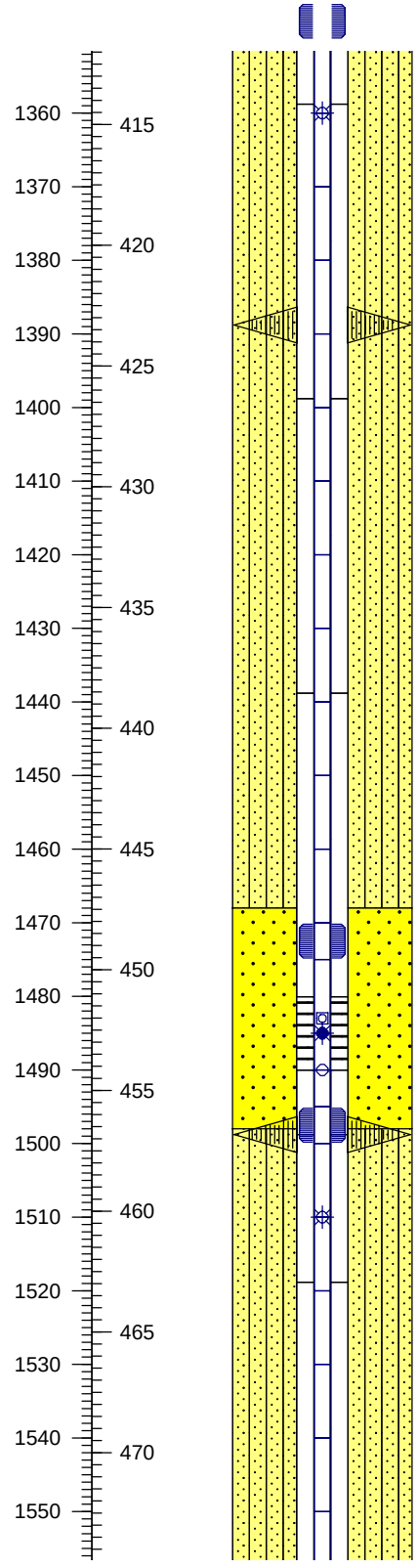
Casing Explanation:

- Surface Casing — **14" OD Steel**
- Conventional Casing — **4" ID Stainless Steel**
- Conventional Screen — **4" ID Stainless Steel 0.020"-Slot**
- Conventional End Cap — **4" ID Stainless Steel**
- **Steel Welded Centralizers**
- Water Table
- **1.5" ID Westbay® MP 38 Casing**
- **1.5" ID Westbay® MP 38 End Cap**
- Measurement Port (MP)
- MP with Filter Sock
- Mechanical Pumping Port (PP)
- Magnetic Collar
- Packer

Annular Materials Explanation:

- Cement
- Bentonite (Grout Well DF)
- Bentonite Seal
- 8/20 Sand/ Bentonite Mix
- Slough
- 1/8 Gravel
- 4/8 Sand
- 6/9 Sand
- 8/12 Sand
- 8/20 Sand
- 10/20 Sand
- 16/40 Sand
- 20/40 Sand
- 30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Packer Depth = 1,345'-1,350' (409.96-411.48 m)

MP Depth = 1,360' (414.53 m)

Three steel centralizers welded to casing 10' above bottom of joint (~60' below screen) = ~1,388.80' (~423.31 m)

Packer Depth = 1,470'-1,475' (448.06-449.58 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,480.1' (451.13 m)

Magnetic Collar Depth = 1,484.6' (452.51 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 1,485' (452.63 m)

PP Depth = 1,490' (454.15 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,490.1' (454.18 m)

Cage centralizer installed at joint (~10' below screen) = ~1,498.78' (~456.83 m)

Packer Depth = 1,495'-1,500' (455.68-457.20 m)

MP Depth = 1,510' (460.25 m)

Annular/Borehole Descriptions
All depths listed are bgs

Mix = 1,349' (411.2 m)

Top of 8/20 Sand = 1,468' (447.4 m)

Top of 8/20 Sand/Bentonite Benseal Mix = 1,498' (456.6 m)

Surface Casing
14" OD Steel
Conventional Casing
4" ID Stainless Steel
Conventional Screen
4" ID Stainless Steel
0.020"-Slot
Conventional End Cap
4" ID Stainless Steel
Steel Welded Centralizers

Water Table

Casing Explanation:

1.5" ID Westbay® MP 38 Casing
1.5" ID Westbay® MP 38 End Cap
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Packer

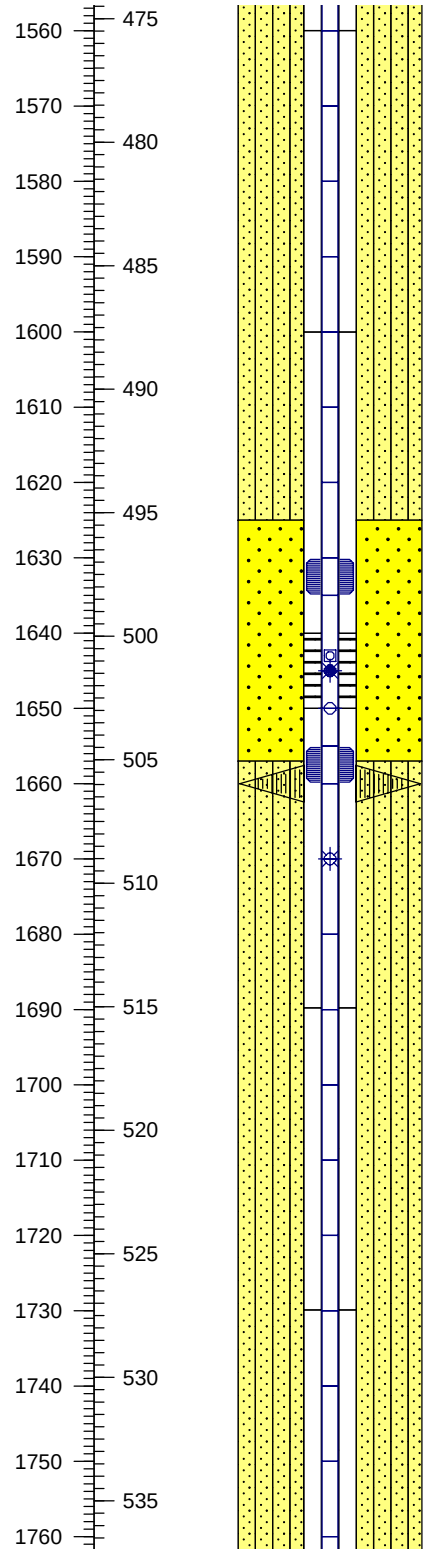
Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
8/20 Sand/ Bentonite Mix
Slough
1/8 Gravel
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters

Well Descriptions
All depths listed are bgs (unless noted)

Annular/Borehole Descriptions
All depths listed are bgs



Packer Depth = 1,630'-1,635' (496.82-498.35 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,640.0' (499.87 m)

Top of 8/20 Sand = 1,625' (495.3 m)

Magnetic Collar Depth = 1,644.6' (501.27 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 1,645' (501.40 m)

PP Depth = 1,650' (502.92 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,650.0' (502.92 m)

Top of 8/20 Sand/Bentonite Benseal Mix = 1,657' (505.1 m)

Cage centralizer installed 10' below top of joint (~10' below screen) = ~1,660' (~505.97 m)

Packer Depth = 1,655'-1,660' (504.44-505.97 m)

MP Depth = 1,670' (509.02 m)

Surface Casing
14" OD Steel
Conventional Casing
4" ID Stainless Steel
Conventional Screen
4" ID Stainless Steel
0.020"-Slot
Conventional End Cap
4" ID Stainless Steel
Steel Welded Centralizers

Water Table

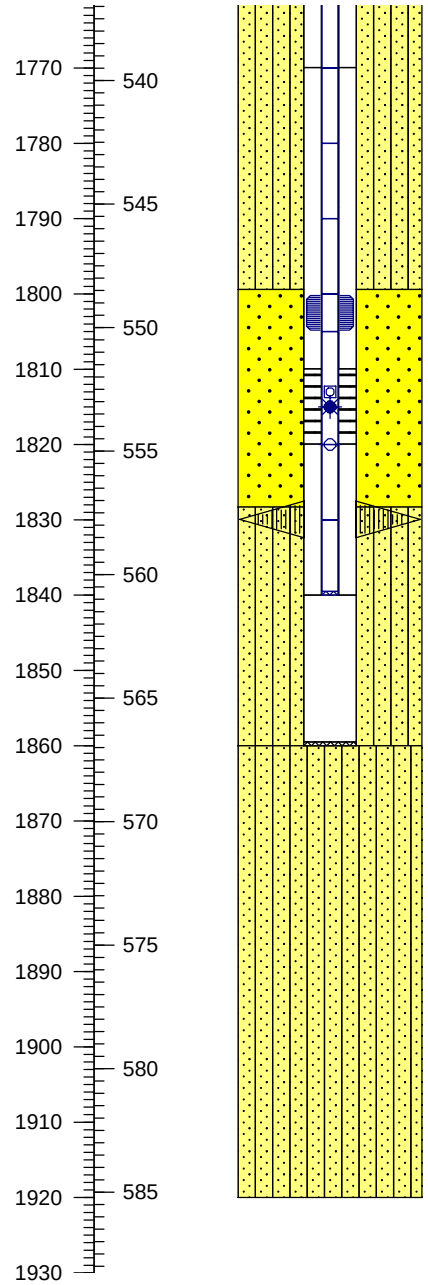
Casing Explanation:

1.5" ID Westbay® MP 38 Casing
1.5" ID Westbay® MP 38 End Cap
Measurement Port (MP)
MP with Filter Sock
Mechanical Pumping Port (PP)
Magnetic Collar
Packer

Annular Materials Explanation:

Cement
Bentonite (Grout Well DF)
Bentonite Seal
8/20 Sand/ Bentonite Mix
Slough
1/8 Gravel
4/8 Sand
6/9 Sand
8/12 Sand
8/20 Sand
10/20 Sand
16/40 Sand
20/40 Sand
30/70 Sand

Feet/Meters



Well Descriptions
All depths listed are bgs (unless noted)

Packer Depth = 1,800'-1,805' (548.64-550.16 m)

Top of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,809.9' (551.41 m)

Magnetic Collar Depth = 1,814.6' (553.09 m)(0.4' above sampling MP)

Sampling MP Depth (with Filter Sock) = 1,815' (553.21 m)

PP Depth = 1,820' (554.74 m)

Bottom of 4.25" ID Schedule 10 Type 304 Stainless Steel 0.020" - Slot Screen = 1,819.9' (554.46 m)

Three steel centralizers welded to casing in middle of joint (~10' below screen) = ~1,829.93' (~557.8 m)

Westbay® MP 38 Casing TD = 1,840' (560.83 m)

Conventional 4" ID Stainless Steel Well TD = 1,860.0' (566.93 m)

Annular/Borehole Descriptions
All depths listed are bgs

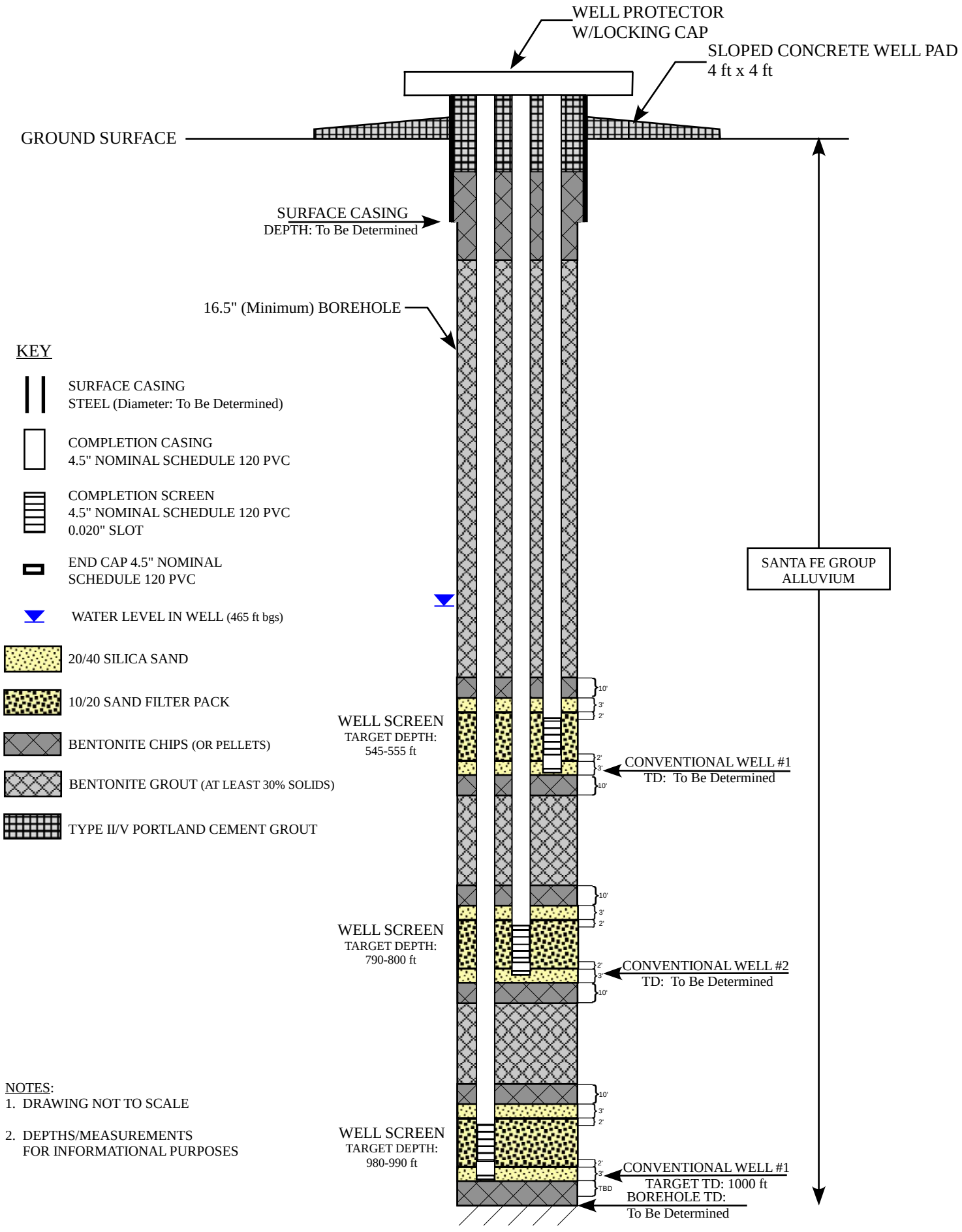
Top of 8/20 Sand = 1,799.4' (548.5 m)

Top of 8/20 Sand/Bentonite Benseal Mix = 1,828.3' (557.3 m)

12 1/4" Borehole TD = 1,920' (585.2 m)

Figure 4 **General 600C-002-GW Well Design**

(SEE NEXT PAGE)



NOTES:
1. DRAWING NOT TO SCALE

2. DEPTHS/MEASUREMENTS FOR INFORMATIONAL PURPOSES

600C-002-GW WELL DIAGRAM: SHOWING CONVENTIONAL NESTED WELL

Figure 5 **PL-6 Borehole Lithology Log**

(SEE NEXT PAGE)

BOREHOLE LITHOLOGIC LOG

NASA JSC - White Sands Test Facility, Las Cruces, New Mexico, USA

Location ID: **PL-6**

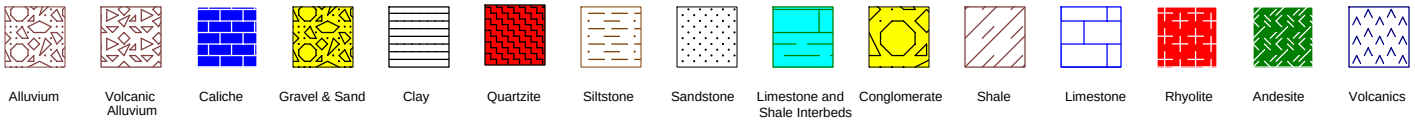
Site ID: **NASA-WSTF, Doña Ana County, NM**

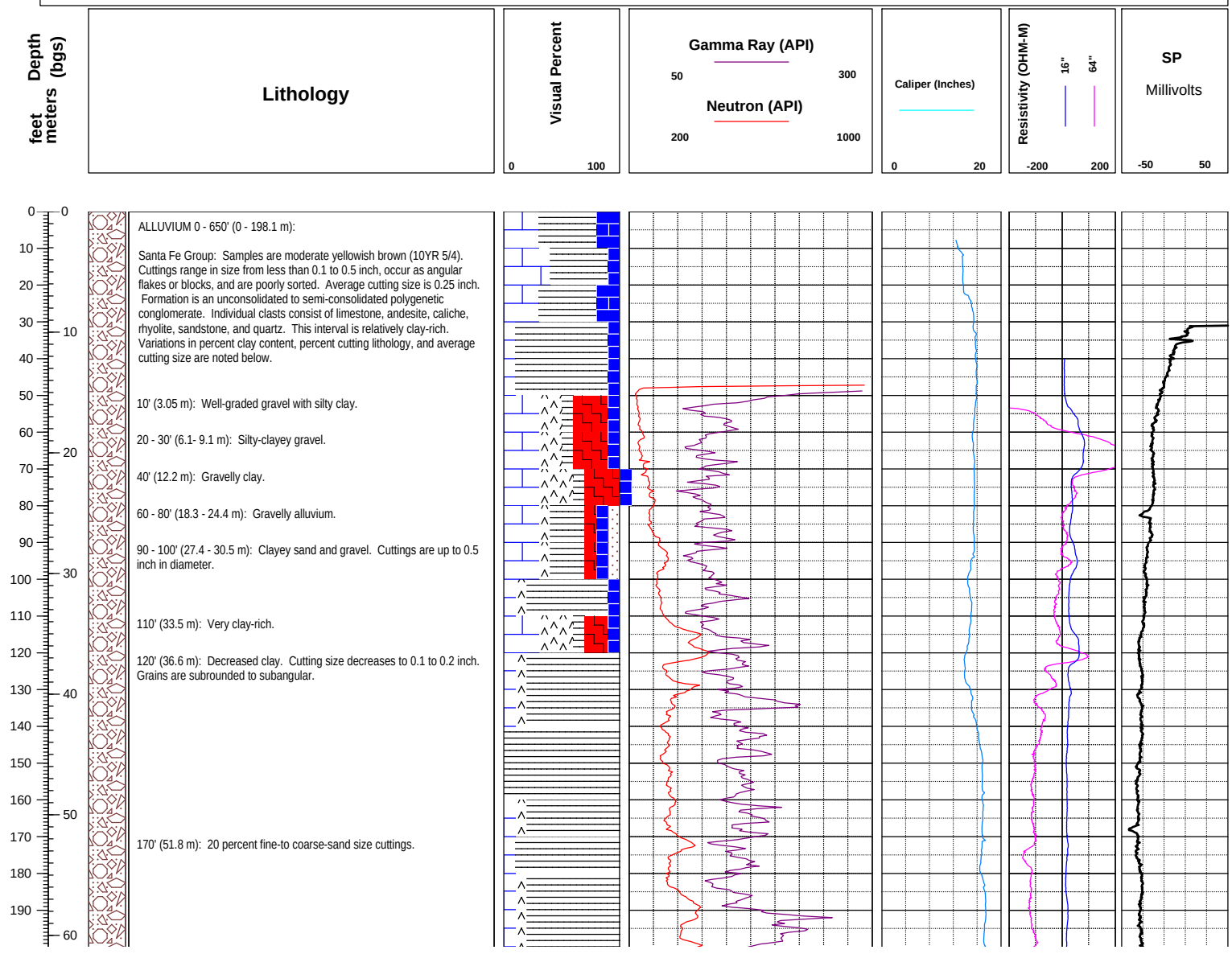
Township and Range: **SW 1/4 NW 1/4 NE 1/4 Section 5, T21S, R3E**
NM State Plane Coordinates (NAD 83): **168127.74N 461544.34E**
Elevation (Brass Cap): **1366.84 m AMSL**
Total Depth of Borehole (bgs): **1,920' (585.22 m)**
Depth to Bedrock (bgs): **Not Reached**
Drilling Method: **Auger; Mud Rotary**
Drilling Contractor: **Beylik Drilling Company**
Driller: **T. Grossi, G. Welts, C. Jenkins, J. Jenkins**

Depth to Groundwater: **Not Recorded**
Surface Casing Depth and Diameter: **14" Carbon Steel to 16.5'**
Borehole Diameter: **20" auger to 16.5' (5.03 m); 12 1/4" to 1,920' (585.2 m)**
Geologist Field Rep: **See comments**
Dates Drilling Started and Completed: **11/30/90 to 1/15/91**
Geophysical Contractor: **Southwest Surveys, Inc. (1/15/90)**
Logger: **S. Stubberud**
Comments: **AMSL = Above Mean Sea Level**
Geologist Field Reps: M. Canavan, G. Contaldo, S. Dubyk, P. Egan, S. Huber, J. Kirby, D. Menzie, J. Rogers, C. Werden

M. Pitterle review 4/02/2021

Explanation:





ALLUVIUM 0 - 650' (0 - 198.1 m):

Santa Fe Group: Samples are moderate yellowish brown (10YR 5/4). Cuttings range in size from less than 0.1 to 0.5 inch, occur as angular flakes or blocks, and are poorly sorted. Average cutting size is 0.25 inch. Formation is an unconsolidated to semi-consolidated polygenetic conglomerate. Individual clasts consist of limestone, andesite, caliche, rhyolite, sandstone, and quartz. This interval is relatively clay-rich. Variations in percent clay content, percent cutting lithology, and average cutting size are noted below.

10' (3.05 m): Well-graded gravel with silty clay.

20 - 30' (6.1- 9.1 m): Silty-clayey gravel.

40' (12.2 m): Gravelly clay.

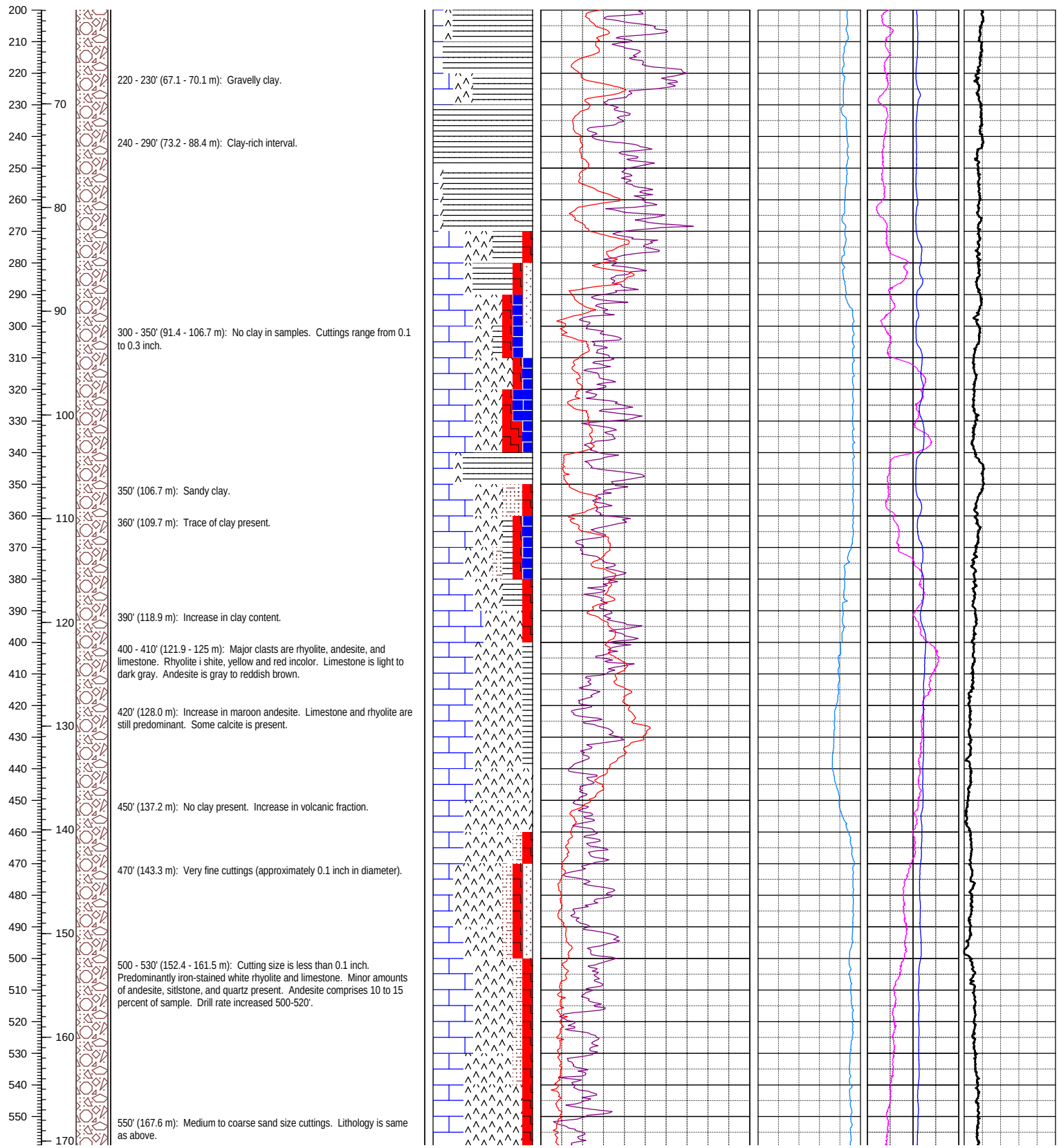
60 - 80' (18.3 - 24.4 m): Gravelly alluvium.

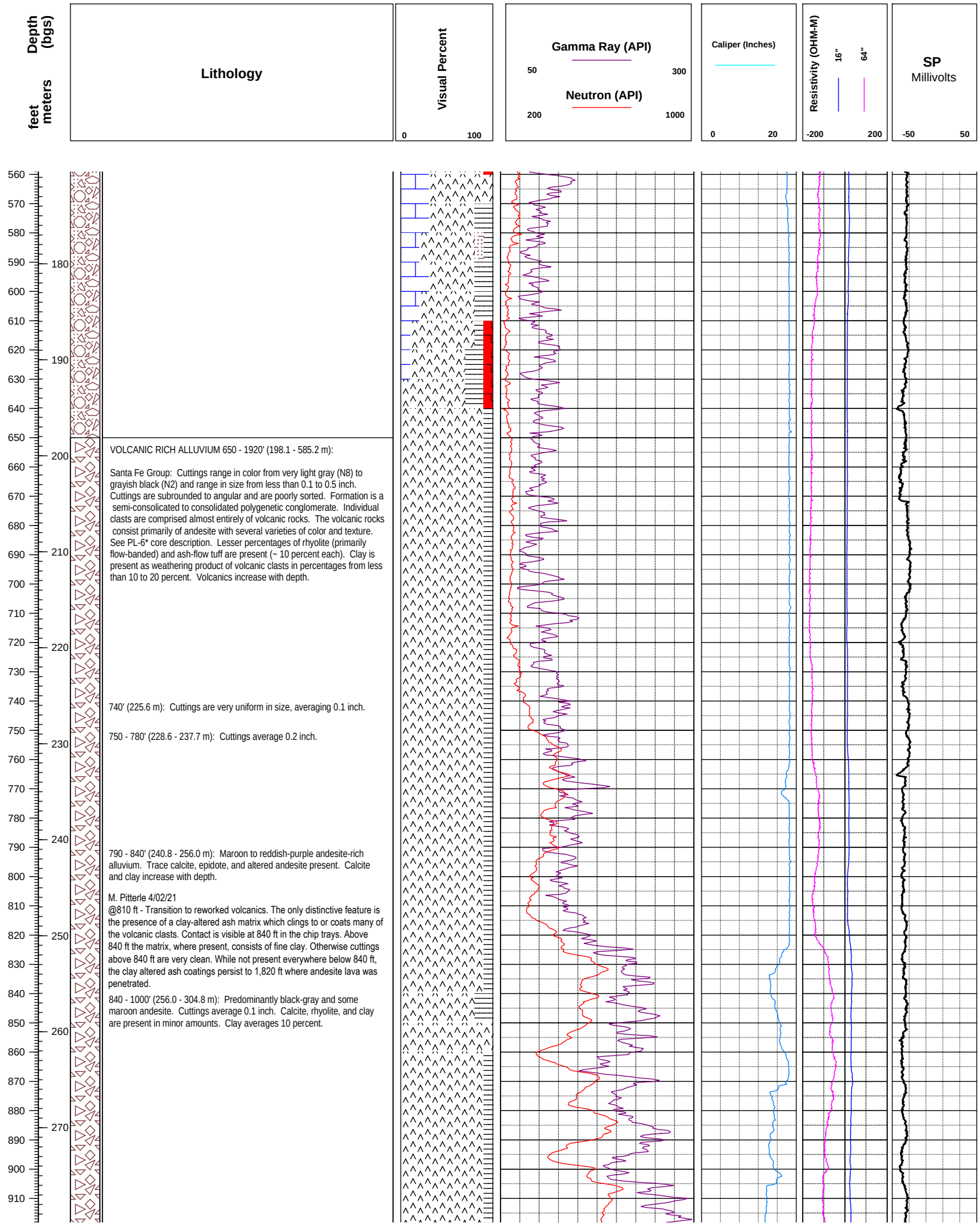
90 - 100' (27.4 - 30.5 m): Clayey sand and gravel. Cuttings are up to 0.5 inch in diameter.

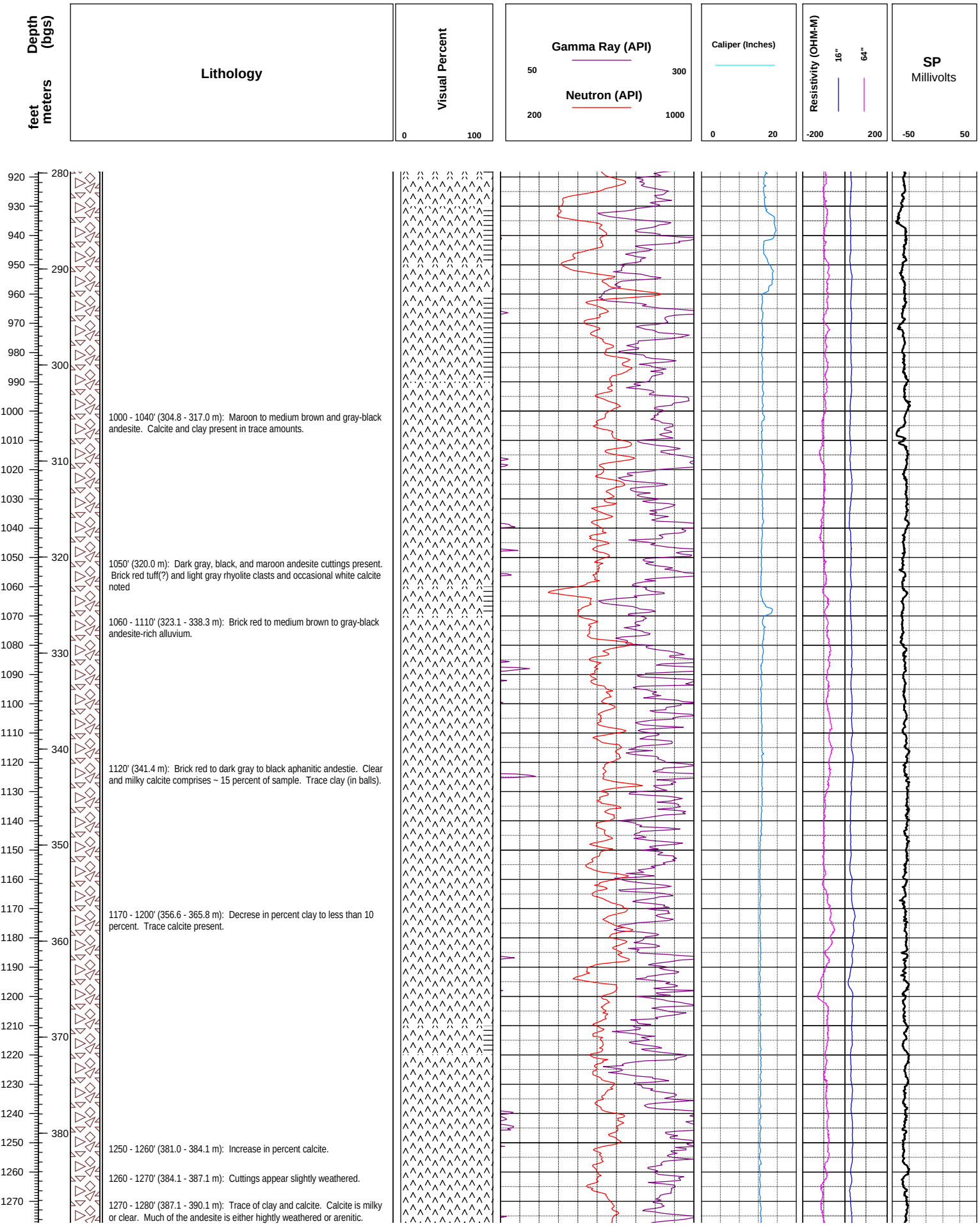
110' (33.5 m): Very clay-rich.

120' (36.6 m): Decreased clay. Cutting size decreases to 0.1 to 0.2 inch. Grains are subrounded to subangular.

170' (51.8 m): 20 percent fine-to coarse-sand size cuttings.


Depth (bgs)
feet
meters
Lithology
Visual Percent
0
100
Gamma Ray (API)
50
300
Neutron (API)
200
1000
Caliper (Inches)
0
20
Resistivity (OHM-M)
16"
64"
-200
200
SP
Millivolts
-50
50
200
210
220
230
70
240
250
260
80
270
280
290
90
300
310
320
100
330
340
350
110
360
370
380
390
120
400
410
420
130
430
440
450
140
460
470
480
150
490
500
510
520
160
530
540
550
170
220 - 230' (67.1 - 70.1 m): Gravelly clay.
240 - 290' (73.2 - 88.4 m): Clay-rich interval.
300 - 350' (91.4 - 106.7 m): No clay in samples. Cuttings range from 0.1 to 0.3 inch.
350' (106.7 m): Sandy clay.
360' (109.7 m): Trace of clay present.
390' (118.9 m): Increase in clay content.
400 - 410' (121.9 - 125 m): Major clasts are rhyolite, andesite, and limestone. Rhyolite i shite, yellow and red incolor. Limestone is light to dark gray. Andesite is gray to reddish brown.
420' (128.0 m): Increase in maroon andesite. Limestone and rhyolite are still predominant. Some calcite is present.
450' (137.2 m): No clay present. Increase in volcanic fraction.
470' (143.3 m): Very fine cuttings (approximately 0.1 inch in diameter).
500 - 530' (152.4 - 161.5 m): Cutting size is less than 0.1 inch. Predominantly iron-stained white rhyolite and limestone. Minor amounts of andesite, sitlstone, and quartz present. Andesite comprises 10 to 15 percent of sample. Drill rate increased 500-520'.
550' (167.6 m): Medium to coarse sand size cuttings. Lithology is same as above.


Depth (bgs)
feet
meters
Lithology
Visual Percent
0
100
Gamma Ray (API)
50
300
Neutron (API)
200
1000
Caliper (Inches)
0
20
Resistivity (OHM-M)
16"
64"
-200
200
SP
Millivolts
-50
50
560
570
580
590
600
610
620
630
640
650
660
670
680
690
700
710
720
730
740
750
760
770
780
790
800
810
820
830
840
850
860
870
880
890
900
910
180
190
200
210
220
230
240
250
260
270
VOLCANIC RICH ALLUVIUM 650 - 1920' (198.1 - 585.2 m):
Santa Fe Group: Cuttings range in color from very light gray (N8) to grayish black (N2) and range in size from less than 0.1 to 0.5 inch. Cuttings are subrounded to angular and are poorly sorted. Formation is a semi-consolicated to consolidated polygenetic conglomerate. Individual clasts are comprised almost entirely of volcanic rocks. The volcanic rocks consist primarily of andesite with several varieties of color and texture. See PL-6* core description. Lesser percentages of rhyolite (primarily flow-banded) and ash-flow tuff are present (~ 10 percent each). Clay is present as weathering product of volcanic clasts in percentages from less than 10 to 20 percent. Volcanics increase with depth.
740' (225.6 m): Cuttings are very uniform in size, averaging 0.1 inch.
750 - 780' (228.6 - 237.7 m): Cuttings average 0.2 inch.
790 - 840' (240.8 - 256.0 m): Maroon to reddish-purple andesite-rich alluvium. Trace calcite, epidote, and altered andesite present. Calcite and clay increase with depth.
M. Pitterle 4/02/21
@810 ft - Transition to reworked volcanics. The only distinctive feature is the presence of a clay-altered ash matrix which clings to or coats many of the volcanic clasts. Contact is visible at 840 ft in the chip trays. Above 840 ft the matrix, where present, consists of fine clay. Otherwise cuttings above 840 ft are very clean. While not present everywhere below 840 ft, the clay altered ash coatings persist to 1,820 ft where andesite lava was penetrated.
840 - 1000' (256.0 - 304.8 m): Predominantly black-gray and some maroon andesite. Cuttings average 0.1 inch. Calcite, rhyolite, and clay are present in minor amounts. Clay averages 10 percent.


Depth (bgs)
feet
meters
Lithology
Visual Percent
0
100
Gamma Ray (API)
50
300
Neutron (API)
200
1000
Caliper (Inches)
0
20
Resistivity (OHM-M)
16"
64"
-200
200
SP
Millivolts
-50
50
920
930
940
950
960
970
980
990
1000
1010
1020
1030
1040
1050
1060
1070
1080
1090
1100
1110
1120
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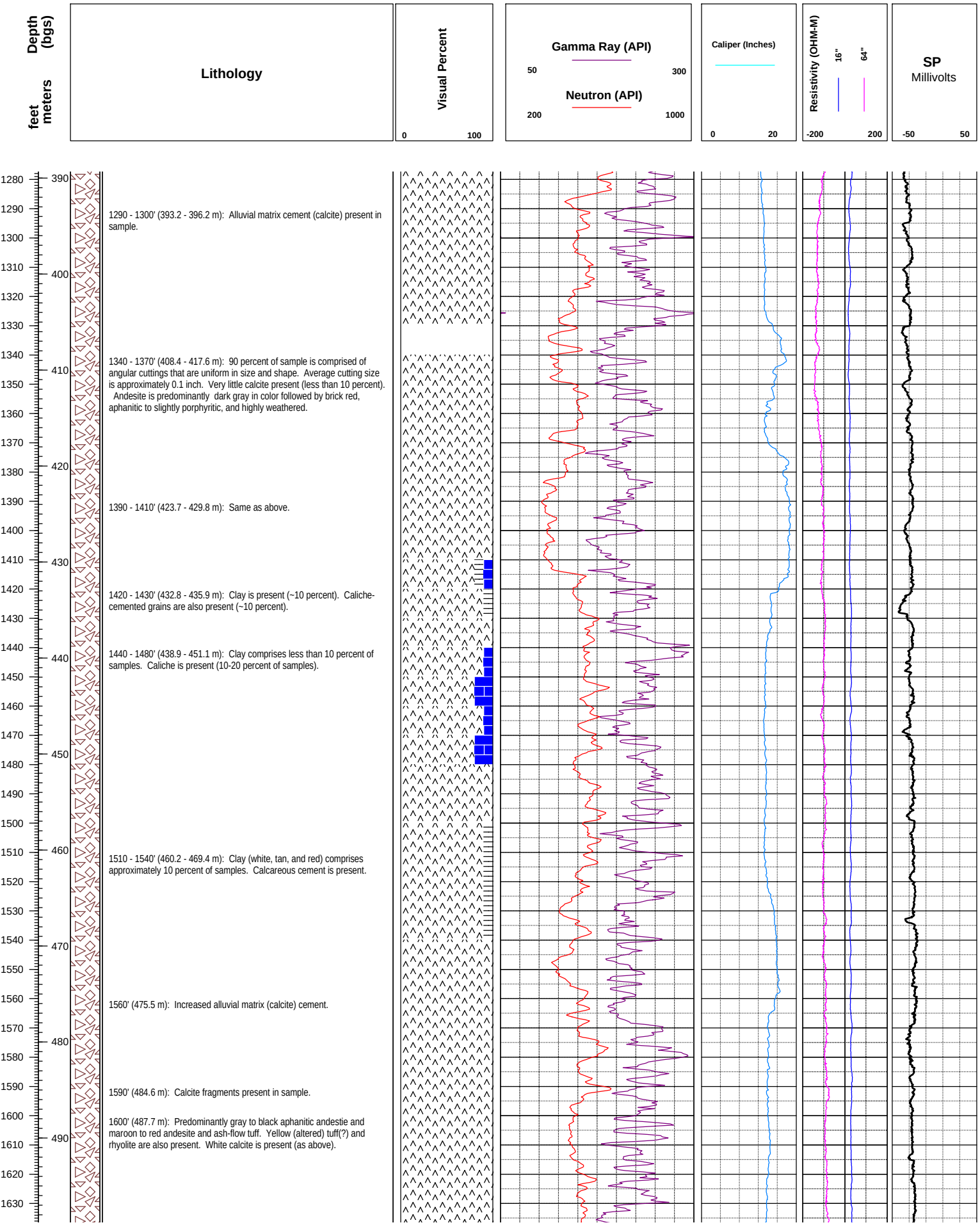
1140
1150
1160
1170
1180
1190
1200
1210
1220
1230
1240
1250
1260
1270
280
290
300
310
320
330
340
350
360
370
380
1000 - 1040' (304.8 - 317.0 m): Maroon to medium brown and gray-black andesite. Calcite and clay present in trace amounts.
1050' (320.0 m): Dark gray, black, and maroon andesite cuttings present. Brick red tuff(?) and light gray rhyolite clasts and occasional white calcite noted
1060 - 1110' (323.1 - 338.3 m): Brick red to medium brown to gray-black andesite-rich alluvium.
1120' (341.4 m): Brick red to dark gray to black aphanitic andestie. Clear and milky calcite comprises ~ 15 percent of sample. Trace clay (in balls).
1170 - 1200' (356.6 - 365.8 m): Decrese in percent clay to less than 10 percent. Trace calcite present.
1250 - 1260' (381.0 - 384.1 m): Increase in percent calcite.
1260 - 1270' (384.1 - 387.1 m): Cuttings appear slightly weathered.
1270 - 1280' (387.1 - 390.1 m): Trace of clay and calcite. Calcite is milky or clear. Much of the andesite is either hightly weathered or arenitic.


Depth (bgs)
feet
meters
Lithology
Visual Percent
0
100
Gamma Ray (API)
50
300
Neutron (API)
200
1000
Caliper (Inches)
0
20
Resistivity (OHM-M)
16"
64"
-200
200
SP
Millivolts
-50
50
1280
1290
1300
1310
1320
1330
1340
1350
1360
1370
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1500
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1600
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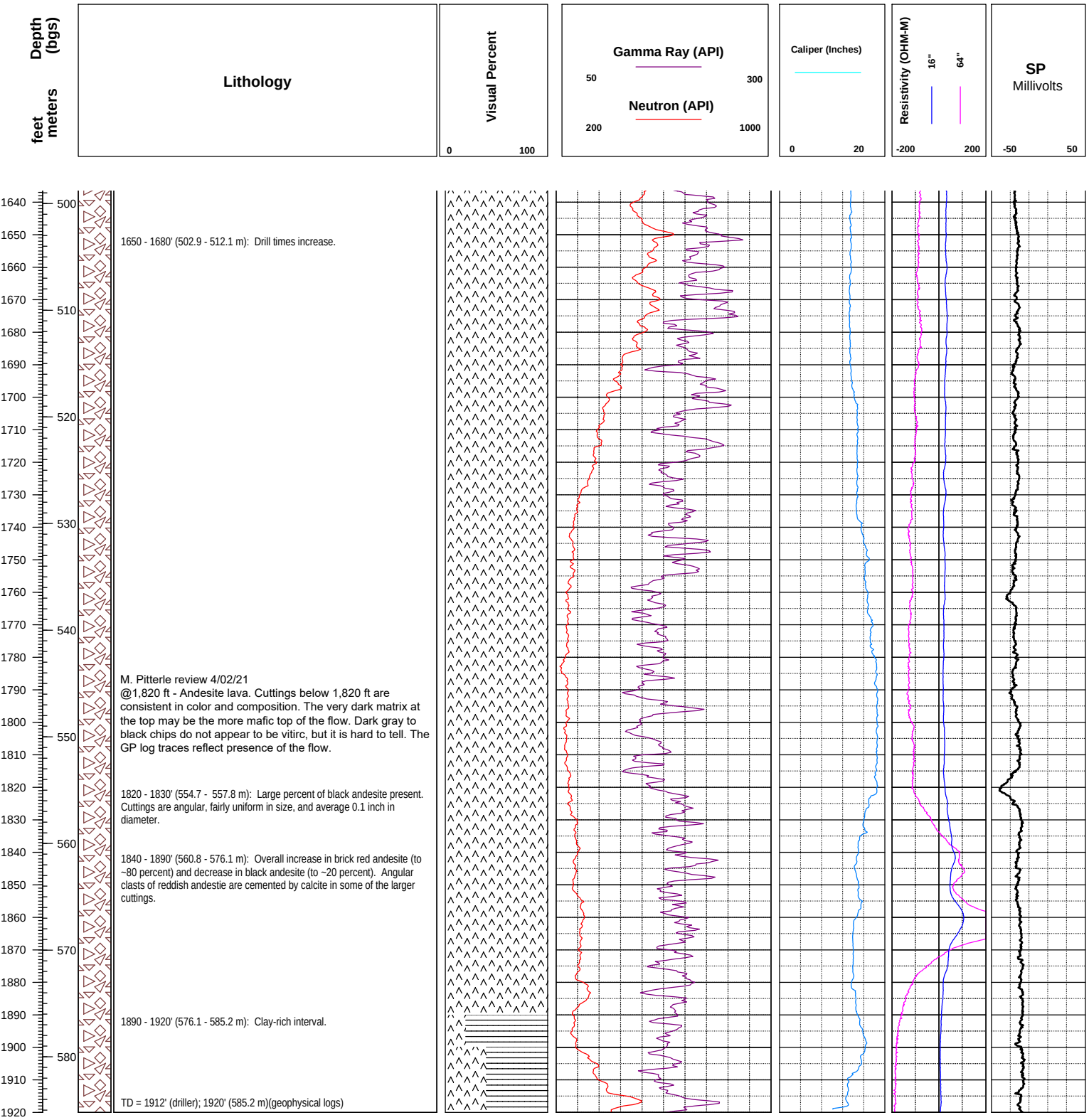
1620
1630
390
400
410
420
430
440
450
460
470
480
490
1290 - 1300' (393.2 - 396.2 m): Alluvial matrix cement (calcite) present in sample.
1340 - 1370' (408.4 - 417.6 m): 90 percent of sample is comprised of angular cuttings that are uniform in size and shape. Average cutting size is approximately 0.1 inch. Very little calcite present (less than 10 percent). Andesite is predominantly dark gray in color followed by brick red, aphanitic to slightly porphyritic, and highly weathered.
1390 - 1410' (423.7 - 429.8 m): Same as above.
1420 - 1430' (432.8 - 435.9 m): Clay is present (~10 percent). Caliche-cemented grains are also present (~10 percent).
1440 - 1480' (438.9 - 451.1 m): Clay comprises less than 10 percent of samples. Caliche is present (10-20 percent of samples).
1510 - 1540' (460.2 - 469.4 m): Clay (white, tan, and red) comprises approximately 10 percent of samples. Calcareous cement is present.
1560' (475.5 m): Increased alluvial matrix (calcite) cement.
1590' (484.6 m): Calcite fragments present in sample.
1600' (487.7 m): Predominantly gray to black aphanitic andestie and maroon to red andesite and ash-flow tuff. Yellow (altered) tuff(?) and rhyolite are also present. White calcite is present (as above).


Depth (bgs)
feet
meters
Lithology
Visual Percent
0
100
Gamma Ray (API)
50
300
Neutron (API)
200
1000
Caliper (Inches)
0
20
Resistivity (OHM-M)
16"
64"
-200
200
SP
Millivolts
-50
50
1640
1650
1660
1670
1680
1690
1700
1710
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1730
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1800
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1880
1890
1900
1910
1920
500
510
520
530
540
550
560
570
580
1650 - 1680' (502.9 - 512.1 m): Drill times increase.
M. Pitterle review 4/02/21
@1,820 ft - Andesite lava. Cuttings below 1,820 ft are consistent in color and composition. The very dark matrix at the top may be the more mafic top of the flow. Dark gray to black chips do not appear to be vitirc, but it is hard to tell. The GP log traces reflect presence of the flow.
1820 - 1830' (554.7 - 557.8 m): Large percent of black andesite present. Cuttings are angular, fairly uniform in size, and average 0.1 inch in diameter.
1840 - 1890' (560.8 - 576.1 m): Overall increase in brick red andesite (to ~80 percent) and decrease in black andesite (to ~20 percent). Angular clasts of reddish andestie are cemented by calcite in some of the larger cuttings.
1890 - 1920' (576.1 - 585.2 m): Clay-rich interval.
TD = 1912' (driller); 1920' (585.2 m)(geophysical logs)