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ENTERED

Kulis, Jerzy, NMENV

From: Kulis, Jerzy, NMENV

Sent: Thursday, August 19, 2010 11:54 AM

To: 'Everett, Mark C'; Cobrain, Dave, NMENV; Dale, Michael, NMENV

Cc: Shen, Hai; Mignardot, Edward R Jr; McCann, John P; Ball, Theodore T; Hickmott, Donald D; Lynnes, Kathryn D; Whitacre, Thomas J

Subject: RE: CdV-16-4ip proposed completion design

Mark,

This e-mail serves as NMED approval for installation of intermediate aquifer well CdV-16-4ip as proposed in your e-mail sent on August 18, 2010 at 10:28 AM, with the following modification.

> The text of the proposed design for well CdV-16-4ip incorrectly states that screen 2 will be installed at 1105 to 1145 ft depth. Screen 2 shall be installed at 1110 to 1140 ft depth, in accordance with Figure 3 in the proposed design.

This approval is based on the information available to NMED at the time of the approval. NMED understands that LANL will provide the results of preliminary water-quality sampling, any modifications to the proposed well design, and any additional information related to the installation of well CdV-16-4ip as soon as such information becomes available. LANL shall give notice of this installation to the New Mexico Office of the State Engineer as soon as possible.

Thanks,

Jerzy Kulis
Environmental Scientist
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg 1
Santa Fe, NM 87505-6303
Phone: 505-476-6039
Fax: 505-476-6030

From: Everett, Mark C [mailto:meverett@lanl.gov]
Sent: Wednesday, August 18, 2010 10:28 AM
To: Cobrain, Dave, NMENV; Kulis, Jerzy, NMENV; Dale, Michael, NMENV
Cc: Shen, Hai; Mignardot, Edward R Jr; McCann, John P; Ball, Theodore T; Hickmott, Donald D; Lynnes, Kathryn D; Whitacre, Thomas J
Subject: CdV-16-4ip proposed completion design

All,

The attached document includes the proposed design for well CdV-16-4ip and provides rational for the selected design. please respond to this e-mail with your concurrence or contact me to discuss further.

Thanks,

Mark Everett, PG
Drilling Project Technical Lead
LANL
(505) 667-5931 (office)
(505) 231-6002 (mobile)

33878

Kulis, Jerzy, NMENV

From: Everett, Mark C [meverett@lanl.gov]
Sent: Wednesday, August 18, 2010 10:28 AM
To: Cobrain, Dave, NMENV; Kulis, Jerzy, NMENV; Dale, Michael, NMENV
Cc: Shen, Hai; Mignardot, Edward R Jr; McCann, John P; Ball, Theodore T; Hickmott, Donald D; Lynnes, Kathryn D; Whitacre, Thomas J
Subject: CdV-16-4ip proposed completion design
Attachments: CdV-16-4ip Well Design 081710 final.doc

All,

The attached document includes the proposed design for well CdV-16-4ip and provides rational for the selected design. please respond to this e-mail with your concurrence or contact me to discuss further.

Thanks,

Mark Everett, PG
Drilling Project Technical Lead
LANL
(505) 667-5931 (office)
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CDV-16-4ip Well Objectives

Perched-intermediate pumping well CdV-16-4ip is being installed as part of a hydrologic testing program to evaluate properties of the deep-perched groundwater zone at Consolidated Unit 16-021(c)-99 (260 Outfall), located in Technical Area 16 in the southwest corner of Los Alamos National Laboratory. The tests will provide field-scale measurements of aquifer parameters for the deep-vadose-zone system that is expected to include zones with variable water-content under capillary and full-saturation conditions. The well will be used to assess the potential for pumping and treatment of contaminants in the deep-vadose-zone groundwater associated with the 260 Outfall. Details of the hydrologic testing program are presented in "Hydrologic Testing Work Plan for Consolidated Unit 16-021(c)-99".

CdV-16-4ip is designed to be the pumping well in the hydrologic testing program. It is located east of the main cluster of observation wells that include multiple well screens at R-25 and single well screens at R-25b, R-25c (screen currently dry), and CdV-16-1(i) (Figure 1). This location was selected to optimize the spatial distribution of potential pumping drawdowns at the observation wells. The distances of the observation wells from the pumping well range between 372 and 483 ft (Figure 2).

The work plan for well CDV-16-4ip tentatively identified a two-screen well design anticipating that the upper screen would be placed near the top of saturation in the Otowi Member of the Bandelier Tuff and the deeper screen in the underlying Puye Formation. Because Schlumberger geophysical logs indicate the Otowi Member is not saturated, we propose that CdV-16-4ip be completed with two well screens in the Puye Formation.

The well design described below is focused on optimizing the aquifer tests that support the CME for the 260 Outfall. Recommendations for final disposition for the purpose of long-term water-quality monitoring will be provided to NMED in separate correspondence following completion of the aquifer tests and interpretation of the data.

CDV-16-4ip Recommended Well Design

It is recommended that CDV-16-4ip be completed as a two-screen well with an upper 60-ft stainless-steel, 20-slot, wire-wrapped well screen near the top of saturation in the Puye Formation (screen 1) and a 30-ft stainless-steel, 20-slot, wire-wrapped well screen near the bottom of the borehole in the Puye Formation (screen 2). The primary filter pack will consist of 10/20 sand extending 5 ft above and 5 ft below both well screen openings. A 3-ft secondary filter pack consisting of 20/40 sand will be placed above the primary filter pack of both well screens. A packer will be installed to prevent cross flow between the two well screens prior to the hydrologic testing program. The proposed well design is shown in Figure 3.

This well design is based on the objectives stated above and on the information summarized below.

CDV-16-4ip Well Design Considerations

At total depth (TD), the CdV-16-4ip borehole was cased from 0–625 ft and open hole from 625–1153.7 ft. Preliminary lithological logs indicate that the geologic contacts are, in descending stratigraphic order: ash-flow tuffs of the Tshirege and Otowi Members of the Bandelier Tuff with intercalated sedimentary deposits of the Cerro Toledo interval (0–800 ft) and boulders, cobbles, gravels, sands, and silts of the Puye Formation (800–1153.7 ft TD). Characterization activities included the collection of cuttings at 5 ft intervals, a borehole video log below 625 ft, Schlumberger

and LANL geophysical logs, and water-level recovery tests at several intervals (see below) during drilling.

Borehole Video Observations:

A borehole video log was run after the borehole was drilled to the TD of 1153.7 ft. At a depth of 794 ft, in the Guaje Pumice Bed, a small amount of water was observed entering the borehole in the stratified pumice deposits but flow on the borehole wall did not appear to increase with depth through the pumice deposits. A 4.5-ft-thick massive silt bed (possible soil) occurs at the top of the Puye Formation between depths of 800–804.5 ft. Because of its fine-grained nature, this zone may act as a confining bed for the hydrostratigraphic units below and above this zone. There is significantly greater water flow entering the borehole within the top of the Puye Formation below the silt bed, which might be an indication for local confinement of the saturated zone. At a depth of 811 ft, there is strong water flow issuing from cobble and gravel beds at several points in the borehole. Water flow increases with depth, and below 825 ft depth cascading water completely obscures the view of the video log until standing water is reached. The water level at the time the video log was collected was 922 ft depth. From 922 ft to total depth, water in the borehole is remarkably clear and the video log provides excellent documentation of the coarse clastic deposits making up the Puye Formation.

Geophysical Logs:

Schlumberger geophysical logs were collected through a cased borehole from 0–625 ft and in an open borehole from 625–1151 ft. The logs included combinable magnetic resonance (CMR), array induction, APS porosity, spectral gamma, caliper, and formation microimager (FMI). Geophysical logging with LANL gamma and induction tools matches and supports the Schlumberger results.

Combined with information from the video log, the geophysical data indicate that the Puye Formation is a coarse fanglomerate made up of boulder and cobble deposits that are stacked in beds 1 to 5 ft thick. Log interpretations provided by Schlumberger indicate that Puye deposits have CMR and APS porosities of 20–30% and that the unit is fully saturated throughout the drilled interval. CMR logs indicate the highest effective porosities occur in the depth interval from 915 ft (the water level at the time of logging) to about 1000 ft (the zones of highest effective porosity are expected also to be highly permeable). High effective porosities probably also occur above 915 ft, especially where the borehole video indicates strong flow near the top of the Puye Formation. However, porosity logs, which are based on water content, are biased low for this interval by drainage of water to the borehole.

To further evaluate saturation above standing water in the borehole, Schlumberger computed water-filled porosity using Archie's equation with the deepest reading (90 in) resistivity log calibrated to the APS log. The water content based on resistivity porosity stays between 20-40% (except higher in fine-grained beds, as would be expected) through the entire section below 812 ft, which is within the total porosity range typical of the Puye and thus suggests total saturation. Also, both the resistivity porosity and deepest reading APS porosity indicate that water content in the Guaje Pumice Bed is 25% or less and water contents decrease up section to less than 10% above 758 ft. The total porosity of the Guaje Pumice Bed is typically 50-60% and porosity in the overlying tuffs is about 40%. Therefore it is likely these units are not saturated, and they probably retained a significant amount of introduced water that is slowly released when the borehole was drilled through them.

The Puye Formation contains thin sand and silt beds that are intercalated within the coarser deposits. Silt beds may act as confining beds for compartmentalizing the saturated zone. The most prominent zones containing such silt beds were identified by induction and FMI logs, and they occur 990–994 ft, 1069–1083 ft, 1100–1111 ft, and 1125–1131 ft depth intervals. The silt beds within these intervals are

commonly intercalated with coarser fanglomerate deposits, and individual silt beds are typically 1 to 3 ft thick.

Water-level recovery tests:

Water-level recovery tests were performed during open-hole drilling at depths of 734, 794, 834, 934, 1034, and1153.7 ft (TD). In each case, drilling was paused, water was airlifted from the bottom of the borehole for 15-30 minutes, and recharge of the borehole was monitored. These tests were conducted to determine if water was present, to measure stable water levels, and to measure recovery rates. Plots of stable water levels in CdV-16-4ip as a function of borehole depth are shown in Figure 4. For reference, Figure 4 also shows water levels as function of screen depths for nearby wells R-25, R-25b, and CdV-16-2i(r) and a borehole water level measurement for R-25c at the Guaje/Puye contact.

At borehole depths of 734 and 794 ft in the Otowi Member at CdV-16-4ip, municipal water introduced during drilling was airlifted from the borehole and subsequent water-level measurements indicated there was no recharge of the borehole, suggesting the strata at these depths were unsaturated. Introduction of municipal water to aid drilling was largely stopped in the Puye Formation because groundwater production from the perched zone was sufficient to aid circulation of cuttings. At 834 and 934 ft depth in the Puye Formation, water levels stabilized within an hour at depths of 772 and 776 ft, respectively. These water levels are within the lower Otowi Member and are higher than expected based on borehole video and geophysical logs and on the dry recovery test performed at 794 ft. A preliminary interpretation of these higher-than-expected water levels is that perched water in the Puye Formation is pressurized (locally confined) beneath the silt bed from 800 to 804.5 ft, and that the observed water levels occurred only when the confining bed was penetrated by the open borehole. When the borehole was advanced to 1034 ft depth, the stable water level was 802 ft bgs, This water level occurs within the silt bed at the top of the Puye Formation, and again suggests locally confined conditions. During the final recovery test at 1153.7 ft (TD), water levels initially recovered from 892 to 867 ft bgs before steadily declining. The current (as of 8/17/2010) composite water level in the open borehole is 932 ft bgs and it continues to decline.

Based on the water-level data, there appear to be two distinct hydrologic zones in the vadose zone penetrated at the CdV-16-4ip location. The upper zone is a well-connected confined system with a upper confining bed at the top of the Puye Formation and a lower confining bed between depths of 934 and 1034 ft. The location of the lower confining bed is inferred in part on the water level decline that occurred when the 934 and 1034 ft interval was drilled (Figure 4). Water levels in nearby wells R-25 (screens 1 and 2) and R-25b were impacted during drilling at CDV-16-4ip, demonstrating hydraulic connection between CDV-16-4ip and R-25/R-25b in the upper zone. Water levels in screen 2 at R-25 measurably declined during drilling of the 934 and 1034 ft interval at CdV-16-4ip, suggesting a pressure response to penetration of a confining bed. Induction and FMI logs indicate that silt beds in the 990 to 994 ft interval at CdV-16-4ip likely form the lower confining bed for the upper hydrologic zone. The lower hydrologic zone is characterized by significantly lower water levels (~100 ft lower) and it appears to be poorly connected to upper vadose-zone groundwater.

Proposed Well Screen Intervals:

Screen 1, at 820 ft to 880 ft depth, targets the upper hydrologic zone in the Puye Formation. CdV-16-4ip is primarily designed to be a pumping well for the hydrologic testing program to assess the potential for pumping and treatment of contaminated deep-perched groundwater associated with the 260 Outfall. Groundwater monitoring data at well R-25 indicate that high-explosive contaminant concentrations are highest near the top of the perched groundwater system and that concentrations

decrease with depth. Thus the planned testing would provide hydrologic information to assess remediation alternatives for the most contaminated part of the perched groundwater system. A 60-ft well screen is recommended for screen 1 to maximize the stress placed on the hydrologic system during pumping, increasing the likelihood that drawdown can be measured in the observation wells. The elevation of screen 1 overlaps the elevation of R-25 screen 2, and it could eventually replace the groundwater monitoring function of the upper screens in that well.

Screen 2, at 1105 to 1145 ft depth, targets the same depth as screen 4 at well R-25. Because of uncertainties associated with the water table map for the area, it is uncertain whether regional groundwater occurs in screen 4 or screen 5 at R-25. During testing, water levels in screens 4 and 5 at well R-25 will be monitored to determine if the two zones show a similar response to pumping of the lower well screen at CdV-16-4ip. Additionally, water levels in the upper well screen at CdV-16-4ip will be monitored during pumping of the lower well screen to assess whether a vertical hydraulic connection exists between the upper and lower part of the thick saturated interval at this location.

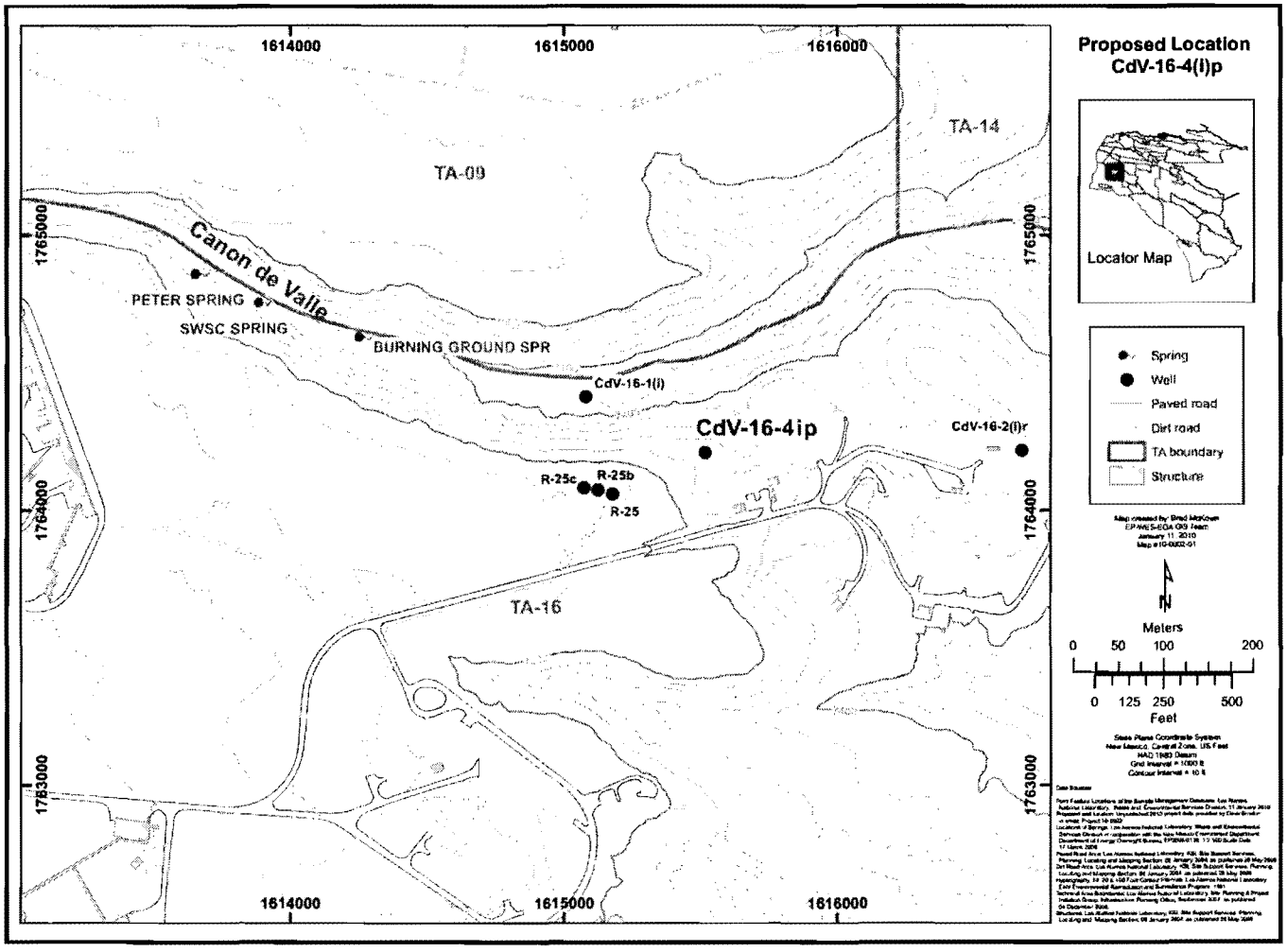

Figure 1. Location map for CDV-16-4ip showing locations of nearby monitoring wells.

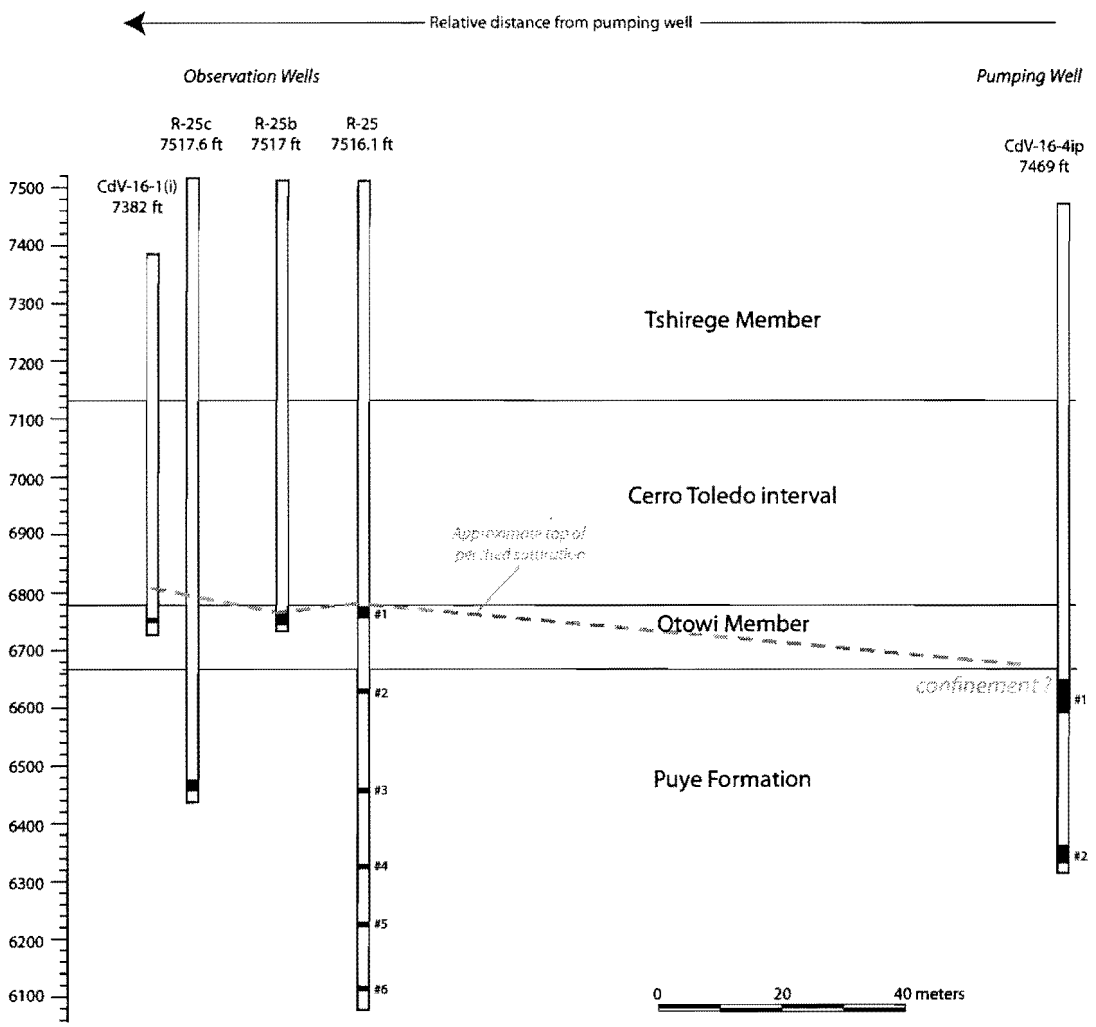

Figure 2. Pump test configuration showing locations of the proposed CdV-16-4ip well screens relative to the observation well screens.

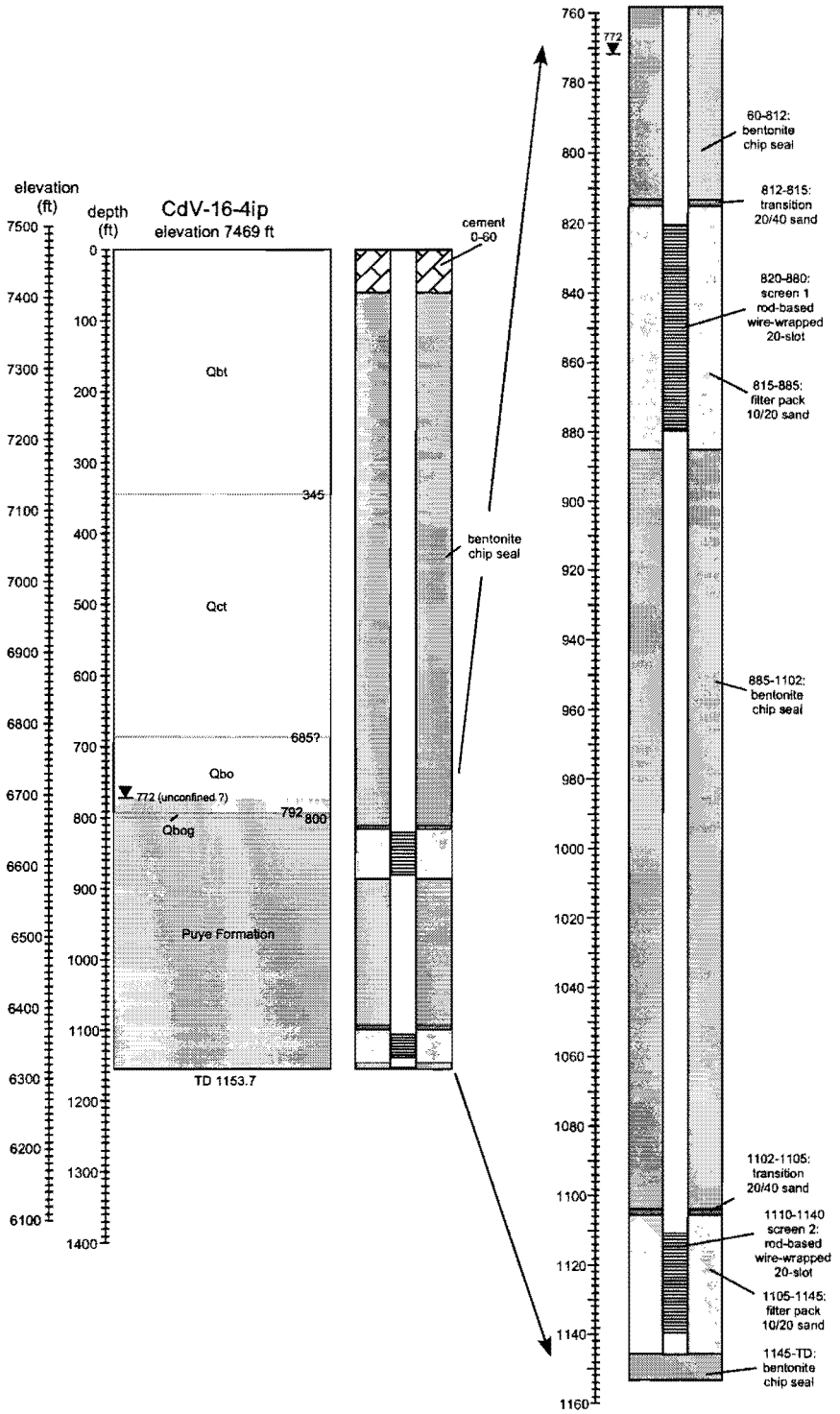

Figure 3. Proposed well design for CDV-16-4ip.

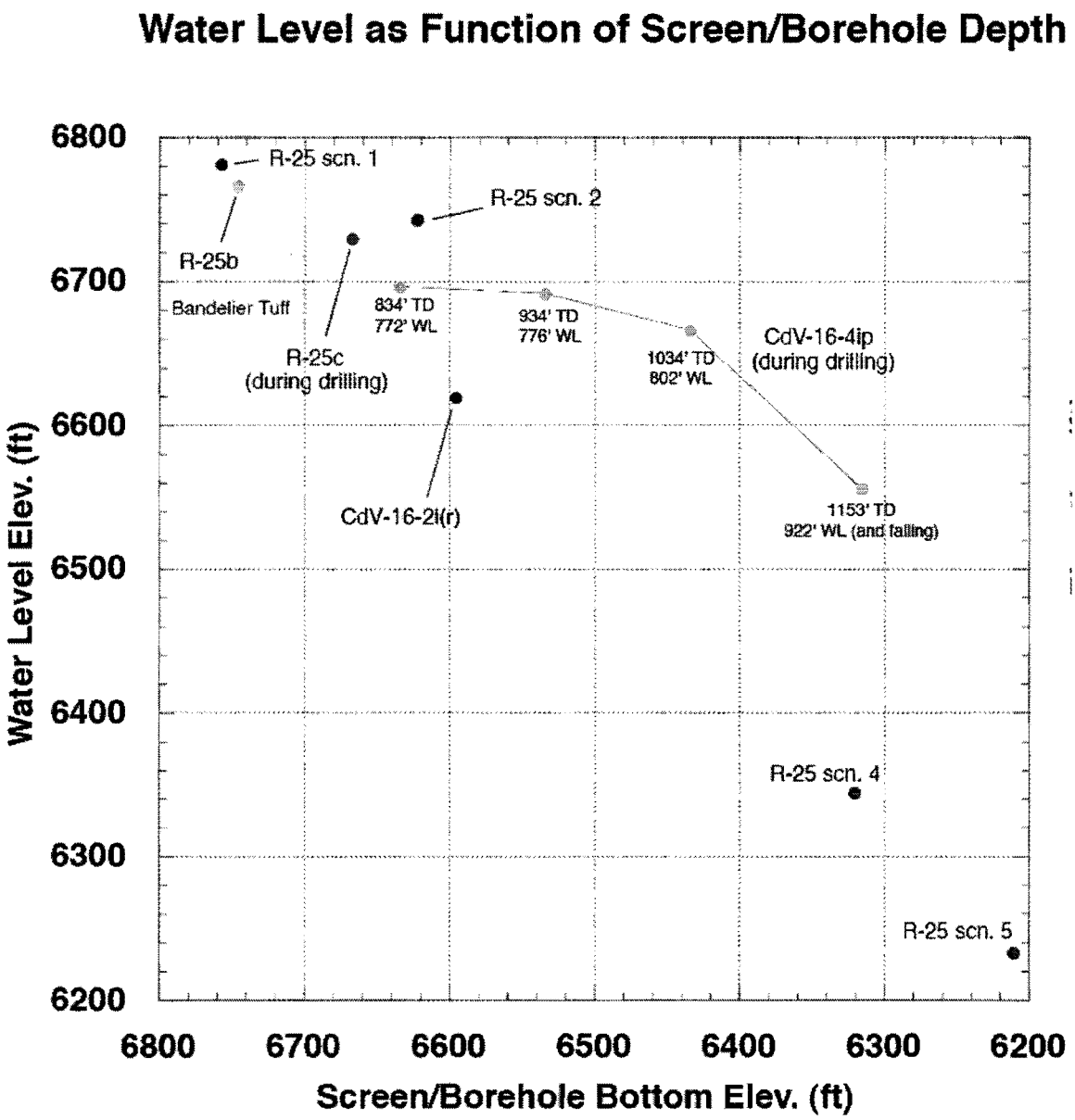

Figure 4. Water level elevations measured in the CDV-16-4ip open borehole during drilling and following water-level recovery tests. Water levels in nearby wells and boreholes are shown for reference.