2. UPDATED SITE DESCRIPTION

The *ICDF Complex Groundwater Monitoring Plan* (DOE-ID 2002) provides information known about the areal geology, hydrology, groundwater chemistry, and operations at the former INTEC percolation ponds through May 2002. New information obtained during drilling, well installation, and groundwater sampling activities conducted since May 2002 is presented here.

2.1 Subsurface Geology

Thorough descriptions of broad regional geology surrounding the ICDF and INTEC areas are published in other DOE-ID documents (1997a, 1997b, and 1998). The local area within the INEEL containing the ICDF and INTEC is described as a Holocene floodplain characterized by numerous abandoned channels and possibly braided channels of the ancestral Big Lost River. The ICDF is sited within Late Pleistocene alluvial gravels on a low terrace above this floodplain. This terrace deposit shows no evidence of significant post-Holocene channels or braids of the river (Dechert, McDaniel, and Falen 1994). The current Big Lost River channel is incised approximately 4 to 7 ft into the Holocene floodplain deposits. Based on the degree of soil development and radiocarbon ages of sediments, the deposits making up this surface were laid down during periods of high run-off associated with retreat of the most recent (Pinedale) glaciers, probably in the range of 15,000 to 20,000 years ago (Scott 1982; Ostenaa, Levish, and Klinger 1999). This broad area of alluvial gravels is approximately 3.7 mi wide on this part of the INEEL and is bounded on the southeast and northwest by outcrops of basalt lava flows. The basalts at the ground surface just east of the INTEC facility, and perhaps lying beneath the surficial sediment layer at the ICDF, are about 230,000 years old and flowed from vents located about 14 km (8.6 mi) southeast of the site (Kuntz et al. 1994). Basalt flows beneath those at the surface are older—as much as 4.3 million years old at the base of the basalt sequence (Hackett and Smith 1992). These basalts have accumulated in the Eastern Snake River Plain basin that has continuously subsided at a rate of about 0.5 mm/year since the passage of the Yellowstone hot spot about 4.3 million years ago (Pierce and Morgan 1992).

Subsurface geology beneath the ICDF was described using lithologic, geophysical, and video log information from numerous boreholes drilled around the ICDF and the adjacent INTEC facility. Geotechnical and hydrologic data were incorporated where available. Figure 1-2 shows the locations of cross-sections constructed through wells in the ICDF vicinity. Identification of depth intervals and correlations between wells in these diagrams are primarily based on geophysical logging data, supplemented by lithologic logs. Because the wells installed during the summer of 2002 were drilled using a reverse circulation air-rotary method, depths of lithologic changes were estimated because of the inherent difficulty in accurately identifying geologic contacts from drill cuttings. Geophysical logging can better indicate discreet lithologic intervals through downhole natural gamma, gamma-gamma, and neutron instrument responses. Other useful information comes from cores. The only corehole in the vicinity of the ICDF is USGS-123, drilled in 1990. The USGS conducted extensive analyses (core descriptions, paleomagnetic inclination, geochemical analyses, and crosshole correlation to USGS-121) of this core. However, because no other holes near the ICDF received these detailed analyses, the USGS data could not be used to make crosshole correlations.

As shown in Figures 2-1, 2-2, 2-3, 2-4, 2-5, and 2-6, the surficial alluvium at the ICDF is approximately 24 to 50 ft thick. A low permeability discontinuous layer of fine sand, silt, and clay known as “old alluvium” in the literature (designation SM to CL, Unified Soil Classification System) is occasionally found at the upper basalt/alluvium interface, and it ranges in thickness from 0 to 13 ft. Its presence and thickness possibly correlate to topographic depressions or collapsed structures on the basalt surface, and it tends to increase in occurrence and thickness to the south and west of the ICDF Complex (DOE-ID 2000).

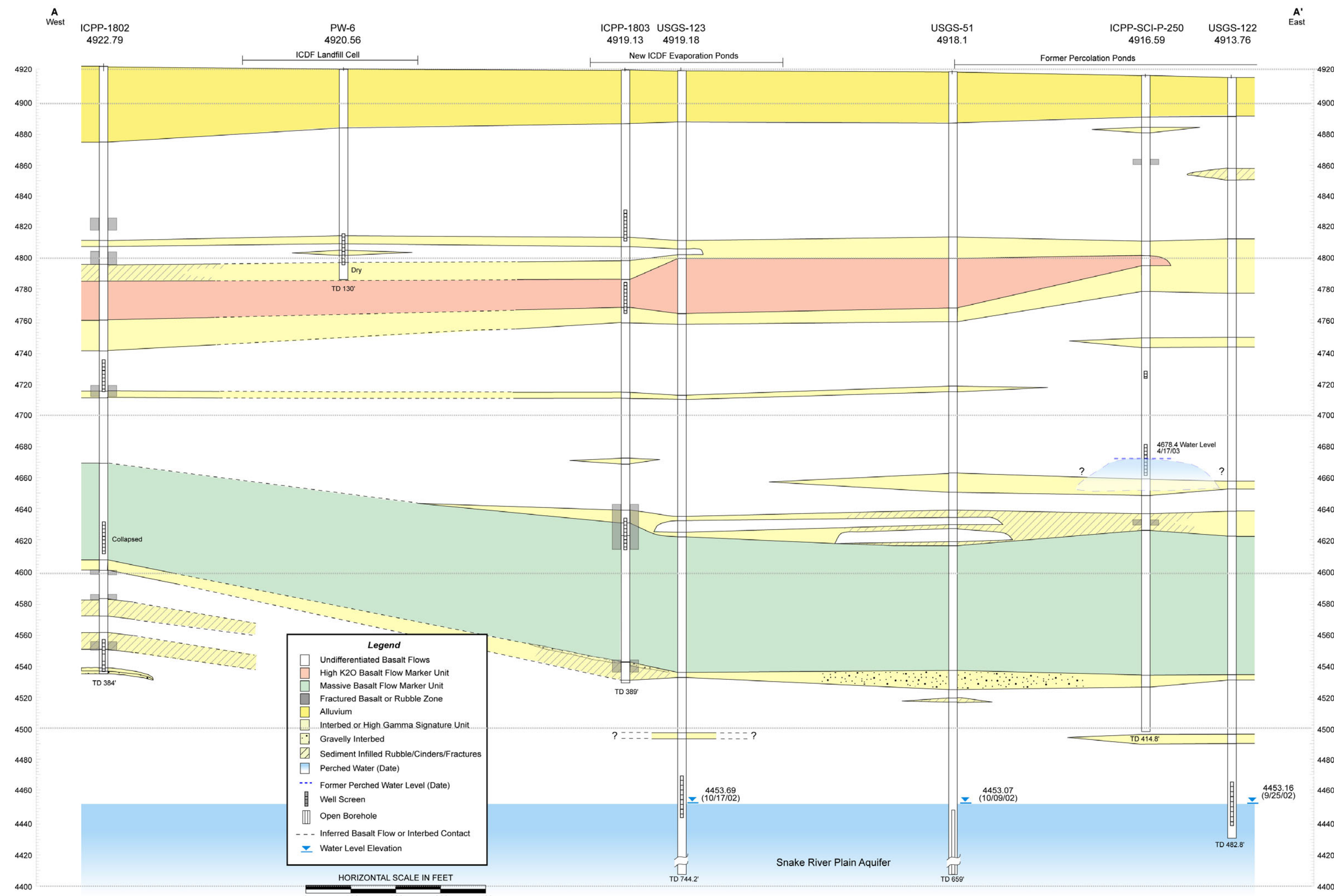

Figure 2-1. East-west cross section A-A′ through wells north of the ICDF.

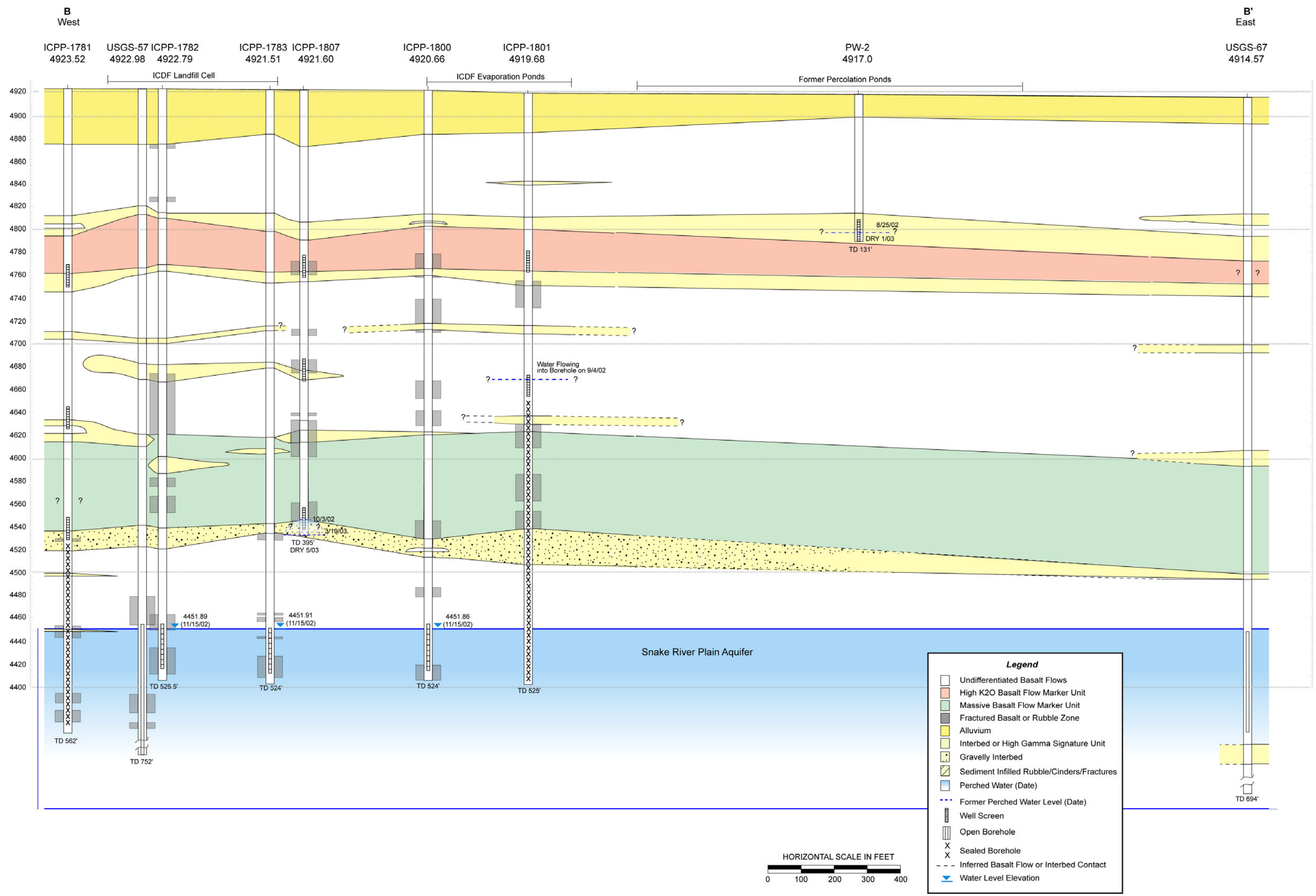

Figure 2-2. East-west cross sections B-B′ through wells south of the ICDF.

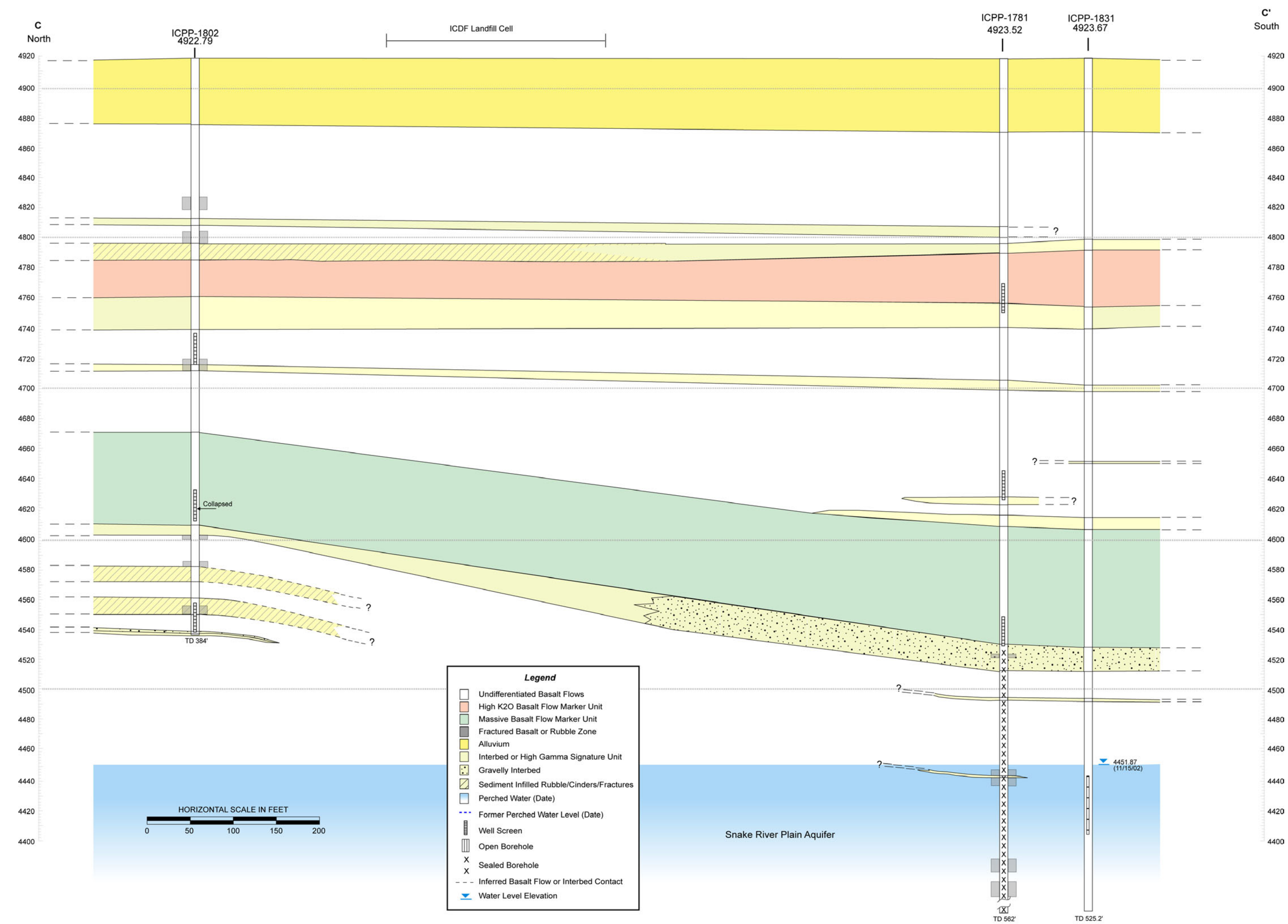

Figure 2-3. North-south cross section C-C′ through wells west of the ICDF.

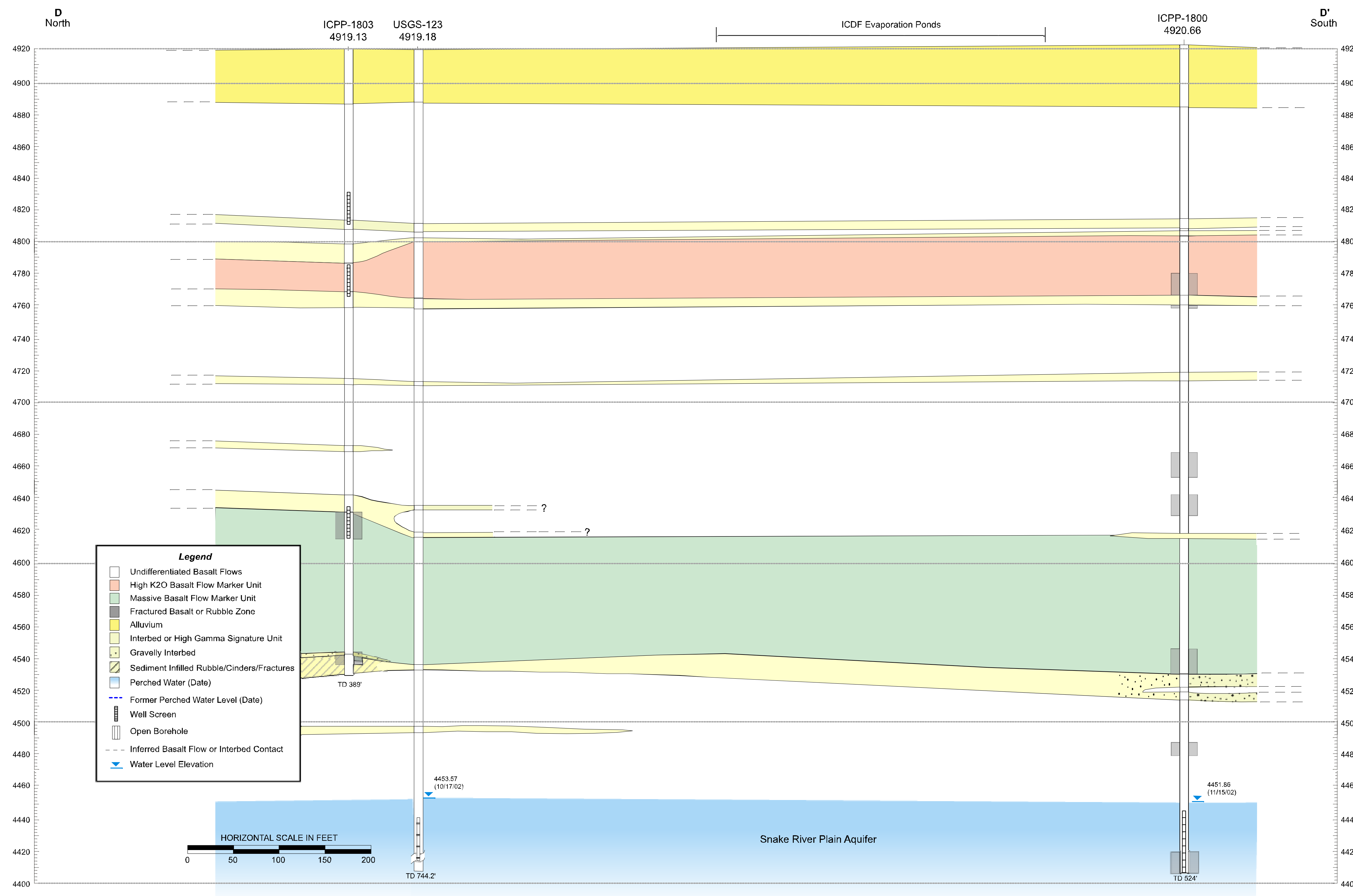

Figure 2-4. North-south cross section D-D′ through the center of the ICDF Complex.

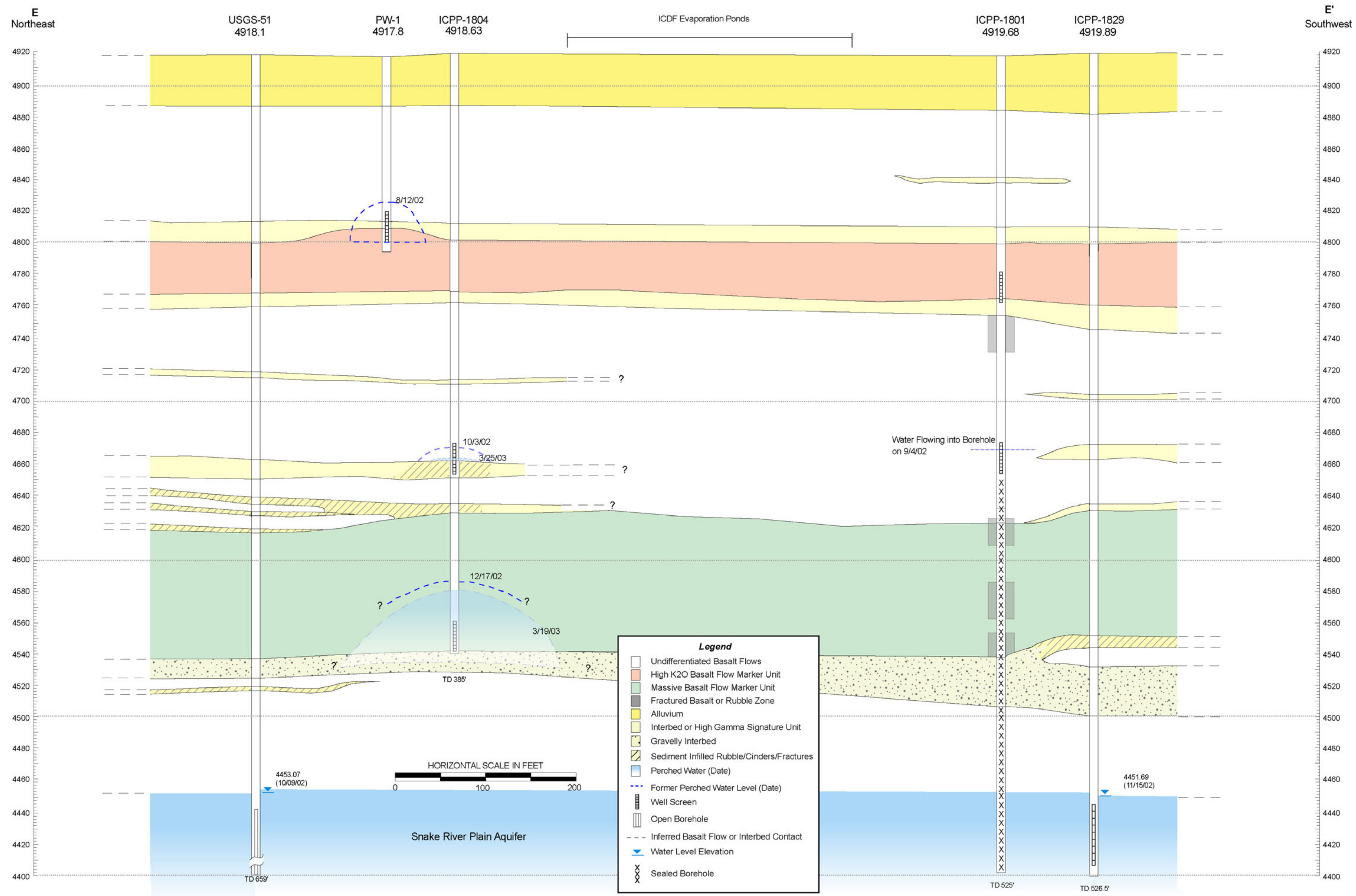

Figure 2-5. North-south cross section E-E′ through wells east of the ICDF.

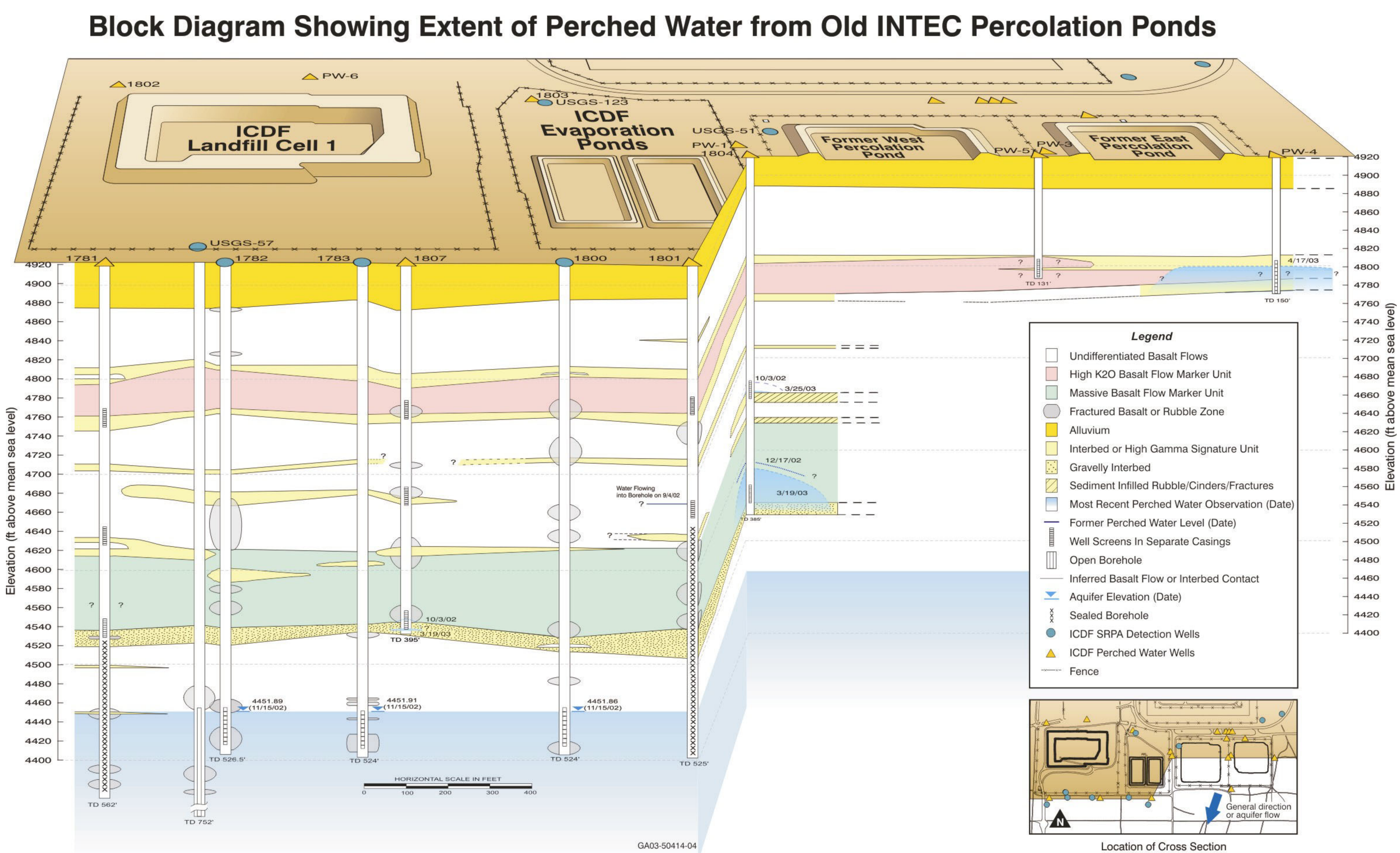

Figure 2-6. Block diagram through the ICDF and the former percolation ponds.

Also shown in Figures 2-1 through 2-6, the unsaturated zone beneath the surficial alluvium is a series of interbedded basalt flows characteristic of the Eastern Snake River Plain. Using the available borehole data, two distinct basalt flow groups were identified as marker beds and correlated between most of the ICDF boreholes with subtle variations in depth. A basalt interval between 120 and 160 ft bls displays a higher natural gamma signature (related to a higher potassium content in the basalt) relative to adjacent basalt intervals. This distinct basalt flow unit, probably equivalent to the CD unit defined by Anderson (1991), is present in all of the boreholes in Figure 2-2 (cross section B-B′). In Figure 2-1 (cross section A-A′), it is present in most of the boreholes but thins and disappears in the easternmost holes, ICPP-SCI-P-250 (or PP-CH-2, shown as ICPP-250 on Figure 1-2) and USGS-122. Another distinct flow unit, located approximately 310 to 380 ft bls, is characterized by a low natural gamma signature relative to adjacent basalt intervals, low gamma-gamma signature signifying higher density, and lithologic descriptions of massive, unfractured basalt. This unit, probably equivalent to Anderson's DE5-6 basalt unit, is continuous across the area represented in the cross sections and averages 50 to 100 ft thick or more.

Several sedimentary interbeds beneath the ICDF are generally continuous, as represented in the cross sections. Laterally continuous sedimentary units are located at depths between 100 to 170 ft (110-ft interbed), which equates to the shallow perched zone at INTEC, 220 to 300 ft (240-ft interbed), and 377 to 420 ft bls (380-ft interbed), the ranges attributed to variations in depths between boreholes. Other interbeds occur within the unsaturated zone beneath the ICDF, but they are not laterally continuous across the facility.

2.2 Hydrogeology

2.2.1 Surface Water Sources

The Big Lost River flow is ephemeral on the INEEL and dependent upon basin run-off in excess of upstream irrigation and hydropower demands. The last recorded flow in the channel on the INEEL was May 2000. The northwest corner of the ICDF landfill is over 3,200 ft from the river channel.

2.2.2 Perched Water Formation

Perched water can form naturally at the base of the surficial alluvium in response to rapid snowmelt or heavy rainfall where it can form a discontinuous lense (Hubbell 1994 and 1992). In addition, perched water can form near the Big Lost River during channel flow. Precipitation is insufficient to form continuous, long-term perched water—in part due to the low precipitation rates (9 to 13 in. per year) and the higher evapotranspiration rates. Perched water also can form in response to infiltration of surface water from percolation ponds. When infiltration from a source of water stops and there is no longer sufficient infiltration to sustain perched water, water levels drop until the perched water drains and ceases to exist.

Detailed analyses of perched water that formed during use of the former INTEC percolation ponds can be found in the *ICDF Complex Groundwater Monitoring Plan* (DOE-ID 2002). Although intermittent perched water had formed around the percolation ponds at the alluvium/basalt interface, geotechnical borings to the top of bedrock beneath the ICDF Complex did not identify any saturation at that depth. However, there was an increase in moisture content related to the fine-grained sediments directly overlying the basalt. Moisture content varied inversely with the amount of sand present and ranged in value from 8 to 30%. The more sand, the lower the moisture content (DOE-ID 2000). Near the former percolation ponds, water perched on top of the primary series of interbeds above the upper high potassium basalt marker unit and at the base of the lower massive basalt marker unit where it overlies a gravel interbed. Perched water also occurred on top of an interbed or in fractured basalt between these two zones at approximately 250 to 260 ft bls.

Long-term water-level data from the perched water (PW) wells around the old percolation ponds show that shallow perched water beneath the ponds has dissipated in the upper unsaturated zone after pond discharge ceased and does not correlate well with Big Lost River flow. Figure 2-7 is a plot of water levels (left axis) over time in the PW wells adjacent to the former percolation ponds. On the bottom portion of Figure 2-7, flow in the Big Lost River measured daily at the USGS Lincoln Boulevard gauging station near INTEC is plotted. The right vertical axis is river flow in cubic ft per second (cfs). There was no flow in the Big Lost River near INTEC from mid-1987 to mid-1993. All of the PW-series perched water wells contained water during this period with the exception of PW-6, which went dry for about 1 year in the middle of this period. During the period of no or minimal flow in the Big Lost River channel, PW-6 contained perched water. When Big Lost River flow resumed in 1985, both PW-1 and PW-6 went dry. Standing water in the wells nearest the ICDF, PW-1 and PW-6, drained during times when discharges to the west percolation pond ceased. Figure 2-7 illustrates that the PW wells around the old percolation ponds and the ICDF Complex are not influenced by flow in the Big Lost River. Rather, the water levels in the wells were influenced by discharge to the old percolation ponds.

2.2.3 Occurrence and Dissipation of Perched Water beneath the ICDF

Drain out of perched water in the upper unsaturated zone near the percolation ponds has been rapid since the percolation ponds were taken out of service. Neutron logs of ICDF boreholes drilled in 2002, most logged within 1 month after the cessation of service wastewater discharges to the old percolation ponds, show higher moisture contents associated with each of the general perching intervals described above. These data were used to determine the screen depths for perched water wells installed in 2002. The water levels were measured during well development and sampling events in October through early December 2002. When baseline sampling began on October 21, 2002, all of the ICDF perched water wells were dry except for three. On December 10, 2002, pressure transducers were installed in the wells.

Shortly after pond discharges ended, the interval from land surface down to approximately 250 ft at the ICDF was essentially void of perched water. Well PW-6 had already gone dry in July 2000 after routine discharges to the west percolation pond were discontinued. Well PW-1, which had been periodically dry over the years, had less than 1 ft of water in it when the percolation pond discharge stopped. Within 10 days, this well went dry. Perched water in PW-2, located on the southern edge between the two percolation ponds, drained out in January 2003. By September 2002, perched water in PW-3, located on the northern edge between the two percolation ponds, had drained out. Well PW-5, located in the middle between the two percolation ponds, went dry within a week after discharge to the ponds stopped. The only PW well that still had water in it after January 2003 was PW-4 (Figure 2-8), which is east of the east percolation pond. Water levels began dropping in PW-4 as soon as discharge to the percolation pond stopped. The water levels have generally decreased except for fluctuations between January and March 2003.

At intermediate depths, perched water was observed during drilling of ICPP-1801 at 257 ft and 270 to 272 ft bls and during video logging. When the well was completed on October 2, 2002—37 days after discharges to the percolation pond stopped—both completion zones including the interval surrounding 260 ft were dry. The only intermediate-depth well that had water in it when sampling began in October 2002 was ICPP-1804M. (Note: The ICDF wells also will be referred to by just their suffix, i.e., 1804M.) As can be seen on Figure 2-9, ICPP-1804M had approximately 18 ft of water in it when it was completed in October but had dropped to 0.8 ft of water by early January 2003, a decline of 17 ft in 3 months. However, the water levels fluctuated by about 5 ft from January to March 2003. Manual water level measurements show a decreasing trend and since May 2003, the well has either been dry or had

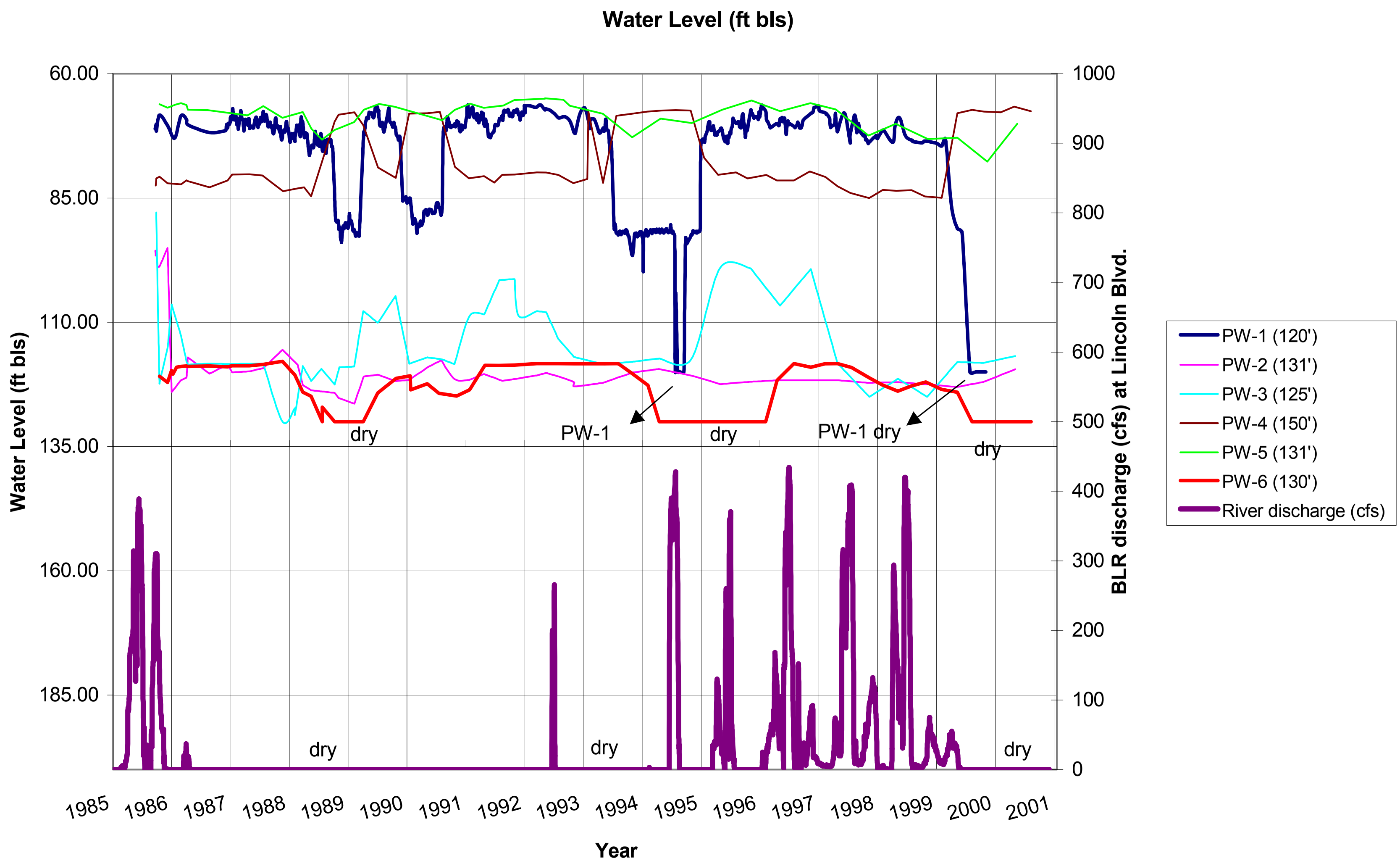

Figure 2-7. Water levels in PW-series perched water wells and flow in the Big Lost River at Lincoln Boulevard. Depth of well is shown on the legend in parentheses.

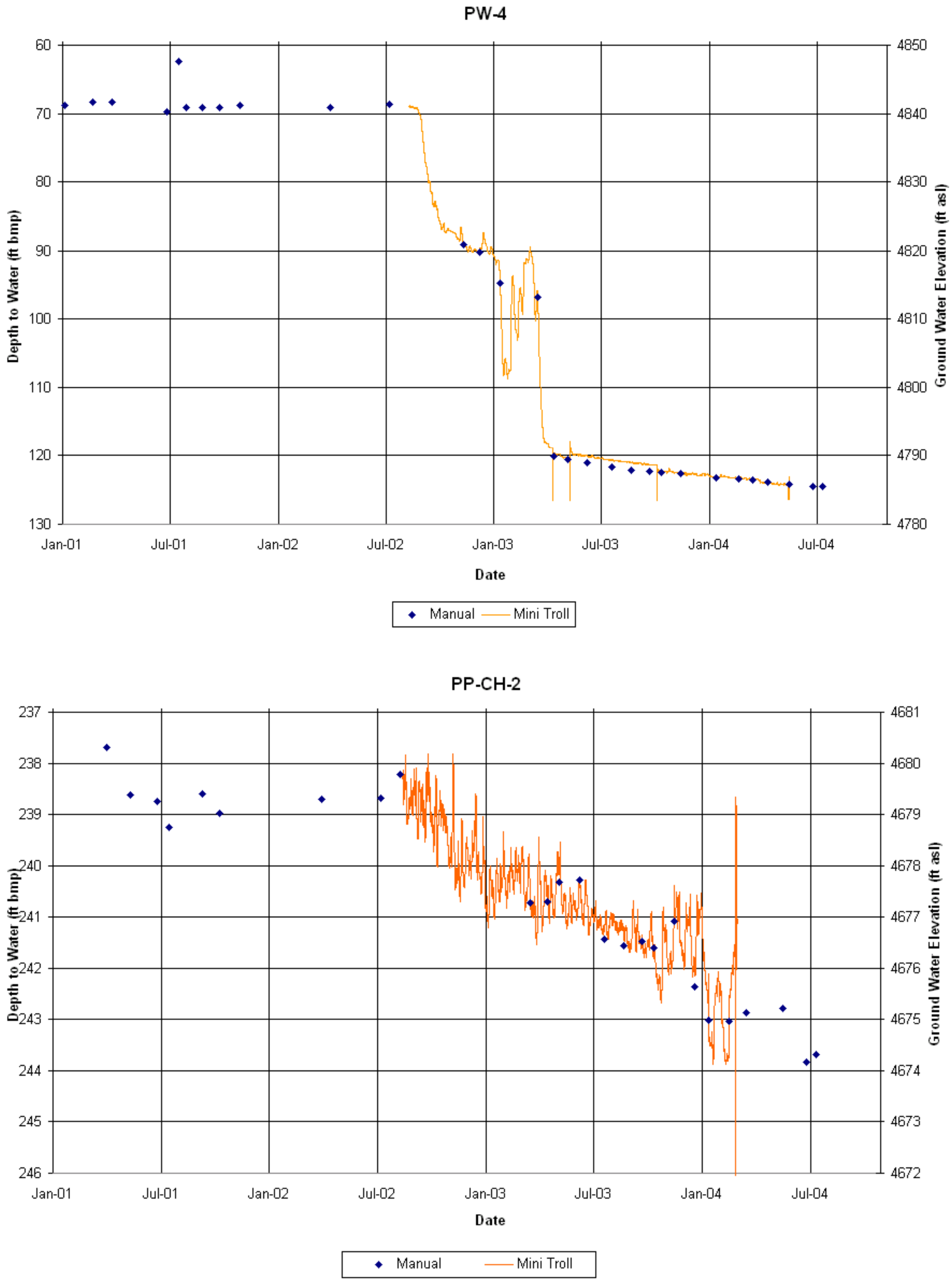

Figure 2-8. Water levels over time in PW-4 and PP-CH-2.

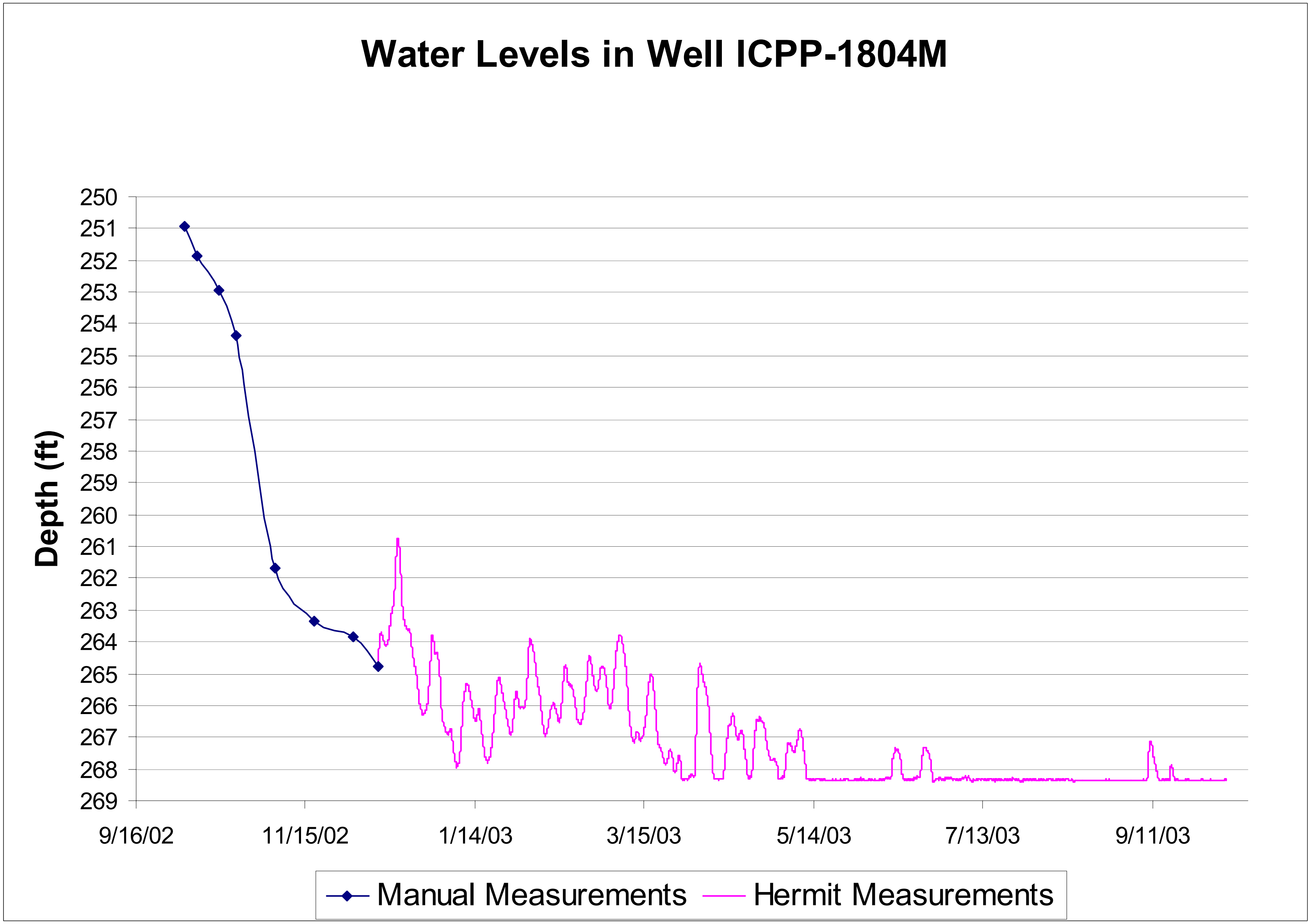

Figure 2-9. Water levels over time for Well ICPP-1804M.

insufficient water for sampling. Since the well first went dry, there have been a few transient pulses of water that last less than 1 week and are approximately 1 ft or less of water. Prior to the well going dry, the water level fluctuations had a larger amplitude and interval between peaks and valleys than the other two perched water wells that had sufficient water for sampling. The water level fluctuations were too large to be attributed to barometric pressure changes. As will be discussed in Section 2.3.2, the water chemistry during October through December in the well was typical of percolation pond water. It is not clear why the water level fluctuations are so different from the other ICDF perched water wells. The pressure transducer and data logger should be tested to ensure that they are functioning properly. If the transducer and data logger are working, the data will be provided to Waste Area Group 3, Operable Unit 3-13 and Group 4 for further investigation. Closer to the percolation ponds, in the PP-CH-2 percolation pond well set (see ICPP-250 on Figure 1-2 for location), the water levels continue to show a generally decreasing trend at this intermediate depth (Figure 2-8).

An additional observation of unsaturated-zone drainage beneath the former percolation ponds is currently underway at USGS-51, located near the northeast corner of the ICDF. Prior to termination of discharges to the ponds, the USGS conducted a baseline neutron log of the well on August 14, 2002. To date, two postdischarge neutron logs were collected approximately 1 and 2 weeks after August 26, 2002. As shown on Figure 2-10, which is a time-series comparison of the logs, some statistically significant moisture changes occur between the August 14 and September 5 logs at 100–125 ft bls. These differences probably represent draining of the perched water at that level. Other observed variations between log traces in Figure 2-10 have no statistical significance and may be attributed to poor depth control and instrument drift. Group 4 could conduct additional logging over the next year to help understand unsaturated zone drainage characteristics.

In ICDF wells monitoring the deeper unsaturated zone, only ICPP-1804L (screened between 358–378 ft bls) and ICPP-1807L (screened between 364–384 ft bls) showed perched water. Perched water level data from the deep completion at ICPP-1804L showed some anomalous variations over time. The water column immediately after completion of the well was 34.5 ft. However, during the first 2-1/2 months of well development, purging, and sampling, the water level rose by 8 ft, but then dropped 18 ft over the next year and a half (Figure 2-11). In the deep completion at ICPP-1807L, 10 ft of water was observed when the well was first completed in October 2002, as shown on Figure 2-12. By mid-May 2003, the well had gone dry, a drop of 10 ft over 7 months. Well ICPP-1802L near the northwest corner of the ICDF landfill receives concentrated snow melt from plowing of the parking lot, but the amount of water in the well is insufficient for sampling. Closer to the percolation ponds, the PP-224-4 (or PP-DP-4, shown as ICPP-224 on Figure 1-2) is dry.

The only well that has had sufficient water since the wells were installed to ensure that a sample could be taken is ICPP-1804L. Although the water levels have been decreasing since mid-December 2002, there is still over 23 ft of water in the well (July 2004). Although it is uncertain whether the current rate of water level decline will change, perched water body drain out should continue until the well is dry, which is consistent with discharges to the former percolation ponds as the source.

Several of the hydrographs are atypical and raise questions about the conceptual model of drain out from the percolation ponds. It is clear that the shallow perched water was the first water body to drain. The intermediate-depth perched water is drying up next and the deep perched water next to the percolation pond is draining slowly, while the deep perched water further away has drained out quickly. The hydrograph for ICPP-1804M is unusual and the cause of the transient pulses is unknown.

The hydraulic head in Well ICPP-1804L is quite high (23 ft), which could potentially indicate a large perched water body. However, a number of factors indicate that the perched water is very localized and that the well is likely in a low permeability zone. Although there is a lot of standing water in ICPP-1804L, it

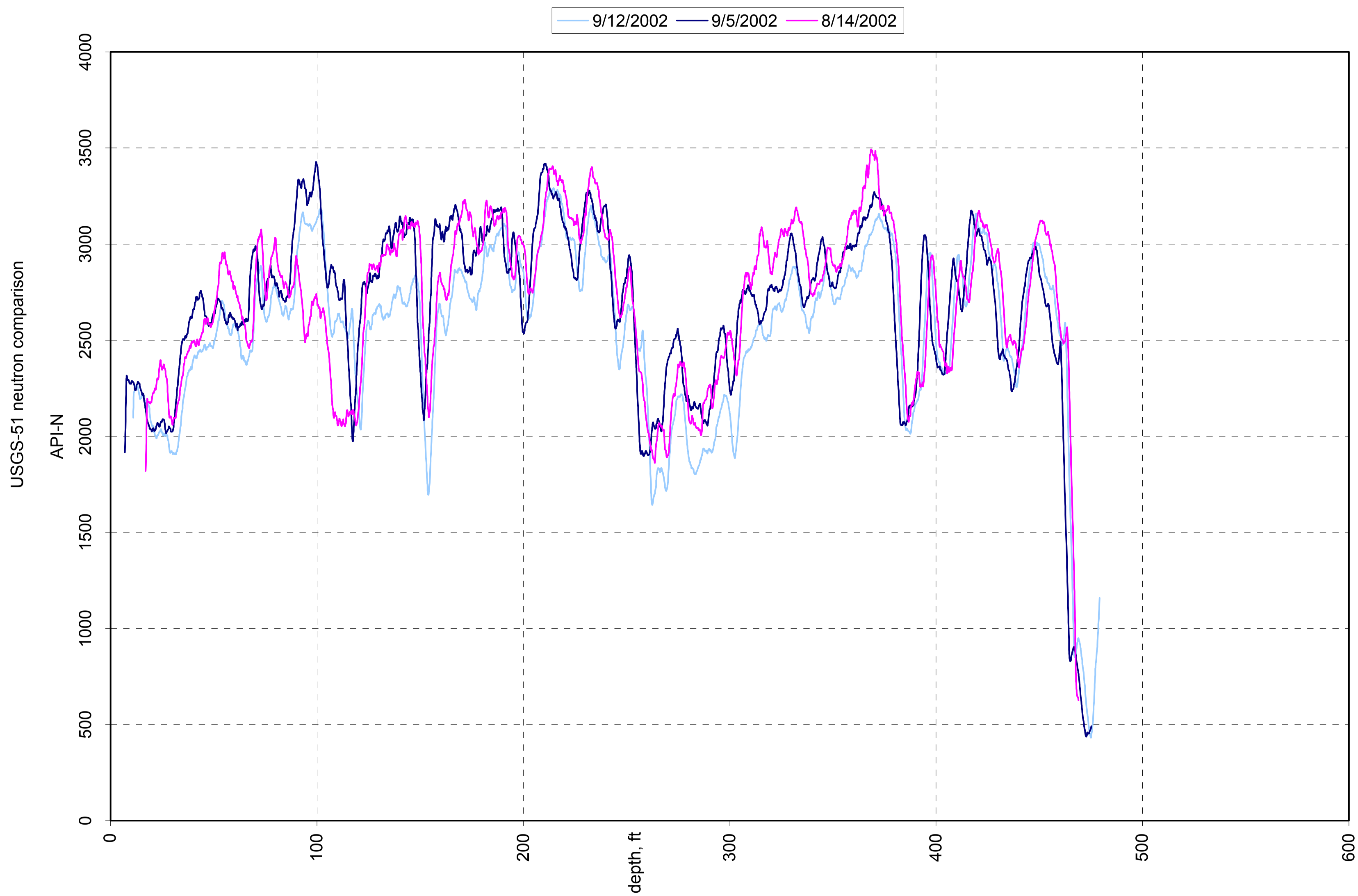

Figure 2-10. Neutron logs of Well USGS-51 (August–September 2002).

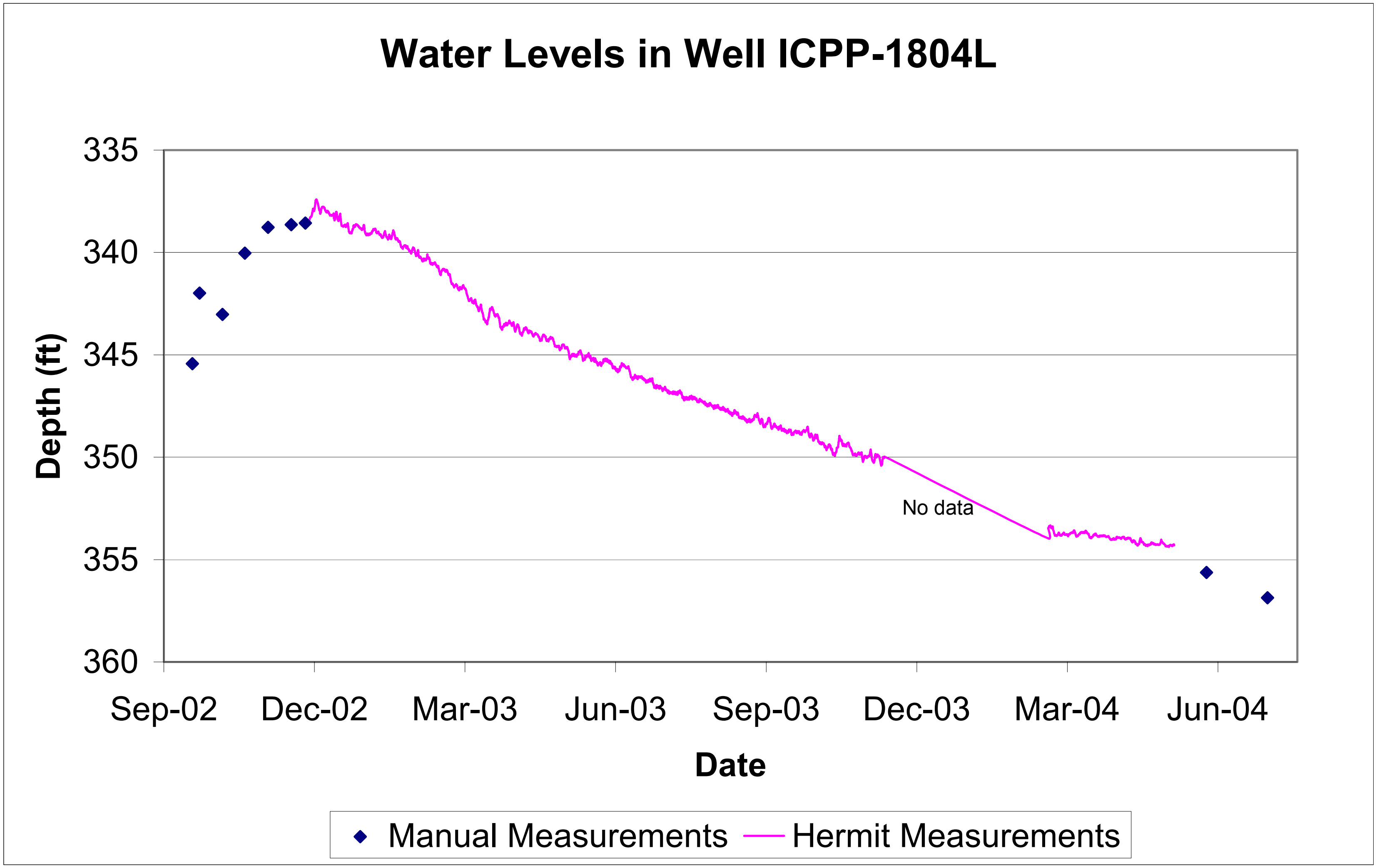

Figure 2-11. Water levels over time for Well ICPP-1804L.

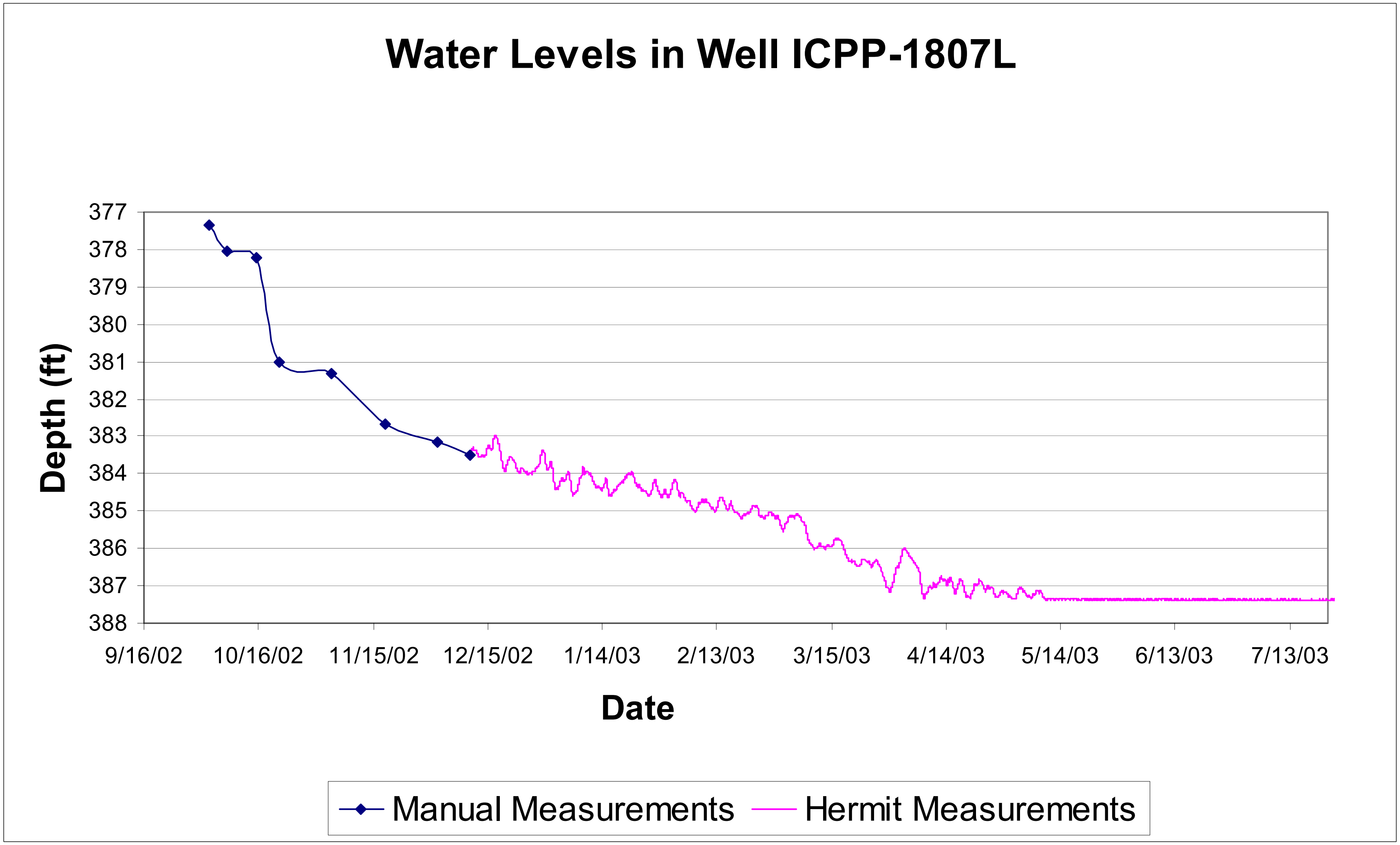

Figure 2-12. Water levels over time for Well ICPP-1807L.

appears that the extent of the perched water is very localized. If a large horizontal body of perched water existed in this deep zone, one would have expected to find perched water at ICPP-1800. This well has a pronounced stratigraphic depression in the basalt underlying the gravel interbed and it is almost in a direct line between the two deep wells with perched water. This depression would be expected to hold perched water, but no perched water was found. The ICPP-1800 is also closer than ICPP-1807L to both ICPP-1804L and the percolation ponds and would be expected to have perched water if a large perched water body existed. A high hydraulic head but limited areal extent of perched water is consistent with a low permeability zone.

The ICPP-1804L hydrograph may also indicate low permeability. The well was being developed, purged, and sampled frequently in the fall of 2002 and the water levels during this time were steadily increasing. It may be that the water level was lowered far below its static level during each purging event and could not recover back up to this level before the next purging event because of slow recharge in a low conductivity zone. Once the well was left undisturbed, the well reached its static hydraulic head and the decreasing water level trend is no longer masked by artificially low water levels caused by over pumping. A low conductivity zone would create a high hydraulic head and slow recharge. It could also create a steeply mounded perched water lense that does not extend very far beyond the well. This is consistent with the absence of deep perched water in the nearest wells.

From these data, it can be seen that there is no continuous layer of perched water at any depth under the ICDF Complex. Of the 17 perched water well completions around the ICDF, 16 are dry or have insufficient water for sampling. Perched water was found in only one middle well completion (ICPP-1804M) and in only two deep completions (ICPP-1804L and ICPP-1807L). Two of these wells have gone dry and the water levels have steadily decreased in the third since December. The data suggest that the deep perched water may have a small horizontal influence and be localized.

2.3 Groundwater Chemistry

Water chemistry can be used to determine the source of perched water. The water quality of the service wastewater is unique. An analysis of the service wastewater was used to show that the source of the perched water in the vicinity of the ICDF is the percolation ponds. In addition, an extensive analysis of water from the ICDF perched water wells was performed to establish preexisting contamination levels. An analysis of water used for drilling also was performed in order to verify the water quality.

2.3.1 Service Wastewater Chemistry

The service wastewater discharged to the percolation ponds has a distinctive chemical signature. Most notably, it is high in chloride and sodium from the ion exchange process used to soften system water and reduce scaling. Sodium concentrations varied over the years, averaging 103 mg/L between 1971 and 1973 (Barraclough and Jensen 1976). From 1996 to 1998, approximately 708,000 lb of sodium was discharged to the ponds. The discharge weighted average ranged from 163 mg/L in 1996 to 124 mg/L in 1998 (Bartholomay and Tucker 2000). Sodium concentrations detected in perched water wells around the ponds ranged from 120 mg/L in PW-6 to 210 mg/L in PW-1. Similar concentrations were reported in SWPP-8 and SWPP-13 (Tucker and Orr 1998). Barraclough and Jensen (1976) reported background concentrations of sodium in the SRPA as 8 to 10 mg/L.

Chloride concentrations also varied over the years. About 3.6 million lb of chloride was discharged to the ponds between 1989 and 1991, and 3.5 million lb was discharged between 1996 and 1998. The discharge-weighted average concentration was 267 mg/L. Chloride concentrations detected in perched water wells around the ponds (SWP wells and PW wells) generally reflected the concentrations in wastewater. In contrast, the background concentration of chloride in the SRPA is between 8 and 15 mg/L (Barraclough and Jensen 1976).

The *ICDF Complex Groundwater Monitoring Plan* (DOE-ID 2002) provides a detailed description of pre-ICDF perched water chemistry for the INTEC area. For summary purposes, Schoeller and Piper diagrams are used to illustrate patterns in water chemistry for perched water, service wastewater, the SRPA, and water from the Big Lost River. These diagrams display the composition of cations and anions in such a way that the origins of perched water may become readily apparent. On Figure 2-13, a Schoeller diagram, all of the shallow perched water around the ICDF Complex and the percolation ponds plots high in sodium and chloride, as expected. Water collected in October 1991 from PW-1 (orange triangles), PW-2 (pink X), PW-4 (brown diamonds), and PW-5 (green asterisk) plots similarly on the diagram. Service wastewater discharged to the percolation ponds in January 2000 is indicated by a dashed green line with open squares. As illustrated on the diagram, recent wastewater has lower sodium and chloride than perched water collected in 1991. This is attributed to improvements in the service wastewater system and replacement of older water softening equipment with reverse osmosis units. Although sodium and chloride concentrations are lower in the 2000 samples, other ionic concentrations demonstrate a general similarity to the 1991 perched water samples.

Other wells plotted on Figure 2-13 include Monitoring Well MW-17, north of the percolation ponds near the CPP-603 fuel storage basins. Monitoring Well MW-17 was originally completed in three zones. The MW-17S (MW-17-2) monitors shallow perched water, is screened from 181.7 to 191.7 ft, and currently has perched water. The MW-17P (MW-17-1), which is dry, is screened from 263.8 to 273.8 ft. The MW-17D (MW-17-4), monitoring deep perched water, is screened from 360 to 381 ft and currently has standing water. Data in January 1995 collected from MW-17S are plotted on Figure 2-13 as yellow triangles and from MW-17D as yellow plus signs. Note that MW-17S plots very low for all ions, whereas MW-17D shows slightly elevated sodium and chloride but not as high as in the PW wells. This may indicate mixing between water in MW-17D and water originating from the percolation ponds and service wastewater system.

At the MW-17 cluster, only the deep well, MW-17-4, was significantly affected by the former percolation ponds based on the analysis of common cations and anions. The water from the ponds did not appear to affect the shallow well at MW-17, based on high tritium concentrations and chloride concentrations only about 1/7 the concentrations in the PW wells. The general chemistry and stable isotope data suggest that the water in MW-17-2 may be derived from precipitation or water from leaking pipes interacting with locally contaminated soil. The chemistry data indicate that percolation pond infiltration appears to move more vertically than horizontally in the shallow perched zones.

Discharge of service wastewater to the former percolation ponds also affected water quality in the SRPA. Water quality data from the SRPA Monitoring Wells USGS-51 and USGS-57, are plotted on Figure 2-13 in blue. The USGS-57 is on the southern boundary of the ICDF landfill and USGS-51 is located northeast of the new ICDF evaporation ponds near the former percolation ponds. The SRPA samples were collected in 1991. As indicated by elevated sodium and chloride concentrations, both wells show the influence of percolation pond water mixing with SRPA water.

In contrast, water from the Big Lost River is chemically different from the perched water that was affected by discharge of service wastewater. Water quality data from samples collected by the USGS in 1995 from the Big Lost River at the Lincoln Boulevard bridge are shown as a dashed light blue line on

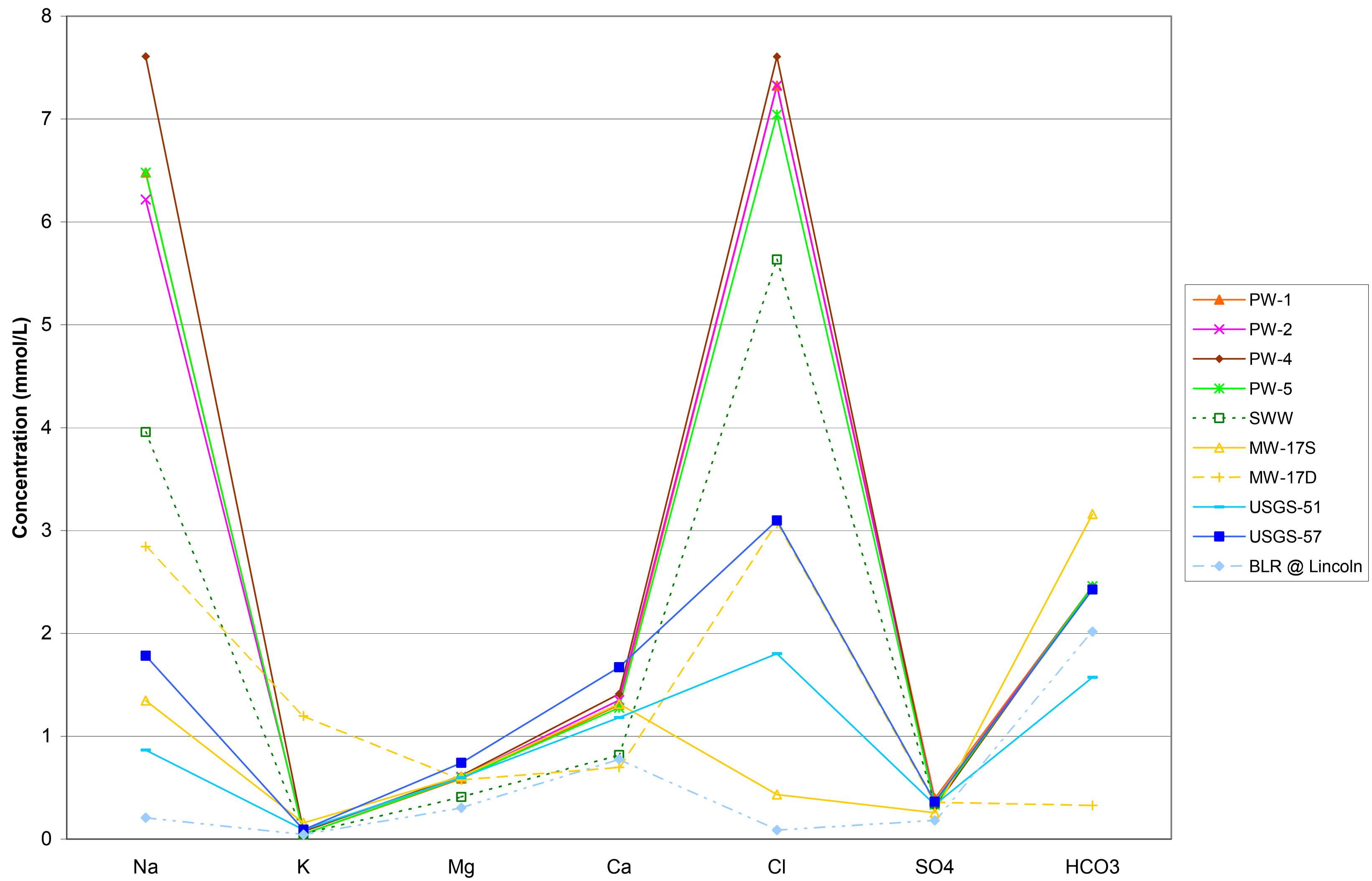

Figure 2-13. Schoeller diagram of water quality in the Idaho Nuclear Technology and Engineering Center vicinity for perched water, service wastewater, the Snake River Plain Aquifer, and the Big Lost River.

Figure 2-13.[a] Because of the difference in water quality, it is easy to distinguish water that originates from the Big Lost River and water that originates from discharges of service wastewater.

The USGS monitored the PW wells around the percolation ponds for Sr-90, H-3, and Cs-137 in addition to other constituents discharged to the percolation ponds. The USGS data indicate H-3 and Sr-90 contamination in the perched water at similar concentrations to wastewater that was discharged to the ponds (Tucker and Orr 1998).

In addition to the chloride and sodium signatures, water in the PW wells has δD, $\delta^{18}O$, $\delta^{13}C$, and $^{87}Sr/^{86}Sr$ isotopic signatures similar or equivalent to the SRPA. Rapid infiltration of water from the former percolation ponds retains the $\delta^{13}C$ signature of the SRPA rather than equilibrating with soil CO_2 (DOE-ID 2003).

2.3.2 Baseline Chemistry of New ICDF Perched Water Wells

In order to establish background water quality prior to operation of the landfill, four rounds of baseline samples were collected from the three ICDF wells with perched water between October 21 and December 2, 2002. The samples represent baseline or preexisting conditions, which is analogous to the background quality in 40 CFR 264, Subpart F. The samples were analyzed for a total of 234 analytes and included radionuclides, major ions, and Appendix IX volatile organic compounds, semivolatile organic compounds, and metals as established in the *ICDF Complex Groundwater Monitoring Plan* (DOE-ID 2002). The entire suite of analyses yielded over 4,000 results. The results are tabulated in Appendix B. The data establish preexisting contamination in the perched water in the vicinity of the ICDF and were used to determine that the source of the water is the former percolation ponds.

The distinctive chemical signature of the service wastewater that was discharged to the percolation ponds' signature was useful in identifying the source of the perched water in the ICDF wells. As was shown on Figure 2-13, all of the shallow perched water wells around the former percolation ponds were high in chloride and sodium. Figure 2-14 shows water chemistry in PW-1 over time. Chloride levels have been generally lower over the last decade, typically under 200. Chloride concentrations from the ICDF perched water wells during four rounds of baseline sampling in the fall of 2002 are shown on Figure 2-15. Data from 1804L are shown as pink squares, from 1804M as blue diamonds, and 1807L as green triangles on this and all subsequent concentrations over time plots. Chloride concentrations in ICPP-1804L are generally under 200 mg/L for ICPP-1804M and ICPP-1807L and similar to levels in PW-1. In contrast, the chloride concentration was about 240 mg/L for ICPP-1804L and higher than concentrations generally observed in PW-1 since early 1998, but similar to PP-CH sampled in 2001. Sodium concentrations in the new ICDF perched water wells are high (ranging from 50 to 133 mg/L) and typical of data from the percolation ponds.

The major ion chemistry of the ICDF perched water monitoring wells (ICPP-1804M, 1804L, and 1807L) and the water supply for drilling activities (CPP-1 and CPP-2) were plotted on a Piper diagram (Figure 2-16) to examine the origin of the water in the three ICDF perched water wells. The piper plot of these waters shows that 1804M and 1807L plot with the same chemistry as the average for the PW-series wells in 2001. However, the ion chemistry for Well 1804L plots away from the percolation pond wells based on higher calcium and lower sodium content, but the chloride content of Well 1804L is similar to that of Well PP-CH (shown as ICPP-250 on Figure 1-2) located near the percolation ponds. The sodium-to-chloride ratio of effluent discharged to the percolation ponds is 0.98 and the ratio for the

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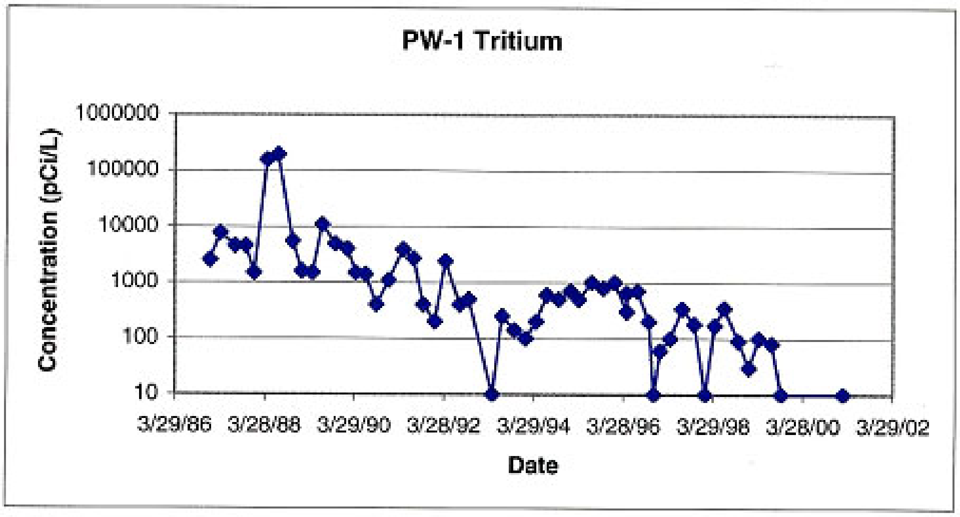
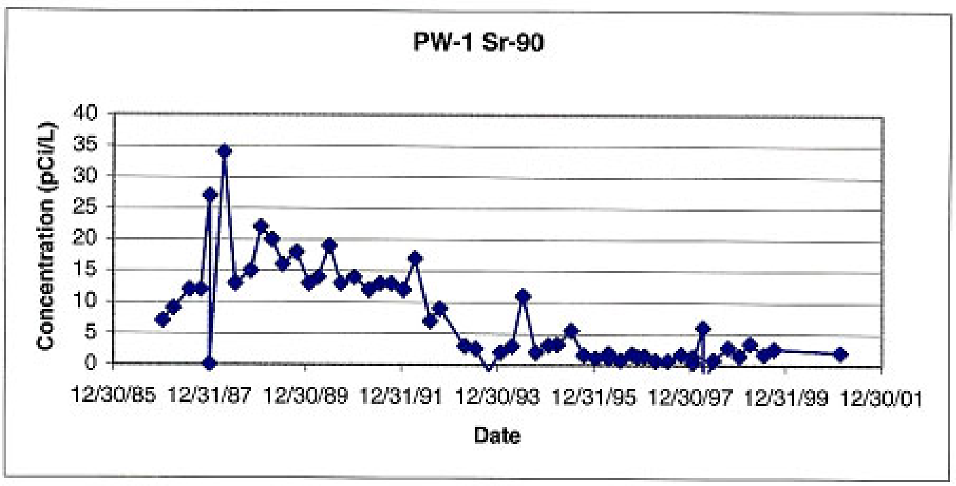
a. Personal communication between Lorie Cahn of the INEEL and Leroy Knobel of the USGS, Idaho Falls, Idaho, November 2001.



Note: concentrations shown below 300 pCi/L are non-detect.



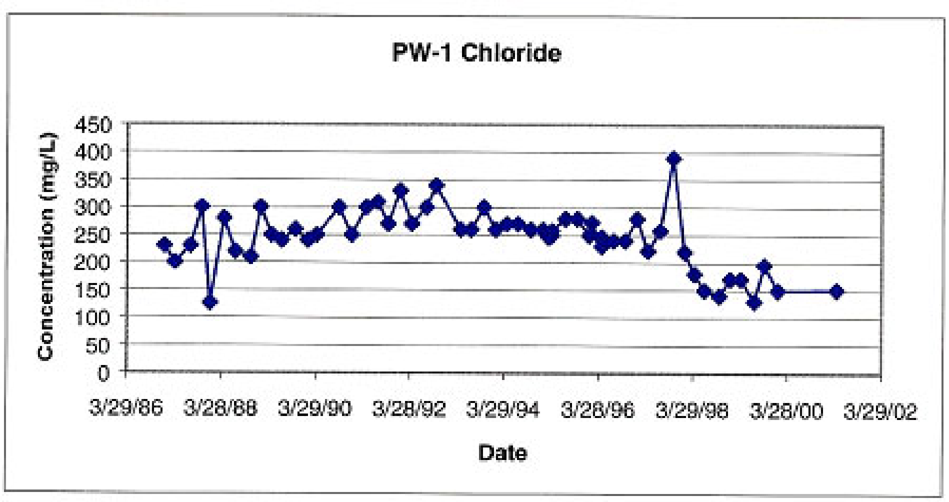


Figure 2-14. Tritium, chloride, and Sr-90 trends for PW-1.

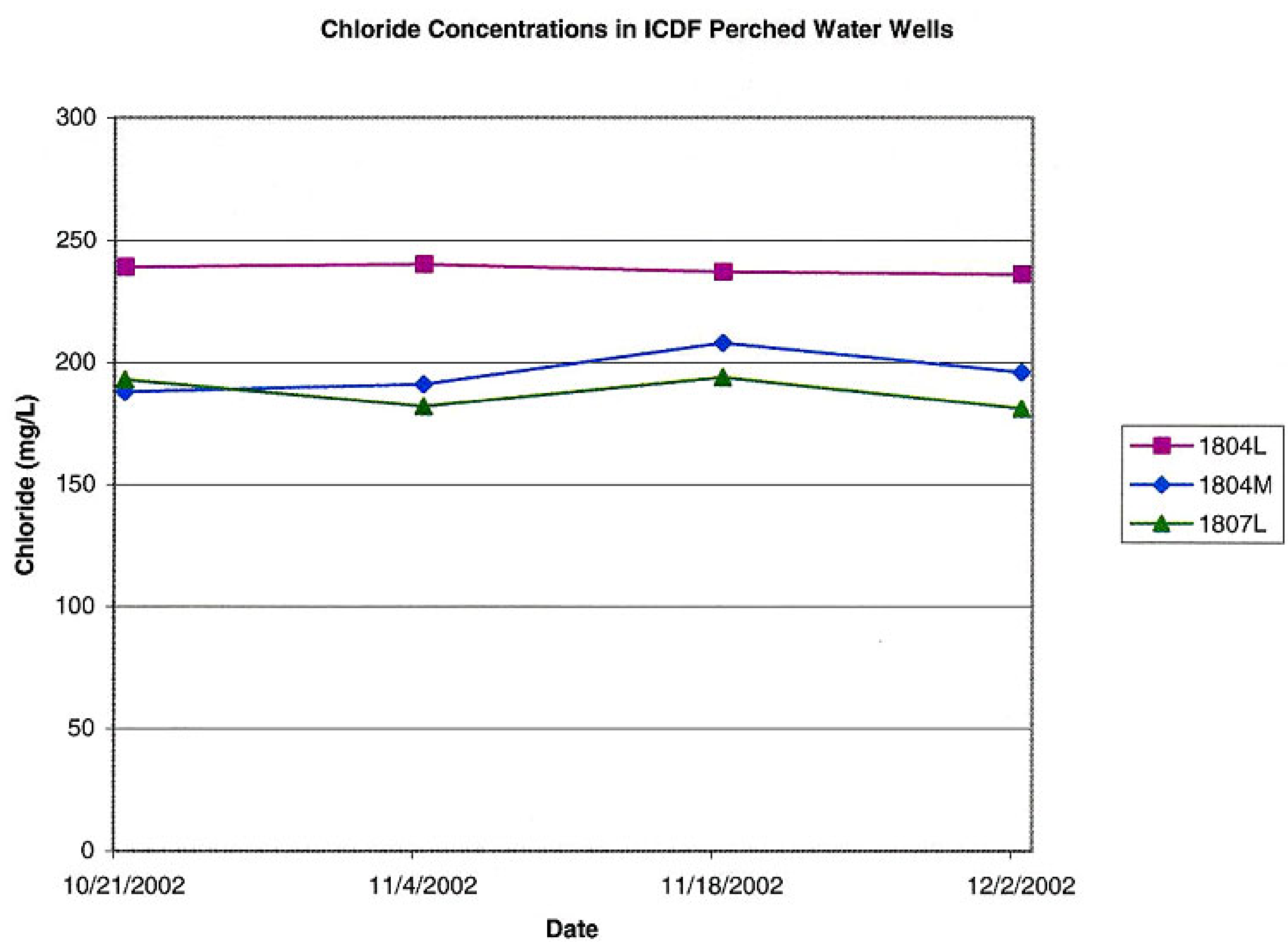


Figure 2-15. Chloride concentrations from ICDF perched water wells.

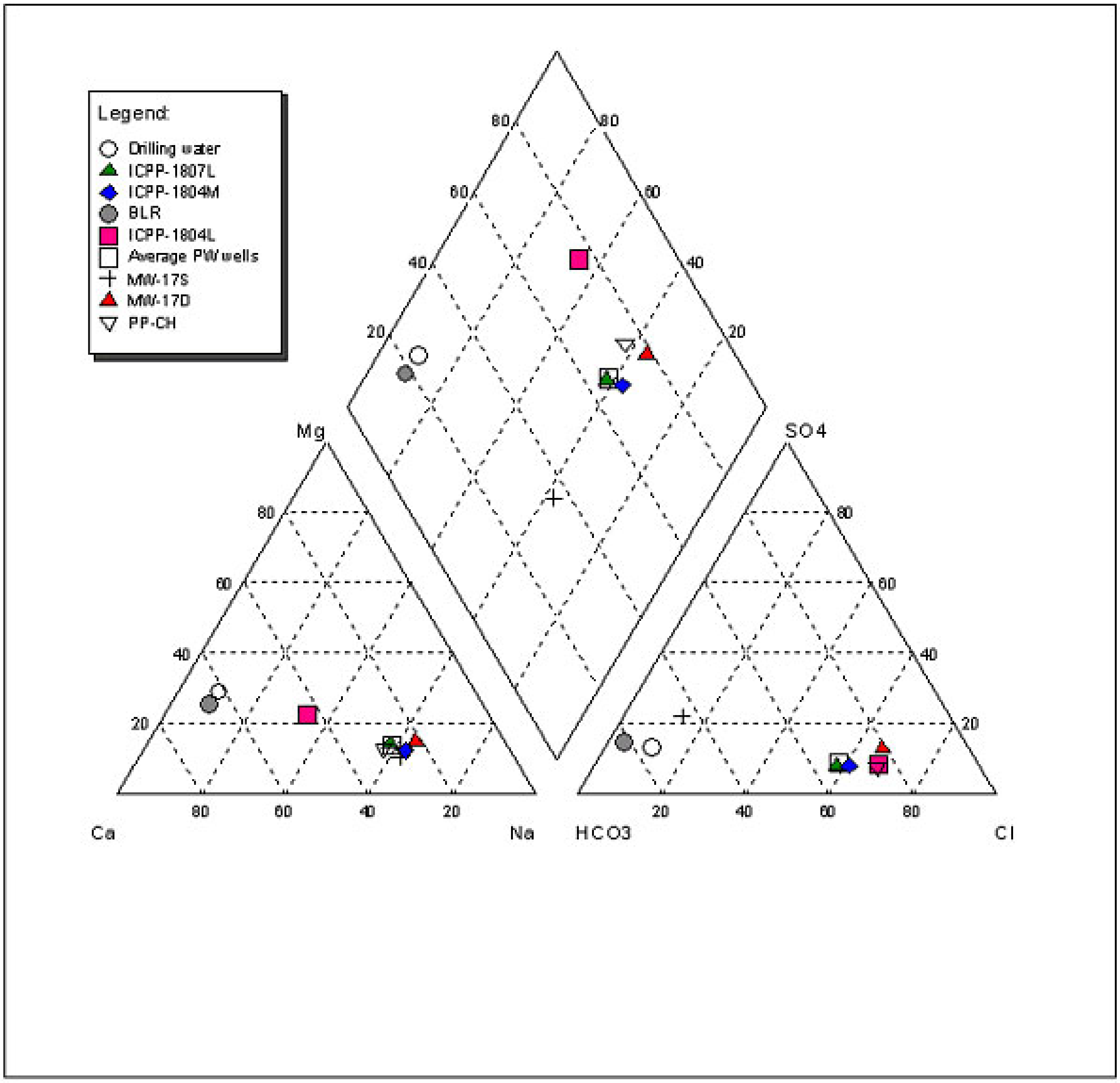


Figure 2-16. Piper diagram for the ICDF perched water wells, nearby perched water wells, and other sources.

shallow percolation pond wells (PW series) is 1.00 on a molar basis (DOE-ID 2003). The ICDF 1804M and 1807L wells both have Na/Cl ratios similar to percolation pond effluent and the shallow PW-series wells and, therefore, plot similarly on the Piper diagram. In contrast, Well 1804L has a sodium/chloride ratio of 0.49 or about half that of the percolation pond effluent and PW-series wells. The different composition in Well 1804L may be attributed to ion exchange between water and soil materials or mixing of two different perched water sources.

Whether the difference in chemical composition in 1804L can be attributed to ion exchange can be evaluated by examining the lower sodium and higher calcium, magnesium, and potassium concentrations. Assuming that the sodium/chloride ratio of the water was originally the same as the percolation pond effluent, then the original sodium concentration was 155.1 mg/L versus the actual measured concentration of 76.8 mg/L during the first baseline sampling round. The difference between actual and assumed original concentration is 78.3 mg/L or 3.41 milliequilivents per liter (meq/L) (concentration divided by the atomic weight and multiplied by the ion charge). The average concentrations of calcium, magnesium, and potassium in the influent to the percolation ponds from 1997 to 2002 were 45.6 mg/L, 13.6 mg/L, and 2.4 mg/L, respectively. The differences in concentrations of calcium, magnesium, and potassium between the average influent to the percolation ponds and 1804L are 39.5 mg/L, 13.6 mg/L, and 6.61 mg/L, respectively.

The sum of the differences for calcium, magnesium, and potassium expressed as millequilivents is 3.26. The milliequilivent values show that the apparent loss of sodium is balanced by gains of calcium, magnesium, and potassium and suggests that ion exchange is the cause of the shift in concentrations in ICPP-1804L. This is consistent with other data that imply that the water in ICPP-1804L is from the old percolation ponds.

It is possible that the different composition in Well 1804L from the other perched water wells may be attributed to mixing with another water source rather than ion exchange between water and soil materials. If water from 1804L were from a similar source to water in MW-17S, then the composition of the well would be expected to plot between MW-17S and the percolation pond wells on the Piper diagram (Figure 2-16). However, Well 1804L is shifted toward a higher calcium concentration, but the chloride concentration is similar to the percolation pond wells. Consequently, 1804L does not plot between the percolation pond wells and MW17S on the Piper plot. This suggests that direct mixing of water from MW17S and the percolation ponds is not a viable explanation for the higher tritium concentrations in 1804L. Dilution with the Big Lost River or water supply does not appear likely because of the low chloride concentration associated with these sources.

Another useful way to determine the source of perched water is to examine the contaminant chemistry. It is also important for characterizing the preexisting contamination in the perched water prior to operation of the ICDF Complex. Strontium-90 concentrations from the ICDF wells are shown on Figure 2-17. Concentrations were very low for the two deep perched water wells (less than 1 pCi/L). In the intermediate-depth well, 1804M, Sr-90 concentrations were much higher and ranged from 10 to 17 pCi/L. These high concentrations have not been seen in PW-1 since 1994 (see Figure 2-14). The Sr-90 concentrations were undetected in both MW-17 wells.

Iodine-129 concentrations from the ICDF wells are shown on Figure 2-18. Concentrations in all wells ranged between 0.22 to 0.4 pCi/L.

Tritium concentrations in the ICDF perched water wells from the baseline sampling rounds are shown on Figure 2-19. The concentration of tritium in ICPP-1804L is much higher (ranging from 5,790 ± 154 to 8,200 ± 202 pCi/L) than in the other two ICDF wells (typically around 1,000 pCi/L or less). These lower tritium concentrations in 1804M and 1807L are typical of tritium found in PW wells around the percolation ponds over the last 10 years, as can be seen on the plot for PW-1 (see Figure 2-14). Concentrations from 5,000 to 8,000 pCi/L tritium, as found in 1804L, are typical of water discharged to the percolation ponds prior to 10 years ago. The tritium concentrations appear to be increasing, although the four samples were collected over a 6-week period. There is too little information to tell if this trend is significant or will continue.

Figure 2-20 is a map of tritium concentrations in perched water wells in the vicinity of INTEC from the Group 5, 2001 sampling. Tritium was undetected in the PW wells and was 737 pCi/L in PP-CH (ICPP-250 on Figure 1-2). The highest tritium concentration was measured in MW-17S also known as MW-17-2 (40,400 ± 2,200 pCi/L). The MW-17 is just east of the CPP-603 fuel basins at INTEC, which were formerly used to store spent nuclear fuel. Although the fuel has been removed from the basins, water is added to the basins to maintain the water level until the basins can be decontaminated and

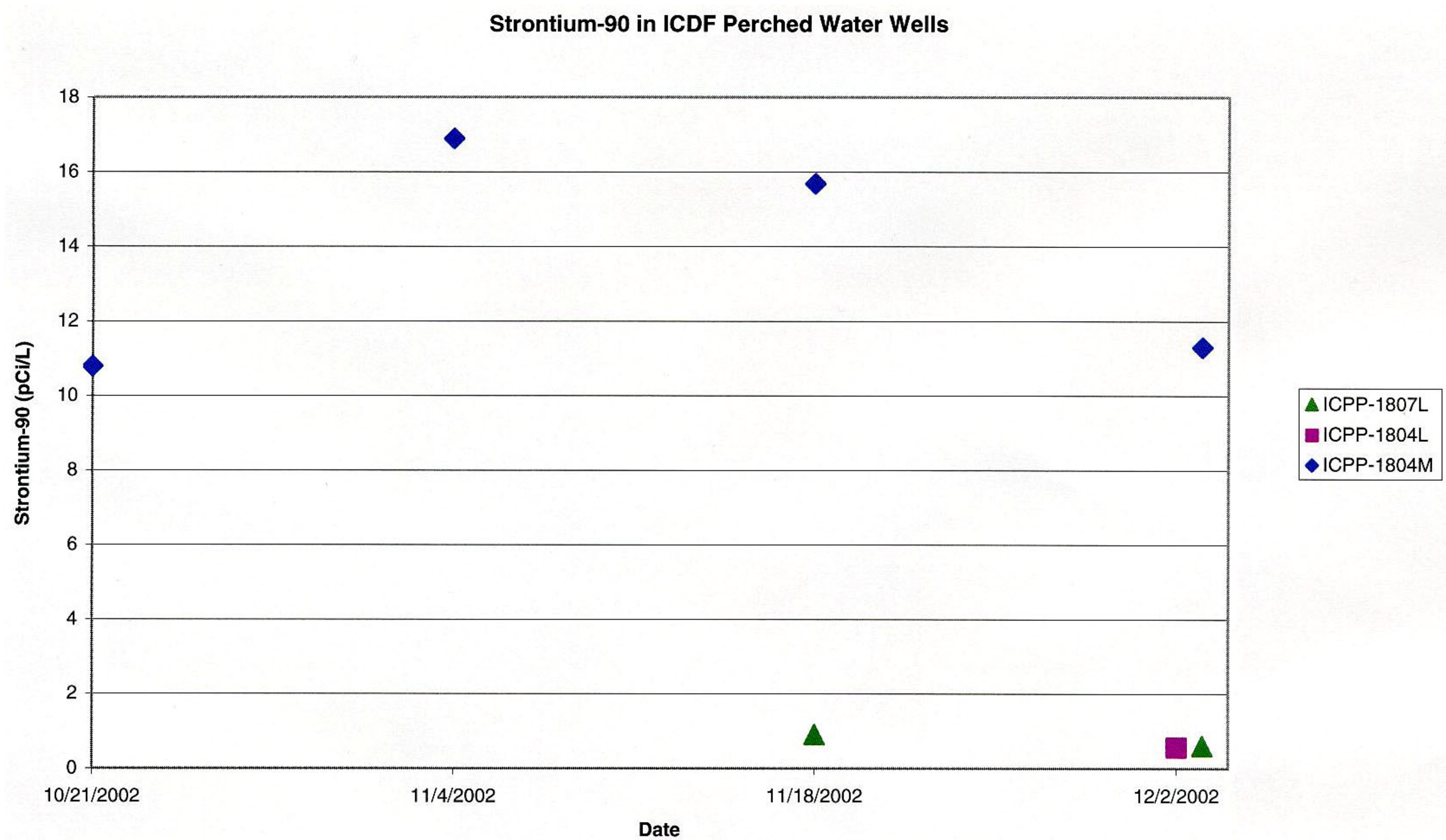


Figure 2-17. Strontium-90 concentrations from ICDF perched water wells.

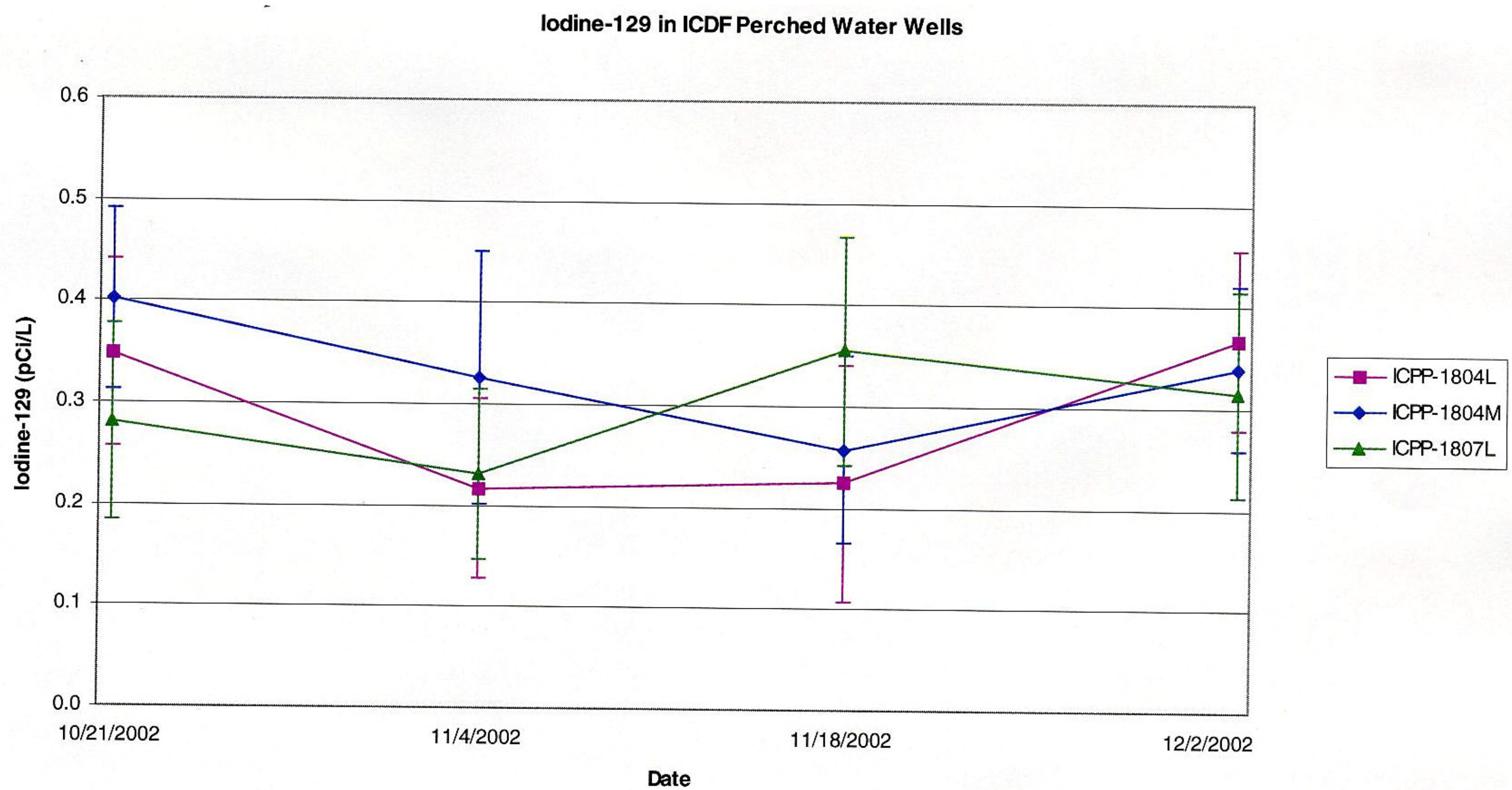


Figure 2-18. Iodine-129 concentrations from ICDF perched water wells.

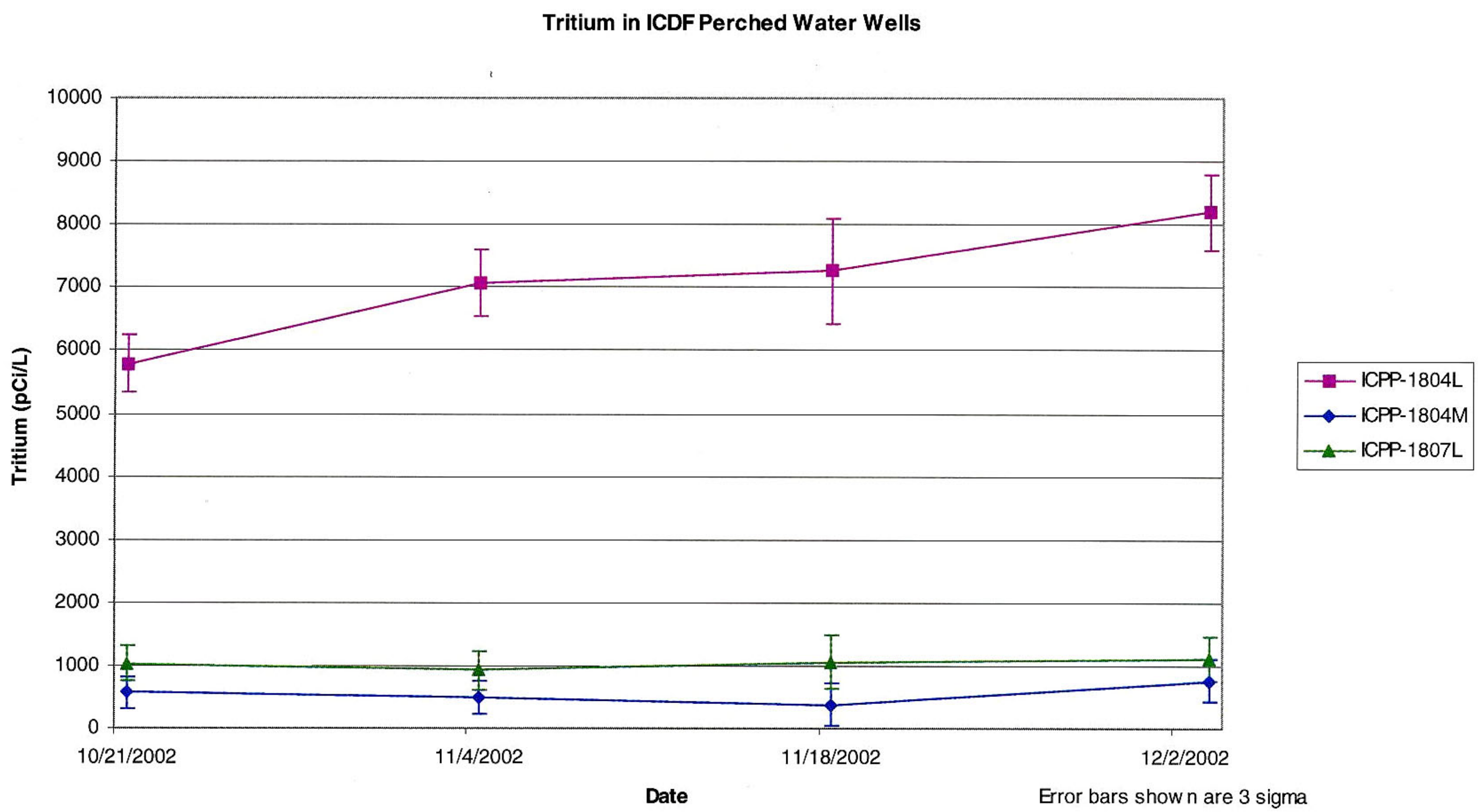


Figure 2-19. Tritium concentrations from ICDF perched wells.

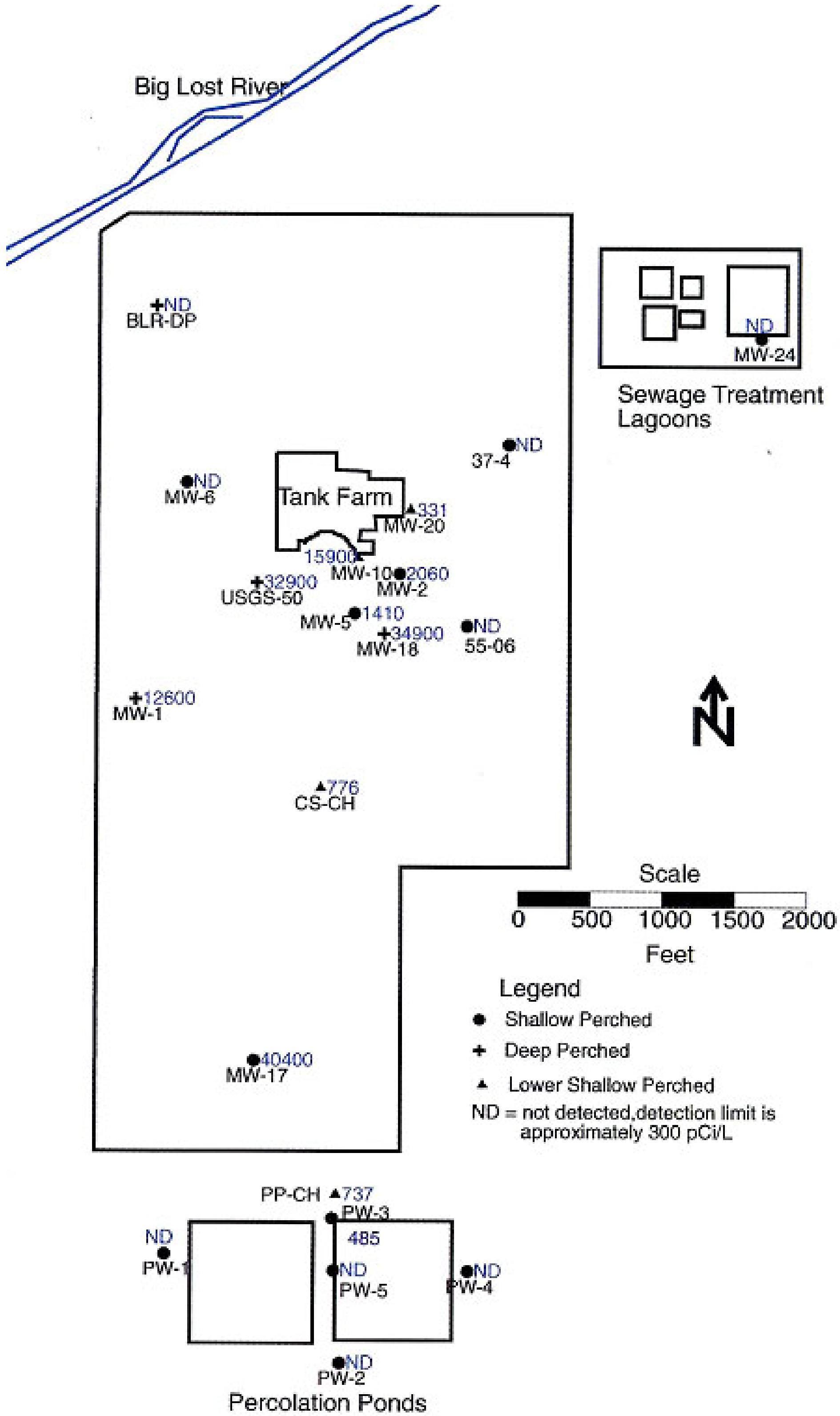


Figure 2-20. Plan map of the Idaho Nuclear Technology and Engineering Center showing tritium concentrations in perched water wells (2001).

decommissioned. Leaks from the fuel basins and estimated loss rates have been reported in the past (DOE-ID 1997a). Nitrate concentrations, however, are much higher in the 603 basins (149 to 682 mg/L) than in the PW and ICDF perched water wells, which were less than 1 mg/L. Nitrate concentrations also are much lower in MW-17D (MW-17-4) and MW-17S, which have been around 4 to 5 mg/L (DOE-ID 2003). These high nitrate concentrations in the CPP-603 basins indicate that the source of the high tritium in MW-17 and ICPP-1804L is not the CPP-603 basins. In the past, chloride concentrations in the CPP-603 basins were similar to percolation pond concentrations; however, more recent data (1995 to 2002) show chloride concentrations approximately one third that of the percolation ponds (382 mg/L in 1977, 35 mg/L in 1995 reported in DOE-ID 1997a), and 43.7 to 57.3 mg/L in 2001 and 2002 data. The MW-17S, however, has very low chloride concentrations (15.4 to 25.8 mg/L in DOE-ID 2003). The MW-17D had higher chloride concentrations (109 to 125 mg/L in 1995).

The chloride-to-nitrate ratios for the CPP-603 basins[b] are very different from the ratios for the ICDF and PW wells. For the 603 basins, the ratios from 2002 and 2003 data are less than 0.3. The ratios are greater than 200 for the ICDF wells and PW-1, from 3 to 5 in MW-17S, and around 27 in MW-17D.

From the above discussion, the percolation ponds are the most likely source of water in the three ICDF perched water wells. It appears most likely that ion exchange between the water and soil materials is responsible for the shift in cation concentrations in water from 1804L. The elevated tritium concentrations are not from the CPP-603 basins and are most likely a relic from over 10 years ago when higher levels of tritium were discharged to the old percolation ponds.

Similarly, the high Sr-90 concentrations in Well 1804M also suggest that Sr-90 remains in the unsaturated zone for more than 10 years after discharge to the old percolation ponds. Historically, the shallow PW-series wells generally reflected discharge to the old percolation ponds. This may indicate that it takes much longer for some intermediate and deeper perched zones to be flushed. Although this may seem unlikely because of the extremely large volume and rapid movement of water through the unsaturated zone from pond discharges, the high water level and slow recharge in ICPP-1804L support the hypothesis of relic water in low permeability zones.

2.3.3 Chemistry of Drilling Water Supply

Samples were collected from the water supply that was used for this drilling project and are labeled boiler plant in Appendix B. The water is pumped from SRPA wells in the northwest corner of INTEC (CPP-1 and CPP-2) and supplies raw water to the boiler plant. The purpose of collecting the samples was to have a record of the quality of the water that was used for drilling. Because the chemistry of the water is typical of SRPA water, the data can be used to provide assurance that the drilling water has been removed from the wells and that the baseline samples are representative of the perched water. Chloride and sodium concentrations in the boiler plant water (13.2 and 7.8 mg/L) were an order of magnitude lower than the perched water wells. The I-129 (0.0812 ± 0.0174 pCi/L) and H-3 concentrations also were much lower than in the perched water wells. Strontium-90, which is high in the perched water wells, was undetected in the boiler plant supply water. Technetium-99, which was undetected in the ICDF perched water wells, was 23.6 ± 2.35 pCi/L in the boiler plant supply water. This information has been provided to Group 5, as it indicates that the Tc-99 plume extends further north from INTEC than previously known.

The water quality of the drilling water is presented in Appendix B. The fact that the water samples from the perched water wells had chemical signatures of the percolation ponds and not drilling water

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[b]. The 603 basin data are from personal communication between Lorie Cahn of the INEEL and Maryanne Willmore of the INEEL, February 2003.

indicates that well development and purging removed much of the injected drilling water. The water used in drilling was likely recirculated up the borehole during drilling and little water entered the formation. This could also indicate that the hydraulic conductivity of the perched water wells is low, which would result in little drilling water entering the formation during drilling activities.

Other Sample Results

Unfiltered perched water samples were often muddy or contained visible sediment. Unfiltered metal samples often contained detectable concentrations of naturally occurring metals such as arsenic, barium, chromium, copper, lead, and nickel that were undetected or flagged by the validator in the filtered samples. Other naturally occurring metals, beryllium, mercury, and selenium were B flagged in some of the unfiltered samples, but were undetected in the filtered samples. Cobalt was detected in one unfiltered sample and B flagged in all the other unfiltered samples. In the filtered samples, it was undetected in all of the filtered samples except one where it was B flagged.

Other compounds that were detected in the samples were typical laboratory contaminants, such as bis-(2-ethylhexyl)phthalate and toluene (all J flagged) or naturally occurring compounds. The complete data set is in Appendix B.

3. EFFECT OF THE BIG LOST RIVER

The Big Lost River, which is over 3,200 ft from the northwest corner of the ICDF landfill, has not flowed past the ICDF site since May 2000. The potential for the Big Lost River to have an affect on the perched water beneath the ICDF can be predicted by evaluating the influence of the Big Lost River on other sites. Perched water that is likely from the Big Lost River was observed during installation of wells for the VZRP. Possible influence of the Big Lost River on INTEC wells has been investigated.

3.1 Idaho National Engineering and Environmental Laboratory Vadose Zone Research Park and New Percolation Ponds

Subsurface investigations at the INEEL VZRP provide subsurface information that is applicable to the ICDF. The INEEL VZRP, collocated with the new INTEC percolation ponds, is approximately 2 mi southwest of the ICDF. The northwest corner of the pond boundary is approximately 1,600 ft southeast of the Big Lost River channel (Figure 3-1). Information obtained from drilling, logging, and installing approximately 30 wells around the new ponds and along the river provides valuable information on the lateral spread and persistence of perched water from the Big Lost River and monitors the development of perched water beneath the percolation ponds.

An analysis of existing perched water was completed during the wastewater land application permitting phase of the new percolation ponds. Although a significant amount of data have since been collected at the VZRP, much of the data are still being processed and are unpublished. Data presented here are preliminary.

A predicted estimate of the lateral spread of perched water from discharges at the new ponds is approximately 1,500 to 1,900 ft from the discharge point based on modeling (DOE-ID 1999b). This is consistent with an observed lateral spread of perched water at the old ponds of approximately 1,750 ft from the point of discharge to detections in PW wells completed between 100 and 150 ft bls.

Because of the extremely large discharge volumes of 0.7 to 2.5 million gal per day, similar perched water conditions were expected to form after the new facility became operable. Background or preoperational perched water conditions were examined as required by the permitting process and because of the proximity of the new facility to the Big Lost River channel.

As shown in Figure 2-7, the last recorded flow in the Big Lost River channel on the INEEL occurred in May 2000. There are no measured or modeled predictions of perched water lateral extent from Big Lost River infiltration during channel flow. However, visual observations during and after VZRP drilling and geophysical logging activities provide an estimate of expected lateral impacts for the ICDF. Between January and May 2000, four aquifer monitoring wells (ICPP-MON-A-164A/B/C, 165, 166, and 167) were drilled and installed around the location of the new percolation ponds.

The ICPP-MON-A-164 (A, B, and C) aquifer monitoring wells are located approximately 900 ft from the channel. This series of three holes, originally intended to be one hole, resulted from poor hole stability attributed to perched water from river flow in the river. All of the following observations were based on video logging of the boreholes several days after drilling with water ceased. Hole A, drilled in January/February 2000, showed some water at 45–46 ft bls at the base of the surficial alluvium and at 177 ft in a rubble zone. Hole B, drilled in February 2000, showed water at 122 ft in rubble above an interbed at 125–140 ft bls. Standing water accumulated in the hole when drilling paused at 117 ft. At

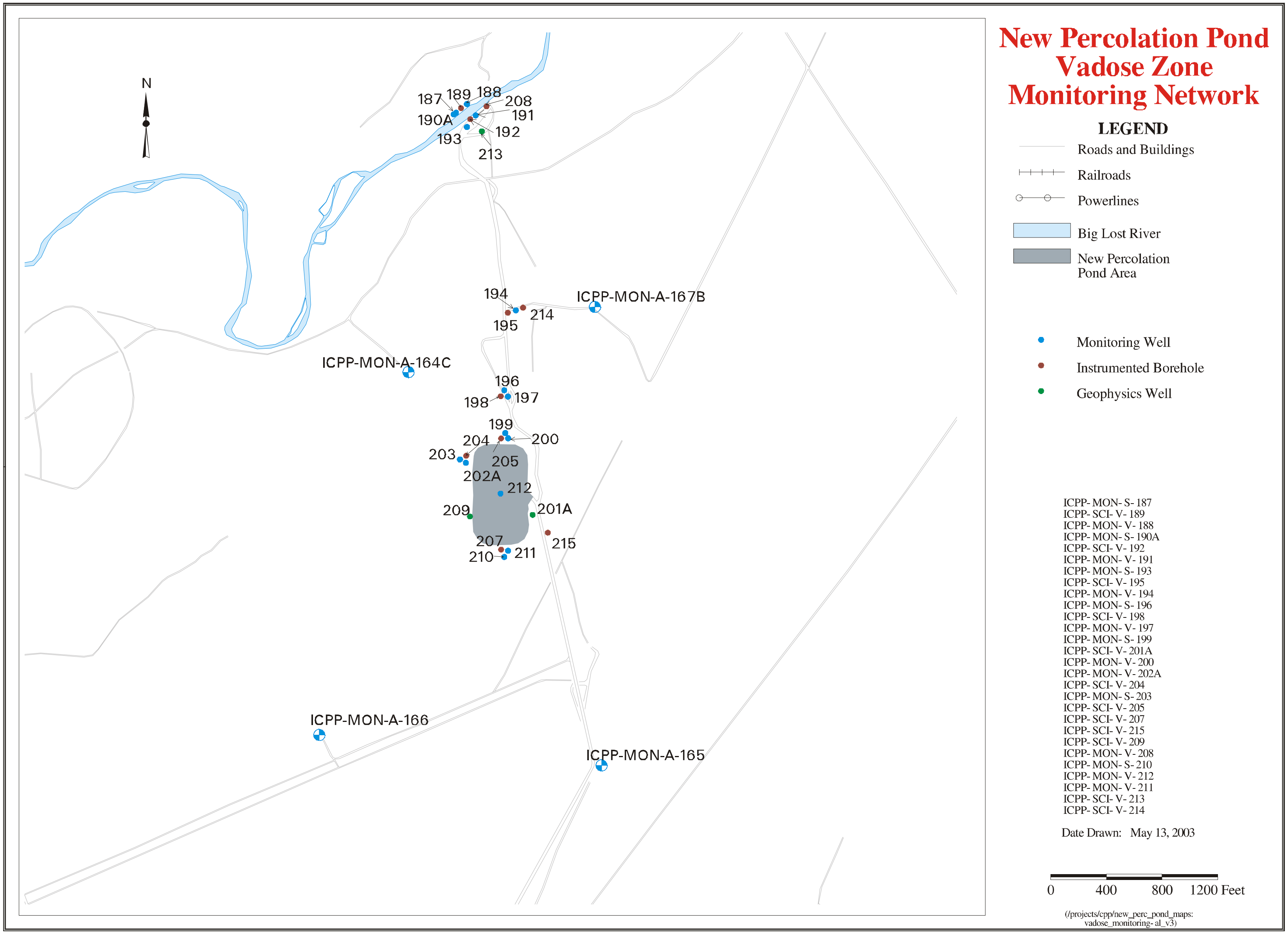

Figure 3-1. Well locations at the Vadose Zone Research Park and the new Idaho Nuclear Technology and Engineering Center percolation ponds.

130 ft, water was dripping down the inside of the casing, and at 170 ft, water was observed cascading down the borehole. Hole C, drilled in June 2000 and approximately 1 month after flow in the channel ceased, showed wet borehole walls from 110 to 235 ft bls and cascading water from a rubble zone at 235 ft.

The ICPP-MON-A-167, located approximately 1,800 ft from the channel, was drilled in May 2000. There was no mention of water or wetness in the borehole during drilling; however, a video log taken in June 2000 showed water cascading from the borehole walls at 198 ft bls.

Wells ICPP-MON-A-166 (located approximately 2,900 ft from the channel) and ICPP-MON-A-165 (located approximately 4,000 ft from the channel) were drilled in March/April 2000. In video logs taken in April and May, there was no cascading water in the holes. In boreholes drilled immediately adjacent to the river channel in September and October 2000, cascading water was not present after river flow ceased.

A series of three deep coreholes (ICPP-SCI-A-213, 214, and 215) were drilled in September and October 2000. In ICPP-SCI-A-213, located approximately 200 ft from the channel, moisture was observed in an interbed at 57–66 ft bls. In ICPP-SCI-A-214, located approximately 1,450 ft from the channel, a video log taken in September showed very wet borehole walls between 108–321 ft bls. Another video log of the same hole taken in February 2001 demonstrated that some drying or draining had occurred because borehole walls were wet only between 214–224 ft and 280–307 ft bls. In ICPP-SCI-A-215, located 2,400 ft from the channel, a video log taken in October 2000 showed very wet borehole walls from 190 ft down to the water table. At 299 ft, a small stream of water was squirting into the borehole. In a later video log of the same hole taken in February 2001, borehole walls were much less wet, but the stream of water at 299 ft was still present 9 months after flow in the river ceased.

Measurements of perched water in completed wells occurred in January and February 2001. In wells completed in the first interbed, approximately 150–170 ft bls, all but two wells were dry during two measurement events. The distance of the perched water wells from the river ranged from less than 100 to over 2,200 ft. In January 2001, water was detected in ICPP-MON-V-194, located approximately 1,300 ft from the river. Approximately 10 ft of standing water was measured in ICPP-MON-V-202, located approximately 1,400 ft from the river during the same month. However, during the second measurement event in February 2001, the standing water in both wells had dissipated and the wells were dry. Video logs of the open holes were not available. These detections of water could be attributed to the Big Lost River or to water injected into the boreholes during drilling. No other perched water was detected in the VZRP perched water wells until the ponds began to receive service wastewater in 2002.

Unsaturated zone monitoring instrument packages were installed in wells surrounding the VZRP to observe the development and movement of perched water associated with new percolation pond discharges. Preliminary data, collected from several instruments beginning several months prior to August 2002 (the beginning of permanent discharges to the ponds) and through the present, suggest that residual saturation existed in some areas beneath the ponds prior to August 2002. Data from the ICPP-SCI-V-189 and ICPP-SCI-V-214 wells show preoperational saturated conditions. Well 189, on the northern bank of the Big Lost River, shows saturation at 103 ft bls, approximately 2,800 ft north of the percolation ponds. Well 214, located approximately 1,300 ft from the river channel, shows saturation at 118, 128, and 180 ft bls. This saturation is probably residual from the last Big Lost River flows occurring in May 2000, but residual drilling water cannot be ruled out as a contributor. After discharge to the ponds began, instrumentation located in Well 189 appeared to respond to pond discharges; however, similar signatures do not appear in the data from Well 214, which is much closer to the ponds.[c]

If the responses in Well 189 are discharge associated, then it may be assumed that the distance between the well and the center of the pond complex (approximately 2,800 ft) provides some information regarding the extent of perched water lateral spread. However, comparison to data from Well 214, located 1,300 ft from the pond, suggests that lateral spread of perched water occurs at the 100-ft interval but not between 118 and 180 ft bls in this particular location. The monitoring intervals are only 15 ft different vertically, which may indicate that the perched water is following preferred pathways rather than forming a continuous pancake layer.

3.2 Big Lost River Influence on Idaho Nuclear Technology and Engineering Center Wells

Hydrologic connections between the major INTEC area recharge sources and perched water bodies beneath the former percolation ponds and the tank farm (north of the ICDF) were evaluated in the *Phase I Monitoring Well and Tracer Study Report Operable Unit 3-13, Group 4, Perched Water* (DOE-ID 2003). The evaluation was based on long-term records of water-level fluctuations in perched water wells, Big Lost River flow history, and pond discharge records. Some wells showed rapid fluctuations over short reports of time and these fluctuations tended to be common within groups of wells completed in the same similar hydrogeologic units. Wells with similar water-level fluctuations were grouped together and then the fluctuations were grouped together and then the fluctuations were compared to historical flow or discharge data for each potential recharge source. A time-series analysis of the potential recharge sources and of selected wells identified the dominant frequencies of potential recharge events and water-level fluctuations observed in the monitoring wells. The results of the recharge source analysis showed positive correlations between perched water levels in the northern perched water zone to flow in the Big Lost River, as far away as 2,500 ft from the channel in Wells 55-06 and MW-4. However, this finding does not rule out that some of the recharge comes from other sources such as infiltrations of precipitation and melting of snow and ice during spring thaw.

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[c]. Unpublished data via verbal communication between Shannon Ansley and Kristine Baker, March 26, 2003.

4. CONCLUSIONS AND PATH FORWARD

Data from an extensive perched water and groundwater investigation in the vicinity of the new ICDF landfill and evaporation ponds have been collected and evaluated. In addition, data have been summarized from other programs that have been monitoring drain out of the perched water from the former percolation ponds and formation of perched water from the new percolation ponds, and investigating sources of perched water under INTEC. Synthesis of these data has confirmed that the former percolation ponds were the source of perched water at the ICDF and that there is no continuous or extensive perched water body under the ICDF. The perched water bodies have rapidly drained since discharges to the former percolation ponds ceased, and remnant perched water occurs in small isolated pockets of low conductivity that are draining at a slower rate. In addition, the ICDF is located sufficiently far from the Big Lost River that a persistent perched water body has not formed and is not expected to form when the river flows again. Water levels will be routinely monitored and if there is a change in a water level trend, the Agencies will be notified and the water sampled. The following sections summarize the conclusions and path forward and provide justifications to support the Agency decision not to add isolated remnant pockets of dissipating perched water to the detection monitoring network for the uppermost aquifer at this time.

4.1 ICDF Perched Water

The data presented in this report support the following conclusions:

- Low yield: The ICDF perched water occurs in small isolated pockets of remnant perched water that are draining. Presently, only one ICDF perched water well is capable of supplying sufficient water for sampling and it is expected to go dry in the near future because there is no longer a source to sustain the perched water. Yield to this well appears to be extremely low and it is very slow to recover from sampling events as suggested by the hydrograph.

- Hydraulic connectivity between perched water and the SRPA: The perched water in the vicinity of the ICDF, which was found in discontinuous remnant pockets of water, has been rapidly dissipating since the water source was shut off. It is very unlikely that the remnant perched water pockets are hydraulically connected to the SRPA because over 75 ft of unsaturated basalt exists between the perched water and the aquifer. It is very unlikely that pumping in the aquifer would have any effect on the water level in the perched water well or vice versa.

- Limited horizontal extent and vertical flow: Because the former percolation ponds at the ground surface were the source of perched water to the ICDF and the perched water wells are draining, flow is predominantly vertical as would be expected in the unsaturated zone. Because the deep perched water well has a high hydraulic head and no perched water was found in adjacent wells, the perched water is likely very steeply dipping in all directions from this perched water mound.

The perched water on the eastern edge of the ICDF originated from a surface source that no longer exists, and it occurs in isolated relic pockets that are draining and cannot reliably provide sufficient water for routine sampling. The flow regime is predominantly vertical and has limited horizontal extent. Therefore, the Agencies have determined that there is currently insufficient perched water to consider the perched water an uppermost aquifer or add it to the detection monitoring program at this time. The uppermost aquifer is considered to be the SRPA at this time and a detection monitoring system has already been installed in the SRPA.

4.2 Influence of the Big Lost River on the ICDF

The last time there was flow in the Big Lost River channel, which is over 3,200 ft from the ICDF Complex, was May 2000. At the INEEL VZRP, perched water attributed to river flow was observed in wells drilled as far away as 1,800 ft from the channel. In the northern part of the INTEC facility, perched water responses from river flow may occur as far away as 2,500 ft from the channel in Wells 55-06 and MW-4 (DOE-ID 2003). However, the INTEC investigation was not able to rule out other factors that could have caused the water level responses and Big Lost River flow, such as infiltration of precipitation and melting of snow and ice during the spring thaw.

It is not expected that flow from the Big Lost River will extend under the ICDF when the river begins to flow again based on the maximum horizontal influence of the river observed at these other sites. Additionally, there is no continuous perched water body under the ICDF, which represents the long-term effect of many years with and without flow in the river. When the Big Lost River begins to flow, transducers will be installed in the westernmost wells, ICPP-1802 and ICPP-1781, in accordance with the *ICDF Complex Groundwater Monitoring Plan* (DOE-ID 2002).

In the event that future flow in the Big Lost River causes perched water to form in the ICDF wells, the well(s) will be sampled. If the perched water persists, recharge controls would be implemented. The Final Record of Decision (DOE-ID 1999a) states that "…if after 5 years, the perched water zones are not draining out as predicted by the RI/FS model then additional recharge controls will be implemented. Additional controls may include: lining, or equivalent, the Big Lost River…" If the Big Lost River flows were to reach the ICDF wells, there would be a lot of other sites closer to the river within the INTEC facility that would also be affected, and recharge controls would be required.

4.3 Conclusions

Perched water chemistry along with evaluation of water levels over time, observations during drilling, interpretation of lithologic logs, and evaluation of recharge sources (Big Lost River, percolation ponds, and other potential sources) were used to determine the nature and extent of perched water under the ICDF. Data from nearby facilities (INTEC and the VZRP, collocated with the new INTEC percolation ponds) were compiled to help understand the occurrence and continuity of perched water zones and help predict the impact of Big Lost River flow on ICDF perched water. All these data were then used to determine the appropriateness of adding the perched water wells to the ICDF detection monitoring network.

Formation of perched water near the ICDF Complex has been linked both physically and chemically to infiltration of an extremely large volume of wastewater discharged to the former INTEC percolation ponds. Discharges to these ponds terminated on August 26, 2002, and the associated perched water bodies beneath these ponds are draining. Most of the perched water wells at the ICDF either did not encounter perched water or no longer contain perched water. No continuous layer of perched water was identified under the ICDF at any depth.

Currently, the lateral boundary of remnant perched water has receded to the eastern edge of the ICDF Complex. Recent well data confirm that the shallowest perched water bodies have drained around the ICDF. In the intermediate and deep perched water bodies, only isolated pockets remain in the vicinity of the ICDF and only one of these has sufficient water for sampling. This well is expected to go dry in the near future as it continues to drain. There are no other known recharge sources near the ICDF sufficient to create a persistent or continuous perched water body.

Four rounds of baseline water samples were analyzed from three ICDF perched water wells installed in 2002. The baseline samples were collected shortly after the percolation ponds were taken off-line, when there was still 9 to 40 ft of water in the wells. Since that time, water levels have dropped significantly in all wells. It is possible that contamination from other potential sources near the ICDF is masked because of the large volume of water in the unsaturated zone from the percolation ponds. If another source (not the percolation ponds or the ICDF) contributes contamination to the perched water near the ICDF, long-term data may show statistically significant increases in contaminant concentrations that may have no relation to the performance of the ICDF. Under any of these scenarios, it would be difficult to prove that the ICDF landfill and evaporation ponds were not leaking, and a tremendous expenditure of funds could occur from false positive results.

The Agencies have agreed that isolated pockets of remnant perched water on the eastern edge of the ICDF will not be added to the existing detection monitoring network in the uppermost aquifer at this time. Perched water levels will be monitored before routine SRPA sampling. If the trend in perched water levels changes, the perched water will be sampled during routine sampling, if sufficient water exists, to determine the source of the water. Future data from these wells, when used with other lines of evidence such as leachate data, might detect a release from the ICDF. However, statistical analysis of the data to determine an exceedance will be complicated or not possible on formerly dry wells because there may not e baseline data to compare with or the source of the water may not be comparable because it is from a different source (i.e., not from the former percolation ponds, which forms the baseline data set). Therefore, it may not be possible to analyze perched water data according to 40 CFR 264, Subpart F statistical methods. The concepts of upgradient and downgradient do not apply to perched water bodies beneath the ICDF because the primary source originated from the ground surface and the flow regime is predominantly vertical. The terms upgradient and downgradient are meaningless for a mounded perched water body originating from a surface point source, with limited lateral extent, that is dipping in all directions from the center of a mound. Because of the unreliable yield of perched water wells, limited extent of perched water in isolated remnant pockets, and the drain out that is occurring, the perched water at the ICDF does not meet the regulatory definition of the uppermost aquifer at this time.

4.4 Path Forward

The Agencies have agreed to the following path forward:

- Monitor water levels using a transducer at the ICPP-1804L perched water well until it is dry.
- Routinely monitor water levels at all perched water wells. If there is a change in water level trend, the Agencies will be notified and the water sampled.
- The existing detection monitoring network in the uppermost aquifer, which is the SRPA at this time, is currently adequate.

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