# Plate 1
## Comparison of Geophysical Logging, Lithology, and Well Completion Information for 4PD

Depth 1in:50ft

Natural Gamma (Open Hole, GLS): 0 counts per second 250
Gamma (Century): 0 API - Gamma Ray 350

Caliper: 5 inches 10

Lithology / Unit Name and Description

Resistivity (8-inch): 2 ohm-meters (log scale, 2 decades) 200
Resistivity (16-inch): 2 ohm-meters (log scale, 2 decades) 200
Resistivity (32-inch): 2 ohm-meters (log scale, 2 decades) 200
Resistivity (64-inch): 2 ohm-meters (log scale, 2 decades) 200

Spontaneous Potential: -100 millivolts 100
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Compensated Density (long spaced, Century): 1 grams per cubic centimeter 4
Compensated Density (short spaced, Century): 2 grams per cubic centimeter 4

Compensated Neutron (near, Century): 4000 counts per second 12000
Compensated Neutron (far, Century): 0 counts per second 6000

Differential Temp Run #2: -0.01 degrees Celsius 0.01
Differential Temp Run #3: -0.01 degrees Celsius 0.01

Fluid Temperature Run #2: 28 degrees Celsius 38
Fluid Temperature Run #3: 28 degrees Celsius 38
Fluid Resistivity Run #2: 4 ohm-meters 6
Fluid Resistivity Run #3: 4 ohm-meters 6

Sonic Delta T: 220 microseconds per foot 20

Sonic RX1-1A: 0 1028
Sonic RX2-1A: 0 1012
Sonic RX1-1A - dt: 0 1028
Sonic RX2-1A - dt: 0 1012

Well Completion: 21 21

Depth 1 in:50 ft

NOTE: DIFFERENT SCALES USED FOR NEAR AND FAR SPACING FOR CLARITY

NOTE: LOG CURVES NONCONTINOUS DUE TO SEPARATE LOGGING RUNS

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(0 to 165 ft) WELL-GRADED SAND WITH GRAVEL (SW) INTERBEDDED WITH WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM):
Unit consists of predominantly thick layers of well-graded sand with gravel (SW) up to 30 ft thick interbedded with thinner layers of well-graded sand with silt and gravel (SW-SM) up to 15 ft thick. The two thickest layers of well graded sand with gravel occur from 35 to 65 ft and at the base of the unit from 140 to 165 ft. Three thin gravelly layers occur at the top of the unit from 10 to 15 ft, in the middle at 95 to 100 ft, and within the basal interval from 145 to 150 ft. Fines in the unit have no plasticity. Gravel clasts are volcanic in origin, subrounded to subangular from surface to 105 ft, and angular from 105 to 165 ft. Sediment color is variable and ranges from brown (10YR 5/3) to light brown (7.5YR 6/3) to reddish-brown (5YR 4/3 and 5/3) to light reddish-brown (5YR 6/4). Unit is not generally cemented, but cementation was observed from 65 to 70 ft, 100 to 120 ft and at the base of the unit from 160 to 165 ft. Sample reaction to 10 percent (%) hydrochloric acid (HCl) is predominantly weak, but strong reactions occur from 5 to 15 ft, 45 to 50 ft, 105 to 120 ft, and at the base of the unit from 160 to 165 ft. All samples were wet due to drilling methods.

(165 to 255 ft) WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM) GRADING INTO WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM):
Upper part of the unit from 165 to 215 ft consists of well-graded gravel with silt and sand (GW-GM) and contains thin layers of well-graded sand with silt and gravel (SW-SM) and well-graded gravel with sand (GW). The lower part of the unit, from 215 to 255 ft, consists of well-graded sand with silt and gravels (SW-SM) and contains thin layers of well-graded gravels with silt and sand (GW-GM). Layering in both upper and lower parts is 5 to 10 ft thick. Fines are nonplastic from 165 to 215 ft and have low plasticity from 215 to 255 ft. Gravel clasts are volcanic in origin and range in shape from angular to subrounded. Sediment color ranges from reddish-brown (5YR 5/3 and 5/4) to brown (7.5YR 5/3). Cementation is variable from none to moderate from 165 to 235 ft and moderate from 235 to 255 ft. Sample reaction to 10% HCl is variable, ranging from none to strong from 165 to 235 ft and strong from 235 to 255 ft. All samples were wet due to wet drilling methods.

(255 to 305 ft) WELL-GRADED GRAVEL WITH SILT AND SAND (GW-GM):
Unit consists of a thick, uniform, well-graded gravel with silt and sand (GW-GM). Unit contains one thin (5 ft) layer of sand with silt. Fines have low plasticity. Gravel clasts are volcanic in origin, predominantly subrounded from 255 to 275 ft and range from rounded to angular from 275 to 305 ft. Sediment color is predominantly reddish-brown (5YR 5/4). Cementation ranges from moderate to weak. Sample reaction to 10% HCl is weak to strong. All samples were wet due to wet drilling methods.

(305 to 390 ft) WELL-GRADED GRAVEL WITH CLAY AND SAND (GW-GC) INTERBEDDED WITH WELL-GRADED SAND WITH CLAY AND GRAVEL (SW-SC):
Unit consists predominantly of thin layers of well-graded gravel with clay and sand (GW-GC) approximately 5 ft thick interbedded with thin layers of well-graded sand with clay and gravel (SW-SC) ranging from 5 to 10 ft thick. Two 5-ft-thick layers of silty sand occur at 305 to 310 ft and 320 to 325 ft. A 5-ft-thick layer of well-graded gravel occurs 355 to 360 ft. Fines increase in the basal section of the unit from 360 to 390 ft with clayey sand predominating. The basal section also contains a 5-ft-thick layer of well-graded gravel with clay from 365 to 370 ft and a 5-ft-thick layer of clayey gravel from 375 to 380 ft. Fines have low plasticity. Gravel clasts are volcanic and subrounded to subangular. Color of sediment is brown (5YR 4/3 and 5/4) from 305 to 385 ft and light brown (7.5YR 6/4) at the base of the unit from 385 to 390 ft. Cementation is weak to moderate from 305 to 365 ft and no cementation was observed from 365 to 390 ft. Samples react weakly to strongly with 10% HCl from 305 to 365 ft, and display no reaction from 365 to 390 ft. From 305 to 340 ft samples were wet due to wet drilling methods; however, the borehole began producing water at a depth of about 340 ft, so samples below 340 ft contain natural moisture.

(390 to 515 ft) SANDY LEAN CLAY WITH GRAVEL (CL) AND CLAYEY SAND (SC):
Unit consists of four intervals: a thick layer of sandy lean clay (CL) from 390 to 420 ft; clayey sand (SC) from 420 to 445 ft; several thinly bedded and alternating layers of sandy lean clay (CL) and clayey sand (SC) with thicknesses ranging from 5 to 10 ft from 445 to 490 ft; and a thick layer of clayey sand (SC) from 490 to 515 ft. The base of the unit from 505 to 515 ft is gravelly. Fines have moderate plasticity throughout. Gravel clasts are volcanic in origin and subangular in shape. Sediment color ranges from moderate brown (5YR 4/4) to light brown (5YR 6/4 to 5YR 5/6) to pale yellowish-brown (10YR 6/2) to pale reddish-brown (10R 5/4). Weak cementation is present throughout the interval. Samples react strongly to 10% HCl. All samples were wet. The interval from 390 to 410 ft may represent a deeply weathered (clayey) primary tuffaceous volcanic unit. The tuff color is light brown (7.5YR 6/4). The tuff contains a trace amount (less than 1%) of small (less than 0.5 mm) quartz crystals and manganese coatings on the matrix. Tuff is nonwelded with an open and porous matrix. From 410 to 515 ft, the material appears to be a reworked tuff with an alluvial gravel component and an argillic ashy matrix. The color of the reworked interval is reddish-brown (5YR 4/3).

(515 to 660 ft) WELL-GRADED GRAVEL WITH CLAY AND SAND (GW-GC) GRADING INTO WELL-GRADED SAND WITH CLAY AND GRAVEL (SW-SC):
The upper part of the unit from 515 to 545 ft consists of well-graded gravel with clay and sand (GW-GC) and fines downward into a sequence of well-graded sand with clay and gravel (SW-SC) from 545 to 660 ft. Gravel clasts are volcanic in origin, subangular from 515 to 540 ft, and angular from 540 to 660 ft. Fines have moderate to high plasticity. Sediment color ranges from grayish-red (10R 4/2) to light brown (5YR 6/4 to 5YR 5/6) to grayish-orange (10YR 7/4). Cementation is weak to moderate throughout most the interval, but is strongly cemented and hard from 620 to 640 ft. Heavy grain coatings of fine to medium sand are prevalent on clasts within the strongly cemented interval. Sample reaction to 10% HCl ranges from none to weak from 515 to 620 ft, is strong in the well-cemented interval from 620 to 640 ft, and is weak from 640 to 660 ft. All samples were wet.

(660 to 740 ft) CLAYEY SAND (SC) WITH INTERBEDS OF SANDY LEAN CLAY (CL):
The upper part of the unit, from 660 to 700 ft, consists of thin layers of clayey sand (SC), ranging in thickness from 5 to 15 ft, interbedded with 10-ft-thick layers of sandy lean clay (CL). The lower part of the unit, from 700 to 740 ft, consists of a fining-downward sequence of clayey sand with very few gravels (less than 5%). Fines have high plasticity. Gravel clasts are volcanic and rounded in shape. Color of sediment is a uniform light brown (5YR 6/4). The interval is weakly to moderately cemented and weakly indurated. Samples react strongly to 10% HCl. All samples were wet. This clay-rich sequence may represent a reworked and weathered tuffaceous volcanic deposit. Matrix clay is likely altered ash mixed with fine- to medium-grained, very well rounded sand. Gravel clasts are predominantly small (0.5 mm) with a few larger clasts present (5 mm) and have subrounded surfaces. The gravels may include lithic clasts derived from the tuff.

(740 to 1,110 ft) SAND WITH CLAY AND GRAVEL INTERBEDDED WITH GRAVELLY SAND AND CLAYEY SAND:
Interval from 740 to 880 ft consists of poorly graded sand with gravel and clay with a thinly laminated sequence of siltstone and claystone from 850 to 880 ft. The remaining interval, from 880 to 1,110 ft, is a fining-downward sequence of sandy sediments. The interval from 880 to 970 ft has coarse volcanic gravel clasts and the interval from 970 to 1,030 ft has finer and more rounded gravel clasts. These gravels include non-volcanic clasts such as siltstone, sandstone, and quartzite. From 1,030 to 1,070 ft the sequence becomes finer and softer and may be a clayey sand with gravel. The lowermost interval in the sequence from 1,070 to 1,110 ft is layers of cemented and thinly bedded (laminated) sandstone, siltstone, and claystone. Fines have high plasticity, except for the uppermost part of the interval from 740 to 770 ft, where they are nonplastic. Color of sediment is light brown (5YR 6/4) to light reddish-brown (5YR 6/3). Samples react strongly to 10% HCl. All samples were wet.

(1,110 to 1,265 ft) LAYERED SEQUENCE OF GRAVELLY SAND WITH SANDY AND SILTY LAYERS:
Unit is composed primarily of gravelly sand beds with numerous interbeds of sandy and silty sediments. The fine layers range in thickness from 10 to 30 ft. The upper part of the interval, from 1,110 to 1,180 ft, displays more layering than the lower part and consists of coarse gravelly sands (possibly cobbles and boulders) interbedded with sandy and silty layers. Below 1,180 ft, a more uniform sedimentary sequence is present. From 1,210 to 1,265 ft the sediments coarsen downward. Fines have low plasticity. The gravels are subangular to subrounded and composed of several clast types including volcanic tuff, siltstone, sandstone, and quartzite. Tuff clasts predominate but quartzite clasts are abundant throughout the interval. Clasts may be as large as cobbles and boulders. Sediment color is reddish brown (5YR 5/3 to 5YR 5/4). Heavy grain coatings (1 to 5 mm) are prevalent on gravel clasts throughout the interval, indicating that the unit is well cemented. Samples react strongly throughout to 10% HCl. All samples were wet.

(1,265 to 1,355 ft) SILTY SAND WITH GRAVEL:
Unit is composed of three distinct layers of silty sand with gravel. From 1,265 to 1,290 ft the sediment is silty, fine- to medium-grained sand with fine gravels. From 1,290 to 1,320 ft gravels become coarse grained and increase in abundance. From 1,320 to 1,355 ft the sediment becomes slightly finer, with gravel content and size decreasing. Fines in the interval are non-plastic. Sediment color is reddish brown (5YR 5/3 to 5YR 5/4). The unit is well cemented with heavy grain coatings up to 5 mm on gravel clasts. Samples react strongly to 10% HCl throughout the interval. All samples were wet.

(1,355 to 1,400 ft) WELL-CEMENTED SAND AND GRAVEL:
Unit consists of well-cemented, fine-to-medium grained, poorly graded sand with gravel. The upper contact at 1,355 ft is marked by the presence of coarse basalt gravels. Sand grains are very well rounded. Sediment color is brown (10YR 5/3). Gravel clasts are predominantly basalt with fewer clasts of volcanic tuff. Basalt clasts are reddish black (10R 2.5/1) and contain a trace of white (N9) zeolitic coatings. Only one type of tuff is represented and is pinkish white (7.5YR 8/2) in color, nonwelded, crystal rich, pumice poor, and contains no lithics. The unit is well cemented, and samples react strongly to 10% HCl. All samples were wet.

(1,400 to 1,430 ft) BASALT LAVA FLOW:
Basalt lava flow is reddish black (7.5YR 8/2) in color with abundant fine white (N9) feldspar phenocrysts and is vesicular, fractured, and has a glassy groundmass. Vesicles constitute about 5% of the rock, are irregularly shaped, are up to 2 mm in diameter, and are commonly partially filled with calcite. Phenocrysts are very small and consist of approximately10% lath-shaped feldspar phenocrysts up to 0.5 mm in length, less than 2% hornblende up to 1 mm long, and 1 to 2% pyroxene up to 2 mm in length. Crystals and matrix are weakly weathered and oxidized reddish-orange (10R 6/6). Top and bottom of flow display greatest degree of weathering. Basalt also contains traces of white (N9) zeolitic mineral coatings on fracture surfaces, is hard and drilled very slowly, and reacts strongly to 10% HCl. All samples were wet.

(1,430 to 1,490 ft) SANDSTONE:
Interval consists of well-cemented clayey sandstone. Sand is well sorted, well rounded, and composed of predominantly dark reddish-brown basaltic grains that are 1 to 5 mm in diameter and rare light gray (N7) quartz clasts 1 to 2 mm in diameter in a pale yellow clayey matrix. Samples contain large fragments, up to 1 cm in length, of cemented sand grains. Color of the sediment is reddish brown (5YR 6/4, 5YR 3/2) and brown (7.5YR 5/2) to pale yellow (5Y 7/3). Samples react strongly to 10% HCl. All samples were wet. Sandstone is interpreted as an epiclastic unit deposited between basaltic flow horizons and accumulating within depressions on the surface of the underlying basalt flow.

(1,490 to 1,540 ft): BASALT LAVA FLOW:
Dark reddish brown (5YR 3/2) basalt is similar to the basalt described above at 1,400 to 1,430 ft. There are two significant differences between the two basalt flows that are recognized. Although both basalt flows have weathered and oxidized zones at the top and bottom, the core of the lower basalt flow (from approximately 1,500 to 1,535 ft) is thicker. The other difference is the presence of a well-developed flow-breccia zone at the bottom of the lower basalt flow (1,535 to 1,540 ft). Samples react weakly to 10% HCl. All samples were wet.

(1,540 to 1,775 ft) WELL-GRADED SAND WITH CLAY AND GRAVEL GRADING INTO CLAYEY SAND:
Unit is a fining-downward sequence of well-graded sand with clay and gravel from 1,540 to 1,630 ft grading into clayey sand from 1,630 to 1,775 ft. Both the upper and lower intervals contain tuffaceous sand and gravel clasts. Sand in the upper interval is well rounded and fine to coarse grained and gravels are volcanic in origin, up to 15 mm in diameter, and composed of roughly equal proportions of welded and nonwelded tuff lithologies. In the lower and finer interval, from 1,630 to 1,775 ft, gravel clasts are smaller (less than 5 mm) and gravel content decreases. Sediment color ranges from light-brown (7.5YR 6/4) to reddish brown (5YR 4/3). The welded tuff clasts are predominantly light reddish-brown (5YR 6/3) and angular. The nonwelded clasts are more heterolithic, range in color from pink (5YR 8/4) to light red (2.5YR 7/8) to light greenish-gray (5GY 8/1) to very pale brown (10YR 8/3), and are distinctly rounded to subrounded. Fines in the upper, coarser, interval display low plasticity. Fines in the lower interval have moderate to high plasticity. Thick grain coatings on clasts suggest that both intervals are at least weakly cemented. A thin (less than 5ft) reddish-brown (5YR 5/4), deeply weathered, oxidized, and clayey layer at the top of the unit may be a paleosol. Samples react strongly to 10% HCl. All samples were wet.

(1,775 to 1,860 ft) ASH-FLOW TUFF:
Tuff is pale yellow (2.5Y 8/4) to very pale brown (10YR 7/3), soft, nonwelded, devitrified, and contains distinctive white (N8) pumice. Pumice constitutes approximately 10% of the tuff, averages 3 mm in length, is predominantly vitric and has a wispy texture. Much of the pumice has been plucked, leaving cavities in the matrix. Pumice has fragmented boundaries. Overall the tuff is crystal and lithic poor. Mafic minerals are black (N 2.5), mostly manganese oxide, comprise from 1 to 3% of the tuff, and are disseminated throughout the matrix. Quartz crystals are small (1 mm), clear, comprise approximately 1% of the tuff, and occur as rounded or boxy grains. Lithics are rare, reddish-gray (5YR 5/2), and occur as small (1 to 2 mm) angular clasts. From 1,820 to 1,860 ft the tuff is slightly weathered and brownish (10YR 7/3) in color. From 1,840 to 1,860 ft the tuff is argillic. The upper contact with valley-fill sediments is sharp. Samples are nonreactive with 10% HCl. All samples were wet.

Drafted By RAM, JSW Checked By LK Approved By LK

Data Sources: Geophysical logs run by Century Geophysical Corporation and Geophysical Logging Services Inc. Century Geophysical logs run in cased hole. Measurements are not corrected for borehole deviation. Some geophysical logs may have been censored for this report. Geologic logging and interpretations performed by Nye County staff and contract geologists.

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