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Summary of R-35a and R-35b Data from the First Characterization Round

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1.0 BACKGROUND

This summary was prepared in response to a request from the Los Alamos Site Office, dated November 21, 2007 (DOE 2007, 099116), to "assess the capability of newly constructed wells R-35a and R-35b to provide reliable and representative groundwater samples."

The paired well configuration of R-35a and R-35b was intended to determine whether chromium contamination is present in regional groundwater near PM-3, and if so, to evaluate if chromium concentrations vary with depth. If chromium contamination is not present, the R-35 wells will serve as sentry wells for PM-3. The drilling objectives were to drill and install two separate single-screened regional aquifer monitoring wells.

The R-35b borehole was drilled to a total depth (TD) of 897.6 ft below ground surface (bgs) in the Santa Fe Group volcanic sediments. A well was installed with a screened interval between 825 and 848 ft bgs. The R-35a borehole was drilled to a TD of 1143 ft bgs in the Miocene basalt. A well was installed with a screened interval between 1013 and 1062 ft bgs in the Santa Fe Group.

Dual-rotary drilling techniques were used to drill both R-35 boreholes. The dual-rotary method used air- and fluid-assisted air to evacuate cuttings from the boreholes. Drilling fluids included municipal water and a mixture of municipal water with Baroid AQF-2 foaming agent within the Cerros del Rio basalt in the vadose zone. No additives other than municipal water were used within the regional groundwater system.

During construction of the well, approximately 1200 gal. of high-solids bentonite grout loss to the formation was recorded at R-35a (LANL 2007, 098129). Bentonite in the sump is thought to either have entered through the screen via transport through the formation or along the filter pack and into the screen. Although a small amount of bentonite (~2 gal.) was recovered from the well sump, it was assumed that the majority of this lost material entered a permeable zone or zones within the aquifer (LANL 2007, 098129). As R-35a was developed, samples were collected and analyzed for a series of constituents to evaluate for the presence of residual bentonite, following methods established in the Laboratory's "Well Screen Analysis Report, Revision 2" (LANL 2007, 096330).

2.0 APPROACH

The first characterization sample following development was collected on August 29, 2007, at R-35b and on August 30, 2007, at R-35a. The assessment performed for this report uses the established methods of the "Well Screen Analysis Report, Revision 2" (LANL 2007, 096330) as employed in the automated data qualification module (DQM). The DQM subjects a groundwater quality sample to 45 tests in seven categories. Table 1 lists the test outcomes for R-35a. The table shows that R-35a passed 35 tests and failed boron, chloride, sulfate, total organic carbon, manganese, barium, magnesium, iron (total), iron ratio (total/dissolved), and one of the zinc tests. Table 2 lists the test outcomes for R-35b. Table 2 shows that R-35b passed 42 out of 43 tests, where nitrate-nitrite as nitrogen and perchlorate were not included as tests because they are known contaminants at this location.

3.0 INTERPRETATION OF RESULTS

Table 3 provides a summary of evaluation outcomes for R-35a. Failure of tests indicating above-threshold concentrations of boron, chloride, and sulfate indicates the presence of residual inorganic products in this sample. Failure of total organic carbon indicates the presence of residual organic products. Failure of manganese indicates that manganese reduction is occurring in this sample. Failure of barium and

magnesium shows that this sample is outside the bounds of equilibration with carbonate minerals in the regional aquifer, as established by background values. Steel corrosion is possible (although unlikely, given that R-35a is a new well), as shown by the failed total iron and iron ratios. The failure of zinc as a general indicator is insignificant because very frequently the first characterization sample from a well screen shows exceptionally high levels of zinc that decrease markedly in subsequent samples. Conceptual models have been developed to explain this decrease, but elaboration of these models is outside the scope of this report.

The presence of residual bentonite is usually indicated by failed tests of sodium and sulfate. Only sulfate failed in this R-35a sample. Nevertheless, the manganese-reducing conditions and carbonate mineral instability indicate that this one sample is not representative of the regional aquifer unless local background in the Santa Fe Group, where this well is screened, differs from the statistically averaged background of the regional aquifer under the Pajarito Plateau. Background values do not exist, and probably never will exist, for individual stratigraphic units.

The high unfiltered iron and iron ratio (total/dissolved) in this R-35a sample may be caused by the presence of colloids. To investigate this possibility, samples from the second watershed sampling campaign were collected and passed through filters sized at 0.45 µ, 0.20 µ, and 0.02 µ to see whether the colloidal fraction is present and what size may be present in the colloidal fraction. The Laboratory is waiting for these analytical results.

Table 3 also provides a summary of evaluation outcomes for R-35b. A somewhat higher level of confidence in the overall condition of R-35b results from the sample passing every one of the indicator tests except the insignificant zinc test. Groundwater redox conditions are oxic at R-35b, as is expected in the regional aquifer and no residual organic or inorganic constituents are present.

Table 4 presents the capability of R-35a and R-35b to detect selected chemicals of potential concern (COPCs), based on the methodology employed by the well screen analysis embodied in the DQM. Based on this assessment for this one sample, R-35b unequivocally provides reliable and representative groundwater quality and is capable of detecting the listed chemicals. The ability to detect the listed chemicals is considerably less certain for R-35a. It should be noted that a well does not need to be able to detect all COPCs, only those that it can detect to meet its objectives. Wells R-35a and R-35b were designed in a location and at depths appropriate for detecting chromium. Based on this one analysis, R-35b meets this objective perfectly. Because of the ambiguity described above, the same cannot be said for the R-35a sample.

4.0 SUMMARY

- Only one characterization sample has been collected. A minimum of three samples is needed to determine with high confidence whether the chemistry at the screen has stabilized after the completion of well development.
- Using the well screen analysis method as employed in the DQM, R-35b can provide reliable water quality that is representative of the regional aquifer. R-35b can also detect the COPCs that it is intended to detect. This conclusion can be stated only with moderate confidence because it is based on only one analysis.
- Using the reasoning above, R-35a is not fully representative of the regional aquifer and has a low confidence of being able to accurately detect most COPCs, including chromium. It appears that residual bentonite may attribute to this condition, but manganese-reducing conditions are also present.

- Future analyses will confirm or deny these conclusions. Investigation of the possible colloidal fraction at R-35a will also provide insights into reasons for failure of some of the tests.

5.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

DOE (U.S. Department of Energy), November 21, 2007. "Request for Assessment of R-35 Data," U.S. Department of Energy memorandum (EO:9MJ-001) to S.G. Stiger (LANL) from G.J. Rael (DOE-LASO), Los Alamos, New Mexico. (DOE 2007, 099116)

LANL (Los Alamos National Laboratory), May 2007. "Well Screen Analysis Report, Revision 2," Los Alamos National Laboratory document LA-UR-07-2852, Los Alamos, New Mexico. (LANL 2007, 096330)

LANL (Los Alamos National Laboratory), September 2007. "Completion Report for Regional Aquifer Wells R-35a and R-35b," Los Alamos National Laboratory document LA-UR-07-5342, Los Alamos, New Mexico. (LANL 2007, 098129)

Table 1
Data Qualification of Groundwater Sample from R-35a for Residual Effects of Drilling

Test #	Indicator	Field Prep		Result	Units	Lab Qual Code	Val Flag Code, Val Reason Code		Threshold Test	Test Outcome	Override Reason (if applicable)
Category A—Residual Inorganic Drilling/Construction Products											
A1	Boron	F		42.9	µg/L	J		<	42.00	Fail	
A2	Chloride	F		6.67	mg/L			<	3.80	Fail	
A3	Sodium	F		20.7	mg/L			<	29.00	Pass	
A4	Sulfate	F		6.64	mg/L			<	6.30	Fail	
A5	Fluoride	F		0.319	mg/L			<	0.53	Pass	
A6	Total Phosphate as Phosphorus	F	<	0.027	mg/L	J	U, l4a	<	0.09	Pass	
Category B—Residual Organic Drilling/Construction Products											
B1	Acetone	UF		3.35	µg/L	J	J-, VWQ9	<	5.00	Pass	
B2	Ammonia as Nitrogen	F	<	0.03	mg/L	U		<	0.05	Pass	
B3	Total Kjeldahl Nitrogen	F		0.063	mg/L	J		<	0.35	Pass	
B4	Total Organic Carbon	UF		1.25	mg/L			<	1.10	Fail	
Category C1—Sulfate-Reducing Conditions											
C1	Sulfate	F		6.64	mg/L			>	1.7	Pass	
C2	Sulfide	F			mg/L			<	0.01	ND*	
C3	Oxygen Reduction Potential	UF						>	0.00	ND	
Category C2—Iron/Manganese-Reducing Conditions											
C4	Vanadium	F		12.2	µg/L			>	3.8	Pass	
C5	Iron	F		32.1	µg/L	J		<	103	Pass	
C6	Manganese	F		18.9	µg/L			<	14	Fail	
C7	Perchlorate	F		0.304	µg/L			>	0.22	Pass	
C8	Uranium	F		0.94	µg/L			>	0.16	Pass	
C9	Chromium	F		2.4	µg/L	J		>	0.9	Pass	
Category C3—Nitrate-Reducing Conditions											
C10	Nitrate-Nitrite as Nitrogen	F		0.71	mg/L			>	0.15	Pass	
C11	Dissolved Oxygen							>	2	ND	
Category D—Adsorption											
D1	Uranium	F		0.94	µg/L			>	0.16	Pass	
D2	Strontium	F		162	µg/L			>	44	Pass	
D3	Barium	F		299	µg/L			>	4.6	Pass	

Table 1 (continued)

Test #	Indicator	Field Prep		Result	Units	Lab Qual Code	Val Flag Code, Val Reason Code		Threshold Test	Test Outcome	Override Reason (if applicable)
Category E—Carbonate Disequilibria											
E1	Barium	F		299	mg/L			<	70	Fail	
E2a	Calcium	F		21.1	mg/L			>	9.3	Pass	
E2b	Calcium	F		21.1	mg/L			<	25	Pass	
E3	Magnesium	F		5.36	mg/L			<	4.9	Fail	
E4	Strontium	F		162	µg/L			<	180	Pass	
E5	Uranium	F		0.94	µg/L			<	1.6	Pass	
Category F—Metal Corrosion											
F1	Iron (total)	UF		792	µg/L			<	500	Fail	
F2	Iron ratio (total/dissolved)			24.67	µg/L			<	10	Fail	
F3	Chromium (total)	UF		9.2	µg/L			<	10	Pass	
F4	Chromium ratio (total/dissolved)			3.83	µg/L			<	5	Pass	
F5	Nickel	F		1.8	µg/L	J		<	50	Pass	
F6	Turbidity				NTU			<	5	ND	
General Indicators											
Gen1a	pH	F		7.79	SU	H	J, I9	>	7.0	Pass	
Gen1b	pH	F		7.79	SU	H	J, I9	<	8.7	Pass	
Gen2	Alkalinity-CO_3+HCO_3	F		102	mg/L			<	106	Pass	
Gen3	Tritium	UF		0.447	pCi/L			<	1	Pass	
Gen4	Chromium	F		2.4	µg/L	J		<	6.7	Pass	
Gen5	Nitrate-Nitrite as Nitrogen	F		0.71	mg/L			<	0.8	Pass	
Gen6	Perchlorate	F		0.304	µg/L			<	0.5	Pass	
Gen7a	Zinc	F		185	µg/L			>	0.6	Pass	
Gen7b	Zinc	F		185	µg/L			<	40	Fail	

*ND = No data.

Table 2
Data Qualification of Groundwater Sample from R-35b for Residual Effects of Drilling

Test #	Indicator	Field Prep		Result	Units	Lab Qual Code	Val Flag Code, Val Reason Code		Threshold Test	Test Outcome	Override Reason (if applicable)
Category A—Residual Inorganic Drilling/Construction Products											
A1	Boron	F		27.3	µg/L	J		<	42.00	Pass	
A2	Chloride	F		2.8	mg/L			<	3.80	Pass	
A3	Sodium	F		14.6	mg/L			<	29.00	Pass	
A4	Sulfate	F		5.42	mg/L			<	6.30	Pass	
A5	Fluoride	F		0.419	mg/L			<	0.53	Pass	
A6	Total Phosphate as Phosphorus	F	<	0.043	mg/L	J	U, l4a	<	0.09	Pass	
Category B—Residual Organic Drilling/Construction Products											
B1	Acetone	UF	<	5.00	µg/L	U		<	5.00	Pass	
B2	Ammonia as Nitrogen	F	<	0.030	mg/L	U		<	0.05	Pass	
B3	Total Kjeldahl Nitrogen	F		0.030	mg/L	J		<	0.35	Pass	
B4	Total Organic Carbon	UF		0.859	mg/L	J		<	1.10	Pass	
Category C1—Sulfate-Reducing Conditions											
C1	Sulfate	F		5.42	mg/L			>	1.7	Pass	
C2	Sulfide	F			mg/L			<	0.01	ND[a]	
C3	Oxygen Reduction Potential	UF		190	mV			>	0.00	Pass	
Category C2—Iron/Manganese-Reducing Conditions											
C4	Vanadium	F		13.6	µg/L			>	3.8	Pass	
C5	Iron	F	<	25.00	µg/L	U		<	103	Pass	
C6	Manganese	F		15.9	µg/L			<	14	n/a[b]	n/a-LTD[c]
C7	Perchlorate	F		0.552	µg/L			>	0.22	Pass	
C8	Uranium	F		0.540	µg/L			>	0.16	Pass	
C9	Chromium	F		4.8	µg/L			>	0.9	Pass	
Category C3—Nitrate-Reducing Conditions											
C10	Nitrate-Nitrite as Nitrogen	F		1.27	mg/L			>	0.15	Pass	
C11	Dissolved Oxygen			4.8	mg/L			>	2	Pass	
Category D—Adsorption											
D1	Uranium	F		.540	µg/L			>	0.16	Pass	
D2	Strontium	F		76	µg/L			>	44	Pass	
D3	Barium	F		31.3	µg/L			>	4.6	Pass	

Table 2 (continued)

Test #	Indicator	Field Prep		Result	Units	Lab Qual Code	Val Flag Code, Val Reason Code		Threshold Test	Test Outcome	Override Reason (if applicable)
Category E—Carbonate Disequilibria											
E1	Barium	F		31.3	mg/L			<	70	Pass	
E2a	Calcium	F		15.1	mg/L			>	9.3	Pass	
E2b	Calcium	F		15.1	mg/L			<	25	Pass	
E3	Magnesium	F		4.54	mg/L			<	4.9	Pass	
E4	Strontium	F		76	µg/L			<	180	Pass	
E5	Uranium	F		.54	µg/L			<	1.6	Pass	
Category F—Metal Corrosion											
F1	Iron (total)	UF		350	µg/L			<	500	n/a	n/a Qualifying condition
F2	Iron ratio (total/dissolved)			14	µg/L			<	10	Pass	
F3	Chromium (total)	UF		6.2	µg/L			<	10	Pass	
F4	Chromium ratio (total/dissolved)			1.29	µg/L			<	5	Pass	
F5	Nickel	F		1.4	µg/L	J		<	50	Pass	
F6	Turbidity			4.63	NTU			<	5	Pass	
General Indicators											
Gen1a	pH	F		7.93	SU	H		>	7.0	Pass	
Gen1b	pH	F		7.93	SU	H	J, I9	<	8.7	Pass	
Gen2	Alkalinity-CO_3+HCO_3	F		73	mg/L	H	J, I9	<	106	Pass	
Gen3	Tritium	UF		.0639	pCi/L			<	1	Pass	
Gen4	Chromium	F		4.8	µg/L			<	6.7	Pass	
Gen5	Nitrate-Nitrite as Nitrogen	F		1.27	mg/L			<	0.8	n/a	Contaminant
Gen6	Perchlorate	F		0.552	µg/L			<	0.5	n/a	Contaminant
Gen7a	Zinc	F		60.4	µg/L			>	0.6	Pass	
Gen7b	Zinc	F		60.4	µg/L			<	40	Fail	

[a] ND = No data.

[b] n/a = Not applicable.

[c] n/a-LTD = Not applicable because other data (DO, ORP, elevated nitrate and perchlorate) indicate that reducing conditions, if present, are limited in extent.

Table 3
Summary of Evaluation Outcomes for R-35a and R-35b

Well	Port Depth (ft)	Date	Level of Confidence	Mod Water	Plume	Outside pH-Alk Range	Resid Inorg	Resid Org	Redox Stage	Enhanced Adsorption	Fe Mineral	CO_3 Mineral	Steel Corrosion
R-35a	1013	30-Aug-07	Low	—[a]	—	—	■[b]	■	Mn	?[c]	—	■	■?
R-35b	825	29-Aug-07	Mod	—	■	—	—	—	Oxic	?	—	—	—

Note: Evaluation conducted following the protocol presented in draft SOP ERSS-SOP-5133, Analytical Data Qualification for Residual Effects of Drilling Products, detailed results are shown in Appendix A.

[a] — = This condition does not appear to be present at this location.

[b] ■ = The condition is inferred as likely to be present at this location.

[c] ? = Indeterminate, i.e., that the presence or absence of this condition at this location cannot be determined with confidence.

These inferences about the likely presence or absence of drilling effects are subject to change as additional information is obtained. The criteria for designating a condition as being present are summarized below:

- "Mod water" = Modern water, in which tritium is present at consistently detectable (>1 pCi/L) activities, based on a review of data. Although this is not a residual drilling impact, this information nonetheless may influence geochemical interpretations and levels of confidence in the outcome. "■" in this column indicates that tritium (^3H) is detected at this location, indicating the presence of a component of water less than 60 yr old.
- "Plume" = A contaminant plume is present at this location.
- "Outside pH-Alk range"= pH and/or carbonate alkalinity values extend significantly above the upper limits for background groundwater, or pH extends below its lower background limit.
- "Resid Inorg" = Residual inorganic constituents from downhole drilling products (Category A), based on geochemical data compiled in Appendix A of the Well Screen Analysis Report, Revision 2 (LANL 2007, 096330).
- "Resid Org" = Residual organic constituents derived from downhole drilling products (Category A), based on geochemical data compiled in Appendix A of the Well Screen Analysis Report, Revision 2 (LANL 2007, 096330).
- "Redox Stage" = Most probable redox stage based on a review of relevant indicators compiled in Appendix A of the Well Screen Analysis Report, Revision 2 (LANL 2007, 096330).
- "Fe mineral" = Geochemical evidence indicates a high probability that the predrilling iron mineralogy has been significantly altered, e.g., as iron sulfides or iron carbonates, as a result of an extended period of very reducing conditions in the presence of an adequate in situ reserve of accessible iron (III) in the formation mineralogy.
- "Enhanced adsorption" = Geochemical evidence indicates that adsorption of some species may be enhanced above that expected for adsorption onto formation materials, due to the presence of residual clays or other adsorbant introduced with drilling fluids. Based on review of data compiled in Appendix A of the Well Screen Analysis Report, Revision 2 (LANL 2007, 096330).
- "CO3 mineral" = Barium, calcium, magnesium, strontium, and/or sulfate values extend significantly outside the limits for background groundwater, based on field and laboratory data compiled in Appendix A of the Well Screen Analysis Report, Revision 2 (LANL 2007, 096330).
- "Steel corrosion" = corrosion of the stainless steel well casing or screen appears to be present, based on data compiled in Appendix A of the Well Screen Analysis Report, Revision 2 (LANL 2007, 096330).

Table 4
Capability of Screen to Provide Reliable and Representative Samples for Selected Chemicals of Potential Concern

Well	Port Depth (ft)	Date	^{3}H	Ba	Cl	ClO_4	Cr	NO_3	Zn	VOCs	Cs-137	Pu	Sr-90	RDX	TNT
R-35a	1013	30-Aug-07	■[a]	—[b]	—	—	—	—	—	—?[c]	—?	—?	■	—	—?
R-35b	825	29-Aug-07	■	■	■	■	■	■	■	■	■	■	■	■	■

[a] ■ = Screen can provide reliable and representative sample for this COPC.

[b] — = Screen cannot provide reliable and representative sample for this COPC.

[c] —? = Screen probably cannot provide reliable and representative sample for this COPC but there is uncertainty associated with this judgment.