6.0 Groundwater Contamination

6.1 Contaminant Mass

Constituents of concern with respect to ARCO's groundwater corrective action program, and subsequently included in the LTSP, are molybdenum, selenium, and uranium because concentrations were above background levels in monitoring wells near the main tailings impoundment. Therefore, the evaluation of contaminant mass that seeped from the tailings impoundment, and continues to seep from the disposal cell, addresses these constituents.

As noted previously, an estimated quantity of 5.7 billion gallons of tailings fluids seeped through the bottom of the main tailings impoundment prior to encapsulation in 1995. Contaminant concentrations in the raw tailings water, or tailings liquor, varied due to changes in milling processes and ore characteristics, but ARCO considered the concentrations listed in Appendix A Table A-2 as representative of the tailings liquor. According to that table, the liquor had a pH of 1.2 and the following concentrations for contaminants of concern: 1.33 mg/L molybdenum, 4.0 mg/L selenium, and 19.5 mg/L uranium (Dames & Moore 1981b).

The estimated mass for each of the constituents of concern that seeped through the bottom of the tailings impoundment prior to completion of the disposal cell cover in 1995 is provided in Table 11. Assuming the seepage volume and contaminant concentrations are representative of actual conditions, nearly 1 million pounds of uranium would have been in the fluids that seeped from the tailings impoundment.

Table 11. Estimated Seeped Contaminant Mass Prior to Disposal Cell Completion

Contaminant	Concentration	Seeped Volume		Contaminant Mass	
	(mg/L)	(billion gallons)	(billion liters)	(mg)[a]	(pounds)
Molybdenum	1.33	5.7	21.6	2.87×10^{10}	63,300
Selenium	4.0	5.7	21.6	8.64×10^{10}	190,500
Uranium	19.5	5.7	21.6	4.21×10^{11}	928,300

Key: mg = milligrams; mg/L = milligrams per liter
[a] Concentration times seeped liters

The mass of uranium in seepage since the cover was completed cannot be estimated because seepage rates and contaminant concentrations in the tailings fluids are unknown. ARCO's efforts to dewater the tailings impoundment means that the fluids currently in the tailings are a mixture of the small amount of remaining leachate and precipitation that has percolated into the tailings since dewatering activities. The current quality of the fluids in the tailings would be better than the original tailings liquor. Regardless, seepage is most likely occurring, and will increase if the tailings become saturated. Therefore, contaminants will continue to enter the aquifers.

Concentrations of hazardous constituents in groundwater beneath the disposal cell are controlled by geochemical reactions between the seeped tailings solution in the geologic formation materials underlying the cell and in the receiving groundwater. The tailings solution with low pH, high reduction potential (Eh), and high sulfate concentrations has high concentrations of trace constituents, including metals, uranium, and molybdenum.

Precipitation of metals, sulfate, molybdenum, and uranium occurs as a result of neutralization of tailings solution. Chloride and selenium are not subject to pH-induced precipitation (Dames & Moore 1981b). Once the ambient pH exceeds about 6.0, further precipitation of sulfate, molybdenum, and uranium is negligible.

Trace components are removed from solution either by precipitation of minerals involving the trace constituent or by coprecipitation and adsorption of trace components on the precipitates. The precipitation process may contribute low concentrations of constituents to groundwater passing through the altered (mineralized) zone. Consequently, constituent concentrations above background levels are expected to persist indefinitely.

ARCO concluded that a neutralizing zone exists in the alluvium and limestone materials beneath the cell (Applied Hydrology Associates Inc. 1995). Their conclusion was based on the geochemistry of groundwater samples from monitoring wells close to the tailings impoundment. The samples had much higher pH values (between 6 and 7 compared to 1.2 in the tailings fluid) and lower constituent concentrations than the seeping tailings fluid. A geochemical analysis of the tailings liquor indicated that it was saturated with respect to metal-carbonates. Therefore, it was implied that uranium, lead, zinc, cadmium, copper, and molybdenum should be precipitated as carbonates in the neutralization zone.

This neutralization zone would be an altered or mineralized zone of constituents that seeped from the tailings impoundment and disposal cell. It would exist under the disposal cell and probably for some distance along the fault zones. If present, it would be an indefinitely continuing source of contamination to the alluvial and San Andres aquifers because groundwater flow through the mineralized zone would mobilize unknown quantities of contaminants. Because of the near-neutral pH of the unaffected inflowing groundwater, however, contaminant mobilization would be expected to be limited.

The actual presence of a mineralized zone cannot be verified without extensive drilling and sampling of the aquifer materials under the disposal cell. However, ARCO's geochemical evaluation of the tailings fluid and the monitoring well samples near the tailings impoundment strongly support its existence.

6.2 Alluvial Aquifer

Anaconda and ARCO sampled wells in the alluvial aquifer from 1980 to 1996. ARCO records indicate that uranium concentrations in POC well T(M) peaked at a concentration of approximately 1.6 mg/L in 1980 and declined rapidly, stabilizing at about 0.1 mg/L in 1995. Uranium concentrations peaked at approximately 0.75 mg/L in 1983 in downgradient well U(M), and peaked at about 0.4 mg/L in POE well X(M) in 1989. ARCO attributed the progressive decline in uranium concentrations from T(M) to U(M) to X(M) to natural attenuation in the alluvial aquifer. The closest offsite downgradient alluvial well (located about 1,400 ft south of the site entrance) indicated negligible uranium concentrations of 0.0031 mg/L in 1989 and 0.0041 mg/L in 1990, supporting ARCO's assessment that uranium in the alluvial aquifer had attenuated to background concentrations near the mill site boundary.

DOE began groundwater monitoring in 1998. Initially, uranium concentrations in POC well T(M) were approximately 0.1 mg/L, which was the same as the lowest results obtained by ARCO. However, uranium concentrations began to increase after the 2000 sampling event. The increasing uranium concentrations coincided with decreasing water levels in that portion of the alluvial aquifer. Before the well dried up, uranium concentrations in well T(M) were averaging 0.54 mg/L, which is less than the peak concentration observed by ARCO. This correlation of increasing uranium and decreasing aquifer water levels has been observed at some UMTRCA Title I sites. Uranium concentrations in POC well F(M) did not change during that period (averaging 0.008 mg/L)—the alluvial aquifer at that location may not have been affected by site contamination—nor did water levels drop significantly (less than 2 ft since 2000).

Although the alluvium at well T(M) has dried up, the aquifer has not dried up because the alluvial sequence is thicker and deeper where the main channel of the former Rio San Jose coursed. For example, the alluvium at well 21(M) is approximately 25 ft thick and is fully saturated. As the volume of water in an aquifer decreases, such as at T(M), it is possible that the contaminant mass is concentrated in the remaining water, resulting in increased concentrations. Uranium is the only contaminant with elevated concentrations to begin with, so its concentration would have increased as the volume of water decreased. As expected under this scenario, total dissolved solids concentrations also increased by approximately 40 percent as water levels in well T(M) dropped. This correlation between reducing water levels and increasing uranium will be addressed further in the conceptual model study.

Whether or not this is the cause for the increasing uranium concentrations in T(M), the increase does not point to a new pulse of contaminated water coming from the disposal cell. The declining water levels are not indicative of additional seepage, and no other mill-related contaminants are showing increasing concentrations in the well. Chloride and sulfate, other indicator constituents of potential cell leakage, had historically low concentrations and decreased slightly in T(M) as water levels dropped.

The uranium concentrations in well 22(M), located about midway between T(M) and 21(M), are averaging 0.33 mg/L, which is nearly equivalent to the last concentration of 0.31 mg/L observed by ARCO for well U(M) in 1990. Wells 21(M) and X(M) are located along downgradient site boundaries, and samples from each well have uranium concentrations of approximately 0.14 mg/L; ARCO's last sample from X(M), collected in 1990, had a uranium concentration of 0.15 mg/L (it averaged 0.31 mg/L during the previous 6 years). Well 23(M), near the site entrance and about 1,600 ft downgradient of well 21(M), has had uranium concentrations averaging 0.02 mg/L, which is below the drinking water standard.

DOE sampled the same offsite alluvial well monitored by ARCO. The bottom of that well apparently is completed in the Chinle Formation (below its contact with the alluvium), but the water is mostly likely from Rio San Jose alluvium because that portion of the Chinle Formation is dry at other nearby well locations (ARCO also considered it to be an alluvial well). Uranium concentrations from two DOE sampling events in 2012 were 0.0033 mg/L and 0.0045 mg/L, which are essentially unchanged from ARCO's results. These results, considered together with DOE's sampling results from 23(M), appear to substantiate ARCO's conclusion regarding the attenuation of uranium in the alluvial aquifer. Although uranium concentrations increased in well T(M), the aquifer at the downgradient wells appears to have reached steady-state conditions because uranium concentrations have remained unchanged since 1990. Fate and transport of contaminants in the alluvial aquifer will be evaluated further in DOE's groundwater conceptual model.

6.3 San Andres Aquifer

6.3.1 Northeast Portion of Site

Uranium concentrations in the San Andres aquifer groundwater north of the east-west-tracking fault continue to be elevated. Uranium concentrations in POC well S(SG) had been declining since the late 1980s when they peaked at 1.8 mg/L. The uranium concentration in POE well I(SG) peaked at 0.66 mg/L in 1989 and then began to decline. ARCO concluded that this peak in well I(SG) was in response to the high seepage rates that occurred in the 1950s, as supported by results of groundwater velocity and uranium transport analyses (Applied Hydrology Associates Inc. 1995). ARCO considered the decrease in uranium concentrations between the POC and POE wells to represent natural attenuation within the San Andres aquifer.

At the location of new well 16(SG), the San Andres Limestone is dry due to the decline of water levels, but the Glorieta Sandstone is saturated. Therefore, the polyvinyl chloride well screen is in the upper part of the Glorieta Sandstone. Uranium concentrations using the low-flow sampling method have been averaging approximately 1.4 mg/L, which is below the ACL of 2.15 mg/L. This concentration is very similar to ARCO's results for OBS-3 and S(SG) in the mid-1990s, when the wells probably were not exhibiting the current extent of corrosion. Therefore, sample results from 16(SG) appear to be more representative of aquifer conditions at that location than current results from the corroded POC wells.

A downhole conductivity test through the open borehole portion of well I(SG) revealed that the aquifer is stratified into two zones at that location; the upper third of the open borehole had a lower conductivity than the lower two-thirds. Low-flow samples collected in November 2013 showed elevated uranium concentrations in both zones, with a result of 0.15 mg/L in the upper third and results of 0.32 mg/L and 0.33 mg/L in the lower two-thirds of the aquifer. A subsequent high-flow sample (using the casing purge method) had a concentration of 0.35 mg/L, which is less than ARCO's last result of 0.42 mg/L (ARCO also used the casing purge method). For comparison, a conductivity test in background well L(SG) showed no change in conductivity with depth, and samples collected at multiple depths within the open borehole portion of that well averaged 0.003 mg/L uranium during the May 2013 sampling event.

Current uranium, chloride, sulfate, and total dissolved solids concentrations are lower than ARCO's results for OBS-3, S(SG), and I(SG). It appears from a comparison of the ARCO and DOE results, therefore, that San Andres aquifer groundwater quality has improved north of the east-west tracking fault, and there is no obvious indication of a new pulse of contamination from the disposal cell. However, historical and recent groundwater data from San Andres aquifer wells north of the east-west-tracking fault and downgradient of the site are being evaluated in DOE's groundwater conceptual model to estimate the fate and transport of contaminants in that portion of the aquifer.

6.3.2 Southeast Portion of Site

ARCO recognized that the Anaconda #5 production well, located along the Ambrosia Lake Fault more than a mile south of the east-west-tracking fault, was affected by mill-related contaminants. Reported uranium concentrations were as high as 0.18 mg/L in 1989 (the well was not monitored while being used as a production well). Despite the presence of mill-related contaminants in Anaconda #5, ARCO did not consider contamination south of the fault to be of concern. As discussed in Section 2.3, ARCO assumed that incoming fresh water (from upgradient recharge) would mix with contaminated water and dilute contaminant concentrations to acceptable levels in the south portion of the site.

Uranium concentrations in DOE's new San Andres aquifer wells south of the east-west-tracking fault are elevated. Sample results from November 2013 showed a high of 0.18 mg/L in well 15(SG) and a low of 0.074 mg/L in 14(SG). A sample from farthest downgradient well 13(SG) had a concentration of 0.099 mg/L. These results lead to the conclusion that the historical results from Anaconda #5 represent contamination that was drawn south during mill production well pumping and that the contamination has migrated downgradient of the fault zone.

ARCO never had San Andres monitoring wells in the southeastern portion of the site. Based on ARCO's sample results from Anaconda #5 well, the groundwater in this portion of the site probably has had elevated uranium concentrations since the mill was being operated. Therefore, the results from DOE's new wells represent contamination drawn to that area by ARCO's production wells rather than a new pulse of contaminated water from the disposal cell.

The offsite former domestic Sabre-Piñon well (now called HMC-951) had background uranium concentrations when monitored by ARCO in the 1980s (see Section 2.3). However, Homestake Mining Company put HMC-951 into production for their groundwater corrective action plan for its mill site located about 4 miles southeast of the Bluewater site. The well was pumped at an average rate of about 350 gpm from 1999 through 2012. During that time, uranium concentrations ranged from a low of 0.020 mg/L to a high of 0.048 mg/L. It appears likely, therefore, that the pumping drew contaminated groundwater from the southeast portion of the site to HMC-951. DOE has begun sampling this well, and the uranium concentration from the first sampling event in November 2013 was 0.031 mg/L.

A comparison of results from wells on both sides of the east-west tracking fault indicates that uranium concentrations are lower in the southeast portion of the site. Historical and recent groundwater data from San Andres aquifer wells south of the fault and downgradient of the site are being evaluated in DOE's groundwater conceptual model to estimate the fate and transport of contaminants in that portion of the aquifer.

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7.0 Conclusions

ARCO estimated that approximately 5.7 billion gallons of tailings fluid seeped through the bottom of the main tailings impoundment prior to construction of the disposal cell cover in 1995; about half of that total was projected to have occurred prior to 1960. These fluids entered the two uppermost aquifers at the site. ARCO expended a considerable effort to dewater the tailings before completing the disposal cell, so the volume of tailings liquor available for continued seepage was significantly reduced.

Tailings fluids, consisting of a less-contaminated mixture of the remaining tailings liquor and precipitation that has percolated through the cell cover materials, are seeping from the disposal cell and may continue to do so indefinitely. The projected maximum annual seepage estimate of 36 million gallons assumes saturated moisture conditions in the tailings and a potential upper limit of 50 percent of precipitation percolating through the cell cover. Although this maximum estimated annual seepage rate is large, it is substantially less than 1 percent of the total seepage that occurred prior to completion of the cover in 1995. However, current seepage appears to be minimal because decreasing water levels and steady-state contaminant concentrations in the aquifers are not indicative of the maximum estimated rate. It is unlikely, therefore, that the tailings are saturated at this time, and hydraulic properties of the cover materials may not have changed enough to allow the maximum projected precipitation infiltration. An increase in vegetation on the cell cover is expected to keep infiltration rates low due to evapotranspiration, which would keep seepage rates low.

The band drains that ARCO installed in the north portion of the tailings impoundment did not completely dewater the slimes—they only reduced the water content to facilitate consolidation of the slimes. Up to 15 ft of relocated silty-clay material, similar to the material used for the radon barrier, was placed over the slimes prior to installation of the radon barrier. This thick, low-permeability layer would significantly reduce infiltration of precipitation into the slimes and keep the seepage rate low.

Based on groundwater monitoring results that showed higher pH values and lower contaminant concentrations than were present in the tailings fluid, ARCO concluded that the acidic tailings fluids that seeped through the bottom of the tailings impoundment were neutralized, causing contaminants to precipitate and adsorb in the underlying aquifer materials. Consequently, a mineralized zone apparently formed in the aquifer materials under the disposal cell. This mineralized zone is assumed to be the current primary source of groundwater contamination, and it will remain indefinitely.

Depressions have formed on the disposal cell cover because the slimes portion of the tailings impoundment continued to consolidate after the cover was completed. Precipitation runoff water forms ponds in these depressions, potentially introducing a second source of fluids infiltrating through the disposal cell. However, observations of the persistence of the ponds and the results of radon flux measurements indicate that there has been no reduction in the performance of the radon barrier and that the ponds are reduced primarily through evaporation rather than infiltration. Therefore, the depressions and associated ponds are not indicative of additional seepage from the cell.

There is no evidence at this time to suggest that the elevated uranium concentrations in onsite wells indicate a new pulse of contamination from within the disposal cell or recharge from ponds on top of the cell. An increase in seepage from the disposal cell is not evident because water levels have dropped significantly in both aquifers and continue to decline. Although uranium concentrations increased in alluvium POC well T(M) until the well dried up, the increase appears to be due to decreasing water levels at that location rather than increased seepage from the disposal cell. Also, uranium concentrations at the POE wells in both aquifers are less than those observed by ARCO.

Considerable uncertainties are associated with the water balance and mass estimates presented in this assessment and are addressed in the following chapter. Nevertheless, they do not negate the primary conclusion that the volume of fluid and mass of contaminants seeping from the cell since it was constructed are very small compared to the corresponding volume and mass that seeped through the bottom of the tailings impoundment prior to cell construction.

8.0 Uncertainties

Uncertainty in regards to the performance of the disposal cell is unavoidable given the sparseness of observed data and the limited amount of information available to corroborate or refute alternative models. The major uncertainties and their effects on the conclusions drawn in this study are provided in Table 12.

Table 12. Uncertainties and Their Effects on Conclusions

Conclusion	Uncertainty	Effect on Conclusion	Significance of Uncertainty
An estimated 5.7 billion gallons of fluids seeped through the bottom of the tailings impoundment prior to encapsulation. This quantity was estimated by ARCO based on a water balance analysis of the milling processes. Unknown proportions seeped into the underlying aquifers.	Actual seepage rates and quantities were not measured.	Precipitation and evaporation were not factored into ARCO's estimates. Therefore, actual seepage could have been greater or less than 5.7 billion gallons.	Attempts to more precisely estimate the amount of seepage that occurred would not impact the conclusion that a very large volume of contaminated tailings fluid seeped into the materials and aquifers below the tailings impoundment.
Approximately 1 million pounds of uranium were in the fluids that seeped from the tailings impoundment prior to completion of the disposal cell. This estimated quantity was based on the estimated 5.7 billion gallons of seepage and one sample that was used by ARCO to characterize the tailings fluid.	Contaminant concentrations in the tailings fluids would have varied considerably throughout the period of milling and as distributed within the tailings. Therefore, the actual quantity of uranium that seeped from the tailings is unknown, and the amount remaining for mobilization in the groundwater is unknown.	The actual quantity of uranium that seeped from the tailings impoundment and is potentially available as a continuing contaminant source is greater or less than 1 million pounds.	Data are not available to determine the actual amount of uranium that seeped from the tailings impoundment or how much entered the aquifers. The primary conclusion that a large mass of uranium is available as a continuing source of groundwater contamination is not impacted by the uncertainty associated with this estimate.
Seepage from the tailings impoundment during milling operations affected the aquifer characteristics (potentiometric surface elevations, flow directions, flow rates, and quality) under the site.	Because aquifer monitoring did not begin until near the end of milling operations, the quantitative impacts on the aquifers during the time that the greatest volumes of fluids seeped from the tailings impoundments are unknown.	Due to the absence of data, whatever happened in the aquifers prior to monitoring cannot be recreated. Because monitoring results during the later stages of milling showed that the highest concentrations were near the tailings impoundment and that groundwater and entrained contaminants were drawn to the production wells, the uncertainties have no effect on the conclusion.	Literature and monitoring have shown that the aquifers are contaminated above background concentrations, that water levels have dropped significantly in the past 20 years, and that flow directions have apparently returned to pre-milling conditions. A quantitative understanding of aquifer changes during milling would not add value to our understanding of current or projected conditions.
Seepage continues to occur at an unknown rate through the bottom of the disposal cell, and is expected to continue indefinitely. It is assumed that seepage is occurring at a minimal rate, but will increase as the tailings become more saturated.	Seepage rates are dependent in part on the degree of saturation within the tailings, which is unknown.	Regardless of the degree of tailings saturation or the seepage rate, seepage is still occurring, thus contributing to a continuous source of contamination in the aquifers. However, the contaminant mass available from present day seepage to impact groundwater concentrations is extremely small compared to the mass associated with the fluids that seeped during milling.	Measuring actual saturation and seepage would require extensive sampling and testing of tailings materials. The source term released during milling is much greater than the source term being released from the disposal cell. Therefore, knowing the actual seepage rate would not have a significant bearing on conclusions relating to the behavior of contaminant migration in the aquifers.

Conclusion	Uncertainty	Effect on Conclusion	Significance of Uncertainty
Unless the cell cover develops into an evapotranspiration cover, precipitation will percolate through the cover, and the tailings materials will approach a saturated condition. Under long-term steady state conditions, seepage through the bottom of the cell is expected to equal the rate of precipitation that percolates through the cover. Under those conditions, the rate of seepage is expected to equal 25 to 50 percent of the rate of precipitation. Even using these values, the estimated annual seepage would be much less than the seepage that occurred prior to encapsulation of the disposal cell.	Current and potential percolation rates are unknown because cover soil hydraulic properties have not been tested and will likely continue to change. The potential length of time needed for the full thickness of the cell to become saturated is unknown because the existing depth of saturation in the tailings is unknown, and the rate of precipitation percolating through the cover is unknown.	Regardless of the rate of seepage from the disposal cell, it is estimated to be significantly less than the seepage that occurred during milling operations. Over time, cover percolation and tailings seepage rates would likely continue to decline if vegetation is allowed or encouraged to establish on the cover.	Soil tests of cover materials and the tailings and monitoring of cover percolation rates would be required to refine the estimates. Contaminant concentrations in the aquifers have remained essentially unchanged. Therefore, knowing the actual seepage rate would not have a significant bearing on conclusions relating to the behavior of contaminant migration in the aquifers.
Based on historical groundwater monitoring results near the tailings impoundment, the fluids that seeped through the bottom of the tailings impoundment are assumed to have formed a mineralized zone in the materials under the disposal cell and along fault zones.	Sampling of materials has never been conducted to confirm the presence or extent of the mineralized zone.	Continued elevated uranium concentrations in wells near the disposal cell indicate the presence of a continuing source of contamination. Because ARCO did not observe changes in groundwater chemistry during dewatering activities of the tailings impoundment, there is a high probability that a mineralized zone is present and that it is the primary source of continuing contamination.	Extensive borehole material analysis and groundwater quality measurements under the disposal cell and along the fault zones would be required to define the postulated mineral zone. It is most likely the characterization would confirm the presence of the mineralized zone and that it should be considered to be a continuing source of contamination to the aquifers.
Contaminant concentrations within the fluids currently seeping from the disposal cell were not estimated. However, it is assumed that the quality of the seeping fluid is not as degraded as during milling operations because of dewatering activities conducted by ARCO and infiltration of clean precipitation water (i.e., current disposal cell fluids are a mixture of residual mill fluids and fresh water from precipitation infiltration).	The current chemistry of the tailings fluids is unknown.	Because the current quality of the tailings fluid has not been tested, the conclusion may or may not be valid.	Tailings fluid characterization, which would require numerous monitoring wells completed in the disposal cell, would be required to determine tailings fluid quality. However, if contaminant concentrations in the aquifers were to increase, determination of the source of increased contamination (cell seepage versus mineralized zone) would be difficult, if not impossible, even if the tailings fluid quality was known.

Conclusion	Uncertainty	Effect on Conclusion	Significance of Uncertainty
Based on cell construction, regional evaporation rates, and the lack of *radon emission in the area where* ponding occurs on the disposal cell cover (over a small area of the slimes portion of the disposal cell), the ponding does not contribute to additional seepage from the disposal cell.	Site-specific evaporation rates and hydraulic properties of the cover and underlying materials in the area of depressions have not been measured. Therefore, actual percolation rates through the approximate 15-ft-thick compacted clay layer over the slimes are unknown.	If some portion of the ponded water is percolating through the thick clay layer, then it would combine with the residual tailings fluids in the slimes and eventually seep through the bottom of the disposal cell.	Evaporation monitoring and characterization of the hydraulic properties of the cover and compacted clay layer materials would be required *to determine if or how much* precipitation is percolating into and through the slimes. Because seepage is likely occurring through the more permeable sand portions of the tailings, any contribution from the ponded water through the very-low permeability slimes would be insignificant.

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Appendix A

Bluewater Main Tailings Impoundment Seepage and Fluid Chemistry

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Table A-1. Estimated Seepage Rates and Quantities from the Main Tailings Impoundment

Year	Estimated Seepage Rates (gpm)[a]			Estimated Seepage Quantities (gallons)	
	Sand Tailings[b]	Slime Tailings[c]	Total	Annual Quantity	Cumulative Quantity
1956	NE	NE	1,717	902,455,200	902,455,200
1957	NE	NE	1,350	709,560,000	1,612,015,200
1958	NE	NE	1,000	525,600,000	2,137,615,200
1959	NE	NE	700	367,920,000	2,505,535,200
1960	NE	NE	400	210,240,000	2,715,775,200
1961	236.8[d]	4.6[e]	241.4	126,879,840	2,842,655,040
1962	236.8	4.6	241.4	126,879,840	2,969,534,880
1963	236.8	4.6	241.4	126,879,840	3,096,414,720
1964	236.8	4.6	241.4	126,879,840	3,223,294,560
1965	236.8	4.6	241.4	126,879,840	3,350,174,400
1966	236.8	4.6	241.4	126,879,840	3,477,054,240
1967	236.8	4.6	241.4	126,879,840	3,603,934,080
1968	236.8	4.6	241.4	126,879,840	3,730,813,920
1969	236.8	4.6	241.4	126,879,840	3,857,693,760
1970	236.8	4.6	241.4	126,879,840	3,984,573,600
1971	236.8	4.6	241.4	126,879,840	4,111,453,440
1972	236.8	4.6	241.4	126,879,840	4,238,333,280
1973	236.8	4.6	241.4	126,879,840	4,365,213,120
1974	236.8	4.6	241.4	126,879,840	4,492,092,960
1975	236.8	4.6	241.4	126,879,840	4,618,972,800
1976	236.8	4.6	241.4	126,879,840	4,745,852,640
1977	236.8	4.6	241.4	126,879,840	4,872,732,480
1978	236.8	4.6	241.4	126,879,840	4,999,612,320
1979	236.8	4.6	241.4	126,879,840	5,126,492,160
1980	236.8	4.6	241.4	126,879,840	5,253,372,000
1981	236.8	4.6	241.4	126,879,840	5,380,251,840
1982	191.8	4.6	196.4	103,227,840	5,483,479,680
1983	146.8	4.6	151.4	79,575,840	5,563,055,520
1984	101.8	4.6	106.4	55,923,840	5,618,979,360
1985	56.8	4.6	61.4	32,271,840	5,651,251,200
1986	11.8[f]	4.6	16.4	8,619,840	5,659,871,040
1987	11.8	4.6	16.4	8,619,840	5,668,490,880
1988	11.8	4.6	16.4	8,619,840	5,677,110,720
1989	11.8	4.6	16.4	8,619,840	5,685,730,560
1990	11.8	4.6	16.4	8,619,840	5,694,350,400
1991	11.8	11.6[g]	23.4	12,299,040	5,706,649,440
1992	11.8	11.6[g]	23.4	12,299,040	5,718,948,480
1993	11.8	4.6	16.4	8,619,840	5,727,568,320
1994	11.8	4.6	16.4	8,619,840	5,736,188,160
1995	11.8	4.6	16.4	8,619,840	5,744,808,000

Key: gpm = gallons per minute; NE = not estimated

[a]Derived from Table 2-2, Applied Hydrology Associates, Inc. (1995).

[b]Area of sand tailings assumed to be 191 acres.

[c]Area of slime tailings assumed to be 74 acres.

[d]Vertical hydraulic conductivity assumed to be 2 ft/yr.

[e]Vertical hydraulic conductivity assumed to be 0.1 ft/yr.

[f]Unsaturated hydraulic conductivity assumed to be 0.1 ft/yr .

[g]Estimated rate due to loading the slimes area with a consolidation layer, totaling approximately 7.4 million gallons.

Table A-2. Tailings Liquor Chemistry

Parameter	Concentration[a,b]
Aluminum	1,020
Arsenic	0.60
Boron	1.7
Barium	< 0.1
Calcium	576
Cadmium	1.03
Cobalt	1.13
Chromium	1.9
Copper	3.17
Iron	2,430
Magnesium	63.3
Manganese	75.1
Molybdenum	1.33
Sodium	1,100
Nickel	1.43
Lead	4.3
Silicon	442
Strontium	16.6
Zinc	5.7
Nitrate (NO_3)	31
Sulfate (SO_4)	24,400
Chloride	1,630
Selenium	4.0
Ammonia (NH_4)	35.67
pH	1.2 standard units
Lead-210	24,224 pCi/L
Uranium-238	6,565 pCi/L[c]
Thorium-230	149,302 pCi/L
Radium-226	3,334 pCi/L

Key: DL = detection limit; pCi/L = picocuries per liter
[a]From Table 3, Dames & Moore (1981b).
[b]Reported in milligrams per liter unless noted otherwise.
[c]Equivalent to 19.54 milligrams per liter.

Appendix B

Bluewater Main Tailings Disposal Cell Configuration

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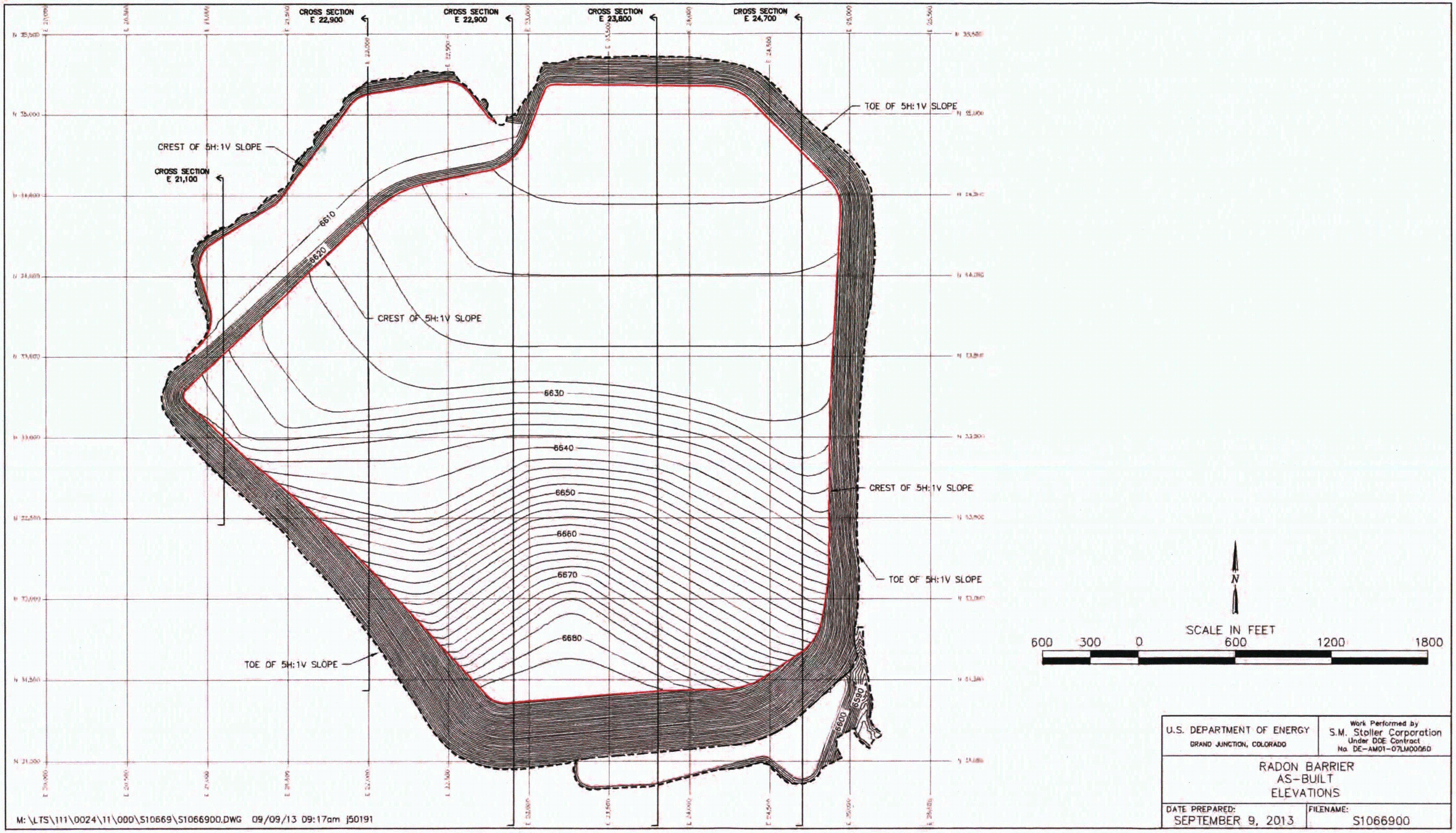


Figure B-1. Main Tailings Disposal Cell Radon Barrier As-Built Surface

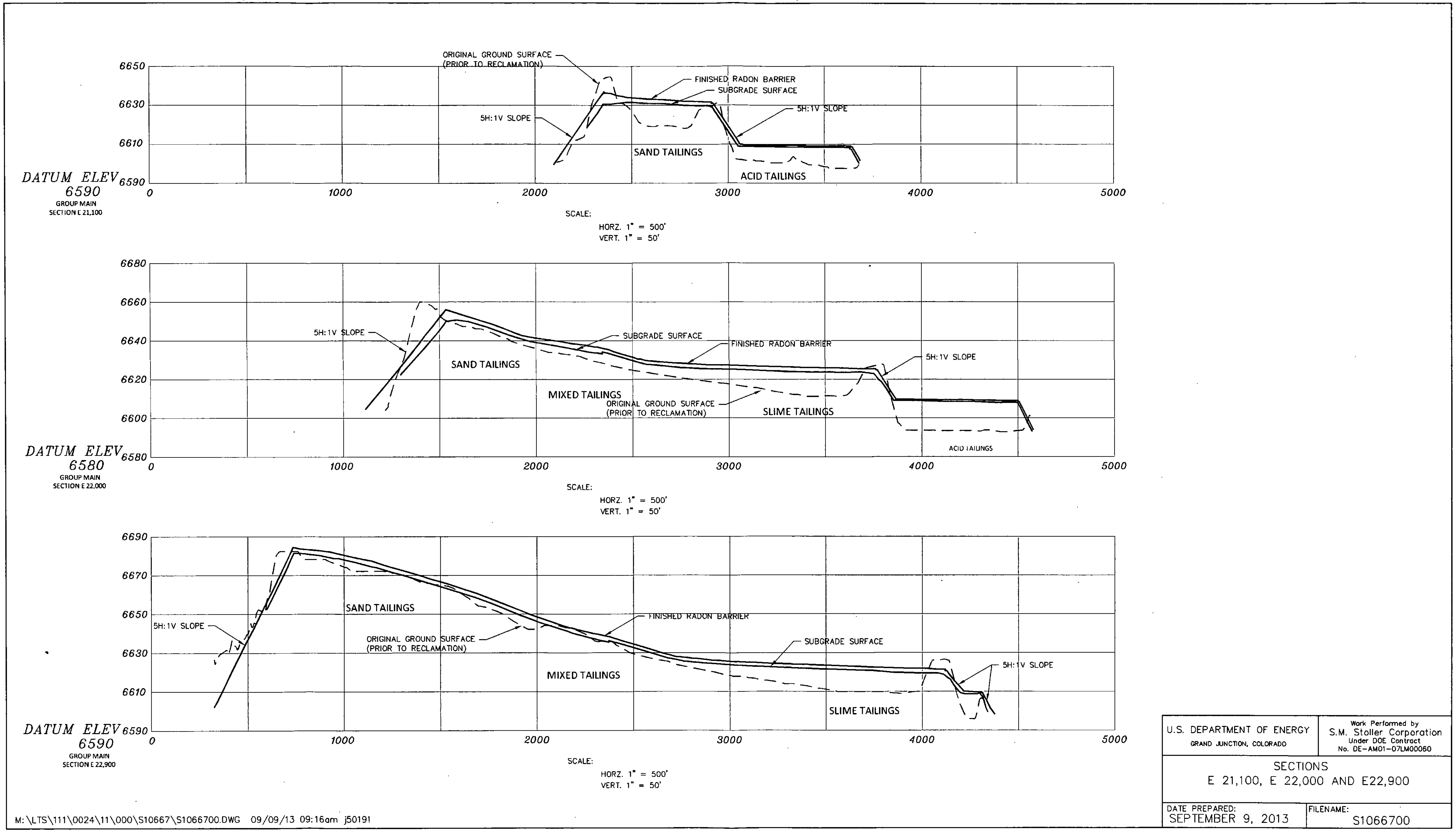
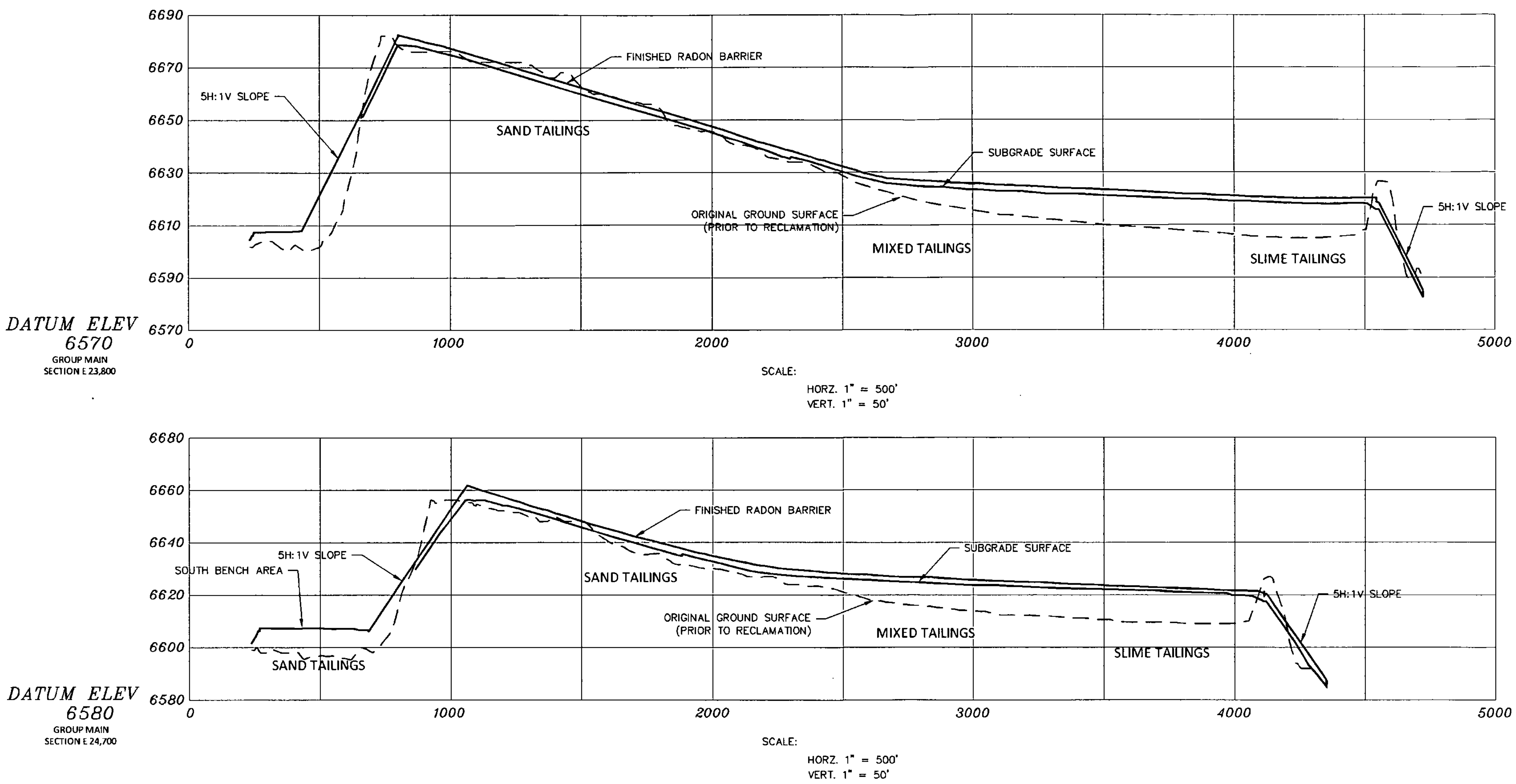


Figure B-2 Main Tailings Disposal Cell As-Built Sections E 21,100, E 22,000, and E 22,900



U.S. DEPARTMENT OF ENERGY GRAND JUNCTION, COLORADO	Work Performed by S.M. Stoller Corporation Under DOE Contract No. DE-AM01-07LM00060
SECTIONS E 23,800 AND E 24,700	
DATE PREPARED: SEPTEMBER 9, 2013	FILENAME: S1066800

Figure B-3. Main Tailings Disposal Cell As-Built Sections E 23,800 and E 24,700

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Appendix C

Bluewater Main Tailings Disposal Cell Material Hydraulic Properties

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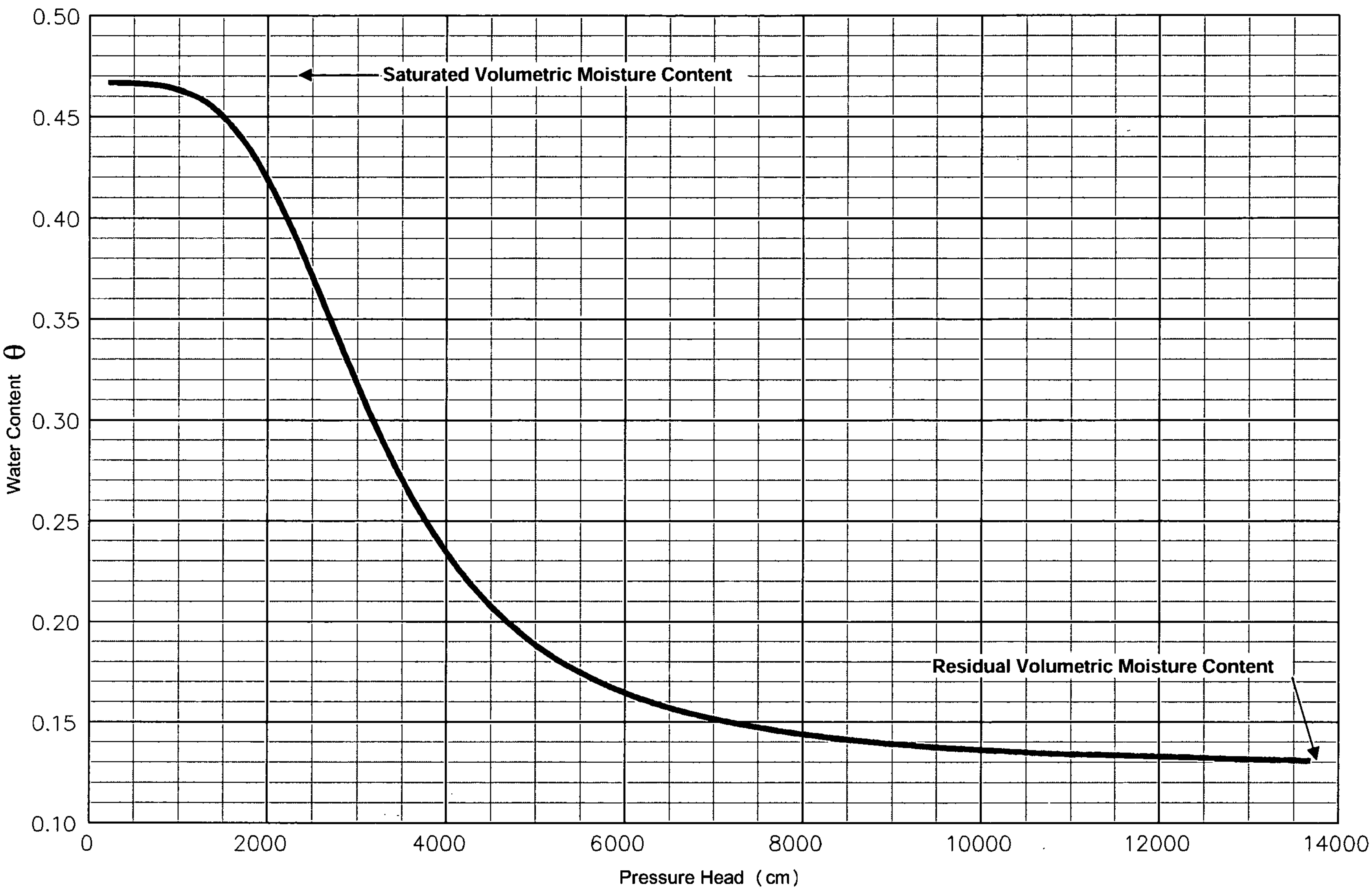

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Figure C-1. Water Content Versus Pressure Head for the Coarse Tailings

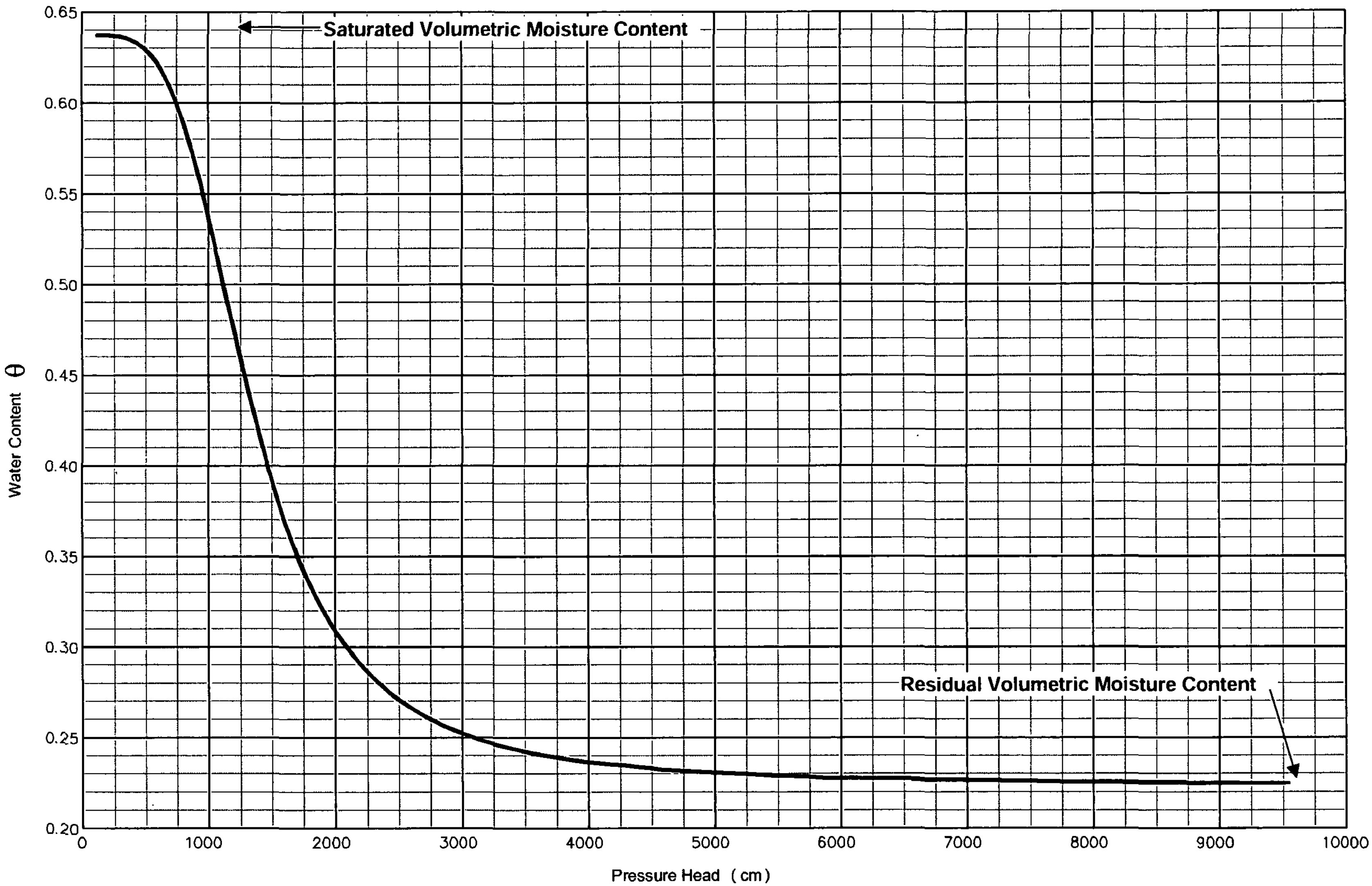

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Figure C-2. Water Content Versus Pressure Head for the Fine Tailings

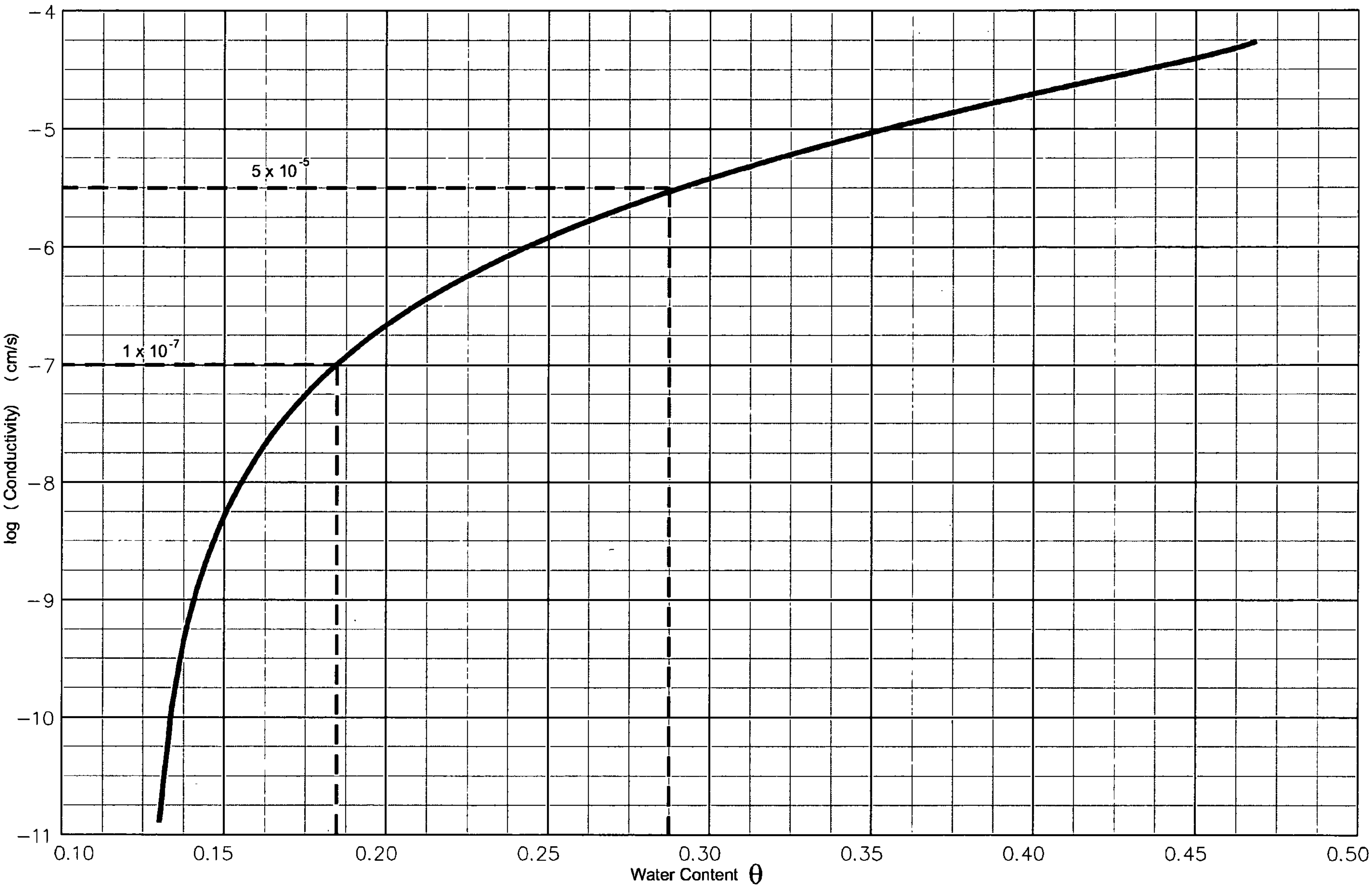

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Figure C-3. Hydraulic Conductivity Versus Water Content for the Coarse Tailings

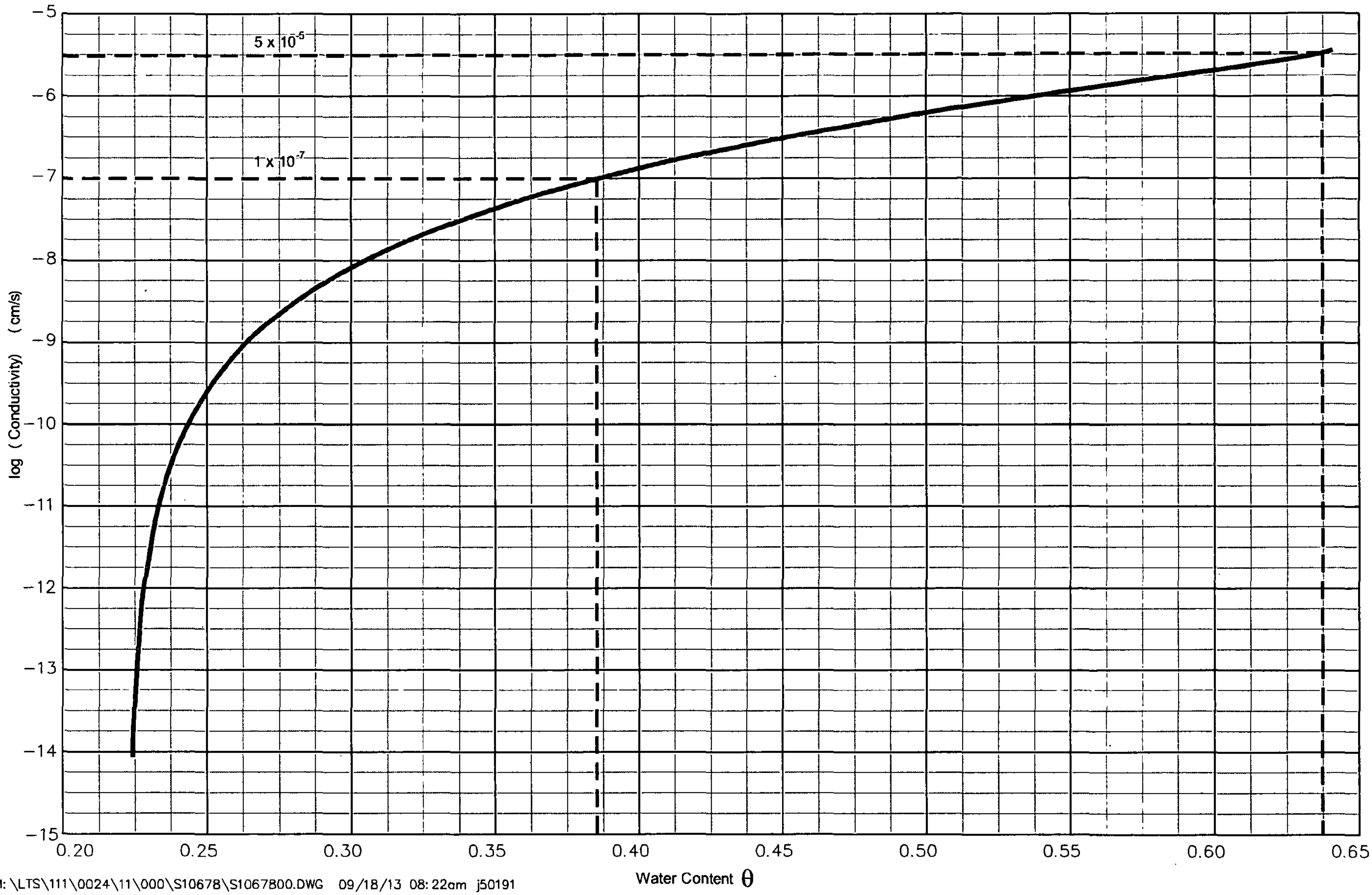

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Figure C-4. Hydraulic Conductivity Versus Water Content for the Fine Tailings

Appendix B

Well Information

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Preface

This appendix documents the locations of the wells in the Grants-Bluewater Valley study regionaddressed in the Site Status Report. Well locations are shown on Plate 7 and Figures 16 through 19 of the main report. Because the monitoring locations were drawn from a variety of studies, several of the wells are identified by more than one label. Therefore, cross-reference information is provided where available.

Data sources used to develop these tables include:

- DOE/Bluewater site database
- Homestake annual reports (mainly HMC and Hydro-Engineering 2013)
- Hydro-Search 1981a
- NMED (New Mexico Environment Department) 2010
- State of New Mexico Drinking Water Branch database
- U.S. Geological Survey (USGS) National Water Information System (Mapper)

Well construction information for wells monitored at the Bluewater site is provided in Table 2 of the main report. Well construction information developed by Hydro-Search (1981a), based on their detailed well inventory of the Grants-Bluewater area, is also provided here. Although some of the wells listed in their inventory have since been decommissioned, and some information may no longer apply (e.g., well ownership), the inventory was a fundamental component of the early site characterization work, and much is still relevant today. For wells monitored by Homestake, well construction information is documented in their annual reports; only coordinates and depths (when available) are listed here. For wells not currently monitored at the Bluewater site, some of the well information provided here may need to be verified, and some locations are uncertain. Limited information is available for domestic wells.

Plate 7 includes close to 570 unique locations; the majority consist of Homestake's alluvial wells. Although only a subset of these wells had water level measurements or water chemistry data for the time periods evaluated in this report, location information for all HMC alluvial wells is provided in Tables B-6 and B-7. Because the focus of the site status report is on the San Andres and alluvial aquifers, information for HMC wells screened in the Chinle aquifer is not provided in this appendix.

Only 9 of the 27 unique SMC sample locations referenced in NMED's study were utilized in the Site Status Report: SMC-03, SMC-04, SMC-05, SMC-08, SMC-10, SMC-11, SMC-12, SMC-13, and SMC-14. The remaining SMC locations were not used because they are outside the study region in the report.

Tables

Abbreviations

amsl	above mean sea level
ARCO	Atlantic Richfield Company
bgs	below ground surface
BW	Bluewater (prefix used by NMED [2010]) for sample IDs)
DOE	U.S. Department of Energy
ft	feet
HMC	Homestake Mining Company
HSI	Hydro-Search Inc.
NM DWB	State of New Mexico Drinking Water Branch (Drinking Water Watch) website
NMED	New Mexico Environment Department
OSE	(New Mexico) Office of State Engineer
SMC	San Mateo Creek
TD	Total Depth
USGS	U.S. Geological Survey

Table B-1. Well Information for Wells Screened in San Andres Aquifer: Bluewater Site Monitoring Wells

Well ID		Easting	Northing	TD (ft bgs)	Well Owner	Alternate Label(s)	OSE ID
11(SG)	*	469874.79	1558335.18	305.7	DOE		B-410-POD31
13(SG)	*	472765.77	1546949.48	314.4	DOE		
14(SG)	*	463598.97	1548886.18	335.2	DOE		
15(SG)	*	469224.43	1550341.01	388	DOE		
16(SG)	*	468714.92	1553798.89	235	DOE		
18(SG)	*	468136.08	1547203.31	305	DOE		
Anaconda #1		465602.60	1548242.67			B00003	
Anaconda #2		465493.49	1548344.17	386			
Anaconda #3	**	465673.99	1544494.28	200	ARCO		
Anaconda #4	**	466076.36	1544171.56	210	ARCO		
Anaconda #5	**	465855.10	1547998.03	440.5	ARCO		
B00050A		476604.01	1540222.92			BW-20, HMC-545	B-50A
B00518		471519.37	1542081.56		non-DOE		
B01614		468584.63	1541060.23				
Berryhill Sec5		473358.86	1561753.67	725			
Bowlins		457941.80	1550791.37	518		BW-24	B-637
C(SG)	**	466600.99	1551103.67	423	ARCO		
D(SG)	**	468324.35	1552464.62	259	ARCO		
DM-7	**	471121.62	1552758.22	142.3	ARCO		
DM-8	**	475535.94	1551456.63	131	ARCO		
G(SG)	**	468771.45	1552696.30	278	ARCO		
HMC-951		473124.09	1545335.99	272	HMC	NMED BW-34, SMC-01 USGS 7 (former Sabre Piñon)	B-28-S-[illegible]47
I(SG)		478106.06	1552131.20	330	DOE	BW-28	
L(SG)		462856.43	1553977.39	610		BW-25	
M(SG)	**	465579.44	1559328.51	575	ARCO		
Mexican Camp	**	468627.95	1545079.99	280	ARCO		
Monitor	**	473949.24	1557023.81	628	ARCO		
North	**	469489.85	1558726.23	250	ARCO		
OBS-2	**	468766.00	1551594.10	319	ARCO		
OBS-3		468776.17	1554101.25	363	DOE	BW-27	
Payne		462186.79	1547042.46	315			
Roundy House		460119.10	1548590.66	300		BW-11	B-1608
S(SG)		468775.21	1553097.93	336	DOE	BW-26	
W(SG)	**	472820.05	1549373.29	355	ARCO		

*	Well installed summer 2012 (see Table 2 of main report)
**	Well decommissioned in February 1997
BW	Bluewater well location prefix, as referenced in NMED 2010, Tables 6 and 8
OSE	New Mexico Office of State Engineer
TD	Total depth

Notes:
Domestic wells B00050A, B00518, and B01614 are listed in this table because they were recently sampled by DOE (locations shown on Figure 18 and Plate 7).

Table B-2. Well Information for Homestake, Domestic, and Other San Andres Wells

Well ID	Easting	Northing	TD (ft bgs)	Data Source(s)	NMED ID	Alternate Label(s)	OSE ID
#1 Deepwell	493633.00	1543307.00	1000	HMC	BW-29		B-28
#2 Deepwell	490972.00	1542424.00	870	HMC	BW-30		B-28S
0951R	484163.26	1544589.39		HMC			
0806	486320.00	1541120.00	584	HMC			
0806R	486264.00	1541177.00	600	HMC			
0534	476549.00	1534589.00	1000	HMC			
0535	478450.00	1530100.00	198	HMC			
0545	476600.00	1540200.00					
0822	488630.00	1538920.00	980				
0907	480800.00	1534250.00	360	HMC		USGS 10	
0911	476800.00	1534350.00	188	HMC	BW-15		B-49
0923	477900.00	1552400.00	330	HMC			
0928	491700.00	1548250.00	864	HMC	BW-32	USGS 13	
0938	473040.00	1539500.00	253	HMC	BW-06	USGS 6	
0943	487407.00	1537222.00	978	HMC	BW-33	USGS 12	B-28S-329
0949	483600.00	1540350.00	551	HMC	BW-23		B-44
0955	483699.00	1537338.00	498	HMC	BW-02*	Vasquez	
0986	483690.00	1537894.00	467	HMC	BW-03	Bachman	
0987	483357.00	1538226.00	500	HMC			
0991	483630.00	1538873.00	500	HMC	BW-04	Gebeau	
B00018	477798.96	1529434.73		NMED 2010	BW-21		B-18
B00019	475656.46	1529453.89		NMED 2010	BW-22		B-19
B00518-2	470586.51	1541289.80		NMED 2010	BW-19		B00518-2
BW-07	452010.17	1551895.36		NMED 2010	BW-07		B-1521
BW-08	457637.03	1552088.01		NMED 2010	BW-08		B-1541
BW-09	457395.34	1545737.16		NMED 2010	BW-09		B-1662
BW-10	460452.44	1548662.82		NMED 2010	BW-10	J Elkins-1	
BW-12	461245.55	1543574.28		NMED 2010	BW-12		B-1637
BW-13	461907.28	1542452.78		NMED 2010	BW-13		B-1663
BW-14	456089.10	1547347.44		NMED 2010	BW-14		B-1688
BW-17	467073.80	1540123.75		NMED 2010	BW-17	Anderson	
BW-35	500601.79	1557138.35		NMED 2010	BW-35		B-1458
Bluewater Well #1	457396.82	1545730.98		NM DWB		Water & San. District	
Bowlins Bluewater DQ Well #1	458701.53	1550395.88		NM DWB			
Bowlins Bluewater DQ Well #2	458936.99	1549481.99		NM DWB	BW-05		B-461
Grants Cibola Sands KOA Well #2	488374.91	1508123.63		NM DWB			
Grants Well #1	490053.74	1512328.52		NM DWB		B-38	
Grants Well #3	486771.00	1514626.76		NM DWB		B-40	
Milan Well #1	482352.49	1518873.19		NM DWB		Village of Milan Well B-23	
Milan Well #3	480171.81	1524218.39	214	NM DWB		B-35	
Milan Well #4	476601.36	1533091.41		NM DWB	BW-16	HMC-998, Golden Acres	B-50
USGS 1	447590.18	1559965.42	523	USGS			
USGS 2	453979.00	1551753.83	457	USGS			
USGS 4	462782.49	1541821.20	365	USGS			
USGS 5	471782.90	1542498.68	245	USGS			
USGS 8	474768.99	1524533.55	100	USGS			
USGS 11	483047.57	1529397.54	480	USGS			
USGS 14	487852.60	1512343.18	158	USGS			

Notes:
Wells listed in this table have not been sampled by DOE—data sources include HMC annual reports, NMED (2010), the State of New Mexico Drinking Water Branch website, and the USGS (links provided below). Figure 26 of the main report shows the USGS wells within the Bluewater study region. Well depth listed for HMC 938 is based on USGS' reporting (as this datum not provided in HMC's annual reports). *NMED (2010) Table 6 cross-reference to HMC well 0965 was incorrect (0955 is the correct location).
https://eidea.nmenv.state.nm.us/DWW; http://maps.waterdata.usgs.gov/mapper/index.html

Table B-3. Well Information for Bluewater Site Alluvial Wells

Well ID		Easting	Northing	TD (ft bgs)	Well Owner	Alternate Label(s)
20(M)	*	463734.80	1551924.38	129.5	DOE	
21(M)	*	472680.71	1546974.11	157	DOE	
22(M)	*	470929.88	1548706.26	153	DOE	
23(M)	*	472920.01	1545333.70	121	DOE	
Aragon		457501.92	1552609.66	130	non-DOE	
B(M)	**	463807.78	1553223.79	161	ARCO	
B00050B		477981.74	1541294.26		non-DOE	
B00168		458687.93	1556148.12	150	non-DOE	Berryhill House
C(M)	**	466654.99	1551083.34	356	ARCO	
E(M)		463534.80	1548937.62	100	DOE	
Engineers		460121.05	1554977.95	115	non-DOE	USGS 3
F(M)		468854.40	1547617.57	136	DOE	
K(M)	**	467051.67	1556177.73	67	ARCO	
OW-8		478083.39	1552708.83		ARCO	
SIMPSON		472965.00	1543628.71	160	non-DOE	BW-18; HMC-936
T(M)		469141.12	1550460.89	142	DOE	
U(M)	**	470946.36	1548625.72	150	ARCO	
V(M)	**	472903.82	1550533.80	90	ARCO	
X(M)		472906.86	1547948.81	134.5	DOE	
Y1(M)	**	466892.00	1548053.88		ARCO	
Y2(M)		467531.78	1548289.19	130	DOE	

* Well recently installed: July 2011 or June-July 2012 (see Table 2 of main report)
** Well decommissioned in February 1997
TD Total depth

Additional well construction information for existing Bluewater site wells provided in Table 2 of the main report.

Table B-4. Information for San Andres Aquifer Wells Adapted from Hydro-Search (1981)

HSI Map			TD	Generalized Geologic Log (all depths in ft)						Type of Data	
No. / ID	Well	Source	(ft)	Qal	Qb	QToa	TRc	Psg	Psy	Water Level	Chemistry
12	Berryhill Sec. 5	NMSE	725	--	--	--	0-620	620-TD	--		X
13	Spencer	G	378							X	
14	North Well	G	250							X	X
15	Monitor Well	NMSE	628	0–35	--	--	35–308	308–TD	--	X	X
16	Bowlins	NMSE	518	0–15	15–72	72–110	110–455	455–TD	--	X	X
17	C(SG)	HSI	423	--	0–125	125–146	146–358	358–TD	--	X	X
18	D(SG)	HSI	259	--	--	--	--	0–TD	--	X	
19	G(SG)	HSI	278	--	--	--	--	0–TD	--	X	X
20	Payne (Allen Payne)	NMSE	315	0–1.5	1.5–46	46–100	--	100–TD	--		X
21	Anaconda #1	ACC	356	--	0–91	91–94	94–252	252–TD	--	X	
22	Anaconda #2	ACC	386	--	0–86	86–115	115–263	263–TD	--	X	X
23	Bluewater Municipal										X
24	Roundy Corral	G	199								X
25	Anaconda #3	ACC	200							X	X
26	Anaconda #4	ACC	210							X	X
27	Mexican Camp	G	280							X	X
28	Sabre-Piñon (current HMC-951)	NMSE	275	--	0–96	96–110	110–227	227–TD	--	X	X
29	Sturges Irrigation	G	225							X	X
30	Dalton									X	X
31	Hardenburg Commissary	ACC	238	0–40	--	--	40–118	118–TD	--	X	X
AN-5	Anaconda #5	HSI	440.5	--	0–90	90–106	106–267	267–TD	--	X	X
AN-5 P.H.	Anaconda #5 Pilot Hole	HSI	511	--	0–94	94–110	110–270	270–TD	--	X	
I(SG)	I(SG)	HSI	330	0–60	--	--	60–229	229–TD	--	X	X
L(SG)	L(SG)	HSI	610	--	0–110	110–122	122–412	412–TD	--	X	X
M(SG)	M(SG)	HSI	575	0–15	--	--	15–432	432–TD	--	X	X
S(SG)	S(SG)	HSI	337	--	--	--	--	0–280	280–TD	X	X
W(SG)	W(SG)	HSI	355	--	0–94	94–120	120–252	252–TD	--	X	X
Obs-2	OBS-2	HSI	319	--	--	--	--	0–269	269–TD	X	X
Obs-3	OBS-3	HSI	355	--	--	--	0–50	50–317	317–TD	X	X
S-1	Roundy Sec. 23	G	865	0–138	--	--	138–804	804–TD	--	X	X
S-2	Murray Ac. Irrigation	G	584							X	
S-3	Card Gas	G	551							X	
S-5	Siemons	NMSE	980	0–?	--	--	?–790	790–TD	--		X
S-6	Gallup Stake Irrigation Sec. 4A	G	315							X	
S-8	Dow	NMSE	198	0–30	30–65	65–106	--	106–TD	--		X
S-10	Gallup Stake Irrigation Sec. 5	G	225							X	
S-11	United Nuclear Sec. 8A	G	165							X	
S-12	United Nuclear Sec. 8B	G	150							X	X
S-13	United Nuclear Sec. 8C	G	150							X	
S-14	Gallup Stake Irrigation Sec. 4B	G	480							X	X
S-22	N.M. Highway Department	NMSE	286	0–5.5	--	--	--	5.5–245	245–TD	X	X
S-24	United Nuclear Sec. 17	G	125							X	
S-34	Bell	NMSE	320	0–5	--	--	--	5–TD	--		X
S-35	Jack Freas	G	135								
S-36	Cottonwood Well	G	253							X	
S-39	Dan's Feed Store	NMSE	164	0–16	--	--	--	16–TD	--	X	
S-42	Sturges Irrigation	Same well as #29 above.								X	X
S-43	Harding Irrigation	G	245							X	
S-49	Hanosh		250(?)							X	X
S-50	Thornton	NMSE	195	0–21	--	--	21–75	75–TD	--	X	X
S-51	Guthrie	NMSE	498	0–40	--	--	40–130	130–TD	--		X
S-53	Harding Domestic	NMSE	220	--	--	--	--	0–TD	--		
S-54	Keel	NMSE	165	--	--	--	--	0–TD	--	X	
S-65	Grants #1	NMSE	300	0–11	11–44	44–120	--	120–TD	--		X
S-66	Grants #3	NMSE	367	0–129	--	--	129–192	192–TD	--		X
S-68	Bell HQ		150(?)								X
S-70	Bluewater (Auro's) Motel	G	502								X
S-71	UN-HP #2	NMSE	1000	0–120	--	--	120–955	955–TD	--		X
S-72	UN-HP #1	G	870								X
S-73	Bluewater Cemetary	NMSE	320	0–1	--	--	--	1–270	270–TD	X	
S-74	Roundy (Harmon) House	G	300								X
S-75	Blue Well	G	450								X
DM-7	DM-7	D & M	142.3	0–5	--	--	5–60	60–TD	--	X	
DM-8	DM-8	D & M	131	0–16	--	--	16–82	82–TD	--	X	

Sources of information and notes:

The preceding table was adapted almost entirely from Appendix A (Well Inventory), Table A-1, "Wells in Grants-Bluewater Area Included in Current Investigations" provided in the following Hydro-Search (HSI 1981) report:

> *Regional Ground-Water Hydrology and Water Chemistry, Grants- Bluewater Area, Valencia County, New Mexico*, prepared for Anaconda Copper Company, June 30, 1981.

Corresponding well locations are shown in Figures B-1 and B-2, adapted from Plate IV, "Well Locations" of the above-cited Hydro-Search report. Locations for most existing and decommissioned wells are also shown on Plate 7 and Figures 16 through 19 of the main report. Corresponding water level and uranium data for 1980–1981 are plotted in Figures 23 and 55 of the Site Status Report.

Table B-4 abbreviations:

The following abbreviations regarding sources of information and geological terms are also taken directly from HSI's tables:

HSI	Hydro-Search, Inc., hydrogeologic investigations, 1977-1978 and 1980-1981
ACC	Anaconda Copper Company
NMSE	New Mexico State Engineer
G	Gordon, 1961
UN-HP	United Nuclear-Homestake Partners
D & M	Dames & Moore (1981)

TD	Total depth
Qal	Recent alluvium including eolian and lacustrine deposits
Qb	Quaternary basalt flows from either El Tintero or the Zuni Canyon centers
QToa	Quaternary-Tertiary older alluvium
TRc	Chinle Formation
Psg	San Andres-Glorieta aquifer
Psy	San Ysidro Member of Yeso Formation

Table B-5. Information for Alluvial Aquifer Wells Adapted from Hydro-Search (1981)

HSI Map			Total	Generalized Geologic Log (all depths in ft)						Type of Data	
No. / ID	**Well**	**Source**	**Depth (ft)**	**Qal**	**Qb**	**QToa**	**TRc**	**Psg**	**Psy**	**Water Level**	**Chemistry**
1	Berryhill House (now B00168)	G	150							X	X
2	Engineer's Well	G	115							X	X
3	Aragon	HSI	130(?)								X
4	Roundy–Up		134	--	0–72	72–134	134–TD	--	--	X	X
5	B(M)	HSI	161		0–121	121–147	147–TD	--	--	X	X
6	C(M)	HSI	356	--	0–128	128–149	149–353	353–TD	--	X	X
7	OW–5	ACC	71	--	0–65	65–70	70–TD	--	--	X	
8	E(M)	HSI	100	--	0–73	73–82	82–TD	--	--	X	X
9	F(M)	HSI	135	--	0–95	95–112	112–TD	--	--	X	X
10	Simpson	G	160							X	X
11	Card Abandoned	G	152							X	X
J(M)	J(M)	HSI	57	0–11	11–41	41–65	65–TD	--	--	X	X
K(M)	K(M)	HSI	67	0–15	15–37	37–60	60–TD	--	--	X	X
T(M)	T(M)	HSI	142	--	0–128	128–133	133–TD	--	--	X	X
U(M)	U(M)	HSI	150	--	0–125	125–140	140–TD	--	--	X	
V(M)	V(M)	HSI	90	--	0–70	70–73	73–TD	--	--	X	
X(M)	X(M)	HSI	134	--	0–121	121–132	132–TD	--	--	X	X
S–9	Gallup Stake Abandoned	NMSE	100(?)							X	
S–25	Evans Abandoned	NMSE	135	0–14	14–98	98–118	118–TD	--	--	X	
S–27	Gallup Stake Domestic	NMSE	138	0–12	12–95	95–132	132–TD	--	--	X	X
S–28	Milan B–23	NMSE	214	0–179	179–193	193–TD	--	--	--		X
S–41, S–41A	Holmes	NMSE	120	0–8	8–102	102–TD	--	--	--	X	X
S–46	Pittard	NMSE	102	0–70	--	70–TD	--	--	--	X	X
S–47	Roundy Sec. 14	G	105 (?)	0–TD	--	--	--	--	--	X	X
S–56	Cibola Sands	NMSE	90(?)							X	X
S–63	Milan B-24	NMSE	160								X
S–64	Milan B-35	NMSE	180								X
S–76	Urie	NMSE	85	0–TD	--	--	--	--	--		X
S–77	Crow	NMSE	140	0–TD	--	--	--	--	--		X
S–78	Clevenger	NMSE	100 (?)								X
S–79	Swierc	NMSE	110 (?)								X
S–81	Caudill	NMSE	116	0–TD	--	--	--	--	--		X
S–82	Roundy Sec. 12	G	100	0–TD	--	--	--	--	--		X
BC	BC	UN–HP	83	0–TD	--	--	--	--	--	X	
D	D	UN–HP	91	0–TD	--	--	--	--	--	X	
P	P	UN–HP	113	0–TD	--	--	--	--	--	X	
Q	Q	UN–HP	104	0–TD	--	--	--	--	--	X	
R	R	UN–HP	96	0–TD	--	--	--	--	--	X	

Source: Hydro-Search (HSI 1981) Appendix A (Well Inventory), Table A-1, "Wells in Grants-Bluewater Area Included in Current Investigations." Corresponding well locations are shown in Figures B-1 and B-3, adapted from Plate IV, "Well Locations" of HSI's report. Locations for most existing and decommissioned alluvial wells are also shown on Plate 7 and Figures 16 through 19 of the Site Status report. Locations for most existing and decommissioned non-domestic alluvial wells are shown on Plate 7 and Figures 16 through 19 of the main report. Corresponding water level and uranium data for 1980–1981 are plotted in Figures 20 and 51 of the Site Status Report.

See notes and abbreviations following Table B-4.

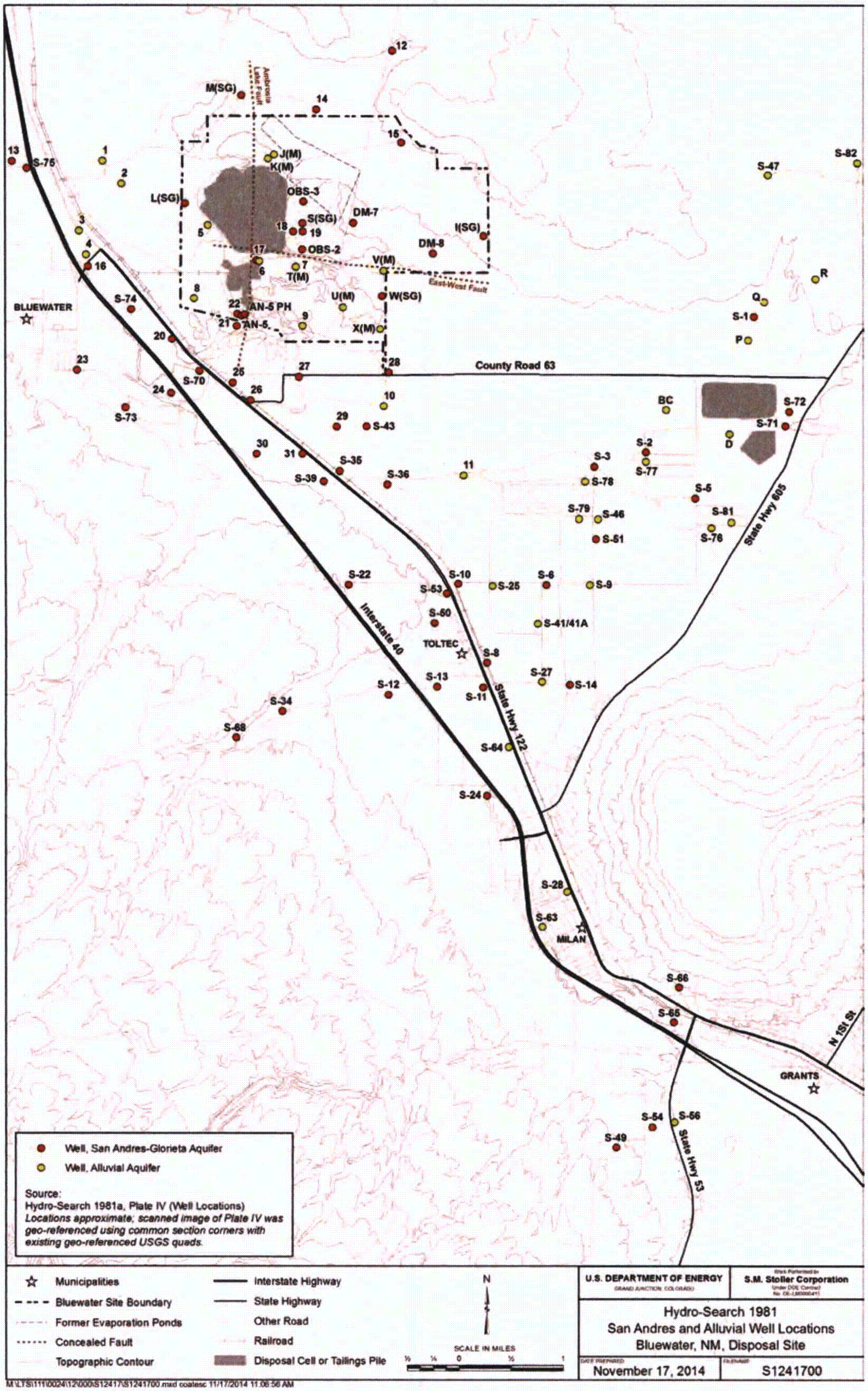

Figure B-1. Hydro-Search 1981 San Andres and Alluvial Well Locations
(Wells labeled with corresponding HSI map number)

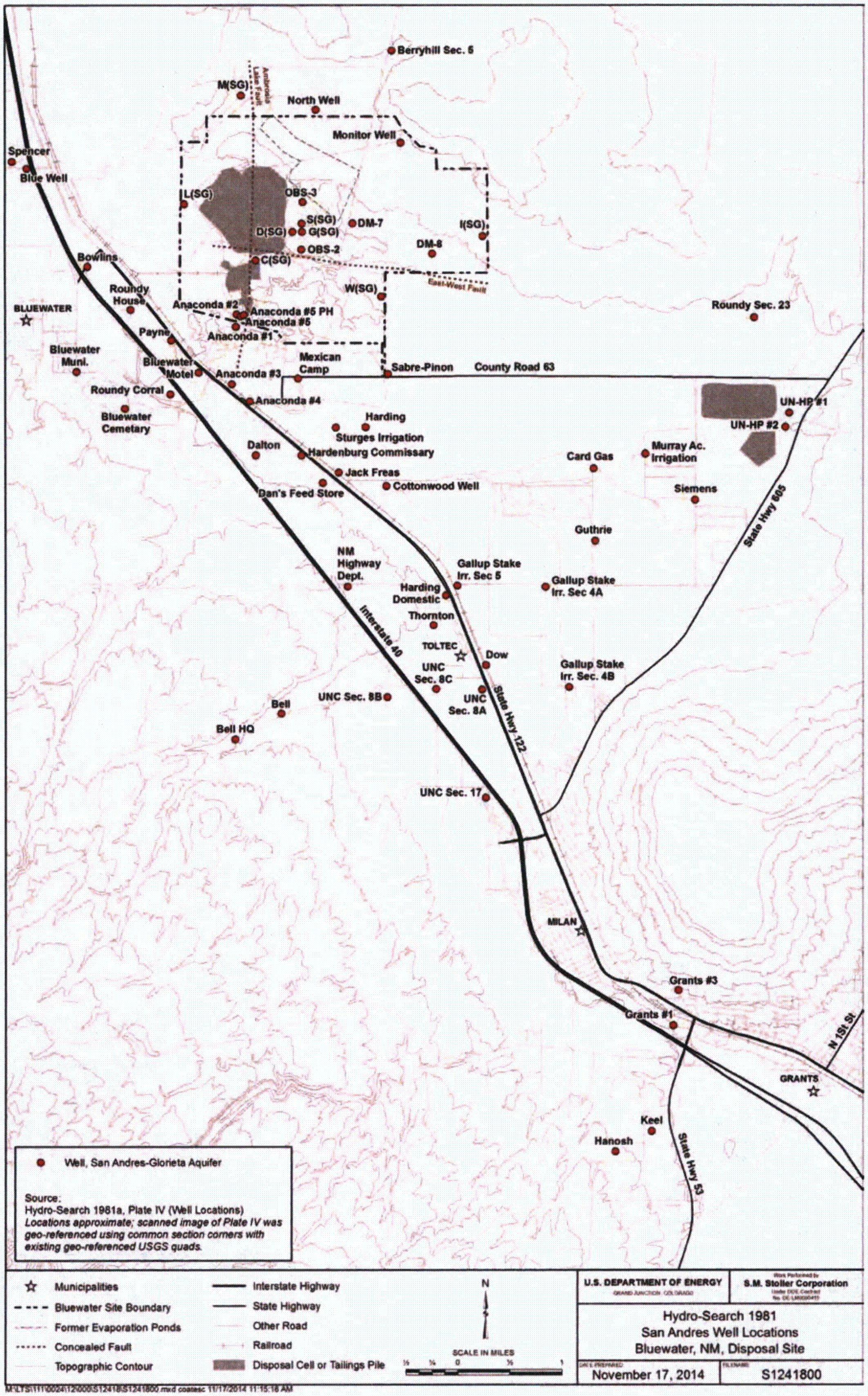

Figure B-2. Hydro-Search 1981 San Andres Well Locations

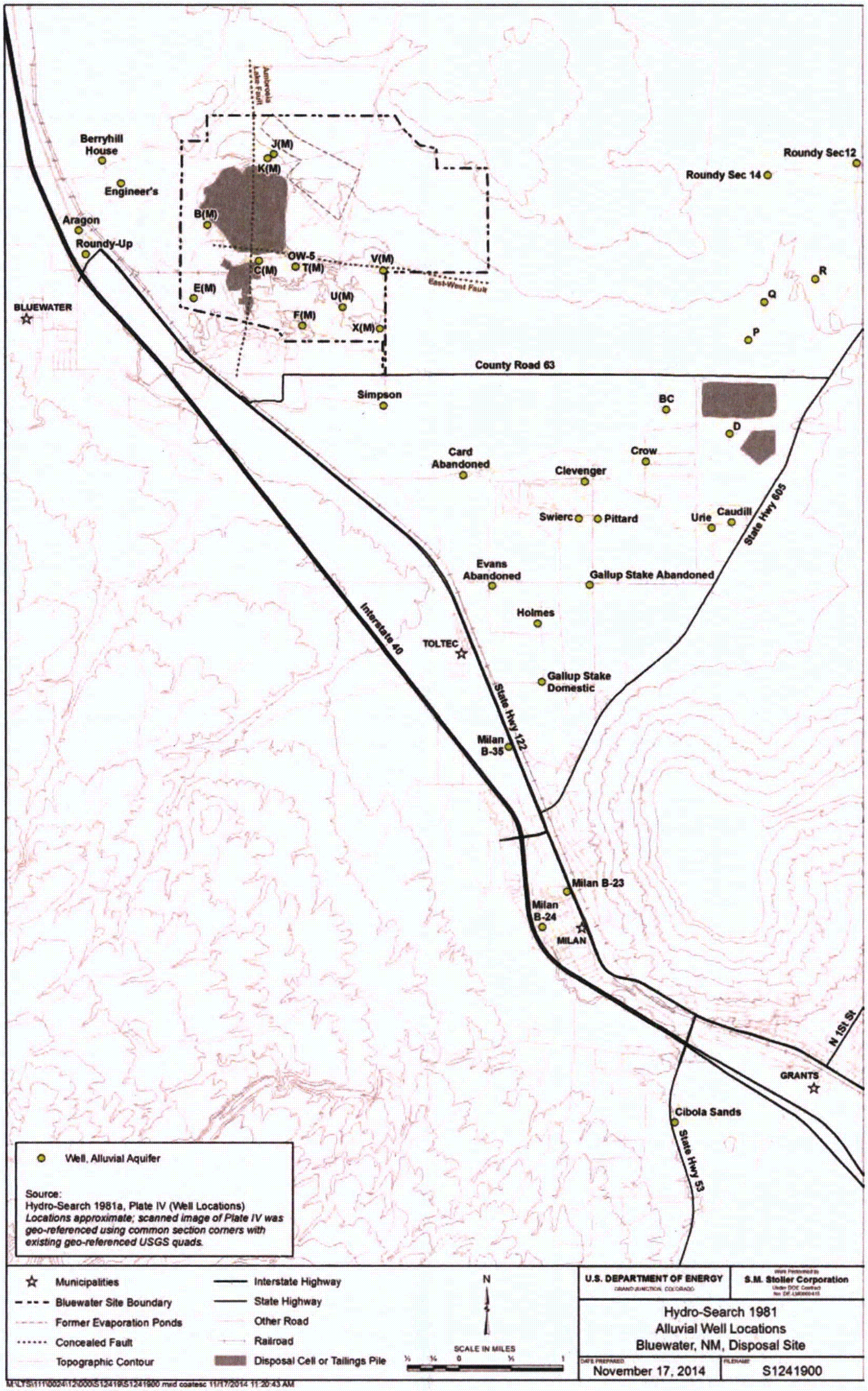

Figure B-3. Hydro-Search 1981 Alluvial Well Locations

Table B-6. Well Location Information for Homestake Alluvial Tailings Area Wells (Source: 2012 HMC Annual Report, Table 4.1-1)

Well ID	Easting	Northing
1A	493768.00	1543790.00
1B	494412.00	1544502.00
1C	494799.00	1545018.00
1D	494752.00	1544142.00
1E	494116.00	1544481.00
1F	493831.00	1544952.00
1G	494170.00	1545034.00
1H	494266.00	1543363.00
1I	493928.00	1542627.00
1J	493695.00	1541986.00
1K	493275.00	1541992.00
1L	493416.00	1541256.00
1M	493133.00	1541327.00
1N	494396.00	1543100.00
1O	494175.00	1542592.00
1P	493924.00	1541902.00
1Q	493619.00	1541993.00
1R	493623.00	1542071.00
1S	493614.00	1541920.00
1T	493656.00	1541990.00
1U	493542.00	1542001.00
1V	493579.00	1541982.00
690	493465.00	1540279.00
691	493860.00	1540276.00
891	493751.00	1540904.00
892	494317.00	1540954.00
A1	491539.00	1542365.00
A2	491539.00	1542356.00
B	489311.00	1541684.00
B1	489370.00	1542071.00
B10	491133.00	1542517.00
B11	491329.00	1542517.00
B12	488915.00	1542524.00
B13	490223.00	1541841.00
B2	489515.00	1542475.00
B3	489731.00	1542480.00
B4	489942.00	1542471.00
B5	490141.00	1542474.00
B6	490341.00	1542478.00
B7	490540.00	1542488.00
B8	490734.00	1542488.00
B9	490935.00	1542514.00
BA	489440.00	1541835.00
BB2	486213.00	1543791.00
BC	487910.00	1543655.00
BP	489841.00	1541882.00
C	490854.00	1541762.00
C1	490780.00	1541533.00
C10	491629.00	1542182.00
C11	491844.00	1542376.00

Well ID	Easting	Northing
C12	492029.00	1542375.00
C13	490655.00	1541394.00
C14	490713.00	1541413.00
C2	490566.00	1541630.00
C3	490481.00	1541344.00
C3R	490472.00	1541338.00
C4	490675.00	1541348.00
C5	490869.00	1541344.00
C6	491142.00	1541533.00
C7	491280.00	1541734.00
C8	491415.00	1541906.00
C9	491545.00	1542075.00
D	490118.00	1542127.00
D1	489615.00	1542140.00
D2	492107.00	1542641.00
D3	491917.00	1542646.00
D4	491724.00	1542652.00
DA	489488.00	1542864.00
DA2	489656.00	1542881.00
DA3	489390.00	1542664.00
DA4	489756.00	1542598.00
DAA	492411.00	1542733.00
DAB	492399.00	1542633.00
DAC	492851.00	1543218.00
DB	489842.00	1542874.00
DBR	489855.00	1542877.00
DC	487060.00	1543646.00
DD	488943.00	1546989.00
DD2	489251.00	1547439.00
DE	490193.00	1542877.00
DF	490869.00	1542839.00
DG	491157.00	1542839.00
DH	491365.00	1542835.00
DIA	491793.00	1542821.00
DJ	491793.00	1542821.00
DK	492094.00	1542799.00
DI	491788.00	1542821.00
DL	492398.00	1542813.00
DM	490035.00	1542628.00
DN	490020.00	1542776.00
DNR	490031.00	1542779.00
DO	490049.00	1542874.00
DP	491012.00	1542754.00
DQ	491006.00	1542592.00
DR	489966.00	1542884.00
DS	490118.00	1542876.00
DT	489293.00	1542871.00
DU	490380.00	1542879.00
DV	490702.00	1542826.00
DW	492029.00	1542818.00

Well ID	Easting	Northing
DX	491074.00	1542838.00
DY	492271.00	1542737.00
DZ	491501.00	1542834.00
E	490187.00	1540553.00
EE	490523.00	1542853.00
F	489554.00	1539908.00
FB	488857.00	1540417.00
FF	490017.00	1542878.00
G	488890.00	1538672.00
GA	489255.00	1538657.00
GB	489456.00	1538654.00
GC	489654.00	1538650.00
GE	489972.00	1538637.00
GF	490097.00	1538632.00
GG	489055.00	1538662.00
GH	489509.00	1538807.00
GJ	490382.00	1538629.00
GK	490482.00	1538622.00
GI	490218.00	1538631.00
GL	490701.00	1538614.00
GM	490824.00	1538605.00
GN	490944.00	1538602.00
GO	489855.00	1538646.00
GO	488973.00	1538663.00
GP	489752.00	1538649.00
GQ	491067.00	1538599.00
GR	490619.00	1538619.00
GS	491408.00	1538597.00
GT	491565.00	1538534.00
GU	491854.00	1538367.00
GV	491428.00	1537701.00
GW1	490530.00	1539755.00
GW2	490497.00	1539471.00
GW3	490835.00	1539532.00
H	490582.00	1538703.00
I	490954.00	1539319.00
J	491302.00	1540174.00
J1	491585.00	1540082.00
J10	491436.00	1540138.00
J11	490909.00	1540545.00
J12	490466.00	1540827.00
J13	492218.00	1540451.00
J14	492367.00	1540585.00
J15	492521.00	1540719.00
J2	491013.00	1540271.00
J3	490499.00	1540414.00
J4	489974.00	1540643.00
J5	489747.00	1540728.00
J6	489221.00	1540919.00
J7	491892.00	1540168.00

Table B-6 (continued). Well Location Information for Homestake Alluvial Tailings Area Wells (Source: 2012 HMC Annual Report, Table 4.1-1)

Well ID	Easting	Northing
J8	492064.00	1540318.00
J9	491759.00	1540101.00
JC	491240.00	1540215.00
K	491590.00	1540730.00
K10	491638.00	1541305.00
K11	491490.00	1541325.00
K2	491587.00	1540736.00
K3	491571.00	1540744.00
K4	492371.00	1541211.00
K5	491935.00	1541269.00
K6	491459.00	1540689.00
K7	492237.00	1541232.00
K8	492081.00	1541250.00
K9	491787.00	1541287.00
KA	491331.00	1540959.00
KB	491406.00	1540893.00
KC	491477.00	1540826.00
KD	491701.00	1540627.00
KE	491776.00	1540566.00
KEB	491487.00	1540570.00
KF	491169.00	1540870.00
KM	491444.00	1540671.00
KN	491492.00	1540734.00
KZ	491183.00	1541100.00
L	492150.00	1538970.00
L10	492310.00	1539250.00
L5	492730.00	1539946.00
L6	493110.00	1540526.00
L7	492842.00	1540113.00
L8	492621.00	1539773.00
L9	492463.00	1539509.00
M1	489157.00	1542797.00
M10	486723.00	1543677.00
M11	486486.00	1542358.00
M12	487209.00	1542174.00
M13	487336.00	1542450.00
M14	487216.00	1542661.00
M15	487094.00	1542872.00
M16	485112.00	1543252.00
M2	489159.00	1542785.00
M3	489151.00	1542805.00
M4	489134.00	1542804.00
M5	489080.00	1542360.00
M6	486674.00	1543097.00
M7	486523.00	1542790.00
M8	486567.00	1542960.00
M9	486699.00	1543310.00
MA	487767.00	1541290.00
MB	487512.00	1541296.00
MC	487264.00	1541304.00

Well ID	Easting	Northing
MD	487050.00	1541311.00
ME	486934.00	1541537.00
MF	486808.00	1541757.00
MG	486694.00	1541972.00
MH	486569.00	1542208.00
MJ	486350.00	1542682.00
MJR	489078.00	1542926.00
MK	486324.00	1543373.00
MI	486413.00	1542486.00
ML	486691.00	1543902.00
MM	486324.00	1544154.00
MN	486325.00	1544613.00
MO	485518.00	1543620.00
MP	485492.00	1544164.00
MQ	486326.00	1543173.00
MR	483574.00	1542609.00
MS	485570.00	1542607.00
MT	483531.00	1543221.00
MU	487143.00	1544461.00
MV	484418.00	1542618.00
MW	486346.00	1543802.00
MX	486244.00	1541287.00
MY	486213.00	1542200.00
MZ	486757.00	1543485.00
N	489665.00	1545101.00
NA	491488.00	1545000.00
NB	491296.00	1545000.00
NC	491282.00	1545220.00
ND	494872.00	1545927.00
NE5	492332.00	1544279.00
NW5	489433.00	1544408.00
O	492725.00	1545060.00
P	491058.00	1546691.00
P1	491060.00	1547017.00
P2	490912.00	1546555.00
P3	490785.00	1546159.00
P4	491899.00	1546504.00
PM	490292.00	1541426.00
Q	492153.00	1548693.00
R	494514.00	1550372.00
S	488816.00	1543871.00
S1	488401.00	1543288.00
S11	488150.00	1544793.00
S12	488628.00	1543297.00
S2	488299.00	1543127.00
S3	488714.00	1542857.00
S4	488359.00	1543344.00
S5R	488938.00	1543150.00
S6	488874.00	1543515.00
S7	488874.00	1543763.00

Well ID	Easting	Northing
S8	488879.00	1543968.00
SA	488811.00	1543122.00
SB	488811.00	1543371.00
SC	488815.00	1543617.00
SD	488564.00	1543490.00
SD4	488556.00	1543497.00
SE	488550.00	1543301.00
SE4	488560.00	1543308.00
SE6	488615.00	1543244.00
SM	488566.00	1543748.00
SN	488716.00	1543752.00
SO	488381.00	1543652.00
SP	488531.00	1543630.00
SQ	488814.00	1543507.00
SR	488669.00	1543611.00
SS	488666.00	1543374.00
SSR	488650.00	1543370.00
ST	488688.00	1543215.00
SUR	488968.00	1542991.00
SV	488813.00	1543676.00
SW	488812.00	1543783.00
SX	489025.00	1544510.00
SZ	488833.00	1544367.00
T	492260.00	1542536.00
T1	490027.00	1543285.00
T10	492791.00	1543434.00
T11	489887.00	1544585.00
T12	490317.00	1544583.00
T13	490619.00	1544534.00
T14	491071.00	1544565.00
T15	491953.00	1544480.00
T16	492718.00	1544276.00
T17	489430.00	1544008.00
T18	490333.00	1543977.00
T19	490722.00	1543958.00
T2	489303.00	1543538.00
T20	491048.00	1543935.00
T21	491882.00	1543951.00
T22	492311.00	1543876.00
T23	492805.00	1543901.00
T36	489688.00	1543735.00
T39	491669.00	1544498.00
T4	489699.00	1543340.00
T40	491466.00	1543819.00
T41	491079.00	1543278.00
T5	490289.00	1543307.00
T6	490655.00	1543282.00
T7	491484.00	1543272.00
T8	491914.00	1543296.00
T9	492337.00	1543347.00

Table B-6 (continued). Well Location Information for Homestake Alluvial Tailings Area Wells (Source: 2012 HMC Annual Report, Table 4.1-1)

Well ID	Easting	Northing
TA	492426.00	1542471.00
TB	492616.00	1542351.00
W	487297.00	1542302.00
W2	486654.00	1542251.00
WN4	489961.00	1543958.00
WR1	488529.00	1541280.00
WR10	487961.00	1542389.00
WR11	487728.00	1542586.00
WR12	488277.00	1541280.00
WR13	488861.00	1541068.00
WR14	488863.00	1540638.00
WR15	488016.00	1541280.00
WR16	487495.00	1543051.00
WR17	487485.00	1543328.00
WR18	487465.00	1543597.00
WR19	487458.00	1543873.00
WR1R	488536.00	1541302.00
WR2	488678.00	1541290.00
WR20	487449.00	1544059.00
WR21	487449.00	1544241.00
WR22	487462.00	1544434.00
WR23	487445.00	1544632.00
WR24	487438.00	1544938.00
WR3	488671.00	1541490.00
WR4	488678.00	1541788.00
WR5	488683.00	1541813.00
WR6	488566.00	1541902.00
WR7	488456.00	1541997.00
WR8	488328.00	1542095.00
WR9	488217.00	1542185.00
X	491892.00	1540512.00
X1	492129.00	1540671.00

Well ID	Easting	Northing
X10	492835.00	1542352.00
X11	492782.00	1542553.00
X12	492852.00	1542861.00
X13	493665.00	1543640.00
X14	493777.00	1544002.00
X15	493800.00	1544222.00
X16	493795.00	1544473.00
X17	493793.00	1544356.00
X18	493569.00	1544593.00
X19	493437.00	1544753.00
X2	492363.00	1540836.00
X20	493256.00	1544855.00
X21	493894.00	1543606.00
X22	493946.00	1543874.00
X23	494012.00	1544064.00
X24	494011.00	1544244.00
X25	494042.00	1544445.00
X26	493702.00	1544693.00
X27	493374.00	1544953.00
X28	491971.00	1540545.00
X29	492256.00	1540735.00
X3	492599.00	1540992.00
X30	492493.00	1540897.00
X31	492731.00	1541052.00
X4	492814.00	1541210.00
X5	492821.00	1541408.00
X6	492828.00	1541609.00
X7	492851.00	1541808.00
X8	492852.00	1542007.00
X9	492852.00	1542194.00
Y	491256.00	1541025.00
Z	490701.00	1540290.00

Table B-7. Well Location Information for Homestake Alluvial Regional Wells (Source: 2012 HMC Annual Report, Tables 4.1-2 through 4.1-4)

Well ID	Easting	Northing
427	490410.00	1538450.00
482	489579.00	1536981.00
483	489753.00	1536586.00
490	489752.00	1536553.00
491	489658.00	1537031.00
496	489603.00	1534650.00
497	489503.00	1535039.00
498	488953.00	1534661.00
CW44	488891.00	1535048.00
Sub1	489100.00	1537620.00
Sub2	490370.00	1537392.00
Sub3	489420.00	1538280.00
688	483955.00	1541257.00
802	488277.00	1540765.00
844	487002.00	1538376.00
845	487833.00	1537280.00
AW	488015.00	1540235.00
520	492935.00	1538934.00
521	492588.00	1539104.00
522	492437.00	1538640.00
523	492896.00	1538680.00
531	478262.00	1541086.00
532	482400.00	1518700.00
538	486899.00	1533486.00
539	487596.00	1534014.00
540	488091.00	1534125.00
541	477236.00	1539831.00
551	479881.00	1536272.00
553	480563.00	1534923.00
554	479107.00	1534967.00
555	486236.00	1538572.00
556	486184.00	1538006.00
557	486000.00	1537809.00
631	483756.00	1532234.00
632	483767.00	1531850.00
634	480362.00	1541652.00
636	476038.00	1545374.00
637	474710.00	1545409.00
638	493265.00	1539628.00
639	492961.00	1539370.00
640	491961.00	1537790.00
644	485450.00	1533481.00
646	484953.00	1533246.00
647	478308.00	1536623.00
648	478343.00	1534730.00
649	479798.00	1534730.00

Well ID	Easting	Northing	Alt. ID
650	482135.00	1536779.00	
653	486570.00	1533283.00	
654	478636.00	1541994.00	
655	479830.00	1541620.00	
657	478392.00	1537497.00	
658	478436.00	1535922.00	
659	480772.00	1541689.00	
681	482734.00	1540676.00	
683	476217.00	1540198.00	
684	478499.00	1540273.00	
686	475438.00	1545319.00	
846	484730.00	1537219.00	
861	488702.00	1534332.00	
862	487800.00	1534265.00	
863	487912.00	1533867.00	
864	486464.00	1533735.00	
865	488429.00	1534123.00	
866	488340.00	1534494.00	
867	488409.00	1533762.00	
869	486073.00	1533251.00	
881	481478.00	1542034.00	
882	482396.00	1541404.00	
883	483039.00	1540097.00	
884	481498.00	1542677.00	
885	483474.00	1541919.00	
886	482487.00	1542327.00	
887	482469.00	1543063.00	
888	479335.00	1542285.00	
890	480088.00	1541365.00	
893	482244.00	1541934.00	
895	476222.00	1541521.00	
896	476237.00	1542246.00	
899	477288.00	1543801.00	
910	481150.00	1528800.00	
914	500850.00	1555500.00	SMC-10
920	496900.00	1555800.00	SMC-11
921	495800.00	1555400.00	SMC-13
922	492500.00	1555200.00	SMC-14
935	476629.00	1540115.00	
942	483710.00	1538300.00	
947	491841.00	1536206.00	
950	498300.00	1560400.00	SMC-12
994	476240.00	1539700.00	
996	477989.00	1537621.00	
999	480187.00	1524230.00	

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Appendix C

Water Level and Water Chemistry Data

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Preface

This appendix documents historical water level and water quality data for wells in the Grants-Bluewater Valley study region addressed in the Site Status Report. Data sources used to develop these tables include:

- DOE/Bluewater site database
- Homestake annual reports for years 1996 through 2013
- Hydro-Search 1981a
- NMED (New Mexico Environment Department) 2010
- State of New Mexico Drinking Water Branch (https://eidea.nmenv.state.nm.us/DWW/)

The following tables document historical data for the Bluewater site and conceptual model study region used to develop the Site Status Report. The database is extensive, including not only Bluewater site wells, but Homestake site and other regional wells (see references in Section 11 of the Site Status Report). The site database is being updated and refined and will undergo DOE's quality control and data validation procedures to the extent possible. Because the database is still under development, there may be gaps in the early historical record documented here. Also, this appendix does not include data for all parameters historically analyzed. Rather, the focus is on the key Bluewater site contaminants (e.g., uranium) and water quality parameters. Data for other parameters not regularly monitored or not considered germane to the study are not reported here. Quality assurance/quality control (e.g., duplicate sample) results are also not documented in this appendix.

Investigators evaluated every available Hydro-Engineering report prepared for the Homestake site between 1996 and 2013. All available historical Homestake information and data pertaining to San Andres wells are included here, as this aquifer is the primary focus of the Site Status Report. However, because the data set for HMC alluvial wells is very large (hundreds of wells), only the data supporting the 2012 alluvial potentiometric and uranium plume snapshots are included. The reader is referred to Homestake's annual reports for data and information regarding historical trends in alluvial wells in this region.

LIST OF TABLES

Water Level Data

Water Quality Data Tables

Abbreviations

AL	alluvium or alluvial aquifer
amsl	above mean sea level
AR	activity ratio (U-234/U-238)
ARCO	Atlantic Richfield Company
As	arsenic
bgs	below ground surface
BW	Bluewater (prefix used by NMED [2010]) for sample IDs)
Ca (mg/L)	calcium
$CaCO_3$	calcium carbonate
Cl (mg/L)	chloride
DO (mg/L)	dissolved oxygen
DOE	U.S. Department of Energy
EC	electrical conductivity
Fe	iron
Fm	formation
ft	feet
HMC	Homestake Mining Company
K (mg/L)	potassium
Mg	magnesium

Abbreviations (continued)

mg/L	milligrams per liter
Mo (µg/L)	molybdenum
µg/L	micrograms per liter
µmhos/cm	micromhos per centimeter
µS/cm	microsiemens per centimeter
N	nitrogen
Na (mg/L)	sodium
NM DWB	State of New Mexico Drinking Water Branch (Drinking Water Watch) website
NMED	New Mexico Environment Department
NO_2	nitrite
NO_3	nitrate
ORP (mV)	oxidation-reduction potential (millivolts)
OSE	(New Mexico) Office of State Engineer
pCi/L	picocuries per liter
s.u.	standard units
SA	San Andres
SC	specific conductance
Se (µg/L)	selenium
SMC	San Mateo Creek
SO_4 (mg/L)	sulfate
T (°C)	temperature (degrees Celsius)
U	uranium
U-234	uranium-234
U-238	uranium-238
USGS	U.S. Geological Survey

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Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
11(SG)	11/14/2012	6434.12	6639.19	205.07	202.38	
11(SG)	1/30/2013	6434.08	6639.19	205.11	202.42	
11(SG)	5/14/2013	6433.89	6639.19	205.3	202.61	
11(SG)	11/19/2013	6433.49	6639.19	205.7	203.01	
11(SG)	4/29/2014	6432.18	6639.19	207.01	204.32	
13(SG)	11/15/2012	6427	6593.57	166.57	164.03	
13(SG)	1/28/2013	6427.24	6593.57	166.33	163.79	
13(SG)	5/15/2013	6426.07	6593.57	167.5	164.96	
13(SG)	11/19/2013	6426.49	6593.57	167.08	164.54	
13(SG)	4/29/2014	6426.09	6593.57	167.48	164.94	
14(SG)	11/14/2012	6428.98	6617.2	188.22	185.77	
14(SG)	1/30/2013	6429.14	6617.2	188.06	185.61	
14(SG)	5/14/2013	6428.2	6617.2	189	186.55	
14(SG)	11/19/2013	6428.2	6617.2	189	186.55	
14(SG)	4/30/2014	6427.79	6617.2	189.41	186.96	
15(SG)	11/13/2012	6427.74	6612.53	184.79	182.38	
15(SG)	1/29/2013	6427.9	6612.53	184.63	182.22	
15(SG)	5/14/2013	6425.85	6612.53	186.68	184.27	
15(SG)	11/19/2013	6427.13	6612.53	185.4	182.99	
15(SG)	4/29/2014	6426.71	6612.53	185.82	183.41	
16(SG)	11/13/2012	6433.97	6618.25	184.28	181.58	
16(SG)	1/30/2013	6433.94	6618.25	184.31	181.61	
16(SG)	5/16/2013	6433.67	6618.25	184.58	181.88	
16(SG)	11/19/2013	6432.23	6618.25	186.02	183.32	
16(SG)	4/29/2014	6432	6618.25	186.25	183.55	
18(SG)	11/14/2012	6427.83	6601.32	173.49	170.89	
18(SG)	1/30/2013	6427.96	6601.32	173.36	170.76	
18(SG)	5/14/2013	6426.98	6601.32	174.34	171.74	
18(SG)	11/19/2013	6427.3	6601.32	174.02	171.42	
18(SG)	4/30/2014	6426.74	6601.32	174.58	171.98	
Anaconda #3	4/12/1990	6473.04		-6473.04	-6473.04	
Anaconda #4	4/26/1984	6470.41		-6470.41	-6470.41	
Anaconda #4	4/22/1986	6473.77		-6473.77	-6473.77	
Anaconda #4	10/6/1986	6476.46		-6476.46	-6476.46	
Anaconda #4	4/13/1987	6475.84		-6475.84	-6475.84	
Anaconda #4	10/8/1987	6478.16		-6478.16	-6478.16	
Anaconda #4	4/13/1988	6475.14		-6475.14	-6475.14	
Anaconda #4	10/11/1988	6477.67		-6477.67	-6477.67	
Anaconda #4	4/19/1989	6474.81		-6474.81	-6474.81	
Anaconda #5	5/17/1984	6472.92		-6472.92	-6472.92	
Anaconda #5	4/22/1986	6475.52		-6475.52	-6475.52	
Anaconda #5	10/6/1986	6478.27		-6478.27	-6478.27	
Anaconda #5	11/19/1986	6477.85		-6477.85	-6477.85	
Anaconda #5	4/6/1987	6476.37		-6476.37	-6476.37	
Anaconda #5	10/8/1987	6478.81		-6478.81	-6478.81	
Anaconda #5	4/5/1988	6476.9		-6476.9	-6476.9	
Anaconda #5	10/5/1988	6479.74		-6479.74	-6479.74	
Anaconda #5	4/18/1989	6477.22		-6477.22	-6477.22	
Anaconda #5	4/12/1990	6473.51		-6473.51	-6473.51	
C(SG)	4/16/1984	6471.47		-6471.47	-6471.47	
C(SG)	5/5/1986	6476.14		-6476.14	-6476.14	
C(SG)	4/9/1987	6474.43		-6474.43	-6474.43	
C(SG)	4/13/1988	6476.87		-6476.87	-6476.87	
C(SG)	4/18/1989	6477.24		-6477.24	-6477.24	
C(SG)	4/11/1990	6470.53		-6470.53	-6470.53	
C(SG)	4/16/1990	6473.52		-6473.52	-6473.52	

Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
HMC-951	4/26/1984	6469.54	6576.79	107.25	107.41	
HMC-951	6/20/1986	6473.22	6576.79	103.57	103.73	
HMC-951	4/9/1987	6474.44	6576.79	102.35	102.51	
HMC-951	4/13/1988	6473.42	6576.79	103.37	103.53	
HMC-951	4/19/1989	6473.9	6576.79	102.89	103.05	
HMC-951	8/18/1998	6464.90	6573.7	108.80		HMC 1999 (see Note)
HMC-951	8/19/1999	6466.20	6573.7	107.50		HMC 2000
HMC-951	8/30/1999	6462.85	6573.7	110.85		HMC 2000
HMC-951	9/7/1999	6462.77	6573.7	110.93		HMC 2000
HMC-951	10/5/1999	6462.91	6573.7	110.79		HMC 2000
HMC-951	11/1/1999	6463.78	6573.7	109.92		HMC 2000
HMC-951	11/29/1999	6466.09	6573.7	107.61		HMC 2000
HMC-951	1/3/2000	6463.82	6573.7	109.88		HMC 2001
HMC-951	1/31/2000	6462.72	6573.7	110.98		HMC 2001
HMC-951	3/6/2000	6464.10	6573.7	109.60		HMC 2001
HMC-951	4/3/2000	6463.45	6573.7	110.25		HMC 2001
HMC-951	5/2/2000	6463.50	6573.7	110.20		HMC 2001
HMC-951	8/9/2000	6458.70	6573.7	115.00		HMC 2001
HMC-951	4/12/2001	6457.76	6573.7	115.94		HMC 2002
HMC-951	12/11/2001	6452.38	6573.7	121.32		HMC 2002
HMC-951	3/4/2002	6447.74	6573.7	125.96		HMC 2003
HMC-951	4/1/2002	6450.94	6573.7	122.76		HMC 2003
HMC-951	4/29/2002	6445.2	6573.7	128.5		HMC 2003
HMC-951	6/4/2002	6443.58	6573.7	130.12		HMC 2003
HMC-951	7/1/2002	6442.22	6573.7	131.48		HMC 2003
HMC-951	8/5/2002	6441.09	6573.7	132.61		HMC 2003
HMC-951	9/3/2002	6440.82	6573.7	132.88		HMC 2003
HMC-951	9/30/2002	6440.92	6573.7	132.78		HMC 2003
HMC-951	10/17/2002	6441.34	6573.7	132.36		HMC 2003
HMC-951	11/5/2002	6442.65	6573.7	131.05		HMC 2003
HMC-951	12/2/2002	6442.85	6573.7	130.85		HMC 2003
HMC-951	12/18/2002	6443.16	6573.7	130.54		HMC 2003
HMC-951	12/30/2002	6443.19	6573.7	130.51		HMC 2003
HMC-951	2/3/2003	6442.38	6573.7	131.32		HMC 2004
HMC-951	3/3/2003	6442.42	6573.7	131.28		HMC 2004
HMC-951	3/31/2003	6440.90	6573.7	132.80		HMC 2004
HMC-951	5/5/2003	6439.09	6573.7	134.61		HMC 2004
HMC-951	6/30/2003	6386.26	6573.7	187.44		HMC 2004
HMC-951	8/2/2003	6389.00	6573.7	184.70		HMC 2004
HMC-951	8/14/2003	6437.60	6573.7	136.10		HMC 2004
HMC-951	9/2/2003	6436.10	6573.7	137.60		HMC 2004
HMC-951	9/29/2003	6437.25	6573.7	136.45		HMC 2004
HMC-951	10/27/2003	6437.89	6573.7	135.81		HMC 2004
HMC-951	11/3/2003	6438.20	6573.7	135.50		HMC 2004
HMC-951	12/1/2003	6389.00	6573.7	184.70		HMC 2004
HMC-951	12/29/2003	6403.30	6573.7	170.40		HMC 2004
HMC-951	2/2/2004	6438.39	6573.7	135.31		HMC 2005
HMC-951	3/1/2004	6438.92	6573.7	134.78		HMC 2005
HMC-951	3/29/2004	6437.15	6573.7	136.55		HMC 2005
HMC-951	5/3/2004	6435.76	6573.7	137.94		HMC 2005
HMC-951	6/1/2004	6435.92	6573.7	137.78		HMC 2005
HMC-951	6/28/2004	6434.83	6573.7	138.87		HMC 2005
HMC-951	8/2/2004	6434.70	6573.7	139.00		HMC 2005
HMC-951	8/30/2004	6433.46	6573.7	140.24		HMC 2005
HMC-951	10/4/2004	6433.42	6573.7	140.28		HMC 2005
HMC-951	11/1/2004	6434.46	6573.7	139.24		HMC 2005

Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
HMC-951	11/29/2004	6438.51	6573.7	135.19		HMC 2005
HMC-951	12/8/2004	6438.80	6573.7	134.90		HMC 2005
HMC-951	1/4/2005	6434.62	6573.7	139.08		HMC 2006
HMC-951	1/31/2005	6433.88	6573.7	139.82		HMC 2006
HMC-951	2/28/2005	6434.32	6573.7	139.38		HMC 2006
HMC-951	4/4/2005	6433.85	6573.7	139.85		HMC 2006
HMC-951	4/25/2005	6433.82	6573.7	139.88		HMC 2006
HMC-951	5/2/2005	6433.03	6573.7	140.67		HMC 2006
HMC-951	5/31/2005	6431.78	6573.7	141.92		HMC 2006
HMC-951	7/5/2005	6431.45	6573.7	142.25		HMC 2006
HMC-951	8/1/2005	6436.92	6573.7	136.78		HMC 2006
HMC-951	8/29/2005	6433.35	6573.7	140.35		HMC 2006
HMC-951	10/3/2005	6432.78	6573.7	140.92		HMC 2006
HMC-951	10/31/2005	6432.80	6573.7	140.90		HMC 2006
HMC-951	11/28/2005	6432.79	6573.7	140.91		HMC 2006
HMC-951	12/5/2005	6432.89	6573.7	140.81		HMC 2006
HMC-951	1/3/2006	6432.75	6573.7	140.95		HMC 2006
HMC-951	1/3/2006	6432.75	6573.7	140.95		HMC 2007
HMC-951	1/30/2006	6432.56	6573.7	141.14		HMC 2007
HMC-951	2/27/2006	6432.30	6573.7	141.40		HMC 2007
HMC-951	3/16/2006	6431.34	6573.7	142.36		HMC 2007
HMC-951	4/3/2006	6431.34	6573.7	142.36		HMC 2007
HMC-951	5/1/2006	6431.83	6573.7	141.87		HMC 2007
HMC-951	5/30/2006	6430.90	6573.7	142.80		HMC 2007
HMC-951	6/26/2006	6430.58	6573.7	143.12		HMC 2007
HMC-951	7/31/2006	6429.47	6573.7	144.23		HMC 2007
HMC-951	8/28/2006	6433.80	6573.7	139.90		HMC 2007
HMC-951	9/25/2006	6429.40	6573.7	144.30		HMC 2007
HMC-951	10/30/2006	6430.62	6573.7	143.08		HMC 2007
HMC-951	11/27/2006	6430.55	6573.7	143.15		HMC 2007
HMC-951	12/27/2006	6431.15	6573.7	142.55		HMC 2007
HMC-951	1/29/2007	6435.10	6573.7	138.60		HMC 2008
HMC-951	2/26/2007	6435.10	6573.7	138.60		HMC 2008
HMC-951	3/9/2007	6431.32	6573.7	142.38		HMC 2008
HMC-951	4/2/2007	6430.45	6573.7	143.25		HMC 2008
HMC-951	4/30/2007	6428.78	6573.7	144.92		HMC 2008
HMC-951	5/29/2007	6427.80	6573.7	145.90		HMC 2008
HMC-951	7/2/2007	6426.90	6573.7	146.80		HMC 2008
HMC-951	7/30/2007	6426.80	6573.7	146.90		HMC 2008
HMC-951	9/4/2007	6426.65	6573.7	147.05		HMC 2008
HMC-951	10/1/2007	6425.70	6573.7	148.00		HMC 2008
HMC-951	10/29/2007	6426.40	6573.7	147.30		HMC 2008
HMC-951	12/3/2007	6427.10	6573.7	146.60		HMC 2008
HMC-951	1/2/2008	6427.33	6573.7	146.37		HMC 2009
HMC-951	2/4/2008	6427.04	6573.7	146.66		HMC 2009
HMC-951	3/3/2008	6427.55	6573.7	146.15		HMC 2009
HMC-951	3/5/2008	6427.51	6573.7	146.19		HMC 2009
HMC-951	3/31/2008	6426.60	6573.7	147.10		HMC 2009
HMC-951	5/5/2008	6425.40	6573.7	148.30		HMC 2009
HMC-951	6/2/2008	6424.97	6573.7	148.73		HMC 2009
HMC-951	6/30/2008	6423.40	6573.7	150.30		HMC 2009
HMC-951	9/2/2008	6422.10	6573.7	151.60		HMC 2009
HMC-951	9/4/2008	6422.65	6573.7	151.05		HMC 2009
HMC-951	9/29/2008	6422.90	6573.7	150.80		HMC 2009
HMC-951	10/27/2008	6426.60	6573.7	147.10		HMC 2009
HMC-951	12/1/2008	6421.60	6573.7	152.10		HMC 2009

Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
HMC-951	12/1/2008	6423.70	6573.7	150.00		HMC 2009
HMC-951	12/29/2008	6423.42	6573.7	150.28		HMC 2009
HMC-951	2/2/2009	6424.05	6573.7	149.65		HMC Electronic, prov. to DOE
HMC-951	3/2/2009	6423.75	6573.7	149.95		HMC Electronic, prov. to DOE
HMC-951	3/20/2009	6421.44	6573.7	152.26		HMC Electronic, prov. to DOE
HMC-951	3/30/2009	6422.38	6573.7	151.32		HMC Electronic, prov. to DOE
HMC-951	5/4/2009	6422.6	6573.7	151.1		HMC Electronic, prov. to DOE
HMC-951	6/1/2009	6423.3	6573.7	150.4		HMC Electronic, prov. to DOE
HMC-951	6/29/2009	6419.7	6573.7	154		HMC Electronic, prov. to DOE
HMC-951	8/3/2009	6422.75	6573.7	150.95		HMC Electronic, prov. to DOE
HMC-951	8/31/2009	6420.3	6573.7	153.4		HMC Electronic, prov. to DOE
HMC-951	9/28/2009	6421.95	6573.7	151.75		HMC Electronic, prov. to DOE
HMC-951	11/2/2009	6422.8	6573.7	150.9		HMC Electronic, prov. to DOE
HMC-951	11/30/2009	6422.43	6573.7	151.27		HMC Electronic, prov. to DOE
HMC-951	12/7/2009	6422.7	6573.7	151		HMC Electronic, prov. to DOE
HMC-951	12/28/2009	6423.5	6573.7	150.2		HMC Electronic, prov. to DOE
HMC-951	2/1/2010	6423.25	6573.7	150.45		HMC 2011
HMC-951	3/1/2010	6422.95	6573.7	150.75		HMC 2011
HMC-951	3/3/2010	6424.9	6573.7	148.8		HMC 2011
HMC-951	3/29/2010	6422.87	6573.7	150.83		HMC 2011
HMC-951	5/3/2010	6422.95	6573.7	150.75		HMC 2011
HMC-951	6/1/2010	6421.3	6573.7	152.4		HMC 2011
HMC-951	6/22/2010	6421.17	6573.7	152.53		HMC 2011
HMC-951	6/28/2010	6421.19	6573.7	152.51		HMC 2011
HMC-951	8/2/2010	6420.58	6573.7	153.12		HMC 2011
HMC-951	8/30/2010	6420.8	6573.7	152.9		HMC 2011
HMC-951	9/7/2010	6420.3	6573.7	153.4		HMC 2011
HMC-951	9/13/2010	6420.49	6573.7	153.21		HMC 2011
HMC-951	9/20/2010	6420.77	6573.7	152.93		HMC 2011
HMC-951	9/27/2010	6421.5	6573.7	152.2		HMC 2011
HMC-951	10/11/2010	6422.3	6573.7	151.4		HMC 2011
HMC-951	10/18/2010	6422.72	6573.7	150.98		HMC 2011
HMC-951	10/25/2010	6381.1	6573.7	192.6		HMC 2011
HMC-951	11/1/2010	6423.4	6573.7	150.3		HMC 2011
HMC-951	11/8/2010	6423.4	6573.7	150.3		HMC 2011
HMC-951	11/15/2010	6423.25	6573.7	150.45		HMC 2011
HMC-951	11/29/2010	6423.75	6573.7	149.95		HMC 2011
HMC-951	12/6/2010	6423.8	6573.7	149.9		HMC 2011
HMC-951	12/27/2010	6424.17	6573.7	149.53		HMC 2011
HMC-951	1/31/2011	6423.7	6573.7	150		HMC 2012
HMC-951	2/28/2011	6423.5	6573.7	150.2		HMC 2012
HMC-951	4/13/2011	6421.85	6573.7	151.85		HMC 2012
HMC-951	4/25/2011	6423.21	6573.7	150.49		HMC 2012
HMC-951	5/23/2011	6422.5	6573.7	151.2		HMC 2012
HMC-951	6/27/2011	6420.1	6573.7	153.6		HMC 2012
HMC-951	7/25/2011	6419.73	6573.7	153.97		HMC 2012
HMC-951	8/29/2011	6420.35	6573.7	153.35		HMC 2012
HMC-951	9/26/2011	6420.9	6573.7	152.8		HMC 2012
HMC-951	10/12/2011	6453.7	6573.7	120		HMC 2012
HMC-951	10/24/2011	6421.35	6573.7	152.35		HMC 2012
HMC-951	11/21/2011	6421.1	6573.7	152.6		HMC 2012
HMC-951	12/19/2011	6421.3	6573.7	152.4		HMC 2012
HMC-951	1/23/2012	6386.3	6573.7	187.4		HMC 2013
HMC-951	2/27/2012	6422.72	6573.7	150.98		HMC 2013
HMC-951	3/9/2012	6423.02	6573.7	150.68		HMC 2013
HMC-951	3/26/2012	6426	6573.7	147.7		HMC 2013

Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
HMC-951	11/20/2013	6424.89	6576.79	151.9	152.06	DOE sampling
HMC-951	4/30/2014	6424.5	6576.79	152.29	152.45	DOE sampling
I(SG)	3/12/1984	6467.06	6625.93	158.87	157.78	
I(SG)	5/23/1984	6467.46	6625.93	158.47	157.38	
I(SG)	4/17/1986	6470.61	6625.93	155.32	154.23	
I(SG)	7/7/1986	6471.25	6625.93	154.68	153.59	
I(SG)	10/6/1986	6472.8	6625.93	153.13	152.04	
I(SG)	2/3/1987	6471.66	6625.93	154.27	153.18	
I(SG)	4/8/1987	6470.12	6625.93	155.81	154.72	
I(SG)	7/7/1987	6472.55	6625.93	153.38	152.29	
I(SG)	10/7/1987	6474.52	6625.93	151.41	150.32	
I(SG)	1/11/1988	6472.75	6625.93	153.18	152.09	
I(SG)	4/6/1988	6471.25	6625.93	154.68	153.59	
I(SG)	7/11/1988	6462.42	6625.93	163.51	162.42	
I(SG)	10/10/1988	6473.62	6625.93	152.31	151.22	
I(SG)	1/18/1989	6473.9	6625.93	152.03	150.94	
I(SG)	4/18/1989	6471.78	6625.93	154.15	153.06	
I(SG)	4/11/1990	6478.59	6625.93	147.34	146.25	
I(SG)	11/4/2008	6431.44	6625.93	194.49	193.4	
I(SG)	11/10/2009	6430.22	6625.93	195.71	194.62	
I(SG)	11/11/2010	6430.3	6625.93	195.63	194.54	
I(SG)	7/27/2011	6426.74	6625.93	199.19	198.1	
I(SG)	11/16/2011	6428.23	6625.93	197.7	196.61	
I(SG)	5/15/2012	6429.11	6625.93	196.82	195.73	
I(SG)	11/14/2012	6426.71	6625.93	199.22	198.13	
I(SG)	1/29/2013	6426.74	6625.93	199.19	198.1	
I(SG)	5/15/2013	6425.72	6625.93	200.21	199.12	
I(SG)	5/15/2013	6425.75	6625.93	200.18	199.09	
I(SG)	5/15/2013	6425.72	6625.93	200.21	199.12	
I(SG)	11/19/2013	6426.19	6625.93	199.74	198.65	
I(SG)	11/19/2013	6426.19	6625.93	199.74	198.65	
I(SG)	11/19/2013	6426.19	6625.93	199.74	198.65	
I(SG)	11/19/2013	6426.19	6625.93	199.74	198.65	
I(SG)	4/30/2014	6425.74	6625.93	200.19	199.1	
L(SG)	2/9/1984	6492.8	6606.09	113.29	112.01	
L(SG)	6/7/1984	6494.57	6606.09	111.52	110.24	
L(SG)	4/15/1986	6496.17	6606.09	109.92	108.64	
L(SG)	7/7/1986	6497.75	6606.09	108.34	107.06	
L(SG)	10/13/1986	6498.65	6606.09	107.44	106.16	
L(SG)	2/3/1987	6497.11	6606.09	108.98	107.7	
L(SG)	4/6/1987	6495.27	6606.09	110.82	109.54	
L(SG)	8/31/1987	6499.83	6606.09	106.26	104.98	
L(SG)	10/5/1987	6500.58	6606.09	105.51	104.23	
L(SG)	1/11/1988	6499.07	6606.09	107.02	105.74	
L(SG)	4/5/1988	6497.65	6606.09	108.44	107.16	
L(SG)	6/14/1988	6499.3	6606.09	106.79	105.51	
L(SG)	7/11/1988	6500.84	6606.09	105.25	103.97	
L(SG)	9/8/1988	6500.81	6606.09	105.28	104	
L(SG)	10/10/1988	6500.11	6606.09	105.98	104.7	
L(SG)	12/6/1988	6499.42	6606.09	106.67	105.39	
L(SG)	12/8/1988	6499.42	6606.09	106.67	105.39	
L(SG)	1/18/1989	6499.97	6606.09	106.12	104.84	
L(SG)	3/7/1989	6497.61	6606.09	108.48	107.2	
L(SG)	4/10/1989	6496.84	6606.09	109.25	107.97	
L(SG)	6/15/1989	6497.99	6606.09	108.1	106.82	
L(SG)	9/20/1989	6496.21	6606.09	109.88	108.6	

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
L(SG)	12/18/1989	6494.35	6606.09	111.74	110.46	
L(SG)	3/13/1990	6493.2	6606.09	112.89	111.61	
L(SG)	4/10/1990	6492.66	6606.09	113.43	112.15	
L(SG)	7/11/1990	6488.98	6606.09	117.11	115.83	
L(SG)	9/18/1990	6487.3	6606.09	118.79	117.51	
L(SG)	10/2/1990	6487.87	6606.09	118.22	116.94	
L(SG)	12/18/1990	6487.16	6606.09	118.93	117.65	
L(SG)	1/9/1991	6487.16	6606.09	118.93	117.65	
L(SG)	4/3/1991	6486.14	6606.09	119.95	118.67	
L(SG)	7/10/1991	6488.46	6606.09	117.63	116.35	
L(SG)	10/2/1991	6491.95	6606.09	114.14	112.86	
L(SG)	1/15/1992	6490.11	6606.09	115.98	114.7	
L(SG)	4/8/1992	6488.95	6606.09	117.14	115.86	
L(SG)	7/21/1992	6490.39	6606.09	115.7	114.42	
L(SG)	10/8/1992	6489.7	6606.09	116.39	115.11	
L(SG)	1/12/1993	6488.57	6606.09	117.52	116.24	
L(SG)	4/5/1993	6487.93	6606.09	118.16	116.88	
L(SG)	7/7/1993	6488.27	6606.09	117.82	116.54	
L(SG)	10/5/1993	6492.15	6606.09	113.94	112.66	
L(SG)	1/5/1994	6491.65	6606.09	114.44	113.16	
L(SG)	4/5/1994	6487.93	6606.09	118.16	116.88	
L(SG)	7/7/1994	6493.8	6606.09	112.29	111.01	
L(SG)	10/13/1994	6494.8	6606.09	111.29	110.01	
L(SG)	1/16/1995	6493.57	6606.09	112.52	111.24	
L(SG)	4/10/1995	6492.69	6606.09	113.4	112.12	
L(SG)	7/18/1995	6496.69	6606.09	109.4	108.12	
L(SG)	10/18/1995	6497.14	6606.09	108.95	107.67	
L(SG)	1/15/1996	6494.78	6606.09	111.31	110.03	
L(SG)	4/3/1996	6493.39	6606.09	112.7	111.42	
L(SG)	11/16/1998	6486.59	6606.09	119.5	118.22	
L(SG)	11/3/2001	6471.89	6606.09	134.2	132.92	
L(SG)	11/18/2004	6455.28	6606.09	150.81	149.53	
L(SG)	11/6/2007	6448.96	6606.09	157.13	155.85	
L(SG)	11/4/2008	6449.35	6606.09	156.74	155.46	
L(SG)	11/10/2009	6444.62	6606.09	161.47	160.19	
L(SG)	11/11/2010	6451.53	6606.09	154.56	153.28	
L(SG)	7/27/2011	6445.27	6606.09	160.82	159.54	
L(SG)	11/17/2011	6446.17	6606.09	159.92	158.64	
L(SG)	5/15/2012	6446.75	6606.09	159.34	158.06	
L(SG)	11/14/2012	6445.94	6606.09	160.15	158.87	
L(SG)	1/30/2013	6445.7	6606.09	160.39	159.11	
L(SG)	5/15/2013	6445.24	6606.09	160.85	159.57	
L(SG)	5/16/2013	6445.24	6606.09	160.85	159.57	
L(SG)	5/16/2013	6445.24	6606.09	160.85	159.57	
L(SG)	11/19/2013	6442.09	6606.09	164	162.72	
L(SG)	4/29/2014	6440.81	6606.09	165.28	164	
M(SG)	6/7/1984	6482.72		-6482.72	-6482.72	
M(SG)	4/15/1986	6484.9		-6484.9	-6484.9	
M(SG)	10/13/1986	6486.8		-6486.8	-6486.8	
M(SG)	4/8/1987	6485.68		-6485.68	-6485.68	
M(SG)	10/8/1987	6487.58		-6487.58	-6487.58	
M(SG)	4/13/1988	6486.41		-6486.41	-6486.41	
M(SG)	10/11/1988	6487.99		-6487.99	-6487.99	
M(SG)	4/19/1989	6486.17		-6486.17	-6486.17	
M(SG)	4/11/1990	6482.9		-6482.9	-6482.9	
Mexican Camp	4/26/1984	6469.31		-6469.31	-6469.31	

Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
Mexican Camp	4/22/1986	6472.72		-6472.72	-6472.72	
Mexican Camp	4/9/1987	6484		-6484	-6484	
Mexican Camp	4/7/1988	6473.65		-6473.65	-6473.65	
Monitor	5/16/1984	6473.17		-6473.17	-6473.17	
Monitor	4/17/1986	6476.36		-6476.36	-6476.36	
Monitor	10/6/1986	6478.91		-6478.91	-6478.91	
Monitor	4/13/1987	6477.51		-6477.51	-6477.51	
Monitor	10/12/1987	6479.04		-6479.04	-6479.04	
Monitor	4/5/1988	6477.39		-6477.39	-6477.39	
Monitor	10/10/1988	6479.06		-6479.06	-6479.06	
Monitor	4/11/1990	6474.62		-6474.62	-6474.62	
North	5/15/1984	6479.65		-6479.65	-6479.65	
North	4/17/1986	6482.68		-6482.68	-6482.68	
North	10/6/1986	6484.13		-6484.13	-6484.13	
North	4/8/1987	6483.14		-6483.14	-6483.14	
North	10/8/1987	6485.51		-6485.51	-6485.51	
North	4/13/1988	6484		-6484	-6484	
North	10/10/1988	6485.32		-6485.32	-6485.32	
North	4/18/1989	6483.88		-6483.88	-6483.88	
North	4/11/1990	6480.84		-6480.84	-6480.84	
OBS-2	4/19/1989	6481.9		-6481.9	-6481.9	
OBS-2	4/10/1990	6478.89		-6478.89	-6478.89	
OBS-3	5/7/1984	6474.56	6617.22	142.66	138.83	
OBS-3	4/17/1986	6479.95	6617.22	137.27	133.44	
OBS-3	10/13/1986	6480.86	6617.22	136.36	132.53	
OBS-3	4/6/1987	6480.45	6617.22	136.77	132.94	
OBS-3	10/7/1987	6482.37	6617.22	134.85	131.02	
OBS-3	4/5/1988	6481.2	6617.22	136.02	132.19	
OBS-3	6/14/1988	6481.5	6617.22	135.72	131.89	
OBS-3	9/8/1988	6482.81	6617.22	134.41	130.58	
OBS-3	10/11/1988	6482.5	6617.22	134.72	130.89	
OBS-3	12/6/1988	6482.61	6617.22	134.61	130.78	
OBS-3	12/8/1988	6482.61	6617.22	134.61	130.78	
OBS-3	3/7/1989	6482.61	6617.22	134.61	130.78	
OBS-3	4/11/1989	6481.44	6617.22	135.78	131.95	
OBS-3	6/15/1989	6481.4	6617.22	135.82	131.99	
OBS-3	9/21/1989	6479.53	6617.22	137.69	133.86	
OBS-3	3/14/1990	6478.33	6617.22	138.89	135.06	
OBS-3	4/10/1990	6477.85	6617.22	139.37	135.54	
OBS-3	5/24/1990	6477.37	6617.22	139.85	136.02	
OBS-3	7/12/1990	6476.69	6617.22	140.53	136.7	
OBS-3	9/18/1990	6474.7	6617.22	142.52	138.69	
OBS-3	10/2/1990	6474.52	6617.22	142.7	138.87	
OBS-3	12/18/1990	6474.3	6617.22	142.92	139.09	
OBS-3	1/10/1991	6474.07	6617.22	143.15	139.32	
OBS-3	4/2/1991	6473.33	6617.22	143.89	140.06	
OBS-3	7/9/1991	6473.29	6617.22	143.93	140.1	
OBS-3	10/2/1991	6474.8	6617.22	142.42	138.59	
OBS-3	1/20/1992	6474.81	6617.22	142.41	138.58	
OBS-3	4/7/1992	6474.25	6617.22	142.97	139.14	
OBS-3	7/20/1992	6473.9	6617.22	143.32	139.49	
OBS-3	10/19/1992	6473.77	6617.22	143.45	139.62	
OBS-3	2/12/1993	6473.3	6617.22	143.92	140.09	
OBS-3	4/12/1993	6473.15	6617.22	144.07	140.24	
OBS-3	7/7/1993	6473.33	6617.22	143.89	140.06	
OBS-3	10/13/1993	6474.16	6617.22	143.06	139.23	

Table C.1-1. Water Level Data for Bluewater Site San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
OBS-3	1/5/1994	6474.93	6617.22	142.29	138.46	
OBS-3	4/12/1994	6473.15	6617.22	144.07	140.24	
OBS-3	7/6/1994	6475.13	6617.22	142.09	138.26	
OBS-3	10/11/1994	6476.62	6617.22	140.6	136.77	
OBS-3	1/16/1995	6476.84	6617.22	140.38	136.55	
OBS-3	4/18/1995	6476.06	6617.22	141.16	137.33	
OBS-3	7/18/1995	6477.11	6617.22	140.11	136.28	
OBS-3	10/23/1995	6478.73	6617.22	138.49	134.66	
OBS-3	1/15/1996	6478.13	6617.22	139.09	135.26	
OBS-3	4/2/1996	6477.86	6617.22	139.36	135.53	
OBS-3	11/13/1998	6476.84	6617.22	140.38	136.55	
OBS-3	11/3/2001	6463.72	6617.22	153.5	149.67	
OBS-3	11/18/2004	6448.99	6617.22	168.23	164.4	
OBS-3	11/6/2007	6441.98	6617.22	175.24	171.41	
OBS-3	11/4/2008	6439.45	6617.22	177.77	173.94	
OBS-3	11/10/2009	6436.51	6617.22	180.71	176.88	
OBS-3	11/10/2010	6437.28	6617.22	179.94	176.11	
OBS-3	11/10/2010	6435.5	6617.22	181.72	177.89	
OBS-3	7/28/2011	6435.22	6617.22	182	178.17	
OBS-3	11/16/2011	6435.08	6617.22	182.14	178.31	
OBS-3	11/13/2012	6434.13	6617.22	183.09	179.26	
OBS-3	1/30/2013	6434.12	6617.22	183.1	179.27	
OBS-3	5/14/2013	6433.7	6617.22	183.52	179.69	
OBS-3	11/20/2013	6432.32	6617.22	184.9	181.07	
OBS-3	4/29/2014	6431.23	6617.22	185.99	182.16	
Payne	5/9/1984	6475.1		-6475.1	-6475.1	
Payne	4/24/1986	6478.52		-6478.52	-6478.52	
Payne	11/19/1986	6480.69		-6480.69	-6480.69	
Payne	4/9/1987	6479.56		-6479.56	-6479.56	
Payne	10/12/1987	6482.43		-6482.43	-6482.43	
Payne	4/11/1988	6476.34		-6476.34	-6476.34	
Payne	10/11/1988	6282.99		-6282.99	-6282.99	
S(SG)	2/15/1984	6476.98	6625.25	148.27	146.84	
S(SG)	5/7/1984	6476.9	6625.25	148.35	146.92	
S(SG)	4/17/1986	6480.41	6625.25	144.84	143.41	
S(SG)	7/7/1986	6480.66	6625.25	144.59	143.16	
S(SG)	10/13/1986	6481.28	6625.25	143.97	142.54	
S(SG)	2/3/1987	6481.32	6625.25	143.93	142.5	
S(SG)	4/6/1987	6480.85	6625.25	144.4	142.97	
S(SG)	7/7/1987	6481.49	6625.25	143.76	142.33	
S(SG)	10/5/1987	6482.9	6625.25	142.35	140.92	
S(SG)	1/4/1988	6482.59	6625.25	142.66	141.23	
S(SG)	4/5/1988	6481.47	6625.25	143.78	142.35	
S(SG)	6/14/1988	6481.89	6625.25	143.36	141.93	
S(SG)	7/11/1988	6482.07	6625.25	143.18	141.75	
S(SG)	9/8/1988	6482.32	6625.25	142.93	141.5	
S(SG)	10/10/1988	6482.94	6625.25	142.31	140.88	
S(SG)	12/6/1988	6483.1	6625.25	142.15	140.72	
S(SG)	12/8/1988	6483.1	6625.25	142.15	140.72	
S(SG)	1/17/1989	6483.09	6625.25	142.16	140.73	
S(SG)	3/7/1989	6482.19	6625.25	143.06	141.63	
S(SG)	4/10/1989	6481.72	6625.25	143.53	142.1	
S(SG)	6/15/1989	6481.34	6625.25	143.91	142.48	
S(SG)	9/21/1989	6480.08	6625.25	145.17	143.74	
S(SG)	12/18/1989	6478.95	6625.25	146.3	144.87	
S(SG)	3/14/1990	6478.89	6625.25	146.36	144.93	

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Data Source/Comment
S(SG)	4/10/1990	6478.34	6625.25	146.91	145.48	
S(SG)	5/24/1990	6477.84	6625.25	147.41	145.98	
S(SG)	7/11/1990	6476.48	6625.25	148.77	147.34	
S(SG)	9/17/1990	6475.25	6625.25	150	148.57	
S(SG)	10/1/1990	6474.99	6625.25	150.26	148.83	
S(SG)	12/18/1990	6475.14	6625.25	150.11	148.68	
S(SG)	1/10/1991	6474.58	6625.25	150.67	149.24	
S(SG)	4/2/1991	6473.92	6625.25	151.33	149.9	
S(SG)	7/9/1991	6473.89	6625.25	151.36	149.93	
S(SG)	10/2/1991	6475.51	6625.25	149.74	148.31	
S(SG)	1/15/1992	6475.39	6625.25	149.86	148.43	
S(SG)	4/6/1992	6474.79	6625.25	150.46	149.03	
S(SG)	7/20/1992	6475.1	6625.25	150.15	148.72	
S(SG)	10/6/1992	6474.56	6625.25	150.69	149.26	
S(SG)	1/12/1993	6474.02	6625.25	151.23	149.8	
S(SG)	4/8/1993	6473.57	6625.25	151.68	150.25	
S(SG)	7/7/1993	6474.01	6625.25	151.24	149.81	
S(SG)	10/6/1993	6474.89	6625.25	150.36	148.93	
S(SG)	1/5/1994	6475.57	6625.25	149.68	148.25	
S(SG)	4/8/1994	6473.57	6625.25	151.68	150.25	
S(SG)	7/6/1994	6477.65	6625.25	147.6	146.17	
S(SG)	10/11/1994	6477.06	6625.25	148.19	146.76	
S(SG)	4/10/1995	6476.54	6625.25	148.71	147.28	
S(SG)	4/16/1995	6477.42	6625.25	147.83	146.4	
S(SG)	7/18/1995	6477.57	6625.25	147.68	146.25	
S(SG)	10/16/1995	6479.3	6625.25	145.95	144.52	
S(SG)	1/16/1996	6479.23	6625.25	146.02	144.59	
S(SG)	4/2/1996	6478.26	6625.25	146.99	145.56	
S(SG)	11/13/1998	6476.8	6625.25	148.45	147.02	
S(SG)	11/3/2001	6462.94	6625.25	162.31	160.88	
S(SG)	11/18/2004	6448.64	6625.25	176.61	175.18	
S(SG)	11/6/2007	6442.23	6625.25	183.02	181.59	
S(SG)	11/4/2008	6439.22	6625.25	186.03	184.6	
S(SG)	11/10/2009	6436.39	6625.25	188.86	187.43	
S(SG)	11/9/2010	6437.14	6625.25	188.11	186.68	
S(SG)	11/16/2011	6435.14	6625.25	190.11	188.68	
S(SG)	11/13/2012	6434.14	6625.25	191.11	189.68	
S(SG)	1/30/2013	6434.04	6625.25	191.21	189.78	
S(SG)	5/16/2013	6432.94	6625.25	192.31	190.88	
S(SG)	11/20/2013		6625.25			Not enough water to sample
S(SG)	4/29/2014	6432.05	6625.25	193.2	191.77	
W(SG)	6/7/1984	6461.58		-6461.58	-6461.58	
W(SG)	4/17/1986	6472.54		-6472.54	-6472.54	
W(SG)	10/6/1986	6475		-6475	-6475	
W(SG)	4/8/1987	6471.91		-6471.91	-6471.91	
W(SG)	10/5/1987	6476.48		-6476.48	-6476.48	
W(SG)	4/6/1988	6473.45		-6473.45	-6473.45	
W(SG)	10/10/1988	6475.63		-6475.63	-6475.63	
W(SG)	4/17/1989	6473.92		-6473.92	-6473.92	

Note:
Water level data listed here for HMC-951 were obtained mostly from Homestake (HMC) annual reports. For these records, the measuring point (MP) elevation differs slightly from the top of casing (TOC) elevation used in the DOE database.

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Table C.1-2. Water Level Data for Bluewater Site Alluvial Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
20(M)	11/14/2012	6508.44	6613.38	104.94	102.1	
20(M)	1/30/2013	6508.37	6613.38	105.01	102.17	
20(M)	5/14/2013	6508.13	6613.38	105.25	102.41	
20(M)	11/19/2013	6507.74	6613.38	105.64	102.8	
20(M)	4/29/2014	6507.23	6613.38	106.15	103.31	
21(M)	7/27/2011	6466.26	6593.8	127.54	124.59	
21(M)	11/15/2011	6466.19	6593.8	127.61	124.66	
21(M)	5/15/2012	6465.87	6593.8	127.93	124.98	
21(M)	11/15/2012	6465.66	6593.8	128.14	125.19	
21(M)	1/29/2013	6465.52	6593.8	128.28	125.33	
21(M)	5/15/2013	6465.71	6593.8	128.09	125.14	
21(M)	11/19/2013	6465.52	6593.8	128.28	125.33	
21(M)	4/29/2014	6465.57	6593.8	128.23	125.28	
22(M)	7/27/2011	6470.02	6606.48	136.46	133.59	
22(M)	11/15/2011	6469.94	6606.48	136.54	133.67	
22(M)	5/15/2012	6470.1	6606.48	136.38	133.51	
22(M)	11/15/2012	6469.57	6606.48	136.91	134.04	
22(M)	1/29/2013	6469.49	6606.48	136.99	134.12	
22(M)	5/14/2013	6469.48	6606.48	137	134.13	
22(M)	11/19/2013	6469.25	6606.48	137.23	134.36	
22(M)	4/29/2014	6469.12	6606.48	137.36	134.49	
23(M)	11/13/2012		6579.22			Dry
23(M)	1/28/2013	6468.61	6579.22	110.61	107.99	
23(M)	5/15/2013	6468.6	6579.22	110.62	108	
23(M)	11/19/2013	6469.02	6579.22	110.2	107.58	
23(M)	4/30/2014	6469.04	6579.22	110.18	107.56	
Aragon	5/9/1984	6531.77		-6531.77	-6531.77	
Aragon	4/24/1986	6534.59		-6534.59	-6534.59	
Aragon	11/19/1986	6535.98		-6535.98	-6535.98	
Aragon	4/13/1987	6531.93		-6531.93	-6531.93	
Aragon	10/12/1987	6533.37		-6533.37	-6533.37	
Aragon	4/11/1988	6534.75		-6534.75	-6534.75	
Aragon	10/11/1988	6538.3		-6538.3	-6538.3	
B(M)	2/13/1984	6520.51		-6520.51	-6520.51	
B(M)	5/7/1984	6519.12		-6519.12	-6519.12	
B(M)	4/15/1986	6522.12		-6522.12	-6522.12	
B(M)	7/7/1986	6522.27		-6522.27	-6522.27	
B(M)	10/13/1986	6523.13		-6523.13	-6523.13	
B(M)	2/3/1987	6521.96		-6521.96	-6521.96	
B(M)	4/6/1987	6521.71		-6521.71	-6521.71	
B(M)	7/7/1987	6521.54		-6521.54	-6521.54	
B(M)	10/5/1987	6521.59		-6521.59	-6521.59	
B(M)	1/4/1988	6521.81		-6521.81	-6521.81	
B(M)	4/5/1988	6521.79		-6521.79	-6521.79	
B(M)	7/11/1988	6521.7		-6521.7	-6521.7	
B(M)	10/6/1988	6522.14		-6522.14	-6522.14	
B(M)	1/17/1989	6522.24		-6522.24	-6522.24	
B(M)	4/10/1989	6521.59		-6521.59	-6521.59	
B(M)	4/12/1990	6520.5		-6520.5	-6520.5	
Berryhill House	5/9/1984	6522.13		-6522.13	-6522.13	
Berryhill House	4/22/1986	6523.68		-6523.68	-6523.68	
Berryhill House	11/19/1986	6523.48		-6523.48	-6523.48	
Berryhill House	4/13/1987	6523.29		-6523.29	-6523.29	
Berryhill House	10/12/1987	6522.36		-6522.36	-6522.36	
Berryhill House	4/11/1988	6522.51		-6522.51	-6522.51	

Table C.1-2. Water Level Data for Bluewater Site Alluvial Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
Berryhill House	10/12/1988	6523.32		-6523.32	-6523.32	
C(M)	3/12/1984	6512.61		-6512.61	-6512.61	
C(M)	4/16/1984	6512.24		-6512.24	-6512.24	
C(M)	4/15/1986	6514.11		-6514.11	-6514.11	
C(M)	7/7/1986	6514.29		-6514.29	-6514.29	
C(M)	10/13/1986	6514.44		-6514.44	-6514.44	
C(M)	2/3/1987	6513.96		-6513.96	-6513.96	
C(M)	4/6/1987	6513.64		-6513.64	-6513.64	
C(M)	7/8/1987	6512.96		-6512.96	-6512.96	
C(M)	10/7/1987	6513.57		-6513.57	-6513.57	
C(M)	1/11/1988	6513.84		-6513.84	-6513.84	
C(M)	4/5/1988	6513.47		-6513.47	-6513.47	
C(M)	7/11/1988	6513.44		-6513.44	-6513.44	
C(M)	10/6/1988	6514.22		-6514.22	-6514.22	
C(M)	1/18/1989	6514.36		-6514.36	-6514.36	
C(M)	4/17/1989	6513.35		-6513.35	-6513.35	
C(M)	4/9/1990	6511.72		-6511.72	-6511.72	
E(M)	4/12/1984	6546.44	6616.32	69.88	68.35	
E(M)	4/22/1986	6548.41	6616.32	67.91	66.38	
E(M)	10/13/1986	6547.72	6616.32	68.6	67.07	
E(M)	4/8/1987	6543.32	6616.32	73	71.47	
E(M)	10/8/1987	6543.66	6616.32	72.66	71.13	
E(M)	4/13/1988	6541.53	6616.32	74.79	73.26	
E(M)	6/14/1988	6540.8	6616.32	75.52	73.99	
E(M)	9/7/1988	6541.93	6616.32	74.39	72.86	
E(M)	10/6/1988	6541.94	6616.32	74.38	72.85	
E(M)	12/6/1988	6541.25	6616.32	75.07	73.54	
E(M)	3/7/1989	6540.25	6616.32	76.07	74.54	
E(M)	4/17/1989	6540.04	6616.32	76.28	74.75	
E(M)	6/15/1989	6439.72	6616.32	176.6	175.07	
E(M)	9/20/1989	6539.7	6616.32	76.62	75.09	
E(M)	12/18/1989	6539.13	6616.32	77.19	75.66	
E(M)	3/12/1990	6538.98	6616.32	77.34	75.81	
E(M)	4/9/1990	6538.88	6616.32	77.44	75.91	
E(M)	7/12/1990	6539.58	6616.32	76.74	75.21	
E(M)	9/18/1990	6538.43	6616.32	77.89	76.36	
E(M)	10/3/1990	6538.38	6616.32	77.94	76.41	
E(M)	12/18/1990	6538.18	6616.32	78.14	76.61	
E(M)	1/8/1991	6538.03	6616.32	78.29	76.76	
E(M)	4/3/1991	6537.67	6616.32	78.65	77.12	
E(M)	7/10/1991	6537.63	6616.32	78.69	77.16	
E(M)	10/3/1991	6537.12	6616.32	79.2	77.67	
E(M)	1/14/1992	6536.97	6616.32	79.35	77.82	
E(M)	4/14/1992	6537.27	6616.32	79.05	77.52	
E(M)	7/21/1992	6537.24	6616.32	79.08	77.55	
E(M)	10/6/1992	6537.46	6616.32	78.86	77.33	
E(M)	1/11/1993	6537.78	6616.32	78.54	77.01	
E(M)	4/5/1993	6538.04	6616.32	78.28	76.75	
E(M)	7/8/1993	6538.47	6616.32	77.85	76.32	
E(M)	10/5/1993	6538	6616.32	78.32	76.79	
E(M)	1/6/1994	6538.18	6616.32	78.14	76.61	
E(M)	4/12/1994	6538.43	6616.32	77.89	76.36	
E(M)	7/6/1994	6539.18	6616.32	77.14	75.61	
E(M)	10/6/1994	6541.9	6616.32	74.42	72.89	
E(M)	1/16/1995	6542.31	6616.32	74.01	72.48	

Table C.1-2. Water Level Data for Bluewater Site Alluvial Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
E(M)	4/10/1995	6541.11	6616.32	75.21	73.68	
E(M)	7/17/1995	6538.53	6616.32	77.79	76.26	
E(M)	10/23/1995	6538.16	6616.32	78.16	76.63	
E(M)	1/16/1996	6537.84	6616.32	78.48	76.95	
E(M)	4/3/1996	6537.43	6616.32	78.89	77.36	
E(M)	11/19/1997	6538.26	6616.32	78.06	76.53	
E(M)	11/14/1998	6537.41	6616.32	78.91	77.38	
E(M)	12/18/1998	6537.37	6616.32	78.95	77.42	
E(M)	11/11/1999	6537.36	6616.32	78.96	77.43	
E(M)	11/11/2000	6538.2	6616.32	78.12	76.59	
E(M)	11/3/2001	6537.97	6616.32	78.35	76.82	
E(M)	10/17/2002	6536.62	6616.32	79.7	78.17	
E(M)	9/19/2003	6536.23	6616.32	80.09	78.56	
E(M)	11/18/2004	6530.21	6616.32	86.11	84.58	
E(M)	11/15/2005	6535.67	6616.32	80.65	79.12	
E(M)	11/28/2006	6535.43	6616.32	80.89	79.36	
E(M)	11/6/2007	6535.37	6616.32	80.95	79.42	
E(M)	11/4/2008	6535.1	6616.32	81.22	79.69	
E(M)	5/13/2009	6535.16	6616.32	81.16	79.63	
E(M)	11/11/2009	6530.08	6616.32	86.24	84.71	
E(M)	11/11/2010	6534.88	6616.32	81.44	79.91	
E(M)	7/27/2011	6534.86	6616.32	81.46	79.93	
E(M)	11/16/2011	6534.86	6616.32	81.46	79.93	
E(M)	5/15/2012	6534.79	6616.32	81.53	80	
E(M)	11/14/2012	6534.84	6616.32	81.48	79.95	
E(M)	1/30/2013	6534.71	6616.32	81.61	80.08	
E(M)	5/14/2013	6534.77	6616.32	81.55	80.02	
E(M)	11/19/2013	6534.93	6616.32	81.39	79.86	
E(M)	4/30/2014	6534.63	6616.32	81.69	80.16	
Engineers	2/9/1984	6522.17		-6522.17	-6522.17	
Engineers	5/9/1984	6522.13		-6522.13	-6522.13	
Engineers	4/22/1986	6523.68		-6523.68	-6523.68	
Engineers	7/7/1986	6523.46		-6523.46	-6523.46	
Engineers	11/19/1986	6523.55		-6523.55	-6523.55	
Engineers	2/3/1987	6523.14		-6523.14	-6523.14	
Engineers	4/13/1987	6522.89		-6522.89	-6522.89	
Engineers	8/31/1987	6522.69		-6522.69	-6522.69	
Engineers	10/12/1987	6522.79		-6522.79	-6522.79	
Engineers	1/11/1988	6523.11		-6523.11	-6523.11	
Engineers	4/11/1988	6522.77		-6522.77	-6522.77	
Engineers	7/11/1988	6522.73		-6522.73	-6522.73	
Engineers	10/12/1988	6523.24		-6523.24	-6523.24	
Engineers	1/18/1989	6522.56		-6522.56	-6522.56	
F(M)	4/17/1984	6494.29	6603.59	109.3	107.93	
F(M)	4/17/1986	6496.19	6603.59	107.4	106.03	
F(M)	10/6/1986	6496.36	6603.59	107.23	105.86	
F(M)	4/6/1987	6495.88	6603.59	107.71	106.34	
F(M)	10/7/1987	6495.23	6603.59	108.36	106.99	
F(M)	4/6/1988	6495.88	6603.59	107.71	106.34	
F(M)	6/14/1988	6495	6603.59	108.59	107.22	
F(M)	9/7/1988	6494.71	6603.59	108.88	107.51	
F(M)	10/5/1988	6494.8	6603.59	108.79	107.42	
F(M)	12/6/1988	6494.77	6603.59	108.82	107.45	
F(M)	3/7/1989	6494.65	6603.59	108.94	107.57	
F(M)	4/11/1989	6494.59	6603.59	109	107.63	

Table C.1-2. Water Level Data for Bluewater Site Alluvial Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
F(M)	6/15/1989	6494.38	6603.59	109.21	107.84	
F(M)	9/20/1989	6494.38	6603.59	109.21	107.84	
F(M)	12/18/1989	6494.1	6603.59	109.49	108.12	
F(M)	3/12/1990	6493.63	6603.59	109.96	108.59	
F(M)	4/9/1990	6493.57	6603.59	110.02	108.65	
F(M)	5/23/1990	6493.36	6603.59	110.23	108.86	
F(M)	9/18/1990	6492.68	6603.59	110.91	109.54	
F(M)	10/2/1990	6492.71	6603.59	110.88	109.51	
F(M)	12/18/1990	6492.19	6603.59	111.4	110.03	
F(M)	1/8/1991	6492.11	6603.59	111.48	110.11	
F(M)	4/3/1991	6491.68	6603.59	111.91	110.54	
F(M)	7/9/1991	6491.27	6603.59	112.32	110.95	
F(M)	10/3/1991	6490.82	6603.59	112.77	111.4	
F(M)	1/15/1992	6490.61	6603.59	112.98	111.61	
F(M)	4/7/1992	6490.54	6603.59	113.05	111.68	
F(M)	7/21/1992	6490.37	6603.59	113.22	111.85	
F(M)	10/5/1992	6490.27	6603.59	113.32	111.95	
F(M)	1/11/1993	6490.25	6603.59	113.34	111.97	
F(M)	4/5/1993	6490.28	6603.59	113.31	111.94	
F(M)	7/6/1993	6490.32	6603.59	113.27	111.9	
F(M)	10/11/1993	6490.36	6603.59	113.23	111.86	
F(M)	1/4/1994	6490.55	6603.59	113.04	111.67	
F(M)	4/5/1994	6490.28	6603.59	113.31	111.94	
F(M)	7/7/1994	6490.92	6603.59	112.67	111.3	
F(M)	10/10/1994	6490.98	6603.59	112.61	111.24	
F(M)	1/17/1995	6491.58	6603.59	112.01	110.64	
F(M)	4/10/1995	6491.92	6603.59	111.67	110.3	
F(M)	7/18/1995	6492.03	6603.59	111.56	110.19	
F(M)	10/23/1995	6492.02	6603.59	111.57	110.2	
F(M)	1/15/1996	6492.38	6603.59	111.21	109.84	
F(M)	4/10/1996	6492.54	6603.59	111.05	109.68	
F(M)	11/19/1997	6493.87	6603.59	109.72	108.35	
F(M)	11/14/1998	6492.78	6603.59	110.81	109.44	
F(M)	12/18/1998	6492.76	6603.59	110.83	109.46	
F(M)	11/11/1999	6492.43	6603.59	111.16	109.79	
F(M)	11/11/2000	6492.23	6603.59	111.36	109.99	
F(M)	11/3/2001	6492.13	6603.59	111.46	110.09	
F(M)	10/17/2002	6491.59	6603.59	112	110.63	
F(M)	9/19/2003	6491.05	6603.59	112.54	111.17	
F(M)	9/26/2003	6491.05	6603.59	112.54	111.17	
F(M)	11/18/2004	6490.77	6603.59	112.82	111.45	
F(M)	5/24/2005	6490.54	6603.59	113.05	111.68	
F(M)	11/15/2005	6490.45	6603.59	113.14	111.77	
F(M)	11/28/2006	6490.26	6603.59	113.33	111.96	
F(M)	11/6/2007	6490.24	6603.59	113.35	111.98	
F(M)	11/4/2008	6490.1	6603.59	113.49	112.12	
F(M)	5/13/2009	6490.2	6603.59	113.39	112.02	
F(M)	11/10/2009	6490.18	6603.59	113.41	112.04	
F(M)	11/10/2010	6490.15	6603.59	113.44	112.07	
F(M)	7/28/2011	6490.12	6603.59	113.47	112.1	
F(M)	11/15/2011	6490.29	6603.59	113.3	111.93	
F(M)	5/15/2012	6490.09	6603.59	113.5	112.13	
F(M)	11/14/2012	6490.17	6603.59	113.42	112.05	
F(M)	1/30/2013	6490.11	6603.59	113.48	112.11	
F(M)	5/14/2013	6489.33	6603.59	114.26	112.89	

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
F(M)	11/19/2013	6490.24	6603.59	113.35	111.98	
F(M)	4/30/2014	6490.14	6603.59	113.45	112.08	
K(M)	5/16/1984	6549.14		-6549.14	-6549.14	
K(M)	4/22/1986	6546.58		-6546.58	-6546.58	
K(M)	10/13/1986	6545.97		-6545.97	-6545.97	
K(M)	4/9/1987	6545.4		-6545.4	-6545.4	
K(M)	10/8/1987	6544.18		-6544.18	-6544.18	
K(M)	4/11/1988	6543.44		-6543.44	-6543.44	
K(M)	10/11/1988	6543.03		-6543.03	-6543.03	
K(M)	4/20/1989	6542.39		-6542.39	-6542.39	
K(M)	4/12/1990	6541.25		-6541.25	-6541.25	
SIMPSON	4/18/1989	6482.23		-6482.23	-6482.23	
SIMPSON	4/12/1990	6478.59		-6478.59	-6478.59	
T(M)	4/17/1984	6492.52	6612.65	120.13	119.58	
T(M)	4/17/1986	6494.88	6612.65	117.77	117.22	
T(M)	10/13/1986	6495.02	6612.65	117.63	117.08	
T(M)	4/6/1987	6494.15	6612.65	118.5	117.95	
T(M)	10/7/1987	6494.35	6612.65	118.3	117.75	
T(M)	4/6/1988	6494.11	6612.65	118.54	117.99	
T(M)	6/14/1988	6493.85	6612.65	118.8	118.25	
T(M)	9/7/1988	6494.8	6612.65	117.85	117.3	
T(M)	10/6/1988	6494.83	6612.65	117.82	117.27	
T(M)	12/6/1988	6494.92	6612.65	117.73	117.18	
T(M)	3/7/1989	6494.42	6612.65	118.23	117.68	
T(M)	4/17/1989	6494.2	6612.65	118.45	117.9	
T(M)	6/15/1989	6493.72	6612.65	118.93	118.38	
T(M)	9/20/1989	6493.59	6612.65	119.06	118.51	
T(M)	12/18/1989	6486.83	6612.65	125.82	125.27	
T(M)	3/14/1990	6492.32	6612.65	120.33	119.78	
T(M)	4/10/1990	6491.88	6612.65	120.77	120.22	
T(M)	5/24/1990	6491.58	6612.65	121.07	120.52	
T(M)	7/11/1990	6490.75	6612.65	121.9	121.35	
T(M)	9/18/1990	6489.95	6612.65	122.7	122.15	
T(M)	10/1/1990	6490.02	6612.65	122.63	122.08	
T(M)	12/18/1990	6489.4	6612.65	123.25	122.7	
T(M)	1/9/1991	6489.17	6612.65	123.48	122.93	
T(M)	4/2/1991	6488.38	6612.65	124.27	123.72	
T(M)	7/10/1991	6487.38	6612.65	125.27	124.72	
T(M)	10/2/1991	6487.3	6612.65	125.35	124.8	
T(M)	1/16/1992	6487.26	6612.65	125.39	124.84	
T(M)	4/6/1992	6486.89	6612.65	125.76	125.21	
T(M)	7/20/1992	6486.03	6612.65	126.62	126.07	
T(M)	10/8/1992	6486.35	6612.65	126.3	125.75	
T(M)	1/12/1993	6486.43	6612.65	126.22	125.67	
T(M)	4/6/1993	6486.27	6612.65	126.38	125.83	
T(M)	7/7/1993	6485.96	6612.65	126.69	126.14	
T(M)	10/13/1993	6487.29	6612.65	125.36	124.81	
T(M)	1/5/1994	6487.55	6612.65	125.1	124.55	
T(M)	4/6/1994	6486.27	6612.65	126.38	125.83	
T(M)	7/6/1994	6489.17	6612.65	123.48	122.93	
T(M)	10/18/1994	6490.74	6612.65	121.91	121.36	
T(M)	1/17/1995	6491.93	6612.65	120.72	120.17	
T(M)	4/10/1995	6491.41	6612.65	121.24	120.69	
T(M)	7/17/1995	6491.26	6612.65	121.39	120.84	
T(M)	10/16/1995	6492.23	6612.65	120.42	119.87	

Table C.1-2. Water Level Data for Bluewater Site Alluvial Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
T(M)	1/15/1996	6492.43	6612.65	120.22	119.67	
T(M)	4/6/1996	6492.03	6612.65	120.62	120.07	
T(M)	11/19/1997	6489.54	6612.65	123.11	122.56	
T(M)	11/16/1998		6612.65			
T(M)	11/11/1999	6487.79	6612.65	124.86	124.31	
T(M)	11/11/2000	6487.71	6612.65	124.94	124.39	
T(M)	11/3/2001		6612.65			
T(M)	10/17/2002		6612.65			
T(M)	11/18/2004	6480.06	6612.65	132.59	132.04	
T(M)	5/24/2005	6479.89	6612.65	132.76	132.21	
T(M)	11/15/2005	6479.7	6612.65	132.95	132.4	
T(M)	11/28/2006	6479.34	6612.65	133.31	132.76	
T(M)	11/4/2008	6478.96	6612.65	133.69	133.14	
T(M)	5/13/2009	6478.87	6612.65	133.78	133.23	
T(M)	10/27/2009	6478.77	6612.65	133.88	133.33	
T(M)	11/10/2009	6478.94	6612.65	133.71	133.16	
T(M)	11/9/2010	6478.83	6612.65	133.82	133.27	
T(M)	4/12/2011	6478.74	6612.65	133.91	133.36	
T(M)	7/26/2011	6478.72	6612.65	133.93	133.38	
T(M)	11/16/2011	6478.76	6612.65	133.89	133.34	
T(M)	5/15/2012	6478.57	6612.65	134.08	133.53	
T(M)	11/13/2012		6612.65			Dry
T(M)	5/14/2013		6612.65			Dry
T(M)	11/19/2013		6612.65			Dry
U(M)	3/12/1984	6485.83		-6485.83	-6485.83	
U(M)	4/17/1984	6485.76		-6485.76	-6485.76	
U(M)	4/17/1986	6488.64		-6488.64	-6488.64	
U(M)	7/7/1986	6488.67		-6488.67	-6488.67	
U(M)	10/13/1986	6488.77		-6488.77	-6488.77	
U(M)	2/3/1987	6488.61		-6488.61	-6488.61	
U(M)	4/8/1987	6488.5		-6488.5	-6488.5	
U(M)	7/7/1987	6488.22		-6488.22	-6488.22	
U(M)	10/7/1987	6488.38		-6488.38	-6488.38	
U(M)	1/11/1988	6488.72		-6488.72	-6488.72	
U(M)	4/6/1988	6488.21		-6488.21	-6488.21	
U(M)	7/11/1988	6487.99		-6487.99	-6487.99	
U(M)	10/5/1988	6488.46		-6488.46	-6488.46	
U(M)	1/18/1989	6488.49		-6488.49	-6488.49	
U(M)	4/11/1989	6488.08		-6488.08	-6488.08	
U(M)	4/9/1990	6486.53		-6486.53	-6486.53	
X(M)	3/12/1984	6478.33	6598.91	120.58	118.71	
X(M)	4/17/1984	6477.29	6598.91	121.62	119.75	
X(M)	4/17/1986	6481.86	6598.91	117.05	115.18	
X(M)	7/7/1986	6482.14	6598.91	116.77	114.9	
X(M)	10/6/1986	6482.7	6598.91	116.21	114.34	
X(M)	2/3/1987	6482.07	6598.91	116.84	114.97	
X(M)	4/8/1987	6481.96	6598.91	116.95	115.08	
X(M)	7/7/1987	6481.63	6598.91	117.28	115.41	
X(M)	10/5/1987	6482.03	6598.91	116.88	115.01	
X(M)	1/11/1988	6482.26	6598.91	116.65	114.78	
X(M)	4/6/1988	6481.66	6598.91	117.25	115.38	
X(M)	7/11/1988	6481.49	6598.91	117.42	115.55	
X(M)	10/5/1988	6482.01	6598.91	116.9	115.03	
X(M)	1/18/1989	6481.96	6598.91	116.95	115.08	
X(M)	4/17/1989	6481.57	6598.91	117.34	115.47	

Table C.1-2. Water Level Data for Bluewater Site Alluvial Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	TOC Elevation (ft amsl)	Depth from Top of Casing (ft)	Depth from Surface (ft)	Comment
X(M)	4/11/1990	6479.67	6598.91	119.24	117.37	
X(M)	11/9/2010		6598.91			Dry
X(M)	7/28/2011		6598.91			Dry
X(M)	11/15/2011		6598.91			Dry
X(M)	5/15/2012		6598.91			Dry
X(M)	11/15/2012	6467.17	6598.91	131.74	129.87	
X(M)	1/29/2013	6467.2	6598.91	131.71	129.84	
X(M)	5/15/2013		6598.91			Dry
X(M)	11/19/2013	6466.89	6598.91	132.02	130.15	
X(M)	4/29/2014	6466.76	6598.91	132.15	130.28	
Y2(M)	11/19/1997	6506.23	6614.13	107.9	105.73	
Y2(M)	11/16/1998		6614.13			
Y2(M)	11/11/1999	6501.67	6614.13	112.46	110.29	
Y2(M)	11/11/2000	6501.55	6614.13	112.58	110.41	
Y2(M)	11/3/2001	6499.95	6614.13	114.18	112.01	
Y2(M)	10/17/2002	6498.54	6614.13	115.59	113.42	
Y2(M)	9/19/2003	6497.35	6614.13	116.78	114.61	
Y2(M)	9/26/2003	6497.65	6614.13	116.48	114.31	
Y2(M)	11/18/2004	6497.08	6614.13	117.05	114.88	
Y2(M)	11/15/2005	6496.77	6614.13	117.36	115.19	
Y2(M)	11/28/2006	6496.55	6614.13	117.58	115.41	
Y2(M)	11/6/2007	6488.13	6614.13	126	123.83	
Y2(M)	11/4/2008	6496.81	6614.13	117.32	115.15	
Y2(M)	5/13/2009	6496.83	6614.13	117.3	115.13	
Y2(M)	11/10/2009	6496.92	6614.13	117.21	115.04	
Y2(M)	11/11/2010	6496.65	6614.13	117.48	115.31	
Y2(M)	7/28/2011	6496.62	6614.13	117.51	115.34	
Y2(M)	11/15/2011	6496.79	6614.13	117.34	115.17	
Y2(M)	5/15/2012	6496.7	6614.13	117.43	115.26	
Y2(M)	11/14/2012	6496.79	6614.13	117.34	115.17	
Y2(M)	1/30/2013	6496.74	6614.13	117.39	115.22	
Y2(M)	5/14/2013	6496.88	6614.13	117.25	115.08	
Y2(M)	11/19/2013	6496.93	6614.13	117.2	115.03	
Y2(M)	4/30/2014	6496.79	6614.13	117.34	115.17	

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Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
#1 Deepwell	5/13/2003	6441.701	142.06	6583.76	HMC 2004
#1 Deepwell	12/20/2004	6435.58	148.18	6583.76	HMC 2005
#1 Deepwell	5/4/2005	6391.06	192.7	6583.76	HMC 2006
#1 Deepwell	12/1/2005	6388.16	195.6	6583.76	HMC 2006
#1 Deepwell	2/26/2007	6480.76	103	6583.76	HMC 2008
#1 Deepwell	11/13/2007	6485.16	98.6	6583.76	HMC 2008
#1 Deepwell	12/12/2007	6484.68	99.08	6583.76	HMC 2008
#2 Deepwell	5/5/1998	6411.16	164.5	6575.66	HMC 1999
#2 Deepwell	2/3/1999	6407.66	168	6575.66	HMC 2000
#2 Deepwell	2/1/2000	6458.06	117.6	6575.66	HMC 2001
#2 Deepwell	5/2/2001	6397.8	177.86	6575.66	HMC 2002
#2 Deepwell	5/13/2003	6441.6	134.06	6575.66	HMC 2004
#2 Deepwell	5/4/2005	6366.86	208.8	6575.66	HMC 2006
#2 Deepwell	12/12/2009	6423.4	152.26	6575.66	HMC electronic
#2 Deepwell	11/4/2013	6368.55	207.11	6575.66	HMC 2014
534	4/12/2001	6462.81	89.76	6552.57	HMC 2002
534	12/11/2001	6458.78	93.79	6552.57	HMC 2002
534	12/18/2002	6453.67	98.9	6552.57	HMC 2003
534	12/23/2003	6449.47	103.1	6552.57	HMC 2004
534	12/14/2004	6445.87	106.7	6552.57	HMC 2005
534	12/4/2008	6434.45	118.12	6552.57	HMC 2009
534	12/16/2010	6432.56	120.01	6552.57	HMC 2011
535	4/12/2001	6454.76	85.24	6540	HMC 2002
535	12/11/2001	6449.51	90.49	6540	HMC 2002
535	12/18/2002	6444.12	95.88	6540	HMC 2003
535	12/23/2003	6409.9	130.1	6540	HMC 2004
535	12/14/2004	6436.32	103.68	6540	HMC 2005
535	11/13/2007	6429.03	110.97	6540	HMC 2008
535	12/4/2008	6425.2	114.8	6540	HMC 2009
535	12/17/2010	6422.15	117.85	6540	HMC 2011
822	2/13/2008	6432.4	135.6	6568	HMC 2009
907	4/12/2001	6457.9	87.7	6545.6	HMC 2002
907	12/11/2001	6452.52	93.08	6545.6	HMC 2002
907	3/4/2002	6451.94	93.66	6545.6	HMC 2003
907	10/17/2002	6445.4	100.2	6545.6	HMC 2003
907	12/18/2002	6447.5	98.1	6545.6	HMC 2003
907	6/3/2003	6444	101.6	6545.6	HMC 2004
907	10/27/2003	6442.32	103.28	6545.6	HMC 2004
907	12/23/2003	6443.22	102.38	6545.6	HMC 2004
907	3/3/2004	6443.6	102	6545.6	HMC 2005
907	12/14/2004	6439.42	106.18	6545.6	HMC 2005
907	12/14/2004	6439.36	106.24	6545.6	HMC 2005
907	4/12/2005	6438.16	107.44	6545.6	HMC 2006
907	12/1/2005	6437.3	108.3	6545.6	HMC 2006
907	3/16/2006	6435.6	110	6545.6	HMC 2007
907	12/20/2006	6435.7	109.9	6545.6	HMC 2007
907	3/9/2007	6435.1	110.5	6545.6	HMC 2008
907	11/13/2007	6432.37	113.23	6545.6	HMC 2008
907	3/5/2008	6432.44	113.16	6545.6	HMC 2009
907	12/4/2008	6428.7	116.9	6545.6	HMC 2009
907	3/3/2010	6425.97	119.63	6545.6	HMC 2011
907	12/15/2010	6426.9	118.7	6545.6	HMC 2011
907	4/13/2011	6425.7	119.9	6545.6	HMC 2012
907	5/9/2012	6424.6	121	6545.6	HMC 2013

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
907	11/20/2012	6418.181	127.42	6545.6	HMC 2013
907	12/11/2013	6423.85	121.75	6545.6	HMC 2014
928	8/27/1998	6462.2	135.4	6597.6	HMC 1999
928	8/9/2000	6458.66	138.94	6597.6	HMC 2001
928	8/29/2001	6453.46	144.14	6597.6	HMC 2002
928	12/11/2001	6451.06	146.54	6597.6	HMC 2002
928	3/4/2002	6452.03	145.57	6597.6	HMC 2003
928	10/21/2002	6444.8	152.8	6597.6	HMC 2003
928	12/18/2002	6445.9	151.7	6597.6	HMC 2003
928	6/3/2003	6443.12	154.48	6597.6	HMC 2004
928	10/27/2003	6440.86	156.74	6597.6	HMC 2004
928	12/23/2003	6442.45	155.15	6597.6	HMC 2004
928	3/3/2004	6442.85	154.75	6597.6	HMC 2005
928	12/9/2004	6438.8	158.8	6597.6	HMC 2005
928	12/14/2004	6438.72	158.88	6597.6	HMC 2005
928	4/12/2005	6438.33	159.27	6597.6	HMC 2006
928	12/1/2005	6436.7	160.9	6597.6	HMC 2006
928	12/5/2005	6436.8	160.8	6597.6	HMC 2006
928	3/16/2006	6436.12	161.48	6597.6	HMC 2007
928	12/10/2006	6434.7	162.9	6597.6	HMC 2007
928	12/20/2006	6434.81	162.79	6597.6	HMC 2007
928	3/9/2007	6435.7	161.9	6597.6	HMC 2008
928	11/13/2007	6432.24	165.36	6597.6	HMC 2008
928	12/3/2007	6432.04	165.56	6597.6	HMC 2008
928	3/5/2008	6433.20	164.40	6597.6	HMC 2009
928	9/17/2008	6425.67	171.93	6597.6	HMC 2009
928	12/4/2008	6442.45	155.15	6597.6	HMC 2009
928	12/22/2008	6428.30	169.30	6597.6	HMC 2009
928	3/20/2009	6427.84	169.76	6597.6	HMC electronic
928	10/12/2009	6457.80	139.80	6597.6	HMC electronic
928	12/7/2009	6427.89	169.71	6597.6	HMC electronic
928	12/9/2009	6427.49	170.11	6597.6	HMC electronic
928	3/3/2010	6428.60	169.00	6597.6	HMC 2011
928	5/3/2010	6430.16	167.44	6597.6	HMC 2011
928	6/14/2010	6423.60	174.00	6597.6	HMC 2011
928	12/6/2010	6455.32	142.28	6597.6	HMC 2011
928	12/16/2010	6432.70	164.90	6597.6	HMC 2011
928	4/13/2011	6441.25	156.35	6597.6	HMC 2012
928	11/11/2011	6455.73	141.87	6597.6	HMC 2012
928	12/6/2011	6447.85	149.75	6597.6	HMC 2012
928	5/30/2012	6459.04	138.56	6597.6	HMC 2013
928	11/14/2012	6463.22	134.38	6597.6	HMC 2013
928	12/11/2013	6467.85	129.75	6597.6	HMC 2014
938	4/12/2001	6458.39	110.41	6568.8	HMC 2002
938	12/11/2001	6453.06	115.74	6568.8	HMC 2002
938	3/4/2002	6452.36	116.44	6568.8	HMC 2003
938	10/17/2002	6445.96	122.84	6568.8	HMC 2003
938	12/18/2002	6447.85	120.95	6568.8	HMC 2003
938	6/3/2003	6443.97	124.83	6568.8	HMC 2004
938	10/27/2003	6442.4	126.4	6568.8	HMC 2004
938	12/23/2003	6443.57	125.23	6568.8	HMC 2004
938	3/4/2004	6443.70	125.10	6568.8	HMC 2005
938	12/14/2004	6439.27	129.53	6568.8	HMC 2005
938	4/12/2005	6438.42	130.38	6568.8	HMC 2006

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
938	12/5/2005	6437.69	131.11	6568.8	HMC 2006
938	3/16/2006	6435.80	133.00	6568.8	HMC 2007
938	12/20/2006	6434.89	133.91	6568.8	HMC 2007
938	3/9/2007	6435.80	133.00	6568.8	HMC 2008
938	12/14/2007	6432.30	136.50	6568.8	HMC 2008
938	3/5/2008	6432.50	136.30	6568.8	HMC 2009
938	12/5/2008	6428.34	140.46	6568.8	HMC 2009
938	12/17/2008	6432.30	136.50	6568.8	HMC 2009
938	3/3/2010	6426.17	142.63	6568.8	HMC 2011
938	12/16/2010	6426.91	141.89	6568.8	HMC 2011
938	4/13/2011	6425.92	142.88	6568.8	HMC 2012
938	10/18/2011	6423.62	145.18	6568.8	HMC 2012
938	10/24/2012	6421.04	147.76	6568.8	HMC 2013
938	11/20/2012	6550.20	18.60	6568.8	HMC 2013
938	12/11/2013	6421.15	147.65	6568.8	HMC 2014
943	8/18/1998	6489.11	66.80	6555.91	HMC 1999
943	9/21/1999	6492.71	63.20	6555.91	HMC 2000
943	8/23/2000	6494.98	60.93	6555.91	HMC 2001
943	8/29/2001	6487.91	68.00	6555.91	HMC 2002
943	12/11/2001	6483.91	72.00	6555.91	HMC 2002
943	11/13/2002	6477.91	78.00	6555.91	HMC 2003
943	12/18/2002	6477.51	78.40	6555.91	HMC 2003
943	10/27/2003	6475.93	79.98	6555.91	HMC 2004
943	12/23/2003	6477.03	78.88	6555.91	HMC 2004
943	3/1/2004	6437.27	118.64	6555.91	HMC 2005
943	3/9/2004	6437.41	118.50	6555.91	HMC 2005
943	3/29/2004	6435.76	120.15	6555.91	HMC 2005
943	5/3/2004	6435.13	120.78	6555.91	HMC 2005
943	6/1/2004	6434.29	121.62	6555.91	HMC 2005
943	6/28/2004	6433.01	122.90	6555.91	HMC 2005
943	7/23/2004	6431.81	124.10	6555.91	HMC 2005
943	8/2/2004	6430.43	125.48	6555.91	HMC 2005
943	8/30/2004	6430.21	125.70	6555.91	HMC 2005
943	10/4/2004	6430.33	125.58	6555.91	HMC 2005
943	11/1/2004	6431.37	124.54	6555.91	HMC 2005
943	11/29/2004	6431.40	124.51	6555.91	HMC 2005
943	12/8/2004	6432.17	123.74	6555.91	HMC 2005
943	1/4/2005	6432.69	123.22	6555.91	HMC 2006
943	1/31/2005	6431.73	124.18	6555.91	HMC 2006
943	2/28/2005	6435.81	120.10	6555.91	HMC 2006
943	4/4/2005	6432.26	123.65	6555.91	HMC 2006
943	4/19/2005	6432.41	123.50	6555.91	HMC 2006
943	5/2/2005	6431.08	124.83	6555.91	HMC 2006
943	5/31/2005	6430.96	124.95	6555.91	HMC 2006
943	7/5/2005	6430.61	125.30	6555.91	HMC 2006
943	8/1/2005	6375.91	180.00	6555.91	HMC 2006
943	8/29/2005	6431.81	124.10	6555.91	HMC 2006
943	10/3/2005	6431.66	124.25	6555.91	HMC 2006
943	10/31/2005	6431.41	124.50	6555.91	HMC 2006
943	11/28/2005	6432.05	123.86	6555.91	HMC 2006
943	12/5/2005	6432.08	123.83	6555.91	HMC 2006
943	1/3/2006	6431.31	124.60	6555.91	HMC 2006
943	1/3/2006	6431.31	124.60	6555.91	HMC 2007
943	1/30/2006	6430.91	125.00	6555.91	HMC 2007

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
943	2/27/2006	6433.61	122.30	6555.91	HMC 2007
943	3/16/2006	6431.29	124.62	6555.91	HMC 2007
943	4/3/2006	6430.41	125.50	6555.91	HMC 2007
943	5/1/2006	6432.71	123.20	6555.91	HMC 2007
943	5/30/2006	6430.46	125.45	6555.91	HMC 2007
943	6/26/2006	6430.41	125.50	6555.91	HMC 2007
943	7/31/2006	6431.79	124.12	6555.91	HMC 2007
943	8/28/2006	6430.40	125.51	6555.91	HMC 2007
943	9/25/2006	6431.36	124.55	6555.91	HMC 2007
943	10/30/2006	6431.81	124.10	6555.91	HMC 2007
943	11/27/2006	6433.61	122.30	6555.91	HMC 2007
943	1/29/2007	6430.46	125.45	6555.91	HMC 2008
943	2/26/2007	6430.49	125.42	6555.91	HMC 2008
943	3/8/2007	6430.66	125.25	6555.91	HMC 2008
943	4/2/2007	6429.51	126.40	6555.91	HMC 2008
943	4/30/2007	6428.54	127.37	6555.91	HMC 2008
943	5/29/2007	6427.31	128.60	6555.91	HMC 2008
943	7/2/2007	6427.11	128.80	6555.91	HMC 2008
943	7/30/2007	6426.89	129.02	6555.91	HMC 2008
943	9/4/2007	6426.41	129.50	6555.91	HMC 2008
943	10/1/2007	6425.61	130.30	6555.91	HMC 2008
943	10/29/2007	6425.31	130.60	6555.91	HMC 2008
943	12/3/2007	6425.74	130.17	6555.91	HMC 2008
943	1/2/2008	6426.71	129.2	6555.91	HMC 2009
943	2/4/2008	6426.12	129.79	6555.91	HMC 2009
943	3/3/2008	6427.08	128.83	6555.91	HMC 2009
943	3/5/2008	6427.27	128.64	6555.91	HMC 2009
943	3/31/2008	6426.21	129.7	6555.91	HMC 2009
943	5/5/2008	6424.81	131.1	6555.91	HMC 2009
943	6/2/2008	6424.31	131.6	6555.91	HMC 2009
943	6/30/2008	6423.06	132.85	6555.91	HMC 2009
943	8/4/2008	6422.31	133.6	6555.91	HMC 2009
943	9/29/2008	6424.81	131.1	6555.91	HMC 2009
943	10/27/2008	6362.31	193.6	6555.91	HMC 2009
943	12/1/2008	6422.61	133.3	6555.91	HMC 2009
943	12/1/2008	6417.11	138.8	6555.91	HMC 2009
943	12/29/2008	6422.61	133.3	6555.91	HMC 2009
943	2/2/2009	6422.51	133.4	6555.91	HMC electronic
943	3/2/2009	6421.39	134.52	6555.91	HMC electronic
943	3/20/2009	6424.03	131.88	6555.91	HMC electronic
943	3/30/2009	6424.71	131.2	6555.91	HMC electronic
943	4/7/2009	6424.87	131.04	6555.91	HMC electronic
943	5/4/2009	6388.61	167.3	6555.91	HMC electronic
943	6/1/2009	6421.56	134.35	6555.91	HMC electronic
943	6/15/2009	6421.47	134.44	6555.91	HMC electronic
943	6/29/2009	6421.51	134.4	6555.91	HMC electronic
943	8/3/2009	6423.11	132.8	6555.91	HMC electronic
943	8/31/2009	6419.6	136.31	6555.91	HMC electronic
943	9/28/2009	6419.96	135.95	6555.91	HMC electronic
943	11/2/2009	6420.56	135.35	6555.91	HMC electronic
943	11/30/2009	6421.65	134.26	6555.91	HMC electronic
943	12/7/2009	6421.78	134.13	6555.91	HMC electronic
943	12/28/2009	6421.31	134.6	6555.91	HMC electronic
943	2/1/2010	6421.45	134.46	6555.91	HMC 2011

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
943	3/1/2010	6421.39	134.52	6555.91	HMC 2011
943	3/3/2010	6421.08	134.83	6555.91	HMC 2011
943	3/29/2010	6423.18	132.73	6555.91	HMC 2011
943	5/3/2010	6421.63	134.28	6555.91	HMC 2011
943	6/1/2010	6420.61	135.3	6555.91	HMC 2011
943	6/22/2010	6421.91	134	6555.91	HMC 2011
943	6/28/2010	6420.36	135.55	6555.91	HMC 2011
943	8/2/2010	6409.31	146.6	6555.91	HMC 2011
943	8/30/2010	6418.91	137	6555.91	HMC 2011
943	9/7/2010	6421.61	134.3	6555.91	HMC 2011
943	9/13/2010	6421.41	134.5	6555.91	HMC 2011
943	9/20/2010	6417.46	138.45	6555.91	HMC 2011
943	9/27/2010	6418.01	137.9	6555.91	HMC 2011
943	10/4/2010	6421.56	134.35	6555.91	HMC 2011
943	10/11/2010	6422.16	133.75	6555.91	HMC 2011
943	10/18/2010	6418.91	137	6555.91	HMC 2011
943	10/25/2010	6419.71	136.2	6555.91	HMC 2011
943	10/27/2010	6419.37	136.54	6555.91	HMC 2011
943	11/1/2010	6419.61	136.3	6555.91	HMC 2011
943	11/8/2010	6418.17	137.74	6555.91	HMC 2011
943	11/15/2010	6420.21	135.7	6555.91	HMC 2011
943	11/29/2010	6420.36	135.55	6555.91	HMC 2011
943	12/6/2010	6420.63	135.28	6555.91	HMC 2011
943	12/27/2010	6420.63	135.28	6555.91	HMC 2011
943	1/31/2011	6420.51	135.4	6555.91	HMC 2012
943	2/28/2011	6420.01	135.9	6555.91	HMC 2012
943	4/4/2011	6419.93	135.98	6555.91	HMC 2012
943	4/13/2011	6420.03	135.88	6555.91	HMC 2012
943	4/25/2011	6419.91	136	6555.91	HMC 2012
943	5/23/2011	6422.27	133.64	6555.91	HMC 2012
943	6/27/2011	6421.01	134.9	6555.91	HMC 2012
943	7/25/2011	6420.5	135.41	6555.91	HMC 2012
943	8/29/2011	6416.01	139.9	6555.91	HMC 2012
943	9/26/2011	6416.31	139.6	6555.91	HMC 2012
943	10/24/2011	6415.51	140.4	6555.91	HMC 2012
943	11/7/2011	6416.61	139.3	6555.91	HMC 2012
943	11/21/2011	6415.91	140	6555.91	HMC 2012
943	12/19/2011	6421.21	134.7	6555.91	HMC 2012
943	1/23/2012	6421.61	134.3	6555.91	HMC 2013
943	2/27/2012	6422.43	133.48	6555.91	HMC 2013
943	3/26/2012	6417.11	138.8	6555.91	HMC 2013
943	4/23/2012	6409.01	146.9	6555.91	HMC 2013
943	5/9/2012	6421.81	134.1	6555.91	HMC 2013
943	5/29/2012	6397.11	158.8	6555.91	HMC 2013
943	6/25/2012	6414.33	141.58	6555.91	HMC 2013
943	7/23/2012	6420.09	135.82	6555.91	HMC 2013
943	9/24/2012	6414.14	141.77	6555.91	HMC 2013
943	10/22/2012	6415.61	140.3	6555.91	HMC 2013
943	11/26/2012	6419.76	136.15	6555.91	HMC 2013
943	12/6/2012	6419.76	136.15	6555.91	HMC 2013
943	1/28/2013	6419.41	136.5	6555.91	HMC 2014
943	2/25/2013	6419.23	136.68	6555.91	HMC 2014
943	3/6/2013	6419.11	136.8	6555.91	HMC 2014
943	3/25/2013	6418.41	137.5	6555.91	HMC 2014

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
943	4/29/2013	6413.11	142.8	6555.91	HMC 2014
943	5/28/2013	6412.86	143.05	6555.91	HMC 2014
943	6/24/2013	6411.93	143.98	6555.91	HMC 2014
949	2/13/2008	6431.7	130.6	6562.3	HMC 2009
951	8/18/1998	6464.9	108.8	6573.7	HMC 1999
951	8/30/1999	6462.85	110.85	6573.7	HMC 2000
951	9/7/1999	6462.77	110.93	6573.7	HMC 2000
951	10/5/1999	6462.91	110.79	6573.7	HMC 2000
951	11/1/1999	6463.78	109.92	6573.7	HMC 2000
951	11/29/1999	6466.09	107.61	6573.7	HMC 2000
951	1/3/2000	6463.82	109.88	6573.7	HMC 2001
951	1/31/2000	6462.72	110.98	6573.7	HMC 2001
951	3/6/2000	6464.1	109.6	6573.7	HMC 2001
951	4/3/2000	6463.45	110.25	6573.7	HMC 2001
951	5/2/2000	6463.5	110.2	6573.7	HMC 2001
951	8/9/2000	6458.7	115	6573.7	HMC 2001
951	4/12/2001	6457.76	115.94	6573.7	HMC 2002
951	12/11/2001	6452.38	121.32	6573.7	HMC 2002
951	3/4/2002	6447.74	125.96	6573.7	HMC 2003
951	4/1/2002	6450.94	122.76	6573.7	HMC 2003
951	4/29/2002	6445.2	128.5	6573.7	HMC 2003
951	6/4/2002	6443.58	130.12	6573.7	HMC 2003
951	7/1/2002	6442.22	131.48	6573.7	HMC 2003
951	8/5/2002	6441.09	132.61	6573.7	HMC 2003
951	9/3/2002	6440.82	132.88	6573.7	HMC 2003
951	9/30/2002	6440.92	132.78	6573.7	HMC 2003
951	10/17/2002	6441.34	132.36	6573.7	HMC 2003
951	11/5/2002	6442.65	131.05	6573.7	HMC 2003
951	12/2/2002	6442.85	130.85	6573.7	HMC 2003
951	12/18/2002	6443.16	130.54	6573.7	HMC 2003
951	12/30/2002	6443.19	130.51	6573.7	HMC 2003
951	2/3/2003	6442.38	131.32	6573.7	HMC 2004
951	3/3/2003	6442.42	131.28	6573.7	HMC 2004
951	3/31/2003	6440.9	132.8	6573.7	HMC 2004
951	5/5/2003	6439.09	134.61	6573.7	HMC 2004
951	6/30/2003	6386.26	187.44	6573.7	HMC 2004
951	8/2/2003	6389	184.7	6573.7	HMC 2004
951	8/14/2003	6437.6	136.1	6573.7	HMC 2004
951	9/2/2003	6436.1	137.6	6573.7	HMC 2004
951	9/29/2003	6437.25	136.45	6573.7	HMC 2004
951	10/27/2003	6437.89	135.81	6573.7	HMC 2004
951	11/3/2003	6438.2	135.5	6573.7	HMC 2004
951	12/1/2003	6389	184.7	6573.7	HMC 2004
951	12/29/2003	6403.3	170.4	6573.7	HMC 2004
951	2/2/2004	6438.39	135.31	6573.7	HMC 2005
951	3/1/2004	6438.92	134.78	6573.7	HMC 2005
951	3/29/2004	6437.15	136.55	6573.7	HMC 2005
951	5/3/2004	6435.76	137.94	6573.7	HMC 2005
951	6/1/2004	6435.92	137.78	6573.7	HMC 2005
951	6/28/2004	6434.83	138.87	6573.7	HMC 2005
951	8/2/2004	6434.7	139	6573.7	HMC 2005
951	8/30/2004	6433.46	140.24	6573.7	HMC 2005
951	10/4/2004	6433.42	140.28	6573.7	HMC 2005
951	11/1/2004	6434.46	139.24	6573.7	HMC 2005

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
951	11/29/2004	6438.51	135.19	6573.7	HMC 2005
951	12/8/2004	6438.8	134.9	6573.7	HMC 2005
951	1/4/2005	6434.62	139.08	6573.7	HMC 2006
951	1/31/2005	6433.88	139.82	6573.7	HMC 2006
951	2/28/2005	6434.32	139.38	6573.7	HMC 2006
951	4/4/2005	6433.85	139.85	6573.7	HMC 2006
951	4/25/2005	6433.82	139.88	6573.7	HMC 2006
951	5/2/2005	6433.03	140.67	6573.7	HMC 2006
951	5/31/2005	6431.78	141.92	6573.7	HMC 2006
951	7/5/2005	6431.45	142.25	6573.7	HMC 2006
951	8/1/2005	6436.92	136.78	6573.7	HMC 2006
951	8/29/2005	6433.35	140.35	6573.7	HMC 2006
951	10/3/2005	6432.78	140.92	6573.7	HMC 2006
951	10/31/2005	6432.8	140.9	6573.7	HMC 2006
951	11/28/2005	6432.79	140.91	6573.7	HMC 2006
951	12/5/2005	6432.89	140.81	6573.7	HMC 2006
951	1/3/2006	6432.75	140.95	6573.7	HMC 2006
951	1/3/2006	6432.75	140.95	6573.7	HMC 2007
951	1/30/2006	6432.56	141.14	6573.7	HMC 2007
951	2/27/2006	6432.3	141.4	6573.7	HMC 2007
951	3/16/2006	6431.34	142.36	6573.7	HMC 2007
951	4/3/2006	6431.34	142.36	6573.7	HMC 2007
951	5/1/2006	6431.83	141.87	6573.7	HMC 2007
951	5/30/2006	6430.9	142.8	6573.7	HMC 2007
951	6/26/2006	6430.58	143.12	6573.7	HMC 2007
951	7/31/2006	6429.47	144.23	6573.7	HMC 2007
951	8/28/2006	6433.8	139.9	6573.7	HMC 2007
951	9/25/2006	6429.4	144.3	6573.7	HMC 2007
951	10/30/2006	6430.62	143.08	6573.7	HMC 2007
951	11/27/2006	6430.55	143.15	6573.7	HMC 2007
951	12/27/2006	6431.15	142.55	6573.7	HMC 2007
951	1/29/2007	6435.1	138.6	6573.7	HMC 2008
951	2/26/2007	6435.1	138.6	6573.7	HMC 2008
951	3/9/2007	6431.32	142.38	6573.7	HMC 2008
951	4/2/2007	6430.45	143.25	6573.7	HMC 2008
951	4/30/2007	6428.78	144.92	6573.7	HMC 2008
951	5/29/2007	6427.8	145.9	6573.7	HMC 2008
951	7/2/2007	6426.9	146.8	6573.7	HMC 2008
951	7/30/2007	6426.8	146.9	6573.7	HMC 2008
951	9/4/2007	6426.65	147.05	6573.7	HMC 2008
951	10/1/2007	6425.7	148	6573.7	HMC 2008
951	10/29/2007	6426.4	147.3	6573.7	HMC 2008
951	12/3/2007	6427.1	146.6	6573.7	HMC 2008
951	1/2/2008	6427.33	146.37	6573.7	HMC 2009
951	2/4/2008	6427.04	146.66	6573.7	HMC 2009
951	3/3/2008	6427.55	146.15	6573.7	HMC 2009
951	3/5/2008	6427.51	146.19	6573.7	HMC 2009
951	3/31/2008	6426.6	147.1	6573.7	HMC 2009
951	5/5/2008	6425.4	148.3	6573.7	HMC 2009
951	6/2/2008	6424.97	148.73	6573.7	HMC 2009
951	6/30/2008	6423.4	150.3	6573.7	HMC 2009
951	9/2/2008	6422.1	151.6	6573.7	HMC 2009
951	9/4/2008	6422.65	151.05	6573.7	HMC 2009
951	9/29/2008	6422.9	150.8	6573.7	HMC 2009

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
951	10/27/2008	6426.6	147.1	6573.7	HMC 2009
951	12/1/2008	6421.6	152.1	6573.7	HMC 2009
951	12/1/2008	6423.7	150	6573.7	HMC 2009
951	12/29/2008	6423.42	150.28	6573.7	HMC 2009
951	2/2/2009	6424.05	149.65	6573.7	HMC electronic
951	3/2/2009	6423.75	149.95	6573.7	HMC electronic
951	3/20/2009	6421.44	152.26	6573.7	HMC electronic
951	3/30/2009	6422.38	151.32	6573.7	HMC electronic
951	5/4/2009	6422.6	151.1	6573.7	HMC electronic
951	6/1/2009	6423.3	150.4	6573.7	HMC electronic
951	6/29/2009	6419.7	154	6573.7	HMC electronic
951	8/3/2009	6422.75	150.95	6573.7	HMC electronic
951	8/31/2009	6420.3	153.4	6573.7	HMC electronic
951	9/28/2009	6421.95	151.75	6573.7	HMC electronic
951	11/2/2009	6422.8	150.9	6573.7	HMC electronic
951	11/30/2009	6422.43	151.27	6573.7	HMC electronic
951	12/7/2009	6422.7	151	6573.7	HMC electronic
951	12/28/2009	6423.5	150.2	6573.7	HMC electronic
951	2/1/2010	6423.25	150.45	6573.7	HMC 2011
951	3/1/2010	6422.95	150.75	6573.7	HMC 2011
951	3/3/2010	6424.9	148.8	6573.7	HMC 2011
951	3/29/2010	6422.87	150.83	6573.7	HMC 2011
951	5/3/2010	6422.95	150.75	6573.7	HMC 2011
951	6/1/2010	6421.3	152.4	6573.7	HMC 2011
951	6/22/2010	6421.17	152.53	6573.7	HMC 2011
951	6/28/2010	6421.19	152.51	6573.7	HMC 2011
951	8/2/2010	6420.58	153.12	6573.7	HMC 2011
951	8/30/2010	6420.8	152.9	6573.7	HMC 2011
951	9/7/2010	6420.3	153.4	6573.7	HMC 2011
951	9/13/2010	6420.49	153.21	6573.7	HMC 2011
951	9/20/2010	6420.77	152.93	6573.7	HMC 2011
951	9/27/2010	6421.5	152.2	6573.7	HMC 2011
951	10/11/2010	6422.3	151.4	6573.7	HMC 2011
951	10/18/2010	6422.72	150.98	6573.7	HMC 2011
951	10/25/2010	6381.1	192.6	6573.7	HMC 2011
951	11/1/2010	6423.4	150.3	6573.7	HMC 2011
951	11/8/2010	6423.4	150.3	6573.7	HMC 2011
951	11/15/2010	6423.25	150.45	6573.7	HMC 2011
951	11/29/2010	6423.75	149.95	6573.7	HMC 2011
951	12/6/2010	6423.8	149.9	6573.7	HMC 2011
951	12/27/2010	6424.17	149.53	6573.7	HMC 2011
951	1/31/2011	6423.7	150	6573.7	HMC 2012
951	2/28/2011	6423.5	150.2	6573.7	HMC 2012
951	4/13/2011	6421.85	151.85	6573.7	HMC 2012
951	4/25/2011	6423.21	150.49	6573.7	HMC 2012
951	5/23/2011	6422.5	151.2	6573.7	HMC 2012
951	6/27/2011	6420.1	153.6	6573.7	HMC 2012
951	7/25/2011	6419.73	153.97	6573.7	HMC 2012
951	8/29/2011	6420.35	153.35	6573.7	HMC 2012
951	9/26/2011	6420.9	152.8	6573.7	HMC 2012
951	10/12/2011	6453.7	120	6573.7	HMC 2012
951	10/24/2011	6421.35	152.35	6573.7	HMC 2012
951	11/21/2011	6421.1	152.6	6573.7	HMC 2012
951	12/19/2011	6421.3	152.4	6573.7	HMC 2012

Table C.1-3. Water Level Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	Water Elevation (ft amsl)	Water Level (ft-MP)	MP Elevation (ft amsl)	Data Source
951	1/23/2012	6386.3	187.4	6573.7	HMC 2013
951	2/27/2012	6422.72	150.98	6573.7	HMC 2013
951	3/9/2012	6423.02	150.68	6573.7	HMC 2013
951	3/26/2012	6426	147.7	6573.7	HMC 2013
951	8/19/199	6466.2	107.5	6573.7	HMC 2000
986	8/22/2008	6426	124	6550	HMC 2009
986	8/23/2008	6426	124	6550	HMC 2009
991	8/26/2008	6424.18	126.82	6551	HMC 2009
0806R	3/5/2008	6432.29	134.71	6567	HMC 2009
0806R	4/13/2011	6418.4	148.6	6567	HMC 2012
0951R	5/29/2012	6419.13	157.65	6576.78	HMC 2013
0951R	6/25/2012	6416.18	160.6	6576.78	HMC 2013
0951R	7/23/2012	6416.41	160.37	6576.78	HMC 2013
0951R	9/24/2012	6416.92	159.86	6576.78	HMC 2013
0951R	10/22/2012	6416.3	160.48	6576.78	HMC 2013
0951R	11/26/2012	6416.48	160.3	6576.78	HMC 2013
0951R	12/26/2012	6416.03	160.75	6576.78	HMC 2013
0951R	1/28/2013	6422.01	154.77	6576.78	HMC 2014
0951R	2/25/2013	6415.98	160.8	6576.78	HMC 2014
0951R	3/6/2013	6416.78	160	6576.78	HMC 2014
0951R	3/25/2013	6416.11	160.67	6576.78	HMC 2014
0951R	4/29/2013	6417.38	159.4	6576.78	HMC 2014
0951R	5/28/2013	6429.38	147.4	6576.78	HMC 2014
0951R	6/24/2013	6444.03	132.75	6576.78	HMC 2014

MP Measuring Point

Note:
Water level data listed here for HMC-951, also provided in Table C.1-1, are duplicated here, as HMC annual reports have been the primary source for these data. HMC did not issue an annual report in 2010 (reporting data for the year 2009). Water level data from 2009 are from an electronic file provided to DOE.

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Table C.1-4. Water Level Data Used to Derive 2012 Potentiometric Surface for Alluvial Aquifer

Well ID	Date	Water Elevation (ft amsl)	Comment
427	9/20/2012	6536.39	
490	11/14/2012	6526.15	
491	11/15/2012	6524.95	
496	10/9/2012	6510.43	
497	11/14/2012	6511.72	
498	11/14/2012	6507.47	
520	11/13/2012	6537.52	
521	10/15/2012	6532.86	
522	10/16/2012	6532.34	
538	11/13/2012	6477.29	
540	11/13/2012	6496.08	
541	11/14/2012	6465.15	
551	11/13/2012	6447.5	
553	11/13/2012	6443.02	
554	11/13/2012	6440.65	
555	11/27/2012	6514.16	
556	11/27/2012	6503.41	
557	11/27/2012	6510.26	
631	11/13/2012	6450.28	
632	11/13/2012	6450.51	
634	11/19/2012	6487.82	
636	10/17/2012	6468.65	
637	10/17/2012	6463.26	
638	11/13/2012	6544.38	
639	10/18/2012	6536.88	
640	11/13/2012	6529.38	
644	11/13/2012	6468.99	
646	10/22/2012	6462.91	
647	11/13/2012	6446.08	
648	5/9/2012	6427.79	Fall 2012 measurement not taken
649	11/13/2012	6440.24	
650	11/15/2012	6463.53	
653	11/13/2012	6474.32	
654	11/19/2012	6478.4	
657	11/13/2012	6450.46	
658	11/13/2012	6441.99	
659	11/19/2012	6489.37	
683	10/19/2012	6465.63	
684	10/19/2012	6467.33	
686	10/17/2012	6465.19	
688	11/15/2012	6502.97	
690	11/13/2012	6546.59	
691	11/13/2012	6546.46	
802	11/19/2012	6474.44	
844	11/27/2012	6520.47	
845	11/27/2012	6522.43	
846	11/15/2012	6503.9	
862	11/13/2012	6499.53	
867	11/13/2012	6494.79	
869	11/13/2012	6471.85	
881	11/19/2012	6491.54	
882	11/1/2012	6496.32	
883	10/23/2012	6496.66	
884	11/1/2012	6493.34	

Table C.1-4. Water Level Data Used to Derive 2012 Potentiometric Surface for Alluvial Aquifer

Well ID	Date	Water Elevation (ft amsl)	Comment
885	11/19/2012	6500.19	
886	11/19/2012	6496.33	
888	11/19/2012	6482.23	
890	11/19/2012	6483.18	
893	11/19/2012	6495.71	
895	10/19/2012	6469.11	
896	10/19/2012	6469.68	
899	10/19/2012	6470.38	
921	10/17/2012	6584.1	
922	10/17/2012	6571.55	
935	10/19/2012	6466.04	
994	10/1/2012	6461.82	
1G	11/14/2012	6547.79	
1K	11/14/2012	6548.93	
1M	11/14/2012	6549.41	
1V	11/26/2012	6548.87	
20(M)	11/14/2012	6508.44	DOE well/result
21(M)	11/15/2012	6465.66	DOE well/result
22(M)	11/15/2012	6469.57	DOE well/result
23(M)	11/15/2012	6468.61	DOE well/result
AW	11/12/2012	6530.73	
B	11/26/2012	6537.1	
B1	11/13/2012	6536.55	
B12	11/15/2012	6537.42	
B13	11/13/2012	6537.28	
BA	11/26/2012	6538.47	
BC	11/15/2012	6540.84	
BP	11/14/2012	6533.87	
C1	11/13/2012	6540.95	
C10	11/30/2012	6530.48	
C11	11/30/2012	6568.64	
C12	11/30/2012	6559.65	
C2	11/13/2012	6539.34	
C5	11/14/2012	6542.15	
C6	11/30/2012	6533.89	
C7	11/30/2012	6537.04	
C8	11/30/2012	6519.89	
C9	11/30/2012	6525.1	
CW44	11/14/2012	6506.23	
DC	11/15/2012	6535.27	
DD	11/26/2012	6542.77	
DD2	11/26/2012	6544.68	
DT	11/26/2012	6539.12	
DZ	11/26/2012	6542.78	
E(M)	11/14/2012	6534.84	DOE well/result
F	11/14/2012	6534.48	
F(M)	11/14/2012	6490.17	DOE well/result
FB	9/17/2012	6533.76	
GA	11/13/2012	6529.95	
GF	11/13/2012	6531.81	
GH	11/13/2012	6530.91	
GV	11/27/2012	6529.18	
I	10/20/2012	6535.37	
K10	11/30/2012	6542.63	

Table C.1-4. Water Level Data Used to Derive 2012 Potentiometric Surface for Alluvial Aquifer

Well ID	Date	Water Elevation (ft amsl)	Comment
K11	11/30/2012	6539.24	
K4	11/30/2012	6533.72	
K5	11/30/2012	6539.73	
K7	11/30/2012	6541.63	
K8	11/30/2012	6540.39	
K9	11/30/2012	6538.32	
KEB	11/30/2012	6548.01	
KF	11/30/2012	6544.23	
KZ	11/26/2012	6543.75	
M11	11/17/2012	6513.35	
M16	10/22/2012	6508.16	
M5	11/13/2012	6537.59	
M6	11/19/2012	6514.91	
M7	11/19/2012	6517.04	
M9	11/15/2012	6509.81	
MA	11/15/2012	6532.42	
MC	11/15/2012	6529.76	
MF	11/15/2012	6526.43	
MH	11/15/2012	6523.67	
MJ	11/15/2012	6518.84	
ML	11/15/2012	6524.66	
MO	10/2/2012	6508.71	
MQ	11/15/2012	6505.60	
MR	11/19/2012	6501.11	
MS	11/19/2012	6511.12	
MT	10/23/2012	6506.87	
MU	11/15/2012	6538.80	
MV	11/19/2012	6505.34	
MW	11/15/2012	6514.81	
MX	11/27/2012	6519.03	
MY	11/27/2012	6518.78	
MZ	11/19/2012	6512.78	
N	11/20/2012	6545.33	
NC	11/19/2012	6543.48	
O	11/20/2012	6546.19	
P	10/1/2012	6543.33	
P2	11/19/2012	6538.60	
P3	11/19/2012	6538.54	
P4	11/19/2012	6539.50	
S	11/13/2012	6541.57	
S11	11/13/2012	6546.35	
S2	11/19/2012	6538.02	
S3	11/13/2012	6537.39	
S4	11/13/2012	6538.91	
S5R	11/19/2012	6533.20	
SE6	11/19/2012	6537.73	
SM	11/19/2012	6540.51	
SN	11/19/2012	6540.31	
SO	11/19/2012	6539.22	
SP	11/19/2012	6539.51	
Sub1	10/5/2012	6527.00	
Sub3	10/5/2012	6528.21	
SW	12/6/2012	6540.94	
SZ	11/13/2012	6545.72	

Table C.1-4. Water Level Data Used to Derive 2012 Potentiometric Surface for Alluvial Aquifer

Well ID	Date	Water Elevation (ft amsl)	Comment
T	12/10/2012	6510.80	
T(M)	5/5/2012	6478.57	DOE well/result
T2	12/10/2012	6548.02	
TA	10/15/2012	6543.92	
TB	10/18/2012	6547.09	
W	11/13/2012	6529.55	
WR12	11/13/2012	6561.19	
X	11/26/2012	6548.41	
X(M)	11/15/2012	6467.17	DOE well/result
Y2(M)	11/14/2012	6496.79	DOE well/result

Note:
Source: HMC 2013 (annual report for 2012) combined with 2012 water level measurements at Bluewater site alluvial wells. These data are plotted in the figure presenting the Fall 2012 potentiometric surface in the Site Status Report.

Table C.1-5. Water Level Data for Bluewater Site San Andres Aquifer Wells: Fall/Winter 1980 (Source: Hydro-Search 1981)

Well ID	Hydro-Search 1981 Map No.	Water Elevation (ft amsl)	Well Depth (ft)	Easting	Northing
Anaconda #1	21	6457.5	356	465476.78	1547734.58
Anaconda #2	22	6457.9	386	465513.60	1548353.14
Anaconda #3	25	6456.7	200	465276.18	1544848.79
Anaconda #4	26	6456.8	210	466181.82	1543967.85
Bluewater Muni.	23	6491.1		457386.61	1545486.08
C(SG)	17	6458.1	423	466480.31	1551114.60
Card Gas	S-3	6455.9	551	483605.02	1540548.97
Cottonwood Well	S-36	6456.9	253	473098.36	1539641.71
D(SG)	18	6467.8	259	468344.23	1552571.51
Dalton	30	6456.4		466478.21	1541201.52
Dan's Feed Store	S-39	6456.2	164	469880.36	1539803.72
G(SG)	19	6466.8	278	468833.93	1552562.36
Gallup Stake Irrigation Sec 4A	S-6	6456.1	315	481170.74	1534517.07
Gallup Stake Irrigation Sec 5	S-10	6456.3	225	476695.52	1534582.09
Gallup Stake Irrigation Sec. 4B	S-14	6452	480	482359.90	1529411.69
Hanosh	S-49	6445.8	250(?)	484713.42	1505803.90
Hardenburg Commissary	31	6456.9	238	468805.24	1541210.21
Harding	S-43	6456.9	245	472052.69	1542624.07
I(SG)	I(SG)	6456.3	330	477984.38	1552334.88
Keel	S-54	6445.9	165	486549.36	1506845.56
L(SG)	L(SG)	6481.7	610	462856.43	1553977.39
M(SG)	M(SG)	6471.4	575	465741.77	1559495.77
Mexican Camp	27	6457.8	280	468618.83	1545136.95
Monitor	15	6460.4	628	473819.29	1557094.45
North Well	14	6466.1	250	469523.70	1558775.19
OBS-2	OBS-2	6467.5	319	468797.32	1551656.17
OBS-3	OBS-3	6467.1	355	468865.97	1554081.82
Roundy Sec. 23	S-1	6453.7	865	491741.69	1548221.65
S(SG)	S(SG)	6467.9	337	468820.20	1552987.99
Sabre-Piñon (now HMC-951)	28	6456.7	275	473179.36	1545356.06
Spencer	13	6515.7	378	454133.39	1556147.67
Thornton	S-50	6456.2	195	475493.48	1532564.98
UNC Sec. 17	S-24	6453.5	125	478150.92	1523772.65
UNC Sec. 8A	S-11	6455	165	477946.95	1529279.96
UNC Sec. 8B	S-12	6456	150	473150.92	1528902.85
UNC Sec. 8C	S-13	6455.2	150	475616.98	1529312.89
W(SG)	W(SG)	6456.9	355	472847.99	1549280.99

Source:

Hydro-Search (HSI), 1981. *Regional Ground-Water Hydrology and Water Chemistry, Grants- Bluewater area, Valencia County, New Mexico*, prepared for Anaconda Copper Company, June 30.

Note:

Water elevation data for the Fall/Winter 1980 time-frame obtained from Plate V (Hydraulic Potential, San Andres-Glorieta) of HSI's report. Coordinates listed above were georeferenced from Plate V. These results were used to derive the potentiometric surface provided in Figure 23 in the Site Status Report.

Table C.1-6. Water Level Data for Bluewater Site Alluvial Aquifer Wells: Fall/Winter 1980 (Source: Hydro-Search 1981)

Well ID	Hydro-Search 1981 Map ID	Water Elevation (ft amsl)	Note
B(M)	5	6518.7	
BC	BC	6520.2	
Berryhill House (now B00168)	1	6520.3	
C(M)	6	6505.7	
Card Abandoned	11	6466.7	
Cibola Sands	S-56	6445.3	
D	D	6520.3	
E(M)	8	6543.2	
Engineer's Well	2	6520.4	
Evans Abandoned	S-25	6461.6	
F(M)	9	6490.9	
Gallup Stake Abandoned	S-9	6455.0	
Gallup Stake Domestic	S-27	6455.1	
Gallup Stake Irr. Sec. 4B	S-14	6452.0	**
Holmes	S-41A/41A	6463.7	
K(M)	K(M)	6553.5	Could be J(M), not clear from HSI maps
P	P	6538.4	
Pittard	S-46	6509.7	
Q	Q	6545.6	
R	R	6556.2	
Roundy Sec. 14	S-47	6564.0	
Roundy-Up	4	6527.0	
T(M)	T(M)	6485.5	
U(M)	U(M)	6478.2	
United Nuclear Sec. 17	S-24	6453.5	**
United Nuclear Sec. 8A	S-11	6455.0	**
United Nuclear Sec. 8B	S-12	6456.0	**
United Nuclear Sec. 8C	S-13	6455.2	**
X(M)	X(M)	6474.6	

Source:

Hydro-Search (HSI), 1981. *Regional Ground-Water Hydrology and Water Chemistry, Grants- Bluewater area, Valencia County, New Mexico*, prepared for Anaconda Copper Company, June 30.

Note:

Water elevation data for the Fall/Winter 1980 time-frame obtained from Plate VII (Hydraulic Potential, Alluvium Aquifer) of HSI's report. These results were used to derive the potentiometric surface provided in Figure 20 in the Site Status Report.

** Denotes location identified as San Andres well in HSI's report.
The reason data from these wells were used to derive the potentiometric surface for the alluvial aquifer may be explained as follows (Indented language below quoted from page 19 of HSI's 1981 report):

> *In the Milan-Grants area, the San Andres-Glorieta and Alluvium aquifers are interconnected and at the same hydraulic potential. Hydraulic head information and water chemistry data indicate that the San Andres-Glorieta loses a substantial volume of water to the alluvium in this area.*

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
11(SG)	11/14/2012	0.0239	<1.5	0.454	<1.7	461	193	<0.017	<0.08	2590	6.93	544	<0.725		182	66.9	235	11.4	0.51	-134
11(SG)	1/30/2013	0.011	<1.5	0.292	16.3	405	187	<0.017	<0.08	2093	7.03	493	<0.725		161	61.9	251	10.4	0.92	-108.5
11(SG)	5/14/2013	0.00739	<1.5	0.204	22.7	371	177	<0.017	<0.08	2227	6.91	598	<0.725		187	69.3	271	10.8	1.44	-84.2
11(SG)	11/19/2013	0.0117	<1.5	1.88	10.3	744	192	<0.017	<0.08	2634	6.93			568	172	60.8	326	10	1.13	-148.3
13(SG)	11/15/2012	0.116	6.39	1.35	3.11	424	86.5	4.4	19.5	1419	6.86	301	<0.725		168	51	109	6.2	2.24	114.4
13(SG)	1/28/2013	0.106	5.45	1.36	2.8	413	84.9	4.25	18.8	1450	6.99	301	<0.725		149	45.1	101	5.55	2.67	156.2
13(SG)	5/15/2013	0.123	6.79	1.33	3.11	405	81.9	4.45	19.7	1519	6.78	296	<0.725		177	52.7	113	6.3	2.24	115.1
13(SG)	11/19/2013	0.0985	4.96	1.98	<1.7	407	87.7	5.18	22.9	1529	7.04			267	151	43.9	97.7	5.82	3.08	-50.7
14(SG)	11/14/2012	0.0437	<1.5	3	73.4	346	162	<0.017	<0.08	2267	7.08	541	<0.725		118	45	277	5.08	0.78	-130.7
14(SG)	1/30/2013	0.0324	<1.5	2.6	86.6	262	165	<0.017	<0.08	1810	7.18	592	<0.725		103	40.8	296	4.57	2.84	-102.7
14(SG)	5/14/2013	0.0308	<1.5	2.31	54	229	146	<0.017	<0.08	1890	6.98	554	<0.725		104	42.4	294	4.49	0.51	-74.3
14(SG)	11/19/2013	0.0741	<1.5	3.3	6.25	465	153	0.0238	0.11	1947	7.07			451	122	47.3	222	4.82	0.85	-18.3
15(SG)	11/13/2012	0.0743	<1.5	7.1	22.6	339	164	<0.017	<0.08	2085	7.26	421	<0.725		83.7	29	280	5.46	0.62	-123
15(SG)	1/29/2013	0.0553	<1.5	4.76	17.9	307	167	<0.017	<0.08	1695	7.33	429	<0.725		78.9	27.9	295	5.34	0.87	-116
15(SG)	5/14/2013	0.0449	<1.5	3.78	14.6	265	151	<0.017	<0.08	1782	7.12	438	<0.725		80.1	27.9	293	5.36	0.35	-77.6
15(SG)	11/19/2013	0.174	2.27	9.95	2.59	436	185	3.78	16.7	1954	7.29			322	100	34.8	232	5.91	0.96	4.3
16(SG)	11/13/2012	1.43	19.6	2.81	<1.7	1200	455	4.32	19.1	4553	6.58	424	<0.725		301	150	369	12.5	0.84	41.4
16(SG)	1/30/2013	1.38	16	2.57	<1.7	1200	453	4.37	19.4	3769	6.69	431	<0.725		290	145	397	11.6	0.83	23.4
16(SG)	5/16/2013	1.45	18.1	2.4	<1.7	1220	461	4.58	20.3	3967	6.53	416	<0.725		337	170	433	13.1	0.97	164.8
16(SG)	11/19/2013	1.4	14.7	2.88	<1.7	1270	479	4.83	21.4	3970	6.77			378	286	138	358	11.4	1.73	86.9
18(SG)	11/14/2012	0.207	5.1	2.54	<1.7	465	100	3.31	14.7	1904	6.82	332	<0.725		161	51.1	123	6.95	0.99	25.9
18(SG)	1/30/2013	0.212	4.6	2.22	<1.7	445	100	3.11	13.8	1610	6.94	331	<0.725		171	54.9	138	7.39	2.02	15.7
18(SG)	5/14/2013	0.232	5.91	2.02	<1.7	451	96.1	3.39	15.0	1700	6.73	326	<0.725		191	59.4	141	8.09	0.57	99.4
18(SG)	11/19/2013	0.127	1.77	3.93	<1.7	469	101	1.07	4.7	1665	6.97			346	143	40.6	144	6.54	0.81	-4.9
Anaconda #2	1/18/1977	0.5	11	<50	<10															
Anaconda #3	1/18/1977	<0.03	4.0	<50	<10															
Anaconda #3	4/12/1990	0.0277	<5	<5		350	67	3.59	15.9	1200	6.86				150	42	79	6.4		
Anaconda #4	4/26/1984	0.004				217	53.7	2.3	10	850	7.27				120	39.7	55	6.1		
Anaconda #4	4/22/1986	0.0168	<10			302	46	4.3	19	1200	7.1				158	45	60	6		
Anaconda #4	10/6/1986	0.00873				265	36	2.9	13	1050	7.25									
Anaconda #4	4/13/1987	0.0104	<5			290	44	5	22	1100	6.99				140	41	61	4		
Anaconda #4	10/8/1987	0.00597				249	31	3.6	16	1025	7.35									
Anaconda #4	4/13/1988	0.00611	<5			300	41	4.1	18	1100	7.32				140	39	71	5.8		
Anaconda #4	10/11/1988	0.0114				275	38	4.3	19	1050	7.39									
Anaconda #4	4/19/1989	0.00917	<5	<5		310	44	3.79	16.8	1100	7.22				150	42	62	5.2		
Anaconda #5	5/17/1984	0.064				471	129	4.3	19	1300	7.1				191	58	140	7.8		
Anaconda #5	4/22/1986	0.0528	<10			358	90	4.3	19	1400	7.2				168	55	93	10		
Anaconda #5	10/6/1986	0.0924				486	151	4.7	21	1900	6.85									
Anaconda #5	11/19/1986					507	162	3.6	16	2000	6.92									
Anaconda #5	4/6/1987	0.0566	<5			400	100	4.7	21	1550	6.86				160	50	110	1		
Anaconda #5	10/8/1987	0.112				486	172	5.4	24	1800	6.85									
Anaconda #5	4/5/1988	0.125	<5			569	186	6.8	30	2050	6.96				200	59	180	7.7		
Anaconda #5	10/5/1988	0.16				580	178	7.2	32	2050	7.51									
Anaconda #5	4/18/1989	0.175	<5	<5		520	200	5.5	24.3	2000	7.15				170	62	230	11		
Anaconda #5	4/12/1990	0.0815	<5	<5		460	190	4.8	21.2	1925	6.86				190	56	160	8.8		

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
B00003	8/13/2013	0.087	6.3	1.59	3.32	489	101	2.5	10.9	1700	6.86	352	<0.725		179	54.2	139	8.37	5.2	-16
B00050A	10/1/2013	0.0114	11.8	0.936	<1.7	417	49.8	3.9	17.1	1365	7	244	<0.725		189	54.2	62.7	4.37	5.22	165
B00518	8/14/2013	0.00666	4.69	1.02	<1.7	295	31.1	4.6	20.3	1150	6.9	304	<0.725		159	41.9	46.4	3.29	6.39	190
B01614	10/2/2013	0.00403	3.63	1.74	<1.7	196	19.3	4.5	20.1	815	7.09	216	<0.725		89.2	37.9	41.6	2.8	4.4	160
Berryhill Sec5	5/9/1984	0.001				706	242	0.6	2.5	2320	7.06				211	76	367	15.1		
Berryhill Sec5	4/22/1986	0.0108	<10			670	255	<0.2	<1	2800	6.8				250	94	386	23		
Berryhill Sec5	11/19/1986	0.0099				804	249	0.2	1.0	2800										
Berryhill Sec5	4/10/1987	0.0115	<5			690	198	0.2	1.0	2900	6.8				230	76	350	14		
Berryhill Sec5	10/8/1987	0.0131				650	192	<0.2	<1	2900	7.01									
Berryhill Sec5	4/4/1988	0.00393	<5			666	236	0.2	1.0	2800	7.15				200	62	350	14		
Berryhill Sec5	10/11/1988	0.00611				660	220	<0.2	<1	2800	7.05									
Bowlin	5/9/1984	0.01				492	96	2.3	10	1300	7.09				184	51.9	137	9.5		
Bowlin	4/24/1986	0.0113	<10			445	89	2.0	7.0	1600	6.9				172	55	147	10		
Bowlin	11/19/1986	0.0115				442	87	2.0	7.0	1600	7									
Bowlin	4/13/1987	0.0179	<5			570	146	2.0	7.0	2000	6.89				210	72	190	5		
Bowlin	10/12/1987	0.00815				555	141	0.9	4.0	2200	6.89									
Bowlin	4/11/1988	0.00932	<5			574	158	2.0	8.0	2000	6.94				190	58	190	5		
Bowlin	10/11/1988	0.0134				610	151	1.0	6.0	1900	6.98									
C(SG)	3/4/1977	2.5	11	<50	<10															
C(SG)	4/16/1984	0.896	<5			927	345	6.48	28.7	2610	6.98				263	137	272	9.8		
C(SG)	5/5/1986	0.8496	<10			1054	352	4.5	20	3100	6.7				262	140	268	12		
C(SG)	4/9/1987	1.37	9			1020	380	6.1	27	3025	6.82				300	140	300	9		
C(SG)	4/13/1988	0.932	<5			841	256	5	22	2800	6.87				240	110	250	7.8		
C(SG)	4/18/1989	1.24	8	<5		830	280	5.6	24.8	2600	6.94				240	120	270	9		
C(SG)	4/11/1990	0.291	6	5.0		580	290	15	66.3	3100	6.71				160	43	350	6.9		
C(SG)	4/16/1990	1.19	8	9.0		820	290	4.09	18.1	2650	6.7				240	110	270	9		
C(SG)	10/22/1996	0.919	<5	8.0		734	181	3.5	15.5		6.96									
D(SG)	3/13/1977	2.4	23	<50	<10															
G(SG)	10/16/1996	1.81	<5	15.0		1180	511	4.5	19.9		7.0									
HMC-951	4/26/1984	0.014				426	87.4	4	17.7	1060	7.58				150	47.6	91	7.1		
HMC-951	6/20/1986	0.0097	<10			357	66	3.8	17	1250	7.2				161	47	79	7		
HMC-951	4/9/1987	0.00376	<5			287	62	0.2	1	1100	7.73				110	47	81	7		
HMC-951	4/13/1988	0.0083	<5			342	56	0.1	0.5	1210	7.24				140	41	76	4.9		
HMC-951	4/19/1989	0.0132	<5	<5		360	59	5.99	26.5	1150	7.22				160	47	78	5.6		
HMC-951	4/12/1990	0.0204	<5	<5		280	74	4.99	22.1	1125	6.86				140	42	78	6.1		
HMC-951	04/15/1993	0.018																		
HMC-951	10/05/1993	0.022																		
HMC-951	04/05/1994	0.022																		
HMC-951	08/31/1995	0.019																		
HMC-951	03/07/1996	0.017																		
HMC-951	10/22/1996	0.005																		
HMC-951	10/23/1996	0.023	<5	5.0		311	48	4.5	19.9		7.015									
HMC-951	08/21/1997	0.024																		
HMC-951	12/17/1997	0.024																		
HMC-951	8/18/1998	0.025	< 5.0	<30		323	50.3			1478	7.85	342	<1.0		148	43.2	76.5	5.6		

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
HMC-951	8/19/1999	0.025	3.0			333														
HMC-951	9/17/1999	0.026	5.0			313				1185										
HMC-951	10/19/1999	0.025	< 5.0			335				1221										
HMC-951	11/2/1999	0.023	3.0			335				1222										
HMC-951	12/10/1999	0.020	6.0			350				1200										
HMC-951	1/20/2000	0.032	< 5.0	<30		333				1240										
HMC-951	8/9/2000	0.003	< 5.0			270				1226										
HMC-951	10/17/2002	0.028	< 5.0			314				1623										
HMC-951	10/27/2003	0.031	< 5.0			342				1305										
HMC-951	12/8/2004	0.027	8.0			334				1288										
HMC-951	4/25/2005	0.028	< 50	<30		358	68.0			1318	7.78	331	<1.0		145	43.1	80.5	4.90		
HMC-951	12/5/2005	0.033	5.0			316				1350										
HMC-951	3/16/2006	0.037	6.0	<30		356	83.0			1459	7.91	342	<1.0		145	43.4	79.9	5.60		
HMC-951	3/9/2007	0.032	< 5.0	<30		360	62.0			1318	7.79	354	<1.0		154	47.2	83.6	5.30		
HMC-951	12/3/2007	0.041	6.0			325				1346										
HMC-951	3/5/2008	0.040	6.0	<30		349	62.0			1348	7.49	352	<1.0		147	43.5	86.0	5.50		
HMC-951	8/27/2008	0.047	5.0	<30		382	74.0			1421	7.66	339	<1.0		170	50.0	98.0	5.70		
HMC-951	12/1/2008	0.042	6.0			348				1401										
HMC-951	3/20/2009	0.038	5.0	<30		356	64				7.44	347	<1.0		152	44.6	88.8	5.3		
HMC-951	3/24/2009	0.037	5.0	<30		349	63				7.35	348	<1.0		168	46.9	80.6	5.4		
HMC-951	3/31/2009		6.3			353	57				7.3	274	<10		162	42.3	71.2	4.59		
HMC-951	12/7/2009	0.037	6.0	<100		356														
HMC-951	3/3/2010	0.033	7.0	<30		341	61.0			1366	7.39	375	<5.0		148	43.6	81.3	5.10		
HMC-951	6/22/2010	0.045	6.0	<30		37.2	72.0			1429	7.47	372	<5.0		152	44.9	90.3	5.60		
HMC-951	6/24/2010	0.048	7.0	<30		391	100.0			907										
HMC-951	12/6/2010	0.034	<5			359				1005										
HMC-951	4/13/2011	0.033	7.0	<30		356	59.0			1340	7.48	360	<5.0		153	44.0	85.0	5.50		
HMC-951	7/6/2011	0.041	5.0	<30		363	64.0			1379										
HMC-951	10/12/2011	0.037	5.0	<30		360	63.0			1366										
HMC-951	3/9/2012	0.035	6.0	<30		348	61.0			1400	7.47	346	<5.0		146	43.3	87.4	5.40		
HMC-951	11/20/2013	0.0313	<7.5	1.42	<8.5	369	59.4	5.04	22.3272	1215	7				129	37	70.3	4.67	3.75	-25
I(SG) - 210 ft	11/19/2013	0.346	7.7	1.66	<8.5	887	293	1.46	6.47	2705	6.71			404	228	84.1	262	11.8	1.06	50
I(SG) - 234.91 ft	5/15/2013	0.00545	<1.5	0.7	<1.7	176	176	<0.017	<0.08	1204	7.97	136	<0.725		30.5	20.6	195	6.45	0.44	-16.7
I(SG) - 240 ft	11/19/2013	0.149	<7.5	0.898	<8.5	601	238	0.43	1.91	2070	6.9			804	138	56.1	227	9.25	1.18	-35
I(SG) - 261.91 ft	5/15/2013	0.35	9.49	1.28	<1.7	849	272	1.42	6.29	2876	6.54	405	<0.725		288	109	320	13.8	3.44	60.7
I(SG) - 265 ft	11/19/2013	0.334	8.39	1.42	<8.5	948	306	1.53	6.78	2745	6.71			414	231	84.7	262	11.5	1.35	95
I(SG) - 298.91 ft	5/15/2013	0.334	8.82	1.08	<1.7	846	272	1.45	6.42	2929	6.61	404	<0.725		283	106	311	13.9	1.1	11.3
I(SG) - 300 ft	11/19/2013	0.324	8.65	1.53	<8.5	902	288	1.45	6.42	2735	6.71			380	224	82.6	249	10.9	1.46	155
I(SG)	3/12/1984					1155	530	2.44	10.8	2400	6.81									
I(SG)	5/23/1984	0.444				1218	525	5.44	24.1	3300	6.81				350	134	439	16		
I(SG)	4/17/1986	0.4291	<10			1123	456	5	22	3650	6.7				340	148	430	23		
I(SG)	7/7/1986	0.349				1120	442	4.7	21	3600	6.77									
I(SG)	10/6/1986	0.431				1109	438	4.5	20	3750	6.73									
I(SG)	2/3/1987	0.405				1089	426	3.6	16	3650	6.78									
I(SG)	4/8/1987	0.443	12			1070	516	5.9	26	3700	6.81				330	130	380	13		

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Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
I(SG)	7/7/1987	0.48				1090	426	5.4	24	4000	6.87									
I(SG)	10/7/1987	0.48				976	430	4.7	21	3800	6.73									
I(SG)	1/11/1988	0.451				1080	430	5	22	3600	6.8									
I(SG)	4/6/1988	0.422	<5			974	399	6.1	27	3550	6.86				290	100	360	12		
I(SG)	7/11/1988	0.437				1010	450	4.3	19	3450	6.98									
I(SG)	10/10/1988	0.451				1005	412	5.2	23	3550	6.85									
I(SG)	1/18/1989	0.655				1100	420	4.3	19	3400	6.98									
I(SG)	4/18/1989	0.597	<5	<5		1100	500	4.99	22.1	3200	6.87				340	120	460	17		
I(SG)	4/11/1990	0.422	8.0	6		760	450	6.1	27	3300	6.55				300	110	340	12		
I(SG)	7/2/1996	0.425	10.0	<5		950	342	3.3	14.6		7.03									
I(SG)	11/4/2008	0.0014	<0.11		0.58			<0.05	<0.2	947	9.37									-125
I(SG)	11/10/2009	0.0013	<0.038	<1.3	0.11	87	210	<0.05	<0.2	894	8.74		16		9.2	6.5	140	4.5		74.4
I(SG)	11/11/2010	0.0027	<1.0	0.777	2.24	124	179	<0.05	<0.2	1236	8.45	102	20.2		17.3	12.4	184	5.6	4.86	-139.7
I(SG)	7/27/2011	0.0011	<0.032	0.81	0.35	79	190	<0.01	<0.04	960	8.96		<10		11	8.9	150	6.1		-130
I(SG)	11/16/2011	0.00636	<1.5	0.663	<1.7	200	190	<0.01	<0.04	1267	8.02	161	<0.725		35.4	21.6	209	7.1	0.3	-243.2
I(SG)	5/15/2012	0.0	<0.1	0.78		230	170	<0.01	<0.04	1435	7.87		<20		39	28	180	9.7	0.38	-221.8
I(SG)	5/15/2012							<0.01	<0.04											
I(SG)	11/14/2012	0.00276	<1.5	0.532	<1.7	215	195	<0.017	<0.08	1454	8.14	140	<0.725		24.4	24.4	194	6.98	0.27	-227.4
I(SG)	1/29/2013	0.00202	<1.5	0.58	<1.7	199	195	<0.017	<0.08	1176	8.31	134	<1.05		18.9	20.6	197	6.29	0.45	-241.4
L(SG) - 438.72 ft	5/15/2013	0.003	<1.5	0.419	<1.7	580	192	<0.017	<0.08	2579	6.61	565	<0.725		153	82.3	378	8.57	0.38	-72.7
L(SG) - 508.72 ft	5/16/2013	0.00301	<1.5	0.57	<1.7	585	188	<0.017	<0.08	2531	6.61	565	<0.725		142	78.2	361	8.37	0.78	-9.5
L(SG) - 578.72 ft	5/16/2013	0.00301	<1.5	0.443	<1.7	571	186	<0.017	<0.08	2560	6.6	572	<0.725		153	78.8	362	8.7	0.6	-3.7
L(SG)	2/9/1984					622	238	0.34	1.5	2200	6.99									
L(SG)	6/7/1984	0.005	<5			624	277	0.41	1.8	2230	7.28				183	82	380	10.9		
L(SG)	4/15/1986	0.0053	<10			603	218	<0.2	<1	2590	6.9				156	90	366	14		
L(SG)	7/7/1986	0.00466				609	218	<0.2	<1	2450	7.06									
L(SG)	10/13/1986	0.00611				650	218	<0.2	<1	2700	6.88									
L(SG)	2/3/1987	0.00584				602	200	<0.2	<1	2650	6.88									
L(SG)	4/6/1987	0.00771	<5			560	192	<0.2	<1	2650	6.78				120	82	400	4		
L(SG)	8/31/1987	0.00408				603	223	<0.2	<1	2700	6.96									
L(SG)	10/5/1987	0.00291				645	206	<0.2	<1	2800	6.85									
L(SG)	1/11/1988	0.00291				596	202	<0.2	<1	2650	6.92									
L(SG)	4/5/1988	0.00422	<5			627	171	0.2	1.0	2590	6.9				130	70	380	8		
L(SG)	6/14/1988	0.003	<5								6.97									
L(SG)	7/11/1988	0.0114				629	180	<0.2	<1	2500	6.9									
L(SG)	9/8/1988	0.0047	<5	<5	<5						6.96									
L(SG)	10/10/1988	0.00771				605	189	0.9	4	2620	6.81									
L(SG)	12/6/1988	0.004	<5	<5	<5						6.96									
L(SG)	12/8/1988	0.004	<5								6.96									
L(SG)	1/18/1989	0.00757				610	210	<0.2	<1	2450	7.07									
L(SG)	3/7/1989	0.004	<5								7.2									
L(SG)	4/10/1989	0.00233	<5	<5		580	220	0.05	0.2	2450	7.05				140	70	380	7.9		
L(SG)	6/15/1989	0.003	<5								6.88									
L(SG)	9/20/1989	0.002	<5								6.77									
L(SG)	12/18/1989	0.003	<5								6.6									

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
L(SG)	3/13/1990	0.003	<5								6.62									
L(SG)	4/10/1990	0.002	<5	<5		610	230	0.07	0.3	2600	6.73				130	64	430	9.1		
L(SG)	7/11/1990	0.003	<5								6.78									
L(SG)	9/18/1990	0.003	<5								6.75									
L(SG)	10/2/1990	0.002	<5								6.67									
L(SG)	12/18/1990	0.002	<5								6.79									
L(SG)	1/9/1991	0.002	<5								6.68									
L(SG)	4/3/1991	0.003	<5								6.56									
L(SG)	7/10/1991	0.002	<5								7.01									
L(SG)	10/2/1991	0.005	<5								6.96									
L(SG)	1/15/1992	0.001	<5								7.01									
L(SG)	4/8/1992	0.003	<5								6.85									
L(SG)	7/21/1992	0.003	<5								6.87									
L(SG)	10/8/1992	0.002	<5								6.86									
L(SG)	1/12/1993	0.003	<5								6.72									
L(SG)	4/5/1993	0.003	<5								6.84									
L(SG)	7/7/1993	0.004	<5								6.83									
L(SG)	10/5/1993	0.002	<5								6.9									
L(SG)	1/5/1994	0.003	<5								6.81									
L(SG)	4/5/1994	0.003	<5								6.84									
L(SG)	7/7/1994	0.002	<5								6.81									
L(SG)	10/13/1994	0.003	<5								6.72									
L(SG)	1/16/1995	0.002	<5								6.73									
L(SG)	4/10/1995	0.004	<5								6.7									
L(SG)	7/18/1995	0.002	<5								6.99									
L(SG)	10/18/1995	0.004	2.0								6.73									
L(SG)	1/15/1996	0.003	<1								6.78									
L(SG)	4/3/1996	0.001	<1								6.76									
L(SG)	10/9/1996	0.001	<5	<5		598	216	<0.10	<0.4		7.08									
L(SG)	11/16/1998	0.0024	<2							1774	7.02									
L(SG)	11/3/2001	0.004	<1							2090	6.98									
L(SG)	11/18/2004	<0.000075	0.32							1514	10.27									-277
L(SG)	11/6/2007	<0.00004	<0.028							1467	10.42									-139.3
L(SG)	11/4/2008	<0.00003	<0.081					0.01	0.04	1450	10.3									-215.5
L(SG)	11/10/2009	<0.00003	<0.027	16.0	0.045	3.7	220	<0.02	<0.09	1317	9.42		**280**		0.7	1.4	240	5.7		75.3
L(SG)	11/11/2010	<0.00005	<1	17.6	2.24	1.7	188	<0.05	<0.2	1654	10.13	15.7	**242**		0.876	1.39	314	5.35	0.39	-211.2
L(SG)	7/27/2011	0.0032	<0.032	0.43	0.13	600	210	<0.01	<0.04	2540	6.71		<20		150	77	310	13		-5
L(SG)	11/17/2011	0.00511	<1.5	0.338	<1.7	548	199	<0.01	<0.04	2585	6.69	540	<0.725		157	76.2	333	11	4.14	50.9
L(SG)	5/15/2012	0.0	<0.095	0.41	0.24	560	180	0.025	0.11	2547	6.9		<20		160	72	260	14	3.42	-61.9
L(SG)	5/15/2012							0.025	0.11											
L(SG)	11/14/2012	0.00316	<1.5	0.464	<1.7	613	197	<0.017	<0.08	2913	6.7	563	<0.725		145	77.8	345	8.14	0.97	-77.6
L(SG)	1/30/2013	0.00341	<1.5	0.458	<1.7	581	190	<0.017	<0.08	2413	6.78	565	<0.725		139	76.6	360	7.87	1.21	-96.9
L(SG)	11/19/2013	0.00294	<7.5	0.657	<8.5	630	203	<0.017	<0.08	2531	6.76			557	129	67.1	320	7.53	0.98	-63.5
M(SG)	6/7/1984	0.01	<5			533	117	0.97	4.3	1500	7.39				205	52	159	18.7		
M(SG)	4/15/1986	0.0114	<10			464	98	0.9	4	1700	7				192	55	143	14		

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
M(SG)	10/13/1986	0.0121				516	95	0.7	3	1750	6.98									
M(SG)	4/8/1987	0.0138	<5			380	90	0.9	4	1700	7.1				180	50	130	9		
M(SG)	10/8/1987	0.00655				430	95	0.9	4	1720	7.04									
M(SG)	4/13/1988	0.00568	<5			435	90	0.79	3.5	1650	7.07				180	45	120	9.2		
M(SG)	10/11/1988	0.0146				425	93	0.9	4	1650	7.08									
M(SG)	4/19/1989	0.00655	<5	<5		470	93	0.79	3.5	1600	7.07				190	50	120	9.4		
M(SG)	4/11/1990	0.00713	<5	<5		400	95	0.77	3.4	1550	6.86				170	47	140	11		
M(SG)	10/16/1996	0.008	5.0	<5		422	78	1.0	4.4											
Mexican Camp	1/14/1977		8.0	<50	<10															
Mexican Camp	4/26/1984	0.006				119	17.3	0.32	1.4	490	7.54				81	24.4	37.1	4		
Mexican Camp	4/22/1986	0.0067	<10			181	12	<0.2	<1	750	7.3				78	34	44	4		
Mexican Camp	4/9/1987	0.00563	<5			149	12	<0.2	<1	725	7.26				84	29	46	3		
Mexican Camp	4/7/1988	0.00786	<5			149	13	0.41	1.8	700	7.32				77	26	46	0.06		
Mexican Camp	10/17/1996	0.009	<5	<5		145	19.2	0.9	4.0		6.8									
Monitor	1/14/1977		13	<50	<10															
Monitor	5/16/1984	0.239	<5			971	355	0.79	3.5	2560	6.9				290	105	342	15.5		
Monitor	4/17/1986	0.2643	<10			950	325	0.2	1	3100	6.7				296	122	342	22		
Monitor	10/6/1986	0.284				907	315	0.2	1	3150	6.73									
Monitor	4/13/1987	0.231	<5			790	340	0.7	3	3000	6.69				260	98	310	13		
Monitor	10/12/1987	0.306				796	308	<0.2	<1	3100	6.82									
Monitor	4/5/1988	0.291	<5			840	295	0.9	4	3000	6.88				270	87	290	11		
Monitor	10/10/1988	0.32				865	330	0.7	3	3000	6.89									
Monitor	4/11/1989	0.349	6	<5		920	320	1.1	4.9						280	99	350	16		
Monitor	4/11/1990	0.32	<5	<5		920	330	0.41	1.8	2900	7.09				270	88	350	13		
North	1/14/1977		19	<50	<10															
North	5/15/1984	0.012	<5			499	196	2.1	9.3	1600	6.92				107	61	238	12.4		
North	4/17/1986	0.0155	<10			554	182	<0.2	<1	2000	7				125	75	228	16		
North	10/6/1986	0.021				593	183	0.2	1	2150	6.99									
North	4/8/1987	0.0179	<5			550	164	0.2	1	2050	7.03				120	72	230	11		
North	10/8/1987	0.0083				497	177	0.2	1	2050	7.24									
North	4/13/1988	0.00844	<5			530	171	0.1	0.5	1900	7.13				92	63	220	13		
North	10/10/1988	0.032				525	168	0.2	1	1900	7.15									
North	4/18/1989	0.032	8.0	<5		630	200	0.47	2.1	2000	7.03				190	81	260	14		
North	4/11/1990	0.0105	<5	7		470	200	0.1	0.6	1800	6.92				96	58	250	11		
North	10/16/1996	0.021	9.0	<5		530	178	0.2	0.89		7.07									
OBS-2	4/19/1989	1.75	<5	17		1100	510	9.98	44.2	3500	6.87				280	150	420	10		
OBS-2	4/10/1990	1.34	14.0	33.0		950	400	9.98	44.2	3300	6.71				240	120	420	11		
OBS-2	10/17/1996	1.02	33.0	12.0		672	245	7.1	31.5		6.61									
OBS-3	5/7/1984	0.807				1722	910	5.83	25.8	4260	6.92				406	215	629	16.8		
OBS-3	4/17/1986	0.5362	<10			1676	829	4.5	20	5100	6.9				380	230	620	22		
OBS-3	10/13/1986	0.611				1677	772	4.1	18	5200	6.94									
OBS-3	4/6/1987	0.378	<5			1570	921	2.7	12	5300	6.92				310	210	640	14		
OBS-3	10/7/1987	0.262				1670	934	2.0	8.0	5700	7.03									
OBS-3	4/5/1988	0.859	<10			1490	750	3.4	15	5000	6.98				300	190	580	16		
OBS-3	6/14/1988	0.51	<8								7.11									

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
OBS-3	9/8/1988	0.42	10	<5	<5						6.95									
OBS-3	10/11/1988	1.27				1610	810	4.7	21	5050	6.88									
OBS-3	12/6/1988	0.92	10	<5	<5						6.94									
OBS-3	12/8/1988	0.92	10								6.94									
OBS-3	3/7/1989	1	11								6.88									
OBS-3	4/11/1989	1.34	11	<5		1700	720	6.98	30.9	4750	6.91				600	190	430	10		
OBS-3	6/15/1989	0.94	11								6.67									
OBS-3	9/21/1989	1.24	20								6.64									
OBS-3	12/19/1989	1.77	10								6.44									
OBS-3	3/14/1990	1.64	14								6.54									
OBS-3	4/10/1990	1.43	13	<5		1600	670	6.39	28.3	4400	6.76				420	180	550	15		
OBS-3	5/24/1990	1.23	8								6.66									
OBS-3	7/12/1990	1.62	8								6.67									
OBS-3	9/18/1990	1.26	11								6.77									
OBS-3	10/2/1990	1.77	10								6.66									
OBS-3	12/18/1990	1.43	<5								6.6									
OBS-3	1/10/1991	1.26	11								6.68									
OBS-3	4/2/1991	1.45	16								6.67									
OBS-3	7/9/1991	1.5	<10								6.91									
OBS-3	10/2/1991	1.4	6								6.69									
OBS-3	1/20/1992	1.38	<5								6.8									
OBS-3	4/7/1992	1.2	7								6.85									
OBS-3	7/20/1992	1.23	7								6.87									
OBS-3	10/19/1992	1.29	10								6.77									
OBS-3	2/12/1993	1.23	5								6.68									
OBS-3	4/12/1993	1.29	16								6.84									
OBS-3	7/7/1993	1.03	14								6.85									
OBS-3	10/13/1993	1.17	10								6.78									
OBS-3	1/5/1994	1.23	<5								6.78									
OBS-3	4/12/1994	1.29	16								6.84									
OBS-3	7/6/1994	1.09	20								6.98									
OBS-3	10/11/1994	1.3	18								6.94									
OBS-3	1/16/1995	0.72	<5								6.9									
OBS-3	4/18/1995	0.95	14								6.76									
OBS-3	7/18/1995	0.69	10								7.05									
OBS-3	10/23/1995	0.83	17								6.84									
OBS-3	1/15/1996	0.69	12								7.15									
OBS-3	4/2/1996	0.75	11								6.93									
OBS-3	10/9/1996	0.705	<5	15		1420	658	4.2	18.6		6.98									
OBS-3	11/13/1998	0.532	5							3050	6.36									
OBS-3	11/3/2001	0.745	<1							3530	6.86									
OBS-3	11/18/2004	0.0054	<0.15							3092	8.73									-143
OBS-3	11/6/2007	0.00082	0.071							3890	7.66									-169.8
OBS-3	11/4/2008	0.00048	<0.1					<0.05	<0.2	3917	7.21									-202.2
OBS-3	11/10/2009	0.00022	<0.034	<0.57	0.061	670	1100	<0.2	<0.9	3567	8.17		<5.0		110	150	410	17		83.2

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
OBS-3, 325 ft	11/10/2010	0.000648	<1	<0.167	<1.6	220	871	<0.05	<0.2	3993	6.63	15.2	<0.725		80.7	93.7	475	14.4	0.79	-101.4
OBS-3, 255 ft	11/10/2010	0.0011	<1	0.386	2.19	79.8	821	<0.05	<0.2	3416	9.82	<0.725	<9.1		24	57.5	463	13.8	1.92	-142.7
OBS-3	7/28/2011	0.12	7.9	0.65	0.079	1000	590	1.6	7.09	3877	7.18		<20		210	170	390	22		-127.1
OBS-3	11/16/2011	0.0106	<1.5	0.197	<1.7	844	626	<0.01	<0.04	3623	6.99	20.3	<0.725		118	168	452	16.3	2.93	-109.3
OBS-3	5/15/2012	0.0076	<0.39	<0.32	0.077	790	650	0.044	0.19	3533	7.08		<5.0		110	140	350	20	1.24	-133.3
OBS-3	11/13/2012	0.0106	<1.5	0.191	<1.7	797	616	0.040	0.18	3928	6.81	16	<0.725		106	132	379	12.4	2.62	-77.6
OBS-3	1/30/2013	0.0116	<1.5	0.175	<1.7	865	577	0.061	0.27	3260	7.18	41.8	<0.725		112	143	436	13.1	1.79	-128.2
OBS-3	5/14/2013	0.228	8.32	1.14	<1.7	908	525	1.75	7.75	3589	7.01	246	<0.725		193	146	420	14.5	6.57	104.7
OBS-3	11/20/2013	0.00931	<1.5	0.852	<1.7	999	622	0.0256	0.113	3240	7.35			38	128	136	372	11.9	0.51	-185
Payne	3/5/1977		5	<50	<10															
Payne	5/9/1984	0.006	<5			315	46.5	2.2	9.8	870	7.16				150	39.2	59	4.8		
Payne	4/24/1986	0.0044	<10			230	43	2.3	10	870	7.1				115	34	31	2		
Payne	11/19/1986	0.0048				220	30	2	8	815	7.15									
Payne	4/9/1987	0.00501	<5			212	25	2.7	12	820	7.43				120	28	31	3		
Payne	10/12/1987	0.0048				240	33	2	9	900	7.24									
Payne	4/11/1988	0.00509	<5			228	30	2	9	850	7.23				120	31	38	4		
Payne	10/11/1988	0.00757				230	27	2.3	10	800	7.49									
Roundy House	5/9/1984	0.006				33.2	44.6	1.3	5.6	1000	7.16				182	40.8	439	2.3		
Roundy House	4/24/1986	0.0097	<10			325	38	4.1	18	1300	6.9				198	47	41	2		
Roundy House	4/13/1987	0.0105	<5			301	30	3.8	17	1200	7.04				190	43	38	2		
Roundy House	4/11/1988	0.00684	<5			242	21	2	9	1050	7.02				170	31	43	2		
S(SG)	2/15/1984					1673	970	1.1	4.9	2625	6.81									
S(SG)	5/7/1984	0.504	<5			1854	950	3.03	13.4	4210	6.96				398	260	670	15.1		
S(SG)	4/17/1986	1.17	<10			1737	763	5.4	24	5100	6.8				405	290	560	20		
S(SG)	7/7/1986	1.63				1716	742	4.1	18	4800	6.77									
S(SG)	10/13/1986	1.14				1689	727	4.1	18	5100	6.71									
S(SG)	2/3/1987	1.11				1614	692	2.7	12	5000	6.89									
S(SG)	4/6/1987	1.25	11			1520	670	4.3	19	5000	6.72				340	230	560	9		
S(SG)	7/7/1987	0.946				1690	710	3.8	17	5000	6.82									
S(SG)	10/5/1987	0.626				1610	655	2.9	13	5080	6.86									
S(SG)	1/4/1988	1.46				1610	670	2.7	12	4750	6.96									
S(SG)	4/5/1988	1.03	<5			1530	690	2	9	4700	6.87				310	200	530	12		
S(SG)	6/14/1988	1.7	12								6.95									
S(SG)	7/11/1988	1.16				1460	660	2.5	11	4550	6.92									
S(SG)	9/8/1988	1.4	10	<5	<5						6.91									
S(SG)	10/10/1988	1.75				1510	678	2.7	12	4550	6.84									
S(SG)	12/6/1988	1.77	12	<5	<5						6.84									
S(SG)	12/8/1988	1.7	12								6.84									
S(SG)	1/17/1989	1.75				1500	620	2.5	11	4400	6.9									
S(SG)	3/7/1989	1.5	7								6.79									
S(SG)	4/10/1989	1.6	7	5		1400	620	3.59	15.9	4200	6.92				330	210	490	15		
S(SG)	6/15/1989	1.6	11								6.8									
S(SG)	9/21/1989	1.2	9								6.82									
S(SG)	12/18/1989	1.6	7								6.68									
S(SG)	3/14/1990	1.64	9								6.66									

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
S(SG)	4/10/1990	1.43	10	5		1500	660	4.7	20.8	4400	6.57				380	200	520	14		
S(SG)	5/24/1990	1.3	5								6.65									
S(SG)	7/11/1990	1.62	6								6.72									
S(SG)	9/17/1990	1.15	7								6.79									
S(SG)	10/1/1990	1.3	5								6.66									
S(SG)	12/18/1990	1.77	<5								6.6									
S(SG)	1/10/1991	1.2	5								6.66									
S(SG)	4/2/1991	1.48	<10								6.65									
S(SG)	7/9/1991	1.4	<10								7.03									
S(SG)	10/2/1991	1.3	5								6.93									
S(SG)	1/15/1992	0.98	<5								6.82									
S(SG)	4/6/1992	1.2	6								6.86									
S(SG)	7/20/1992	1.39	6								6.86									
S(SG)	10/6/1992	1.4	10								6.83									
S(SG)	1/12/1993	1.2	12								6.82									
S(SG)	4/8/1993	1.03	10								6.9									
S(SG)	7/7/1993	1.2	9								6.89									
S(SG)	10/6/1993	1.29	11								6.88									
S(SG)	1/5/1994	1.45	<5								6.8									
S(SG)	4/8/1994	1.03	8								6.9									
S(SG)	7/6/1994	1.32	16								6.79									
S(SG)	10/11/1994	1.4	5								6.76									
S(SG)	4/10/1995	0.96	13								6.85									
S(SG)	4/16/1995	1.09	<5								6.81									
S(SG)	7/18/1995	1.27	15								6.9									
S(SG)	10/16/1995	1.15	16								6.97									
S(SG)	1/16/1996	1	14								7									
S(SG)	4/2/1996	1.05	13								7.02									
S(SG)	10/9/1996	1.01	<5	13.0		1200	528	4.0	17.7		7.12									
S(SG)	11/13/1998	0.577	4							2520	7.02									
S(SG)	11/3/2001	0.178	<1							3280	6.98									
S(SG)	11/18/2004	0.00043	<0.029							5194	6.5									-135
S(SG)	11/6/2007	<0.0002	<0.066							6264	6.52									-159.9
S(SG)	11/4/2008	0.00036	<0.1					0.02	0.0886	6991	6.33									-120.4
S(SG)	11/10/2009	<0.00002	<0.034	0.43	0.087	300	2500	<5	<22	6632	8.3		<5.0		860	54	78	1.4		70
S(SG)	11/9/2010	<0.00005	<1	<0.167	<1.6	295	2570	0.056	0.24808	7701	5.97	<0.725	<0.725		897	52.7	105	1.95	0.51	-78.3
S(SG)	7/26/2011	0.26	11	0.73	0.22	1200	800	2.1	9.303	4421	6.83		<20		410	180	390	21		-97.1
S(SG)	11/16/2011	0.312	10.6	0.916	<1.7	1260	609	2.64	11.6952	4289	7.16	325	<0.725		334	177	443	16.5	0.98	-105.6
S(SG)	5/15/2012	0.44	13	1	0.23	1200	520	3.0	13.29	4265	7.03		<20		340	170	360	21	2.69	-138.2
S(SG)	11/13/2012	0.367	12	1.26	<1.7	1160	493	2.64	11.6952	4576	7.01	374	<0.725		287	161	385	13.3	3.57	-95.5
S(SG)	1/30/2013	0.441	11	1.27	<1.7	1200	467	2.91	12.8913	3780	7.05	400	<0.725		310	173	427	13.5	3.96	-129
S(SG)	5/16/2013	0.639	13.7	1.48	<1.7	1210	463	2.66	11.7838	4065	6.74	422	<0.725		326	172	425	14	2.13	-65.2
S(SG)	11/20/2013	0.525	8.97	2.26	<1.7	1190	485	2.61	11.5623	3635	6.87			432	283	160	388	12.7	3.41	-40
W(SG)	6/7/1984	0.06	<5			1098	419	21	91	2850	6.82				370	106	363	15.8		
W(SG)	4/17/1986	0.0885	<10			992	418	18	81	3450	6.8				356	120	386	18		

Table C.2-1. Water Quality Data for Bluewater Site San Andres Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
W(SG)	10/6/1986	0.0886				981	406	17	76	3450	6.93									
W(SG)	4/8/1987	0.104	10			910	449	19	84	3400	6.92				310	99	360	11		
W(SG)	10/5/1987	0.0961				926	387	17	75	3400	6.96									
W(SG)	4/6/1988	0.124	<5			859	364	20	88	3200	7.02				270	86	320	9.3		
W(SG)	10/10/1988	0.0917				895	392	18	80	3200	7.03									
W(SG)	4/17/1989	0.146	9	<5		1000	420	18	79.6	3000	7.02				300	93	390	12		

Notes:

Data for S(SG) and OBS-3 from 1996 through the present are suspect for reasons discussed in the Site Status Report. Results for more recently installed well 16(SG) are considered more representative of groundwater quality in this region of the site.

For well HMC-951, refer to Appendix C, Table C.2-6 for the complete historical record.

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
20(M)	11/14/2012	0.0197	4.67	1.86	9.41	394	56.4	3.18	14.1	1511	7.1	258	<0.725		148	38.1	83.7	4.5	6.12	29.4
20(M)	1/30/2013	0.015	3.73	1.9	9.62	391	55.8	3.15	14.0	1267	7.24	257	<0.725		149	38.4	91.8	4.54	7.08	-35.3
20(M)	5/14/2013	0.0155	5.47	1.98	8.54	370	54.8	3.38	15.0	1318	7.02	251	<0.725		166	41.3	92.8	5	6.5	87.1
20(M)	11/19/2013	0.0139	3.81	2.54	<8.5	395	58.3	4.37	19.4	1297	7.23			250	137	33.9	82.9	4.17	7.47	-0.2
21(M)	7/27/2011	0.13	10	1.1	2.4	520	170	7.9	35.0	1885	7.28		<20		160	42	190	7.8		62
21(M)	11/15/2011	0.123	10.5	0.893	1.98	467	154	8.41	37.3	1927	7.33	256	<0.725		162	42.9	214	6.66	6.18	140.8
21(M)	5/15/2012	0.13	9	0.87	2.8	490	150	7.9	35.0	1934	7.28		<20		170	41	180	7.9	4.24	79.1
21(M)	11/15/2012	0.132	10.6	0.937	<1.7	490	150	8.68	38.5	1726	7.14	164	<0.725		151	40.8	196	5.53	4.22	109.6
21(M)	1/29/2013	0.128	9.35	0.865	3.21	483	152	9.46	41.9	1762	7.29	260	<0.725		146	39.4	203	5.52	4.58	87.4
21(M)	5/15/2013	0.148	12	0.918	<1.7	489	135	9.81	43.5	1859	7.06	263	<0.725		168	44.7	216	6.52	4.27	125.3
21(M)	11/19/2013	0.137	10.1	1.45	<1.7	509	150	12	53.2	1874	7.32			261	132	34.4	178	5.13	4.9	33.5
22(M)	7/27/2011	0.33	7.6	3.3	2.7	280	44	26	115.2	1440	7.18		<20		100	29	170	6.7		75
22(M)	11/15/2011	0.314	6.7	0.819	2.78	263	37.6	31.2	138.2	1442	7.32	316	<0.725		102	28.2	181	5.36	0.59	147.1
22(M)	5/15/2012	0.31	6.8	0.73	3.8	240	36	29	128.5	1426	7.29		<20		100	27	150	6.2	0.67	90.9
22(M)	11/15/2012	0.315	5.58	0.783	2.51	239	33.4	32.3	143.1	1251	7.18	327	<0.725		86.2	24.4	157	4.69	1.12	104.3
22(M)	1/29/2013	0.352	4.69	0.796	3.08	231	31.8	30.7	136.0	1276	7.31	323	<0.725		90.1	25.9	176	4.89	1.56	7.9
22(M)	5/14/2013	0.38	5.98	0.711	3.26	221	33.6	36.4	161.3	1332	7.02	326	<0.725		97.6	27	177	5.22	1.58	62.7
22(M)	11/19/2013	0.388	3.72	0.975	3.46	222	32.8	34	150.6	1323	7.34			315	78.4	21.2	151	4.32	2.67	31.2
23(M)	1/28/2013	0.0203	8.86	8.11	<1.7	325	94.2	3.98	17.6	1113	7.29	133	<0.725		134	29.9	53.9	6.56	4.82	170
23(M)	5/15/2013	0.0203	6.91	8.42	<1.7	285	88.8	3.46	15.3	1153	7.26	139	<0.725		152	34.7	60.3	6.76	3.48	68.6
23(M)	11/19/2013	0.0209	2.75	7.47	<1.7	295	91.7	2.35	10.4	970	6.75			150	118	26.1	46.5	5.23	3.03	250
Aragon	1/14/1977		16	<50	<10															
Aragon	5/9/1984	0.005				354	59.8	4.79	21.2	990	7.22				180	48.2	26.2	2.9		
Aragon	4/24/1986	0.0072	10			325	48	4.7	21	1200	7				168	50	24	2		
Aragon	11/19/1986	0.0106				324	58	3.8	17	1200	7.06									
Aragon	4/13/1987	0.00689	<5			310	54	6.1	27	1150	7.12				180	47	25	3		
Aragon	10/12/1987	0.003				316	54	5.2	23	1200	7.22									
Aragon	4/11/1988	0.005	<5			325	57	5.2	23	1150	7.24				170	40	26	5		
Aragon	10/11/1988	0.00742				315	55	5.4	24	1200	7.06									
B(M)	3/3/1977	3.3	34	<50	<10															
B(M)	3/20/1977	1.55	61	<50	<10															
B(M)	2/13/1984					3411	3279	14	61	7400	6.42									
B(M)	5/7/1984	2.504	<5			3654	3009	11.7	51.6	11000	6.42				719	600	1860	29.9		
B(M)	4/15/1986	3.292	50			3449	3030	14	60	14000	6.4				780	620	1810	50		
B(M)	7/7/1986	3.57				3451	3092	12	52	14000	6.42									
B(M)	10/13/1986	4.53				3510	3115	13	58	15000	6.31									
B(M)	2/3/1987	3.67				3438	3059	11	47	14500	6.42									
B(M)	4/6/1987	3.52	57			3200	3050	11	49	15000	6.51				610	580	2000	29		
B(M)	7/7/1987	3.2				3290	3010	9.9	44	15000	6.5									
B(M)	10/5/1987	2.91				3380	3010	14	62	15000	6.4									
B(M)	1/4/1988	3.2				3370	2850	12	53	14500	6.59									
B(M)	4/5/1988	4.22	75			3110	3000	11	50	14200	6.51				670	580	1800	20		
B(M)	7/11/1988	4.66				3122	3020	9.5	42	13500	6.66									
B(M)	10/6/1988	4.66				3174	2982	12	54	14000	6.58									
B(M)	1/17/1989	6.4				3100	2800	14	62	13500	6.57									
B(M)	4/10/1989	3.2	54	<5		3200	3000	15	66	13000	6.65				740	510	1900	30		
B(M)	4/12/1990	4.66	32	<12		3200	3200	14	61.9	13250	6.55				780	480	2200	30		
B000508	10/1/2013	0.133	25.2	3.37	3.43	697	162	2.73	12.1	2280	6.96	328	<0.725		226	65.5	219	7.19	5.56	180

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
Berryhill House	1/14/1977		7	<50	<10															
Berryhill House	5/9/1984	0.011				349	48.4	6.46	28.6	930	7.57				160	44.6	63	4.3		
Berryhill House	4/22/1986	0.0094	<10			312	48	3.6	16	1150	7.4				142	43	52	4		
Berryhill House	11/19/1986	0.00742				300	43	2.5	11	1100	7.38									
Berryhill House	4/13/1987	0.0067	<5			301	39	4.3	19	1100	7.39				140	38	53	4		
Berryhill House	10/12/1987	0.00597				284	42	3.2	14	1100	7.38									
Berryhill House	4/11/1988	0.00655	<5			296	41	3.2	14	1050	7.41				130	37	57	5		
Berryhill House	10/12/1988	0.0099				298	40	3.6	16	1050	7.49									
B00168	8/13/2013	0.00884	2.85	1.23	1.7	417	68	3.19	14.1	1370	6.77	258	<0.725		184	50	59.6	4.97	6.44	7
C(M)	3/25/1977	0.33	9.0	<50	20															
C(M)	3/12/1984					313	84	2.1	9.4	980	6.77									
C(M)	4/16/1984	0.091				325	100	5.6	24.8	1190	6.73				132	57	99	4.3		
C(M)	4/15/1986	0.073	10			314	61	3.6	16	1200	6.7				141	41	70	5		
C(M)	7/7/1986	0.0547				304	60	3.2	14	1200	6.73									
C(M)	10/13/1986	0.0709				352	58	3.2	14	1200	6.71									
C(M)	2/3/1987	0.0626				305	55	2.3	10	1150	6.81									
C(M)	4/6/1987	0.0738	<5			301	65	3.4	15	1150	6.82				130	38	95	1		
C(M)	7/8/1987	0.0684				320	59	2.5	11	1200	6.9									
C(M)	10/7/1987	0.0757				292	56	3.2	14	1200	6.88									
C(M)	1/11/1988	0.0597				308	51	2.9	13	1150	6.85									
C(M)	4/5/1988	0.0524	<5			299	53	3.2	14	1100	6.95				130	34	69	2.3		
C(M)	7/11/1988	0.0786				315	54	2.7	12	1100	7.18									
C(M)	10/6/1988	0.0801				287	59	3.6	16	1120	7.4									
C(M)	1/18/1989	0.0699				310	51	2.9	13	1100	7.15									
C(M)	4/17/1989	0.0684	<5	<5		300	52	2.89	12.8	1100	7				130	34	76	4.1		
C(M)	4/9/1990	0.0495	<5	<5		300	58	4	17.7	960	6.77				130	38	72	4.2		
E(M)	4/12/1984	0.018				454	159	2.1	9.3	1350	7.19				183	40	123	5		
E(M)	4/22/1986	0.0355	<10			296	48	2	8	1100	7.5				120	34	92	5		
E(M)	10/13/1986	0.0231				342	57	2.3	10	1150	7.4									
E(M)	4/8/1987	0.0185	<5			313	61	2.7	12	1100	7.42				150	34	59	5		
E(M)	10/8/1987	0.0189				292	56	2	9	1150	7.36									
E(M)	4/13/1988	0.0105	<5			305	64	2.1	9.3	1075	7.69				130	30	63	5.4		
E(M)	6/14/1988	0.013	<5	<5							7.72									
E(M)	9/7/1988	0.017	<5	<5	<5						7.73									
E(M)	10/6/1988	0.0291				322	61	2.5	11	1050	7.41									
E(M)	12/6/1988	0.019	<5	<5	<5						7.04									
E(M)	3/7/1989	0.022	<5	<5							7.49									
E(M)	4/17/1989	0.0233	<5	<5		290	60	2	8.8	980	7.14				120	32	77	5		
E(M)	6/15/1989	0.027	<5	<5							7.14									
E(M)	9/20/1989	0.017	<5	<5							7.27									
E(M)	12/18/1989	0.03	<5	<5							7.21									
E(M)	3/12/1990	0.029	<5	<5							7.16									
E(M)	4/9/1990	0.025	<5	<5		300	65	2.3	10.2	910	7.18				130	34	72	5.3		
E(M)	7/12/1990	0.027	<5	<5							7.25									
E(M)	9/18/1990	0.022	<5	<5							6.9									
E(M)	10/3/1990	0.03	<5	<5							7.22									
E(M)	12/18/1990	0.031	<5	<5							7.22									
E(M)	1/8/1991	0.031	<5	<5							7.03									

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
E(M)	4/3/1991	0.024	<5	<5							7.09									
E(M)	7/10/1991	0.027	<5	<5							7.29									
E(M)	10/3/1991	0.019	<5	<5							7.14									
E(M)	1/14/1992	0.024	<5	<5							7.33									
E(M)	4/14/1992	0.021	<5	<5							7.24									
E(M)	7/21/1992	0.022	<5	<5							7.2									
E(M)	10/6/1992	0.031	<5	<5							7.3									
E(M)	1/11/1993	0.025	<5	<5							7.36									
E(M)	4/5/1993	0.024	<5	<5							7.3									
E(M)	7/8/1993	0.032	<5	<5							7.34									
E(M)	10/5/1993	0.032	<5	<5							7.32									
E(M)	1/6/1994	0.024	<5	<5							7.26									
E(M)	4/12/1994	0.024	<5	<5							7.21									
E(M)	7/6/1994	32.0	0.6	<5							7.29									
E(M)	10/6/1994	0.032	<5	<5							7.32									
E(M)	1/16/1995	0.028	<5	<5							7.29									
E(M)	4/10/1995	0.022	<5	<5							7.48									
E(M)	7/17/1995	0.024	<5	<5							7.37									
E(M)	10/23/1995	0.021	1	<5							7.34									
E(M)	1/16/1996	0.023	<1	<3							7.34									
E(M)	4/3/1996	0.025	<1	<3							7.36									
E(M)	11/19/1997									819	7.66									
E(M)	11/14/1998	0.0122	<2	<10						600	7.11									
E(M)	12/18/1998									877	7.75									
E(M)	11/11/1999	0.005	<2	<10						584	7.13									
E(M)	11/11/2000	0.004	<1	4.2						1018	7.14									
E(M)	11/3/2001	<0.001	2	2.0						1043	7.48									
E(M)	10/17/2002	0.001	2	2.0						1089	8.02									
E(M)	9/19/2003									1179	8.65									
E(M)	11/18/2004	<0.0002	<0.055	<0.61						1337	8.45									-235
E(M)	11/15/2005									1592	8.28									-272.2
E(M)	11/28/2006									1742	7.55									-177.9
E(M)	11/6/2007	<0.00004	0.038	0.47						1683	8.37									-269.8
E(M)	11/4/2008	<0.00002	<0.077	0.59				0.019	0.084	1688	8.15									-263.5
E(M)	5/13/2009	<0.00003						<0.01	<0.04	1607	8.07									-309
E(M)	11/11/2009	0.00009	0.39	<1.5	0.046	960	42	<0.1	<0.4	1586	7		<5.0		250	58	51	4.8		95.5
E(M)	11/11/2010	<0.00005	<1	0.18	<1.6	949	37.8	<0.05	<0.2	2042	7.03	16.2	<0.725		262	63.1	63.6	5.43	0.32	-117.1
E(M)	7/27/2011	0.0004	<0.032	0.31	0.063	870	39	<0.01	<0.04	1600	7.32		<5.0		250	61	58	5.4		-60
E(M)	11/16/2011	<0.00007	<1.5	0.294	<1.7	890	31.2	<0.01	<0.04	1591	7.69	8.14	<0.725		233	59.5	56.9	5.56	0.41	-231.7
E(M)	5/15/2012	0.0001	<0.069	0.49	0.07	780	32	<0.01	<0.04	1552	7.62		<5.0		240	56	55	4.9	0.64	-26.6
E(M)	11/14/2012	<0.00007	<1.5	0.404	<1.7	750	32.7	<0.017	<0.08	1701	7.21	11.8	<0.725		195	50.2	50.9	3.99	3.92	-85.9
E(M)	1/30/2013	<0.00007	<1.5	0.416	<1.7	751	32.2	<0.017	<0.08	1411	8.31	2.61	<0.725		202	53.2	57.1	4.11	0.45	-313.6
E(M)	5/14/2013	<0.00007	<1.5	0.345	<1.7	754	31.7	<0.017	<0.08	1445	8.05	<0.725	<0.725		225	58.8	56.6	4.45	0.12	-158
E(M)	11/19/2013	<0.00007	<1.5	0.638	<1.7	747	33	<0.017	<0.08	1338	8.02			15	164	42.1	47.4	3.88	0.35	-284
Engineers	2/9/1984					342	56	3.82	16.9	900	7.78									
Engineers	5/9/1984	0.013	<5			392.5	63.4	17	74	1120	7.59				156.5	51.7	86	5.7		
Engineers	4/22/1986	0.0161	<10			302	48	4.7	21	1150	7.6				142	43	56	4		
Engineers	7/7/1986	0.0127				300	46	6.1	27	1150	7.68									

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
Engineers	11/19/1986	0.0132				299	47	3.2	14	1100	7.54									
Engineers	2/3/1987	0.0131				310	45	2.7	12	1100	7.59									
Engineers	4/13/1987	0.0108	<5			287	38	6.1	27	1100	7.4				130	37	59	4		
Engineers	8/31/1987	0.005				296	46	3.2	14	1100	7.74									
Engineers	10/12/1987	0.006				287	42	3.2	14	1100	7.59									
Engineers	1/11/1988	0.005				300	41	2.9	13	1050	7.52									
Engineers	4/11/1988	0.00771	<5			299	42	3.2	14	1020	7.59				130	34	66	6		
Engineers	7/11/1988	0.00684				283	45	2.3	10	1020	7.79									
Engineers	10/12/1988	0.00742				285	42	2.9	13	1020	7.6									
Engineers	1/18/1989	0.0102				310	46	3.2	14	1000	7.45									
F(M)	4/17/1984	0.006				183	41.5	5.13	22.7	730	7.26				98	39	20.9	3.8		
F(M)	4/17/1986	0.005	<10			181	36	2.3	10	770	7.3				107	34	16	3		
F(M)	10/6/1986	0.00713				200	36	2.5	11	820	7.39									
F(M)	4/6/1987	0.00675	<5			196	33	2.7	12	830	7.27				110	33	30	1		
F(M)	10/7/1987	0.0064				208	37	2.9	13	900	7.36									
F(M)	4/6/1988	0.00713	<5			222	41	3.8	17	900	7.26				120	31	22	3.3		
F(M)	6/14/1988	0.006	<5	<5							7.54									
F(M)	9/7/1988	0.007	<5	<5	<5						7.8									
F(M)	10/5/1988	0.00713				214	44	4.7	21	910	7.32									
F(M)	12/6/1988	0.007	<5	<5	<5						7.46									
F(M)	3/7/1989	0.007	<5	<5							7.53									
F(M)	4/11/1989	0.00568	<5	<5		290	48	3.5	15.5	880	7.42				150	36	31	5.4		
F(M)	6/15/1989	0.006	<5	<5							7.1									
F(M)	9/20/1989	0.005	<5	<5							7.29									
F(M)	12/18/1989	0.006	<5	<5							7.25									
F(M)	3/12/1990	0.007	<5	<5							7.1									
F(M)	4/9/1990	0.00582	<5	<5		260	52	7.5	33.2	815	7.12				150	37	30	4.8		
F(M)	5/23/1990	0.008	<5	<5							7.27									
F(M)	9/18/1990	0.003	<5	<5							7.2									
F(M)	10/2/1990	0.007	<5	<5							7.12									
F(M)	12/18/1990	0.013	<5	<5							7									
F(M)	1/8/1991	0.008	<5	<5							7.08									
F(M)	4/3/1991	0.006	<5	<5							7.14									
F(M)	7/9/1991	0.008	<5	<5							7.19									
F(M)	10/3/1991	0.003	<5	<5							7.22									
F(M)	1/15/1992	0.004	<5	<5							7.15									
F(M)	4/7/1992	0.009	<5	<5							7.2									
F(M)	7/21/1992	0.009	<5	<5							7.24									
F(M)	10/5/1992	0.008	<5	<5							7.25									
F(M)	1/11/1993	0.014	<5	<5							7.24									
F(M)	4/5/1993	0.011	<5	<5							7.32									
F(M)	7/6/1993	0.013	<5	<5							7.33									
F(M)	10/11/1993	0.013	<5	<5							7.32									
F(M)	1/4/1994	0.012	<5	<5							7.3									
F(M)	4/5/1994	0.011	<5	<5							7.32									
F(M)	7/7/1994	0.013	6	<5							7.2									
F(M)	10/10/1994	0.013	<5	<5							7.14									
F(M)	1/17/1995	0.012	<5	<5							7.32									

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (μg/L)	Mo (μg/L)	As (μg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (μS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
F(M)	4/10/1995	0.014	<5	<5							7.06									
F(M)	7/18/1995	0.011	<5	<5							7.34									
F(M)	10/23/1995	0.01	3	<5							7.24									
F(M)	1/15/1996	0.013	<1	<3							7.32									
F(M)	4/10/1996	0.013	<1	<3							6.99									
F(M)	11/19/1997									730	7.39									
F(M)	11/14/1998	0.0144	<2	<10						438	6.98									
F(M)	12/18/1998									826	7.57									
F(M)	11/11/1999	0.0125	<2	<10						450	7.14									
F(M)	11/11/2000	0.0156	<1	0.8						733	6.92									
F(M)	11/3/2001	0.016	2	<1						677	7.45									
F(M)	10/17/2002	0.015	2	<1						680	7.63									
F(M)	9/19/2003									601	7.73									
F(M)	9/26/2003									601	7.73									
F(M)	11/18/2004	0.011	1	<1						607	7.67									-10
F(M)	5/24/2005									611	7.71									140.7
F(M)	11/15/2005									596	7.53									-47.7
F(M)	11/28/2006									578	7.94									43.6
F(M)	11/6/2007	0.0067	0.97	0.76						573	7.98									133.5
F(M)	11/4/2008	0.0057	0.43	0.71				0.065	0.29	580	7.8									-16.4
F(M)	5/13/2009	0.007						0.75	3.32	548	7.58									0.1
F(M)	11/10/2009	0.0093	1	4	1.1	120	13	0.93	4.12	585	8.39		<20		78	19	17	2.6		85
F(M)	11/10/2010	0.00806	1.22	0.797	1.71	106	12.2	0.765	3.39	672	7.8	173	<0.725		75.2	19.4	22.3	3.59	3.69	-117.1
F(M)	7/28/2011	0.0074	1.2	0.85	1.2	110	13	0.68	3.01	565	7.68		<20		72	19	19	3		89
F(M)	11/15/2011	0.0076	<1.5	0.93	<1.7	102	11.5	0.182	0.81	575	7.65	167	<0.725		76.8	20.1	21.7	3.89	5.78	93.3
F(M)	5/15/2012	0.0073	1.1	1	1.2	99	11	0.7	3.10	569	7.71		<20		74	19	19	2.9	3.05	177.9
F(M)	11/14/2012	0.0086	<1.5	1.03	<1.7	101	11	0.695	3.08	625	7.58	170	<0.725		70.2	19	20.2	3.45	2.67	37.4
F(M)	1/30/2013	0.00808	<1.5	1.03	<1.7	99.1	11.1	0.654	2.90	536	7.7	180	<0.725		70.4	19.2	21.3	3.38	2.65	6.4
F(M)	5/14/2013	0.00753	1.76	0.895	<1.7	101	11	0.665	2.95	547	7.4	174	<0.725		75.4	20.6	21.1	3.49	2.39	78.7
F(M)	11/19/2013	0.00734	<7.5	1.39	<8.5	104	12.2	0.66	2.92	537	7.71			162	60.7	16.1	18.4	3.01	2.96	-18.3
H(C) (Chinle well)	4/15/1986	0.0076	<10			520	100	<0.2	<1	1750	9.6				15	8	342	13		
H(C) (Chinle well)	7/2/1986	0.00568				499	92	<0.2	<1	1500	9.94									
H(C) (Chinle well)	10/1/1986	0.004				330	94	<0.2	<1	1190	10.03									
H(C) (Chinle well)	1/5/1987	0.00722				193	58	<0.2	<1	990	9.95									
H(C) (Chinle well)	4/2/1987	0.004	20			235	61	<0.2	<1	1100	10.16				3	<1	210	4		
H(C) (Chinle well)	7/6/1987	0.004				242	67	<0.2	<1	950	10.07									
H(C) (Chinle well)	10/5/1987	0.00728				463	100	<0.2	<1	1700	9.83									
H(C) (Chinle well)	2/1/1988	0.0009				712	122	<0.2	<1	2150	9.48									
H(C) (Chinle well)	4/4/1988	0.003	<10			1105	133	0.2	1	2750	7.42				36	24	560	10		
H(C) (Chinle well)	7/11/1988	0.001				538	157	<0.2	<1	2650	7.91									
H(C) (Chinle well)	10/4/1988	0.001				1102	145	0.099	0.44	2400	9.74									
H(C) (Chinle well)	1/17/1989	0.005				780	150	<0.2	<1	1700	10.23									
H(C) (Chinle well)	4/16/1990	0.00655	50	34		410	100	2.6	11.5	1575	10.37				10	0.36	330	8.2		
K(M)	5/16/1984	0.37				2432	2099	22	97	7900	6.8				810	210	1350	4.8		
K(M)	4/22/1986	0.0696	20			2262	1710	19	84	7900	6.7				669	256	1175	15		
K(M)	10/13/1986	0.0926				2288	1573	19	84	7700	6.52									
K(M)	4/9/1987	0.0438	22			2000	1500	9	40	7250	6.74				600	140	1100	3		
K(M)	10/8/1987	0.003				2070	1640	2.3	10	7800	6.61									

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
K(M)	4/11/1988	0.118	6.9			1740	1000	14	62	5850	6.74				410	120	790	2		
K(M)	10/11/1988	0.0335				1810	1115	12	52	6000	7.1									
K(M)	4/20/1989	0.0815	<5	<5		870	1200	0.34	1.5	4600	7.41				97	100	920	7.6		
K(M)	4/12/1990	0.121	<5	7		990	840	0.79	3.5	4450	8.16				25	66	1100	3.9		
Raw Tailings Water	3/6/1977	66.0	27	<50	780															
SIMPSON	4/18/1989	0.003	8	<5		300	65	6.69	29.6	1100	7.28				170	37	37	2.6		
SIMPSON	4/12/1990	0.004	16	<5		280	73	0.79	3.5	1125	6.92				180	36	35	2.8		
SIMPSON	5/15/2012	0.003	42	0.6	0.65	570	120	7.9	35.0	1842	7.4		<20		260	47	110	3.6	7.91	117.5
SIMPSON	11/13/2012	0.005	56.4	0.645	<1.7	617	122	8.69	38.5	2097	7.22	205	<0.725		224	46.8	109	3.22		37.4
T(M)	4/17/1984	0.286				435	159	7.48	33.1	1610	7.14				97	42	300	7.4		
T(M)	4/17/1986	0.2146	<10			324	80	4.7	21	1450	7.2				130	52	130	7		
T(M)	10/13/1986	0.197				376	73	4.5	20	1450	6.83									
T(M)	4/6/1987	0.198	10			310	70	5.9	26	1425	7.01				120	42	150	1		
T(M)	10/7/1987	0.179				326	69	5	22	1500	7.12									
T(M)	4/6/1988	0.233	<5			332	72	5.9	26	1500	7.18				110	37	120	5.1		
T(M)	6/14/1988	0.18	13	2.7							7.16									
T(M)	9/7/1988	0.17	8	19	<5						7.46									
T(M)	10/6/1988	0.175				288	64	4.1	18	1300	7.19									
T(M)	12/6/1988	0.19	8	27	<5						7.24									
T(M)	3/7/1989	0.16	7	33							7.19									
T(M)	4/17/1989	0.175	8	35		310	73	5.11	22.6	1200	7.17				120	36	130	4.8		
T(M)	6/15/1989	0.16	8	34							7									
T(M)	9/20/1989	0.15	7	32							7.07									
T(M)	12/18/1989	0.15	<5	45							7.1									
T(M)	3/14/1990	0.013	5	25							7.01									
T(M)	4/10/1990	0.132	6	30		290	66	5.69	25.2	1175	7				140	41	100	5.3		
T(M)	5/24/1990	0.11	12	34							7.01									
T(M)	7/11/1990	0.13	5	32							7.08									
T(M)	9/18/1990	0.18	5	28							7.05									
T(M)	10/1/1990	0.14	5	33							7.02									
T(M)	12/18/1990	0.15	<5	34							6.96									
T(M)	1/9/1991	0.15	5	30							6.95									
T(M)	4/2/1991	0.13	5	37							6.95									
T(M)	7/10/1991	0.18	6	31							7.21									
T(M)	10/2/1991	0.12	<5	33							7.04									
T(M)	1/16/1992	0.13	<5	29							6.99									
T(M)	4/6/1992	0.15	5	29							7.15									
T(M)	7/20/1992	0.14	6	24							7.1									
T(M)	10/8/1992	0.15	8	30							7.12									
T(M)	1/12/1993	0.18	8	34							7.02									
T(M)	4/6/1993	0.14	6	30							6.98									
T(M)	7/7/1993	0.18	8	31							7.06									
T(M)	10/13/1993	0.14	<5	31							7.07									
T(M)	1/5/1994	0.12	6	30							7.04									
T(M)	4/6/1994	0.14	6	30							6.98									
T(M)	7/6/1994	0.12	6	30							7.2									
T(M)	10/18/1994	0.12	<5	38							7.06									
T(M)	1/17/1995	0.11	<5	25							6.96									

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
T(M)	4/10/1995	0.11	8	26							7.07									
T(M)	7/17/1995	0.08	<5	28							7.19									
T(M)	10/16/1995	0.1	4	26							6.86									
T(M)	1/15/1996	0.11	5	<30							7.05									
T(M)	4/6/1996	0.09	2	<30							7.21									
T(M)	11/19/1997									969	7.34									
T(M)	11/11/1999	0.0962	5	<10						974	7.07									
T(M)	11/11/2000	0.117	6	27.6						1307	6.93									
T(M)	11/18/2004	0.17	19	35						1710	7.16									-4.6
T(M)	5/24/2005									1701	7.13									37
T(M)	11/15/2005									1698	6.96									-56
T(M)	11/28/2006									1741	7.25									91.4
T(M)	11/6/2007	0.24	8.5	29						1683	7.28									178
T(M)	11/4/2008	0.31	5.4	29				57	252.5	1689	7.1									99
T(M)	5/13/2009	0.32						48	212.6	1635	6.89									-4.4
T(M)	11/10/2009	0.41	4.1	30	4	290	58	66	292.4	1753	6.88		<20		110	30	210	5.3		105.7
T(M)	11/9/2010	0.557	4.31	26.1	3.08	264	47.9	52	230.4	1738	6.71	388	<0.725		116	31.4	238	4.89	1.28	-84
T(M)	4/12/2011	0.512				275	46.4	59.5	263.6	1725	6.86									155.8
T(M)	7/26/2011	0.53	2.6	24	3.4	250	46	49	217.1	1679	6.94		<20		120	32	200	5.9		95.2
T(M)	11/16/2011	0.531	2.79	24.9	2.16	241	37.7	53.5	237.0	1718	7.05	405	<0.725		120	32.7	222	5.15	1.24	127.5
T(M)	5/15/2012	0.55	3.7	23	3	220	36	47	208.2	1673	6.99		<20		120	30	180	5.5	1.21	63.3
U(M)	3/12/1984					1203	675	5.35	23.7	2680	7.24									
U(M)	4/17/1984	0.711				1192	870	15.4	68.2	3850	6.93				395	84	680	13		
U(M)	4/17/1986	0.4645	<10			689	298	10	45	2800	7.2				189	60	455	16		
U(M)	7/7/1986	0.393				674	268	10	45	2600	7.15									
U(M)	10/13/1986	0.403				674	255	9	40	2600	7.18									
U(M)	2/3/1987	0.402				588	222	7.7	34	2450	7.35									
U(M)	4/8/1987	0.409	6			570	194	9.7	43	2400	7.3				150	39	370	7		
U(M)	7/7/1987	0.466				540	216	8.8	39	2600	7.36									
U(M)	10/7/1987	0.422				497	192	9	40	2580	7.31									
U(M)	1/11/1988	0.393				540	184	9	40	2200	7.41									
U(M)	4/6/1988	0.277	11			510	162	10	46	2050	7.31				120	33	300	6.7		
U(M)	7/11/1988	0.393				463	150	11	50	1900	7.44									
U(M)	10/5/1988	0.335				526	157	9.7	43	1900	7.43									
U(M)	1/18/1989	0.524				470	140	7.7	34	1850	7.57									
U(M)	4/11/1989	0.335	9	12.0		430	130	7.88	34.9	1700	7.35				110	27	300	6.3		
U(M)	4/9/1990	0.306	13	19.0		430	130	9.19	40.7	1420	7.08				100	28	270	9		
X(M)	3/12/1984					1332	1160	34.3	152	2980	7.21									
X(M)	4/17/1984	0.319				1448	995	34.3	152	4470	7.18				485	146	630	11.3		
X(M)	4/17/1986	0.2957	<10			1073	762	20	87.0	3950	7.2				393	117	577	18		
X(M)	7/7/1986	0.266				1029	774	22	96.0	3650	7.22									
X(M)	10/6/1986	0.304				952	475	19	84.0	3650	7.22									
X(M)	2/3/1987	0.287				871	409	14	64.0	3350	7.34									
X(M)	4/8/1987	0.298	<5			850	350	19	84.0	3300	7.29				350	64	430	7		
X(M)	7/7/1987	0.364				786	376	16	71.0	3350	7.35									
X(M)	10/5/1987	0.247				779	344	16	71.0	3300	7.39									
X(M)	1/11/1988	0.277				722	340	16	71.0	2950	7.45									
X(M)	4/6/1988	0.378	<5			666	310	17	75.0	2800	7.21				190	47	370	6		

Table C.2-2. Water Quality Data for Bluewater Site Alluvial and Chinle Aquifer Wells

Sample ID	Date Sampled	U (mg/L)	Se (µg/L)	Mo (µg/L)	As (µg/L)	SO_4 (mg/L)	Cl (mg/L)	NO_3+NO_2 as N (mg/L)	Nitrate as NO_3 (mg/L)	SC (µS/cm)	pH (s.u.)	Alkalinity, Bicarbonate (as $CaCO_3$)	Alkalinity, Carbonate (as $CaCO_3$)	Alkalinity, Total (as $CaCO_3$)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	DO (mg/L)	ORP (mV)
X(M)	7/11/1988	0.262				672	320	12	52.0	2700	7.35									
X(M)	10/5/1988	0.364				678	330	17	74.0	2650	7.57									
X(M)	1/18/1989	0.393				680	280	13	57.0	2500	7.55									
X(M)	4/17/1989	0.32	5	<5		620	280	14	61.8	2400	7.33				190	38	360	6.6		
X(M)	4/11/1990	0.146	11	<5		950	380	17	75	2400	7.23				270	82	370	11		
X(M)	11/15/2012	0.134	7.32	0.702	<1.7	499	192	9.8	43.4	1795	7.43	230	<0.725		163	45.9	186	5.49	4.22	142.8
X(M)	1/29/2013	0.139	6.35	0.754	2.03	495	199	11.1	49.2	1836	7.56	224	<0.725		159	44.5	197	5.41	2.99	85.4
X(M)	11/19/2013	0.145	6.59	1.81	<1.7	504	195	8.71	38.6	1920	7.69			200	165	46.7	183	5.49	3.07	18.9
Y2(M)	11/19/1997									678	7.14									
Y2(M)	11/11/1999									700	7.84									
Y2(M)	11/11/2000									724	7.01									
Y2(M)	11/3/2001									681	7.6									
Y2(M)	10/17/2002									734	7.61									
Y2(M)	9/19/2003									588	7.43									
Y2(M)	9/26/2003									586	7.42									
Y2(M)	11/18/2004									620	7.46									227
Y2(M)	11/15/2005									635	7.43									-13.4
Y2(M)	11/28/2006									641	7.6									-60.4
Y2(M)	11/6/2007									599	7.63									150.3
Y2(M)	11/4/2008							1.2	5.3	641	7.5									83.5
Y2(M)	5/13/2009	0.005						1.1	4.9	587	7.35									18.1
Y2(M)	11/10/2009	0.005	0.64	3	1.2	110	7	0.62	2.7	552	8.14		<20		77	18	14	2.6		79.4
Y2(M)	11/11/2010	0.005	1.31	1.57	3.64	96.1	15.8	1.42	6.3	740	7.67	194	<0.725		59.3	16.2	56.5	3.33	5.48	-104
Y2(M)	7/28/2011	0.005	1.2	1.6	1.5	98	17	1.4	6.2	630	7.52		<20		61	17	47	3.1		80
Y2(M)	11/15/2011	0.005	1.75	1.68	<1.7	92.2	13.6	0.494	2.2	642	7.59	201	<0.725		65	17.8	53	3.67	5.57	140.5
Y2(M)	5/15/2012	0.005	1.0	1.6	1.3	92	14	1.3	5.8	648	7.57		<20		62	17	48	3.1	5.61	160.6
Y2(M)	11/14/2012	0.005	<1.5	1.71	<1.7	99.9	15.2	1.52	6.7	718	7.45	206	<0.725		58.2	16.6	52.3	3.21	5	33.3
Y2(M)	1/30/2013	0.005	<1.5	1.61	<1.7	97	14.4	1.39	6.2	617	7.54	208	<0.725		62.1	17.8	55	3.24	6.23	11.1
Y2(M)	5/14/2013	0.005	2.17	1.76	<1.7	100	15.6	1.54	6.8	640	7.25	201	<0.725		63.1	18	55.8	3.17	5.42	107.1
Y2(M)	11/19/2013	0.005	<1.5	2.55	<1.7	101	17.3	1.66	7.4	643	7.63			205	56.5	16.6	54.1	2.92	5.89	-29

Note:

Berryhill House and location B00168 correspond to the same location; original nomenclature used in historical records.

Table C.2-3. Uranium Isotope Results for Bluewater Site Region Based on DOE and NMED Sampling

Bluewater Site Wells

Fm	Well ID	NMED ID	Data Source	Date Sampled	Uranium (mg/L)	U-234 (pCi/L)	U-235/236 (pCi/L)	U-238 (pCi/L)	U-234/U-238 Activity Ratio
AL	20(M)		DOE	11/19/2013	0.0139	6.58	0.418	4.66	1.41
AL	21(M)		DOE	7/27/2011	0.13	46.5	2	43	1.08
AL	21(M)		DOE	11/19/2013	0.137	46.1	1.9	40.4	1.14
AL	22(M)		DOE	7/27/2011	0.33	117	5.4	116	1.01
AL	22(M)		DOE	11/19/2013	0.388	122	4.77	118	1.03
AL	23(M)		DOE	11/19/2013	0.0209	8.95	0.587	6.24	1.43
AL	E(M)		DOE	11/11/2010	<0.00005	<0.234	<0.0647	<0.167	--
AL	E(M)		DOE	7/27/2011	0.00038	<0.0673	<0.034	<0.045	--
AL	E(M)		DOE	11/19/2013	<0.000067	<0.113	<0.139	<0.113	--
AL	F(M)		DOE	11/10/2010	0.00806	4.19	<0.15	2.95	1.42
AL	F(M)		DOE	7/28/2011	0.0074	3.4	0.123	2.44	1.39
AL	F(M)		DOE	11/19/2013	0.00734	3.2	<0.189	2.53	1.26
AL	T(M)		DOE	11/9/2010	0.557	161	7.61	169	0.95
AL	T(M)		DOE	7/26/2011	0.53	176	9.7	182	0.97
AL	X(M)		DOE	11/19/2013	0.145	47.8	1.77	44.8	1.07
AL	Y2(M)		DOE	11/11/2010	0.00519	2.56	<0.162	1.7	1.51
AL	Y2(M)		DOE	7/28/2011	0.0048	2.61	0.101	1.63	1.60
AL	Y2(M)		DOE	11/19/2013	0.0053	2.97	<0.288	1.94	1.53
SA	11(SG)		DOE	11/19/2013	0.0117	5.73	<0.19	3.61	1.59
SA	13(SG)		DOE	11/19/2013	0.0985	37.8	1.86	35.4	1.07
SA	14(SG)		DOE	11/19/2013	0.0741	26.9	0.971	23.8	1.13
SA	15(SG)		DOE	11/19/2013	0.174	60.2	2.71	55.8	1.08
SA	16(SG)		DOE	11/19/2013	1.4	381	19.6	401	0.95
SA	18(SG)		DOE	11/19/2013	0.127	44.7	1.45	44.1	1.01
SA	HMC-951	BW-34	NMED 2010	8/27/2008	0.053	13.5	0.5	12.3	1.10
SA	HMC-951		DOE	11/20/2013	0.031	12	0.518	11	1.09
SA	I(SG)	BW-28	NMED 2010	8/27/2008	<0.002	0.4	−0.01	0.04	--
SA	I(SG)		DOE	11/11/2010	0.0027	1.48	<0.0682	1.4	1.06
SA	I(SG)		DOE	7/27/2011	0.0011	0.476	<0.054	0.449	1.06
SA	I(SG)		DOE	11/19/2013	0.346	53.4	3.06	54	0.99
SA	I(SG)		DOE	11/19/2013	0.149	49.9	2.48	49.1	1.02
SA	I(SG)		DOE	11/19/2013	0.334	110	4.98	106	1.04
SA	I(SG)		DOE	11/19/2013	0.324	105	5.74	103	1.02
SA	L(SG)	BW-25	NMED 2010	8/27/2008	<0.002	0.01	0.0008	-0.03	--
SA	L(SG)		DOE	11/11/2010	<0.00005	<0.133	<0.165	<0.0523	--
SA	L(SG)		DOE	7/27/2011	0.0032	1.85	0.108	1.11	1.67
SA	L(SG)		DOE	11/19/2013	0.00294	1.33	<0.141	1.2	1.11
SA	OBS-3	BW-27	NMED 2010	8/27/2008	<0.002	0.06	0.08	7.61	
SA	OBS-3 (255-ft)		DOE	11/10/2010	0.0011	0.422	<0.2	0.456	0.93
SA	OBS-3 (325-ft)		DOE	11/10/2010	0.000648	0.526	<0.17	0.558	0.94
SA	OBS-3		DOE	7/28/2011	0.12	37.2	2.35	39.8	0.93
SA	OBS-3		DOE	11/20/2013	0.00931	3.05	<0.273	2.56	1.19
SA	S(SG)	BW-26	NMED 2010	8/27/2008	<0.002	0.4	−0.1	0.2	
SA	S(SG)		DOE	11/9/2010	<0.00005	<0.134	<0.065	<0.0876	
SA	S(SG)		DOE	7/26/2011	0.26	71	4.5	77.4	0.92
SA	S(SG)		DOE	11/20/2013	0.525	163	7.52	176	0.93

Fm Formation
AL Alluvium
SA San Andres

Note:
As discussed in the Site Status Report, uranium concentrations reported for S(SG) (BW-26), OBS-3 (BW-27), and I(SG) (BW-28) are suspect, as uranium concentrations in San Andres aquifer wells in this region are known to be higher. Results for well 16(SG), averaging ≈ 1 mg/L uranium, are considered more characteristic of this region.

Table C.2-3. Uranium Isotope Results for Bluewater Site Region Based on DOE and NMED Sampling

Other NMED Results

Fm	Well ID	NMED ID	Data Source:	Date Sampled	Uranium (mg/L)	U-234 (pCi/L)	U-235/236 (pCi/L)	U-238 (pCi/L)	U-234/U-238 Activity Ratio
AL	HMC-914	SMC-10	NMED 2010	3/30/2009	0.0309	0.1	0.01	0.04	2.5
AL	HMC-920	SMC-11	NMED 2010	3/31/2009	0.228	78.1	2.8	63	1.24
AL	HMC-950	SMC-12	NMED 2010	3/31/2009	0.163	61.9 [54.6]	2.3	52 [44.8]	1.19
AL	HMC-921	SMC-13	NMED 2010	4/2/2009	0.24	75.8	3.2	64.3	1.18
SA	BW-05	BW-05	NMED 2010	8/25/2008	0.0105	6.4	0.07	3.0	2.13
SA	BW-14	BW-14	NMED 2010	8/27/2008	0.0105	13.8	0.08	3.4	4.06
SA	HMC-911	BW-15	NMED 2010	8/25/2008	0.012	4.5	0.1	2.8	1.61
SA	HMC-949	BW-23	NMED 2010	8/25/2008	0.0138	7.1	0.4	4.3	1.65
SA	BW-24	BW-24	NMED 2010	8/25/2008	0.0109	14.4	0.1	3.2	4.50
SA	HMC #1 Deepwell	BW-29	NMED 2010	8/27/2008	0.0089			0.3	
SA	HMC-928	BW-32	NMED 2010	9/16/2008	0.029	22.9	0.5	11.0	2.08
UNK	SMC-04	SMC-04	NMED 2010	3/31/2009	0.0206	[11.1]		[5.61]	1.98
UNK	SMC-08	SMC-08	NMED 2010	3/30/2009	<0.002	3.9	0.2	2.8	--

Fm Formation
AL Alluvium
SA San Andres
UNK Unknown

NMED results for SMC samples in brackets are SLD radiochemical data (NMED 2010; Table 10)

Table C.2-4. Water Quality Data for San Andres Aquifer Wells from Hydro-Search 1981

Well ID	HS Map No.	Date	U (mg/L)	pH (s.u.)	TDS (mg/L)	EC (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	As (mg/L)	Fe (mg/L)	Mo (mg/L)	Se (mg/L)
Berryhill Sec. 5	12	10/1/1957							226	621	1.0								
Berryhill Sec. 5	12	5/28/1960		7.7	2269	2500	682	Nil	241	686	4.0	350		230	76.0				
Berryhill Sec. 5	12	7/26/1980	<0.01	7.3	2270	2910	745	Nil	250	625	<0.1	330	17.0	230	62.0	ND	11	ND	ND
North Well	14	Jun-56							126	553	3.0								
North Well	14	May-60			1768														
North Well	14	7/29/1980	0.02	7.2	1871	2460	509	Nil	186	680	0.9	175	11.0	200	95	ND	0.5	ND	ND
Monitor Well	15	7/23/1980	0.30	7.4	2532	3290	510	Nil	350	895	4.0	315	17	330	96	ND	0.14	ND	ND
Bowlins	16	7/17/1980	<0.01	6.9	2207	2530	472	Nil	123	983	3.5	250	12.0	269	80.0	ND	0.03	ND	ND
C(SG)	17	1/10/1981	0.08	7.8	1344	1600	255	Nil	150	530	13.3	180	14	135	55	ND	0.01	ND	ND
G(SG)	19	1/10/1981	3.5	6.9	5734	6550	500	Nil	1050	2400	53.1	840	29.0	560	275	ND	1.4	ND	ND
Allen Payne	20	7/22/1980	<0.01	7.5	926	1140	287	Nil	89	275	8.9	59	3.3	134	44	ND	ND	ND	ND
Anaconda #1	21	Apr-52							70	380	15								
Anaconda #1	21	May-57			1167														
Anaconda #2	22	7/18/1956		7.4	1086	1330	351	Nil	60	351	19		105.0	142	42				
Anaconda #2	22	11/20/1980	0.24	7.2	1776	1960	535	Nil	135	570	37.2	210	10	195	66	ND	0.02	ND	ND
Bluewater Municipal	23	May-61		7.2	1150	1400	320	Nil	57	379	80	80		185	49				
Bluewater Municipal	23	7/23/1980	<0.01	7.4	1007	1210	331	Nil	40	350	14.2	50	3.3	155	45	0.01	ND	ND	ND
Roundy Corral	24	7/25/1980	<0.01	7.4	1087	1310	363	Nil	48	360	14.2	66	3.7	165	49	ND	0.01	ND	ND
Anaconda #3	25	7/11/1946			1100	1320	366	Nil	57	356	29		95	147	49				
Anaconda #3	25	7/22/1980	<0.01	7.6	883	1100	306	Nil	36	280	11.5	63	3.3	125	40	ND	ND	ND	ND
Anaconda #4	26	9/27/1961		7.4	988	1325	340	Nil	48.0	321	27	60		150	42				
Anaconda #4	26	10/22/1980	<0.01	7.5	893	1120	307	Nil	30	287	26.6	60	3.2	126	35	ND	ND	ND	ND
Mexican Camp	27	Jul-56							16	134	32								
Mexican Camp	27	May-60			585														
Mexican Camp	27	10/22/1980	<0.01	7.5	649	798	289	Nil	18	162	7.1	45	2.7	89	26	ND	ND	ND	ND
Sabre-Piñon (now HMC-951)	28	Mar-59							89	232	5								
Sabre-Piñon (now HMC-951)	28	7/25/1980	<0.01	7.5	965	1220	306	Nil	66	300	20.4	52.0	3.0	155	44	ND	ND	ND	ND
Sturges Irrigation	29	1945			997		386	Nil	46	300	26		6	158	75				
Sturges Irrigation	29	11/18/1980		7.6	1053	1200	380	Nil	41	318	36	33	2	180	45				
Dalton	30	7/25/1980	<0.01	7.4	716	864	287	Nil	16	200	21.7	39	2.0	96	38	ND	0.03	ND	ND
Hardenburg Commissary	31	7/23/1980	<0.01	7.6	712	826	268	Nil	12	230	7.5	49	2.0	88	39	ND	ND	ND	ND
AN-5	AN-5	1/9/1981	0.33	7.5	2071	2420	335	Nil	270	790	57.5	275	17.0	240	68	ND	0.14	ND	ND
I(SG)	I(SG)	10/24/1980	0.35	7.1	3066	3730	491	Nil	365	1290	28.8	380	28	320	146	ND	ND	ND	ND
L(SG)	L(SG)	1/20/1981		7.2	1952	2380	600	Nil	180	605	1.3	270	21.0	190	71	ND	0.05	ND	ND
M(SG)	M(SG)	3/26/1981		7.7	1640	1810	420	Nil	105	640	4.4	180	18.0	205	51	ND	0.04	ND	ND
OBS-2	OBS-2	2/6/1981		7.7	5293	6490	450	Nil	1140	2040	41.2	805	28	515	250	ND	0.07	ND	ND
OBS-3	OBS-3	2/7/1981		7.3	4413	6690	415	Nil	810	1880	28.8	540	24	505	190	ND	0.07	ND	ND
S(SG)	S(SG)	1/28/1981		7.8	5077	6270	490	Nil	895	2110	48.7	700	29	560	220	ND	0.06	ND	ND
Roundy Sec. 23	S-1	7/12/1946			2523	3040	702	Nil	270	829	0.6		379	254	88				
Roundy Sec. 23	S-1	7/9/1980	0.05	7.7	1399	1930	333	Nil	49	567	1.3	390	9.0	31	5.4	ND	0.01	ND	0.002
Roundy Sec. 23	S-1	1/12/1981		7.0	2171	2460	520	Nil	180	810	0.4	430	16	155	44	ND	0.06	ND	ND
United Nuclear Sec. 8B	S-12	7/11/1946			468	581	225	Nil	8.0	122	0.7	20		60	32				
United Nuclear Sec. 8B	S-12	7/24/1980	<0.01	7.5	468	556	223	Nil	5.0	115	2.2	23.0	1.7	46	30	ND	ND	ND	ND

Table C.2-4. Water Quality Data for San Andres Aquifer Wells from Hydro-Search 1981

Well ID	HS Map No.	Date	U (mg/L)	pH (s.u.)	TDS (mg/L)	EC (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	As (mg/L)	Fe (mg/L)	Mo (mg/L)	Se (mg/L)
Gallup Stake Irrigation Sec. 4B	S-14	7/22/1980	<0.01	7.5	1052	1270	299	Nil	39.0	400	14.2	66	3.3	142	54	ND	ND	ND	ND
Murray Ac. Irr.	S-2	7/10/1980	<0.01	7.3	1582	1900	393	Nil	109	600	10.6	190	11	195	57	ND	0.01	ND	0.004
N.M. Highway Department	S-22	7/17/1980	<0.01	7.4	532	671	224	Nil	7.7	153	<0.1	25.0	2.0	67	34	ND	ND	ND	ND
Jack Freas	S-35	7/12/1980	<0.01	7.4	664	836	248	Nil	25	197	9.3	39	2.7	93	35	ND	0.01	ND	0.002
Hanosh	S-49	7/12/1980	<0.01	7.4	471	576	248	Nil	8.4	80	4.4	21	1.7	61	26	ND	0.02	ND	ND
Siemons	S-5	7/12/1980	0.02	7.0	1614	1950	448	Nil	111	575	8.4	190	12	198	55	ND	0.04	ND	0.003
Thornton	S-50	7/16/1980	<0.01	7.6	721	838	254	Nil	19	240	8.4	38	2.7	105	34	ND	0.02	ND	ND
Guthrie	S-51	7/10/1980	<0.01	7.2	1140	1420	333	Nil	61	414	5.8	91	7.0	166	47	ND	0.02	ND	ND
Grants #1	S-65	9/27/1977	<0.01	7.7	816	1068	298	Nil	36.2	260.3	6.1	64.4	4.3	111.2	35.1	0.01	0.01	ND	0.01
Grants #1	S-65	7/24/1980	<0.01	7.5	947	1180	338	Nil	50	280	3.1	80	3.7	130	40	ND	0.01	ND	ND
Grants #3	S-66	11/15/1978		7.7	776	998	291.3	Nil	30.5	241.5	6.1	57.5	3.5	110.4	34.9	0.01	ND	ND	0.03
Grants #3	S-66	7/24/1980	0.14	7.5	820	999	293	Nil	30	260	3.5	59	2.7	110	40	ND	ND	ND	ND
Bell HQ	S-68	7/25/1980	<0.01	7.4	476	552	229	Nil	<3	115	0.9	23	1.7	55	31	ND	ND	ND	ND
Bluewater (Auro's) Motel	S-70	10/23/1980	<0.01	7.6	708	848	327	Nil	10	167	4	39	2	112	21	ND	ND	ND	ND
UN-HP #2	S-71	10/23/1980	<0.01	7.4	1927	2340	558	Nil	139	669	3.5	259	13	207	62	ND	ND	ND	ND
UN-HP #1	S-72	10/23/1980	0.02	7.0	2217	2680	614	Nil	358	569	2.2	330	24	244	59	ND	ND	ND	ND
Roundy (Harmon) House	S-74	6/4/1947			653	794	305	Nil	12	158	18		9.4	121	30				
Roundy (Harmon) House	S-74	10/30/1980	<0.01	7.3	1489	1560	421	Nil	63	490	32.3	63	3.2	251	43	ND	ND	ND	ND
Blue Well	S-75	11/14/1980	<0.01	7.4	1605	1800	414	Nil	91	627	4.4	190	14	215	37	ND	0.05	ND	ND
Dow	S-8	7/16/1980	<0.01	7.3	944	1220	387	Nil	18	261	7.5	39	3.3	169	29	ND	ND	ND	ND
W(SG)	W(SG)	1/17/1981	0.04	7.3	2184	2510	355	Nil	205	940	53.1	265	16	250	82	ND	0.02	ND	ND

ND Not Detected

Source:

Tables 2 through 4 of Hydro-Search (HSI), 1981. *Regional Ground-Water Hydrology and Water Chemistry, Grants- Bluewater area, Valencia County, New Mexicc*, prepared for Anaconda Copper Company, June 30. EC units reported by HSI as mg/L but assumed here to be µmhos/cm.

These data are tabulated separetely because they were used as the basis for characterizations of early (1980-1981) contaminant (uranium) distributions in the Site Status Report.

Table C.2-5. Water Quality Data for Alluvial Aquifer Wells from Hydro-Search 1981

Well ID	HS Map No.	Date	U (mg/L)	pH (s.u.)	TDS (mg/L)	EC (mg/L)	HCO_3 (mg/L)	CO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	Na (mg/L)	K (mg/L)	Ca (mg/L)	Mg (mg/L)	As (mg/L)	Fe (mg/L)	Mo (mg/L)	Se (mg/L)
Berryhill House	1	Jun-56							32	258	16								
Berryhill House	1	May-60			949														
Berryhill House	1	7/23/1980	<0.01	7.5	1048	1370	287	Nil	68	375	11.1	65	3.3	150	54	ND	ND	ND	ND
Engineers	2	6/7/1957		7.5	692	1020	264	Nil	17	211	6.6	33		102	34				
Engineers	2	7/23/1980	0.06	7.7	1009	1190	287	Nil	64	350	12	80	3.7	145	35	ND	ND	ND	ND
Aragon	3	7/23/1980	<0.01	7.4	945	1130	312	Nil	54	300	8.9	38	2.7	160	46	ND	ND	ND	ND
Roundy-Up	4	7/17/1980	<0.01	7.4	940	1170	278	Nil	40	346	8.4	43	3.3	159	40	0.01	0.02	ND	ND
B(M)	5	3/3/1977	3.3	7.7	9265	12500	551	Nil	2802	2779	79.3	1710	25.3	790	498	ND	0.01	ND	0.034
B(M)	5	7/22/1980	3.1	7.2	10762	15000	656	Nil	3000	3550	44.3	2000	50	920	512	ND	0.04	ND	ND
C(M)	6	11/20/1980	0.22	7.0	1274	1540	315	Nil	115	450	8.0	140	7	170	37	ND	0.08	ND	0.002
E(M)	8	7/22/1980	0.04	7.5	884	1170	236	Nil	100	280	8.9	56	3.0	115	59	ND	ND	ND	ND
F(M)	9	7/22/1980	<0.01	7.5	707	880	236	Nil	36	220	9.7	20	2.3	110	39	ND	0.2	ND	ND
Simpson	10	Jun-56							24	178	26								
Simpson	10	Nov-56			707														
Simpson	10	10/22/1980	<0.01	7.5	1101	1330	298	Nil	46	419	36.7	43	2.7	197	38	ND	ND	ND	0.003
Card Abandoned	11	10/24/1980	0.02	7.5	1487	1870	231	Nil	58	727	34.5	181	6.5	180	43	ND	ND	ND	ND
K(M)	9	11/6/1980		7.5	5283	8260	245	Nil	1320	1960	79.7	910	18	549	178	ND	0.07	ND	ND
T(M)	T(M)	12/19/1980	1.62	7.0	8264	11500	320	Nil	1620	3450	106.2	1900	100	600	140	0.02	0.12	0.02	0.003
U(M)	U(M)	12/19/1980	0.36	7.5	1495	1740	315	Nil	115	565	62	155	10	215	30	ND	0.02	ND	ND
X(M)	X(M)	1/18/1981	0.06	7.6	2387	3050	300	Nil	390	850	133.0	335	16	280	56	ND	0.03	ND	ND
Gallup Stake Domestic	S-27	7/11/1980	<0.01	7.3	997	1190	303	Nil	32	350	20.4	54	4.0	167	35	ND	ND	ND	ND
Milan B-23	S-28	3/28/1979		7.8	505	652	236	Nil	12	117.4	13.9	28	1.56	68.6	28				
Milan B-23	S-28	7/16/1980	<0.01	7.4	610	730	242	Nil	19	167	8.4	33	2.7	93	26	ND	ND	ND	ND
Holmes	S-41A	7/12/1980	<0.01	7.4	1079	1290	272	Nil	41	437	19	85	6	154	35	ND	0.01	ND	0.003
Pittard	S-46	11/12/1980	0.02	7.5	2230	2670	221	Nil	100.5	1210	30.6	330	8.5	249.5	56	ND	0.02	ND	ND
Cibola Sands	S-56	7/24/1980	<0.01	7.5	1838	2380	586	Nil	180	530	<0.1	220	10	210	77	ND	0.03	ND	ND
Milan B-24	S-63	6/7/1957		7.6	581	898	256	Nil	15	147	8.2	39		39	51				
Milan B-24	S-63	2/1/1978														ND		ND	0.005
Milan B-24	S-63	7/16/1980	<0.01	7.4	556	695	236	Nil	14	138	9.7	28	2.3	77	28	ND	0.03	ND	ND
Milan B-35	S-64	2/1/1978		7.87	701	924	261	Nil	20.3	215	18.3	36.8	3.12	103.6	42				
Milan B-35	S-64	7/16/1980	<0.01	7.4	778	902	260	Nil	23	260	16.8	41	3.0	120	30	ND	0.04	ND	ND
Urie	S-76	11/15/1980	1.16	7.5	3195	3360	414	Nil	144	1660	35.4	460	10	361	87	ND	0.06	ND	0.007
Crow	S-77	11/15/1980	0.10	7.4	2460	3080	315	Nil	140	1240	12.4	430	12	245	46	ND	ND	ND	ND
Clevenger	S-78	11/21/1980	0.03	7.6	1553	1940	315	Nil	55	700	17.3	210	6.5	195	30	ND	ND	ND	ND
Swierc	S-79	11/21/1980	0.05	7.7	1773	2120	325	Nil	69	820	26.6	310	7.0	155	36	ND	ND	ND	ND
Caudill	S-81	11/24/1980	1.26	7.5	2465	3100	365	Nil	120	1240	9.3	390	9.0	255	64	ND	0.02	ND	0.011
Roundy Sec. 12	S-82	May-60		7.7	1847	2000	243	Nil	57	1006	26	200		269	46				
Roundy Sec. 12	S-82	12/11/1980	0.09	7.4	3012	2940	225	Nil	84	1740	106	305	15	440	76	ND	0.04	ND	ND

ND Not Detected

Source:

Tables 2 through 4 of Hydro-Search (HSI), 1981. *Regional Ground-Water Hydrology and Water Chemistry, Grants- Bluewater area, Valencia County, New Mexicc*, prepared for Anaconda Copper Company, June 30. EC units reported by HSI as mg/L but assumed here to be µmhos/cm.

These data are tabulated separetely because they were used as the basis for characterizations of early (1980-1981) contaminant (uranium) distributions in the Site Status Report.

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Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
#1 Deepwell	5/22/1958				671	1.2		1790		214	74.0	0.0		617	<0.10	205	
#1 Deepwell	4/20/1979	0.21	0.22	0.03	649	0.86		1500						569		149	
#1 Deepwell	5/8/1980	<0.01	0.02	0.02	801	1.3	7.1	1575								191	1.5
#1 Deepwell	5/8/1980	<0.01	0.02	0.02	734	1.1	7.0	1800								206	0.9
#1 Deepwell	7/2/1980	<0.01	0.02	<0.01	714	<0.1	7.4		1261			0.0		651			1.9
#1 Deepwell	10/23/1980	0.02	<0.05	<0.00	569	2.2	7.0	2217		244	59.0	24.0	330	614		358	0.31
#1 Deepwell	5/11/1983	<0.01	0.01	<0.01	708	0.7	7.0	1920	2273			13.0	315	622		248	0.5
#1 Deepwell	12/20/1983	0.01	0.02	0.01	714	2.5	7.5	1780	2581			0.0		509		191	2.3
#1 Deepwell	3/21/1984	0.01	<0.00	0.01	779	12	7.2	1950	2778	305	61.0	16.0	310	633		213	2.4
#1 Deepwell	7/31/1984				730			2130	2607								
#1 Deepwell	9/28/1984	0.01	0.07	0.01	807	8.4	7.1	1990	2613	301	7.0	15.0	340	511	<0.00	206	0.2
#1 Deepwell	12/29/1984				734			2670									
#1 Deepwell	3/13/1985		<0.01	0.01	755	4.6	7.1	1520		284	31.0	10.0	260	540	<0.00	156	<0.01
#1 Deepwell	6/27/1985				709			3080	2378								
#1 Deepwell	9/13/1985	<0.01	<0.01	<0.01	782	6.0	7.0	1770		271	24.0	14.0	313	566	<0.00	184	1.5
#1 Deepwell	12/20/1985				730			2920									
#1 Deepwell	6/26/1986				742			1170									
#1 Deepwell	9/17/1986	<0.01	0.01	0.01	713	2.9	7.6	1680	2582	269	7.0	12.0	325	523	0.00	191	0.8
#1 Deepwell	1/8/1987				712			2920								149	
#1 Deepwell	3/30/1987	<0.01	0.01	0.01	743	0.9	7.7	1710		297	17.0	16.0	320	547	<10.00	213	1
#1 Deepwell	7/15/1987		0.01		802			1720	2938								
#1 Deepwell	9/30/1987	<0.01	0.01	<0.01	818	1.4	7.0	1890	2744	319	10.0	14.0	335	558	<10.00	206	2.3
#1 Deepwell	12/22/1987				963			3230	2470								
#1 Deepwell	1/21/1988				802			1890									
#1 Deepwell	3/29/1988	0.03	0.01	0.01	777	1.0	7.6	1730		271	6.0	15.0	358	488	<10.0	248	0.2
#1 Deepwell	6/15/1988		0.01		710			3330	2470								
#1 Deepwell	9/27/1988	0.04	0.01	<0.01	771	2.0	7.5	1880		284	10.0	15.0	338	412	<10.0	206	0.2
#1 Deepwell	12/8/1988				754			3300									
#1 Deepwell	6/21/1989				820			3670									
#1 Deepwell	11/29/1989				821			1940	2768								
#1 Deepwell	12/19/1989	0.02	<0.01	<0.01	773	0.2	7.0	1950	2756	318	37.0	14.0	373	650		213	<0.1
#1 Deepwell	2/15/1990				886			2000									
#1 Deepwell	5/9/1990	<0.01	<0.01	0.01	808	1.8	7.3	1990		314	9.0	7.0	352	603		199	0.4
#1 Deepwell	8/7/1990				754			1780									
#1 Deepwell	2/25/1991				1005			2070									
#1 Deepwell	5/22/1991	0.08	<0.01	<0.01	717	2	7.1	1900		297	18.0	14.0	317	561	<0.1	213	
#1 Deepwell	8/22/1991				701			1810									3.1
#1 Deepwell	11/6/1991				753			2010	2673								
#1 Deepwell	2/5/1992				711			2010									
#1 Deepwell	5/4/1992	0.03	0.01	0.01	844	1.7	7.2	1890		310	16.0	18.0	337	620		199	
#1 Deepwell	8/12/1992				708			1860	2572								2.7
#1 Deepwell	11/12/1992				795			1940	2464								
#1 Deepwell	3/2/1993				876			2020	2577								
#1 Deepwell	5/14/1993	0.02	<0.01	<0.01	709	1.7	7.4	1950	2481	269	22.0	14.0	337	575	<0.01	199	0.8
#1 Deepwell	9/1/1993	0.01		<0.00	736			1795	2526								

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
#1 Deepwell	11/8/1993				660			1940	2552								
#1 Deepwell	2/9/1994				591			1653	2226								
#1 Deepwell	5/5/1994	0.02	<0.03	<0.01	823	<0.1	7.17	1890	2609	209	58.4	10.0	309	529	<0.1	200	1.3
#1 Deepwell	8/1/1994	0.02		<0.01	723			1806	2525								
#1 Deepwell	11/16/1994	0.01		<0.01	696			1948	2631	219	72.0	12.0	317				
#1 Deepwell	2/9/1995	0.01		<0.01	689			1970	2814								
#1 Deepwell	5/10/1995	0.03	<0.1	<0.01	580	<0.1	8.01	1716	2623	165	74.0	11.5	307	459	<0.10	215	<0.2
#1 Deepwell	8/16/1995	<0.01		<0.01	742			999	1822								
#1 Deepwell	11/15/1995	<0.01		0.01	390			1071	1711								
#1 Deepwell	2/15/1996	<0.01	<0.03	0.01	727	0.16	7.67	1999	3203	218	73.2	12.2	310	645	<0.10	222	0.7
#1 Deepwell	5/15/1996	0.014	<0.10	<0.01	751	<0.10	7.98	1720	2497	125	38.6	6.6	393	464	<0.10	148	6.4
#1 Deepwell	8/12/1996	0.011	<0.03	<0.005	733	0.35	7.77	2030		232	73.1	12.3	322	627	<0.10	235	0.3
#1 Deepwell	10/30/1996	0.008	<0.03	<0.005	701	0.24	7.85	1810	2648	207	65.3	10.4	309	582	<0.10	210	1.4
#1 Deepwell	2/27/1997				440			1140	1822								
#1 Deepwell	4/29/1997	0.012	<0.1	<0.001	630	0.19	7.71	1910		193	61.7	10.4	303	608	0	183	0.8
#1 Deepwell	7/24/1997				641			1650	2367								
#1 Deepwell	11/3/1997	0.012			748			2010	2802								
#1 Deepwell	2/4/1998	0.013		<0.005	647			1860	2652								
#1 Deepwell	5/5/1998	0.01	<0.03	<0.005	681	0.33	7.91	1940		206	66.7	11.6	310	605	<1.0	214	0.4
#1 Deepwell	8/3/1998				641			1730	2443								
#1 Deepwell	10/28/1998				755			1970	2709								
#1 Deepwell	2/3/1999				811			1820	3081								
#1 Deepwell	5/11/1999				752			2070	31								
#1 Deepwell	8/17/1999				722			1980	2969								
#1 Deepwell	11/2/1999	0.0087	<0.03	<0.0010	763	0.38	8.25	2040	3160	164	65.9	12.6	267	469	<1.0	224	<0.200
#1 Deepwell	2/1/2000				744			2000	2759								
#1 Deepwell	4/27/2000	0.0101	<0.03	<0.005	716	0.41	7.62	2030	3013	225	74.2	13.1	302	635	<1.0	256	1.3
#1 Deepwell	8/2/2000				736			1780	2850								
#1 Deepwell	11/21/2000				718			1910	2846								
#1 Deepwell	5/16/2001	0.007	<0.03	<0.005	523	0.24	7.88	1660		169	65.6	11.8	232	445	<1.0	182	<0.200
#1 Deepwell	5/7/2002	0.011	<0.03	0.009	706	0.5	8	2000	2958	225	73.8	12.8	300			229	0.6
#1 Deepwell	5/13/2003	0.01	<0.03	0.007	713	0.5	7.87	1800	2898	232	78.5	12.5	281			228	1.4
#1 Deepwell	5/10/2004	0.0088	<0.03	<0.005	809	0.390	7.37	2130	2851	244	82.8	14.5	313			267	0.700
#1 Deepwell	4/5/2005	0.0072	<0.03	0.005	746	0.500	7.48	2000	2821	222	72.8	13.7	309			249	0.800
#1 Deepwell	10/10/2005	0.0090	<0.03	<0.005	703			2040	2815								
#1 Deepwell	5/23/2006	0.0095	<0.03	0.0050	759	0.800	8.19	2140	2870	234	76.0	14.2	320			307	1.50
#1 Deepwell	10/10/2006	0.0081	<0.03	0.0050	726			1950	2852								
#1 Deepwell	5/7/2007	0.0082	<0.03	0.0050	763	0.800	7.16	1980	2755	243	82.0	12.8	304			232	0.500
#1 Deepwell	10/1/2007	0.0100	<0.03	0.0060	682			1950									
#1 Deepwell	5/5/2008	0.0078	<0.03	<0.005	769	0.930	7.22	1900	2689	249	83.7	13.0	320			229	0.280
#1 Deepwell	8/27/2008	0.0073	<0.03	0.0130	738	1.000	7.47	1970	2751	244	80.6	12.8	318	585	<1.0	224	0.0400
#1 Deepwell	5/4/2009	0.0072	<0.03	<0.005	705	1.09	6.99	1980		226	74.1	11.4	293			221	0.41
#1 Deepwell	10/5/2009	0.0071	<0.03	<0.005	744			1990									
#1 Deepwell	3/30/2010	0.0089	<0.03	<0.005	730	1.10		1940	2795							223	
#1 Deepwell	5/3/2010	0.0076	<0.03	0.0070	758	1.10	7.20	1980	2792	229	75.7	13.3	323			238	0.230

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
#1 Deepwell	10/6/2010	0.0086	<0.03	<0.005	736			2020	2807								
#1 Deepwell	5/9/2011	0.008	<0.03	0.006	747	1.1	7.43	1960	2758	233	75.3	13.1	312			236	0.44
#1 Deepwell	10/10/2011	0.0120	<0.03	<0.005	758			1930	2726								
#1 Deepwell	5/7/2012	0.0075	<0.03	<0.005	744	1.1	7.34	1970	2762	237	74.4	12.8	284			226	0.46
#1 Deepwell	10/2/2012	0.0090	<0.03	0.0050	777			2030	2769								
#1 Deepwell	5/6/2013	0.0095	<0.03	0.005	754	1.1	7.28	2040	2840	241	79.7	12.4	307			238	11
#1 Deepwell	11/5/2013	0.008	<0.03	<0.005	748			1990	2770								
#2 Deepwell	10/15/1956				467	3.2	7.0	1170		65.0	128	0.0		466	<0.10	106	
#2 Deepwell	9/16/1977	0.06	0.07	0.01	634.9	1.6	7.1	1275								141.8	5.6
#2 Deepwell	9/28/1977	0.06	0.08	0.03	644	1.9	7.1	1500								141.8	0.8
#2 Deepwell	10/14/1977	0.03	0.02	<0.01	659	1.6	6.9	1500								127.65	2.1
#2 Deepwell	10/28/1977	0.03	0.01	<0.01	641	1.9	7.5	1350								134.71	0.2
#2 Deepwell	11/10/1977	0.05	<0.10	<0.01	609	1.6	7.5	1275								145	0.6
#2 Deepwell	11/23/1977	0.05	0.05	0.01	621	1.4	7.3	1575								145	1.0
#2 Deepwell	12/8/1977	0.08	0.05	0.01	650	1.1	7.2	1200								135	0.6
#2 Deepwell	12/29/1977	0.08	0.04	0.01	608	1.2	8.2	1350								145	1.2
#2 Deepwell	1/11/1978	0.07	0.03	0.01	634	1.2	7.6	1275								142	2.0
#2 Deepwell	3/20/1978	0.03	0.01	<0.01	609	1.5	7.5	1500		135						163	1.6
#2 Deepwell	5/22/1978	0.19	<0.01	<0.01	614	2.1	7.2	1200				0.0		823.2		135	2.9
#2 Deepwell	7/24/1978	0.04	0.03	0.04	608	1.2	7.35	1350								142	1.6
#2 Deepwell	9/15/1978	0.02	0.03	0.02	652	1.2	7.8	1500								149	1.6
#2 Deepwell	11/10/1978	0.05	0.03	0.01	656	1.8	7.4	1425								92	2.9
#2 Deepwell	1/12/1979	<0.01	0.09	0.01	641	2.1	7.7	1350								142	1.5
#2 Deepwell	3/5/1979	0.06	0.11	0.03	654	1.8	8.2	1425								177	2.2
#2 Deepwell	5/4/1979	0.09	0.08	0.03	541	1.4	8.1	1397						553		135	1.6
#2 Deepwell	7/3/1979	0.10	0.10	0.08	602	1.35	8.0	975								148.9	1.3
#2 Deepwell	9/4/1979	0.08	0.13	0.01	617.7	1.35	7.7	1200								149	1.8
#2 Deepwell	11/2/1979	<0.01	0.06	0.01	642	1.2	7.1									490	0.2
#2 Deepwell	1/3/1980	<0.01	0.09	<0.01	616.8	1.2	7.5	1575								199	0.7
#2 Deepwell	3/3/1980	<0.01	0.05	<0.01	807	1.1	7.75	1500								160	1.1
#2 Deepwell	9/4/1980	<0.01	0.02	0.02	668	1.2	7.9	1050						549		135	0.6
#2 Deepwell	10/23/1980	<0.01	<0.05	<0.00	669	3.5	7.4	1927		207	62	13.0	259	558		139	0.36
#2 Deepwell	11/6/1980	<0.01	0.03	0.02	650	1.1	7.8	1050				0.0		523		156	1.1
#2 Deepwell	1/6/1981	<0.01	0.02	<0.01	659	5.6	7.25									149	1.0
#2 Deepwell	3/16/1981	<0.01	<0.01	0.02	653	1.0	7.7	1640				0.0				149	1.7
#2 Deepwell	5/4/1981	<0.01	0.02	<0.01	646	1.05	7.6	1680				0.0		602		57	1.4
#2 Deepwell	7/1/1981	<0.01	0.02	<0.01	656	1.1	7.4	1600				0.0		561		178	0.5
#2 Deepwell	9/16/1981	<0.01	0.03	<0.01	638	5.4	8.0	1510				0.0		563		170	3.8
#2 Deepwell	12/23/1981	<0.01	0.02	<0.01	662	1.2	8.0	1620				0.0		374		163	1.2
#2 Deepwell	3/1/1982	<0.01	0.03	<0.01	713	1.1	7.8	1690				0.0		553		163	1.3
#2 Deepwell	7/29/1982	<0.01	0.04	<0.01	713	1.0	8.5	1620				0.0		558		156	4.6
#2 Deepwell	1/25/1983	<0.01	<0.01	0.03	650	1.3	7.9	1660		240	26.0	15.4	250	549		92	1.0
#2 Deepwell	4/7/1983	<0.01	0.02	0.03	664	0.7	7.8	1670				0.0		531		104	2.4
#2 Deepwell	6/16/1983	<0.01	<0.01	0.01	666	1.3	7.0	1590				0.0		573		77	0.9
#2 Deepwell	12/21/1983	<0.01	0.02	0.01	670	2.1	7.4	1540	2578			0.0		481		156	0.6

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
#2 Deepwell	3/22/1984	<0.01	0.01	0.01	669	6.2	7.8	1560	2125	250	49	14.0	245	549		156	0.9
#2 Deepwell	5/25/1984								2086								
#2 Deepwell	7/31/1984				629			1620	2193								
#2 Deepwell	9/24/1984	<0.01	0.02	0.01	702	13.1	7.3	1660	2384	298	6.0	14.0	260	437	<0.00	170	0.3
#2 Deepwell	12/29/1984				779			2430									
#2 Deepwell	3/13/1985	0.02	<0.01	0.02	762	4.1	7.1	1530		318	29.0	10.0	260	551	<0.00	156	0.5
#2 Deepwell	6/27/1985				702			3310	2346								
#2 Deepwell	9/12/1985	<0.01	<0.01	<0.01	682	7.8	7.0	1650		276	10.0	14.0	257	548	<0.00	156	1.8
#2 Deepwell	12/20/1985				675			3030									
#2 Deepwell	6/26/1986				718			1530									
#2 Deepwell	9/17/1986	<0.01	<0.01	0.02	707	5.4	7.7	1180	2384	279	10.0	13.0	275	471	<0.00	163	1.0
#2 Deepwell	1/9/1987				663			3090									
#2 Deepwell	7/15/1987	0.02			772			1730	2630								
#2 Deepwell	8/15/1987	0.02	0.01	0.01	772	2.7	7.0	1730		297	24.0	14.0	303	590	<10.0	203	0.3
#2 Deepwell	9/30/1987	0.01	0.01	0.01	806	2.5	7.3	1670	2360	298	2.0	14.0	295	449	<10.0	156	0.6
#2 Deepwell	12/22/1987				810			2950	2182								
#2 Deepwell	1/21/1988				815												
#2 Deepwell	2/21/1988							2460									
#2 Deepwell	3/29/1988	0.03	0.01		682	1.4	7.7	1440		234	22.0	15.0	287	468	<10.0	177	0.2
#2 Deepwell	6/15/1988				690			3510	2207								
#2 Deepwell	9/27/1988	0.17	0.01	<0.01	721	2.5	7.5	1500		279	15.0	14.0	278	421	<10.0	170	0.2
#2 Deepwell	12/8/1988				665			2820									
#2 Deepwell	6/21/1989				749			3680									
#2 Deepwell	12/19/1989	0.03	<0.01	<0.01	737	0.8	7.2	1850	2575	307	20.0	14.0	333	595	<10.0	191	<0.10
#2 Deepwell	2/15/1990				731			1720									
#2 Deepwell	5/9/1990	<0.01	<0.01	0.01	765	3.1	7.3	177.0		297	7.0	3.0	303	540		177	0.3
#2 Deepwell	8/7/1990				695			1700									
#2 Deepwell	11/27/1990				700			1730									
#2 Deepwell	2/25/1991				927			1820									
#2 Deepwell	5/22/1991	0.04	<0.01	<0.01	716	3.6	7.0	1850		308	22.0	14.0	285	572	<0.10	184	
#2 Deepwell	8/21/1991				711			1870									0.1
#2 Deepwell	11/6/1991				683			1840	2501								
#2 Deepwell	2/5/1992				711			1860									
#2 Deepwell	5/4/1992	0.02	0.01	0.01	831	3.3	7.4	1800		304	20.0	17.0	300	571	<0.10	184	
#2 Deepwell	8/12/1992				698			1830	2446								<0.20
#2 Deepwell	11/12/1992				823			1860	2361.55								
#2 Deepwell	3/3/1993				782			1870	2349.21								
#2 Deepwell	5/14/1993	0.05	<0.01	<0.01	669	3.5	7.5	1800	2308.99	269	26.0	15.0	277.0	536	<0.10	177	0.5
#2 Deepwell	9/1/1993	0.02		0.00	691			1761	2369.97								
#2 Deepwell	11/8/1993				633			1808	2363.58								
#2 Deepwell	2/9/1994				652			1777	2184.55								
#2 Deepwell	5/5/1994	0.05	<0.03	<0.01	768	1.96	7.06	1808	2411.62	222	64.1	10.1	257	487	<0.10	178	0.6
#2 Deepwell	8/1/1994	0.01		0.01	705			1714	2357.41								
#2 Deepwell	11/16/1994	0.01		<0.01	677			1799	2362.69	214	69.8	11.5	256				
#2 Deepwell	2/9/1995	0.01		<0.01	646			1790	2496.87								

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
#2 Deepwell	5/10/1995	<0.01	<0.10	<0.01	649	1.44	8.02	1817		218	74.0	11.4	250.0	549	<0.10	192	0.6
#2 Deepwell	8/16/1995	0.02		<0.01	679			1813	2553.11								
#2 Deepwell	11/15/1995	0.01		<0.01	704			1869	2525.80								
#2 Deepwell	3/13/1996	0.012	<0.03	<0.01	823	1.73	7.59	1854		267	86.7	12.0	253.0	560	<0.10	244	<0.20
#2 Deepwell	5/14/1996	0.011	<0.10	<0.01	698	1.84	7.47	1836	2739	220	89.8	11.8	263	565	<0.10	196	2.4
#2 Deepwell	8/28/1996	0.019	<0.03	0.009	662			1860									
#2 Deepwell	10/24/1996	0.008	<0.03	0.009	700	1.96	8.01	1830	2647	228	72.6	11.8	264	555	<0.10	206	0.4
#2 Deepwell	2/27/1997				702			1800	2350								
#2 Deepwell	4/29/1997	0.011	<0.1	0.004	627	2.25	7.83	1850		214	67.8	11.2	246	539	0	181	0.8
#2 Deepwell	7/24/1997				1031			1850	2492								
#2 Deepwell	11/3/1997	0.025	0.007	0.006	730			1960	2699								
#2 Deepwell	2/4/1998	0.011		0.008	642			1850	2521								
#2 Deepwell	5/5/1998	0.012	<0.03	0.008	661	1.71	7.8	1850	2597	212	69.3	11.4	257	558	<1.0	195	0.3
#2 Deepwell	8/3/1998				697			1860	2475								
#2 Deepwell	10/28/1998				716			1790	2453								
#2 Deepwell	2/3/1999				732			1780	2619								
#2 Deepwell	5/11/1999				693			1810	2806								
#2 Deepwell	8/17/1999				704			1790									
#2 Deepwell	11/2/1999	0.0106	<0.03	<0.0010	684	2.05	8.16	1800	3055	161	64.4	11.7	226	384	<1.0	197	<0.200
#2 Deepwell	2/1/2000				688			1810	2480								
#2 Deepwell	4/27/2000	0.0119	<0.03	<0.005	654	2.39	7.79	1810	2840	210	69.1	12.1	237	529	<1.0	218	0.4
#2 Deepwell	8/1/2000				678			1920	2721								
#2 Deepwell	11/21/2000				693			1800	2766								
#2 Deepwell	5/2/2001	0.01	<0.03	0.009	603	3.17	7.79	1790		211	69.1	10.7	237	512	<1.0	189	<0.200
#2 Deepwell	5/7/2002	0.009	<0.03	0.01	646	2.58	8.1	1780	2792	215	69.7	11.6	236			198	<0.200
#2 Deepwell	5/13/2003	0.0113	<0.03	0.013	646	2.3	7.86	1770	2628	234	76.3	12	239			198	0.2
#2 Deepwell	5/10/2004	0.0109	<0.03	0.0070	693	2.61	7.53	1790	2449	218	73.5	12.3	230			211	<0.200
#2 Deepwell	4/5/2005	0.0091	<0.03	0.0120	666	2.40	7.71	1730	2395	206	68.4	11.40	230.0			212.0	0.5
#2 Deepwell	10/10/2005	0.0113	<0.03	0.0080	602			1800	2455								
#2 Deepwell	5/23/2006	0.0108	<0.03	0.0090	653	2.60	8.36	1970	2434	206	67.6	12.0	240			237	<0.200
#2 Deepwell	10/10/2006	0.0118	<0.03	0.0090	681			1770	2670								
#2 Deepwell	5/7/2007	0.0115	<0.03	0.0080	706	2.40	7.29	1780	2426	230	75.1	12.0	251			210	<0.200
#2 Deepwell	10/1/2007	0.0114	<0.03	0.0090	612			1720	2389								
#2 Deepwell	5/5/2008	0.0110	<0.03	0.0080	709	2.43	7.38	1660	2412	225	76.6	11.5	256			194	0.230
#2 Deepwell	8/27/2008	0.0155	<0.03	0.0070	719	4.80	7.51	1900	2549	251	81.8	12.1	272	512	<1.0	216	0.0700
#2 Deepwell	5/4/2009	0.0128	<0.03	0.007	720	2.18	7.18	1890		227	76.2	12.3	267			222	0.25
#2 Deepwell	10/5/2009	0.472	0.25	0.006	1050			2180									
#2 Deepwell	3/29/2010	0.0904	0.0400	0.0070	757	1.20		1920	2711							210	
#2 Deepwell	3/30/2010	0.0124	<0.03	0.0070	714	2.00		1860	2659							216	
#2 Deepwell	5/3/2010	0.0110	<0.03	0.0090	736	2.00	7.21	1890	2576	228	76.0	12.7	290			230	0.0800
#2 Deepwell	10/6/2010	0.0118	<0.03	0.0070	684			1890	2600								
#2 Deepwell	5/9/2011	0.0116	<0.03	0.0080	716	2.10	7.74	1820	2586	225	72.5	12.1	281			218	0.1100
#2 Deepwell	10/10/2011	0.0109	<0.03	0.0070	698			1770	2509								
#2 Deepwell	5/7/2012	0.0276	<0.03	0.0060	712	1.50	7.68	1840	2528	224	71.6	11.3	265			198	0.0600
#2 Deepwell	10/2/2012	0.0115	<0.03	0.0080	709			1840	2538								

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
#2 Deepwell	5/6/2013	0.0122	<0.03	0.008	661	2.5	7.44	1790	2462	219	71.7	10.6	243			197	1.8
#2 Deepwell	11/4/2013	0.0108	<0.03	0.007	695			1800	2566								
534	7/24/1956				252	19.0	8.2					0.00		258	<0.10	28.0	
535	11/8/1995	0.02	<0.03	0.02	301	2.69	7.57	801	1154	143	34.0	3.2	77.0	322	<0.10	35.5	<0.2
545	5/6/2004	0.008	<0.03	0.0090	327	3.94	7.36	857	1178	155	43.4	2.50	56.5	423	<1.0	34.2	<0.200
806	7/25/1956				392	6.9	7.3					0.00		392.0	<0.10	72.0	
806	9/18/1981	<0.01	0.02	<0.01	617	3.6		1330				0.00		398.53			0.5
806	11/9/1994	0.012	<0.03	0.01	581	5.16	7.58	1500	1925	205	63.0	9.3	186	416	<0.10	168	0.3
806	7/24/1996	0.013	<0.03	0.008	578	4.06	8.06	1486	2190	200	62.8	9.1	182	404	<0.10	156	<0.2
806	11/12/1996	0.014	<0.03	0.008	585	4.5	7.79	1440	2217	210	64.1	9.0	176	399	<0.10	165	<0.2
806	9/2/1997	0.01	<0.03	0.007	592	4.42	7.95	1550	2063	212	63.4	9.2	184	406	<0.10	165	<0.2
806	8/10/1998	0.018	0.1	0.009	559	4.3	7.93	1500		197	61.7	8.8	179	406	<1.0	154	0.5
806	8/22/2000	0.018		0.008	498			1480	2304								
806	8/24/2001	0.018		0.011	540			1550	2178								
806	10/17/2002	0.015		0.01	566			1570	2673								
806	10/27/2003	0.015		<0.05	589			1570	2120								
806	4/21/2005	0.015	<0.03	<0.05	607	3.90	7.62	1510	2173	188	63.8	9.30	193	404	<1.0	193	0.300
806	11/18/2005	0.018		0.0090	1190			1460	2118								
806	10/4/2006	0.018	<0.03	0.0110	555	3.80		1530	2259							162	
806	10/2/2007	0.0184		0.0090	605			1570									
0806R	9/24/2008	0.0178	<0.03	0.008	634	4.10	7.13	1630	2258	234	76.8	9.90	211	423	<1.0	189	0.41
0806R	9/13/2010	0.0170		0.009	658			1660	2301								
0806R	4/14/2011	0.0203	<0.03	0.010	636	3.80	7.37	1650	2276	219	69.5	10.8	226	447	<5.0	191	0.33
0806R	10/18/2011	0.0274		0.017	635			1530	2291								
822	11/14/1988	<0.01	<0.01	<0.01	580	19.0	7.1	1400	2217	200	60	9.9	170	430	<0.10	150	0.3
822	8/23/1995	0.01	<0.03	0.01	592	3.18	7.34	1510	2174	185	59	8.9	230	442	<0.10	152	1.3
822	11/20/1996	0.096	<0.03	0.009	604	3.25	7.87	1490	2279	192	58.4	8	222	423	<0.10	149	6.1
907	8/5/1948													296	<0.10	28.0	
907	8/10/1953													296	<0.10	31.0	
907	6/15/1955						7.3							296	<0.10	33.0	
907	7/17/1956				291	14.0	7.5					0.00		286	<0.10	31.0	
907	6/7/1957				277	17.0	7.6							284	<0.10	31.0	
911	7/17/1956				253	15.0	7.5					0.00		261	<0.10	21.0	
911	6/7/1957				255	12.0	7.5					0.00		262	<0.10	22.0	
911	7/17/1996	0.016	<0.03	0.0080	300	5.1	7.61	869	946	134	37.3	3.5	67.6	298	<0.10	44.8	0.4
911	8/25/2008	0.010	<0.03	0.0150	336	4.2	7.80	823	1165	150	41.9	3.70	63.0	280	<1.0	38.0	-0.04
923	4/7/1993	0.44	0.01	0.01	960	15.47	6.78	2500	3729	290	110	14.0	320	480	<0.10	370	
923	10/11/1993	0.43	0.01	0.01	890	15.0	6.71	2300								350	
923	4/6/1994	0.35	<0.01	0.01	910	15.91	6.72	2850		300	120	13.0	340	500	<0.10	490	
928	7/12/1946				829	0.60		2170		254	88.00	0.00		702	<0.10	270	
928	6/4/1947				794									669	<0.10	238	
928	8/4/1948													688	<0.10	250	
928	8/18/1949													686	<0.10	254	
928	10/16/1950													668	<0.10	239	
928	6/25/1952													682	<0.10	245	

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
928	8/25/1952													675	<0.10	250	
928	10/6/1954				604	<0.1						0.00		360	<0.10	53.0	
928	8/10/1955				772		6.8					0.00		656	<0.10	242	
928	7/12/1976				829	0.60		2520				0.00		702		270	
928	07/09/1980	0.04	<0.05	<0.01	567	1.3	7.7	1400				0.00		333		49	0.86
928	01/12/1981		<0.05	<0.01	810	0.4	7.0	2170				0.00		520		180	
928	11/15/1988	0.062	<0.01	<0.01	630	0.8	8.36	1200	2208	30.0	7.2	1.8	420	330	5.0	43.0	0.2
928	03/14/1994	0.086	<0.03	0.01	818	0.48	7.71	1618	2236	81.5	16.8	2	439	299	<0.10	47.3	<0.2
928	10/24/1994	0.078	<0.03	0.03	835	0.53	8.01	1652	2197	79.6	19.3	2.8	408	316	<0.10	45.7	<0.2
928	02/09/1995	0.033	<0.03	0.01	569	0.15	8.4	1182	1819	18.1	4.9	1.6	372	319	4.5	40.9	<0.2
928	3/8/1996	0.071	<0.03	0.20	861	0.50	8.03	1580	2384	81.4	20.2	2.7	381	317	<0.10	45.5	<0.2
928	10/23/1996	0.072	<0.03	0.02	774	0.62	8.19	1490	2271	67.2	16.2	2.4	403	250	<0.10	43.2	<0.2
928	09/02/1997	0.061	<0.03	0.018	823	0.53	8.12	1500	2271	93.2	21.4	2.9	392	315	<0.10	46.0	<0.2
928	8/27/1998	0.101	<0.03	0.14	826	0.74	8.13	1640	2297	83.4	20.3	3.0	416	307	<1.0	49.2	0.4
928	8/26/1999	0.0945		0.03	836			1640									
928	8/9/2000	0.106		0.034	790			1590	2844								
928	8/29/2001	0.086		0.036	810			1710	2889								
928	10/21/2002	0.087		0.042	799			1740	2973								
928	12/9/2004	0.0822		0.0350	892			1700	2359								
928	12/5/2005	0.0887		0.0390	849			1620	2330								
928	12/10/2006	0.0853		0.032	863			1680	2335								
928	12/3/2007	0.0823		0.0290	806			1650	2321								
928	9/15/2008	0.0400	<0.03	0.0140	599	0.200	8.00	1230		31.7	7.50	1.60	422	319	<1.0	39.0	0.130
928	9/16/2008	0.0330	<0.03	0.0110	585	0.100	8.24	1210	1842	23.0	5.70	1.60	436	318	<1.0	44.0	0.290
928	9/17/2008	0.0285	<0.03	0.0100	556	0.100	8.19	1180	1819	15.6	4.10	1.50	431	317	2.0	44.0	0.720
928	3/24/2009	0.0326	<0.03	0.011	639	0.2	7.96	1320		39	10.2	2.6	396	347	<1.0	57	0.02
928	10/12/2009	0.0572		0.018	742			1390									
928	12/7/2009	0.0474	<0.1	0.015	660			1270									
928	5/3/2010	0.0568		0.016	720			1360	2065								
928	6/3/2010	0.0291	<0.03	0.009	537	<0.100	7.94	1120		12.1	2.80	1.40	434	344	<5.0	40.0	0.0060
928	6/14/2010	0.0323	<0.03	0.008	546	0.100		1180	1804							41.0	
928	12/6/2010	0.0780		0.020	865			1620	1835								
928	11/11/2011	0.0744		0.028	933			1640	2393								
938	7/12/1946				268	21.0		691		126	42.0	0.00		308	<0.10	32.0	
938	6/15/1955					22.0	7.30							295	<0.10	30.0	
938	7/18/1956				295	14.0	7.50					0.00		281	<0.10	23.0	
938	9/14/2010	0.0086		<0.005	316			819	1176								
943	8/28/1956				563	0.6	7.8					0.00		305	<0.10	88	
943	6/15/1995	0.02	<0.03	0.05	1053	8.56	8.04	2095	3108	22.5	4.4	2.3	615	261	<0.10	73.2	<0.2
943	6/15/1995	0.02	<0.03	0.05	1066	8.29	8.04	2012	3108	22.6	4.5	2.3	620	262	<0.10	71.5	
943	6/12/1996	0.029	<0.03	0.062	1189	8.36	8.13	2130		29.6	6.0	2.3	628	249	<0.10	81.0	<0.2
943	10/23/1996	0.025	<0.03	0.069	1170	8.64	8.25	2080	3189	31.4	6.6	2.6	641	320	<0.10	83.5	<0.2
943	8/21/1997	0.007	0.05	<0.005	1180	0.21	8.68	2040	3178	9.2	5.6	2.9	654	215	5.8	91.0	<0.2
943	8/18/1998	0.0006	<0.03	<0.005	1100	<0.10	8.29	1980	3046	8.4	6.5	4.3	623	222	<1.0	83.9	<0.2
943	9/2/1999	0.0024		0.006	1170			2070	3919								

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
943	8/23/2000	0.0017		<0.005	1070			2010	3832								
943	8/29/2001	<0.00030		<0.005	1000			2040	3822								
943	11/13/2002	0.001		<0.005	1080			2010	3840								
943	10/27/2003	0.0005		<0.005	1090			2030	2899								
943	3/9/2004	0.0180	<0.03	0.029	793	5.25	7.43	1830	2505	166	52.9	8.80	314	391	<1.0	188	0.3
943	12/8/2004	0.0136		0.020	690			1720	2315								
943	4/19/2005	0.0136	<0.03	<0.05	712	4.2	7.66	1680	2365	165	54.3	8.8	282	399	<1.0	181	<0.2
943	12/5/2005	0.0160		0.027	658			1690	2314								
943	3/16/2006	0.0179	<0.03	0.029	695	4.0	7.80	1670	2551	167	54.8	10.2	261	412	<1.0	161	0.400
943	12/19/2006	0.0149	<0.03	0.022	716	3.8	7.12	1710		191	62.4	9.80	282	298	<1.0	188	<0.2
943	3/8/2007	0.0184	<0.03	0.028	753	4.2	7.57	1790	2420	178	58.5	9.20	310	403	<1.0	175	0.600
943	12/3/2007	0.0185		0.023	649			1700	2356								
943	3/5/2008	0.0217	<0.03	0.029	742	4.0	7.48	1640	2411	181	56.2	9.40	288	422	<1.0	177	-0.06
943	9/16/2008	0.0182	<0.03	0.022	689	4.2	7.40	1650	2312	206	64.1	9.20	293	401	<1.0	168	1.20
943	12/1/2008	0.0162		0.022	666			1700	2344								
943	6/15/2009	0.0187	<0.03	0.022	696	4.0	7.26	1670		162	55.4	12.2	263	413	<1.0	182	0.18
943	12/7/2009	0.0199	<0.1	0.024	733			1670									
943	3/3/2010	0.0229	<0.03	0.029	697	5.20	7.52	1710	2494	176	56.0	8.70	302	467	<5.0	171	0.120
943	6/22/2010	0.0724	<0.03	0.087	1150	6.80	7.74	2200	3378	52.0	13.3	3.40	670	330	<5.0	144	-0.0500
943	8/5/2010	0.0753	<0.03	0.087	1330	9.40	8.09	2390	3502	62.0	15.6	3.30	788	347	<5.0	160	0.0900
943	9/21/2010	0.0208	<0.03	0.024	724	4.40		1700	2425							187	
943	10/27/2010	0.0246	<0.03	0.024	725			1740	2446							187	
943	12/6/2010	0.0239		0.022	731			1770	2085								
943	4/13/2011	0.0220	<0.03	0.025	713	4.2	7.46	1750	2497	195	60.6	10.00	316	439	<5.0	185	0.33
943	11/7/2011	0.0197		0.020	686			1620	2384								
943	8/16/2012	0.0484	<0.03	0.047	818	4.30	7.39	1850	2564	133	42.3	7.60	371	403	<5.0	176	0.560
943	11/30/2012	0.0402	<0.03	0.034	784			1810	2480							182	
949	10/6/1954				394	11.0						0.00		377	<0.10	65.0	
949	7/17/1956				407	9.5						0.00		377	<0.10	65.0	
949	5/7/1957				407	9.1						0.00		377	<0.10	65.0	
949	11/14/1988	<0.01	<0.01	0.01	470	16.0	7.21	1000	1725	160	51	7.5	100	310	<0.10	54.0	0.2
949	7/27/1994	0.010	<0.03	0.01	531	5.36	7.67	1151	1626	193	50	6.2	87.4	327	<0.10	89.8	0.6
949	11/20/1996	0.008	<0.03	0.008	464	5.3	7.69	1110	1703	189	51.9	5.87	104	340	<0.10	82	3.7
949	8/25/2008	0.012	<0.03	0.009	512	5.00	7.63	1200	1620	184	56.6	6.80	128	344	<1.0	108	0.170
951	04/15/1993	0.018	<0.01	<0.01	350	22.1	7.13	890	1422	140	42.0	4.7	74.0	260	<0.10	60.0	
951	10/05/1993	0.022	<0.01	<0.01	340	23.0	7.11	830					75.0			55.0	
951	04/05/1994	0.022	<0.01	<0.01	350	20.8	7.08	890	1514	160	46.0	5.2		340	<0.10	57.0	
951	08/31/1995	0.019	<0.03	<0.01	327	0.16	8.27	841	1262	138	44	5.1	77.0	325	<0.10	54.0	<0.2
951	03/07/1996	0.017	<0.03	<0.01	567	0.11	8.21	993	1530	87.2	69	9.8	117	113	<0.10	88.9	<0.2
951	10/22/1996	0.005	<0.03	<0.005	7.4	2.66	7.66	104	213	27.6	3.7	11.7	2.3	94.5	<0.10	3.1	<0.2
951	08/21/1997	0.024	<0.03	<0.005	330	1.48	7.94	872	1388	153	43	5.2	75.6	346	<0.10	50	<0.2
951	12/17/1997	0.024	<0.03	0.005	314	4.52	8.21	867	1243	148	42.3	5.2	73.0	340	<0.10	51	<0.2
951	8/18/1998	0.025	<0.03	<0.005	323	4.57	7.85	872	1478	148	43.2	5.6	76.5	342	<1.0	50.3	<0.200
951	8/19/1999	0.025		0.003	333			842									
951	9/17/1999	0.026		0.005	313			855	1185								

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
951	10/19/1999	0.025		<0.005	335			838	1221								
951	11/2/1999	0.023		0.003	335			857	1222								
951	12/10/1999	0.020		0.006	350			861	1200								
951	1/20/2000	0.032	<0.03	<0.005	333			824	1240								
951	8/9/2000	0.003		<0.005	270			623	1226								
951	10/17/2002	0.028		<0.005	314			896	1623								
951	10/27/2003	0.031		<0.005	342			942	1305								
951	12/8/2004	0.027		0.0080	334			919	1288								
951	4/25/2005	0.028	<0.03	<0.05	358	4.40	7.78	921	1318	145	43.1	4.90	80.5	331	<1.0	68.0	0.2
951	12/5/2005	0.033		0.0050	316			892	1350								
951	3/16/2006	0.037	<0.03	0.0060	356	4.20	7.91	912	1459	145	43.4	5.60	79.9	342	<1.0	83.0	0.800
951	3/9/2007	0.0317	<0.03	<0.005	360	4.50	7.79	916	1318	154	47.2	5.30	83.6	354	<1.0	62.0	<0.200
951	12/3/2007	0.0406		0.0060	325			932	1346								
951	3/5/2008	0.0400	<0.03	0.0060	349	4.50	7.49	938	1348	147	43.5	5.50	86.0	352	<1.0	62.0	7.60
951	8/27/2008	0.0470	<0.03	0.0050	382	5.00	7.66	976	1421	170	50.0	5.70	98.0	339	<1.0	74.0	-0.200
951	12/1/2008	0.0416		0.0060	348			982	1401								
951	3/20/2009	0.0384	<0.03	0.005	356	4.8	7.44	962		152	44.6	5.3	88.8	347	<1.0	64	0.09
951	3/24/2009	0.0366	<0.03	0.005	349	4.7	7.35	937		168	46.9	5.4	80.6	348	<1.0	63	-0.01
951	3/31/2009			0.0063	353	4.7	7.3	884		162	42.3	4.59	71.2	274	<10	57	
951	12/7/2009	0.0367	<0.1	0.006	356			899									
951	3/3/2010	0.0333	<0.03	0.0070	341	4.40	7.39	872	1366	148	43.6	5.10	81.3	375	<5.0	61.0	0.060
951	6/22/2010	0.0452	<0.03	0.0060	37.2	4.30	7.47	990	1429	152	44.9	5.60	90.3	372	<5.0	72.0	0.008
951	6/24/2010	0.0482	<0.03	0.0070	391	6.30		1040	907							100.0	
951	12/6/2010	0.0339		<0.005	359			985	1005								
951	4/13/2011	0.0325	<0.03	0.007	356	4.50	7.48	966	1340	153	44.0	5.50	85.0	360	<5.0	59.0	0.09
951	7/6/2011	0.0410	<0.03	0.0050	363	4.40		927	1379							64.0	
951	10/12/2011	0.0371	<0.03	0.005	360	4.6		927	1366							63.0	
951	3/9/2012	0.0351	<0.03	0.0060	348	4.50	7.47	960	1400	146	43.3	5.40	87.4	346	<5.0	61.0	0.48
0951R	4/24/2012	0.0317	<0.03	0.009	536			1410								147	
0951R	6/11/2012	0.0228	<0.03	0.009	520			1380	1973							139	
0951R	8/16/2012	0.0302	<0.03	0.0090	548	4.00	7.45	1490	2027	182	61.3	9.20	167	438	<5.0	156	0.95
0951R	8/27/2012	0.0286	<0.03	0.007	555	3.20		1420	2045							156	
0951R	3/6/2013	0.0377	0.08	0.009	581	4	7.25	1490	2107	205	67.3	9.6	195	425	<5.0	169	1.7
955	7/10/1980	<0.01	<0.05	<0.01	414	5.80	7.20	1149				0.00		333		61.0	0.3
955	7/21/1994	<0.00	<0.03	0.01	495	3.27	7.73	1082	1468	157	47.1	5.9	106	315	<0.10	64.3	1.0
955	11/3/1995	<0.01	<0.03	0.01	441	3.17	6.84	1031	1443	159	48.0	6.2	107	398	<0.10	63.0	0.3
955	7/18/1996	0.006	<0.03	0.007	433	3.08	7.58	1109	1645	152	48.1	6.2	109	320	<0.10	63.4	0.50
955	10/22/1996	0.019	<0.03	0.0110	454	3.56	7.85	1050	1577	159	48.8	6.2	109	328	<0.10	65.7	0.30
955	5/1/2006	0.0054	<0.001	0.011	461	3.60	7.84	1030	891	164	51.8	6.60	107	336	<1.0	68.0	1.0
955	8/25/2008	0.0054	<0.03	0.011	438	4.20	7.65	1030	1460	165	53.8	6.30	103	320	<1.0	70.0	0.21
986	1/11/1900																
986	11/2/1995	0.01	<0.03	0.010	435	4.53	7.95	1058	1476	170	47.0	5.60	99	331	<0.10	70.0	<0.2
986	11/3/1995								1476								
986	5/2/2006	0.0458	0.0020	0.018	606	2.90	7.92	1330		139	39.5	3.10	268	410	<1.0	48.0	<1.0
986	05/15/2007	0.0514															

Table C.2-6. Water Quality Data for Homestake Site and Distal San Andres Aquifer Wells

Well ID	Date	U (mg/l)	Mo (mg/l)	Se (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	pH (s.u.)	TDS (mg/l)	SC (µS/cm)	Ca (mg/l)	Mg (mg/l)	K (mg/l)	Na (mg/l)	HCO_3 (mg/l)	CO_3 (mg/l)	Cl (mg/l)	Ra-226 (pCi/l)
986	8/22/2008	0.0111	<0.03	0.01	468	4.30	7.62	1100	1290	166	50.7	5.70	119	328	<1.0	71.0	0.35
986	8/23/2008	0.0094	<0.03	0.01	474	4.90	7.60	1090	1310	178	52.5	5.90	114	328	<1.0	78.0	0.31
986	8/25/2008	0.0087	<0.03	0.01	476	4.60	7.52	1150	1300	173	54.5	6.20	118	337	<1.0	81.0	0.27
986	11/13/2008	0.0534	<0.03	0.024	876	5.10	7.84	1760	2270	192	50.6	3.70	322	384	<1.0	65.0	0.05
986	11/13/2008	0.0573	<0.03	0.024	876	5.10	7.78	1730	1640	196	51.7	3.70	319	385	<1.0	66.0	0.09
987	11/3/1995	0.01	<0.03	0.010	422	4.74	7.61	1054	1487	143	41.0	5.30	139	353	<0.10	61.0	<0.2
987	5/10/2007	0.0091	0.0010	0.011	547	3.60	7.60	1170		172	51.2	6.00	116	366	<1.0	59.0	<0.2
991	11/8/1995	<0.01	<0.03	<0.01	435	4.63	7.67	1064	1476	168	48.0	5.60	101	344	<0.10	70.0	<0.2
991	8/26/2008	0.0062	<0.03	0.010	427	4.40	7.73	1030	1430		52.3	6.10	101	320	<1.0	71.0	0.55
995	6/28/1956					31.0	7.40					0.00					
995	5/14/1958						7.60					0.00					
995	8/23/1995	0.01	<0.03	0.01	423	4.41	7.40	990	1489	169	46.4	4.80	85	315	<0.10	53.0	0.60
Old #1	7/19/1994	0.01	0.2	0.16	12.9	<0.10	9.77	696	1284	1.6	0.2	2.8	296	316	105	135	0.6
Old #1	3/8/1996	0.02	<0.03	<0.01	632	<0.10	8.24	1382		7.6	1.4	1.1	440	351	<0.10	53.7	<0.2

Notes:

Data from tables in HMC's annual reports issued since 1996, "Water Quality Analyses for the San Andres Aquifer" (scan quality was poor in very early reports so some results are uncertain).
HMC did not issue an annual report for the year 2009, so electronic data provided by HMC are used in some cases.
This table is limited to key parameters; some analytes not regularly reported by HMC and/or not monitored in Bluewater site wells are excluded (e.g., chromium, Ra-228, Th-230, vanadium).
Locations for most HMC wells are shown on Plate 7 (and Figures 16-19) of the Site Status Report; a few (e.g., Old #1) are not mapped due to the paucity of data and/or lack of relevance.
Although included in HMC's database, well 923 (three results from 1993–1994) was located at the Bluewater site in the region of San Andres well I(SG).
Results for HMC well 951 are duplicated in Table C.2-1 as it is at the Bluewater site boundary and is currently monitored by DOE.
Results from Bahar 2007 were also consulted to verify and/or supplement uranium results reported by HMC (reference provided below).

Bahar, 2007. Letter from Dana Bahar, Manager, Superfund Oversight Section of New Mexico Environment Department, to Chris Clayton, Office of Long-Term Stewardship, U.S. Department of Energy Office of Environmental Management, and to Ron Linton, Senior Groundwater Hydrologist, U.S. Nuclear Regulatory Commission Office of Federal and State Materials and Environmental Management Programs. Subject: Request for DOE and NRC to sample San Andres aquifer. October 17, 2007.

Uranium data obtained from Figure 6 ("Data from HMC" of this letter. Note that the units for uranium concentrations in this exhibit, listed as ppb (parts per billion) are incorrect. As confirmed by comparison of results with those in Homestake's reports, the units should be as mg/L uranium.

Table C.2-7. Water Quality Data, from NMED 2010 (Tables 8 and 10)

Sample ID	Fm	Alternate IDs (see App. B)	Latitude	Longitude	Date Sampled	U (µg/L)	U-238 (pCi/L)	U-235 (pCi/L)	U-234 (pCi/L)	Se (µg/L)	Mo (µg/L)	SO_4 (mg/L)	HCO_3 (mg/L)	SC (µS/cm)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)
BW-02	SA	HMC-965	35.225595	-107.888629	8/25/2008	6.4				10.9	<2	434	267	1289	159	47.1	106	6.19
BW-03	SA	HMC-986	35.224344	-107.888396	8/25/2008	11.7				10.8	<2	463	273	1379	171	49.4	126	6.11
BW-04	SA	HMC-991	35.229749	-107.888762	8/27/2008	7				9.2	<2	434	262	1273	160	50.2	105	6.16
BW-05	SA	BW-05	35.258875	-107.972292	8/25/2008	10.5	3.0	0.07	6.4	4	<2	475	356	1613	170	52.7	178	6.32
BW-06	SA	HMC-938	35.231733	-107.923966	8/25/2008	5.1				3.7	<2	249	230	1115	109	38.5	46.9	2.9
BW-07	SA	BW-07	35.265414	-107.994713	8/26/2008	9.4				2.2	<2	1440	476	3231	422	96.1	420	13.7
BW-08	SA	BW-08	35.265967	-107.975864	8/26/2008	4.9				2.5	<2	245	249	847	138	35.2	37.3	3.38
BW-09	SA	BW-09	35.248517	-107.976643	8/26/2008	7.8				4.8	2.1	345	293	1068	164	43.3	71.1	5.46
BW-10	SA	BW-10	35.256567	-107.966417	8/26/2008	5.5				2	<2	241	335	962	165	35.3	34.9	2.69
BW-11	SA	BW-11	35.25595	-107.967767	8/26/2008	5				<2	<2	222	312	910	147	33.6	26.5	2.97
BW-12	SA	BW-12	35.242589	-107.963738	8/27/2008	6.8				4.7	<2	352	288	1474	143	47	95.7	7.83
BW-13	SA	BW-13	35.23951	-107.961517	8/27/2008	6.4				3.8	<2	342	286	1446	149	44.8	83.7	6.1
BW-14	SA	BW-14	35.252936	-107.981026	8/27/2008	10.5	3.4	0.08	13.8	10	<2	451	284	1688	196	59.4	56.1	3.99
BW-15	SA	HMC-911	35.21802	-107.912511	8/25/2008	12	2.8	0.1	4.5	10.1	<2	341	233	1033	134	39.1	63.5	3.59
BW-16	SA	HMC-998	35.213846	-107.912278	8/27/2008	17.7				18.8	<2	385	230		148	42.3	80.6	3.92
BW-17	SA	BW-17	35.233128	-107.944206	8/28/2008	4.4				3.9	3.3	181	200	7889	79.3	37.7	33.8	2.18
BW-18	AL	Simpson, HMC-936	35.242809	-107.924478	8/28/2008	3.6				31	<2	529	188	1804	228	48.2	116	3.11
BW-19	SA	BW-19	35.236342	-107.932447	8/28/2008	14.2				11.1	3.3	290	242	1113	131	43.7	63.8	3.8
BW-20	SA	HMC-545	35.23341	-107.912254	8/28/2008	7.2				18.7	<2	415	222	1373	185	52.3	56.6	4.39
BW-21	SA	BW-21	35.203787	-107.908264	8/25/2008	11.8				16.3	<2	329	220	995	125	36.5	72.5	3.45
BW-22	SA	BW-22	35.203835	-107.915436	8/25/2008	5.4				7.3	3.4	162	182	644	73.3	29.2	32.5	2.22
BW-23	SA	HMC-949	35.234271	-107.888866	8/25/2008	13.8	4.3	0.4	7.1	8.5	<2	517	280	1624	187	54.5	133	7.02
BW-24	SA	BW-24	35.26193	-107.97442	8/25/2008	10.9	3.2	0.1	14.4	4.1	<2	478	362	2101	167	53.5	191	5.34
BW-25	SA	L(SG)	35.271106	-107.957824	8/27/2008	<2	-0.03	0.0008	0.01	<2	16.5	2.5	102	1344	0.6	1.9	332	5.47
BW-26	SA	S(SG)	35.268777	-107.938559	8/27/2008	<2 *	0.2	−0.1	0.4	<2	<2	357	<5	6753	758	61.6	113	1.84
BW-27	SA	OBS-3	35.271529	-107.938604	8/27/2008	<2 *	7.61	0.08	0.06	<2	<2	567	<5	3727	83.5	132	535	15.3
BW-28	SA	I(SG)	35.266163	-107.907318	8/27/2008	<2 *	0.04	−0.01	0.4	<2	<2	103	80	1175	14.5	10.8	192	5.22
BW-29	SA	HMC #1 Deepwell	35.242032	-107.856229	8/27/2008	8.9	0.3			7.3	<2	749	485	2828	225	77.8	312	13
BW-30	SA	HMC #2 Deepwell	35.239529	-107.864253	8/27/2008	16.7				7.7	3.5	727	426	2530	231	78.1	282	12.6
BW-32	SA	HMC-928	35.255295	-107.86176	9/16/2008	29	11.0	0.5	22.9	5	9.0	555	315	1858	15.2	4.3	423	1.56
BW-33	SA	HMC-943	35.225191	-107.876176	9/16/2008	20				16	1.0	678	400	2079	187	62.2	286	9.36
BW-34	SA	HMC-951	35.24748	-107.923981	8/27/2008	53.3	12.3	0.5	13.5	5.3	<2	383	274	1254	159	47.5	101	5.62
BW-35	SA	BW-35	35.279927	-107.831931	8/25/2008	6.4				10.9	<2	434	267	3857	159	47.1	106	6.19
SMC-03	AL	SMC-03	35.204251	-107.897797	3/31/2009	11				22.1	<50	369	272	1481	172	40.1	54.3	4.1
SMC-04	UNK	SMC-04	35.206449	-107.871402	3/31/2009	20.6 [19]	[5.61]		[11.1]	5.8	<50	200	284	1291	11.2	3.24	208	2.4
SMC-05	UNK	SMC-05	35.204204	-107.872925	3/31/2009	26.2 [26]				4.6	<50	105	308	1126	2.63	0.58	199	0.5
SMC-08	UNK	SMC-08	35.266714	-107.835451	3/30/2009	<2 [9]	2.8	0.2	3.9	3.8	<50	911	10	727	106	23.4	341	2.3
SMC-10	AL	HMC-914	35.277739	-107.830824	3/30/2009	30.9	0.04	0.01	0.1	32.1	<50	2110	170	2341	567	149	261	7
SMC-11	AL	HMC-920	35.276939	-107.84418	3/31/2009	228 [200]	63.0	2.8	78.1	367	<50	1580	188	3590	479	88.5	269	10.1
SMC-12	AL	HMC-950	35.289443	-107.839515	3/31/2009	163 [150]	52 [44.8]	2.3	61.9 [54.6]	382	<50	955	210	3206	59	10.3	628	0.5
SMC-13	AL	HMC-921	35.275482	-107.850652	4/2/2009	240 [220]	64.3	3.2	75.8	618	<50	1610	180	2922	389	73.7	355	8.4
SMC-14	AL	HMC-922	35.275194	-107.859294	4/2/2009	23.2 [21]				52.9	<50	535	246	1643	4.94	0.84	434	1.1

See Notes on following page. Results for SMC- samples in brackets are SLD radiochemical data (as reported in NMED 2010, Table 10).
* Result suspect; see Notes on following page and Figure 57 of Site Status Report.

Table C.2-7. Water Quality Data, from NMED 2010 (Tables 8 and 10)

Sample ID	Fm	Alternate IDs (see App. B)	Latitude	Longitude	Date Sampled	Cl (mg/L)	NO_3+NO_2 (mg/L)	Temp (°C)	DO (mg/L)	ORP (mV)	pH (s.u.)	Fe (µg/L)
BW-02	SA	HMC-965	35.225595	-107.888629	8/25/2008	65	3.83	16.23	2.0	69.4	6.89	<25
BW-03	SA	HMC-986	35.224344	-107.888396	8/25/2008	73	4.28	16.5	2.21	99.8	6.79	<25
BW-04	SA	HMC-991	35.229749	-107.888762	8/27/2008	67	4.13	16.2	3.68	-22	6.9	177
BW-05	SA	BW-05	35.258875	-107.972292	8/25/2008	101	1.75	18.51	1.98	118.6	6.69	<25
BW-06	SA	HMC-938	35.231733	-107.923966	8/25/2008	20	4.39	13.25	4.15	118.5	7.14	<25
BW-07	SA	BW-07	35.265414	-107.994713	8/26/2008	262	0.33	15.29	1.84	147.4	6.34	53.9
BW-08	SA	BW-08	35.265967	-107.975864	8/26/2008	25	2.69	14.9	4.86	115.6	6.98	<25
BW-09	SA	BW-09	35.248517	-107.976643	8/26/2008	40	4.18	13.94	15.87	135.2	6.66	<25
BW-10	SA	BW-10	35.256567	-107.966417	8/26/2008	17	2.79	14.43	9.67	160.1	6.55	<25
BW-11	SA	BW-11	35.25595	-107.967767	8/26/2008	14	2.24	14.58	8.62	170.1	6.55	<25
BW-12	SA	BW-12	35.242589	-107.963738	8/27/2008	45	3.83	13.52	3.9	153	6.84	<25
BW-13	SA	BW-13	35.23951	-107.961517	8/27/2008	39	3.46	13.67	3.89	191.6	6.82	<25
BW-14	SA	BW-14	35.252936	-107.981026	8/27/2008	48	4.79	15.01	5.32	132.3	6.58	<25
BW-15	SA	HMC-911	35.21802	-107.912511	8/25/2008	33	4.13	13.96	13.15	113.9	7.25	<25
BW-16	SA	HMC-998	35.213846	-107.912278	8/27/2008	42	4.2					<25
BW-17	SA	BW-17	35.233128	-107.944206	8/28/2008	11	3.51	15.55	7.89	104.2	7.14	<25
BW-18	AL	Simpson, HMC-936	35.242809	-107.924478	8/28/2008	147	10	16.95	7.76	80.5	6.99	<25
BW-19	SA	BW-19	35.236342	-107.932447	8/28/2008	27	4.65	13.62	4.98	197.3	6.85	<25
BW-20	SA	HMC-545	35.23341	-107.912254	8/28/2008	60	4.77	13.88	5.12	37	7.15	<25
BW-21	SA	BW-21	35.203787	-107.908264	8/25/2008	31	3.36	14.21	10.81	129.7	7.25	<25
BW-22	SA	BW-22	35.203835	-107.915436	8/25/2008	10	1.4	15.31	10.48	134.6	7.52	<25
BW-23	SA	HMC-949	35.234271	-107.888866	8/25/2008	101	4.76	16.35	8.24	135.6	7.06	<25
BW-24	SA	BW-24	35.26193	-107.97442	8/25/2008	107	0.34	15.42	1.53	125.5	6.72	45.4
BW-25	SA	L(SG)	35.271106	-107.957824	8/27/2008	217	0.02	17.16	0.81	-232.8	10.21	<25
BW-26	SA	S(SG)	35.268777	-107.938559	8/27/2008	2380	0.07	17.94	1.03	-75.4	5.4	564000
BW-27	SA	OBS-3	35.271529	-107.938604	8/27/2008	996	0.13	17.7	2.76	-119.6	6.48	1020
BW-28	SA	I(SG)	35.266163	-107.907318	8/27/2008	216	0.07	15.38	0.89	88.6	8.66	68.5
BW-29	SA	HMC #1 Deepwell	35.242032	-107.856229	8/27/2008	219	1.02	20.47	3.97	124.4	6.69	87.2
BW-30	SA	HMC #2 Deepwell	35.239529	-107.864253	8/27/2008	209	2.33	18.13	9	132.2	6.75	<25
BW-32	SA	HMC-928	35.255295	-107.86176	9/16/2008	36.5	0.11	14.95	0.81	74	8.27	<50
BW-33	SA	HMC-943	35.225191	-107.876176	9/16/2008	139	4.8	18.66	0.93	121.6	6.86	<50
BW-34	SA	HMC-951	35.24748	-107.923981	8/27/2008	57	4.61	13.92	8.95	172.8	7.22	33.4
BW-35	SA	BW-35	35.279927	-107.831931	8/25/2008	65	3.83	22.99	3.8	64.9	8.48	<25
SMC-03	AL	SMC-03	35.204251	-107.897797	3/31/2009	32	4.12	13.28	4.55	130.2	7.29	<25
SMC-04	UNK	SMC-04	35.206449	-107.871402	3/31/2009	33	0.82	12.79	1.29	25.2	8.57	<25
SMC-05	UNK	SMC-05	35.204204	-107.872925	3/31/2009	27	0.86	15.09	3.24	93.3	8.81	<25
SMC-08	UNK	SMC-08	35.266714	-107.835451	3/30/2009	78	0.05	12.74	5.01	116.5	8.36	2740
SMC-10	AL	HMC-914	35.277739	-107.830824	3/30/2009	47	21.2	12.98	0.16	-195.3	7.94	<25
SMC-11	AL	HMC-920	35.276939	-107.84418	3/31/2009	55	0.02	13.05	0.2	207.4	6.92	<25
SMC-12	AL	HMC-950	35.289443	-107.839515	3/31/2009	125	11.5	12.43	4.1	201	7.7	<25
SMC-13	AL	HMC-921	35.275482	-107.850652	4/2/2009	59	18.6	13.52	1.52	13.7	6.83	<25
SMC-14	AL	HMC-922	35.275194	-107.859294	4/2/2009	58	2.36	11.8	0.17	-222.5	8.76	28.4

Abbreviations

AL Alluvial Aquifer
Fm Formation
SA San Andres Glorieta (San Andres)
UNK Unknown

Notes

Data taken directly from NMED 2010, Tables 8 and 10 for sampling conducted in 2008 (not all parameters reported by NMED are listed here). For many locations, results are split samples of DOE and Homestake sampling.

Only 9 of the 27 unique SMC sample locations referenced in NMED's study were utilized in the Site Status Report: SMC-03, SMC-04, SMC-05, SMC-08, SMC-10, SMC-11, SMC-12, SMC-13, and SMC-14. The remaining SMC locations were not used because they are outside the study region addressed in the Site Status Report.

Uranium concentrations reported for BW-26 (S(SG)), BW-27 (OBS-3), and BW-28 (I(SG)) are all suspect, as uranium concentrations in San Andres aquifer wells in this region are known to be higher. Results for San Andres well 16(SG), about 1 mg/L uranium, are considered more characteristic

Table C.2-8. Uranium and Uranium Isotope Results from New Mexico Drinking Water Branch

Sample Location (DWB Facility Name)	System Name	Latitude	Longitude	Well Depth (ft)	Sample Date	DWB Hyperlink (= Lab Sample No.)	Result Type	Sampling Point	Combined Uranium (mg/L)	Combined Uranium (pCi/L)	U-234 (pCi/L)	U-238 (units vary)	Activity Ratio	Comment
Grants Well #1 (B-38)	Grants Domestic Water System	35.1568	-107.8672	300	10/27/2004	RC20040452	RAD	SP261330011	0.006			6 µg/L		
Grants Well #3 (B-40)	Grants Domestic Water System	35.1631	-107.8782	388	10/27/2004	RC20040453	RAD	SP261330031	0.006			6 µg/L		
Well #1 (B-23)	Milan Community Water System	35.1748	-107.8930	214	10/27/2004	RC20040449	RAD	SP255330011	0.005			5 µg/L		
Well #1 (B-23)	Milan Community Water System	35.1748	-107.8930	214	8/5/2008	RC200800268	RAD	SP255330011	0.005					
Well #1 (B-23)	Milan Community Water System	35.1748	-107.8930	214	12/2/2009	RC200900327	RAD	SP255330011	0.004		3.07	1.3 pCi/L	2.4	
Well #1 (B-23)	Milan Community Water System	35.1748	-107.8930	214	5/26/2010	RC201000119	RAD	SP255330011	0.005					
Well #1 (B-23)	Milan Community Water System	35.1748	-107.8930	214	5/26/2011	2011019872	RAD	SP255330061	0.004					
Well #1 (B-23)	Milan Community Water System	35.1748	-107.8930	214	7/2/2014	2014021196	RAD	SP255330061	0.005					See Note 1
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	6/19/1996	RC960292	RAD	SP255330031	0.011	8.4	6.26	3.69 pCi/L	1.7	See Note 2
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	10/27/2004	RC20040450	RAD	SP255330031	0.005			5 µg/L		
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	8/5/2008	RC200800270	RAD	SP255330031	0.004					
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	12/2/2009	RC200900325	RAD	SP255330031	0.004		2.6	1.25 pCi/L	2.1	
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	5/26/2010	RC201000120	RAD	SP255330031	0.004					
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	9/15/2011	2011033474	RAD	SP255330051	0.004					
Well #3 (B-35)	Milan Community Water System	35.2061	-107.9004	185	7/2/2014	2014021200	RAD	SP255330051	0.004					See Note 1
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	6/23/1997	RC980131	RAD	SP255330041	0.008	7				See Note 3
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	9/23/1997	RC980131	RAD	SP255330041	0.008	7				See Note 3
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	12/23/1997	RC980131	RAD	SP255330041	0.008	7				See Note 3
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	3/23/1998	RC980131	RAD	SP255330041	0.008	7				See Note 3
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	10/27/2004	RC20040451	RAD	SP255330041	0.013			13 µg/L		
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	8/5/2008	RC200800269	RAD	SP255330041	0.013					
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	12/2/2009	RC200900326	RAD	SP255330041	0.012		5.79	3.81 pCi/L	1.5	
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	5/26/2010	RC201000121	RAD	SP255330041	0.013					
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	null	RC980131	RAD	SP255330041	0.007					
Well #4 (Golden Acres)	Milan Community Water System	35.2138	-107.9123	165	7/2/2014	2014021198	RAD	SP255330071	0.012					See Note 1
Bluewater Well #1	Bluewater Water & Sanitation District	35.2485	-107.9766	345	11/30/2005	10500973	RAD	SP250330011	0.0066					
Bluewater Well #1	Bluewater Water & Sanitation District	35.2485	-107.9766	345	11/30/2005	8290DW1	RAD	SP250330011	0.0066					
Bluewater Well #1	Bluewater Water & Sanitation District	35.2485	-107.9766	345	5/1/2012	2012015919	RAD	SP250330011	0.008					

DWB Drinking Water Branch (State of New Mexico website)
U Uranium
0.011 Mass uranium (in mg/L) calculated based on actual or assumed U isotope concentrations using: (a*2.989) + (b*0.4683) + (c*0.00016), where a = U-238 in pCi/L; b=U-235 (pCi/L), and c=U-234 (pCi/L)
U-235 contribution assumed to be negligible given lack of data for these samples. See Notes below.

Notes

1 Results from July 2014 weren't available at the time the Site Status report was being developed, so these are not included in Figure 61 of the report.
2 Mass uranium calculated using the formula above. The combined uranium result for this record, 8.4 pCi/L, is anomalous given reported activites of U-234 and U-238 isotopes for that sample.
3 Mass uranium calculated using the formula above assuming a U-234/U-238 activity ratio of 1.5 based on the 12/2/2009 result.

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Appendix D

Information Sources

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D1.0 Information Sources

Numerous sources of information were accessed to develop the Bluewater-site components and regional components of the conceptual model. Given the long history of the Bluewater site and widespread interest in how mill-related contaminant plumes have evolved in the study area, groundwater-elevation and water-chemistry data for the alluvial and San Andres aquifers were drawn from a variety of databases, government publications, and consulting reports. This chapter briefly summarizes the content of some of the information sources used for the conceptual model and highlights findings that have bearing on the long-term fate of uranium in the regional groundwater system. More detailed summaries of environmental investigations performed in the Grants-Bluewater Valley are available in the bibliography by Otton (2011).

D1.1 Bluewater Site–Related Reports

From the late-1970s to the mid-1980s, the firm Hydro-Search, Inc. (Hydro-Search) developed several reports describing the hydrogeology of the Bluewater site and surrounding region, and presented water chemistry data collected from numerous wells in the Grants-Bluewater Valley. In the report *Hydrogeology of the Bluewater Mill Tailings Pond Area, Valencia County, New Mexico*, Hydro-Search (1977) summarized the geology of and groundwater conditions in the alluvial and San Andres aquifers at the Bluewater site and developed a conceptual model of contaminant seepage from the main tailings impoundment to the aquifers. The chemistry of tailings fluids was examined along with the chemistry at site wells to develop a contaminant source mechanism for plumes migrating east and southeast of the site. Taking into account the apparent impact of the Ambrosia Lake fault and the East-West fault on local groundwater flow, Hydro-Search (1977) described various flow processes by which contamination originating as tailings waste fluids was distributed between the two aquifers. A follow-up report the next year (Hydro-Search 1978a) refined some of the hydrologic- and transport-process descriptions as well as quantities attributed to the processes.

Hydro-Search (1978b) provided a thorough report on the groundwater-monitoring program at the Bluewater site as of the late 1970s, including construction details for the wells comprising the monitoring network and descriptions of the physical measurements and chemical analyses that facilitated characterization of the ambient and mill-impacted groundwater system. In addition, several recommendations were made in this report regarding monitoring system improvements to better evaluate spatial and temporal trends of site-related contaminant plumes. A detailed history of contaminant concentrations at key wells within the monitoring system was provided in a separate report a few years later (Hydro-Search 1981a).

Hydro-Search (1981b) conducted a study of the groundwater hydrology of the Grants-Bluewater Valley, producing a useful and insightful assessment of the potential impact of contamination stemming from milling at the Bluewater site on regional hydrologic resources. Map views and extensive tabulations of groundwater-elevation and groundwater-chemistry data provided an initial perspective on the extent to which impacted groundwater had, at the time, migrated eastward and southeastward in the alluvial and San Andres aquifers from the mill site.

The consulting firm Dames & Moore (1981c) summarized the activities and results from several aquifer pumping tests performed on wells at the Bluewater site. The report shed light on the wide range of transmissivity, hydraulic conductivity, and storativity values that characterize the San

Andres aquifer. Several of the tests analyzed also provided information on the nature of groundwater flow in ancestral Rio San Jose deposits below basalt flows at the site.

Dames & Moore (1986a) developed a comprehensive model of groundwater flow and transport processes at the Bluewater site and in downgradient areas. In addition to accounting for flow in both the alluvial and San Andres aquifers, the model simulated the transport of chloride, sulfate, and TDS in areas hydraulically downgradient of the Bluewater site. The model report provides detailed descriptions of the geologic units that comprise both the regional and site-specific groundwater flow and transport systems and summarizes numerous subsurface processes that impact the fate of inorganic constituents in the Grants-Bluewater Valley.

Much of the modeling effort by Dames & Moore (1986a) focused on the steps taken to calibrate the regional flow and transport simulator. Multiple calibration targets in the form of measured water levels at regional wells, groundwater discharges at springs, and the concentrations of nitrate and chloride in Bluewater site wells were selected. One of the findings from the modeling was that an effective porosity of 0.02 for the San Andres aquifer was needed to accurately match the plume extents for contaminants transported east and southeast of the site. Dames & Moore confirmed earlier findings from Hydro-Search that the velocities in the two aquifers were large enough to establish mostly steady-state constituent concentrations in onsite plumes within just a few years. Predictions made with the model suggested that both onsite and offsite contaminant concentrations would decrease steadily in following years.

Dames & Moore (1986b) followed up its modeling investigation of the Bluewater site with a lengthy summary of water quality conditions in the alluvial and San Andres aquifers. The assessments of water quality was based on the preparation of plume maps of key contaminants in 1986 and temporal plots of contaminant concentrations at onsite wells over several years.

The consulting company Applied Hydrology Associates Inc. (1990, 1993, 1995) developed a corrective action program for the Bluewater site after assessing the benefits of site remediation steps designed to reduce the amount of contamination loaded into the local groundwater system and remove contamination residing in the subsurface. Several different alternatives were evaluated, all of which took into consideration a list of physicochemical processes that could impact contaminant migration. Though the list of contaminants included in the evaluations comprised uranium, selenium, and molybdenum, most of the technical assessments conducted dealt with uranium because of its relatively high mobility and apparently large extent in areas downgradient of the site. Applied Hydrology Associates, Inc. (1995) provided detailed estimates of the volume of tailings waste fluids and associated uranium contaminant mass that was loaded to the subsurface at the main tailings impoundment, covering the period from 1953 to 2000. Measured uranium levels at key wells were plotted over multi-year periods from the early 1980s through the early 1990s to ascertain the relative stability of uranium concentrations during that period, and to help in projecting future concentration beneath onsite areas.

Applied Hydrology Associates Inc. (1995) summarized the results of previous and recent aquifer pumping tests at the site to characterize hydraulic properties that govern contaminant transport in the alluvial and San Andres aquifers. Assessments of the aquifers' capacity to attenuate uranium transport with flow distance were also conducted. After a thorough evaluation of the various processes that influence long-term fate of contaminants at the Bluewater site, Applied Hydrology Associates, Inc. (1995) proposed ACLs for uranium, selenium, and molybdenum.

D1.2 Homestake Site-Related Reports

The geology, hydrogeology, and groundwater remediation activities at the Homestake site have been documented in a large number of reports that have been prepared by a variety of sources, including HMC, environmental consultants to HMC, and the EPA. Annual reports on the progress of the GRP have been prepared by HMC and their consultants over the past few decades. A few of the more recent examples include HMC and Hydro-Engineering (2010, 2013). These reports provide detailed summaries of the remediation activities carried out each year under the GRP and tabulations and maps of monitoring results. Some map products and accompanying cross sections illustrate the latest understanding of the spatial distribution of hydrogeologic units, which include San Mateo alluvium, several distinct strata within the Chinle Formation, and the underlying San Andres Limestone. Other maps contain posted groundwater levels and concentrations of select contaminants, including uranium and sulfate, in the geologic units present, along with contoured representations of these parameters. Detailed tables provide time-varying values of these parameters over the course of the reporting year and potential explanations for anomalous changes in concentration for monitored contaminants. In recent years, monitoring results from a vast array of wells completed in the alluvial aquifer have made it possible to prepare contour maps of groundwater levels and uranium concentration in the aquifer, including at areas where ancestral Rio San Jose alluvium extends from near the Bluewater site and merges with San Mateo alluvium extending westward from the Homestake site. The annual reports (e.g., HMC and Hydro-Engineering 2010, 2013) also provide maps and tabulated versions of water quality results, including for uranium, from wells screened in the San Andres aquifer at and near the Homestake site.

A corrective action plan for the Homestake site, outlining the various components and procedures of the GRP, has been published a few times. Hydro-Engineering (1989) developed a version of the Homestake corrective action plan that comported with early phases of the GRP. An updated corrective action plan was prepared in 2012 (HMC 2012). The plans provide detailed descriptions of the geologic and hydraulic properties of the hydrogeologic units, including updates that result from new characterization activities. The latest water quality results for the components of the GRP are also reported.

Three five-year review reports have been prepared for the Homestake site, as mandated under Superfund. In addition to reporting on the progress being made by HMC in its attempt to meet prescribed groundwater remediation goals, the five-year reports (CH2M-Hill 2001; EPA 2006, 2011) identify potential problems with site-cleanup efforts and make recommendations for improving the groundwater remediation strategy and remediation activities. In the third and most recent five-year review of the Homestake site, the EPA (2011) expressed concern that the complex groundwater remedy might be contributing to elevated uranium concentrations observed at wells screened in the San Andres aquifer in the vicinity of the site. Specifically, the concern is that the combination of HMC's pumping from the San Andres aquifer and injection of water into shallow alluvium has created about 100 ft of hydraulic-head difference between the two aquifers, which, when combined with the local presence of a major fault zone that can act as conduit, has the potential to convey alluvial groundwater with high levels of uranium contamination to the San Andres aquifer. Elevated uranium concentrations have been observed locally in recent years.

D1.3 USGS Reports

The USGS has published several reports that address the hydrology of the Grants-Bluewater Valley and the Zuni Mountains. The reports shed light on the potential impacts that both surface water and groundwater features in the region can have on contaminant migration from the Bluewater and Homestake sites.

A USGS report by Baldwin and Anderholm (1992) assessed regional groundwater flow in the San Andres Limestone and the underlying Glorieta Sandstone in west-central New Mexico, as well as in the alluvial aquifer in the Grants-Bluewater Valley. The effects that less permeable geologic units have on the regional hydrogeology, including the Triassic-age Chinle Formation and Permian-age formations underlying the Glorieta Sandstone, were also identified. The authors described how a large amount of subsurface flows in the region occurs within secondary permeability features, particularly solution channels, cavernous zones, and fractures in the San Andres Limestone. The presence of these features was identified using aquifer-test results and the rock lithologies reported in well logs for several key wells screened in the San Andres aquifer. In addressing the spatial variability of hydraulic properties for the aquifer, this report identified a wide range of values for transmissivity and hydraulic conductivity derived from aquifer tests at San Andres aquifer wells. The authors used this information to divide the region into seven transmissivity zones. The spatial distribution of the zone helped explain the regional potentiometric surface that is typically observed for the San Andres aquifer in the Grants-Bluewater Valley.

Baldwin and Anderholm (1992) identified multiple recharge zones for the San Andres aquifer on the northeast flanks of the Zuni Mountains where outcrops of limestones and sandstones associated with the aquifer are observed. The importance of recharge from precipitation and surface water features in the region, including Bluewater Lake, Bluewater Creek, Rio San Jose, and several irrigation canals was also identified. A significant finding in the report was that recharge varies substantially from year to year depending on yearly precipitation amounts and the general availability of surface water over multi-year periods. Significant areas of groundwater discharge from the San Andres and alluvial aquifers, such as at springs, were also pointed out along with rough estimates of the discharge quantities. The combination of recharge and discharge features in the region allowed the authors to illustrate general directions of groundwater flow in the Grants-Bluewater Valley and the impact that faults have on regional flow patterns. Baldwin and Anderholm (1992) also described the inorganic chemistry and general quality of water in the alluvial and San Andres aquifers as well as in less permeable geologic units affecting aquifer flows. The chemical data helped in identifying flow patterns in the regional groundwater system.

Baldwin and Rankin (1995) authored a USGS report that summarized the hydrogeology of Cibola County and evaluated occurrence, availability, and quality of groundwater resources. Rocks of Precambrian through Quaternary age were studied. The report focused mostly on the most productive aquifers in the county, including Quaternary alluvium and basalt, sandstones in the Mesaverde Group, the Dakota-Zuni-Bluff aquifer, the Westwater Canyon aquifer, the Todilto-Entrada aquifer, and the San Andres-Glorieta aquifer. The authors described how well yields can vary greatly within the county. Baldwin and Rankin (1995) also described the water quality in the most productive aquifers in the region, characterizing dissolved-solids levels and the concentrations of the major anions and cations in each geologic unit.

Frenzel (1992) developed a numerical model of groundwater flow in the San Andres aquifer and overlying valley fill. The work was performed in cooperation with the New Mexico Office of the State Engineer, two Native American Pueblos east of Grants, and the U.S. Bureau of Indian Affairs. The purpose of the study was to determine the effects of current and projected water development in the region containing the San Andres aquifer on hydraulic heads in the aquifer and flow in the Rio San Jose.

The digital, finite-difference flow model by Frenzel (1992) contained 2 layers, 76 rows, and 43 columns. In addition to simulating groundwater flow in the Grants-Bluewater valley fill, the model accounted for flow to and from Bluewater Lake and flow in Bluewater Creek and the Rio San Jose. A major spring in the region, Ojo del Gallo, was simulated as a stream. The effects of multiple faults in the region were assessed with the model. Historical groundwater withdrawals and recharge were simulated for the period of fall 1899 to fall 1985. Measured hydraulic heads and streamflows were considered to have been matched reasonably well by the simulated values.

A study was conducted by Risser (1983) to estimate the natural streamflow in the Rio San Jose just upstream of two Native American Pueblos east of Grants. The estimates were based on numerous streamflow and precipitation records compiled by the author, along with historical accounts of streamflow, records of irrigated acreage, and empirically derived estimates of the effects of Bluewater Lake, groundwater withdrawals, and irrigation diversions on surface water flows at various locations within the Rio San Jose watershed. The Risser study used 55 years of recorded and reconstructed streamflow data, from water years 1913 to 1972. The report provides historical precipitation data for meteorology stations in the region and streamflow data for several streams in the Rio San Jose drainage.

West (1972) examined the geologic and hydrologic environments in the vicinity of the Bluewater uranium mill to ascertain whether Permian formations older and beneath the Glorieta Sandstone were favorable for disposal of mill effluent via an injection well north of the main tailings impoundment. His investigation specifically evaluated the capacity of beds of sandstone in the Yeso Formation to accept effluent delivered by gravity flow at rates of 200 to 400 gallons per minute (gpm) at depths of 950 to about 1,400 ft below ground surface. It was demonstrated in the study that a thick interval of siltstone, anhydrite, and gypsum of low permeability in the upper part of the Yeso Formation would separate the injection interval from the principal freshwater aquifer in the Glorieta Sandstone and the San Andres Limestone.

An exploratory disposal well was tested thoroughly during and following drilling (West 1972), and borehole core samples were analyzed for porosity and permeability. The water quality of native formation fluids was examined, which showed the injection interval contained 3,900 mg/L of dissolved solids, of which 2,200 mg/L was sulfate. The exploratory well was subjected to various aquifer pumping tests, after which additional casing intervals were perforated and all perforated horizons were fractured hydraulically. A 90-day injection test followed, using intermittent inflow rates varying between 380 and 1,300 gpm. Operational injection began in December 1960, after which additional testing of the Yeso Formation was conducted and the capacity of the well to accept injection water was recorded. Some data from the testing suggested that the Yeso Formation might be leaking effluent to overlying formations. The injected water contained mill waste effluent with TDS concentrations as high as 13,000 mg/L and uranium concentrations considerably higher than regional background values.

D1.4 Regional Studies

Gordon (1961) described the geology and hydrogeology of the Grants-Bluewater area at a time when uranium mining and milling activity in the region was approaching its peak. This work provided a scientific assessment of the aquifers in the region and summarized the development of regional groundwater resources while reporting on the historical importance of both the alluvial and San Andres aquifers to local agricultural, industrial, and municipal needs. Gordon (1961) reported on the physical effects of groundwater withdrawals in the valley and the potential environmental issues stemming from using the groundwater for irrigation and industrial uses, including uranium milling.

In addition to providing detailed descriptions of the physical, lithologic, and hydraulic properties of geologic units in the region, Gordon (1961) characterized the groundwater quality. The author discussed how hydrologic and other processes such as recharge, pumping, chemical weathering, and evapotranspiration might impact water chemistry. The earliest aquifer pumping tests performed on wells in the Grants-Bluewater Valley were discussed in Gordon (1961).

Kaufmann et al. (1975) summarized the degree to which contamination from uranium mining and milling activities in the Grants Mineral Belt affected regional groundwater quality. In their study, radium, selenium, and nitrate were of most value as indicators of contamination. The authors described how effluents from recent mining contained high radioactivity levels and mill-tailing seepage contributed to elevated levels of selenium in local, shallow alluvial aquifers. The study was sponsored by the EPA at the request of the New Mexico Environmental Improvement Agency in 1974. Water sampling and analysis occurred in 1975. Many of the findings in the EPA report were subsequently summarized in a journal paper (Kaufmann et al. 1976).

The New Mexico Environment Department (NMED) (2010) conducted a study in 2008 of the groundwater chemistry at a large number of wells in the Grants-Bluewater Valley to ascertain whether the chemical results could be used to determine the source of mill-related contaminants in the valley. The region included in this investigation extended from the Bluewater site to the Homestake site, and covered areas between the Ambrosia Lake mining district and the Homestake site. A large variety of chemical parameters were measured in 2008 at the wells in the study region, ranging from major ions to TDS, metals and other dissolved inorganic constituents, and both stable and radioactive isotopes.

NMED (2010) examined isotopic ratios of carbon, oxygen, hydrogen, sulfur, and the radioactive uranium series from a limited number of groundwater samples. One of the objectives of this effort was to determine if discrepancies in the isotopic ratios could distinguish background water quality from groundwater impacted by releases from uranium mining and milling operations. Utilization of environmental forensic methods such as these was expected to more accurately define baseline water quality conditions in groundwater sources with and without possible anthropogenic impacts.

D1.5 DOE Reports

DOE (1997) developed a long-term surveillance plan (LTSP) for the Bluewater site. The plan described physical, geological, and hydrological features of the site and addressed how groundwater contamination resulting from the former uranium mill operations would be monitored by DOE in coming years. Relevant construction features of the main tailings disposal cell and the carbonate tailings disposal cell were described to help facilitate future inspections of remnant features of the milling activities.

DOE (2014) assessed the water balance of the main tailings disposal cell at the Bluewater site (Appendix A). The assessment took into account the history of the cell from its origin as an impoundment for the storage of tailings fluids produced by the Bluewater mill. Technical reviews of previous work performed by various environmental consultants aimed at quantifying the seepage rates and volumes of tailings fluids discharging to the subsurface from the base of the impoundment and disposal cell were also performed. As part of its assessment, DOE (2014) took into consideration some recent geologic characterization work aimed at describing the physical and potential hydraulic relationships between the hydrogeologic units underlying the disposal cell, concentrating a great deal on the impacts of the Ambrosia Lake fault and the East-West fault on local and regional groundwater flow.

Conclusions drawn from the water balance assessment included the recognition that nearly half of the mass loading of uranium contamination from the main tailings impoundment and disposal cell occurred prior to 1960. The water balance report also concluded that most of the acidic tailings fluids that had drained from the impoundment in earlier years of mill operation had been neutralized, such that the contaminants in the fluids remained in the alluvial and San Andres aquifer media as solids, in adsorbed and mineralized phases. As a result of the subsurface neutralization processes, dissolved concentrations of uranium and other tailings-related contaminants had been greatly reduced. DOE (2014) found no evidence that the groundwater beneath and near the main tailings disposal cell had received a pulse of contamination from the cell over the past several years. The mineralized zone beneath the disposal cell was expected to be a continuing source of groundwater contamination for an indefinite period in the future.

D1.6 Miscellaneous Papers

Longmire et al. (1984) authored a paper that described the general impacts of the uranium industry in the Grants Mineral Belt on groundwater quality in the region. The paper described the thermodynamic controls on the geochemistry of the principal contaminants in mill tailings and raffinates, including uranium, iron, selenium, and molybdenum, and some of the controlling mineral reactions. It noted differences in the aqueous geochemistry of raffinates and the seepage from mill tailings, and between the seepage derived from acid-leach mill processes and those derived from alkaline-leach mill processes. Contamination of groundwater from acid-tailings seepage was characterized by sulfate, chloride, nitrate, iron, aluminum, manganese, and other metals (Longmire et al. 1984). Contamination of groundwater from alkaline-tailings seepage was characterized by elevated levels of arsenic, sodium, bicarbonate, nitrate, selenium, molybdenum, sulfate, and uranium.

Zielinski et al. (1997) identified a tool that can sometimes be used to help identify sources of dissolved uranium at mill and mining sites. The method involves the examination of uranium isotope distributions in water samples collected at several monitoring locations. Specifically, the ratio of the activity concentrations for uranium-234 (U-234) and uranium-238 (U-238) are calculated under the hypothesis that mill-related contamination would have a U-234/U-238 value, or uranium activity ratio (AR), that was noticeably different from that of naturally derived uranium. In applying this logic to a former uranium mill site near Cañon City, Colorado, Zielinski et al. (1997) showed that the AR in contaminated groundwater samples exhibited ratios generally reflective of secular equilibrium (AR ≅ 1), while those of natural waters had ratios greater than 1.3. The Cañon City study built upon previous work by researchers that suggests natural waters tend to show an excess of U-234 activity in comparison to that of U-238 at the mineral/water interface during prolonged mild leaching of subsurface uranium-bearing rock by groundwater. This excess comprises a form of isotopic fractionation related to alpha recoil displacement (Zielinski et al. 1997) of the U-234 atom from its U-238 parent, with the net effect of enhanced leachability of U-234. In contrast, high-grade uranium ores with more recent histories of open-system alteration appear to be mixtures of materials with both AR<1 and AR>1, which, when leached over periods of just a few decades or more, yield waters with an AR of 1.0 ± 0.1. The work by Zielinski et al. (1997) suggests that uranium isotope data can be used in areas on and near the Bluewater site to distinguish mill-related uranium with ARs of about 1.0 with naturally-occurring uranium with ARs higher than 1.1.

Appendix E

Glossary

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Glossary

absorption. The incorporation of a chemical in the interior of a solid.

adsorption. The adhesion of molecules (in a thin layer) to the surfaces of solid bodies or liquids with which they are in contact.

advection. The process by which solutes are transported by the bulk motion of the flowing groundwater.

advection-dispersion equation (ADE). The most widely used equation for simulating solute transport in porous media. Also referred to as the classical advective-dispersive equation.

advective flux. The mass of chemical in a fluid passing through a unit cross-sectional area per unit time due to advection. Advective flux is calculated as the product of Darcy velocity (specific discharge) and the chemical concentration.

advective front. The location downgradient of the source in a contaminant plume that is equal to the product of average linear velocity and time since onset of groundwater contamination.

aerobic. Living, active, or occurring only in the presence of oxygen.

alluvium. General term for deposits of clay, silt, sand, gravel, or other particulate material deposited by a stream or other body of running water in a streambed, on a floodplain, on a delta, or at the base of a mountain.

anaerobic. Living, acting, or occurring in the absence of free oxygen.

analytical model. A mathematical model that uses closed formed solutions of the governing equations applicable to groundwater flow and chemical transport processes.

anion. A negatively charged ion.

anisotropy. The condition of an aquifer in which the value of a material property (such as hydraulic conductivity) varies depending on the direction of measurement.

aquifer. (1) Stratum of permeable rock, sand, or gravel that can store and supply groundwater to wells and springs. (2) A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and/or springs.

aquitard. A less permeable bed in a stratigraphic sequence that is incapable of yielding significant quantities of water to a pumping well. A semipervious geologic formation transmitting water at a very slow rate compared to the aquifer.

average linear velocity (groundwater). The Darcy velocity divided by aquifer effective porosity. Also known as mean pore water velocity or seepage velocity.

bedrock. A general term for the consolidated (solid) rock that underlies soils or other unconsolidated surficial material.

biodegradation. The chemical alteration of substances through the action of biota.

breakthrough curve. A representation of the concentration of solute in a fluid as a function of time at a selected point.

calibration. The process of refining a model representation of flow and transport in a groundwater system in order to achieve a desired degree of correspondence between the model simulation and observations of the groundwater system.

capillary fringe. Zone of constant water saturation extending upward from the water table, containing water held in capillary tension. Capillarity is the cohesion of water molecules and the adhesion of water to solid materials. The thickness of the capillary fringe depends on the soil properties and the uniformity of pore sizes.

cation. Positively charged ion.

chemical precipitation. The process of removing a substance from solution by chemical reaction.

complex. A type of compound in which a central metal ion is surrounded by a number of ions or molecules, called ligands, that can also exist separately, also known as a coordination compound. A chelate is a type of complex.

complexation. Combination of cations and anions to form a more complex ion.

complexing agent. A dissolved ligand that binds with a simple charged or uncharged molecular species in a liquid solution to form a complex, or coordination compound.

computer code. The assembly of numerical techniques, bookkeeping, and control language that represents a mathematical model of groundwater flow and contaminant transport.

conceptual model. An interpretation or working description of the characteristics and dynamics of a groundwater system.

cone of depression. The depression of hydraulic heads around a pumping well caused by the withdrawal of groundwater.

confined aquifer. A permeable geologic unit located between two saturated, less permeable units (i.e., between confining beds).

confining bed. A geologic unit that will not readily transmit water and which impedes or stops the free movement of water into or out of an aquifer. Confining beds have also been called aquicludes, aquitards, or semi-confining beds.

contaminant. Harmful or hazardous matter introduced into the environment.

continuous release. A contaminant release from a source area that continues indefinitely at a relatively constant rate.

coprecipitation. The incorporation of elements into other compounds, such as metal oxide minerals, as they precipitate from solution.

Darcy velocity. The volumetric flow rate of groundwater per unit cross-sectional area perpendicular to the flow direction. Also known as Darcy flux or specific discharge.

denitrification. Conversion by microorganisms of nitrate or nitrite to more reduced states, ending in nitrogen gas under anaerobic conditions.

deterministic model. A model in which there is an exact mathematical relationship between the independent and dependent variables that characterize a groundwater system.

diffusion. (1) the transport process of a chemical in the direction of decreasing concentration of the chemical due to thermal kinetic energy (and resulting Brownian motion) of the dissolved chemical. (2) The natural tendency of molecules to move out of areas of high concentration into areas of low concentration until a solution or gas has a uniform concentration of the molecules. Also known as molecular diffusion.

diffusion coefficient. The capacity of a specific chemical to migrate through a specific material (e.g., water or air) by the process of molecular diffusion. It is expressed in terms of the mass of chemical that will diffuse through a unit area in a unit time under the influence of a unit concentration gradient.

diffusive flux. The mass of a contaminant or other constituent passing through a unit area per unit time due to molecular diffusion. Diffusive flux is calculated as the product of a diffusion coefficient and a concentration gradient.

discharge. (1) With respect to fluid flow, the rate of flow at a given instance in terms of volume per unit of time; pumping discharge equals pumping rate, usually given in gallons per minute (gpm); stream discharge, usually given in cubic feet per second (cfs). With respect to groundwater, the movement of water out of an aquifer. Discharge may be natural, as from springs, as by seepage, or by evapotranspiration, or it may be artificial as by constructed drains or from wells. (2) With respect to mass movement, the rate of mass movement in terms of mass per unit of time. See also **mass discharge**.

dispersion (in porous media transport). Fluid mixing due to velocity variations at unresolved spatial scales. These velocity variations are often attributed to unresolved heterogeneities in permeability, and other phenomena existing at the pore scale or larger. Dispersion is usually the greatest in the direction parallel to flow (longitudinal direction), and is usually less in the transverse directions. Also known as mechanical dispersion.

dispersion coefficient. Capacity of a specific chemical to migrate through a specific material (e.g., water or air) by the process of hydrodynamic dispersion. It is expressed in terms of the mass of chemical that will disperse through a unit area in a unit time under the influence of a unit concentration gradient.

dispersive flux. The mass of chemical in a fluid passing through a unit cross-sectional area per unit time due to dispersion. Dispersive flux is calculated as the product of a dispersion coefficient and a concentration gradient.

dispersivity. a parameter representing the spreading potential of a solute-porous medium system.

dissolved constituents. Chemical compounds in solution, also called solutes.

dissolved oxygen. The amount of free (not chemically combined) oxygen in water. Usually expressed in milligrams per liter (mg/L).

drawdown (groundwater). The depression or decline of the hydraulic head or water level in a pumped well or in nearby wells caused by pumping. At the well, it is the vertical distance between the static water level and the water level under pumping conditions.

effective porosity. (1) The percent of the total volume of soil or rock that consists of interconnected pore space. (2) The porosity through which flow can occur.

Eh. Oxidation-reduction potential; the relative susceptibility of a substrate to oxidation or reduction.

equipotential line. A contour line on a map or cross section along which hydraulic heads are the same.

equivalent porous medium. A concept that is used to model or simulate the flow of groundwater in fractured rocks. The concept is that is you take a large enough volume, the fractured geologic material will behave mathematically like a porous medium.

evaporation. Process by which water is changed from the liquid state to the vapor state. See also **evapotranspiration, transpiration**.

evapotranspiration. Process by which water is returned to the air through direct evaporation, or by transpiration from vegetation.

Fickian model. A model that simulates contaminant transport as governed by the classical advection-dispersion equation and linear, equilibrium sorption.

Fickian transport. Contaminant transport that can be simulated with models based on the classical advection-dispersion equation and linear, equilibrium sorption. Also referred to as ideal transport.

finite-difference method. A numerical technique for solving a system of equations using a rectangular mesh representing an aquifer or other hydrostratigraphic unit and solving for the dependent variable in a piece wise manner.

finite-element method. A numerical technique for solving a system of equations using an irregular triangular or quadrilateral mesh representing an aquifer or other hydrogeologic unit and solving for the dependent variable in a continuous manner.

floodplain. Land bordering a stream. The land was built up of sediment from overflow of the stream and is still subject to flooding when the stream is at flood stage.

flow. The movement of a fluid.

flow path. The idealized path followed by particles of water. Also known as a flow line.

flux. Fluid or mass discharge per unit area.

gaining stream. A river, or a reach of a stream or river, that gains in flow from upward groundwater seepage from the streambed, or from springs in, or alongside, the river channel; sometimes called an effluent stream.

groundwater. Water in the saturated zone that is under a pressure equal to or greater than atmospheric pressure. More generally, all subsurface water as distinct from surface water; specifically, the portion of subsurface water within the saturated zone.

groundwater flow model. Application of a mathematical model to represent a site-specific groundwater flow system.

groundwater storage. The amount of water in storage within the defined limit of an aquifer.

half-life. The time required for half of the atoms of a radioactive substance to disintegrate.

heterogeneous. Consisting of diverse or dissimilar constituents.

hydraulic conductivity. The capacity of a rock or soil formation to transmit water through it under hydraulic gradients. It is expressed as the volume of water of a given viscosity that will move in unit time under a unit hydraulic gradient through a unit area, measured at right angles to the direction of flow. It is a combined property of the porous medium and the fluid flowing through it.

hydraulic gradient. Change in hydraulic head per unit of distance measured in the direction of the steepest change. In a three-dimensional coordinate system, the hydraulic gradient consists of three components, with two corresponding to horizontal (x and y) axes, and one corresponding to the vertical (z) axis. A non-zero hydraulic gradient represents the potential for flow to occur.

hydraulic head. (1) The height above a datum plane of a column of water. In a groundwater system, it is the sum of elevation head and pressure head. (2) The height at which water stands in a piezometer or well due to the presence of elevation and pressure forces in groundwater surrounding the well. Also called piezometric head.

hydrodynamic dispersion. Fluid mixing due to the combined effect of mechanical dispersion and molecular diffusion.

hydrograph. A graph showing the stage, flow, velocity, or other property of water with respect to the passage of time. Hydrographs of wells show the changes in water levels during the period of observation.

hydrologic unit. Aquifer or surface water body.

hydrolysis. The splitting of a bond by a reaction with water, specifically the addition of the hydrogen cation and the hydroxide anion of water.

hydrophobic compound. A nonpolar organic compound that tends to exhibit low solubility in water and a preference for sorbing to the organic matter component of a soil matrix porous medium.

hydrostratigraphic unit. A geologic formation, group of formations, or part of a formation that consists of materials with similar hydraulic properties, in contrast to adjacent formations or parts of a formation. Also referred to as a hydrogeologic unit.

immobilization. The precipitation or binding of a substance so that it is no longer able to circulate freely.

inorganic compounds. Chemicals that do not contain carbon; for example, metals are inorganic.

insoluble. Not readily dissolved in a liquid.

ion. An atom or group of atoms that carries a positive or negative electric charge as a result of having lost or gained one or more electrons; a charged subatomic particle (as a free electron).

ion exchange. A reversible reaction in which ions are interchanged. This phenomenon is common in soils.

isotope. Any of two or more species of atoms of a chemical element with the same atomic number (number of protons) and nearly identical chemical behavior but with a different number of neutrons, hence a different atomic weight.

isotropy. Having the same properties in all directions.

karst aquifer. An aquifer in which the flow of groundwater is or can be appreciable through one or more of the following: joints, faults, bedding-plane partings, and cavities—any or all of which have been enlarged by dissolution

leaching. The process of separating the soluble components from some material by percolation.

ligand. A group, ion, or molecule coordinated to a central atom or molecule in a complex.

long-term stewardship. The physical controls, institutions, information, and other mechanisms needed to ensure protection of people and the environment.

losing stream. A river, reach of a stream or river, that loses a portion of its flow to groundwater through seepage in, or alongside, the channel. Sometimes called an influent stream.

mass discharge. The mass of chemical in a fluid that passes from one point to another per unit time. Mass discharge is the product of the fluid discharge rate and the concentration of the contaminant (in units of mass per unit volume) in the fluid.

mass flux. The mass of chemical in a fluid that passes through a unit cross-sectional area per unit time. Mass flux can be caused by advection (advective flux), dispersion (dispersive flux), and molecular diffusion (diffusive flux).

mathematical model. The representation of a physical or chemical system by mathematical expressions from which the behavior of a groundwater system can be simulated.

mechanical dispersion. pore-scale spreading of a chemical caused by flow through a macroscopically tortuous and nonuniform porous medium with nonuniform pore size.

milligrams per liter or mg/L. The mass in milligrams of any substance contained in 1 liter of liquid. (Equivalent to parts per million for values less than about 7,000 mg/L).

non-Fickian model. A model that simulates contaminant transport as governed by the classical advection-dispersion equation and linear, equilibrium transport.

non-Fickian transport. Contaminant transport that does not coincide with that simulated by models governed by the classical advection-dispersion equation as affected by linear, equilibrium sorption. Also referred to as ideal transport.

numerical methods. A set of procedures used to solve the equations of a mathematical model in which the applicable partial differential equations are replaced by a set of algebraic equations written in terms of discrete values of state variables at discrete point in space and time.

oxidation. The reaction of a substance, in the presence of oxygen, with a chemical that causes removal of electrons from the original substance.

pE. A dimensionless measure of the oxidizing or reducing tendency of a solution. By definition, $pE = -\log_{10} [e]$, where [e] is equal to electron activity. pE is analogous to pH, which is used to measure hydrogen-ion activity.

perched groundwater. Water within a saturated zone of material underlain by a relatively impervious stratum which acts as a barrier to downward flow and which is separated from the main groundwater body by a zone of unsaturated material above the main groundwater body.

permeability. The capacity of a material to transmit fluids. Permeability is a material property that is not dependent on the property of the fluid.

phreatophyte. A plant that habitually obtains its water supply from the zone of saturation, either directly or through the capillary fringe.

physicochemical. Of or pertaining to both physical and chemical properties, changes, and reactions.

piezometer. A device or type of well used to measure hydraulic head at a point in the subsurface.s

piezometric head. The height at which water stands in a piezometer or well due to the presence of elevation and pressure forces in groundwater surrounding the well. Also called hydraulic head.

plume. An elongated body of fluid that is used to define the contaminated areas of an environment.

porosity. The ratio of the total volume of pore space (voids) in a rock or soil to its total volume, sometimes stated as a percentage. Effective porosity is the ratio of the volume of interconnected voids to the total volume. Unconnected voids contribute to total porosity but are ineffective in transmitting water through the rock.

porous medium. A multi-phase material consisting of a continuum of solid matrix with some interconnected void space.

potentiometric surface. An imaginary surface representing the static head of groundwater in tightly cased wells that tap a water-bearing rock unit (aquifer); or in the case of unconfined aquifers, the water table.

precipitation. The process whereby a solid settles out of a solution.

pressure head. Fluid pressure expressed as the height of an equivalent column of water. Calculated by dividing the fluid pressure by the product of fluid density and the acceleration due to gravity.

pulse release. A contaminant release from a source area that occurs for a finite period of time. See also **slug release.**

radioactivity. Spontaneous emission by radionuclides of energetic particles through the disintegration of their atomic nuclei; the rays emitted.

radioisotope. An isotope of an element that has an unstable nucleus; it tries to stabilize itself by giving off radioactive particles and undergoes spontaneous decay.

radionuclide. Radioisotope.

reactant. A substance that enters into and is altered in the course of a chemical reaction.

reaction. A process in which one or more substances are changed chemically into one or more different substances. Examples include biotransformation, radioactive decay, and hydrolosis.

recalcitrant. (1) Resistant to degradation/transformation. (2) Resistant to decreases in concentration.

recharge. The addition of water to the saturated zone in an aquifer by infiltration, either directly into the aquifer or indirectly by way of another soil or rock formation. Recharge may be natural, as when precipitation infiltrates to the water table, or artificial, as when water is injected through wells or spread over permeable surfaces for the purpose of recharging an aquifer.

redox reaction. Oxidation-reduction reaction in which electrons are transferred between two or more compounds.

retardation. The slowing of the rate of movement of a solute due to partitioning to and from stationary solid material within the porous media.

retardation factor. a parameter in the advection-dispersion equation that accounts for association of a dissolved chemical with immobile phases in a porous medium (e.g., sorption)

riparian vegetation. Vegetation growing on the banks of a stream or other body of surface water.

rock. Any naturally formed, consolidated or unconsolidated material (but not soil) consisting of two or more minerals.

runoff. The part of the precipitation that appears in surface streams.

saturated zone. The subsurface zone in which all the connected interstices or voids in permeable rock or soil formations are filled with water under pressure equal to, or greater than atmospheric pressure. The saturated zone should not be confused with isolated zones of perched groundwater.

secondary permeability. The increased permeability or hydraulic conductivity due to the presence of secondary porosity.

secondary porosity. Voids and associated hydraulic media that form through physical and chemical processes following deposition, including compaction, fracturing, faulting, dissolution, and mineralization.

sediment. Material in suspension in water or deposited from suspension or precipitation.

seepage. (1) The infiltration or percolation of water through rock or soil to or from the surface. (2) The very slow velocity movement of groundwater.

simulation. One complete execution of groundwater modeling computer program, including input and output.

sink. In groundwater flow modeling, a process whereby, or a feature from which, water is extracted from the groundwater system. In transport modeling, a process whereby, or a feature from which, a contaminant is extracted from the groundwater system.

slug release. A contaminant release from a source area that occurs for a finite period of time. See also **pulse release**.

soil-water distribution coefficient (K_d). The ratio of the mass fraction of a chemical adsorbed to the solid phase to the concentration of the chemical in aqueous solution.

solubility. The relative capacity of a substance to serve as a solute, usually in reference to water as the solvent.

soluble. Able to be dissolved; to pass into solution.

solute. Any material that is dissolved in another, such as salt dissolved in water.

solution. A homogeneous mixture of a solute in a solvent. When a solute is dissolved in a solvent, the solute molecules are separated from one another and dispersed throughout the liquid medium.

solution channel. Tubular or planar channel formed by solution in carbonate rock, usually along joints and bedding planes. It is the main water carrier in carbonate rocks.

sorption. The process by which a chemical partitions between solid and fluid phases. Sorption, exchange, absorption, adsorption and desorption are often used synonymously, although these terms may represent different physical processes.

sorption isotherm. A regression of sorbed-phase concentrations against aqueous-phase concentrations at a given, constant temperature.

source. The process by which a contaminant is released or fed into subsurface water.

specific discharge. Darcy velocity.

specific storage. The volume of water that a unit volume of porous medium releases from storage per unit change in hydraulic head. In confined aquifers, a quantity with units of 1/Length that represents the volume of water released from storage in a unit volume of the aquifer per unit change in hydraulic head.

specific yield. The ratio of the volume of water that will drain under the influence of gravity to the volume of saturated soil or rock. In an unconfined aquifer, a dimensionless quantity representing the volume of water that is released from storage per unit surface area of aquifer, per unit decline in the water table. Specific yield is relevant only to unconfined aquifers, and is analogous to storativity in a confined aquifer.

stable plume. A contaminant plume, or a portion of a contaminant plume, in which groundwater concentrations are virtually constant with time. Also referred to as a steady-state plume or a steady plume.

static water level. The level at which water stands in a well screened in a confined or unconfined aquifer when no water is being removed from the aquifer either by pumping or free flow to the ground surface.

steady-state flow. A condition where the magnitude and direction of the flow field are constant with time.

stochastic process. A process in which the dependent variable is random, so that prediction of its value depends on a set of underlying probabilities, and the outcome at any instant is not known with certainty.

storativity. The volume of water released from storage in a unit prism of an aquifer when the hydraulic head is lowered a unit distance. In a confined aquifer, a dimensionless quantity representing the volume of water an aquifer releases or takes into storage per unit surface area of the aquifer per unit change in hydraulic head. Storativity, which is equal to the product of specific storage and aquifer thickness, is synonymous with the storage coefficient of a confined aquifer and analogous to the specific yield of an unconfined aquifer.

stratification. The layered structure of sedimentary rocks and alluvium.

stream, ephemeral. A stream or portion of a stream that flows only in direct response to precipitation. Such flow is usually of short duration.

stream, perennial. A stream that normally has water in its channel at all times and flows continuously.

streamflow. The discharge that occurs in a natural channel of a surface stream course.

subsurface. The geologic zone below the surface of the Earth.

surface water. An open body of water, such as a stream, pond or a lake.

total dissolved solids (TDS). An aggregate of anions (carbonates, bicarbonates, chlorides, sulfates, phosphates, nitrates, etc.) and cations (calcium, magnesium, manganese, sodium, potassium, etc.) which form salts. High TDS solutions have the capability of changing the chemical nature of water.

transient flow. A condition that occurs when at some point in a flow field the magnitude or direction of the flow velocity changes with time.

transmissivity (groundwater). The rate at which water at the prevailing water temperature is transmitted through a unit width of the aquifer under a unit hydraulic gradient. It was traditionally expressed as gallons per day through a vertical strip of the aquifer 1 foot wide under a gradient of 1 foot per foot. More recently, it has been expressed as cubic feet per day through a vertical strip of the aquifer 1 foot wide under a gradient of 1 foot per foot.

transpiration. Process by which water is absorbed by plants, usually through the roots. The residual water vapor is emitted into the atmosphere from the plant surface. See also **evaporation, evapotranspiration**.

transport. Conveyance of solutes and particles in flow systems.

unconfined aquifer. A permeable geologic unit with the water table forming its upper boundary; also referred to as a water-table aquifer.

unsaturated zone. Soil or rock partially saturated with water, lying above the capillary fringe. Sometimes used to refer to the vadose zone.

vadose zone. The zone containing both the unsaturated zone and the capillary fringe just above the water table. Sometimes used to refer to the unsaturated zone.

valence. The property of an element that determines the number of other atoms with which an atom of the element can combine.

volumetric moisture content. In porous media, the volume of water divided by the combined volume of solid, liquid, and vapor.

water budget. An accounting of the inflow to, outflow from, and storage changes of water in a hydrologic unit.

water table. The level in the saturated zone at which the pressure is equal to atmospheric pressure; the upper surface of the zone of saturation. Also called the phreatic surface. See also **potentiometric surface**.

withdrawal. Water removed from the ground or diverted from a surface water source for use.

Appendix F

Appendix F

Processes Affecting Contaminant Plumes

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F1.0 Introduction

Physical processes such as advection, mechanical dispersion, and recharge can play significant roles in the attenuation of groundwater contamination at LM sites. These processes by themselves contribute to reductions in contaminant concentration but do not cause net reduction of contaminant mass. Consequently, physical influences on contaminant transport are generally considered "nondestructive." However, mass-reducing, or "destructive," processes at LM sites would not occur to the degree observed were it not for the manner in which processes like advection, dispersion, and recharge facilitate them. Destructive processes such as biodegradation and abiotic chemical transformation rely on groundwater flow and the resulting mixing of contaminants with other reactants to effect significant attenuation. Moreover, additional processes like volatilization and sorption are influenced by the hydraulic transport of contaminants. Most of this appendix discusses the nondestructive contributions of transport processes to contaminant attenuation.

Before a discussion of how attenuation of dissolved constituents occurs in aquifers, it is important to clarify what "concentration" represents. Often, concentration represents the dissolved mass of a contaminant within a limited volume of groundwater that has been collected in a piezometer, which is screened over a small vertical interval (e.g., ≤3 feet). Such a concentration can be considered a point value. Alternatively, concentration can also represent the contaminant mass collected in water pumped at a relatively high rate from a well with a long screen (e.g., >3 feet), which tends to represent a mixture of water from various depths. This latter type of concentration can be considered a vertically averaged, composite value rather than a point concentration.

Point concentrations can be used to assess the three-dimensional distribution of a contaminant in an aquifer. However, complete spatial characterization of a contaminant plume using point concentrations is rarely achieved because the associated costs can be prohibitive. Rather than collecting the entire suite of concentrations necessary for showing the full horizontal and vertical extents of a plume, it is common practice to assume that transport occurs solely within a horizontal plane in a limited-depth aquifer, and that contaminant concentrations do not vary significantly with depth in the groundwater. In such cases, the two-dimensional, horizontal distribution of a contaminant is sometimes described using vertically averaged concentration values measured by purging wells with long screens. Unfortunately, this latter approach to plume delineation can result in poor estimation of flow direction, inaccurate bifurcation of the plume, incorrect identification of contaminant source areas and release mechanisms, and overestimation of natural attenuation impacts (Martin-Hayden and Robbins 1997). The challenges to plume delineation, regardless of the monitoring practices employed, suggest that caution should be applied when attempting to interpret measured contaminant levels and identify influential transport processes.

F2.0 Groundwater Flow and Velocity

F2.1 Darcy's Law

The direction and rate of groundwater flow at a given point in an aquifer is governed by Darcy's law. Several mathematical expressions of this law exist, depending on the number of spatial dimensions that are used to describe the flow, and the specific hydraulic properties of the porous medium in which the flow is occurring. Discussions of groundwater flow in this appendix focus initially on the more general form of Darcy's law that applies to a three-dimensional domain containing aquifer materials that transmit water more readily in some directions than in others. A simplified form of the law is also given to represent flow in domains that tend to be less complex than those represented by the law's general form.

The general form of Darcy's law is (Bear 1979)

$$\mathbf{q} = [\mathrm{K}]\,\mathbf{J} \tag{1}$$

where $\mathbf{q}$ = Darcy velocity (length/time),
[K] = hydraulic conductivity (length/time), and
$\mathbf{J}$ = hydraulic gradient (dimensionless).

Boldface lettering is applied to the symbols for Darcy velocity and hydraulic gradient to indicate that each of these variables is a vector. Vectors are used to describe three-dimensional fields. That is, velocity and gradient are each characterized by a direction and three components (Bear 1979), with the components describing the magnitude of the variable parallel to horizontal (x and y) and vertical (z) directions in space. In Equation **(1)**, hydraulic conductivity is placed in brackets to indicate that it is a 3 × 3 matrix consisting of 9 components. The vectors $\mathbf{q}$ and $\mathbf{J}$ are sometimes referred to as first-order tensors, and the matrix [K] is sometimes referred to as a second-order tensor (Bear 1972).

Each of the nine components of [K] has subscripts i and j, with the first representing the direction of the Darcy velocity and the second representing the direction of the hydraulic gradient. The three components composing the diagonal of the hydraulic conductivity matrix are symbolized by K_{xx}, K_{yy}, and K_{zz}, wherein i = j. In contrast, the indices i and j are different in each of the off-diagonal components (e.g., K_{xy}). A simple interpretation of each [K] component is that it is the hydraulic conductivity value determining the Darcy velocity in the i direction due to a hydraulic gradient in the j direction.

Equation **(1)** is applicable to an anisotropic domain (Bear 1979), wherein the hydraulic conductivity components in the x, y, and z directions are not equal to each other. If the axes of the 3-dimensional domain are oriented so that x and y are parallel to the direction of sediment bedding, and z is perpendicular to this direction, the off-diagonal components of [K] have zero values. Furthermore, in most alluvial aquifers, it is usually assumed that K_{xx} is equal to K_{yy}, which signifies that the only anisotropy applicable to the aquifer is attributed to differences between K in the horizontal and vertical directions. In cases where Darcy's law is applied to an anisotropic medium, the Darcy velocity (**q**) will not be oriented in the same direction as the hydraulic gradient (**J**) (Bear 1979).

If a porous medium is isotropic, all components of the hydraulic conductivity tensor take on a uniform value, symbolized by K. K in this case is described as a scalar value, or a zero-order tensor (Bear 1972). Darcy's law in this simplified instance can be written

$$q = K J \tag{2}$$

where q = a single value of Darcy velocity in the direction of the hydraulic gradient (length/time), and
J = a single value of the hydraulic gradient (i.e., in the direction of maximum drop in hydraulic head) (dimensionless).

F2.2 Average Linear Velocity

Though the Darcy velocity is useful for describing quantities of water and associated contaminants that move in specific directions, it is not a direct indicator of the rate at which the contaminant is moving through space. This latter rate is estimated using the average linear velocity (Freeze and Cherry 1979), which is the average rate at which water moves through the pores of an aquifer

$$\mathbf{v} = \frac{\mathbf{q}}{n_e} \tag{3}$$

where $\mathbf{v}$ = average linear velocity (length/time), and
n_e = effective porosity of the aquifer (dimensionless).

Because $\mathbf{q}$ is a vector, consisting of both a direction and a magnitude, $\mathbf{v}$ is also a vector with three components, each aligned with the *x*, *y*, and *z* axes. Average linear velocity is more commonly described with a single, scalar value that applies to the direction of groundwater flow.

F3.0 Contaminant Transport in Groundwater

F3.1 Contaminant Mass Balance

The movement and concentration of a chemical in groundwater is affected by four general factors: (1) advection, (2) mechanical dispersion, (3) molecular diffusion, and (4) sources and sinks of the contaminant, such as chemical and biological reactions, or sorption onto the solid materials that compose the porous medium and solid matrix (Domenico and Schwartz 1997). Models of aqueous-phase transport are based on mass-balance equations that describe these factors. In general terms, the contaminant mass balance can be written (Mercer and Waddell 1993):

> Advection by natural flow + advection by pumping or injection + dispersion + diffusion + contaminant sources and sinks = rate of change of mass of aqueous-phase contaminant stored in the medium. **(4)**

The various components of Equation **(4)** are discussed further in the following sections.

F3.2 Advection

Transport by advection consists of the movement of a contaminant caused by the net or average motion or flow of the groundwater (Mercer and Wadell 1993). For a non-reactive contaminant, the rate of transport is equal to the average linear groundwater velocity, v, as defined by Equation **(3)**. The effects of advection on plume behavior can be examined by first considering a plume that emanates from, or is "fed" by, a "continuous contaminant source." This type of source maintains relatively constant contaminant concentrations along its downgradient edge and remains undepleted (Mercer and Waddell 1993).

Advection, by itself, does not cause attenuation of a contaminant plume fed by a continuous source. The reason for this is seen in the advection of a dissolved contaminant in a hypothetical stream tube located directly downgradient of the source (Domenico and Schwartz 1997). By definition, the stream tube is associated with a steady flow system, and flow does not occur across the stream tube walls. And when only advection is operating, the contaminant front in the stream tube at any given time is a flat surface determined by the average linear velocity along the transport path. Because contaminant mass cannot spread beyond either the stream tube walls or the plume front, the concentration at all points in the stream tube is equal to the concentration observed on the downgradient edge of the source, and no attenuation occurs. This concept is illustrated in Figure F-1a, which shows the effects of processes on flow and transport along a 1-dimensional (1-D) plume originating at a continuous contaminant source in a steady-state flow field. Pure advection, denoted by process A in Figure F-1a, affects the location but not the concentration of a dissolved contaminant in 1-D transport. A continuous source is also referred to as a continuous-release source in this appendix.

In cases where the contaminant source varies in strength over time, it is possible for pure advection to appear as contributing to natural attenuation. This occurs, for instance, when a contaminant source is depleted or removed and uncontaminated water moves in behind the released contaminant. Process A in Figure F-1b illustrates this phenomenon for 1-D flow and transport fed by a "pulse" source. In effect, the clean water has displaced the contaminant pulse through advection, moving the pulse farther down the flow path. Such displacement of contaminated water by uncontaminated water can potentially occur in a vertical direction when recharge to a groundwater system occurs above the dissolved contaminant plume. A pulse source is also referred to in this appendix as a pulse-release source, and in the scientific literature as a slug source.

F3.2.1 Travel Time

The time it takes for a non-reactive contaminant to migrate from one location to another in the direction of groundwater flow is called the travel time. It is defined by

$$t_a = s_a/v \qquad \textbf{(5)}$$

where t_a = advective travel time (time), and
s_a = travel distance (length).

Because it is determined using the average linear velocity v, the parameter t_a represents the average time it would take for a non-reactive contaminant to migrate the travel distance. In a porous medium, the velocities with which molecules of water travel through the medium's pores vary around the average value. A non-reactive constituent in groundwater is sometimes referred to as a conservative constituent.

F3.2.2 Mass Flux and Mass Discharge

The chemical mass flux due to advection is equal to the product of the Darcy velocity and the aqueous concentration of the chemical. Because Darcy velocity in three-dimensional space has three components, advective mass flux can also have three components. For example, the advective mass flux of a contaminant in the *x*-direction is

$$F_{ax} = q_x C_w \qquad \textbf{(6)}$$

where F_{ax} = advective mass flux in the *x*-direction, [(mass/area)/time],
q_x = Darcy velocity in the *x*-direction (length/time), and
C_w = dissolved contaminant concentration (mass/volume).

Typically, mass flux is simply described using a single scalar value representative of the direction of groundwater flow.

Another measure of mass transport brought about by advection is mass discharge, which is equal to the product of volumetric discharge of the groundwater and the aqueous concentration of the dissolved chemical in that discharge, i.e.:

$$M_d = Q C_w \qquad \textbf{(7)}$$

Where M_d = mass discharge (mass/time),
Q = volumetric discharge rate (volume/time), and
C_w = dissolved contaminant concentration (mass/volume).

Example units for the parameters in Equation **(7)** are milligrams per liter for C_w, liters per day for Q, and milligrams per day for M_d.

F3.3 Hydrodynamic Dispersion

Advection in real groundwater systems is neither perfectly uniform in space nor steady in time. Water migrates in the direction of flow at variable velocities, and water flowing in individual stream tubes mixes with water in adjacent stream tubes. In addition, some dissolved contamination may move between adjacent stream tubes if contaminant concentrations in the stream tubes differ. The effects of these phenomena are described using the concept of hydrodynamic dispersion.

Hydrodynamic dispersion is a term used to describe the spreading of contaminants in groundwater caused by both mechanical processes (mechanical dispersion) and molecular-scale chemical processes (molecular diffusion). Each of these processes can be considered potential contributors to plume attenuation because they can non-destructively reduce contaminant concentrations compared to the concentration that emanates from the contaminant source.

F3.3.1 Mechanical Dispersion

Mechanical dispersion in porous media flow is water mixing that occurs as a consequence of local variations in velocity around the average, or mean, water velocity (Domenico and Schwartz 1997). Because this mixing occurs in response to groundwater velocity variations, it is the product of advective processes, rather than chemical processes. The net impact of mechanical dispersion on dissolved mass transport is to cause spreading of a contaminant plume beyond the plume extent that would be expected based on bulk advection alone.

The effects of mechanical dispersion have traditionally been represented as if the dispersion process obeyed Fick's first and second laws of diffusion (Anderson 1984). Fick's first law expressed for dispersion in porous media is:

$$F_d = -[D_m]\ i_c \qquad \textbf{(8)}$$

where F_d = the dispersive flux of mass [(mass/length^2)/time, or (mass/area)/time],
D_m = the coefficient of mechanical dispersion (length^2/time), and
i_c = the dissolved concentration gradient [(mass/length^3)/length, or (mass/volume)/length].

Note that the dispersion coefficient D_m can have as many as three or more components depending on the dimensionality of the groundwater system being studied and the manner with which dispersion is characterized (Bear 1979). Mechanical dispersion in a 1-D plume occurs only along the direction of groundwater flow. A plume influenced by mechanical dispersion in two or three spatial dimensions will spread groundwater contamination in directions normal to (perpendicular to) the flow as well as parallel to the flow.

The effects of mechanical dispersion as governed by Fick's laws in a 1-D plume fed by a continuous source are illustrated in Figure F-1a. The concentration-versus-distance curve reflective of both advection and dispersion (processes A + D) in this graphic shows that contaminant spreading has occurred both downgradient and upgradient of the transport distance associated with advection alone (process A). However, the concentration at the source remains at the same concentration as that attributed solely to advection. Figure F-1b shows the combined influences of advection and mechanical dispersion in a 1-D plume supplied by a pulse source. In this case, contaminant spreading has occurred along both the leading and trailing portions of the plume, resulting in a peak concentration that is less than the concentration associated with pure advection.

Equation **(8)** is based on the assumption that the concentration gradient is a driving force for mechanical dispersion, and the dispersive flux will increase linearly with increasing gradient. This is a mathematical convenience rather than a representation of cause-and-effect. In reality, mechanical dispersion is caused by velocity variations at various spatial scales.

Laboratory-scale experiments in the 1960s designed to identify the relationship between mechanical dispersion coefficients and the velocity of water in a porous medium generally found that, in cases where the effects of longitudinal dispersion overwhelm the effects of molecular diffusion, the dispersion coefficient is proportional to velocity, i.e.:

$$D_{mi} = \alpha_i|\mathbf{v}| \quad \textbf{(9)}$$

where D_{mi} = the mechanical dispersion coefficient in direction i (length^2/time),
α_i = the dispersivity in the direction i (length), and
$|\mathbf{v}|$ = the magnitude of the average linear groundwater velocity (length/time).

On the basis of this relationship, it is typically assumed that a porous medium, at least at a laboratory scale, can be characterized by single values of dispersivity in the longitudinal and transverse directions. Centimeters and feet are commonly used units for dispersivity in the scientific literature. Commonly used units for the dispersion coefficient include centimeters^2/second and feet^2/day.

Many groundwater transport models that simulate advection and dispersion use the linear relationship in Equation **(9)** between the dispersion coefficient and the average linear velocity. Thus, average linear velocities are determined separately from the transport model and the modeler chooses dispersivities for input in the model. The dispersivity values are often finalized through model calibration. Though early column-based experiments that focused on the quantification of dispersion coefficients (e.g., Harleman and Rumer 1963) found the relationship in Equation **(9)** to be accurate, more recent laboratory experiments have shown that it is not always correct (e.g., Olsson and Grathwohl 2007). For problems dealing with dispersive transport at a field scale (e.g., hundreds to thousands of feet), the direct proportionality between the dispersion coefficient and flow velocity is questionable.

Mechanical dispersion in groundwater can be analyzed in terms of the three scales upon which it is observed: microscopic (local scale), macroscopic (local to field scale), and megascopic (field to regional scale). Variations in velocity leading to dispersion at each of these scales are produced by nonidealities in the porous medium. At the microscopic scale, the nonidealities are attributed to pore-size distribution, different pore geometries, and such phenomena as dead-end pore space (Domenico and Schwartz 1997). Macroscopic nonidealities consist of variations in medium properties that occur within a given formation or between neighboring wells. Included in this latter category are nonuniform hydraulic conductivities, permeability trends, directional permeabilities, and variations in aquifer stratification. Dispersion on a macroscopic scale is expected to be larger in a very heterogeneous aquifer than in a less heterogeneous system. Megascopic nonidealities, which occur at the interformational and regional scales, are features such as large changes in geologic structure and the overall stratigraphic framework (Domenico and Schwartz 1997). The multiple scales over which dispersion occurs results in mechanical dispersion coefficients that appear to increase as a function of plume length (e.g., Gelhar et al. 1992).

F3.3.2 Longitudinal and Transverse Mechanical Dispersion

Mechanical dispersion can be characterized as being either longitudinal or transverse. Longitudinal dispersion is the mixing that occurs along the direction of flow, whereas transverse dispersion is the mixing that occurs in directions normal to (perpendicular to) the flow path (Mercer and Waddell 1993). The combined influence of longitudinal and transverse dispersion is seen in 2-dimensional (2-D) and 3-dimensional (3-D) plumes fed by sources with limited, finite dimensions.

Figure F-2a illustrates the relative influences of longitudinal and transverse dispersion on plume-centerline concentrations downgradient of a continuous source of limited width in a 2-D groundwater system with a uniform (non-varying) velocity in the direction of flow. Whereas longitudinal spreading affects concentrations in the leading portion of the plume, transverse dispersion causes spreading laterally from the interior of the plume. As a result, contaminant concentrations at a given time along the plume centerline are less than those resulting solely from combined advection and longitudinal dispersion (Domenico 1987). In effect, the downgradient migration of a plume affected by transverse dispersion is lessened, or retarded, in comparison to a plume subject to dispersion only in the direction of flow. Similar effects from transverse dispersion are observed in a 2-D plume fed by a pulse source (Figure F-2b).

Contaminant spreading in a 3-D plume is governed by three components of dispersivity (longitudinal, transverse horizontal, and transverse vertical). Dispersivities are not amenable to direct measurement, though evaluation of carefully conducted field-scale tracer tests with a high-resolution monitoring network may yield valid site-specific values. Generally, the horizontal transverse dispersivity is less than the longitudinal dispersivity, and the vertical transverse dispersivity is less than the transverse horizontal dispersivity. Vertical dispersivities are strongly influenced by the natural stratification of an aquifer.

In most modeling investigations of contaminated sites, dispersivity values are estimated through model calibration. Models that resolve heterogeneities at smaller spatial scales usually require smaller values of dispersivity to achieve an acceptable calibration to field data. If field concentration data are insufficient for model calibration, empirical relationships between plume length and longitudinal and transverse dispersivities (EPA 1986a, 1986b; ASTM 1995; Xu and Eckstein 1995) can be employed to estimate dispersion parameters. These latter methods are subject to considerable uncertainty.

An increased "apparent dispersion" in directions transverse to groundwater flow may be observed in transient flow systems (e.g., Goode and Konikow 1990, Cirpka and Attinger 2003, Swain and Chin 2003). As illustrated in Figure F-3, changing flow directions in these systems create individual plumes with different orientations, which, when considered together, suggest that the plume is wider than would be observed in a steady-state flow field.

Some field investigations that focus on very detailed characterization of the concentrations in a 3-D plume (e.g., Rivett et al. 2003) have suggested that transverse dispersion is a less important transport process than is frequently assumed. In addition, modeling studies tend to over-represent the magnitude of dispersion (Gelhar et al. 1992, Cirpka et al. 1999). The magnitude of transverse mixing can strongly affect overall plume attenuation (Cirpka et al. 1999). The mixing between contaminated and uncontaminated water along the lateral borders of a plume facilitates chemical reactions that are destructive of contaminant mass. As a consequence, the plume is shorter than it would be if no reactions took place.

Gelhar et al. (1992) compiled and evaluated dispersivity data from 59 separate sites. The data collected in the study indicated a systematic increase of longitudinal dispersivity with the observation scale. On the basis of this and similar work, dispersion in many modeling investigations has been treated as a scale-dependent process (e.g., Falta et al. 2007). At a given scale, Gelhar et al. (1992) found that estimated longitudinal dispersivities tended to vary over 2 to 3 orders of magnitude. In addition to reflecting the propensity for dispersion to increase in magnitude with increasing heterogeneity in the subsurface media examined, the large variability in derived dispersivities indicated that it is inappropriate to represent longitudinal dispersion using a single, universal relationship between transport scale and dispersivity.

F3.3.3 Molecular Diffusion

Contaminants can migrate in groundwater in response to spatial variations in dissolved concentration, from an area of greater concentration to an area where it is less concentrated. This phenomenon is referred to as molecular diffusion, a mixing process caused by random molecular motions due to the thermal kinetic energy of the dissolved contaminant (Domenico and Schwartz 1997). Molecular diffusion will occur as long as a concentration gradient exists, even if the water is not moving. Aqueous diffusive transport in a subsurface medium obeys a form of Fick's first law for diffusion that has been adapted to porous media:

$$F^* = -D^* \, i_c \qquad \textbf{(10)}$$

where F^* = the diffusive flux of mass [(mass/area)/time],
D^* = the effective diffusion coefficient (area/time), and
i_c = the dissolved concentration gradient [(mass/volume)/length].

The effective diffusion coefficient in a porous medium is smaller than the bulk diffusion coefficient for a given contaminant in pure water. This reduction in magnitude accounts for a decreased diffusive flux caused by (a) the limited pore space through which diffusion can occur, as represented by the porosity; and (b) the tortuous path that diffusing molecules must follow to transport the chemical around soil grains (Domenico and Schwartz 1997). In relatively permeable groundwater systems, the contributions of molecular diffusion to spreading of contamination are generally regarded as less than those attributed to mechanical dispersion. Diffusion transverse to the ambient flow direction provides another mechanism for mixing contaminated water with uncontaminated water, thus helping to facilitate reactions that are potentially destructive of contamination.

F3.4 Advective-Dispersive Transport

Assessments of aqueous-phase contaminant migration in porous media typically account for the cumulative effects of advection, mechanical dispersion, molecular diffusion, and contaminant sources and sinks, which are the processes listed in the mass balance expression in Equation **(4)**. Appropriately, this combination of processes is called advective-dispersive transport (Cherry et al. 1984). Most models of contaminant transport in groundwater are formulated upon a partial differential equation representative of one form or another of Equation **(4)** (e.g., Bear 1979, Freeze and Cherry 1979, Domenico and Schwartz 1997, Karanovic et al. 2007).

Traditional models of advective-dispersive transport attribute contaminant spreading to the combined influences of mechanical dispersion and molecular diffusion, assuming that both are proportional to the concentration gradient [Equation **(8)** and Equation **(10)**]. The combined process is referred to as hydrodynamic dispersion, with coefficients defined by

$$D_{hi} = D_{mi} + D^*$$

where: D_{hi} = the coefficient of hydrodynamic dispersion in direction i (area/time),
D_{mi} = the coefficient of mechanical dispersion in direction i (area/time), and
D^* = the effective diffusion coefficient (area/time).

Contaminant spreading in 3-D models of transport is simulated using hydrodynamic dispersion coefficients in the longitudinal, transverse horizontal, and transverse vertical directions.

Because hydrodynamic dispersion is assumed to obey Fick's laws (see Section F.3.3.1), advective-dispersive models are commonly referred to as Fickian models. The differential equation upon which the models are based is called the advection-dispersion equation, or simply the ADE. Because it has become tradition over several decades to use models of this kind to simulate contaminant transport in groundwater, the ADE is also sometimes referred to as the classical ADE.

Researchers and practitioners alike have long recognized that Fickian models do not accurately represent transport processes in real groundwater systems. With this recognition, it is not surprising that predictive transport simulations are rarely borne out by subsequent plume monitoring, despite the best efforts of groundwater modelers to calibrate their models. Konikow (2011) describes several characteristics of the Fickian model that do not comport with transport phenomena observed in real groundwater systems. Deviations of the observed transport behavior from that expected by the Fickian model is generally referred to as non-Fickian transport. In response to the fundamental differences between real transport behavior and the results of models based on the classical ADE, Konikow (2011) has called for the development of a better governing equation of transport in groundwater, an equation that captures non-Fickian transport. He is encouraged by recent efforts directed toward that goal, of few of which are briefly mentioned later in Section F3.8.

F3.5 Dispersion Contributions to Plume Stability

A contaminant plume fed by a continuous source could eventually reach a stable, or steady-state, configuration due solely to the effects of transverse dispersion. The development of such a stable plume without the benefit of contaminant degradation processes may seem counterintuitive. However, as discussed in the scientific literature dealing with contaminant transport (e.g., Domenico and Schwartz 1997), virtually steady conditions can result from transverse dispersion alone. As a plume evolves, transverse spreading of contaminant mass across an increasing area causes concentrations to decrease with flow distance, eventually producing contaminant levels at the plume front and margins that are less than the background concentration. In effect, enough time has elapsed and the plume has migrated sufficiently far downgradient that concentrations outside the zone containing constant concentrations (i.e., along the plume edges) are so low as to be considered inconsequential. At this later time, loss of contaminant mass along the plume's border, as defined by the background concentration, occurs at the same rate new contaminant mass is added to the aquifer from the plume source area.

Figure F-4 illustrates conceptually how steady concentrations gradually evolve in a plume that is fed by a continuous source of constant concentration C_0 and is subject to both longitudinal and transverse dispersion. This graph shows concentration-versus-distance profiles along the centerline of the plume for successive times t_1 through t_6. As the plume front migrates, increasing lengths of the plume, extending downgradient from the downstream edge of the source, become stable. This process continues until all parts of the plume with concentrations greater than or equal to the background concentration C_b have effectively stabilized. In Figure 4, the steady-state concentration equal to the background concentration C_b occurs at location S_b beginning at time t_5. At this time, concentrations upgradient of S_b are stable, ranging between C_0 and C_b, while concentrations downgradient of S_b are less than background and in a transient state. As of time t_6, the plume front has moved even farther downgradient of location S_b (Figure F-4), but it may be a challenge to distinguish the contaminant plume in this area from naturally occurring uranium because contaminant concentrations near the plume front are less than the background value.

The discussion above regarding plume stability is strictly theoretical in the sense that steady-state concentrations are rarely, if ever, observed in groundwater plumes. In real groundwater systems, fluctuations of measured concentration at each location in space are a natural consequence of hydrologic and transport processes and measurement error. Nonetheless, the concentrations at each point within a so-called stable plume tend to fluctuate around an average, representative value for that point, instead of showing an increasing or decreasing trend. These average concentrations are, in effect, representative of the steady concentrations that would be observed in a theoretical system.

Domenico (1987) used an analytical solution to the transient form of the advection-dispersion equation to illustrate that the steady concentrations produced solely by transverse dispersion occur in areas some distance upgradient of the plume's advective front, which is defined as the product of average linear velocity and the time since the onset of contamination in the groundwater. The distance separating the downgradient extent of steady concentrations from the advective front is small in cases where the influence of longitudinal dispersion is relatively minor in comparison to the influence of advection (Domenico 1987). The length of a stable plume created by transverse mixing processes and the concentrations within the plume can also be calculated directly using analytical solutions to the steady-state version of the advection-dispersion transport equation (e.g., Domenico and Palciauskus 1982, Domenico and Robbins 1985, Leij and Bradford 1994). The mathematical derivations of the steady-state models assume that transverse concentration gradients determine the width of the plume and that longitudinal dispersion is an insignificant process.

In most real-world situations, a relatively long transport distance is necessary in order for transverse mixing, by itself, to produce a steady-state plume with border concentrations that are inconsequential. At LM sites, this might require transport distances of a mile or more. Though groundwater flow paths at most LM sites might not meet this requirement, the available transport distance downgradient of the contaminant source at a few sites is sufficiently long for development of effectively stable plumes.

F3.6 Sorption and Retardation

Sorption is one form of the "contaminant sinks" in Equation (4) that can cause the mass of a contaminant in solution to decrease. "Sorption" is a general term that encompasses four general processes known as absorption, adsorption, ion exchange, and desorption (McCutcheon et al. 1993). Absorption refers to the incorporation of a chemical into the interior of a solid. Adsorption signifies the attraction of a dissolved chemical to the surface of solid particles, and ion exchange is a specific form of adsorption involving the charge-for-charge replacement of an ionic species on a solid surface by other ionic species in solution. Desorption, in which the affected chemical dissolves back into the aqueous phase, is the opposite of each of the above adsorption mechanisms. In much of the literature dealing with subsurface transport, it has become generally accepted to use the term sorption as if it specifically represents adsorption (Mercer and Waddell 1993).

The phenomenon of adsorption, in which contaminants leave the dissolved state and affix to the surface of solid materials composing a porous medium, is commonly conceptualized as a partitioning process (i.e., a mass-transfer process) between phases. Chemicals once dissolved in water are said to partition from the aqueous phase to the solid phase (McCutcheon et al. 1993). Because the contaminant is being removed from solution, the adsorptive process effectively reduces the aqueous-phase concentration of the contaminant.

Several relationships can be used to mathematically describe the relative distribution of a contaminant between dissolved and adsorbed states. The most common relationship used in transport modeling assumes linear, equilibrium adsorption. In this context, "equilibrium" means that there is a unique, one-to-one relationship between the aqueous-phase and solid-phase concentrations of the contaminant. This relationship allows the propensity for a chemical to adsorb to solid materials to be described in terms of a soil-water distribution coefficient (Freeze and Cherry 1979):

$$S = K_d C_w \tag{11}$$

where S = the quantity of chemical mass adsorbed on the solids surface (mass/mass),
K_d = the soil-water distribution coefficient (volume/mass), and
C_w = the dissolved chemical (contaminant) concentration (mass/volume).

The parameter K_d is also sometimes referred to as a soil-water partition coefficient (EPA 1996). The larger the K_d value, the greater the tendency is for the contaminant to adsorb to subsurface media.

Equation **(11)** is representative of a linear isotherm. A sorption isotherm is a curve through several experimentally derived points relating adsorbed concentration to dissolved concentration at a specific temperature (Freeze and Cherry 1979). Contaminant transport in some media may not conform to a linear isotherm, and is better simulated using nonlinear expressions. The Freundlich and Langmuir isotherms are examples of mathematical models that are sometimes used to represent adsorption in nonlinear sorption fields (Mercer and Waddell 1993).

Adsorption slows the downgradient movement of a contaminant in groundwater in comparison to the movement provided by advection and dispersion. Consequently, transport of the contaminant is described as being retarded. In effect, equilibrium partitioning of the contaminant between phases causes its rate of advance to be slower than the average groundwater flow velocity. This is manifested in a concentration-versus-distance profile along the plume's length that is upgradient of the profile resulting from no sorption. Figure F-1a shows the concentration profile attributed to the combined effects of advection, dispersion, and sorption (processes A + D + S) in a 1-D plume fed by a continuous source. In a 1-D plume supplied by a pulse source (Figure F-1b), the combination of these three processes not only retards plume migration but also reduces the peak concentration in the plume.

A retardation factor, which measures the ratio of the average groundwater velocity to the average velocity of a sorbing chemical, can be determined from the chemical's K_d (Freeze and Cherry 1979)

$$R = 1 + \frac{K_d \rho_b}{n} \qquad \textbf{(12)}$$

where: R = the retardation factor (dimensionless),
ρ_b = dry soil bulk density (mass/volume), and
n = porosity (dimensionless).

The structure of Equation **(12)** dictates that R will always have a value that is greater than or equal to 1. An R value greater than 1 signifies that the contaminant migration is retarded relative to the movement of groundwater. Stated another way, an R value greater than 1 signifies that contaminant migration is retarded relative to the average linear velocity of the groundwater.

Contaminant transport models that simulate advective-dispersive transport with sorption defined by Equations **(11)** and **(12)** are described as simulators of linear, equilibrium adsorption, or linear, equilibrium sorption. More commonly, a model of this kind is referred to as a simulator based on the K_d approach, or simply a K_d model. K_d models are still considered to be Fickian because the governing transport equation is identical to the classical ADE with the exception that the average linear velocity and the hydrodynamic dispersion coefficient are reduced by a factor equal to R.

The mechanisms by which dissolved species adsorb to solids vary depending on the type of chemical in solution and the porous media through which transport is occurring. Inorganic chemicals such as metals are adsorbed primarily because of the positive electric charges they carry or chemical reactions that bind them to solid surfaces. Inorganics are particularly adsorbed by hydrous ferric oxide and clay minerals, which typically have very large surface areas and carry an overall negative electric charge. Inorganic chemical K_ds can be measured in laboratory experiments or determined through field tracer studies (Domenico and Schwartz 1997).

From a theoretical perspective, equilibrium sorption does not attenuate the long-term concentration of a contaminant at a given location if the plume is supplied by a continuous contaminant source. This is because the contaminant will eventually arrive at the downgradient location with the same concentration it would have if it were not affected by sorption (i.e., if it were a non-reactive contaminant). In contrast, attenuation of the long-term concentration at a given location due to sorption is possible in a plume fed by a pulse source because the peak concentration in such a plume decreases with increasing transport distance (see Figure F-1b).

F3.7 Accounting for Variable Sorption

Contaminant transport models based on the K_d approach were adopted decades ago as a mathematical convenience, primarily in the interest of simplifying the simulation of advective-dispersive transport of adsorbing contaminants. Though this simplification has made prediction of contaminant fate more efficient, the results of K_d models do not comport with real-world conditions. This is partly because contaminant sorption is a non-equilibrium (kinetic) process rather than an equilibrium process. In addition, the amount of contaminant adsorbed to the aquifer medium is not solely a function of the contaminant's aqueous-phase concentration, as assumed in Equation (**11**), but also the chemistry of the groundwater and the mineralogy of the aquifer solids. When the variable water chemistry of a groundwater system is taken into account along with the mineral composition of the sediment composing a porous medium, researchers tend to find that the K_d for a specific chemical can vary greatly in both space and time. Accordingly, models that allow for a spatially and temporally variable K_d dependent on ambient aquifer conditions are likely to provide more realistic appraisals of groundwater remedies.

To overcome the limitations of uranium transport models that adopt a constant K_d, models based on surface complexation theory (e.g., Davis and Curtis 2003) have been developed. A considerable amount of aquifer sediment characterization is necessary for the development of a surface complexation model (SCM) for a specific site. But such characterization can prove worthwhile if the SCM accurately accounts for variable sorption as affected by the geochemical characteristics of a groundwater system.

Studies focused on the development of surface complexation models addressing the sorption of hexavalent uranium at LM sites show that uranium K_d values are strongly affected by water pH and the aqueous-phase concentrations of uranium, calcium, and bicarbonate. These studies have demonstrated that equilibrium uranium K_ds for a given site can vary by more than an order magnitude and that uranium transport is considerably more retarded than was previously assumed. They also tend to suggest that the solid-phase uranium available in alluvial aquifers as a contaminant source is much larger than was estimated on the basis of characterization activities at the LM sites.

F3.8 Secondary Sources and Contaminant Tailing

Monitoring of contaminant plumes in groundwater during the past few decades indicates that aqueous-phase concentrations tend to attenuate at much slower rates than predicted by advective-dispersive transport models. This is generally attributed to slow release of contamination from secondary sources in the aquifers containing the plumes. Secondary contaminant sources are distinguished from primary sources in that they consist of contamination beneath or downgradient of the original source of contamination, which was usually at or near the ground surface. The contaminant mass in the secondary sources was left in the subsurface in earlier days of site contamination, when both the contaminant concentrations and the rate of contaminant mass loading to the subsurface were especially high.

Secondary sources can consist of low-permeability sediments in which groundwater velocities are particularly low; intraparticle storage of contaminants in the fractures and dead-end pores of individual sediment grains (intraparticle porosity); adsorbed mass that is released back to groundwater at rates much slower than the rate at which contamination was originally taken out of solution; and solid-phase minerals containing the contaminant that precipitated out of solution due to differences in water chemistry between the primary source fluids and the ambient groundwater chemistry. Because secondary sources release contaminant mass back to groundwater at slow rates, aqueous concentrations in the subsurface tend to remain relatively constant for many years, and often at levels that exceed the applicable groundwater standard. This is manifested as "contaminant tailing" in temporal concentration plots for monitoring wells located downgradient of the original source (Figure F-5). The slow release of secondary contamination to groundwater is sometimes referred to as back-diffusion.

Expected cleanup times for contaminated aquifers are commonly predicted using advective-dispersive transport simulations with Fickian models based on the classical ADE, and linear equilibrium sorption is often assumed to govern the exchange of contaminant mass between the solid and aqueous phases (i.e., the K_d approach). As illustrated in Figure F-5, such models cannot capture the slow, delayed release of contaminant mass from secondary sources and are thus incapable of simulating the contaminant tailing observed at monitoring wells. Consequently, the predicted cleanup times for plumes using model simulation tend to be grossly over-optimistic.

Despite the apparent shortcomings of Fickian models, it is still common for a groundwater modeler to rely on a calibrated K_d model to estimate the remediation time for an aquifer. As a consequence, a modeler can predict full plume remediation within a decade or so, only to realize several years beyond the predicted cleanup the presence of persistently high contaminant concentrations (i.e., contaminant tailing). Moreover, new predictive transport simulations using a revised K_d model are shown to be no more reliable than before. Though there are potentially multiple reasons for such poor predictive performance, reliance on Fickian models assuming equilibrium sorption provides the primary explanation for the overly optimistic projections. In effect, the modeler, by applying a K_d model to evaluate contaminant removal, has vastly underestimated the total contaminant mass that must be flushed from the subsurface to achieve aquifer cleanup. Models capable of simulating non-equilibrium contaminant transport are necessary for capturing contaminant tailing attributed to secondary sources.

A type of model used to simulate non-equilibrium transport assumes that the groundwater system consists of two distinct pore domains, with linear contaminant transfer between them. One domain represents the more permeable sediments in an aquifer that, when connected form preferential pathways (mobile domain) in which contaminant migration is rapid. The second domain (immobile domain) represents media that slowly feed contaminants to the preferential pathways, such as low-permeability sediments or intraparticle porosity. Simulators of this type, which are referred to as dual-porosity, dual-permeability, or dual-domain models, assume that the linear exchange of mass between the domains can be handled with a single, constant mass transfer coefficient. The mass transfer coefficient is typically treated as a model calibration variable. An example of a non-equilibrium model that uses analytical solutions to the governing equations of dual-domain transport is found in Leij and Toride (1997).

More-sophisticated modeling techniques have been developed over the past few decades to improve simulation of the effects of non-equilibrium exchange of contaminant mass between domains. Rather than labeling them as non-equilibrium simulators, these methods are generally referred to as non-Fickian transport models because they attempt to overcome fundamental shortcomings of models based on the classical ADE. Three non-Fickian methods have been sufficiently developed to be of practical use for this purpose, including the continuous time random walk method (e.g., Berkowitz et al. 2006), the fractional advection-dispersion equation (fADE) method (e.g., Benson et al. 2000), and the multi-rate mass transfer (MRMT) method (e.g., Haggerty and Gorelick 1995).

The flow domain in an MRMT model consists of a mobile zone and any number of immobile zones. Transport in the mobile zone conforms to the classical ADE. However, mass transport between the immobile domains and the mobile domain is a diffusion process, enabling the

MRMT model to capture non-Fickian phenomena. The mathematical formulation of a MRMT model produces multiple equations that are solved simultaneously to produce, at each time step, a contaminant concentration in the mobile domain as well as a unique concentration in each of the immobile zones. Mass transfer between each immobile zone and the mobile zone is governed by a unique mass transfer coefficient; generally, the values of the coefficients are stochastically determined via a predefined probability density function. The MRMT approach has been successfully applied to simulate non-Fickian uranium transport phenomena at DOE sites (e.g., Ma et al. 2010). Because MRMT models have been shown to be reliable for simulating contaminant tailing behavior (e.g., Zhang et al. 2007) in alluvial groundwater systems, they could prove useful for capturing recalcitrant contaminant behavior at LM sites, thereby improving the prediction of groundwater remedy performance.

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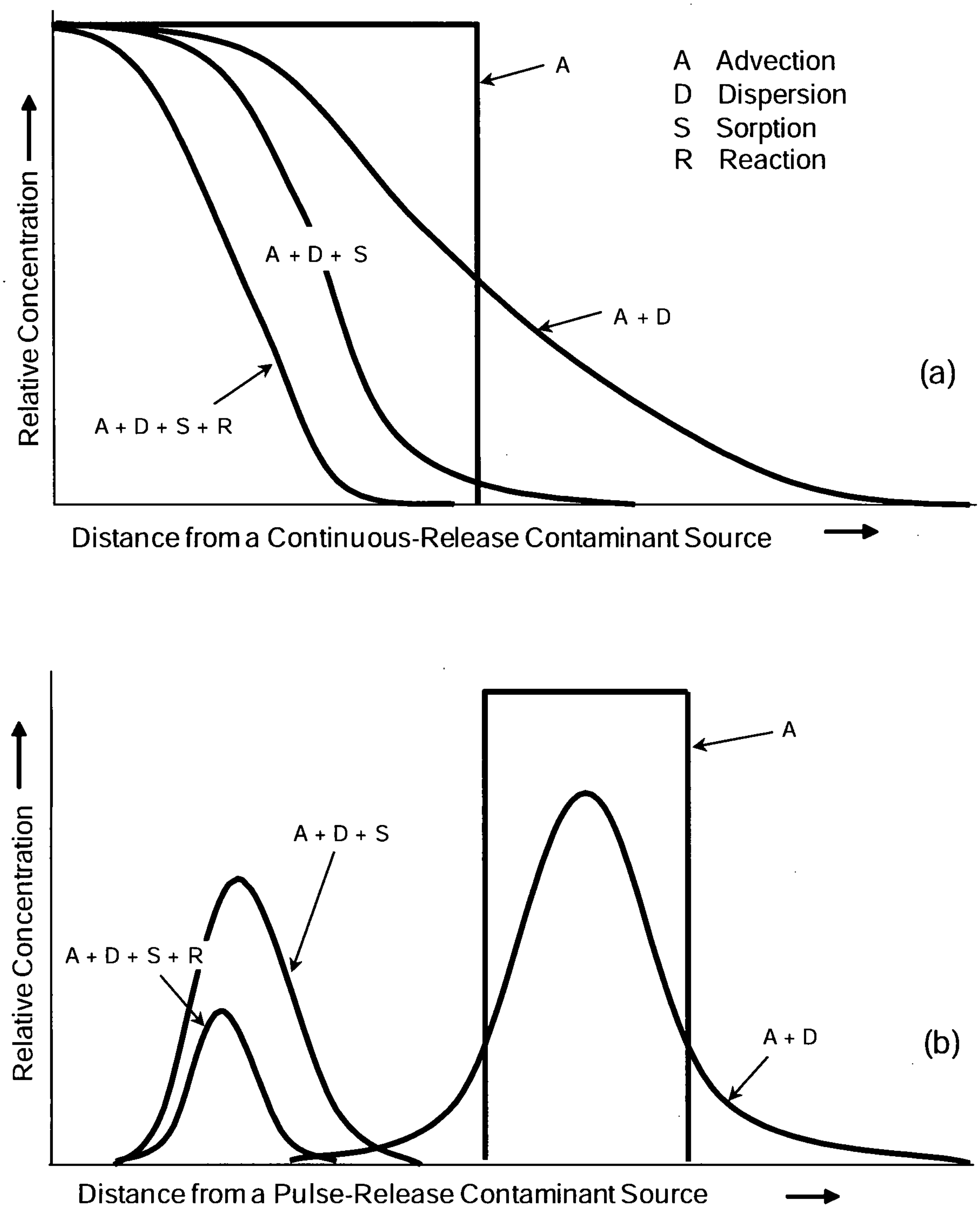

Figure F-1. Contaminant concentration profiles with distance in a one-dimensional plume fed by (a) a continuous-release and (b) a pulse-release source (after Keely et al. 1986).

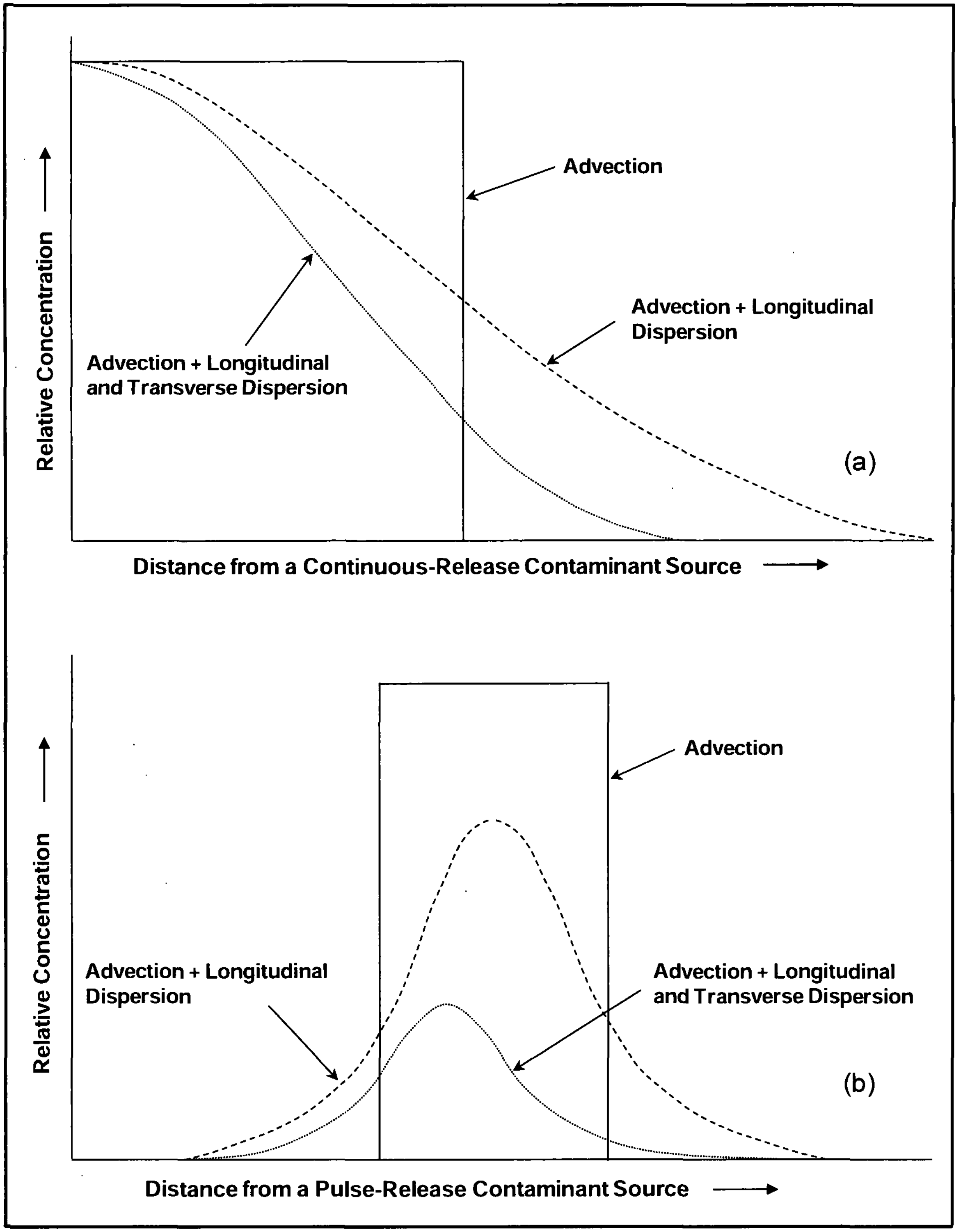

Figure F-2. Relative effects of longitudinal and transverse dispersion on contaminant concentrations along the centerline of a two-dimensional contaminant plume fed by (a) a continuous source and (b) a pulse source.

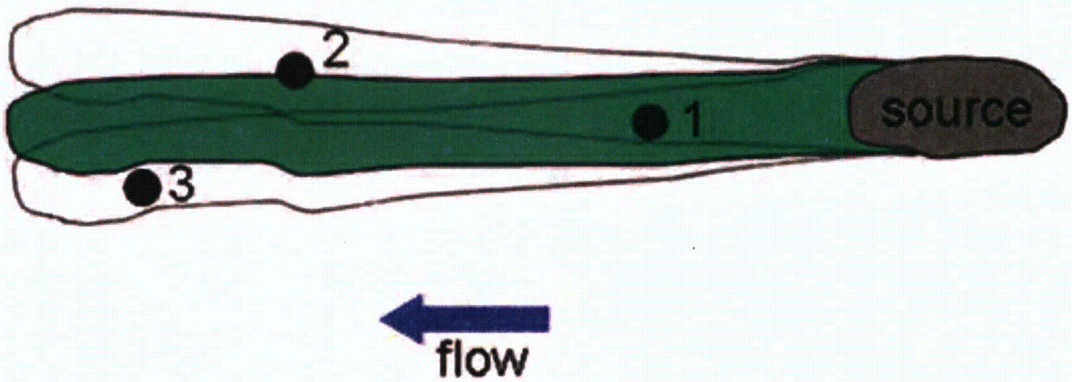

Figure F-3. Schematic illustration of how changing flow direction in a transient flow system produces an apparent dispersion in directions transverse to the average flow direction

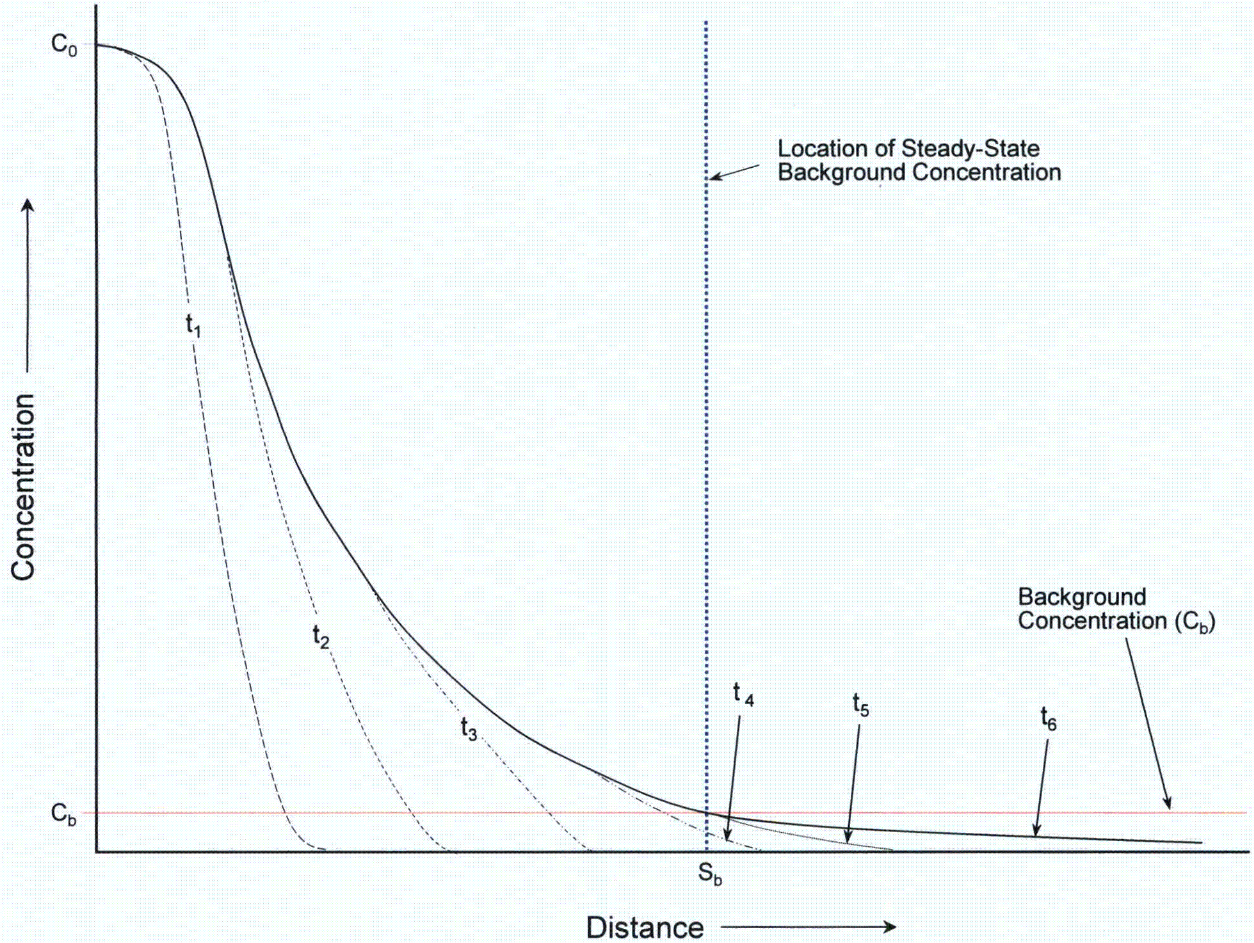

Figure F-4. Graphical Depiction of Contaminant Plume Evolution—Concentration Profiles Along the Plume Centerline at Successive Times t_1 Through t_6

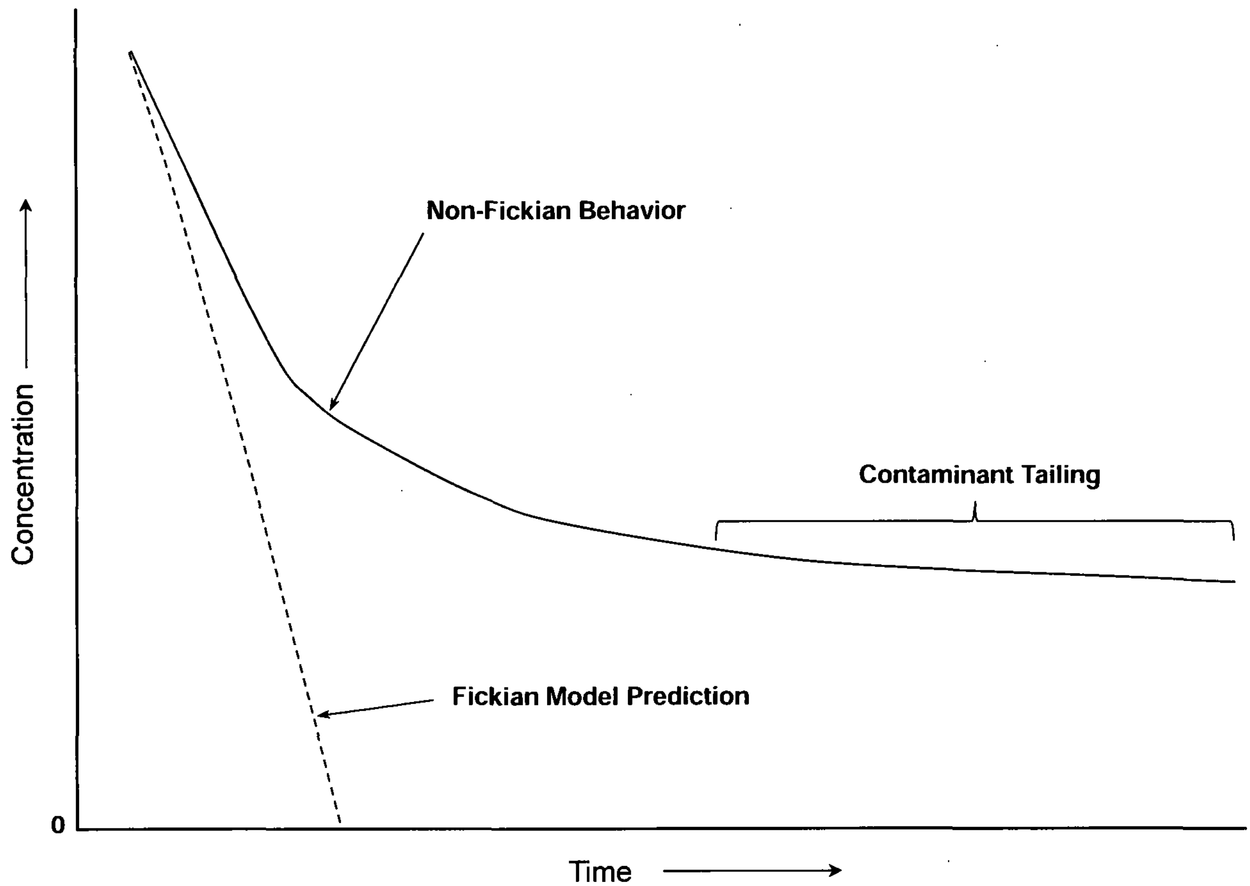

Figure F-5. Late-Time Non-Fickian Behavior and Contaminant Tailing at Monitoring Wells Due to Rate-Limited Mass Transfer from Secondary Sources

Plates

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The 7 drawings specifically referenced in the table of contents have been processed into ADAMS.

These drawings can be accessed within the ADAMS package or by performing a search on the Document/Report Number.

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