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UMTRA Project

Moab UMTRA Project
2008 Performance Assessment of the Ground Water Interim Action Well Field

Revision 1

October 2009

U.S. Department of Energy

Office of Environmental Management

Prepared by the Technical Assistance Contractor under contract number DE-AC30-07CC60012 for the U.S. Department of Energy Office of Environmental Management, Grand Junction, Colorado.

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Review and Approval

10/08/09

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10/9/09

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10/13/09

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Revision History

Revision No.	Date	Reason/Basis for Revision
0	August 2009	Initial issue.
1	October 2009	Removed Attachment 1; reformatted figure and table designations..

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Acronyms and Abbreviations

AWQC	ambient water quality criteria
bgs	below ground surface
btoc	below top of casing
cfs	cubic feet per second
CF	configuration
DOE	U.S. Department of Energy
ft	feet
gal	gallons
gpm	gallons per minute
gpm/ft	gallons per minute per foot
IA	interim action
kg	kilogram
µg/L	micrograms per liter
mg/L	milligrams per liter
msl	mean sea level
TDS	total dissolved solids
UMTRA	Uranium Mill Tailings Remedial Action

1.0 Introduction

The Moab Uranium Mill Tailings Remedial Action (UMTRA) Project site is a former uranium ore processing facility located approximately 3 miles northwest of the city of Moab in Grand County, Utah (Figure 1). The plant was constructed in 1956 by the Uranium Reduction Company, who operated the mill until 1962 when the assets were sold to the Atlas Minerals Corporation (Atlas). Operations continued under Atlas until 1984. When the processing operations ceased in 1984, the mill had accumulated an estimated 16 million yards of uranium mill tailings in an unlined impoundment in the floodplain of the Colorado River. Relocation of the tailings by rail began April 20, 2009. The tailings and associated material are being transported approximately 30 miles north to a disposal cell near Crescent Junction, Utah.

The results of a number of investigations, including the most recent one completed by the U.S. Department of Energy (DOE) (DOE 2003), indicate that contaminants have leached from the tailings pile into the ground water. Several site-related contaminants have been identified, but the most pervasive and highest concentration constituents are ammonia and uranium. The DOE investigations have identified two plumes of ammonia associated with the site: a deep plume beneath the tailings pile and a shallower plume emanating from the toe of the tailings pile to the Colorado River. Ground water from the shallow plume has been demonstrated to discharge to the Colorado River and to have a localized impact on surface water quality. Degradation of surface water quality is of concern because of potential effects on aquatic species in the area, particularly endangered fish.

DOE initiated an interim action (IA) ground water extraction system (Figure 2) in 2003 to pump contaminated ground water from the shallow plume to an evaporation pond on top of the tailings pile. Another IA includes the injection of diverted Colorado River water into the alluvial aquifer. This is accomplished by wells (and an infiltration trench since September 2006) near the west bank of the river. In 2008, the IA exclusively extracted ground water.

The current ground water treatment system was built using a phased approach as data collected from the system was evaluated and showed the need to expand ground water treatment at the site. Currently, the ground water IA well field contains four well configurations (CFs), each consisting of 10 remediation wells, upgradient and downgradient observation wells, river bank well points, and surface water locations. In addition, the well field also contains a freshwater infiltration trench and a baseline area. The objectives of the ground water IA are to: (1) protect aquatic species by reducing ammonia-contaminated ground water from discharging to backwater areas that may potentially be suitable habitat for threatened and endangered aquatic species; and, (2) provide performance data for use in selecting and designing a final ground water remedy.

The purpose of this performance assessment is to compile the 2008 data to describe how the alluvial ground water responds to various pumping regimes and fluctuating river flow.

1.1 Site History and Background

Ground water remediation at the Moab site is aimed mostly at improving surface water quality, particularly in areas that are potential habitat for endangered fish. Therefore, the most important processes to understand are those that relate to ground water and surface water interactions, such as those occurring in the hyporheic zone that underlies the river. The activities associated with the IA expansion are focused on improving the understanding of those interactions and on identifying ways in which the IA can reduce ammonia concentrations in surface water.

Characterization at the site has identified different water types in the alluvial aquifer near the river based on total dissolved solid (TDS) concentrations (DOE 2003). The first is a relatively thin layer of water with a moderate-to-high salinity (TDS < 35,000 milligrams per liter [mg/L]), which overlies a deeper, thicker layer of brine (TDS > 35,000 mg/L). The boundary between the two layers, the "brine surface," is relatively sharp and is found at progressively shallower depths from the vicinity of the tailings pile toward the Colorado River. The brine interface elevation also varies with fluctuating river flow.

The relatively sharp transition from very saline water to brine is believed to be an important feature in the alluvial aquifer for a number of reasons. It appears that the highest concentrations of ammonia—the primary constituent of concern at the site—are associated with the brine surface (DOE 2003). Limited sampling of ground water near the river indicates increasing concentrations of ammonia from the water table to a short distance below the brine surface and decreasing concentrations with continued depth. The uranium concentrations are typically the highest in the upper portion of the ground water. Because water density increases with increasing salinity, the brine surface tends to act as a barrier to flow from above; there is apparently little flow across the brine surface at locations away from the river. As a result, the two aquifer layers located above and below the brine surface tend to represent two distinct sources of ammonia discharge to the river.

1.2 Monitoring Requirements

The performance of the IA well field is monitored through hydraulic and chemical data to: (1) optimize the extraction, freshwater injection, and treatment systems; (2) evaluate the effectiveness in reducing ammonia concentrations discharging to the surface water by either extraction of contaminated ground water or injection of freshwater into the aquifer; (3) minimize the upcoming of the salt water interface in response to pumping the aquifer; and (4) develop and design a final ground water remedy.

The remediation wells, observation wells, well points, and surface water locations are sampled on a rotational monthly basis. At the chosen sampling locations, water levels below top of casing (btoc) and field parameters, including temperature, pH, oxidation reduction potential, conductivity, dissolved oxygen, and turbidity, are recorded. Water samples are collected at various depths and locations to monitor the main constituents of concern: ammonia (as N); uranium; TDS; and manganese (see Table 1). A few locations with historic high concentrations of metals are also sampled for selenium and copper. Water sampling was performed in accordance with the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (DOE 2006b) and the *Environmental Procedures Catalog* (STO 6) (DOE 2007b).

Table 1. Analyte EPA Methods and Detection Limits

Analyte	EPA Method	Detection Limit
Ammonia as N	350.3	0.1 mg/L
Chloride	9056	0.5 mg/L
Bromide	9056	0.5 mg/L
Sulfate	9056	0.5 mg/L
TDS	160.1	10 mg/L
Copper	SW-846 6010	25 µg/L
Selenium	SW-846 6020	0.1 µg/L
Manganese	SW-846 6010	5 µg/L
Uranium	SW-846 6020	0.1 µg/L

mg/L = milligrams per liter; µg/L = micrograms per liter

1.3 Performance Assessment Methods

The performance of ground water extraction methods in contributing to the mitigation of environmental effects is based on comparisons of hydraulic and water chemistry data collected since extraction began, with equivalent data reflective of pertinent baseline conditions at the Moab site. Such baseline information is drawn from two sources. In most instances, baseline conditions are based on data collected at the well field before the wells were used for ground water extraction (or injection). In other instances, baseline information is drawn from observations made in a separate part of the well field called the Baseline Area, which is located north of both the well field and the infiltration trench and about 400 feet (ft) south-southwest of the confluence of the Moab Wash and the Colorado River. The Baseline Area is used to portray ambient hydraulic and water chemistry conditions that occur between the tailings pile and the river. The conditions in the Baseline Area reflect the effects of ammonia and uranium contamination originating in the area of the tailings pile but are unaffected by either ground water pumping or the injection of relatively fresh water diverted from upstream portions of the river.

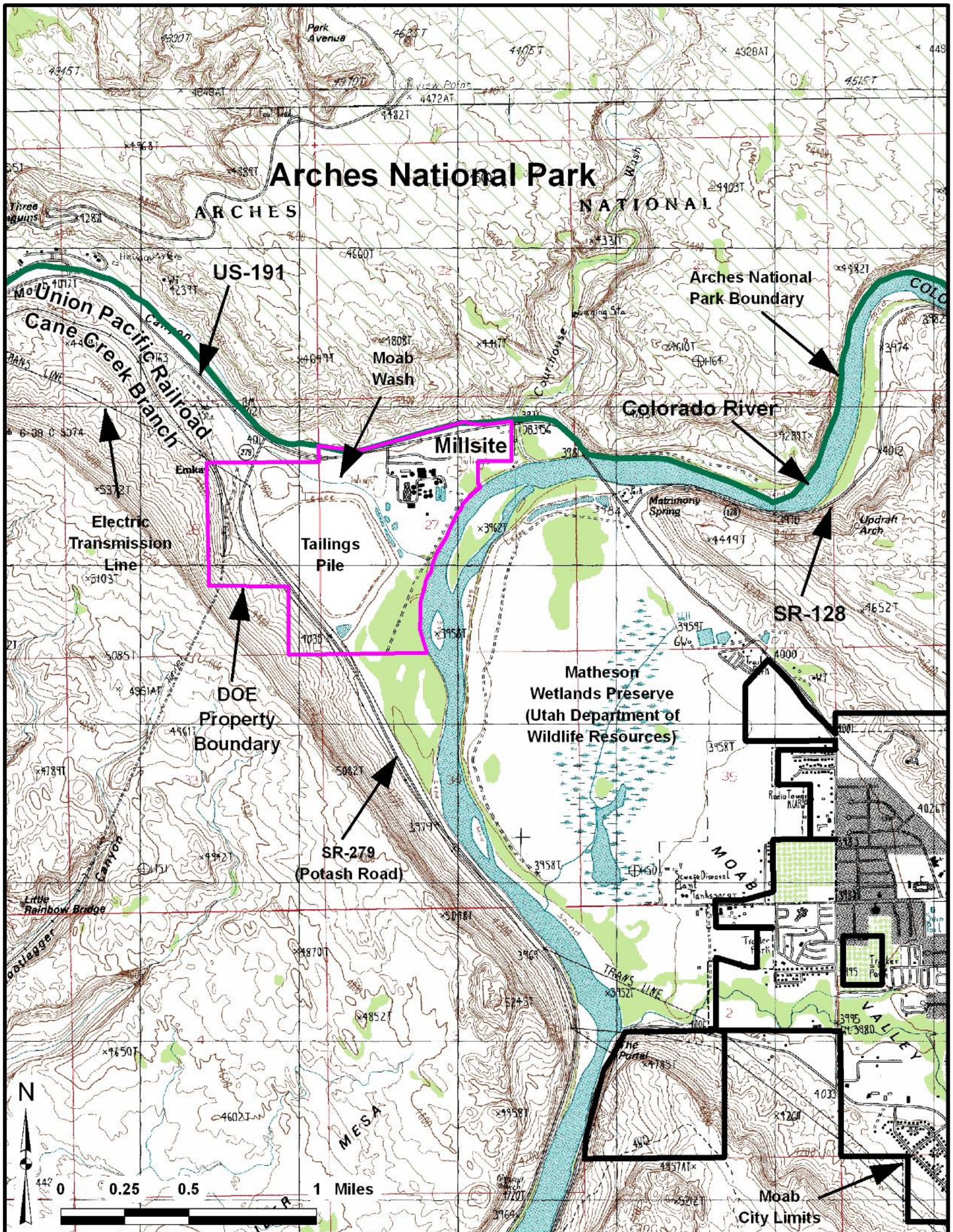

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Figure 1. Location Map of the Moab Site and Surrounding Area

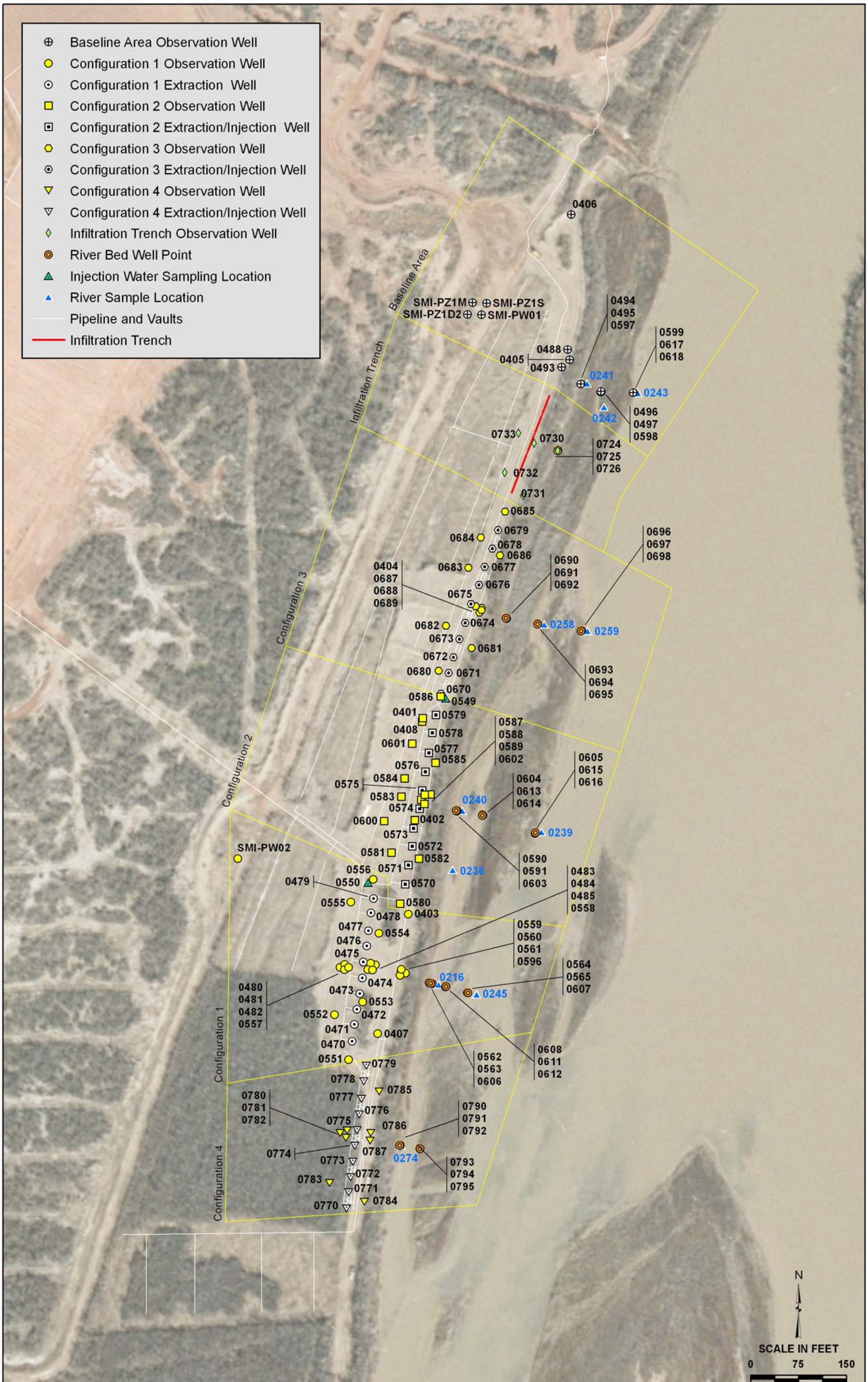

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Figure 2. Map View of IA Components and Sampling Locations in the Well Field

2.0 Conceptual Model of Ground Water Flow and Hydrochemistry

Discharge of ground water to the river at the Moab site is affected by density-dependent flow induced by the presence of very saline to briny water. In addition, evidence for the presence of a hyporheic zone below the river, discussed in previous performance evaluations of the ground water IA (DOE 2005a, DOE 2005b, DOE 2006a), indicates that the chemistry of this ground water is significantly altered before it enters the river. A detailed conceptual model presented in preceding performance assessments (DOE 2006a, DOE 2007a) is briefly summarized here.

2.1 Alluvial Ground Water System

The uppermost 10 ft of alluvium in the vicinity of the ground water IA generally consists of sandy silt and silty sand deposits. These silt-bearing sediments are typically underlain by 5 to 6 ft of fine- to coarse-grained sand. From depths of approximately 15 to 29 ft below ground surface (bgs), gravelly sands predominate, but thin clayey, gravelly sand units may also be present. Below 100 ft bgs, the alluvium consists of gravelly sands and sandy gravels. The water table in ground water IA areas is located at about 10 to 12 ft bgs. Stratification within the alluvium causes hydraulic anisotropy, with the effective hydraulic conductivity in the vertical direction 10 to 100 times smaller than the horizontal hydraulic conductivity (DOE 2003). The alluvium is underlain by the Paradox Formation.

Natural ground water at the Moab site originates as recharge from atmospheric precipitation, surface water flow across alluvium in the vicinity of the Moab Wash, and infiltration through river banks during high river stage conditions. A relatively minor amount of flow occurs through deep bedrock units into the site. The majority of the recharge water appears to enter the valley as subsurface discharge to the alluvium that dominates the unconsolidated deposits found throughout most of the valley. In general, flow in the alluvium at the Moab site is from the tailings pile southeast towards the river. The flow of ground water is influenced by changes in density associated with the level of salinity. Discussion of salinity is pertinent to understanding ground water flow at the site as the presence of very saline or brine water indicates minimal ground water flow in those areas as soluble salts would otherwise be flushed from the system.

Salinity data collected from ground water in alluvium on both sides of the river show that TDS concentrations in both areas are in a wide range, from as low as 700 mg/L to greater than 110,000 mg/L (DOE 2003, Gardner and Solomon 2003, DOE 2006a, DOE 2007a). These TDS concentrations are higher than the TDS levels commonly reported for river water (500 to 1,000 mg/L). Brine in the deepest parts of the alluvium was derived from chemical dissolution of the underlying Paradox Formation (Doelling, et al., 2002). For purposes of characterization, water is typically characterized as being either mildly saline (TDS = 1,000 to 3,000 mg/L), moderately saline (TDS = 3,000 to 10,000 mg/L), very saline (TDS = 10,000 to 35,000 mg/L), or briny (TDS > 35,000 mg/L) (McCutcheon, et al., 1993). These TDS concentrations are higher than the TDS levels commonly reported for river water (500 to 1,000 mg/L), which is referred to as freshwater in this report.

On the west side of the river at the Moab site, moderately saline and very saline waters result mostly from the mixing of southeastward-moving shallow ground water with the deeper brine. However, some of the highly saline ground water close to the river is also attributed to historical seepage of high TDS fluids from the base of the Moab tailings pile located to the west, which occurred mostly during and immediately after the years of milling operations at the Moab site (DOE 2003). TDS concentrations increase with depth in the vicinity of the ground water IA (DOE 2006a). Salinity data collected from ground water in alluvium on both sides of the river show that TDS concentrations in both areas are in a wide range, from as low as 700 mg/L to greater than 110,000 mg/L (DOE 2003, Gardner and Solomon 2003, DOE 2006a, DOE 2007a).

2.2 Recharge and Discharge Relationships between the Alluvial Aquifer and the Colorado River

The Colorado River reach within Moab Valley is a gaining watercourse, and ground water discharge to the river occurs mostly within relatively narrow bands on either side of the river. The occurrence of highly saline water in shallow ground water near the river along both its west and east shores is upwelling of brine (DOE 2006a).

Analyses of salinity in ground water under the Moab site (DOE 2003) indicate that the brine surface is deepest in the western portion of the site and becomes shallower in the direction of the river. Assessments of IA CFs 1 and 2 indicate that, under nonpumping conditions, brine is usually found in these areas at about 25 to 40 ft bgs (DOE 2004, DOE 2005a, DOE 2005b, DOE 2006a), and extrapolation of the brine surface in these areas shows it intersecting the river close to its west bank (Figure 3). The CF4 wells that were installed in 2006 show similar conditions, but with the brine surface at slightly shallower depths than CFs 1 or 2. Figure 3 shows a conceptual model of ground water flow to the Colorado River. It is hypothesized that shallow, moderately saline water migrates faster than the deeper brine (DOE 2006a, DOE 2007a).

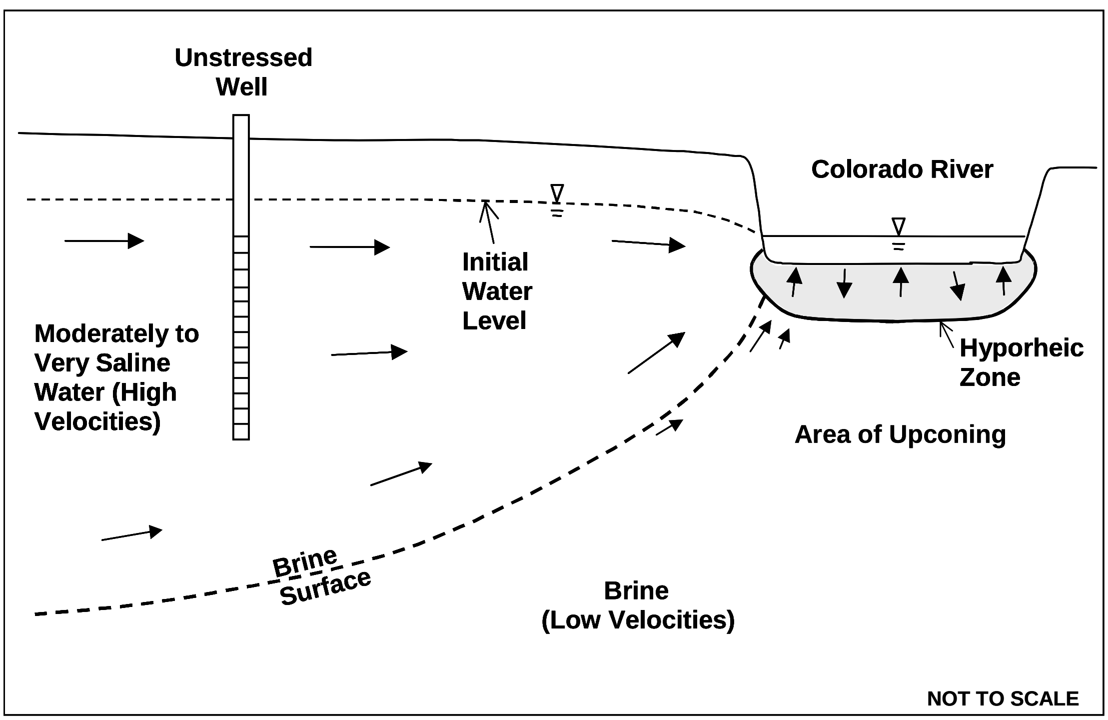


Figure 3. Conceptualization of Ground Water Flow Near the Colorado River Under Nonpumping Conditions

Ground water salinity in the vicinity of the river is controlled by:

- The rate of ground water flow (slow velocities are associated with high TDS).
- The depth of the slightly saline brine interface increases with the depth to the Paradox Formation.
- The depth of the slightly saline brine interface decreases with the presence of riparian channels.

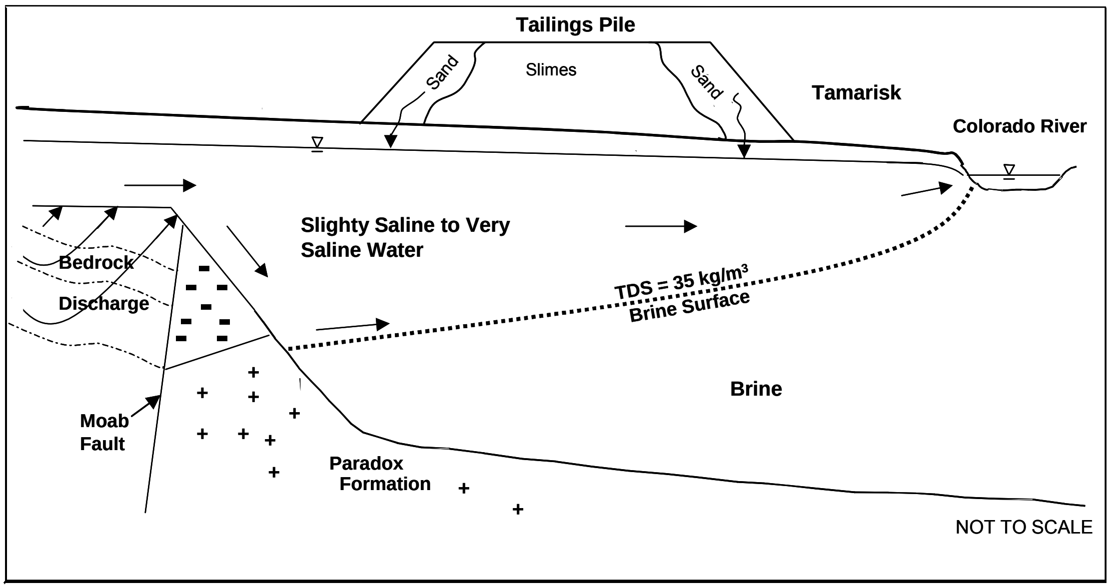


Figure 4. Conceptualization of Ground Water Flow at the Moab Site

Based on this information, the conceptual model shown in Figure 4 was expanded (DOE 2007a) to illustrate how density-dependent ground water flow occurs on both sides of the river, as shown in Figure 5. With this updated conceptualization, both the total distance and depth over which dissolution of Paradox Formation sediments occurs south and east of the river can be quite different from what occurs on the west side of the river. As a result, the profile of the brine surface in the vicinity of the river can be asymmetric (DOE 2007a).

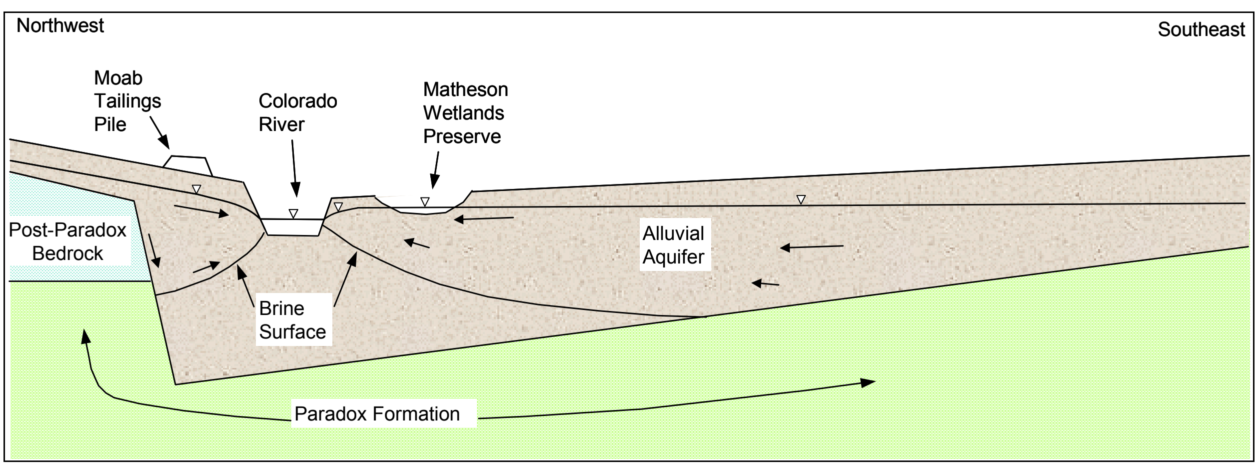


Figure 5. Conceptual Model of Density-Dependent Flow on Both Sides of the Colorado River

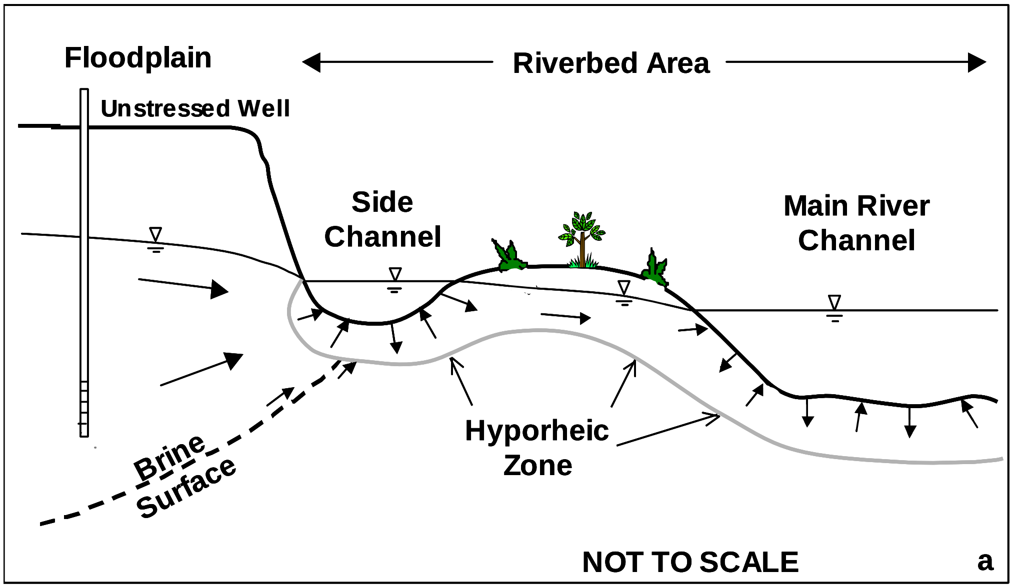
During years in which high ammonia concentrations have been detected in surface water, they have typically been found in river side channels (backwaters) that are separated from the main river channel and are located close to a steep bank that separates the river bed from the floodplain on which the Moab site sits (Figure 6, illustration a). These occurrences indicate that the contaminated ground water discharging to the river tends to converge on the side channels rather than migrating to the main channel where surface water flows tend to be larger.

However, because the river processes that helped create the backwaters vary over time, some side channels near the river's west bank have eventually filled in with sediment, and ground water under those conditions migrates farther east to discharge to the river's main channel (Figure 6, illustration b). Under these circumstances, the brine surface also migrates farther to the east, and the depth to brine near the steep bank increases. Such river bed infilling appears to have occurred over the past several years adjacent to the Baseline Area and CF3. If depths to the brine surface in these areas deepened as a result of sedimentation processes, the changes could be technically attributed to increases in distance from the river (i.e., proximity to the river).

Surface water flow in the Colorado River is hydraulically connected to the alluvial system at the Moab site (DOE 2003), and ground water levels fluctuate with river stage. A lag time of approximately 1 day is typically observed between river rise and increases in ground water levels in wells located hundreds of feet from the river. However, the response time of ground water levels close to the river is relatively short, making it likely that river effects on water levels in the ground water IA wells would be observed within periods of a few to tens of minutes.

Generally, under normal river flow conditions, changes in river elevation do not affect the elevation of the brine/freshwater interface inland west of the river. The exception to this is under higher stage conditions relative to low-flow conditions in drought years increasing salinity was observed with increase in river stage. It is hypothesized that, as the water table increases with increasing river stage, the vertical thickness of the water located above the brine surface essentially remains constant so that the net flow of ground water to the river is also constant (DOE 2006a). Another exception was during very high river flows where a decrease in constituent concentrations in shallow ground water located close to the river was observed. These concentration decreases were attributed to significant water losses from the river to the subsurface in the form of bank storage (DOE 2006a).

Mixing of river water with ambient ground water in the hyporheic zone facilitates the various biogeochemical processes that can cause attenuation of contaminant concentrations prior to their discharge to surface water (DOE 2006a). Microbially mediated processes are shown on Figure 7) (Dahm, et. al., 1998).



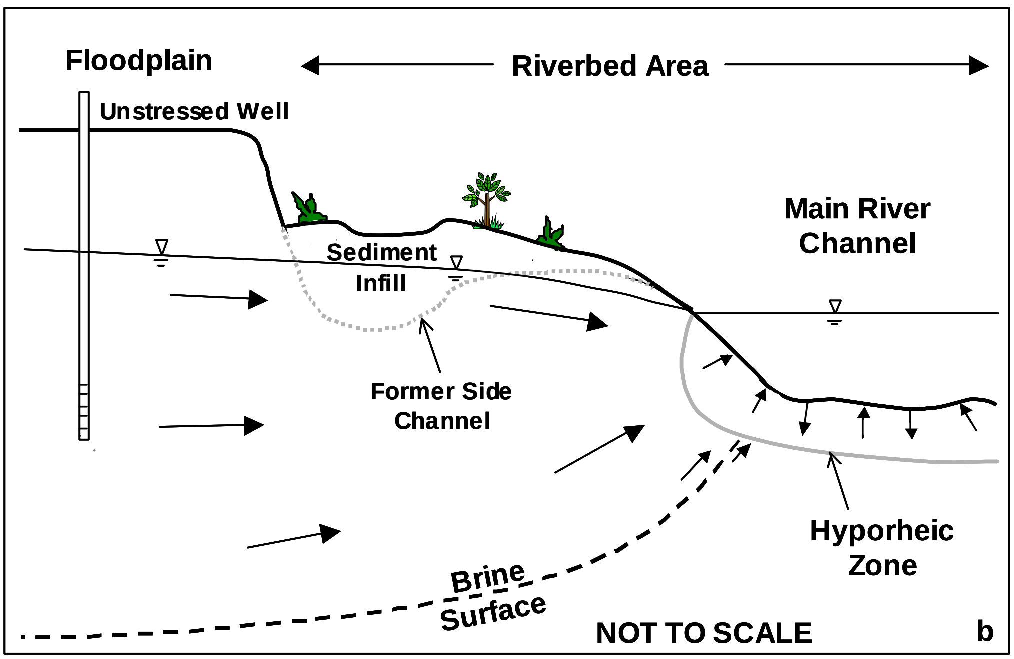


Figure 6. Conceptualization of Brine Surface Behavior in Response to River Sedimentation a) Before Sedimentation and (b) After Sedimentation

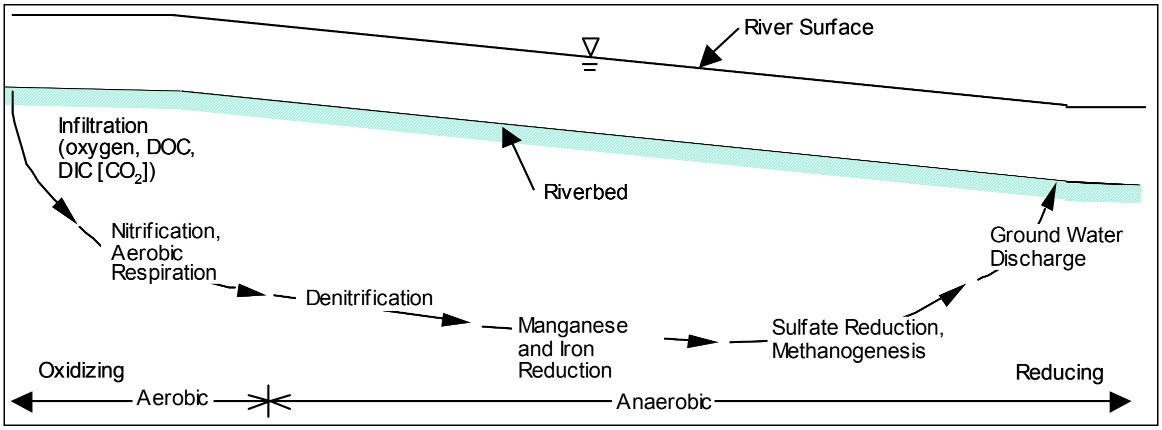


Figure 7. Microbially Mediated Processes in the Hyporheic Zone

For the range of oxidation reduction potential in the hyporheic zone, several types of bacterial metabolism, including nitrification and denitrification, can occur locally beneath the river. Tests for nitrifying bacteria indicate that ammonia in local ground water is converted to nitrate, which may in turn be subject to biodegradation downgradient in the hyporheic zone where mixing of river water and ground water produces an environment conducive to heterotrophic respiration (DOE 2006a). In addition, microcosm studies of site conditions indicate nitrogen/ammonia removal is likely to be the result of microbial nitrification, denitrification, and another microbially mediated reaction known as anammox (Ahn 2006). Conclusions of these studies suggest that several bacterially mediated nitrogen removal processes are possible in the hyporheic zone.

3.0 Ground Water IA Well Field System Operations

This section provides information regarding the ground water IA well field performance during the 2008 pumping season when CFs 1, 3, and 4 were actively extracting ground water. Also included in this section is a discussion regarding the total well field ground water extraction rate, evaporation pond storage volume, and sprinkler system discharge rate.

From May 20 to June 19, 2008, the well field was shut down due to high river stage during the spring runoff. As a result, the observed contaminant concentrations were greatly reduced because surface water migrated into the soils beneath the site, as described in the *Moab UMTRA Project Well Field Optimization Plan* (DOE-EM/GJTAC1791), Appendix A.

CF2 was not operated since the remediation wells have not shown adequate productivity and have a low well efficiency. CF2 used to be adjacent to the location of an endangered fish habitat, however, the habitat area has since migrated south towards CFs 1 and 4 due to natural stream channel migration and sediment filling. Extraction well SMI-PW02 was only operated from November 13 to 20, 2008, due to mechanical and electrical problems and is not included in this analysis.

Table 2 presents the average ground water extraction rates and the total volume removed from each configuration during 2008. As shown, the average extraction rate from the entire well field was 64.3 gallons per minute (gpm), and more than 21 million gallons (gal) were removed and transported to the evaporation pond. CF3 extracted the most volume of ground water in 2008.

Table 2. Total Volume and Average Ground Water Extraction Rate During 2008

Configuration	Total Avgerage Extraction Rate (gpm)	Total Ground Water Volume Extracted (gal)
1	14.4	7,763,900
3	29.2	8,201,520
4	20.7	5,189,737
Total	**64.3**	**21,155,157**

The individual pumping rates and associated volume of ground water extracted by each well contained within CFs 1, 3, and 4 are presented in Appendices A, B, and C, respectively. Some of the monthly extracted ground water volumes presented are estimates. The data listed were generally based on flow rates recorded at meters installed at each extraction well head. These flow meters occasionally malfunctioned, which meant that some pumping rates had to be assumed using rates that were accurately captured prior to and after periods of malfunction. Figure 8 provides a graphic summary of the cumulative volume of ground water extracted from each configuration in 2008.

As in 2007, CF1 ran on extraction mode year-round in 2008. CFs 3 and 4 were winterized and shut down in October 2008.

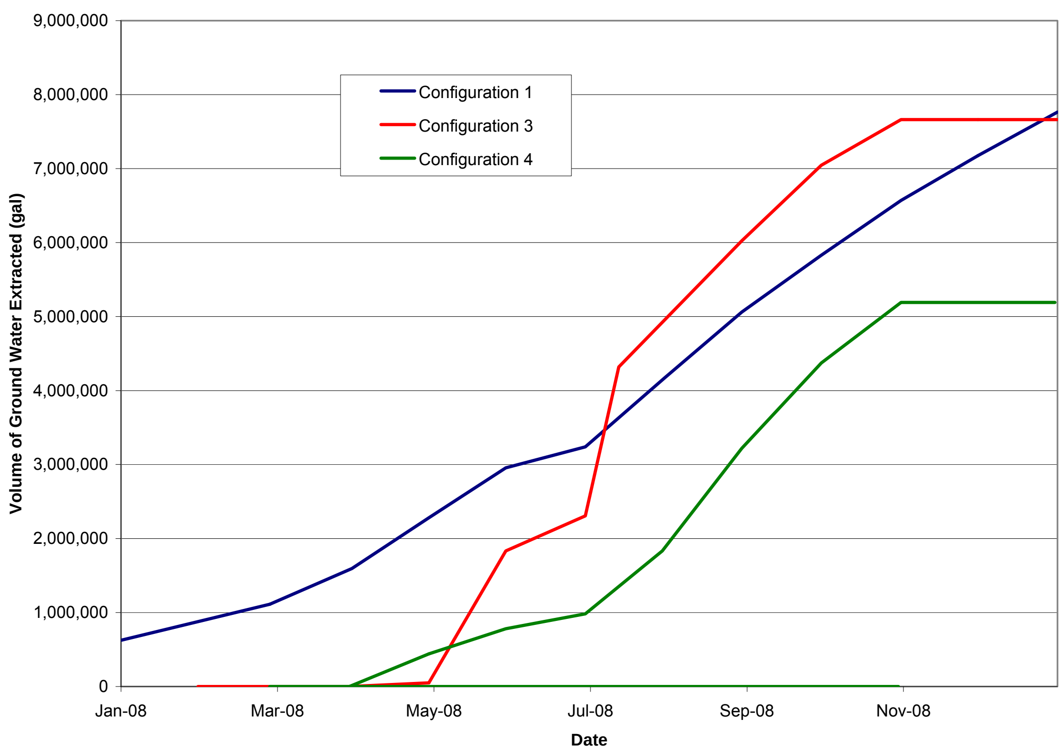


Figure 8. Cumulative Volume of Extracted Ground Water from Each Configuration During 2008

3.1 CF1 Pumping Rate and Ground Water Extracted Volume

CF1 extraction wells 0470 through 0477 (see Appendix A, Figure A-1 and Table A-1) are screened from approximately 10 to 20 ft bgs (3,957 to 3,947 ft mean sea level [msl]), and wells 0478 and 0479 are screened from approximately 10 to 25 ft bgs (3,957 to 3,942 ft msl). These extraction wells ran through the winter of 2007, but were shut down from December 13, 2007, to January 3, 2008, and then again from December 11, 2008, to January 3, 2009, due to below-freezing air temperatures.

Monthly extraction volumes between January and December 2008 for each of the 10 wells comprising the CF1 system are listed in Table A-1 in Appendix A. As indicated in Table A-3, the CF1 wells individually extracted between approximately 512,000 gal (0470) and 1 million gal (0477) in 2008. CF1 wells extracted a combined volume of about 7.8 million gal of ground water during 2008. Pumping from well SMI-PW02 removed 266,535 gal of ground water during the short time (approximately 1 week) in which it was operating.

3.2 CF3 Pumping Rate and Ground Water Extracted Volume

CF3 remediation wells 0670 through 0679 (see Appendix B, Figure B-1 and Table B-1), designed to both extract ground water and inject freshwater, were used only to extract ground water during 2008. The well screens are placed at 15 to 45 ft bgs (3,952 to 3,921 ft msl). The CF3 remediation wells began extracting ground water on April 3, 2008, and were shut down for the winter on October 16, 2008.

Estimated pumping rates and extraction volumes between April and October 2008 for each of the 10 wells comprising CF3 are listed in Table B-3 (see Appendix B). As indicated in Table B-3, the CF3 wells individually extracted between approximately 84,000 gal (0673) and 1 million gal (0674). The difference in the amount of gallons pumped in each extraction well is due to problems with submersible pumps and the limit of the evaporation pond and sprinkler system capacities.

3.3 CF4 Pumping Rate and Ground Water Extracted Volume

CF4 remediation wells 0770 through 0779 (also designed for both freshwater injection and ground water extraction) were installed in May 2006 with approximate screen intervals of 15 to 35 ft bgs (3,951 to 3,930 ft msl). CF4 ran on extraction mode from April 3 to October 16, 2008 (see Appendix C, Figure C-1 and Table C-1).

Estimated monthly pumping rates and extraction volumes between April and October 2008 for each of the 10 CF4 remediation wells are listed in Table C-3 in Appendix C. A total of 5.1 million gal of ground water was extracted from the CF4 wells during the 2008 pumping season. Remediation well 0770 did not run during the 2008 pumping season due to issues with the submersible pump.

As indicated in Table C-3, the CF4 wells individually extracted between approximately 43,000 gal (0778) and 1.2 million gal (0774) in 2008. The amount of gallons pumped was limited to the evaporation pond and sprinkler system capacities.

4.0 Well Field System Performance

4.1 Ground Water Levels and Hydraulic Control

The Baseline Area is located upstream of the well field configurations and the infiltration trench, just south of the confluence of the Moab Wash and the Colorado River (Figure 2). This area has been used as an analogue of hydraulic and water chemistry conditions in the alluvium that are unaffected by ground water pumping or injection. These types of aquifer materials encountered in the Baseline Area are generally the same as those observed in the vicinities of the IA configurations. Observed phenomena in the Baseline Area, such as ground water level variations in response to changing river flows, the presence or absence of riparian channels, concomitant changes in brine surface elevation, and hyporheic zone processes, were useful for comparison with equivalent phenomena in the IA areas.

4.1.1 Drawdown and Capture

Drawdown hydrographs were created by comparing ground water elevations with water elevations from Baseline Area observation well 0406 and applicable pumping rates for the period of ground water extraction. Baseline Area water elevation data were adjusted so that both wells were assigned the same starting ground water elevation prior to the time period when pumping began and after the pumping was suspended for the winter. Differences between the two curves are a qualitative estimate of drawdown in response to pumping. The drawdown hydrographs show that it becomes difficult to gauge extraction and observation well drawdowns during the months of high runoff in the river or a long period after startup.

The peak mean daily flow in the Colorado River in 2008 was 40,100 cubic feet per second (cfs) on May 23, which represents a peak flow of almost double the average annual peak flow (23,400 cfs).

Figure 9 is a temporal plot comparing the ground water elevation measured in Baseline Area well 0406 and the Colorado River flow measured at the U.S. Geological Survey Cisco gauging station during 2008. As the plot exhibits, the ground water elevation fluctuations are in response to changes in the river flow. As typically occurs during the spring runoff, the Colorado River changes from gaining to losing conditions, which results in a freshwater influx to the ground water system. Figure 9 shows how the ground water elevation remained high after the Colorado River peak flow had diminished.

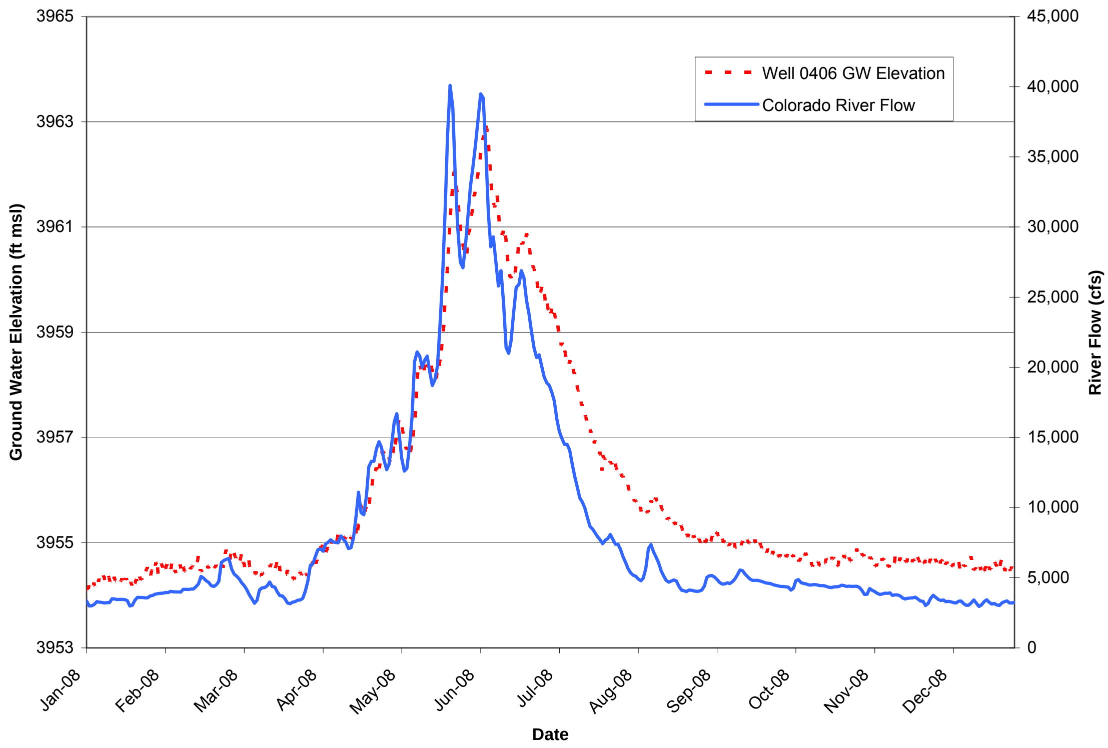


Figure 9. Hydrograph of Baseline Area Well 0406 Ground Water Elevation and Colorado River Flow in 2008

Figure 10 presents an example plot of measured ground water levels at observation well 0480, along with adjusted ground water elevation fluctuations measured in Baseline Area well 0406. The water level in 0406 was manually adjusted to match the measured water level in 0480 during nonpumping conditions. Also shown in the plot is the CF1 total extraction rate over the same time period. During CF1 pumping, the water level in 0480 decreased (as noted by the blue rectangles in Figure 10). When the well field was shut off in May and June 2008, the ground water level at well 0480 matched the ground water level at Baseline Area well 0406.

Similar plots generated for select observation wells in CFs 1, 3, and 4 are contained in Appendices A, B, and C, respectively. These drawdown estimates provide the best available means to measure the capture zone in the vicinity of extraction wells at each configuration and the effectiveness of capturing contaminants migrating toward the river.

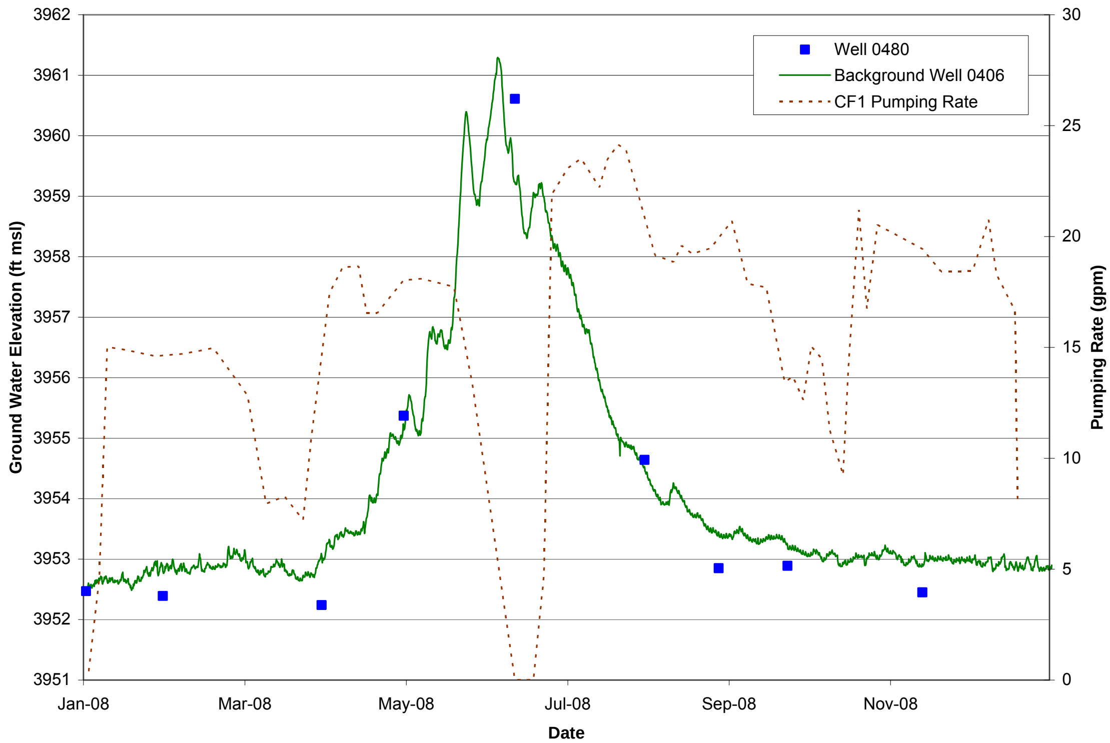


Figure 10. Ground Water Elevations at Observation Well 0480 and Baseline Area Well 0406 During 2008

Computed drawdowns are presented in Table 3, along with drawdown measured during the 2007 pumping season, for comparison purposes. As the results show, the drawdowns measured in 2008 are comparable to those measured in 2007. The measured drawdown in CF3 observation well 0688 was greater than what was observed in 2007. Since CF4 did not run consistently throughout the 2008 pumping season, drawdown data is not available.

Table 3. Computed Drawdowns at Selected Observation Wells During 2008

Configuration	Well	Distance from Well Field Axis (ft)	2008 Drawdown (ft)	2007 Drawdown (ft)
1	0480	23	0.5	0.8
	0552	30	0.4	0.7
3	0682	26	0.6	0.6
	0688	20	1.8	0.7

4.1.2 Remediation Well Specific Capacity

Specific capacity is a measure of a well's performance relative to formation hydraulic characteristics. Figure 11 is an example plot showing the discernible drawdowns at extraction well 0470 during 2008 (note that the ground water elevation for well 0406 was adjusted to the ground water elevation of 0470 in December 2007). As this figure shows, ground water elevation data collected from extraction well 0470 drops below the background fluctuation elevation data. This difference represents the approximate drawdown inside the extraction well due to ground water extraction, especially during the months leading up to the peak runoff, and thereafter when the extraction rate was increased.

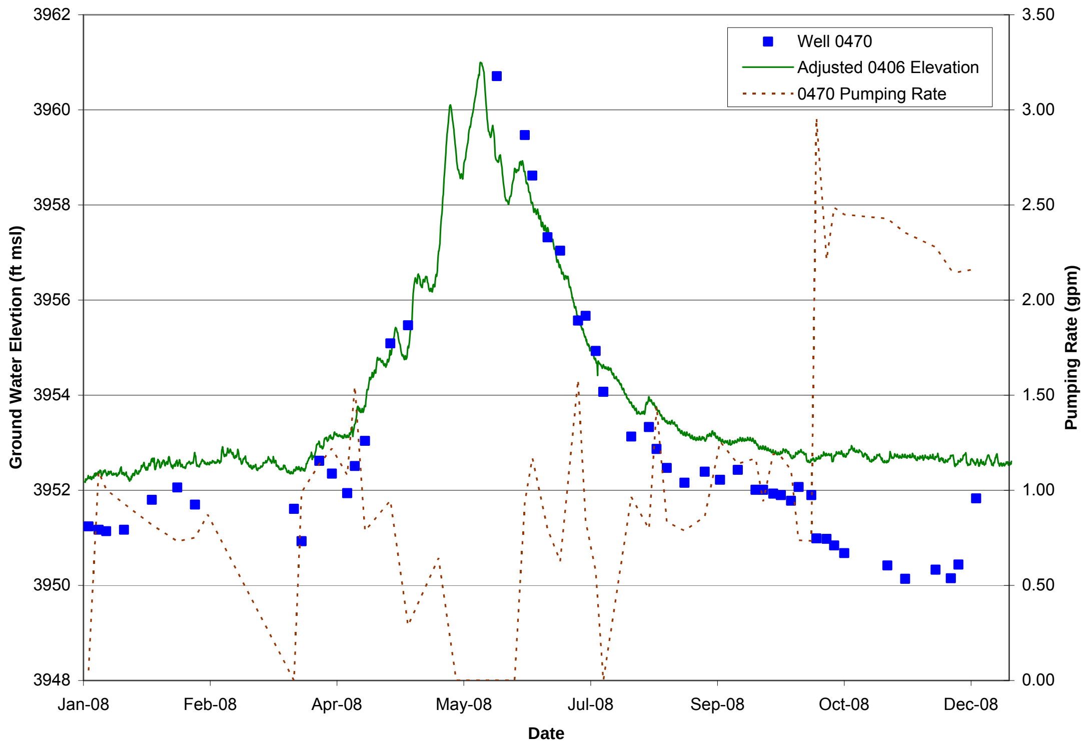


Figure 11. Well 0470 Ground Water Elevations and Pumping Rates Plotted with Background Well 0406 Fluctuation During 2008

The graphs contained in Appendices A, B, and C for select CFs 1, 3, and 4 extraction wells, respectively, were used to compute drawdowns and estimate the specific capacity during the 2008 pumping season. While this is not a rigorous method of calculating specific capacity because it does not account for well interference, it provides a qualitative evaluation of the relative performance of each configuration.

The wells listed in Table 4 were selected based on calculated specific capacity estimates in 2008 and represent wells associated with the lowest and highest specific capacities in each of the three configurations. The 2008 results also include the range of specific capacities calculated during 2007 for comparison purposes. CF4 specific capacity was three times as high in 2008 as it was in 2007. The reason for the difference is likely linked to the above average Colorado River peak runoff.

Table 4. Computed Specific Capacities at Selected Extraction Wells During 2008

Configuration	Well	2008 Specific Capacity (gpm/ft)	2007 Specific Capacity Range (gpm/ft)
1	0479	0.6	0.7 to 1.8
	0474	2.8	
3	0675	2.3	1.5 to 7.0
	0678	6.2	
4	0772	4.5	1.6 to 5.6
	0774	17	

gpm/ft = gallons per minute per foot

4.2 Contaminant Mass Removal

This section presents the estimated ammonia and uranium mass removed by CFs 1, 3, and 4 extraction wells during 2008. These estimates are based on the ground water extraction rate and volumes recorded by flow meters located along the well head discharge pump lines. The masses of ammonia and uranium removed from ground water by the extraction wells during 2008 were estimated by multiplying the monthly extraction volumes by corresponding concentration of ammonia and uranium measured in each well.

The concentrations used in these calculations were drawn from analytical data presented in Appendices A, B, and C for CFs 1, 3, and 4, respectively. In order to estimate the contaminant mass removed when analytical data were not available for a specific month, concentrations from the previous and subsequent months were averaged to provide the approximate concentration.

Table 5 presents a summary of the ammonia and uranium mass removed during 2008 by each configuration. As shown, during the 2008 pumping season, a total of 30,379 kilograms (kg) of ammonia and 140.2 kg of uranium were extracted from the ground water.

Table 5. Total Volume and Average Ground Water Extraction Rate During 2008

Configuration	Total Ammonia Mass Removed (kg)	Total Uranium Mass Removed (kg)
1	8,894	49.7
3	13,978	64.2
4	7,507	26.3
Total	**30,379**	**140.2**

4.2.1 CF1 Contaminant Mass Removal

The monthly estimates of ammonia mass removed by CF1 wells (0470 through 0479) are listed in Table A-4. During 2008, the largest mass quantities were associated with wells 0475 and 0471. In previous years, the extraction wells that removed the largest mass quantities were the wells that extracted the greatest volume. This was not the case in 2008, where extraction wells 0477 (1,007,007 gal) and 0478 (988,741 gal) removed the largest volume of ground water, but not the most ammonia mass.

The 2008 ammonia mass removal for CF1 is higher than what was recorded in 2007. One reason for the increase is that CF1 ran year-round in 2008, from January to December. The largest ammonia removal from the CF1 ground water occurred in March and April 2008, when each of the 10 wells were running on extraction mode and before the contaminants were diluted by the influx of freshwater when the Colorado River stage increased.

Estimated masses of uranium removed from ground water during 2008 by pumping of CF1 extraction wells were developed using the same techniques applied to ammonia. The monthly estimates of uranium mass removed by CF1 wells are listed in Table A-5 (Appendix A). The 10 CF1 wells removed an estimated total of 49.7 kg of uranium from the ground water in 2008. Wells 0478 and 0477 removed the most uranium mass at 7.2 and 6.6 kg, respectively. The largest uranium mass was removed in April, August, and September 2008.

Extracting ground water from January to March 2008 and from October to December 2008 increased the uranium removal by approximately 29 kg and increased the ammonia removal by approximately 4,100 kg.

4.2.2 CF3 Contaminant Mass Removal

The data presented in Table B-4 (Appendix B) indicate that an estimated total of 13,987 kg of ammonia was extracted from ground water at CF3 wells (0670 through 0679) during the 2008 pumping season. This mass removal is greater than what was estimated for CF1, but in a shorter amount of time. This is likely due to the impact of the high river flow in 2008, which diluted the contaminants in the ground water in the southern end of the well field but, as described in Appendix A of the *Moab UMTRA Project Well Field Optimization Plan*, did not impact the water chemistry in this area of the well field.

Wells 0678 (2,575 kg) and 0677 (1,894 kg) removed the most ammonia mass from the ground water. The greatest concentration of ammonia was removed from CF3 during May and July 2008, when the extraction rate was increased.

Estimated mass withdrawals of uranium at CF3 extraction wells (see Appendix B, Table B-5) indicate that a total of 64.2 kg of uranium was removed by this system between April and October 2008. The greatest concentration of uranium was extracted from wells 0678 (12.4 kg) and 0674 (8.5 kg), and the most mass was removed in May and July 2008.

4.2.3 CF4 Contaminant Mass Removal

An estimated 7,507 kg of ammonia was extracted from ground water at CF4 wells (0770 through 0779) during the 2008 pumping season (Table C-4). This ammonia mass removal represents the lowest of the three configurations during 2008. The reason for the lower mass removal is because CF4 was not run to its full potential because of several shutdowns and in order to keep the evaporation pond level in check.

Wells 0774 (1,856 kg) and 0779 (1,216 kg) removed the most ammonia mass. The greatest concentration of ammonia was removed from CF4 during April and September 2008, when the extraction rate was high and the ground water was not as diluted from the surface water migration into the well field. A total of 7,507 kg of ammonia was extracted from CF4 and, as with CF1, the contaminants were diluted due to the above average Colorado River peak flow.

Estimated mass withdrawals of uranium at CF4 extraction wells (Appendix C, Table C-5) indicate that a total of 26.3 kg of uranium was removed by this system between April and October 2008. The greatest concentration of uranium was extracted from wells 0774 (7.4 kg) and 0773 (5.5 kg), and the most mass was removed in August and September 2008.

5.0 Contaminant Distributions and Temporal Ground Water and Surface Water Chemistry

Section 5.1 describes the contaminant distributions observed during the 2008 pumping season. Sections 5.2 through 5.4 contain information on the contaminant distribution and temporal water chemistry associated with CFs 1, 3, 4, and the Baseline Area, respectively. Section 5.5 discusses the surface water chemistry and trends of 2008.

5.1 Summary of the 2008 Sampling Season

Samples were collected from the well field from January through October of 2008. Some of the sample locations, including well points and surface water locations, were inaccessible from May to July 2008 due to the Colorado River spring runoff.

Because of the above average peak flow, the contaminant concentrations were greatly reduced from May to September 2008, especially in CFs 1 and 4. This portion of the well field is adjacent to a prominent backwater channel that flows through to the river until a flow of approximately 2,000 cfs.

Appendix A of the *Moab UMTRA Project Well Field Optimization Plan* includes a summary of the results of the ground water/surface water interaction investigation that was conducted in 2008 to determine the lateral and vertical extent that the surface water migrates into the IA well field during peak river flows. It was determined that the surface water migration plays an integral role in regulating the contaminant concentration during the spring and summer months.

The following sections describe the temporal ground water chemistry for selected wells from CFs 1, 3, 4, and the Baseline Area. The wells that were chosen for the chemical analysis include observation wells both upgradient and downgradient of the well field that are screened at varying depths, extraction wells, and a few select well points and surface water locations.

5.2 CF1 Temporal Ground Water Chemistry

This section evaluates temporal variations of water chemistry in samples collected from extraction wells, observation wells, river bank well points, and surface water locations within CF1 in 2008. The chemical data from CF1 used to assess temporal variations are contained in Appendix H. The evaluation attempts to determine whether changes in ammonia, uranium, and TDS concentrations are significant and whether they are related to upgradient changes in water quality, pumping by the extraction well field, or changes in river stage.

5.2.1 CF1 Extraction Wells

CF1 extraction wells were sampled monthly during the full-scale operation of the system, which ran year-round in 2008. During system operation, samples were collected directly from the discharge water of the dedicated submersible pump in each well. The pump intake depths at extraction wells 0470 through 0477 are located at about 18 ft bgs (3,948 ft msl); in wells 0478 and 0479, the pump intake is located at approximately 21 ft bgs (3,945 ft msl). Time concentration plots that present the 2008 data can be found in Figure A-4 in Appendix A.

The above average 2008 spring runoff had a significant impact on the CF1 contaminant concentration. Ammonia, uranium, and TDS concentration plots indicate that the river water migrated into the IA well field and diluted the contaminants. The time concentration plots of the odd-numbered extraction wells indicate that the surface water migration affected the contaminant concentration from early May until September 2008.

The surface water migration into the well field had the biggest impact on extraction wells 0471 and 0473. For example, the ammonia concentration in well 0471 dropped from 730 mg/L on

March 13, 2008, to 38 mg/L on July 14, 2008. This suggests the southern end of the well field is greatly influenced by the backwater channel adjacent to CF1.

The TDS and uranium concentrations decreased greatly during the 2008 peak runoff months. For example, extraction well 0471 TDS concentration decreased by more than 85 percent from April to May 2008. The two extraction wells that were sampled at 21 ft bgs were also impacted by the surface water migration, but to a lesser extent. Please refer to the ground water/surface water interaction investigation results in the *Moab UMTRA Project Well Field Optimization Plan* Appendix A.

5.2.2 CF1 Observation Wells

CF1 observation wells located upgradient and downgradient of the well field axis were sampled on nearly a monthly basis while the well field was operating in 2008. The ammonia data is plotted with the CF1 extraction rate data, and the TDS and uranium concentration data are plotted with the Colorado River flow data in Figures A-5 through A-8 in Appendix A.

Upgradient Observation Wells 0480, 0481, 0482, and 0557

Figure A-5 (Appendix A) presents analytical results of samples collected upgradient of CF1 from well 0480 at a depth of 18 ft bgs (3,949 ft msl), well 0481 from a depth of 28 ft bgs (3,939 ft msl), well 0557 from a depth of 36 ft bgs (3,931 ft msl), and well 0482 from a depth of 55 ft bgs (3,912 ft msl). These wells are located approximately 25 ft upgradient from the well field axis.

Ammonia concentrations fluctuated in wells 0480, 0557, and 0482 throughout 2008. The time concentration plot indicates that well 0480 (18 ft bgs) was influenced by the surface water migration into the IA well field because the ammonia concentration decreased from 550 mg/L in May 2008 to 50 mg/L in June 2008. Well 0481 had a nearly constant ammonia concentration throughout 2008, and wells 0557 (36 ft bgs) and 0482 (55 ft bgs) showed an ammonia increase during the peak runoff. This indicates that the surface water migrated into the upgradient portion of the well field at depths of 18 ft bgs. The slight increase in ammonia in the two deeper observation wells (0557 and 0482) may represent a slight lowering of the brine interface. The ground water/surface water interaction investigation (see *Moab UMTRA Project Well Field Optimization Plan*, Appendix A.) contains Stiff diagrams that show how the brine interface was depressed in response to the migration of freshwater. An increase in ammonia at 36 and 55 ft bgs suggests the brine interface recessed because ammonia concentrations tend to be the highest right at the interface in the IA well field.

The TDS plots indicate that the brine interface was located above 55 ft bgs in this potion of the well field during 2008. Freshwater migration into the well field following the peak runoff affected the TDS concentration of the shallow observation well 0480 (18 ft bgs), where the TDS concentration dropped from 20,000 mg/L on April 30, 2008, to 600 mg/L on June 2, 2008. The TDS concentration of wells 0481, 0557, and 0482 remained fairly constant throughout 2008. The uranium hydrograph is very similar to the observed TDS trend. Well 0482 (55 ft bgs) had the lowest uranium concentration (0.61 mg/L) in 2008, and well 0481 had the highest concentration (3.2 mg/L in October 2008). Uranium concentrations remained fairly constant through 2008 in wells 0481, 0557, and 0482. As in the ammonia and TDS hydrographs, the uranium concentration at well 0480 (18 ft bgs) decreased during the peak runoff.

Downgradient Observation Well Cluster 0483, 0484, 0485, and 0558

The downgradient well cluster located closest to the well field (less than 25 ft downgradient from the well field axis) provided data from wells 0483 at 18 ft bgs (3,949 ft msl), 0484 at 28 ft bgs (3,939 ft msl), 0558 from 36 ft bgs (3,930 ft msl), and 0485 from 55 ft bgs (3,911 ft msl). Figure A-6 (Appendix A) presents the analytical results of these sample locations.

The ammonia concentration hydrograph shows that the ammonia concentration decreased in wells 0483, 0484, and 0558 during the peak runoff months. Well 0483 (18 ft bgs) had the most significant decrease in ammonia concentration, suggesting that the surface water migration greatly impacted the top 18 ft of the alluvial ground water system. Near the axis of the well field, the ammonia concentration decreased up to 36 ft bgs (well 0558). However, ammonia increased in well 0485 at 55 ft bgs in response to the lowering of the brine interface.

The TDS concentration plot suggests that the brine interface was located between 28 and 36 ft bgs in this portion of the well field during base flow conditions in the late winter of 2008. During the peak runoff months, the TDS concentration decreased up to 55 ft bgs in response to the surface water migration. From June to October 2008, the brine interface was located between 36 and 55 ft bgs.

Wells 0483 (18 ft bgs) and 0484 (28 ft bgs) both decreased in uranium concentration from March until July 2008, while wells 0558 (36 ft bgs) and 0485 (55 ft bgs) increased in uranium concentration during the peak runoff. Since the uranium concentration is generally higher in the upper portion of the alluvial aquifer, the increase is likely due to the surface water migration and the lowering of the brine interface.

Downgradient Observation Well Cluster 0559, 0560, and 0561

The downgradient well cluster located closest to the river bank (approximately 65 ft downgradient from the well field axis) provided data from wells 0559 at 18 ft bgs (3,949 ft msl), 0560 at 36 ft bgs (3,930 ft msl), and 0561 from 55 ft bgs (3,911 ft msl). Figure A-7 in Appendix A presents the analytical results of these sample locations.

During base flow conditions, the ammonia concentration was the greatest at 36 ft bgs (well 0560) and the lowest at 18 ft bgs (well 0559). When the river flow peaked in late May/early June 2008, the concentration remained fairly constant at 18 and 55 ft bgs, but greatly decreased at 36 ft bgs. The decrease at 36 ft bgs is likely due to the suppression of the brine interface at CF1. Ammonia concentrations in the well field are typically the highest right at the brine interface, which supports the idea that the brine interface lowered in elevation in response to the surface water migration.

The TDS plots shows the brine interface was located above 36 ft bgs during base flow conditions. During the peak runoff, all of the downgradient wells decreased in TDS concentration and did not rise back to the base flow concentrations until late fall 2008. Well 0559 (18 ft bgs) did not increase to base flow concentrations during the sampling season.

Uranium concentration plots indicate that a decrease occurred at 18 ft bgs, and an increase in uranium occurred at 55 ft bgs. The concentration at 36 ft bgs decreased and then increased slightly during the peak runoff and then decreased again. This is likely due to the suppression of the brine interface as described in the previous section.

Downgradient Observation Wells 0403 and 0407

Observation wells 0403 and 0407 are located at the north and south ends of CF1, respectively. The sample depth at these wells is 18 ft bgs (3,948 ft msl). Figure A-8 (Appendix A) presents the analytical results of these sample locations.

The ammonia, TDS, and uranium plots all indicate that the contaminant concentration is higher at observation well 0403. For instance, in January 2008, the TDS concentration at well 0403 was 12,000 mg/L, and the concentration at 0407 was 2,100 mg/L. The higher concentration on the northern end of the well field was also observed in the extraction wells in CF1.

Analyte concentrations abruptly decreased in both wells in March 2008 and did not begin to increase again until September 2008, indicating that the surface water migration into the well field remained at 18 ft bgs up to 3 months after the peak flow occurred.

5.2.3 CF1 Well Points 0562, 0563, and 0606

Well points 0562 at 1.3 to 2.3 ft bgs (approximately 3,951 ft msl), 0563 at 4.6 to 5.6 ft bgs (approximately 3,948 ft msl), and 0606 at 9.3 to 10.3 ft bgs (approximately 3,943 ft msl) are located on the river bank adjacent to CF1. These well points were only accessible during base flow conditions in February and March 2008 and after the peak runoff in August and October 2008. Figure A-9 (Appendix A) presents the analytical results of these sample locations.

During base flow conditions, the contaminant concentration increased with depth. The ammonia, TDS, and uranium plots all follow the same trend: a slight increase in concentration from February to March 2008; a significant drop in concentration in August 2008; and an increase in October 2008. In October 2008, the TDS and uranium increased at 1.3 to 2.3 ft bgs (0562). It is apparent that the river flow affects the contaminant concentration in this well point cluster.

5.2.4 CF1 Surface Water Location 0216

Surface water location 0216 is located directly off of the bank of CF1, adjacent to the well point cluster 0562, 0563, and 0606. This location was sampled more frequently than the well points due to inaccessibility during the high river flow. During the months of high river flow (May to July), this location was sampled approximately 20 ft upriver from the well point cluster. Figure A-10 (Appendix A) presents the analytical results for this sample location.

The ammonia, TDS, and uranium concentrations followed the same trend throughout 2008. A slight increase in concentration occurred from February to March 2008, followed by a slight decrease during the peak flow, and an increase from July to October 2008. The fluctuation in contaminant concentration is more likely due to the slight chemical variation of the surface water during the peak flow. As noted in the CF1 observation wells and well points, the chemical concentration in surface water location 0216 decreases with the higher river stage.

5.3 CF3 Temporal Ground Water Chemistry

This section evaluates temporal variations of water chemistry in samples collected from extraction wells and observation well sample locations within CF3 in 2008. The time concentration plots from CF3 used to assess temporal variations are contained in Appendix B, Figures B-4 though B-6. The evaluation attempts to determine whether changes in ammonia, TDS, and uranium concentrations are significant and whether they are related to upgradient changes in water quality, pumping by the extraction well field, or changes in river stage

5.3.1 CF3 Extraction Wells 0671, 0673, 0675, 0677, and 0679

CF3 extraction wells were sampled monthly during full-scale operations. The remediation wells ran on extraction mode from April 8 to October 16, 2008. Due to the potential of flooding in the well field, CF3 was shut down from May 27 to June 19, 2008. During system operation, samples were collected directly from the discharge of the dedicated submersible pump in each well. The pump intake depths at extraction wells 0670 to 0679 are located at about 35 ft bgs (3,932 ft msl). Figure B-4 (Appendix B) presents the analytical results for this sample location.

The ammonia, TDS, and uranium concentrations in extraction wells 0671, 0673, 0675, and 0677 follow an incipient annual trend consisting of higher concentration in the winter months and lower concentrations following periods of peak runoff. Well 0679 also follows the same trend, however, the concentration fluctuations are much greater than what was observed in the other extraction wells.

Since the brine interface is located near 54 ft bgs in this portion of the well field, the remediation wells do not tend to respond to changes in the river stage in the same manner as in the other configurations. The TDS concentrations decreased following the peak runoff and then slightly increased throughout the late summer and fall of 2008.

Ammonia and uranium concentrations also decreased following the peak runoff and then increased in the late summer and fall of 2008. The contaminant increase also corresponds to a decrease in the extraction rate, so it is difficult to distinguish whether the increase is due to the Colorado River stage or pumping rate.

5.3.2 CF3 Observation Wells

The performance of CF3 upgradient observation wells 0680, 0682, and 0683 and the CF3 downgradient observation well cluster 0687, 0688, and 0689 is discussed below.

Upgradient Observation Wells 0680, 0682, and 0683

As shown in Figure 2, observation wells 0680 and 0682 are located in the southern half of the well field, and well 0683 is located in the northern half of the well field. Figure B-5 (Appendix B) presents analytical results of samples from wells 0680 at 18 ft bgs (3,949 ft msl), 0683 at 27 ft bgs (3,941 ft msl), and 0682 at 28 ft bgs (3,940 ft msl).

The ammonia hydrograph indicates that the concentration decreased at 18 and 27 ft bgs in response to the peak runoff, while well 0682 at 28 ft bgs increased slightly. The same incipient trend is also observed in the TDS and uranium hydrographs. This indicates that the surface water migration may have impacted the alluvial ground water system to a depth of 27 ft bgs in this portion of the well field.

These wells are located near the flood-irrigated C plots in the well field. In previous years, an increase in uranium concentration has been noted in these locations due to the influx of oxygenated river water, however, it appears that the surface water migration caused an even greater increase in the uranium concentration in 2008.

Downgradient Observation Well Cluster 0687, 0688, and 0689
The CF3 downgradient cluster is located less than 25 ft downgradient (southeast) of the well field axis and includes wells 0687 (screened from 20 to 30 ft bgs; 3,946 to 3,936 ft msl), 0688 (screened from 32 to 41 ft bgs; 3,934 to 3,925 msl), and 0689 (screened from 46 to 56 ft bgs; 3,920 to 3,910 ft msl). These wells were sampled prior to startup and during the CF3 2008 pumping season. Figure B-6 (Appendix B) presents the analytical results for this sample location.

The ammonia hydrograph shows that the ammonia concentration varied greatly in the downgradient observation wells at CF3. A decrease was observed at wells 0687 (28 ft bgs), 0688 (31 ft bgs), and 0689 (46 ft bgs), and a slight decrease was observed at well 0689 (54 ft bgs). Well 0688 at 39 ft bgs showed an increase in ammonia concentration from February to August 2008.

At base flow conditions, the brine interface was located at approximately 54 ft bgs. During the peak runoff, the TDS data shows that the brine interface was located at approximately 39 ft bgs, which may have resulted in the ammonia fluctuations. In August 2008, after the peak runoff, the brine interface was located between 31 and 39 ft bgs. The data suggest that the brine interface may have actually increased in elevation in this portion of the well field. Another scenario could be that the TDS increased in May and July 2008 when CF3 was at the maximum extraction rate for 2008.

The uranium hydrograph shows a general decrease in uranium during the peak runoff months and an increase in uranium concentration at 39 ft bgs. As the TDS plot indicates, the brine interface was located near this depth during the peak runoff, which may have led to fluctuations in the uranium concentration.

5.4 CF4 Temporal Ground Water Chemistry

This section evaluates temporal variations of water chemistry in samples collected from extraction wells and observation wells within CF4 during 2008. The well points were only sampled in February 2008 due to access issues. The chemical data from CF4 used to assess temporal variations are contained in Appendix C, Figures C-4 though C-6. The evaluation attempts to determine whether changes in ammonia, uranium, and TDS concentrations are significant and whether they are related to upgradient changes in water quality, pumping by the extraction well field, or changes in river stage. For evaluation purposes, a significant temporal variation is a factor of two changes in concentration within the annual period. Otherwise the trend is incipient.

5.4.1 CF4 Extraction Wells
CF4 remediation wells ran on extraction mode from April to October 2008, and ground water samples were collected during this time. During system operation, samples were collected directly from the discharge of the dedicated submersible pump in each well. The pump intake depth at the extraction wells is located at about 30 ft bgs (3,939 ft msl).

The ammonia, TDS, and uranium concentrations in extraction wells 0771, 0774, and 0776 follow an incipient annual trend consisting of higher concentrations in the winter months and lower concentrations following periods of peak runoff. The time concentration plot pattern in Figure C-4 (Appendix C) shows uniform decrease in analyte concentration in response to increased flow in the Colorado River. The lowest concentrations of TDS, ammonia, and uranium coincide with periods of high river flow. These observations show that the river water migrates into the ground water system during periods of high river flow.

The TDS concentration indicates that the brine interface was located just slightly above 35 ft bgs in April 2008. By mid-April 2008, the location of the brine interface was located below 35 ft bgs, as noted by the dramatic decrease in TDS concentration from near 40,000 mg/L to between 5,000 and 15,000 mg/L. By mid-July 2008, the TDS concentrations began an increase, likely due to the decrease in river flow. The brine interface remained below 35 ft bgs through October 2008, when the extraction system was shut down for the winter season.

5.4.2 CF4 Observation Wells

CF4 observation wells located upgradient and downgradient of the well field axis were sampled on a monthly basis while the well field was operating between April and October 2008. The TDS and uranium concentration data are plotted with the Colorado River flow data, and the ammonia data are plotted with the CF4 extraction rate data on Figures C-5 and C-6 (Appendix C).

Upgradient Observation Wells 0780, 0781, 0782, and 0783

Figure C-5 (Appendix C) presents analytical results of samples collected upgradient of CF4 from observation well 0780 from a depth of 28 ft bgs (3,940 ft msl), well 0781 from a depth of 48 ft bgs (3,920 ft msl), well 0782 from a depth of 33 ft bgs (3,935 ft msl), and well 0783 from a depth of 18 ft bgs (3,950 ft msl). The chemical data from 2008 indicates that the contaminant concentrations changed dramatically throughout the year, especially in the shallow observation wells. This fluctuation is likely due to the above average spring runoff.

The ammonia concentration of wells 0783 (18 ft bgs), 0780 (28 ft bgs), and 0782 (33 ft bgs) followed the same general trend, with a higher concentration near the brine interface near 30 ft bgs, a lower concentration in the shallow ground water at 18 ft bgs, and the lowest concentration in the deeper ground water at 48 ft bgs. Following the peak runoff, the concentration decreased up to 33 ft bgs and increased at 48 ft bgs. As observed in CF1, the ammonia increase at a depth of 48 ft bgs indicates that the brine interface was suppressed when the surface water migrated into the well field, leading to an increased ammonia concentration near 50 ft bgs.

Well 0782 at 33 ft bgs had a 90 percent decrease in TDS concentration from March to July 2008. This decrease signifies the impact that the freshwater migration had on the contaminant concentrations at CF4. The TDS concentration also decreased at 48 ft bgs, but the brine interface remained higher than 48 ft bgs in elevation throughout 2008. Wells 0780 and 0783 also showed a decrease in TDS concentration.

Uranium concentrations decreased at 18 and 28 ft bgs during the peak runoff, but increased at 33 and 48 ft bgs. Since uranium concentrations are highest above the brine interface, it is logical that the increases at 33 and 48 ft bgs represent a depression in the brine interface.

Downgradient Observation Wells 0784, 0785, 0786, and 0787
Figure C-6 (Appendix C) presents analytical results of samples collected downgradient of CF4 from observation well 0784 from a depth of 18 ft bgs (3,950 ft msl), well 0785 from a depth of 18 ft bgs (3,950 ft msl), well 0786 from a depth of 28 ft bgs (3,940 ft msl), and well 0787 from a depth of 36 ft bgs (3,932 ft msl).

The ammonia concentration decreased significantly from May until August 2008 up to 28 ft bgs and increased slightly at 36 ft bgs. The timing of the decrease correlates to the onset of CF4 extraction, but the decrease is likely due to the surface water migration into the well field.

All of the downgradient CF4 observation wells decreased in TDS concentration during the peak runoff months and then wells 0786 and 0787 (28 and 36 ft bgs, respectively) had a slight increase in TDS beginning in mid-July 2008. The increase correlates to the maximum extraction rate for CF4 in 2008.

Prior to the startup of CF4, the uranium concentration was the greatest in the shallow wells (3.5 mg/L at 18 ft bgs) and lowest in the deep well (0.15 mg/L at 36 ft bgs). After the peak runoff, the uranium concentration decreased in the shallow wells, and well 0787 increased from 0.15 mg/L in January to 0.34 mg/L in July 2008. Well 0786 increased in concentration from July to September 2008 to 2.8 mg/L, which is greater than the January 2008 concentration.

5.5 Baseline Area

The Baseline Area is located just south of where the Moab Wash discharges into the Colorado River and to the north of the infiltration trench. This area consists of four upgradient wells, three downgradient wells, and nine river bed well points. While the water chemistry in this area is not impacted by ground water extraction (CF3 is more than 200 ft to the south), the concentrations may be influenced by freshwater injection (the northern end of the infiltration trench is less than 50 ft from the downgradient well cluster) and irrigation practices (irrigation plot C-6 is located between the upgradient and downgradient observation well clusters). Appendix D summarizes all of the Baseline Area data.

5.5.1 Baseline Area Observation Wells
The performance of Baseline Area upgradient observation wells SMI-PZ1S, SMI-PZ1M, and SMI-PW01 and Baseline Area downgradient observation wells 0405, 0488, and 0493 is discussed below.

Upgradient Observation Wells SMI-PZ1S, SMI-PZ1M, and SMI-PW01
Figure D-3 (Appendix D) presents the 2008 time versus concentration plots for TDS, ammonia, and uranium. Samples were collected from well SMI-PZ1S (18 ft bgs; 3,948 ft msl), well SMI-PW01 (36 ft bgs; 3,930 ft msl), and SMI-PZ1M (52 ft bgs; 3,914 ft msl) at this upgradient cluster located approximately 150 ft inland from the river bank.

During the first half of 2008, water chemistry data indicate the TDS, ammonia, and uranium concentrations followed the trend of increasing concentration with increasing depth. By early July 2008, the contaminant concentration decreased in all three of the Baseline Area upgradient observation wells, indicating that infiltration of surface water during the peak river flow affected the wells. The fluctuations were not as great as observed in other portions of the well field, indicating that the migration of freshwater into the ground water system was not as prevalent in the northern portion of the well field. This is likely due to the lack of an adjacent secondary backwater channel near the Baseline Area.

Downgradient Observation Wells 0405, 0488, and 0493

Figure D-4 (Appendix D) presents the 2008 time versus concentration plots for TDS, ammonia, and uranium. Samples were collected from wells 0405 (18 ft bgs; 3,948 ft msl), 0488 (36 ft bgs; 3,930 ft msl), and 0493 (52 ft bgs; 3,914 ft msl).

The chemical plots of the downgradient Baseline Area observation wells follow the same trend as the upgradient observation wells. The concentration of the contaminants decreased as the Colorado River flow peaked in late May/early June 2008. However, the overall contaminant concentration was less in the downgradient wells (likely due to the proximity to the river). By September 2008, the concentration in the wells began to increase to base flow levels.

5.5.2 Baseline Area Well Points 0495 and 0597

A majority of the Baseline Area well points were not accessible during the entire period of monitoring due to the above average Colorado River peak flow. However, sufficient data was collected from the Baseline river bank well points 0495 (screened from 4.6 to 5.6 ft bgs; approximately 3,952 ft msl) and 0597 (screened from 9.3 to 10.3 ft bgs; approximately 3,947 ft msl). Figure D-5 (Appendix D) presents the analytical results for this sample location.

The ammonia plot signifies that the ammonia concentration decreases with depth during base flow conditions. Ammonia concentrations at well point 0495 did not fluctuate much throughout the year. Well point 0597 showed a fluctuating ammonia concentration, increasing to near 140 mg/L on the ascending limb of the hydrograph and during base flow conditions in the fall, and decreasing during the peak flow. This indicates that the river flow impacts the ammonia concentration.

The TDS plot indicates that the concentration typically decreases with depth at the Baseline river bank well points. Well point 0495 increased in concentration after the peak flow from 16,100 mg/L in April to 18,000 mg/L in July 2008. The TDS concentration then decreased again in October 2008. In April 2008 the concentration was slightly higher at well point 0597, which suggests that some mixing occurs at shallow depths. The TDS concentration in well point 0597 increased from 2,900 mg/L in February to 9,000 mg/L in April 2008, and then decreased back down to 5,500 mg/L after the peak flow.

Uranium concentrations decreased with depth in well points 0495 and 0597 throughout 2008. While the uranium concentration in well point 0597 decreased in response to the peak flow, the concentration increased in well point 0495. The chemical plot indicates that the uranium concentration decreased in both well points into the fall and winter months of 2008.

5.5.3 Baseline Area Surface Water

Surface water location 0243 is located adjacent to the Baseline Area, in the main river channel. Due to access problems, this is the only surface water location in the Baseline Area that was consistently sampled during 2008. It should be noted that this surface water location is approximately 100 ft east of well points 0495 and 0597. Figure D-6 (Appendix D) presents the analytical results for this sample location.

The contaminant concentration plots do not show a large fluctuation during 2008. In general, the TDS and uranium concentrations increased slightly throughout the year.

5.6 Surface Water

Surface water locations (Figure 2) associated with the well field were sampled intermittently during 2008 when water was present. Table 6 presents a summary of the ammonia (as N), TDS, and uranium concentrations measured in samples collected from these locations.

Table 6. Summary of Ammonia (as N), TDS, and Uranium Surface Water Concentrations (mg/L) During 2008

Location	N	Ammonia Concentration Range (mg/L)	TDS Concentration Range (mg/L)	Uranium Concentration Range (mg/L)
0201	4	0.1	250-790	0.0017-0.006
0204	1	0.1	680	0.0078
0216	8	0.1-2.2	190-830	0.0015-0.031
0218	2	0.1	600-790	0.0084-0.013
0226	4	0.1-0.18	260-790	0.0017-0.0091
0228	3	0.1-0.12	280-790	0.0018-0.0073
0239	2	0.1	580-590	0.004
0240	4	0.1-0.17	460-700	0.0048-0.026
0241	2	0.1-0.24	200-350	0.0015-0.0026
0242	2	0.1-0.15	1063-1441	0.0017-0.04
0243	4	0.27-0.51	590-750	0.01-0.017
0245	4	0.1-0.14	580-740	0.0052-0.01
0258	3	0.1	2400-3100	0.039-0.078
0259	2	0.1-0.11	480-610	0.004-0.0048
0274	1	0.16	570	0.0059
0276	3	0.1	220-300	0.0017-0.002

N = number of samples collected

Table 7 summarizes the ammonia concentration recorded for each surface water location and the corresponding state/federal ambient water quality criteria (AWQC) acute and chronic concentrations for fish in early life stages. The aquatic habitat areas adjacent to the site are occasionally ideal locations for young-of-year endangered Colorado pikeminnow, so it is vital to protect these habitats. The chronic criteria are based on temperature, and the acute criteria are only based on pH.

The only surface water exceedance that was recorded in 2008 was at location 0216 (adjacent to CF1) on October 18, 2008. On this day, the total ammonia (as N) concentration was 2.2 mg/L, and while this level is below the acute criteria, it is 1.03 mg/L above the chronic threshold. It should be noted that the Colorado pikeminnow young-of-year are known to use these habitat areas from July to September, so it is unlikely that this location was a habitat area when the sample was collected.

Table 7. Surface Water Sample Ammonia (as N) Results Compared to Acute and Chronic Criterion

Location	Date	Ammonia Total as N (mg/L)	State/Federal AWQC-Acute Total as N (mg/L)	State/Federal AWQC-Chronic Total as N (mg/L)
0216	10/18/2008	2.2	3.88	1.17
0216	03/19/2008	1.2	8.4	2.43
0243	10/21/2008	0.51	4.71	1.52
0243	02/14/2008	0.43	6.95	2.1
0243	03/19/2008	0.36	4.71	1.39
0216	09/30/2008	0.31	3.88	1.17
0243	09/30/2008	0.27	2.65	0.646
0241	07/10/2008	0.24	14.4	2.21
0226	06/30/2008	0.18	4.71	1.07
0240	02/26/2008	0.17	14.4	3.58
0274	02/28/2008	0.16	3.2	1.09
0226	01/22/2008	0.16	5.72	1.79
0242	04/29/2008	0.15	6.95	1.91
0254	02/27/2008	0.14	3.88	1.29
0228	01/22/2008	0.12	2.2	0.778
0259	02/25/2008	0.11	5.72	1.79

AWQC = ambient water quality criteria

5.7 Summary of Temporal Time Concentration Plots

The above average peak runoff of 2008 allowed for an analysis of how the river system impacts the IA well field adjacent to the Moab site. It is apparent that the river stage affects the contaminant concentration more than the pumping schedule, however, the purpose of the extraction system is to remove contaminant mass.

Time concentration plots indicate that the southern end of the well field is more impacted by the river flow stage. This is likely because a main backwater channel runs adjacent to CFs 1 and 4. At these configurations, the time concentration plots suggest that a lens of freshwater migrated into the well field to a horizontal distance of approximately 50 ft to a vertical depth of 33 ft bgs. Evidence of ground water surface water mixing is present up to 48 ft bgs in CF4. These wells were affected by the surface water migration until the July-August 2008 timeframe.

The downgradient CFs 1 and 4 wells were impacted by the surface water migration to a vertical depth of 36 ft bgs until August to October 2008. This indicates that the surface water lens lags in the ground water system for a few months after the peak flow.

The time concentration plots in the northern portion of the well field indicate that the river flow does not affect the CF3 and Baseline Area wells to the extent that was observed in the southern portion. The CF3 and Baseline Area wells show evidence of mixing at 36 ft bgs at the downgradient wells until July 2008. The well point chemical results at the Baseline Area well points indicate that mixing occurs at shallow depths near the river bank. This location is approximately 50 ft from the main river channel and does not appear to be as affected by the river flow as the CF1 well points.

6.0 Infiltration Trench Performance

The infiltration trench was installed in August and September 2006 and consists of a 160-ft perforated high density polyethylene pipe buried approximately 10 ft bgs (3,957.5 ft above msl) north of CF3 (Figure 2). The purpose of the infiltration trench is to inject fresh river water into the ground water to form a hydraulic barrier and to dilute contaminant concentrations. Infiltration trench flow is monitored at four individual ports with flow meters, and the hydrologic response is monitored by a series of four observation wells and three well points which are sampled throughout the year. The construction of the observation wells is summarized in Table E-1 (Appendix E). Infiltration trench performance is evaluated based on the magnitude and extent of ground water mounding and its effect on operational and downgradient water quality. Figure E-1 (Appendix E) shows the location of the observation wells and well points relative to the trench.

6.1 Volume Injected

Freshwater injection began on October 14, 2008, and continued until November 13, 2008 (see Appendix E, Table E-2). The trench was shut down from October 30 to November 5, 2008, to repair a flooded vault.

The infiltrated water requires treatment by sedimentation and filtering to prevent clogging of the trench. Freshwater is diverted from the river and pumped into a freshwater storage pond. Sediments reaching the pond from the river-pumping operation will either settle or are filtered through a turbidity barrier between the inlet and outlet of the pond. Water from the pond is pumped into a sand media filter, which filters out additional algae or sediment. In addition, a smaller filter is located at each of the four entry ports to further remove any remaining solid material from the freshwater prior to injection into the trench.

Injection flow varied from 2.6 to 11.2 gpm, and a total of 258,900 gal of freshwater was pumped into the infiltration trench during the 2008 calendar year.

6.2 Hydraulic Mounding

Observation wells 0731 and 0732 contain pressure transducers that collect water elevation data during all phases of the infiltration trench. The hydrograph of observation well 0731 shows the response of the water levels to freshwater injection. To determine mounding, ground water elevations in the transducer water level data from the trench observation wells were compared with the ground water elevation fluctuations of the Baseline Area observation well 0406, approximately 300 ft north of the trench. This allows subtracting the effects of river stage on water levels. Table 8 below and Figure E-2 (Appendix E) show the amount of freshwater mounding that occurred in observation well 0731 during the operation of the infiltration trench.

Table 8. Freshwater Mounding in the Infiltration Trench Observation Wells in October 2008

Well No.	Date	Location to Trench	Ground Water Elevation (ft above msl)	Well 0406 Elevation (ft above msl)	Mounding (ft)
0731	10/21/2008	10 ft Downgradient	3,952.64	3,951.24	1.4

The October/November 2008 mounding of 1.4 ft was calculated during the maximum injection rate of approximately 11.2 gpm. In 2007, well 0731 had 2.02 ft of mounding during the maximum pumping rate of 95 gpm. The 2008 ground water elevation data suggests that the freshwater mounding that occurred in well 0731 may have had a slight impact on the water elevation through December 2008.

6.3 Summary

The infiltration trench injected diverted river water into the northern portion of the IA well field from October 14 to November 15, 2008. The system was shut down from October 30 to November 5, 2008. Infiltration of diverted river water into the trench resulted in freshwater mounding of 1.4 ft during the maximum pumping rate of 11.2 gpm in late October 2008.

7.0 Evaporation Pond and Sprinkler System Performance

The main components of the IA treatment system include the remediation wells in CFs 1, 2, 3, and 4, the infiltration trench, the evaporation pond on the tailings pile, and the sprinkler system, also on the tailings pile. Ground water that is extracted from the IA well field is pumped up the southeast side of the tailings pile to the evaporation pond, which is the source of the sprinkler system. As of August 2008, the Remedial Action Contractor has also begun to use the evaporation pond water for dust suppression in the contaminated area.

7.1 Well Field and Sprinkler System Pumping Rates and Volumes

Table F-1 (Appendix F) summarizes important dates associated with operation of the IA treatment system during 2008. Prior to the startup of the treatment system, half of the CF1 wells were running on extraction mode in order to protect the adjacent backwater channel. The sprinkler system was started up March 20, 2008, and by March 24, all of the CF1 wells were extracting ground water. By early April 2008, all of the CF1 and half of the CFs 3 and 4 wells were operating to maximize the amount of ground water removal and contaminant mass removal.

On May 21, 2008, the IA well field was shut down for potential flooding due to high river flows. At this time, the evaporation pond was at 7.5 ft. By June 19, 2008, the evaporation pond had decreased to 4.1 ft, and since the potential for flooding in the well field had diminished, portions of CFs 1 and 3 were turned on. CF4 was restarted on June 24, 2008, and the pond level had increased to nearly 6 ft. Figure 13 shows a graphic record of well field delivery rates to the evaporation pond, delivery rates from the evaporation pond to the sprinkler system, and pond levels during 2008. The delivery rates to the sprinkler system shown in Figure 13 were based on flow volumes recorded at meters on sprinkler delivery lines.

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Figure 12. Treatment System Components

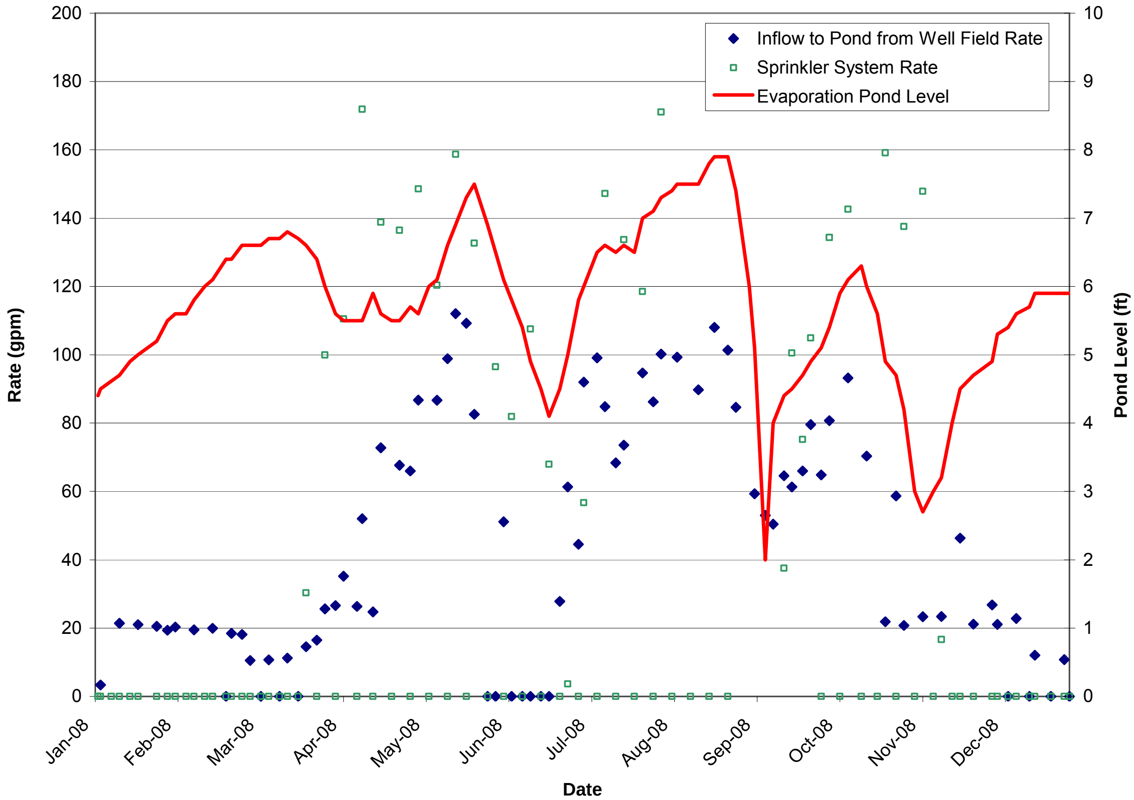

Figure 13. Rates of Water Delivery to the Evaporation Pond and the Sprinkler System and Pond Depths During 2008

As indicated in Figure 13, the pond level was dynamic throughout 2008. The main reason for the constant fluctuation is because the well field was shut down for a month due to flooding potential. During this month, the sprinkler system cycled while there was no extracted water delivery to the evaporation pond. In addition, a portion of CF3 was shut down on August 20, 2008, and CF4 was shut down August 27, 2008, which was a factor in the evaporation pond level dropping from 7.9 ft on August 25 to 2.0 ft on September 8, 2008. A summary of the monthly water volumes delivered to the evaporation pond and the sprinkler system during 2008 is presented in Table F-2 (Appendix F).

The sprinkler system was winterized on November 11, 2008. As the data indicate, the well field delivered approximately 24.5 million gal of ground water to the evaporation pond, and approximately 20.5 million gal were distributed through the sprinkler system. The difference of approximately 4 million gal may represent a loss due to evaporation from the pond.

7.2 Evaporation Pond Concentration Trends

During the 2008 pumping season, samples were collected during the timeframe when the IA well field was actively extracting ground water. Samples were collected of the ground water discharging into the evaporation pond and from the recirculation pump.

The inlet sample (0547) is representative of the extracted ground water transported to the pond from the entire well field, and the sample collected off the recirculation pump (0548) is representative of the water stored in the pond.

Time versus TDS, ammonia, and uranium concentration plots generated from data collected during 2008 are presented in Figure 14. Each was plotted with the evaporation pond level data collected during the same time frame.

Water chemistry data indicate TDS concentrations in samples collected from both locations tend to fluctuate in the same manner. The TDS of the pond inlet was higher than the pond concentration in March 2008, which is likely due to the fact that the ground water contaminant concentration is higher during base flow conditions (winter and early spring). Otherwise, the TDS concentration between the inlet and the pond were similar, ranging from 24,000 to 810 mg/L. The ammonia and uranium concentration followed the same trend as TDS, ranging from 1.4 to 2.5 mg/L throughout 2008.

8.0 Conclusions

CF1 ran on extraction mode year-round during 2008, and CFs 3 and 4 ran on extraction mode from April to October 2008. CF2 was not used in 2008 due to poor well efficiency. The infiltration trench injected freshwater from October 14 to November 13, 2008, and extraction well SMI-PW02 ran from November 17 to 25, 2008.

Water quality in the vicinity of the well field was greatly impacted by the above average Colorado River peak flow in late May and early June 2008. A ground water/surface water interaction investigation took place to determine the lateral and vertical extent of surface water migration into the IA well field during the annual maximum river flow (Appendix F). The results of this study indicate that the surface water migration greatly affects the southern portion of the well field, leading to a dramatic decrease in contaminant concentration (particularly in the shallow ground water) and a rise in ground water elevation. It is evident that the river flow had a greater impact on the ground water than the extraction system.

Some overall well field performance observations and conclusions are provided below. These are followed by conclusions specific to the Baseline Area, individual well field configurations, the infiltration trench, and the treatment system.

Overall Observations and Conclusions

Some overall well field performance observations and conclusions include:

- The conceptual site model regarding location and response of the brine interface to pumping and river flow remains valid.
- The distribution of ammonia and uranium with respect to the brine interface remains valid. Uranium concentrations are highest in shallow ground water and decrease with depth. Ammonia concentrations increase from the water table to the brine interface, reach a maximum just below the interface, and continue to decrease with depth.
- During high Colorado River flow, the brine interface decreased in elevation. In general, the brine interface increases in elevation to the south.

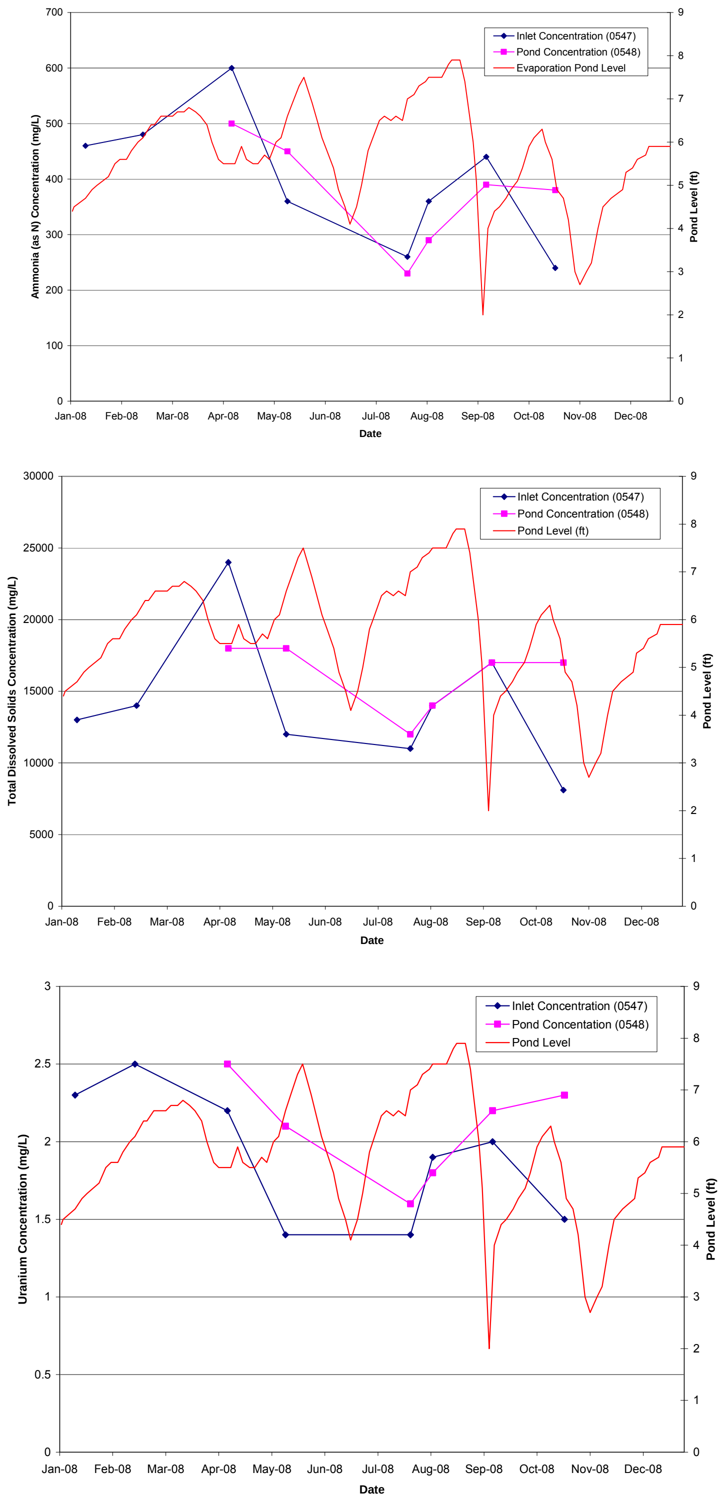

Figure 14. Measured Concentrations of Ammonia, TDS, and Uranium at 0547 (Pond Inlet) and 0548 (Pond Storage) During 2008

System Performance

Some overall system performance observations and conclusions include:

- From May 20 to June 19, 2008, the well field was shut down due to potential flooding during the spring runoff.
- The average extraction rate from the entire well field was 64.3 gpm, and more than 21 million gal were removed and transported to the evaporation pond.
- Drawdowns in CFs 1, 3, and 4 measured in 2008 are comparable to those measured in 2007.
- The CF4 remediation wells are the most efficient based on specific capacity calculations, while CF2 wells are the least efficient.
- The highest producing remediation wells for 2008 (based on volume of ground water extracted and average extraction rate) were in CF3 (8,201,520 gal), with CF4 (5,189,737 gal) remediation wells producing the lowest.

CF1

- CF1 remediation wells extracted a combined volume of about 7.8 million gal of ground water during 2008. Pumping from well SMI-PW02 removed 266,535 gal of ground water during the short time (approximately 1 week) in which it was operating.
- The 10 CF1 wells removed an estimated total of 49.7 kg of uranium from the ground water in 2008.
- The 10 CF1 wells removed an estimated total of 8,894 kg of ammonia from the ground water in 2008.
- Extraction well 0477 extracted the greatest volume of ground water (1,007,007 gal).
- Extracting ground water from January to March 2008 and from October to December 2008 increased the uranium removal by 28.5 kg and increased the ammonia removal by 4,089.6 kg.
- The greatest ammonia mass was extracted from well 0475, and the greatest uranium mass was extracted from well 0478.
- CF1 removed more mass in 2008 than in 2007 because it ran on extraction mode year-round in 2008.
- The above average spring runoff had a significant impact on CF1 contaminant concentrations. Ammonia, uranium, and TDS concentration plots indicate that the river water migrated into the IA well field and diluted the contaminants.
- The only surface water exceedance that was recorded in 2008 was at location 0216 (adjacent to CF1) on October 18, 2008. On this day, the total ammonia (as N) concentration was 2.2 mg/L; while this level is below the acute criteria, it is 1.03 mg/L above the chronic threshold. It should be noted that the Colorado pikeminnow young-of-year are known to use these habitat areas from July to September; however, it is unlikely that this location was a habitat area when the sample was collected.

CF3

- CF3 wells individually extracted between 84,121 (0673) and 1 million (0674) gal.
- Remediation well 0674 extracted the most volume in CF3 (1,050,800 gal).
- Estimated mass withdrawals of uranium at CF3 extraction wells indicate that a total of 64.2 kg of uranium was removed by this system between April and October 2008. Well 0678 removed the greatest uranium mass (12.4 kg).
- Estimated mass withdrawals of ammonia at CF3 extraction wells indicate that a total of 13,978 kg was removed. Well 0674 removed the greatest ammonia mass (1,845 kg).

- The CF3 TDS plot indicates the brine interface was located near this depth during the peak runoff, which may have led to fluctuations in the uranium concentration.

CF4

- Remediation well 0774 removed the most volume of water in CF4 (1,279,207 gal).
- A total of 7,507 kg of ammonia was extracted from CF4. Remediation well 0774 removed the greatest ammonia mass (1,856 kg).
- A total of 26.3 kg of uranium was extracted from CF4 in 2008. Remediation well 0774 also removed the greatest uranium mass (7.4 kg).
- CF4 was shut down on occasion in order to make repairs to the system. As a result, the mass removal from CF4 is less than in the other configurations.

Baseline Area

- Chemical fluctuations in the Baseline Area were not as great as observed in other portions of the well field, indicating that the migration of freshwater into the ground water system was not as prevalent in the northern portion of the well field. This is likely due to the lack of an adjacent secondary backwater channel near the Baseline Area.
- The time concentration plots in the northern portion of the well field indicate that the river flow does not affect the CF3 and Baseline Area wells to the extent that was observed in the southern portion. The CF3 and Baseline Area wells show evidence of mixing at 36 ft at the downgradient wells until July 2008.

Infiltration Trench

- Injection flow into the infiltration trench varied from 2.6 to 11.2 gpm, and a total of 258,900 gal of freshwater was pumped into the infiltration trench during the 2008.
- Infiltration trench October/November 2008 mounding of 1.4 ft was calculated during the maximum injection rate of approximately 11.2 gpm.

Treatment System

- Due to above average peak river flow, the well field was shut down from May 20 to June 19, 2008, and as a result, the evaporation pond level dropped from 7.5 ft to 4.1 ft.
- The sprinkler system was initiated on March 20, 2008, and was winterized on November 13, 2008.
- The pond level was dynamic throughout 2008. The main reason for the constant fluctuation is because the well field was shut down for a month due to flooding potential. During this month, the sprinkler system cycled while there was no extracted water delivery to the evaporation pond.

Ground Water/Surface Water Interactions

- The Colorado River peak flow for 2008 was 40,100 cfs on May 23, 2008; the overall annual average peak flow is 23,400 cfs.
- During the spring runoff, the Colorado River changes from gaining to loosing conditions, which results in a freshwater influx to the ground water system.
- Many of the well points and surface water locations were inaccessible for sampling during 2008 due to the high river flow.
- Water chemistry data indicate that during ground water extraction, CF1 (not including SMI-PW02), CF3, and CF4 analyte concentrations mostly decrease in response to increases in the Colorado River stage.

- The above average river flow resulted in a surface water migration into the well field which impacted greatly decreased contaminant concentration in CFs 1 and 4.
- After the peak flow, the CF3 upgradient wells show evidence of ground water/surface water mixing at 28 ft bgs.
- Time concentration plots indicate that the southern end of the well field is more impacted by the river flow stage. This is likely because a main backwater channel runs adjacent to CFs 1 and 4. At these configurations, the time concentration plots suggest that a lens of freshwater migrated into the well field to a horizontal distance of approximately 50 ft to a vertical depth of 33 ft bgs. Evidence of ground water/surface water mixing is present up to 48 ft bgs in CF4. These wells were affected by the surface water migration until the July to August 2008 timeframe.
- The ammonia and TDS concentrations in the surface water locations were less in 2008 than in 2007.

9.0 References

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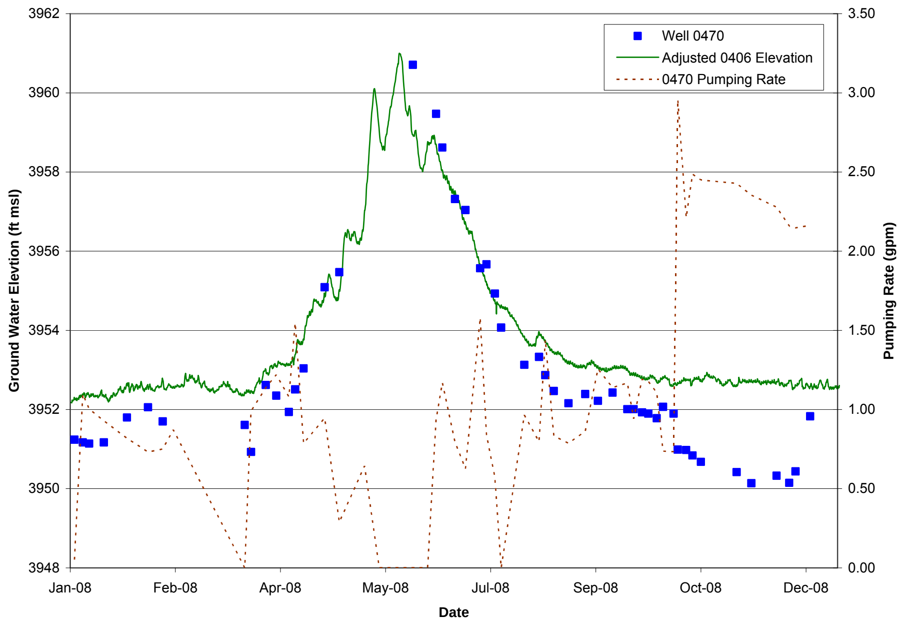
Appendix A.
CF1 Figures and Tables

Appendix A. CF1 Figures and Tables

Figure A-1. Map View of CF1 Wells and Sampling Locations

Appendix A. CF1 Figures and Tables (continued)



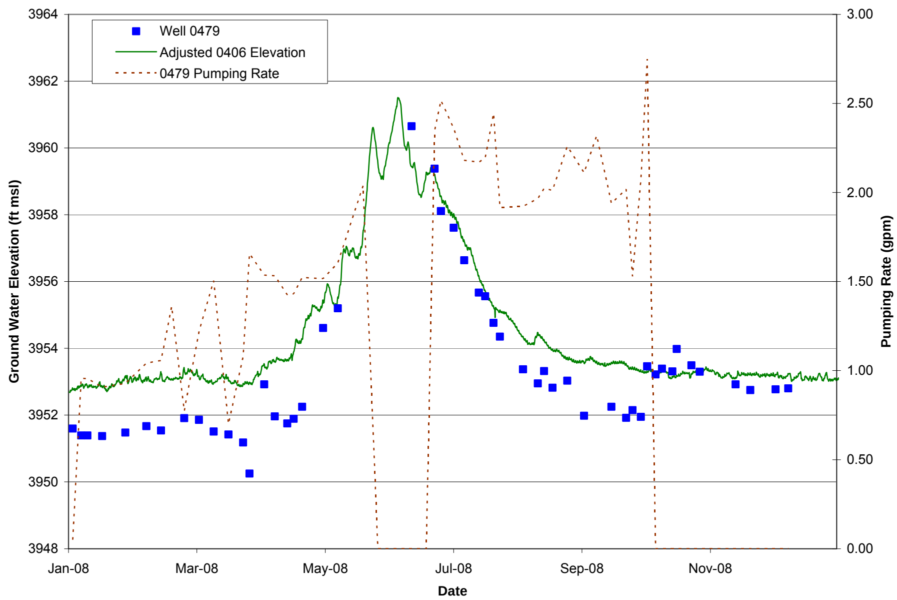
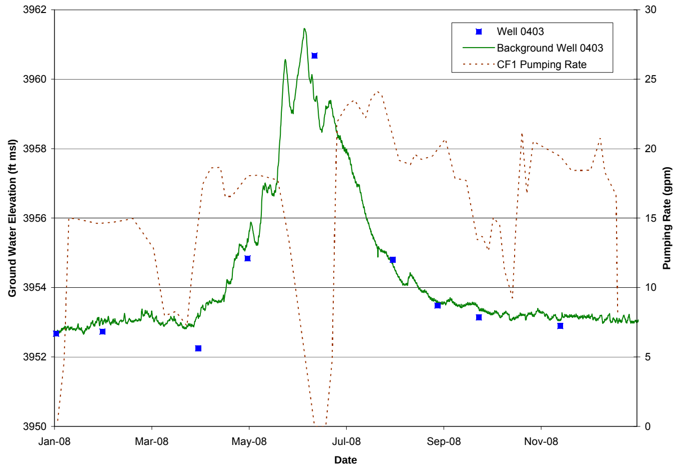
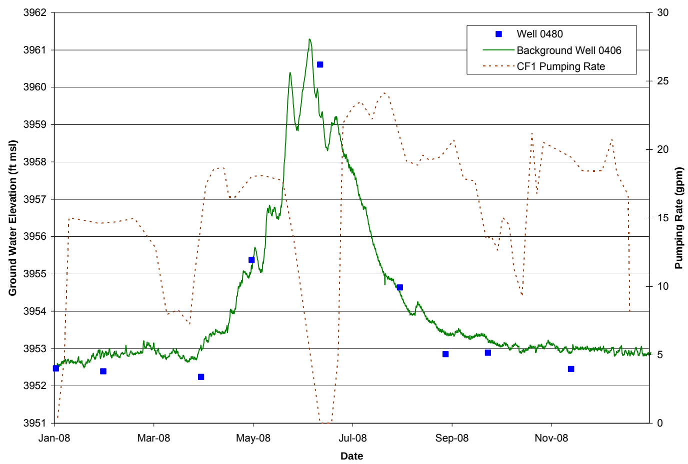


Figure A-2 Ground Water Elevations at CF1 Extraction Wells 0470 and 0479 and Baseline Area Well 0406 During 2008

Appendix A. CF1 Figures and Tables (continued)





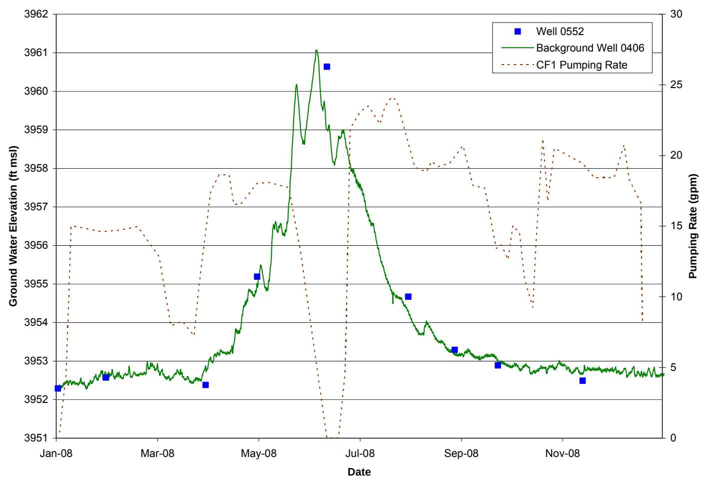
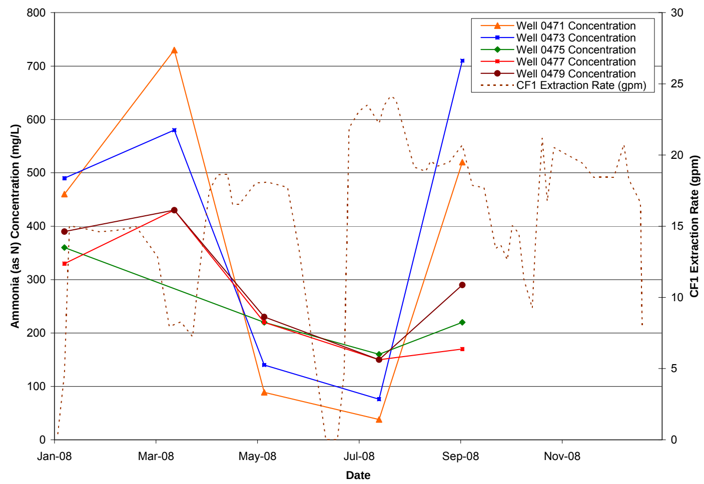
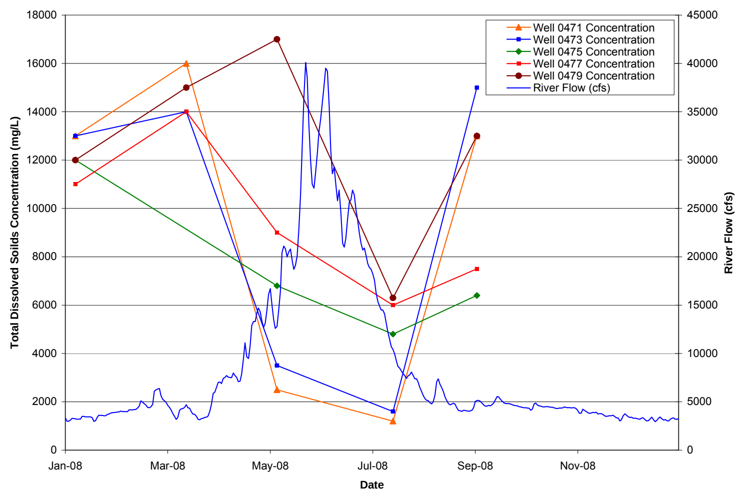


Figure A-3. Ground Water Elevations at CF1 Observation Wells 0403, 0480, and 0552 and Baseline Area Well 0406 During 2008





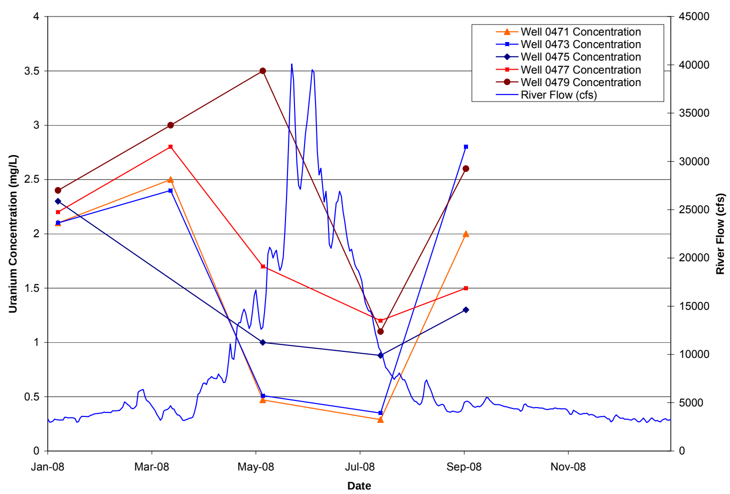
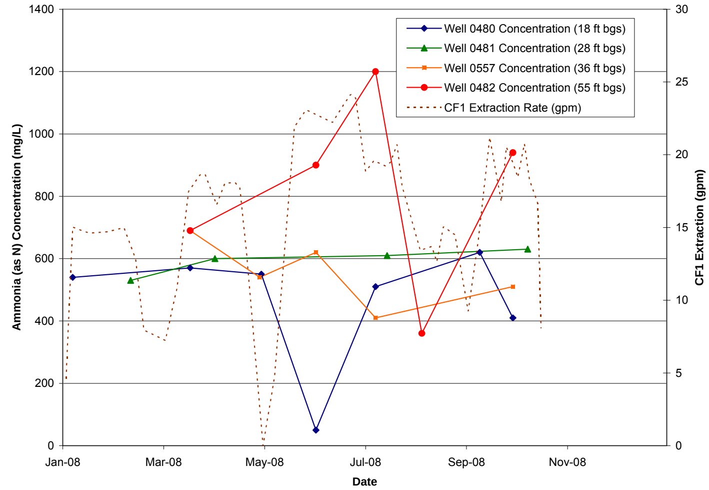
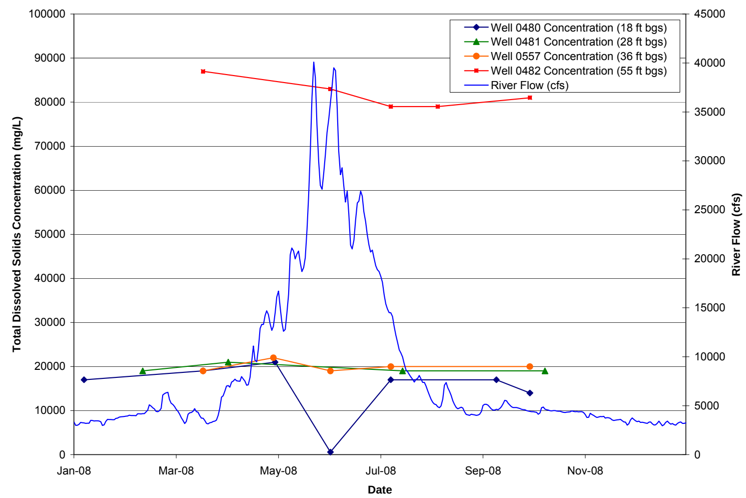


Figure A-4. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 Extraction Wells 0471, 0473, 0475, 0477, and 0479

Appendix A. CF1 Figures and Tables (continued)





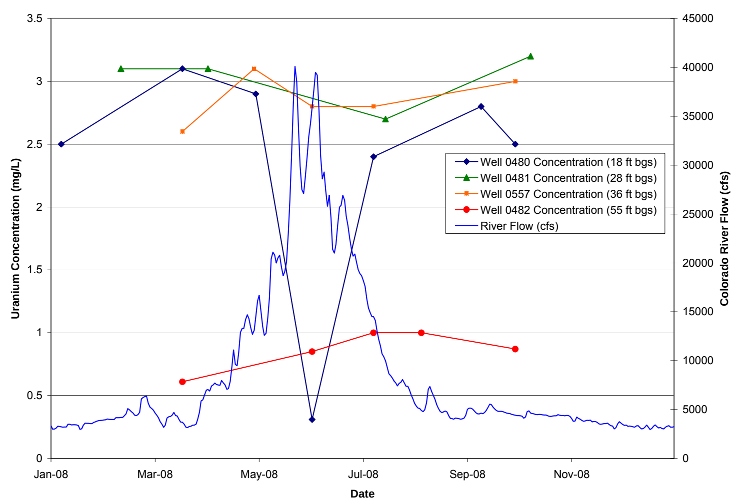
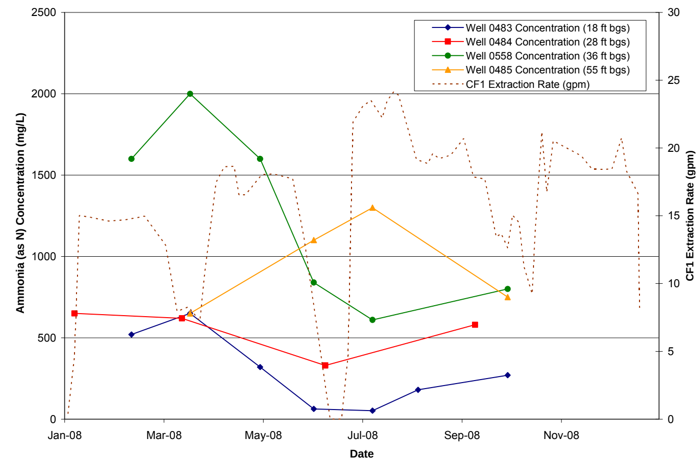
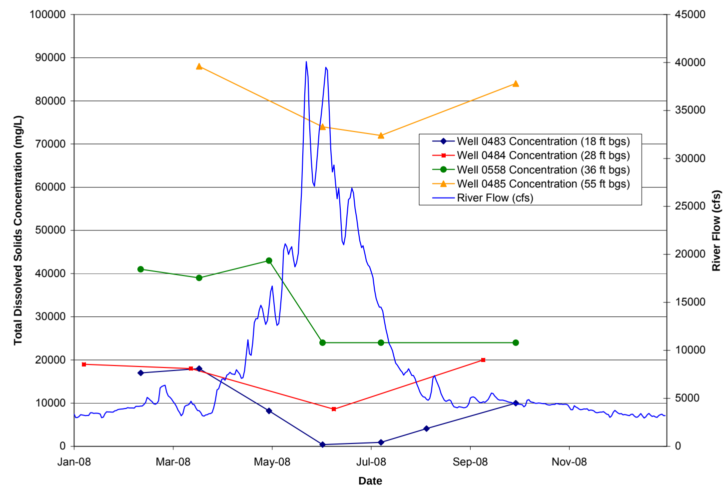


Figure A-5. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 Upgradient Observation Wells 0480, 0481, 0557, 0482





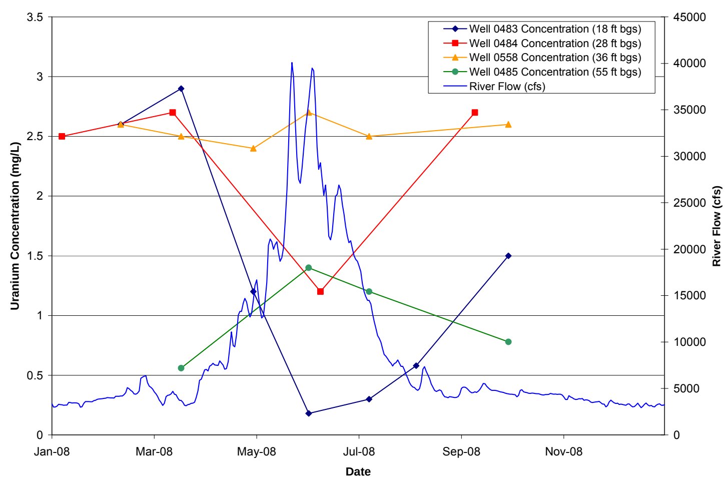


Figure A-6. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 Downgradient Observation Wells 0483, 0484, 0558, and 0485

Appendix A. CF1 Figures and Tables (continued)

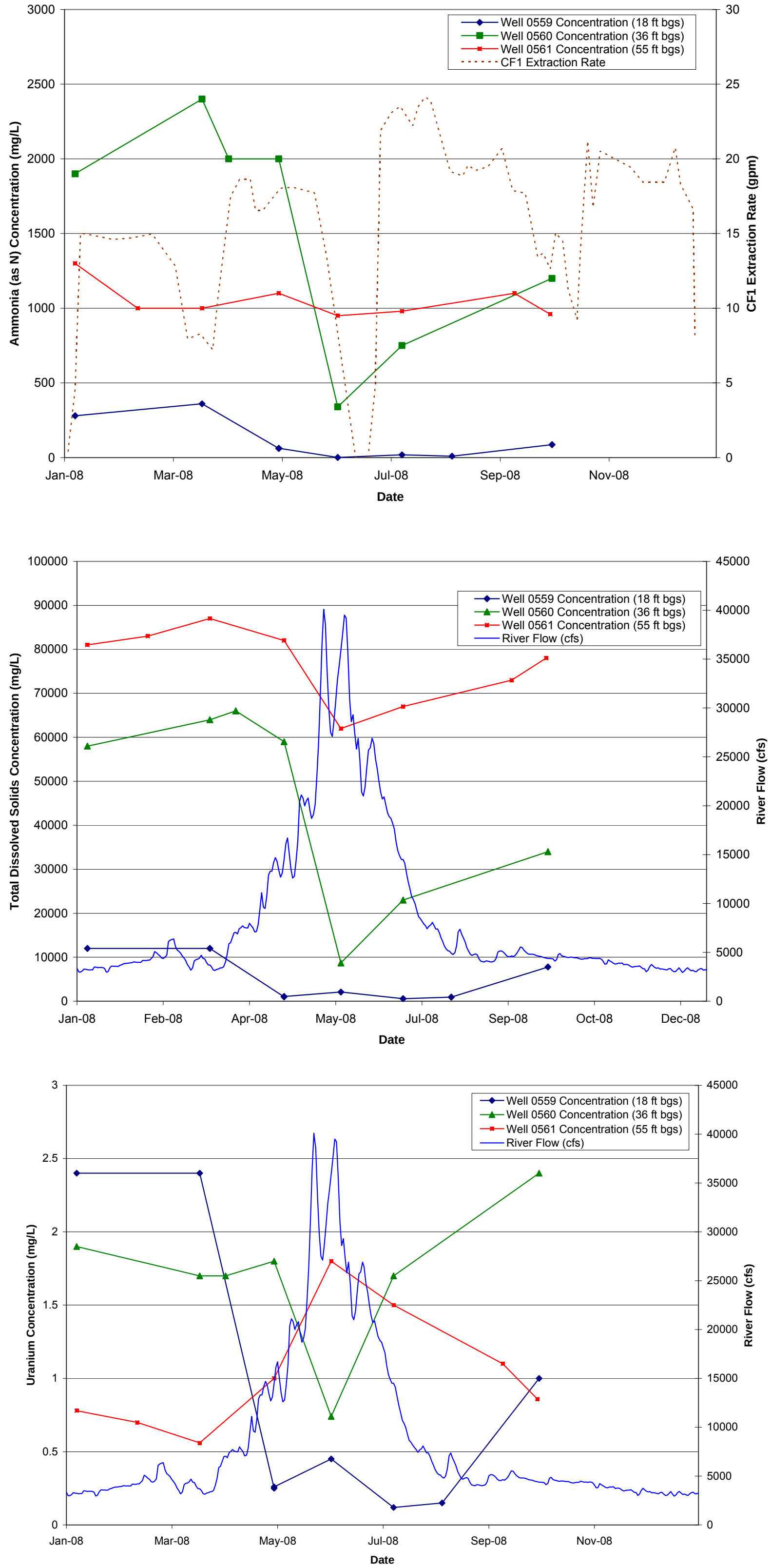
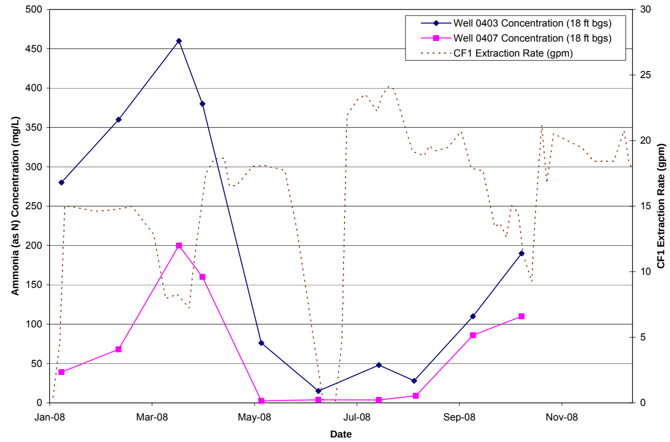
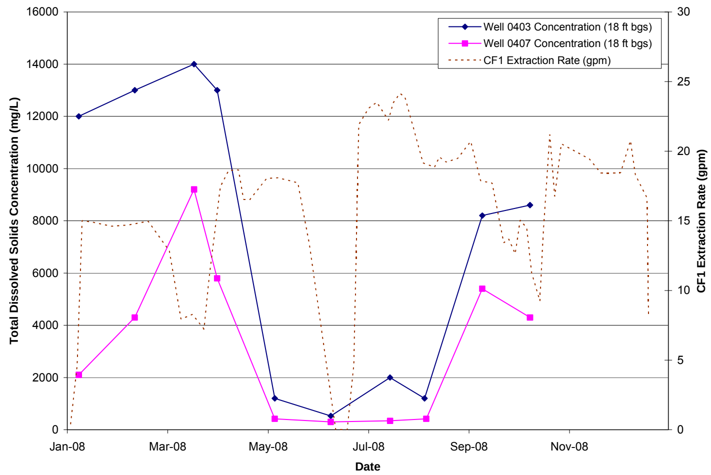


Figure A-7. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 Downgradient Wells 0559, 0560, and 0561





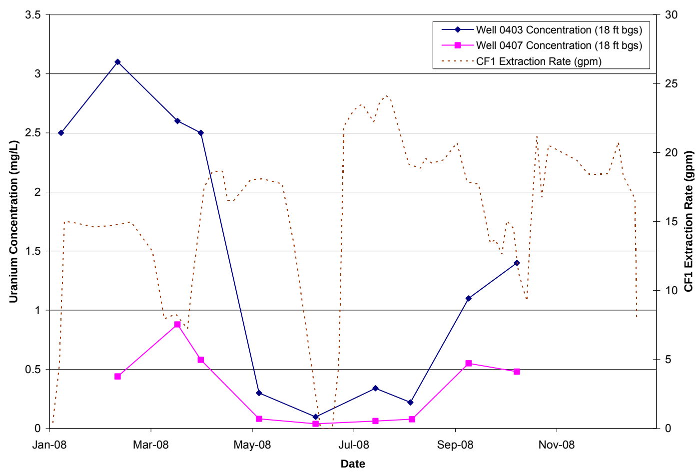


Figure A-8. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 Downgradient Observation Wells 0403 and 0407

Appendix A. CF1 Figures and Tables (continued)

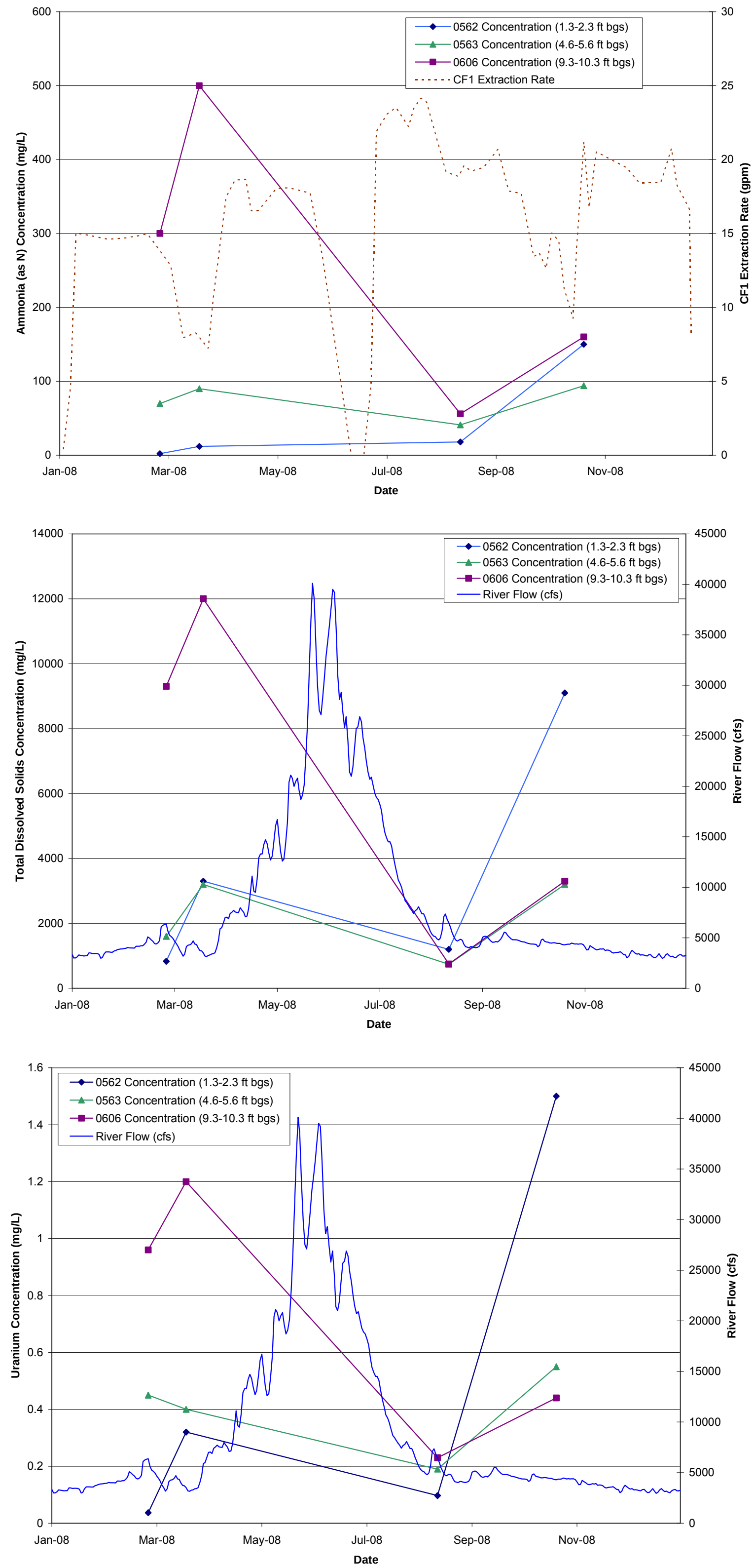


Figure A-9. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 River Bank Well Points 0562, 0563, and 0606

Appendix A. CF1 Figures and Tables (continued)

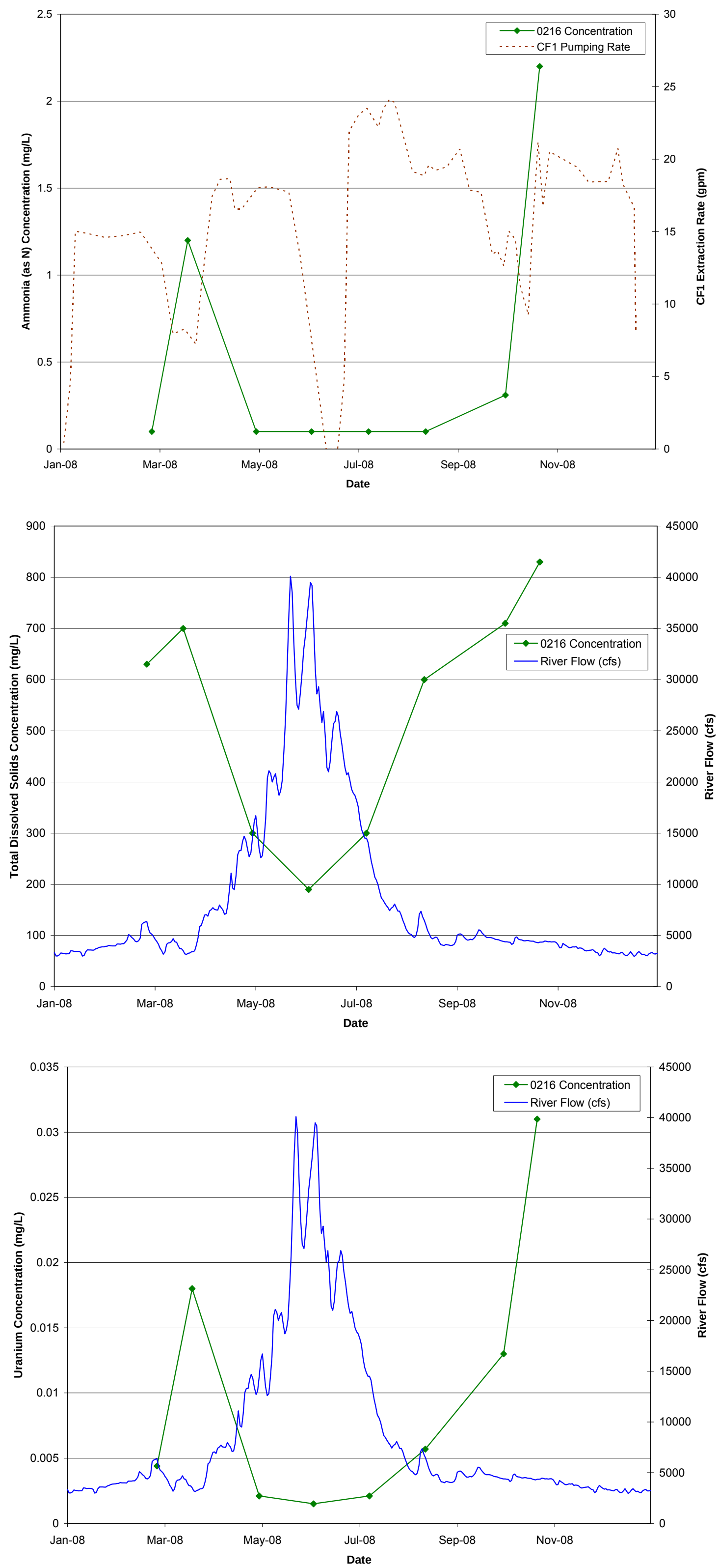


Figure A-10. Time Concentration Plots of Ammonia, TDS, and Uranium for CF1 Surface Water Location 0216

Table A-1 Summary of Well and Well Point Construction in CF1

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
0470	Extraction	4	3,966.56	10.3–19.7	21.3
0471	Extraction	4	3,966.59	10.3–19.7	21.3
0472	Extraction	4	3,966.62	10.3–19.7	21.3
0473	Extraction	4	3,966.67	10.3–19.7	21.3
0474	Extraction	4	3,967.02	10.3–19.7	21.3
0475	Extraction	4	3,967.13	10.3–19.7	21.3
0476	Extraction	4	3,967.38	10.3–19.7	21.3
0477	Extraction	4	3,967.30	10.3–19.7	21.3
0478	Extraction	4	3,966.82	9.6–23.9	25.5
0479	Extraction	4	3,966.60	9.3–23.6	25.2
SMI-PW02	Extraction	4	3,965.60	20–60	60.3
0403	Observation/Shallow	1	3,966.90	13.3–18.2	18.4
0407	Observation/Shallow	1	3,967.20	13.3–18.3	18.5
0480	Observation/Shallow	4	3,966.94	15.5–19.8	20.3
0481	Observation/Intermediate	4	3,967.01	25.4–29.7	31.3
0482	Observation/Deep	4	3,967.03	55.4–59.7	61.3
0483	Observation/Shallow	4	3,967.00	15.5–19.8	20.3
0484	Observation/Intermediate	4	3,967.19	25.5–29.8	30.3
0485	Observation/Deep	4	3,966.99	55.6–59.9	60.4
0551	Observation/Shallow	1	3,966.65	10.3–20.3	20.6
0552	Observation/Shallow	1	3,966.33	10.2–20.2	20.4
0553	Observation/Shallow	1	3,966.87	10.6–20.5	20.8
0554	Observation/Shallow	1	3,967.63	10.4–20.4	20.6
0555	Observation/Shallow	1	3,967.32	10.2–20.1	20.4
0556	Observation/Shallow	1	3,966.69	10.2–20.1	20.4
0557	Observation/Intermediate	6	3,967.01	35.0–45.0	45.9
0558	Observation/Intermediate	6	3,966.85	35.0–45.0	45.1
0559	Observation/Shallow	1	3,967.84	10.5–20.5	20.7
0560	Observation/Intermediate	6	3,966.95	30.0–40.0	40.4
0561	Observation/Deep	6	3,966.46	45.2–55.2	55.3
0596	Observation/Shallow	1	3,966.91	15.3–25.3	25.5
0562	Well point/Shallow	1	3,953.82	1.3−2.3	2.3
0563	Well point/Intermediate	1	3,953.82	4.6−5.6	5.6
0606	Well point/Deep	1	3,953.79	9.3−10.3	10.3
0611	Well point/Shallow	1	3,954.57	2.2−3.2	3.2
0612	Well point/Intermediate	1	3,954.57	4.3−5.3	5.3
0608	Well point/Deep	1	3,954.57	8.9−9.9	9.9
0564	Well point/Shallow	1	3,953.50	1.2−2.2	2.2
0565	Well point/Intermediate	1	3,953.50	4.0−5.0	5.0
0607	Well point/Deep	1	3,952.99	9.6−10.6	10.6

Appendix A. CF1 Figures and Tables (continued)

Table A-2. Chronology of CF1 Activities in 2008

Date	River Flow (daily mean cfs)	Activity	Samples Collected
Dec 11, 2007 to Jan 2, 2008	3,000	CF1 shut down due to cold air temperatures	N/A
Jan 7-10, 2008	3,630 to 4,150	Monthly sampling	Five extraction wells (0471, 0473, 0475, 0477, 0479), nine observation wells (0403, 0407, 0480, 0484, 0485, 0557, 0559, 0560, 0561), one evaporation pond location (0547)
Feb 4-28, 2008	4,160 to 6,090	Monthly sampling	Five extraction wells (0470, 0472, 0474, 0476, 0478), 10 observation wells (0403, 0407, 0481, 0482, 0483, 0552, 0555, 0558, 0561, 0596), nine well points (0562, 0563, 0606, 0608, 0611, 0612, 0564, 0565, 0607), two surface water locations (0216, 0245)
Feb 19, 2008	4,430	Shut down CF1 470, 472, 474, 476, and 479 to reduce flow	N/A
March 11-13, 2008	4,150 to 4,520	Monthly sampling	Four extraction wells (0471, 0473, 0477, 0479), one observation well (0484)
March 18-20, 2008	3,160 to 3,610	GW/SW interaction sampling	One extraction well (0474), 11 observation wells (0403, 0407, 0480, 0482, 0483, 0485, 0557, 0558, 0559, 0560, 0561), three well points (0562, 0563, 0606), one surface water location (0216)
March 24, 2008	3,400	CF1 brought back to full capacity	N/A
March 31-April 10, 2008	6,500 to 7,640	Monthly sampling	Five extraction wells (0470, 0472, 0474, 0476, 0478), five observation wells (0403, 0407, 0481, 0560, 0555), two evaporation pond locations (0547, 0548)
April 28-30, 2008	12,300 to 14,200	GW/SW interaction sampling	One extraction well (0474), 11 observation wells (0403, 0407, 0480, 0482, 0485, 0557, 0558, 0559, 0560, 0561), one surface water location (0216)
May 6-13, 2008	12,400 to 20,600	Monthly sampling	Five extraction wells (0471, 0473, 0475, 0477, 0479), three observation wells (0403, 0407, 0552), two evaporation pond locations (0547, 0548)
May 20, 2008	26,400	CF1 shut down due to potential flooding	N/A
June 2-4, 2008	34,900 to 38,200	GW/SW interaction sampling	One extraction well (0474), nine observation wells (0480, 0482, 0483, 0485, 0557, 0558, 0559, 0560, 0561), one surface water location (0216)
June 9-11, 2008	24,600 to 28,100	Monthly sampling	Four observation wells (0403, 0407, 0484, 0596)
June 19, 2008	25,900	Portion of CF1 turned back on	N/A
July 8-10, 2008	12,200	GW/SW interaction sampling	One extraction well (0474), nine observation wells (0480, 0482, 0483, 0485, 0557, 0558, 0559, 0560, 0561), one surface water location (0216)

Table A-2. Chronology of CF1 Activities in 2008 (continued)

Date	River Flow (daily mean cfs)	Activity	Samples Collected
July 14-24, 2008	7,090 to 9,990	Monthly sampling	Five extraction wells (0471, 0473, 0475, 0477, 0479), four observation wells (0403, 0407, 0481, 0555), two evaporation pond locations (0547, 0548)
Aug 4-13, 2008	4,600 to 6,610	Monthly sampling	Five extraction wells (0470, 0472, 0474, 0476, 0478), six observation wells (0403, 0407, 0482, 0483, 0552, 0559), three well points (0562, 0606, 0563), one surface water location (0216), two evaporation pond locations (0547, 0548)
Sept 2-11, 2008	4,410 to 4,940	Monthly sampling	Five extraction wells (0471, 0473, 0475, 0477, 0479), seven observation wells (0403, 0407, 0480, 0484, 0557, 0561, 0596), two evaporation pond locations (0547, 0548)
Sept 29-30, 2008	4,220 to 4,260	GW/SW interaction sampling	One extraction well (0474), nine observation wells (0480, 0482, 0483, 0485, 0557, 0558, 0559, 0560, 0561), one surface water location (0216)
Sept 29-Oct 22, 2008	4,150 to 4,680	Monthly sampling	Four extraction wells (0470, 0472, 0476, 0478), four observation wells (0403, 0407, 0481, 0555), nine well points (0562, 0563, 0606, 0608, 0611, 0612, 0564, 0565, 0607), two surface water locations (0216, 0245), two evaporation pond locations (0547, 0548)
Nov 13, 2008	3,740	Begin extraction on SMI-PW02	N/A
Nov 20, 2008	3,580	Cease extraction on SMI-PW02	N/A
Dec 11, 2008	3,210	Shut down 0471, 0473, 0475, 0477, 0479 to decrease flow to pond	N/A
Dec 18, 2008	3,160	CF1 shut down due to cold air temperatures	N/A

GW/SW = ground water/surface water

Table A-3. Monthly Average Pumping Rates and Extraction Volumes at CF1 Remediation Wells, January through December 2008

Month	Well 0470		Well 0471		Well 0472		Well 0473		Well 0474	
	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)
Jan 2008	34,587	0.65	53,870	0.97	46,938	0.98	81,283	1.34	77,547	1.69
Feb 2008	24,009	0.79	57,158	1.42	41,664	1.34	60,549	1.68	66,763	2.17
Mar 2008	4,173	0.20	62,306	1.51	8,974	0.43	84,261	1.96	19,187	0.25
Apr 2008	40,786	1.15	82,529	2.29	75,540	1.28	93,373	2.31	29,482	0.81
May 2008	27,850	0.47	84,962	1.53	83,293	1.52	64,903	1.21	38,659	0.70
June 2008	10,448	0.53	160	0.00	22,192	1.03	49,227	1.91	25,245	1.18
July 2008	33,824	0.74	70,865	1.81	61,884	1.50	111,697	2.40	96,837	2.49
Aug 2008	42,630	0.96	73,774	1.60	52,729	1.16	96,498	2.32	98,784	2.16
Sept 2008	55,093	1.09	89,816	1.76	16,995	0.24	13,202	0.25	110,598	2.17
Oct 2008	65,570	1.73	86,235	2.21	45,140	1.22	29,257	0.65	90,107	2.29
Nov 2008	83,985	2.39	88,744	2.52	71,946	2.01	764	0.02	82,105	2.33
Dec 2008	88,683	1.75	73,556	1.45	82,378	1.65	23,507	0.71	95,485	1.96
Annual Avg/Total	**511,638**	**1.03**	**823,975**	**1.58**	**609,673**	**1.19**	**708,521**	**1.39**	**830,799**	**1.68**

Month	Well 0475		Well 0476		Well 0477		Well 0478		Well 0479	
	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)
Jan 2008	118,655	1.60	62,813	1.05	53,881	0.97	59,512	1.06	35,007	0.70
Feb 2008	80,533	2.24	21,468	0.86	60,070	1.49	39,729	1.09	34,848	1.15
Mar 2008	106,655	2.40	8,340	0.18	72,153	1.73	58,683	0.46	59,656	1.23
Apr 2008	95,098	2.37	76,261	2.12	95,559	2.65	42,181	1.20	53,872	1.49
May 2008	63,585	1.19	87,321	1.59	107,718	1.96	45,075	0.84	71,958	1.29
June 2008	47,288	1.83	31,697	1.48	33,847	1.58	36,272	1.67	26,156	1.22
July 2008	101,134	2.28	122,666	3.08	130,721	3.29	117,537	2.94	88,416	2.21
Aug 2008	45,694	1.08	130,343	2.84	140,048	2.94	113,879	2.47	93,417	2.04
Sept 2008	39,755	0.92	99,847	1.87	101,531	2.06	139,196	2.71	103,300	2.00
Oct 2008	101,107	1.45	39,809	1.06	86,519	2.17	182,922	2.74	12,035	0.34
Nov 2008	57,759	2.12	68,360	2.03	71,529	2.02	82,693	3.00	0	0.00
Dec 2008	35,544	1.12	63,149	1.25	53,431	1.03	71,062	1.84	0	0.00
Annual Avg/Total	**892,807**	**1.71**	**812,074**	**1.97**	**1,007,007**	**1.99**	**988,741**	**1.83**	**578,665**	**1.13**

Q = pumping rate; Vol = volume

Appendix A. CF1 Figures and Tables (continued)

Table A-4. Estimated Ammonia Mass Withdrawals at CF1 Extraction Wells During 2008

Month	Well 0470[a]		Well 0471[b]		Well 0472[a]		Well 0473[b]		Well 0474[a]	
	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)
Jan 2008	406	53.1	460	93.7	500	88.7	490	150.6	425	140.7
Feb 2008	560	50.8	530	114.5	500	78.7	535	122.4	480	169.1
Mar 2008	600	9.5	730	171.9	555	18.8	580	184.7	670	34.1
Apr 2008	640	98.7	409.5	127.7	610	174.2	360	127.1	470	20.1
May 2008	180	18.9	89	28.6	115	36.1	140	34.3	180	26.3
June 2008	26	1.0	63.5	0.0	26	2.2	108	20.1	26	2.5
July 2008	107	13.6	38	10.2	57	13.3	76	32.1	66	24.2
Aug 2008	280	45.1	279	77.8	370	73.7	393	143.4	340	127.0
Sept 2008	370	77.1	520	176.5	305	19.6	710	35.4	210	87.8
Oct 2008	460	114.0	350	114.1	240	41.0	266	29.4	266	90.6
Nov 2008	324	102.9	324	108.7	324	88.1	324	0.9	324	100.6
Dec 2008	324	108.6	324	90.1	324	100.9	324	28.8	324	116.9
Total		**693**		**1,114**		**735**		**909**		**940**

Month	Well 0475[b]		Well 0476[a]		Well 0477[b]		Well 0478[a]		Well 0479[b]	
	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)
Jan 2008	360	161.5	345	81.9	330	67.2	360	81.0	390	51.6
Feb 2008	415	126.3	350	28.4	380	86.3	380	57.1	402.5	53.0
Mar 2007	568	229.0	390	12.3	430	117.3	440	97.6	415	93.6
Apr 2007	530	190.5	430	124.0	325	117.4	500	79.7	322.5	65.7
May 2007	220	52.9	220	72.6	220	89.6	225	38.3	230	62.6
June 2007	190	34.0	26	3.1	185	23.7	26	3.6	190	18.8
July 2007	160	61.2	155	71.9	150	74.1	150	66.6	150	50.1
Aug 2007	190	32.8	270	133.0	160	84.7	250	107.6	220	77.7
Sept 2007	220	33.1	220	83.0	170	65.2	250	131.5	290	113.2
Oct 2007	266	101.7	170	25.6	210	68.7	250	172.9	266	12.1
Nov 2007	324	70.7	324	83.7	324	87.6	324	101.3	324	0.0
Dec 2007	324	43.5	324	77.3	324	65.4	324	87.0	324	0.0
Total		**1,137**		**797**		**947**		**1,024**		**598**

Notes: [a]Used average concentrations for September and November due to the sampling schedule.
[b]Used average concentrations for April, June, July, and December due to the sampling schedule.
Conc = concentration

Table A-5. Estimated Uranium Mass Withdrawals at CF1 Extraction Wells During 2008

Month	Well 0470[a]		Well 0471[b]		Well 0472[a]		Well 0473[b]		Well 0474[a]	
	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)
Jan 2008	2.2	0.3	2.1	0.4	2.2	0.4	2.1	0.6	2	0.6
Feb 2008	2.7	0.2	3	0.6	2.5	0.4	2.25	0.5	2.4	0.6
Mar 2008	2.5	0.0	2.5	0.6	2.25	0.1	2.4	0.8	2.7	0.2
Apr 2008	2.3	0.4	1.485	0.5	2	0.6	1.45	0.5	2.1	0.2
May 2008	1.3	0.1	0.47	0.2	0	0.2	0.5	0.1	0.58	0.1
June 2008	0.2	0.0	0.385	0.0	0.2	0.0	0.425	0.1	0.17	0.0
July 2008	1.1	0.1	0.3	0.1	0	0.1	0.35	0.1	0.35	0.1
Aug 2008	0.67	0.1	1.15	0.3	1.5	0.3	1.575	0.6	1.7	0.6
Sept 2008	1.385	0.3	2	0.7	1.3	0.1	2.8	0.1	1.1	0.5
Oct 2008	2.1	0.5	2	0.5	1.1	0.2	1.5	0.2	1.5	0.5
Nov 2008	1.6	0.5	1.6	0.5	1.6	0.4	1.6	0.0	1.6	0.5
Dec 2008	1.6	0.5	1.6	0.4	1.6	0.5	1.6	0.1	1.6	0.6
Total		**3.2**		**4.8**		**3.2**		**3.8**		**4.6**

Month	Well 0475[b]		Well 0476[a]		Well 0477[b]		Well 0478[a]		Well 0479[b]	
	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)
Jan 2008	2.3	1.0	2	0.5	2.2	0.4	2	0.5	2.4	0.3
Feb 2008	3	0.8	2.9	0.2	2.5	0.6	2.6	0.4	2.7	0.4
Mar 2008	2.7	1.1	2.8	0.1	2.8	0.8	2.65	0.6	3	0.7
Apr 2008	2.4	0.8	2.7	0.8	2.25	0.8	2.7	0.4	3.25	0.7
May 2008	1	0.2	1	0.4	1.7	0.7	3	0.4	3.5	1.0
June 2008	0.94	0.2	0.2	0.0	1.45	0.2	0.2	0.0	2.3	0.2
July 2008	0.88	0.3	1	0.5	1.2	0.6	1	0.5	1.1	0.4
Aug 2008	1.09	0.2	1.9	0.9	1.35	0.7	2.2	0.9	1.85	0.7
Sept 2008	1.3	0.2	1.5	0.6	1.5	0.6	2.05	1.1	2.6	1.0
Oct 2008	1.5	0.6	1.1	0.2	2	0.5	1.9	1.3	1.5	0.1
Nov 2008	1.6	0.3	1.6	0.4	1.6	0.4	1.6	0.5	1.6	0.0
Dec 2008	1.6	0.2	1.6	0.4	1.6	0.3	1.6	0.4	1.6	0.0
Total		**6.0**		**5.0**		**6.6**		**7.2**		**5.3**

Notes: [a]Used average concentrations for September and November due to the sampling schedule.
[b]Used average concentrations for April, June, July, and December due to the sampling schedule.
Conc = concentration; U = uranium

Appendix B.
CF3 Figures and Tables

Appendix B. CF3 Figures and Tables

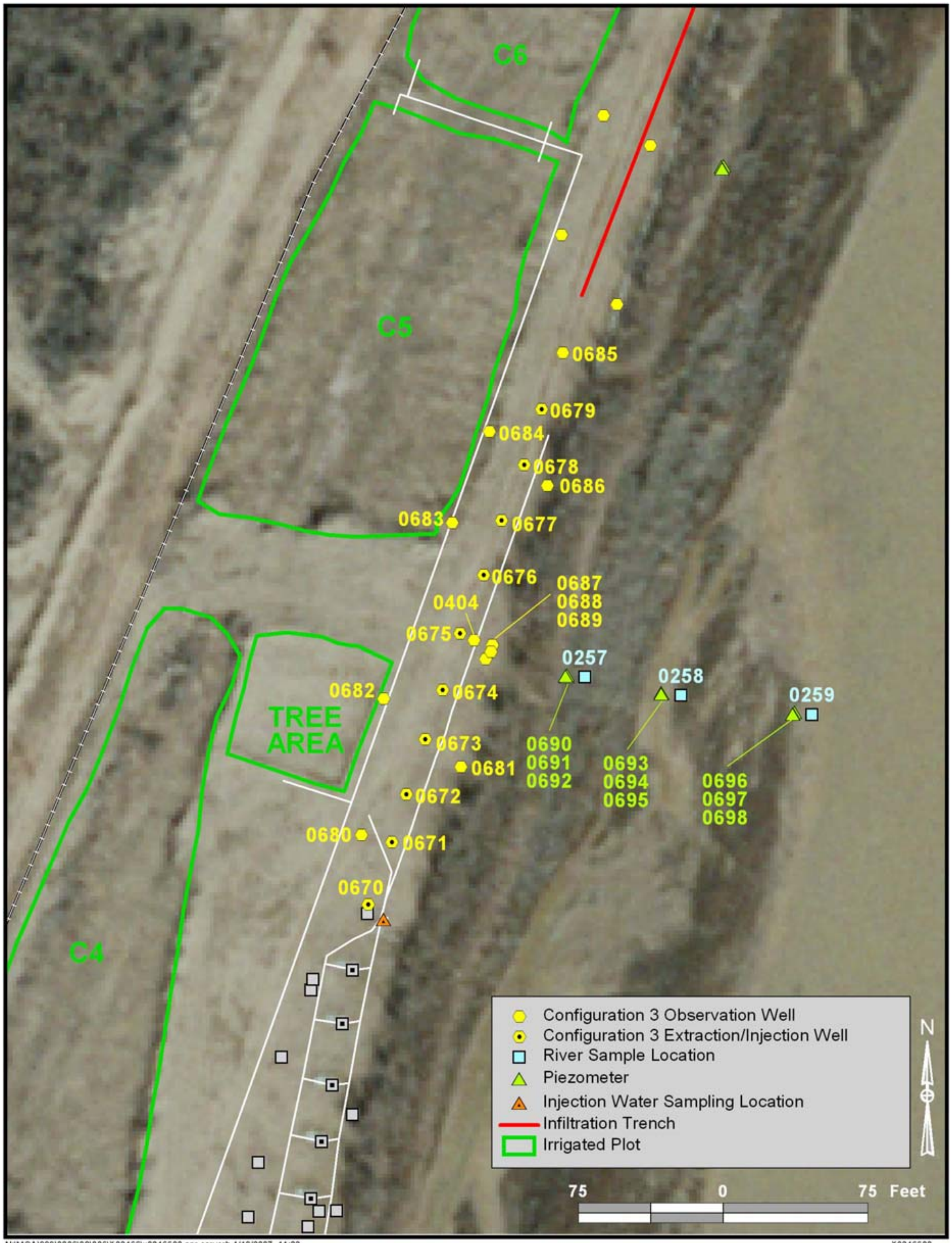


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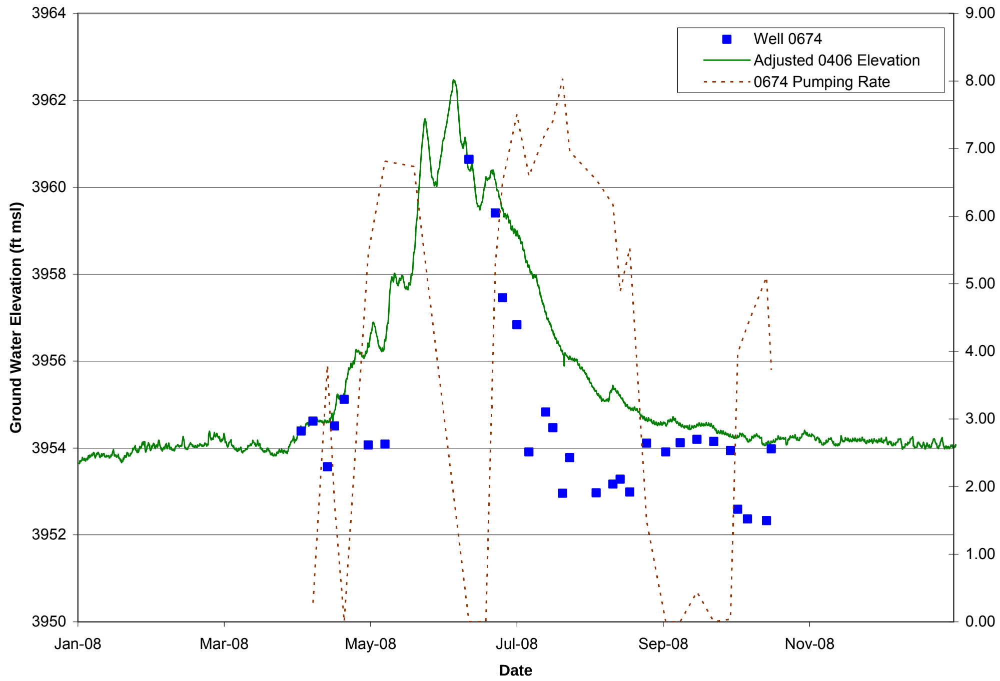
Figure B-1. Map View of CF3 Wells and Sampling Locations



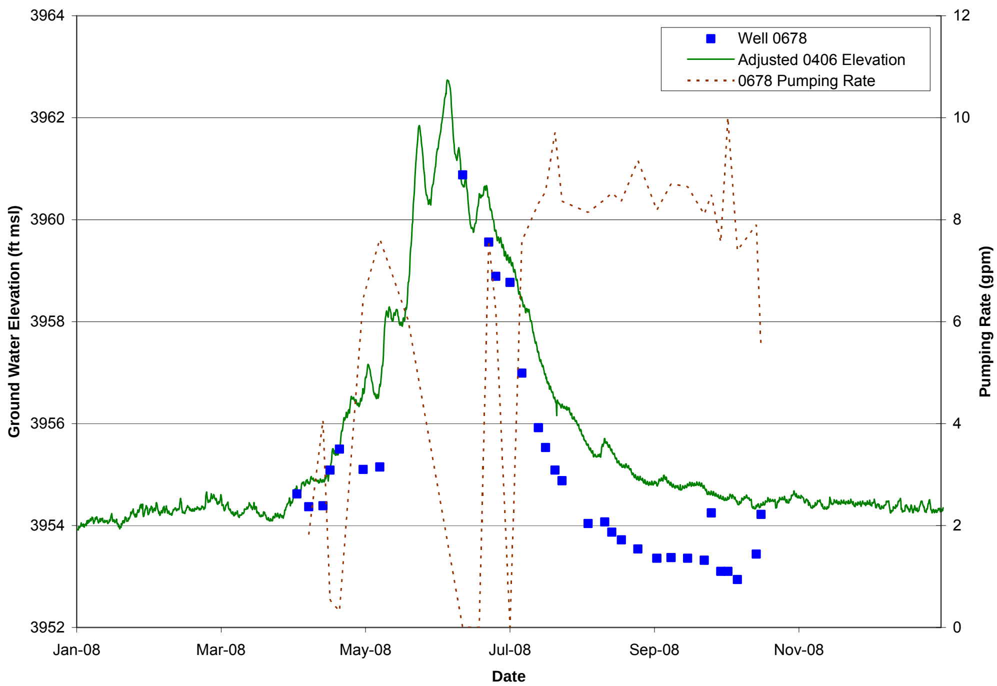


Figure B-2. Ground Water Elevations at CF3 Extraction Wells 0674 and 0678 and Background Well 0406 During 2008

Appendix B. CF3 Figures and Tables (continued)

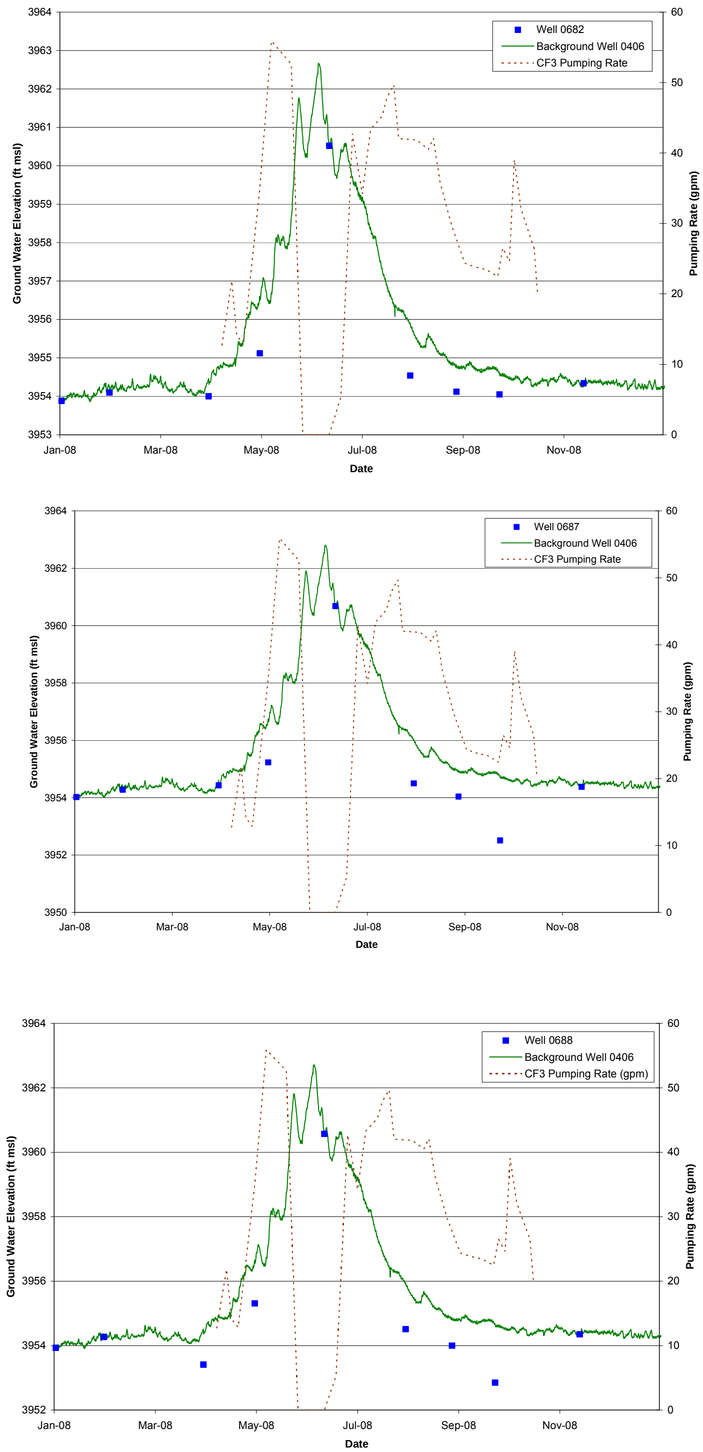
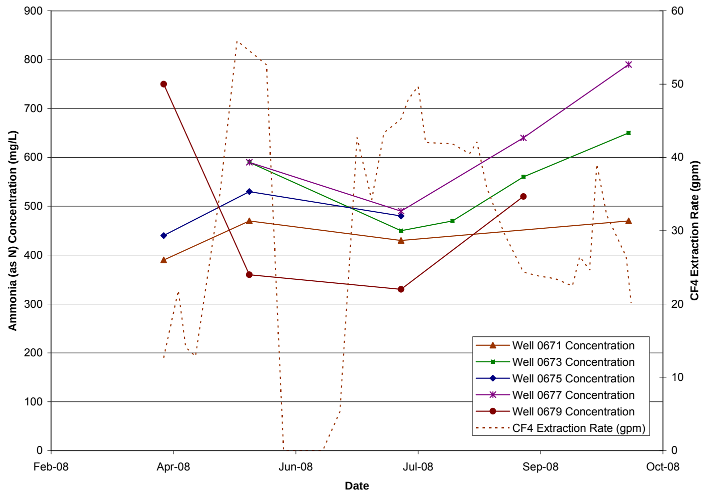
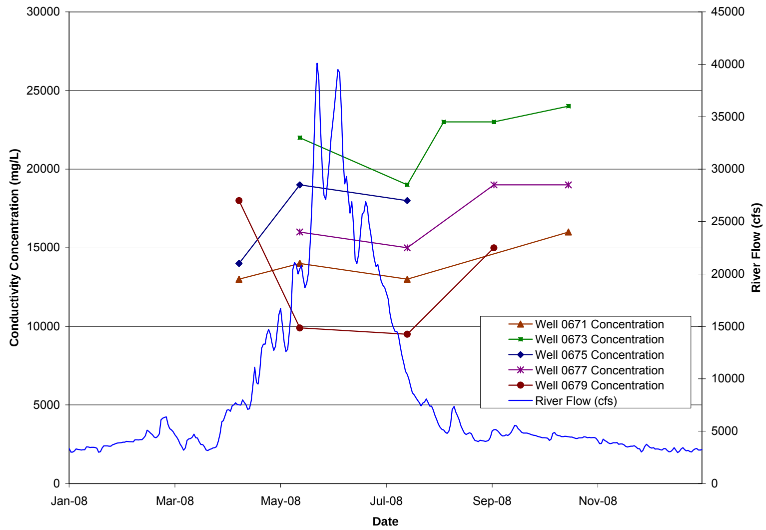


Figure B-3. Ground Water Elevations at CF3 Observation Wells 0682, 0687 and 0688 and Background Well 0406 During 2008





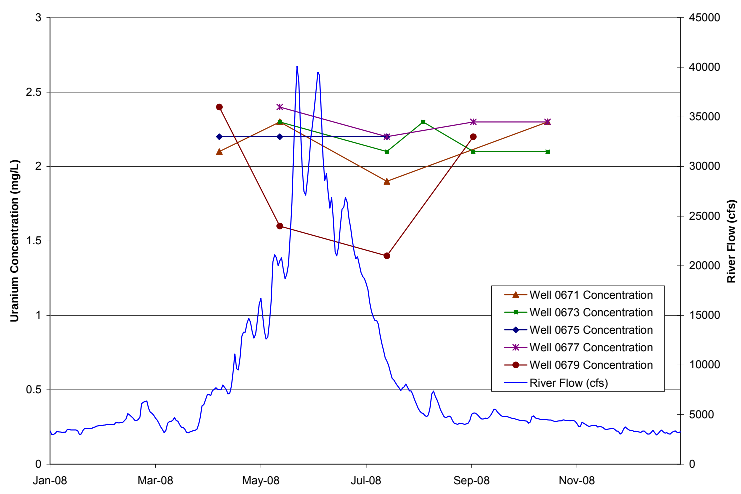
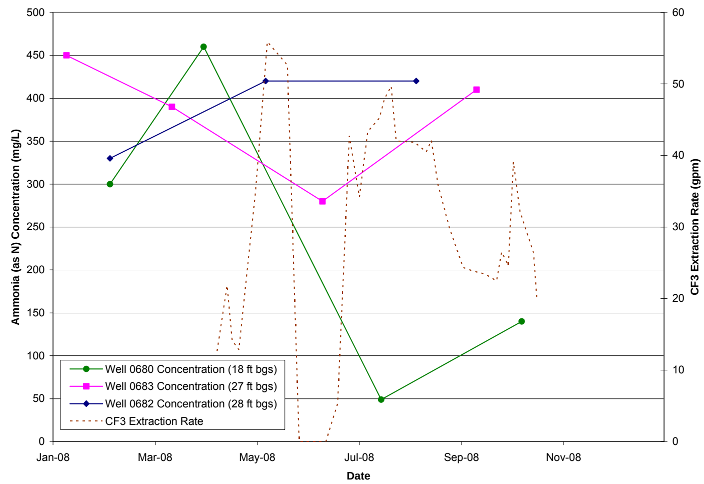
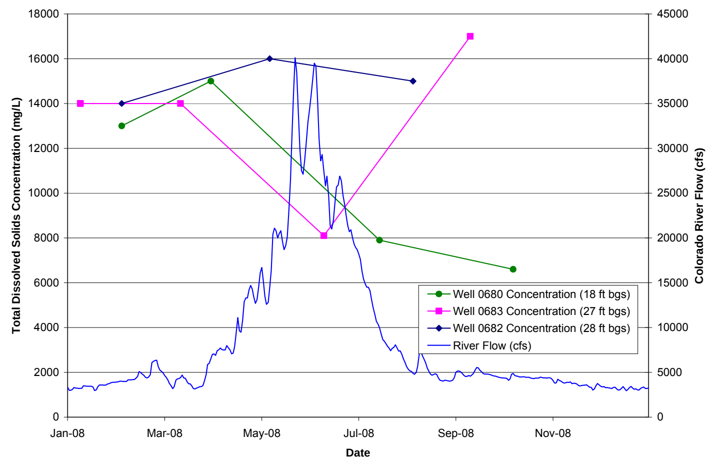


Figure B-4. Time Concentration Plots for CF3 Extraction Wells 0671, 0673, 0675, 0677, and 0679





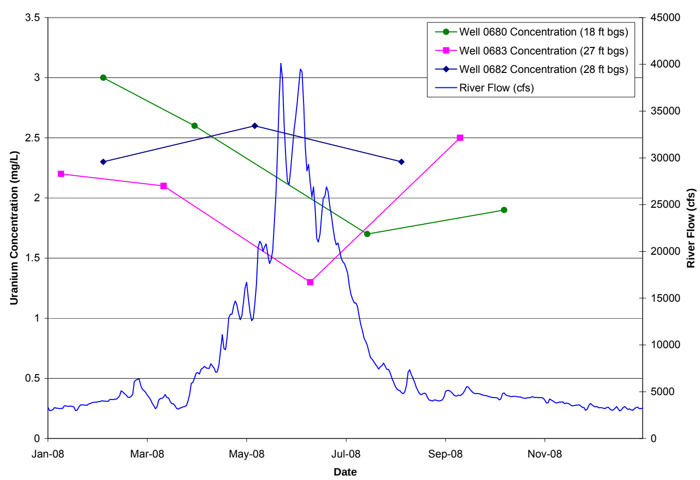
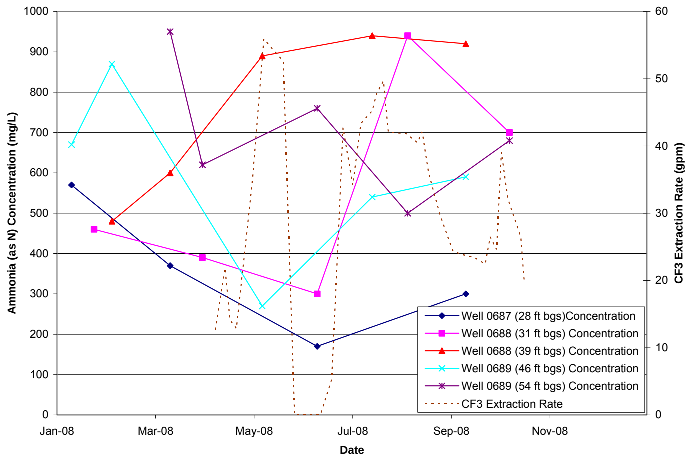
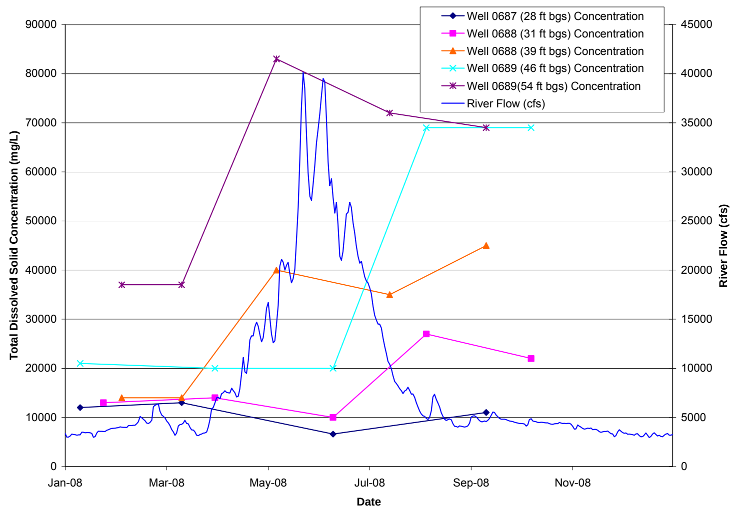


Figure B-5. Time Concentration Plots for CF3 Upgradient Observation Wells 0680, 0683, and 0682





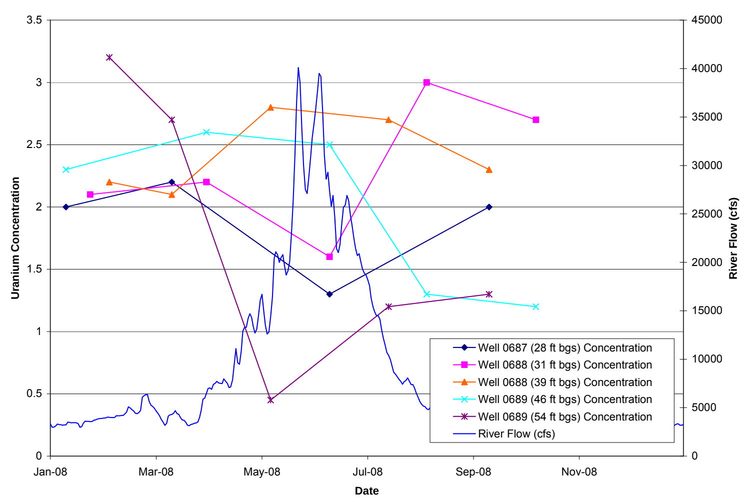


Figure B-6. Time Concentration Plots for CF3 Downgradient Observation Wells 0687, 0688, and 0689

Appendix B. CF3 Figures and Tables (continued)

Table B-1. Summary of Well and Well Point Construction in CF3

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
0670	Remediation/Deep	6	3,967.05	15.9–45.9	46.3
0671	Remediation/Deep	6	3,967.31	14.4–44.4	44.8
0672	Remediation/Deep	6	3,967.27	15.0–45.0	45.4
0673	Remediation/Deep	6	3,967.19	16.3–46.3	46.7
0674	Remediation/Deep	6	3,967.11	15.1–45.1	45.5
0675	Remediation/Deep	6	3,966.99	16.0–46.0	46.4
0676	Remediation/Deep	6	3,967.27	15.9–45.9	46.3
0677	Remediation/Deep	6	3,967.17	15.2–45.2	45.6
0678	Remediation/Deep	6	3,967.11	16.3–46.3	46.6
0679	Remediation/Deep	6	3,967.03	15.0–45.0	45.4
0404	Observation/Shallow	1	3,967.70	13.0–17.9	18.9
0680	Observation/Shallow	1	3,967.75	9.9–19.8	20.0
0681	Observation/Shallow	1	3,967.65	10.2–20.2	20.4
0682	Observation/Shallow	1	3,968.25	19.6–29.5	29.7
0683	Observation/Shallow	1	3,968.76	21.2–31.2	31.4
0684	Observation/Shallow	1	3,968.48	11.3–21.3	21.5
0685	Observation/Shallow	1	3,967.11	20.0–30.0	30.2
0686	Observation/Shallow	1	3,967.08	10.0–20.0	20.2
0687	Observation/Shallow	1	3,966.74	20.0–30.0	30.2
0688	Observation/Intermediate	6	3,966.57	30.6–40.6	41.0
0689	Observation/Deep	6	3,966.62	46.0–56.0	56.4
0690	Well point/Shallow	1	3,957.15	3.3–4.3	4.3
0691	Well point/Intermediate	1	3,957.15	6.5–7.5	7.5
0692	Well point/Deep	1	3,957.15	9.7–10.1	10.1
0693	Well point/Shallow	1	3,955.36	2.0–3.0	3.0
0694	Well point/Intermediate	1	3,955.36	4.3–5.3	5.3
0695	Well point/Deep	1	3,955.36	9.3–10.3	10.3
0696	Well point/Shallow	1	3,954.50	1.3–2.3	2.3
0697	Well point/Intermediate	1	3,954.50	4.3–5.3	5.3
0698	Well point/Deep	1	3,954.50	9.9–10.3	10.3

Appendix B. CF3 Figures and Tables (continued)

Table B-2. Chronology of CF3 Activities in 2008

Date	River Flow (daily mean cfs)	Activity	Samples Collected
Jan 7-10, 2008	3,630 to 4,150	Monthly sampling	Three observation wells (0682, 0687, 0689-54)
Feb 4-28, 2008	4,160 to 6,040	Monthly sampling	Nine observation wells (0682, 0688-39, 0689-54, 0404, 0680, 0681, 0684, 0685, 0686), nine well points (0690, 0691, 0692, 0693, 0694, 0695, 0696, 0697, 0698), two surface water locations (0258, 0259)
March 11-13, 2008	4,150 to 4,520	Monthly sampling	Five observation wells (0683, 0686, 0687, 0688-39, 0689-54)
April 3, 2008	6,890	CF3 was initiated on extraction	N/A
March 31-April 10, 2008	6,500 to 7,640	Monthly sampling	Seven remediation wells (0670, 0671, 0674, 0675, 0676, 0678, 0679), five observation wells (0684, 0689-46, 0688-31, 0681, 0680), two well points (0691, 0692), one surface water location (0258)
May 1, 2008	16,100	CF3 shut down for the day for electrical work	N/A
May 6-13, 2008	12,400 to 20,600	Monthly Sampling	Five remediation wells (0671, 0673, 0675, 0677, 0679), five observation wells (0682, 0688-39, 0689-54, 0404, 0685)
May 21, 2008	31,200	CF3 shut down due to potential flooding	N/A
June 9-11, 2008	24,600 to 28,100	Monthly sampling	Five observation wells (0683, 0686, 0687, 0688-31, 0689-46)
June 19, 2008	25,900	Portion of CF3 initiated on extraction mode	N/A
July 14-24, 2008	7,090 to 9,990	Monthly sampling	Five remediation wells (0671, 0673, 0675, 0677, 0679), six observation wells (0688-39, 0689-544, 0404, 0680, 0681, 0684), three well points (0690, 0691, 0692), one surface water location (0259)
Aug 4-13, 2008	4,600 to 6,610	Monthly sampling	Five remediation wells (0670, 0673, 0674, 0676, 0678), five observation wells (0682, 0688-31, 0689-46, 0404, 0685)
Aug 20, 2008	4,760	Shut down portion of CF3 to reduce flow to pond	N/A
Sept 2-11, 2008	4,410 to 4,940	Monthly sampling	Five remediation wells (0670, 0673, 0674, 0677, 0679), five observation wells (0683, 0686, 0687, 0689-54, 0688-39)
Oct 15, 2008	4,460	CF3 shut down for winter	N/A
Sept 29-Oct 22, 2008	4,150 to 4,680	Monthly sampling	Five remediation wells (0671, 0673, 0674, 0677, 0678), five observation wells (0680, 0681, 0684, 0688-31, 0689-46)

Table B-3. Monthly Average Pumping Rates and Extraction Volumes at CF3 Wells in 2008

Month	Well 0670		Well 0671		Well 0672		Well 0673		Well 0674	
	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)
Apr 2008	31,107	1.21	48,219	1.79	13,966	0.25	62,910	1.65	42,018	1.46
May 2008	26,514	0.48	144,938	2.49	70,155	1.64	213,988	3.92	260,000	4.75
June 2008	21,986	0.97	25,950	1.68	0	0.00	130,293	5.07	59,179	2.95
July 2008	139,690	3.54	223,835	5.75	0	0.00	217,386	4.34	293,632	7.41
Aug 2008	121,014	2.58	213,309	4.58	0	0.00	142,845	3.37	236,197	4.52
Sept 2008	19,470	0.88	25,058	1.11	0	0.00	48,786	2.21	4,908	0.12
Oct 2008	25,373	1.21	92,622	3.60	0	0.00	76,518	2.58	109,866	4.30
Annual Avg/Total	**385,154**	1.55	**773,931**	3.00	84,121	0.27	76,518	3.31	1,050,800	3.64

Month	Well 0675		Well 0676		Well 0677		Well 0678		Well 0679	
	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)
Apr 2008	33,123	1.18	125,687	4.97	118,659	2.84	52,779	1.70	51,066	1.76
May 2008	124,833	2.25	235,463	4.31	149,023	2.24	270,817	5.03	296,608	5.44
June 2008	36,856	1.77	8,132	0.47	104,003	3.82	71,582	3.45	17,580	0.99
July 2008	155,160	3.83	154,661	3.54	219,431	4.27	402,105	8.69	205,727	4.46
Aug 2008	127,864	2.71	149,916	2.98	175,660	4.24	355,585	8.56	182,127	4.37
Sept 2008	21,577	0.29	166,096	3.13	181,376	3.90	360,661	8.54	194,014	4.62
Oct 2008	0	0.00	47,939	2.46	69,858	2.32	149,976	5.19	43,844	1.38
Annual Avg/Total	499,413	1.72	887,894	3.12	1,018,010	3.38	1,663,505	5.88	990,966	3.29

Q = pumping rate; Vol = volume

Table B-4. Estimated Ammonia Mass Withdrawals at CF3 Extraction Wells During 2008

Month	Well 0670		Well 0671		Well 0672		Well 0673		Well 0674	
	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)
Apr 2008	410	48	390	71	520	27	520	124	390	62
May 2008	508	51	440	241	515	137	590	477	560	550
June 2008	472	39	472	46	472	0	520	256	472	106
July 2008	436	230	436	369	436	0	450	370	465	516
Aug 2008	430	197	430	347	450	0	470	254	490	437
Sept 2008	400	29	400	38	400	0	400	74	400	7
Oct 2008	400	38	400	140	400	0	400	116	400	166
Total		**633**		**1,252**		**164**		**1,670**		**1,845**

Month	Well 0675[b]		Well 0676[a]		Well 0677[b]		Well 0678[a]		Well 0679[b]	
	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)
Apr 2008	405	51	430	204	630	283	830	166	750	145
May 2008	530	250	560	498	590	332	475	486	360	404
June 2008	505	70	472	15	540	212	472	128	345	23
July 2008	480	282	485	284	490	406	300	456	330	257
Aug 2008	455	220	420	238	422	280	422	567	422	291
Sept 2008	400	33	400	251	400	274	400	545	400	293
Oct 2008	400	0	400	72	400	106	400	227	400	66
Total		**905**		**1,562**		**1,894**		**2,575**		**1,478**

Notes: [a]Used average concentrations for September and November due to the sampling schedule.
[b]Used average concentrations for April, June, July, and December due to the sampling schedule
Conc = concentration

Appendix B. CF3 Figures and Tables (continued)

Table B-5. Estimated Uranium Mass Withdrawals at CF3 Extraction Wells During 2008

Month	Well 0670[a]		Well 0671[b]		Well 0672[a]		Well 0673[b]		Well 0674[a]	
	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)
Apr 2008	2.1	0.2	2.1	0.4	2.2	0.1	2.2	0.5	2.1	0.3
May 2008	2.2	0.2	2.3	1.3	2.3	0.6	2.3	1.9	2.3	2.2
June 2008	2.1	0.2	2.1	0.2	2.1	0.0	2.2	1.1	2.1	0.5
July 2008	2.0	1.0	2.0	1.7	2.0	0.0	2.1	1.7	2.2	2.4
Aug 2008	2.0	0.9	1.9	1.5	2.1	0.0	2.3	1.2	2.5	2.2
Sept 2008	2.0	0.1	2.0	0.2	2.0	0.0	2.0	0.4	2.0	0.0
Oct 2008	2.0	0.2	2.0	0.7	2.0	0.0	2.0	0.6	2.0	0.8
Total		**2.9**		**5.9**		**0.7**		**7.4**		**8.5**

Month	Well 0675[b]		Well 0676[a]		Well 0677[b]		Well 0678[a]		Well 0679[b]	
	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)
Apr 2008	2.1	0.3	2.2	1.0	2.3	1.0	2.4	0.5	2.4	0.5
May 2008	2.2	1.0	2.3	2.0	2.4	1.4	2.0	2.0	1.6	1.8
June 2008	2.2	0.3	2.1	0.1	2.3	0.9	2.1	0.6	1.5	0.1
July 2008	2.2	1.3	2.2	1.3	2.2	1.8	1.7	2.6	1.4	1.1
Aug 2008	2.3	1.1	2.0	1.1	2.1	1.4	2.1	2.8	2.1	1.4
Sept 2008	2.0	0.2	2.0	1.3	2.0	1.4	2.0	2.7	2.0	1.5
Oct 2008	2.0	0.0	2.0	0.4	2.0	0.5	2.0	1.1	2.0	0.3
Total		**4.1**		**7.2**		**8.4**		**12.4**		**6.7**

Notes: [a]Used average concentrations for September and November due to the sampling schedule.
[b]Used average concentrations for April, June, July, and December due to the sampling schedule.
Conc = concentration; U = uranium

Appendix C.
CF4 Figures and Tables

Appendix C. CF4 Figures and Tables

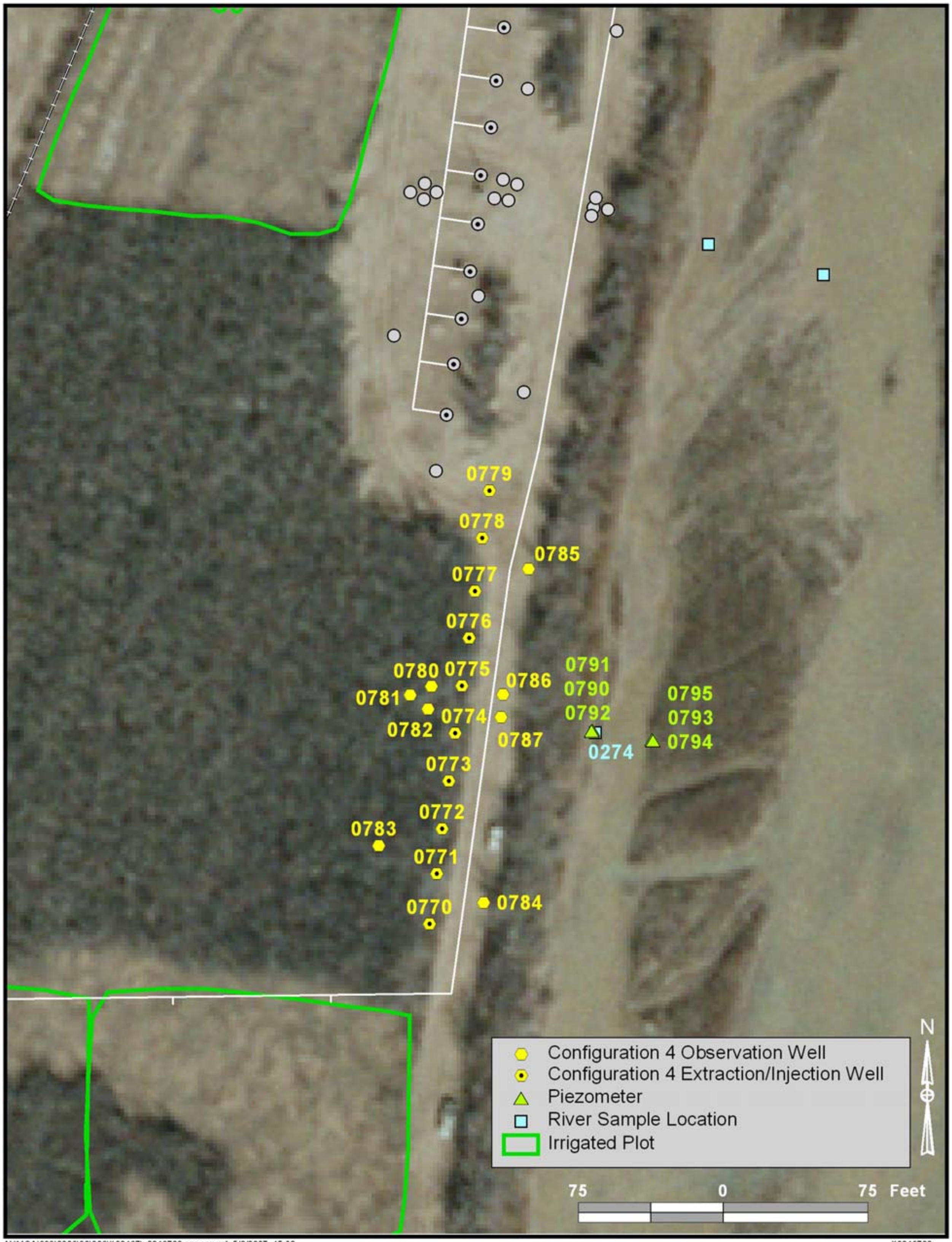
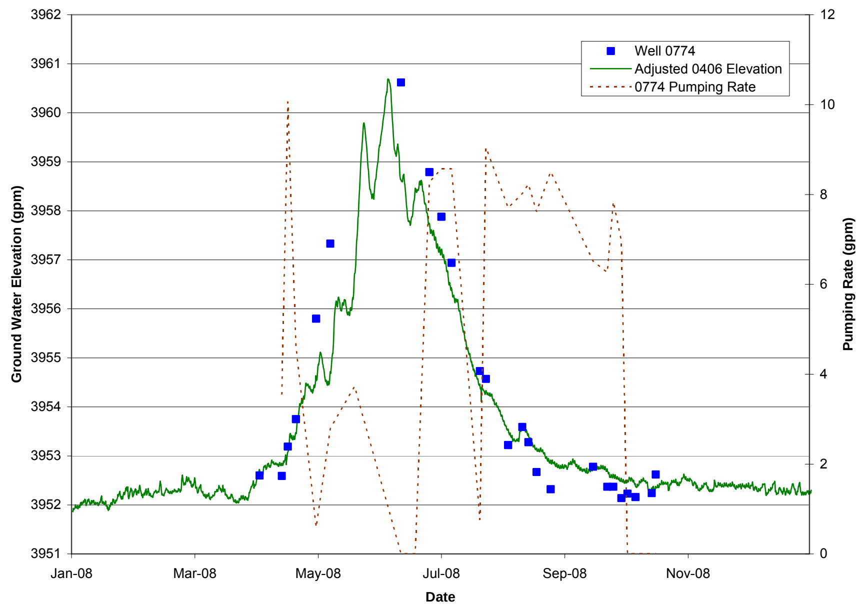


Figure C-1. Map View of CF4 Wells and Sampling Locations

Appendix C. CF4 Figures and Tables (continued)



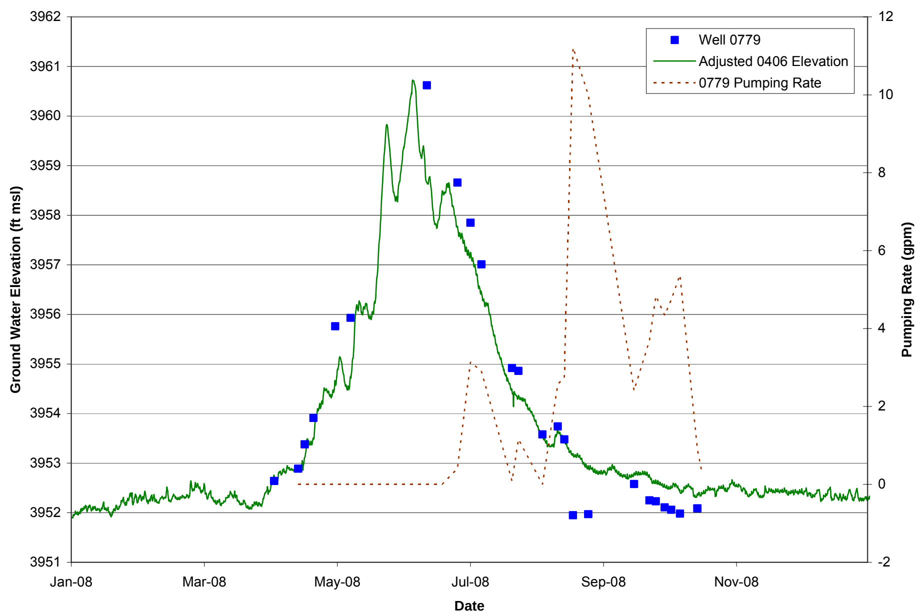
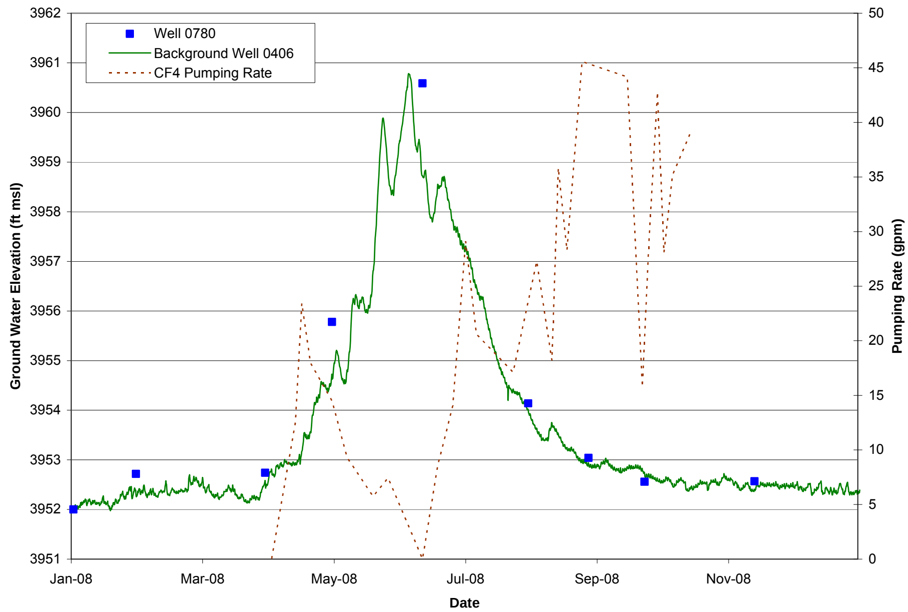


Figure C-2. Ground Water Elevations At CF4 Extraction Wells 0774 and 0779 and Background Well 0406 During 2008

Appendix C. CF4 Figures and Tables (continued)



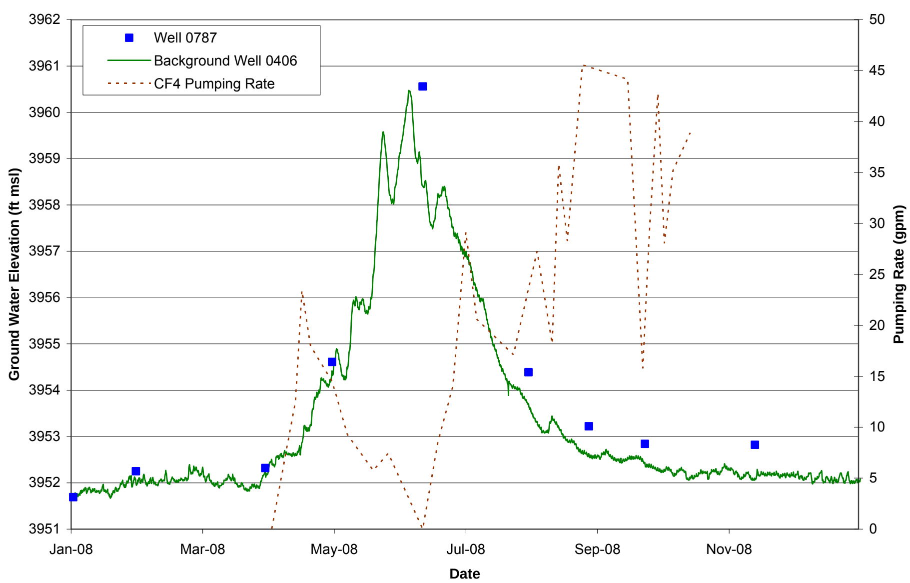


Figure C-3. Ground Water Elevations at CF4 Observation Wells 0780 and 0787 and Background Well 0406 During 2007

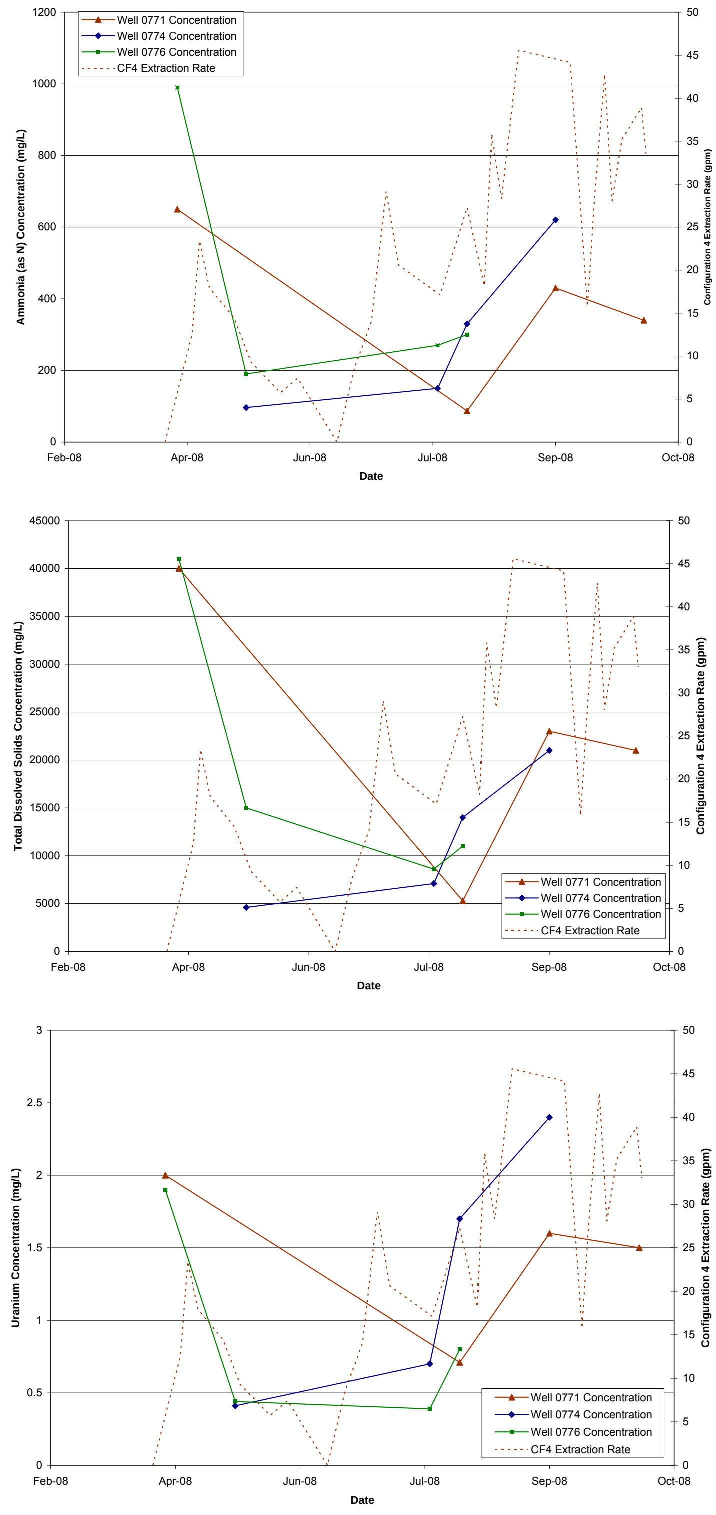
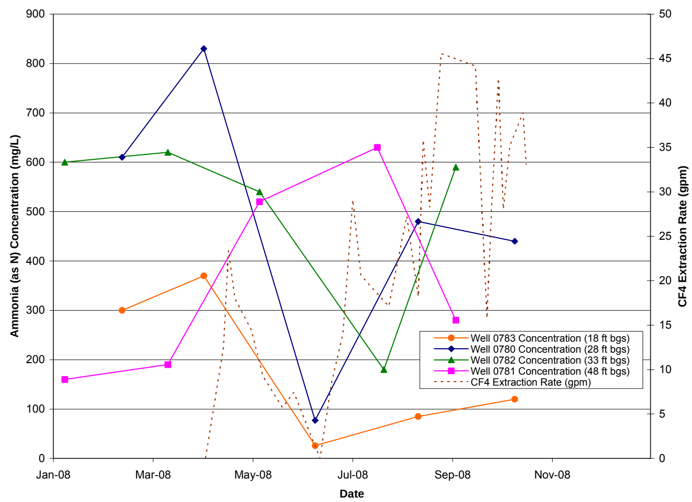
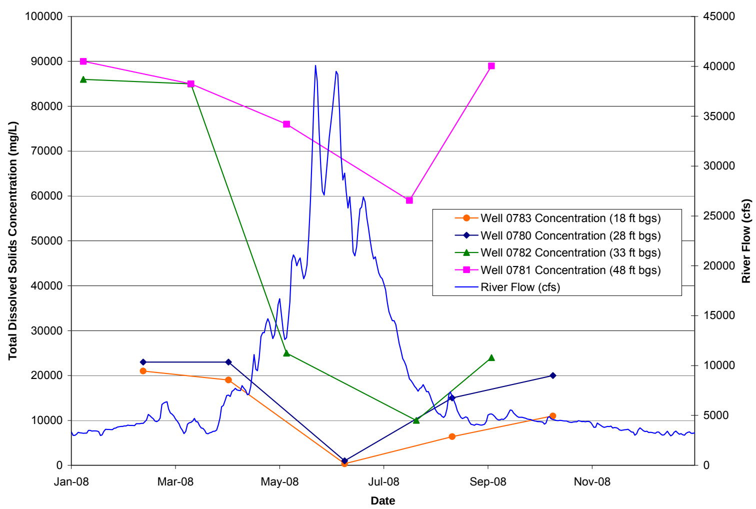


Figure C-4. Time Concentration Plots for CF4 Extraction Wells 0771, 0774, and 0776





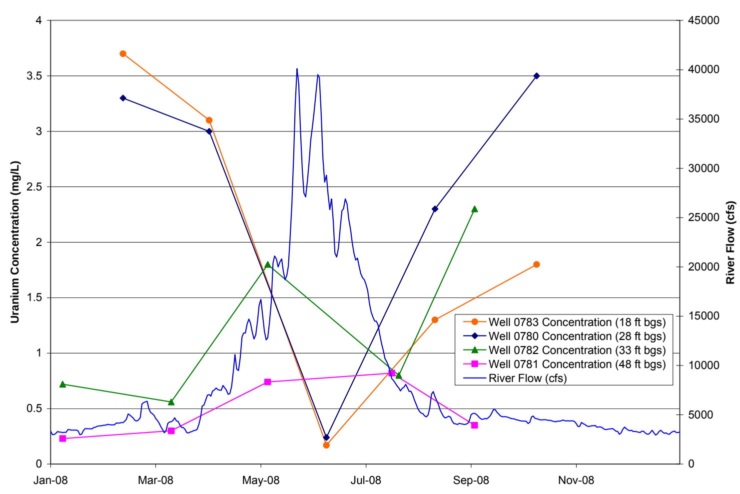
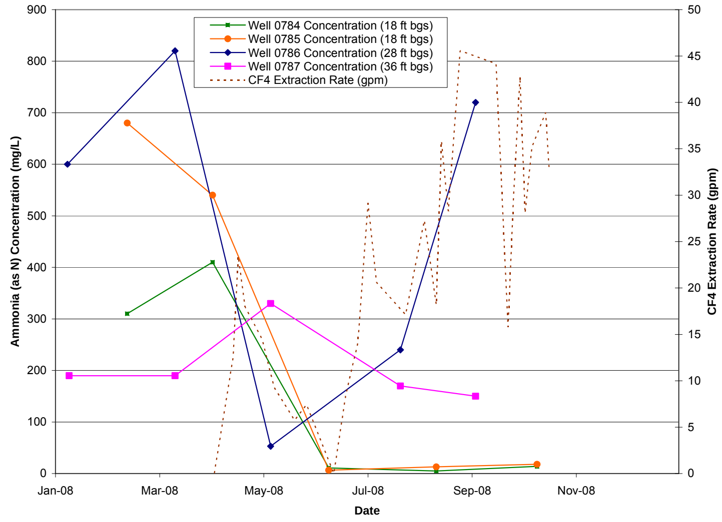
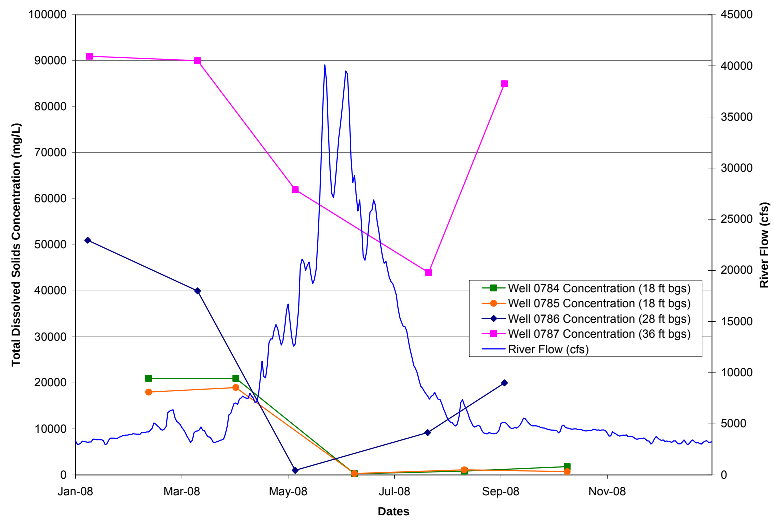


Figure C-5. Time Concentration Plots for CF4 Upgradient Observation Wells 0783, 0780, 0782, and 0781

Appendix C. CF4 Figures and Tables (continued)





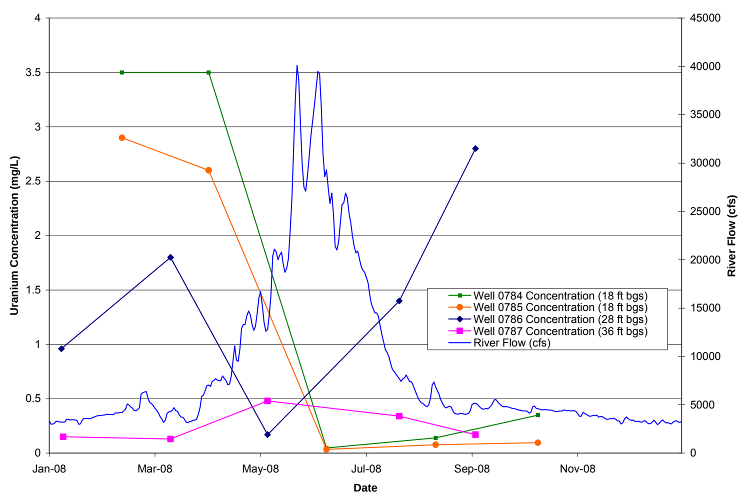


Figure C-6. Time Concentration Plots for CF4 Downgradient Observation Wells 0784, 0785, 0786, and 0787

Appendix C. CF4 Figures and Tables (continued)

Table C-1. Summary of Well and Well Point Construction in CF4

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
0770	Remediation/Deep	6	3,968.86	14.9–34.8	35.2
0771	Remediation/Deep	6	3,969.04	15.0–34.9	35.3
0772	Remediation/Deep	6	3,969.21	15.2–35.1	35.5
0773	Remediation/Deep	6	3,969.15	15.2–35.1	35.5
0774	Remediation/Deep	6	3,968.77	15.5–35.4	35.8
0775	Remediation/Deep	6	3,969.18	15.1–35.0	35.4
0776	Remediation/Deep	6	3,968.97	15.2–35.1	35.5
0777	Remediation/Deep	6	3,968.76	15.3–35.2	35.6
0778	Remediation/Deep	6	3,968.93	15.1–35.0	35.4
0779	Remediation/Deep	6	3,968.34	15.7–35.6	36.0
0780	Observation/Shallow	6	3,968.45	20.3–30.1	30.5
0781	Observation/Deep	6	3,968.56	44.8–54.5	55.0
0782	Observation/Deep	6	3,968.46	31.0–40.8	41.2
0783	Observation/Shallow	2	3,968.82	8.6–18.6	19.1
0784	Observation/Shallow	2	3,968.73	9.4–19.4	19.9
0785	Observation/Shallow	2	3,968.24	9.6–19.6	19.9
0786	Observation/Shallow	6	3,968.14	20.5–30.3	30.7
0787	Observation/Deep	6	3,968.43	35.4–45.2	45.7
0790	Well Point/Shallow	1	3,953.91	2.0–3.0	3.0
0791	Well Point/Intermediate	1	3,953.91	4.3–5.3	5.3
0792	Well Point/Deep	1	3,953.91	9.3–10.3	10.3
0793	Well Point/Shallow	1	3,952.69	2.0–3.0	3.0
0794	Well Point/Intermediate	1	3,952.69	4.3–5.3	5.3
0795	Well Point/Deep	1	3,952.69	9.3–10.3	10.3

Appendix C. CF4 Figures and Tables (continued)

Table C-2. Chronology of CF4 Activities in 2008

Date	River Flow (daily mean cfs)	Activity	Samples Collected
Jan 7-10, 2008	3,630 to 4,150	Monthly sampling	Four observation wells (0781, 0782, 0786, 0787)
Feb 4-28, 2008	4,160 to 6,040	Monthly sampling	Four observation wells (0780, 0783, 0784, 0785), three well points (0790, 0791, 0792), one surface water location (0274)
March 11-13, 2008	4,150 to 4,520	Monthly sampling	Four observation wells (0781, 0782, 0786, 0787)
March 31-April 10, 2008	6,500 to 7,640	Monthly sampling	Three remediation wells (0771, 0772, 0776), four observation wells (0780, 0783, 0784, 0785)
Apr 3, 2008	6,890	CF4 initiated on extraction mode	N/A
Apr 30-May 6, 2008	14,500 to 16,700	CF4 shut down for electrical work	N/A
May 6-13, 2008	12,400 to 20,600	Monthly sampling	Three remediation wells (0772, 0774, 0776), four observation wells (0781, 0782, 0786, 0787)
May 21, 2008	31,200	CF4 shut down due to potential flooding	N/A
June 9-11, 2008	24,600 to 28,100	Monthly sampling	Four observation wells (0780, 0783, 0784, 0785)
June 24, 2008	22,500	Portion of CF4 wells on extraction mode	N/A
July 7, 2008	14,500	CF4 shut down for electrical work	N/A
July 22, 2009	7,420	CF4 initiated on extraction mode	N/A
July 14-24, 2008	7,090 to 9,990	Monthly sampling	Five remediation wells (0770, 0772, 0774, 0776, 0778), four observation wells (0781, 0782, 0786, 0787)
July 24, 2008	7,790	Portion of CF4 shut down to reduce flow to pond	N/A
Aug 4-13, 2008	4,600 to 6,610	Monthly sampling	Five remediation wells (0771, 0772, 0773, 0775, 0779), four observation wells (0780, 0783, 0784, 0785)
Aug 27-Sept 3, 2008	4,020 to 5,150	CF4 shut down	N/A
Sept 2-11, 2008	4,410 to 4,940	Monthly sampling	Four remediation wells (0771, 0774, 0777, 0779), four observation wells (0781, 0782, 0786, 0787)
Sept 3-4, 2008	5,050 to 5,150	CF4 initiated on extraction mode	N/A
Sept 29-Oct 22, 2008	4,150 to 4,680	Monthly sampling	Five remediation wells (0771, 0773, 0775, 0777, 0779), four observation wells (0780, 0783, 0784, 0785)
Oct 16, 2008	4,440	CF4 winterized	N/A

Table C-3. Monthly Average Pumping Rates and Extraction Volumes at CF4 Wells in 2008

	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)
Apr 2008	0	0	121,165	3.75	103,106	3.19	0	0	125,000	3.65
May 2008	0	0	592	0.01	195,389	3.27	0	0	100,000	1.78
June 2008	0	0	0	0	8,972	0.28	10,385	0.32	165,078	2.76
July 2008	0	0	0	0	289,678	6.96	183,908	6.15	183,153	6.74
Aug 2008	0	0	288,032	7.44	87,784	1.07	216,254	5.97	368,864	8.02
Sept 2008	0	0	235,039	6.17	0	0	242,555	9.18	337,107	6.89
Oct 2008	0	0	183,081	7.15	0	0	312,933	12.03	0	0
Annual Avg/Total	**0**	**0**	**706,744**	**3.50**	**684,929**	**2.11**	**966,035**	**4.80**	**1,279,207**	**4.26**

Month	Well 0775		Well 0776		Well 0777		Well 0778		Well 0779	
	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)	Vol (gal)	Q (gpm)
Apr 2008	0	0	90,000	2.88	2,470	0.03	0	0	0	0
May 2008	0	0	40,118	0.71	4,564	0.08	0	0	0	0
June 2008	7,412	0.23	0	0	4	0	4,582	0.08	4,355	0.14
July 2008	60,872	2.27	13,442	1.13	17,984	0.67	38,879	1.18	54,559	1.82
Aug 2008	0	0	114,015	1.39	116,158	3.41	0	0	197,061	5.30
Sept 2008	0	0	0	0	181,166	4.45	0	0	157,035	3.82
Oct 2008	99,087	3.65	0	0	159,193	6.31	0	0	62,701	2.84
Annual Avg/Total	**167,371**	**0.87**	**263,575**	**0.87**	**481,539**	**2.13**	**43,461**	**0.18**	**475,711**	**1.98**

Q = pumping rate; Vol = volume

Table C-4. Estimated Ammonia Mass Withdrawals at CF4 Extraction Wells During 2008

Month	Well 0770[a]		Well 0771[b]		Well 0772[a]		Well 0773[b]		Well 0774[a]	
	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)
Apr 2008	823	0	650	298	830	323	823	0.0	823	389
May 2008	129	0	129	0	100	74	129	0.0	96	36
June 2008	148	0	148	0	110	4	148	5.8	123	77
July 2008	130	0	125	0	120	131	135	93.8	150	104
Aug 2008	331	0	87	95	190	63	260	212.5	330	460
Sept 2008	565	0	430	382	565	0	565	518.0	620	790
Oct 2008	520	0	330	228	335	0	340	402.2	540	0
Total		**0**		**1,003**		**596**		**1,232**		**1,856**

Month	Well 0775[b]		Well 0776[a]		Well 0777[b]		Well 0778[a]		Well 0779[b]	
	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)	NH_3-N Conc (mg/L)	Mass Removed (kg)
Apr 2008	823	0	990	337	823	8	823	0	823	0
May 2008	129	0	190	29	129	2	129	0	129	0
June 2008	148	4	230	0	148	0	148	3	148	2
July 2008	210	48	270	20	215	15	160	24	168	35
Aug 2008	315	0	300	129	331	145	331	0	750	559
Sept 2008	565	0	565	0	480	329	605	0	730	433
Oct 2008	740	277	565	0	390	235	590	0	790	187
Total		**330**		**515**		**733**		**26**		**1,216**

Notes: [a]Used average concentrations for September and November due to the sampling schedule.
[b]Used average concentrations for April, June, July, and December due to the sampling schedule.
Conc = concentration

Appendix C. CF4 Figures and Tables (continued)

Table C-5. Estimated Uranium Mass Withdrawals at CF4 Extraction Wells During 2008

Month	Well 0770[a]		Well 0771[b]		Well 0772[a]		Well 0773[b]		Well 0774[a]	
	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)
Apr 2008	2.0	0.0	2.0	0.9	2.1	0.8	2.0	0.0	2.0	0.9
May 2008	0.4	0.0	0.4	0.0	0.4	0.3	0.4	0.0	0.4	0.2
June 2008	0.5	0.0	0.5	0.0	0.5	0.0	0.5	0.0	0.6	0.3
July 2008	0.5	0.0	0.5	0.0	0.6	0.6	0.6	0.4	0.7	0.5
Aug 2008	1.0	0.0	0.7	0.8	0.9	0.3	1.3	1.1	1.7	2.4
Sept 2008	1.8	0.0	1.6	1.4	1.8	0.0	1.8	1.6	2.4	3.1
Oct 2008	2.0	0.0	1.5	1.0	1.8	0.0	2.0	2.4	2.5	0.0
Total		**0**		**4.1**		**2.0**		**5.5**		**7.4**

Month	Well 0775[b]		Well 0776[a]		Well 0777[b]		Well 0778[a]		Well 0779[b]	
	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)	U Conc (mg/L)	Mass Removed (kg)
Apr 2008	2.0	0.0	1.9	0.6	2.0	0.0	2.0	0.0	2.0	0.0
May 2008	0.4	0.0	0.4	0.1	0.4	0.0	0.4	0.0	0.4	0.0
June 2008	0.5	0.0	0.4	0.0	0.5	0.0	0.5	0.0	0.5	0.0
July 2008	0.5	0.1	0.4	0.0	0.4	0.0	0.5	0.1	0.5	0.1
Aug 2008	1.0	0.0	0.8	0.3	1.0	0.5	1.0	0.0	1.1	0.8
Sept 2008	1.8	0.0	1.8	0.0	1.6	1.1	1.6	0.0	1.5	0.9
Oct 2008	3.0	1.1	2.4	0.0	1.7	1.0	1.7	0.0	1.7	0.4
Total		**1.3**		**1.1**		**2.6**		**0.1**		**2.2**

Notes: [a]Used average concentrations for September and November due to the sampling schedule.
[b]Used average concentrations for April, June, July, and December due to the sampling schedule.
Conc = concentration; U = uranium

Appendix D.
Baseline Area Figures and Tables

Appendix D. Baseline Area Figures and Tables

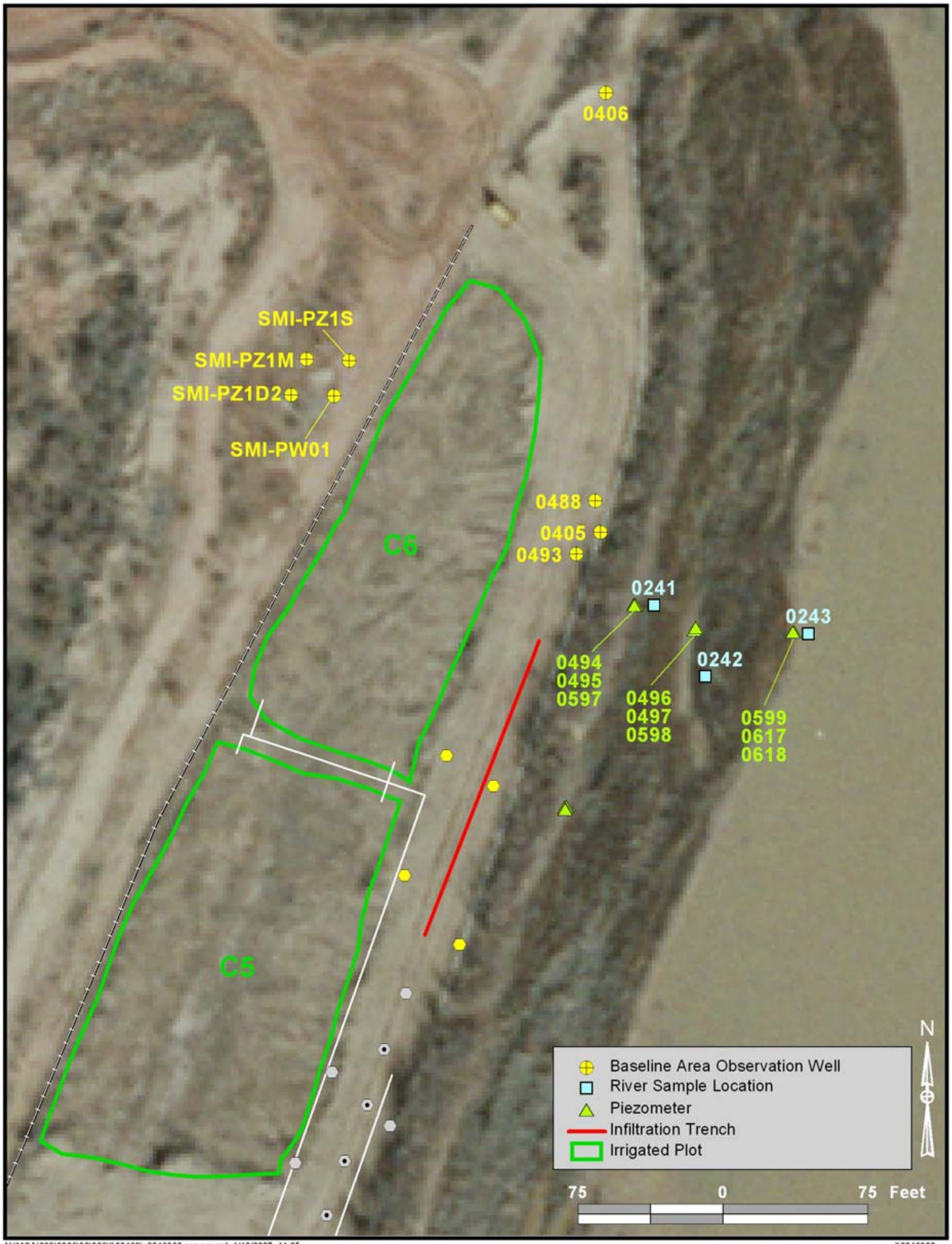


Figure D-1. Map View of Baseline Area Sampling Locations

Appendix D. Baseline Area Figures and Tables (continued)

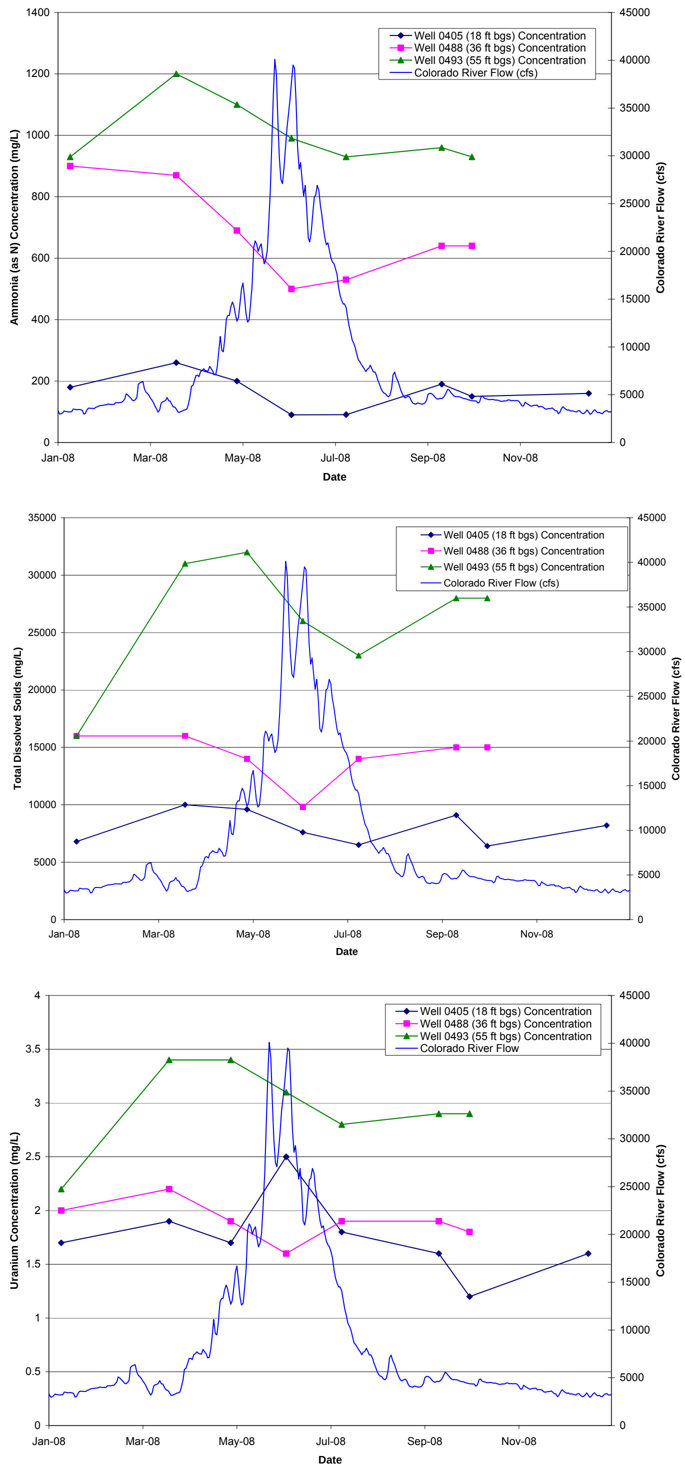


Figure D-2. Time Concentration Plots for Observation Wells 0405, 0488, and 0493

Appendix D. Baseline Area Figures and Tables (continued)

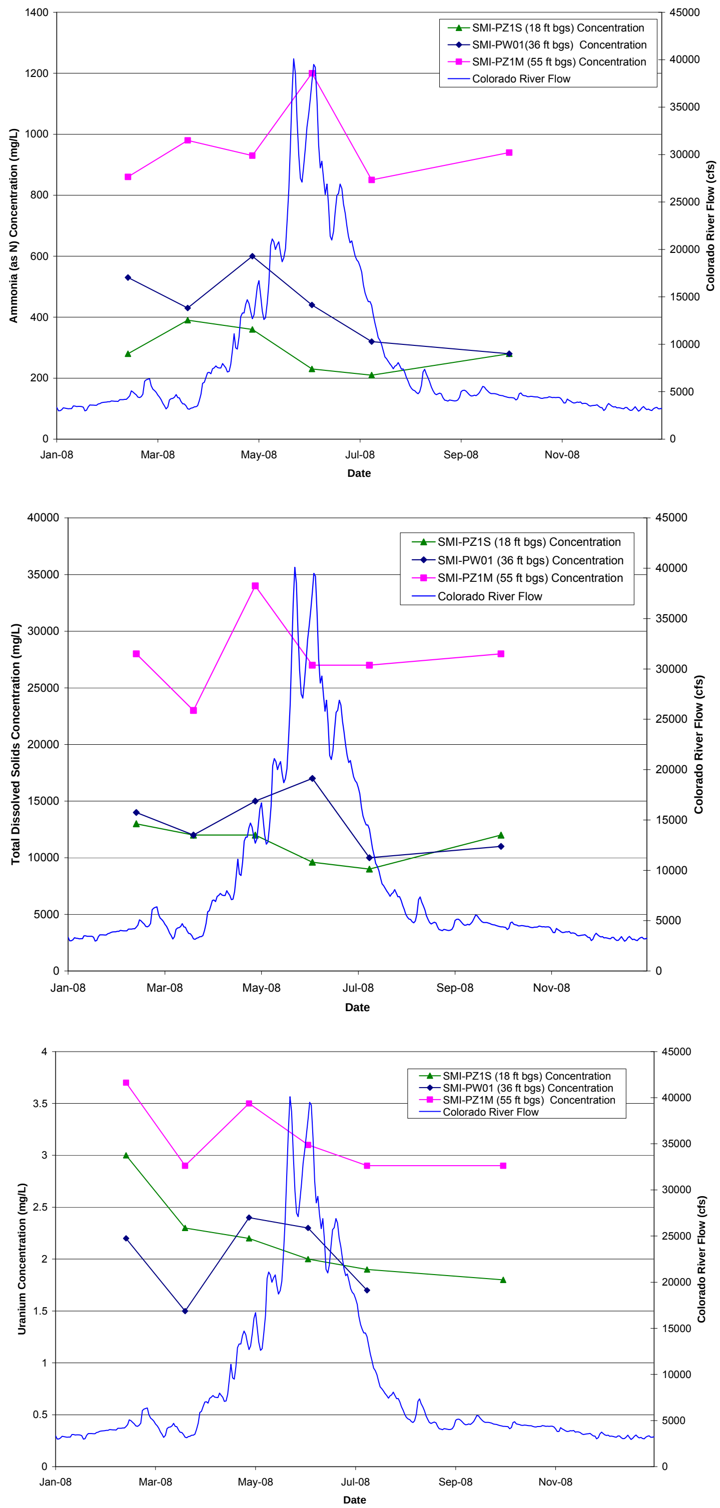


Figure D-3. Time Concentration Plots for Baseline Observation Wells SMI-PZ1S, SMI-PW01, and SMI-PZ1M

Table D-1. Summary of Baseline Area Well and Well Point Construction

Well	Well Type/Relative Depth	Diameter (inches)	Ground Surface Elevation (ft above msl)	Screen Interval (ft bgs)	Total Depth (ft bgs)
0405	Observation/Shallow	1	3,966.40	15.1 - 20.0	20.3
0406	Observation/Shallow	1	3,967.90	13.1 – 18.0	18.3
0488	Observation/Intermediate	6	3,966.82	25.0 - 40.0	40.3
0493	Observation/Deep	6	3,966.08	45.0 - 55.0	55.3
SMI-PW01	Observation/Deep	4	3,966.40	20.1 – 60.1	60.2
SMI-PZ1S	Observation/Shallow	2	3,966.70	13.9 – 18.9	19.1
SMI-PZ1M	Observation/Intermediate	2	3,966.30	55.5 – 60.5	60.8
SMI-PZ1D2	Observation/Deep	2	3,966.40	69.8 – 74.8	75.0
0494	Well Point/Shallow	1	3,957.41	2.4 – 3.4	3.4
0495	Well Point/Intermediate	1	3,957.41	4.6 – 5.6	5.6
0597	Well Point/Deep	1	3,957.41	9.3 – 10.3	10.3
0496	Well Point/Shallow	1	3,955.62	2.2 – 3.2	3.2
0497	Well Point/Intermediate	1	3,955.62	4.0 – 4.9	4.9
0598	Well Point/Deep	1	3,955.62	9.1 – 10.1	10.1
0617	Well Point/Shallow	1	3,954.24	1.7 – 2.7	2.7
0618	Well Point/Intermediate	1	3,954.24	5.3 – 6.3	6.3
0599	Well Point/Deep	1	3,954.24	9.4 – 10.4	10.4

Table D-2. Chronology of Baseline Area Activities in 2008

Date	River Flow (daily mean cfs)	Activity	Samples Collected
Jan 7-10, 2008	3,630 to 4,150	Monthly sampling	Three observation wells (0405, 0488, 0493)
Feb 4-28, 2008	4,160 to 6,040	Monthly sampling	Four observation wells (SMI-PZ1M, SMI-PZ1S, SMI-PZ1D2, SMI-PW01), seven well points (0495, 0597, 0496, 0598, 0617, 0618, 0599)
March 18-20, 2008	3,160 to 3,610	GW/SW interaction	Six observation wells (SMI-PZ1M, SMI-PZ1S, SMI-PW01, 0405, 0488, 0495), two well points (0495, 0597), one surface water location (0243)
April 28-30, 2008	12,300 to 14,200	GW/SW interaction	Six observation wells (SMI-PZ1M, SMI-PZ1S, SMI-PW01, 0405, 0488, 0495), three well points (0494, 0495, 0597), one surface water location (0243)
May 6-13, 2008	12,400 to 20,600	Monthly sampling	Six observation wells (SMI-PZ1M, SMI-PZ1S, SMI-PW01, 0405, 0488, 0495), one surface water location (0241)
July 8-10, 2008	12,200	GW/SW interaction	Six observation wells (SMI-PZ1M, SMI-PZ1S, SMI-PW01, 0405, 0488, 0495), one surface water location (0241)
July 14-24, 2008	7,090 to 9,990	Monthly sampling	Two observation wells (0406, SMI-PZ1D2), three well points (0494, 0495, 0597), one surface water location (0242)
Sept 2-11, 2008	4,410 to 4,940	Monthly sampling	Three observation wells (0405, 0488, 0493)
Sept 29-30, 2008	4.220 to 4,260	GW/SW interaction	Two observation wells (0406, SMI-PZ1D2), three well points (0494, 0495, 0597), one surface water location (0243)
Sept 29-Oct 22, 2008	4,150 to 4,680	Monthly sampling	Seven well points (0495, 0597, 0496, 0598, 0599, 0617, 0618), one surface water location (0243)

GW/SW = ground water/surface water

Appendix E.
Infiltration Trench Figures and Tables

Appendix E. Infiltration Trench Figures and Tables

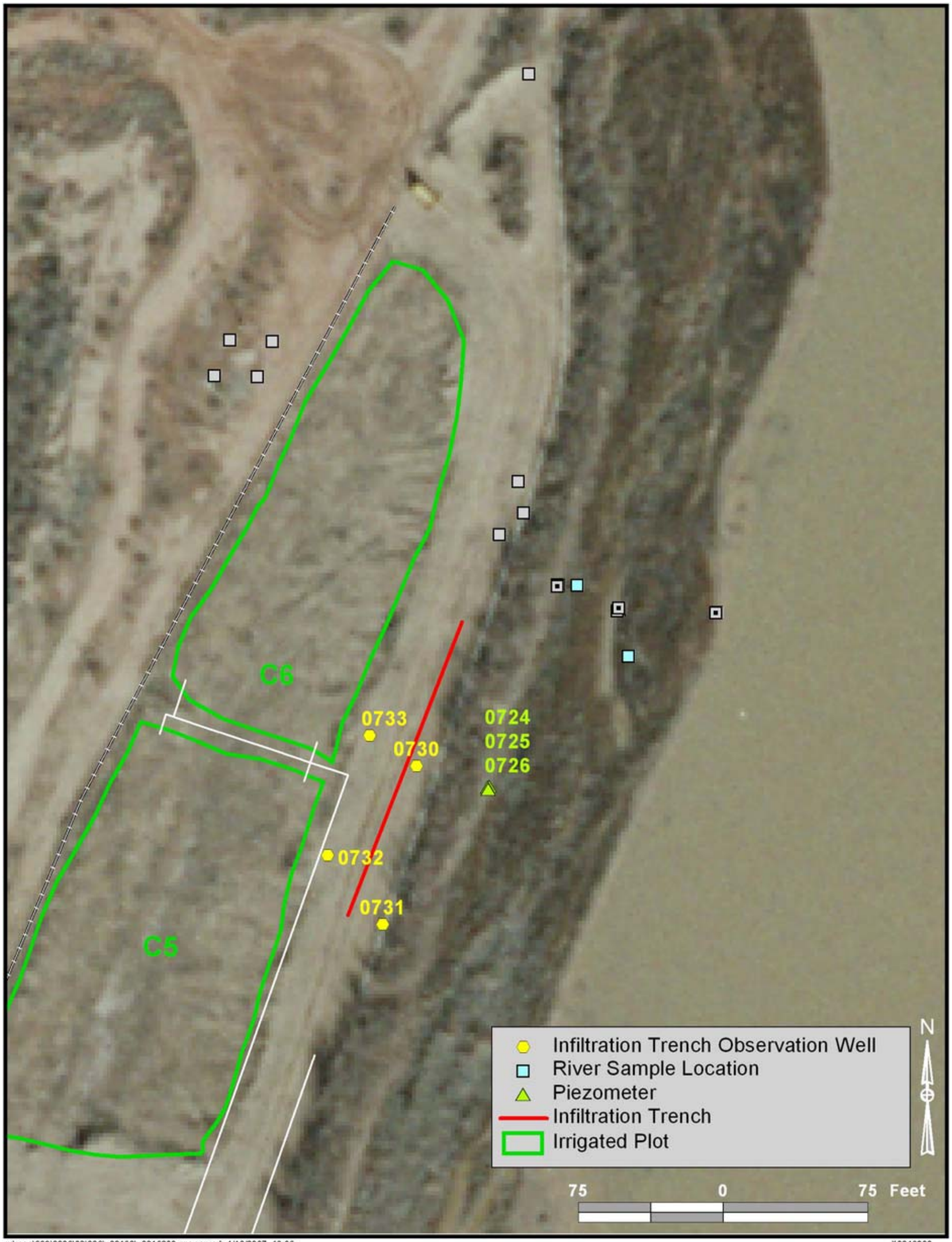


Figure E-1. Map View of Infiltration Trench and Sampling Locations

Appendix E. Infiltration Trench Figures and Tables (continued)

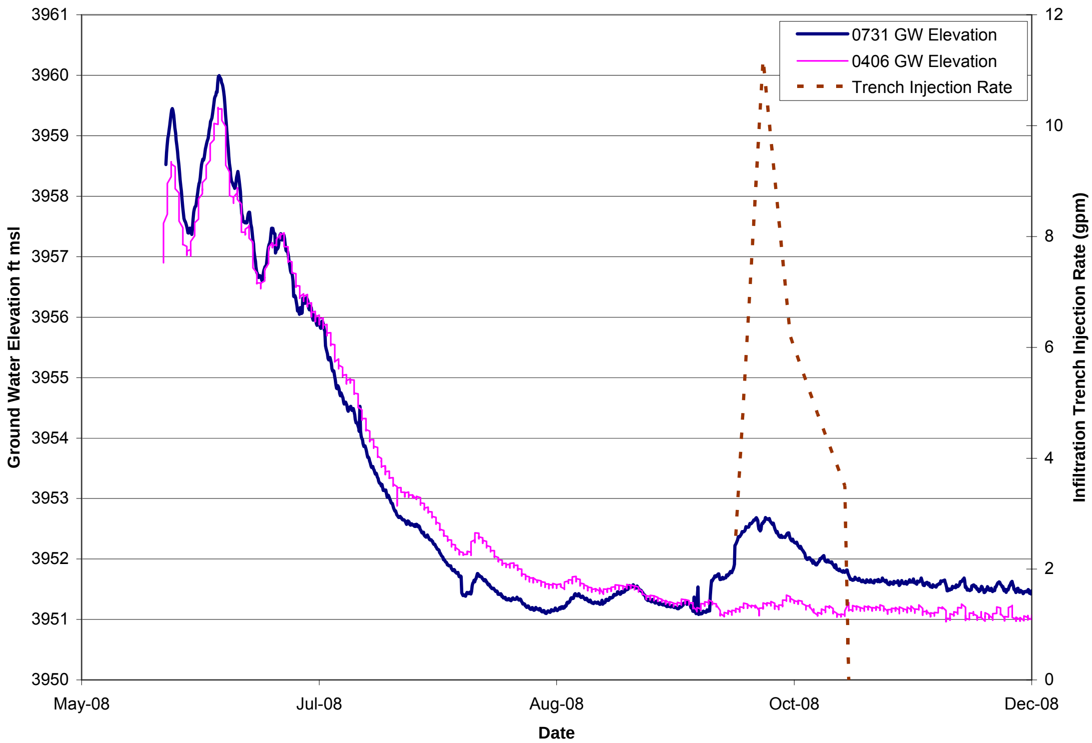


Figure E-2. Ground Water Elevation Determined from Pressure Transducer Versus the Infiltration Trench Injection Rate

Appendix E. Infiltration Trench Figures and Tables (continued)

Table E-1. Summary of the Infiltration Trench Well and Well Point Construction

Well	Well Type/Relative Depth	Distance from trench (ft)	Ground Surface Elevation (ft above msl)	Screen Interval (ft above msl)
0730	Observation/Shallow	< 5	3965.90	3957.3 - 3947.3
0731	Observation/Shallow	10	3966.95	3957.1 - 3956.55
0732	Observation/Shallow	10	3967.02	3957.42 - 3956.42
0733	Observation/Shallow	10	3966.31	3945.81 - 3936.01
0724	Well Point/Shallow	~ 50	3957.50	3955.1 - 3954.1
0725	Well Point/Intermediate	~ 50	3957.50	3952.9 - 3951.9
0726	Well Point/Deep	~ 50	3957.50	3948 - 3947

Appendix E. Infiltration Trench Figures and Tables (continued)

Table E-2. Chronology of Infiltration Trench Activities in 2008

Date	River Flow (daily mean cfs)	Activity	Samples Collected
Feb 4-28, 2008	4,160 to 6,040	Monthly sampling	Four observation wells (0730, 0731, 0732, 0733), two well points (0725, 0726)
March 31-April 10, 2008	6,500 to 7,220	Monthly sampling	Two observation wells (0731, 0733), two well points (0725, 0726)
May 6-13, 2008	12,400 to 20,600	Monthly sampling	Two observation wells (0730, 0732)
June 9-11, 2008	24,600 to 28,100	Monthly sampling	Two observation wells (0731, 0733)
July 14-24, 2008	7,090 to 9,990	Monthly sampling	Two observation wells (0730, 0732), three well points (0724, 0725, 0726)
Sept 29-Oct 22, 2008	4,150 to 4,680	Monthly sampling	Four observation wells (0730, 0731, 0732, 0733), three well points (0724, 0725, 0726)
October 14, 2008	4,500	Infiltration trench initiated	None
October 30, 2008	4,390	Trench shut down for repairs	None
November 5, 2008	4,100	Trench restarted	None
November 13, 2008	3,740	Trench winterized	None

Appendix F.
Evaporation Pond Tables

Appendix F. Evaporation Pond Tables

Table F-1. Important Dates, Evaporation Pond Levels, and Activities Associated with the IA Treatment System During 2008.

Date	Pond Level (ft)	Activity
January 2, 2008	4.4	CF1 turned on
February 19, 2008	6.4	CF1 flow rate reduced
March 20, 2008	6.6	Sprinkler system turned on
March 24, 2008	6.4	CF1 brought on full capacity
April 4, 2008	5.5	CF3 and CF4 initiated on extraction mode
April 30, 2008	5.7	CF1 and CF3 down for half of the day, CF4 down
May 1, 2008	5.6	CF4 restarted, begin site irrigation
May 20, 2008	7.3	CF1 shut down for potential flooding
May 21, 2008	7.5	CF3 and CF4 shut down for potential flooding
June 19, 2008	4.1	Portion of CF1 and CF3 initiated on extraction mode
June 23, 2008	4.5	Portion of CF4 initiated on extraction mode
June 26, 2008	5.0	Started irrigation on C plots
July 8, 2008	6.5	CF4 shut down
July 22, 2008	6.5	CF4 initiated on extraction mode
July 24, 2008	7.0	Reduced CF4 flow
August 20, 2008	7.9	Portion of CF3 shut down
August 27, 2008	7.4	CF4 shut down
August 28-30, 2008	7.4	RAC removed ~50,000 gal from evaporation pond
September 3, 2008	6.0	CF4 shut down
October 9, 2008	6.1	Infiltration trench initiated
October 15, 2008	6.0	CF3 and CF4 winterized
October 30, 2008	4.2	Infiltration trench shut down
November 5, 2008	2.7	Infiltration trench initiated
November 13, 2008	3.2	Sprinkler system and infiltration trench shut down for winter
November 17, 2008	4.0	Initiated extraction well SMI-PW02
November 20, 2008	4.5	Shut down SMI-PW02
December 11, 2008	5.6	Shut down portion of CF1
December 18, 2008	5.9	Shut down CF1 due to cold temperatures

Table F-2. Summary of Monthly Water Deliveries to the Evaporation Pond and the Sprinkler System for 2008

Month	Volume Pumped to Pond (gal)	Volume Pumped to Sprinkler System (gal)
Jan 2008	861,439	0
Feb 2008	687,902	0
Mar 2008	715,303	814,192
Apr 2008	2,690,745	2,206,008
May 2008	3,271,933	2,512,318
Jun 2008	1,141,651	1,127,997
Jul 2008	4,070,059	2,591,037
Aug 2008	3,938,564	3,655,313
Sept 2008	2,950,128	4,130,669
Oct 2008	2,464,422	2,815,181
Nov 2008	1,097,237	744,548
Dec 2008	624,550	0
Total	**24,513,933**	**20,597,263**