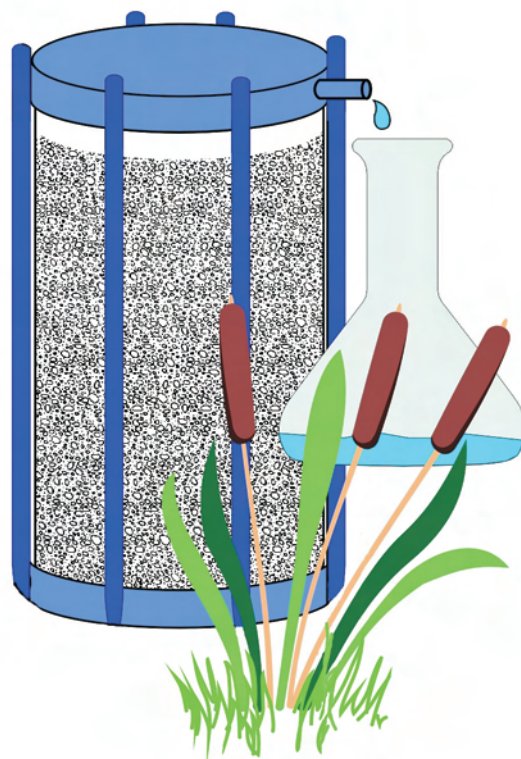


Environmental Sciences Laboratory

Third (March 2006) Coring and Analysis of Zero-Valent Iron Permeable Reactive Barrier, Monticello, Utah

November 2006



Prepared for
U.S. Department of Energy
Grand Junction, Colorado



Work Performed by the S.M. Stoller Corporation under DOE Contract No. DE-AC01-02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
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Plate 1 Monticello PRB Coring Locations

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1.0 Introduction

Remediation of ground water at 22 former uranium mill sites is mandated by Congress and was formerly conducted by the U.S. Department of Energy (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Ground Water Project (NRC 1980). In 2003 this responsibility was transferred to the DOE Office of Legacy Management. At many of these former ore processing sites, U has entered the ground water system and has contaminated more than 10 billion gallons of ground water (DOE 1996). Uranium ore processing outside the United States, particularly in Australia, Canada, South Africa, and Europe, has also resulted in significant ground water with U contamination. In addition to tailings sites, U has been reported in ground water at 12 of 18 major DOE facilities because of contamination from the weapons production cycle (Riley et al. 1992).

In 1995, the U.S. Environmental Protection Agency (EPA) promulgated a ground water concentration limit of 30 picocuries per liter (pCi/L) (approximately 44 micrograms per liter [$\mu\text{g/L}$]) for uranium (U) to ensure protection of human health and the environment near these sites (EPA 1995); this U concentration is also being used as a ground water cleanup goal at a former uranium-ore processing site near Monticello, Utah.

Cost-effective means of cleaning up ground water contaminated by U are needed. Ground water at some of the tailings sites is being extracted and treated ex situ, but costs are high and no site has yet been remediated to EPA's prescribed standards. Permeable reactive barriers (PRBs) are subsurface engineered zones containing reactive material that removes contaminants from ground water passing through it. PRBs to treat ground water contaminated by U are currently being used at Monticello, Utah; Fry Canyon, Utah; and Oak Ridge National Laboratory Y-12 Plant, Tennessee as low-cost alternatives to pumping and treating ground water.

Zero-Valent Iron (ZVI), a scrap-metal product that is available from the automotive industry, is being used as a reactive material in the PRBs at these three sites. Contact with ZVI causes U concentrations in ground water to decrease to a few micrograms per liter. Results of numerous laboratory experiments have confirmed the ability of ZVI to remove U from ground water. Because of the promising results of laboratory and field studies, project managers are expressing increasing interest in using ZVI to treat U. Research is still needed, however, to better understand the reactive chemistry within the ZVI. In particular, some chemical reactions are known to cause precipitation of minerals that can foul the reactive media. Mineral fouling causes a decrease in permeability and often an increase in dispersivity, two effects that can limit the treatment capacity of the PRB.

In 1999, a PRB was installed in the shallow alluvial aquifer, downgradient of a former uranium processing site at Monticello, Utah; a National Priorities List site. The PRB removes U and other contaminants from the ground water. The purpose of this project was to determine rates of U and calcium (Ca) mineralization by analyzing the solid fraction of the PRB. The rate of U mineralization is used to determine if the PRB remains effective at cleaning the ground water; whereas, the rate of Ca mineralization is an indication of the reduction in permeability due to mineral accumulation. Data to examine the rates of U and Ca precipitation come from analyses of approximately 300 samples of the solid reactive media collected from three episodes of coring in February 2002, August 2003, and March 2006.

1.1 Description of the Monticello PRB Site

Uranium was processed from 1942 through 1959 at the Monticello Site. Approximately 900,000 tons of ore were processed and the resulting tailings were placed in four unlined impoundments: Carbonate, Acid, Vanadium, and East (Figure 1). The tailings impoundments are underlain by a shallow alluvial system within the valley of Montezuma Creek, a small perennial stream. The alluvial aquifer is underlain by a hydraulic confining layer of Dakota Formation composed of siltstone, shale, and sandstone. Contaminated leachate entered the shallow alluvial ground water system and has migrated downgradient about a mile (Figure 1).

In 1999, the DOE together with EPA and the State of Utah Department of Environmental Quality designed and constructed a PRB to treat the contaminated ground water. The Monticello PRB is a funnel-and-gate system with a three-zone PRB (Morrison et al. 2002). The furthest upgradient zone (the gravel/ZVI zone) has 13-percent ZVI by volume mixed with pea gravel (Figure 2). Downgradient from the gravel/ZVI zone is a zone of 100-percent ZVI, followed by the third zone that contains 100-percent gravel. The gravel zones were designed to help homogenize the ground water flow. The upgradient gravel/ZVI zone was intended to initiate chemical reduction of the ground water and remove some of the mineral matter before entering the less permeable 100 percent ZVI zone.

1.2 Previous Investigations at the Monticello, Utah, PRB Site

Hydraulic conductivity of the PRB was calculated from pneumatic slug test data collected from about 40 ground water wells four times during its operation: June 2000, August 2003, November 2004, and November 2005 (Mushovic et al. 2006). The mean value of hydraulic conductivity the ZVI zone decreased from 1.99×10^{-2} to 4.59×10^{-5} centimeters per second (cm/s) during this period. This significant decrease in hydraulic conductivity in the ZVI zone caused ground water to mound upgradient of the PRB and some ground water to flow around the ends without treatment.

Core samples were previously collected in February 2002 (70 cores) and August 2003 (22 cores). Analysis of these cores provided important information about the changing conditions of the PRB including: (1) distributions of contaminants in the PRB, (2) distribution and mass of constituents such as calcium and sulfur, (3) estimates of ground water flux, and (4) nature of minerals containing U, Ca, sulfur and other constituents (Morrison 2003; DOE 2004). Important observations from the previous investigations include: (1) nearly all the U had precipitated in the gravel/ZVI zone with hardly any in the ZVI zone, (2) calcite was precipitated in both the gravel/ZVI and ZVI zones, (3) calcite replaced matrix minerals and filled some of the pore space, (4) porosity was reduced by as much as 20 percent, and (5) concentration trends indicated that U and Ca precipitated between the two sampling events indicating the PRB was removing contaminants from the ground water. The current investigation was conducted to determine if these trends continue.

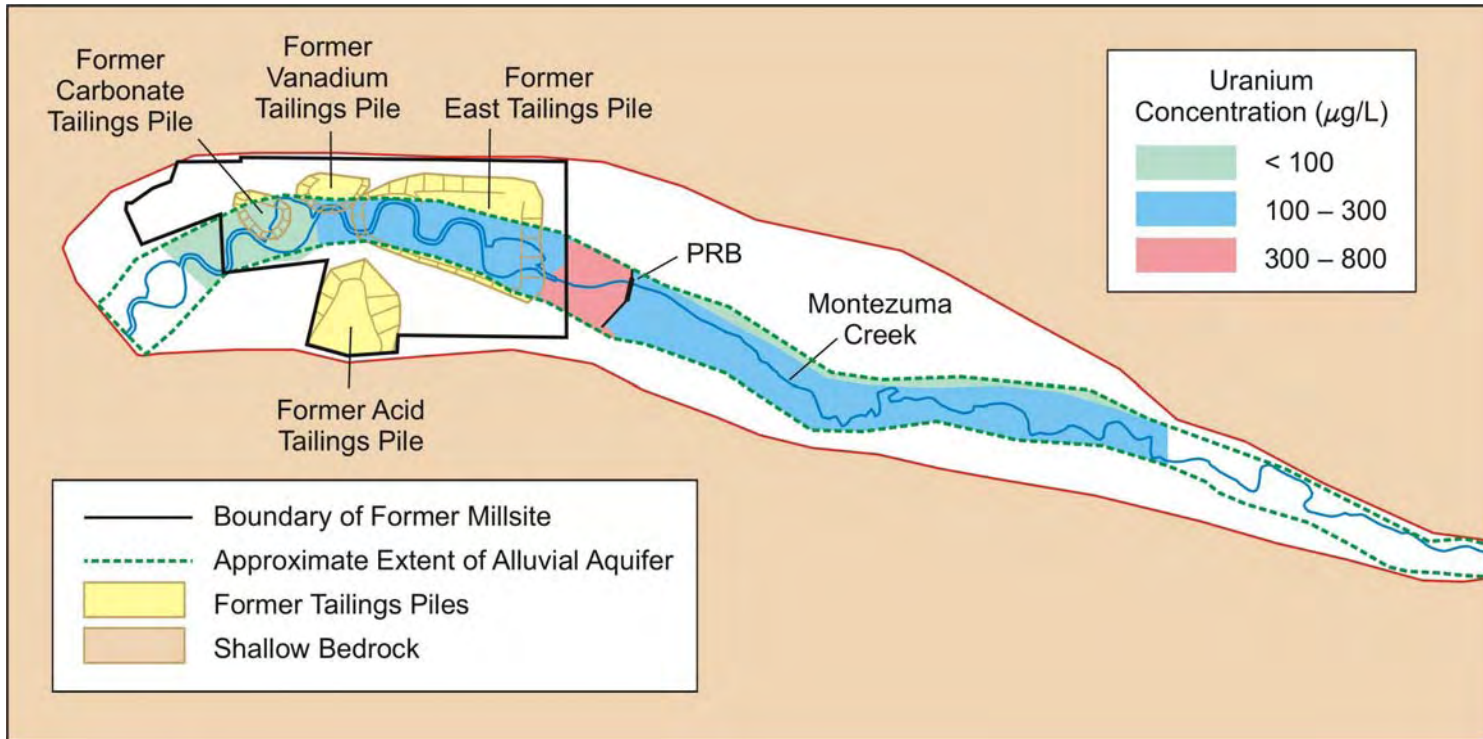


Figure 1. Location of Uranium Plume, Former Tailings Piles, Montezuma Creek, and Permeable Reactive Barrier, Monticello, Utah Site

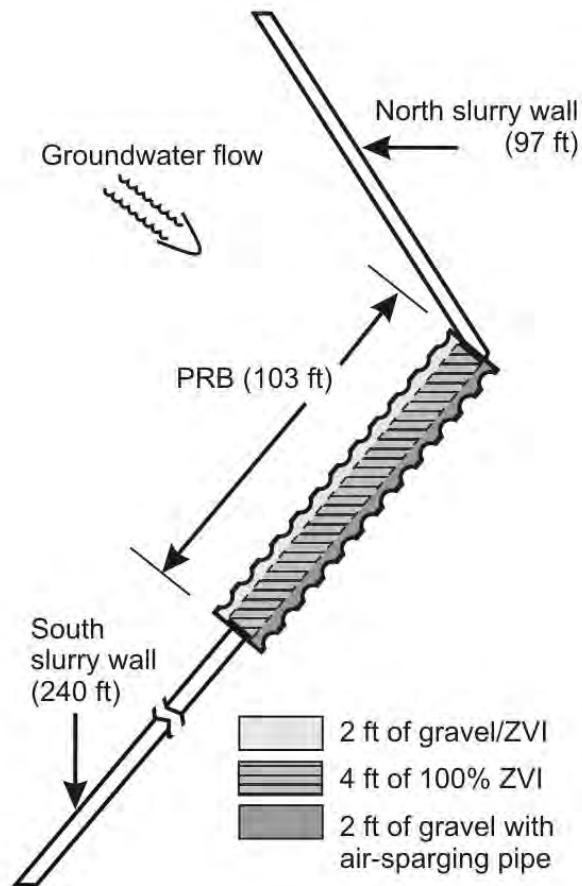


Figure 2. Components of the Permeable Reactive Barrier and Slurry Wall System

2.0 Methods

2.1 Field Methods

During the March 2006 investigation, 23 vertical and 2 angle cores (2-inch diameter) were collected from the Monticello PRB with a Model 66DT Geoprobe track-mounted percussion drilling rig utilizing the same methods and procedures as in the previous coring projects (Figure 3). Locations of the cores are shown on Plate 1 (map pocket). Most of the vertical cores were located within 1 to 2 feet of the coring locations from the August 2003 coring episode. The angle cores were obtained on a 45 degree angle; one starting from the downgradient side and the other from the upgradient side of the PRB. Coring locations were surveyed by measuring from wells located within a few feet of the borings.

Approximately 450 samples were collected from the vertical cores. Cores were processed in an identical fashion to those collected during the previous two coring episodes. Cores were numbered sequentially with an MPC (Monticello PRB Coring) prefix and each approximately 6-in sample was numbered sequentially from top to bottom. Samples were placed in plastic zip-lock bags and were surveyed for radioactivity before being transported to the U. S. Department of Energy Environmental Sciences Laboratory (ESL) in Grand Junction, Colorado. Samples with above-background radioactivity were appropriately labeled and manifested for transportation.

Samples from the angle cores were sent to the EPA's laboratory in Ada, Oklahoma for analyses of sulfide composition and U oxidation states. Results from the EPA investigations are not yet available.

2.2 Laboratory Methods

Samples were dried at 90 °C, and were weighed before and after drying to determine moisture content. The volume of each sample was calculated from the measured length, and known diameter (2 in). Density was calculated from this volume and the dried weight. Density measurements were not possible for all samples because the material was disaggregated and the volume was not accurate. Radioactivity was measured on dried samples with a hand-held counter. Radiological controls, including a limited access controlled area, were implemented in the ESL. Approximately 100 samples (four samples selected randomly from each core) were subjected to chemical analysis. These samples were digested in nitric acid using microwave energy. The digestates were analyzed for U by kinetic phosphorescence analysis (KPA – ESL procedure AP[U-2]) and for Ca by atomic absorption (ESL procedure AP[Ca-1]) (DOE 2003).



Figure 3. Photo of Geoprobe Rig Obtaining a Core

3.0 Results and Discussion

Raw data from the analyses of the March 2006 cores are provided in Appendix A; core locations are shown on Plate 1 (map pocket).

3.1 Density and Moisture Content of Bulk Samples

A frequency distribution of the density measurements is shown in Figure 4. The mean density and one standard deviation in the gravel/ZVI and ZVI zones are 1.68 ± 0.24 and 2.28 ± 0.27 grams per milliliter(g/mL), respectively. These values are consistent with those measured on samples collected previously. For example, the mean densities measured on the gravel/ZVI and ZVI samples in February 2002 were 1.74 and 2.21 g/mL, respectively (Morrison 2003). These densities are similar to laboratory measurements made on samples of parent materials (reactive materials prior to use in a PRB) indicating that the mineralization of the reactive material has not significantly changed the density.

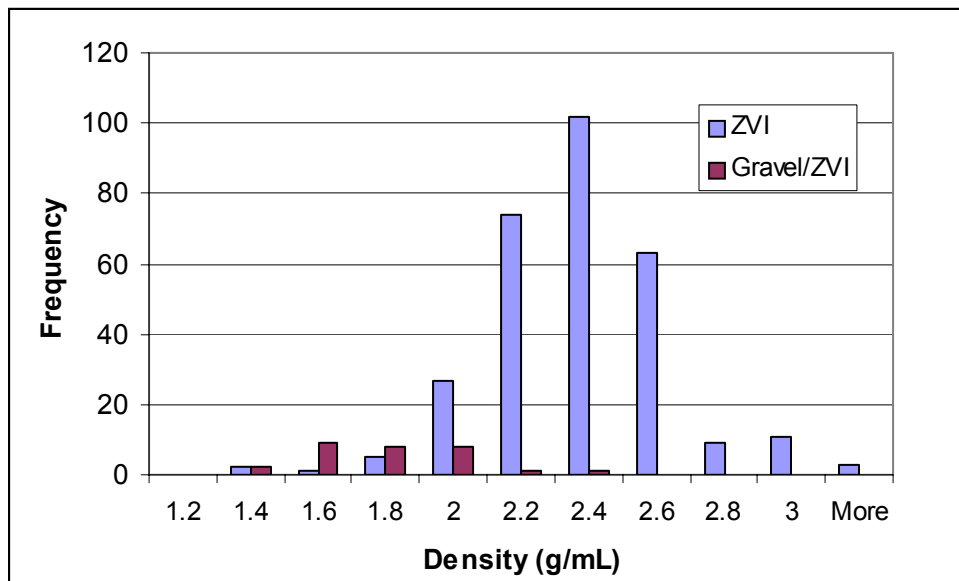


Figure 4. Frequency Distributions of Dry Weight Density on Samples From the March 2006 Sampling

A frequency distribution of moisture content data is shown in Figure 5. Samples from the ZVI zone had distinctly higher moisture contents (mean 13.7 ± 3.7 wgt %) than those from the gravel/ZVI (10.6 ± 2.6 wgt %). These values are consistent with values measured in February 2002. The higher values in the ZVI zone probably reflect higher porosity in the ZVI zone.

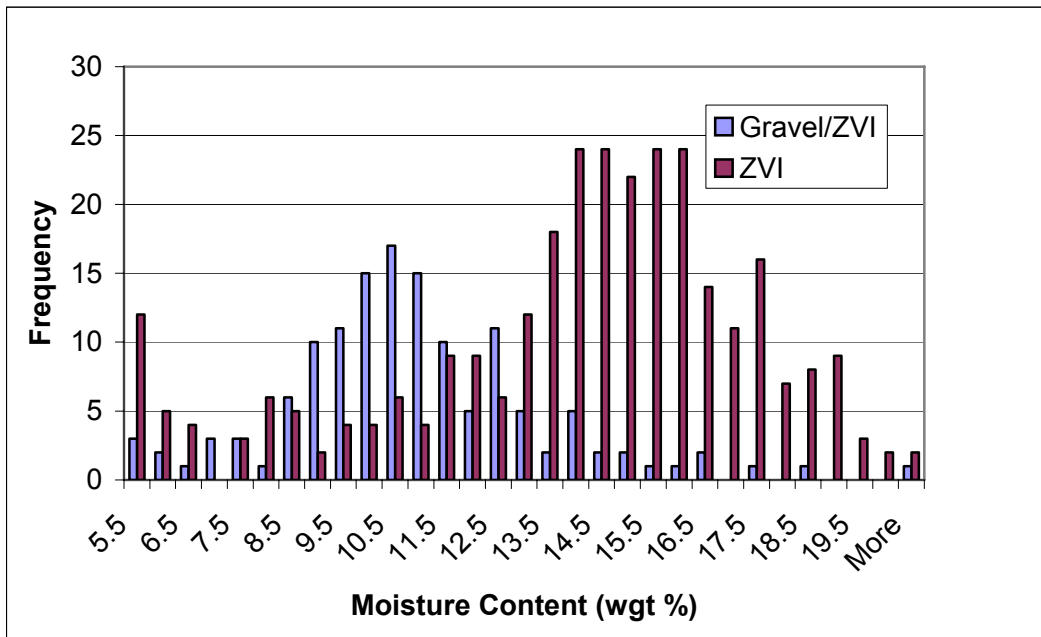


Figure 5. Frequency Distributions of Moisture Content in Samples From the March 2006 Sampling

3.2 Chemical Concentrations in Bulk Samples

Figure 6 shows a frequency distribution of the U concentrations in samples of gravel/ZVI and ZVI collected in the March 2006 sampling. The mean concentration and one standard deviation of U in the gravel/ZVI is 513 ± 293 milligrams per kilogram (mg/kg); whereas, in the ZVI the mean U concentration is only 1.2 ± 3.2 mg/kg. Fifty two of the 62 values of U from the ZVI zone were less than the detection limit of 0.5 mg/kg. The high standard deviation in the ZVI samples is largely due to two values (12.2 and 23.3 mg/kg) that were much higher than other values.

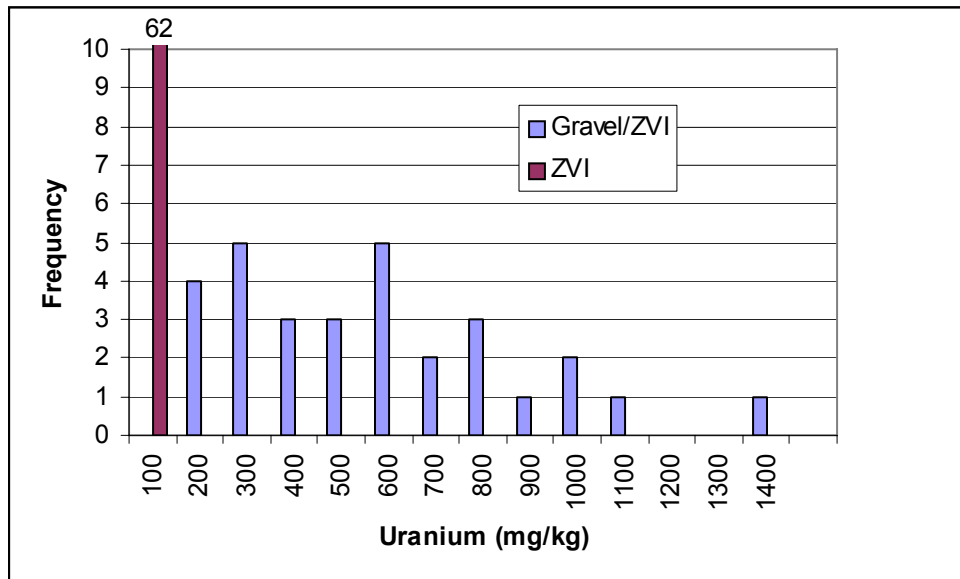


Figure 6. Frequency Distributions of Uranium Concentrations in Solid-Phase Samples From the March 2006 Sampling

A frequency distribution for the Ca concentrations is shown in Figure 7. The Ca distribution in the gravel/ZVI has higher values and is more spread out than for the ZVI zone. The mean and standard deviation of Ca concentration in the gravel/ZVI is $38,948 \pm 27,273$ mg/kg, and is $22,708 \pm 9,094$ mg/kg in the ZVI zone. Thus, the mean concentrations of Ca are not different between the two zones within one standard deviation.

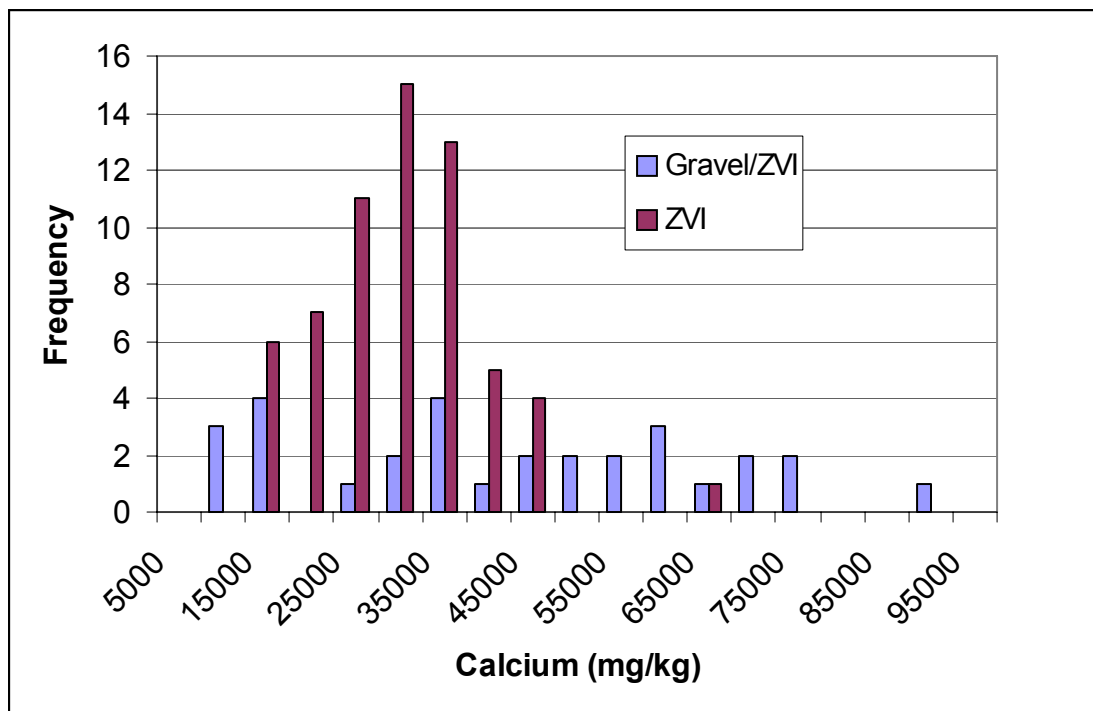


Figure 7. Frequency Distributions of Calcium Concentrations in Solid-Phase Samples From the March 2006 Sampling

The changes in concentrations in samples collected from the three sampling events at the same locations within the PRB were used to evaluate changes in U and Ca concentrations over time. Table 1 and Table 2 present the solid-phase chemistry for cores collected at identical locations from all three sampling events. Each value listed in the tables is the mean of the individual sample results (usually four) from that core. Thus, the statistics provided in these tables for the March 2006 data differ somewhat from the mean and standard deviation statistics given above that were based on all of the individual data points.

As in previous coring events, the March 2006 data show that the U concentration in the gravel/ZVI zone is substantially greater than in the ZVI zone (Table 1). In fact, very little uranium has been precipitated in the ZVI zone since installation of the PRB in 1999, indicating that little ground water containing uranium has flowed into the ZVI zone. The U concentration in the gravel/ZVI zone appears to have increased from February 2002 (mean concentration 260 mg/kg) to August 2003 (mean concentration 558 mg/kg); however, the values from all 3 years are within a standard deviation of each other. The mean U concentrations in August 2003 and March 2006 are nearly the same (Table 1). The U inventories corresponding to these U concentrations are 11.4, 24.5 and 22.8 kilograms for February 2002, August 2003, and

March 2006, respectively. The core results are not inconsistent with other data that suggest that ground water flow paths were changing and eventually led to bypass of the PRB.

*Table 1. Change in Solid-Phase Uranium Concentrations From 2002 to 2006
(Each value is the mean of all samples from the core [approximately 4 each])*

Core Location	February 2002 U Concentration (mg/kg)	August 2003 U Concentration (mg/kg)	March 2006 U Concentration (mg/kg)
Gravel/ZVI Zone			
MPC-1	157	822	630
MPC-4	250	804	600
MPC-10	93	804	564
MPC-11	252	290	558
MPC-12	320	449	589
MPC-14	437	405	627
MPC-19	190	444	179
MPC-21	384	448	402
<i>Mean ± 1SD</i>	<i>260 ± 108</i>	<i>558 ± 201</i>	<i>519 ± 145</i>
ZVI Zone			
MPC-2	1.0	0.5	1.0
MPC-3	1.0	0.5	0.5
MPC-5	0.2	84.7	1.1
MPC-6	0.2	86.8	0.9
MPC-7	<0.1	1.5	0.8
MPC-8	<0.1	<0.1	0.9
MPC-9	<0.1	0.6	0.5
MPC-13	1.0	6.1	6.2
MPC-15	1.0	6.1	0.5
MPC-16	1.0	3.2	0.5
MPC-17	<0.1	<0.1	0.5
MPC-18	0.2	0.1	0.5
MPC-20	1.8	4.8	2.8
MPC-22	6.3	2.6	0.5
MPC-23	0.1	na	0.5
<i>Mean ± 1 SD</i>	<i>0.9 ± 1.5</i>	<i>14.1 ± 29.3</i>	<i>1.2 ± 1.5</i>

na = not analyzed

Negligible U has precipitated in the ZVI zone. Two cores (MPC-5 and MPC-6) that were collected within 1 foot of each other had mean U concentrations of 84.7 and 86.8 mg/kg in the August 2003 data indicating that in at least one location U was deposited in the upgradient portion of the ZVI zone (Table 1). Uranium concentrations in cores collected nearby (MPC-9, MPC-2, and MPC-3) indicate that the higher concentrations in MPC-5 and MPC-6 are discontinuous. Also, concentrations in two cores (MPC-7 and MPC-8) collected immediately downgradient from MPC-5 and MPC-6 indicate that U does not extend far into the ZVI zone. The U concentrations in the March 2006 offsets of these two cores had low values (1.1 and 0.9 mg/kg) providing additional indication of the discontinuous nature of the U mineralization.

Table 2. Change in Solid-Phase Calcium Concentrations From 2002 to 2006
(Each value is the mean of all samples from the core [approximately 4 each])

Core Location	February 2002 Ca Concentration (mg/kg)	August 2003 Ca Concentration (mg/kg)	March 2006 Ca Concentration (mg/kg)
Gravel/ZVI Zone			
MPC-1	35,600	25,550	10,650
MPC-4	25,975	25,650	42,500
MPC-10	37,575	25,650	41,700
MPC-11	32,300	39,875	60,150
MPC-12	26,900	40,800	46,525
MPC-14	23,150	42,400	46,700
MPC-19	29,050	23,350	30,775
MPC-21	15,075	27,950	36,350
<i>Mean ± 1SD</i>	<i>28,203 ± 6,751</i>	<i>31,403 ± 7,568</i>	<i>39,418 ± 13,508</i>
ZVI Zone			
MPC-2	24,785	14,678	36,075
MPC-3	24,785	14,678	27,825
MPC-5	17,300	27,600	26,575
MPC-6	17,300	25,380	28,780
MPC-7	11,465	25,750	23,775
MPC-8	11,465	23,100	19,625
MPC-9	28,283	27,600	26,800
MPC-13	11,510	41,200	37,750
MPC-15	11,510	41,200	23,225
MPC-16	11,510	22,125	24,800
MPC-17	5,295	13,905	26,875
MPC-18	11,485	9,778	26,020
MPC-20	15,185	19,488	22,760
MPC-22	21,850	30,910	28,700
MPC-23	10,255	na	29,175
<i>Mean ±1 SD</i>	<i>15,599 ± 6,381</i>	<i>24,099 ± 9,153</i>	<i>27,251 ± 4,557</i>

Mean Ca concentrations were higher in the gravel/ZVI (39,418 mg/kg) zone than in the ZVI zone; however, high concentrations (mean 27,251 mg/kg) were also present in the ZVI zone (Table 2). The presence of high Ca but low U concentrations in the ZVI zone indicates that ground water moved through the ZVI zone and continued to precipitate calcium carbonate minerals after the U had been removed in the gravel/ZVI zone. The mean Ca concentrations in the gravel/ZVI zone appear to increase from February 2002 (28,203 mg/kg) to August 2003 (31,403 mg/kg) to March 2006 (39,418 mg/kg); however, the values are all within a standard deviation of each other (Table 2). The mean Ca concentration increased each year in the ZVI zone; however, the mean increase from August 2003 to March 2006 was minimal.

4.0 Summary and Conclusions

Results of analyses of samples collected in March 2006 from 23 cores were compared to data collected from the same locations using identical methods from two previous coring events (February 2002 and August 2003). Analyses of 346 samples indicate that the mean dry densities of the gravel/ZVI and ZVI zone are 1.68 and 2.28 mg/kg, respectively. These densities are nearly the same as in the previous two coring events. Analyses of 458 samples indicates that the mean moisture content in the gravel/ZVI and ZVI zones are 10.6 and 13.7 wgt %, respectively. The moisture contents are consistent with values from the previous two coring events. Chemical analysis of 96 samples from the March 2006 cores resulted in mean U concentrations of 519 and 1.2 mg/kg in the gravel/ZVI and ZVI zones, respectively. Mean Ca concentrations, based on the same samples were 39,418 and 27,251 mg/kg for the gravel/ZVI and ZVI zones, respectively. The chemical concentrations were highly variable as indicated by high standard deviations of the means. The high variability in the data indicates that chemical precipitation has not proceeded in a uniform manner within the reactive material, but instead has occurred preferentially. One of the goals of this study was to determine the maximum rate of ground water flow through the PRB, based on the rate that U and Ca concentrations have increased. Because of the high variability of results between sample locations, estimates of flow rate were not definitive. However, the results are consistent with other data that indicate mineral precipitation has degraded permeability and caused ground water to bypass the PRB. Results also support the conclusion that ground water flow through the PRB diminished substantially after 2003.

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Appendix A

Compilation of Data From the March 2006 Coring Event

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Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 1-1	G	3/23/2006	1	3	3.5	3.5	<= bkg	4.72			
MPC 1-2	G	3/23/2006	2	3.5	7.5	4.3	<= bkg	6.66			
MPC 1-3	G	3/23/2006	2	3.5	7.5	5.1	<= bkg	12.20			
MPC 1-4	G	3/23/2006	2	3.5	7.5	5.9	1400	8.59			
MPC 1-5	G	3/23/2006	2	3.5	7.5	6.7	2800	10.59			
MPC 1-6	G	3/23/2006	2	3.5	7.5	7.5	4800	10.39		8500	222.9
MPC 1-7	G	3/23/2006	3	7.5	11.5	8.2	1700	8.61			
MPC 1-8	G	3/23/2006	3	7.5	11.5	8.8	2800	11.30			
MPC 1-9	G	3/23/2006	3	7.5	11.5	9.5	2800	10.02			
MPC 1-10	G	3/23/2006	3	7.5	11.5	10.2	2800	8.89		11600	516.7
MPC 1-11	G	3/23/2006	3	7.5	11.5	10.8	12000	12.32			
MPC 1-12	G	3/23/2006	3	7.5	11.5	11.5	3400	12.22		7900	465.8
MPC 1-13	G	3/23/2006	4	11.5	14	12.3	24000	11.39		14600	1314.5
MPC 1-14	G	3/23/2006	4	11.5	14	13.2	48000	9.98	1.84		
MPC 1-15a	G	3/23/2006	4	11.5	14	14.0	24000	9.08	1.85		
MPC 1-15b	B	3/23/2006	4	11.5	14	14.0	9000	12.78	1.92		
MPC 2-1	Z	3/22/2006	1	3	3.5	3.1	<= bkg	2.64	2.30		
MPC 2-2	Z	3/22/2006	2	3.5	6	4.1	3000	7.77	2.01		
MPC 2-3	Z	3/22/2006	2	3.5	6	4.8	<= bkg	9.99	2.11		
MPC 2-4	Z	3/22/2006	2	3.5	6	5.4	<= bkg	13.15	2.40		
MPC 2-5	Z	3/22/2006	2	3.5	6	6.0	4000	13.68	2.21		
MPC 2-6	Z	3/22/2006	3	6	8.5	6.4	2500	16.75	2.20		
MPC 2-7	Z	3/22/2006	3	6	8.5	6.8	<= bkg	15.82	2.23		
MPC 2-8	Z	3/22/2006	3	6	8.5	7.3	<= bkg	14.93	2.40		
MPC 2-9	Z	3/22/2006	3	6	8.5	7.7	<= bkg	11.45	2.67		
MPC 2-10	Z	3/22/2006	3	6	8.5	8.1	<= bkg	15.13	2.32		
MPC 2-11	Z	3/22/2006	3	6	8.5	8.5	<= bkg	15.30	2.25		
MPC 2-12	Z	3/22/2006	4	8.5	11	9.0	<= bkg	15.84	2.33		
MPC 2-13	Z	3/22/2006	4	8.5	11	9.5	<= bkg	16.23	2.18		
MPC 2-14	Z	3/22/2006	4	8.5	11	10.0	<= bkg	12.79	2.57		
MPC 2-15	Z	3/22/2006	4	8.5	11	10.5	<= bkg	11.28	2.47		
MPC 2-16	Z	3/22/2006	4	8.5	11	11.0	<= bkg	12.98	2.26	33000	0.5
MPC 2-17	Z	3/22/2006	5	11	14.7	11.7	<= bkg	13.45	2.29	33200	0.5
MPC 2-18	Z	3/22/2006	5	11	14.7	12.5	<= bkg	14.87	2.26	43100	0.5
MPC 2-19	Z	3/22/2006	5	11	14.7	13.2	<= bkg	12.51	2.55	35000	2.4
MPC 2-20	Z	3/22/2006	5	11	14.7	14.0	<= bkg	13.68	2.54		
MPC 2-21	Z	3/22/2006	5	11	14.7	14.7	<= bkg	15.04	2.41		
MPC 2-22	Z	3/22/2006	5	11	14.7	14.7	<= bkg	15.14	2.35		
MPC 3-1	Z	3/22/2006	1	3	3.5	3.5	<= bkg	2.46	2.34		
MPC 3-2	Z	3/22/2006	2	3.5	6	4.1	<= bkg	6.47	2.10		
MPC 3-3	Z	3/22/2006	2	3.5	6	4.8	<= bkg	4.87	2.19		
MPC 3-4	Z	3/22/2006	2	3.5	6	5.4	<= bkg	11.01	2.09		
MPC 3-5	Z	3/22/2006	2	3.5	6	6.0	<= bkg	13.35	2.27		
MPC 3-6	Z	3/22/2006	3	6	8.5	6.5	<= bkg	13.97	2.26		

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 3-7	Z	3/22/2006	3	6	8.5	7.0	</= bkg	16.67	2.16		
MPC 3-8	Z	3/22/2006	3	6	8.5	7.5	</= bkg	15.52	2.25		
MPC 3-9	Z	3/22/2006	3	6	8.5	8.0	</= bkg	15.51	2.26		
MPC 3-10	Z	3/22/2006	3	6	8.5	8.5	</= bkg	15.99	2.03		
MPC 3-11	Z	3/22/2006	4	8.5	11	9.0	</= bkg	17.34	2.03		
MPC 3-12	Z	3/22/2006	4	8.5	11	9.5	</= bkg	16.25	2.27		
MPC 3-13	Z	3/22/2006	4	8.5	11	10.0	</= bkg	16.10	2.19		
MPC 3-14	Z	3/22/2006	4	8.5	11	10.5	</= bkg	15.69	2.41	12000	0.50
MPC 3-15	Z	3/22/2006	4	8.5	11	11.0	</= bkg	14.45	2.33		
MPC 3-16	Z	3/22/2006	5	11	14.7	11.6	</= bkg	15.43	2.21	31900	0.50
MPC 3-17	Z	3/22/2006	5	11	14.7	12.2	</= bkg	14.19	2.44		
MPC 3-18	Z	3/22/2006	5	11	14.7	12.9	</= bkg	13.68	2.48	29600	0.50
MPC 3-19	Z	3/22/2006	5	11	14.7	13.5	</= bkg	14.16	2.30		
MPC 3-20	Z	3/22/2006	5	11	14.7	14.1	</= bkg	13.81	2.33	37800	0.50
MPC 3-21a	Z	3/22/2006	5	11	14.7	14.4	</= bkg	13.29	2.63		
MPC 3-21b	B	3/22/2006	5	11	14.7	14.7	</= bkg	17.55	1.45		
MPC 4-1	G	3/23/2006	1	3	3.5	3.5	</= bkg	6.78			
MPC 4-2	G	3/23/2006	2	3.5	7.5	4.3	</= bkg	9.41			
MPC 4-3	G	3/23/2006	2	3.5	7.5	5.1	2000	10.06			
MPC 4-4	G	3/23/2006	2	3.5	7.5	5.9	6000	9.52			
MPC 4-5	G	3/23/2006	2	3.5	7.5	6.7	2800	12.59			
MPC 4-6	G	3/23/2006	2	3.5	7.5	7.5	6000	12.30			
MPC 4-7	G	3/23/2006	3	7.5	11.5	8.1	3700	9.24			
MPC 4-8	G	3/23/2006	3	7.5	11.5	8.6	3000	8.75			
MPC 4-9	G	3/23/2006	3	7.5	11.5	9.2	2800	9.13		8800	273
MPC 4-10	G	3/23/2006	3	7.5	11.5	9.8	3000	9.65			
MPC 4-11	G	3/23/2006	3	7.5	11.5	10.4	6000	9.29		45400	534.3
MPC 4-12	G	3/23/2006	3	7.5	11.5	10.9	6000	10.59			
MPC 4-13	G	3/23/2006	3	7.5	11.5	11.5	2800	10.47		43000	1001.3
MPC 4-14	G	3/23/2006	4	11.5	14.2	12.2	12000	9.92			
MPC 4-15	G	3/23/2006	4	11.5	14.2	12.9	12000	9.99		72800	592.5
MPC 4-16	G	3/23/2006	4	11.5	14.2	13.5	2800	11.75			
MPC 4-17	G	3/23/2006	4	11.5	14.2	14.2	2800	12.58			
MPC 5-1	Z	3/22/2006	2	3.5	6	3.6	</= bkg	9.45	2.42		
MPC 5-2	Z	3/22/2006	2	3.5	6	5.2	</= bkg	11.34	2.58		
MPC 5-3	Z	3/22/2006	2	3.5	6	6.0	</= bkg	15.79	2.03		
MPC 5-4	Z	3/22/2006	3	6	10	6.5	</= bkg	11.92	2.79		
MPC 5-5	Z	3/22/2006	3	6	10	7.0	</= bkg	12.20	2.78		
MPC 5-6	Z	3/22/2006	3	6	10	7.5	</= bkg	10.32	2.89	37800	0.50
MPC 5-7	Z	3/22/2006	3	6	10	8.0	</= bkg	8.58	2.82		
MPC 5-8	Z	3/22/2006	3	6	10	8.5	</= bkg	9.55	2.89		
MPC 5-9	Z	3/22/2006	3	6	10	9.0	</= bkg	10.04	2.87		
MPC 5-10	Z	3/22/2006	3	6	10	9.5	</= bkg	9.37	2.93		
MPC 5-11	Z	3/22/2006	3	6	10	10.0	</= bkg	6.02	3.04		
MPC 5-12	Z	3/22/2006	4	10	12	10.3	</= bkg	6.45	2.84	10100	3.06

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 5-13	Z	3/22/2006	4	10	12	10.7	</= bkg	9.55	2.27		
MPC 5-14	Z	3/22/2006	4	10	12	11.0	</= bkg	7.95	2.73		
MPC 5-15	Z	3/22/2006	4	10	12	11.3	</= bkg	5.80	3.24		
MPC 5-16	Z	3/22/2006	4	10	12	11.7	</= bkg	10.07	2.85		
MPC 5-17	Z	3/22/2006	4	10	12	12.0	</= bkg	10.89	2.35	31100	0.50
MPC 5-18	Z	3/22/2006	5	12	14	12.4	</= bkg	13.81	2.27	27300	0.50
MPC 5-19	Z	3/22/2006	5	12	14	12.8	</= bkg	13.58	2.35		
MPC 5-20	Z	3/22/2006	5	12	14	13.2	</= bkg	12.70	2.31		
MPC 5-21	Z	3/22/2006	5	12	14	13.6	</= bkg	11.27	2.32		
MPC 5-22	Z	3/22/2006	5	12	14	14.0	</= bkg	11.59	2.19		
MPC 6-1	F	3/22/2006	1	3	3.5	3.5	</= bkg	2.95	1.78		
MPC 6-2	F/Z	3/22/2006	2	3.5	6	4.1	</= bkg	10.63	2.26		
MPC 6-3	F/Z	3/22/2006	2	3.5	6	4.8	</= bkg	10.04	2.36		
MPC 6-4	F/Z	3/22/2006	2	3.5	6	5.4	</= bkg	11.57	2.13		
MPC 6-5	F/Z	3/22/2006	2	3.5	6	6.0	</= bkg	12.29	2.31		
MPC 6-6	F/Z	3/22/2006	3	6	8.5	6.6	</= bkg	13.80	2.25		
MPC 6-7	Z/F	3/22/2006	3	6	8.5	7.3	</= bkg	14.71	2.46		
MPC 6-8	Z/F	3/22/2006	3	6	8.5	7.9	</= bkg	11.81	2.45	23100	0.50
MPC 6-9	Z	3/22/2006	3	6	8.5	8.5	</= bkg	13.07	2.36		
MPC 6-10	Z	3/22/2006	4	8.5	11	9.0	</= bkg	14.21	2.45		
MPC 6-11	Z	3/22/2006	4	8.5	11	9.5	</= bkg	15.03	2.47	22400	0.50
MPC 6-12	Z	3/22/2006	4	8.5	11	10.0	</= bkg	14.90	2.50		
MPC 6-13	Z	3/22/2006	4	8.5	11	10.5	</= bkg	14.46	2.47		
MPC 6-14	Z	3/22/2006	4	8.5	11	11.0	</= bkg	14.84	2.59	34100	0.50
MPC 6-15	Z	3/22/2006	5	11	14.9	11.6	</= bkg	14.09	2.44		
MPC 6-16	Z	3/22/2006	5	11	14.9	12.1	</= bkg	13.43	2.47		
MPC 6-17	Z	3/22/2006	5	11	14.9	12.7	</= bkg	13.73	2.45	23700	0.50
MPC 6-18	Z	3/22/2006	5	11	14.9	13.2	</= bkg	12.49	2.59		
MPC 6-19	Z	3/22/2006	5	11	14.9	13.8	</= bkg	13.62	2.49	40600	2.26
MPC 6-20	Z	3/22/2006	5	11	14.9	14.3	</= bkg	20.66	2.30		
MPC 6-21a	Z	3/22/2006	5	11	14.9	14.8	</= bkg	13.84	2.60		
MPC 6-21b	B	3/22/2006	5	11	14.9	14.9	</= bkg	19.90	1.26		
MPC 7-1	Z	3/21/2006	3	6	8.5	6.5	</= bkg	18.26	2.09		
MPC 7-2	Z	3/21/2006	3	6	8.5	7.0	</= bkg	15.71	2.31		
MPC 7-3	Z	3/21/2006	3	6	8.5	7.5	</= bkg	15.17	2.49	25000	0.50
MPC 7-4	Z	3/21/2006	3	6	8.5	8.0	</= bkg	14.82	2.53		
MPC 7-5	Z	3/21/2006	3	6	8.5	8.5	</= bkg	14.12	2.58	26800	0.22
MPC 7-6	Z	3/21/2006	4	8.5	11	9.1	</= bkg	14.44	2.42		
MPC 7-7	Z	3/21/2006	4	8.5	11	9.8	</= bkg	15.00	2.38	15100	1.75
MPC 7-8	Z	3/21/2006	4	8.5	11	10.4	</= bkg	15.08	2.49		
MPC 7-9	Z	3/21/2006	4	8.5	11	11.0	</= bkg	15.64	2.48		
MPC 7-10	Z	3/21/2006	5	11	14.2	11.4	</= bkg	14.31	2.71		
MPC 7-11	Z	3/21/2006	5	11	14.2	11.8	</= bkg	13.85	2.48		
MPC 7-12	Z	3/21/2006	5	11	14.2	12.2	</= bkg	11.70	2.48		
MPC 7-13	Z	3/21/2006	5	11	14.2	12.6	</= bkg	13.78	2.48		

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 7-14	Z	3/21/2006	5	11	14.2	13.0	</= bkg	12.21	2.50		
MPC 7-15	Z	3/21/2006	5	11	14.2	13.4	</= bkg	13.36	2.53		
MPC 7-16	Z	3/21/2006	5	11	14.2	13.8	</= bkg	12.99	2.47		
MPC 7-17a	Z	3/21/2006	5	11	14.2	14.0	</= bkg	15.01	2.00	28200	0.57
MPC 7-17b	Z	3/21/2006	5	11	14.2	14.2	</= bkg	20.69	0.97		
MPC 8-1	Z	3/21/2006	1	3	3.5	3.2	</= bkg	1.96	2.51		
MPC 8-2	Z	3/21/2006	2	3.5	6	4.1	</= bkg	4.65	1.77		
MPC 8-3	Z	3/21/2006	2	3.5	6	4.8	</= bkg	5.28	2.11		
MPC 8-4	Z	3/21/2006	2	3.5	6	5.4	</= bkg	7.65	2.18		
MPC 8-5	Z	3/21/2006	2	3.5	6	6.0	</= bkg	14.97	2.18		
MPC 8-6	Z	3/21/2006	3	6	8.5	6.5	</= bkg	15.02	2.32		
MPC 8-7	Z	3/21/2006	3	6	8.5	7.0	</= bkg	18.45	2.09		
MPC 8-8	Z	3/21/2006	3	6	8.5	7.5	</= bkg	17.32	1.94	19500	0.50
MPC 8-9	Z	3/21/2006	3	6	8.5	8.0	</= bkg	18.40	1.92		
MPC 8-10	Z	3/21/2006	3	6	8.5	8.5	</= bkg	13.11	2.53	13800	2.19
MPC 8-11	Z	3/21/2006	4	8.5	11	9.0	</= bkg	17.66	2.22		
MPC 8-12	Z	3/21/2006	4	8.5	11	9.5	</= bkg	17.76	2.15	14100	0.50
MPC 8-13	Z	3/21/2006	4	8.5	11	10.0	</= bkg	18.67	2.05		
MPC 8-14	Z	3/21/2006	4	8.5	11	10.5	</= bkg	13.66	2.26		
MPC 8-15	Z	3/21/2006	4	8.5	11	11.0	</= bkg	15.71	1.97		
MPC 8-16	Z	3/21/2006	5	11	14.7	11.5	</= bkg	13.40	1.92		
MPC 8-17	Z	3/21/2006	5	11	14.7	12.1	</= bkg	17.11	2.24		
MPC 8-18	Z	3/21/2006	5	11	14.7	12.6	</= bkg	16.59	2.36		
MPC 8-19	Z	3/21/2006	5	11	14.7	13.1	</= bkg	16.46	2.32	31100	0.50
MPC 8-20	Z	3/21/2006	5	11	14.7	13.6	</= bkg	15.74	2.24		
MPC 8-21	Z	3/21/2006	5	11	14.7	14.2	</= bkg	17.00	2.12		
MPC 8-22	B	3/21/2006	5	11	14.7	14.7	</= bkg	16.08	1.65		
MPC 9-1	Z	3/22/2006	1	3	3.5	3.5	</= bkg	2.43	2.28		
MPC 9-2	Z	3/22/2006	2	3.5	6	4.0	</= bkg	6.04	2.07		
MPC 9-3	Z	3/22/2006	2	3.5	6	4.5	</= bkg	4.65	2.03		
MPC 9-4	Z	3/22/2006	2	3.5	6	5.0	</= bkg	11.65	2.30		
MPC 9-5	Z	3/22/2006	2	3.5	6	5.5	</= bkg	13.13	2.21		
MPC 9-6	Z	3/22/2006	2	3.5	6	6.0	</= bkg	11.33	2.40		
MPC 9-7	Z	3/22/2006	3	6	8.5	6.6	</= bkg	12.01	1.95		
MPC 9-8	Z	3/22/2006	3	6	8.5	7.3	</= bkg	15.31	2.15		
MPC 9-9	Z	3/22/2006	3	6	8.5	7.9	</= bkg	17.10	2.16		
MPC 9-10	Z	3/22/2006	3	6	8.5	8.5	</= bkg	14.52	2.14		
MPC 9-11	Z	3/22/2006	4	8.5	11	8.9	</= bkg	16.25	2.15		
MPC 9-12	Z	3/22/2006	4	8.5	11	9.3	</= bkg	13.65	2.23		
MPC 9-13	Z	3/22/2006	4	8.5	11	8.9	</= bkg	16.14	2.27		
MPC 9-14	Z	3/22/2006	4	8.5	11	10.2	</= bkg	14.34	2.22	24900	0.50
MPC 9-15	Z	3/22/2006	4	8.5	11	10.6	</= bkg	13.21	2.23	26700	0.50
MPC 9-16	Z	3/22/2006	4	8.5	11	11.0	</= bkg	13.02	2.38		
MPC 9-17	Z	3/22/2006	5	11	14.8	11.8	</= bkg	13.46	2.21	26200	0.50
MPC 9-18	Z	3/22/2006	5	11	14.8	12.5	</= bkg	14.71	2.29		

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 9-19	Z	3/22/2006	5	11	14.8	13.3	</= bkg	13.14	2.41		
MPC 9-20	Z	3/22/2006	5	11	14.8	14.0	</= bkg	13.27	2.31	29400	0.50
MPC 9-21	Z	3/22/2006	5	11	14.8	14.8	</= bkg	14.61	2.28		
MPC 10-1	G	3/23/2006	1	3	3.5	3.5		5.83			
MPC 10-2	G	3/23/2006	2	3.5	7.5	4.1		9.02			
MPC 10-3	G	3/23/2006	2	3.5	7.5	4.6	2000	9.95			
MPC 10-4	G	3/23/2006	2	3.5	7.5	5.2	2000	9.13			
MPC 10-5	G	3/23/2006	2	3.5	7.5	5.8	1400	10.89			
MPC 10-6	G	3/23/2006	2	3.5	7.5	6.4	3000	10.22			
MPC 10-7	G	3/23/2006	2	3.5	7.5	6.9	7600	10.64			
MPC 10-8	G	3/23/2006	2	3.5	7.5	7.5	9600	12.35			
MPC 10-9	G	3/23/2006	3	7.5	11.5	8.3	2800	9.71			
MPC 10-10	G	3/23/2006	3	7.5	11.5	9.1	3400	8.96			
MPC 10-11	G	3/23/2006	3	7.5	11.5	9.9	4000	9.19		39600	386.4
MPC 10-12	G	3/23/2006	3	7.5	11.5	10.7	3000	10.17		30600	474.9
MPC 10-13	G	3/23/2006	3	7.5	11.5	11.5	9000	10.92			
MPC 10-14	G	3/23/2006	4	11.5	14	12.1	6800	9.47		30600	582.6
MPC 10-15	G	3/23/2006	4	11.5	14	12.8	5600	8.46			
MPC 10-16	G	3/23/2006	4	11.5	14	13.4	9000	10.33			
MPC 10-17	G	3/23/2006	4	11.5	14	14.0	6000	9.90		66000	812.8
MPC 11-1	G	3/22/2006	1	3	3.5	3.0	</= bkg	7.92	1.67		
MPC 11-2	G	3/22/2006	2	3.5	7	4.2	2800	8.21	1.54		
MPC 11-3	G	3/22/2006	2	3.5	7	4.9	</= bkg	6.67	1.64		
MPC 11-4	G	3/22/2006	2	3.5	7	5.6	</= bkg	9.73	2.12		
MPC 11-5	G	3/22/2006	2	3.5	7	6.3	</= bkg	10.02	1.99		
MPC 11-6	G	3/22/2006	2	3.5	7	7.0	5600	11.43	1.72		
MPC 11-7	G	3/22/2006	3	7	9	7.7	6000	11.83			
MPC 11-8	G	3/22/2006	3	7	9	8.3	6000	12.94			
MPC 11-9	G	3/22/2006	3	7	9	9.0	3000	12.31		32400	386.6
MPC 11-10	G	3/22/2006	4	9	12	9.5	4000	14.74			
MPC 11-11	G	3/22/2006	4	9	12	10.0	4000	13.99			
MPC 11-12	G	3/22/2006	4	9	12	9.5	6000	12.32			
MPC 11-13	G	3/22/2006	4	9	12	11.0	3000	11.46			
MPC 11-14	G	3/22/2006	4	9	12	11.5	9000	11.45		72000	734.6
MPC 11-15	G	3/22/2006	4	9	12	12.0	6000	13.63		85600	906.2
MPC 11-16	G	3/22/2006	5	12	14.5	12.6	4000	10.95		50600	203.8
MPC 11-17	G	3/22/2006	5	12	14.5	13.3	4000	14.96			
MPC 11-18	G	3/22/2006	5	12	14.5	13.9	6000	21.75			
MPC 11-19	G	3/22/2006	5	12	14.5	14.5	6000	14.06			
MPC 12-1	G	3/22/2006	1	3	3.6	3.1	4800	5.06			
MPC 12-2	G	3/22/2006	2	3.6	7.7	4.4	6200	9.61			
MPC 12-3	G	3/22/2006	2	3.6	7.7	5.2	3400	10.46			
MPC 12-4	G	3/22/2006	2	3.6	7.7	6.1	3400	10.50			
MPC 12-5	G	3/22/2006	2	3.6	7.7	6.9	7600	13.06			

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 12-6	G	3/22/2006	2	3.6	7.7	7.7	6000	11.75			
MPC 12-7	G	3/22/2006	3	7.7	10.5	8.4	4000	8.90		26500	553.8
MPC 12-8	G	3/22/2006	3	7.7	10.5	9.1	3400	9.95			
MPC 12-9	G	3/22/2006	3	7.7	10.5	9.8	2800	10.99			
MPC 12-10	G	3/22/2006	3	7.7	10.5	10.5	12000	15.81		42000	997.1
MPC 12-11	G	3/22/2006	4	10.5	14	11.1	12000	12.66			
MPC 12-12	G	3/22/2006	4	10.5	14	11.7	12000	12.19		53800	612.7
MPC 12-13	G	3/22/2006	4	10.5	14	12.3	4000	13.20			
MPC 12-14	G	3/22/2006	4	10.5	14	12.8	2800	11.05		63800	192
MPC 12-15	G	3/22/2006	4	10.5	14	13.4	3400	11.52			
MPC 12-16	G	3/22/2006	4	10.5	14	14.0	4200	11.91			
MPC 13-1	Z/F	3/21/2006	1	3	3.5	3.5	1200	4.24	2.40		
MPC 13-2	Z/F	3/21/2006	2	3.5	6	4.1	</= bkg	4.72	1.90		
MPC 13-3	Z	3/21/2006	2	3.5	6	4.8	</= bkg	7.32	2.15		
MPC 13-4	Z	3/21/2006	2	3.5	6	5.4	</= bkg	7.17	2.29		
MPC 13-5	Z	3/21/2006	2	3.5	6	6.0	</= bkg	13.49	2.38		
MPC 13-6	Z	3/21/2006	3	6	8.5	6.5	</= bkg	16.26	2.15		
MPC 13-7	Z	3/21/2006	3	6	8.5	7.0	</= bkg	16.44	1.89		
MPC 13-8	Z	3/21/2006	3	6	8.5	7.5	</= bkg	18.34	1.91	27900	0.50
MPC 13-9	Z	3/21/2006	3	6	8.5	8.0	</= bkg	15.70	2.11		
MPC 13-10	Z	3/21/2006	3	6	8.5	8.5	</= bkg	15.22	2.09		
MPC 13-11	Z	3/21/2006	4	8.5	11	9.0	</= bkg	15.61	2.15		
MPC 13-12	Z	3/21/2006	4	8.5	11	9.5	</= bkg	14.72	2.33		
MPC 13-13	Z	3/21/2006	4	8.5	11	10.0	</= bkg	14.09	2.54	33000	0.50
MPC 13-14	Z	3/21/2006	4	8.5	11	10.5	1200	14.28	2.40		
MPC 13-15	Z	3/21/2006	4	8.5	11	11.0	</= bkg	14.54	2.28		
MPC 13-16	Z	3/21/2006	5	11	15.1	11.7	</= bkg	15.71	2.06	60200	23.30
MPC 13-17	Z	3/21/2006	5	11	15.1	12.4	</= bkg	16.23	2.16	29900	0.50
MPC 13-18	Z	3/21/2006	5	11	15.1	13.1	</= bkg	16.78	2.14		
MPC 13-19	Z	3/21/2006	5	11	15.1	13.7	</= bkg	14.32	2.11		
MPC 13-20	Z	3/21/2006	5	11	15.1	14.4	</= bkg	16.75	2.08		
MPC 13-21	Z	3/21/2006	5	11	15.1	15.1	</= bkg	17.28	1.96		
MPC 14-1	G	3/22/2006	2	3.5	7	4.2	1200	7.09			
MPC 14-2	G	3/22/2006	2	3.5	7	4.9	3000	7.22			
MPC 14-3	G	3/22/2006	2	3.5	7	5.6	3000	10.38			
MPC 14-4	G	3/22/2006	2	3.5	7	6.3	2800	16.27			
MPC 14-5	G	3/22/2006	2	3.5	7	7.0	11200	18.06			
MPC 14-6	G/F	3/22/2006	3	7	10.5	7.9	11200	15.78		54000	687.7
MPC 14-7	G	3/22/2006	3	7	10.5	8.8	8400	8.96			
MPC 14-8	G	3/22/2006	3	7	10.5	9.6	8400	13.76		48400	744.4
MPC 14-9	G	3/22/2006	3	7	10.5	10.5	8400	13.52		57200	724.1
MPC 14-10	G	3/22/2006	4	10.5	14	11.7	5600	14.36		27200	351.4
MPC 14-11	G	3/22/2006	4	10.5	14	12.8	5600	15.03			
MPC 14-12		3/22/2006	4	10.5	14	14.0	8400	13.58			

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 15-1	Z	3/21/2006	1	3	3.5	3.5	1000	5.91	1.95		
MPC 15-2	Z	3/21/2006	2	3.5	6	4.0	</= bkg	8.05	1.95		
MPC 15-3	Z	3/21/2006	2	3.5	6	4.5	</= bkg	7.53	2.13		
MPC 15-4	Z	3/21/2006	2	3.5	6	5.0	</= bkg	12.79	2.23		
MPC 15-5	Z	3/21/2006	2	3.5	6	5.5	</= bkg	17.38	1.73		
MPC 15-6	Z	3/21/2006	2	3.5	6	6.0	</= bkg	18.23	1.77		
MPC 15-7	Z	3/21/2006	3	6	8.5	6.6	</= bkg	18.68	2.11		
MPC 15-8	Z	3/21/2006	3	6	8.5	7.3	</= bkg	12.44	2.48		
MPC 15-9	Z	3/21/2006	3	6	8.5	7.9	</= bkg	14.87	2.49	26700	0.50
MPC 15-10	Z	3/21/2006	3	6	8.5	8.5	</= bkg	14.06	2.58	27700	0.50
MPC 15-11	Z	3/21/2006	4	8.5	11	9.1	</= bkg	17.22	2.17	22800	0.50
MPC 15-12	Z	3/21/2006	4	8.5	11	9.8	</= bkg	17.72	2.25	15700	0.50
MPC 15-13	Z	3/21/2006	4	8.5	11	10.4	</= bkg	15.00	2.19		
MPC 15-14	Z	3/21/2006	4	8.5	11	11.0	</= bkg	13.95	2.17		
MPC 15-15	Z	3/21/2006	5	11	13.5	11.5	</= bkg	13.95	2.30		
MPC 15-16	Z	3/21/2006	5	11	13.5	12.0	</= bkg	15.79	2.22		
MPC 15-17	Z	3/21/2006	5	11	13.5	12.5	</= bkg	17.82	2.14		
MPC 15-18	Z	3/21/2006	5	11	13.5	13.0	</= bkg	16.06	2.13		
MPC 15-19	Z	3/21/2006	5	11	13.5	13.5	</= bkg	17.21	2.14		
MPC 15-20a	Z	3/21/2006	6	13.5	14.2	13.9	</= bkg	14.36	1.87		
MPC 15-20b	B	3/21/2006	6	13.5	14.2	14.2	</= bkg	17.26			
MPC 16-1	Z	3/21/2006	1	3	3.5	3.1	</= bkg	4.27	2.30		
MPC 16-2	Z	3/21/2006	2	3.5	6	4.0	</= bkg	5.28			
MPC 16-3	Z	3/21/2006	2	3.5	6	4.5	</= bkg	7.54	2.13		
MPC 16-4	Z	3/21/2006	2	3.5	6	5.0	</= bkg	8.34	2.24		
MPC 16-5	Z	3/21/2006	2	3.5	6	5.5	</= bkg	13.71	2.38		
MPC 16-6	Z	3/21/2006	2	3.5	6	6.0	</= bkg	14.01	2.15		
MPC 16-7	Z	3/21/2006	3	6	8.5	6.5	</= bkg	15.93	2.11		
MPC 16-8	Z	3/21/2006	3	6	8.5	7.0	</= bkg	18.29	2.08		
MPC 16-9	Z	3/21/2006	3	6	8.5	7.5	</= bkg	17.90	2.17		
MPC 16-10	Z	3/21/2006	3	6	8.5	8.0	</= bkg	17.24	2.29		
MPC 16-11	Z	3/21/2006	3	6	8.5	8.5	</= bkg	18.68	2.13		
MPC 16-12	Z	3/21/2006	4	8.5	11	9.0	</= bkg	21.06	1.95	14400	0.50
MPC 16-13	Z	3/21/2006	4	8.5	11	9.5	</= bkg	15.44	2.18		
MPC 16-14	Z	3/21/2006	4	8.5	11	10.0	</= bkg	15.81	2.30	22700	0.50
MPC 16-15	Z	3/21/2006	4	8.5	11	10.5	</= bkg	15.28	2.28		
MPC 16-16	Z	3/21/2006	4	8.5	11	11.0	</= bkg	16.52	2.21	36500	0.47
MPC 16-17	Z	3/21/2006	5	11	14.1	11.4	</= bkg	14.71	1.97		
MPC 16-18	Z	3/21/2006	5	11	14.1	11.9	</= bkg	18.39	2.15		
MPC 16-19	Z	3/21/2006	5	11	14.1	12.3	</= bkg	19.81	2.11		
MPC 16-20	Z	3/21/2006	5	11	14.1	12.8	</= bkg	19.11	2.19		
MPC 16-21	Z	3/21/2006	5	11	14.1	13.2	</= bkg	19.20	2.15	25600	0.50
MPC 16-22a	Z	3/21/2006	5	11	14.1	13.7	</= bkg	18.90	2.34		
MPC 16-22b	B	3/21/2006		11	14.1	14.1	</= bkg	16.80	2.03		
MPC 17-1	Z	3/21/2006	2	3.5	6	4.8	</= bkg	7.53	3.01		

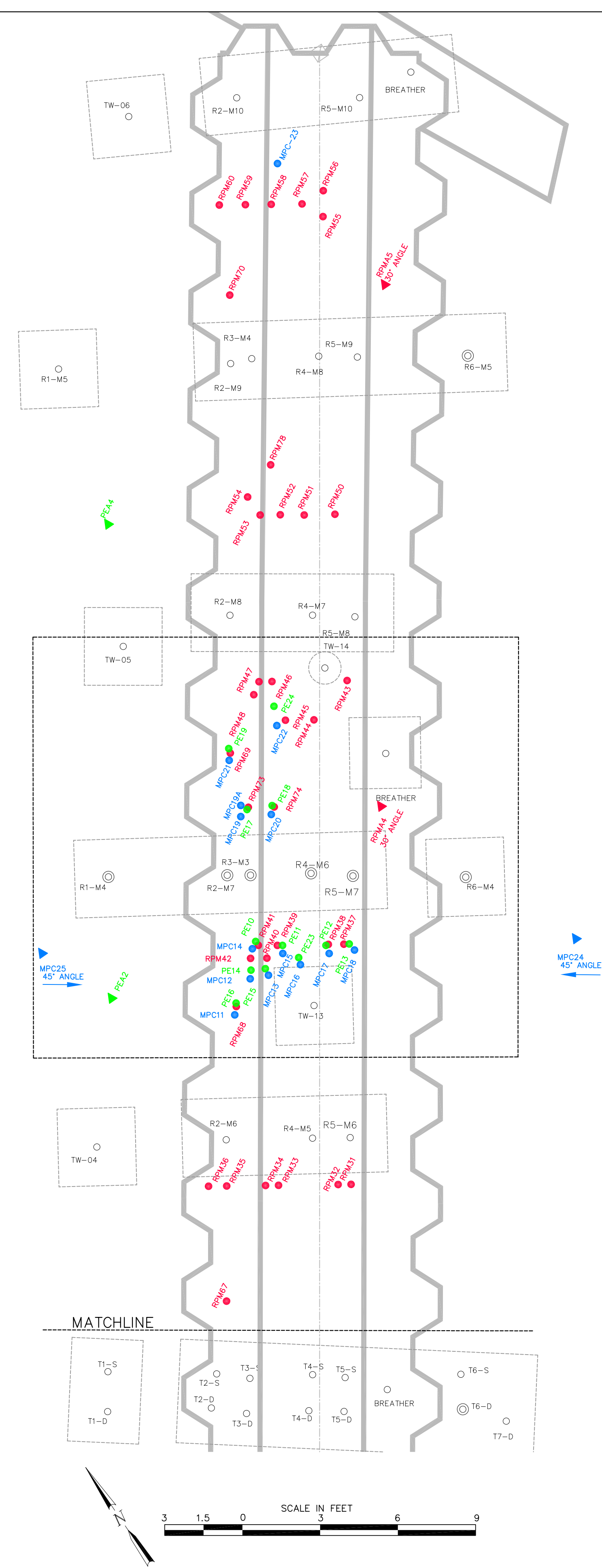
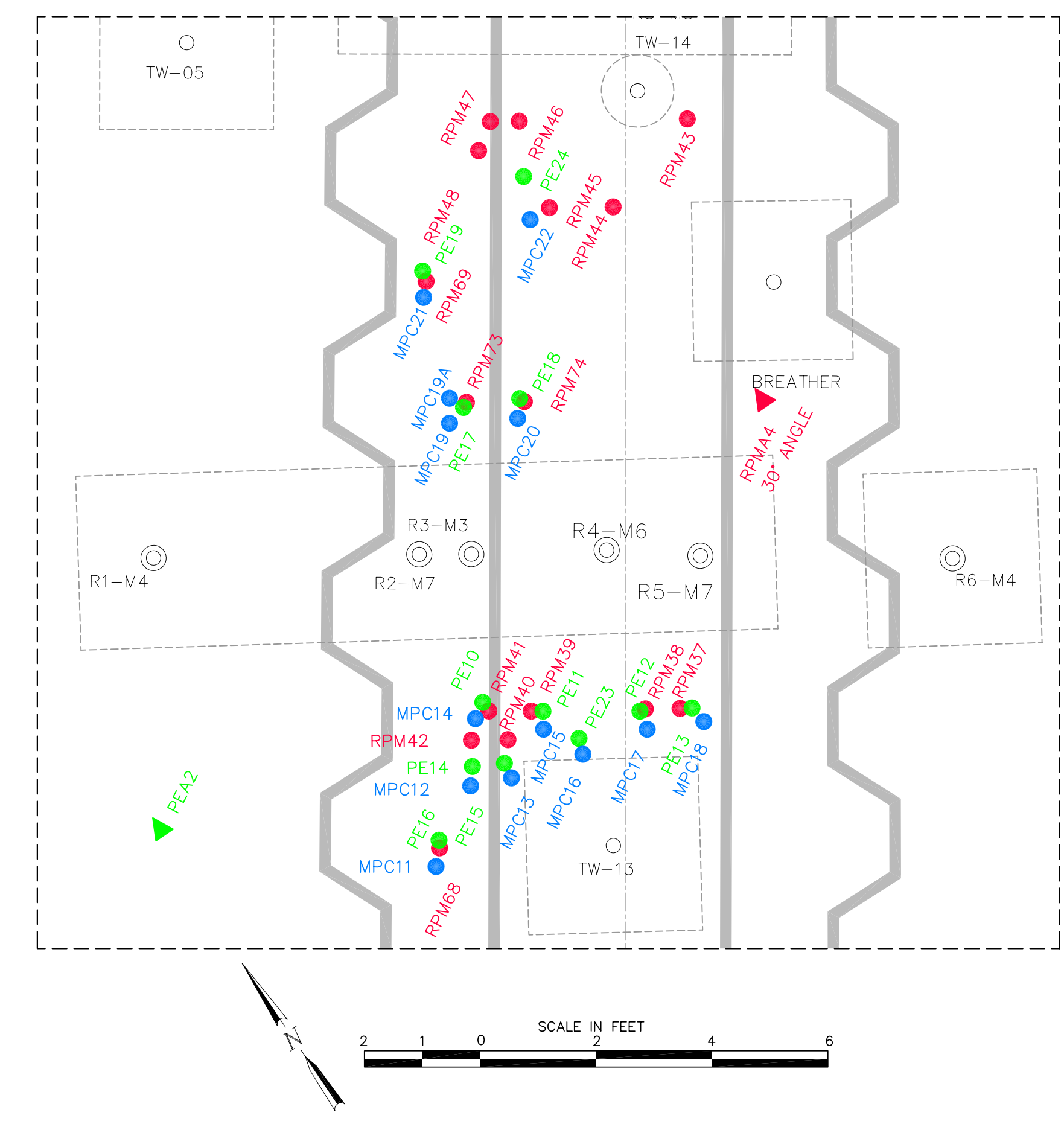
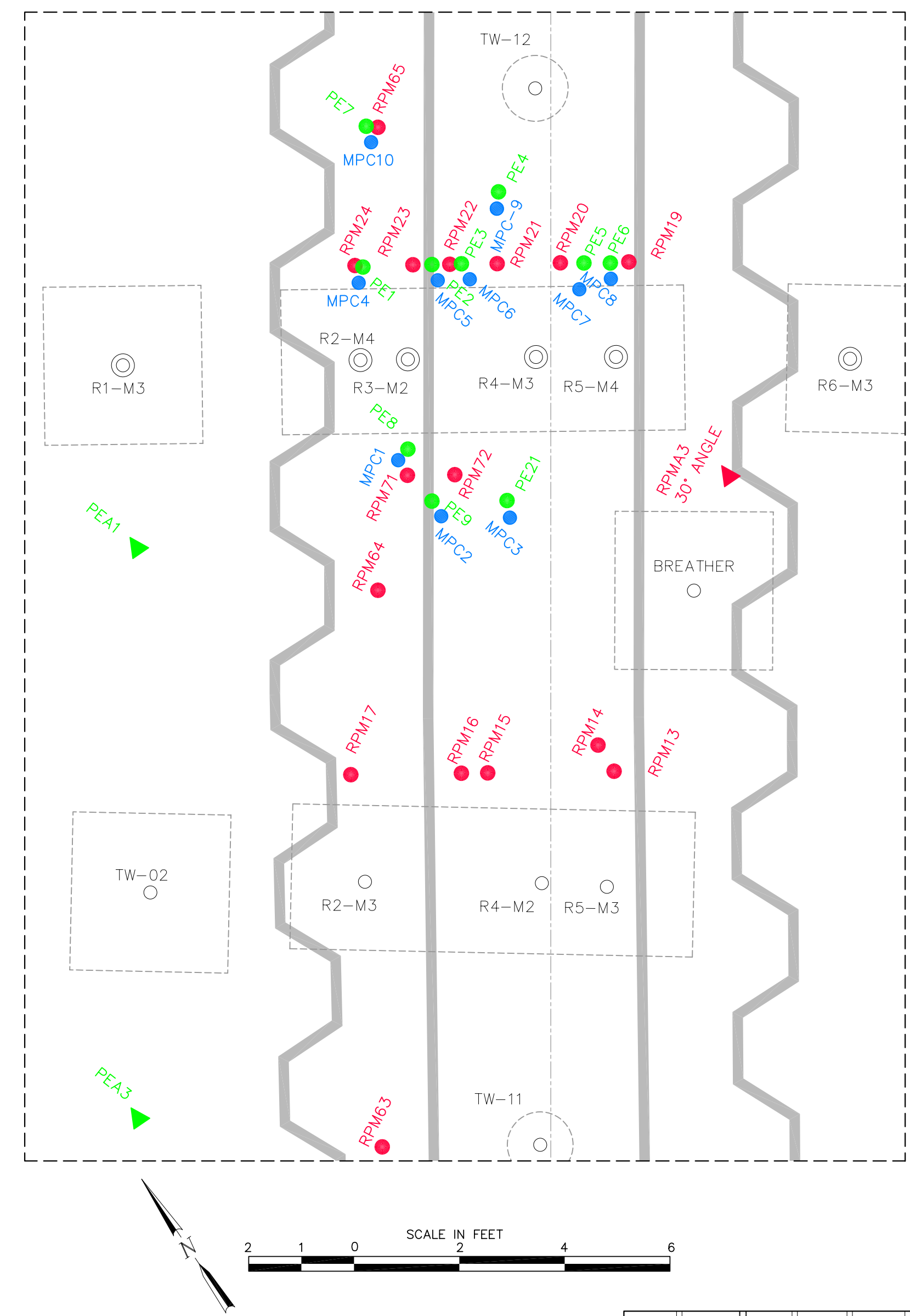
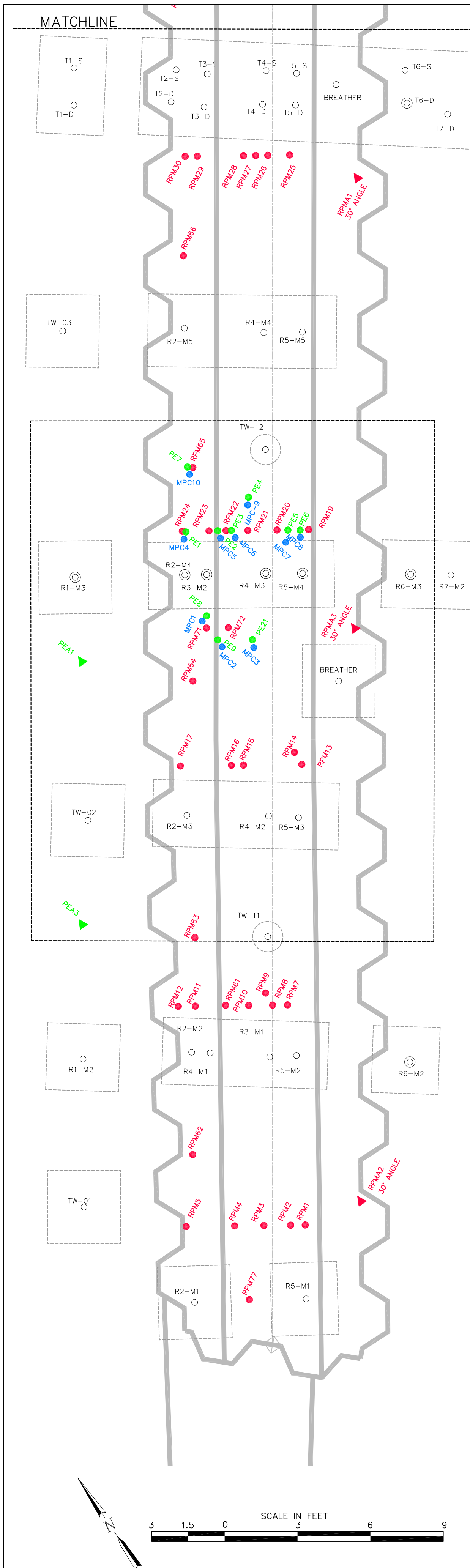
Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 17-2	Z	3/21/2006	2	3.5	6	6.0	</= bkg	9.64	2.05		
MPC 17-3	Z	3/21/2006	3	6	8.5	6.6	</= bkg	7.46	1.74		
MPC 17-4	Z	3/21/2006	3	6	8.5	7.3	</= bkg	9.48	2.04	28800	0.50
MPC 17-5	Z	3/21/2006	3	6	8.5	7.9	</= bkg	10.02	2.17		
MPC 17-6	Z	3/21/2006	3	6	8.5	8.0	</= bkg	10.75	2.07		
MPC 17-7	Z	3/21/2006	4	8.5	11	9.1	</= bkg	11.65	2.16		
MPC 17-8	Z	3/21/2006	4	8.5	11	9.8	</= bkg	13.64	2.56		
MPC 17-9	Z	3/21/2006	4	8.5	11	10.4	</= bkg	15.39	2.45		
MPC 17-10	Z	3/21/2006	4	8.5	11	10.5	</= bkg	15.30	2.45	37000	0.50
MPC 17-11	Z	3/21/2006	5	11	14.3	11.5	</= bkg	19.62	1.99	18800	0.50
MPC 17-12	Z	3/21/2006	5	11	14.3	11.9	</= bkg	18.82	2.06		
MPC 17-13	Z	3/21/2006	5	11	14.3	12.4	</= bkg	18.49	2.27		
MPC 17-14	Z	3/21/2006	5	11	14.3	12.9	</= bkg	17.25	2.22	22900	0.50
MPC 17-15	Z	3/21/2006	5	11	14.3	13.4	</= bkg	18.75	1.90		
MPC 17-16a	Z	3/21/2006	5	11	14.3	13.8	</= bkg	18.57	2.10		
MPC 17-16b	B	3/21/2006	5	11	14.3	14.3	</= bkg	13.07	1.47		
MPC 18-1	Z	3/21/2006	1	3	3.5	3.1	</= bkg	4.50	2.04		
MPC 18-2	Z	3/21/2006	2	3.5	6	4.1	</= bkg	10.72	2.32		
MPC 18-3	Z	3/21/2006	2	3.5	6	4.8	</= bkg	9.01	2.24		
MPC 18-4	Z	3/21/2006	2	3.5	6	5.4	</= bkg	12.80	2.21		
MPC 18-5	Z	3/21/2006	2	3.5	6	5.5	</= bkg	15.46	1.98		
MPC 18-6	Z	3/21/2006	3	6	8.5	6.8	</= bkg	17.91	1.97		
MPC 18-7	Z	3/21/2006	3	6	8.5	7.7	</= bkg	15.99	2.19		
MPC 18-8	G	3/21/2006	3	6	8.5	8.5	</= bkg	17.10	1.64		
MPC 18-9	G	3/21/2006	4	8.5	11	9.3	</= bkg	8.27	1.34		
MPC 18-10	G	3/21/2006	4	8.5	11	10.2	</= bkg	8.47	1.54		
MPC 18-11	G	3/21/2006	4	8.5	11	11.0	</= bkg	8.06	1.52		
MPC 18A-1	Z	3/21/2006	1	3	6.5	3.9	</= bkg	5.98	2.24		
MPC 18B-1	Z	3/21/2006	1	3	3.5	3.5	</= bkg	5.55	2.26		
MPC 18B-2	Z	3/21/2006	2	3.5	6	4.0	</= bkg	10.02	1.94		
MPC 18B-3	Z	3/21/2006	2	3.5	6	4.5	</= bkg	8.82	2.06		
MPC 18B-4	Z	3/21/2006	2	3.5	6	5.0	</= bkg	15.80	1.81		
MPC 18B-5	Z	3/21/2006	2	3.5	6	5.5	</= bkg	19.21	1.55		
MPC 18B-6	Z	3/21/2006	2	3.5	6	6.0	</= bkg	18.69	1.90		
MPC 18B-7	Z	3/21/2006	3	6	8.5	6.5	</= bkg	18.56	1.63		
MPC 18B-8	Z	3/21/2006	3	6	8.5	7.0	</= bkg	16.71	2.20		
MPC 18B-9	Z	3/21/2006	3	6	8.5	7.5	</= bkg	15.23	2.30		
MPC 18B-10	Z	3/21/2006	3	6	8.5	8.0	</= bkg	14.78	2.43		
MPC 18B-11	Z	3/21/2006	3	6	8.5	8.5	</= bkg	13.08	1.98	27000	0.50
MPC 18B-12	Z	3/21/2006	4	8.5	11	9.1	</= bkg	15.81	2.10		
MPC 18B-13	Z	3/21/2006	4	8.5	11	9.8	</= bkg	16.83	2.33		
MPC 18B-14	Z	3/21/2006	4	8.5	11	10.4	</= bkg	17.04	2.20		
MPC 18B-15	Z	3/21/2006	4	8.5	11	11.0	</= bkg	15.30	2.21	40100	0.50
MPC 18B-16	Z	3/21/2006	5	11	13.5	11.8	</= bkg	15.51	2.16	24900	0.50

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 18B-17	Z	3/21/2006	5	11	13.5	12.7	<= bkg	16.96	2.32	20500	0.50
MPC 18B-18	Z	3/21/2006	5	11	13.5	13.5	<= bkg	17.06	2.22		
MPC 18B-19	Z	3/21/2006	6	13.5	14.1	14.1	<= bkg	17.71	1.82	17600	0.50
MPC19-1	G	3/20/2006	1	3	3.5	3.0	1200	6.11	1.38		
MPC19-2	G	3/20/2006	2	3.5	6	4.8	1200	10.70			
MPC19-3	G	3/20/2006	2	3.5	6	6.0	2800	11.41			
MPC19-4	G	3/20/2006	3	6	8.5	6.5	2800	8.58	2.00		
MPC19-5	G	3/20/2006	3	6	8.5	7.0	7000	10.77	1.90		
MPC19-6	G	3/20/2006	3	6	8.5	7.5	6000	11.14	1.87		
MPC19-7	G	3/20/2006	3	6	8.5	8.0	1500	10.69	1.92		
MPC19-8	G	3/20/2006	3	6	8.5	8.5	4000	8.69	1.44		
MPC19A-1	G	3/23/2006	1	3	3.5	3.5	<= bkg	3.85			
MPC19A-2	G	3/23/2006	2	3.5	6.8	4.2	2800	10.32			
MPC19A-3	G	3/23/2006	2	3.5	6.8	4.8	4200	12.07			
MPC19A-4	G	3/23/2006	2	3.5	6.8	5.5	4000	9.95			
MPC19A-5	G	3/23/2006	2	3.5	6.8	6.1	2300	10.75			
MPC19A-6	G	3/23/2006	2	3.5	6.8	6.8	5600	9.80			
MPC19A-7	G	3/23/2006	3	6.8	10.8	7.5	5600	10.26			
MPC19A-8	G	3/23/2006	3	6.8	10.8	8.1	5600	10.97		22100	240
MPC19A-9	G	3/23/2006	3	6.8	10.8	8.8	4200	10.88		13900	181.1
MPC19A-10	G	3/23/2006	3	6.8	10.8	9.5	2800	10.34			
MPC19A-11	G	3/23/2006	3	6.8	10.8	10.1	4000	10.33			
MPC19A-12	G	3/23/2006	3	6.8	10.8	10.8	2800	9.84		55800	184.3
MPC19A-13	G	3/23/2006	4	10.8	12.5	11.1	8400	16.37			
MPC19A-14	G	3/23/2006	4	10.8	12.5	11.5	15400	10.91			
MPC19A-15	G	3/23/2006	4	10.8	12.5	11.8	15400	11.33			
MPC19A-16	G	3/23/2006	4	10.8	12.5	12.2	1400	10.21			
MPC19A-17	G	3/23/2006	4	10.8	12.5	12.5	2000	9.96		31300	110
MPC20-1	Z/F	3/20/2006	1	3	3.5	3.0	2800	10.27	2.31		
MPC20-2	Z	3/20/2006	2	3.5	6	4.5	<= bkg	11.37	2.46		
MPC20-3	Z	3/20/2006	2	3.5	6	5.0	<= bkg	8.10	2.57		
MPC20-4	Z	3/20/2006	2	3.5	6	5.5	<= bkg	12.11	2.75		
MPC20-5	Z	3/20/2006	2	3.5	6	6.0	<= bkg	14.33	2.50	30300	12.15
MPC20-6	Z	3/20/2006	3	6	8.5	6.4	<= bkg	14.04	2.26		
MPC20-7	Z	3/20/2006	3	6	8.5	6.8	<= bkg	11.63	2.51		
MPC20-8	Z	3/20/2006	3	6	8.5	7.3	<= bkg	11.98	2.45		
MPC20-9	Z	3/20/2006	3	6	8.5	7.7	<= bkg	13.44	2.33	32400	0.50
MPC20-10	Z	3/20/2006	3	6	8.5	8.1	<= bkg	13.72	2.33		
MPC20-11	Z	3/20/2006	3	6	8.5	8.5	<= bkg	13.74	1.97		
MPC20-12	Z	3/20/2006	4	8.5	11	9.0	<= bkg	12.97	1.94		
MPC20-13	Z	3/20/2006	4	8.5	11	9.5	<= bkg	14.99	2.28	16900	0.50
MPC20-14	Z	3/20/2006	4	8.5	11	10.0	<= bkg	14.51	2.20		
MPC20-15	Z	3/20/2006	4	8.5	11	10.5	<= bkg	16.73	1.99	19800	0.50
MPC20-16	Z	3/20/2006	4	8.5	11	11.0	<= bkg	14.36	2.07		

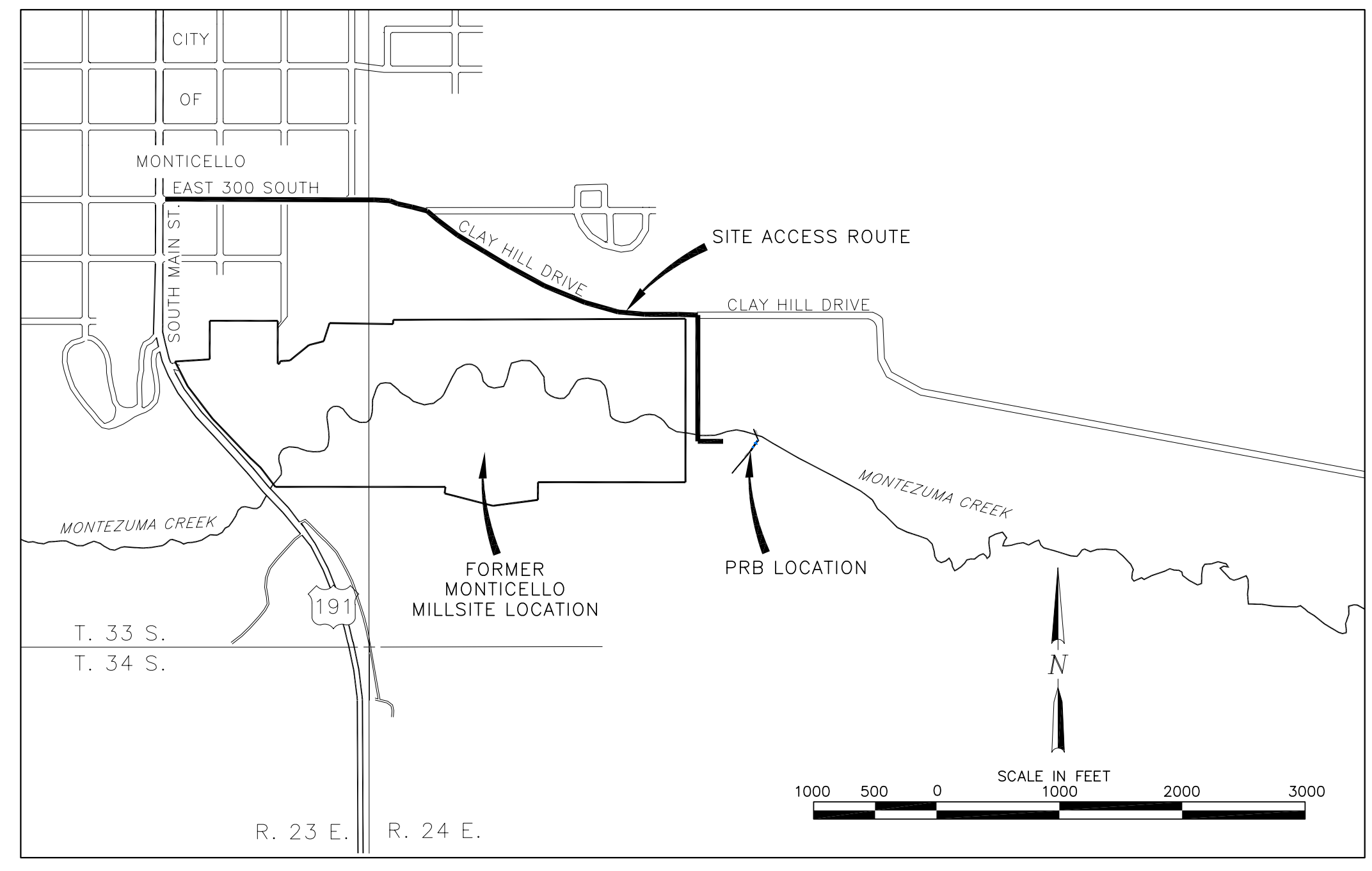
Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC20-17	Z/F	3/20/2006	5	11	13.5	11.6	</= bkg	15.47	2.41		
MPC20-18	Z	3/20/2006	5	11	13.5	12.3	</= bkg	12.92	2.75		
MPC20-19	Z	3/20/2006	5	11	13.5	12.9	</= bkg	11.83	2.91		
MPC20-20	Z	3/20/2006	5	11	13.5	13.5	</= bkg	12.51	2.84	14400	0.50
MPC20-21	Z	3/20/2006	6	13.5	14	14.0	</= bkg	11.81	2.90		
MPC 21-1	G	3/20/2006	2	3.5	7.5	4.8	1200	7.88	1.22		
MPC 21-2	G	3/20/2006	2	3.5	7.5	6.2	1200	5.51	1.40		
MPC 21-3	G	3/20/2006	2	3.5	7.5	7.5	</= bkg	7.40			
MPC 21-4	G	3/20/2006	3	7.5	10	8.0	1200	9.28	1.48		
MPC 21-5	G	3/20/2006	3	7.5	10	8.5	4000	11.03	1.71		
MPC 21-6	G	3/20/2006	3	7.5	10	9.0	4000	12.00	1.55	59800	447.2
MPC 21-7	G	3/20/2006	3	7.5	10	9.5	4000	13.71	1.45		
MPC 21-8	G	3/20/2006	3	7.5	10	10.0	5600	12.85	1.49	67000	694.3
MPC 21-9	G	3/20/2006	4	10	15	11.0	2800	10.43	1.62		
MPC 21-10	G	3/20/2006	4	10	15	12.0	4500	8.26	1.72	11500	242.4
MPC 21-11	G	3/20/2006	4	10	15	13.0	5100	9.25	1.64	7100	223.5
MPC 21-12	G	3/20/2006	4	10	15	14.0	</= bkg	8.62	1.89		
MPC 21-13	G	3/20/2006	4	10	15	15.0	</= bkg	10.01	2.22		
MPC 21-14	G	3/20/2006	5	15	15.1	15.1	</= bkg	12.44			
MPC22-1	Z	3/20/2006	1	3.5	4	4.0	</= bkg	5.73	2.49		
MPC22-2	Z	3/20/2006	2	3.5	5.5	4.0	</= bkg	13.64	2.32		
MPC22-3	Z	3/20/2006	2	3.5	5.5	4.5	</= bkg	14.49	2.39		
MPC22-4	Z	3/20/2006	2	3.5	5.5	5.0	</= bkg	11.40	2.47		
MPC22-5	Z	3/20/2006	2	3.5	5.5	5.5	</= bkg	10.33	2.43		
MPC22-6	Z	3/20/2006	3	5.5	9	6.4	</= bkg	10.85	2.38		
MPC22-7	Z	3/20/2006	3	5.5	9	7.3	</= bkg	15.54	2.26		
MPC22-8	Z	3/20/2006	3	5.5	9	8.1	</= bkg	15.31	2.35		
MPC22-9	Z	3/20/2006	3	5.5	9	9.0	</= bkg	16.05	2.21	11900	0.50
MPC22-10	Z	3/20/2006	4	9	11.5	9.5	</= bkg	16.08	2.17		
MPC22-11	Z	3/20/2006	4	9	11.5	9.8	</= bkg	13.94	2.43		
MPC22-12	Z	3/20/2006	4	9	11.5	10.3	</= bkg	13.65	2.53	27300	0.50
MPC22-13	Z	3/20/2006	4	9	11.5	11.0	</= bkg	14.97	2.46	31400	0.50
MPC22-14	Z	3/20/2006	4	9	11.5	11.5	</= bkg	14.42	2.37	34600	0.50
MPC22-15	Z	3/20/2006	5	11.5	14	11.9	</= bkg	15.20	2.32		
MPC22-16	Z	3/20/2006	5	11.5	14	12.3	</= bkg	16.34	2.29	38300	0.50
MPC22-17	Z	3/20/2006	5	11.5	14	12.8	</= bkg	15.91	2.36		
MPC22-18	Z	3/20/2006	5	11.5	14	13.2	</= bkg	14.90	2.37		
MPC22-19	Z	3/20/2006	5	11.5	14	13.6	</= bkg	14.32	2.40		
MPC22-20a	Z	3/20/2006	5	11.5	14	13.9	</= bkg	14.88	2.54		
MPC22-20b	Z	3/20/2006	5	11.5	14	14.0	</= bkg	17.37	1.37		
MPC 23-1	Z	3/23/2006	1	3	3.5	3.5	</= bkg	4.75			
MPC 23-2	Z	3/23/2006	2	3.5	7	4.0	</= bkg	8.07	1.38		
MPC 23-3	Z	3/23/2006	2	3.5	7	4.5	</= bkg	8.09	2.22		
MPC 23-4	Z	3/23/2006	2	3.5	7	5.0	</= bkg	13.64	2.56		

Sample Number	Zone	Sampling Date	Core No.	Core Interval start (ft)	Core Interval end (ft)	Bottom Sample Depth (ft)	Radiation Dry Sample (dpm)	Moisture Content (wgt %)	Dry Bulk Density (g/cc)	Ca (mg/kg)	U (mg/kg)
MPC 23-5	Z	3/23/2006	2	3.5	7	5.5	<= bkg	15.57	2.43		
MPC 23-6	Z	3/23/2006	2	3.5	7	6.0	<= bkg	14.84	2.37		
MPC 23-7	Z	3/23/2006	2	3.5	7	6.5	<= bkg	17.23	2.19		
MPC 23-8	Z	3/23/2006	2	3.5	7	7.0	<= bkg	15.11	1.92		
MPC 23-9	Z	3/23/2006	3	7	10.3	7.6	<= bkg	11.41	2.77		
MPC 23-10	Z	3/23/2006	3	7	10.3	8.1	<= bkg	12.52	2.93	24900	0.50
MPC 23-11	Z	3/23/2006	3	7	10.3	8.7	<= bkg	17.10	2.31		
MPC 23-12	Z	3/23/2006	3	7	10.3	9.2	<= bkg	17.06	2.41		
MPC 23-13	Z	3/23/2006	3	7	10.3	9.8	<= bkg	15.21	2.49	20100	0.50
MPC 23-14	Z	3/23/2006	3	7	10.3	10.3	<= bkg	14.41	2.44		
MPC 23-15	Z	3/23/2006	4	10.3	12.8	10.9	<= bkg	12.88	2.11	30700	0.50
MPC 23-16	Z	3/23/2006	4	10.3	12.8	11.6	<= bkg	15.47	2.34		
MPC 23-17	Z	3/23/2006	4	10.3	12.8	12.2	<= bkg	14.24	2.49	41000	0.50
MPC 23-18	Z	3/23/2006	4	10.3	12.8	12.8	<= bkg	16.37	2.26		

End of current text



- LEGEND**
- R1-M2 ○ MONITORING WELL
 - R1-M3 ○ MONITORING WELL - CURRENTLY BEING SAMPLED
 - RPM1 ● VERTICAL CORING LOCATION - FEBRUARY 2002
 - PE1 ● CORING LOCATION - AUGUST 2003
 - MPC1 ● CORING LOCATION - MARCH 2006
 - RPM1▲ ANGLE CORING LOCATION - FEBRUARY 2002
 - PE1▲ ANGLE CORING LOCATION - AUGUST 2003
 - MPC25▲ ANGLE CORING LOCATION - MARCH 2006



U.S. DEPARTMENT OF ENERGY
 GRAND JUNCTION OFFICE
 GRAND JUNCTION, COLORADO

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 S.M. Stoller Corporation
 Under DOE Contract
 No. DE-AC13-02GJ79491

**MONTICELLO PRB
 CORING LOCATIONS**

DATE PREPARED:
 APRIL 11, 2006

FILENAME:
 Q0027200