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July 16, 2009

Mr. Aaron Yue
Department of Toxic Substances Control
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Cypress, CA 90630

Ms. Pamela Innis
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Subject: Summary of Results - MW-56 Anaerobic Core Hexavalent Chromium Uptake Capacity
PG&E Topock Compressor Station, Needles, California

Dear: Mr. Yue and Ms. Innis:

This letter transmits the technical memorandum *Summary of Results - MW-56 Anaerobic Core Hexavalent Chromium Uptake Capacity* for the Pacific Gas and Electric Company (PG&E) Topock Compressor Station site. This report summarizes the tests conducted on core sections collected from slant well cluster MW-56. The work was conducted by PG&E to supplement previous anaerobic core studies at the Topock site. The results provide evidence of similar anaerobic conditions on the Arizona side of the river, via testing of core samples collected at regularly spaced depth intervals, rather than sample selection based on geological or geochemical observations in the field.

Please contact me at (805) 234-2257 with any questions or concerns.

Sincerely,

Yvonne Meeks

Yvonne Meeks
Topock Project Manager

cc: Chris Guerre/DTSC
Karen Baker/DTSC
Richard Newill/DOI

Summary of Results – MW-56 Anaerobic Core Hexavalent Chromium Uptake Capacity, PG&E Topock Compressor Station, Needles, California

PREPARED FOR:	Pacific Gas and Electric Company
DATE:	July 8, 2009

Introduction and Purpose

This technical memorandum summarizes results of tests conducted on anaerobic core sections collected at the boring for monitoring well MW-56 on the Arizona side of the Colorado River from the Pacific Gas and Electric Company (PG&E) Topock Compressor Station in Needles, California. The testing program evaluated hexavalent chromium [Cr(VI)]) interactions between groundwater and solids collected from the anaerobic fluvial aquifer zone adjacent to and beneath the Colorado River. The results provided in this technical memorandum include tabulated data from laboratory testing and preliminary interpretation of the data.

The overall purpose of the anaerobic core test program was to demonstrate the capacity of fluvial sediments to chemically reduce Cr(VI) to trivalent chromium [Cr(III)]. This process results in the removal of chromium from groundwater since Cr(III) is relatively insoluble. Site characterization data indicate that, where reducing conditions dominate, Cr(VI) concentrations in site groundwater are low (CH2M HILL, 2009). The core testing program was designed to provide direct evidence to support or refute that this process is occurring at the site and to quantify the reducing capacity of the fluvial sediments.

Two previous anaerobic core testing events were documented in reports submitted to the California Department of Toxic Substances Control (DTSC). The first phase of anaerobic core testing was performed on samples collected from floodplain well clusters MW-28 and MW-36 in 2004 and was reported in the *Summary of Results - Anaerobic Core Hexavalent Chromium Uptake Capacity at the PG&E Topock Compressor Station, Needles, California* (CH2M HILL, 2005a). The second phase of anaerobic core testing was performed on samples collected in February 2007 from the MW-52 and MW-53 slant well clusters drilled on the western edge of the Colorado River and reported in the *Phase II Anaerobic Core Testing Summary Report, PG&E Topock Compressor Station, Needles, California* (CH2M HILL, 2008).

In each previous study, core samples were incubated under nitrogen (i.e., anaerobic) atmosphere with Cr(VI)-containing site groundwater. After a designated reaction time, a sample of the aqueous phase was removed and analyzed for Cr(VI) to measure the progress of Cr(VI) reduction. The apparent Cr(VI) reduction capacity was calculated as the mass of Cr(VI) lost per dry mass of core sample. Each calculation is described as apparent because the calculated reduction capacity of the solids actually increases as more reaction time is allowed. No sample was found to reach equilibrium and to exhibit a constant Cr(VI) concentration; ongoing reduction of Cr(VI) was observed in all samples. Reduction capacities described below should therefore be viewed as "snapshots" of reducing capacities after a specific time rather than maximum total reducing capacities.

The five cores tested in Phase I showed measureable but relatively small reducing capacity (160 to 300 micrograms Cr(VI) per kilogram dry solid [µg/kg]), due in part from the invasion of atmospheric oxygen during core preservation in the field (CH2M HILL, 2005a). Samples sat in the open air for about 5 to 15 minutes before being heat-sealed in specialized core-wrapping material. Laboratory reaction time for the Phase I core samples was 30 minutes. Two of the cores were allowed to react further, and samples were collected from those two cores after six weeks of total reaction time. Phase II cores were preserved inside a field nitrogen glove box, and cores were selected for maximum grain size and most reduced appearance to provide the opportunity for quantification of capacity. Not only were Phase II cores extracted within a glovebox, but the core-wrapping material was purged of air with nitrogen gas before being heat-sealed. In this way, Phase II samples had far less exposure to air than Phase I samples. The four Phase II cores showed substantially higher average reducing capacity (28,000 to 150,000 µg/kg at six weeks) compared to the Phase I core. Phase II cores were allowed to react for 26 weeks and, by then, the range in calculated reducing capacity was about 44,000 to over 191,000 µg/kg (CH2M HILL, 2008). Measured reducing capacities in all Phase II cores were following increasing trends at the end of 26 weeks, indicating that the maximum reducing capacity is likely greater than that measured at 26 weeks. Four other Phase II cores, dosed with much lower amounts of Cr(VI), were measured after 31 weeks of reaction, and the amount of Cr(VI) remaining in solution was close to the reporting limit. The calculated reduction capacities of the four low-dose, 31-week samples were lower than the 26-week samples because the amount of Cr(VI) mass available for reduction was much lower in the 31-week samples. Overall, the data demonstrated that all eight cores showed significant reducing capacity.

In a meeting between the Southern California Metropolitan Water District (MWD) and PG&E in July 2007, the consultant to MWD suggested collecting anaerobic core samples from regularly-spaced depth intervals to provide a complete profile of reducing capacity. Previous core samples had been selected from zones that were considered likely to have above-average reducing capacity based on color or organic content.

The testing described in this technical memorandum was conducted for PG&E without order from regulatory agencies. It is designed to supplement existing data and to provide a profile of reducing capacity from regularly-spaced sample depths.

Selected Cores

During April 2008, drill cores were collected from the boring for the MW-56 slant well cluster located along the floodplain on the Arizona side of the Colorado River. Cores were collected using the same nitrogen glove box techniques as used in Phase II (CH2M HILL, 2008).

Anaerobic conditions were identified in groundwater samples from MW-56 by a combination of: (1) strongly negative oxidation-reduction potential readings, (2) the presence of dissolved iron and manganese, and (3) non-detectable nitrate concentrations.

Nineteen core samples were collected over the 223-foot drilled boring length. Because MW-56 was drilled at a 30-degree angle from the horizontal, the total vertical drilling depth was about 112 feet. Where feasible, core samples were collected every 10 feet of drilled depth (5-foot vertical depth interval). There was insufficient sample available for collection at the 180-foot drilled depth. Core sample depth intervals and logged descriptions are provided in Table 1.

Work Performed

Preserved cores were sent to the CH2M HILL Applied Sciences Laboratory, located in Corvallis, Oregon, for testing. Selected cores were analyzed following the procedures described in Attachment 1. Procedures were similar to those described in the Anaerobic Core Testing Work Plan for the Phase II sampling program (CH2M HILL, 2006). The core tests were carried out in a nitrogen atmosphere inside a glove box.

Unlike previous core testing—which evaluated other properties such as Walkley-Black reduction capacity, total organic carbon, ferrous iron content, and sequential extraction metals concentrations in addition to reaction with site groundwater—the current work focused solely on Cr(VI) reduction from site groundwater. Groundwater from well MW-51 was used as a reagent and was diluted to achieve a starting Cr(VI) concentration of 2,855 micrograms per liter (µg/L) Cr(VI). Moisture content of each core sample was measured for use in final calculations.

Based on measured moisture content of each core, a mass of field-moist core sample equivalent to exactly 50 grams dry mass was placed in the reaction vessel. Then 1.5 liters of diluted groundwater were added to the sample and agitated. The system was allowed to react under anaerobic conditions for 17 weeks. During this period, the samples were periodically stirred to promote liquid-solid contact, as was done during the Phase II testing. At the end of 17 weeks, a water sample was extracted from each core system and was sent to Truesdail Laboratories, Inc., the analytical laboratory contracted by PG&E, for analysis of Cr(VI) concentration.

Reducing capacity was calculated by subtracting the total starting µg Cr(VI) in solution from the total final µg Cr(VI) and dividing the difference by the 0.050-kilogram dry mass of core sample used in the experiment. The calculation may be expressed by the following equation:

$$\text{Reduction Capacity } (\mu\text{g Cr(VI)/kg dry soil}) = (1.5/0.05) \times \{[\text{Cr(VI)}]_i - [\text{Cr(VI)}]_f\}$$

where the subscripts "i" and "f" represent initial and final Cr(VI) concentrations, in µg/L, with $[\text{Cr(VI)}]_i$ equal to 2,855 µg/L for each experiment.

Quality Assurance/Quality Control

The laboratory analytical data generated from the anaerobic core testing were independently reviewed by project chemists to assess data quality, as described below. Quality assurance and quality control requirements outlined in the Quality Assurance Project Plan for the PG&E Topock Program, which is Appendix D of the *Sampling, Analysis,* *and Field Procedures Manual, Revision 1* (CH2M HILL, 2005b), are not specifically relevant to the anaerobic core testing data.

Analytical Data – Quality Review

At 17 weeks after initial exposure, Cr(VI) aqueous samples were extracted to determine the extent of Cr(VI) reduction. The samples were collected on October 22, 2008 and were sent to Truesdail Laboratory, Inc. for analysis. Due to a delay in FedEx delivery, the samples were received in the laboratory on October 24 (48 hours after sample collection). The laboratory analyzed for Cr(VI) using United States Environmental Protection Agency (USEPA) Method 218.6, which is standard protocol for the PG&E Topock project, following the USEPA authorization of a 28-day holding time for Cr(VI) (USEPA, 2007). The samples met all the PG&E Topock Quality Assurance Project Plan quality control criteria (calibration, method blanks, blank spikes, matrix spikes, and laboratory duplicates) with two exceptions:

- **Holding time or method preservation.** The samples were received outside the recommended 24-hour holding time associated with SW846 Method 7199 and were not preserved within 24 hours as recommended for USEPA Method 218.6. The samples were prepared and analyzed immediately following receipt in the laboratory. Holding-time exceedances or improper preservation can result in the possible loss of target analytes due to degradation or chemical reactions that usually cause a negative bias to sample results. However, the addition of one extra day prior to analysis (less than 1 percent of the overall reduction time) should provide little to no bias because the anaerobic core test program was performed to demonstrate the capacity of fluvial sediments to chemically reduce Cr(VI) to Cr(III) over time. Unlike natural samples, these Cr(VI) samples were collected from a laboratory incubation in chemically-reducing soil-water mixture under a nitrogen atmosphere and were placed in sample containers open to the atmosphere. The sample container atmosphere would be expected to have far less ability to reduce Cr(VI) than the incubated samples, so the holding time is not considered important for samples of this type. Nonetheless, in keeping with USEPA protocol, the samples analyzed after the 24-hour holding time were qualified as estimated and "J" flagged but should be acceptable for the purpose of this study.
- **Field duplicate relative percent difference (RPD).** One field duplicate pair had an RPD (113 percent) greater than the upper control limit (20 percent). The detected results were qualified and flagged "J." This issue should also provide little to no bias when viewed from the reduction capacity perspective. The sample and its field duplicate reduced the Cr(VI) concentration by 99.6 percent and 98.4 percent, respectively. The calculated RPD of the reduced Cr(VI) is 1.2 percent.

Summary of Results

Results of Cr(VI) reducing capacity experiments are provided in Table 2. Calculated reducing capacity ranged from 2,850 to 85,644 µg/kg over the 17-week exposure period. Five of the core samples showed Cr(VI) below reporting limit for the 17-week water samples. Their reduction capacities were calculated assuming the reporting limit of 0.2 µg/L (assuming a lower concentration would make little difference in the calculated capacities). The average reducing capacity of the 19 cores was 54,053 µg/kg. By comparison, the four

Phase II cores selected for long-term testing ranged from 33,542 to 176,446 µg/kg after 15 weeks of reaction, with an average of 115,536 µg/kg. However, the Phase II cores were deliberately selected in the field for above average reduction capacity, and then the four highest capacity cores out of eight were selected in the lab on the basis of short-term performance. The current data set represents an unbiased selection of cores and, as expected, the high end of the range overlaps with the Phase II results, but the low end of the range is less than was measured in Phase II. It would be expected that additional reducing capacity would be observed if reaction time were extended beyond 17 weeks, as occurred in the Phase II samples.

Core sample results are shown plotted against depth in the MW-56 borehole in Figure 1. The results were found to cluster along distinct depth intervals, with the highest values found in the 18- to 59-foot and 109- to 169-foot depth ranges. Comparatively lower capacities were found at the shallowest sample (8 feet), 69 to 99 feet, and at the bottom of the boring at 209 to 219 feet.

Discussion and Conclusions

Reduction Capacity Related to Natural Attenuation

As reported in the previous section, the measured reduction capacity of the 19 core samples ranged between 2,850 and 85,644 µg Cr(VI)/kg dry mass after 17 weeks. These are considered minimum values because five samples had consumed all of the measurable Cr(VI) at the end of the testing, and Phase II sample data indicated upward trends in reducing capacity even after 26 weeks. The maximum capacity of 85,644 µg/kg represents the greatest achievable reduction based on test design, as all available Cr(VI) was used up. These values can be compared to estimated Topock site plume Cr(VI) mass to assess the approximate degree to which the entire Cr(VI) plume could be mitigated were it to encounter the anaerobic floodplain materials.

The Phase II core testing report used an estimate of total plume Cr(VI) mass of 21,000 pounds (CH2M HILL, 2008). During modeling of remedial alternatives in 2008, a more refined estimate of plume mass was made by digitizing concentration contours using more recent data. The resulting total mass estimate was about 34,000 pounds. The calculations and assumptions presented below are similar to those provided in the Phase II core testing report but incorporate the increased plume mass estimate and the range of measured reduction capacity from the additional testing of MW-56 cores.

Using the revised Cr(VI) plume mass estimate and assuming a total porosity of 0.35 and soil particle density of 2.65 grams per cubic centimeter, the range of measured capacities indicates that between 6.9 and 206 million cubic feet of anaerobic aquifer would be needed to reduce all of the Cr(VI) in the plume, based on the 17-week exposure time. Obviously, longer exposure times would occur under field conditions. The groundwater flow model was used to estimate the total area along which the simulated plume flowlines intersect with the anaerobic materials in the floodplain and under the river bottom, assuming no Interim Measures extraction. Assuming a 60-foot thickness of reducing fluvial aquifer (the observed range is 40 to 100 feet over the floodplain and river areas) and the total porosity and aquifer solids density presented above, the average reducing capacity required of the fluvial material beneath the floodplain and river to reduce the entire Cr(VI) plume would be 1,720 µg/kg. If the entire anaerobic zone consisted of the same range of measured reducing capacity found in the boring for well cluster MW-56, the current data indicate a capacity of between 1.7 and 50 times the required capacity for plume reduction, based on the 17-week core sample exposure time.

These calculations, although only approximate, suggest that there is capacity within the floodplain and beneath the river to reduce at least a significant portion of the Cr(VI) plume were the plume to reach the anaerobic portions of the floodplain and beneath the river. The most significant unknowns are:

1. The range of reducing capacities for all anaerobic materials. The current data provide a non-biased survey of core sample results from a single borehole. Through interpretation of the depositional history in this area, it would be reasonable to assume that the MW-56 data would be typical of the range found throughout the floodplains on either side of the river and beneath the river itself. However, a detailed map of all low- and high-capacity zones is not feasible.
2. The estimate of total Cr(VI) mass in the plume. This is based on estimated concentration contours and interpolation between well samples over three depth intervals. Additional data may render a more accurate value.

Conclusions

Conclusions of the testing conducted on anaerobic core sections are as follows:

- Laboratory evidence confirms that reducing fluvial sediments in the anaerobic zone beneath the floodplain and river have the capacity to remove Cr(VI) from groundwater via a chemical/biochemical reduction process. Chemical reduction of Cr(VI) to Cr(III) is effectively permanent and irreversible under site conditions (CH2M HILL, 2009).
- The core samples collected from the MW-56 slant borehole on the Arizona side of the river represent an unbiased collection of fluvial material, with samples collected at regular depth intervals when possible.
- Results indicate that reduction capacity ranges between 2,850 and 85,644 µg Cr(VI) per kg dry mass after 17 weeks of laboratory reaction time. Using estimates of plume Cr(VI) mass and mass of reducing fluvial material downgradient of the plume, these results correspond to between 1.7 and 50 times the required capacity to reduce the plume mass. These are very rough estimates made to place the results in the context of natural attenuation capacity.
- The conclusions of the Phase II core testing report are supported by the additional testing data from the MW-56 slant boring: the calculations suggest that there is sufficient capacity within the floodplain and beneath the river to reduce at least a significant portion of the Cr(VI) plume were the plume to come in contact with these sediments.

References

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__________. 2005b. *Sampling, Analysis, and Field Procedures Manual, Revision 1*. March.

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United States Environmental Protection Agency (USEPA). 2007. 40 CFR Part 122, 136, 141, 143, 430, 455, and 465. *Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; National Primary Drinking Water Regulations; and National Secondary Drinking Water Regulations; Analysis and Sampling Procedures*; Final Rule. March 12.

Tables

TABLE 1
Core Depth Intervals for Samples Collected from MW-56 Boring

SampleID	Depth Along Angled Boring Top Depth	Depth Along Angled Boring Bottom Depth	Time Outside Glove Box (min)	Date	Time	Vertical Depth Below Ground Surface Top Depth	Vertical Depth Below Ground Surface Bottom Depth	Log Description
MW-56-CS-8-10	8	10	0	04/09/08	11:35	4	5	POORLY GRADED SAND (SP)- Yellowish brn (10YR 5/6), 100% fn sand, loose, slightly moist
MW-56-CS-18-20	18	20	5	04/09/08	11:40	9	10	POORLY GRADED SAND (SP)- very dk greyish brn, 98% fn sand, 2% silt, wet
MW-56-CS-49-50	49	50	0	04/09/08	17:30	24.5	25	POORLY GRADED SAND (SP)- Yellowish brn (10YR 5/6), 100% fn sand, loose, slightly moist
MW-56-CS-59-60	59	60	5	04/10/08	8:45	29.5	30	POORLY GRADED SAND (SP)- dk yellowish brn (10YR 4/4), 10% med sand, 88% fine sand, 2% silt, wet
MW-56-CS-69-70	69	70	0	04/10/08	8:40	34.5	35	POORLY GRADED SAND (SP)- Yellowish brn (10YR 5/6), 2% subrnd gravel, 98% subrnd sand [10% cse sand, 10% med sand, 78% fn sand], no fines, very moist. Iron oxide staining present
MW-56-CS-79-80	79	80	8	04/10/08	10:58	39.5	40	POORLY GRADED SAND (SP)- greyish brn (10YR 5/2), 2% subrnd gravel, 98% subrnd sand [10% cse sand, 10% med sand, 78% fn sand], no fines, very moist. Iron oxide staining present
MW-56-CS-89-90	89	90	0	04/10/08	10:50	44.5	45	POORLY GRADED SAND WITH GRAVEL (SP)- greyish brn (10YR 4/2), predominantly fn-cse sand with trace subrnd-rnd fn-cse gravel (up to 2.5 cm), very moist
MW-56-CS-99-100	99	100	7	04/10/08	13:10	49.5	50	POORLY GRADED SAND WITH GRAVEL (SP)- greyish brn (10YR 4/2), predominantly fn-cse sand with trace subrnd-rnd fn-cse gravel (up to 2.5 cm), very moist
MW-56-CS-109-110	109	110	0	04/10/08	13:03	54.5	55	POORLY GRADED SAND (SP)- dk grey (10YR 4/1), 98% fn sand, 2% silt
MW-56-CS-119-120	119	120	5	04/11/08	9:30	59.5	60	POORLY GRADED SAND (SP)- very dk greyish brn (10YR 3/2), 90% fn sand, 10% fines
MW-56-CS-129-130	129	130	0	04/11/08	9:25	64.5	65	POORLY GRADED SAND (SP)- greyish brn (10YR 5/2), 85% fn sand, 10% med sand, 5% fines, very moist

TABLE 1

Core Depth Intervals for Samples Collected from MW-56 Boring

SampleID	Depth Along Angled Boring		Time Outside Glove Box (min)	Date	Time	Vertical Depth Below Ground Surface		Log Description
	Top Depth	Bottom Depth				Top Depth	Bottom Depth	
MW-56-CS-139-140	139	140	5	04/11/08	12:55	69.5	70	POORLY GRADED SAND (SP)- greyish brn (10YR 4/2), 5% subrnd gravel (up to 5 cm), 85% fn sand, 10% fines, organic (wood) material present, wet
MW-56-CS-149-150	149	150	0	04/11/08	12:50	74.5	75	POORLY GRADED SAND with GRAVEL (SP): Composition change to 20% subrnd-rnd fn-cse gravel (up to 7.5 cm), 80% fn sand
MW-56-CS-159-160	159	160	5	04/11/08	16:15	79.5	80	POORLY GRADED SAND with GRAVEL (SP): dk grey (10YR 3/1), 78% fn sand, 20% med sand, 2% subrnd-rnd gravel (up to 2.5 cm), moist
MW-56-CS-169-170	169	170	0	04/11/08	16:10	84.5	85	POORLY GRADED SAND with GRAVEL (SP): very dk grey (10YR 3/1), 2% subrnd-rnd gravel (up to 6.5 cm), 98% fn-med sand, moist. 6-inch interval of organic material (wood) present
MW-56-CS-179-180	No sample collected							No Recovery
MW-56-CS-189-190	189	190	0	04/12/08	9:35	94.5	95	POORLY GRADED SAND with GRAVEL (SP)- Very dk greyish brn (2.5YR 3/2), 15% gravel (up to 6 cm), 80% fn sand, 5% fines, loose, slightly moist
MW-56-CS-199-200	199	200	5	04/12/08	12:25	99.5	100	SILTY GRAVEL (GM) - Very dk brn (10YR 2/2), 60% ang-subang gravel (up to 10 cm), 10% fn sand, 30% fines, poorly graded, gravel becomes well rnd with depth
MW-56-CS-209-210	209	210	0	04/12/08	12:20	104.5	105	SILTY GRAVEL (GM) - Very dk brn (10YR 2/2), 60% ang-subang gravel (up to 10 cm), 10% fn sand, 30% fines, poorly graded, gravel becomes well rnd with depth
MW-56-CS-219-220	219	220	0	04/12/08	16:15	109.5	110	MIOCENE CONGLOMERATE (BR) - Reddish brn (2.5YR 4/4), consolidated, dry

TABLE 2
Results of MW-56 Anaerobic Core Testing

Sample ID	Moisture (%)	Initial Cr(VI) (mg/L)	Final (17-week) Cr(VI) (mg/L)	Calculated Reduction Capacity (mg Cr(VI)/kg dry)
MW-56-CS-8	17.69	2,855	2,760	2,850
MW-56-CS-8 dup	dup	2,855	2,760	2,850
MW-56-CS-18	22.43	2,855	<0.2	>85,644
MW-56-CS-49	23.28	2,855	217	79,140
MW-56-CS-59	19.21	2,855	<0.2	>85,644
MW-56-CS-69	16.58	2,855	2,400	13,650
MW-56-CS-79	17.12	2,855	2,590	7,950
MW-56-CS-89	16.42	2,855	2,300	16,650
MW-56-CS-99	18.21	2,855	1,920	28,050
MW-56-CS-109	22.48	2,855	<0.2	>85,644
MW-56-CS-119	22.27	2,855	<0.2	>85,644
MW-56-CS-129	19.33	2,855	5.23	85,493
MW-56-CS-139	22.87	2,855	581	68,220
MW-56-CS-149	19.79	2,855	11.6	85,302
MW-56-CS-149 dup	dup	2,855	41.9	84,393
MW-56-CS-159	14.41	2,855	1,680	35,250
MW-56-CS-169	32.23	2,855	<0.2	>85,644
MW-56-CS-189	8.78	2,855	757	62,940
MW-56-CS-209	7.28	2,855	2,260	17,850
MW-56-CS-209 dup[a]	9.19	2,855	2,320	16,050
MW-56-CS-219	3.73	2,855	1,220	49,050

Notes:

[a] Original sample erroneously marked “MW-56-CS-219b,” but time of collection and observed properties verified it to be a duplicate 209-foot sample.

Figure

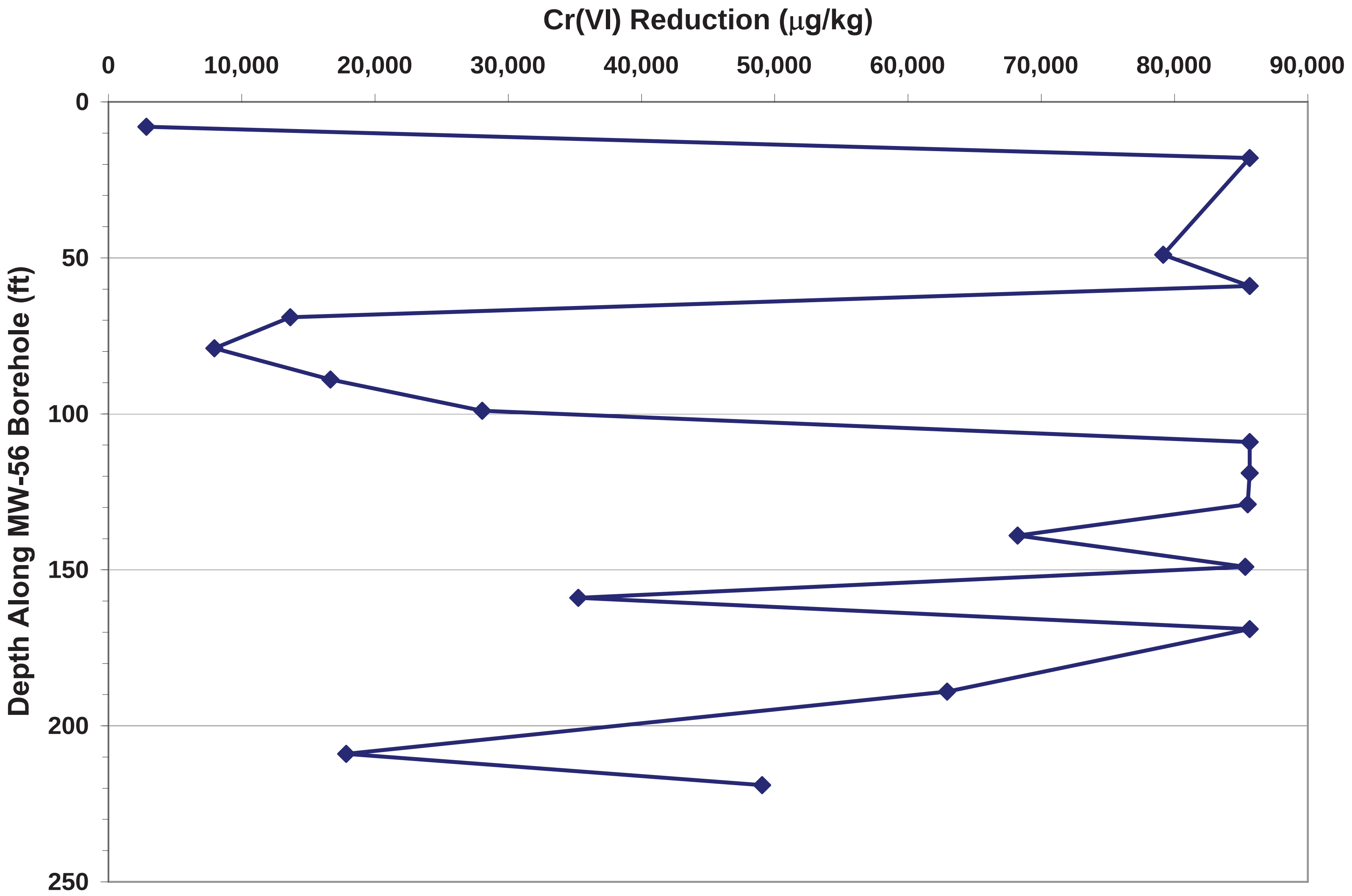

FIGURE 1
CALCULATED REDUCING CAPACITY WITH DEPTH

SUMMARY OF RESULTS – MW-56 ANAEROBIC CORE
HEXAVALENT CHROMIUM REDUCTION
TOPOCK COMPRESSOR STATION
NEEDLES, CALIFORNA

CH2MHILL

Attachment 1
Laboratory Testing Procedures

ATTACHMENT 1

Laboratory Testing ProceduresTask Descriptions

All work with anaerobic core sections will be performed under nitrogen, in an enclosed glove box, to preserve the cores and sub-samples in anaerobic conditions throughout the entire testing and post-testing period. Each sample will be analyzed in duplicate for data quality control. Unlike water samples, soil samples can be highly variable in their properties, and duplicate samples provide a measure of this variability, as well as a tool to identify outliers.

Preparations

Task 1 – Test Plan Review and Material Acquisition

- Review test plan and specific test procedures.
- Obtain materials needed to perform tests.

Task 2 – Initial Sample Preparation and Moisture Content

- Form 1,000-gram composite samples from each of the selected core segments by selecting representative materials from each core section (avoid moisture loss to the extent possible).
- Homogenize each composite sample and determine the moisture content by drying a small aliquot at 103 to 107 degrees Celsius. Perform one duplicate moisture analysis.
- Dry and weigh each screened fraction.
- Screen sufficient homogenized bulk core material to produce more than 1,000 grams (dry basis) of formation material from each of the nine samples. Discard any portion of larger particles that would damage test equipment, and report the actual grain size distribution and the weight-fraction of the original core sample used in the ensuing tasks. Preserve both large- and small-grain screened fractions in a cold, humid, anaerobic environment (wrapped in two layers of Saran Wrap and cooled to approximately 40 degrees Fahrenheit) to inhibit biological activity and prevent dehydration.

Task 3 – Anaerobic Core Hexavalent Chromium Uptake

- This test must be run under anaerobic conditions.
- Weigh out one 50-gram (dry basis) aliquot of each screened core sub-sample, plus two quality control duplicates, and place each (including the duplicate) into extraction vessels (flask, tumbler, or other device).
- Charge the 50-gram samples with 1.5 liters of anaerobic (de-aerated) groundwater from a hexavalent chromium [Cr(VI)] plume well that has been adjusted (either diluted or spiked with chromate stock solution) to provide a Cr(VI) concentration of approximately 3,200 micrograms per liter. This is the concentration used in the Cr(VI) uptake experiments in the previous anaerobic core testing (1.0 percent of Walkley-Black uptake).

- Gently agitate for 30 minutes, allow solids to settle, decant and filter liquid.
- Agitate mixture once per week to ensure even contact between liquid and solids.
- After 12 weeks, analyze initial MW-51 water and filtrate from each sample for Cr(VI).
- Calculate the loss in Cr(VI) and interpret the loss as uptake by anaerobic core solids.