March 16, 2004

Mr. Edwin P. Madera
Raytheon Integrated Defense Systems
528 Boston Post Road
Mail Stop 1880
Sudbury, MA 01776

Re: **Public Commentary on March 3, 2004 Draft**
Phase IV Remedy Implementation Plan (RIP) Addendum
Former Raytheon Facility, 430 Boston Post Road, Wayland MA
DEP RTN 3-13574; Tier IB Permit No. 133939
CMG ID 2002-003

Dear Mr. Madera:

The following are my comments on the March 3, 2004 Draft Phase IV RIP Addendum report for the former Raytheon facility in Wayland, Massachusetts (the Site) regarding RTN 3-13574 prepared by Environmental Resources Management (ERM). For the record, the Wayland Board of Selectmen has retained me to provide technical review of document submittals and other activities at the Site on behalf of the Town of Wayland, especially those that pertain to satisfying requirements set forth by the Massachusetts Department of Environmental Protection (DEP).

As in past document reviews, I have prefaced my comments according to ERM's heading designations for ease of comparison, and used uppercase Roman numerals to identify each comment.

3.0 DESIGN BASIS
3.1 Impacted Areas
I) On page 7 of the Draft Phase IV RIP Addendum report, ERM states that "Under current land use conditions, risks to human health are considered negligible since the area of impact is remote from the Baldwin Pond wellfield." It is true that the contamination which is the subject of this report (i.e., the 'Southern Area' chlorinated VOC plume) is a substantial distance from the Baldwin Pond wellfield. However, this plume is still located within the DEP-approved Zone II for the Baldwin Pond wellfield and a Town Aquifer Protection District Overlay Zone. Furthermore, Russell's Garden Center operates a private production well located on their property, which is located hydraulically downgradient and proximal to this plume (although screened at a much deeper interval). Therefore, because of the current or future drinking water source area designation, neither the Town of Wayland, the DEP, nor the concerned public would characterize risks associated with this plume as "negligible."

In addition, promulgated DEP regulations and published DEP guidance continually stress the importance of 'reasonably foreseeable' uses. Wayland believes that reasonably foreseeable use of groundwater that DEP has classified GW-1 (current or potential drinking water supply) should

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include consumption as drinking water. At present, some groundwater at the Southern Area of the Site significantly exceeds drinking water standards (which is, of course, why ERM has proposed the remedial strategy outlined in the Draft Phase IV RIP Addendum report).

The Town requests that ERM change their wording in this portion of Section 3.1.

4.0 REMEDIAL DESIGN
4.2 ISCO Design and Implementation
4.2.1 Establish Baseline Groundwater Data
&
4.2.4 Post-Injection Groundwater Monitoring

II) Wayland sees it as a positive sign that Raytheon plans to include dissolved chromium and hexavalent chromium analyses in both the baseline monitoring program and the post-injection groundwater monitoring program. We believe it is important to track these potentially hazardous byproducts of in-situ chemical oxidation (ISCO).

4.2.3 Oxidant Injection

III) Erratum: the numerical header for this section should be 4.2.2 (which also means that Section 4.2.4 should be numbered 4.2.3).

IV) The table "Summary of Permanganate Mass and Volumes for Treatment Areas" does not have consistent correlation between permanganate mass and sodium permanganate volume. To wit, if 15,000 pounds of permanganate is equivalent to 13,000 gallons of 10% solution, one would expect 1,500 pounds of permanganate to involve 1,300 gallons of solution, not 1,400 gallons as tabulated. This may simply be a rounding error artifact.

The Town is not exactly sure what ERM means when it refers to "A 10 percent (by volume) sodium permanganate solution" because the published literature we reviewed indicated that sodium permanganate is "completely soluble." Without knowing the saturation limit (i.e., 100% solution), we cannot be sure what absolute concentration 10% refers to. We did find one reference that 40-42% sodium permanganate has a specific gravity of 1.36 and another literature reference to "40 weight %" sodium permanganate equaling 3.8M. Based on these two data, Wayland infers that 10% sodium permanganate would have a specific gravity of approximately 1.09 and be about 0.95M. (ERM's September 18, 2002 Release Abatement Measure Plan Modification indicates that sodium permanganate with an "approximately 18% weight base concentration" had a specific gravity of 1.16, which agrees well with the other data we identified.) Thus it would take approximately 13,300 gallons of solution to provide 15,000 pounds of sodium permanganate; 2,930 gallons to yield 3,300 pounds; and 1,330 gallons to yield 1,500 pounds. These numbers are fairly close to the values ERM tabulated. However, these volumes of solution would only account for 12,600; 2,770; and 1,260 pounds of permanganate ion, respectively.

If the '10% sodium permanganate' refers to a mass-to-mass ratio, then each gallon (3.78 L) of solution would include 0.83 pounds (378 g) of sodium permanganate (0.70 pounds of just ionic permanganate). Therefore 13,000 gallons of 10% (w:w) sodium permanganate would contain about 10,850 pounds of sodium permanganate, or about 9,090 pounds of permanganate ion (not 15,000 pounds).

Please provide a better description of the sodium permanganate concentrations you intend to use, and/or state the anticipated solution molarity. Furthermore, the table in Section 4.2.3 [4.2.2] of the Phase IV RIP Addendum should explicitly state whether 'permanganate mass' refers to the total mass of sodium permanganate or permanganate ion.

GENERAL QUESTIONS

V) In the initial Release Abatement Measure (RAM) pilot testing conducted to address chlorinated VOC contamination, ERM evaluated solutions of 4% sodium permanganate and 2% potassium permanganate. The results seemed to indicate that the 4% sodium permanganate solution was more successful than the 2% potassium permanganate solution. However, Raytheon has not provided Wayland with any conclusive analysis of whether the different chemicals caused the observed variation in results or if it was simply due to using double the concentration of oxidant.

The Town is concerned about secondary effects of injecting large amounts of sodium permanganate solution into the drinking water aquifer, namely increased sodium levels. Massachusetts has not promulgated any Maximum Contaminant Level (MMCL) drinking water standard for sodium (or potassium). However, the DEP's Office of Research and Standards has established a guideline (ORSG) of 20 mg/L for sodium in drinking water. Laboratory analyses in the RAM pilot test area included numerous tests for sodium beginning in November 2002. The lowest level detected (2.2 mg/L at well MW-44D) likely represents the background sodium concentration. However, analysis identified up to 450 mg/L sodium (Well MW-211) after sodium permanganate injections, which is much higher than the ORSG value for sodium in drinking water.

Wayland requests that Raytheon provide a detailed analysis of the amount of residual sodium that will remain in the drinking water aquifer following full-scale implementation of the proposed ISCO remedy. The Town expects that you will address the ORSG value for sodium in drinking water as a 'suitably analogous standard' in your comprehensive evaluation. Given the potential health risks of elevated sodium in the drinking water supply, Wayland also requests that Raytheon provide a more detailed explanation of why you have chosen 10% sodium permanganate for ISCO over potassium permanganate.

VI) The RAM Status and Completion reports present a large amount of data regarding injection procedures, field testing, and laboratory analytical results. However, these reports have relatively little to say about what contaminant reduction may be occurring. The January 31, 2002 RAM Status Report (#1) concluded:

> In the MW-33 pilot study area, TCE concentrations decreased by an average of 55% through December 2001 in half the wells sampled. … In the MW-43 pilot study area, TCE concentrations decreased by an average of 75% through December 2001 in three of four wells sampled.

The July 25, 2002 RAM Status Report (#2) concluded:

> Six wells located within the MW-33 pilot study area (MW-111, MW-112, MW-113, MW-114, MW-115 and MW-116) exhibited an average [TCE] concentration decrease of 67% since the baseline monitoring round (August 2001). … The MW-43 pilot study area exhibited an average decrease in TCE concentrations of 84% in three wells either directly affected by the oxidant injection or located generally downgradient of the injection area.

The July 31, 2003 RAM Status Report (#4), after a substantial injection of much more concentrated sodium permanganate solution, concluded that in the MW-43 pilot study area:

> TCE concentrations decreased greater than 90% versus baseline in the February 2003 sampling, approximately three months after the application. TCE concentrations were approximately 80% lower than baseline levels in the April 2003 sampling, approximately six months after the application.

The November 12, 2003 RAM Completion Report concluded:

> The average TCE concentration in the MW-43 Pilot Study Area decreased by 92% as a result of RAM activities, as of 30 September 2003.

While these conclusions are all very encouraging, ERM does not explicitly state how they arrived at their various 'average concentration' percentages. Furthermore, ERM seems to focus entirely on trichloroethene (TCE), neglecting to discuss other chlorinated VOCs in the Southern Area of the Site with similar toxicities.

The published literature indicates that oxidative dechlorination of TCE is a multi-step process, which generates the 'daughter product' dichloroethenes (1,1-dichloroethene [1DCE], *cis*-1,2-dichloroethene [*c*DCE]) & *trans*-1,2-dichloroethene [*t*DCE]) and vinyl chloride (VC). Naturally-occurring anaerobic microbial degradation also degrades TCE to *c*DCE (to the near-exclusion of 1DCE or *t*DCE), and it also degrades *c*DCE to VC. In natural degradation, VC tends to accumulate (unless aerobic microbial degradation occurs). Chemical oxidation, on the other hand, is not nearly as selective: mono-dechlorination of TCE tends to produce similar amounts of 1DCE, *c*DCE, and *t*DCE daughter products. Therefore, one expects natural degradation processes to exhibit much higher *c*DCE than 1DCE or *t*DCE concentrations, and significant amounts of VC (which often increase over time). Conversely, one expects chemical oxidation to produce roughly equal amounts of 1DCE, *c*DCE, and *t*DCE, but little VC.

CMG reviewed the published analytical results from 13 representative monitoring wells in the RAM pilot study area in detail (wells MW-33S, MW-33M, MW-43S, MW-101, MW-102, MW-105, MW-106, MW-107, MW-108, MW-109, MW-112, MW-117, and MW-212). In 93 VOC analyses from these 13 wells, testing identified TCE 81 times, and *c*DCE 26 times. However, analysis identified 1DCE only once, and did not detect *t*DCE or VC at all. Lack of 1DCE and *t*DCE detections suggests at least some microbial activity, while lack of VC detections suggests the observed contaminant reductions may be due to ISCO or dilution.

CMG took an even more detailed look at four of the monitoring wells (MW-43S, MW-102, MW-105, and MW-107). We wanted to quantify how effective the RAM pilot study was, so we totaled all chlorinated ethenes and ethanes in each analysis. For accuracy, we first converted the reported concentration values into µmoles, since these chlorinated VOCs have substantially different molecular weights. CMG then plotted the total chlorinated VOC values versus time (see attached Charts 1A through 1D). These charts also depict millimoles of total sodium permanganate residual (the sum of sodium permanganate, sodium, and manganese analyses) and chloride (which represent the residual concentrations of applied oxidant and dechlorination byproducts, respectively).

By plotting a regression line through each set of total chlorinated VOC data, CMG concludes a measurable decrease in chlorinated VOCs occurred at wells MW-43S, MW-102, and MW-105 during the RAM pilot study. Regression analysis for well MW-107 shows a slight increase over time. However, the correlation coefficients (r^2 values) show poor to very poor correlations in these four wells. This is also evident from the substantial oscillations in total chlorinated VOC

concentrations over time. CMG only reviewed testing results from four monitoring wells at this level of detail; no doubt a detailed review of the results from all wells in and around the pilot study area would provide a better understanding of chlorinated VOC degradation.

Wayland requests that Raytheon present a detailed and quantifiable assessment of the efficacy of sodium permanganate ISCO before proposing to substantially increase the scale of oxidant injections into the Town's drinking water aquifer.

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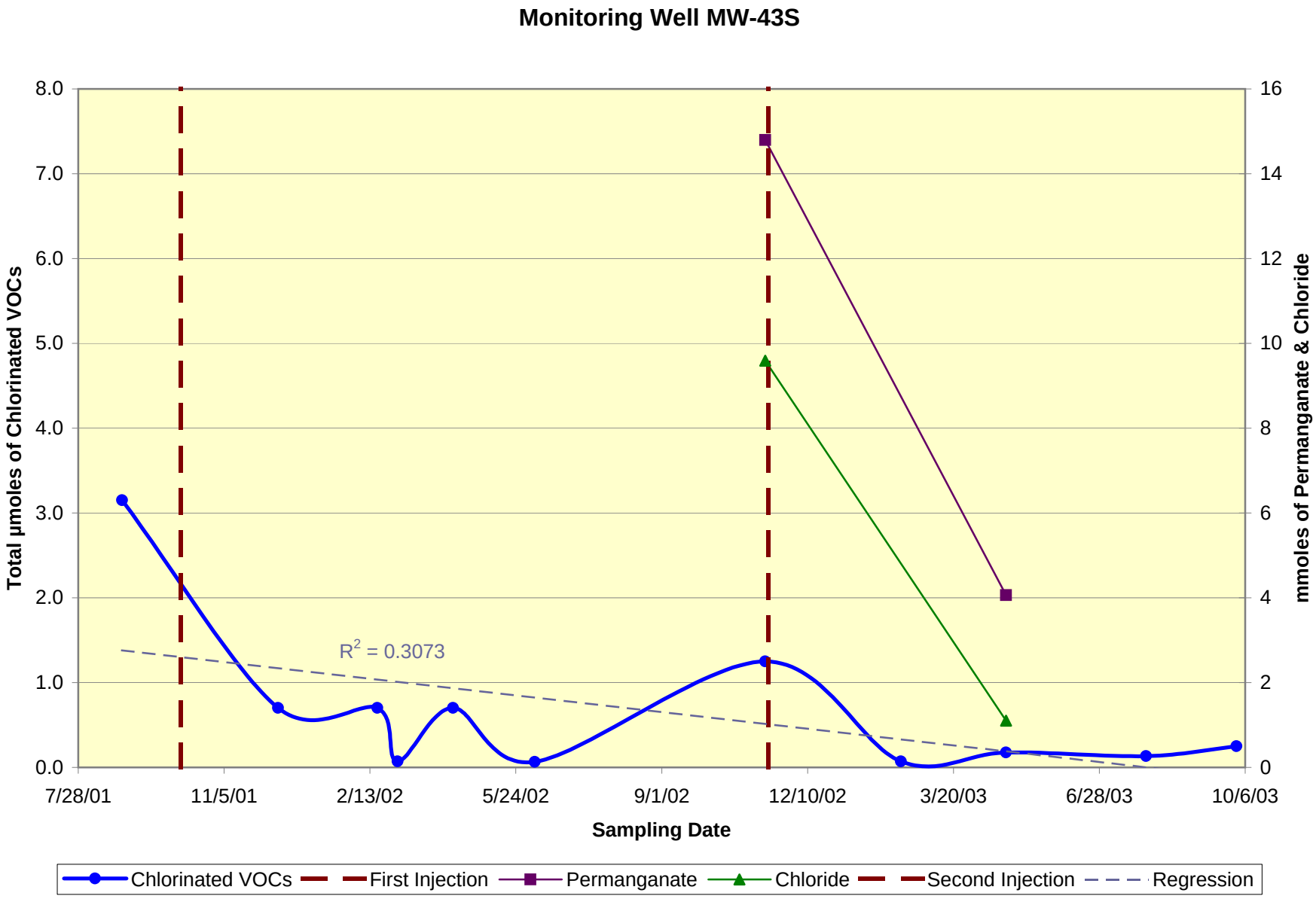
As always, I thank you in advance for your timely response to this commentary submitted on behalf of the Town of Wayland.

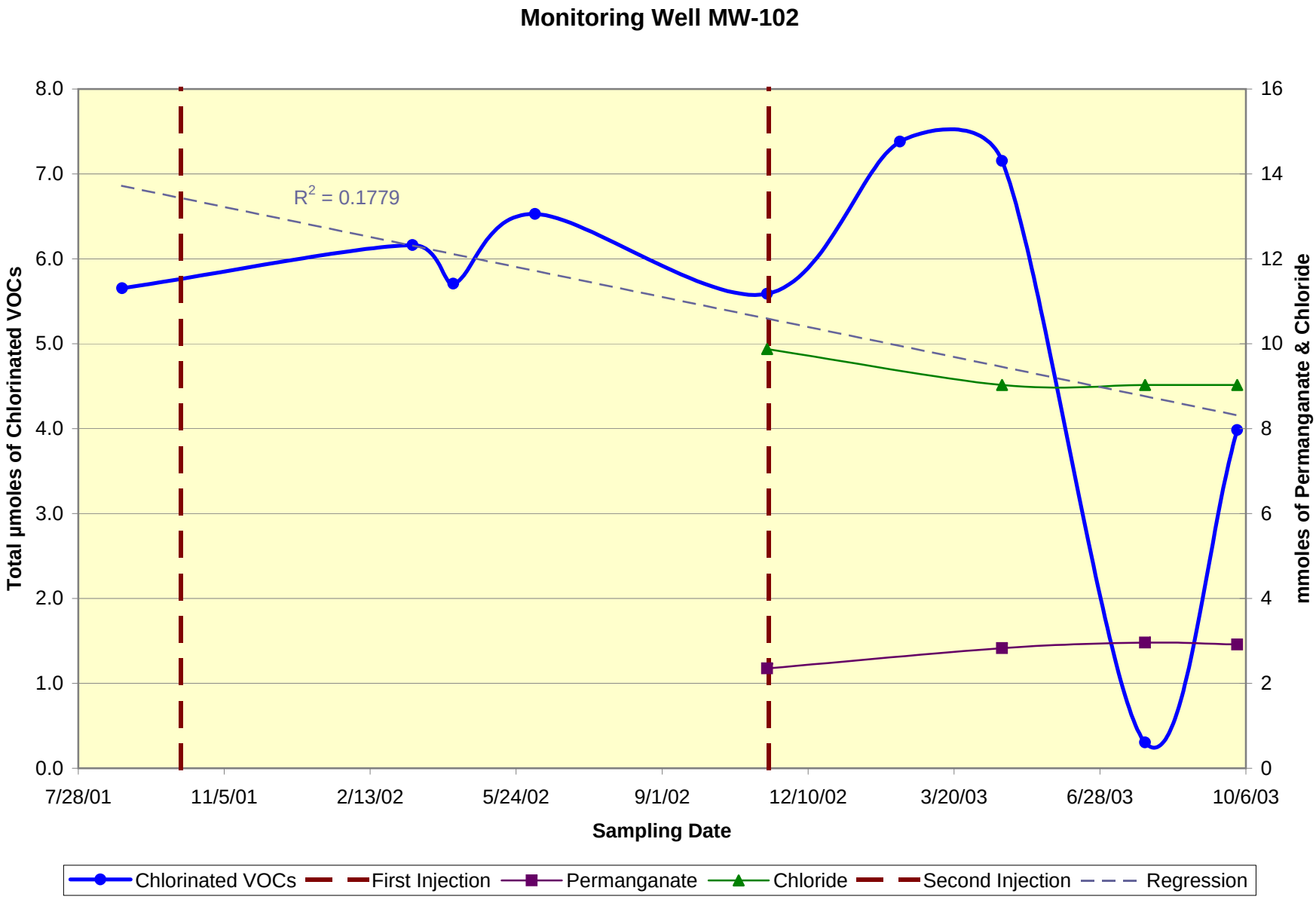
Sincerely,
CMG ENVIRONMENTAL, INC.

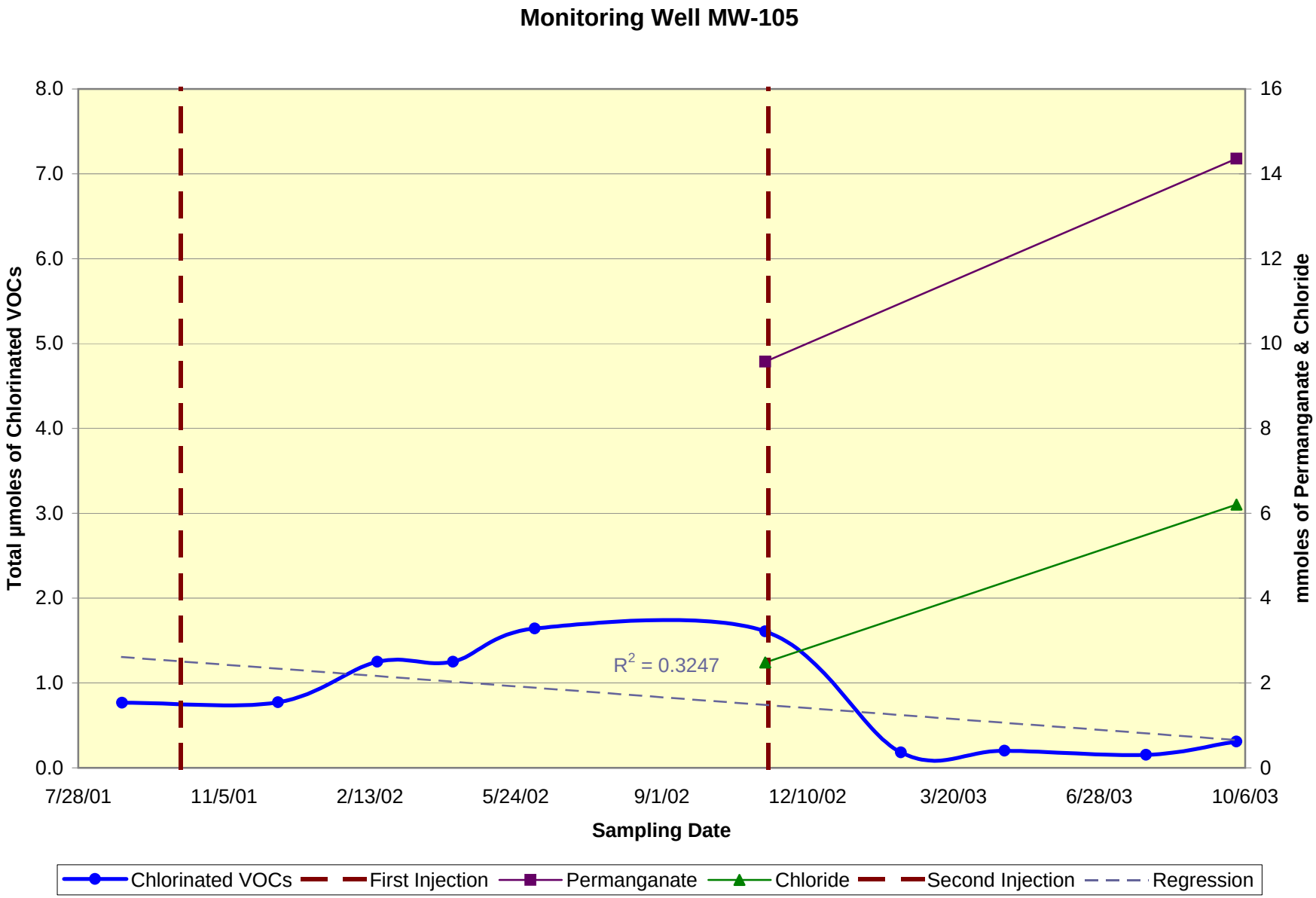
Benson R. Gould, LSP, LEP
Principal

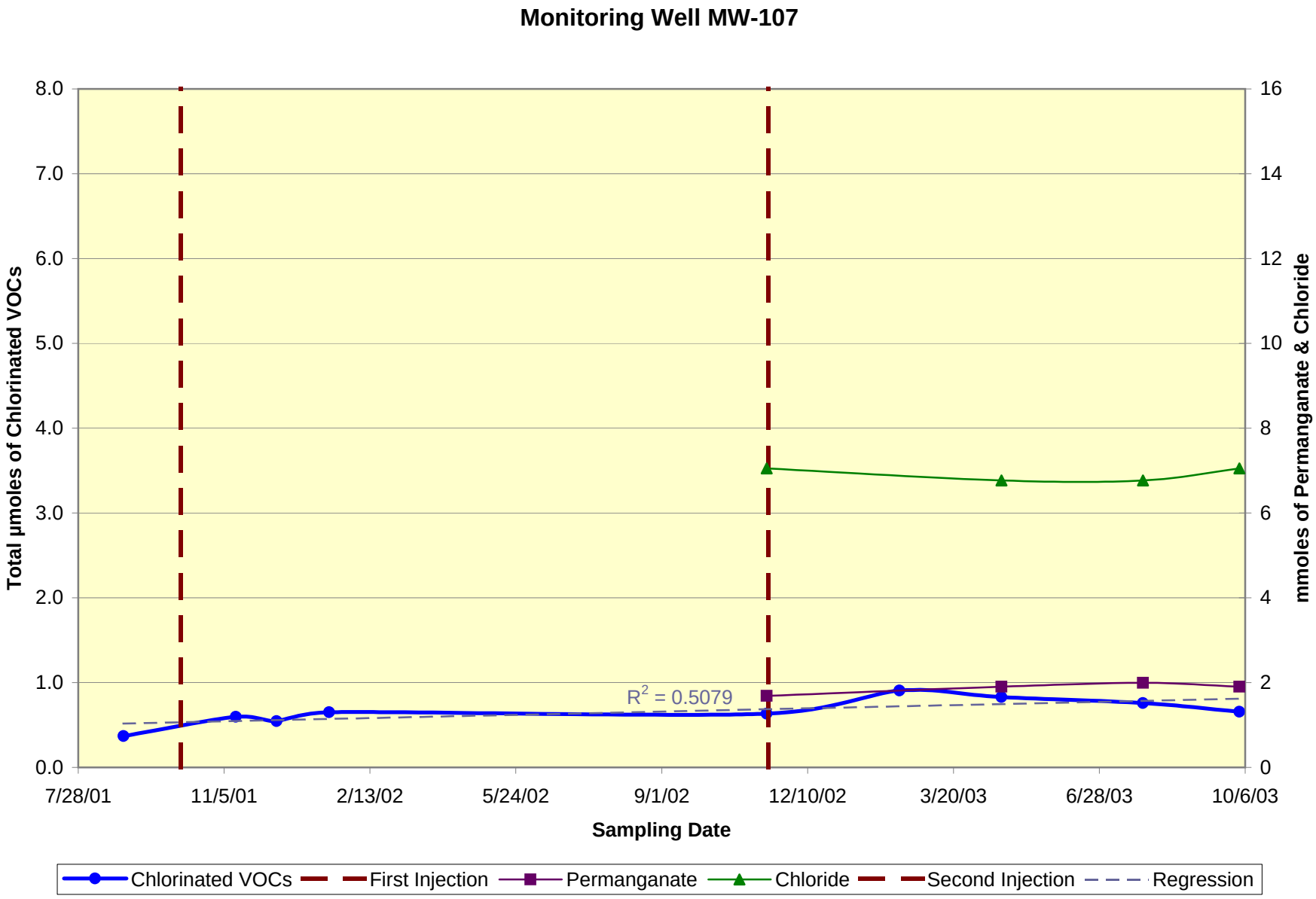
Attachments: Chart 1A (Monitoring Well MW-43S)
Chart 1B (Monitoring Well MW-102)
Chart 1C (Monitoring Well MW-105)
Chart 1D (Monitoring Well MW-107)

cc: Environmental Resources Management (John C. Drobinski, P.G., LSP)
Mr. J. Andrew Irwin, Wayland
Ms. Anette Lewis, Wayland
Massachusetts DEP (Pat Donahue, Larry Immerman, Karen Stromberg)
National Parks Service (% Jamie Fosberg)
Mr. Lewis Russell, Wayland
Mr. Harvey and Ms. Linda Segal, Wayland
Ms. Kimberly Tisa, U.S. EPA Region I
Wayland Board of Health PIP Repository (% Steve Calichman, Health Director)
Wayland Board of Selectmen (% Executive Secretary Jeff Ritter)
Wayland Business Center, LLC (% Paula Phillips, Congress Group Ventures)
Wayland Conservation Commission (% Brian Monahan)
Wayland Public Library PIP Repository (% Ann Knight)


Monitoring Well MW-43S
Total µmoles of Chlorinated VOCs
mmoles of Permanganate & Chloride
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
16
14
12
10
8
6
4
2
0
R2 = 0.3073
7/28/01
11/5/01
2/13/02
5/24/02
9/1/02
12/10/02
3/20/03
6/28/03
10/6/03
Sampling Date
Chlorinated VOCs
First Injection
Permanganate
Chloride
Second Injection
Regression


Monitoring Well MW-102
Total µmoles of Chlorinated VOCs
mmoles of Permanganate & Chloride
Sampling Date
R2 = 0.1779
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
16
14
12
10
8
6
4
2
0
7/28/01
11/5/01
2/13/02
5/24/02
9/1/02
12/10/02
3/20/03
6/28/03
10/6/03
Chlorinated VOCs
First Injection
Permanganate
Chloride
Second Injection
Regression


Monitoring Well MW-105
Total µmoles of Chlorinated VOCs
mmoles of Permanganate & Chloride
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
16
14
12
10
8
6
4
2
0
7/28/01
11/5/01
2/13/02
5/24/02
9/1/02
12/10/02
3/20/03
6/28/03
10/6/03
Sampling Date
R^2 = 0.3247
Chlorinated VOCs
First Injection
Permanganate
Chloride
Second Injection
Regression


Monitoring Well MW-107
Total µmoles of Chlorinated VOCs
mmoles of Permanganate & Chloride
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
16
14
12
10
8
6
4
2
0
7/28/01
11/5/01
2/13/02
5/24/02
9/1/02
12/10/02
3/20/03
6/28/03
10/6/03
Sampling Date
R2 = 0.5079
Chlorinated VOCs
First Injection
Permanganate
Chloride
Second Injection
Regression