SHANNON & WILSON
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

May 27, 2021

Ms. Janet DiMaggio
Wisconsin Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg, WI 53711-5397

RE: HACCO, Inc., Randolph, Wisconsin
Response to March 29, 2021 WDNR Letter

Dear Ms. DiMaggio:

In response to the March 29, 2021 letter from the Wisconsin Department of Natural Resources (WDNR)and as part of our discussions about the Hacco, Inc., (Hacco) facility in Randolph, Wisconsin, Shannon & Wilson, Inc. would like to address the WDNR's request for the installation of one to two additional groundwater extraction wells to the south and southeast of the major source areas at the Hacco property. Shannon & Wilson, on behalf of Hacco, requests a waiver of this requirement as part of the mandated groundwater monitoring activities at the Hacco property. The rationale for removing this requirement is provided in the accompanying narrative.

Previously, we had discussed the WDNR's concerns of contaminant migration based on a 2003 pilot/laboratory test that reported the mobilization of contaminants after permanganate/Fenton's reagent chemical treatment of soil and groundwater test samples. The WDNR's issue was that the chemical injection mobilized contaminants of concern with the potential to impact nearby private water supply wells. It was agreed by both parties that a review of the 2003 pilot/laboratory test was warranted in order to determine if the concern for contamination migration as a result of chemical injection was valid.

Shannon & Wilson completed a review of an August 21, 2003 document entitled *Bench-Scale Treatability Testing of Contaminated Soil and Groundwater, Hacco Facility, Randolph, Wisconsin* (United Agri Products & RMT, Inc.) The United Agri Products and RMT 2003 document described a laboratory bench test that evaluated the destruction efficiencies of potassium permanganate and a modified Fenton's reagent on the primary contaminants at the Hacco property (e.g. organochlorine, organophosphorus, and urea-carbamate pesticides, VOCs, and limited SVOCs). This study found that both reagents showed an initial increase in VOC and lindane levels, and a decrease in urea-carbamates. Higher dosages resulted in near complete destruction of VOCs and urea-carbamates, but a further increase in lindane. Groundwater

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mobilization for certain pesticides was confirmed. However, these tests were performed on groundwater samples contained in plastic pails and in the absence of naturally occurring organic carbon that would be part of the saturated zone at the Hacco facility.

The United Agri Products/RMT 2003 document recognized the limitations of the chemical treatment technologies that were available at that time. Their recommendations included that "ongoing evaluations of emerging treatment technologies be continued, so that as potentially viable alternatives are identified, appropriate testing can be performed to assess their effectiveness in treating the chemical constituents present at (the Hacco) facility".

To that end, Shannon & Wilson and Hacco performed a subsequent laboratory treatability test in 2018 that evaluated destruction efficiencies of several reagents (see *Corrective Measures Study - 2018 Update*, SWI, November 2018). This study found that the best results included Bioavailable Absorbent Media (BAM®) combined with either zero-valent iron (ZVI), Fenton's reagent, or PermeOx® for the group of site contaminants. The report noted that "…the sorbing character of BAM® appeared to mitigate these contaminants from ongoing leaching to groundwater, allowing degrading bacteria to remediate residual concentrations over time." The report concluded that eliminating this leaching potential, along with the destruction capacities shown by the reagents in groundwater would mitigate further groundwater contamination.

The assumption that chemical injection for the treatment of contaminants of concern at the Hacco facility will mobilize contaminants (with potential impacts to off-site private water wells) is not valid based on newer injectates such as BAM®. In our opinion, the construction of additional groundwater extraction wells as a capture mechanism is not needed.

Shannon & Wilson has completed the additional technology review. In fulfillment of the March 29, 2021 letter, Shannon & Wilson will provide the pilot test work plan and the results of the technology review to the WDNR on or before June 27, 2021, within the requested 90-day submittal period.

If you have any questions or concerns, please contact me directly at (414) 477-0279 or via e-mail at mxr@shanwil.com.

Sincerely,

SHANNON & WILSON

Mark A. Rutkowski, P.G.
Sr. Associate/Madison Office Manager

Attachments: United Agri Products\RMT Bench-Scale Treatment study (2003)

Richard D. Yabroff, P.E., CSP
Manager, Environmental & Regulatory Services

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SEP - 2
Janesville Service Center

August 21, 2003

Mr. James A. Kralick
Wisconsin Department of Natural Resources
N 7725 Highway 25
Horicon, WI 53202

Subject: Submittal of Report
Bench-Scale Treatability Testing of Contaminated Soil and Ground Water
HACCO, Inc., Randolph, Wisconsin
FID #114010820

Dear Mr. Kralick:

HACCO, Inc. (HACCO), is submitting the report entitled "Bench-Scale Treatability Testing of Contaminated Soil and Ground Water, HACCO Facility, Randolph, Wisconsin, prepared by RMT, Inc. (RMT).

The results of the study were not as positive as we had hoped. It appears that the treatment chemicals used in the study (potassium permanganate and Fenton's Reagent) resulted in limited destruction (oxidation) of contaminants. It is also apparent that these treatment chemicals caused significant release of some contaminants from particulate matter (soil particles and colloidal material in ground water) to which they were bound. As we indicated in our meeting last fall, HACCO is very concerned about creating a bigger problem than we have now. In light of the complex nature of the site hydrogeology, we are not comfortable at this time employing a technology that will actually increase contaminant concentrations in the hope that we can capture them with the existing pump and treatment system in a fractured bedrock environment.

HACCO, in consultation with RMT, is contemplating upgrading the current pump and treat system in order to provide a higher level of assurance that the contaminants in site ground water are adequately controlled in the future. We are considering adding one or more extraction wells to the current system. In addition, RMT is continuing to evaluate emerging remediation technologies that may be more effective in destroying the pesticides present at this site.

We are evaluating the best approach to move forward on these options. One approach would involve making these upgrades part of an interim remedial action and to hold off on the Corrective Measures Study (CMS) until an effective *in-situ* treatment technology

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is identified. An alternative approach would be to incorporate these tasks into a CMS at this time. HACCO would appreciate input from the Department on how best to proceed.

We look forward to discussing these ideas with you. In the meantime, if you have any questions please call me, at (970) 347-1472.

Sincerely,

United Agri Products

Richard D. Yabroff.
Manager, Environmental & Regulatory Services

Attachment:

cc: Lee Schwalenberg, HACCO, Inc.
Steven Martin, RMT

RMT®
Integrated Environmental Solutions

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August 18, 2003

Mr. Richard D. Yabroff, P.E., C.S.P.
United Agri Products
7251 W. 4th Street
Greeley, CO 80634

Subject: Results of Bench-Scale Treatability Testing of Contaminated Soil and Groundwater HACCO Facility, Randolph, Wisconsin

Dear Rick:

This letter presents the results of the bench-scale treatability tests RMT, Inc. (RMT), performed on samples of contaminated soil and groundwater from the HACCO, Inc. (HACCO), facility in Randolph, Wisconsin. The scope of this testing was described in RMT's proposal dated September 19, 2002.

Background

The effectiveness of chemical oxidation in remediating contaminated groundwater and saturated soil from the HACCO facility at Randolph, Wisconsin, was evaluated in bench-scale treatability testing. The major objectives of this testing were to optimize treatment chemistries for potential future pilot testing and to evaluate the effectiveness of chemical oxidation in remediating contaminated groundwater and saturated soil under the conditions present in the aquifer.

Most of the treatability testing was carried out with potassium permanganate as the oxidant. Potassium permanganate ($KMnO_4$) was chosen on the basis of RMT's experience in oxidant delivery and the effectiveness of *in situ* oxidation of organic contaminants, in general, and RMT's knowledge of the nature of the contaminants and the site conditions at the HACCO facility, in particular. Limited comparison tests were carried out with Fenton's reagent (hydrogen peroxide [H_2O_2] catalyzed with acidified ferrous sulfate [$FeSO_4$]).

The effects of oxidant dosage, the sequential addition of oxidant, and the influence of reaction by-products (precipitates formed during oxidation) on flowability through the treated contaminated soil were evaluated.

This report summarizes the results of the bench-scale treatability testing and provides preliminary recommendations for *in situ* pilot-scale demonstration of the chemical oxidation chemistry for remediation of the site.

Experimental Procedure

Groundwater

The groundwater used for the bench-scale testing was collected from monitoring well MW-3AR, which historically has the highest concentrations of constituents of concern. HACCO collected the samples into five 5-gallon covered buckets on November 3, 2002, and delivered them on ice to RMT's Applied Chemistry Laboratory on November 4, 2002. An equal-volume composite of the

groundwater from the different buckets received from HACCO was prepared. This composite sample was used for all testing and analyses. The untreated and treated groundwater samples were identified as follows:

- **Time zero** - Composite groundwater sample at the start of testing.
- **Control** - Groundwater sample that received no oxidant but that had gone through the same handling steps as the treated samples.
- **Treated** - Samples that are identified with various oxidants and levels of treatment. After each level of oxidant addition, the treated groundwater was allowed to react for 1 week prior to shipment for analysis by commercial analytical laboratories.

Saturated Soil

Saturated soil samples also underwent bench-scale treatabliity tests to evaluate the effects of the aquifer matrix on the treatment chemicals. Soil samples retained from previous site investigations were used for the testing. In particular, deeper soil investigation samples corresponding to the lower till unit, which is seasonally saturated, were selected. These soil samples were mixed to prepare a composite sample, and the composite sample was saturated using the composite groundwater sample described above. The oxidants were added to aliquots of the composite soil sample and allowed to react for 1 week prior to analysis. The control soil sample was saturated with deionized (DI) water and processed through the same steps as those taken for the treated soil samples.

The treated and untreated groundwater and soil samples were analyzed for special semivolatile organic compounds (SVOCs); volatile organic compounds (VOCs); and organophosphorus, organochlorine, and urea-carbamate pesticides. Additionally, the saturated untreated and treated soil samples were tested for specific filtration resistance (SFR).

Results and Discussion

Groundwater

The analytical results are summarized in Table 1, and the complete laboratory reports are presented in Attachment 1. The untreated groundwater sample (time zero sample) was characterized generally by low levels (< 50 µg/L) of VOCs; SVOCs; and organophosphorus, organochlorine, and urea-carbamate pesticides. The contaminants present at levels > 10 µg/L included two SVOCs (2,4-dimethylphenol and pentachlorophenol) and two urea-carbamate pesticides (tebuthiuron and monuron). Handling of the groundwater sample through the treatability processing steps with no treatment (control samples) showed removal of the SVOCs to below detection levels, while the urea-carbamate pesticide concentrations remained practically unchanged.

Groundwater treatment with $KMnO_4$ at a treatment dosage of 20 g/L (Level 1) showed an increase in VOC and lindane concentrations, and a decrease in urea-carbamate pesticides. A higher treatment dosage (Level 2 at 40 g/L and Level 3 at 80 g/L) showed complete elimination of the VOCs and almost complete removal of the urea-carbamate pesticides, except that lindane concentrations

generally increased after each level of treatment. Treatment in multiple additions of $KMnO_4$, rather than a higher dosage in a single addition, appears more effective for the destruction of the organic contaminants and the release of recalcitrant organics (lindane) for follow-up treatment.

An evaluation of the chromatogram data for uncalibrated totals (unquantified constituents) shows one to two orders of magnitude reductions of unidentified pesticide-related organics, as a result of oxidation treatment of the groundwater in the initial dosage. Subsequent dosages showed low to modest changes.

Comparison tests using Fenton's reagent (H_2O_2 + acidified $FeSO_4$) showed trends in results similar to those with $KMnO_4$.

Saturated Soil

The saturated soil analysis results are summarized in Table 2. Analytical laboratory reports are included in Attachment 1. The untreated soil saturated with deionized water was characterized by below-detection level concentrations of VOCs, SVOCs, and organophosphorous pesticides, and by the presence of various organochlorine pesticides at concentrations ranging from 6.3 to 540 µg/kg. Urea-carbamates were present at relatively lower concentrations.

The chromatogram data on uncalibrated totals (unquantified constituents) showed little or no change in organophosphorous and urea-carbamate compounds following treatment. However, the chlorinated pesticide–related organic concentrations increased by two orders of magnitude upon oxidation treatment.

Treatment with both $KMnO_4$ and Fenton's reagent generally showed lower concentrations of organochlorine pesticides and higher concentrations of the urea-carbamates.

In order to make a preliminary assessment of how precipitation of inorganic by-products, owing to oxidation, may affect groundwater flowability through the contaminated soil, SFR values of the treated and untreated saturated soil samples were measured. The SFR value increased slightly from 0.0625×10^8 sec^2/g for the untreated soil to 0.1550×10^8 sec^2/g and 0.1780×10^8 sec^2/g , respectively, for the $KMnO_4$- and Fenton's reagent–treated soil. The SFR values indicate that both the treated and the untreated soil are highly filterable and exert very low resistance to water flow (for comparison, the SFR of colloidal clay[1], which is difficult to filter and which offers significant resistance to water flow, is approximately 64×10^8 sec^2/g). Therefore, the *in situ* oxidation of the contaminated soil at the HACCO site should have no significant impact on groundwater flow characteristics through the soil body.

[1] "Look up table for specific filtration resistance and cake concentration," www.filtration-and-separation.com

Conclusions

- Modest reductions in certain pesticides occurred following initial treatment dosages, indicating some oxidation of these contaminants. Subsequent dosages showed little or no reductions in concentrations. In fact, some concentrations increased. This behavior was expected and is likely due to the liberation of these contaminants from organic carbon in the water and soil matrices.
- Certain other pesticide constituents showed little or no reductions, and in some cases, actually increased in concentration in later dosages following treatment.

Recommendations

It is not clear from these results that treatment of site groundwater or soil with either potassium permanganate or Fenton's Reagent will substantially improve groundwater quality to the point of approaching drinking water standards. In addition, although increased mobilization of pesticides may allow for more efficient removal by the site groundwater extraction system, it may also increase the risk for off-site contaminant migration. Therefore, we recommend enhancing the current groundwater remediation system to provide a higher level of assurance that adequate constituent capture is occurring and will continue. In addition, we also recommend that ongoing evaluations of emerging treatment technologies be continued, so that, as potentially viable alternatives are identified, appropriate testing can be performed to assess their effectiveness in treating the chemical constituents present at this facility.

Please contact us, if you have any questions or comments.

Sincerely,

RMT, Inc.

Steven L. Martin, P.G.
Senior Project Manager

Ajit Chowdhury
Consulting Engineer

Attachments

cc: Lee Schwalenberg, HACCO

Table 1
Results of Bench-Scale Treatability of Contaminated Groundwater
HACCO, Inc., Randolph, Wisconsin

Treatment		None		$KMnO_4$			$KMnO_4$ Dosage Level 2			Fenton's	Fenton's	Fenton's
				Dosage Level 1	Dosage Level 2	Dosage Level 3	Test No. 2 Replicate	Second Treatment of Test No. 2 Replicate	Third Treatment of Test No. 2 Replicate	Dosage Level 1	Level 1 Second Treatment	Level 1 Third Treatment
Test No./Sample ID		Time Zero	Control	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
Analyte	Units	830671-001	831064-003	830671-004	830671-005	830839-001	830839-002	830839-003	831064-001	830839-004	831064-002	831184-001
Analyte												
SVOCs (SW 846 3510/8270C)												
2,3,5,6-Tetrachlorophenol	µg/L	7.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2,3,4,6-Tetrachlorophenol	µg/L	5.9	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
2,4-Dimethylphenol	µg/L	11	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Pentachlorophenol	µg/L	31	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Uncalibrated totals	**µg/L**	**61.2**	**2,040**	**350**	**506**	**1,417**	**1,170**	**1,740**	**2,187**	**BDL**	**576**	**4.8**
VOCs (SW 846 5030B/8260B)												
Acetone	µg/L	BDL	BDL	81	82	250	BDL	BDL	320	BDL	BDL	BDL
Bromodichloromethane	µg/L	BDL	BDL	4.8	2.1	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Carbon tetrachloride	µg/L	BDL	BDL	38	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Choroform	µg/L	BDL	BDL	18	3.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chloromethane	µg/L	BDL	BDL	18	3.0	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.74	0.74	BDL
Xylenes-m,p	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	4.3	4.7	BDL
Xylenes-o	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	5.3	4.8	BDL
Uncalibrated totals	**µg/L**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**	**BDL**
Pesticides (8141A)												
Dichlorvos	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Phorate	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Diazinon	µg/L	0.07	0.059	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Disulfoton	µg/L	0.31	0.055	BDL	BDL	0.05	BDL	BDL	BDL	BDL	BDL	BDL
Malathion	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Parathion	µg/L	BDL	BDL	BDL	BDL	0.18	0.32	0.075	BDL	BDL	BDL	BDL
Uncalibrated totals	**µg/L**	**1.35×10^5**	**1.28×10^5**	**1.84×10^4**	**2.17×10^4**	**6.36×10^4**	**7.97×10^4**	**8.55×10^4**	**6.32×10^4**	**4.28×10^4**	**3.8×10^4**	**1.92×10^4**
Pesticides (8081)												
Lindane	µg/L	BDL	0.0099	4.9	8.8	3.4	3.1	8.3	8.1	3.2	1.4	1.4
Heptachlor	µg/L	BDL	0.0098	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
a-Chlordane	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Endosulfan I	µg/L	0.15	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.04	BDL	0.012
Dieldrin	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Endrin	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	0.016	0.011	BDL	BDL	BDL
Endosulfan II	µg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.016	BDL
Methoxychlor	µg/L	BDL	BDL	0.041	0.046	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Uncalibrated totals	**µg/L**	**2.39×10^6**	**1.02×10^6**	**2.78×10^4**	**3.25×10^4**	**3.47×10^5**	**4.67×10^5**	**3.48×10^5**	**2.98×10^5**	**4.12×10^5**	**2.66×10^5**	**2.01×10^5**
Pesticides (8321-HPLC UV)												
Fenuron	µg/L	0.68	1.0	4.7	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Tebuthiuron	µg/L	22	22	5.3	2.3	0.93	3.1	BDL	BDL	BDL	BDL	BDL
Bromacil	µg/L	7.2	6.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Monuron	µg/L	36	37	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Uncalibrated totals	**µg/L**	**8.9×10^4**	**5.25×10^4**	**5.7×10^4**	**5,124.6**	**5.75×10^4**	**9.00×10^4**	**9.14×10^4**	**6.15×10^4**	**3.43×10^4**	**2.16×10^4**	**6.09×10^4**

Note:
BDL = below detection level.

Table 2
Results of Bench-Scale Treatability of Saturated Soil
HACCO, Inc., Randolph, Wisconsin

Treatment		Fenton's Level 1	$KMnO_4$ Level 2	DI Water (control)
Test No./Sample ID Analyte	Units	No. 10 831269-001	No. 11 831269-002	No. 12 831269-003
SVOCs (SW 846 3510/8270C)				
2,3,5,6-Tetrachlorophenol	µg/kg	BDL	BDL	BDL
2,3,4,6-Tetrachlorophenol	µg/kg	BDL	BDL	BDL
2,4-Dimethylphenol	µg/kg	BDL	BDL	BDL
Pentachlorophenol	µg/kg	BDL	BDL	BDL
Uncalibrated totals	**µg/kg**	**1,170**	**10,236**	**2,932**
VOCs (SW 846 5030B/8260B)				
Acetone	µg/kg	92	330	BDL
Bromodichloromethane	µg/kg	BDL	BDL	BDL
Carbon tetrachloride	µg/kg	BDL	BDL	BDL
Choroform	µg/kg	BDL	BDL	BDL
Chloromethane	µg/kg	BDL	BDL	BDL
Ethylbenzene	µg/kg	BDL	BDL	BDL
Xylenes-m,p	µg/kg	BDL	BDL	BDL
Xylenes-o	µg/kg	BDL	BDL	BDL
Uncalibrated totals	**µg/kg**	**BDL**	**BDL**	**BDL**
Pesticides (8141A)				
Dichlorvos	µg/kg	BDL	BDL	BDL
Phorate	µg/kg	BDL	BDL	BDL
Diazinon	µg/kg	BDL	BDL	BDL
Disulfoton	µg/kg	BDL	BDL	BDL
Malathion	µg/kg	BDL	BDL	BDL
Parathion	µg/kg	BDL	9.8	BDL
Uncalibrated totals	**µg/kg**	**1.27×10^5**	**8.08×10^4**	**2.31×10^5**
Pesticides (8081)				
Lindane	µg/kg	44	77	99
Heptachlor	µg/kg	BDL	BDL	BDL
a-Chlordane	µg/kg	29	30	33
Endosulfan I	µg/kg	50	10	68
Dieldrin	µg/kg	5.2	5.3	6.3
Endrin	µg/kg	BDL	BDL	BDL
4,4'-DDD	µg/kg	53	26	59
Endosulfan II	µg/kg	37	10	50
4,4'-DDT	µg/kg	27	24	31
Methoxychlor	µg/kg	410	400	540
Uncalibrated totals	**µg/kg**	**5.26×10^6**	**3.14×10^6**	**9.1×10^4**
Pesticides (8321-HPLC UV)				
Fenuron	µg/kg	BDL	BDL	BDL
Tebuthiuron	µg/kg	17	35	16
Bromacil	µg/kg	BDL	BDL	BDL
Monuron	µg/kg	77	9.6	5.3
Uncalibrated totals	**µg/kg**	**3.57×10^4**	**4.27×10^4**	**4.18×10^4**
Specific filtration resistance (SFR)	$sec^2/g \times 10^{-8}$	0.178	0.155	0.0625

Note:
BDL = below detection level.