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ENVIRONMENTAL CONSULTATION & REMEDIATION

KPRG and Associates, Inc.

GROUNDWATER REMEDIAL ACTION OPTIONS MEMORANDUM

August 3, 2021

To: Mr. Mark Drews, P.G., Wisconsin Department of Natural Resources
141 NW Barstow Street, Room 180
Waukesha, WI 53188

From: Josh Davenport, Tim Stohner, Rich Gnat, KPRG and Associates, Inc. (KPRG)

VIA E-MAIL KPRG Project No. 11717

Re: Technical Memorandum – Responses to DNR Questions - Groundwater Remedial Action Options / Interim Remedial Action Plan
Former Navistar/RMG Foundry - 1401 Perkins Avenue, Waukesha, WI
BRRTS # 02-68-098404

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KPRG and Associates, Inc. (KPRG), in support of our client Navistar Inc. (Navistar), is presenting responses to the WDNR's questions provided to KPRG via email dated June 17, 2021. The WDNR questions are listed below in italics and KPRG's responses are provided following each question.

1. *Have they considered using a tracer to do real time monitoring during the injection to protect apartment complex and Hobo Spring?*

The field test kit for persulfate that was previously proposed allows for real-time monitoring of persulate in the groundwater. The field test kits allow for a result in approximately 15 minutes after the test is started. An example test kit is CHEMets Visual Kit for persulfate manufactured by CHEMetrics.

2. *Evaluate the potential for impacts to Fox River and Hobo Spring - what is known about persulfate toxicity to fish and aquatic life if discharged to the Fox River? Hobo Spring discharges to the Fox River and we are concerned about possible impacts to aquatic life.*

For Hobo Spring and the Fox River to be impacted by the persulfate injection, the persulfate would have to reach these water entities at a concentration that has the potential to be detrimental to fish and aquatic life. To evaluate the potential for impacts, the reaction time for the persulfate was compared to the travel time of the groundwater through the subsurface where the groundwater/persulfate would flow. This comparison would determine if any persulfate in the

groundwater has the potential to reach Hobo Spring and then the Fox River prior to its complete reaction.

In discussion with the injection contractor, the persulfate will persist in the groundwater for approximately two weeks before it fully reacts with the TCE contamination and other reactants present in the groundwater. The travel time for the groundwater was calculated using the seepage velocity of the formation and the distance the groundwater travels between the site boundary and Hobo Spring and then the Fox River.

The seepage velocity was calculated for the bedrock formation and for the combined bedrock/unconsolidated formation. The seepage velocity equation used is provided below.

$$V = \frac{ki}{n_e}$$

Where: V = seepage velocity, feet per second (ft/s)
k = hydraulic conductivity of formation, ft/s
i = hydraulic gradient, ft/ft
n_e = porosity of formation, dimensionless

The calculated seepage velocity for the bedrock formation is shown as follows:

$$V = \frac{\frac{8.40x10^{-6}ft}{s} \times 0.027ft/ft}{0.20}$$

V = $1.13x10^{-6}$ ft/s = 0.098 feet/day

The calculated seepage velocity for the combined bedrock/unconfined formation is shown as follows:

$$V = \frac{\frac{3.551x10^{-5}ft}{s} \times 0.027ft/ft}{0.30}$$

V = $3.20x10^{-6}$ ft/s = 0.28 feet/day

The hydraulic conductivities for each equation were determined using slug test data collected in November 2018 by KPRG. The porosity estimates were obtained from Applied Hydrogeology, Fetter, 1980. These same values were previously provided to the DNR as part of the Site Investigation Report in Table 3-2. The hydraulic gradient was determined from the groundwater flow maps from March/April 2021 created by KPRG. The seepage velocity from the combined bedrock/unconfined formation will be used as part of the evaluation because it is higher than the bedrock seepage velocity. Using this seepage velocity will provide a conservative estimate of the groundwater velocity and the time it will take for the injectate to potentially reach Hobo Spring.

The distance from the west property line to Hobo Spring is approximately 320 feet. This distance was used along with the seepage velocity for the bedrock/unconfined formation to determine the length of time for groundwater from the west property line to reach Hobo Spring. This calculation is shown below.

$$V = \frac{320\ ft}{0.28\ ft/day} = 1{,}142\ days = 163\ weeks$$

It is estimated that it will take approximately 1,142 days or 163 weeks for groundwater to travel from the west property line to Hobo Spring.

The persulfate will not persist long enough in the groundwater to cause any potential concern to fish and aquatic life in either Hobo Spring or the Fox River. The persulfate will last for approximately two weeks in groundwater after it is injected and it takes approximately 163 weeks for groundwater to reach Hobo Spring. Therefore, the persulfate will breakdown and will not be present by the time groundwater reaches Hobo Spring and does not present a risk to fish or aquatic life in Hobo Spring or the Fox River.

Once injected in the groundwater, the persulfate reacts with the groundwater contamination and other entities present in the groundwater, which causes the persulfate to disassociate into sulfate ions. PeroxyChem is the potential provider of the persulfate (Klozur® SP) injectate that will be used during the groundwater remediation injection. PeroxyChem addressed the presence of sulfate in groundwater. PeroxyChem generated a fact sheet that shows laboratory and field data identified that any increase in sulfate concentrations at an injection site do not last longer than 6 months post injection. The decrease in sulfate concentrations occurred because of dilution by incoming groundwater into the injection zone and the conversion of sulfate to sulfide by sulfate-reducing bacteria (SRB). Laboratory testing with Klozur CR, which is a calcium peroxide-persulfate combination involving the treatment of PCBs and PAH contaminated sediment. The lab test tracked the SRB microbial population and within 12 weeks, the conversion of sulfate to sulfide was observed in the three lab tests performed. Based on this, any sulfate generated by the injection of the sodium sulfate at Navistar will not be present by the time groundwater reaches Hobo Spring because it will take 163 weeks for this to occur.

The fact sheet also presented field data from three different sites that also demonstrate the above noted observations. The first site involved a sand and gravel site lithology, a high groundwater flow of about 1 foot per day and the treatment of petroleum hydrocarbons. The observed sulfate concentration decrease was in a monitoring well within the injection zone. The decrease in the well was noted as rapid with a reduction rate of 37 mg/kg per day of sulfate. The decrease was noted from ~4,000 mg/L to <1,000 mg/L in roughly 2 months. The downgradient wells at this site did not show an increase in the sulfate concentration.

The second site consisted of the injection of persulfate and hydrogen peroxide into a subsurface of interbedded layers of sand, silts, and clay. The data from a monitoring well within the injection zone shows an increase in the sulfate concentrations right after the injection (~9,000 mg/L), but within one hundred days, the observed sulfate concentrations were at levels observed prior to the injection (<1,000 mg/L). The third site shows similar sulfate reduction as the first and second sites.

The third site consists of silts and sands with a moderate groundwater flow. As with the second site, the sulfate concentration increased after the initial injection as observed in a monitoring well within the injection zone, but decreased within one hundred days post injection. A monitoring well was located fifty feet downgradient of the injection zone and it did not show any increase in sulfate concentrations with two hundred days of monitoring.

The above demonstrates that using persulfate as a groundwater remediation agent only temporarily increases persulfate and sulfate concentrations in groundwater. The concentrations are reduced within anywhere from two weeks for persulfate to 200 days for sulfate and that the sulfate does not travel great distances downgradient.