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October 30, 2020

Christopher Black
U.S. Environmental Protection Agency Region 5
Land, Chemicals & Redevelopment Division
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Subject: **Response to EPA and WDNR Review of *Arsenic Migration Pathways Evaluation Report* dated March 9, 2020, Tyco Fire Products LP, Stanton Street Facility, Marinette, Wisconsin, WID 006 125 215**

Dear Mr. Black:

On behalf of Tyco Fire Products LP (Tyco), Jacobs Engineering Group Inc. (Jacobs) has prepared this response to U.S. Environmental Protection Agency (EPA) and Wisconsin Department of Natural Resources (WDNR) (Agencies) comments on the document referenced above documenting the summer/fall 2019 river investigation work adjacent to the site. The proposed work scope was outlined in the Arsenic Migration Pathway Evaluation Work Plan dated June 24, 2019 and approved by the Agencies on July 17, 2019. The Agencies comments were provided in a letter attached to an email from Mr. Black delivered on September 30, 2020. For ease of review, the Agency comments are presented in italics followed by the Tyco response in plain text.

Response to Comments

General Comments

1. ***Summary****: The purpose of the 2019 Work Plan was to identify the potential migration mechanisms which resulted in arsenic concentrations in sediments above the 20 milligram per kilogram (mg/kg) remedial goal identified during the 2018 sampling activities. The June 2019 Work Plan included pore water sampling to assess potential sources and mechanisms for arsenic contamination in sediments.*

   Response: Comment noted.

   Conclusions: *Review of the Migration Report indicates that not all proposed activities could be completed, especially as they related to the sediment sampling in the Menominee River. Nevertheless, the Migration Report concludes that "the data collected in 2019 are sufficient for evaluating the arsenic migration pathways, and no further data collection or activities are necessary at this time."* ***EPA believes this is not an appropriate conclusion and recommends additional sediment sampling be conducted in 2021 to verify the modeling results presented in the Migration Report. A revised work plan should be submitted to address the issues detailed in the 2019 Report. This work plan should evaluate the failures of the 2019 sampling event and document how sampling objectives will be achieved with proposed changes to scheduling, procedures and equipment.***

Response: While Tyco can appreciate the Agencies' desire for more information, Tyco believes that additional sediment sampling following a period of only 2 years is unlikely to advance the understanding of the conceptual site model. As with any sediment project, sedimentation rates, which are critical to natural recovery of sediment concentrations, are variable from year to year, and the additional time afforded by conducting the sampling currently planned in 2023 allows for more accurate measurement of that rate (that is, annual variations will be averaged out over multiple years). A work plan will be prepared for the 2023 sampling event that will include any proposed changes to procedures, locations, and equipment.

2. ***Summary:*** *The Migration Report concludes that the data collected during the 2019 sampling effort demonstrated that upwelling of groundwater from bedrock through the glacial till is not a primary arsenic migration pathway. The Migration Report suggests that diffusion of arsenic from glacial till to overlying sediment is the primary migration pathway for arsenic since dredging the site.*

   The major processes for the presence of arsenic and its movement that were evaluated in the Migration Report consisted of the following:

   - *dredge residuals in overlying sediment*
   - *diffusive flux from high to low concentrations*
   - *vertical and horizontal advective groundwater transport*
   - *sedimentation*

   Although not all tasks described in the approved Work Plan were conducted, historical data was used along with modeling results to evaluate each of these migration processes. Specifically, field work in 2019 was stopped prior to Work Plan completion for health and safety concerns. In addition, the collection of samples from the dense and thick glacial till layer proved challenging. There are potential data gaps in the conceptual model of arsenic migration pathways in the Menominee River.

   The Work Plan activities that could not be carried out during the 2019 field activities included collection of pore water concentration data from all but one of the planned borings in the glacial till layer; glacial till pore water was only collected from location VP-102. Glacial till pore water was estimated at other locations based on a mathematical relationship using pore water and sediment data from the samples collected at VP-102 in 2019 and historical samples collected from 2010 through 2014.

   Due to the high density of the glacial till, collection of data on hydraulic conductivity was also challenging. As a result, data from 2007 was used along with the limited data from 2019 to calculate hydraulic conductivity. The hydraulic conductivity in glacial till is used to model vertical hydraulic gradients and groundwater transport through the glacial till layer. The modeling found insufficient vertical advectivity to account for movement of arsenic vertically through the glacial till pore water. When coupled with the verification of the CapSim modeling results with 2019 data presented in Section 6.3 of the Migration Report, the lack of 2019 data on hydraulic conductivity in the glacial till throughout the site does not appear to present a major data gap.

   Overall, the analyses presented in the Migration Report support the conclusion that the dominant process affecting glacial till historically and presently appears to be concentration gradient-driven diffusion (in the downward direction pre-dredging, and in the upward direction post-dredging.

   Response: Comment noted. Tyco agrees with the Agencies' conclusions that lack of 2019 hydraulic conductivity data does not appear to represent a major data gap and that the dominant process affecting glacial till historically and presently appears to be concentration gradient-driven diffusion. The significance of any remaining uncertainty in the inputs to the conceptual site model and CapSIM modeling can be assessed using the 2023 soft sediment data.

Conclusions:

- *The Work Plan activities were conducted as a result of elevated arsenic concentrations identified during 2018 sampling. However, the 2019 sampling results identified a couple of areas where the* ***detected arsenic concentrations were higher than the 2018 results****. Specifically, VP-103 (11 mg/kg) and VP-106 (350 mg/kg) were higher than the co-located 2018 samples SD-12 (3.2 mg/kg) and SD-18 (210 mg/kg), respectively.*

Response: Some 2019 locations varied slightly from 2018 locations because of the high water conditions at the time of the 2019 diving work. The river current proved challenging and at times was difficult to position the temporary station markers precisely because of boat drift due to current and winds. VP-103 and SD-12 are approximately 29 feet away from each other, and VP-103 is relatively farther from the glacial till cover area and in a direction where increasingly higher concentrations in exposed till were observed. SD-12 had just under 1 foot of sand cover observed, while no sand cover was observed at VP-103 (see Section A-A′ on Figure 5-1). It is these variances in conditions between locations that would account for the variability seen in the samples from 2018 and 2019 and the expected slightly higher result at VP-103, since there was no cover material; however, both of the results are relatively low (less than the 20 mg/kg criterion) and within the same order of magnitude.

VP-106 and SD-18 are approximately 5 feet apart and located on a steep slope (see Section B-B′ on Figure 5-2). The slope would make it more likely for results to vary as sediment deposition could be uneven along the slope. There was 7 inches measured soft sediment thickness on average in 2019 and less than 6 inches was estimated in 2018 (there was no vibracore recovery to be able to confirm sediment thickness). The uneven river bottom elevation conditions may account for the variability noted in the samples from 2018 and 2019.

- *Surface Weighted Average Concentrations (SWAC) for arsenic were calculated by combining both 2018 and 2019 data.* ***It is unclear whether this approach is appropriate and whether SWACs should be calculated based on the individual sampling events. It is also unclear the rationale for and impact on the results by using this approach.*** *Given the differences in arsenic measured in co-located samples from 2018 and 2019 the time trends may not be supportable. A reasonable explanation for the variability is that the sediment is heterogeneous with respect to arsenic concentrations with considerable variability over short distances. The 2019 work plan had a 10-foot radius allowance for sampling in the vicinity of the intended sampling coordinates. This is not an unusual allowance for sampling and measurements in deep water conditions however the allowance does introduce uncertainty in the comparability of samples gathered over time. It is recommended that the 2021 work plan evaluate the change in arsenic by collecting and analyzing samples from 10 feet apart at multiple locations to assess macro scale spatial variability.*

Response: Tyco agrees that it is not typical to use data from different years for SWAC calculations; however, because the 2019 event was a follow-on event to the 2018 event and the 2019 data set was adding to the density of samples, the 2018 SWAC was updated for evaluation/comparison purposes as the sample density was not sufficient with 2019 data alone. For the SWAC calculation, either the new 2019 locations were added with a new polygon and other polygons adjusted, or an averaged value was used where a 2018 and 2019 location were close to each other. Moving forward, data collected in 2023 will be used to calculate a sampling-event specific SWAC in the glacial till-affected Turning Basin for comparison to previous SWACs and evaluate progress.

Tyco does not believe it is necessary to conduct sampling from 10 feet apart at multiple locations to assess macro-scale spatial variability. Historical sampling investigation and confirmation sampling results and the 2019 soil boring sampling results do not indicate this as a major concern. In addition, the sediment samples typically have been collected from more than one core or Ponar to obtain the needed sample volume and are then composited. Furthermore, confirmation samples during dredging were collected from a 4,900-square-foot dredge management unit (DMU) area, and the later 2014 confirmation sampling approach changed slightly, and instead, three to five sub-DMUs of approximately 4,900 square feet were grouped together and composited for a typical DMU size of approximately 19,600 square feet. Looking at smaller-scale variability within select areas is inconsistent with the requirements for remediation. If EPA is concerned with the small-scale spatial variability around sample locations, Tyco recommends a composite sampling approach for soft sediment sampling locations. Collecting four to five grab samples within a 10-foot radius at each location for compositing would address the concern of sediment heterogeneity.

- *Because not all field activities could be completed,* ***pore water arsenic concentrations and hydraulic conductivity had to be estimated*** *by supplementing with historical data. In addition, the data validation report (Appendix A Data Quality Evaluation) noted that the laboratory saw considerable heterogeneity in samples submitted for lab analyses that resulted in data flags for many arsenic and TOC* [total organic carbon] *results. The heterogeneity of samples prepared for the lab would appear to be a non-compliance issue with the approved work plan and would suggest improper sample field preparation. The 2021 work plan should offer procedures to ensure that the lab receives samples properly prepared.*

Response: Upon review of the laboratory data, it does not appear that there were improper sample field preparations or an issue that would indicate there was a noncompliance issue with the approved work plan. The laboratory did have issues with the TOC analysis, which is not uncommon for sediment/soil samples. This was primarily associated with glacial till samples and only involved one sediment sample. Note that the glacial till samples likely had more calcium carbonate that may “cement” the sample. For both the TOC and arsenic samples, the laboratory would have mixed the sample well before weighing out a portion for analysis, but they do not grind them, so variability in the density of the soil/sediment can cause precision issues. For the TOC analysis, a 1:1 phosphoric acid was used that may not have a complete and/or reproduceable reaction with the calcium carbonate present in the sample, thereby causing variation in the results.

This issue was not observed with the arsenic samples, which go through a nitric acid digestion before analysis. Nitric acid is a stronger acid than phosphoric acid, which is likely why matrix issues associated with calcium carbonate were not an issue. The attached Table 1 provides a data summary of the samples that had non-homogeneous issues for the TOC analysis, those noted with “Dup” in the comments, and were “J/UJ” flagged. No changes are anticipated in the work plan to the field sample preparations. In addition, because Freundlich isotherms, which do not incorporate organic carbon concentrations, were used in CapSIM modeling, TOC concentrations did not affect CapSIM results. If TOC data are collected during future sampling events, field and laboratory preparation procedures will be discussed with the laboratory to reduce uncertainty.

- *The conceptual site models presented in Figures 2-1 and 6-1 are valuable for presenting environmental features and COC migration pathways. However, both figures assume the till beneath the site is homogeneous and without fractures, coarse lenses, or other preferential* *pathways. This assumption is a critical premise of the report's conclusions, but work to date has not proven this assumption is valid.*

Response: The site has been investigated since 1975, with most investigations occurring in the early to mid-2000s and in the 2009/2010 timeframe. Descriptions of the glacial till conditions described in reports and data collected from borings onsite and beneath the river have not indicated any major preferential pathways such as fractures or continuous coarse lenses within this unit. Any relatively coarser lenses that have been observed have been limited in thickness and cannot be correlated with other adjacent locations. In addition, the calcium carbonate present in the glacial till matrix likely serves to reduce the effect of any preferential pathways on its conductivity.

It is noted that additional sampling is planned for 2023 to collect data on the sediment arsenic concentrations and that this data will be used to verify whether concentrations continue to meet the CapSim predictions. However, ***the inability to collect the planned porewater and sediment data during 2019 resulted in major uncertainties in the pore water arsenic concentrations and hydraulic conductivity values that were used as input to the CapSim modeling.***

In particular, the hydraulic conductivity developed from the 2019 data differed substantially from historical values. ***Again, in order to reduce these uncertainties, we recommend that the 2023 sampling event be performed in 2021 as well as in 2023.*** *The 2021 sampling event will provide data on sediment concentrations of arsenic that can be compared with 2019 data and with CapSim modeling output to help ensure that the model, as it is configured with uncertain input values, is not underpredicting future sediment concentrations of arsenic. This approach would result in sediment arsenic data collected in two-year intervals instead of a four-year interval. Furthermore, consideration should be given to calculating SWAC results for the individual sampling event.*

Response: See response to Comment 1 regarding 2021 sampling and response to Comment 2, "Conclusions," second bullet regarding SWAC calculations. The porewater calculations were based on a data set of 31 co-located pore water and soft sediment samples that related porewater concentration to measured sediment concentrations and showed a strong correlation to a Freundlich isotherm (r-squared value of 0.88). Groundwater concentrations (in the glacial till) were estimated using a data set of six co-located groundwater and soil samples, and also showed a strong correlation (r-squared value of 0.86). In 2019, soft sediment data were successfully collected at all eight planned locations (16 samples total). Vertical profile soil concentration data in the till were collected at four of six locations and were consistent with previous vertical profiles in the till, showing the highest concentrations near the top of the glacial till layer. Hydraulic conductivity data in the till was available from four samples (one result from 2019, three results from prior sampling). As with all environmental projects, and modeling projects, there is some uncertainty in the results; however, we believe that this uncertainty is relatively small, and uncertainty will be reduced by collecting soft sediment data in 2023 to verify trends over a 4-year period. We do not believe that collecting data in 2021 will provide a significant additional reduction in uncertainty.

Should the CapSim model verification efforts using 2021 and 2023 data continue to show sufficient predictability, the exercises should help reduce the uncertainties in using the limited glacial till pore water arsenic concentration data and hydraulic conductivity values that were estimated in the Migration Report. Verification of the CapSim predictions with 2021 and 2023 data will also help determine whether the inability to collect the full pore water data and hydraulic conductivity data from the glacial till layer during the 2019 sampling effort resulted in major data gaps.

Response: See response to Comment 1 regarding sampling in 2021. We agree that future data will reduce uncertainties; however, as indicated in the response to Comment 1, we believe that the benefit of collecting data in 2021 will be limited and may even be misleading because of the limited amount of time that will have elapsed since the 2019 event. Data collected in 2023 will be used to calculate a sampling event-specific SWAC (to be compared to previous SWACs) to evaluate site progress. If necessary, soft sediment results from areas where 2019 data were modeled in CapSIM will be evaluated to assess whether sediment concentration trends are progressing as expected, and if not, identifying likely causes and potential implications.

We trust the enclosed responses address EPA's comments. Please contact Jeffrey Danko at 414-524-3344 if you have any question.

Regards,

Jacobs Engineering Group Inc.

Heather Ziegelbauer
Project Manager

Copies to: Angela Carey/Wisconsin Department of Natural Resources
Ryan Suennen/Tyco Fire Protection Products
Jeffrey Danko/Johnson Controls
Mariel Carter/Stephenson Public Library

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Table

Table 1. Total Organic Carbon Sample Data Summary

Field ID	Laboratory Sample ID	Sample Date	CAS	Result	Final Qualifier	Units	MDL	RL	DF	Percent Solids	Final Q/ Code
SD103-2019-0.0/0.3	500-170395-10	9/18/2019	TOC	32,000	J	mg/kg	1,600	2,200	1	45.7	J/Dup
SO103-2019-5.0/5.5	500-172205-12	10/18/2019	TOC	2,100	J	mg/kg	810	1,100	1	92.1	J/DUP
SO103-2019-7.0/7.5	500-172205-16	10/18/2019	TOC	8,500	J	mg/kg	800	1,100	1	93.5	J/DUP
SO103-2019-7.5/8.0	500-172205-17	10/18/2019	TOC	1,600	J	mg/kg	800	1,100	1	92.9	J/DUP
SO103-2019-8.0/8.5	500-172205-18	10/18/2019	TOC	12,000	J	mg/kg	790	1,100	1	94.2	J/DUP
SO103-2019-0.5/1.0	500-172205-2	10/18/2019	TOC	7,600	J	mg/kg	800	1,100	1	93.3	J/DUP
SO103-2019-13.5/14.0	500-172205-30	10/18/2019	TOC	3,500	J	mg/kg	810	1,100	1	92	J/DUP
SO103-2019-14.5/15.0	500-172205-32	10/18/2019	TOC	5,200	J	mg/kg	800	1,100	1	93.1	J/DUP
SO103-2019-1.0/1.5-D	500-172205-4	10/18/2019	TOC	1,800	J	mg/kg	800	1,100	1	93.6	J/DUP
SO103-2019-18.0/18.5	500-172205-40	10/18/2019	TOC	4,100	J	mg/kg	800	1,100	1	93.8	J/DUP
SO103-2019-19.5/20.0	500-172205-43	10/18/2019	TOC	2,000	J	mg/kg	800	1,100	1	93.8	J/DUP
SO103-2019-2.0/2.5	500-172205-6	10/18/2019	TOC	13,000	J	mg/kg	800	1,100	1	93.2	J/DUP
SO103-2019-3.5/4.0	500-172205-9	10/18/2019	TOC	6,200	J	mg/kg	800	1,100	1	93.3	J/DUP
SO102-2019-0.0/0.5	500-172192-1	10/17/2019	TOC	790	UJ	mg/kg	790	1,100	1	94	UJ/DUP
SO102-2019-5.3/5.8	500-172192-10	10/17/2019	TOC	800	UJ	mg/kg	800	1,100	1	93.8	UJ/DUP
SO102-2019-5.8/6.2	500-172192-11	10/17/2019	TOC	2,100	J	mg/kg	800	1,100	1	93.1	J/DUP
SO102-2019-0.5/1.0	500-172192-2	10/17/2019	TOC	800	UJ	mg/kg	800	1,100	1	93.7	UJ/DUP
SO102-2019-1.5/2.0	500-172192-4	10/17/2019	TOC	5,200	J	mg/kg	800	1,100	1	92.9	J/DUP
SO102-2019-2.0/2.5	500-172192-5	10/17/2019	TOC	12,000	J	mg/kg	800	1,100	1	93.6	J/DUP
SO102-2019-3.0/3.5	500-172192-6	10/17/2019	TOC	2,300	J	mg/kg	800	1,100	1	93.8	J/DUP
SO102-2019-3.5/4.0	500-172192-7	10/17/2019	TOC	880	UJ	mg/kg	880	1,200	1	85.2	UJ/DUP
SO102-2019-4.3/4.8	500-172192-8	10/17/2019	TOC	800	UJ	mg/kg	800	1,100	1	93.7	UJ/DUP
SO104-2019-1.0/1.5	500-172449-12	10/24/2019	TOC	4,200	J	mg/kg	800	1,100	1	93.1	J/DUP/OT
SO104-2019-11.0/12.0	500-172449-25	10/24/2019	TOC	2,000	J	mg/kg	790	1,100	1	94.2	J/BS/DUP

Table 1. Total Organic Carbon Sample Data Summary

Field ID	Laboratory Sample ID	Sample Date	CAS	Result	Final Qualifier	Units	MDL	RL	DF	Percent Solids	Final Q/ Code
SO104-2019-13.0/14.0	500-172449-28	10/24/2019	TOC	1,800	J	mg/kg	790	1,100	1	94.6	J/BS/DUP
SO104-2019-14.0/14.3	500-172449-29	10/24/2019	TOC	6,400	J	mg/kg	800	1,100	1	93.8	J/BS/DUP
SO102-2019-8.0/9.0	500-172449-3	10/23/2019	TOC	1,700	J	mg/kg	800	1,100	1	93.8	J/DUP/HT/FD/OT
SO102-2019-9.0/10.0	500-172449-5	10/23/2019	TOC	790	UJ	mg/kg	790	1,100	1	94.5	UJ/DUP/OT