MEETING SUMMARY NOTES

Date: January 16, 2020

Attendees: Citizens of Sauk Prairie, Local and regional agencies, and the US Geological Survey

RE: Questions concerning Badger Army Ammunition Plant

The meeting focused on questions and concerns related to the Badger Ammunition Plant. The USGS role is to help communicate these questions/concerns to the Army from this meeting. A follow up meeting with the Restoration Advisory Board (RAB) was proposed for February (exact date TBD) where the follow questions could be discussed with the Army.

1. Which reports are pending or planned and what are the timelines for completion for each?
2. What is the purpose of each report? For example, what is the purpose for the groundwater model – to test alternatives? Or predict future conditions?

Here is a description and status of U.S. Geological Survey projects/reports related to BAPP:

- ***Gruber's Grove Bay Mercury Site Assessment, U.S. Geological Survey Data Release***

Data were collected to assess mercury (Hg) concentrations and isotopic compositions at Gruber's Grove Bay (GGB), Wisconsin for future management decisions related to the site. Bed sediments (52 samples), soils (13 samples), and suspended particulate matter (12 samples) were collected for Hg analysis from regions of GGB and upstream sites with no known Hg discharge (Weigand's Bay and Lake Wisconsin). These data will be provided for presentation and release to the Restoration Advisory Board for the Badger Army Ammunition Plant and the general public by the US Army Environmental Command

The highest concentrations and isotopic signatures (δ202Hg) were observed in soils collected from historic water settling ponds from the Badger Army Ammunition Plant (BAAP). Sediments from the upper portion of GGB showed higher isotopic compositions than sediments from the Wisconsin River. Hg concentrations in sediments were also higher in the upper portion of GGB and decreased towards the river. Sediments collected from the GGB margin (the confluence with the Wisconsin River) were within the concentration and isotopic ranges of Weigand's Bay and further upstream sites. Suspended particulate matter collected from the Wisconsin River and GGB site were isotopically similar to particulate matter from upstream and reference sites.

The review process for this data information product has been completed and the data are available to the public. The results of this study were presented at the September 2019 RAB meeting.

Janssen, S.E., and Krabbenhoft, D.P., 2019, Gruber's Grove Bay Mercury Site Assessment: U.S. Geological Survey data release, https://doi.org/10.5066/P990MFHU.

- ***Plume Delineation and Monitoring Network Optimization at the Badger Army Ammunition Plant, Sauk County, Wisconsin, U.S. Geological Survey Scientific Investigations Report.***

A consistent data aggregation and interpolation method is applied to derive the likely maximum groundwater plume extents in four 3-year time intervals between 2000 and 2018. The plume extent is defined by the enforcement standard for each contaminant of concern, and represents the maximum concentration observed in each 3-year time period.

A series of statistical analyses using the Monitoring and Remediation Optimization System (MAROS 3.0) program are applied to the available contaminant concentration data for two distinct periods: from 2000 to 2012, and 2013 to 2018, with the break between periods coinciding with changes to the monitoring network in 2013. Statistical trends in the concentration of contaminants are determined (where sufficient data are available) for individual wells and for contaminant plumes.

A draft version report has been completed and the report is in peer review. The estimated release date is July 2020.

- ***Presentation of Water Quality Data as a Story Map at the Badger Army Ammunition Plant, Sauk County, Wisconsin, U.S. Geological Survey Web-based Visualization Product.***

This project will provide a series of base maps of the BAAP site and surrounding area, including coverage of all areas in which any groundwater quality monitoring wells are located. Base maps will include an outline of the boundary of the three main contaminant plumes associated with BAAP. Plume boundaries may be based on previous work presented in the 2018 RIFS, or on previous work conducted by USGS, as determined in consultation with AEC.

Maps will display approximately 166 wells that are part of the current monitoring network and sampled on a routine basis. The maps will also display approximately 52 residential wells in the area that have been sampled periodically, specifically in 2004, 2009 and 2018. Mapped well locations will be linked to a database of groundwater quality analytical results, such that a user can click on a well location and pull up available water quality data. Data to be displayed will be limited to three constituents of concern for each separate contaminant plume. For monitoring network wells, analytical results from the three most recent years of sampling events will be displayed in a table. For residential wells, results from the three historical sampling events will be displayed. Personally Identifiable Information associated with residential wells will not be displayed. No reference to owner's name or address will be available; wells will only be identified by a well identification

number. Measures will be taken to obscure or mask the exact locations of residential wells so that ownership cannot be discerned by users.

The target date for completion of this product is September 30, 2020.

- ***Development of a Groundwater Flow and Transport Model, U.S. Geological Survey***

The purpose of this project is to develop a groundwater-flow and transport model capable of describing the three contaminant areas-of-concern at the Badger Army Ammunition Plant (BAAP) site: 1) the Propellant Burning Ground plume in the southwest part of BAAP, 2) the Deterrent Burning Ground/Landfill no. 5/Landfill no. 3 plume in the northeast part of BAAP, and 3) the Central Plume of unknown origin. The model will produce results quantifying likely contaminant transport at the site under various conditions. The model will be designed to help AEC communicate with stakeholders and to test ideas regarding plume migration and remediation. In particular, the modeling effort will be directed toward understanding a) the general decline in contaminant concentrations, b) the episodic rebounds in concentrations, and c) controls on plume behavior that condition potential remedial measures (pump and treat, bioremediation, natural attenuation from degradation). The ultimate aim of the modeling work is to test remediation strategies. Remedial options to be tested for each plume include natural attenuation, pump-and-treat, and enhanced biodegradation. This is not currently a predictive modeling effort to predict concentrations at individual wells or match history of the plumes.

The purpose and scope described above constitutes phase 1 of the project to be completed by September 30, 2020. Deliverables for phase 1 include preliminary documentation and archive of the model and presentation of preliminary results at the September 2020 RAB meeting.

3. There is a 60-day period for public comment. What happens after 60 days? Does the RAB still have an opportunity to comment on the path forward of the RI/FS?

4. Is it possible to change strategy on cleanup activities based on potentially new information discovered at a future time? For example, information from these reports or models?

5. What is the status of the contract to dredge Grover's Bay?

6. How do regulators deal with proposed alternatives? For example, will Wisconsin Department of Natural Resources (WDNR) comment on the alternative?

   At the Dec 5, 2019 meeting, a member of WDNR said that they would not make a recommendation or preference for a specific option but would comment on the selected option.

7. Has vegetable oil ever been used on a large scale for bioremediation? Are there potential side effects from using vegetable oil? For example, if it goes into the river, will it cause algal blooms? Are there examples of where it did work in other parts of the country?

In situ bioremediation of groundwater is a widely used technology for contaminated site treatment because of its relatively low cost, adaptability to site-specific conditions, and effectiveness. Vegetable oil contamination and algal blooms should not be a concern with a properly implemented program. A bioremediation project was successfully implemented at the Department of Energy's Savanah River site, located 1,600 feet from the Savanah River. EVO in the groundwater completely degraded before reaching the river (https://web.ornl.gov/info/news/pulse/no394/feature.shtml).

During bioremediation, the EVO is expected to remain in the aquifer for about two years before degrading. EVO tends to adhere to the soil particles and groundwater flows through the distributed EVO. Even if the EVO were to move with the groundwater, it would not move more than a few hundred feet before degrading. Estimated groundwater flow velocities at the BAAP are 306 feet/year, 109 feet/year, and 143.feet/year for the PBG plume, DBG plume, and the Central Plume, respectively (section 4.4.4, November Draft Final RI/FS).

Proposed EVO treatment lines are shown in appendix J of the RI/FS.

Another helpful reference: Introduction to In Situ Bioremediation of Groundwater (U.S. Environmental Protection Agency, 2013, https://semspub.epa.gov/work/11/171054.pdf).

8. Is there a way to test if rises in the groundwater table are causing COC exceedances in locations? Are more clean-up actions needed because if it's linked to the rains?

To test if rising groundwater (near source areas) affects COC exceedances, more sampling would be required during and after groundwater level rises. Continuous real-time groundwater-level monitors would need to be located near the waste pits. Rises in groundwater levels can be immediately identified and sampling could be coordinated with these rises.

9. What actions have been going of for the past 30 years?

The November 2019 Draft Final RI/FS is a good reference for production and remediation history at the BAAP.

Section 2.2 (2 pages) provides a site history, including Production Time Periods (section 2.2.1), Waste Disposal Practices (section 2.2.2), and Demolition and Restoration time periods (section 2.2.3).

Section 3.0 (12 pages) provides a useful summary of BAAP contaminate source investigations and remedial actions at the PBG (section 3.1), DBG (section 3.2), Central Plume Area (section 3.3), and the Nitrocellulose Production Area (section 3.4).

Also, section 5.0 is the "Groundwater Human Health Risk Assessment." Subsections 5.4, 5.5, 5.6, and 5.7 provide additional background information on sources of contamination. remediation efforts, and extent of contamination. These sections include some supportive graphics to help visualize the three major plumes in relation to local geology, monitoring wells. Residential wells, and other area features.

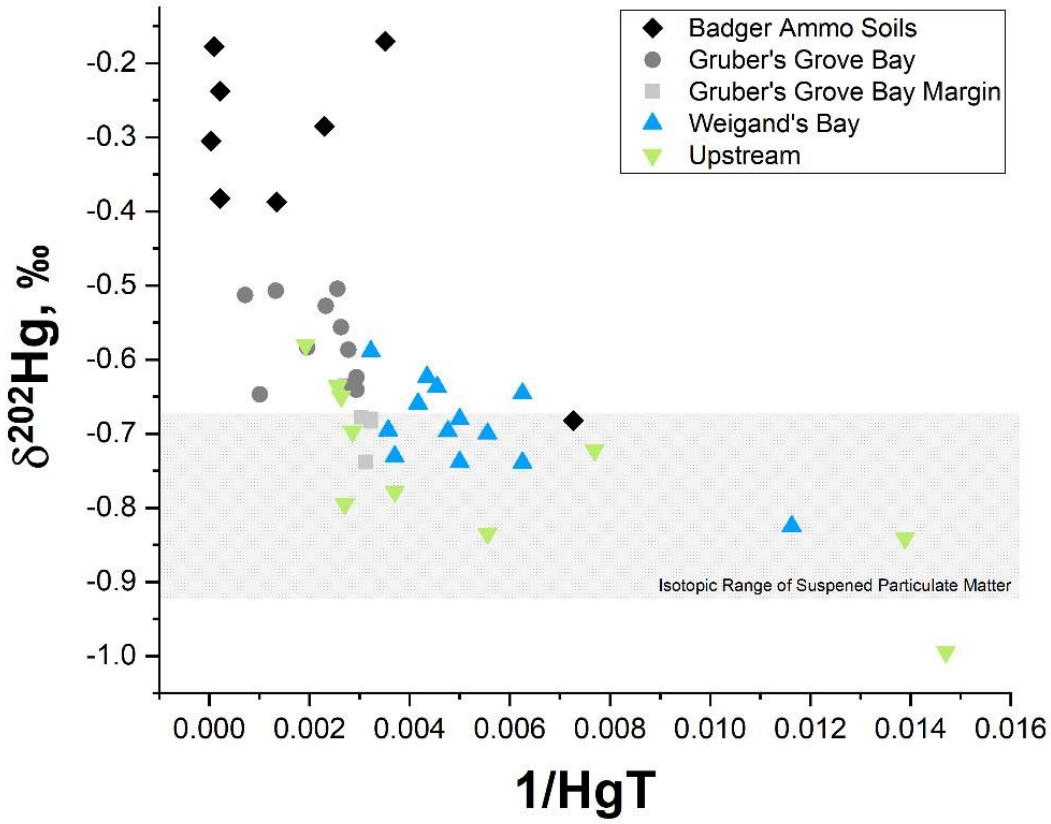
10. Was more mercury exposed as a result of dredging? Did they use the right technology to clean it up?

A letter from the State of Wisconsin DNR, dated January 23, 2018 (Appendix A, U.S. Army's "Gruber's Grove Bay Sediment Sampling Report", April 19, 2019), identifies some problems with the 2006 Gruber's Grove dredging: "*While the 2006 project removed significant quantities of mercury contaminated sediment, large quantities of dredged residuals containing significant concentrations of mercury were left behind.*" The DNR also stated that "*the Department believes that the project goals are achievable using more modern dredging equipment and contracting specifications specific to modern environmental dredging techniques.*" Regarding the question whether more mercury was exposed, certainly, mercury-contaminated sediments are disturbed during the dredging process, resulting in an environmental impact. However, significant quantities of mercury were removed. So, it is probably not precise to say that more mercury was exposed. Regarding the use of the right remediation technology, you might say that the 2006 dredging effort was "inadequate" because of technological shortcomings. However, the Wisconsin DNR has expressed confidence that the right technology and methods are available for successful remediation for the next dredging operation.

11. Where is the source of the mercury?

In May of 2019 the USGS performed field sampling within Gruber's Grove Bay (GGB), Weigand's Bay, upstream sites, and on site at the Badger Army Ammunition Plant (near former settling ponds). Sediments and suspended particulate matter were collected from GGB, Weigand's Bay, and upstream sites. Soils were collected from former settling ponds. The objective of the sampling was to determine the source fingerprint (isotope signatures) of mercury from the Gruber's Bay region and the extent of contamination. Isotope signatures are independent of mercury concentration and can be assessed on a scale from terrestrial to industrial sources.

The figure below shows that mercury isotope signatures collected by the USGS from the BAAP soils are the most positive and likely are indicative of the original source of mercury from the BAAP. Sediments from GGB show similar characteristics to these soils but are less negative suggesting the influence of mercury releases from the plant as well as the accumulation of mercury from the Wisconsin River. Sediments from Weigand's Bay and Upstream sites represent the isotopic fingerprint of mercury within the Wisconsin River and are similar to suspended particulate matter (gray box) collected from the water column.



Mercury Isotope-Source plot for Sediments (from U.S. Geological Survey presentation to the BAPP RAB, September 2019)

12. RI/FS should look at the source areas more, as compared to once it's in the groundwater.

Agree that the PBG and DBG plume source areas are an important issue. In fact, both the PBG and DBG plume proposed remedial alternatives (Draft RI/FS, November 2020) include "Source Area Treatment" which focus on the source areas. The Source Area Treatment alternative involves in-situ biochemical injection to stimulate anaerobic biodegradation. The target areas for injection are immediately downgradient of the source areas (not in the actual unsaturated source areas—see response to question 15). The Source Area Treatment area alternative also includes continued monitoring of residential and monitoring wells and the provision for well replacement.

In addition, the "Pump and Treat" and "Anaerobic Bioremediation" alternatives for the PBG and DBG plumes also include treatment immediately downgradient of the source areas, as well as other target locations.

13. What is the source area of the central plume? How did they identify and treat the source area?

According to the Nov 2019 draft RI/FS (section 3.3), "*Based on the groundwater flow direction and the groundwater contaminant detections, the source of 2,6-DNT contaminated groundwater was believed to be in the north-central portion of BAAP where nitroglycerin, rocket paste, and rocket propellant were produced. However, several investigations/excavations to date have not determined a specific source of DNT contamination (e.g., landfill or disposal area). It is believed that the broad production area may have caused the groundwater impacts*." Also, section 3.3.1 documents remediation efforts involving removal and disposal of contaminated sewer piping and soil removal around buildings and ditches. Section 3.3.1 concludes with: "*Based on these activities, there remains no source of DNT contaminated soil in the Central Plume.*"

14. What technology could be done at the source areas? For example, take off the cap and remediate?

The issue of removing a cap to remediate a source area was discussed at the December 2019 RAB meeting. The Army pointed out that the purpose of the cap is to prevent rain, snowmelt, and surface-water runoff from seeping through the contaminated material and carrying contaminants to the groundwater. Disturbing the integrity of the cap, even in a remediation effort would likely make the groundwater contamination worse.

15. Can you do anaerobic remediation under the cap to clean up the source area?

Not in this case. Anaerobic remediation is typically a treatment for a groundwater-saturated aquifer. A mixture of water and emulsified vegetable oil (EVO) is injected into the area to be treated and the mixture is distributed through the aquifer pore space. The PBG and DBG source areas are unsaturated. To distribute the EVO into the unsaturated source area would require injection of a lot of water along with the EVO. The water would drain through the contaminated soil, carrying contamination into the groundwater. To maintain the EVO mixture in the unsaturated zone for a length of time necessary for biodegradation, could require continued pumping of the EVO-water mixture, resulting in additional transport of the contaminants into the groundwater system.

16. What does it take for WDNR to reopen site for cleanup?

A member of WDNR present at the December 2019 RAB meeting said it would require new information (for example, new data).

17. Should the RI/FS look at more than just groundwater? For example, look at soils also?

The Army has received closure approval from the WDNR on all soil-related investigations and response actions at BAAP (Section 3.0, Draft RI/FS, November 2019). These actions include excavation of contaminated soil, installation of clay and geomembrane

caps covering waste pits and landfills, and operation of a soil vapor extraction system (PBG waste pits).

18. There are new releases near the cap. Is this enough to revaluate the treatment technologies proposed?

    There is a potential for groundwater to be contaminated from additional contact with soils that have elevated levels of contamination. For example, increasing DNT concentrations in some PBG wells in 2018 appear to be related to rising groundwater coming into contact with contaminated soil. Treatment alternatives should consider this and some of the proposed treatment alternatives would address this issue. See the response to questions 8 and 12.

19. DNT sorbs to the sediment, so pump and treat alternative action may not be appropriate.

    Pump and treat techniques might have some limits of effectiveness in treating groundwater for COCs. However, *"2,4- and 2,6-DNT only have a slight tendency to sorb to sediments, suspended solids, or biota based on their relatively low organic-carbon partition coefficients"* (EPA Technical Fact Sheet, 2012). Pump and treat systems were operated at the Propellant Burning Ground (PBG) plume during 1993–2012 (Interim Remedial Measures, IRM) and 1996–2015 (Modified, Interim Remedial Measures, MIRM). The IRM and MIRM pump and treat systems at the PBG plume reduced quantities of DNT near the source areas (Section 3.1.1, November 2019 RI/FS)). Another potential advantage of pump and treat systems that are deployed near the source areas is to lower the groundwater level. That could help prevent groundwater from rising and contacting source-area contamination.

20. What is the timetable for cleaning up and paying for the BAAP?

21. Is it possible to cap the bottom of the source area?

    This is not a feasible alternative. More practical alternatives to remediate contamination downgradient from the source areas are proposed in the November 2018 Draft RI/FS—see response to questions 8, 12, 15, and 18.

22. Why is 2,6-DNT vs Total DNT listed as a COC?
    It was stated at the Dec 5, 2019 meeting that this was based on a conservative approach.

23. Why are there two different cancer risks for on-site vs off-site people? Should it be the same for both groups of people?

24. Currently, the Army is performing Monitoring and Natural Attenuation (MNA), so why is that listed as an alternative action?

Although MNA is ongoing, it is carried forward as a process option which could also be combined with other process options to meet the remedial action objectives. Under CERCLA, MNA is considered to be a remedy as other alternative action remedies.

25. What are the three reasons for being listed as CERCLA?

26. What was the specific reasons for not being authorized to create a new water system? What was the written Opinion of the Army on this ruling?

27. Are the source areas still producing high levels of COCs? If so, why only treat the groundwater? Why not go to the source area and clean it up completely?

The PBG and DBG source areas still contain soils that have elevated levels of contamination. Periods of rising groundwater could present a potential threat of re-exposing the contamination to the groundwater. See responses to questions 8, 12, and 18.

28. Are there restrictions for depth and/or screening intervals for new wells where contamination is known to occur?

29. Does the Army have plans to test future installed wells?