Subject: Final Minutes, Quarterly Restoration Advisory Board (RAB) Meeting
Longhorn Army Ammunition Plant (LHAAP)
Location of Meeting: Karnack Community Center
Date of Meeting: February 15, 2023, 6:00 PM Central Standard Time (CST)

Meeting Participants:

Army BRAC:	Rose M. Zeiler
USACE:	Aaron Williams, Chelsea Montoya
USAEC:	Lena Sierocinski, Michael Bowlby
Bhate:	Zachary Beck
APTIM:	Bill Foss
HDR, Inc.:	Philip Werner, Gregory Kelly
MMG-TLI JV:	Jonathon Tatman
USEPA Region 6:	Brian Follin
TCEQ:	April Palmie
RAB:	Present: Sharon McAvoy, John Fortune, Richard LeTourneau, Deon Hall, and Judy VanDeventer Absent: Tom Walker and Nigel Shivers
Public:	George Rice, Gene Byrd, Laura-Ashley Overdyke, Erik Duerkop, and Jessica Harker

---

A color copy of the slide presentation and handouts (see list at end of meeting minutes) were provided for meeting attendees.

Welcome and Introduction

Ms. Judy VanDeventer welcomed everyone to the RAB Meeting and called the meeting to order, which Mr. John Fortune seconded. New attendees introduced themselves including Ms. Jessica Harker of the Marshall News Messenger. Ms. Rose Zeiler introduced Mr. Michael Bowlby and Ms. Lena Sierocinski with United States Army Environmental Command (USAEC). Ms. Zeiler explained that Base Realignment and Closure (BRAC) Installation Services has administrative control over Longhorn and has implemented the environmental program as well. There are two separate funding streams at LHAAP including BRAC funds and USAEC funds. The transfer program, some non-CERCLA environmental cleanup, and non-environmental programs are funded by BRAC. However, the environmental program is funded by USAEC, and recently USAEC has expressed an interest in being the lead decision maker on the LHAAP environmental program. Ms. Zeiler said that BRAC has agreed, and Ms. Zeiler will be stepping aside in her role as the environmental lead. Ms. Zeiler explained that Ms. Sierocinski will become the new RAB co-chair alongside Ms. VanDeventer. Ms. Zeiler assured the RAB that BRAC retains administrative control and will continue to carry out the transfer program. A BRAC monitor, who has yet to be assigned, will also monitor the environmental program for BRAC. Mr. Bowlby

reiterated that the transition will largely be transparent, with U.S Army Corps of Engineers (USACE) managing the environmental work, with USAEC as the lead instead of BRAC. Mr. Bowlby said that the program is a team effort and that will remain unchanged. Ms. Laura-Ashley Overdyke asked about USACE's role is in the new relationship. Mr. Bowlby explained that USACE procures the subcontractors and oversees the technical aspects of the program jointly with USAEC. Ms. Overdyke asked if the institutional knowledge from Ms. Zeiler will be carried forward. Mr. Bowlby explained that he would reach out to the BRAC as needed. Ms. Zeiler added that she will be with BRAC for another two years and available for assistance. Ms. Rose Zeiler introduced the contractors presenting at the RAB, including Bhate Environmental Associates, Inc. (Bhate); APTIM Federal Services (APTIM); MMG-TLI Joint Venture (JV); and HDR, Inc. (HDR).

Membership Update

Ms. Zeiler, Army BRAC, asked if there were any members of the public interested in joining the RAB. Mr. Gene Byrd introduced himself as a retired chemical engineer and a local resident of Karnack, and expressed interest in joining the RAB. Ms. Judy Van Deventer presented a RAB application for Ms. Margaret Roland, who was unable to attend. Ms. Zeiler provided an overview of the membership process, stating that anyone in the public can become a RAB member. Ms. Zeiler encouraged participation of the public attending the RAB regardless of whether they are part of the board. She explained that the RAB meets three times a year.

Minutes (November 2023 RAB Meeting)

Ms. Zeiler verified that there were no comments or changes to the November 2023 meeting minutes. Motion to approve the November 2023 RAB meeting minutes was provided by Ms. VanDeventer, with Mr. Fortune seconding the motion.

Documents in Progress

Mr. Zachary Beck, Bhate, introduced the sites that Bhate is managing. Mr. Beck explained that work at LHAAP-18/24, which Bhate oversees as an interim remedy, overlaps with HDR, who is developing the final remedial design.

Mr. Beck then presented the documents and field work completed since the last RAB in November 2022. He explained that most of the sites under the Bhate contract already have remedies. Mr. Beck said that once the remedies are implemented, periodic monitoring is completed with is called Remedial Action-Operation (RA-O). The RA-O performance groundwater monitoring is completed to evaluate those remedies. An annual report is then produced to document the monitoring. Mr. Beck said that once the documents have been reviewed and approved by the regulatory agencies, the documents are posted to the LHAAP administrative record. Mr. Beck then explained that between February 2023 and the next RAB in June 2023, groundwater monitoring would continue to ensure compliance at the sites within the Bhate contract.

Groundwater Treatment Plant (GWTP) Update

Mr. Beck provided an overview of the GWTP, which currently treats groundwater from LHAAP-18/24 and recently started processing groundwater from LHAAP-17. He presented a handout depicting a graph of the amount of treated groundwater discharged each month. Mr. Beck explained the GWTP process that includes metals' treatment, air stripping of volatile contaminants, and a fluidized bed reactor (FBR) that treats perchlorate. Mr. Beck explained that the FBR contains microbes that consume the perchlorate contamination prior to discharge to the Harrison Bayou.

Surface Water

Mr. Beck said that the surface water is sampled quarterly within Harrison Bayou and Goose Prairie Creek. He pointed everyone to the handout for the surface water sampling with the surface water results to date. Mr. Beck said that perchlorate is monitored quarterly at five locations to evaluate potential impacts to the surface water bodies.

LHAAP-18/24

Mr. Philip Werner, HDR, introduced Sites LHAAP-18/24, LHAAP-29, and LHAAP-47. Mr. Werner presented an overview of the selected remedy for LHAAP-18/24. Mr. Werner explained that the 90 percent (%) Remedial Design (RD) for Longhorn Site LHAAP-18/24 is currently under regulatory review. He explained the RD process in which there is a 30 % RD, 60 % RD, 90 % RD, and a Final Specification Package. Mr. Werner said that the 30 % RD is a conceptual design, while the 60 % RD is more detailed and presents the technology that was approved in the Record of Decision (ROD). He explained that 60 % RD evaluates the technology to determine that the remedy is feasible, cost effective, and available. Mr. Werner said that the 90 % RD includes a cost evaluation and further details on the specifics of implementing the remedy. Mr. Werner said the Final Specification Package will include the design elements, how the design elements will be completed, cost estimates, and design drawings.

LHAAP-29

Mr. Werner provided an overview of the selected remedy for LHAAP-29. He said that the 90 % RD planned for submittal in April 2023.

LHAAP-47

Mr. Gregory Kelly, HDR, said that the Pre-Design Investigation (PDI) Work Plan for LHAAP-47 has also been submitted for regulatory review. Mr. Kelly said that the scope of work for the PDI is to collect a round of groundwater samples at existing monitoring wells across the site and install and develop new monitoring wells (4 shallow zone wells and 2 intermediate zone wells). Redevelopment of existing monitoring wells may also be necessary. Mr. Kelly said that the new monitoring wells will be surveyed, and a topographic survey of the site will be completed to help guide the RD. Mr. Fortune asked if the monitoring well casing is cemented in place. Mr. Kelly explained the monitoring well completion process, including placement of the filter pack, the grout seal to the ground surface, and the concrete pad and steel protective casing at the surface. Ms. Zeiler added that these monitoring wells will be considered permanent wells and are completed in accordance with Texas Commission on Environmental Quality (TCEQ) regulations.

Mr. Byrd asked how these sites came about initially. Ms. Zeiler explained that a Preliminary Assessment (PA) was completed in the mid-1990s, and environmental sites were identified through the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. Mr. Byrd asked about the end point or goal for all these sites. Mr. Brian Follin, with the U.S. Environmental Protection Agency (USEPA), said that each site has different remedial action goals, with the primary goal of returning the sites for reuse. Mr. Byrd asked if the work is funded by the Department of Defense (DoD). Mr. Bowlby explained that the funding, which is "fenced," is DoD set aside money through Congress, which is available to the Army to fund environmental work.

LHAAP-17

Mr. Jonathon Tatman, MMG-TLI JV, discussed the Time Critical Removal Action (TCRA) completed at LHAAP-17. Mr. Tatman explained that the Time Critical Removal Action was completed to reduce the impact of Munitions and Explosives of Concern (MEC) at the site. He outlined the major work elements completed including a civil survey, and the use of robotic machinery to filter and shift previously dug material known to contain MEC. Mr. Tatman explained that the soils were then sampled for perchlorate and explosives and either returned to the site or transported for offsite disposal at a landfill. He stated that 13 different excavation areas were opened, MEC items were removed, and explosive contaminated soil was hauled offsite. The excavations were then backfilled with clean backfill. Mr. Tatman said that after the explosive contaminated soil was removed and known MEC disposed of, then the entire site underwent a surface sweep. After the surface sweep, 425 targets of interest were identified and excavated. Overall, 96 MEC items were confirmed and destroyed onsite, along with 2,500 cubic yards of contaminated soil hauled offsite. Ms. Zeiler explained that this site was an open burn/open detonation site. Ms. VanDeventer asked if this site was related to missile development or pyrotechnics. Mr. Tatman said that LHAAP-17 was related to pyrotechnics, specifically signal flares or fusing components. Mr. Tatman explained that when a target of interest is encountered it is treated as a MEC item. At that point, it goes through a two-person inspection to certify if the item is either free of explosives and can be disposed of safely offsite or detonated onsite if it cannot be 100% ascertained as a non-MEC item. MEC items are safety detonated onsite and additional soil sampling is conducted for explosives around the detonation site.

Mr. Beck then presented the groundwater extraction system performance data. He explained that LHAAP-17 extraction system began operation on August 5, 2022. Mr. Beck said that approximately 279,000 gallons of impacted groundwater has been extracted and pumped to the GWTP at the end of December 2022. Mr. Beck explained that five monitoring wells are sampled monthly to monitor the system's performance. He said that as of November 2022, the horizontal extent of perchlorate groundwater contamination has decreased, since baseline groundwater sampling was conducted in April 2022. Mr. Beck said that in addition to the decreasing footprint of contamination, the highest concentration of perchlorate onsite has decreased from 120,000 parts per billion (ppb) in April 2022 to 89,900 ppb as of November 2022. Mr. Beck said the concentrations of perchlorate indicate that the groundwater extraction system is working as designed and reducing the impacted groundwater extent. Ms. Overdyke asked about increasing

perchlorate concentrations at 17WW02. Mr. Beck explained that 17WW02 is one of the two extraction wells, and that an initial increase in perchlorate is not surprising as the extraction wells pull perchlorate contamination to the center of the site. Mr. Byrd asked about operation of the GWTP. Mr. Beck explained that the GWTP is operated by two technicians local to the area.

Metals Discussion

Ms. Zeiler introduced Mr. George Rice, with the Caddo Lake Institute, and the concerns regarding metals that were raised by Mr. Rice in the January 2022 RAB meeting. Ms. Zeiler said that the Army would like to present its perspective on metals in groundwater and have further discussion with the RAB. Ms. Zeiler said that in addition, Mr. Rice has authored a report to present to the RAB regarding metals' contamination at LHAAP-16. Mr. Bill Foss presented the general approach to the evaluation of metals at LHAAP. Mr. Foss explained that metals have been detected in groundwater at many sites within LHAAP. At sites where metals have exceeded screening values, there has either been additional evaluation or ongoing monitoring to determine if further action is required. Mr. Foss explained that sampling methods can also affect metals' concentrations in groundwater. Mr. Foss explained that turbidity in water may bias groundwater analytical results that are high for metals and that groundwater data collected in the 1990s used sampling methods that did not reduce turbidity. Groundwater data collected in the 1990s used sampling methods that did not remove turbidity for the groundwater. Mr. Foss said newer sampling methods utilize low flow sampling, which minimizes turbidity and allows for collection of a more representative sample. Mr. Foss said that different analytical methods (Method 6010 versus 6020) can also result in elevated metals detections due to interference. Mr. Foss discussed how naturally occurring metals in soil can result in elevated metals in groundwater. Mr. Foss explained how groundwater geochemistry (oxidation-reduction potential and pH) can affect how metals will dissolve in groundwater. Mr. Foss explained that many remedies such as enhanced reductive dechlorination are designed to create reducing conditions. Reduced arsenic in particular, is more soluble in groundwater.

Mr. Foss said that the distribution and frequency of metals detections are also evaluated by the Army to determine if there is evidence of a release or a plume. He said that there are considerations regarding naturally occurring metals and whether there is a known source that would have created the metals' detections in the groundwater. These factors are considered to determine if a metal is a constituent of concern and whether a remedy is needed. Mr. Foss presented an example of this evaluation that was completed in the LHAAP-46 ROD. Mr. Foss outlined the sites that have RODs requiring metals' analysis as part of the remedy or remedial design. He said that groundwater remedies are evaluated via a Five-Year Review (FYR) to determine if the remedies are protective of human health and the environment. The FYR includes a review of metals' data collected from groundwater during the previous 5 years as required by the ROD. Mr. Foss said that the next FYR is currently underway. Mr. Foss explained that there are regional influences that may increase the presence of metals over a large area. He said that TCEQ has a list of Texas-Specific Background Concentrations in soil to help account for situations where naturally occurring concentrations are higher than the risk based cleanup values.

Mr. Foss discussed LHAAP-03 where an excavation of soil containing arsenic, and lead was completed in August 2020. He said that arsenic is detected in groundwater at LHAAP-03 may or may not be attributed to a release from LHAAP-03. However, as part of the ongoing remedy at LHAAP-58 that encompasses LHAAP-03, arsenic monitoring of groundwater continues. Mr. Foss discussed the backfill source sampling completed for the LHAAP-03 and LHAAP-17 excavations and explained how multiple offsite sources of clean backfill had elevated arsenic. This highlights the challenges in determining which metals are a result of a release and which may be naturally occurring.

Mr. Foss discussed LHAAP-12 where samples collected in 1998 contained antimony and lead above action levels. However, a risk assessment performed in 2002, identified trichloroethene as the only contaminant that exceeded a Hazard Quotient of 1 for the non-residential exposure scenarios evaluated. As a result, the ROD did not include metals as requiring remedial action.

Mr. Foss discussed LHAAP-16 where five different metals have been detected in sporadic locations. In this situation, the metals were identified as constituents of concern in the ROD. The Remedial Action Plan does include metals' sampling as part of the regular monitoring at LHAAP-16 to support the FYR. Mr. Foss explained that it is unknown whether metals are naturally occurring or not.

Mr. Beck discussed LHAAP-18/24 where the ROD includes arsenic, barium, cobalt, nickel, and chromium as contaminants of concern. He said that metals' sampling is conducted at 47 wells semiannually at LHAAP-18/24. Mr. Beck explained that there are isolated detections of arsenic, barium, and chromium exceeding the cleanup levels in the shallow zone groundwater. However, there are no clear plume patterns. In addition, Mr. Beck said that groundwater at LHAAP-18/24 is extracted and treated at the GWTP, which includes a metals' treatment process. The GWTP effluent is sampled for metals prior to discharge to Harrison Bayou.

Mr. Foss discussed LHAAP-50 where antimony and chromium were detected above their respective cleanup levels in 1998. He explained the risk evaluation in the Feasibility Study showed both metals with a hazard quotient below 1 and they were not carried forward as contaminants of concern requiring remediation. Mr. Foss said that it is likely that the 1998 samples were collected using non-low flow methods that may have increased the turbidity in the samples. The sample location with the highest metals in 1998, also had very high chlorinated solvent concentrations that may have influenced the groundwater geochemistry and redox state.

Mr. Beck discussed LHAAP-58, where the remedy to address solvent contamination of Enhanced In-Situ Bioremediation (EISB) injections was implemented in 2013 and 2018. He said that this remedy results in reducing conditions, which may temporarily result in increased dissolution of metals. Although arsenic is not named a contaminant of concern in the ROD, it is included in semiannual sampling at six wells as required by a 2018 Explanation of Significant Differences. Mr. Beck explained that declining arsenic detections since 2018, indicate the presence of arsenic is temporary as the aquifer recovers from the reducing conditions caused by the EISB remedy.

Mr. Foss discussed LHAAP-67, where thallium was detected above the maximum contaminant level in 1998. Mr. Foss said that the 2003 Human Health Risk Assessment identified thallium with

a Hazard Quotient less than 1 and so thallium was not carried forward as a contaminant of concern in the ROD. As with LHAAP-50, the 1998 samples were collected using non-low flow methods that may have increased the turbidity in the samples. Mr. Fortune asked if magnesium was a contaminant of concern. Mr. Foss explained that TCEQ has identified approximately five metals (including magnesium) that are considered nutrients instead of contaminants.

Mr. Foss summarized the metals' discussion and said that in many cases metals continue to be monitored even if they were not considered contaminants of concern. Mr. Rice said that it is important that metals continue to be monitored at LHAAP. Mr. Rice reiterated his four conclusions from his presentation in January 2022. Mr. Rice said that it is possible that the change in redox in groundwater can result in the precipitation of arsenic in the aqueous phase. However, the question is whether this is happening at LHAAP. Mr. Rice has looked at data provided from LHAAP-16 and said that there is no evidence that this is occurring at LHAAP-16. Mr. Rice added that with so little data there is also no evidence that it is not occurring either. Ms. Zeiler said that the Army will continue collecting metals data.

Next RAB Meeting Schedule and Closing Remarks

Ms. Zeiler said that the next RAB meeting was proposed for June 21, 2023. Mr. Fortune requested that the RAB meeting be moved to Thursday instead of Wednesday. Mr. Bowlby said that Wednesdays are best for government employees and contractors; however, the meeting could be moved to either Tuesday or Thursday to accommodate as many RAB members as possible. Ms. Zeiler stated that the RAB will be informed of the RAB meeting date – whether the 20th or the 22nd of June 2023– when a final decision has been made.

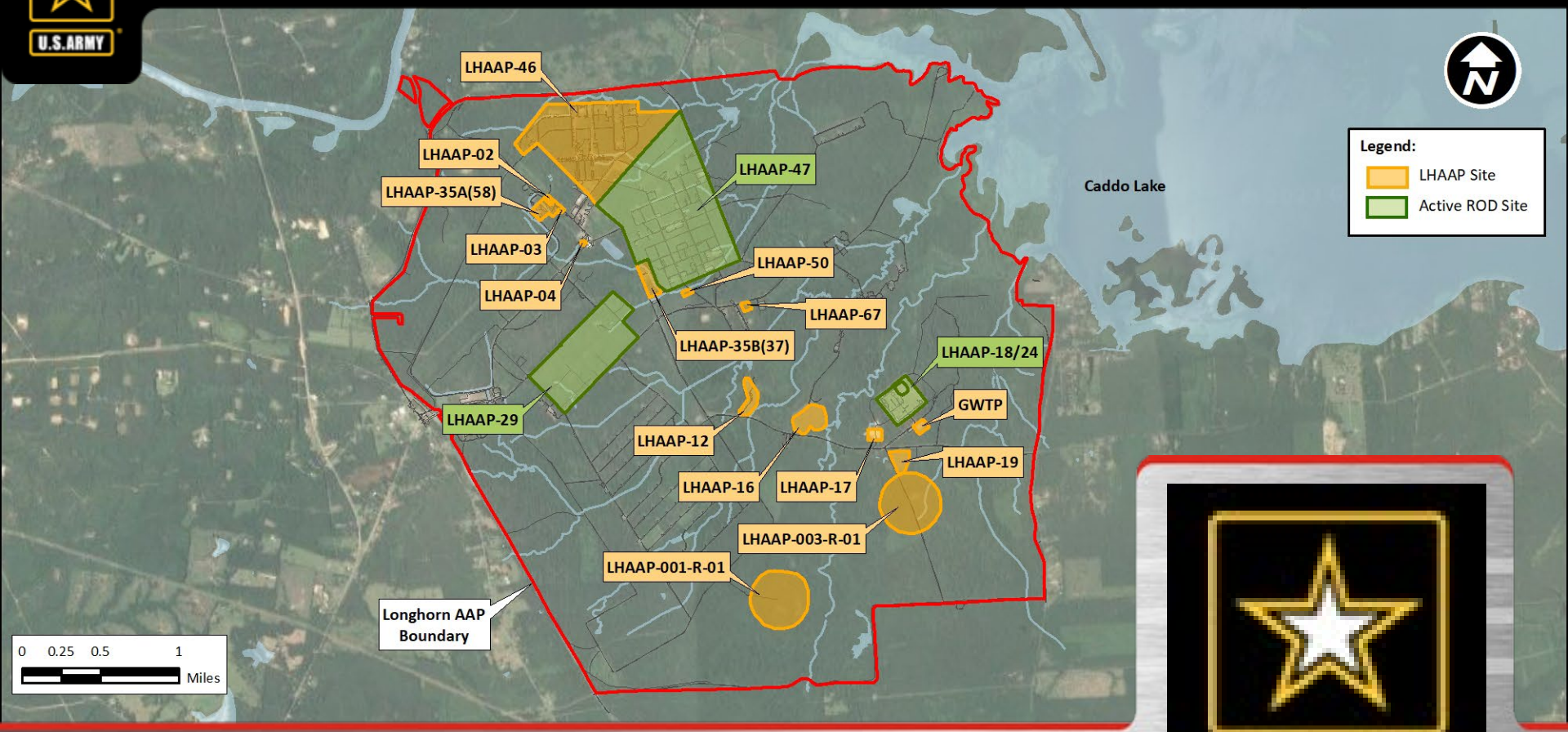
Ms. VanDeventer requested a site tour for the RAB members.

Adjourn

Ms. VanDeventer made a motion to adjourn, which was seconded by Mr. Fortune. The meeting adjourned at 7:21 pm CST.

November 2022 Meeting Attachments and Handouts:

- Color copy of Bhate presentation slides
- GWTP – Processed Groundwater Volumes Handout
- Surface Water Sampling Handout



Longhorn Army Ammunition Plant (LHAAP) Restoration Advisory Board Meeting

15 February 2023

Abbreviations and Acronyms

%	Percent
µg/L	Micrograms per liter
bgs	Below ground surface
DERP	Defense Environmental Restoration Program
DNAPL	Dense Non-aqueous Phase Liquid
EISB	Enhanced In-Situ Bioremediation
EPA	Environmental Protection Agency
FYR	Five Year Review
GPW	Goose Prairie Creek Water Sample
GWP-Res	Residential Groundwater Use Protection
GWTP	Groundwater Treatment Plant
HBW	Harrison Bayou Water Sample
ISB	In-Situ Bioremediation
ISTD	In-Situ Thermal Desorption
J	Estimated laboratory value
LHAAP	Longhorn Army Ammunition Plant
LTM	Long term monitoring
LUCs	Land Use Controls
MCL	Maximum Contaminant Level
MEC	Munitions and explosives of concern
mg/L	Milligrams per liter
MNA	Monitored Natural Attenuation
MSC	Medium-Specific Concentration
PCL	Protective Concentration Level
RAB	Restoration Advisory Board
PDI	Pre-Design Investigation
RA(O)	Remedial Action Operation
RAWP	Remedial Action Work Plan
ROD	Record of Decision
TCE	Trichloroethene
TCEQ	Texas Commission on Environmental Quality
TNT	Trinitrotoluene
TRRP	Texas Risk Reduction Program
UEP	Unlined Evaporative Pond
USFWS	United States Fish and Wildlife Service

AGENDA – 15 February 2023 at 6 p.m.

6:00 Welcome and Introduction

6:05 Open Items

- Ongoing Outreach/Website
- Restoration Advisory Board (RAB) Administrative Issues
  - Membership Update
  - Minutes (November 2022 RAB Meeting)

6:10 Defense Environmental Restoration Program (DERP) Update

- Documents and Field Work Completed since last RAB Four Month Look ahead
- Groundwater Treatment Plant Update

6:20 Other DERP Update

- LHAAP-18/24, -29 and -47 Status
- LHAAP-17 Status

6:35 Metals discussion

6:50 Transfer Update

6:55 Next RAB Meeting Schedule and Closing Remarks

The Army wants you to be informed

- The Army is committed to protecting human health and the environment; key to that commitment is engaging the community and increasing public participation in environmental restoration at the Longhorn Army Ammunition Plant (LHAAP).
- You are encouraged to:
  - Attend Restoration Advisory Board (RAB) Meetings and/or become a member of the RAB.
  - Visit the Longhorn environmental website at www.longhornaap.com.
- The website is regularly updated to indicate the upcoming field events at each site including groundwater sampling, monitoring well installations, soil sampling, or remediation activities.
  - Make suggestions for improving communication – the Army welcomes and appreciates community feedback.

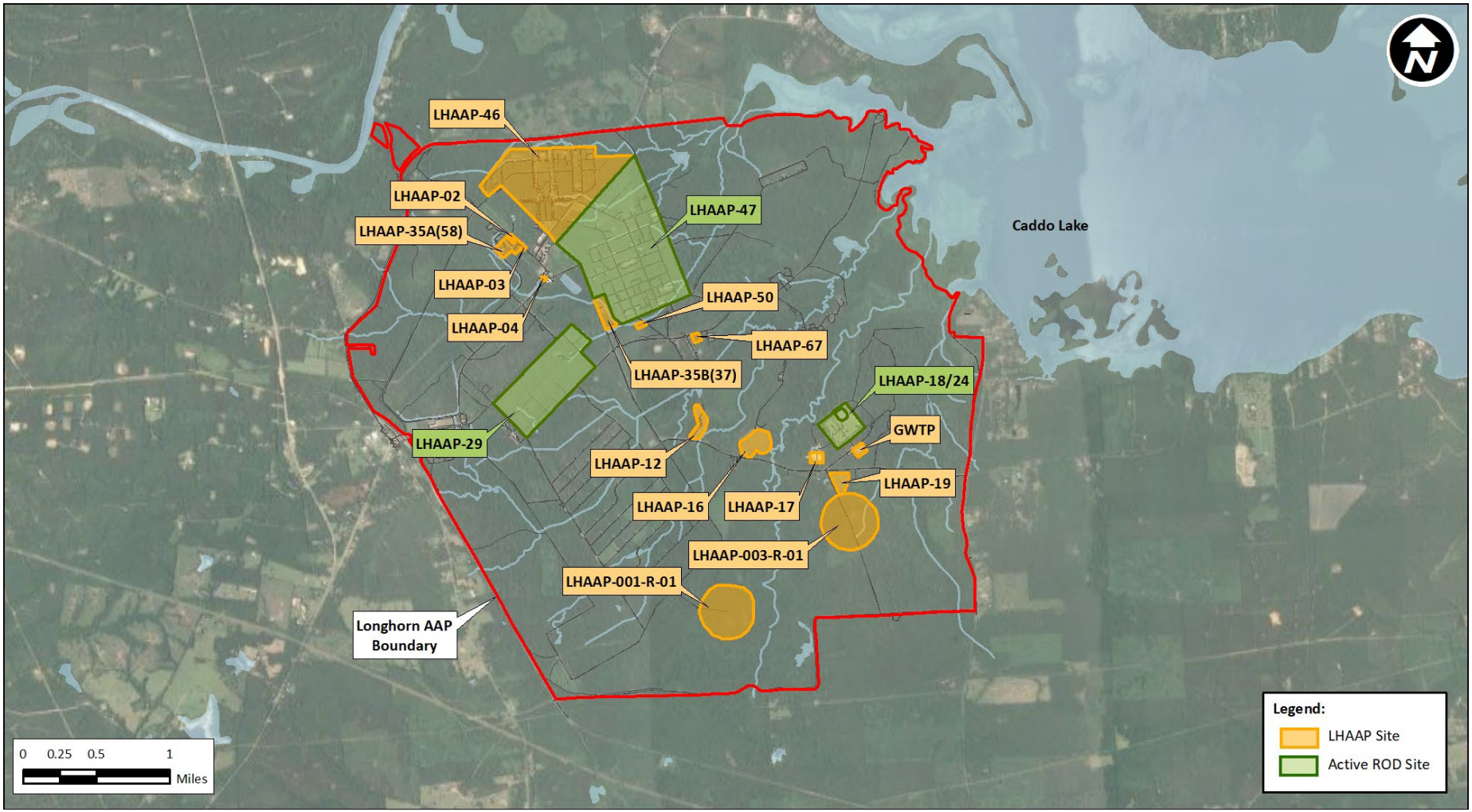
Administrative Issues

- Restoration Advisory Board (RAB) Membership Update
  - Persons interested in being new members
- Minutes (November 2022 RAB Meeting)

LHAAP Environmental Contractors

- Bhate/APTIM: LHAAP-02, -03, -04, -12, -16, -19 -37, -46, -50, -58, -67, -001-R-01, -003-R-01, and -18/24 (interim remedy)
- HDR: LHAAP-18/24, -29, and -47
- MMG-TLI Joint Venture: LHAAP-17

Bhate/APTIM


LHAAP-46
LHAAP-02
LHAAP-35A(58)
LHAAP-03
LHAAP-04
LHAAP-47
LHAAP-50
LHAAP-67
LHAAP-35B(37)
LHAAP-29
LHAAP-12
LHAAP-16
LHAAP-17
LHAAP-18/24
GWTP
LHAAP-19
LHAAP-003-R-01
LHAAP-001-R-01
Longhorn AAP Boundary
Caddo Lake
0 0.25 0.5 1
Miles
Legend:
LHAAP Site
Active ROD Site

Documents in Progress

- LHAAP-04: Year 3 Annual Remedial Action Operation (RA[O]) Report – In Regulatory Review
- LHAAP-16: Year 2 Annual RA(O) Report – Addressing Regulatory Comments
- LHAAP-37: Year 5 Annual RA(O) Report – In Regulatory Review
- LHAAP-46: Year 8 Annual RA(O) Report – In Regulatory Review
- LHAAP-50: Year 8 Annual RA(O) Report – Addressing Regulatory Comments
- LHAAP-58: Year 8 Annual RA(O) Report – In Regulatory Review
- Groundwater Treatment Plant: Quarterly Evaluation Report: Fourth Quarter (October - December 2022) – In Progress

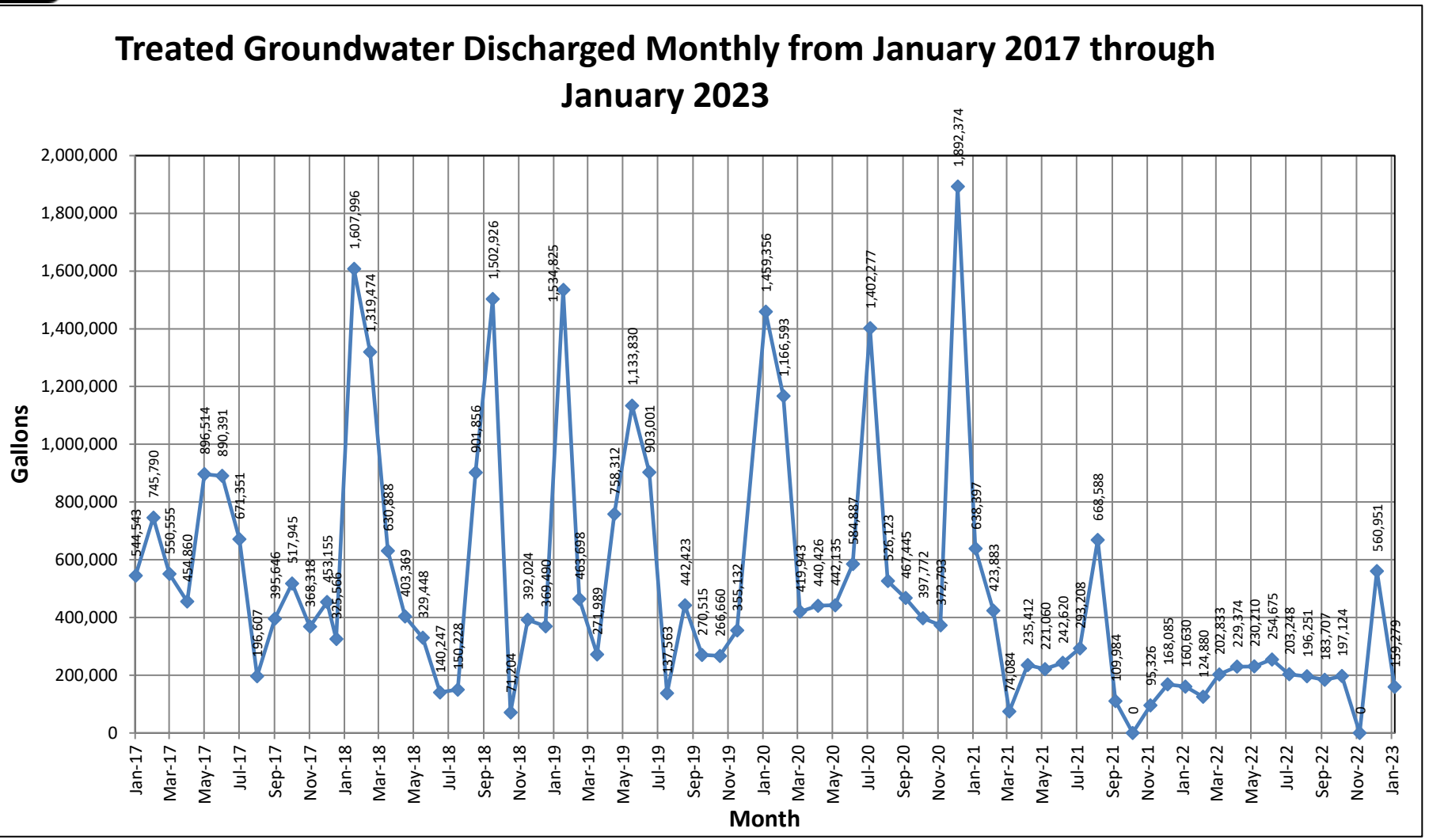
Completed Field Work Since Last RAB Meeting

- LHAAP-16: Year 3 Semiannual Remedial Action Operation (RA[O]) Sampling Event #2 (January 2023)
- LHAAP-12: 2022 Annual RA(O) Sampling (Delayed to January 2023)
- LHAAP-37: Year 6 Annual RA(O) Sampling (November 2022)
- LHAAP-67: Year 9 Annual RA(O) Sampling (November 2022)
- LHAAP-58: Year 8 Semiannual Sampling Event #2 (January 2023)
- LHAAP-18/24: Semiannual Groundwater Sampling (December 2022/January 2023)
- Surface Water: Fourth Quarter Sampling (December 2022)

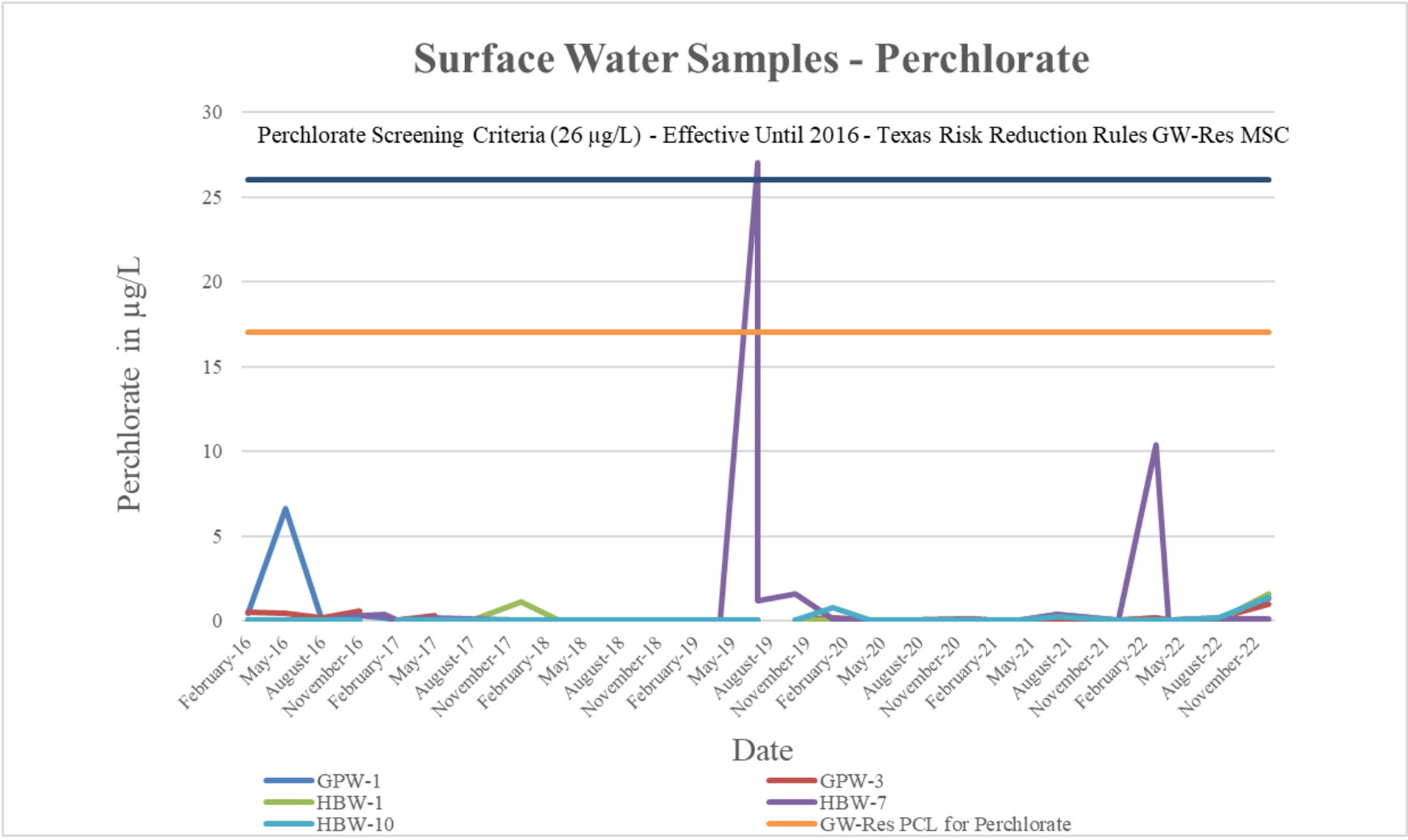
4 Month Look Ahead-Documents by Bhate Team

- LHAAP-04: Draft Final Remedial Action Operation (RA[O]) Report to Regulators
- LHAAP-16: Final Year 2 Annual RA(O) Report to Regulators
- LHAAP-37: Draft Final Year 5 RA(O) Report to Regulators
- LHAAP-46: Draft Final Year 8 RA(O) Report to Regulators
- LHAAP-50: Draft Final Year 8 RA(O) Report to Regulators
- LHAAP-58: Draft Final Year 8 RA(O) Report –Revisions following regulatory input
- LHAAP-67: Draft Final Year 9 RA(O) Report to Regulators
- Groundwater treatment plant and LHAAP-18/24: Quarterly Evaluation Report Fourth Quarter (October – December 2022) to Regulators

GWTP Update

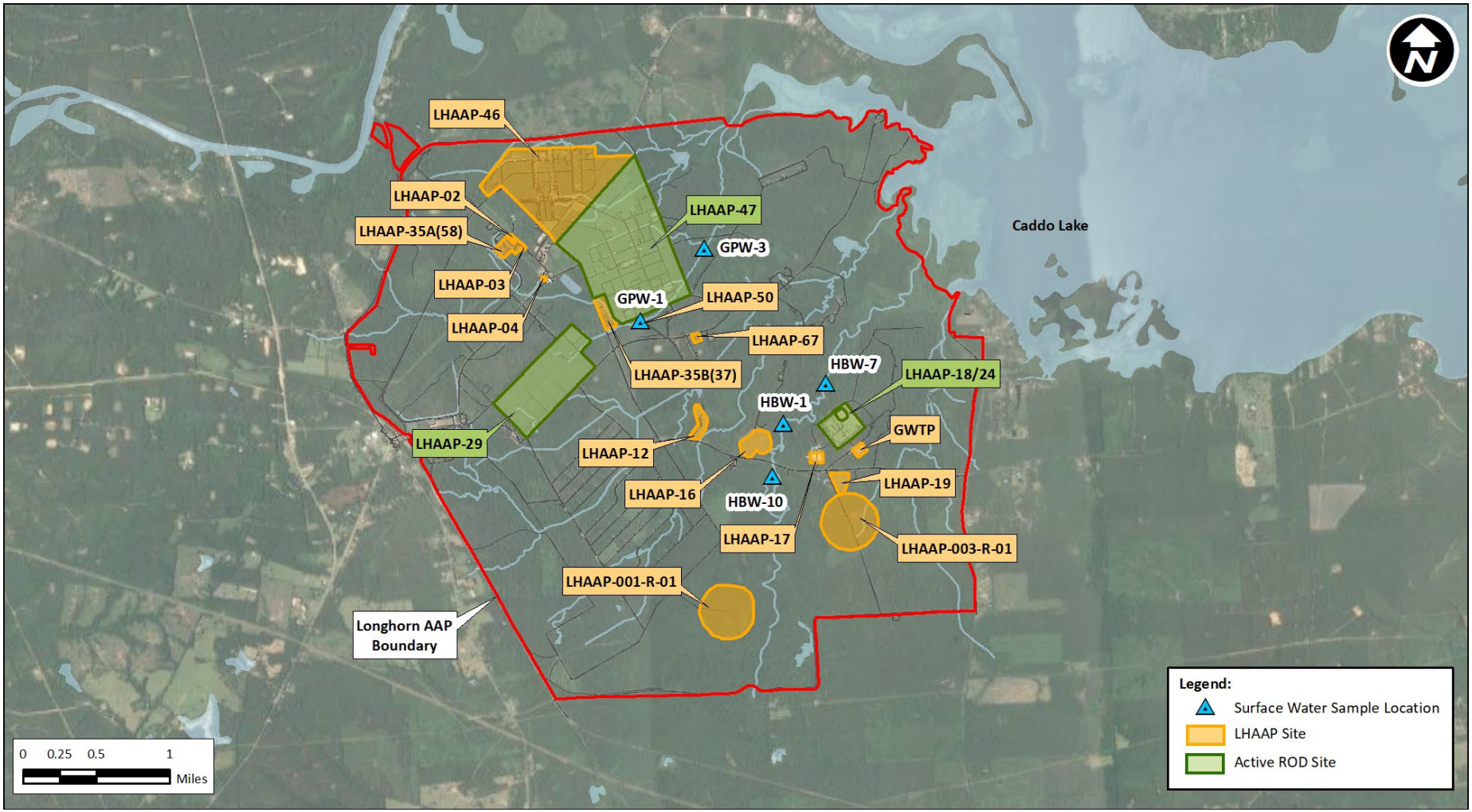

Treated Groundwater Discharged Monthly from January 2017 through January 2023
Gallons
Month
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Jan-17
Mar-17
May-17
Jul-17
Sep-17
Nov-17
Jan-18
Mar-18
May-18
Jul-18
Sep-18
Nov-18
Jan-19
Mar-19
May-19
Jul-19
Sep-19
Nov-19
Jan-20
Mar-20
May-20
Jul-20
Sep-20
Nov-20
Jan-21
Mar-21
May-21
Jul-21
Sep-21
Nov-21
Jan-22
Mar-22
May-22
Jul-22
Sep-22
Nov-22
Jan-23
544,543
745,790
550,555
454,860
896,514
890,391
671,351
196,607
395,646
517,945
368,318
453,155
325,566
1,607,996
1,319,474
630,888
403,369
329,448
140,247
150,228
901,856
1,502,926
71,204
392,024
369,490
1,534,825
463,698
271,989
758,312
1,133,830
903,001
137,563
442,423
270,515
266,660
355,132
1,459,356
1,166,593
419,943
440,426
442,135
584,887
1,402,277
526,123
467,445
397,772
372,793
1,892,374
638,397
423,883
74,084
235,412
221,060
242,620
293,208
668,588
109,984
0
95,326
168,085
160,630
124,880
202,833
229,374
230,210
254,675
203,248
196,251
183,707
197,124
0
560,951
159,279

Surface Water Sample Results

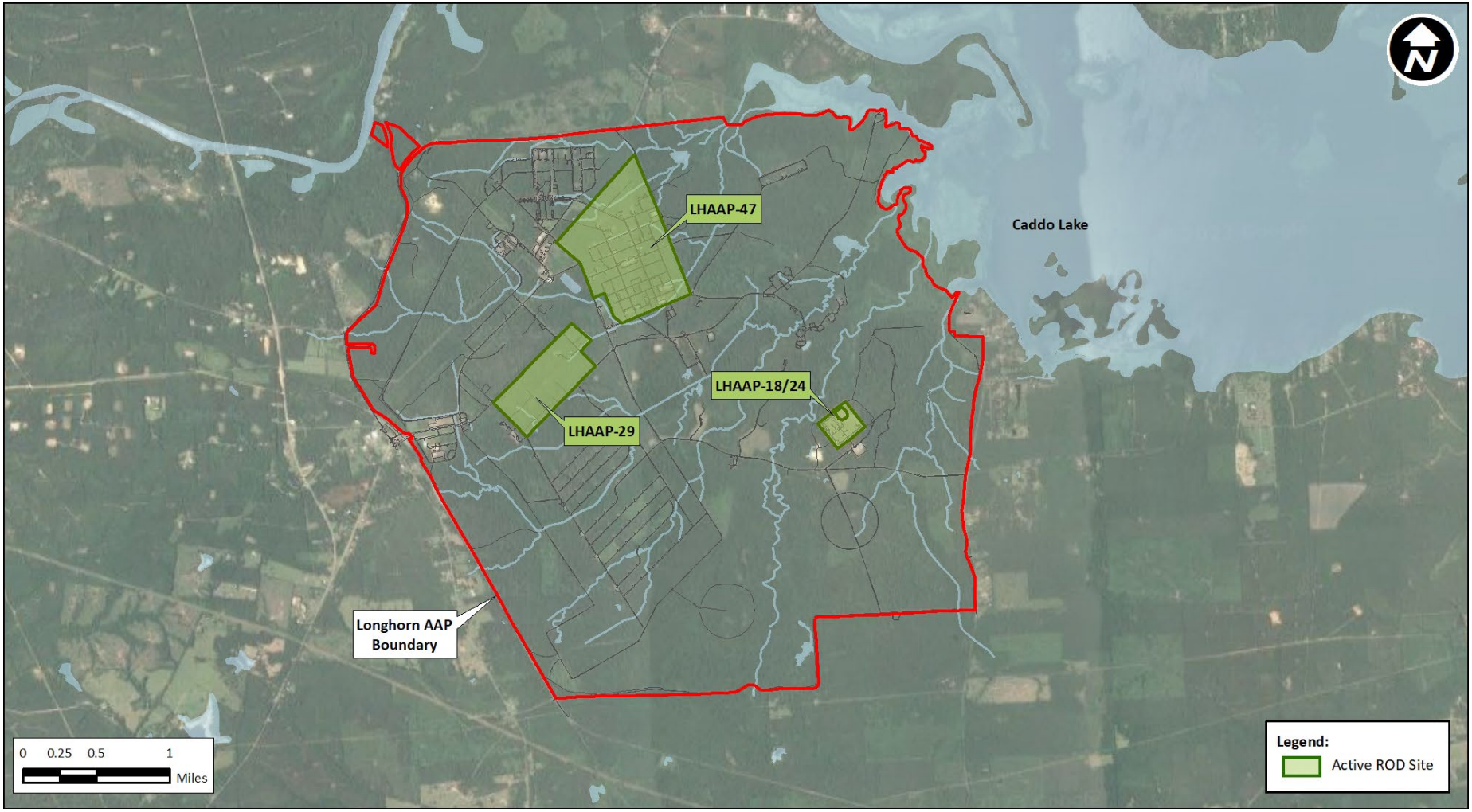


Note: Surface water at HBW-7 had a detection of 27 µg/L from a sample collected on 11 July 2019. Surface water at HBW-7 was resampled 19 days later (30 July 2019) with a detection of 1.2 J µg/L.

Surface Water Sampling Locations



HDR Update


LHAAP-47
Caddo Lake
LHAAP-18/24
LHAAP-29
Longhorn AAP Boundary
0 0.25 0.5 1
Miles
Legend:
Active ROD Site

LHAAP-18/24, -29, and -47 Document Status, HDR

- LHAAP-18/24: 90% Remedial Design submitted 7 February 2023 for Regulatory review.
- LHAAP-29: 90% Remedial Design to be submitted 14 April 2023 for Regulatory review.
- LHAAP-47: Draft Pre-Design Investigation Work Plan to be submitted in February 2023 for Regulatory review.

LHAAP-18/24: 90% Remedial Design

Selected Remedy

- Continued operation of the existing groundwater extraction and treatment system.
- Enhanced In-Situ Bioremediation in Shallow Zone and Wilcox Formation groundwater both inside and outside the containment area.
- Thermal treatment to remove Dense Non-aqueous Phase Liquid.
- Maintenance of the existing cap over the Unlined Evaporative Pond.
- Unsaturated soil excavation and off-site disposal.
- Land Use Controls, Monitored Natural Attenuation, and long-term monitoring.

LHAAP-29: 90% Remedial Design

Selected Remedy

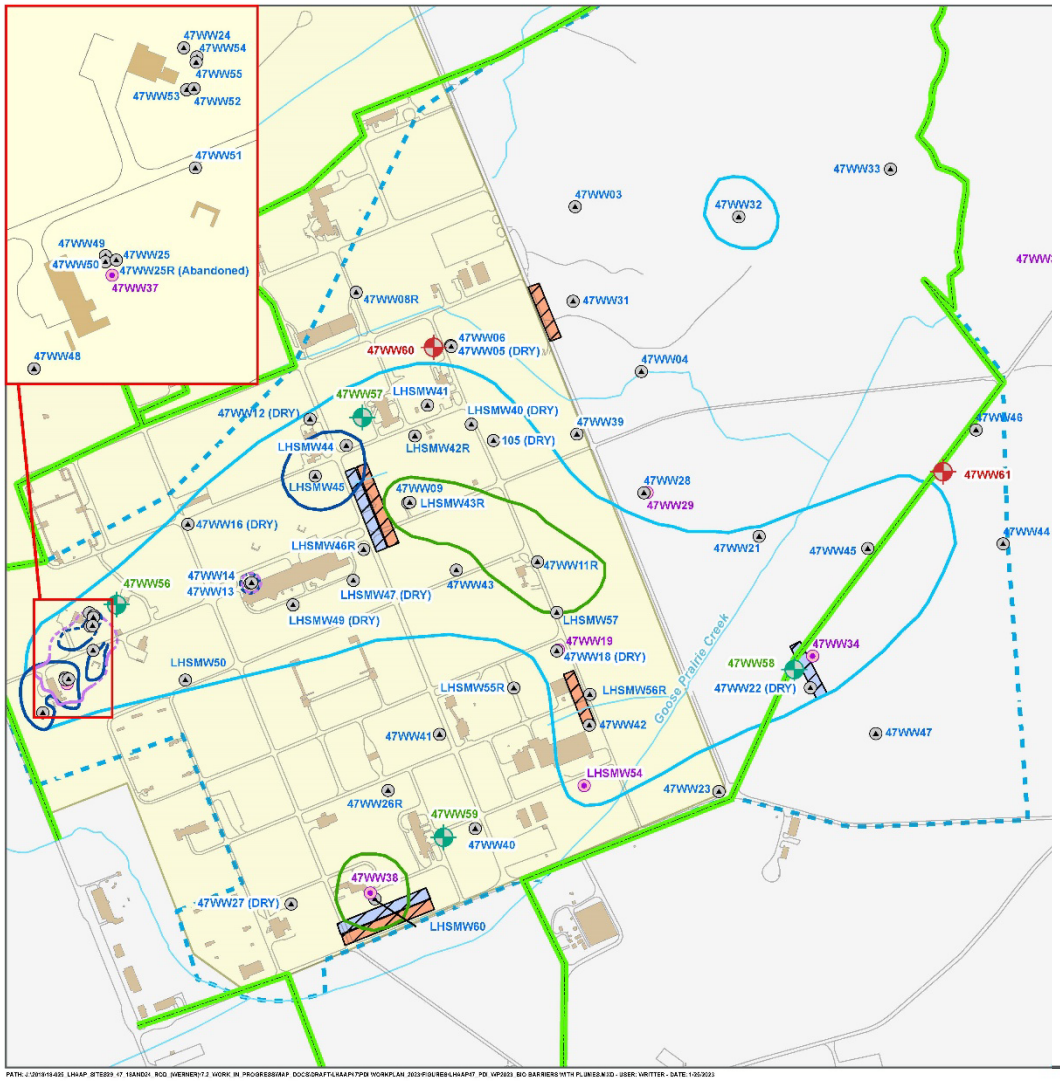
- Flushing, inspection, and plugging of the transite trinitrotoluene (TNT) wastewater line and the vitrified clay cooling water lines.
- Excavation and off-site disposal of the wooden TNT wastewater line and impacted soil.
- In-Situ Thermal Desorption (ISTD) treatment of the intermediate groundwater zone dense non-aqueous phase liquid plume.
- Monitored natural attenuation in the shallow groundwater zone plumes and for the intermediate groundwater plume following ISTD.
- Land Use Controls.

LHAAP-47 Pre-Design Investigation

Draft Pre-Design Investigation Scope

- Collect water level elevations of wells located within the historical and current extent of groundwater contamination.
- Install and develop four Shallow Zone wells to a maximum depth of 40 feet below ground surface (bgs).
- Install and develop two Upper Intermediate/Intermediate wells to a maximum depth of 50 - 60 feet bgs.
- Perform one sampling event for metals, perchlorate, and volatile organic compounds analysis from existing and planned new monitoring wells near the historical plume boundaries and within the current extent of groundwater contamination.
- Survey of all newly installed well locations by a licensed Texas land surveyor.
- Perform topographic survey of areas that will require direct remediation efforts depicted at no more than a 2-foot contour interval.

LHAAP-47 Pre-Design Investigation



LEGEND

- Proposed Shallow Zone PDI Monitoring Well
- Proposed Upper Intermediate/Intermediate Zone PDI Monitoring Well
- Existing Shallow/Shallow Intermediate Monitoring Well
- Existing Intermediate Monitoring Well
- Intermediate Zone Perchlorate Exceeding TRRP PCL (17µg/L), July 2018
- Intermediate Zone Trichloroethene Exceeding USEPA MCL (5 µg/L), July 2018
- Shallow Zone Trichloroethene Exceeding USEPA MCL (5 µg/L), July 2018 and 2020
- Upper Intermediate Groundwater Zone Trichloroethene Exceeding USEPA MCL (5 µg/L), 2020
- Road
- Stream
- USFWS Refuge Boundary
- Land Use Control Boundary
- Former Buildings or Concrete Slab
- LHAAP-47
- ISB Biobarrier Intermediate
- ISB Biobarrier Shallow

MMG-TLI Joint Venture Update

LHAAP-17 Time Critical Removal Action

- Major Work Elements:
  - Civil survey, vegetation removal & erosion control repair
  - Robotic sifting of all pre-existing soil piles to remove potential Munitions and Explosives of Concern (MEC)
  - Confirmation sampling and analysis to confirm excavation extents
  - Backfilling in areas previously determined clean
  - Off-site disposal of sifted soils
  - Complete excavations and receive regulatory approval to backfill all areas
  - Complete geophysical survey across the site to identify subsurface anomalies (i.e., targets) that may be MEC
  - Dig/remove identified targets
  - Install the groundwater extraction system components and site restoration

LHAAP-17

- **Status:**
  - All soil piles have been sifted and disposed of off-site.
  - Over 4,048 cubic yards of soil have been excavated and approximately 2,500 cubic yards of this material have been sifted and transported for off-site disposal.
  - All excavations with validated confirmation samples are complete and backfilled.
  - 96 Munitions and Explosives of Concern (MEC) items have been disposed of through on-site detonations.
  - An estimated 41,000 pounds of Non-Munitions Related debris and 18,700 pounds of Munitions Debris have been inspected and transported off-site for recycling/disposal.
  - Groundwater extraction system installation is complete and operating per the design.

LHAAP-17 Groundwater Extraction System Performance

- Groundwater extraction system began operation on 5 August 2022.
- As of 31 December 2022, approximately 279,000 gallons of groundwater have been extracted and pumped to the Groundwater Treatment Plant for treatment. (1,900 gallons per day).
- Groundwater samples are collected from five wells for perchlorate analysis monthly to evaluate extraction system performance.
- As of November 2022, the extent of perchlorate impacts has decreased.

LHAAP-17 Perchlorate Groundwater Analytical Results

Well ID	PCL	4/8/2022	8/31/2022	10/7/2022	11/10/2022
130	17	15	0.064	0.075	0.463
17WW01		**239**	**1,740**	**25**	0.549
17WW02 *		**5,250**	**16,400**	**19,000**	**17,200**
17WW03		**44.7**	0.0694	0.0559	0.0271
17WW06 *		**120,000**	**101,000**	**104,000**	**89,900**

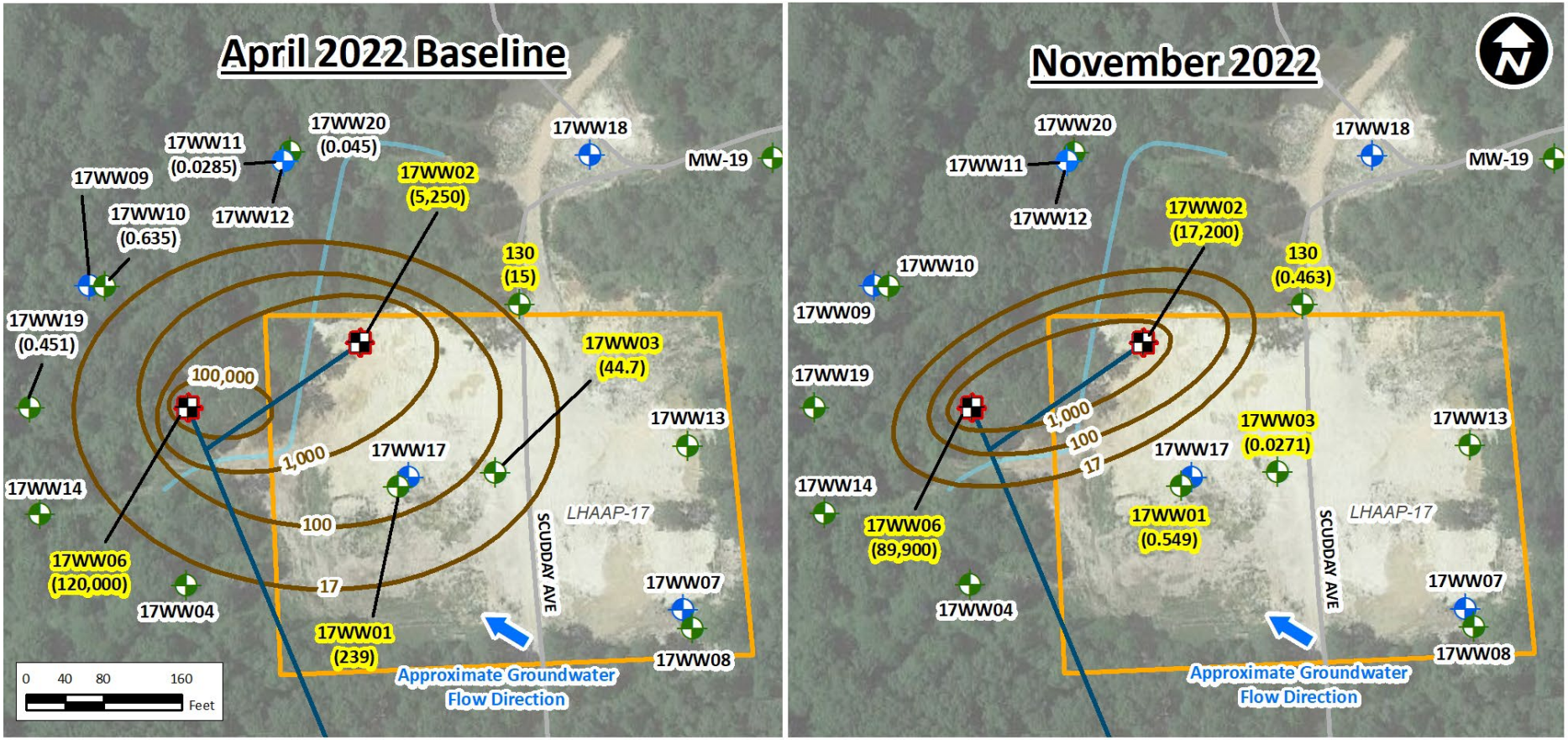
All results reported in micrograms per liter (µg/L)

PCL – Texas Risk Reduction Program (TRRP) Tier 1 Groundwater Residential Protective Concentration Level

* Extraction wells

Bold values exceed the PCL

LHAAP-17 Lateral Extent of Perchlorate



17WW02 Performance Monitoring Locations Highlighted

Extraction Well

Shallow Monitoring Well

Intermediate Monitoring Well

LHAAP-17 Boundary

Road

Stream

(0.0271) Perchlorate Concentration Reported in Micrograms per Liter (µg/L)

Perchlorate Isoconcentration Contour

Metals Discussion

General Discussion

- The Army appreciates the concerns raised by Mr. George Rice with the Caddo Lake Institute-Technical Assistant Grant during the January 2022 RAB Meeting
- Throughout the environmental restoration program at LHAAP, metals have been detected in groundwater. Where metals concentrations have exceeded screening levels, additional evaluation or ongoing monitoring may be used to determine the need for further action
- There are a number of factors that can affect metals concentrations detected in groundwater including, but not limited to:
  - Sampling methods
  - Analytical methods
  - Naturally occurring metals concentrations in soil
  - Turbidity in groundwater samples
  - Groundwater pH and redox conditions

Metals Discussion

General Discussion

- The evaluation of whether to consider elevated metals to be a "constituent of concern" or in need of a remedy encompasses several considerations:
  - Distribution and frequency of detection
  - Background/naturally occurring?
  - Is there a known source that could have caused a metals release?
  - Do metals concentrations coincide with other COC source areas?

Metals Discussion

General Discussion

- As an example, the LHAAP-46 Record of Decision included the following discussion for the selection of constituents of concern (COC) requiring a remedy (bold added here for emphasis): *"In the evaluation of constituents of potential concern (COPCs), reasons for not considering a COPC as a COC include: the elevated concentration during baseline human health risk assessment (BHHRA) sampling* ***was due to a non-low flow sampling technique****,* ***absence of the COPC from recent sampling****, elevated concentration* ***due to well corrosion****, the COPC* ***is naturally occurring****, the COPC's* ***contribution to the hazard index (HI) is low****, and/or the chemical was detected in the laboratory blank."*

Metals Discussion

General Discussion

- The RODs for the following sites required metals analysis as part of the remedy or remedial design:
  - LHAAP-03, LHAAP-16, LHAAP-18/24, LHAAP-29, LHAAP-37, LHAAP-47, and LHAAP-67
  - The ROD for LHAAP-58 does not require metals analysis, but arsenic sampling is included in the Remedial Action Work Plan and the Explanation of Significant Differences
- Five Year Reviews (FYR) are conducted for every site with a remedy in place to evaluate the ongoing protectiveness of the selected remedy
- The next FYR is currently underway for 2023

Metals Discussion

Naturally Occurring Metals in Native Soils/Geology

- As noted by Mr. Rice, identifying naturally occurring background concentrations is complicated
- Abundant naturally occurring metals may be present in areas with high clay content or soils derived from geologic formations with high metals content
  - Metals in soil can leach into groundwater and cause elevated groundwater concentrations
  - Finding soil to backfill LHAAP-03 and LHAAP-17 from the Karnack area was difficult because of naturally occurring elevated lead and arsenic
- Regional historical influences such as use of pesticides for large scale agriculture or emissions from power plants burning lignite may increase the concentrations of metals over wide areas
- TCEQ has a list of Texas-Specific Background Concentrations in soil included in the Texas Administrative Code (30 TAC §350.51[m]) to help account for situations where naturally occurring concentrations are higher than the risk based cleanup values

Turbidity and Sampling Methodology

- Turbidity is a term used to describe the presence of solids suspended in a water sample, which can be caused by fine-grained particles that do not settle out of the water column easily
- Wells at Longhorn frequently have high turbidity because they are screened in groundwater bearing zones that contain a large percentage of fine-grained particles such as silt and clay that bind with metals and result in elevated concentrations in groundwater
- Early samples at Longhorn (before the early 2000s) clearly had turbidity issues, which confounded attempts to define COCs
- Prior to the use of low-flow sampling, filtered vs unfiltered samples or geochemical analysis were used to evaluate whether metals in groundwater were caused by turbidity or other natural causes

Turbidity and Sampling Methodology (continued)

- Low flow sampling became standard operating procedure in the early 2000s and is performed to minimize the turbidity in the samples being collected. Where subsequent low flow sampling showed concentrations below the screening values, metals were not carried forward as COCs
- Samples collected prior to that time are viewed with some skepticism if metals were high because they likely had elevated turbidity

Metals Discussion

Groundwater Redox and pH Influence on Metals in Groundwater

- The redox state of groundwater, whether the groundwater is oxic (oxidized) or anoxic (reduced), has implications for groundwater quality.
- Redox conditions determine whether some constituents, like arsenic and manganese, are released from naturally occurring sediments into the groundwater.
- Active remedies such as in-situ bioremediation may also result in reducing conditions leading to secondary impacts such as metals mobilization.
- These secondary impacts are not a result of a contaminant release.
- These secondary impacts typically attenuate rapidly outside of the treatment area.
- Changes in pH generated by organic acids produced by the degradation process can also influence the concentrations of metals dissolved into groundwater

Metals Discussion

LHAAP-03

- Excavation of soil containing arsenic and lead (related to paint shop processes) was completed in August 2020
- Arsenic in groundwater is found within the TCE plume area and may be related to the redox state caused by the LHAAP-35A (58) groundwater plumes
- Monitoring of arsenic in groundwater under LHAAP-03 continues as part of the LHAAP-35A (58) RA-O
- Arsenic detected above the Environmental Protection Agency (EPA) maximum contaminant level (MCL) (0.010 milligrams per liter [mg/L]) in recent years at two locations near LHAAP-03 (03WW01 and 35AWW08), but concentrations at both locations have fluctuated above and below this MCL from event to event
- June 2021 arsenic concentrations exceeded the MCL (0.010 mg/L) at one location (0.0169 J mg/L)
- Monitoring of arsenic at LHAAP-35A (58) will continue as long as arsenic is detected above the MCL. The effectiveness of the existing remedy at protecting human health and the environment will be evaluated in the 2023 FYR.

Metals Discussion

2019-2020 Backfill Source Evaluation for LHAAP-03 and LHAAP-17

Location	Arsenic (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Vanadium (mg/kg)
Moore Pit				
BS-1	**17.4**	33.0	10.2	**78.2**
BS-2	**22.9**	**56.3**	9.35	**106**
BS-3	4.18	11.8	4.29	26
BS-4	**9.56**	21.5	7.80	49.7
BS-5	5.91	16.3	6.37	42.9
BS-6	**11.5**	33.5	8.54	**82.7**
BS-7	**23.0**	**47.8**	11.5	**106**
BS-8	**10.5**	32.4	7.89	55.7
Jefferson Pit				
BS-9	**7.04**	22.40	5.54	54.20
BS-10	**18.20**	**48.60**	8.51	**113.00**
BS-11	**21.10**	**48.80**	11.00	**108.00**
BS-12	**7.50**	21.40	5.90	53.00
BS-13	5.61	24.60	7.39	70.70
BS-14	**12.00**	37.10	8.40	**75.60**
Pearce Woodlawn Pit				
BS-17	4.09	9.93	4.00	25.20
BS-18	1.93	5.22	3.39	16.20
BS-19	1.89	8.25	4.40	21.20
BS-20	5.03	11.60	5.09	30.40
BS-21	**9.57**	20.60	5.27	55.20
BS-22	1.28	5.74	3.64	12.90
RRS2 GWP-Ind	*1*	*10*	*1.5*	*72*
2004 Final Background Study 95% UTL	*6.15*	*38.6*	*12.9*	*50*

Mg/Kg – milligrams per kilogram
RRS2 GWP-Ind – Risk Reduction Standard Groundwater Protection Cleanup Value for non-residential sites
UTL – Upper Tolerance Limit

- Army sampled 20 locations from 3 different backfill sources at locations between Jefferson and Marshall
- At least one metal exceeded the groundwater protection standard in 12 of the 20 samples
- The third source sampled (Pierce Woodlawn Pit) was selected because it was sandier, with less clay and 5 of the 6 samples were acceptable for backfill
- This highlights the challenge of identifying what metals detections represent evidence of a release and which are naturally occurring

Metals Discussion

LHAAP-12

- Most recent samples collected in 1998 contained antimony and lead at concentrations above the Texas Commission on Environmental Quality (TCEQ's) media specific concentration (MSC) for non-residential groundwater (0.006 mg/L and 0.015 mg/L, respectively)
- Cadmium detected above the MSC in 1995, but did not exceed the value at any location in the 1998 sampling
- Groundwater samples were likely collected using non-low flow methods that may have induced significant turbidity in the samples
- Risk Assessment performed in 2002 identified trichloroethene (TCE) as the only contaminant that exceeded a Hazard Quotient of 1 for the non-residential exposure scenarios evaluated
- The Record of Decision (ROD) did not include metals as requiring remedial action

Metals Discussion

LHAAP-16

- Five metals (arsenic, chromium, manganese, nickel, and thallium) were detected sporadically in 2009
- Those five metals are identified as constituents of concern in groundwater in the ROD
- Remedial Action Work Plan (RAWP) called for sampling in Harrison Bayou as part of the remedial action monitoring
- ROD required sampling of groundwater prior to the first FYR after remedy implementation to determine if further monitoring is warranted
- The groundwater sampling was performed in June 2022 to prepare for the FYR to be conducted in 2023
- Arsenic, chromium, manganese, and nickel were detected above the cleanup levels established in the RAWP in at least one well in 2022
- Ongoing bioremediation and large chlorinated solvent plume has induced changes in the geochemistry that may influence the metals concentrations

Metals Discussion

LHAAP-18/24

- The Record of Decision includes arsenic, barium, cobalt, nickel and chromium as contaminants of concern (HDR, March 2020).
- Total analyte list metals are analyzed and evaluated at 47 Shallow and Wilcox zone wells semi-annually.
- In the Shallow zone there are isolated detections of arsenic, barium, and chromium exceeding the cleanup levels. However, there are no clear plume patterns. Cobalt and nickel are not detected consistently (HDR, March 2020).
- In the Wilcox zone there are sporadic detections of arsenic above the clean up level in 3 out of 28 wells.
- The groundwater from LHAAP-18/24 is extracted and treated at the LHAAP groundwater treatment plant (GWTP). The GWTP includes a metals treatment process.
- GWTP effluent is also sampled for metals monthly to confirm satisfactory metals treatment prior to discharge to Harrison Bayou.

Metals Discussion

LHAAP-50

- Two metals (antimony and chromium) were detected above the cleanup level in 1998
- The risk evaluation in the Feasibility Study showed both metals with a hazard quotient below 1 and they were not carried forward as contaminants of concern (COCs) requiring remediation
- The ROD did not include sampling for metals as part of the selected remedy
- The 1998 samples were collected using non-low flow methods that may have increased the turbidity in the samples
- The sample location with the highest metals (50WW02) also had very high chlorinated solvent concentrations that may have influenced the groundwater geochemistry and redox state

Metals Discussion

LHAAP-58 and LHAAP-03

- Remedy of Enhanced In-Situ Bioremediation (EISB) injections was implemented in 2013 and 2018.
- This remedy results in reducing conditions which may temporarily result in the presence of metals. Although arsenic is not a contaminant of concern it is included in semi-annual sampling at 6 wells to monitor the aquifer geochemistry.
- In June 2022 arsenic was detected in only one well above the MCL (0.10 milligrams per liter [mg/L]) at 0.314 mg/L. However, this detection represents a 73 percent (%) decrease from arsenic detected in June 2019.
- The declining arsenic detections indicate the presence of arsenic is transitory; as the aquifer recovers from the reducing conditions caused by the EISB remedy

Metals Discussion

LHAAP-67

- In 1998 thallium was detected in one location at a concentration (0.0021 mg/L) that exceeded the MCL (0.002 mg/L)
  - Note that the detection of thallium is within laboratory equipment variations.
- The 2003 Human Health Risk Assessment identified thallium with a Hazard Quotient less than 1 and it was not carried forward as a COC in the ROD
- The 1998 samples were collected using non-low flow sampling methods that may have resulted in elevated turbidity in the samples

Metals Discussion

Summary

- Five year reviews (FYR) are conducted at sites with a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedy to evaluate protectiveness. If metals were identified as contaminants of concern (COCs) in the record of decision (ROD), sampling for metals would have taken place and would be reviewed in the FYR report.
  - Therefore, metals in groundwater will not be forgotten, even when a remedy to address metals was not included in the ROD.
  - If future action is required to address an unacceptable risk, a recommendation will be made in the FYR.
  - Longhorn's fifth FYR is taking place this year.
- While there is concern about the validity of background studies, when comparing metals exceedances of the maximum contaminant levels (MCLs) or non-residential medium-specific concentrations at each site, the exceedances are sporadic and limited.
- At any given site, if the metals weren't removed as a COC based on the risk assessment, then they continue to be monitored to ensure protection of human health and the environment.

Next RAB Meeting Schedule & Closing Remarks

- Schedule Next Restoration Advisory Board Meeting
  - 15 June 2023
- Other Issues/Remarks
- Thank you for coming

Groundwater Treatment Plant - Processed Groundwater Volumes

The amount of groundwater treated is determined by measuring the number of gallons of processed water discharged.

Processed Water Discharged Data (in gallons)

Oct-07	Nov-07	Dec-07	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08
1,041,491	848,356	804,822	792,148	665,883	818,872	791,306	568,812	776,904	748,377	690,052	617,199

Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09
655,059	619,274	726,118	552,299	598,144	433,800	488,807	526,958	387,644	0	414,853	735,716

Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10
808,322	636,306	727,492	391,898	695,343	802,656	894,731	962,121	1,257,977	1,314,924	1,041,495	1,136,547

Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11
956,567	705,805	849,712	811,679	668,281	1,090,348	817,325	900,338	916,552	784,369	652,524	733,456

Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12
748,102	658,250	684,903	865,453	725,000*	730,000*	980,000*	630,000*	0	0	0	349,012

Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13
617,037	607,610	560,436	869,710	751,213	641,708	699,776	746,885	392,719	962,890	843,913	716,057

Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14
813,974	727,442	706,416	552,657	738,691	844,095	811,346	972,913	611,505	626,253	573,601	575,376

Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15	Sep-15
440,877	572,479	634,890	614,073	516,592	1,111,859	1,108,336	822,637	1,020,313	1,002,887	951,758	306,467

Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16
128,586	209,088	120,234	454,444	1,028,210	1,201,904	1,224,064	1,094,528	792,311	844,916	1,032,732	805,728

Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17
890,892	617,570	353,327	544,543	745,790	550,555	454,860	896,514	890,391	528,538	195,198	961,324

Oct-17	Nov-17	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul - 18	Aug-18	Sep-18
517,945	368,318	453,155	325,566	1,607,996	1,319,474	630,888	403,369	329,448	140,247	150,228	901,856

Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul - 19	Aug-19	Sep-19
1,502,926	71,204	392,024	369,490	1,534,825	463,698	271,989	758,312	1,133,830	1,415,203	493,063	442,423

Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20
270,515	288,683	355,132	1,459,356	1,166,593	419,943	440,426	442,135	584,887	1,402,277	539,526	467,445

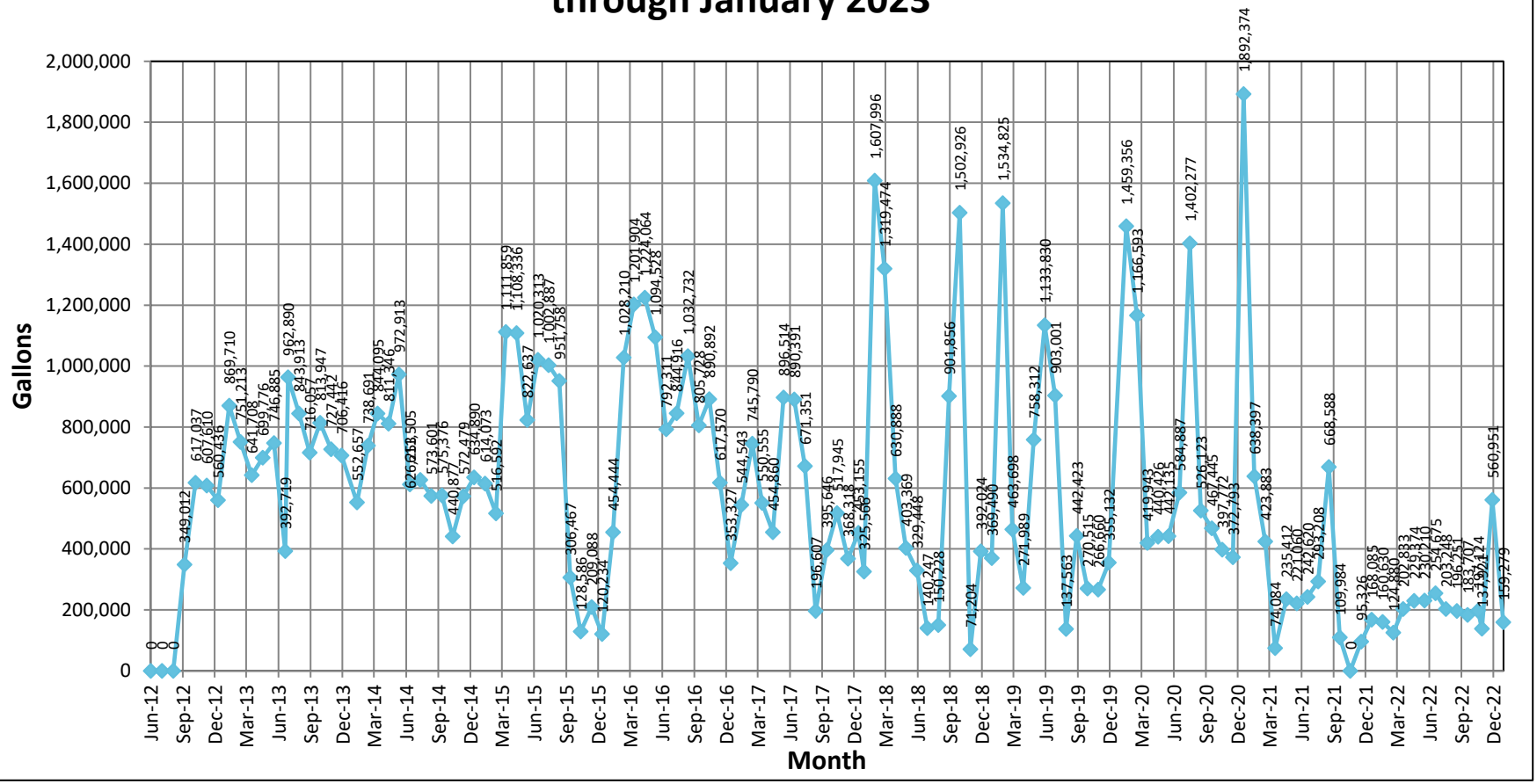
Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21
397,772	372,793	1,832,274	638,397	423,883	74,084	235,412	1,121,060	242,620	293,208	668,588	109,984

Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
0	95,326	439,585	322,130	124,880	202,833	229,374	230,210	254,675	203,248	196,251	183,707

Oct-22	Nov-22	Dec-22	Jan-23
197,124	137,921	560,951	159,279

*Indicates Estimate

Figure ES-2. Treated Groundwater Discharged Monthly from June 2012 through January 2023



Water Discharge Location and Volume (Gallons)					
Month	**Total Combined to Harrison Bayou**	**LHAAP-18/24 Sprinklers**	**GWTP To INF Pond**	**INF Pond to Harrison Bayou**	**Contract Hauled Off-Site**
Dec-16	0	236,688	0	0	0
Jan-17	0	0	0	0	0
Feb-17	0	0	0	0	14,355
Mar-17	127,242	0	0	0	14,400
Apr-17	113,038	0	236,821	0	0
May-17	0	0	534,155	0	0
Jun-17	958,404	0	294,550	490,574	0
Jul-17	0	0	528,538	0	0
Aug-17	0	0	195,197	0	0
Sep-17	651,434	0	309,980	651,434	0
Oct-17	0	0	517,945	0	0
Nov-17	0	0	368,318	0	0
Dec-17	560,350	0	453,155	560,350	0
Jan-18	325,566	0	253,177	325,566	0
Feb-18	1,607,996	0	62,017	1,430,634	0
Mar-18	1,319,474	0	0	870,816	0
Apr-18	630,888	0	0	630,888	0
May-18	403,369	0	0	403,369	0
Jun-18	193,669	0	135,779	0	0
Jul -18	0	0	140,247	0	0
Aug -18	49,409	0	100,819	0	0
Sep-18	585,397	0	316,459	524,484	0
Oct-18	1,409,106	0	93,820	1,016,285	0
Nov-18	71,204	0	0	0	0
Dec-18	392,024	0	0	0	0
Jan-19	369,490	0	0	369,490	0
Feb-19	1,534,825	0	0	1,326,485	0
Mar-19	463,698	0	0	83,250	0
Apr-19	271,989	0	0	0	0
May-19	758,312	0	0	253,817	0
Jun-19	1,133,830	0	0	847,918	0
Jul-19	1,415,203	0	0	903,001	0
Aug-19	374,629	0	118,434	0	0
Sep-19	0	0	442,423	0	0

Water Discharge Location and Volume (Gallons)					
Month	**Total Combined to Harrison Bayou**	**LHAAP-18/24 Sprinklers**	**GWTP To INF Pond**	**INF Pond to Harrison Bayou**	**Contract Hauled Off-Site**
Oct-19	0	0	270,515	0	0
Nov-19	115,503	0	173,180	0	0
Dec-19	318,248	0	36,884	0	0
Jan-20	1,459,396	0	0	1,115,183	0
Feb-20	1,166,593	0	0	741,954	0
Mar-20	419,943	0	0	0	0
Apr-20	440,426	0	0	0	0
May-20	442,135	0	0	0	0
June-20	584,887	0	0	0	0
July-20	1,402,277	0	0	984,393	0
Aug-20	216,197	0	323,359	0	0
Sep-20	0	0	467,445	0	0
Oct-20	0	0	397,772	0	0
Nov-20	0	0	372,793	0	0
Dec-20	1,832,274	0	60,199	1,571,432	0
Jan-21	638,397	0	0	383,318	0
Feb-21	423,883	0	0	259,875	0
Mar-21	74,084	0	0	74,084	0
Apr-21	235,412	0	0	0	0
May-21	1,121,060	0	0	900,000	0
Jun-21	242,620	0	0	0	0
Jul-21	293,208	0	0	243,675	0
Aug-21	668,588	0	0	561,527	0
Sep-21	0	0	109,984	0	0
Oct-21	0	0	0	0	0
Nov-21	0	0	95,326	0	0
Dec-21	271,500	0	168,085	271,500	0
Jan-22	161,500	0	160,630	161,500	0
Feb-22	0	0	124,880	0	0
Mar-22	190,898	0	11,935	0	0
Apr-22	229,374	0	0	0	0
May-22	230,210	0	0	0	0
June-22	254,675	0	0	0	0
July-22	0	0	203,248	0	0
Aug-22	34,115	0	162,136	0	0

Water Discharge Location and Volume (Gallons)					
Month	**Total Combined to Harrison Bayou**	**LHAAP-18/24 Sprinklers**	**GWTP To INF Pond**	**INF Pond to Harrison Bayou**	**Contract Hauled Off-Site**
Sept-22	83,312	0	100,395	0	0
Oct-22	0	0	197,124	0	0
Nov-22	0	0	137,921	0	0
Dec-22	560,951	0	0	514,515	0
Jan-23	159,279	0	0	145,321	0
Feb-23	0	0	137,921	0	0
Mar-23	560,951	0	0	514,515	0
Apr-23	0	0	0	0	0

Harrison Bayou and Goose Prairie Creek – Perchlorate Data

Surface water samples are collected quarterly from each location in Harrison Bayou and Goose Prairie Creek, unless the sampling location is dry.

Surface Water Sample Data (in micrograms per liter)

Quarter	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st
Creek Sample ID	Jul 1999	Sep 1999	Feb 2000	Apr 2000	Aug 2000	Dec 2000	Feb 2001	Apr 2001	July 2001	Oct 2001	Jan 2002
GPW-1	<1.0 U	-	4	<4.0 U	<4.0 U	<4.0 U	-	2.65	<4.0 U	<4.0 U	<4.0 U
GPW-3	<1.0 U	<4.0 U	17	8	<4.0 U	<4.0 U	-	2.28	<4.0 U	<4.0 U	<4.0 U
HBW-1	-	<8.0 U	310	23	-	-	<4.0 U	-	<4.0 U	<4.0 U	<4.0 U
HBW-7	-	<8.0 U	370	110	-	-	<4.0 U	-	<4.0 U	<4.0 U	<4.0 U
HBW-10	-	<8.0 U	905	650	<4.0 U	-	<4.0 U	-	<4.0 U	-	-

Quarter	2nd	3rd	4th	1st	2nd	3rd	3rd	4th	2nd	3rd	4th
Creek Sample ID	June 2002	Sept 2002	Dec 2002	Feb 2003	June 2003	Aug 2003	July 2004	Dec 2006	May 2007	Aug 2007	Dec 2007
GPW-1	<4.0 U	<4.0 U	18.3	18.6	59.9	-	2.25	-	<1.0 U	<1.0 U	10.7
GPW-3	<4.0 U	<4.0 U	5.49	12.6	14.7	-	2.2	-	<1.0 U	<1.0 U	7.48
HBW-1	<4.0 U	<4.0 U	<4.0 U	-	<4.0 U	99.3	<0.2 U	<1.0 U	<1.0 U	122	<1.0 U
HBW-7	<4.0 U	<4.0 U	<4.0 U	-	<4.0 U	<4.0 U	<0.2 U	<1.0 U	<1.0 U	1.02	<1.0 U
HBW-10	<4.0 U	<4.0 U	<4.0 U	-	<4.0 U	-	<0.2 U	<1.0 U	<1.0 U	<1.0 U	<1.0 U

Quarter	1st	2nd	3rd	4th	2nd	3rd	3rd	3rd	4th	1st	2nd
Creek Sample ID	Mar 2008	Jun 2008	Sep 2008	Dec 2008	May 2009	Jul 2009	Aug 2009	Sep 2009	Dec 2009	Mar 2010	Jun 2010
GPW-1	27	<0.5 U	<0.5 U	<0.22 U	16	<4 U	NS	<1.2 U	3.7	1.3 J	<0.6 U
GPW-3	21.9	9.42	1.1	<0.22 U	8.9	<4 U	NS	<0.6 U	2.8	1.8 J	<0.6 U
HBW-1	<0.5 U	<0.5 U	<0.5 U	<0.22 U	<0.55 U	<4 U	NS	<1.5 U	<0.275 U	1.5 U	<0.6 U
HBW-7	<0.5 U	<0.5 U	<0.5 U	<0.22 U	<0.55 U	<4 U	24	<1.2 U	<0.275 U	1.5 U	<0.6 U
HBW-10	<0.5 U	<0.5 U	<0.5 U	<0.22 U	<0.55 U	<4 U	NS	<1.5 U	<0.275 U	1.2 U	<0.6 U

Quarter	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st
Creek Sample ID	Sep 2010	Dec 2010	Mar 2011	Jun 2011	Sep 2011	Dec 2011	Mar 2012	Jun 2012	Not Applicable	Jan & Feb 2013	Mar 2013
GPW-1	Dry	<0.1 U	8.7	Dry	Dry	1.76	0.163 J	Dry	NS	1.65	0.735
GPW-3	Dry	0.199 J	0.673	Dry	Dry	1.31	0.261	Dry	NS	1.74	0.754
HBW-1	Dry	<0.1 U	<0.2 U	Dry	Dry	<0.1 U	<0.1 U	Dry	NS	<0.2 U	<0.2 U
HBW-7	Dry	<0.1 U	<0.2 U	Dry	Dry	0.171 J	<0.1 U	Dry	NS	<0.2 U	<0.2 U
HBW-10	Dry	<0.1 U	<0.2 U	Dry	Dry	<0.1 U	<0.1 U	Dry	NS	<0.2 U	<0.2 U

Quarter	2nd	3rd	4th	1st	2nd	3nd	4th	1st	2nd	3rd	4th
Creek Sample ID	Jun 2013	Sept 2013	Dec 2013	Feb 2014	May 2014	Aug 2014	Nov 2014	Feb 2015	May 2015	Aug 2015	Nov 2015
GPW-1	Dry	<0.2 U	Dry	0.766	Dry	Dry	0.244 J	0.311 J	0.156 J	Dry	0.142 J
GPW-3	Dry	<0.2 U	Dry	1.15	Dry	Dry	0.276 J	0.344 J	Dry	Dry	0.311 J
HBW-1	<0.2 U	<0.2 U	Dry	<0.2 U	Dry	Dry	<0.2 U	<0.2 U	Dry	Dry	<0.2 U
HBW-7	<0.2 U	<0.2 U	Dry	0.201 J	Dry	Dry	<0.2 U	0.124 J	Dry	Dry	<0.2 U
HBW-10	<0.2 U	<0.2 U	Dry	<0.2 U	Dry	Dry	<0.2 U	<0.2 U	Dry	Dry	<0.2 U

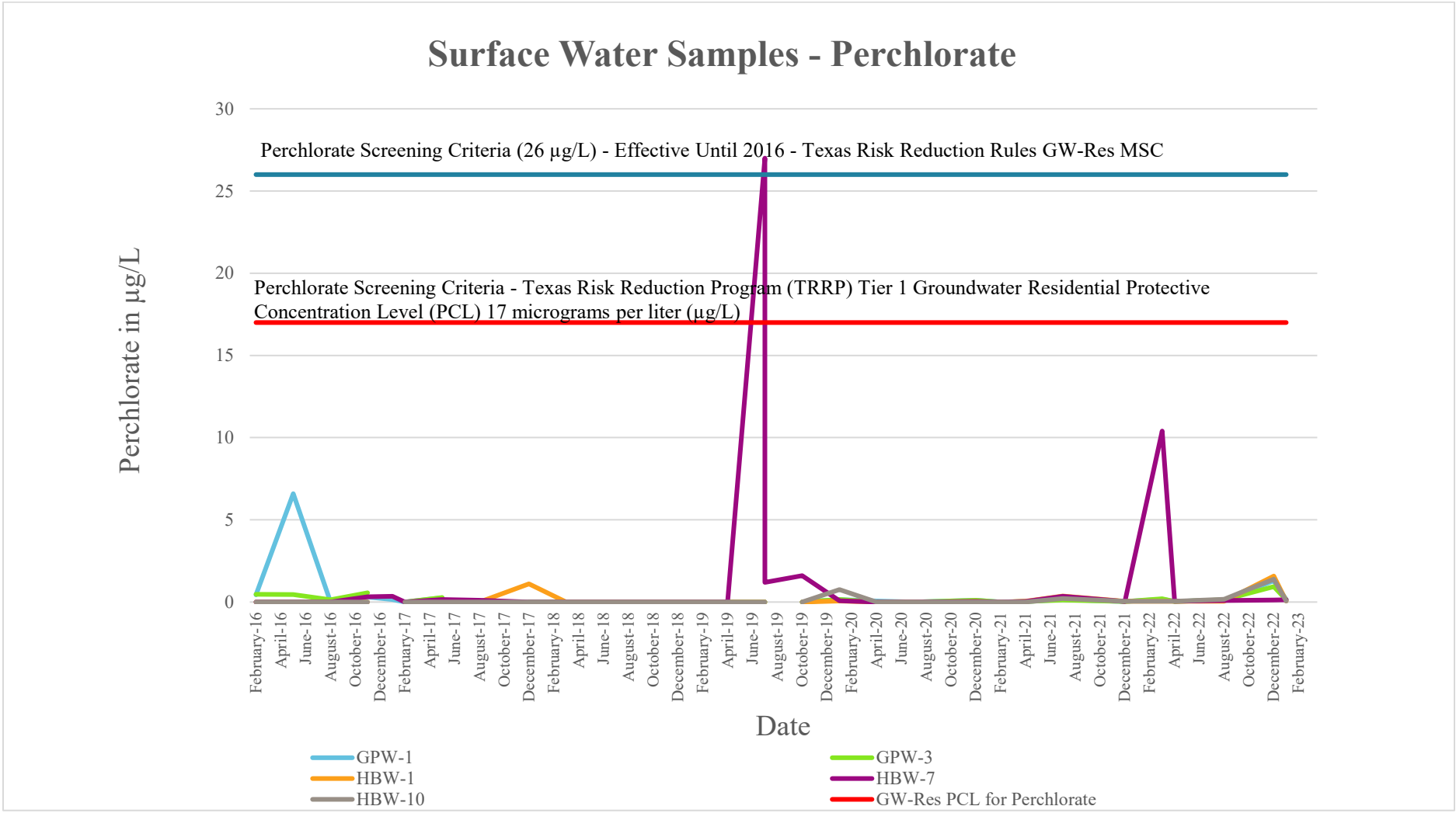
Quarter	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd
Creek Sample ID	Feb 2016	May 2016	Aug 2016	Nov 2016	Feb 2017	May 2017	Aug 2017	Dec 2017	Mar 2018	Jun 2018	Aug 2018
GPW-1	0.447	6.59	<0.2 U	0.301 J	<1 U	0.263	Dry	<2.0 U	<2.0 U	Dry	<2.0 U
GPW-3	0.474	0.457	0.141	0.563	<1 U	0.274	Dry	<2.0 U	<2.0 U	Dry	<2.0 U
HBW-1	<0.2 U	<0.2 U	<0.2 U	<0.2 U	<1 U	<0.2 U	<0.2 U	1.1 J	<2.0 U	Dry	<2.0 U
HBW-7	<0.2 U	<0.2 U	<0.2 U	0.318 J	<1 U	0.155	<0.2 U	<2.0 U	<2.0 U	Dry	<2.0 U
HBW-10	<0.2 U	<0.2 U	<0.2 U	<0.2 U	<1 U	<0.2 U	0.111 J	<2.0 U	<2.0 U	Dry	<2.0 U

NS – not sampled U – non-detect J – Estimated Dry – no surface water

Quarter	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st
Creek Sample ID	Oct 2018	Jan 2019	Apr 2019	Jul 2019	Oct 2019	Jan 2020	Apr 2020	Jul 2020	Dec 2020	Feb 2021
GPW-1	<2.0 U	<2.0 U	<2.0 U	<2.0 U	<2.0 U	0.163	0.0589 J	<0.05 U	0.110	<0.05 U
GPW-3	<2.0 U	<2.0 U	<2.0 U	<2.0 U	<2.0 U	0.156	0.0662 J	0.0326 J	0.108	<0.05 U
HBW-1	<2.0 U	<2.0 U	<2.0 U	<2.0 U	<2.0 U	0.0600 J	<0.05 U	<0.05 U	0.0374 J	<0.05 U
HBW-7	<2.0 U	<2.0 U	<2.0 U	27 (initial)/ 1.2 J (resample)	1.6 J	0.0761 J	<0.05 U	0.0318 J	0.0265 J	<0.05 U
HBW-10	<2.0 U	<2.0 U	<2.0 U	<2.0 U	<2.0 U	0.0782 J	<0.05 U	<0.05 U	<0.05 U	<0.05 U

Quarter	2nd	3rd	4th	1st	2nd	3rd	4th	1st
Creek Sample ID	Apr 2021	Jul 2021	Dec 2021	Mar 2022	Apr 2022	Aug 2022	Dec 2022	Jan 2023
GPW-1	0.0268 J	0.154	0.0394 J	0.162	0.042 J	0.104	1.30	0.153
GPW-3	0.0321 J	0.122	0.0344 J	0.198	0.0384 J	0.132	0.938	0.137
HBW-1	0.0410 J	0.369	0.050 U	0.052 J	<0.05 U	0.0540 J	1.58	0.0568 J
HBW-7	0.0373 J	0.348	0.0359 J	10.4	0.0493 J	0.0880 J	0.125	0.133
HBW-10	<0.05 U	0.207	0.0464 J	<0.05 U	<0.05 U	0.171	1.39	0.0654J

NS – not sampled U – non-detect J – Estimated Dry – no surface water



Note: Surface water at HBW-7 had a detection of 27 µg/L from a sample collected on 11 July 2019. Surface water at HBW-7 was resampled 19 days later (30 July 2019) with a detection of 1.2 J µg/L.

Longhorn Army Ammuntion Plant Creek Sampling Locations