



ARM Group LLC

Engineers and Scientists

January 7, 2026

Mr. Shane Rozelle, Geologist
Oil Control Program
Maryland Department of the Environment
1800 Washington Boulevard, Suite 620
Baltimore, MD 21230

Re: Vacuum Truck EFR Work Plan
MDE Case No. 2013-0321-AA
SMO Fort Meade Shell, SMO-1550
2631 Annapolis Road, Hanover, MD 21076
ARM Project No. 000190292.00

Dear Mr. Rozelle,

Per the fourth quarter 2025 status report dated November 12, 2025, ARM Group LLC (ARM) has prepared this work plan to present the methods to be used to implement Enhanced Fluid Recovery (EFR) using vacuum truck methods combined with Air Lifting Pumping.

BACKGROUND

Non-aqueous phase liquid (NAPL, or petroleum product) is present in the subsurface and located within layers of soil with low permeability (i.e., perched conditions) that result in intermittent and relatively slow accumulation of NAPL within some of the monitoring wells. The presence of NAPL within the affected wells is in direct response to the infiltration of precipitation along with associated groundwater elevation fluctuations. A site map depicting monitoring well locations is attached as **Figure 1**. **Figure 2** (attached) is a stratigraphic cross section that was originally presented in the Preliminary Subsurface Environmental Site Assessment dated July 2013 (Envirotech Consultants/ACV Enviro, now Republic Services). The cross section depicts the various depths that NAPL and groundwater were observed in soil core samples, and static groundwater levels after monitoring wells were constructed. Note that the depths of some of the monitoring wells presented in the cross section were deepened per MDE direction after the July 2013 assessment (i.e., MW-10 was redrilled and deepened from approximately 34 feet to 43.5 feet depth in May 2014). Further, MW-7 and MW-11 have since been abandoned (coincident with the UST Closure project in September 2022).

As noted above and presented in previous submittals to the MDE, groundwater at the site is represented by two main zones: a perched zone and a regional groundwater zone. This condition is represented by the hydrograph presented as **Figure 3**, attached. The hydrograph(s) show some wells with considerably shallower (higher elevation) groundwater levels such as MW-1, MW-4, MW-12 and MW-16. These wells range in depth from approximately 34.5 to 35 feet below ground surface (bgs) with 15 to 20 feet long screen sections (e.g., top of screen sections range from approximately 15 to 20 feet bgs). MW-2 is located along the southeastern side of the site and is also approximately 35 feet bgs, but the well consistently does not contain groundwater because of a lack of perched conditions in the area of MW-2. Consequently, not all portions of the site are underlain with perched groundwater. The hydrograph(s) also show the deeper zone represented by MW-9, MW-15 and MW-18 is several feet deeper than the perched groundwater wells. The deeper groundwater wells range from 41 to 45 feet bgs with 20 feet long screen sections (e.g., top of screen sections range from approximately 21 to 25 feet bgs).

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Some wells are screened across both the perched zone and deeper zone, and groundwater elevations have significantly changed over the years of monitoring. For example, MW-14 groundwater elevations (bright blue hydrograph) have varied across a 12 feet thick zone during the multi-year monitoring record. MW-8 and MW-10 groundwater elevations (orange and pink hydrographs) were consistent with the deeper zone into mid to late-2018 but became much shallower in the latter 2010s and early 2020s. Both MW-8 and MW-10 were abandoned with the September 2022 UST Closure. Groundwater elevations in a newer well, MW-17 (green hydrograph), constructed near the former location of MW-8, were initially consistent with the deeper groundwater zone (into late-2023). Groundwater elevations have since been increasing (becoming shallower) in MW-17, likely caused by perched groundwater conditions and infiltration from its proximity to the UST tankfield serving as a groundwater recharge zone. Note the decreasing groundwater elevations in MW-14 since August 2025 (over 6 feet), which is located further from the effects of the tankfield and consistent with the general lack of precipitation since Summer 2025.

NAPL is currently detected in two monitoring wells: MW14 and MW15. Sampling of the groundwater in the two wells (when NAPL was not present) allowed measurement of the various volatile organic compounds (VOC). Plotting the concentrations and proportions of VOC compounds on radar graphs (**Figure 4**, attached) shows that the NAPL is from two separate sources based on differing signatures. MW-14 NAPL contains proportionally lower Benzene, Toluene and O-Xylene concentrations than the MW-15 NAPL. Further, MW-14 NAPL contains proportionally more 124-Trimethylbenzene (124-TMB), 135-TMB and Naphthalene, and is significantly more malodorous and much darker than MW-15 NAPL. The higher enrichment of Benzene and Toluene in MW-15 NAPL is indicative of a less-aged product than that in MW-14.

Vacuum truck EFR events were performed several times in the mid-2010s and early 2020s. The most recent event (May 2022) was performed in response to the 2 feet of NAPL in MW-14 detected in April 2022. To date, 24 events resulted in the removal of 14,9100 gallons of impacted groundwater and NAPL (approximately 620 gallons per event, but ranged from 100 to 2,125 gallons per event). An estimated 357 gallons of NAPL have been removed of which approximately 40 gallons were removed by hand bailing (e.g., EFR removed an estimated 317 gallons of NAPL). Subsequent gauging of MW-14 after the April 2022 EFR event showed the well devoid of NAPL until late-2023 after groundwater had dropped over 3.6 feet between May 2022 and November 2023. Groundwater elevations in MW-14 continued to drop through 2023 by nearly 3 additional feet (e.g., over 6 feet drop between May 2022 and December 2023). Since that time, MW-14 groundwater elevations reached a peak by August 2025 with approximately 0.5 feet of NAPL and have since been decreasing with a similar reduction in NAPL thickness.

Current depths to groundwater in the wells with perched groundwater (MW-1, MW-4, MW-12 and MW-16) average about 28 feet bgs. The depth to groundwater in the deeper zone (MW-9, MW-15 and MW-18) averages about 37.5 feet bgs. Groundwater in MW-14 and MW-17, which are affected by both the perched and deeper groundwater zones, ranges from 31 (MW-17) to 35 (MW-14) feet bgs. VOCs are near to or below detection limits in the perched groundwater wells, as well as deeper zone wells MW-9 and MW-18. Consequently, only MW-14, MW-15 and MW-17 contain elevated VOC concentrations and/or NAPL. During 2025, the average Benzene, BTEX and VOC concentrations in MW-17 were 10, 130 and 360 µg/L, respectively, with TMBs averaging an additional 335 µg/L (e.g., MW-17 Total VOC averaged 695 µg/L). Because of NAPL presence, the groundwater in MW-14 was last sampled in June 2024 when groundwater was much shallower (27 feet bgs in June 2024 compared to 35 feet bgs in December 2025). Similarly, MW-15 was last sampled in October 2024 (groundwater approximately 35.5 feet bgs compared to 37 feet bgs in December 2025). Benzene, BTEX and VOC concentrations in MW-14 were 0.8 µg/L, 1,373 µg/L and 4,970 µg/L, respectively (with an additional 4,970 µg/L TMBs). MW-15 contained 624 µg/L, 20,845 µg/L and 21,600 µg/L, respectively (with an additional 4,790 µg/L TMBs). MW-14, MW-15 and MW-17 range from 44 to 47 feet deep (averaging 45.25 feet deep). In summary, only MW-14, MW-15 and MW-17 warrant remedial efforts.



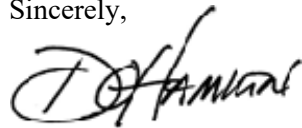
PROPOSED VACUUM TRUCK EFR WITH AIR-LIFTING

Conventional vacuum lift of a fluid from a monitoring well (by a vacuum truck) is essentially restricted to about 30 feet bgs and necessitates very high and sustained rpm operation of the truck's vacuum system, which can quickly overheat and deteriorate the vacuum truck's systems. Fluid recovery can be achieved using air-entrainment to about 32 feet bgs by piercing/perforating the bottom few feet of a vacuum stinger pipe and repeatedly adjusting the depth of the stinger pipe (along with high vacuum rpm). The volume of fluid recovery may be limited, and not cost-effective in consideration of the cost of vacuum truck operations and offsite fluid disposal. In lieu of conventional vacuum-lift/air-entrainment methods, ARM proposes to use vacuum truck EFR combined with air-lifting methods.

A 2"-diameter vacuum-rated PVC hose that is tethered with a ¼"-diameter compressed air hose will be lowered into a well, and the paired hoses sealed within the well with an air-tight well seal. Within the well, the air hose is fabricated to extend up and into the lower 3 to 5 feet of the 2" PVC hose using a steel U-tube. At ground level, the air hose is connected into an air compressor (tow-behind). When compressed air is applied to the air hose, an air-lift pumping action is created that ejects the contents of the well up and out of the 2" PVC hose. Similar air-lift methods are used for well redevelopment. The blown liquids are collected in a 55-gallon drum for intermittent pump-out by the vacuum truck. After the contents of the well is ejected and the well mostly devoid of liquids, the bottom of the 2" PVC hose will be lifted to approximately 30 feet depth and the grade-level end of the 2" PVC hose is connected to the vacuum truck hose. The vacuum truck is operated at up to 20 inches of mercury to create a high vacuum on the well, resulting in forced movement of liquids (NAPL and groundwater from wetted soil) into the well. A portion of the liquids is removed under vacuum, with the remainder collecting in the well. After several minutes of intense vacuum recovery, the process is repeated with air-lifting of liquids from the well followed by high-vacuum recovery. It is expected that several vacuum truck EFR/air-lifting events may be required at 2 to 3-week (±) increments for desired effect. After approximately six events, combined with weekly (±) well gauging to monitor for NAPL presence, the groundwater in the wells can be sampled per MDE Guidelines. A schematic of the proposed operation is presented as **Figure 5**, attached.

Pending the Department's comment and approval for this proposed plan, ARM will provide a schedule of implementation to allow MDE to be present during an initial event, if so desired. If you have any questions concerning this submittal, please contact us below, dhamilton@armgroup.net, or Cell (443)255-1633.

Sincerely,

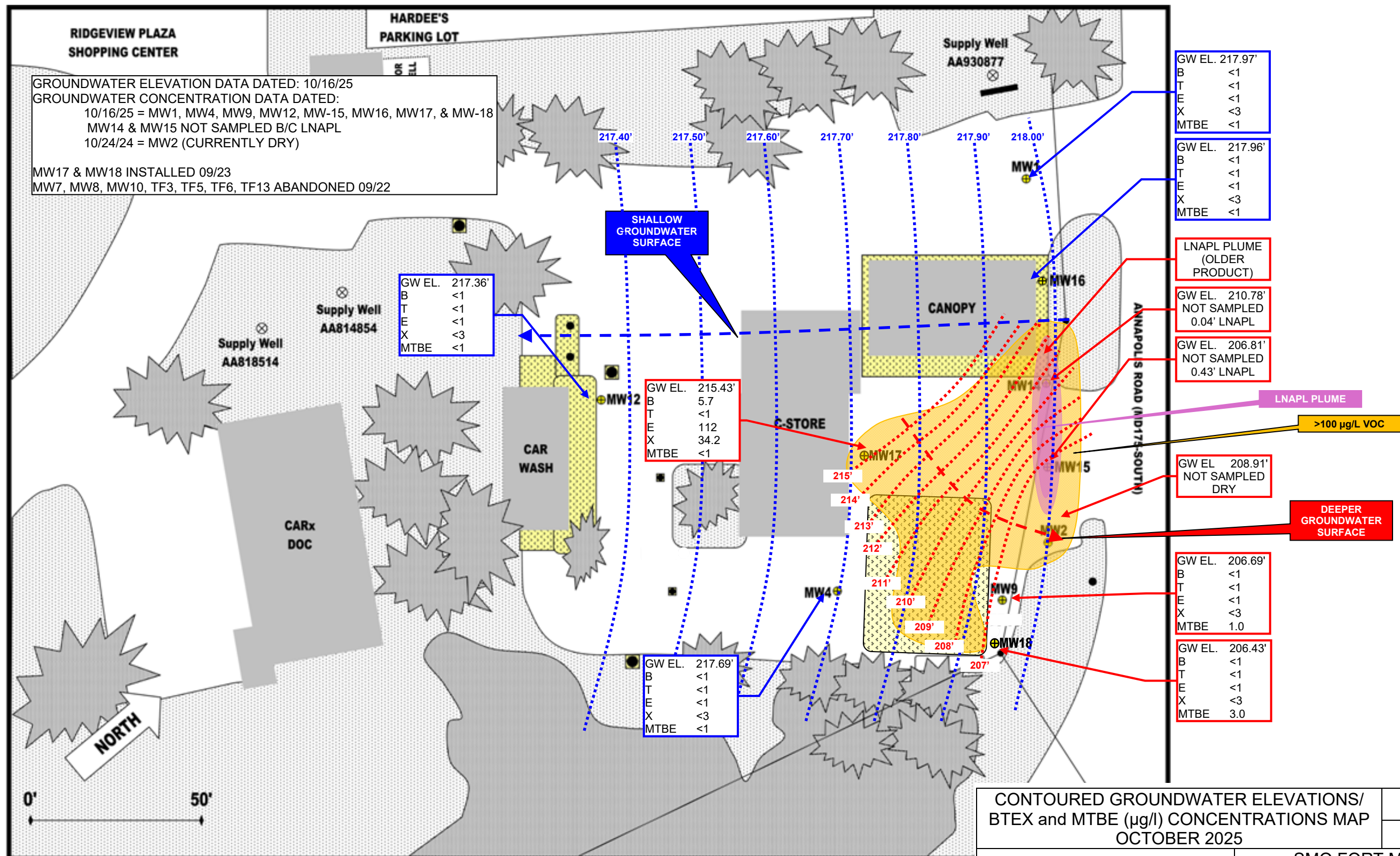


Douglas O. Hamilton
Director of Geology

cc. Matt Jolly, Southern Maryland Oil c/o The Wills Group, 102 Centennial Street, LaPlata, MD 20646
Robin Wedding, Southern Maryland Oil c/o The Wills Group, 102 Centennial Street, LaPlata, MD 20646

Attachments



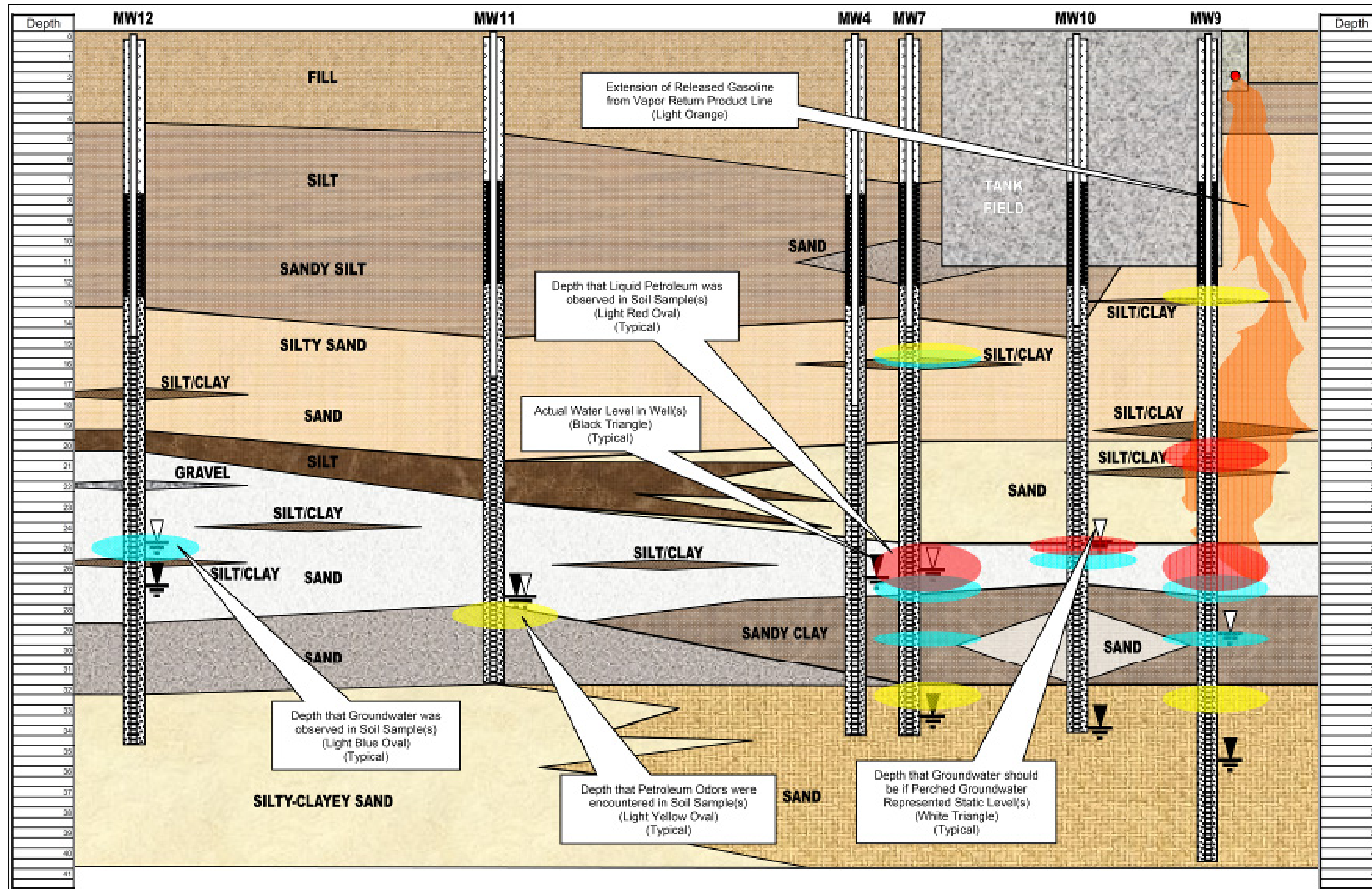



CONTOURED GROUNDWATER ELEVATIONS/
 BTEX and MTBE (µg/l) CONCENTRATIONS MAP
 OCTOBER 2025

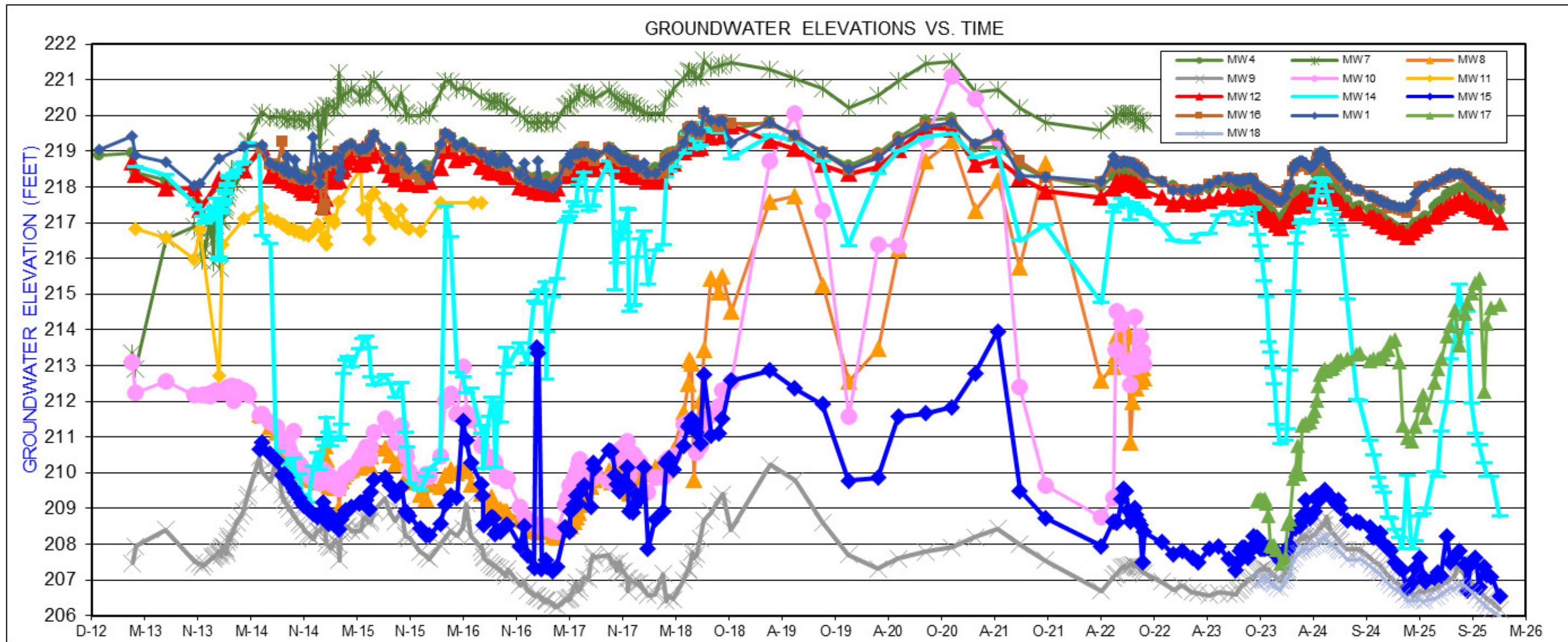
FIGURE
 1




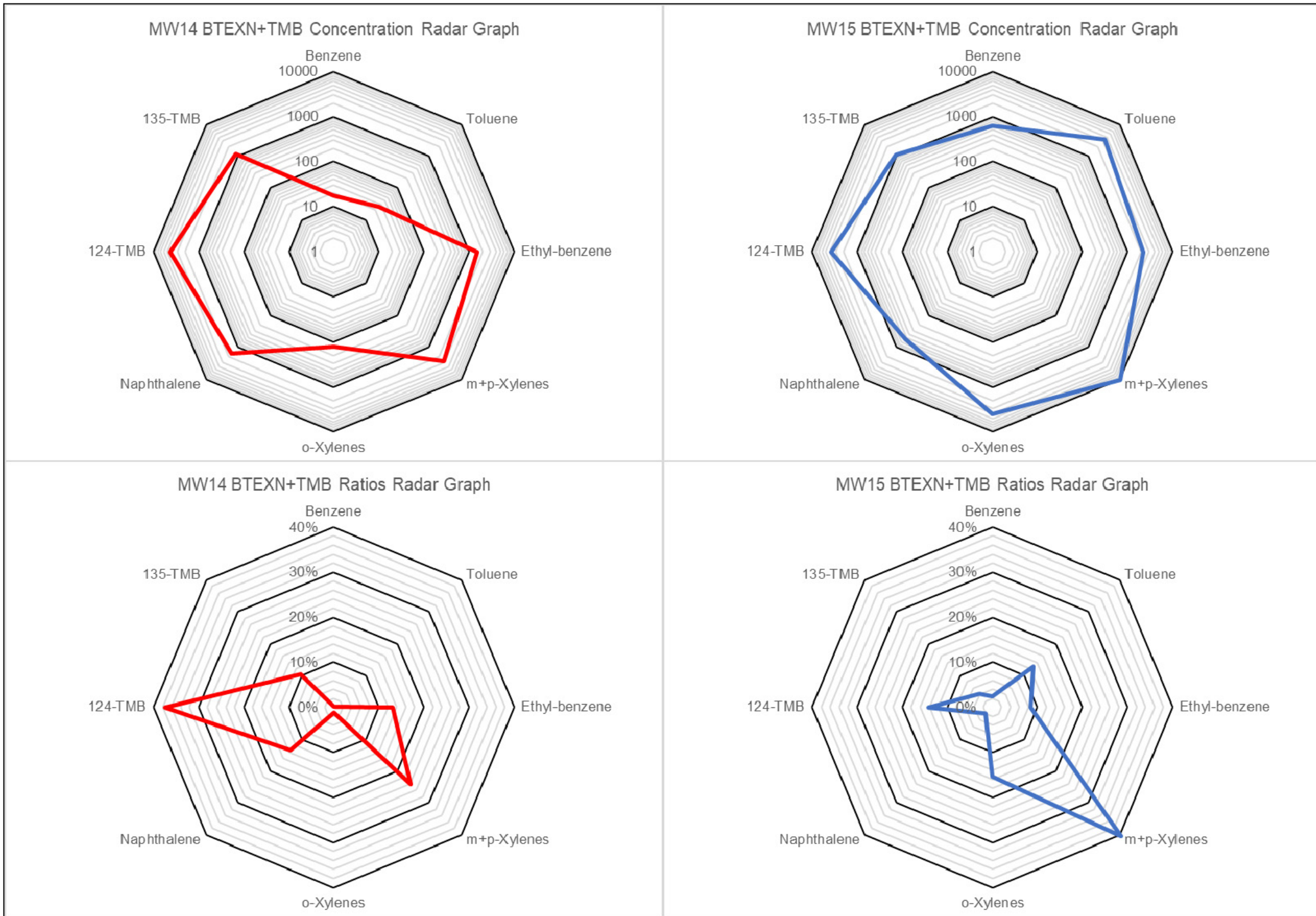
SMO FORT MEADE SHELL
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 HANOVER, MD
 ARM NO. 190292M




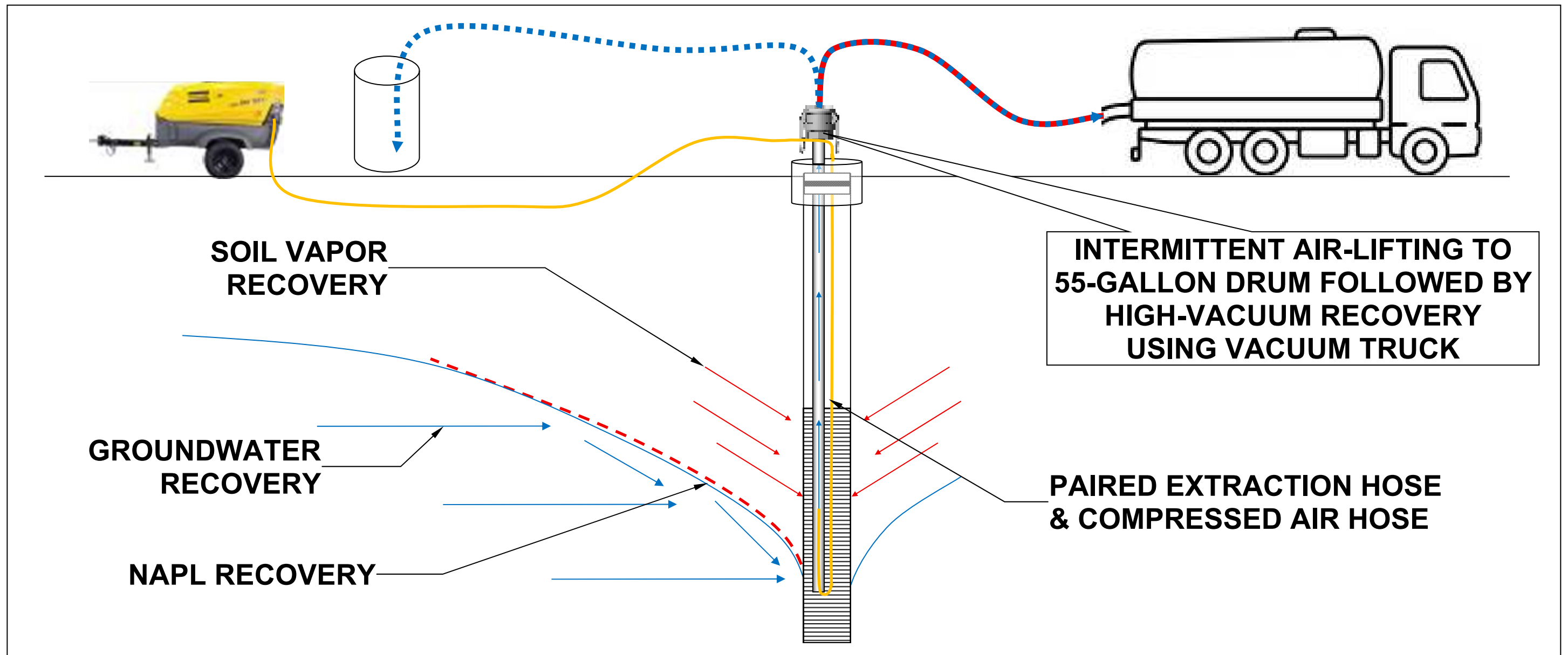
STRATIGRAPHIC CROSS SECTION	FIGURE
	2
 ARM Group LLC <small>Engineers and Scientists</small>	SMO FORT MEADE SHELL
	SS-1550
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HYDROGRAPHS		FIGURE
		3
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	SS-1550	
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	HANOVER, MD	
		ARM NO. 190292M



 ARM Group LLC <small>Engineers and Scientists</small>	MW-14 & MW-15 RADAR GRAPHS	FIGURE 4
	SMO FORT MEADE SHELL SS-1550 2631 ANNAPOLIS ROAD HANOVER, MD ARM NO. 190292M	



VAC TRUCK EFR WITH AIR-LIFT SCHEMATIC	FIGURE
	5
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