

Groundwater Modeling Conceptual Site Model Technical Memorandum

Main Installation
Defense Depot Memphis, Tennessee
U.S. EPA I.D. Number TN4210020570

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1 Introduction

HDR has prepared this technical memorandum to document the conceptual site model (CSM) update and to describe the groundwater flow and transport model objectives, construction and calibration, and the data limitations. The CSM will guide construction and calibration of the groundwater flow and transport model for the Main Installation (MI) at the former Defense Depot Memphis, Tennessee (DDMT). This revision incorporates the approved responses to comments received from the United States Geological Survey in August 2018 and adds results of the supplemental remedial investigation (SRI) conducted from April 2015 through November 2019.

This work is being performed under Contract No. W91278-16-D-0061, Task Order No. 0002 to the United States Army Corps of Engineers, Mobile District. The environmental restoration program at DDMT is directed by the Department of the Army, Office of the Deputy Chief of Staff, G9, Base Realignment and Closure Division.

DDMT was added to the National Priorities List (NPL) in 1992. All the selected remedies for DDMT have been implemented; the *Preliminary Close Out Report* (United States Environmental Protection Agency [USEPA] 2010) was approved in May 2010 and the NPL site status is Construction Complete. Responsibility for environmental restoration at DDMT transferred from the Defense Logistics Agency to the Department of the Army in December 2010. The regulatory oversight agencies are USEPA, Region 4 and Tennessee Department of Environment and Conservation. The USEPA Identification Number for DDMT is TN4210020570.

Details of the site location and site conditions are described in the 2020 *Supplemental Remedial Investigation Report* (HDR, 2020b).

2 Conceptual Site Model

The CSM is a narrative description of the groundwater flow system that forms the basis of the numerical groundwater flow and transport model. The purpose of the CSM is to identify all relevant hydrogeologic components of the local groundwater system, including all inflows and outflows, in order to later translate this information into a numerical model that is representative of the physical processes within the groundwater system.

In addition to the narrative description of the CSM, a three-dimensional (3D) hydrogeologic model of the subsurface underlying the MI and the surrounding area was created using previous hydrogeologic interpretations of DDMT well boring lithologic logs. The model was created in Leapfrog Hydro version 2.5.2 (ARANZ Geo Limited, 2006) and can be directly translated into the numerical groundwater flow and transport model.

The following sub-sections detail the components of the CSM. A description of the 3D hydrogeologic model is provided in [Section 3](#).

2.1 Topography

Topography of the study area was obtained from the Tennessee GIS Clearinghouse (<http://www.tngis.org/elevation.htm>). Digital Elevation Models (DEMs), created by the United States Geological Survey with a resolution of 10 meter grid size, were downloaded for Memphis and Shelby County. The DEMs were merged and used as the ground surface elevation for the 3D hydrogeologic model of the DDMT site area. A check was performed to verify DEM ground surface elevation conformity with measured ground surface at monitoring wells; the variance was minimal and deemed acceptable. Ground surface at the MI is nearly flat with average elevations generally from 290 to 305 feet (ft) North American Vertical Datum of 1988 (NAVD); the highest point is at 312 ft NAVD along Dunn Avenue near the northwest MI and the lowest point is at 267 ft NAVD below the earthen dam for Lake Danielson within the golf course (HDR, 2020b).

2.2 Hydrostratigraphic Units

Site investigations at DDMT from 1989 to 2013 included completion of 154 soil borings for installation of piezometers and monitoring wells on the MI and along the southern boundary of Dunn Field; 111 monitoring wells and 7 piezometers were installed in the Fluvial Deposits Aquifer (FDAQ), 34 wells were installed in the Intermediate Aquifer (IAQ) and 2 wells were installed in the Memphis Aquifer (MAQ). An additional 90 wells were installed in the FDAQ for enhanced bioremediation treatment injections or performance monitoring during the treatability study and remedy implementation in TTA-1 and TTA-2.

The SRI conducted from April 2015 through December 2019 included installation of 55 monitoring wells (MW-262 to MW-316) with 10-ft well screens including 46 wells in the FDAQ, 8 wells in the IAQ and 1 well in the MAQ. In addition, two nested wells (MW-317-NW and MW-318-NW) were installed in Phase 4, each well has four 1-in diameter wells with 2.5-ft well screens; each nested well has two wells screened in the FDAQ and two wells screened in the IAQ (HDR, 2020b).

The hydrostratigraphic units at the MI have been previously discussed (HDR, 2020b) and are summarized in the following text from youngest to oldest. The same hydrostratigraphic classifications have been incorporated into the 3D hydrogeologic model developed for the MI. The model boundary and hydrostratigraphic cross-sections from the model are provided in Appendix A. [Figure A-1](#) is an aerial photograph showing the horizontal limits of the model and the locations of monitoring wells at DDMT, production wells at the Memphis Light, Gas and Water (MLGW) Allen Well Field, and hydrostratigraphic cross-sections. A fence diagram with the cross-sections is provided on [Figure A-2](#). The fence diagram was generated by the software use to create the model input files, Leapfrog Hydro.

2.2.1 Loess

Loess is an aeolian deposit consisting of clayey silt to silty clay and is the uppermost hydrostratigraphic unit at the MI. It is unsaturated in borings drilled on the MI and is a continuous deposit approximately 20 to 30 ft thick at DDMT and the surrounding area (HDR,

2020b). This deposit is considered a semi-confining unit that limits groundwater recharge to the underlying hydrogeologic units.

2.2.2 Fluvial Aquifer

The FDAQ consists of a silty, sandy clay to clayey sand upper unit, which is approximately 0 to 30 ft thick and a lower unit consisting of interlayered sand and gravels approximately 30 to 100 ft thick. The upper unit is semi-confining and unsaturated at DDMT, while the lower unit is more permeable and is partially saturated. The base of the FDAQ is controlled by the surface of the uppermost clay in units of the upper Claiborne Group. Groundwater elevations within the FDAQ range from a high of about 245 ft NAVD in the northeast corner of the MI to a low of about 206 ft in the south-central MI (HDR, 2020b).

Horizontal hydraulic conductivity of the FDAQ has been determined through aquifer performance tests to range from approximately 10 to 193 feet per day (ft/d) and from slug test analyses to range from 0.2 to 70 ft/d (CH2MHILL, 2004). Based on the limited volume of material surrounding a well screen that is affected during most slug tests, the aquifer performance test values are considered more representative of aquifer permeability; the geometric mean of the aquifer performance test values is 39 ft/d.

Vertical hydraulic conductivity of the FDAQ has not been determined for the MI. However, published vertical hydraulic conductivity values for the FDAQ in the Memphis area range from 0.1 to 0.74 ft/day (Robinson et al., 1997).

2.2.3 Upper Confining Unit and Intermediate Aquifer

Units of the upper Claiborne Group (Cockfield and Cook Mountain Formations) make up the upper Claiborne confining unit, also referred to as the Upper Confining Unit (UCU), that underlies the Fluvial deposits at the MI. The Cockfield Formation consists of inter-fingering fine sand, silt, clay, and local lenses of lignite. The Cook Mountain Formation consists primarily of clay with varying amounts of fine sand and is reported to be the most persistent clay layer in the UCU (HDR, 2020b). The dark gray clay of the UCU has been used to distinguish this unit from the overlying FDAQ. The hydraulic conductivity of the dark gray clay has been measured at 0.0007 to 0.00005 ft/d using Shelby tube samples (CH2MHILL, 2001).

Sand lenses or beds that are present in the UCU locally may be above or below the dark gray clay and constitute the IAQ. The sand units are generally described in DDMT boring logs as light gray to white fine sand; the color and texture are used to differentiate sand in the Fluvial Deposits from UCU sands when the units are in direct contact (HDR, 2020b). The uppermost clay layer in the UCU, which usually forms the base of the FDAQ, is absent in the central part of the MI, and the FDAQ and the IAQ form a single water table aquifer in that area (Figure 1). Groundwater elevations in the IAQ wells at DDMT at locations not in contact with the FDAQ are approximately 175 ft NAVD.

Three monitoring well borings at DDMT (MW-67, MW-254 and MW-255) were drilled through the UCU into the underlying Memphis Sand. The thickness of the UCU in those borings were 188.5 ft, 208 ft and 203 ft, respectively. Because the UCU contains much fine sand and sandy silt, a better indicator of areal differences in its ability to retard the movement of water between

the surficial aquifers and the MAQ is the aggregate thickness of clay beds within the unit. (Graham and Parks, 1986). The aggregate thickness of clay beds thicker than 10 ft in the UCU at MW-67, MW-254 and MW-255 were 125 ft, 54 ft and 55 ft, respectively (HDR, 2020b).

2.2.4 Memphis Aquifer

The MAQ is a deep regional aquifer used extensively for water supply in the Memphis area and is within the Memphis Sand. At DDMT, the uppermost part of the Memphis Sand is primarily composed of clean, light colored, medium-sized sand with little silt or clay, and the top of the Memphis Sand was encountered at depths of 254.5 to 283 ft bgs (elevations of 10 to 21 ft NAVD) (HDR, 2020b). Regionally, the MAQ ranges from 500 to 850 ft in thickness (Parks and Carmichael, 1990). Groundwater elevations measured at the DDMT wells (MW-67, MW-254 and MW-255) are approximately 174 ft NAVD (HDR, 2020a).

Groundwater elevations in the MAQ are similar to the IAQ, which indicates hydraulic connectivity. The screened interval in MW-140 is in a thick sandy interval of the UCU at an elevation approximately 66 ft higher than the screened intervals for MW-254 and MW-255, which are within the upper part of the Memphis Sand. The water levels in MW-140 and MW-255 were 174.17 and 173.31 ft NAVD, respectively, in October 2019 (HDR, 2020a). An intervening clay layer was not observed in the boring logs for MW-140 and MW-255 ([Figure 1](#)).

Transmissivity values from 60 aquifer tests in the Memphis area, ranged from about 6,700 to 54,000 foot squared per day (ft^2/d) but most were in the range of 20,000 to 43,000 ft^2/d (average: 33,000 ft^2/d) (Parks and Carmichael, 1990). Storage coefficients from these tests ranged from 0.0001 to 0.003 (average: 0.001), which is typical for a confined aquifer (Parks and Carmichael, 1990). Assuming an estimated aquifer thickness of 850 ft (the maximum screened interval in the nearby Allen Well Field production wells), the average hydraulic conductivity is equal to about 39 ft/d , which is typical for a sand aquifer (HDR, 2020b).

2.3 Hydraulic Interconnection between Hydrostratigraphic Units

Historically, the MAQ was thought of as an “ideal” confined aquifer that was overlain by a thick, impermeable clay layer associated with units of the upper Claiborne Group (Cockfield and Cook Mountain Formations) that served as a confining unit and protected the aquifer from contamination that entered the shallower alluvial and fluvial deposits aquifers from near-surface sources. Studies from the 1960s to the 1980s changed that understanding and showed that, in places, the confining unit is thin or absent and contains sand “windows” that provide “pathways” for contaminants to reach the MAQ. Studies also indicate that downward leakage from the water-table aquifers (Alluvial and Fluvial Deposits Aquifers) to the MAQ is widespread in the Memphis area (Parks, 1990).

Within the northwestern MI, a connection or “window” between the FDAQ and IAQ has been identified through numerous soil borings and water-level measurements, in addition to the presence of elevated chlorinated volatile organic compounds (CVOCs) that have moved downward from the FDAQ into IAQ within the area. The extent of the “window” is displayed on [Figure 2](#); the cross-section on [Figure 1](#) and the hydrostratigraphic cross-sections on [Figure A-2](#)

indicate there is also a connection to the underlying MAQ. Additional evidence of the hydraulic connection between the FDAQ and the IAQ is that water levels in the FDAQ, shown on [Figure 2](#), are depressed in the central MI near MW-39 (Sink 2) and MW-259 (Sink 1) indicating downward leakage of water (HDR, 2020a).

Time-trend plots of groundwater elevations in IAQ and MAQ wells are shown in Appendix C of the 2019 annual long-term monitoring report. The plots show a strong correlation in the water levels indicating hydraulic interconnection between the IAQ and the MAQ (HDR, 2020a).

2.4 Surface Water

There are no naturally flowing perennial streams or creeks on DDMT. Site drainage occurs by overland flow via swales, ditches, concrete-lined channels, and a storm drainage system, which directs storm water into a series of storm drains for transport to discharge points around the perimeter of the MI (HDR, 2020b).

Nonconnah Creek, located just south of the model boundary, is within alluvium and has a relatively shallow channel (Moore and Diehl, 2004), and is not considered to impact water levels on the MI. The channel bottom is approximately 235 ft NAVD while groundwater levels in the FDAQ at the southern MI boundary are less than 210 ft NAVD ([Figure 2](#)).

2.5 Groundwater Flow System

2.5.1 Fluvial Aquifer

Based on groundwater elevations measured in October 2019, groundwater flow within the FDAQ appears to be onto the MI from all directions, to the west-southwest across the north and central sections of Dunn Field, and to the south onto the MI from the south section of Dunn Field ([Figure 2](#)). The October 2019 FDAQ groundwater elevations are highest in the northeast corner of the MI (MW-16, 245.73 ft NAVD) and the northeastern area of Dunn Field (MW-28, 243.65 ft NAVD) and are lowest in the south-central MI (MW-259, 205.77 ft NAVD) (HDR, 2020a). The hydraulic gradient between MW-16 and MW-259 is approximately 0.011 ft/ft. This yields a groundwater flow velocity of 1.7 ft/d from the northeast corner of the MI to the south-central area of the MI, using a horizontal hydraulic conductivity of 39 ft/d and a porosity of 26 percent (%) (Robinson et. al. 1997), in conjunction with the calculated gradient.

Groundwater flow within the FDAQ on the MI is toward the window in the northwest MI and an extended depression in groundwater elevations in the south-central MI, with sinks at MW-39 and MW-259 ([Figure 2](#)). The depression may be linked to a lack of confinement between the FDAQ and the underlying IAQ.

2.5.2 Intermediate Aquifer

IAQ water levels in the northwest MI, downgradient of the window where a thick clay layer is present between the FDAQ and IAQ, are approximately 46 ft lower than the overlying FDAQ water levels (FDAQ MW-55, 223.13 ft NAVD to IAQ MW-256, 177.15 ft NAVD). This relatively large, downward vertical hydraulic gradient results in groundwater flow from the FDAQ into the southeast area of the window as shown on [Figure 3](#). Groundwater flow in the IAQ is generally to

the northwest from the MI towards Dunn Field with a hydraulic gradient of 0.018 (MW-107 to MW-34) (HDR, 2020a). This yields a groundwater flow velocity of 2.7 ft/d assuming similar hydraulic parameters as the overlying FDAQ.

2.5.3 Memphis Aquifer

MAQ water levels in the northwest MI, depicted on [Figure 4](#), are approximately 6 ft lower (MW-262, 178.48 ft NAVD to MW-254, 172.73 ft NAVD) than the overlying IAQ water levels ([Figure 3](#)) and indicate a downward vertical hydraulic gradient. Groundwater flow in the MAQ is generally to the southwest at MW-254 with a hydraulic gradient of 0.002. This yields a groundwater flow velocity of 0.31 ft/d to the west, using a hydraulic conductivity of 39 ft/d and a porosity of 25% (Robinson et. al. 1997), in conjunction with the calculated gradient. This flow velocity likely increases closer to pumping water supply wells in the Allen Well Field; however, water levels in the MAQ within the Allen Well Field were not available to calculate a gradient.

2.6 Groundwater Recharge

Groundwater recharge to the FDAQ is the component of precipitation that is not subject to evapotranspiration or runoff from the MI. Although there are no measurements of groundwater recharge at the MI, a previous study in the Memphis area and with similar stratigraphy has produced estimates of 0.67 to 1.8 inches per year (Robinson et al., 1997); this is approximately 1.2% to 3.3% of the normal annual precipitation of 54.0 inches (NOAA, 2020). DDMT land use maps will be used to determine permeable (open areas) and impermeable (buildings and pavement) ground surfaces to specify areas that are capable of receiving direct infiltration of recharge to the underlying aquifer system.

2.7 Groundwater Withdrawal

The groundwater withdrawal location nearest to the MI is the Allen Well Field, which is a municipal well field operated by MLGW; the central part of the well field is approximately 1.2 mile west of the MI ([Figure 5](#)). All production wells are completed within the MAQ. Details on the overall pumping rate of the Allen Well Field and the status of the production wells has been previously reported (HDR, 2020b). Based on overall Allen Well Field pumping rates (19.33 million gallon per day average in the April 2017 Monthly Report for Allen Pumping Station), it is assumed that the Allen Well Field is influencing the groundwater flow direction for the MAQ and probably the IAQ; influence on groundwater flow direction in the FDAQ is dependent on proximity to areas of leakage into the deeper aquifers. The groundwater flow direction for the MAQ wells at DDMT shown on [Figure 4](#) is to the southwest. While the number and spacing of MAQ wells at DDMT are limited, the flow direction may result from the layout of the Allen Well Field, which has the closest highly-rated extraction wells (115A and 117A) located southwest of the MI. Individual pumping rates for active production wells in the Allen Well Field were requested from the MLGW, but the data has not been made available. In lieu of individual well pumping rates, the groundwater model will divide the total average pumping rate for the Allen Well Field among the active wells based on their reported pumping rates.

2.8 Contaminants of Concern

Several tetrachloroethene (PCE) and trichloroethene (TCE) plumes are present in the FDAQ and the IAQ, based on past and present sampling events at monitoring wells at the MI. The designations for the plumes are displayed on [Figure 6](#).

Based on October 2019 sampling data (HDR, 2020a), PCE and TCE concentrations continue to exceed the maximum contaminant level (MCL) in multiple areas of the MI within the FDAQ ([Figures 7 and 8](#)) and IAQ ([Figures 9 and 10](#)). Contaminant migration within plumes appears to follow the general downgradient flow directions in the FDAQ as described in [Section 2.5](#).

- The PCE plumes within the FDAQ are in the areas of the MI designated as TTA-1N, TTA-1S, TTA-2, North-Central, West-Central, Window and Southeast plumes. The North-Central, West-Central and Window plumes merge in the central area of the MI ([Figure 7](#)).
- The TCE plumes within the FDAQ are in the areas of the MI designated as TTA-1N, TTA-2, Building 835, North-Central, West-Central, South-Central and Southeast plumes. Isolated exceedances were measured at MW-270. The Building 835, North-Central and West-Central plumes merge in the central area of the MI ([Figure 8](#)).
- The PCE plume within the IAQ is upgradient (south and southwest) of the window, within the window and downgradient (northwest) of the window ([Figure 9](#)).
- The TCE plume within the IAQ is upgradient (south) of the window and at the downgradient edge of the window, near MW-34 and MW-256 ([Figure 10](#)).

2.9 Contaminant Source Areas

The contaminant source areas are generally considered to be within the upgradient areas of existing FDAQ PCE and TCE plumes at the MI ([Figures 7 and 8](#)). Off-site impacts have been identified for the TTA-1N plume (PCE and TCE) and the North-Central plume (TCE) and potentially for the TTA-1S plume (PCE). The extent of the other MI plumes are bounded by wells with PCE and TCE concentrations below or slightly above the MCL.

A source area investigation of the MI was conducted in 2008 (e²M, 2009) that included a membrane interface probe (MIP) survey and confirmation soil sampling to identify areas of soil contamination. The study identified areas impacted by PCE and TCE, but did not find a large contaminant source at any of the presumed source-area locations. Soil contamination is considered to have resulted from multiple, small undocumented releases over time across the MI (HDR, 2020b). Source area concentrations will be established by initially adding source concentrations in the areas of the greatest concentrations of PCE and TCE, adjusting the concentrations and spatial extent through model calibration, and referencing the previous modeling effort (CH2MHill, 2009).

2.10 Contaminant Transport Parameters

Parameters that will be used to construct the flow and transport model include the variable hydraulic gradient determined from recent water levels and hydraulic conductivity values using aquifer test values for the FDAQ and literature values for the IAQ and MAQ. Transport parameters and their initial values specific to PCE and TCE transport are included in Table 1.

Table 1. Initial PCE and TCE Transport Parameters

Transport Specific Parameters	Value
Effective Porosity (all aquifer units)	25% (1)
Longitudinal Dispersivity	40 ft (2)
Transverse Dispersivity	40 ft (2)
Vertical Dispersivity	4 ft (2)
Biodegradation Rate	1 st order decay (PCE 0.5/yr, TCE 0.8/yr) (3)
Soil Adsorption Coefficient (Kd)	0.1 – 5 mL/g (4)
Bulk Density	1.8 g/cm ³ (5)

Notes:

- (1) Value from Robinson et al., 1997 for a site in Millington, TN, approximately 20 miles north of Memphis. All aquifers have similar characteristics.
- (2) Value from CH2MHill, 2009. Values may change during model calibration.
- (3) The previous model (CH2MHill, 2009) and model review (HDR, 2020b) were both in agreement that attenuation is occurring through 1st order decay. The values used in the 2009 model are shown.
- (4) The soil adsorption coefficient is the mobility of a substance in the subsurface. Site-specific values are not available. Literature values are from the Savannah River Site (Riley et. al., 2006).
- (5) The bulk density value is of the sandy aquifer at the Savannah River Site (Riley et. al., 2006).

3 Groundwater Flow and Transport Model

The groundwater flow and transport model is the numerical representation of the CSM. The flow model will be constructed using MODFLOW-2005 (McDonald and Harbaugh, 1988) with MT3D (Zheng, 1990) as the solute-transport model, and Groundwater Vistas (Environmental Simulations, Inc., 2011) as the interface for model design and calibration.

3.1 Planned Modeling Objectives, Construction and Calibration

Predictive scenarios will include simulating the movement of PCE and TCE 50 years into the future from the calibration period. Predictive scenarios will be performed under varying ranges of model-sensitive parameters to provide a range of possible migration distances and concentrations. Model-sensitive parameters will be determined during model calibration and used to provide a sensitivity analysis of model predictions by altering sensitive parameters to provide a range of model results.

The 3D geological model will be used as input for the elevations and thicknesses of aquifer and confining units in the numerical model. The model will be constructed to include the FDAQ, IAQ and MAQ represented by 8-10 model layers to provide vertical resolution of PCE and TCE

movement. Flow and transport parameters discussed in [Section 2](#) will be used as initial model conditions, but may be revised during flow and/or transport calibration.

The model boundaries include a buffer of at least 1,000 ft from DDMT and a sufficient distance from the Allen Well Field to minimize the effects from the general head boundaries and to allow for contaminant movement offsite (if contaminants do indeed move offsite). General head boundaries will be used to allow inflow and/or outflow along the model boundaries and are appropriate to use where natural groundwater divides are not present. The model will likely have 20 ft x 20 ft lateral discretization within DDMT and will gradual increase to 50 ft or greater away from DDMT. The goal is to keep the grid cell count to less than 1.25 million cells to improve computational efficiency. Vertical discretization has already been described.

Model calibration will involve matching simulated water levels to the most recently measured water levels. PCE and TCE concentrations will be calibrated to transient conditions over an 18-month period, which is enough time to capture trends in concentrations and any seasonal variations that may occur. The calibration objective for matching water levels is a root mean squared error of less than 10% between measured and model simulated heads. The calibration objective for measured PCE and TCE concentrations is to qualitatively match simulated concentrations to measured concentrations over the 18-month calibration period in measured monitoring wells.

3.2 Data Limitations

The following limitations, based on necessary assumptions, will be inherent within the completed groundwater flow and transport model:

- The hydrostratigraphy of the FDAQ at DDMT is well defined. The hydrostratigraphy of the IAQ is well defined in the north-western area of the MI and the MAQ hydrostratigraphy is sparsely defined at DDMT.
- Individual production well pumping and water-level data for the Allen Well Field is not known and it will not be possible to determine the correct water-level drawdown within the well field and the vicinity or calibrate to those water levels. Additionally, without potentiometric data for the well field, the calibrated hydraulic gradient and flow velocity towards the well field from the MI may not be accurate and will introduce a level of inaccuracy to contaminant travel times from the MI. A best attempt will be conducted to simulate reasonable water level drawdowns within the Allen Well Field, although it is not possible to quantify the inaccuracies without the requested water levels and pumping rates at individual wells in the Allen Well Field.
- Site-specific aquifer recharge values are not available for DDMT. Literature values from a site in Millington, TN (Robinson et al, 1997) will be used and refined during model calibration.
- Aquifer testing results for site-specific hydraulic conductivity values at DDMT are sparse, and will be supplemented with local data. Hydraulic conductivity values used in the model will be taken from the available data and will be refined during model calibration.

- Dispersion or dispersivity of a contaminant within the subsurface is difficult to quantify. Values listed in [Table 1](#) will be used initially and will be refined during calibration.
- Site-specific porosity values are not available for DDMT. However, the values listed in [Table 1](#) from a site in Millington, TN (Robinson et al, 1997) are consistent for sand and gravel aquifers. Confining units consisting of clay will have smaller values.
- Site-specific soil adsorption coefficients (K_d) have not been tested. The range of potential values from [Table 1](#) will be refined during calibration.

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Figures



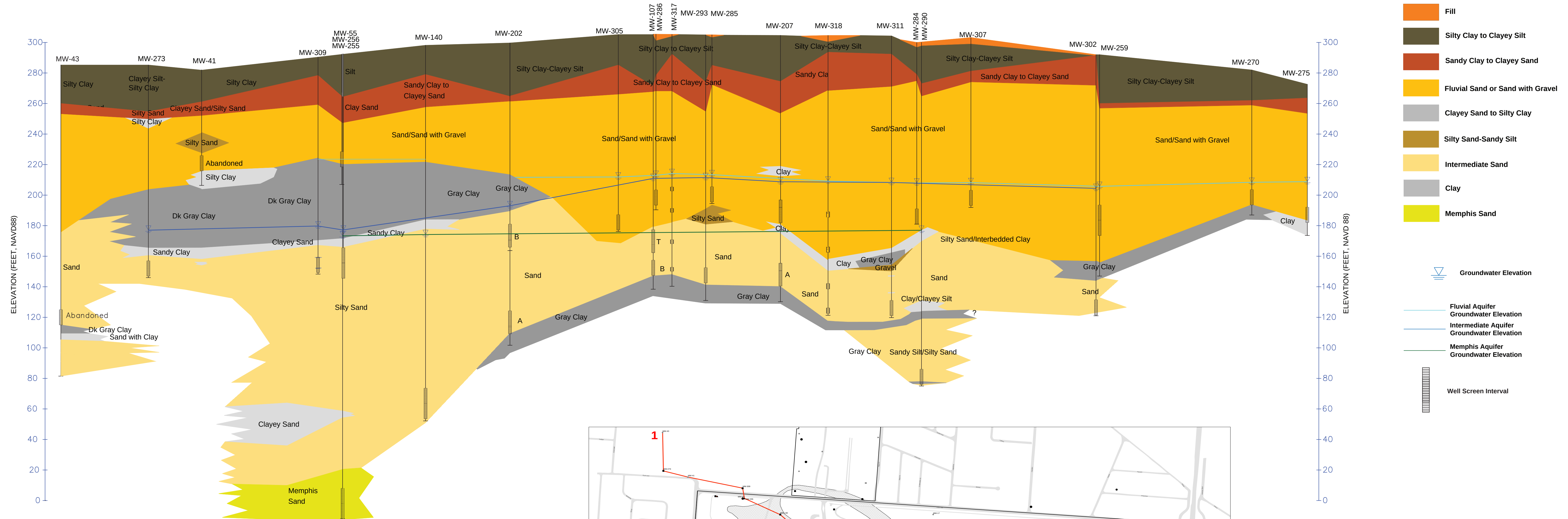
Figure 1
Cross Section 1,
MW-43 to
MW-275

Conceptual Site Model

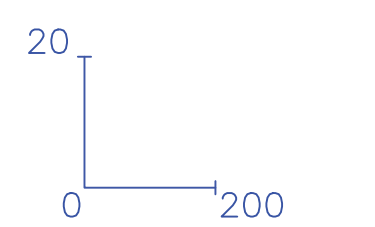
Defense Depot
Memphis,
Tennessee

1 NORTH

1' SOUTH

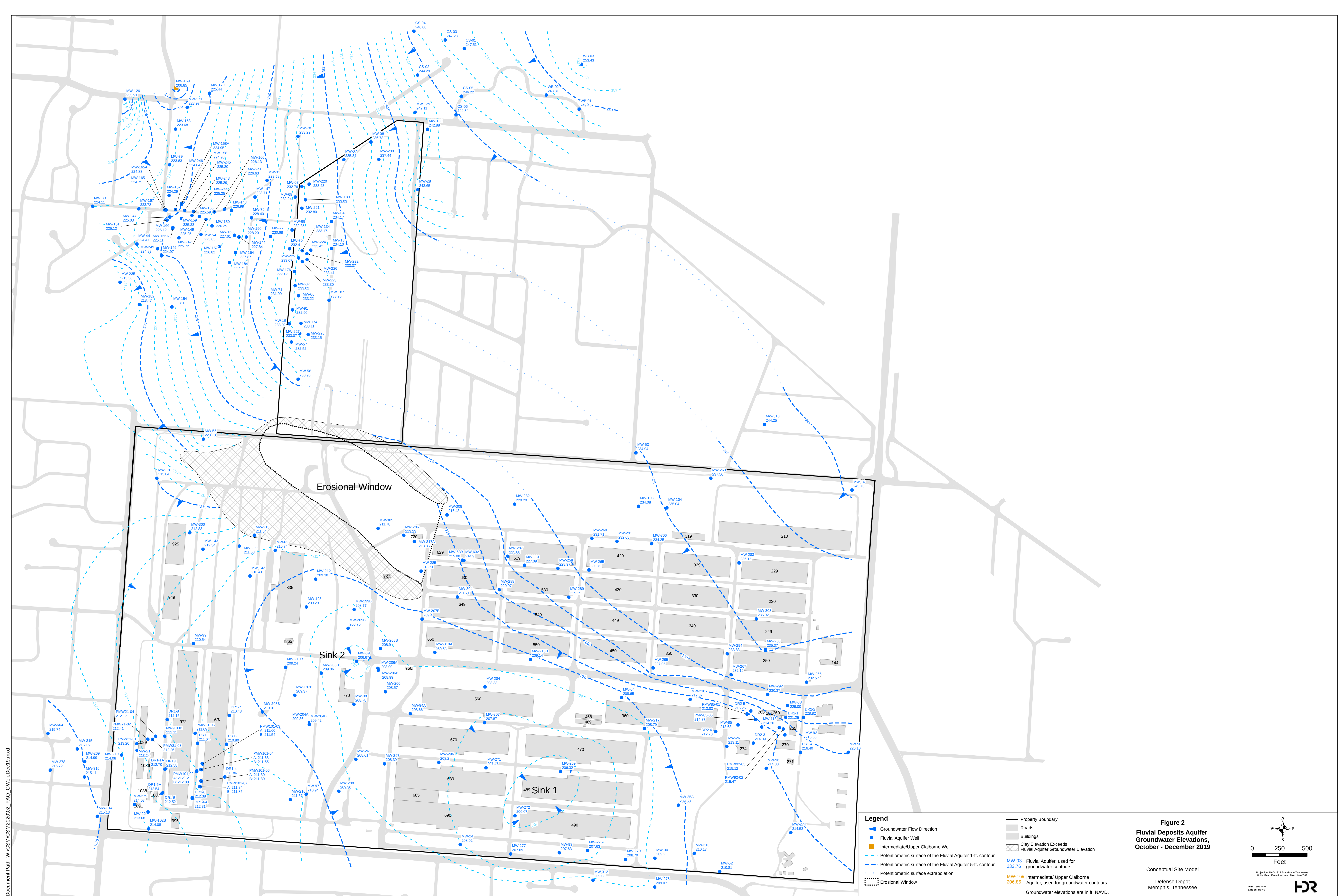


Note: Water levels measured during LTM in October 2019 and at Phase 4 wells and nearby LTM wells in December 2019.



Date: April 2020
Edition: Rev 0

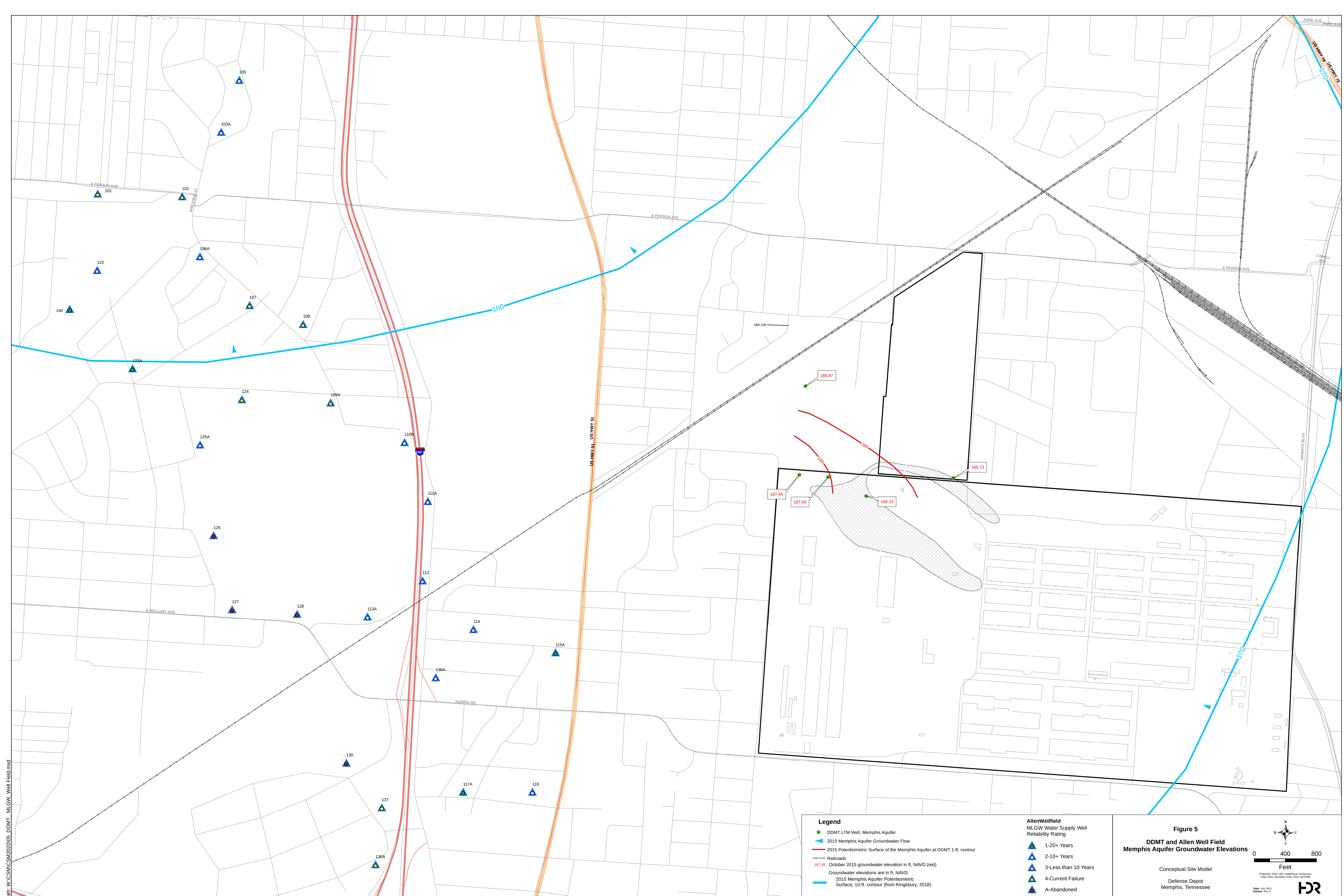




Document Path: W:\CSM\CSM2020\03_ILUC_GW\eleDec19.mxd







Path: W:\CS\GIS\2020\05-DDMT-MLGW-Well-Field.mxd

Legend

- DDMT LTM Well, Memphis Aquifer
- 2015 Memphis Aquifer Groundwater Flow
- 2015 Potentiometric Surface of the Memphis Aquifer at DDMT 1-ft. contour
- Railroads
- October 2015 groundwater elevation in ft. NAVD (red)
- Groundwater elevations are in ft. NAVD.
- 2015 Memphis Aquifer Potentiometric Surface, 10-ft. contour (from Kingsbury, 2018)

AllenWellfield
MLGW Water Supply Well
Reliability Rating

- 1-20+ Years
- 2-10+ Years
- 3-Less than 10 Years
- 4-Current Failure
- A-Abandoned

Figure 5
DDMT and Allen Well Field
Memphis Aquifer Groundwater Elevations

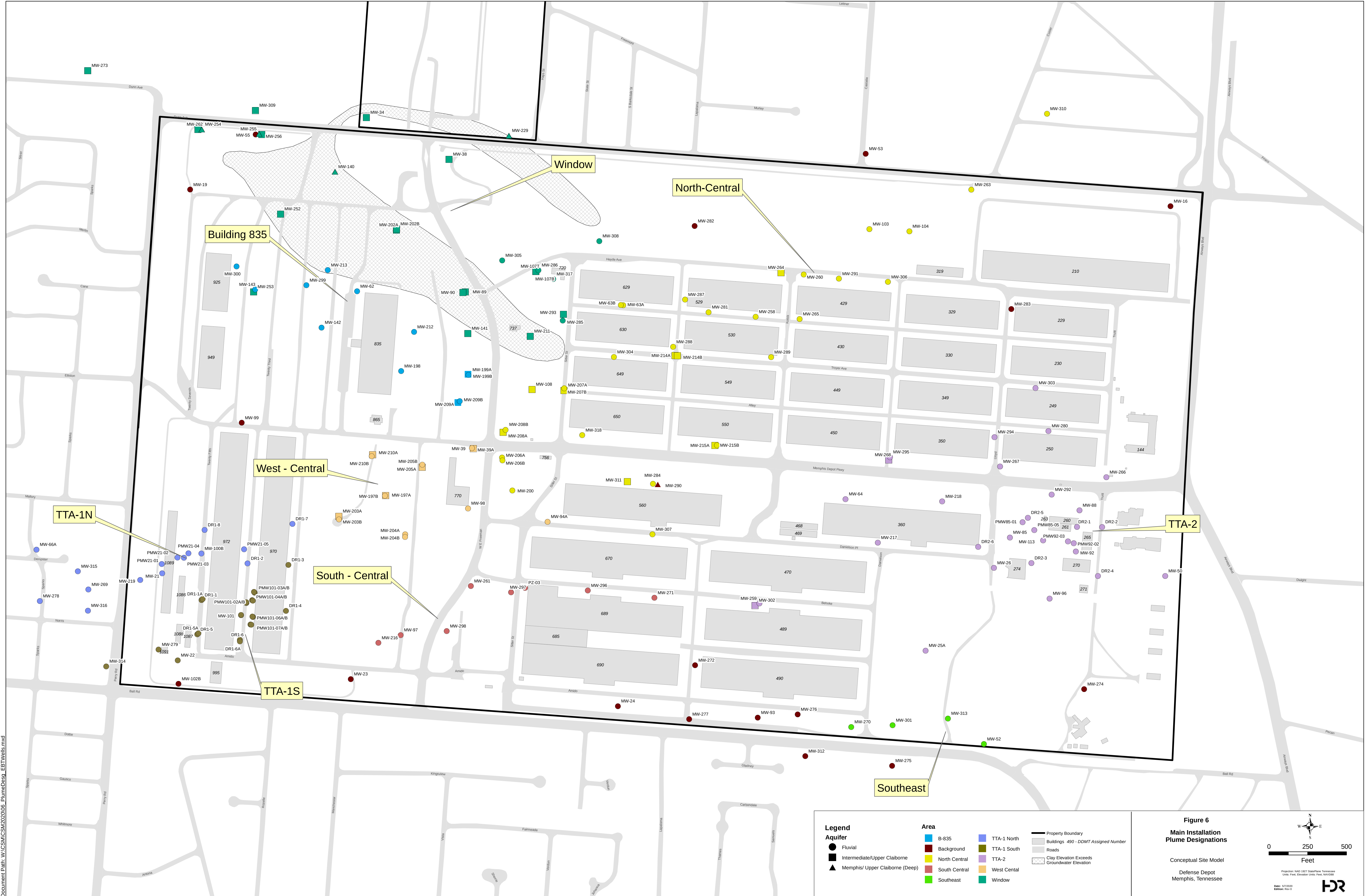
Conceptual Site Model
Defense Depot
Memphis, Tennessee

0 400 800
Feet

Projection: NAD 1983 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, No Unit
Date: July 2015
Editor: FHV 0

DR

Document Path: W:\CSM\CSM202006 PlumeDespl EBTWells.mxd



Notes:
1. Color-coded well symbols are based on the most recent analytical results at each well. Results are from the October 2018, October 2019 LTM and SRI Phase 4 November 2019 events.
Only concentration from the November 2019 event are shown below the well ID.
2. Groundwater contours are from the October 2019 LTM and November 2019 SRI events.

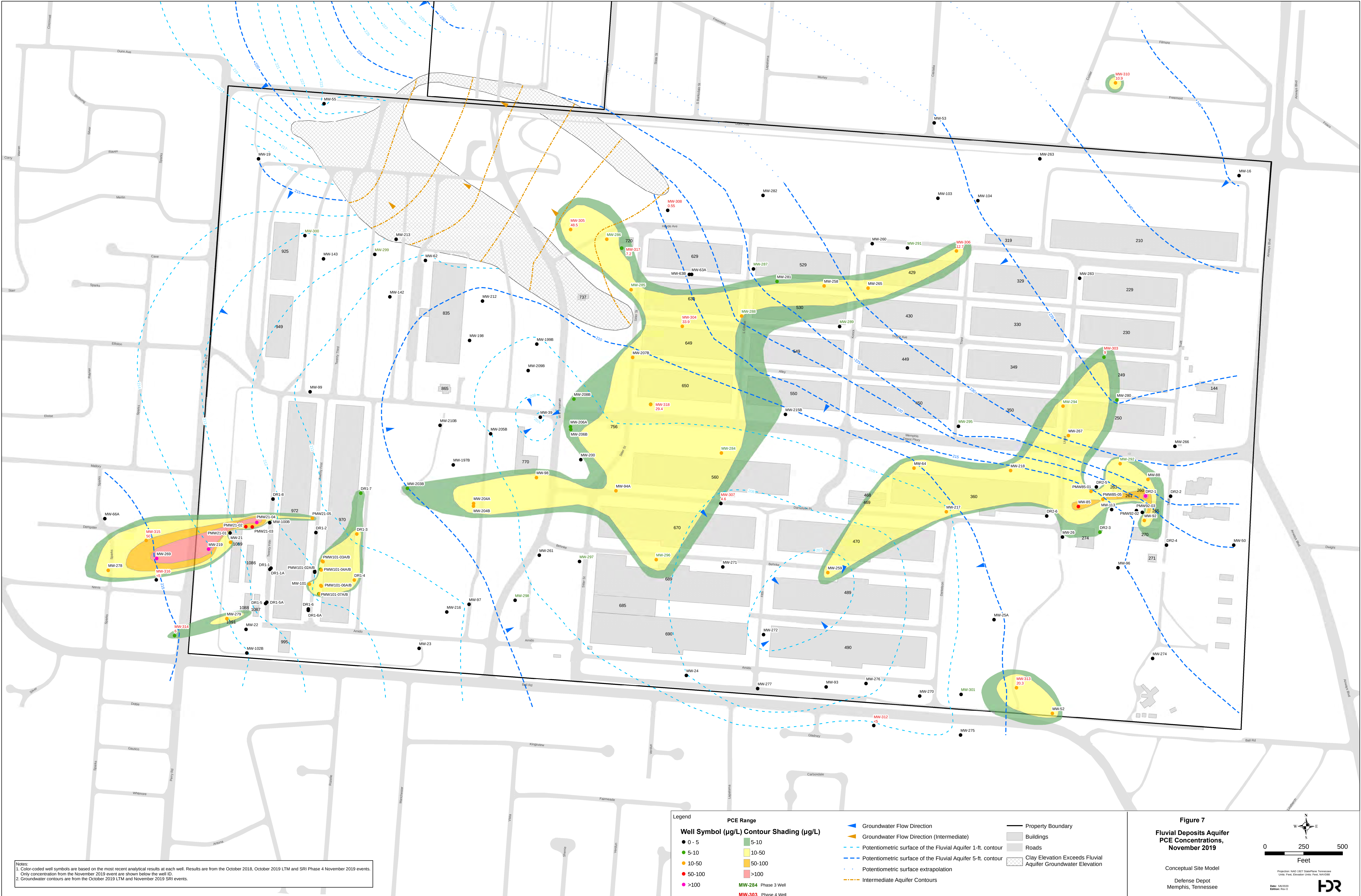
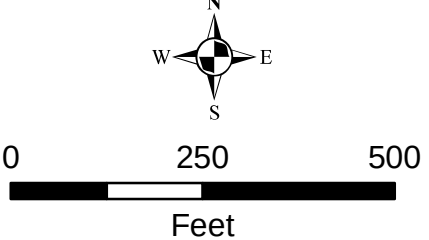


Figure 7
Fluvial Deposits Aquifer
PCE Concentrations,
November 2019

Conceptual Site Model
Defense Depot
Memphis, Tennessee



Projection: NAD 1983 StatePlane Tennessee
Units: Feet, Elevator Units: Feet, Meters

Date: 5/6/2020
Edition: Rev 0



Notes:
1. Color-coded well symbols are based on the most recent analytical results at each well. Results are from the October 2018, October 2019 LTM and SRI Phase 4 November 2019 events.
Only concentration from the November 2019 event are shown below the well ID.
2. Groundwater contours are from the October 2019 LTM and November 2019 SRI events.

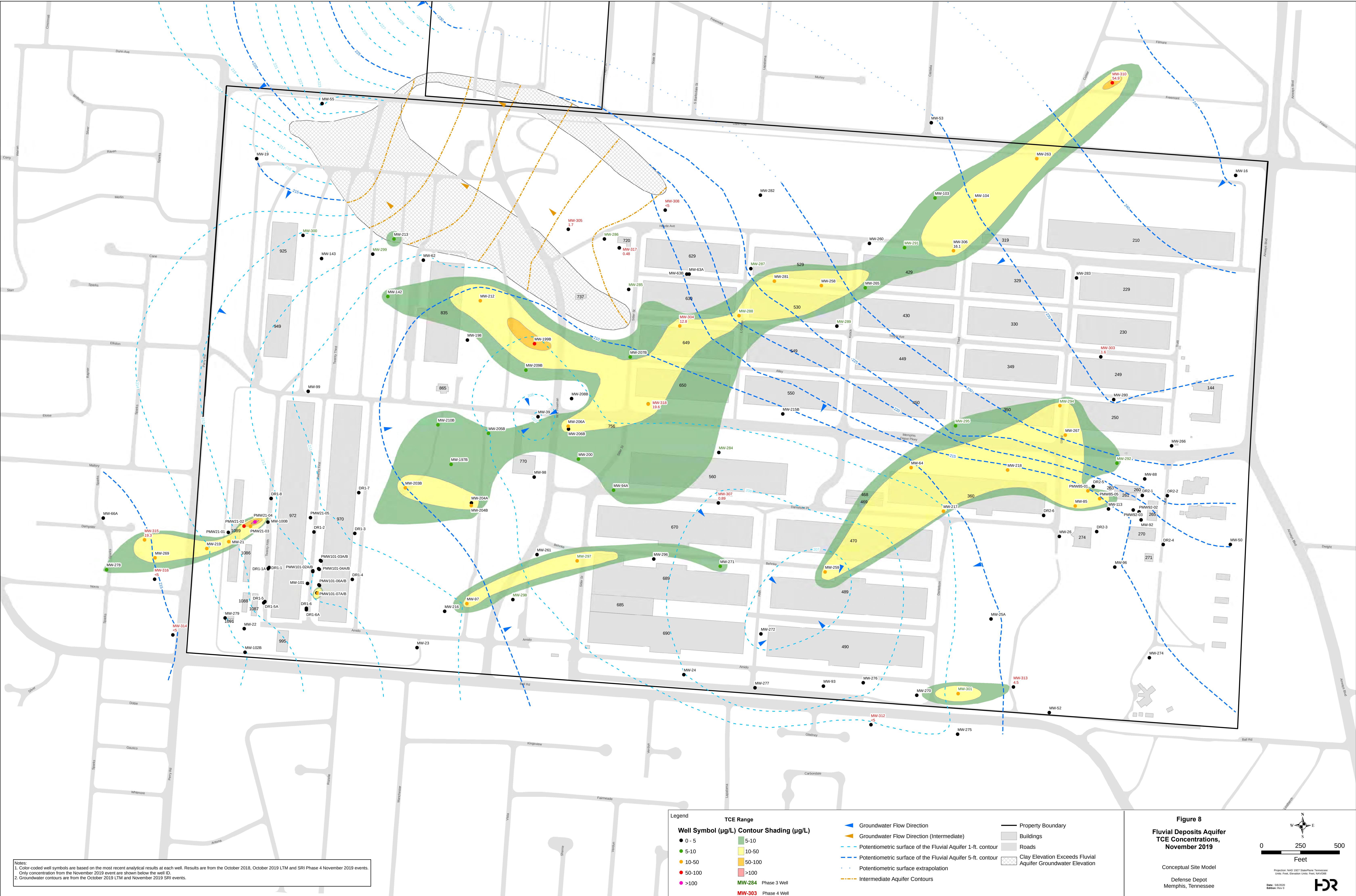
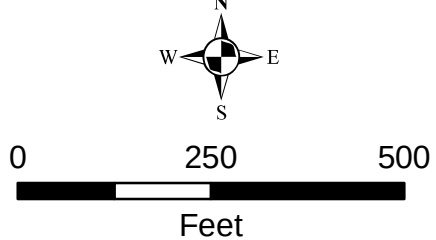
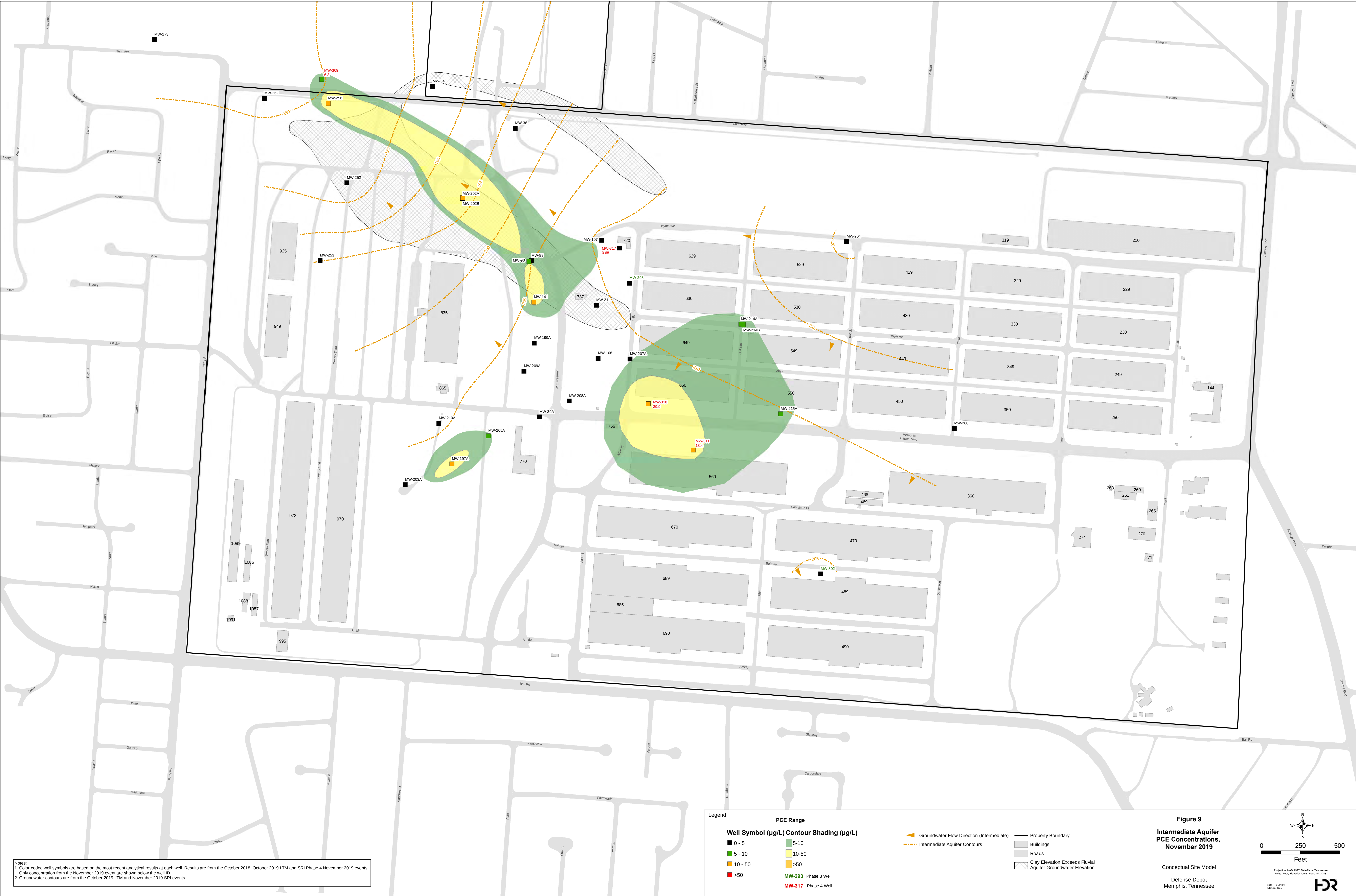


Figure 8
Fluvial Deposits Aquifer
TCE Concentrations,
November 2019

Conceptual Site Model
Defense Depot
Memphis, Tennessee

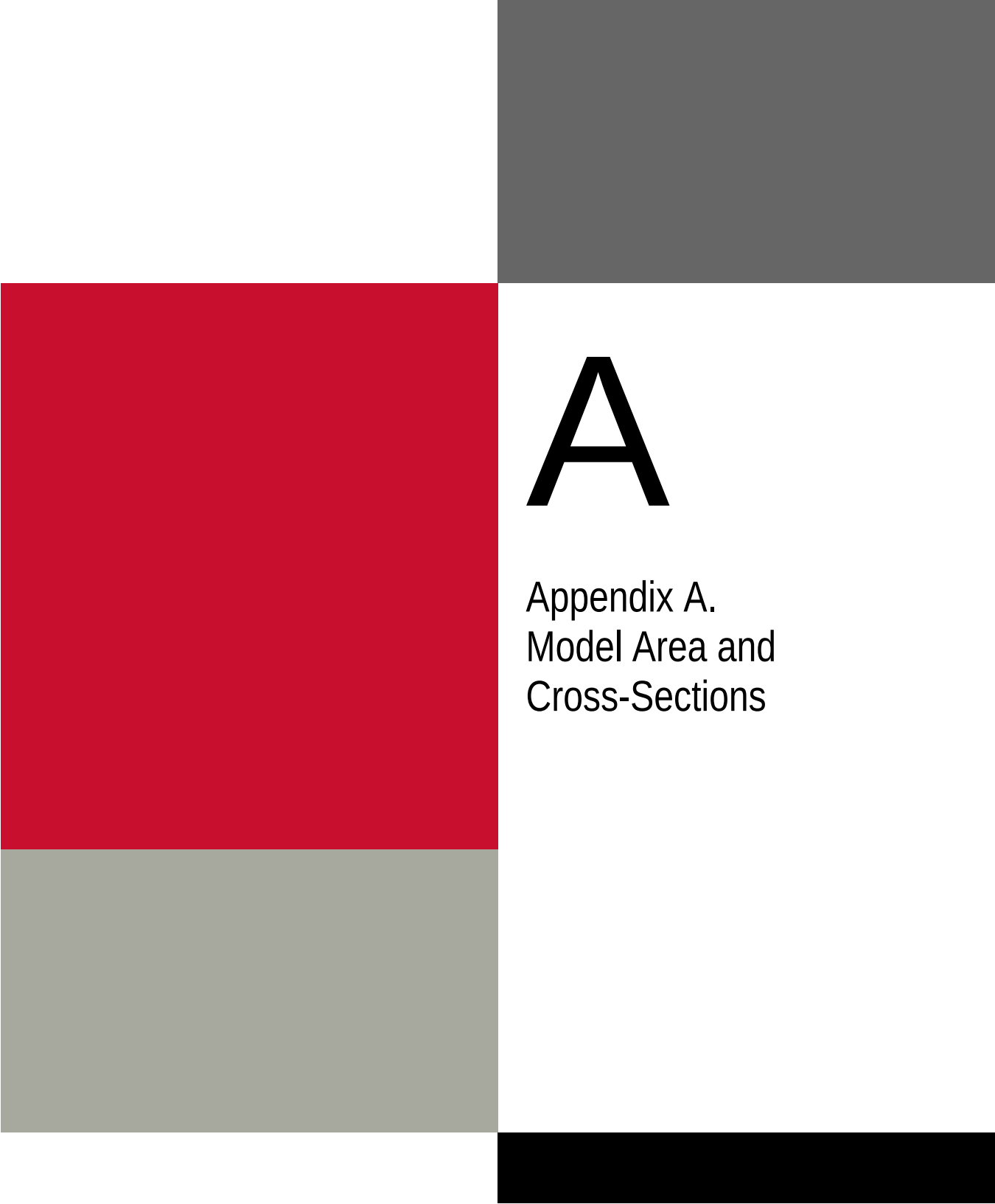


Notes:
1. Color-coded well symbols are based on the most recent analytical results at each well. Results are from the October 2018, October 2019 LTM and SRI Phase 4 November 2019 events.
2. Only concentration from the November 2019 event are shown below the well ID.
3. Groundwater contours are from the October 2019 LTM and November 2019 SRI events.



Notes:
1. Color-coded well symbols are based on the most recent analytical results at each well. Results are from the October 2018, October 2019 LTM and SRI Phase 4 November 2019 events.
2. Only concentration from the November 2019 event are shown below the well ID.
3. Groundwater contours are from the October 2019 LTM and November 2019 SRI events.

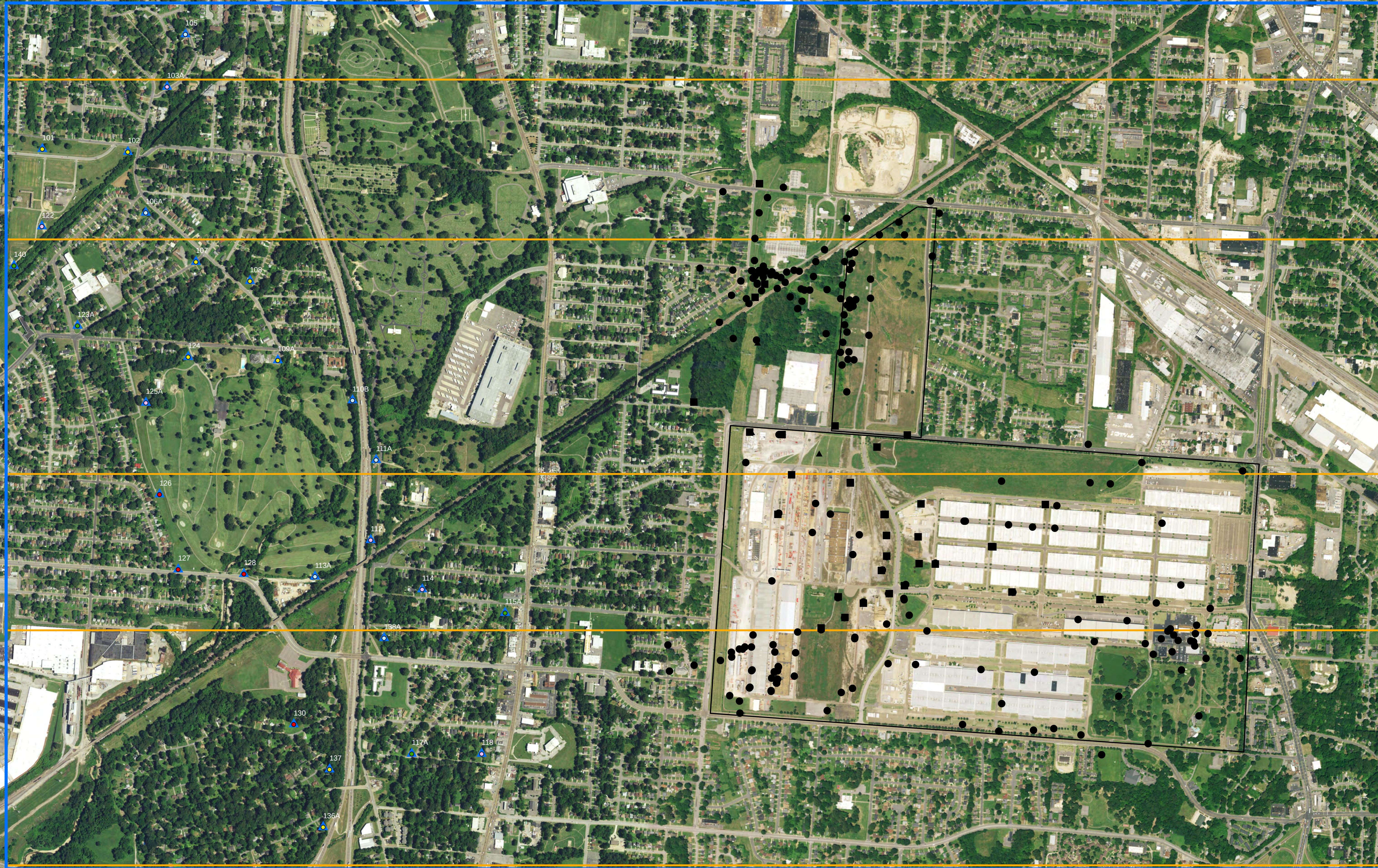


A decorative graphic on the left side of the page consists of a large red rectangle, a smaller grey rectangle above it, a larger grey rectangle below it, and a black rectangle at the bottom right.

A

Appendix A. Model Area and Cross-Sections

Path: W:\CSM\GIS\A1-CrossSectionLocations.mxd



- Legend**
- Memphis Aquifer Well
 - Intermediate/Upper Claiborne Well
 - Fluvial Aquifer Well
 - Cross Section Location
 - Model Boundary
 - Property Boundary

- MLGW Water Supply Well**
- 20+ Years
 - 10+ Years
 - Less than 10 Years
 - Current Failure
 - Abandoned

Figure A-1
Model Boundary and Cross Section Locations
Conceptual Site Model
Main Installation
Defense Depot
Memphis, Tennessee

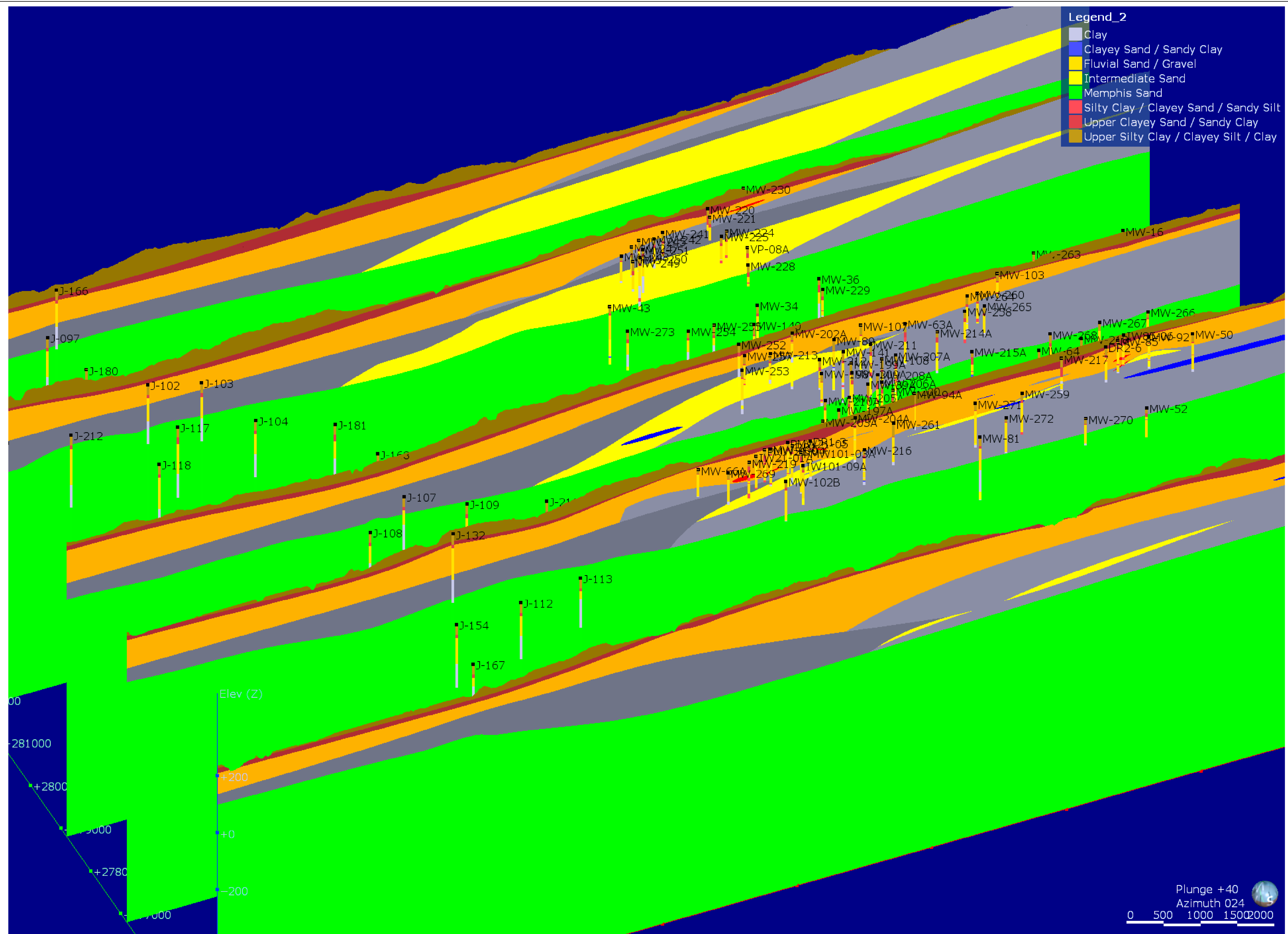
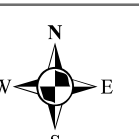


Figure A-2

Cross Sections

Conceptual Site Model

Main Installation
Defense Depot
Memphis, Tennessee



Project: NAD 1927 StatePlane Tennessee
Units: Feet, Elevation Units: Feet, NAVD83
Date: 9/28/2017
Station: 10000000