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Subject: Revised Final Technical Letter Report
Former City Lagoon No. 3 Site
Camdenton, MO

This Revised Final Technical Letter Report (Report) presents a summary of the soil gas investigation conducted pursuant to the Soil Gas Investigation Work Plan (Work Plan), revised December 22, 2017 and approved by Missouri Department of Natural Resources (MDNR) on January 3, 2018 (Work Plan). The Report includes an evaluation of the vapor intrusion (VI) pathway using multiple lines of evidence and an updated conceptual site model (CSM) for the former City Lagoon No. 3 Site in Camdenton, MO (former lagoon), as required by the Work Plan. The Report and CSM, originally submitted to MDNR on November 8, 2019, have been revised to address comments from the Missouri Geological Survey (MGS).

Background

In August 2017, MDNR asked Hamilton Sundstrand to determine if the former lagoon could be a potential source of volatile organic compound (VOC) vapors. The Work Plan presents the procedures for evaluating the nature and extent of VOC vapors in and around the former lagoon and for determining whether additional investigation of the vapor intrusion (VI) pathway is needed.

2018-2019 Soil Gas Investigation

Soil gas probes required by the Work Plan were installed and sampled in February and May 2018 at the locations shown in Figure 1. Three additional rounds of soil gas sampling were conducted in August and November 2018, and July 2019, at the locations shown in **Figure 1**. Soil gas probes GP-01S/D through GP-24S/D were installed around the perimeter of the former lagoon and sampled in February 2018 (Phase I) and step-out soil gas probes GP-28S through GP-52S were installed and sampled in May 2018 (Phase II).

Where the depth to bedrock was sufficiently deep, soil gas probes were installed at nominal depths of 5 feet (shallow) and 10 feet (deep). In several areas, particularly along the west side of the former lagoon near the bottom of the valley, the depth to bedrock was too shallow for deep probes and, in the case of step-out wells, too shallow for any probes. In these cases, step-out probe locations were moved further uphill toward the northwest (GP-42S, 43S, 44S) and west (GP-51S, 52S).

Soil gas sample collection was attempted at 26 soil gas monitoring probes during the three subsequent monitoring events (August 2018, November 2018, and July 2019); of these, 23 sampling locations were sampled at least two times and 14 sampling locations were sampled at least three times (**Figure 1**). Soil gas samples could not be collected in certain probes and times during the investigation because water was present in the probes due to high levels of precipitation, which resulted in wet ground conditions, or the soil was too tight to produce sufficient vapor for sampling.

More details regarding the probe installation and sampling procedures are provided in the Soil Gas Investigation Report (AECOM, July 2018), and in the subsequent soil gas monitoring event memoranda (Geosyntec, October 22, 2018, January 3, 2019, and September 26, 2019) (Technical Memoranda).

Summary of Soil Gas Sampling Results

The results of soil gas sampling over the four monitoring events are presented in the Soil Gas Investigation Report (AECOM, 2018) and the three subsequent Technical Memoranda, and are also summarized on Table 1 and Figure 1. Trichloroethene (TCE) was the only VOC detected above its U.S. Environmental Protection Agency (US EPA) residential soil gas Vapor Intrusion Screening Level (VISL). TCE was detected above the VISL of 70 $\mu g/m^3$ in six of the probes installed around the perimeter of the former lagoon during Phase I (GP-8S, GP10S, GP10D, GP12S, GP-15S, and GP-16S), generally located on the western side of the former lagoon. TCE was below the VISL and frequently not detected in all probes located on the eastern side of the former lagoon. As anticipated based on the initial CSM, TCE concentrations decreased with distance from the former lagoon. TCE was either not detected or below the VISL in all step-out (Phase II) probes, except for two probes located southwest of the former lagoon (GP-30D, GP-50S).

Soil gas samples were collected after installation and during three subsequent sampling events to evaluate the variability in VOC concentrations over time. While TCE concentrations varied to some degree over time, as expected, all sampled locations where concentrations were below the VISL during the first sampling event remained below the VISL during the subsequent three sampling events (see Figure 1). No buildings were within 100 feet of any probes where TCE

was above the VISL during any sampling event except the building at Property No. 23 (near GP-50S), where four quarters of indoor air testing by CH2M Hill resulted in no VOC detections above health-based levels or project specific action levels (CH2M Hill, 2017).

Eight soil gas sampling locations had TCE detections from three or more sampling events. For these locations, the minimum and maximum TCE detections varied by a factor of 2 to 170, with the largest variations in measurements observed at GP-15S, near the northwest corner of the former lagoon. This variation, however, was due to substantial decreases in TCE concentration over time, rather than increases (see Table 1). In general, there doesn't appear to be a strong seasonal or temporal signature to the concentrations results. The highest soil gas TCE concentrations were observed during the first or second sampling events (February/May and August 2018) and lower concentrations were observed during the third and fourth sampling events (November 2018 and July 2019).

In addition to TCE, tetrachloroethene (PCE), cDCE, and trans-1,2-dichloroethene (tDCE) were detected at one or more locations during the soil gas investigation. PCE was detected at 10 locations, cDCE detected at two locations, and tDCE detected at one location, all at relatively low concentrations and below their respective residential soil gas VISLs.

Updated Conceptual Site Model

The Work Plan presents an initial VI CSM based on information available at the time. Data gaps identified by the initial CSM included the nature and magnitude of VOC concentrations in soil gas around the former lagoon, the extent of VOC lateral migration in soil gas from the lagoon, and extent of the VI inclusion zone, i.e., whether any occupied buildings were potentially impacted by VOCs in soil gas from the former lagoon.

The soil gas investigation conducted pursuant to the Work Plan successfully addressed these data gaps, as discussed above. The data indicate the nature and extent of VOC concentrations in soil gas around the former lagoon, and the extent of VOC (i.e., TCE) concentrations above the residential VISL. The potential for VI impacts in surrounding residential buildings is evaluated below, based on a multiple lines of evidence evaluation, as required by the Work Plan.

The CSM was updated based on the results of the soil gas investigation, as presented in Attachment A, including an updated discussion of the nature and extent of VOC concentrations in soil gas around the former lagoon and the observed temporal variability of concentrations over time.

Multiple Lines of Evidence Evaluation

The potential for VI to occur in any specific building is commonly addressed through an evaluation of multiple lines of evidence (e.g., US EPA, 2015; ITRC, 2007), as required by the

Work Plan. These lines include evidence of a source of the VOCs of concern, evidence of a completed pathway between the source and the building interior, and evidence that indoor air concentrations of VOCs, if any, are at levels of concern and due to VI rather than background sources. An evaluation of these lines of evidence is presented below.

Vapor Source:

The soil gas investigation results show that VOCs are present in soil gas near the former lagoon, likely due to partitioning of the VOCs from residual levels of contamination in geologic materials within the former lagoon footprint. TCE is the only VOC that was detected above the VISL. Therefore, this line of evidence indicates that further evaluation of the potential for VI due to TCE migration in soil gas is warranted, as discussed below.

Subsurface Migration Pathway:

The results of the soil gas investigation indicate that TCE is diffusing in soil gas beyond the edges of the former lagoon. TCE concentrations decrease with distance from the former lagoon (as expected, since diffusion is driven by concentration gradients). Specifically,

- TCE soil gas concentrations detected above VISLs are limited to the western and southwestern portions of the former lagoon and tend to decrease with distance from the former lagoon.
- TCE soil gas concentrations were below the VISL during all sampling events (when soil gas could be collected) in all soil gas probes within 100 feet of residential buildings, except GP-50S (see below).
- Although TCE soil gas concentrations varied over the four sampling events, the extent of TCE concentrations above the VISL did not increase over time, indicating a stable soil gas plume that will reduce in magnitude and extent over time due to natural depletion processes.
- Limited VOC migration in the soil is consistent with the prevalence of moist plastic clays with silts and sands ("fine-grained soils") comprising the shallow (5 to 10 feet below ground surface) deposits adjacent to the former lagoon (AECOM, 2020). Locations to the south and north of the former lagoon contain the same fine-grained deposits in the upper 5 to 15 feet of the soil strata. These soils typically have lower coefficients of diffusion due to smaller pore sizes and higher natural moisture contents than coarser-grained soil (EPA, 2017).
- Localized layers of silt, sand and gravel observed in some locations and depths in the soil are not continuous between the former lagoon and the areas with buildings, and would not significantly affect the overall rate of VOC diffusion from the former lagoon.

- Intermittent saturated conditions in shallow soils in some locations (e.g., during and following periods of heavy precipitation), which can reduce or even inhibit VOC migration in soil gas (Hers et al., 2002; McHugh and McAlary, 2009; Shen et al., 2013).
- No atypical pathways (e.g., open conduits connecting sources with building structures) have been identified at the former lagoon.

Based on the results of the soil gas investigation, no completed pathway between the former lagoon source area and surrounding buildings is observed, except potentially at Property No. 23 near GP-50S, as discussed below.

Building Data:

As discussed above, where TCE was detected above the VISL during one event (May 2018) in GP-50S, approximately 50 feet from the building at Property No. 23. Soil gas samples collected by others during a previous investigation at Property No. 23 also showed detections of TCE above the residential soil gas VISL, approximately 20 feet to the south and southeast of the building (CH2M Hill, 2017). Quarterly indoor air and crawl space air sampling conducted in 2016 and 2017 by CH2M Hill showed that TCE concentrations were below action levels; therefore, this building was removed from the VI evaluation program as approved by MDNR (CH2M Hill, 2019).

Conclusion of the Multiple Lines of Evidence Evaluation:

Based on the lines of evidence presented above, the VI pathway between the former lagoon and surrounding buildings is not complete; therefore, further investigation of the VI pathway at former lagoon is not necessary.

Closing

We appreciate the opportunity present these data and the results of our evaluation pursuant to the Work Plan. Please do not hesitate to contact me if you have any questions.

Sincerely,
Geosyntec Consultants, Inc.

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Attachments:

Reference List
Table 1
Figure 1
Attachment A – Updated CSM

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Table 1
Laboratory Results From Soil Gas Sampling Program
City Lagoon #3
Camdenton, Missouri

Probe Designation	Sample Date	CVOC Concentration [µg/m³]						Mobile or Fixed Sample	Comments
		PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	Vinyl Chloride		
EPA R6 VISL		*1400*	*70*	*NA*	*NA*	*7000*	*56*		
GP-01S	2/13/2018	5.1	5.4	6.2	7.1	5.8	4	M	
	8/27/2018	1.5	2.1	1.5	1.4	1.9	1.2	F	
	11/5/2018	NS	NS	NS	NS	NS	NS	NS	
	7/24/2019	NS	NS	NS	NS	NS	NS	NS	
GP-03S	2/14/2018	5.1	5.4	6.2	7.1	5.8	4	M	
	8/27/2018	1.6	2.3	1.6	1.5	2	1.3	F	
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/24/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-08S	2/15/2018	5.1	**2,600**	6.2	7.1	5.8	4	M	
	8/30/2018	**4.7**	**2,000**	1	1.4	1.7	1.7	F	
	8/30/2018	**4.9**	**2,200**	1.1	1.5	1.8	1.8	F	DUP01
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	1.6	**32**	2.3	3.2	1.9	0.78	F	
GP-10S	2/15/2018	5.1	**4,800**	6.2	7.1	5.8	4	M	
	8/30/2018	3.4	**1,300**	1.1	1.5	1.8	1.8	F	
	8/30/2018	1.8	**490**	1.1	1.5	1.8	1.8	F	DUP02
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	**4.2**	**1,200**	2.3	3.1	1.9	0.77	F	
GP-10D	2/15/2018	**6.7**	**29,000**	**14**	7.1	5.8	4	M	
	8/30/2018	23	**28,000**	23	31	38	38	F	
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-12S	2/16/2018	43	**68,000**	**380**	76	62	19	F	
	8/30/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	**4**	**5,600**	**34**	**4.7**	2	0.82	F	
GP-15S	2/16/2018	5.1	**310**	6.2	7.1	5.8	4	M	
	8/28/2018	1.8	**1.8**	1.1	1.5	1.8	1.8	F	
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	1.6	0.87	2.2	3	1.9	0.75	F	
	7/25/2019	1.6	**1.9**	2.3	3.2	1.9	0.78	F	DUP02
GP-16S	2/16/2018	5.1	**330**	6.2	7.1	5.8	4	M	
	8/31/2018	1.5	2.1	1.5	1.4	1.9	1.2	F	
	8/31/2018	1.5	2.2	1.5	1.4	1.9	1.2	F	DUP03
	11/6/2018	1.7	**110**	1.1	1.5	1.8	1.8	F	
	11/6/2018	1.2	**70**	0.99	2.1	1.7	0.51	F	DUP01
	7/25/2019	1.7	0.93	2.4	3.2	2	0.8	F	
GP-19D	2/17/2018	5.1	**31**	6.2	7.1	5.8	4	M	
	8/27/2018	1.5	2.2	1.5	1.4	1.8	1.8	F	
	11/5/2018	1.7	1.1	1.1	1.5	1.8	1.8	F	
	7/23/2019	3.5	2.5	1.4	1.5	2.2	1.3	F	
GP-22S	2/17/2018	5.1	**41**	6.2	7.1	5.8	4	M	
	8/27/2018	1.5	2.2	1.5	1.4	1.9	1.2	F	
	11/5/2018	1.6	1	1	1.4	1.7	1.7	F	
	7/23/2019	3.6	2.6	1.5	1.6	2.3	1.3	F	
GP-30D	5/8/2018	**1.7**	**830**	1.5	1.4	1.9	1.2	F	
	8/30/2018	**4.3**	**1,500**	1.2	1.6	2	2	F	
	11/6/2018	1.9	**460**	1.2	1.6	2	2	F	
	7/24/2019	3.4	**940**	1.4	1.5	2.2	1.3	F	
GP-33SR	5/11/2018	5.1	5.4	6.2	7.1	5.8	4	M	Filter pack to 3.5 ft bgs
	8/27/2018	1.2	2.7	0.84	1.6	2.3	0.81	M	
	11/5/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/24/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-34S	5/8/2018	1.7	**37**	1.7	1.6	2.1	1.4	F	
	8/27/2018	1.6	2.2	1.5	1.4	1.9	1.2	F	
	11/5/2018	1.6	1	1	1.4	1.7	1.7	F	
	7/24/2019	3.5	**5.3**	1.4	1.5	2.2	1.3	F	
GP-35SR	5/11/2018	1.5	2.2	1.5	1.4	1.9	1.2	F	Filter pack to 3.0 ft bgs
	8/30/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	11/5/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/24/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-36S	5/9/2018	1.5	**3**	1.4	1.4	1.8	1.2	F	
	8/28/2018	1.2	**3.9**	0.83	1.6	2.3	0.81	F	
	11/7/2018	1.1	1.2	0.96	2	1.6	0.49	F	
	7/25/2019	1.8	**3.3**	2.5	3.4	2.1	0.84	F	
GP-37S	5/9/2018	5.1	5.4	6.2	7.1	5.8	4	M	
	8/29/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	11/7/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-38SR	5/14/2018	NS	NS	NS	NS	NS	NS	NS	Filter pack to 4.0 ft bgs High vacuum
	8/30/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	11/7/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.

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Camdenton, Missouri

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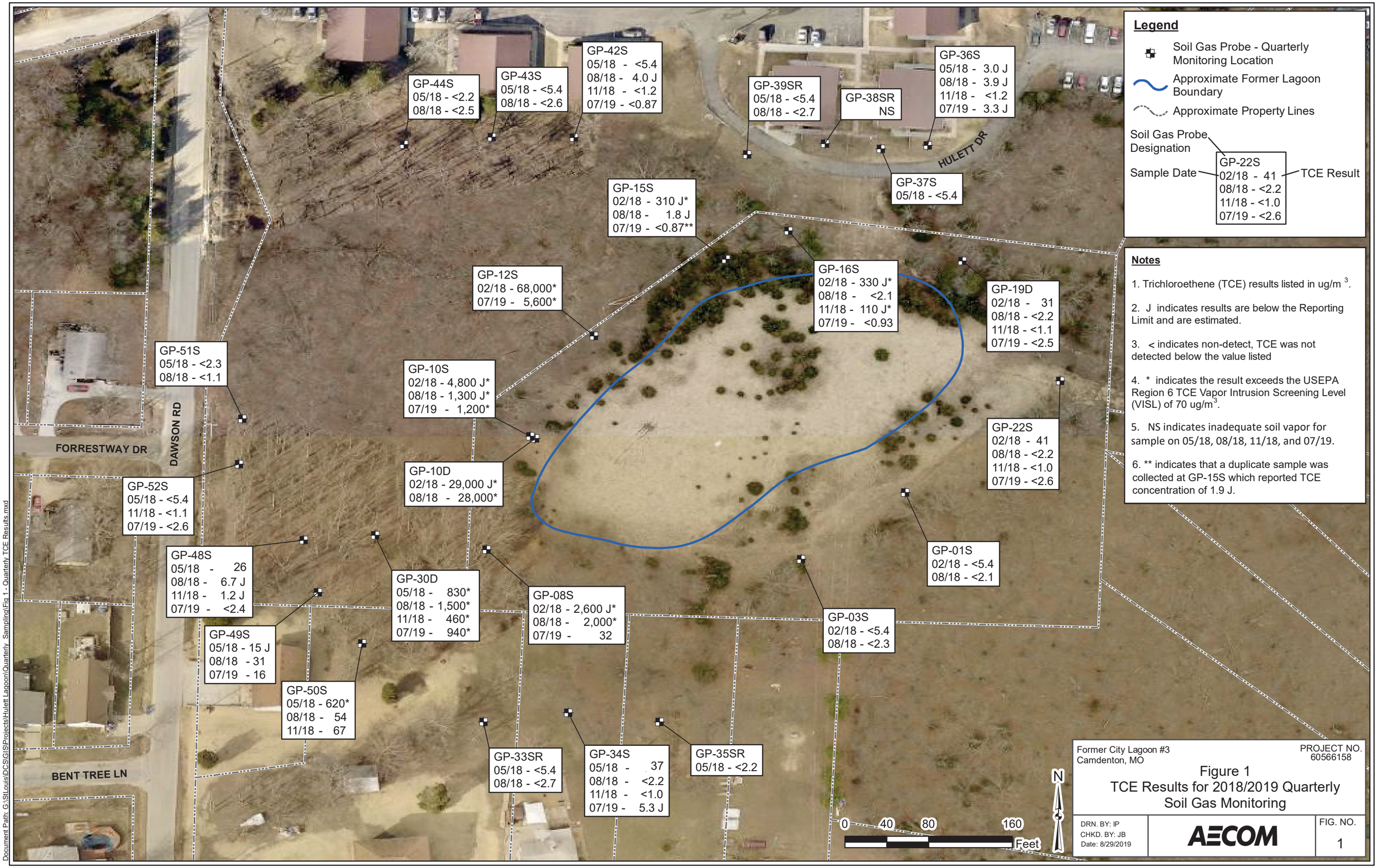
		PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	1,1-DCE	Vinyl Chloride		
EPA R6 VISL		*1400*	*70*	*NA*	*NA*	*7000*	*56*		
GP-39SR	5/11/2018	5.1	5.4	6.2	7.1	5.8	4	M	Filter pack to 3.5 ft bgs
	8/28/2018	1.2	2.7	0.83	1.6	2.3	0.81	F	
	11/7/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-42S	5/9/2018	5.1	5.4	6.2	7.1	5.8	4	M	
	8/28/2018	**1.6**	**4**	0.8	1.5	2.2	0.78	F	
	11/7/2018	1.2	1.2	0.98	2	1.7	0.5	F	
	11/7/2018	1.1	1.1	0.91	1.9	1.5	0.47	F	DUP02
	7/25/2019	1.6	0.87	2.2	3	1.9	0.75	F	
GP-43S	5/9/2018	5.1	5.4	6.2	7.1	5.8	4	M	
	8/28/2018	1.2	2.6	0.82	1.5	2.3	0.8	F	
	11/7/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-44S	5/9/2018	1.5	2.2	1.5	1.4	1.9	1.2	F	
	8/28/2018	1.2	2.5	0.78	1.5	2.1	0.75	F	
	11/7/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/25/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-48S	5/10/2018	1.5	**26**	1.5	1.4	1.9	1.2	F	
	8/27/2018	**3.6**	**6.7**	**1**	1.5	2.2	0.79	F	
	11/6/2018	1.7	**1.2**	1.1	1.5	1.8	1.8	F	
	7/24/2019	3.4	2.4	1.4	1.5	2.2	1.3	F	
GP-49S	5/10/2018	5.1	**15**	6.2	7.1	5.8	4	M	
	8/27/2018	**2.1**	**31**	0.87	1.6	2.4	0.84	F	
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/24/2019	3.4	**16**	1.4	1.5	2.2	1.3	F	
GP-50S	5/11/2018	**2.6**	**620**	1.5	1.4	1.9	1.2	F	
	8/27/2018	1.2	**54**	0.84	1.6	2.3	0.81	F	
	11/6/2018	1.8	**67**	1.1	1.5	1.8	1.8	F	
	7/24/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-51S	5/11/2018	**1.7**	2.3	1.6	1.5	2	1.3	F	
	8/29/2018	1.8	1.1	1.2	1.6	1.9	1.9	F	
	11/6/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	7/24/2019	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
GP-52S	5/11/2018	5.1	5.4	6.2	7.1	5.8	4	M	
	8/29/2018	NS	NS	NS	NS	NS	NS	NS	Insufficient gas for sample.
	11/6/2018	1.7	1.1	1.1	1.5	1.8	1.8	F	
	7/24/2019	3.6	2.6	1.5	1.6	2.3	1.4	F	
	7/24/2019	3.6	2.6	1.5	1.6	2.3	1.3	F	DUP01

Notes
Bold results indicate detection above reporting limit
Highlighted results indicate detection above EPA Region 6 Vapor Intrusion Screening Level (VISL)
NS = Not sampled
M = Analysis by mobile laboratory
F = Analysis by fixed laboratory


GP-44S
05/18 - <2.2
08/18 - <2.5
GP-43S
05/18 - <5.4
08/18 - <2.6
GP-42S
05/18 - <5.4
08/18 - 4.0 J
11/18 - <1.2
07/19 - <0.87
GP-39SR
05/18 - <5.4
08/18 - <2.7
GP-38SR
NS
GP-36S
05/18 - 3.0 J
08/18 - 3.9 J
11/18 - <1.2
07/19 - 3.3 J
HULETT DR
GP-37S
05/18 - <5.4
GP-15S
02/18 - 310 J*
08/18 - 1.8 J
07/19 - <0.87**
GP-16S
02/18 - 330 J*
08/18 - <2.1
11/18 - 110 J*
07/19 - <0.93
GP-19D
02/18 - 31
08/18 - <2.2
11/18 - <1.1
07/19 - <2.5
GP-12S
02/18 - 68,000*
07/19 - 5,600*
GP-51S
05/18 - <2.3
08/18 - <1.1
GP-10S
02/18 - 4,800 J*
08/18 - 1,300 J*
07/19 - 1,200*
GP-22S
02/18 - 41
08/18 - <2.2
11/18 - <1.0
07/19 - <2.6
FORRESTWAY DR
DAWSON RD
GP-10D
02/18 - 29,000 J*
08/18 - 28,000*
GP-52S
05/18 - <5.4
11/18 - <1.1
07/19 - <2.6
GP-01S
02/18 - <5.4
08/18 - <2.1
GP-48S
05/18 - 26
08/18 - 6.7 J
11/18 - 1.2 J
07/19 - <2.4
GP-30D
05/18 - 830*
08/18 - 1,500*
11/18 - 460*
07/19 - 940*
GP-08S
02/18 - 2,600 J*
08/18 - 2,000*
07/19 - 32
GP-03S
02/18 - <5.4
08/18 - <2.3
GP-49S
05/18 - 15 J
08/18 - 31
07/19 - 16
GP-50S
05/18 - 620*
08/18 - 54
11/18 - 67
GP-33SR
05/18 - <5.4
08/18 - <2.7
GP-34S
05/18 - 37
08/18 - <2.2
11/18 - <1.0
07/19 - 5.3 J
GP-35SR
05/18 - <2.2
BENT TREE LN
0 40 80 160
Feet
N
Legend
Soil Gas Probe - Quarterly Monitoring Location
Approximate Former Lagoon Boundary
Approximate Property Lines
Soil Gas Probe Designation
Sample Date
TCE Result
GP-22S
02/18 - 41
08/18 - <2.2
11/18 - <1.0
07/19 - <2.6
Notes
1. Trichloroethene (TCE) results listed in ug/m 3.
2. J indicates results are below the Reporting Limit and are estimated.
3. < indicates non-detect, TCE was not detected below the value listed
4. * indicates the result exceeds the USEPA Region 6 TCE Vapor Intrusion Screening Level (VISL) of 70 ug/m3.
5. NS indicates inadequate soil vapor for sample on 05/18, 08/18, 11/18, and 07/19.
6. ** indicates that a duplicate sample was collected at GP-15S which reported TCE concentration of 1.9 J.
Former City Lagoon #3
Camdenton, MO
PROJECT NO.
60566158
Figure 1
TCE Results for 2018/2019 Quarterly Soil Gas Monitoring
DRN. BY: IP
CHKD. BY: JB
Date: 8/29/2019
AECOM
FIG. NO.
1
Document Path: G:\StLouis\DCS\GIS\Projects\Hulett Lagoon\Quarterly_Sampling\Fig 1 - Quarterly TCE Results.mxd

APPENDIX A

UPDATED CONCEPTUAL SITE MODEL

FORMER CITY LAGOON NO.3 SITE

April 2020

Table of Contents

1. INTRODUCTION 1
   1.1 Site Setting 1
   1.2 Former Lagoon Operations and Decommissioning 3
2. POTENTIAL SOURCES OF VOCS AT THE FORMER LAGOON 3
   2.1 VOCs in Soil 3
   2.2 VOCs in Bedrock 4
   2.3 VOCs in Groundwater 4
   2.4 VOCs in Soil Gas 4
3. VOC MIGRATION PATHWAYS AND MECHANISMS 5
   3.1 VOC Source Zone 5
   3.2 VOC Migration in the Vadose Zone 6
   3.3 VOC Migration into Buildings 8
   3.4 Preferential Pathways 9
   3.5 Temporal Variability 9
4. POTENTIAL RECEPTORS 10
5. REFERENCES 11

List of Figures

A-1 Location Map

A-2 Conceptual Cross-Section

A-3 Results of Soil Investigations at Former Hulett Lagoon

A-4 TCE Results for 2018/2019 Quarterly Soil Gas Monitoring

1. INTRODUCTION

This document presents an updated vapor intrusion (VI) conceptual site model (CSM) for the former Hulett Lagoon, also known as the former City Lagoon No.3 (former lagoon) in Camdenton, Missouri (Figure A-1). A VI CSM provides a general description of the source(s) of volatile organic compounds (VOCs) that may be present in soil gas, the potential soil gas migration pathways and transport mechanisms, the potential for VOCs in soil gas to enter existing or future buildings, and the potential receptors (EPA, 2015, ITRC, 2007). The initial CSM for the former lagoon site, dated October 18, 2017, was based on information available at the time and identified certain data gaps that were addressed by the 2018-2019 soil gas investigation conducted by AECOM around the former lagoon, as summarized in the Final Technical Letter Report (Final Report). The CSM was updated in November 2019 based on the results of the soil gas investigation, which included four rounds of soil gas sampling over a period of approximately 17 months. The current CSM was updated based on comments provided by the Missouri Department of Natural Resources (MDNR) on the November 2019 Final Report and CSM, and additional information on soils in the area of the former lagoon (AECOM, 2020).

The following subsections describe the former lagoon setting and historic lagoon operations and decommissioning. Subsequent sections describe the potential sources of VOCs that may be present in soil gas at the former lagoon (Section 2), potential VOC migration pathways in the vadose zone (Section 3), potential receptors of any VOC vapors from the former lagoon (Section 4), and references (Section 5).

1.1 Site Setting

The site of the former lagoon is located within a low-lying, wooded area approximately 1000 feet northeast of the former manufacturing facility at 221 Sunset Drive (the Facility), as shown on Figure A-1. The former lagoon is now an open field covered with grass and a few small trees and shrubs. The current ground surface elevation at the former lagoon is approximately 930 to 940 feet above mean sea level (amsl). The ground surface rises to the north, east, and south of the former lagoon, and declines to the west along a small drainage (Figure A-2).

The former lagoon is underlain by 5 to more than 10 feet of silty to sandy clays and silts ("fine grained soil"), which have developed from weathering of dolomite bedrock, which underlies the fine grained soil in the immediate vicinity of the former lagoon. The soils are less than 5 feet thick or absent along the small drainage west of the former lagoon (AECOM, 2020). The fine

grained soils in the vicinity of the lagoon are primarily moist plastic clays with some interbedded silts and sands in some locations. The soils remain fine grained and increase in thickness as the ground rises to the north (11 feet at MW-16/25) and to the south (12 feet at MW-12 and 35 feet at MW-13/14) of the former lagoon (ibid). In these areas the upper 10-foot portion of the fine grained soils are generally clayey with interbed silts and sands. Soils encountered during installation of the soil gas probes in the vicinity of the former lagoon encountered the same moist, plastic clays observed at well locations, with little to some silt, sand, and gravel. (AECOM, 2020). In some areas, the fine grained soils contain chert nodules and isolated layers of chert.

Some of the soil gas probes would not yield a soil gas sample. These probes were screened in the fine grained soil and although high vacuums were applied, insufficient sample was generated for laboratory analysis. In some instances, the soil gas probe eventually became saturated. This likely reflects a combination of low vapor permeability in the fine grained soil and an accumulation of infiltrating water in more permeable pockets of soil (AECOM, 2018).

Soils in the vicinity of the 221 Sunset Drive site, approximately 600 feet southwest of the former lagoon, vary in thickness from about 15 feet to over 50 feet, and consist of lean clays, sandy clays and silty clays interbedded with sand and silt (greater than 50 percent sand) and chert strata and lenses (CH2M HILL, 2017, 2019). As discussed above, the chert is found at 15 to 25 feet below ground surface (bgs) in discontinuous layers or as isolated nodules. The fine grained soil, which is developed from the weathered dolomite, transitions to bedrock with depth. In one location at 221 Sunset Drive (MW-101/102) gravel (limestone fragments) was encountered at a depth of about 10 to 15 feet (ibid). In some borings below the building at 221 Sunset Drive, one or two rod drops were reported, typically within or near weathered bedrock deposits, indicating the potential for local cavities or karst features (CH2M HILL, 2019). These features were not observed in the soil gas probe borings at the former lagoon.

While the data from 221 Sunset Drive provide more detailed context for the broader geologic setting, the focus of this CSM is to evaluate the potential for TCE impacted soil gas from the former lagoon to represent a risk to nearby residential and commercial structures. The soil gas investigation shows that there is a wide-spread presence of fine grained soil overlying the bedrock in all areas investigated, except the small drainage, which minimizes the overall VOC mass flux in soil gas in the near surface soils where the residential and commercial structures of concern are located.

The first saturated groundwater zone below the former lagoon, encountered in the dolomite bedrock at a depth of approximately 110 feet below ground surface,[1] is described as a sporadic and discontinuous perched zone, hydraulically separated from a deeper, more extensive aquifer located at a depth of approximately 140 to 160 feet in the vicinity of the former lagoon (SECOR, 2008, 2009).

1.2 Former Lagoon Operations and Decommissioning

The former lagoon was an above-grade sewage lagoon with clay berms operated by the City of Camdenton from 1961 through 1989. Wastes from the Facility, including trichloroethene (TCE), were discharged to the former lagoon during a portion of its period of operation. The City decommissioned the former lagoon in 1990 by removing accumulated sludge, removing the inlet and outfall structures, and regrading the former lagoon area using clayey soils from the berms and excavation sidewalls (SECOR 2004, 2008).

2. POTENTIAL SOURCES OF VOCS AT THE FORMER LAGOON

Although the wastewater and sludge that accumulated on the bottom of the former lagoon were removed at the time of decommissioning in 1990, some residual VOCs remain in soil, bedrock, and perched zone groundwater at the former lagoon, as discussed below.

2.1 VOCs in Soil

Soil samples were collected at the former lagoon site by the Missouri Department of Natural Resources (MDNR) and Hamilton Sundstrand in the 1990s and early 2000s, respectively. TCE was detected at 3 of the 25 boring locations, as summarized on Figure A-3 (SECOR, 2003). TCE and 1,2-cis-dichloroethene (cDCE), a breakdown product of TCE, were detected in the soil at concentrations ranging from 240 to 9,500 parts per billion (ppb) and 140 to 650 ppb, respectively, at depths of ranging from 4 to 9 feet bgs. The distribution of TCE on Figure A-3 is consistent with the results of the soil gas investigations, which indicate low to non-detectable concentrations of TCE in soil gas on the east and north sides of the former lagoon, and higher levels on the west side and south sides of the former lagoon (see Section 2.4).

These data suggest that some TCE-contaminated soil may have been mixed with clean soil during regrading of the former lagoon. No soil remedial action was considered necessary at the

[1] Groundwater elevations in perched zone wells have typically ranged from 817 to 828 feet amsl at and in the vicinity of the former lagoon (SECOR, 2004).

time, based on the above soil sample results (SECOR, 2003); nevertheless, small pockets of contaminated soil on the west and south sides of the former lagoon appear to act as local sources of TCE and cDCE in the soil gas phase.

2.2 VOCs in Bedrock

Wastewater may have seeped from the former lagoon during its period of operation, potentially resulting in residual levels of TCE and cDCE in the underlying bedrock that could act as sources of TCE and cDCE to soil gas in the vadose zone in the vicinity of the former lagoon.

2.3 VOCs in Groundwater

Seepage of wastewater from the former lagoon may have impacted groundwater in the perched zone at a depth of approximately 110 feet bgs. Between 2006 and 2008, TCE concentrations in perched zone wells on the south side of the former lagoon ranged from 99 to 560 ppb in MW-5 and from 252 to 550 in MW-8, while cDCE was less than 30 ppb in both wells over the same period (Stantec, 2009). TCE and cDCE concentrations in MW-25, on the north side of the former lagoon, ranged from 474 to 1,200 ppb and 29 to 74 ppb from late 2007 through 2008 (ibid). Based on the relatively consistent TCE concentration levels over time, concentrations in perched zone groundwater today are likely of the same order of magnitude. The potential for shallow soil gas impacts, however, is unlikely given the depth of the groundwater and other factors, as discussed in Section 3. The results of the soil gas investigation are consistent with these observations, indicating that VOC concentrations in soil gas are highest on the west and south sides and decrease rapidly with distance from the former lagoon, which is inconsistent with the spatial pattern of VOC concentrations in the perched zone groundwater described above.

2.4 VOCs in Soil Gas

The soil gas investigation shows VOC detections predominantly along the south and west sides of the former lagoon, and limited VOC detections beyond the perimeter of the former lagoon, as shown on Figure A-4. Tetrachloroethene (PCE), TCE, cDCE, and trans-1,2-dichloroethene (tDCE) were detected at one or more locations during the soil gas investigation. PCE was detected at 10 locations, cDCE detected at two locations, and tDCE detected at one location and all at relatively low concentrations. TCE was detected at 15 locations, with eight locations having one or more samples with concentration above the U.S. Environmental Protection Agency (US EPA) residential soil gas Vapor Intrusion Screening Level (VISL) of 70 $\mu g/m^3$. TCE was detected above the VISL of 70 $\mu g/m^3$ in six of the probes installed around the perimeter of the former lagoon during Phase I (GP-8S, GP10S, GP10D, GP12S, GP-15S, and

GP-16S), generally located on the western side of the former lagoon. TCE was below the VISL and frequently not detected in all probes located on the eastern side of the former lagoon. As anticipated based on the initial CSM, TCE concentrations decreased with distance from the former lagoon. TCE was either not detected or below the VISL at all locations beyond the former lagoon perimeter, except for two probes located southwest of the former lagoon (GP-30D, GP-50S).

All sampled locations where concentrations were below the VISL during the first soil gas sampling event remained below the VISL during the subsequent three sampling events (see Figure A-4). While TCE concentrations in soil gas varied to some degree over time, as expected, the extent of TCE in soil gas above the VISL did not increase. Concentrations at all sampled distal (most distant from the former lagoon) monitoring locations remained below the VISL. All soil gas probes within 100 feet of residential buildings were below the VISL during all sampling events, except GP-50S, which is approximately 50 feet from the building at Property No. 23. Similar soil gas concentrations were observed in soil gas probes installed by CH2M Hill near this building; however, four quarters of indoor air testing by CH2M Hill resulted in no VOC detections above health-based levels or project specific action levels as reported by CH2M Hill (2017).

3. VOC MIGRATION PATHWAYS AND MECHANISMS

The following sections describe the potential VI pathway at the former lagoon, including 1) the VOC source zones; 2) the VOC migration pathway in the vadose zone; 3) potential VOC migration pathways into buildings; 4) the potential impacts of preferential pathways on VOC migration, and 5) the potential for temporal variability.

3.1 VOC Source Zone

The results of the soil gas and prior investigations indicate that a few pockets of VOC-impacted[2] soil may be present at the former lagoon (Figure A-3). Some of the VOCs adsorbed to the soil will partition to the soil gas phase, based on their relative affinity to the solid, water, and soil gas

$$C_{source} = \frac{H'_{TS}\, C_R\, \rho_b}{\theta_w + K_d \rho_b + H'_{TS}\, \theta_a} \qquad [1]$$

[2] Although the principal VOC of concern is TCE, and detections in groundwater and soil have generally been limited to TCE and DCE, we will use the more generic VOC term for efficiency.

phases, as well as the recent soil gas investigation results. At equilibrium, the relative concentrations in each phase are described by the following equation (EPA, 2004):

where C_{source} is the soil gas concentration, H'_{TS} is the Henry's Law partition coefficient between the water and gas phase (at the in-situ soil temperature), C_R is the soil concentration, ρ_b is the soil density, θ_w is the water-filled soil porosity, K_d is the soil to water partition coefficient (and equal to K_{OC} x f_{OC}), θ_a is the air-filled soil porosity, K_{OC} is the soil organic carbon partition coefficient, and f_{OC} is the fraction of natural organic carbon in the soil.

3.2 VOC Migration in the Vadose Zone

VOCs principally migrate in the soil gas phase by a process known as diffusion, where the VOC molecules move in the soil gas from areas of high VOC concentration (e.g., the source zone) to areas of low VOC concentration (e.g., areas adjacent to the source zone, or the ground surface). It should be noted that VOC diffusion typically occurs in the subsurface without any significant soil gas movement, although soil gas can flow close to buildings, as discussed below.

The rate of VOC diffusion in soil gas is determined by Fick's Law:

$$E = A\,(C_{source}-C_L)D_{eff}/L \qquad [2]$$

where E is the rate of VOC mass migration due to diffusion, A is the cross-sectional area through which the VOCs are diffusing, C_{source} and C_L are the VOC concentrations in the soil gas at the source and any distance L from the source, and D_{eff} is the effective diffusivity of the soil or bedrock (EPA, 2004). In other words, VOC mass flux across a unit area of soil or bedrock is equal to the VOC concentration gradient times the diffusivity of the soil or bedrock (i.e., its resistance to diffusion).

In general, fine grained soils or bedrock will be more resistant to VOC diffusion and have lower D_{eff} values (EPA, 2017). The soils in the immediate vicinity of the former lagoon where TCE was observed above the soil gas VISL, vary with location and depth, but are predominantly fine grained lean to plastic clay, silty clay, or sandy clay with local deposits of silt, silty sand, and sand and gravel (SECOR, 2003; AECOM, 2020). The exponential decreases in TCE concentrations and numerous instances of high vacuum conditions limiting collection of soil gas samples over relatively short lateral distances from the former lagoon (e.g., on the order of 100 feet) observed during the soil gas investigation are consistent with the predominance of fine grained soils, expected to have low effective diffusivities. The coarser-grained soils, which are

expected to have higher effective diffusivities, are not laterally continuous in the vicinity of the former lagoon, limiting the effect of these deposits on vapor migration.

The intermittent presence of water in soil gas probes during the soil gas investigation also reflects locally saturated soil conditions that would further minimize the rate and extent of soil gas migration. Although more permeable deposits are observed at depth in some areas near 221 Sunset Drive,[3] the soil gas data indicate that TCE has not migrated this far and is unlikely to migrate this distance in the future. If further migration did occur, upward migration of TCE in soil gas would still be limited by the low diffusivity of overlying finer-grained soils.

Similarly, the matrix of the dolomite bedrock likely has small effective (i.e., connected) porosities. Most of the VOC diffusion in bedrock would likely occur through small joints or fractures, which will be more permeable than the intact rock but also represent a smaller cross-sectional area of transport (i.e., the cross-sectional area comprised of fractures will be a small percentage of the total area). Local karst features, where present, would enhance migration of any VOCs across these features, but lateral and upward diffusion beyond these features would again be limited by surrounding or overlying unconsolidated fine grained soil with lower diffusivities. Therefore, relatively slow rates of VOC migration due to diffusion are also expected in the bedrock portion of the vadose zone.

In summary, VOCs in soil gas at the edge of the former lagoon, either in the fine grained soils or in the underlying bedrock, tend to diffuse laterally away from the source materials, and upward toward the ground surface (the shortest distance to areas of lowest concentration), as shown in Figure A-2. Concentrations decrease with distance, according to Fick's Law of Diffusion (no diffusion would occur without a concentration gradient). As a result, VOC concentrations are highest in the former lagoon footprint and decrease rapidly with distance from the former lagoon (see Figure A-4).

Soil gas concentrations (C_{SV}) above dissolved VOCs in the perched zone can be estimated by the following equation (EPA, 2004, 2015):

$$C_{SV} = H'_{TS} C_W \qquad [3]$$

where H'_{TS} is the temperature-dependent Henry's Law Constant, as before, and C_W is the VOC concentration dissolved in groundwater. Note that this equation is not applied to soil moisture or

[3] The more permeable deposits encountered in the shallow deposits above bedrock in the vicinity of the property at 221 Sunset Drive are not consistent or continuous across this area.

pockets of water in the vadose zone above the water table, where soil concentrations may dominate, and Equation 1 should be used.

In most cases, however, soil gas concentrations will reduce substantially above the groundwater table due to diffusion across the capillary fringe (EPA, 2004), so that the VOC concentrations driving diffusion in soil gas through the overlying vadose zone are lower than indicated by Equation 2.

Although EPA (2015) recommends site-specific evaluation of horizontal and vertical screening distances, it notes that groundwater sources deeper than 100 feet are often screened from further VI evaluation (EPA, 2015). This is because distances greater than 100 feet result in smaller diffusion gradients. Low permeability zones and wet intervals observed within the dolomite strata above the perched zone would also reduce the rate of diffusion and potential for VI. This is consistent with the results of VI investigations at several homes, where sub-slab soil gas concentrations were well below the TCE action level for mitigation and commonly below detection (CH2M, 2017a).

3.3 VOC Migration into Buildings

VOCs that migrate from a vapor source to a building may continue to diffuse into the building through cracks or other openings in the foundations (EPA, 2015). In some cases, negative building pressures can cause soil gas to be pulled into the building (ibid). Negative building pressures may occur due to a sudden drop in outdoor barometric pressure, operation of exhaust fans, wind effects, and/or heating of the building during cold weather, also called the “heat stack effect” (ibid).

Indoor air concentrations due to VI are a function of the concentration in the soil gas below the building (e.g., the sub-slab soil gas concentration), the rate of VOC diffusion and/or soil gas flow into the building (i.e., the rate that VOC mass enters the building), and the volume of diluting air over the same time period (i.e., the volume of the building times the air exchange rate). Indoor and outdoor sources of VOCs (background sources) can also contribute to the indoor air concentration (ITRC, 2007, EPA, 2015, and others).

If VOC molecules due to subsurface sources enter a building, EPA (2015) considers the VI pathway to be complete. The resultant VOC concentrations, however, may or may not be above concentrations of concern or require further action (ibid). TCE concentrations in soil gas were above the VISL near one building (Property 23) during the soil gas investigation; the results in four quarters of indoor air testing by CH2M Hill, however, indicated that indoor air

concentrations were below action levels (CH2M Hill, 2019). Soil gas concentrations were below the TCE VISL at all other soil gas probe locations within 100 feet of buildings.

3.4 Preferential Pathways

Preferential pathways are generally considered to be natural or anthropogenic subsurface features that significantly increase the rate of VOC migration (i.e., the mass flux) above rates normally observed (EPA, 2015, ITRC, 2007). Typical underground utilities, such as sanitary sewers and storm sewers, may increase VOC mass flux to some degree, but usually not above rates commonly seen at VI sites (and reflected in empirical databases that support generic screening levels and attenuation factors) (ibid, Folkes, 2016). Of greatest concern are "atypical" preferential pathways that directly connect the source of vapors to buildings by advective pathways that bypass the diffusion component of most VI pathways (Folkes, 2016).

To the extent that geologic features, such as bedrock bedding planes or more permeable strata, enhance horizontal diffusion of vapors beyond the perimeter of the former lagoon, these would not be atypical preferential pathways (to the extent that migration rates and distances would still be within ranges normally observed for higher permeability/diffusivity materials). The potential for smaller scale geologic variability in natural formations was addressed by the close spacing of the soil gas samples; i.e., 50 feet around the former lagoon, and 50 to 100 feet in step-out samples (50 feet closer to buildings). Further, high volume sampling was conducted in two locations indicating no substantial short distance variability in soil gas concentrations.

To the extent that more permeable backfill material is present near the former lagoon, e.g., associated with the former discharge line from the Facility, or other pipelines that may have entered the former lagoon, soil gas may diffuse from the former lagoon along the backfill more readily than in the surrounding native soils. However, the resultant VOC flux and potential impact on buildings, if any, would be limited by the small cross-sectional area of the backfill.

No current atypical pathway (e.g., open conduit) was identified at the former lagoon during the soil gas investigations. Therefore, screening levels and buffer zone distances that are based on upper bound observations from other sites where migration is controlled by diffusion through subsurface materials should still be applicable.

3.5 Temporal Variability

VOC source concentrations, rates of diffusion, rates of soil gas entry into buildings, and degree of dilution within the building can all vary over time, resulting in variations in indoor air

concentrations over time. Some of these variations can occur rapidly over the short term (building ventilation rates and pressure levels), while others tend to have seasonal (temperature) or long term (natural attenuation or remediation of sources) trends.

Based on low permeability/diffusivity soils at the former lagoon, lack of preferential pathways that might result in atypical vapor migration rates, limited temporal variability observed for soil gas concentrations, and the results of VI investigations at several residential homes in the area (CH2M, 2017a), VOC concentrations along the VI pathway are expected to vary within normal ranges and reflect typical seasonal behavior.

No change in the extent of TCE concentrations above the VISL was observed during the four monitoring events, although concentrations within the area above the VISL varied to some degree, as expected. Eight soil gas sampling locations had TCE detections from three or more sampling events. For these locations, the minimum and maximum TCE detections varied by a factor of 2 to 170, with the largest variations in measurements observed at GP-15S, near the northwest corner of the former lagoon. This variation, however, was due to substantial decreases in TCE concentration over time, rather than increases (see Table 1). In general, there doesn't appear to be a strong seasonal or temporal signature to the concentrations results. The highest soil gas TCE concentrations were observed during the first or second sampling events (February/May and August 2018) and lower concentrations were observed during the third and fourth sampling events (November 2018 and July 2019).

4. POTENTIAL RECEPTORS

Multi-family residential buildings are located approximately 150 feet north of the former lagoon boundary, while single-family homes are located approximately 250 feet to the south, 300 feet west, and 200 feet southwest of the former lagoon. Some homes have basements, while others have slab-on-grade and/or crawl-space construction. A number of these structures have already been tested by Modine for VI impacts related to other potential sources of VOCs. The results of these investigations have been submitted to MDNR (e.g., CH2M, 2017a).

Based on the results of the soil gas investigation, none of the residential buildings are impacted by soil gas migration from the former lagoon.

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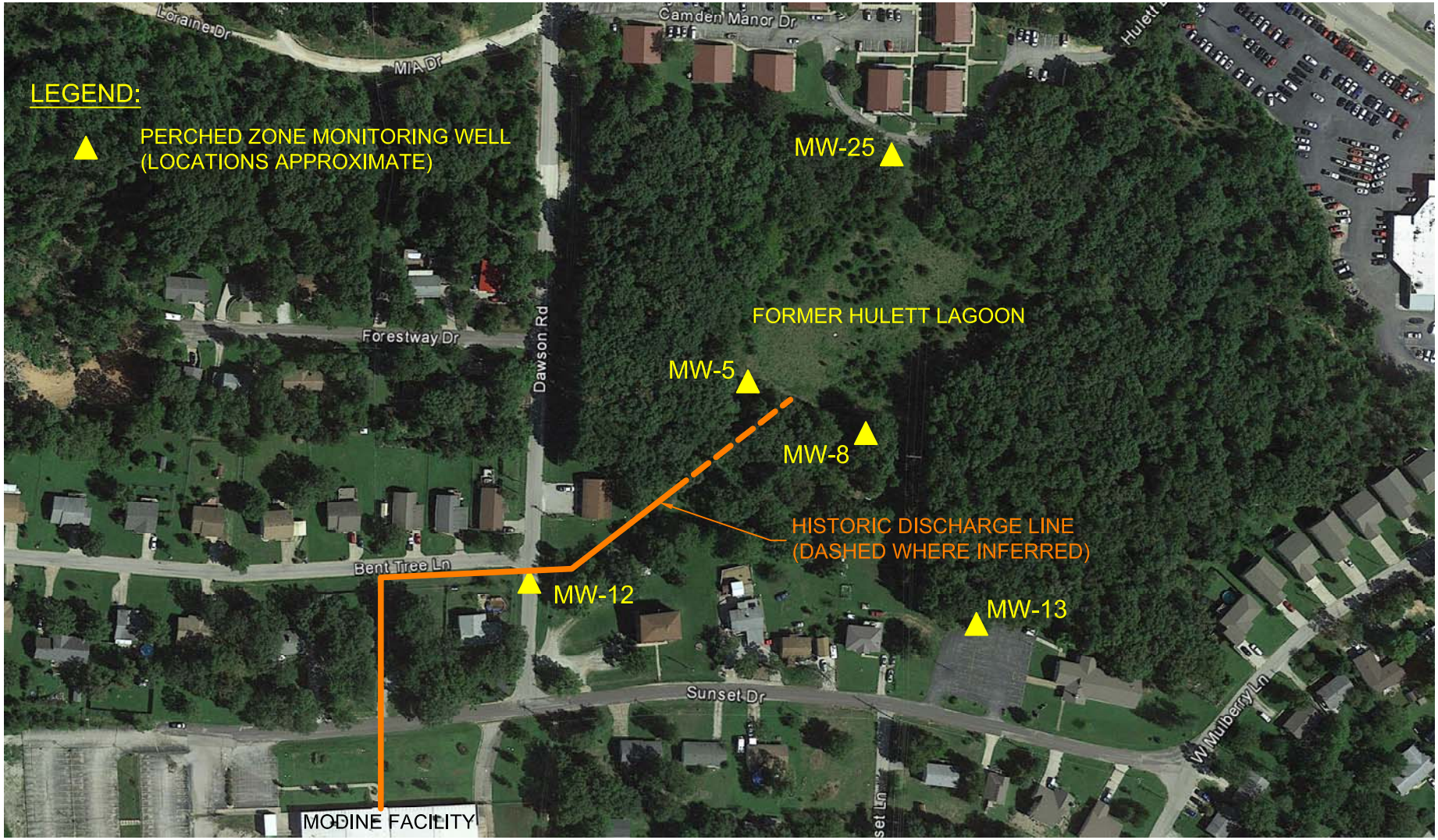


N

0 200' 400'

SCALE IN FEET

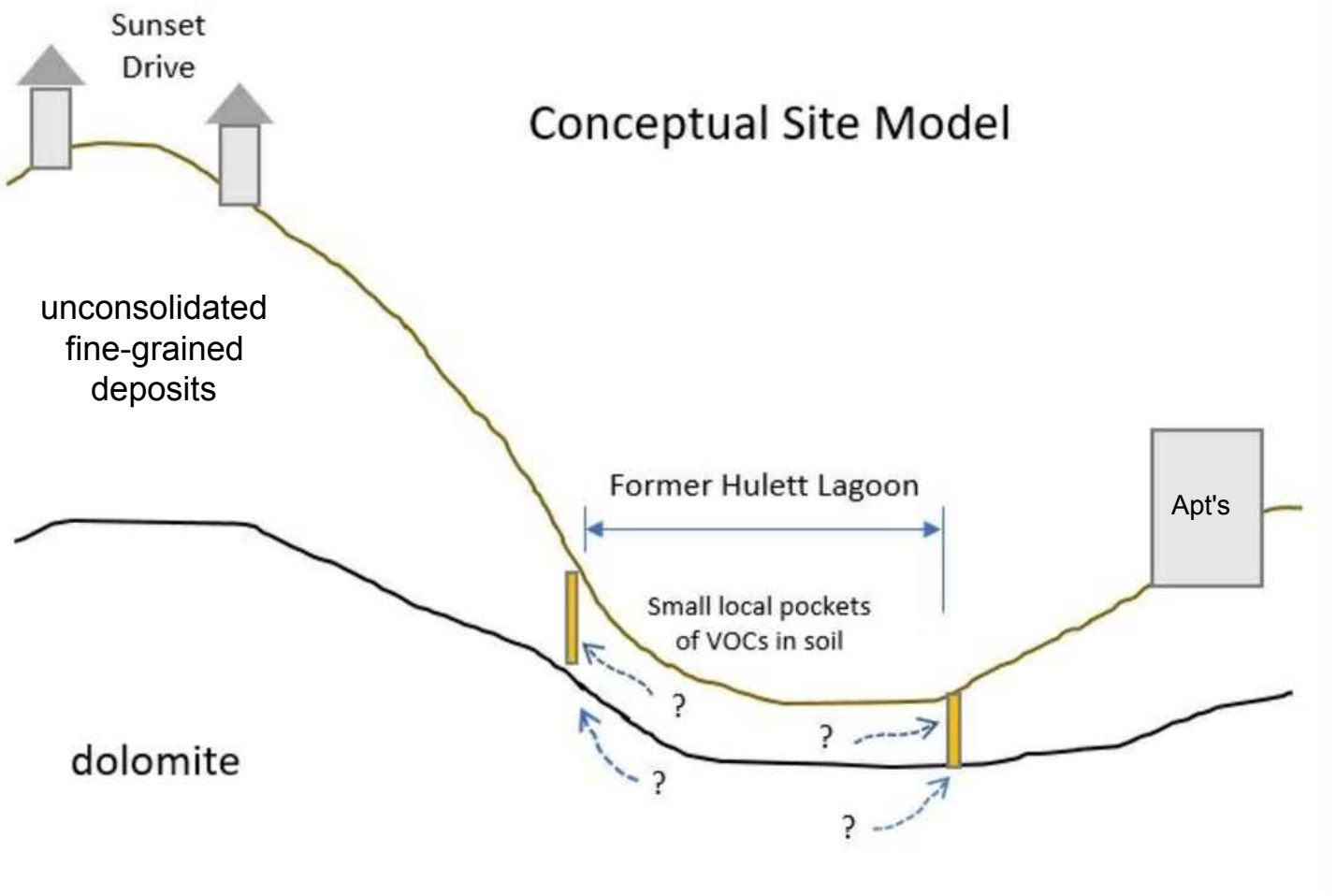
LOCATION MAP
FORMER HULETT LAGOON
HAMILTON SUNDSTRAND
CAMDENTON, MISSOURI

Geosyntec consultants

FIGURE A-1

PROJECT NO: MEM1501 | OCTOBER 2017

R:\2_INACTIVE GEOSYNTEC PROJECTS\GEOSYNTEC\MEM1501\SHEET FILES\FIGURES 2-3-4-5-APPA



Explanation

Potential VOC diffusion in vapor phase

Proposed perimeter soil vapor probe

Note

Uncosolidated fine-grained deposits are primarily silty clays and clayey silts with interbedded chert and sand at greater depths.

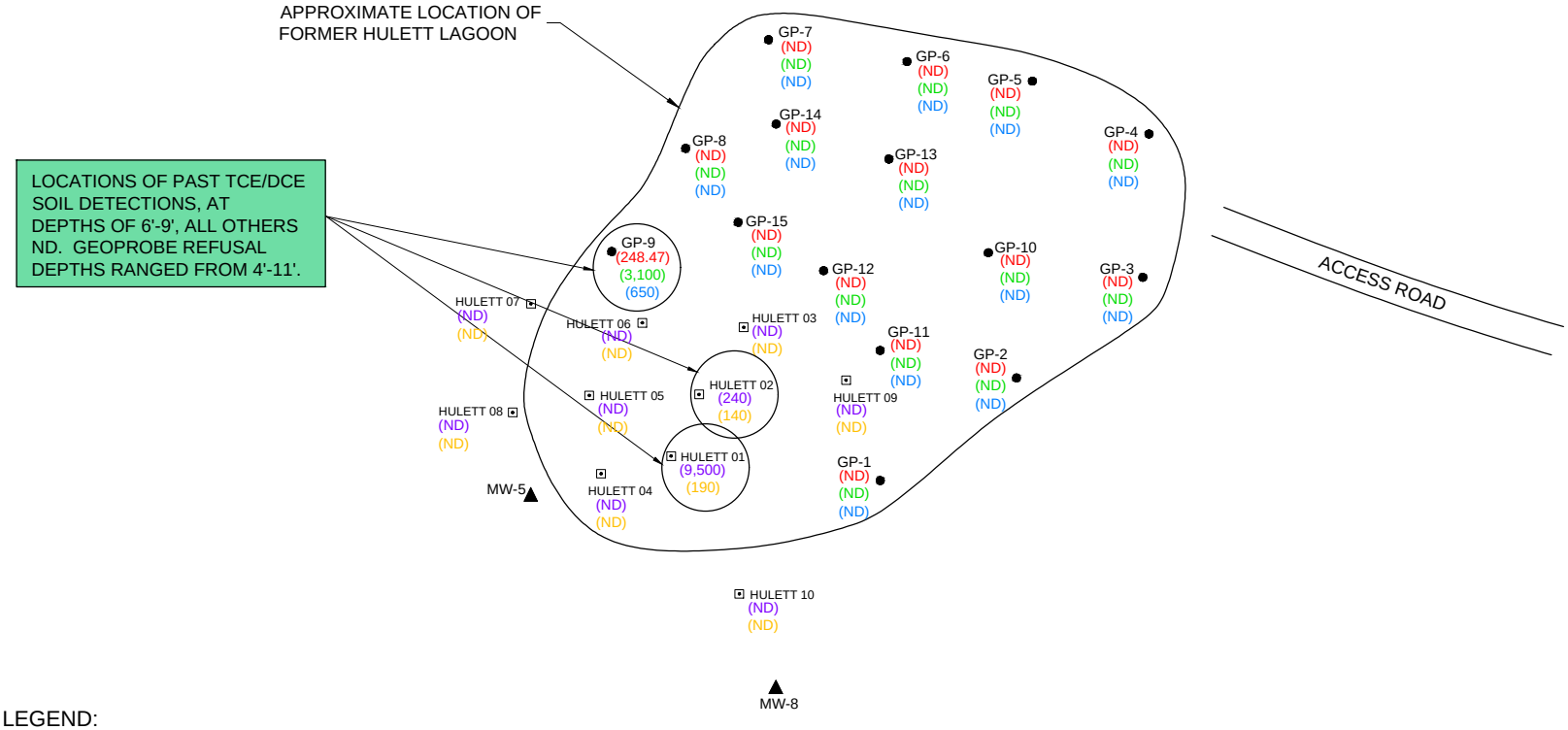
CROSS-SECTION
FORMER HULETT LAGOON
HAMILTON SUNDSTRAND
CAMDENTON, MISSOURI

Geosyntec consultants

FIGURE A-2

PROJECT NO: MEM1501 | MARCH 2020

P:_PROJECT_FILES\1-CLOSED GEOSYNTEC PROJECTS\GEOSYNTEC\MEM1501\SHEET FILES\FIGURES 2-3-4-5-APPA



LEGEND:

- ▲ MONITORING WELL LOCATION
- ● SECOR SOIL BORING LOCATION, JUNE 2000
- ⊡ MDNR SOIL BORING LOCATION, JANUARY 1999
- (248.47) TCE CONCENTRATIONS IN µg/L, MOBILE LABORATORY - SECOR
- (3,100) TCE CONCENTRATIONS IN µg/kg, FIXED BASE LABORATORY - SECOR
- (650) DCE CONCENTRATIONS IN µg/kg, FIXED BASE LABORATORY - SECOR
- (9,500) TCE CONCENTRATIONS IN µg/kg, MDNR
- (190) TCE CONCENTRATIONS IN µg/kg, MDNR
- (ND) = NOT DETECTED

N

0 100' 200'

SCALE IN FEET

SOURCE: SECOR 2003.

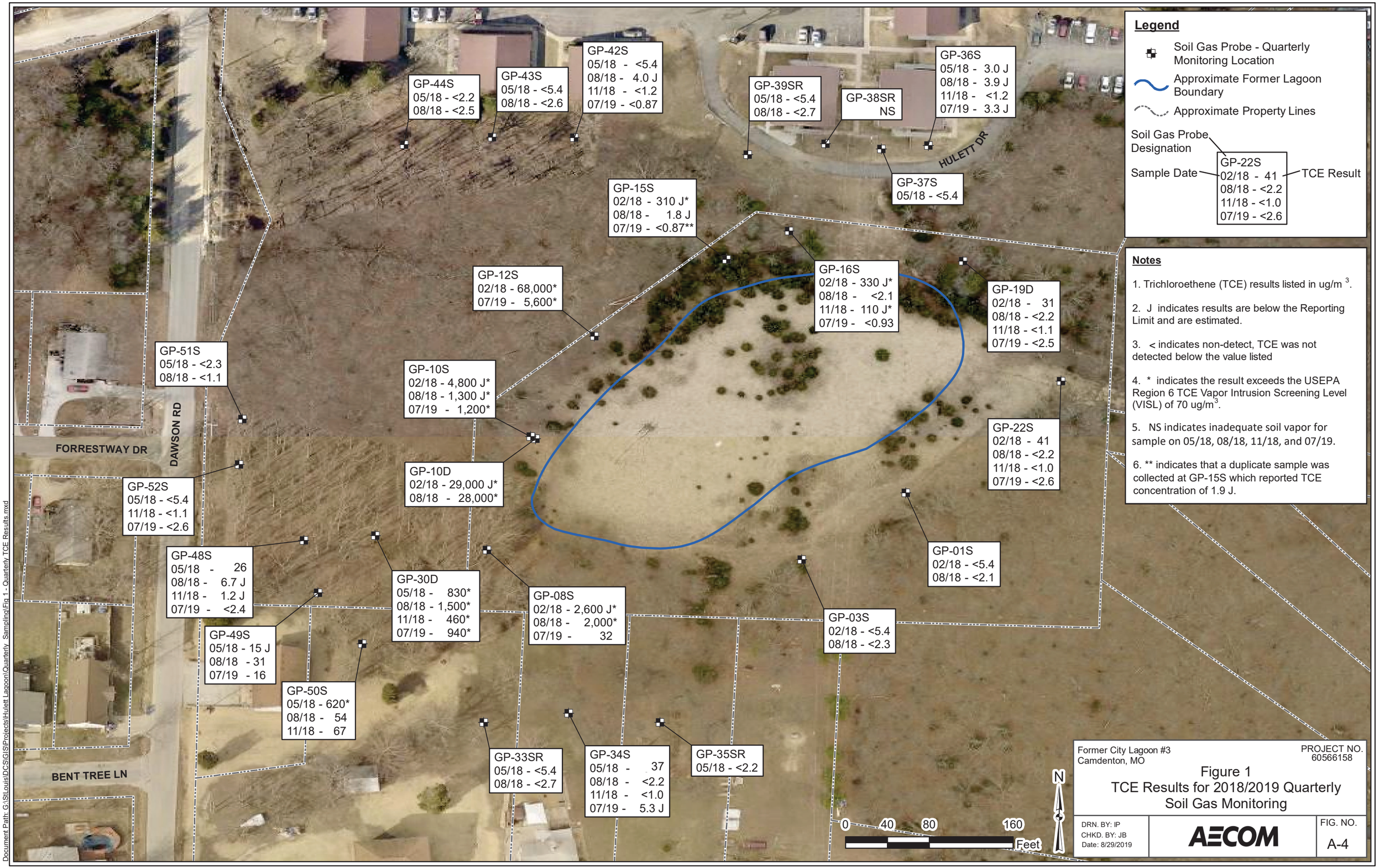
TCE & DCE CONCENTRATIONS IN SOIL
FORMER HULETT LAGOON
HAMILTON SUNDSTRAND
CAMDENTON, MISSOURI

Geosyntec consultants

FIGURE A-3

PROJECT NO: MEM1501 | OCTOBER 2017

R:\2_INACTIVE GEOSYNTEC PROJECTS\GEOSYNTEC\MEM1501\SHEET FILES\FIGURES 2-3-4-5-APPA


GP-44S
05/18 - <2.2
08/18 - <2.5
GP-43S
05/18 - <5.4
08/18 - <2.6
GP-42S
05/18 - <5.4
08/18 - 4.0 J
11/18 - <1.2
07/19 - <0.87
GP-39SR
05/18 - <5.4
08/18 - <2.7
GP-38SR
NS
GP-36S
05/18 - 3.0 J
08/18 - 3.9 J
11/18 - <1.2
07/19 - 3.3 J
HULETT DR
GP-37S
05/18 - <5.4
GP-15S
02/18 - 310 J*
08/18 - 1.8 J
07/19 - <0.87**
GP-16S
02/18 - 330 J*
08/18 - <2.1
11/18 - 110 J*
07/19 - <0.93
GP-19D
02/18 - 31
08/18 - <2.2
11/18 - <1.1
07/19 - <2.5
GP-12S
02/18 - 68,000*
07/19 - 5,600*
GP-51S
05/18 - <2.3
08/18 - <1.1
GP-10S
02/18 - 4,800 J*
08/18 - 1,300 J*
07/19 - 1,200*
GP-22S
02/18 - 41
08/18 - <2.2
11/18 - <1.0
07/19 - <2.6
FORRESTWAY DR
DAWSON RD
GP-10D
02/18 - 29,000 J*
08/18 - 28,000*
GP-52S
05/18 - <5.4
11/18 - <1.1
07/19 - <2.6
GP-01S
02/18 - <5.4
08/18 - <2.1
GP-48S
05/18 - 26
08/18 - 6.7 J
11/18 - 1.2 J
07/19 - <2.4
GP-30D
05/18 - 830*
08/18 - 1,500*
11/18 - 460*
07/19 - 940*
GP-08S
02/18 - 2,600 J*
08/18 - 2,000*
07/19 - 32
GP-03S
02/18 - <5.4
08/18 - <2.3
GP-49S
05/18 - 15 J
08/18 - 31
07/19 - 16
GP-50S
05/18 - 620*
08/18 - 54
11/18 - 67
GP-33SR
05/18 - <5.4
08/18 - <2.7
GP-34S
05/18 - 37
08/18 - <2.2
11/18 - <1.0
07/19 - 5.3 J
GP-35SR
05/18 - <2.2
BENT TREE LN
0 40 80 160
Feet
N
Legend
Soil Gas Probe - Quarterly Monitoring Location
Approximate Former Lagoon Boundary
Approximate Property Lines
Soil Gas Probe Designation
Sample Date
TCE Result
GP-22S
02/18 - 41
08/18 - <2.2
11/18 - <1.0
07/19 - <2.6
Notes
1. Trichloroethene (TCE) results listed in ug/m 3.
2. J indicates results are below the Reporting Limit and are estimated.
3. < indicates non-detect, TCE was not detected below the value listed
4. * indicates the result exceeds the USEPA Region 6 TCE Vapor Intrusion Screening Level (VISL) of 70 ug/m3.
5. NS indicates inadequate soil vapor for sample on 05/18, 08/18, 11/18, and 07/19.
6. ** indicates that a duplicate sample was collected at GP-15S which reported TCE concentration of 1.9 J.
Former City Lagoon #3
Camdenton, MO
PROJECT NO.
60566158
Figure 1
TCE Results for 2018/2019 Quarterly Soil Gas Monitoring
DRN. BY: IP
CHKD. BY: JB
Date: 8/29/2019
AECOM
FIG. NO.
A-4
Document Path: G:\StLouis\DCS\GIS\Projects\Hulett Lagoon\Quarterly Sampling\Fig 1 - Quarterly TCE Results.mxd