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May 4, 2021

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Subject: **Independent Review of Direct Push Technology**
Groundwater Sampling Work Plan
Lockheed Martin Tallevast Site (Former American Beryllium Company Site)
1600 Tallevast Road
Tallevast, Manatee County, Florida
E Sciences Project Number 1-1440-004

Dear Mrs. Ward and Mrs. Washington:

E Sciences, Incorporated (E Sciences) is pleased to submit this letter outlining the results and opinions derived from our review of an April 12, 2021 document titled *Direct Push Technology Groundwater Sampling Work Plan – Lockheed Martin Tallevast Site* prepared by AECOM Technical Services, Inc. This document will be referenced herein as the "DPT Work Plan".

INTRODUCTION

E Sciences has provided FOCUS with consulting services related to the review of certain documents associated with assessment and remediation of contamination caused by the former operation of the former American Beryllium Company facility at the property located at 1600 Tallevast Road (the "Site"). The Site is owned by Lockheed Martin and contamination remediation is on-going. Recently, we were requested to compile information and opinions about the ongoing remediation progress and reporting. E Sciences documented the results of this review in a letter dated January 11, 2021 titled *Independent Review of Remedial Action Summary Reports*.

During this evaluation we reviewed the contamination plume and capture zone configurations and system modifications for each year of remedial progress, minutes from remedial action status update meetings, Florida Department of Environmental Protection (FDEP) letters issued in response to Remedial Action Summary Reports (RASRs) and Lockheed Martin's responses to those letters. Our findings outlined items that, in our opinion, need to be addressed. These items related to Lockheed Martin's characterization of groundwater modeling, plume capture zone,

plume delineation, geochemical data and provided evidence of under assessed areas associated with the contamination that originated at the Site.

The FDEP issued an internal memorandum dated November 23, 2020 outlining the following comments in response to Lockheed Martin's submittal of the 2020 RASR. Relevant FDEP comments are outlined below:

- The lateral and down gradient extent of 1,4-dioxane in the Upper Surficial Aquifer System (USAS) has not been adequately delineated. Additional monitoring wells should be installed as follows to better define and monitor the extent of 1,4-dioxane:
    - East and west of MW-114.
    - East, west, and Southeast of PA-USAS-19.
    - Following the installation of the additional monitoring wells, PZ-USAS-15, PZ-USAS-16, PZ-USAS-17, PZ-USAS-18, PZ-USAS-20, and the new wells should be sampled and the samples analyzed for 1,4-dioxane.
- There are several hot spots that the treatment system does not appear to be affecting and where contaminant concentrations remain quite a bit above the cleanup goals. FDEP advised that they should explore treatment methods other than pumping to enhance the cleanup progress in those areas. FDEP stated that they may want to set up a meeting to discuss this with AECOM.

Lockheed Martin provided a response to FDEP's comments in a letter dated January 19, 2021. In this letter, Lockheed Martin indicated that to address the 1,4-dioxane USAS delineation inadequacies they would first collect groundwater samples from existing piezometers and analyze the samples for 1,4-dioxane. Based upon the results of that testing, they proposed to develop a DPT Work Plan to provide proposed locations and depth intervals for groundwater screening for FDEP approval. Following the implementation of the DPT Work Plan, Lockheed Martin proposes to prepare and submit to FDEP a Monitoring Well Installation Work Plan. The results of this phased assessment are to be included into the 2021 RASR document expected to be issued in Fall of 2021.

With respect to the hot spots referenced by FDEP in their comment, Lockheed Martin proposed to conduct a plume stability analysis and discuss the results with FDEP. It is Lockheed Martin's position that it is premature to consider other remedial technologies for areas of elevated contaminant concentrations.

SCOPE OF REVIEW

The technical objective of the DPT Work Plan was to better define the USAS 1,4-dioxane plume in the southeast area of the Site. Therefore, the scope of the plan proposes initial direct push points in the mid to lower part of the USAS and to analyze groundwater samples for 1,4-dioxane. This additional assessment activity was precipitated by reporting the results of recent groundwater monitoring that revealed concentrations of 1,4-dioxane at a considerable distance downgradient from the site. Therefore, our review of this plan was focused on an analysis of data gaps around and below the remediation focus area south and east of the facility. This area is of critical importance for the following reasons:

- Contamination in this area is apparently resulting in continued dissolution of contamination that is feeding the spread of downgradient contamination. Undetected higher concentrations of all contaminants of concern (COCs) should be properly assessed in order to determine where the contamination is so that it can be effectively and efficiently remediated.
- If under assessed contamination exists in the shallow part of the USAS in this area then residences are situated above these volatile contaminants. This could provide a source of vapor encroachment into residential structures. Therefore, it is critical to know if shallow contamination of all COCs is present beneath these homes.
- Lack of vertical delineation in the area of highest concentrations of contamination can result in continued spread to deeper aquifer zones without being recovered by the remediation system that has been put into place. The contaminant plumes are not vertically delineated and therefore it is not possible to ensure that the extent of vertical contamination is being addressed by the remediation system.

Although the scope of E Sciences' review was to evaluate the proposed groundwater monitoring proposal outlined in the DPT Work Plan, we also provide a discussion and examples of data gaps in this letter as they pertain to the area between the facility and the area of proposed direct push. It is imperative that the scope of Lockheed Martin's review of the efficacy of the remediation system include some focus on how to improve system operation in the area of recalcitrant contamination and possible impacts to sensitive receptors.

We also note that the area to the northwest of the site is not included in the DPT work plan. We recommend that a separate analysis be conducted to evaluate potential plume spread that may be undetected due to the sparse monitoring well placement and use of dynamic extraction wells for delineation.

FINDINGS

The DPT Work Plan did not provide a rationale for selection of sample locations or depth intervals proposed for the groundwater assessment. The placement of the sample points and proposed depths suggests that Lockheed Martin will use this data to identify the leading edge of 1,4-dioxane plume in the USAS. The proposed sample depths range from 10 to 40 feet or 30 to 40 feet below ground surface (BGS), with some contingency sample depths ranging from six to 40 feet BGS. We identified several concerns associated with the DPT Work Plan as it relates to its technical objective. Some of these concerns are outlined below with graphic examples to illustrate the point. It should be noted that each example provided below is just one instance representing a concept but there are several other similar situations identified in the RASRs.

Shallow impacts in the USAS in the adjacent neighborhood have not been adequately assessed to ensure that potential human exposure (vapor encroachment) to contamination has been properly evaluated. This portion of the neighborhood that abuts the source property to the south and southeast of the Site is about 26 acres in size and is in the apparent downgradient direction of the shallow plume movement. The area is characterized by single family homes, sparse monitoring well coverage and no shallow groundwater monitoring data in the USAS in this area. This is further explained below.

- Insufficient monitoring well coverage - "Clean" USAS monitoring wells such as MW-20R (screened from 34 to 39 feet) and MW-25 (screened from 36 to 43 feet) are located 600 to 700 feet south of the facility and in public right of ways, essentially bypassing the area with the highest concentration of residential homes within the plume. See **Figure 1**.

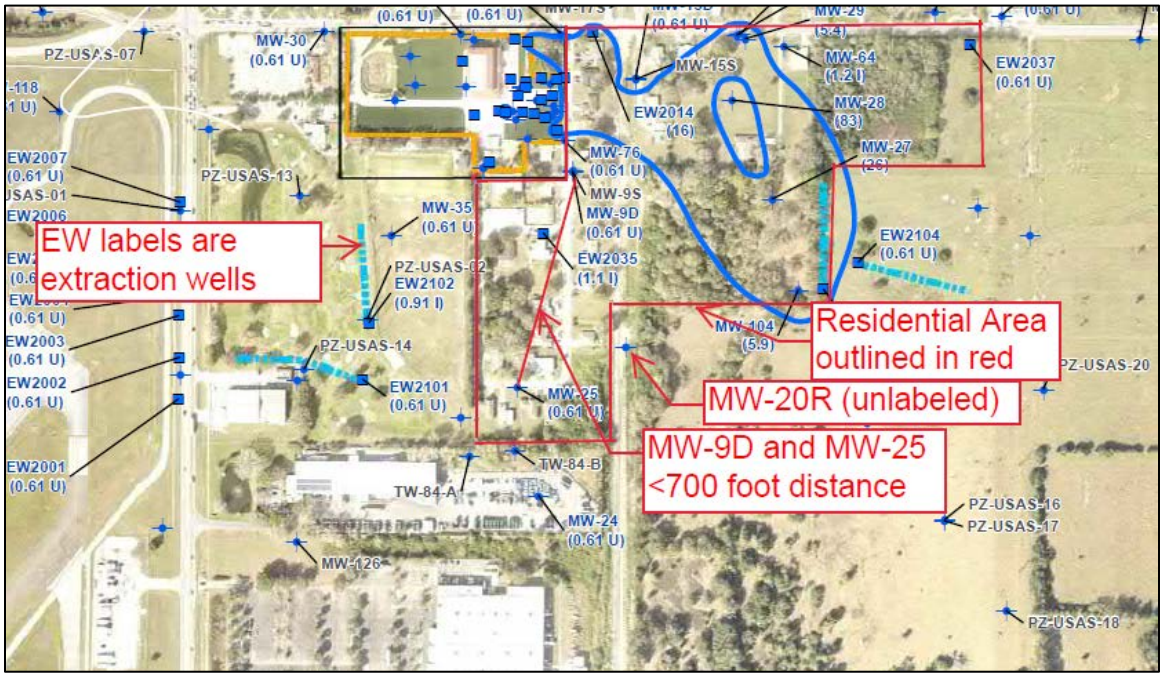

Figure 1 -TCE Concentrations in the Upper Surficial Aquifer System (from Figure 12B from 2020 RASR)

- Possible undetected shallow groundwater impacts –COCs within the upper strata of the USAS has not been assessed in this area. ARCADIS' Vapor Intrusion Assessment Report dated February 13, 2007 states that "the water table is first encountered in the USAS and may be as shallow as 2 feet BGS." More recently, in the 2020 RASR Lockheed indicated that the groundwater depth measurements ranged from 4.7 to 7.7 feet BGS in the USAS monitoring wells located southeast of the facility. However, none of the USAS monitoring wells in this area are in the shallow portion of the USAS. The USAS wells here have the following screened depth intervals:

Table 1 –Screened Depth Intervals of USAS Monitoring Wells Proximal to Neighborhood

USAS Monitoring Well	Screened Depth Interval Feet below ground surface
MW-20R	30-34
MW-25	36-43
MW-27	30-35
MW-104	25.1-30.1

Therefore, the potential presence of shallow groundwater impacts within the USAS has not been fully evaluated in this area. This is of concern because vapor intrusion studies were not informed with shallow groundwater contamination.

Vapor intrusion studies associated with the contamination at the Site have used a weight of evidence approach to conclude that the contamination is not a cause of COC vapors identified within the homes. One rationale used was that the COC plumes were not co-located with the vapor screening locations. Available assessment data is insufficient to locate where the COCs are within the shallow groundwater in the neighborhood. The conclusion that the vapors and groundwater contamination are not co-located and not related cannot be made when COCs have not been tested in the shallow groundwater in those areas. It is reasonably possible that shallow groundwater monitoring in the area of these homes may demonstrate the presence of COCs consistent with indoor vapor detections.

Recommendation: We recommend that the DPT Work Plan include a grid of shallow groundwater samples to be collected throughout this area on residential properties. Further, the shallowest interval should intersect the top of the water table. If shallow groundwater impacts are identified in the residential area, vapor encroachment surveys should be conducted to evaluate the existence of potential human exposure pathways and to evaluate the risk of the contamination on the residents in this area.

The vertical extent of the contamination into deeper zones has also not been delineated. The DPT Work Plan is focused on horizontal delineation of the 1,4-dioxane in the USAS plume, and the preceding comment focuses on that. However, it is also important to note that monitoring well coverage below the USAS decreases with depth and that vertical delineation of COCs in these zones has also not been achieved. This is especially true in the downgradient direction of the plume, where Lockheed Martin acknowledges that the capture zone of the system has not contained the contaminant plume. The contamination in the Lower Surficial Aquifer System (LSAS) is clearly not delineated horizontally or vertically. The DPT Work Plan does not assess groundwater impacts beneath 40 feet and after implementation of the plan, the location and concentrations of contamination in the LSAS and deeper will remain unknown. Based upon the concentrations of tetrachloroethene, trichloroethene and 1,4-dioxane above natural attenuation default concentrations identified in the USAS in this residential "hot spot" area and the pattern of contamination migration patterns documented, it is imperative that the LSAS be assessed in this area to identify the location and contaminant concentrations in this area immediately downgradient of the Site.

Figure 2 below shows an overlay of the proposed DPT locations relative to the LSAS plume contour. This graphic demonstrates that there are no horizontal delineation monitoring wells east or south of the leading edge well, MW-105, which is screened from 42 to 47 feet BGS. The graphic further indicates that there are no deeper downgradient monitoring wells. The DPT locations proposed are limited to a maximum depth of 40 feet BGS, which is actually less deep than some of the contaminated monitoring well screened intervals that have exhibited COCs exceedances. Due to the complexities associated with the solvent migration and hydrogeology, it would be reasonable to use this direct push planning opportunity to assess the deeper zone to ensure that the downgradient plume configuration is evaluated.

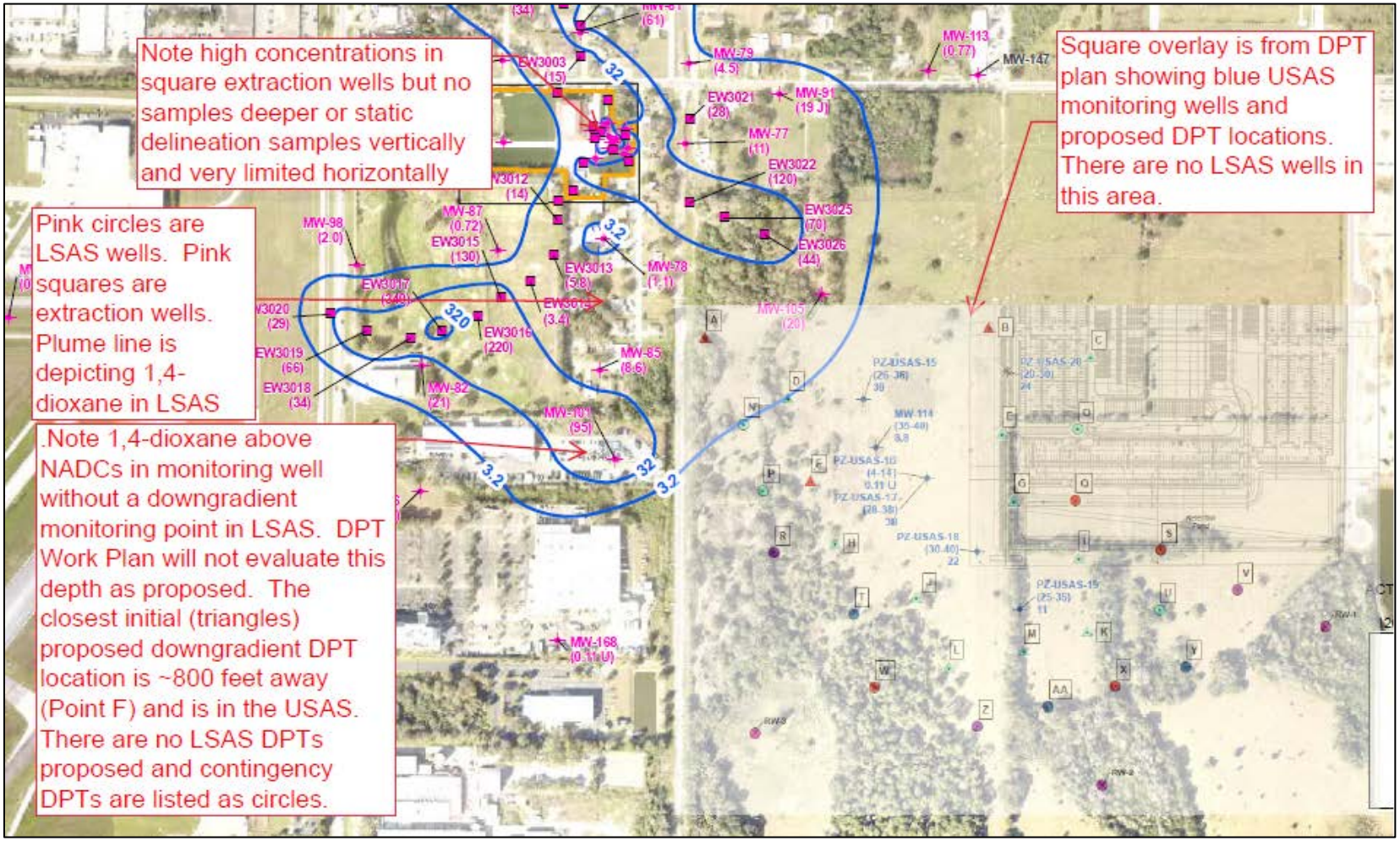

Figure 2 – 1,4-Dioxane Concentrations in Lower Surficial Aquifer System
(from Figure 13A from 2020 RASR) and
Proposed Sampling Location Identification (from Figure 2 from DPT Work Plan)

Figure 3 below shows Arcadia Formation (AF) wells that are screened down to 100 feet and show 1,4-dioxane above the GCTL. This demonstrates that there are un-delineated deeper impacts, well below the 40-foot proposed DPT intervals.

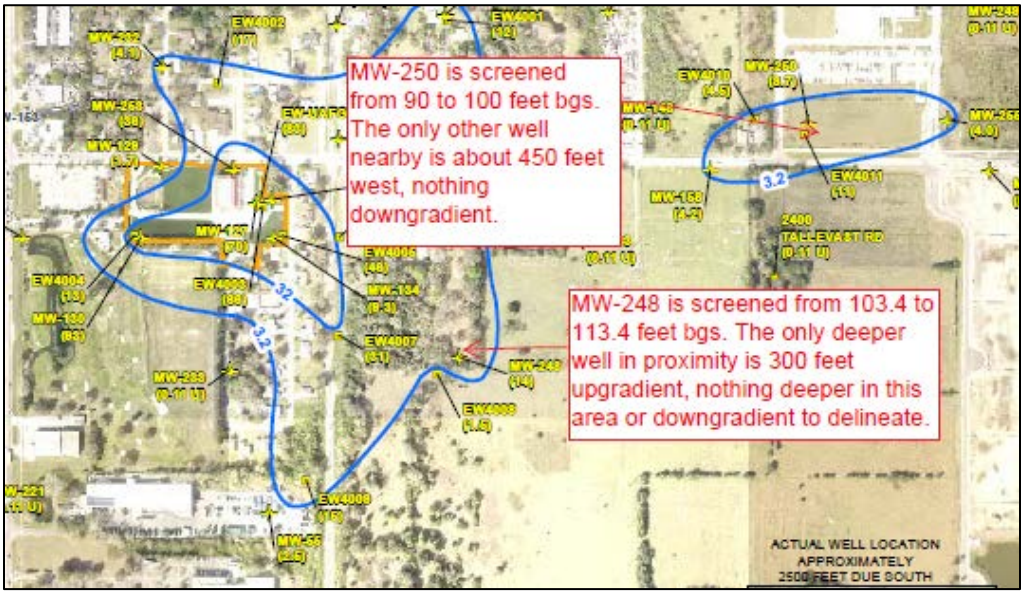

Figure 3 – 1,4-Dioxane Concentrations in the Arcadia Formation Gravels (Figure 14A from 2020 RASR)

Figure 4 below shows that there are no deeper or downgradient monitoring wells to delineate the impacts shown in Figure 3. Note that IWI-2 is screened from 162 to 172 feet BGS.

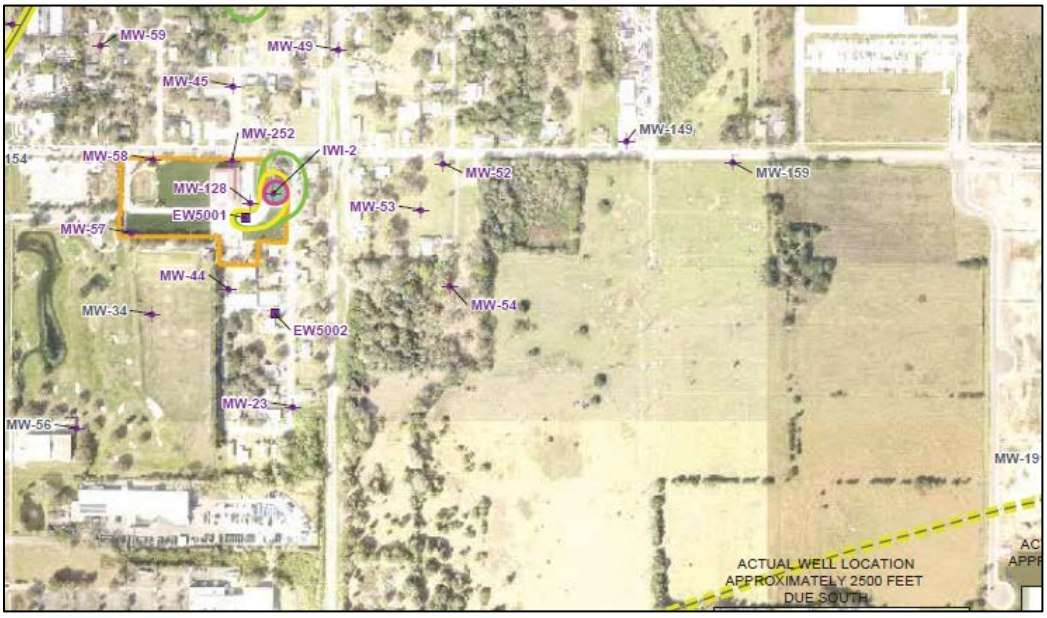

Figure 4 – Composite COC Plumes in the Salt & Pepper Sands (Figure 15E from 2020 RASR)

When taking a critical eye to these figures it can be observed that contamination is documented in AF Gravels monitoring wells screened at depths ranging in the ~90 to 115 foot BGS zone, but there are no downgradient AF Gravels monitoring wells delineating the horizontal extent of the plume. Further there are no deeper downgradient wells to delineate the vertical extent of the impacts. It is also of interest to see that groundwater contamination identified down to 172 feet BGS is not vertically delineated. There are no deeper downgradient monitoring wells to delineate the impacts identified at this depth.

Recommendation: We recommend that continuous samples be collected from the direct push borings from the water table down to the hard streak at the bottom of the USAS. We also recommend that groundwater samples in the LSAS be collected in this area. If the hard streak prevents the use of direct push, an alternative technology should be used to delineate the horizontal and vertical extent of contamination in the deeper zones of the aquifer. Based upon data collected in the field from the USAS and LSAS sampling described here, additional sampling should proceed deeper into the AF Gravels and Salt and Pepper Sands as necessary to achieve vertical delineation. A thoughtful approach to assessing deeper impacts should be developed.

The DPT Work Plan is too narrowly focused to address obvious data gaps. This is a complex site, with several COCs that are migrating independently through the different heterogenous geologic formations in the vicinity of the Site. The RASR documents include maps for each COC for each formation and a composite figure. There are over 30 maps in each RASR. Each map spans acres, sometimes as much as 200 acres, and includes monitoring and extraction well data which can make the distance between data points very difficult to appreciate. As a result, it is challenging to review the various pieces of information and obtain a wholistic picture of the plumes and identify data gaps.

Lockheed Martin reportedly uses three different methods for drawing plume contours: groundwater data, modeling information, and professional judgement. Lockheed asserts that the professional judgment used to draw contours considers the localized effects of extraction wells and infiltration galleries, as well as modeling information. While all of these are acceptable means, professional judgement should rely heavily on the contaminant concentrations resulting from the results of groundwater testing of samples collected from static monitoring wells. This should be complemented with the predictions outlined in the groundwater model.

The remedial action implemented relied heavily on a model conducted at the time of the RAP development and in 2018 Lockheed provided a five-year model update. However, the 2018 updated model information is not being used to identify data gaps and predict contaminant behavior. This is evident because the updated model predicts contaminant concentrations well outside of the boundaries of the plume contours drawn by Lockheed Martin's professional judgement. The next

few Figures depict how Lockheed Martin uses different approaches to represent contours without providing a rationale.

Figure 5 below shows an example of how data from remediation extraction wells (EWs) are used to delineate plumes.

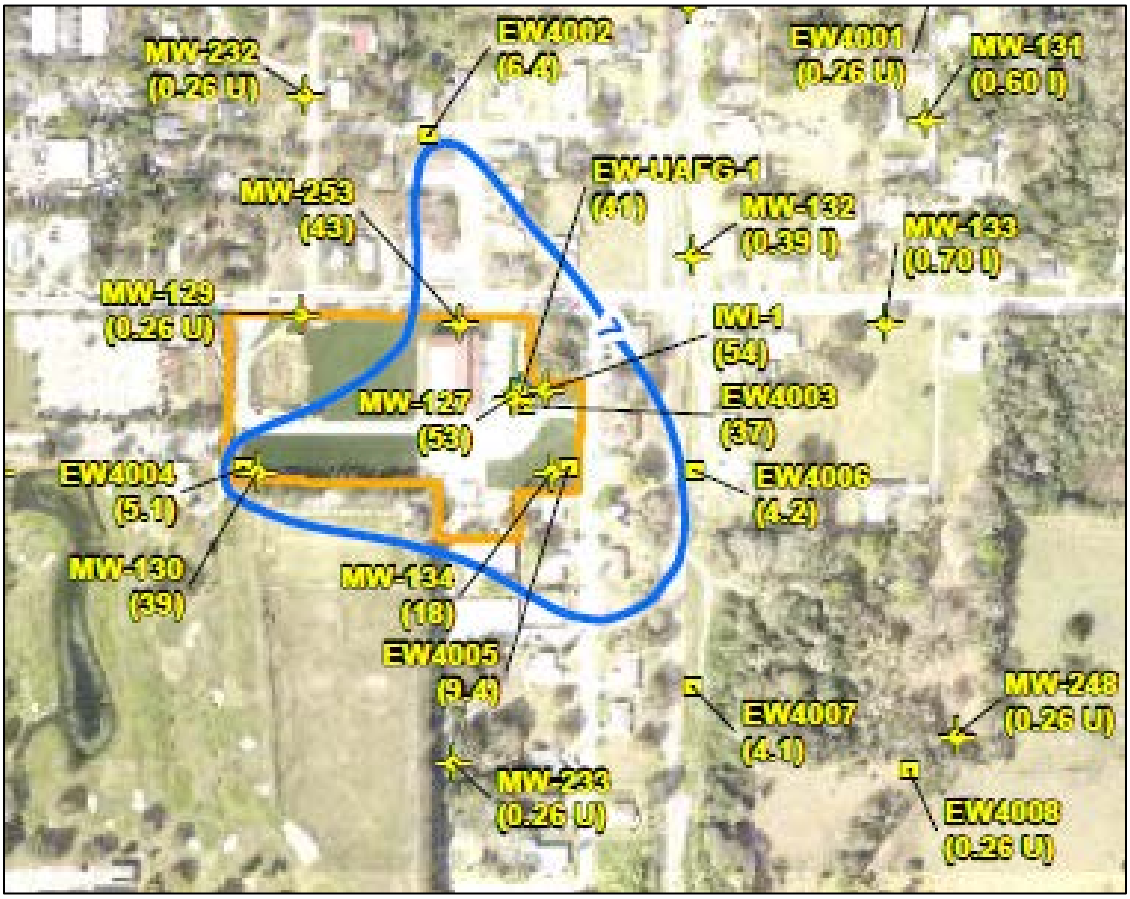

Figure 5 – 1,1-Dichloroethene Concentrations in the Arcadia Formation Gravels (Figure 14D from 2020 RASR)

Figure 6 shows one example of delineation contours drawn without any monitoring data nearby to substantiate the contours. The 1,4-dioxane contour in **Figure 6** is delineated to be mostly within the facility and not within the neighborhood, but the downgradient monitoring wells are hundreds of feet away.

Figure 6 – 1,4-Dioxane Concentrations in the Salt & Pepper Sands
(from Figure 15A of the 2020 RASR)

It is critical that Lockheed Martin take this opportunity to identify where the contaminants are and place monitoring wells to assess the changes in the plume and the migration patterns of the contaminants initially and for the duration of the remediation.

Recommendation: We recommend that FDEP review the current contour delineations to assess any data gaps recognizing that these may only be identifiable with enlarged graphics. We also recommend that FDEP request direct push sampling points be added to confirm plume delineation where no properly constructed monitoring wells exist in the different hydrogeologic zones. Once the DPT monitoring data is available, we recommend that Lockheed Martin review and revise the groundwater contours accordingly and that clarity regarding its approach for each contour delineation be provided where data gaps exist.

We also recommend that all groundwater samples be analyzed for the COCs associated with the Site, not just 1,4-dioxane. If the location of the contamination is unknown then exposure pathways cannot be identified and remediation will be inefficient, lengthy and will not necessarily target source areas or sensitive receptor areas. The site and plumes are so complex and not expanding the assessment would be a lost opportunity to determine where the contamination is and therefore how to best remediate it.

While this review focused on the downgradient area of the plume and the area with the highest concentration of residences, we do recommend that FDEP conduct a similar analysis of the other areas of the facility to identify other data gaps that should be addressed by additional assessment. In particular, the 2018 groundwater model shows contamination outside of the predicted capture zone in the northwest area of the plume. This direct push sampling is an opportunity to delineate the contamination plume in that area as well.

We appreciate the opportunity to offer our professional services to you. If you have any questions concerning our evaluation, please contact us at 954-484-8500.

Sincerely,
E SCIENCES, INCORPORATED

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