Responses to EPA Comments Dated October 14, 2016
Former Williams Air Force Base ST012 Remedial Action Field Variance Memorandum #5 – Extraction and Treatment System Construction, September 30, 2016

The U.S. Environmental Protection Agency (EPA) provided comments on the ST012 Remedial Action Field Variance Memorandum (FVM) #5, Former Williams Air Force Base, Mesa, Arizona in a letter dated October 14, 2016. Excerpts and comments are presented below and are followed by Air Force (AF) responses in bold.

Excerpts (*italics*)

'EPA requested a containment system because the steam enhanced extraction (SEE) system was terminated prematurely, leaving in the subsurface hot groundwater and light non-aqueous phase liquid (LNAPL).'

Response: The Air Force (AF) does not agree the SEE system was terminated prematurely. The AF demonstrated the SEE system was terminated in accordance with criteria established in the approved Remedial Design/Remedial Action Work Plan. Elevated temperatures and residual LNAPL are expected post-steam conditions. Residual LNAPL mass remains within the parameters predicted to achieve the remedial objectives in the approved Final RD/RAWP. Phase 1 and 2 characterization results are not expected to provide information inconsistent with the planned implementation of the EBR remedy.

'Raising the temperature of liquids lowers their viscosity, and the lower viscosity allows them to migrate more rapidly. The elevated temperatures also increase dissolution of jet fuel components, and thus increases the amount of dissolved phase contaminants that will migrate with the hot groundwater.'

Response: Contaminant migration has not been indicated by six months of post-steam monitoring. The monitoring network is in place and is being further enhanced (over 30 new wells installed/planned during post-steam Phase 1 and 2 investigations). Statements on hot water and contaminants migrating are not supported and are counterproductive to remedial progress. The elevated subsurface temperature is a desirable and positive factor for enhanced bioremediation (EBR) that is deteriorating. While AF agrees with the need for post-steam characterization and containment (including containment through monitoring), extended delays will continue to interrupt the AF's ability to achieve the long-term remedial objectives and prevent taking advantage of favorable EBR conditions. If the ongoing delays and planned implementation of active hydraulic containment continue, post-steam advantages of increased temperature, increased contaminant solubility/dissolution, and increased anaerobic degradation will be eliminated. The AF is aggressively taking action to address post-steam characterization concerns. Once enhanced containment monitoring is in place based on post-SEE characterization, implementation of the selected EBR technology would take advantage of favorable post-steam conditions.

'Furthermore, the groundwater level in the subsurface has now risen into the cobble zone, which is believed to be significantly more permeable than the lower zones which are affected by the fuel contamination, and thus will allow for significantly greater migration of contaminated groundwater and LNAPL.'

Response: The AF has been providing weekly reports to EPA and ADEQ with water level, temperature, LNAPL, and dissolved phase monitoring results since week ending 27 May 2016. As documented in the weekly reports, presented in the August BRAC Cleanup Team meeting, and discussed during the June, September, and October BCT conference calls, there is minimal mobile LNAPL within SEE and perimeter wells in the cobble zone (total of 5 gallons removed post-SEE, none since May). As reported to EPA in the 24 August 2016 BCT meeting, there were no positive dye tests or indications of LNAPL in the cobble zone at the 16 boring locations completed during the Phase 1 post-SEE characterization. Post-steam monitoring results for downgradient cobble zone well ST012-C02 (<1 µg/L) have not exceeded the MCL. These previously distributed site data do not support EPA's statement regarding cobble zone migration. Additional borings and wells are planned to address potential cobble zone data gaps. The planned borings, wells and monitoring program will enhance the cobble zone characterization and monitoring network to support ongoing evaluation of potential contaminant impacts and migration.

'While it is true that the most recent groundwater concentration data from downgradient sentinel wells have been below maximum concentration levels (MCLs), data collected from the wells U02, W36 and W34 during SEE operations showed increasing benzene concentrations that were well above MCLs. The recent low concentrations were brought about by aggressive groundwater extraction once steam injection was terminated. ... Thus, without groundwater extraction for containment, benzene concentrations at downgradient wells may be expected to increase rapidly.'

Response: EPA acknowledges there has been no indication of migration. The AF is taking action to augment the monitoring network to further address the concern. Throughout evaluation, selection, and implementation, it was well known by the regulatory agencies and AF that steam enhanced extraction at ST012 was an aggressive remedial action approach that would have localized impacts on LNAPL and dissolved contaminant distribution. It was also well established and known that significant quantities of LNAPL, commensurate with current estimates of residual LNAPL, would be remaining after SEE, primarily at or outside the thermal treatment zone perimeter. As had been planned by the Air Force and communicated to EPA (see letter dated 19 May 2016 from C. Jerrard, as well as BCT meeting presentations and other related ST012 communications), the AF has implemented phased actions to address post-steam LNAPL and dissolved phase characterization. These phased characterization actions, including the planned Phase 2, are addressing the impacts and contaminant distribution in the area of U02, W36 and W34. The Phase 1 and 2 well locations will provide additional monitoring wells for the downgradient perimeter network. To date, post-steam results from downgradient sentinel wells have been below the MCL as they were pre-steam. Groundwater extraction was turned off on 29 April 2016. Six months of monitoring results for the perimeter wells as well as documented reductions of mobile LNAPL in all zones, do not confirm EPA's statement that "benzene concentrations at downgradient wells may be expected to increase rapidly". The Phase 2 investigation will further increase confidence in site characterization and the containment monitoring network. On the basis of sufficient characterization and monitoring, planned implementation of EBR could be addressing elevated dissolved benzene concentrations, further reducing the potential of downgradient migration.

'Based on a review of the modeling report in Appendix E of Addendum 2, the containment system proposed in the FVM does not appear to be sufficient to contain the hot groundwater and LNAPL plume.

Also, the extraction and treatment system proposed in the FVM does not appear to take into account the current temperatures in the subsurface, and this may cause failure of the extraction and above ground treatment system. It is also noted here that the basic information on the groundwater extraction and treatment system provided in this FVM would not normally be considered a completed design that was ready for construction.'

Response: EPA has requested immediate construction of an active containment system yet is creating delays to its implementation. The system, as designed, is compatible with subsurface temperatures as described in the responses to general comments 3 and 7. The combination of the planned extraction and treatment system with the enhanced characterization and monitoring provided from the Phase 1 and Phase 2 investigations will initially be evaluated for overall contaminant containment. Construction of the system proposed in the Draft Final Addendum #2, combined with over 30 new monitoring wells installed as part of Phase 1 and 2, will provide the data for initial evaluation of containment effectiveness. However, as the AF has previously indicated, startup and extended operation of the system strictly for containment will destroy the already deteriorating optimal conditions for EBR implementation and prevent the AF from achieving the remedial objectives within the estimated remedial timeframe. The AF agreed to construct the groundwater extraction and treatment system at EPA's insistence. Considering characterization and monitoring available from the Phase 1 and 2 investigations, the AF considers EPA's direction to implement active hydraulic containment as premature, and an unwarranted and unnecessary departure from the remedy. EBR implementation will take advantage of favorable site conditions to reduce contaminant mass, contaminant extent, and the potential for contaminant migration.

'Loss of source zone containment is now a very significant concern and continued recovery of contaminants is necessary to prevent formation of a large groundwater plume which would require an extensive groundwater pump and treat remedy in the future. Therefore, this containment system needs to be installed as expeditiously as possible.'

Response: EPA's concern for loss of source zone containment, both pre- and post-SEE, has been shared by the AF but has not materialized. Nonetheless, AF continues to take aggressive actions to address the concern, including stopping site remediation at EPA's request to install over 30 additional new wells. Continued remediation is needed and once characterization and containment through monitoring can be demonstrated, there is no reason to continue preventing the AF's progress towards remedial objectives. EBR is the selected technology that will address groundwater contamination such that the unrealized concern over the loss of containment can be significantly reduced if not eliminated by remediation. Pump and treat has already been established as an ineffective technology for ST012 and was the reason SEE/EBR was selected as the new groundwater remedy. The AF urges EPA's coordination and support to gain the best remediation results at ST012. Based on the site characterization results, the AF and EPA should be working constructively toward continued implementation of the remedy and not ignoring or missing the opportunity to significantly advance site remediation at ST012. Evaluation and implementation of contingency actions will be based on performance in regard to remedial objectives and performance metrics. The AF recommends resolving implementation comments on the Addendum #2 Work Plan and implementing EBR.

General Comments

1. According to Section 3.1 of the FVM, the proposed containment system is essentially the same as that detailed in Addendum 2. However, the proposed groundwater extraction system in Addendum 2 was not designed for the purpose of containment of the hot groundwater and LNAPL, but to distribute terminal electron acceptor (TEA) for Enhanced Bioremediation (see Section 3.2 of Addendum 2). Modeled TEA injection pathlines shown in Appendix E of Addendum 2 (Figures E-1, E-8, and E-15) clearly show that the proposed pumping for TEA distribution will not contain the TEA at the downgradient side of the site in any of the three zones, and thus this extraction system cannot be expected to contain the hot groundwater and LNAPL plumes.

Response: The system was designed for containment and thermal electron acceptor distribution. The modeling was performed for short-term TEA distribution because that was the planned implementation of the selected remedial technology. The modeled TEA pathlines in Appendix E include both the extraction and post-extraction periods. The change from extraction to post-extraction can be seen clearly, for example, in the pathlines from W34 (Figure E-10) where the pathlines are toward the site under pumping conditions and then turn downgradient under non-pumping conditions. Overall, these figures should not be used to assess the containment ability of the extraction system. EPA has requested immediate implementation of an active containment capability. The AF indicated in the August BCT meeting that it was prepared to proceed with construction of the planned system and Phase 2 containment monitoring enhancements immediately as the most effective way to provide containment capability at the earliest time, predicted as October/November at that time. To date, construction startup has been delayed due to lack of approval and continuing identification of new requirements. To expedite implementation, the AF will proceed with system construction and evaluate the effectiveness of the planned system based on water level and contaminant monitoring results from the enhanced characterization and monitoring network. However, extended operation of the system strictly for containment will destroy the already deteriorating optimal conditions for EBR implementation and prevent the AF from achieving the remedial objectives within the estimated remedial timeframe.

2. A revised containment system proposal, which is supported by groundwater modeling that demonstrates capture, should be provided. Capture zone modeling should be applied independently to each of the three zones.

Response: The AF has agreed to establish containment through an active extraction system and an enhanced monitoring network. The AF will proceed with construction of the planned containment system and evaluate containment based on the observed hydraulic influence and the enhanced monitoring system. Prior to start up, particle tracks using the groundwater model will be provided for the CZ, UWBZ, and LSZ using the design extraction network. Adjustments or additions to the extraction or monitoring systems will be evaluated based on operational data. This approach is more effective and expeditious in accomplishing the containment objective. However, extended operation of the containment system departs from the remedial approach, diminishes favorable conditions, and prevents the AF from achieving remedial objectives within the expected timeframe.

3. Please confirm that these pumps can provide the desired extraction rates and operate in groundwater with temperatures close to the boiling point of water.

Response: The pumps will be connected to a variable frequency drive (VFD). The pump flow range stated in the pump literature is for standard power frequency (60 hz) as supplied by the utility. The VFD allows the pump motor to operate at a slower speed by reducing the frequency of the electrical power supply. At a lower speed, the flow and pressure of the pump are down rated. Consequently, the pumps with the VFDs will be able to provide the 15 gpm specification as well as even lower rates. The pumps will be fitted with Teflon bearings and seal rings and a submersible pump motor rated to 175°F. It is likely that some perimeter wells will pull groundwater into the site from outside the former SEE TTZs and lower the well temperatures. Pumping of hot wells will proceed with caution to protect submersible pump motors from overheating. Adjustments in pump depth and elevation set points will be used to manage temperatures. In some cases, hot wells may not be able to be pumped and alternate extraction locations in the vicinity will be considered. This response will be incorporated into the final FVM

4. Please revise the FVM to detail how the initial pumping rate will be set for each extraction well and how pumping rates will be adjusted to maintain containment.

Response: The FVM indicates the pumps will be level controlled. In this control method, the pumping rate is not set. Instead, the desired groundwater elevation in the well is programmed in the VFD. A pressure transducer in the well transmits the actual level to the VFD. The VFD compares the actual level to the programmed set point and automatically adjusts the frequency of the electric supply to the pump motor to slow it down or speed it up depending on whether the actual level is above or below the set point. Eventually, the pump reaches a roughly steady state pumping rate that maintains the desired elevation in the well. It is expected that the flow rate will vary from well to well based on the permeability. This response will be incorporated into the final FVM

5. Please revise the FVM #5 to include additional CZ extraction wells or demonstrate through modeling that three extraction wells will be sufficient to achieve containment in the CZ.

Response: Prior to start up, particle tracks using the groundwater model will be provided for the CZ, UWBZ, and LSZ using the designed extraction network. After startup and equilibration, containment effectiveness will be evaluated based on extraction pumping and the enhanced monitoring network. If necessary based on combined containment provided by active extraction or the monitoring network, additional extraction or monitoring wells can be added or pumps can be moved to optimize the extraction configuration. This response will be incorporated into the final FVM

6. Without groundwater modeling to demonstrate that the proposed pumping rate of less than 75 gpm can provide containment, a flow rate closer to 150 gpm is recommended, as that flow rate was demonstrated to be effective for containment during the post-SEE pumping.

Response: The comparison to SEE extraction rates is not applicable since SEE extraction was designed to achieve 1.5-2x the steam injection rate and there is no steam injection occurring and no steam bubble present. The pumping rate of 75 gpm is comparable to the SEE extraction rate when not accounting for steam injection and is initially sufficient for containment evaluation in combination with the enhanced containment monitoring network.

7. What is the maximum temperature that the downstream treatment equipment can handle? What is the temperature limitation on the City of Mesa sewer discharge permit? The FVM does not describe what

would be done to reduce the groundwater temperatures so treatment and discharge could resume. Considering the high temperatures - approaching the boiling point of water - that were measured in the SEE treatment area on September 2, 2016 (Health, Safety, Environmental and Remediation Weekly Reports provided by Amec Foster Wheeler for the week ending September 2, 2016), a heat exchanger is likely needed in the treatment system. Shutdown of the containment system due to high temperatures without a means to cool the water and continue with extraction, treatment and discharge, cannot be tolerated.

Response: As noted in response to General Comment 3, the well pumps can pump groundwater at up to 175°F; however, the combined average discharge temperature will need to be maintained below 150°F, the permitted temperature limit of the system discharge. The treatment system components are designed to function at this temperature. Adjustment of pumping rates and wells will be the primary operational method used to maintain temperatures below discharge criteria. If such adjustments do not allow full containment to be demonstrated, cooling by blending with city water can be implemented until a heat exchange system is implemented. This response will be incorporated into the final FVM

8. EBR is not a hydraulic containment remedy. This extraction system will be necessary until another remedy is implemented that will eliminate the offsite migration of the plumes.

Response: This statement is not supported and is in conflict with the ROD and approved Work Plan. There is no data supporting migration of the contaminant plumes beyond the monitoring network. There is no requirement for active hydraulic containment as part of EBR implementation. AF is taking aggressive action to address site characterization concerns and will have installed over 30 additional Phase 1 and 2 wells to enhance containment monitoring. Extended operation of the extraction system will be contrary to implementing the selected remedy and result in deterioration of site conditions conducive to the maximum effectiveness of EBR.

9. Numerous SEE wells could not be checked for LNAPL accumulations in all three treatment zones because of eductor pumps. The extraction well network for this effort should be re-evaluated based on observations and measurements after the removal of eductor pumps.

Response: The wells could not be checked because EPA requested the AF to discontinue SEE decommissioning which interrupted removal of the eductors for the purpose of evaluating the presence of post-steam LNAPL as provided for in the Addendum #2 Work Plan (contingencies for LNAPL in new or existing wells are addressed in Addendum #2 Section 4.2.5). Based on EPA's direction, the AF will remove the eductors and begin monitoring and removal of LNAPL as applicable.

<u>Specific Comments</u>

1. The objectives should also include the recovery of accumulated LNAPL and contaminant mass.

Response: Concur. LNAPL monitoring, removal and recovery is a part of the remedy and will be addressed.

2. Please consider operating for an evaluation period in each zone at higher extraction rates (e.g., 10 to 12 gpm from each extraction well) and deeper drawdown to assess the potential for mass recovery via

simple physical methods augmented by the residual heat from SEE. The total extraction rate closer to that of SEE (or more) is recommended until the mass recovery rate diminishes to a low level and containment is demonstrated via groundwater sampling and analyses.

Response: LNAPL recovery efforts are appropriate, effective, and will be implemented but would not have the overall impact of site wide EBR implementation in regard to making progress towards remedial objectives. Based on Phase 1 characterization results, planned Phase 2 activities are expected to provide sufficient site characterization and monitoring for remedy decisions and initial implementation. Further enhancements will be evaluated as applicable. If EBR implementation is delayed despite sufficient site characterization and monitoring, the actions recommended in the comment may be an appropriate interim measure pending dispute resolution. It is the AF conclusion that sufficient site characterization and monitoring are a suitable basis to implement EBR consistent with the remedy. Given suitable characterization and monitoring, any further regulatory delays in EBR implementation, or insistence on extended active containment operations, will fatally impact the efficacy of EBR implementation and achieving the remedial action objectives.

3. Containment should not be based solely on monitoring of groundwater levels. Hydraulic control based on groundwater elevation monitoring is complicated by variations in groundwater temperature. A more detailed capture zone analysis is required.

Response: Evaluation of containment is not limited to groundwater levels. Containment will be based on evaluation of groundwater levels and results from the enhanced perimeter monitoring network.

4. Table 3-1. Please add a column that lists the design extraction rate for each well (i.e., the estimated initial extraction rate) and placement of pump within the screened interval (top of screen, bottom of screen, middle)

Response: As explained in response to general comment 3, there is a design groundwater elevation for each extraction well. These elevations will be added. The average extraction rate necessary to achieve these elevations will be evaluated with the groundwater model and provided prior to start up. However, operationally the flow rate will be allowed to vary automatically by the VFDs in order to maintain the specified groundwater elevation.

5. Section 3.2, Groundwater Treatment System Installation, Pages 4 and 5: Section 3.2 discusses the use of a chemical feed system, but the chemical(s) that will be used are not specified. Please revise FVM #5 to specify the chemical(s) that will be used.

Response: Section 3.2 indicates a biocide, defoamer, or descaler may be necessary. These three classes of chemicals were used during SEE. It is anticipated that the same chemicals will be used as were used during SEE; however, adjustments based on actual operating conditions are possible. Information on any new chemicals is submitted to the City of Mesa in accordance with the permit prior to use and will also be distributed to EPA and ADEQ.

6. 3.2 Groundwater Treatment System Installation Page 5, paragraph 4 should be edited to read, "All process air produced by the air stripper will be treated by the SVE thermal oxidizer." Please describe how the air stripper effluent air will be integrated with the extracted vapors from the SVE wells. Will the SVE well rate be significantly diminished by the flow from the air stripper? Will the air stripper effluent air serve as dilution air or combustion air in the thermal oxidizer? The text indicates that the

air stripper will be operated manually – does this mean it can only operate when an operator is present? Will extraction only occur if an operator is present? Will there be a holding tank for storage between operations of the air stripper? Or will an operator be present 24/7?

Response: The details of the air stripper connection to off-gas treatment will be provided. The air stripper will be connected to thermal oxidizer and the SVE system will remain on the flame oxidizer. Unlike the thermal oxidizer, the SVE flow rate for the flame oxidizer will not be significantly affected by high SVE well concentrations. The text indicates that the air stripper will be started manually but operation will be automatic once started and it will operate unattended. Operator presence will only be required to start the system following a manual or alarm-based shutdown. This response will be incorporated into the final FVM.

7. We note an inconsistency between Section 3.2 and Figure 3-1; Section 3.2 states that the bag filters are after the equalization tank, the figure shows the bag filters before this tank.

Response: Bag filters will be in both locations. The text and figure will be updated.

8. Figure 3-1, Treatment System Process Flow Diagram: The Treatment System Process Flow Diagram should indicate rates of various process flows including both anticipated and maximum rates. The diagram should indicate the production and treatment of air used in the air stripper. The treatment system should have sampling ports (e.g., between granular activated carbon [GAC] vessels, at a point before discharge to the sewer system, etc.), but the location of sampling ports are not shown on Figure 3-1. Please revise Figure 3-1 of FVM #5 to indicate the location of influent and effluent sampling ports.

Response: The requested information will be added to the figure.

9. Figure 3-2. Please add ST012-CZ01 or ST012-CZ08 to the monitoring well network. Why the proposed Cobble Zone (CZ) extraction wells are located mostly upgradient of the CZ contamination? The CZ is of greatest concern for containment given the expected increased transmissivity rates. What are the anticipated extraction rates required to contain downgradient LNAPL and dissolved phase contaminants to prevent offsite migration?

Response: ST012-CZ08 will be added for groundwater elevation and concentration measurements. The well is within an area of known dissolved phase contamination and therefore not ideal for perimeter groundwater concentration monitoring; however, given the extraction layout in the CZ may indicate the influence of extraction on the northern portion of the CZ. ST012-CZ23 and ST012-C02 provide perimeter coverage for monitoring dissolved phase groundwater to the northeast in the CZ. The three wells, ST012-CZ18, ST012-CZ19, and ST012-CZ21, represent three of the CZ wells with the highest dissolved phase contaminant levels, and ST012-CZ21 is well located at the perimeter of the site downgradient of impacted CZ wells. Existing well ST012-C02, and planned wells ST012-CZ23 and ST012-CZ24, will provide the perimeter downgradient monitoring network for the northeastern portion of the site pending overall evaluation of Phase 1, Phase 2 and initial extraction performance data. The pumping elevation setpoints an anticipated extraction rates will be provided prior to startup as described in response to specific comment 4. Future considerations regarding additional or alternate extraction and monitoring wells will be based on evaluation of the Phase 1, Phase 2, and initial extraction performance data (including LNAPL monitoring after removal of the remaining eductor pumps).

10. Figure 3-3. Please add ST012-UWBZ28 to the monitoring well network. Consider additional extraction and monitoring wells in the UWBZ thermal treatment zone pending the outcome of observations and measurements in former SEE extraction wells after the removal of 4 eductor pumps.

Response: ST012-UWBZ28 will be added for groundwater elevation measurements. The well is within an area of known dissolved phase contamination and therefore not ideal for perimeter groundwater concentration monitoring. Proposed well ST012-UWBZ37 provides perimeter coverage for monitoring dissolved phase groundwater to the north. Future considerations regarding additional or alternate extraction and monitoring wells will be based on evaluation of the Phase 1, Phase 2, and initial extraction performance data (including LNAPL monitoring after removal of the remaining eductor pumps).

11. Figure 3-4. Please add ST012-LSZ43 to the monitoring well network. Consider additional extraction and monitoring wells in the LSZ thermal treatment zone pending the outcome of observations and measurements in former SEE extraction wells after the removal of 11 eductor pumps.

Response: ST012-LSZ43 will be added for groundwater elevation measurements. The well is within an area of known dissolved phase contamination and therefore not ideal for perimeter groundwater concentration monitoring. ST012-W36, which has historically provided dissolved phase contamination data in this area, has fluctuated in concentration in part due to pumping, and is better suited for containment monitoring. ST012-W36 is missing from Table 4-1 but was included in Figure 3-4. Sampling and groundwater elevations at ST012-W36 will be added to the monitoring network. Future considerations regarding additional or alternate extraction and monitoring wells will be based on evaluation of the Phase 1, Phase 2, and initial extraction performance data (including LNAPL monitoring after removal of the remaining eductor pumps).

12. Section 4.0 Performance Monitoring. Performance monitoring should include volume of LNAPL collected in the oil water separator.

Response: LNAPL volumes will be added to the performance monitoring.

13. Table 4-1. Performance monitoring should include air flow rates into the air stripper and sampling of VOCs in the air effluent before its treatment.

Response: Air flow rates and air stripper vapor effluent samples will be added to the performance monitoring.

14. Section 6.0 Schedule. Fine tuning of active containment GWETS operation should include optimizing recovery of mobile LNAPL and contaminant mass.

Response: LNAPL recovery efforts are appropriate, effective, and will be implemented but would not have the overall impact of site wide EBR implementation in regard to making progress towards remedial objectives. LNAPL monitoring, removal and recovery is a part of the remedy and will be addressed during containment.