Hello! Thanks for helping to look at this, provide thoughts and insights, etc. - it's very appreciated.

It's important that your edits are easily found. So, with that in mind, please do all edits using Track Changes.

To use track changes in Excel, click on the "review" tab. Under Review, click "Track Changes" (located in the right-most a

Then click on "Highlight Changes". This should open a box with various options.

Check the box at the top, to track changes while editing.

Then make sure that the box next to "when" is checked, and the text says "all".

Make sure the box is checked next to "highlight changes on screen".

Project Stage	General Topic	Specific Metric(s)	Analysis Already Agreed To By USAF?
Monitoring Well Installations			
Baseline Data			
	Field Data		
		Groundwater gauge data (depth to water, depth to product, product thickness)	
		Perform Slug Tests	

Timing of Analyses	Frequency of Analyses	Location of Analyses
Before baseline geochemistry, field data, and microbial analyses performed	(Installation)	(Location of Installations)
	Once	CZ
	Once	UWBZ
	Once	LSZ
After SEE but before EBR injections or amendments	Once	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
	Once	All New Wells and Existing Wells that have not been tested

Purpose
These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. The extraction wells can be used, but must be considered in separate groups and are not sufficient for this evaluation. MWs are needed in suitable locations to monitor the effectiveness of EBR. Otherwise, data evaluation will be much less meaningful. Accurate delineation of concentrations in downgradient portions of the site should also be emphasized relative to off-site migration potential, sulfate utilization, etc. To the degree possible, wells should also be located so that aquifer heterogeneities (low-permeability zones) can be monitored and accurate spatial averages for parameter values can be computed.
These data, collectively, will help establish baseline criteria against which project progress and goals can be compared.
Hydraulic Conductivity Measurement

Additional Comments

New MWs must have time to equilibrate after installation and development before baseline field data, geochemistry, and microbial analyses are performed.

7 treatment "ovals" proposed, but only 3 ovals have monitoring wells that are in reasonable locations (5/17 BCT slides)

5 initial treatment "ovals" proposed; however, only one of the first 5 "ovals" where EBR is proposed for initial implementation has a monitoring well (ST012-UWBZ24), but it is not located in an optimal location for monitoring the effectiveness of treatment (i.e., it Is not located on the path between the injection and extraction wells); 5 additional treatment "ovals," but there are no monitoring wells in these ovals (5/17 BCT slides)

15 treatment "ovals" proposed, but only 2 have monitoring wells in suitable locations. 3 additional "ovals" have monitoring wells located beyond the extraction well. Depending on how the extraction wells are pumped, sulfate may never reach these monitoring wells (5/17 BCT slides)

	Biofouling	Y

Mapping Contaminant Locations and Concentrations

	Locate and map LNAPL presence and depth Locate and map dissolved-phase benzene presence and concentration, in excess of 5 ug/L	
	Locate and map dissolved-phase TPH presence and concentration [Do we want TPH or SVOC analyses, whereby we could get more specific hydrocarbon concentration data that could be used for comparing to model results?] - Doug	
	Calculate total LNAPL mass is present at start of EBR	Bo/Doug - has this been done to your satisfaction already?
	Determine the content of COCs in the LNAPL at the start of EBR	Bo/Doug - has this been done to your satisfaction already?
	Locate and map sulfate concentrations	Y

Modeling

After SEE but before EBR injections or amendments	Once	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
		New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area **[Testing LNAPL that naturally moves into monitoring wells does not give datat representative of the entire subsurface/LNAPL, but is a quick and easy way to get an idea if EBR is depleting COCs from LNAPL-DFP]** I agree
		Targeted treatment area and downgradient portions of the site
After SEE but before EBR injections or amendments	Once	

Comparison of NAPL compositions before/during EBR to assess reductions in COC content

When compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas and facilitate comparison of EBR modeling results with field data

This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this? Or maybe you just mean using LNAPL data from the existing wells, as AF has been doing to make the maps in the BCT Call PP presentations.-DFP I agree with Dan. Also, refer to Bo's comment on this topic --> Bo has sent comments to AF

ADEQ transmitted extensive comments on the most recent AF mass and composition estimates of remaining NAPL on May 16.

The existing characterization of NAPL composition is dated and displays a large deviation in a relatively small set of analyses. The most recent samples were collected from a NAPL holding tank. This NAPL was the combined recovery from the CZ, UWBZ and LSZ with unknown fractions from each. To allow a meaningful comparison of NAPL compositions before/during EBR to assess reductions in COC content, large set of NAPL should be collected and analyzed separately from each zone and across each zone.

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in email dated 5/11)? benzene mole-fraction/concentration changes with time in the LNAPL ?

	Provide a time estimate for sufficient LNAPL depletion of COCs	Bo/Doug - has this been done to your satisfaction already?
	Provide details of EBR modeling to calculate time estimates for remediation	Bo/Doug - has this been done to your satisfaction already?
	Provide proof of concept supporting the sulfate reduction for EBR	Bo/Doug - has this been done to your satisfaction already?
	Provide details used to determine the optimal sulfate injection strategy.	Bo/Doug - has this been done to your satisfaction already?

GW Geochemistry

	Temperature	Y
	pH	Y
	ORP value	Y
	Dissolved Oxygen	Y
	Nitrate	Y
	Ferrous Iron	
	Total Iron	
	Sulfate	Y
	Hydrogen Sulfide	
	Methane	
	Alkalinity	
	TPH (DRO, GRO)	Y
	VOCs	Y

After SEE but before EBR injections or amendments	Once [Not sure what "once" means, but these geochemistry analyses should be done on every groundwater sample]	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area

EBR modeling by the AF ignored rate-limited mass transfer of hydrocarbons from the LNAPL to groundwater (AF modeling assumes equilibrium conditions between LNAPL and groundwater, which means unlimited mass transfer from the LNAPL). This mechanism is is very important and can significantly extend remediation time frames.The Regulatory Agencies technical team has performed volume-averaged EBR modeling that confirms the importance of rate-limited LNAPL dissolution (sent to AF under separate cover).

Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results. The Regulatory Agencies technical team has sent a list of these deficiencies to AF.

In particular, very little field data exists for the CZ and the UWBZ. The AF has not performed the EBR pilot test in the UWBZ that was agreed to in the ST012 Work Plan.

Reported on AF flowchart as Eh
[AF converts field ORP values to Eh by correcting for the electrode potential of the reference electrode. In the Decision Tree they indicate: "(Correct to hydrogen electrode) Eh should be in expected range for anaerobic SRBs" - DFP]

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored
[Probably means ferrous iron (i.e., dissolved iron), though it could be total iron (ferrous plus ferric), which is almost always mostly ferrous iron - since ferric iron has low solubility - DFP]
AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

	Arsenic	Y
Indigenous Microbial Population		
	Total size	
	Major groups within population, and their proportion of total	
	Total size of sulfate-reducing bacteria	Y(?)
	Total size of benzene-degrading bacteria	
	In-situ benzene degradation rate	
	Amount of benzene converted to biomass during stable isotope study	Y
	Amount of benzene converted to carbon dioxide during stable isotope study	Y
	The overall health of the indigenous microbial population, as determined via PLFA analyses	
	The dominant electron-accepting process for indigenous microbial population, and reason for the conclusion	

After SEE but before EBR injections or amendments	In an ideal world, it would be helpful to have these samplers placed so as to monitor the core of a plume (1-2 samplers), its periphery (1-2 samplers), and downgradient (1 sampler). These samplers cannot be used in LNAPL, but can be deployed underneath LNAPL. Any thoughts, Dan? [Maybe they could pick one representative plume (portion of the Site) to do the whole nine yards as you suggest. Mainly, I just want to see that the microbes respond strongly (in a good way - increased populations) to injection of sulfate, and that response is related to increased disappearance of COCs]. I don't know that we need to continuously monitor all parts of the Site/plume with all the microbiological analyses, as long as we have some initial analyses, and COC disappearance continues at a useful rate.]

These analyses will quantify the size, makeup, and health of the indigenous microbial community. All items other than the last metric are included as part of the already-proposed standard stable-isotope probe (SIP; Bio-Trap) study listed on the AF decision flowchart, but are not included in the metrics to be reported. All of these data are key to fully understanding the makeup, activities, and health of the indigenous microbial population.

AF decision flowchart references SRB gene, but Microbial Insights uses the APS gene to screen for sulfate reducers. Unclear as to what "SRB" gene is being referenced in flowchart.

Assessments During EBR

	Field Data		
		Groundwater gauge data (depth to water, depth to product, product thickness)	
		Biofouling	Y
	Mapping Contaminant Locations and Concentrations		
		Locate and map LNAPL presence and depth - monitoring wells	y
		Locate and map dissolved-phase benzene presence and concentration, in excess of 5 ug/L	y
		Locate and map dissolved-phase TPH presence and concentration	y
		Calculate total LNAPL mass	
		Determine the content of COCs in the LNAPL	
		Locate and map sulfate concentrations in the targeted treatment area as well as downgradient	Y

	Monthly for the first quarter of EBR, followed by quarterly	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
During EBR		New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
	Sampling and analysis following schedule outlined in Table 4.1 of referenced document; mapping performed once per month	
	Quarterly	
	Quarterly	MWs with recoverable NAPL located in the area to be impacted by injections/ amendments

These assessments will be used to monitor the progress of EBR, and to determine if changes to the EBR strategy need to be made. These will also help monitor progress of EBR.

Comparison of NAPL compositions before/during EBR to assess reductions in COC content

Final Field Variance Memorandum #5 – Extraction and Treatment System Construction, Former Liquid Fuels Storage Area, Site ST012, Former Williams Air Force Base, Mesa, Arizona; 01 Dec 2016

Update based on additional field data
[I suspect that the range of variability in LNAPL mass calculations is so great that we won't be able to detect differences in estimated LNAPL mass from quarter to quarter, or even year to year-DFP] I definitely agree with Dan. Quarterly is too often to be reasonable. Probably should just do this post-EBR, and characterize as many LNAPL sample as possible in order to obtain a meaningful spatial average for LNAPL composition in the treatment zone.

Update based on additional field data [same comment as in above cell]

when compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas

Modeling

Provide a time estimate for sufficient LNAPL depletion of COCs
Provide details of EBR modeling to calculate time estimates for remediation

Provide proof of concept supporting the sulfate reduction for EBR

Provide details used to determine the optimal sulfate injection strategy.

During EBR	Quarterly (see my comment to the right ---> Just do modeling post-EBR after all field data have been collected and use these modeling results (and, for example, measured bio rates) as part of the overall assessment of whether EBR is viable	

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in email dated 5/11)? benzene mole-fraction/concentration changes with time in the LNAPL ? [I believe we've covered this. Don't worry about half-saturation constants. AMEC needs to give us much more documentation of their modeling in order for us to understand what they did]	
Ongoing updates as field data become available. EBR modeling by the AF ignored rate-limited mass transfer of hydrocarbons from the LNAPL to groundwater (AF modeling assumes equilibrium conditions between LNAPL and groundwater, which means unlimited mass transfer from the LNAPL). This mechanism is is very important and can significantly extend remediation time frames.The Regulatory Agencies technical team has performed volume-averaged EBR modeling that confirms the importance of rate-limited LNAPL dissolution (sent to AF under separate cover). Ongoing updates as field data become available. Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results. The Regulatory Agencies technical team has sent a list of these deficiencies to AF.	
Ongoing updates as field data become available	
Ongoing updates as field data become available	

GW Geochemistry		
	Temperature	Y
	pH	Y
	ORP value	Y
	Dissolved Oxygen	Y
	Nitrate	Y
	Ferrous Iron	
	Total Iron	
	Sulfate	Y
	Hydrogen Sulfide	
	Methane	
	Alkalinity	
	TPH (DRO, GRO)	Y
	VOCs	Y
	Arsenic	Y
Soil Geochemistry		
	Continuous logging	Y
	PID readings	Y

During EBR	Monthly for the first quarter of EBR, followed by quarterly	New and existing MWs, located in the area to be impacted by injections/ amendments, and downgradient of this area
During EBR, following Table 5.1	During EBR, following Table 5.1	Following Table 5.1

Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous microbial populations? What is the dominant TEA process being used over time? If/when sulfate is no longer limiting rates of degradation, what will limit the reaction and what degradation rates can be expected?
[Not sure what other degradation processes might be inhibitive.

AMEC probably will include nutrients in the injection solution just to be sure plenty of nutrients (N and P, maybe some vitaminoids) are available. Sometimes N and P are monitored, which may be worthwhile for a hydrocarbon plume with large excesses of electron donors. AMEC indicates in the Decision Tree:
"a. Evaluate other factors that could be limited EBR (e.g., lack of micronutrients) and implement additional extraction/injections if necessary
b. Implement additional injections if necessary (e.g., to address micronutrients)"

Determining other limiting factors can be tricky. - DFP]

Will periodic sulfate injections or recirculation be necessary to sustain degradation rates?
[I think AMEC is going toward multiple injections over time
Will hydrogen sulfide concentrations inhibit degradation or will subsurface conditions mitigate their buildup?

These analyses will provide an indirect method of monitoring the indigenous microbial community.

Reported on AF flowchart as Eh

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored
AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

Taken from Table 5.1, RD-RAWP Addendum 2 (March 2016)

	LNAPL Dye Test	Y
	VOCs	Y
	TPH (DRO, GRO)	Y
TEA Injection Fluid		
	ICP Metals	Y
	Sulfate	Y
Indigenous Microbial Population		
	Total size	
	Major groups within population, and their proportion of total	
	Total size of sulfate-reducing bacteria	Y (?)
	Total size of benzene-degrading bacteria	
	In-situ benzene degradation rate	
	Amount of benzene converted to biomass during stable isotope study	Y
	Amount of benzene converted to carbon dioxide during stable isotope study	Y
	The overall health of the indigenous microbial population, as determined via PLFA analyses	
	The dominant electron-accepting process for indigenous microbial population, and reason for the conclusion	
Injection/ Amendment Information		
	Location of each injection/amendment	

	Monthly, per Table 5.1	
During EBR, 6-9 months post-injection (per Decision Matrix)	At least once during EBR	Ideally, samplers would be deployed in the same MWs as for pre-EBR analysis. This way, we're comparing apples to apples, and have eliminated any variability due to different locations. Any thoughts, Dan? [Same wells sounds good.-DFP]
During EBR, for every injection/ amendment event and location		

Is benzene slower to degrade than other aromatics, or faster, or average?

To record makeup and concentration of injection fluid

What is the lag time for SRB to acclimate to elevated sulfate concentrations (not included in the model)? Determine if highly concentrated injections of sulfate will be inhibitive to bacterial activity

Taken from Table 5.1, RD-RAWP Addendum 2 (March 2016)

This data will be used to determine how the indigenous microbial community has responded to the injections/amendments and if EBR is increasing benzene biodegradation as intended. These analyses will also be a direct method to monitor the health of the indigenous population, including their response to the concentrations of sulfate being injected. Additional rounds of microbial analyses may be needed if direct or indirect monitoring data suggests.

Taken from Table 5.1, RD-RAWP Addendum 2 (March 2016). AF decision flowchart references SRB gene, but Microbial Insights uses the APS gene to screen for sulfate reducers. Unclear as to what "SRB" gene is being referenced in flowchart.

This data will provide a record of exactly what was injected, where, and at what concentration. This, when compared with the response by the contaminants and other geochemical and biological data, will help determine if any changes need to be made to amendment variables such as frequency, concentration, etc.

		Concentration of sulfate at each injection/ amendment location Anticipated zone of influence for each injection/ amendment When sulfate is no longer limiting rates of degradation, what will limit the reaction and what degradation rates can be expected?	
Post-EBR Data			
	Field Data		
		Groundwater gauge data (depth to water, depth to product, product thickness)	
		Biofouling	Y
	Mapping Contaminant Locations and Concentrations		
		Locate and map LNAPL presence and depth Locate and map dissolved-phase benzene presence and concentration, in excess of 5 ug/L Locate and map dissolved-phase TPH presence and concentration Calculate total LNAPL mass present at conclusion of EBR Determine the content of COCs in the LNAPL at the conclusion of EBR	

Post-EBR	Quarterly, until the official start of the MNA phase of the site (??) [What is the "official start of MNA"? Do you need data this often?]	Each MW used for injections, amendments, or any analyses
Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)	Each MW used for injections, amendments, or any analyses
[Same comments as above]		

Will the injected sulfate become well distributed with respect to NAPL accumulations?

This data will be compared against baseline data, and data taken during EBR, to determine the success of the project as well as to identify necessary future actions. This data will also become the baseline information used at the start of MNA

Update based on additional field data

[At the end of EBR, LNAPL should be sampled throughout the Site (not just from LNAPL in monitoring wells) to determine if LNAPL throughout the Site, including in low permeability/low flow zones), is depleted of COCs to the extent necessary to keep GW COC concentrations below RAOs. This LNAPL sampling will require boreholes. - DFP] Very good comment. We need to emphasize this clearly

	Locate and map sulfate concentrations in the targeted treatment area as well as downgradient	Y
Modeling		
	Provide a time estimate for sufficient LNAPL depletion of COCs by MNA	
	Provide details of post-EBR modeling to calculate time estimates for remediation	
GW Geochemistry		
	Temperature	Y
	pH	Y
	ORP value	Y
	Dissolved Oxygen	Y
	Nitrate	Y
	Ferrous Iron	
	Total Iron	
	Sulfate	Y
	Hydrogen Sulfide	
	Methane	
	Alkalinity	
	TPH (DRO, GRO)	Y
	VOCs	Y
	Arsenic	Y
Indigenous Microbial Population		

Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)	
[Same comments as above. Per my above comments, I don't think you need "modeling" during EBR, just post-EBR]		
Post-EBR	Quarterly, until the official start of the MNA phase of the site (??)	Each MW used for injections, amendments, or any analyses
Post-EBR	Once, within 3 months of the last injection/ amendment	Ideally, samplers would be deployed in the same MWs as for pre-EBR, and during-EBR analyses. This way, we're comparing apples to apples, and have eliminated any variability due to different locations. Any thoughts, Dan? [Same wells sounds good.-DFP]

when compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in email dated 5/11)? benzene mole-fraction/concentration changes with time in the LNAPL ? [Refer to our comments throughout on this questions]

[Same comments as above]

Reported on AF flowchart as Eh

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored

This data will be used to determine how the indigenous microbial community has responded to the injections/amendments and if EBR is increasing benzene biodegradation as intended. These analyses will also be a direct method to monitor the health of the indigenous population

		Total size	
		Major groups within population, and their proportion of total	
		Total size of sulfate-reducing bacteria	
		Total size of benzene-degrading bacteria	Y (?)
		In-situ benzene degradation rate	
		Amount of benzene converted to biomass during stable isotope study	Y
		Amount of benzene converted to carbon dioxide during stable isotope study	Y
		The overall health of the indigenous microbial population, as determined via PLFA analyses	
		The dominant electron-accepting process for indigenous microbial population, and reason for the conclusion	

AF decision flowchart references SRB gene, but Microbial Insights uses the APS gene to screen for sulfate reducers. Unclear as to what "SRB" gene is being referenced in flowchart.

Cell: D15
Comment: Bo Stewart:
I provided extensive comments to ADEQ on the most recent AF mass estimates. These were transmitted to AF on May 16. Short answer is No.

Cell: D16
Comment: Doug:
I think Bo has addressed your question

Cell: C55
Comment: Doug:
Same comments as above

Cell: C58
Comment: Doug:
Same comments/questions as above

Action Number	Date	Time	Who	Change	Sheet	Range
1	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I16
2	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	G16
3	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	H16
4	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I15
5	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C19
6	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C20
7	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I20
8	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C22
9	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C21
10	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I21
11	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C16
12	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C57
13	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	F56
14	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	F57
15	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I56
16	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I57
17	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	H57
18	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	G57
19	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I60
20	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	F59
21	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C60
22	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C61
23	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C62
24	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C63
25	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I61
26	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I63
27	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I62
28	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C64
29	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C112
30	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	I112
31	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C113
32	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C56

New Value
The existing characterization of NAPL composition is dated and displays a large deviation in a relatively small set of analyses. The most recent samples were colle
New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area
Comparison of NAPL compositions before/during EBR to assess reductions in COC content
ADEQ transmitted extensive comments on the most recent AF mass and composition estimates of remaining NAPL on May 16.
Provide a time estimate for sufficient LNAPL depletion of COCs
Provide details of EBR modeling to calculate time estimates for remediation
Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results
Provide details used to determine the optimal sulfate injection strategy.
Provide proof of concept supporting the sulfate reduction for EBR
In particular, very little field data exists for the CZ and the UWBZ. The AF has not performed the EBR pilot test in the UWBZ that was agreed to in the ST012 Work
Determine the content of COCs in the LNAPL at the start of EBR
Determine the content of COCs in the LNAPL
Quarterly
Quarterly
Update based on additional field data
Update based on additional field data
Comparison of NAPL compositions before/during EBR to assess reductions in COC content
MWs with recoverable NAPL located in the area to be impacted by injections/ amendments
Ongoing updates as field data become available
Quarterly
Provide a time estimate for sufficient LNAPL depletion of COCs
Provide details of EBR modeling to calculate time estimates for remediation
Provide proof of concept supporting the sulfate reduction for EBR
Provide details used to determine the optimal sulfate injection strategy.
Ongoing updates as field data become available
Ongoing updates as field data become available
Ongoing updates as field data become available
<blank>
Calculate total LNAPL mass present at conclusion of EBR
Update based on additional field data
Determine the content of COCs in the LNAPL at the conclusion of EBR
Calculate total LNAPL mass

Old Value
<blank>
<blank>
<blank>
<blank>
Determine the time estimate for LNAPL removal
Provide details of how pre-EBR LNAPL models were generated
<blank>
Provide details used to determine the sulfate calculations
Calculate the amount of sulfate needed to maximize benzene biodegradation
<blank>
Determine the amount of benzene in the LNAPL at the start of EBR
Determine the amount of benzene in the LNAPL
Monthly
Monthly
<blank>
<blank>
<blank>
<blank>
<blank>
Quarterly (?)
Determine the time estimate for LNAPL removal
Provide details of how pre-EBR LNAPL models were generated
Calculate the optimal amount of sulfate needed to maximize benzene biodegradation
Provide details used to determine the sulfate calculations
<blank>
<blank>
<blank>
Assess depletion of aromatic compounds from NAPL
Calculate total LNAPL mass is present at conclusion of EBR
<blank>
Determine the amount of benzene in the LNAPL at the conclusion of EBR
Calculate total LNAPL mass is present

Action Type	Losing Action

33	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C116
34	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C117
35	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C118
36	5/24/2017	4:11 PM	Bo Stewart	Cell Change	Entire Lifecycle	C119
37	5/25/2017	10:23 AM	Windows User	Cell Change	Entire Lifecycle	H2
38	5/25/2017	10:23 AM	Windows User	Cell Change	Entire Lifecycle	I2
39	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	I56
40	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	I12
41	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	G16
42	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	F23
43	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	I26
44	5/25/2017	10:54 AM	Windows User	Cell Change	Entire Lifecycle	G38
45	5/25/2017	11:00 AM	Windows User	Cell Change	Entire Lifecycle	I12
46	5/25/2017	11:11 AM	Windows User	Cell Change	Entire Lifecycle	G89
47	5/25/2017	11:15 AM	Windows User	Cell Change	Entire Lifecycle	G135
48	5/25/2017	1:04 PM	Windows User	Cell Change	Entire Lifecycle	I29
49	5/25/2017	1:04 PM	Windows User	Cell Change	Entire Lifecycle	H65
50	5/25/2017	1:14 PM	Windows User	Cell Change	Entire Lifecycle	H73
51	5/25/2017	1:14 PM	Windows User	Cell Change	Entire Lifecycle	H65
52	5/25/2017	1:14 PM	Windows User	Cell Change	Entire Lifecycle	I26
53	5/25/2017	1:24 PM	Windows User	Cell Change	Entire Lifecycle	I113
54	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'104:104
55	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'48:48
56	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'6:6
57	5/25/2017	1:24 PM	Windows User	Row Delete	Entire Lifecycle	'2:2
58	5/25/2017	2:43 PM	Doug	Cell Change	Entire Lifecycle	H2

Provide a time estimate for sufficient LNAPL depletion of COCs by MNA
Provide details of post-EBR modeling to calculate time estimates for remediation
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These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be u
New MWs must have time to equilibrate after installation and development before baseline field data, geochemistry, and microbial analyses are performed.

Update based on additional field data
[I suspect that the range of variability in LNAPL mass calculations is so great that we won't be able to detect differences in estimated LNAPL mass from quarter
This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this?-DFP
New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area [Testing LNAPL that
Once
[Not sure what "once" means, but these geochemistry analyses should be done on every groundwater sample]
Reported on AF flowchart as Eh
[AF may convert field ORP values to Eh by correcting for the electrode potential of the reference electrode]
In an ideal world, it would be helpful to have these samplers placed so as to monitor the core of a plume (1-2 samplers), its periphery (1-2 samplers), and downgr

This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this? Or maybe you ju

Ideally, samplers would be deployed in the same MWs as for pre-EBR analysis. This way, we're comparing apples to apples, and have eliminated any variability due to different locations. Any thoughts, Dan?

Ideally, samplers would be deployed in the same MWs as for pre-EBR, and during-EBR analyses. This way, we're comparing apples to apples, and have eliminated any variability due to different locations. Any thoughts, Dan?

AF decision flowchart only mentions "Iron" as an analyte, without differentiating which iron species will be monitored
[Probably means ferrous iron (i.e., dissolved iron), though it could be total iron (ferrous plus ferric), which is almost always mostly
Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous r

Will periodic sulfate injections or recirculation be necessary to sustain degradation rates?
[I think AMEC is going toward multiple injections over time
Inhibition by other degradation processes and nutrient availability are not included in the model, are these factors important? How healthy are the indigenous r
Reported on AF flowchart as Eh
[AF converts field ORP values to Eh by correcting for the electrode potential of the reference electrode. In the Decision Tree they indicate: "(Correct to

[At the end of EBR, LNAPL should be sampled throughout the Site (not just from LNAPL in monitoring wells) to determine if LNAPL throughout the Site, including i

These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be u

Determine the time estimate for remaining LNAPL removal
Provide details of how post-EBR LNAPL models were generated
Calculate the amount of sulfate needed to complete benzene (dissolved and LNAPL) biodegradation
Provide details used to determine the sulfate calculations

These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be u
New MWs must have time to equilabrate after installation and development before baseline field data, geochemistry, and microbial analyses are performed.

Update based on additional field data
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New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area

Once

Reported on AF flowchart as Eh
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59	5/25/2017	2:49 PM	Doug	Cell Change	Entire Lifecycle	H2
60	5/25/2017	2:50 PM	Doug	Cell Change	Entire Lifecycle	H2
61	5/25/2017	2:52 PM	Doug	Cell Change	Entire Lifecycle	H2
62	5/25/2017	2:56 PM	Doug	Cell Change	Entire Lifecycle	H2
63	5/25/2017	3:01 PM	Doug	Row Insert	Entire Lifecycle	'9:9
64	5/25/2017	3:01 PM	Doug	Cell Change	Entire Lifecycle	C9
65	5/25/2017	3:01 PM	Doug	Cell Change	Entire Lifecycle	F9
66	5/25/2017	3:01 PM	Doug	Cell Change	Entire Lifecycle	H9
67	5/25/2017	3:02 PM	Doug	Cell Change	Entire Lifecycle	C9
68	5/25/2017	3:02 PM	Doug	Cell Change	Entire Lifecycle	G9
69	5/25/2017	3:03 PM	Doug	Range Move	Entire Lifecycle	I9, H9
70	5/25/2017	3:06 PM	Doug	Cell Change	Entire Lifecycle	I12
71	5/25/2017	3:09 PM	Doug	Cell Change	Entire Lifecycle	G16
72	5/25/2017	3:11 PM	Doug	Cell Change	Entire Lifecycle	C14
73	5/25/2017	3:14 PM	Doug	Cell Change	Entire Lifecycle	C17
74	5/25/2017	3:17 PM	Doug	Cell Change	Entire Lifecycle	G17
75	5/25/2017	3:17 PM	Doug	Cell Change	Entire Lifecycle	C17
76	5/25/2017	3:19 PM	Doug	Cell Change	Entire Lifecycle	I17
77	5/25/2017	3:22 PM	Doug	Cell Change	Entire Lifecycle	I17
78	5/25/2017	3:22 PM	Doug	Cell Change	Entire Lifecycle	H17
79	5/25/2017	3:27 PM	Doug	Cell Change	Entire Lifecycle	I19
80	5/25/2017	3:29 PM	Doug	Cell Change	Entire Lifecycle	I20
81	5/25/2017	3:37 PM	Doug	Cell Change	Entire Lifecycle	I20
82	5/25/2017	3:39 PM	Doug	Cell Change	Entire Lifecycle	I19
83	5/25/2017	3:51 PM	Doug	Cell Change	Entire Lifecycle	I56
84	5/25/2017	3:52 PM	Doug	Cell Change	Entire Lifecycle	I56
85	5/25/2017	3:53 PM	Doug	Cell Change	Entire Lifecycle	I57
86	5/25/2017	3:56 PM	Doug	Cell Change	Entire Lifecycle	I60
87	5/25/2017	3:58 PM	Doug	Cell Change	Entire Lifecycle	I61
88	5/25/2017	4:03 PM	Doug	Cell Change	Entire Lifecycle	F59
89	5/25/2017	4:03 PM	Doug	Cell Change	Entire Lifecycle	I59
90	5/25/2017	4:08 PM	Doug	Cell Change	Entire Lifecycle	E113

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Perform Slug Tests in New Wells Once Hydraulic Conductivity Measurement
Perform Slug Tests All New Wells and Existing Wells that have not been tested
This would be a major effort, with multitudes of new boreholes, to map LNAPL in any more detail than we already have! Do we really need this? Or maybe you ju
New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area [Testing LNAPL that
Locate and map dissolved-phase TPH presence and concentration [Do we want TPH or SVOC analyses, whereby we could get more specific hydrocarbon concentr
Locate and map sulfate concentrations in the targeted treatment area as well as downgradient portions of the site
Targeted treatment area and downgradient portions of the site Locate and map sulfate concentrations
When compared to this baseline data, this information will help monitor for sulfate migration outside of the COC areas and facilitate comparison of EBR modeling
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EBR modeling by the AF ignored rate-limited mass transfer of hydrocarbons from the LNAPL to groundwater (AF modeling assumes equilibrium conditions betwe
Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results. EPA/ADEQ has sent a list of these deficiencies to
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Update based on additional field data [I suspect that the range of variability in LNAPL mass calculations is so great that we won't be able to detect differences in estimated LNAPL mass from quarter
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Update based on additional field data [same comment as in above cell]
Ongoing updates as field data become available. EBR modeling by the AF ignored rate-limited mass transfer of hydrocarbons from the LNAPL to groundwater (AF
Ongoing updates as field data become available. Modeling to date by the AF has not been sufficiently documented to allow an independent check on the results.
Quarterly [see my comment to the right --> Just do modeling post-EBR after all field data have been collected and use these modeling results (and, for example,
Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in ema
[Same comments as above]

These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. Neither the injection wells nor the extraction wells can be u

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Perform Slug Tests in New Wells

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New and existing MWs with recoverable NAPL, located in the area to be impacted by injections/ amendments, and downgradient of this area [Testing LNAPL that

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Quarterly

Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in ema

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91	5/25/2017	4:08 PM	Doug	Cell Change	Entire Lifecycle	E117
92	5/25/2017	4:09 PM	Doug	Cell Change	Entire Lifecycle	I113
93	5/25/2017	4:14 PM	Doug	Cell Change	Entire Lifecycle	I115
94	5/25/2017	4:14 PM	Doug	Cell Change	Entire Lifecycle	E117
95	5/25/2017	4:14 PM	Doug	Cell Change	Entire Lifecycle	I115
96	5/25/2017	4:15 PM	Doug	Cell Change	Entire Lifecycle	I115
97	5/25/2017	4:15 PM	Doug	Cell Change	Entire Lifecycle	I117
98	5/25/2017	4:17 PM	Doug	Cell Change	Entire Lifecycle	F105
99	5/25/2017	3:37 PM	KBrasaemle	Cell Change	Entire Lifecycle	H2

The history ends with the changes saved on 5/25/2017 at 3:37 PM.

[Same comments as above]
[At the end of EBR, LNAPL should be sampled throughout the Site (not just from LNAPL in monitoring wells) to determine if LNAPL throughout the Site, including i
Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in ema
[Same comments as above. Per my above comments, I don't think you need "modeling" during EBR, just post-EBR]
Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in ema
Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in ema
[Same comments as above]
Quarterly, until the official start of the MNA phase of the site (??) [What is the "official start of MNA"? Do you need data this often?]
These MWs are needed to ensure that there are sufficient MWs to evaluate the effectiveness of EBR. The extraction wells can be used, but must be considered in

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[At the end of EBR, LNAPL should be sampled throughout the Site (not just from LNAPL in monitoring wells) to determine if LNAPL throughout the Site, including i
Bo/Doug: Want to comment on the use of proper transport mechanisms when doing modeling? What about half-saturation comments (Doug mentioned in ema [Same comments as above]
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