Department of Energy
Savannah River Operations Office
P.O. Box A
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JUN 11 2020

Ms. Susan B. Fulmer, P.G., Manager
Federal Remediation Section
Division of Site Assessment, Remediation and Revitalization
Bureau of Land and Waste Management
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201

Mr. Jon Richards
Savannah River Site Remedial Project Manager
Superfund Division
U. S. Environmental Protection Agency, Region 4
61 Forsyth Street, SW
Atlanta, Georgia 30303

Dear Ms. Fulmer and Mr. Richards:

SUBJECT: Removal Action Report (RAR) for the C-Area Groundwater (CAGW) Operable Unit (OU) Bio-Barrier Non-Time Critical (NTC) Removal Action (U) (SRNS-RP-2019-00584, Revision 1, June 2020) (Redline Pages and Clean Copy) and the Savannah River Site's Responses to the Regulatory Comments on the Revision 0 Document, SEMS Number: 82

The U. S. Department of Energy (DOE) is submitting the subject document for your review and approval. The South Carolina Department of Health and Environmental Control (SCDHEC) provided approval of the Revision 0 document on February 25, 2020 and U. S. Environmental Protection Agency (EPA) provided comments on the Revision 0 Document on April 3, 2020. The Savannah River Site's responses to the regulatory comments are also enclosed. Please review the enclosures and provide your response within thirty (30) days of receipt. The effort and time that the SCDHEC and the EPA have given on the subject operable unit are greatly appreciated.

Questions from you or your staff may be directed to me at (803) 952-8365, or the DOE Federal Project Director, Ms. Karen Adams, at (803) 952-7871.

Sincerely,

Brian T. Hennessey
SRS Remedial Project Manager
Infrastructure and Area Completion Division

IACD-20-163

Enclosures:
1. Removal Action Report (RAR) for the C-Area Groundwater (CAGW) Operable Unit (OU) Bio-Barrier Non-Time Critical (NTC) Removal Action (U) (SRNS-RP-2019-00584, Revision 1, June 2020) (Redline Pages and Clean Copy) SEMS Number: 82
2. SRS Responses to the U.S. Environmental Protection Agency Comments on the Removal Action Report (RAR) for the C-Area Groundwater (CAGW) Operable Unit (OU) Bio-Barrier Non-Time Critical (NTC) Removal Action (U) (SRNS-RP-2019-00584, Revision 0, December 2019) SEMS Number: 82

cc w/o encl:
H. Porter, SCDHEC-Columbia
S. French, SCDHEC-Columbia
M. Reece, SCDHEC-Columbia
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T. Fuss, SCDHEC–Aiken Environmental Affairs Office
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R. H. Pope, EPA-Atlanta

cc w/encl:
J. Tufts, EPA-Atlanta
M. McRae, TechLaw, Inc.

SRS Responses to EPA Comments on the Removal Action Report for the C-Area Groundwater Operable Unit Bio-barrier Non-time Critical Removal Action SEMS Number: 82, SRNS-RP-2019-00584, Revision 0, December 2019, Savannah River Site, South Carolina

Received April 3, 2020

I. GENERAL COMMENTS

1. The Draft RAR should provide a summary table(s) that presents information that includes the following: injection location; injection date; injection time; injection depth; injection rates (average, minimum, maximum); conditions of each of the injection components including (as applicable) temperature, pH, dissolved oxygen, specific conductance, oxygen reduction potential); and, any visual observations noted in the field. Revise the Draft RAR to provide a table(s) summarizing the details of the above-referenced data for each of the fifteen injection points.

   Response: Agree.

   New "Table 3. Oil Injection Locations, Depths and Injections Rates" and new "Table 4. Oil Injection Field Parameters", included with these responses, will be cited in Section 4.2.3 and added to the tables section in the revised RAR. Note that the number of "Table 3. Project Cost Comparison" will change to Table 5 in the revised document.

   Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

2. The Draft RAR should provide additional information to confirm that the final design requirements were met. For example, the list on Page 11 of 28 in Section 4.1.3 summarizes how the final design requirements were documented as being met; however, the following deficiencies are noted:

   a) The text states that emulsified oil mixture injections were primarily within the MAZ; however, the Draft RAR does not discuss or document how the presence of the MAZ at each injection point was confirmed.

      Response: Agree/Clarification.

      The depth interval for the MAZ was established by Lithology CPTs and cores at two wells CRW023C and CRW024C in each injection area. Section 4.1.3 item "b" will be revised as follows:

      "**b)** The emulsified oil mixture injections were primarily within the MAZ where the groundwater contamination is present. **Within Oil Injection Area 1 the MAZ depth and thickness were determined by the core described at well CRW024C. Within Oil Injection Area 2 the MAZ depth and thickness were determined by the core described at well CRW023C. Lithology CPTs CGW-68, CGW106, CSB-107, CSB-108 and CSB-122 provide a regional context for the MAZ depth and thickness**."

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   b) The text states that the goal of the two buffers (i.e. sodium bicarbonate and EOS CoBupHMg™) were to raise groundwater pH to the optimal range for bioremediation.

However, the Draft RAR does not discuss or provide supporting documentation to confirm that pH conditions of the groundwater unit post injection were monitored to confirm this goal was met.

Revise the Draft RAR to provide supporting documentation.

Response: Agree/Clarification.

Sampling to determine the pH of groundwater immediately after injections was not available because injections were performed using DPT. However, the performance of the buffering agents will be assessed through future effectiveness monitoring. The *Removal Action Design Plan with Effectiveness Monitoring Plan for the C-Area Groundwater Operable Unit* (SRNS-RP-2018-00807) specifies the monitoring of the bio-barriers. There are 5 primary wells (CRW023C, CRW024C, CRW026C, CRW027C and CRW028C) monitoring the effectiveness, which have pH measurements taken every sample event. SRS believes these wells will identify pH changes in the groundwater. The first CAGW OU Removal Action EMR is due August 30, 2020. Section 4.1.3 item "c" will be revised as follows:

"c) The emulsified oil mixture contained 136 kg (300 lbs) of sodium bicarbonate, per the final design. After all the emulsified oil mixture was injected into the subsurface, an additional 151 L (40 gal) of EOS CoBupHMg™ buffer mixed with 757 L (200 gal) of dilution water was injected into the subsurface, per the final design. The goal of these two buffers is to raise groundwater pH to the optimal range, 6 to 8, for bioremediation by the microbes. **Five wells (CRW023C, CRW024C, CRW026C, CRW027C and CRW028C) monitor the groundwater chemistry near Oil Injection Areas 1 and 2. These wells have pH measurements taken every sample event and will identify pH changes in the groundwater. These data will be reported in the annual CAGW OU Removal Action Effectiveness Monitoring Reports."**

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3. Per Appendix E, Subcontractor Field Notebook, visual observations of daylighting were used during construction activities. However, the Draft RAR lacks discussion of visual observations of daylighting and how this information was used to implement the removal action. Revise the Draft RAR to include discussion of how visual observations of daylighting were used to successfully implement removal action construction activities.

Response: Agree/Clarification.

The oil injection crew visually monitored for day-lighting (i.e., oil observed at the ground surface) at all locations. Day-lighting was observed at 2 locations and oil injection operations were halted immediately and all fittings were tightened and tested before oil injection operations resumed. Rather than true day-lighting from over-pressurization,

both observed cases were due to a loose connection at the DPT rods. The following sentences will be added to Section 4.2.3 of the CAGW OU RAR:

"The oil injection crew visually monitored for day-lighting (i.e., oil observed at the ground surface) at all locations. Day-lighting was observed on two occasions: 1) On 7-18-2019 at CCIW-01, the emulsified oil mixture was observed at the ground surface around the DPT rod; and 2) On 7-30-2019 at CCIW-13, the emulsified oil mixture was observed at the ground surface around the DPT rod. At CCIW-01 the injection was stopped immediately, all fittings and connectors were tightened, the DPT screen heighted was adjusted up by one foot, and injections were resumed without issue. At CCIW-13, the injection was immediately stopped, the rods were pulled, and the first rod was re-taped and tightened. The rods were then driven back to the target depth and the injection was resumed without issue. Rather than true day-lighting from over-pressurization, both observed cases were due to loose connections at the top of the DPT rods. These two episodes caused only minor delays."

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II. SPECIFIC COMMENTS

1. **Section 1.3.2, Selected Removal Action, Pages 4/5 of 28:**
The text of Section 1.3.2 presents the key elements of the selected remedy including element 2) listed on Page 5 of 28 which states, "Establish and utilize fifteen DPT injection points to construct the treatment barriers (Figure 4): five injection points ~20.2- to 23.2-m (66- to 76-ft) below ground surface (bgs) and ten injection points ~10.1- to 13.1-m (33- to 43-ft) bgs in the distal portion of the groundwater plume location." However, the RADP specifies the five injection points for Oil Injection Area 1 to have screen zone depths of 55- to 65-ft bgs, rather than 66 to 76-ft bgs. Revise the Draft RAR to address this discrepancy.

Response: Agree.

The RADP incorrectly states the depth of the MAZ at Oil Injection Area 1. The injection depth for Oil Injection Area 1 is based on the screen zone (66-76 ft bgs) and core from well CRW024C, as indicated by the well construction record in Appendix D of the RAR. The correct depth is 66 to 76 ft bgs. Section 1.3.2 item 2 of the RAR will be revised as follows:

"2) Establish and utilize fifteen DPT injection points to construct the treatment barriers (Figure 4): five injection points ~20.2- to 23.2-m (66- to 76-ft) below ground surface (bgs) and ten injection points ~10.1- to 13.1-m (33- to 43-ft) bgs in the distal portion of the groundwater plume location. Inject within a 3.05-m (10-ft) section of the MAZ where the groundwater TCE contamination is present. **Within Oil Injection Area 1, the MAZ depth and thickness was determined by the core described at well CRW024C. Within Oil Injection Area 2, the MAZ depth and thickness within Oil Injection Area 2 was determined by the core described at well CRW023C. Lithology CPTs CGW-68, CGW106, CSB-107, CSB-108**

and CSB-122 provided a regional context for the MAZ depth and thickness. A schematic cross section of the area is shown in Figure 5."

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2. **Section 2.1, Construction Details, Page 6/7 of 28:**
The last sentence on Page 6 and first sentence of Page 7 of 28, of Section 2.1 states, "After all the emulsified oil mixture was injected, 151 L (40 gal) of EOS CoBupHMg™ was mixed with 757 L (200 gal) of water and injected into the aquifer. Finally, 1,136 L (300 gal) of chase water was injected into the aquifer." However, this does not specify the addition of the BAC-9 microbial supplement injected midway during the emulsified oil mixture injection, as listed in the first sentence of the same paragraph. Revise the text to list all of the components injected into the subsurface at each injection point.

Response: Agree.

This sentence will be revised to the following:

"After all the emulsified oil mixture **and EOS BAC-9** was injected, 151 L (40 gal) of EOS CoBupHMg™ was mixed with 757 L (200 gal) of water and injected into the aquifer. Finally, 1,136 L (300 gal) of chase water was injected into the aquifer."

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3. **Section 2.3, Waste Management, Page 7 of 28:**
The text in Section 2.3 states, "There was no radioactive or hazardous waste associated with this project, as determined by waste management guidance. All job waste and personal protective equipment was disposed of as sanitary waste. All decontamination water was land applied on location." However, the text does not include a reference to the waste management guidance used for this determination. In addition, the text does not discuss the generation of soils (if any) during DPT injection activities. Further, because monitoring well installation records are provided in Appendix D, including well development data, the text should discuss the management of soil and development water generated during these activities and reference. Revise the Draft RAR to cite the appropriate waste management guidance used to determine the disposition of wastes generated during the RA. In addition, discuss if soils were generated during the RA construction activities and discuss waste management related to monitoring well installation/development and reference supporting documents under which such activities are reported.

Response: Agree/Clarification.

The Investigative Derived Waste (IDW) Management Strategy (SGCP-IDW-2017-00006) for wells CRW023C and CRW024C was followed for this project and will be added to the references. All decon water and soil, including the soil cores, from the installations of wells CRW023C and CRW024C was land applied. No soil samples/cores were collected as part of the DPT oil injections, all decon water and any incidental soil stuck on the outside of the DPT rods was also land applied on location as part of

decontamination activities. Section 2.3 will be modified to include the IDW Management Strategy reference and waste management activities as follows:

"There was no radioactive or hazardous waste associated with this project~~, as determined by waste management guidance~~. All job waste **from well installations (CRW023C and CRW024C) and DPT oil injections, including** ~~and~~ personal protective equipment was disposed of as sanitary waste **(SGCP 2017)**. All decontamination water **and soil were** ~~was~~ land applied on location **for well installations (CRW023C and CRW024C), including the soil cores from these wells**. **All decontamination water, including any incidental soil on the outside of the DPT rods, was land applied on location for DPT oil injections.**"

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4. **Section 4.2.3, Continuous Monitoring of Injections, Pages 14/15 of 28:**
The last paragraph of Section 4.2.3 on Page 14 of 28 documents a process improvement made following observation of oil separation on July 24, 2019 during injection at CCIW-02, which corresponds to the last of the five injections completed at Oil Injection Area 1 per Appendix E, Subcontractor Field Notebook. Thus, the process improvement change was only implemented at Oil Injection Area 2. Revise the Draft RAR to discuss if the condition leading to a process change for the ten injection points in Oil Injection Area 2 is expected to impact successful treatment in Oil Injection Area 1.

Response: Agree.

At all five injections in Oil Injection Area 1, SRS estimates approximately 75 gallons of EOS100 emulsified oil was injected during the first half of injections and approximately 200 gallons of EOS100 emulsified oil was injected during the second half oil injections. Although the total amount of oil injected is not affected, it is not clear if the proportional differences in oil over the course of the injection may cause the bio-barrier to sequester less efficiently in Oil Injection Area 1. Therefore, the process improvement change was made for Oil Injection Area 2. The last paragraph of section 4.2.3 will be revised as follows:

"Observation of the **emulsified oil mixing** process shortly after injection began led to a process improvement **for all ten injections in Oil Injection Area 2.** One-half of the emulsified oil mixture at CCIW-02 was injected on July 23, 2019, and the second half was to be injected on July 24, 2019, following injection of the BAC-9. After sitting over-night, the project team observed oil separation in the 9,464 L (2,500 gal) polyethylene tank (Figure 6). Approximately 757 L (200 gal) of EOS was still in the tank, but only about 520 L (137.5 gal) should have been in the remaining half-batch. It was determined that mixing of the oil via recirculation was occurring primarily in the lower half of the tanks because of the height of the tanks and the injection and extraction port locations being near the bottom of the tanks. **Although the total amount of oil injected is not affected, it is not clear if the proportional differences in oil over the course of the injection may cause the bio-barrier to sequester less efficiently in Oil Injection Area 1.** This issue was resolved **in Oil Injection Area 2** by mixing only one-half of a batch of the oil mixture at one time, and then injecting it into the aquifer to ensure a

better distribution of the EOS emulsified oil in the subsurface (Figure 7). The mixing and injecting procedures were revised to reflect this change, which caused approximately a 2-day delay."

Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

5. **Figure 4, CAGW OU Pre-Removal Action Site Plan**
Revise Figure 4 to include groundwater flow direction.

Response: Agree.

Figure 4 (attached) was revised to include groundwater flow directions and will be included in the revised RAR.

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6. **Appendix D, Groundwater Monitoring Well Records and Injection Point Soil Boring Installation Reports, Page D-30 of D-44:**
The screen length for temporary injection point CCIW02 is listed as 66 to 78 feet bgs; however, per the RADP, the injection point screen would have a 10-foot DPT screen zone. Revise the Draft RAR to address this discrepancy.

Response: Clarification.

The injection screen zone is only 10-ft long. However, after all the oil mixture and BAC-9 had been injected at 66-76 ft bgs at location CCIW-02, the screen became clogged and the driller was given technical direction to raise and lower the DPT rods to unclogged them. The final total depth when injection could resume was 78 ft bgs, so the EOS CoBupH and chase water were injected at 68-78 ft bgs. Since the oil mixture was injected in the 66-76 ft bgs zone and the EOS CoBupH injected in the 68-78 ft bgs zone, SRS used the total zone of injection (66-78 ft bgs) rather than the planned zone. No change to the RAR is proposed.

Contact: Terry Killeen, 803-952-6850 (terry.killeen@srs.gov)

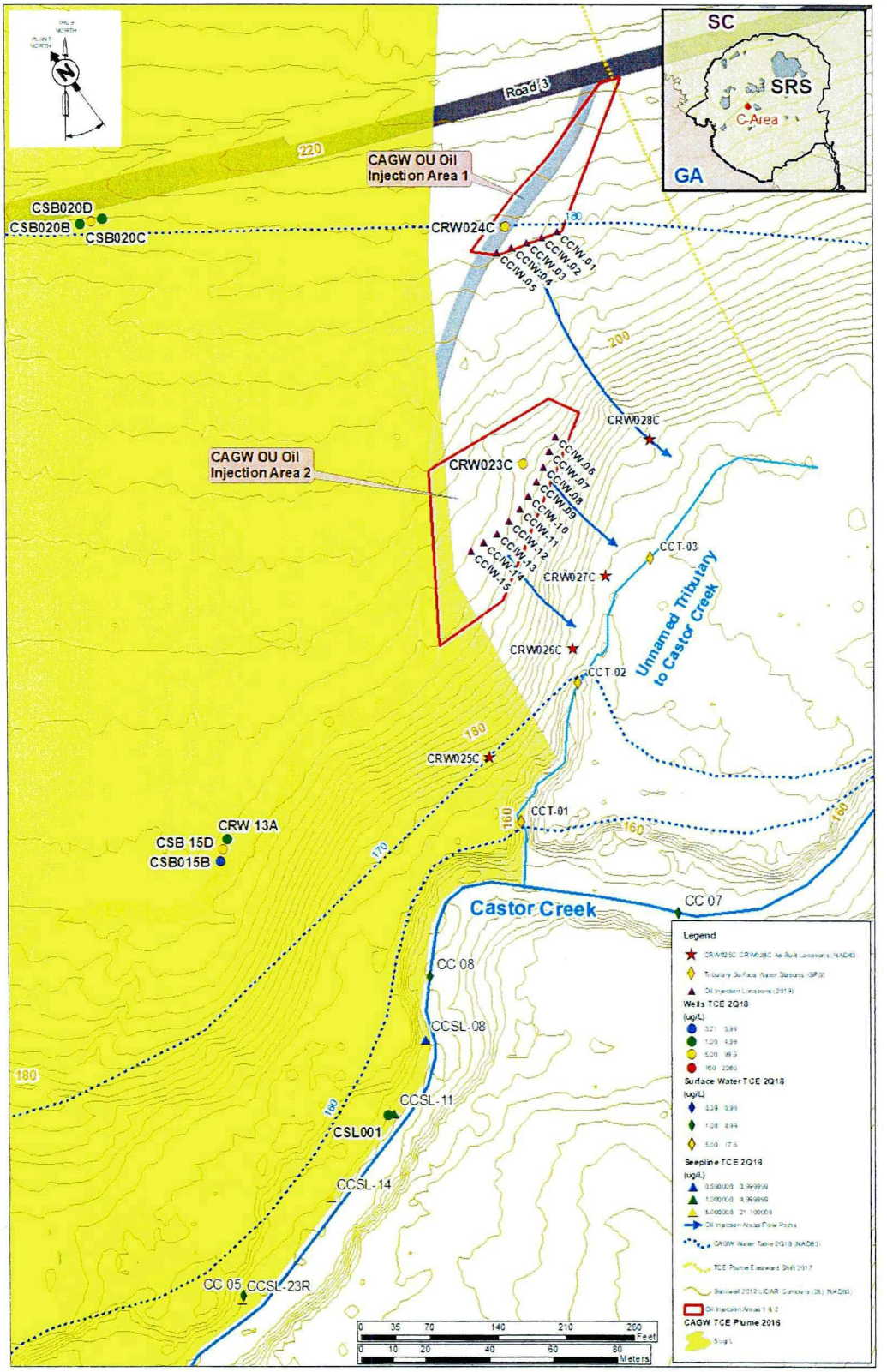

Figure 4. CAGW OU Pre-Remedial Action Site Plan

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Location ID	SRS East Coodinates	SRS North Coodinates	Ground Elevation (ft-msl)	Start Inject Date	Finish Inject Date	Injection Interval	Avg. Injection Rate of Emulsified Oil Mixture (gpm)	Avg. Injection Rate of CoBupHMg™ (gpm)	Avg. Injetion Rate of Chase Water (gpm)	Total Liquid Volume Injected (Gal)	Total BAC-9 Inected (Liters)	Grout Date	Amount (Gal) of Grout	# Bags Portland	Comment
CCIW-01	41169.49	65476.32	212.3	7/18/2019	7/18/2019	66-76'	7.75	5.63	8.75	2,190	2 L	7/22/2019	25	4	Mixed oil in one batch
CCIW-02	41153.95	65481.18	213.9	7/23/2019	7/24/2019	66-78' *	6.04	5.22	16.67	2,190	2 L	7/29/2019	25	4.5	Mixed oil in one batch
CCIW-03	41138.40	65486.00	213.8	7/18/2019	7/18/2019	66-76'	13.87	15.00	9.38	2,190	2 L	7/22/2019	25	4	Mixed oil in one batch
CCIW-04	41122.82	65490.97	214.1	7/24/2019	7/24/2019	66-76'	13.98	15.00	14.29	2,190	2 L	7/25/2019	25	4	Mixed oil in one batch
CCIW-05	41107.12	65495.70	214.1	7/23/2019	7/23/2019	66-76'	12.04	11.43	9.38	2,190	2 L	7/25/2019	25	4	Mixed oil in one batch
CCIW-06	41045.98	65310.67	196.9	8/5/2019	8/6/2019	33-43'	12.60	8.89	11.54	2,190	2 L	8/7/2019	15	2	Mixed oil in two, half-batches
CCIW-07	41031.94	65301.52	195.1	8/6/2019	8/6/2019	33-43'	9.02	7.50	9.09	2,190	2 L	8/7/2019	15	2	Mixed oil in two, half-batches
CCIW-08	41018.10	65292.90	194.2	8/5/2019	8/5/2019	33-43'	10.00	13.33	11.11	2,190	2 L	8/8/2019	15	2	Mixed oil in two, half-batches
CCIW-09	41003.70	65284.99	194.1	8/1/2019	8/1/2019	33-43'	13.64	14.12	14.29	2,190	2 L	8/6/2019	15	2.5	Mixed oil in two, half-batches
CCIW-10	40987.88	65278.46	194.7	8/7/2019	8/7/2019	33-43'	12.41	9.60	12.00	2,190	2 L	8/8/2019	15	2	Mixed oil in two, half-batches
CCIW-11	40972.68	65272.56	196.5	7/31/2019	7/31/2019	33-43'	14.60	20.00	14.29	2,190	2 L	8/1/2019	15	2	Mixed oil in two, half-batches
CCIW-12	40957.10	65269.40	197.8	8/7/2019	8/8/2019	33-43'	13.20	11.43	15.00	2,190	2 L	8/8/2019	15	2	Mixed oil in two, half-batches
CCIW-13	40939.21	65266.34	199.3	7/30/2019	7/31/2019	33-43'	10.78	10.00	10.71	2,190	2 L	8/1/2019	15	2	Mixed oil in two, half-batches
CCIW-14	40922.68	65267.05	199.5	8/8/2019	8/8/2019	33-43'	10.65	8.57	11.11	2,190	2 L	8/12/2019	15	2	Mixed oil in two, half-batches
CCIW-15	40906.62	65268.11	199.8	7/30/2019	7/30/2019	33-43'	13.87	13.33	12.50	2,190	2 L	8/1/2019	15	2	Mixed oil in two, half-batches

* = Please note that the oil injectables were injected at the interval of 66-76ft, but the CoBupH buffer and chase water were injected in the 68-78ft interval per SRNS direction due to low injection rates at 66-76ft.

Table 3. Oil Injection Locations, Depths and Injections Rates

		Tank 1			Tank 2			
Station	Matrix	Temp. (°C)	DO (mg/L)	pH	Temp. (°C)	DO (mg/L)	pH	Comments
CCIW-01	Emulsified Oil Mixture				34.2	0.40	8.21	Mixed in 1 Batch.
CCIW-02	Emulsified Oil Mixture	33.7	0.78	8.26				Mixed in 1 Batch.
CCIW-03	Emulsified Oil Mixture	35.3	0.94	8.24				Mixed in 1 Batch.
CCIW-04	Emulsified Oil Mixture				30.2	0.66	8.15	Mixed in 1 Batch.
CCIW-05	Emulsified Oil Mixture				32.2	0.93	8.11	Mixed in 1 Batch.
CCIW-06	Emulsified Oil Mixture	28.7	0.95	8.17	30.6	0.64	8.15	Mixed in 2 Batches.
CCIW-07	Emulsified Oil Mixture	29.0	0.70	7.86	28.6	0.12	8.39	Mixed in 2 Batches.
CCIW-08	Emulsified Oil Mixture	25.7	0.98	8.05	25.3	0.98	8.25	Mixed in 2 Batches.
CCIW-09	Emulsified Oil Mixture	31.3	0.95	8.21	29.6	0.98	8.26	Mixed in 2 Batches.
CCIW-10	Emulsified Oil Mixture	29.2	0.97	7.23	28.7	0.91	8.47	Mixed in 2 Batches.
CCIW-11	Emulsified Oil Mixture	30.9	0.95	8.51	30.7	0.16	8.43	Mixed in 2 Batches.
CCIW-12	Emulsified Oil Mixture	30.1	0.90	8.14	32.0	0.66	8.08	Mixed in 2 Batches.
CCIW-13	Emulsified Oil Mixture	29.6	0.94	8.18	30.4	0.95	8.23	Mixed in 2 Batches on 7/30.
CCIW-13	Emulsified Oil Mixture	---	---	---	29.8	0.96	8.27	Injected on 7/31.
CCIW-14	Emulsified Oil Mixture	32.1	0.91	8.10	31.6	0.91	8.25	Mixed in 2 Batches.
CCIW-15	Emulsified Oil Mixture	31.0	0.43	8.38	30.7	0.22	8.36	Mixed in 2 Batches on 7/29
CCIW-15	Emulsified Oil Mixture	29.8	0.79	9.22	30.0	0.82	8.14	Injected on 7/30.

Table 4. Oil Injection Field Parameters