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Western Sector In-Situ Chemical Oxidation Project: Supplemental Results After Injection Activities (U)

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%	percent
bgs	below ground surface
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
ft	foot, feet
Hg^0	elemental mercury
Hg^{+2}	ionic mercury
HWMF	hazardous waste management facility
ID	identification
ISCO	in-situ chemical oxidation
J	estimated value
K	potassium
LLAZ	Lost Lake Aquifer Zone
µg/kg	microgram per kilogram
µg/L	microgram per liter
µS/cm	microsiemens per centimeter
m	meter, meters
mg/L	milligram per liter
Mn	manganese
msl	mean sea level
mV	milliVolt
Na	sodium
ND	non-detect
ORP	oxidation-reduction potential
PCE	tetrachloroethylene
PTO	permit to operate
R	rejected
RCRA	Resource Conservation and Recovery Act
SC	Specific Conductivity
SCDHEC	South Carolina Department of Health and Environmental Control
SRNS	Savannah River Nuclear Solutions, LLC
SRS	Savannah River Site
SO_4	sulfate
TA	temporary authorization
TCE	trichlorethylene
UIC	underground injection control
VOCs	volatile organic compounds

1.0 INTRODUCTION

The persistence of elevated groundwater concentrations of volatile organic compounds (VOCs) (i.e., trichloroethylene [TCE] and tetrachloroethylene [PCE]) in the Lost Lake Aquifer Zone (LLAZ) requires focused treatment to supplement the removal of these contaminants by the existing corrective action systems. The 2000 Resource Conservation and Recovery Act (RCRA) Part B Permit Renewal Application: M-Area and Metallurgical Laboratory Hazardous Waste Management Facilities (HWMFs) Post Closure (WSRC-IM-98-30, Volume III, Revision 7, March 2014) included the use of four temporary authorization (TA) requests to assess the effectiveness of different corrective action technologies at the field scale in the Western and Southern Sectors of A/M Area. There is indeterminate amount of dense non-aqueous phase liquid (DNAPL) associated with historic migration along geologic strata. The DNAPL source is likely the M-Area Settling Basin; however, the 321-M Solvent Storage Tank Area is another potential source. Both of these source areas have been treated using dynamic underground stripping and soil vapor extraction. Groundwater from both of these potential source locations is currently undergoing groundwater pump and treat.

One of the Western Sector TAs included the installation of an additional recovery well (i.e., RWM018) and a field scale study of in-situ chemical oxidation (ISCO). ISCO was used to address the high concentration dissolved phase VOCs and any residual DNAPL in the lower LLAZ. RWM018 will provide hydraulic capture and establish local gradients that will better allow Savannah River Site (SRS) to evaluate the ISCO treatment.

SRS submitted the TA request for the installation of RWM018 and the ISCO project on February 23, 2016 (SRNS 2016) and South Carolina Department of Health and Environmental Control (SCDHEC) approved it on March 9, 2016 (SCDHEC 2016). In addition to the TA request, SRS submitted an underground injection control (UIC) permit application (SRNS 2017). SCDHEC issued the UIC permit to construct (Permit #SCHE03020522) on December 12, 2017 (SCDHEC 2017). After SCDHEC was notified of the installation of the eight injection wells (i.e., WSI001B, WSI001C, WSI002B, WSI002C, WSI003B, WSI003C, WSI004B, and WSI004C), the

UIC permit to operate (PTO) was issued on May 24, 2018 (SCDHEC 2018a). Due to a change in the injectates, SCDHEC modified the UIC PTO on July 2, 2018 (Permit #SCHE03020522M1) (SCDHEC 2018b). The well casing for RWM018 was installed in July 2017, the pump was installed in January 2018, and the well went online as part of the M-1 Air Stripper recovery well system in May 2018.

2.0 PURPOSE AND OBJECTIVE

The purpose of the Western Sector ISCO project is to inject chemical oxidants (i.e., potassium permanganate and sodium persulfate) into the eight injections wells (i.e., WSI001B, WSI001C, WSI002B, WSI002C, WSI003B, WSI003C, WSI004B, and WSI004C) and evaluate the effectiveness of the chemical oxidants at degrading indiscriminate DNAPL that is present in the subsurface. Fifteen monitoring wells (i.e., WSM001BB, WSM001B, WSM001CC, WSM001C, WSM002BB, WSM002B, WSM002CC, WSM002C, WSM003BB, WSM003B, WSM003CC, WSM003C, MSB107B, MSB107CC, and MSB107C) are currently being used by SRS to monitor the effect of the oxidant injections on the VOC plume of the Western Sector of the M-Area HWMF. Figure 1 shows the project location in reference to the M-Area Settling Basin.

This is the second of three planned interim reports to track the performance of the project. The purpose of this document is to report groundwater monitoring data collected during the baseline monitoring before oxidant injections occurred and the fifteen months after oxidant injections were completed.

3.0 MONITORING AND INJECTION WELL NETWORK

The monitoring well network consists of 15 monitoring wells located in the Western Sector of the A/M area. Monitoring wells WSM001BB, WSM001B, WSM001CC, WSM001C, WSM002BB, WSM002B, WSM002CC, and WSM002C are located about 7.6-meters (m [25-feet {ft}]) downgradient of the injection wells; monitoring wells WSM003BB, WSM003B, WSM003CC, and WSM003C are located about 76.2-m (250-ft) downgradient of the injection wells; and monitoring wells MSB107B, MSB107CC, and MSB107C are located about 152.4-m (500-ft) downgradient of the injection wells. The monitoring well network is designed to monitor four permeable horizons of the LLAZ: the BB-, B-, CC-, and C-Horizons. The BB- and B-Horizons monitor the two deeper portions of the LLAZ, with the BB-Horizon being the deepest below ground surface (bgs). The CC- and C-Horizons monitor the two shallower portions of the LLAZ, with the C-Horizon being the shallowest bgs.

The injection well network consists of eight injections wells. Injection wells WSI001B, WSI001C, WSI002B, WSI002C, WSI003B, WSI003C, WSI004B, and WSI004C are immediately upgradient of monitoring well clusters WSM001 and WSM002. Each of the injection wells have 4.6-m (15-ft) screens. The injection wells are designed to allow the injection of oxidants into the LLAZ along two groundwater horizons. The 'B' injection wells are screened through the B- and BB-Horizons. Likewise, the 'C' injection wells correspond to the C- and CC-Horizons.

Table 1 shows the screen coordinate locations and screen intervals of the eight injection wells. Table 2 shows the screen coordinate locations and screen intervals of the 15 monitoring wells. Figure 2 shows the Western Sector ISCO injection and monitoring well locations and Figure 3 illustrates the vertical relationship between the injection and monitoring well screens.

4.0 INJECTION ACTIVITIES

The injection of the two chemical oxidants (i.e., potassium permanganate and sodium persulfate) began on August 30, 2018 and was completed on October 1, 2018. There were 151,416.5 liters (40,000 gallons) of potassium permanganate injected equally into the eight injection wells from August 30, 2018 through September 14, 2018. Soon after the injection of potassium permanganate, 151,416.5 liters (40,000 gallons) of sodium persulfate were injected equally into the eight injection wells from September 18, 2018 through October 1, 2018 (North Wind 2018). Groundwater recovery well RWM018 was in service during injection activities to provide capture and control of contaminated groundwater and injection solutions.

5.0 SAMPLING FREQUENCY

Attachment D of the UIC application (SRNS 2017) describes the monitoring program associated with the injection activities. The monitoring included establishment of baseline or pre-operational groundwater conditions, proximal groundwater conditions shortly after oxidant injection (less than two months), and proximal and distal conditions associated with injection (two to six months). Baseline samples were collected from all 15 monitoring wells associated with the Western Sector ISCO project on July 17, 2018 and July 18, 2018. Table 3 presents the sampling conditions described in Table D-1 and Table D-2 of the UIC application.

Immediately following the completion of the injection of potassium permanganate, the eight proximal monitoring wells (i.e., WSM001BB, WSM001B, WSM001CC, WSM001C, WSM002BB, WSM002B, WSM002CC, and WSM002C) were sampled weekly from September 17, 2018 through November 6, 2018. After the completion of the weekly sampling, the eight proximal monitoring wells were sampled monthly from December 2018 to March 2019. These wells were then sampled quarterly in June, September, and November of 2019.

Following baseline sampling prior to injection activities, the four distal monitoring wells (i.e., WSM003BB, WSM003B, WSM003CC, WSM003C) were sampled quarterly between November 2018 and November 2019.

Three RCRA permitted wells (MSB107B, MSB107C, and MSB107CC) were also included in this evaluation. These wells are located about 152.4-m (500-ft) downgradient of the injection wells and were sampled semiannually following injection activities.

6.0 RESULTS

Groundwater monitoring activities involved the measurement of field parameters as discussed in Section 6.1 and the collection of groundwater samples for subsequent chemical analysis in laboratory environments as discussed in Sections 6.2 and 6.3. This evaluation focuses on those parameters related to supplemental effects of oxidant injections on the groundwater quality observed in monitoring wells WSM001BB, WSM001B, WSM001CC, WSM001C, WSM002BB,

WSM002B, WSM002CC, WSM002C, WSM003BB, WSM003B, WSM003CC, and WSM003C. Table 4 presents values for basic field parameters (pH, specific conductance [SC], dissolved oxygen [DO] and oxidation reduction potential [ORP]) that indicate the presence of an oxidant; analytical results for the target contaminants (TCE, PCE); and analytical parameters related to specific oxidants or effectiveness (chloride, manganese, potassium, sulfate and mercury). Time trends of various parameters are presented in Figures 4 through 22. The evaluation includes baseline parameters determined between the initial well installation, prior to oxidant injections, and the period following oxidant injections through December 31, 2019.

6.1 Field Parameters

Field parameters of specific interest to the evaluation of ISCO include water elevation (ft mean sea level [msl]), activity of hydrogen ions present in the groundwater (pH), the ORP measured in millivolt (mV), DO reported in milligrams per liter (mg/L), and electrical conductivity (or SC) in microSiemens per centimeter (µS/cm). Figure 4 presents these parameters for monitoring wells that are located in the C-Horizon (WSM001C, WSM002C, WSM003C, and MSB107C). Figure 5 presents these same parameters for those wells that are located in the CC-Horizon (WSM001CC, WSM002CC, WSM003CC, and MSB107CC). Figure 6 presents these parameters for the wells that are located in the B-Horizon (WSM001B, WSM002B, WSM003B, and MSB107B). Figure 7 presents the same parameters for monitoring wells located in the BB-Horizon (WSM001BB, WSM002BB, and WSM003BB). Included in the top panel of Figure 4, Figure 5, Figure 6, and Figure 7 is the amount of each oxidant (potassium permanganate and sodium persulfate) that was injected into the subsurface.

Water Levels: Panel 2 of Figure 4, Figure 5, Figure 6, and Figure 7 present the water level data from monitoring wells in the C, CC, B, and BB-Horizons, respectively. The initial groundwater levels in the Spring of 2018 were on the order of 63.7 m (209 ft) in the C- and the CC-Horizons (Figures 4 and 5, respectively), 63.1 m (207 ft) in the B-Horizon (Figure 6), and 62.8 m (206 ft) in the BB-Horizon (Figure 7). This downward gradient is characteristic of the LLAZ throughout the A/M Area. In May of 2018, groundwater recovery well RWM018 went online as part of the corrective action program in A/M Area. This well provides hydraulic containment of groundwater in the vicinity of the injection location. The decreasing water levels that are observed between April and July of 2018 are directly associated with start-up and continuous operation of RWM018. As indicated in Figure 4 for the C-Horizon and Figure 5 for the CC-Horizon, groundwater levels increased during injection activities in each horizon. Following injection, groundwater levels returned to pre-injection levels. During the monitoring period, groundwater levels throughout the injection zone were decreased below baseline. This drawdown is associated with the operation of RWM018 and is apparent in all monitoring wells. In December of 2019 the groundwater extraction system was down and water levels began to recover. The increase in groundwater levels in February and November 2019 are associated with the shutdown of RWM018 during maintenance activities at the M-1 Air Stripper.

pH: The activity of the hydrogen ion is indicated as pH and is presented in Panel 3 of Figure 4 and Figure 5 for the C- and the CC-Horizons, respectively. As indicted in Figure 4, the pH in the wells within the C-Horizon did not change in response to injection activities. It is noted that the pH in monitoring well WSM002C is elevated in comparison to others in the C-Horizon. In the BB-Horizon (Figure 7), the pH in monitoring well WSM001BB decreased immediately following the injection of the oxidants and has remained low. Immediately following injection, the pH in WSM002BB decreased but was more variable and appears to have returned to pre-injection levels. As indicated in Figure 7 and Table 4, 16-months following injection the pH in monitoring well WSM001BB is approximately 1 pH unit below adjacent well WSM002BB.

Specific Conductance: The specific conductance is presented in Panel 4 of Figure 4 through Figure 7. Similar to pH, the specific conductance of wells within the C-Horizon (Figure 4) have not responded to the injection activities. In the BB-Horizon (Figure 7), the specific conductance in monitoring well WSM001BB increased following oxidant injections and is trending upward. Similar to WSM001BB, the specific conductance in monitoring well WSM002BB increased after injection and has remained elevated above baseline levels.

ORP: The oxidation-reduction potential is indicated as ORP (mV) and is presented in Panel 6 of Figure 4 through Figure 7. In the BB-Horizon (Figure 7), the ORP generally increased following oxidant injections. The increase in monitoring wells WSM001BB and WSM002BB was on the order of 500 mV following oxidant injections and has remained elevated throughout the monitoring period. The ORP in monitoring wells WSM001B and WSM002B (Figure 6) increased following injection and appears to be decreasing to pre-injection levels. In the CC-Horizon (Figure 5), an increase in ORP was observed in well WSM001CC starting in February 2019 and continuing throughout the monitoring period. In the C-Horizon (Figure 4), ORP has been variable; however, there hasn't been an observable response to the injection of oxidant.

6.2 Analytical Results

Groundwater monitoring activities involved the collection and analysis of groundwater samples for a variety of chemical constituents. Constituents of specific interest to evaluating the effectiveness of chemical oxidation are the source contaminants TCE and PCE, total chloride since this is an end product of the oxidation of both TCE and PCE, potassium (K) and manganese (Mn) as these ions are components of the oxidant potassium permanganate, and sodium (Na) and sulfate (SO_4) since these are ions of sodium persulfate.

The following guidelines are applied to evaluate the effectiveness of oxidant injections at a specific location. These guidelines are based upon input and discussions with the oxidants' injection contractor (Redox Tech) and literature reports (Siegrist et.al. 2011).

- If chloride is above baseline (pre-injection) concentrations, then TCE and PCE have likely been oxidized to the end product;
- When sodium and potassium are above baseline, then the oxidant solution is/was there but there is uncertainty whether it has been consumed or still has oxidizing power;
- When manganese is above the baseline, then there is active oxidant as permanganate;
- When sulfate is above the baseline, then there is less oxidizing power (less persulfate); and
- Increases in mercury concentration in groundwater indicate the presence of DNAPL.

The analytical suite also includes total mercury. Previous work in A/M Area with DNAPL have indicated that non-polar compounds such as elemental mercury (Hg^0) will partition into the organic

DNAPL phase, be transported due to DNAPL specific transport mechanisms, and subsequently released due to DNAPL specific remediation actions (Jackson et al. 2006). Previously, a DNAPL sample recovered near the M-Area Settling Basin was found to have a total mercury concentration of 656 μg/kg, which is at or near the solubility of elemental mercury in the non-aqueous solvent (Jackson et al. 2006). As corrective actions are implemented to address the subsurface DNAPL, the mobilization and migration of mercury is a possibility. This mobilization will impact the operation of subsurface corrective action programs as effluents will have to consider regulatory aspects associated with environmental release of mercury. The presence and release of mercury from DNAPL has impacted the groundwater pump and treat system such that technologies have been developed to address the removal of ionic mercury (Hg^{+2}) from groundwater using chemical reduction and air stripping (Jackson et al. 2013). The conceptual model for mercury contained in DNAPL and associated impacts to groundwater are evolving. Data and observations from this project will enable additional refinement of this transport process.

The current paradigm for the presence of mercury is that as DNAPL is removed through chemical oxidation of organic compounds (TCE and PCE) in the aqueous phase, dissolution rates of these compounds from the non-aqueous phase will increase, reducing the mass (volume) of DNAPL present in the subsurface. As DNAPL mass is removed through dissolution, elemental mercury will become oxidized and form highly soluble mercury chloride complexes in the aqueous phase.

6.3 Specific Well Discussions

6.3.1 WSM001B

Analytical results for monitoring well WSM001B are presented in Figure 8. The pre-injection/baseline sampling showed TCE and PCE concentrations of 25,200 μg/L and 1,880 μg/L, respectively. This monitoring well first experienced dark, purple-stained water on October 2, 2018, following the completion of injection. This provides a visual indication of the presence of the oxidant permanganate. The baseline concentrations decreased to non-detect (ND) for the sampling event on October 9, 2018, a week after the purple-stained water was observed. The analytical results for these samples were rejected by the analytical laboratory due to exceedance of transport temperature. Sampling data from October 16, 2018, indicate the TCE and PCE concentrations increased, but remained slightly below baseline levels. Quarterly monitoring in 2019 indicate groundwater concentrations have stabilized following injection activities. In 2019, TCE and PCE concentrations were similar to baseline concentrations.

The other constituents (chloride, manganese, potassium, sodium, and sulfate) all showed an increase in concentration on October 9, 2018, the week after the purple-stained water was observed. Sampling data from October 16, 2018, indicate the concentrations of chloride, manganese, potassium, sodium, and sulfate all decreased, but remained slightly above baseline levels. The corresponding increase in the oxidation product of TCE and PCE (chloride), and the presence of oxidation compounds (potassium, manganese, sodium, and sulfate) indicate that the October 9, 2018, sample did not contain TCE or PCE. Field parameters did not present a trend; the pH varied between 4.4 and 5.7 (Figure 6, Panel 3). The specific conductivity increased for the sampling event on October 9, 2018, but decreased back to near baseline levels the following week (Figure 6, Panel 4). Quarterly monitoring in 2019 indicates that these constituents have stabilized to baseline levels since October 2018. Sodium increased in March of 2019 to a value of 18,900 µg/L and then returned to baseline levels (Figure 8, Panel 5).

Sampling data from October 30, 2018, included analysis of groundwater for total mercury. Total mercury was observed at 2.34 µg/L, which was greater than baseline results, suggesting the nearby presence of DNAPL. The mercury results decreased in 2019 and was reported as ND in November 2019 (Figure 8, Panel 6).

6.3.2 WSM001BB

Analytical results for monitoring well WSM001BB are presented in Figure 9. The baseline sample showed TCE and PCE concentrations of 21,900 µg/L and 1,560 µg/L, respectively. These concentrations decreased to ND for the sampling event on September 25, 2018, when purple-stained water was first observed (SRNS 2019). The TCE and PCE concentrations have remained ND through 2019. Chloride (the oxidation product of TCE and PCE) has remained elevated suggesting the oxidation of TCE and PCE has occurred at this location.

Manganese and potassium (the components of the oxidant potassium permanganate) increased on September 25, 2018, when purple-stained water was observed, and have been steadily declining since. Through 2019 these values have continued to decrease and appear to have stabilized, slightly above pre-injection concentrations. Concentrations of sodium increased three weeks after the conclusion of the injection of sodium persulfate (October 1, 2018) and has plateaued at approximately 500 mg/L. The presence of sodium, with the lack of sulfate indicates, that the active oxidant persulfate is present after October 25, 2018. As shown in Figure 9, Panel 5, sulfate concentrations lag sodium concentrations until June 2019 when sulfate concentrations increased and sodium concentrations decreased. As sulfate is the byproduct of oxidation by the persulfate ion, this supports the observation that active persulfate was present 2-months following injection. Sodium and sulfate have remained elevated throughout 2019.

Sampling data from October 2, 2018, included analysis of groundwater for total mercury. Total mercury was observed at 56.1 µg/L, suggesting the nearby presence of DNAPL. Subsequent sampling on October 30, 2018, contained mercury at 28.4 µg/L (Figure 9, Panel 6). In 2019, total mercury concentration has continued to decrease. In December of 2019, the concentration of total mercury was 7.70 µg/L.

6.3.3 WSM001CC

Observations from monitoring well WSM001CC were not discussed in detail in the previous reporting (SRNS 2019). As previously reported, purple-stained water was observed at WSM001CC on December 11, 2018. In 2019, analytical results indicate impacts from the oxidant injection activities that may be associated with the stained water. As indicated in Panel 2 of Figure 11, the TCE concentrations began to decline in December of 2018 and continued to decline throughout most of 2019. In February of 2019 the TCE concentration was reported as ND and remained below detection levels until December when a value of 2.28 µg/L was reported. The decrease in TCE concentration corresponds to increase of chloride, potassium, manganese, sodium, and sulfate. All of these responses are indicative of advanced oxidation processes. In addition, total mercury was also detected in the quarterly monitoring activities.

6.3.4 WSM002B

Analytical results for monitoring well WSM002B are presented in Figure 12. The baseline sample showed TCE and PCE concentrations of 29,700 µg/L and 2,650 µg/L, respectively. These concentrations decreased to ND for the October 2, 2018, sampling event where the purple-stained water was first observed (SRNS 2019) and remained at ND through October 23, 2018. Beginning with the October 30, 2018, sampling event, TCE and PCE concentrations increased to levels that are lower than the baseline concentrations. In December 2018, there was a slight decrease in TCE and PCE concentrations. In 2019, TCE and PCE concentrations have stabilized but remain below baseline concentrations.

Beginning October 2, 2018, the chloride concentration increased with the decrease in TCE and PCE. A heuristic mass balance calculation based upon pre-injection concentrations of TCE and PCE, suggests that 91% of the chloride observed between October 2, 2018 and October 23, 2018, can be accounted for from the oxidation of TCE and PCE. Chloride concentrations increased again in December 2018 and remained elevated during January 2019, which corresponds to the decrease in TCE and PCE concentrations in December 2018. Chloride concentrations decreased to baseline concentrations for the remainder of 2019.

As shown in Figure 12, Panel 4, the concentrations of manganese and potassium also increased and decreased with chloride in October 2018. Since October 2018, these compounds have remained near baseline concentrations. Between December 2018 and March 2019, sodium and sulfate concentrations increased above baseline concentrations, suggesting the presence of the active oxidant persulfate. This increase corresponds with the December 2018 to January 2019 increase in chloride concentrations. Since March 2019, sodium and sulfate concentrations have remained near baseline concentrations.

The postulated oxidation of TCE and PCE observed between October 2, 2018 and October 23, 2018, is accompanied by an increase in mercury that was observed on October 2, 2018, when total mercury concentration of 7.95 µg/L was observed. Following this event, total mercury concentrations decreased to 0.31 µg/L and stabilized during 2019. Overall the data suggests that potassium permanganate was effective immediately after injection as both TCE and PCE decreased, chloride, potassium and manganese all increased in October of 2018. Subsequent to this in December 2018 TCE and PCE slightly decreased while chloride, sodium, and sulfate increased.

6.3.5 WSM002BB

Analytical results for monitoring well WSM002BB are presented in Figure 13. In general the concentration profiles observed in this well are similar to those observed in monitoring well WSM001BB (Figure 9). One observable difference is the shift in the timing of events related to the oxidation of TCE and PCE. TCE and PCE concentrations decrease and chloride concentration increases in WSM002BB approximately one month after the similar response is observed in WSM001BB. This is likely associated with the timing of injection activities in the upgradient injection wells that are located in the B-Horizon. Monitoring well WSM001BB is located 8.5 m (28 ft) to the west of WSM002BB. As shown in Figure 13, the baseline sample showed TCE and PCE concentrations of 24,900 µg/L and 1,750 µg/L, respectively. TCE concentrations decreased to ND on October 23, 2018, when purple-stained water was first observed and remained ND for the remainder of the weekly sampling. PCE concentrations decreased to ND a week after the sampling event when purple-stained water was first observed and remained ND for the remainder of the weekly sampling. TCE and PCE concentrations were reported as ND until the PCE concentrations began to increase in September of 2019 and TCE increased in November of 2019 (Table 4).

The chloride, manganese, and potassium concentrations showed an increase in concentration in October 2018 while an increase in sodium and sulfate concentration was not observed until December 2018. In 2019 chloride has remained elevated while other ions associated with oxidant by-products (manganese, potassium, sodium, and sulfate) have decreased or peaked and then decreased to baseline concentrations. The decreasing oxidant by-products indicate the oxidation potential has diminished and corresponds with increasing PCE and TCE concentrations.

The increase in total mercury (18.2 μg/L) on October 30, 2018, is associated with in-situ oxidation. Groundwater concentrations immediately decreased in March 2019 and have begun to trend upward in the last half of 2019.

6.3.6 Distal Monitoring Wells

Quarterly sampling results of the distal monitoring wells (WSM003B, WSM003BB, WSM003C, and WSM003CC) were not presented in the initial results following injection activities (SRNS 2019) since these wells are located approximately 76.2-m (250-ft) downgradient of the injection wells. These supplemental results include quarterly groundwater results from March 2018 (pre-injection) through November 2019. These results are presented graphically in Figures 16 through 19 and tabularized in Table 4. In reviewing this information no specific variations in groundwater quality are identified that can be associated with the oxidant injection activities performed in 2018. Variations in observed TCE and PCE concentrations are likely associated with the commencement of groundwater pumping using RWM018. As shown in Figure 2, these distal monitoring wells are approximately half-way between the injection wells and RWM018. The only possible indication of injection activities is a slight increase in potassium concentration observed at WSM003C and WSM003CC in the later part of 2019. This is not unexpected when one considers the nominal transport time between the proximal monitoring well clusters (WSM001 and WSM002) and the distal well cluster (WSM003). Based upon observed horizontal gradients that are between 0.004 (for a 1 ft difference in water level) and 0.02 (for a 4 ft difference in level), estimated travel times between the proximal monitoring well clusters and the distal well cluster ranges from 182 days to 730 days. This estimate is based upon an effective porosity of 0.25 and average hydraulic conductivity of 21.4 ft/day (Dixon 2018). Since chloride acts as a conservative tracer in groundwater systems, these transport times will be improved with future monitoring, specifically in the BB- and CC-Horizon.

6.3.7 RCRA Monitoring Wells

As shown in Table 3 the monitoring program for these injection activities includes three wells that are a part of monitoring well cluster MSB107. These wells are 146.4-m (480-ft) downgradient of the injection wells and 70.2-m (230-ft) downgradient of distal monitoring well cluster WSM003. Results from the MSB107 cluster are presented graphically in Figures 20 through 22 and the data is tabularized in Table 4. Similar to the results from the distal well cluster (WSM003), no specific variations in groundwater quality are identified that can be associated with the oxidant injection activities performed in 2018. The basis for the anomaly observed in TCE and PCE concentrations in August of 2019 is unknown and is not considered to be associated with the injection of oxidants. This statement is supported with the estimated transport times associated with upgradient well cluster WSM003.

6.3.8 Other Monitoring Wells

Monitoring wells WSM001C (Figure 10), WSM002C (Figure 14), and WSM002CC (Figure 15) had variations in the concentrations of TCE following the conclusion of oxidant injections. In reviewing this information no specific variations in groundwater quality are identified that can be associated with the oxidant injection activities performed in 2018.

In early 2019 the concentration of potassium, sodium, and sulfate increased and then began to decrease at monitoring well WSM001C (Figure 10). No variations in chloride, TCE, or PCE were observed during this time frame at this location.

7.0 SUMMARY AND CONCLUSIONS

The injection of the two chemical oxidants, potassium permanganate and sodium persulfate, initially impacted the B- and BB-Horizons of the LLAZ. Based on the arrival of purple-stained water into the B- and BB-Horizons, it confirms field observations that these horizons are more permeable than the C- and CC-Horizons. Within the B- and BB-Horizons, the oxidant injections had a greater impact on the BB-Horizon. Since the 'B' injection wells are screened in both the B- and BB-Horizons, this implies that the BB-Horizon accepted a larger volume of the oxidant injected than the B-Horizon. Indicator parameters (manganese, potassium, sulfate, and sodium) corresponding with the B-Horizon are representative of a "slug" of injectate traveling through the aquifer and quickly dissipating. Indicator parameters corresponding with the BB-Horizon show that the injectate was accepted and has hesitated to dissipate from the aquifer. The injection of the two chemical oxidants also provide positive insight into remediating the contaminated aquifer. In the B- and BB-Horizons, TCE and PCE concentrations decreased as the injectate traveled through the aquifer. Further monitoring will be imperative in determining the longevity of the effects of the oxidants in the aquifer.

The increase in chloride and oxidant by-product concentrations observed in WSM001CC in early 2019 suggest the effectiveness of the oxidant for a period beyond the initial injection. The process for the rebound of TCE and PCE concentrations at WSM002BB is being considered. Possible processes include back-diffusion of dissolved phase from clays or advective transport from upgradient sources. Understanding and delineating these processes is important in developing a corrective action based upon oxidant-injection.

Overall the injection activity demonstrated the effective use of a dual oxidant injection scheme; however, one limitation was observed. This limitation relates to the ability to effectively distribute the oxidant vertically across the interbedded layers of sand silt and clay that are characteristic of the LLAZ in the target area. Generally, the monitoring results indicate that the oxidants remained in the lower portion of each horizon but had minimal or no impact on the upper portion of each horizon. In order to refine the injection well configuration, SRS is planning a second round of oxidant injection with an injection well configuration that utilizes shorter screens to effectively target the discrete horizons present in the LLAZ. All applicable regulatory approvals (i.e., TA, UIC, etc.) will be obtained prior to field deployment of the second round of oxidant injection. The second round of oxidant injection is scheduled to be completed in 2020.

8.0 REFERENCES

Dixon, K. L., 2018. Hydraulic Testing of Lost Lake Aquifer Near Recovery Wells RWM018, RWM 3, and RWM 5. Technical Report SRNL-STI-2018-00434, Savannah River National Laboratory, Aiken, SC. doi:10.2172/1472007.

Jackson, D. G., M. E. Denham, and B. B. Looney, 2006. "A Framework for the Transport and Release of Mercury from DNAPL." *Remediation of chlorinated and recalcitrant compounds—2006. Proc., Fifth Int. Conf. on Remediation of Chlorinated and Recalcitrant Compounds*, Bruce M. Sass, ed., Battelle Press, Columbus, OH

Jackson, D., Looney, B., Craig, R., Thompson, M., and Kmetz, T. 2013. "Development of Chemical Reduction and Air Stripping Processes to Remove Mercury from Wastewater." *J. Environ. Eng.*, 139(11), 1336–1342

North Wind, 2018. *Technical/Health & Safety Oversight of Western Sector In-Situ Chemical Oxidation Injection Project Field Summary Report*, November 2018, North Wind Inc., Greenville, SC (SRNS-OS-2018-00259)

SCDHEC, 2016. Letter, D. Scaturo (SCDHEC) to A. Meyer (SRNS), *Re: Temporary Authorization Request for the M-Area Hazardous Waste Management Facility: Western Sector Insitu Chemical Oxidation Letter Meyer to Scaturo dated March 9, 2016 Savannah River Site (SRS) SC1 890 008 989*, dated March 15, 2016, South Carolina Department of Health and Environmental Control, Columbia, SC (SRNS-OS-2016-00013)

SCDHEC, 2017. Letter, R. Devlin (SCDHEC) to B. C. Terry (SRNS), *Re: Underground Injection Control Permit #SCHE03020522 M-Area – HWMF -Western Sector Site Aiken County*, dated December 12, 2017, South Carolina Department of Health and Environmental Control, Columbia, SC (SRNS-OS-2017-00151)

SCDHEC, 2018a. Letter, B. Crawford (SCDHEC) to B. C. Terry (SRNS), *Re: Underground Injection Control Permit #SCHE03020522 Savannah River Site M-Area – HWMF -Western Sector Site*, dated May 24, 2018, South Carolina Department of Health and Environmental Control, Columbia, SC (SRNS-OS-2018-00073)

SCDHEC, 2018b. Letter, B. Crawford (SCDHEC) to A. J. Meyer (SRNS), *Re: Underground Injection Control Permit #SCHE03020522M1 Savannah River Site M-Area – HWMF -Western*

Sector Site, dated July 2, 2018, South Carolina Department of Health and Environmental Control, Columbia, SC (SRNS-OS-2018-00112)

Siegrist, Robert L., Michelle Crimi, Thomas J. Simpkin – editors (2011). *In Situ* Chemical Oxidation for Groundwater Remediation. SERDP/ESTCP Remediation Technology Monograph Series. Springer New York

SRNS, 2016. Letter, A. Meyer (SRNS) to D. Scaturo (SCDHEC), *Temporary Authorization Request for the M-Area Hazardous Waste Management Facility: Western Sector In-Situ Chemical Oxidation*, SRNS-J2000-2016-00097, dated February 23, 2016, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2017. Letter, A. Meyer (SRNS) to B. Crawford (SCDHEC), *Request for Approval of the Savannah River Site Underground Injection Control Permit Application for Pilot Testing of Advanced Oxidation Processes in the Western Sector of M-Area Hazardous Waste Management Facility (SRNS-RP-2017-00574, Revision 0, November 2017)*, SRNS-J2000-2017-00574, dated November 16, 2017, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2019. *Western Sector In-Situ Chemical Oxidation Project: Initial Results Following Injection Activities (U)*, SRNS-STI-2019-00166, Revision 0, June 2019, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

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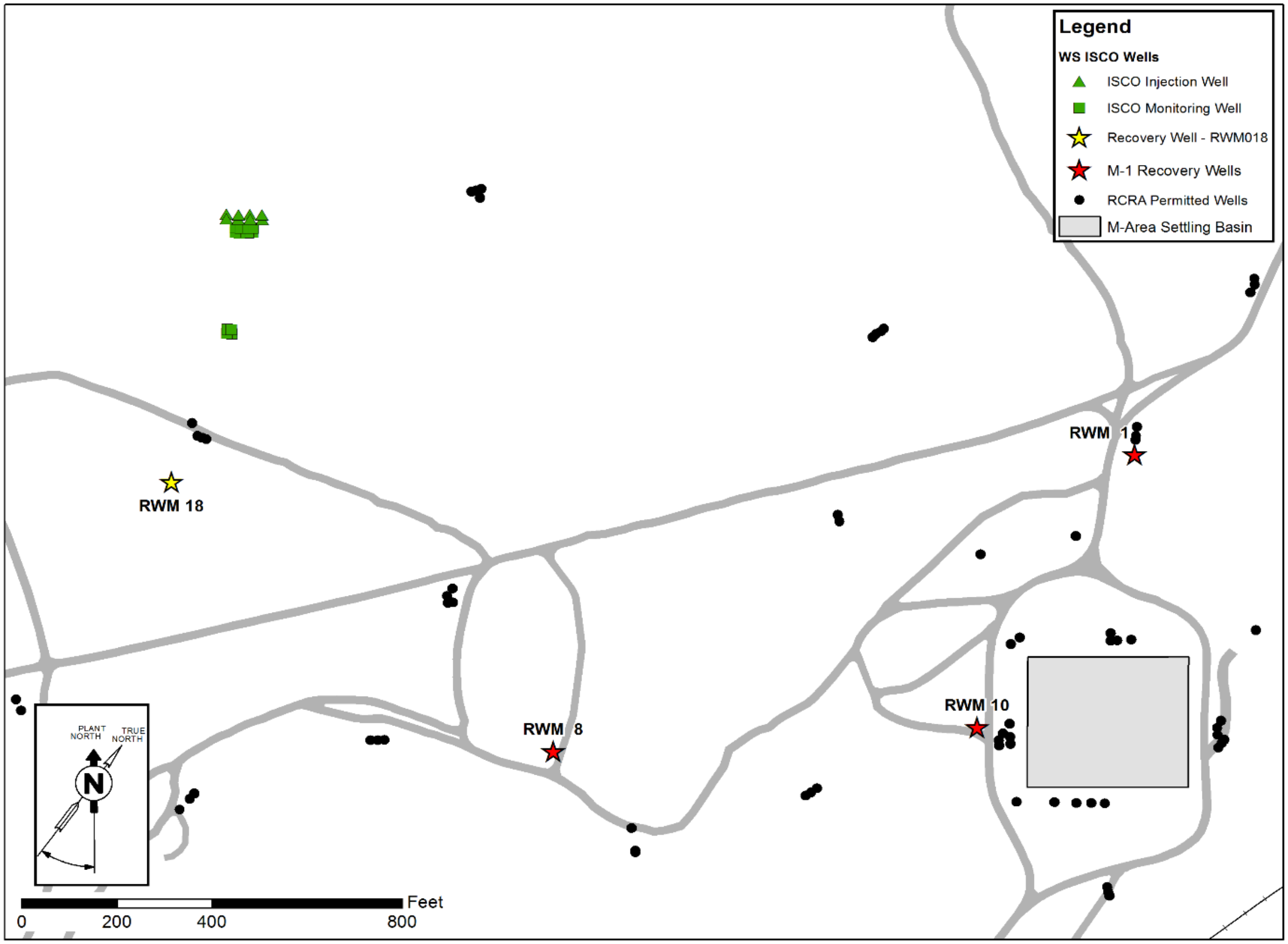

Figure 1. Western Sector ISCO Injection Project Location within A/M Area

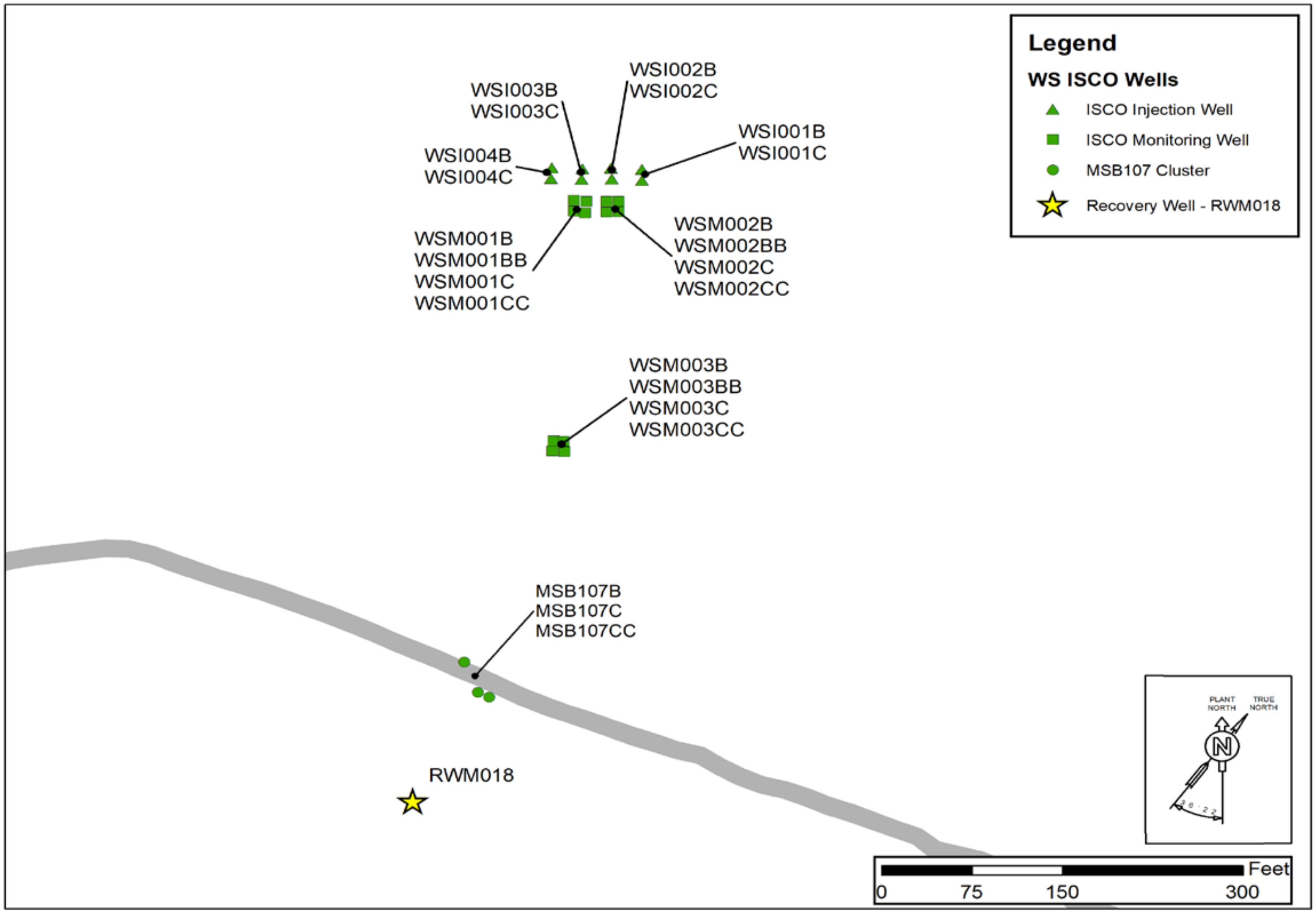

Figure 2. Western Sector ISCO Injection and Monitoring Well Locations

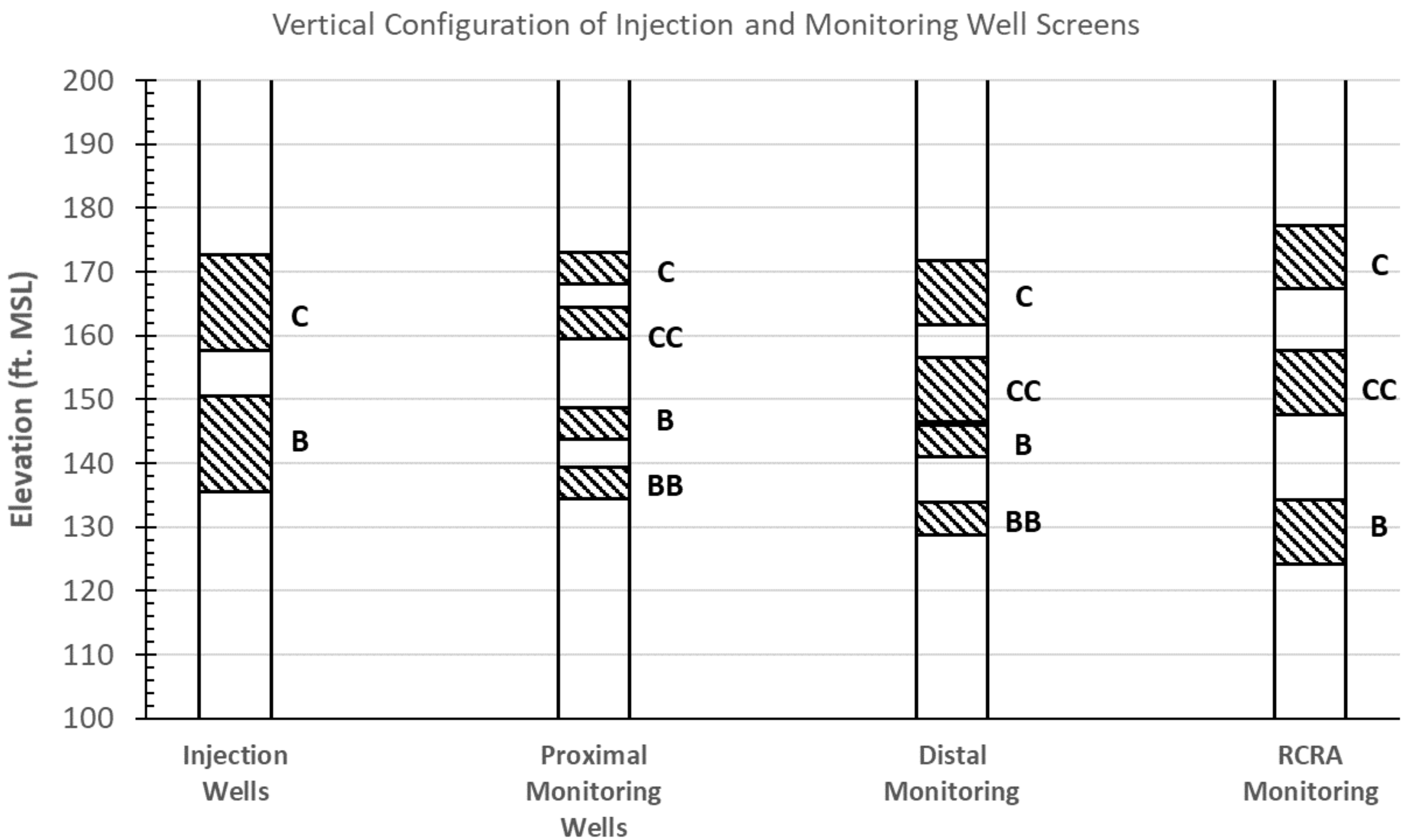

Figure 3. **Vertical Configuration of Injection and Monitoring Well Screens**

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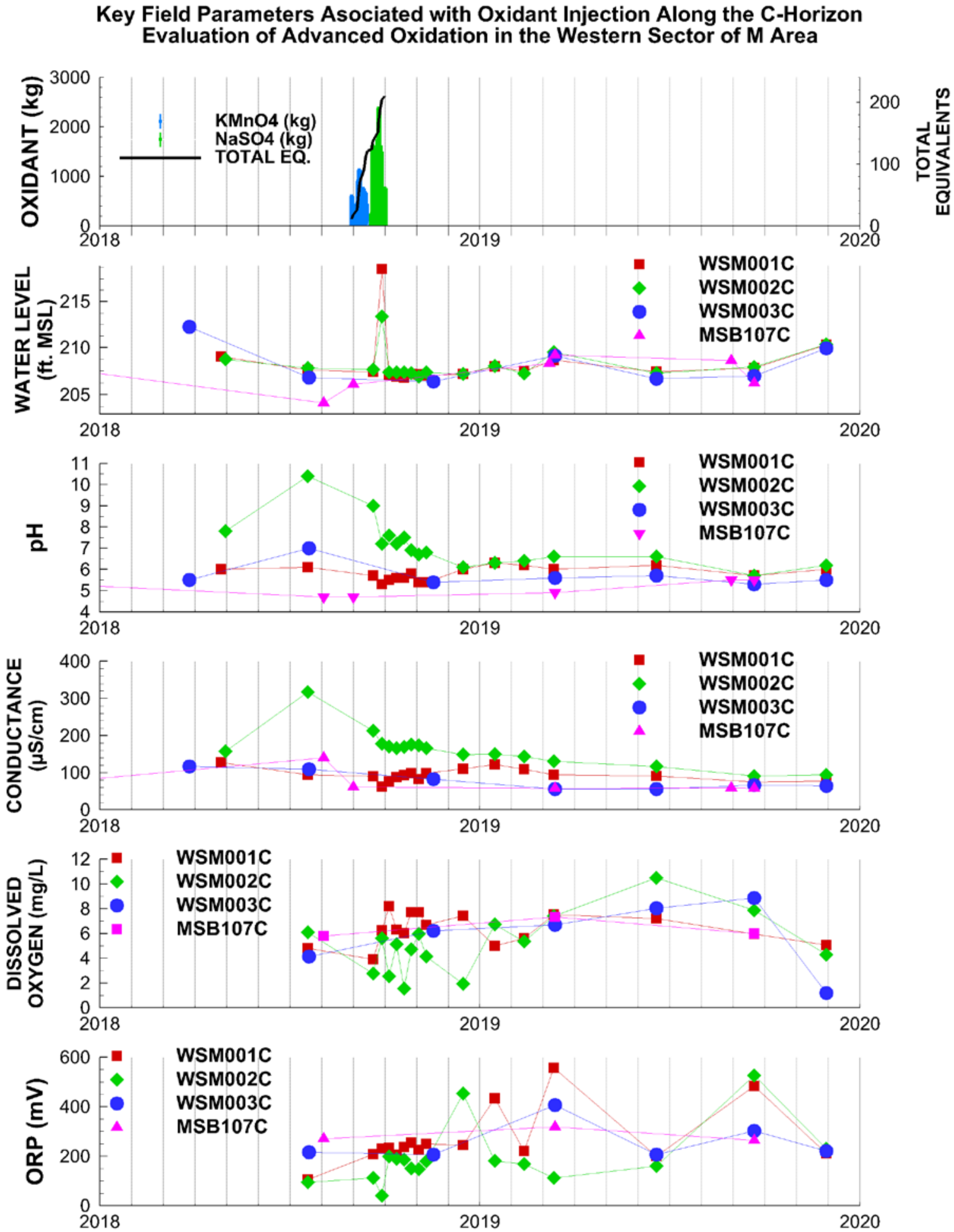

Figure 4. Key Field Parameters Associated with Oxidant Injection Along the C-Horizon (Data from Monitoring Wells WSM001C, WSM002C, WSM003C, and MSB107C)

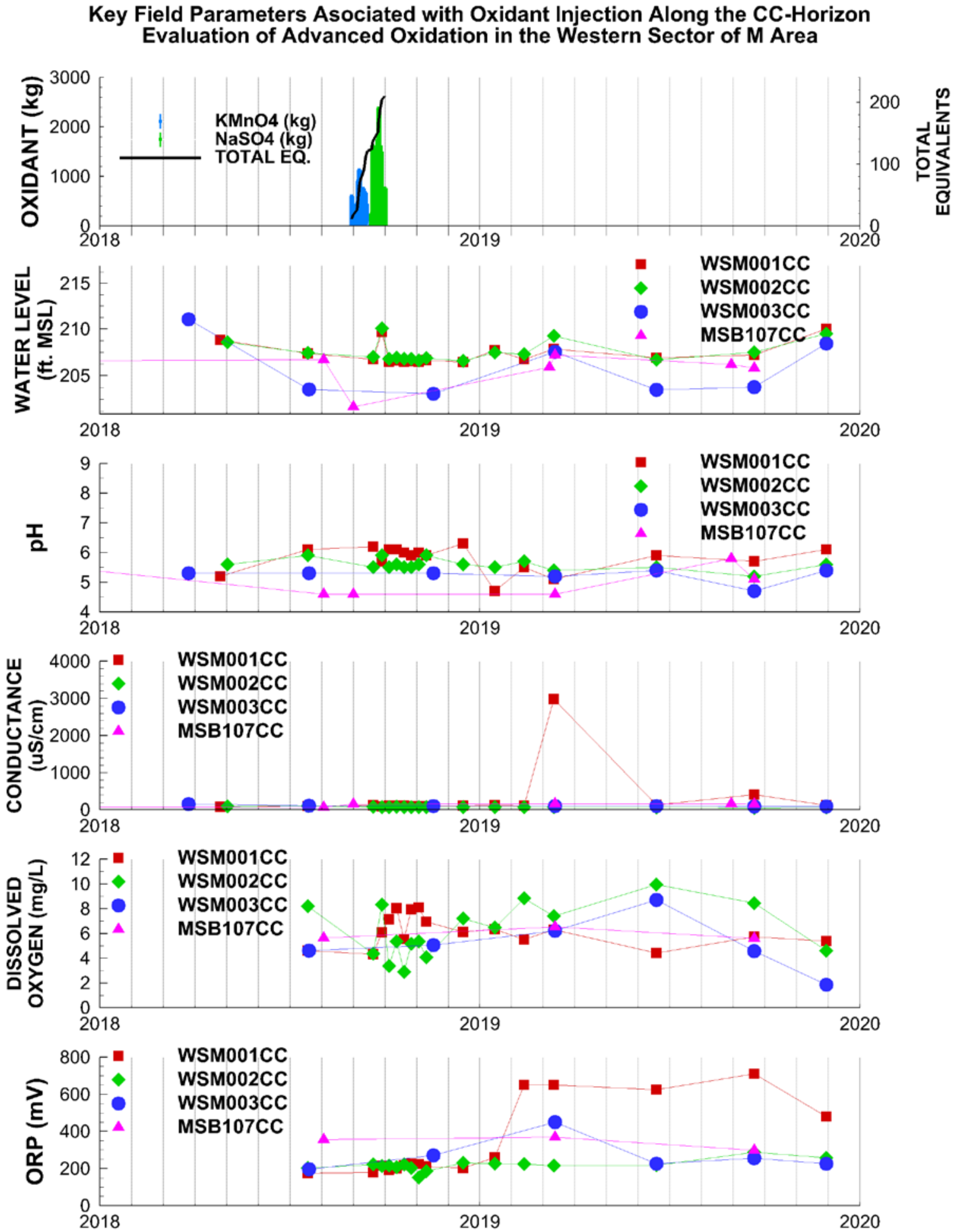

Figure 5. Key Field Parameters Associated with Oxidant Injection Along the CC-Horizon (Data from Monitoring Wells WSM001CC, WSM002CC, WSM003CC and MSB107CC)

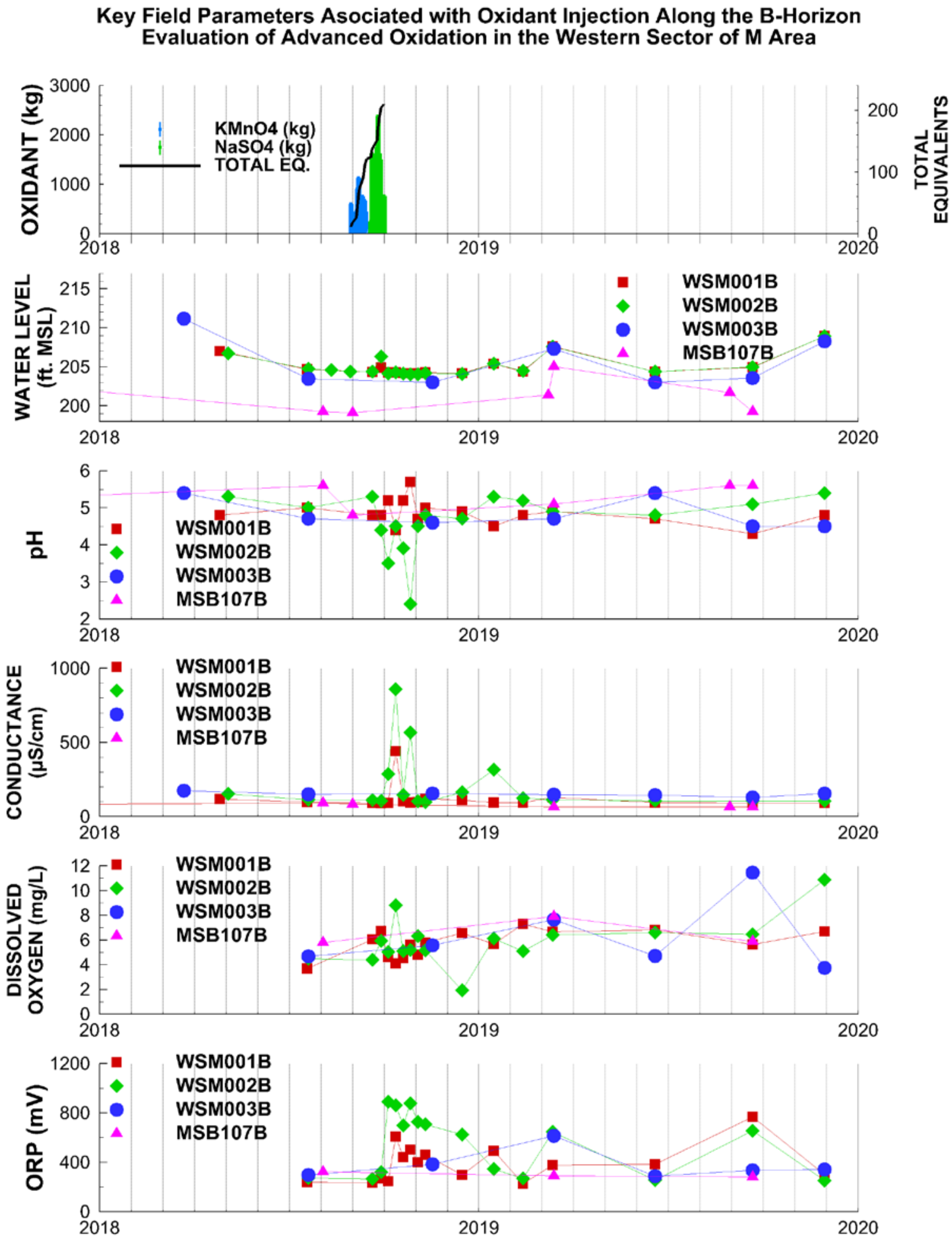

Figure 6. Key Field Parameters Associated with Oxidant Injection Along the B-Horizon (Data from Monitoring Wells WSM001B, WSM002B, WSM003B, and MSB107B)

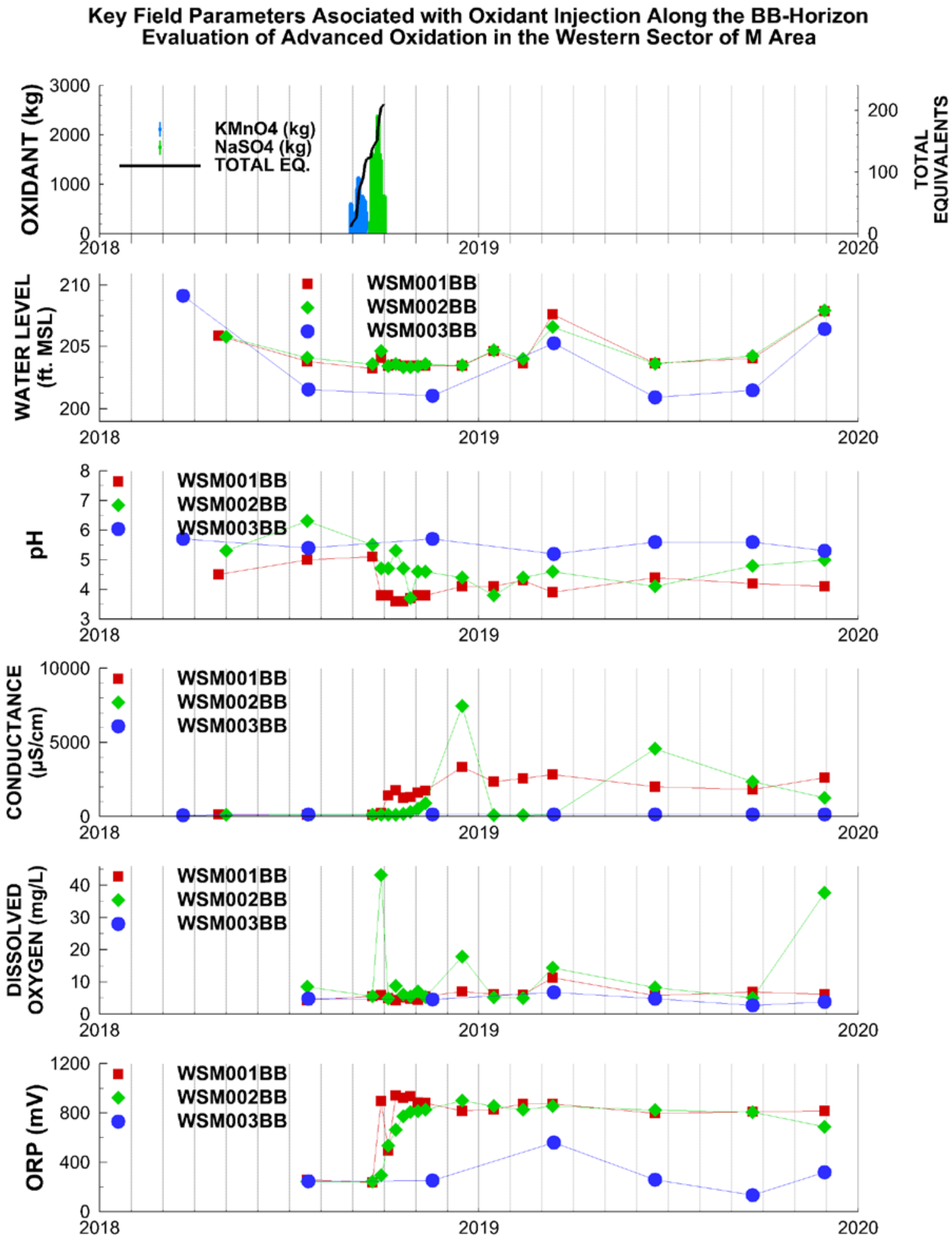

Figure 7. Key Field Parameters Associated with Oxidant Injection Along the BB-Horizon (Data from Monitoring Wells WSM001BB, WSM002BB, and WSM003BB)

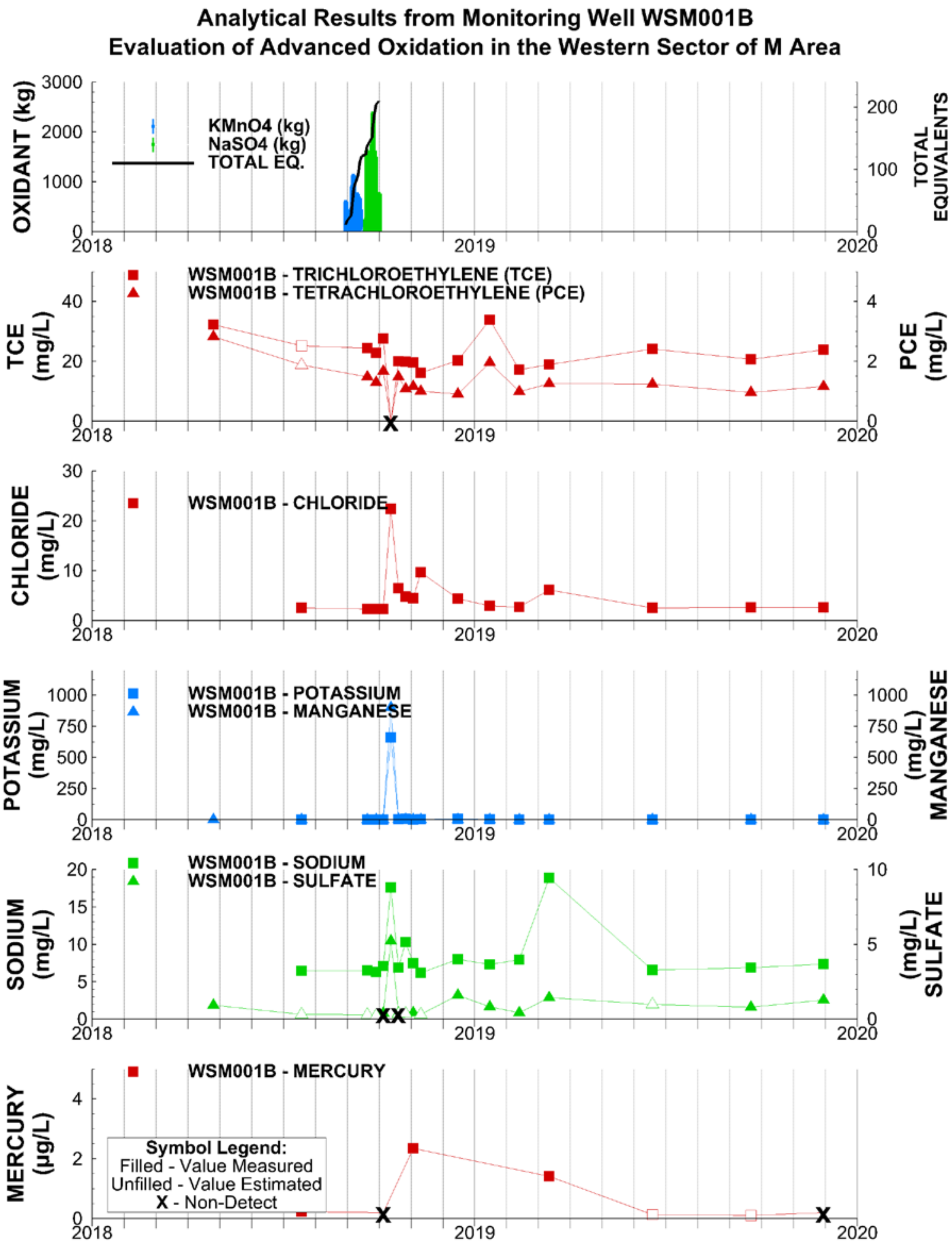

Figure 8. Analytical Results from Monitoring Well WSM001B

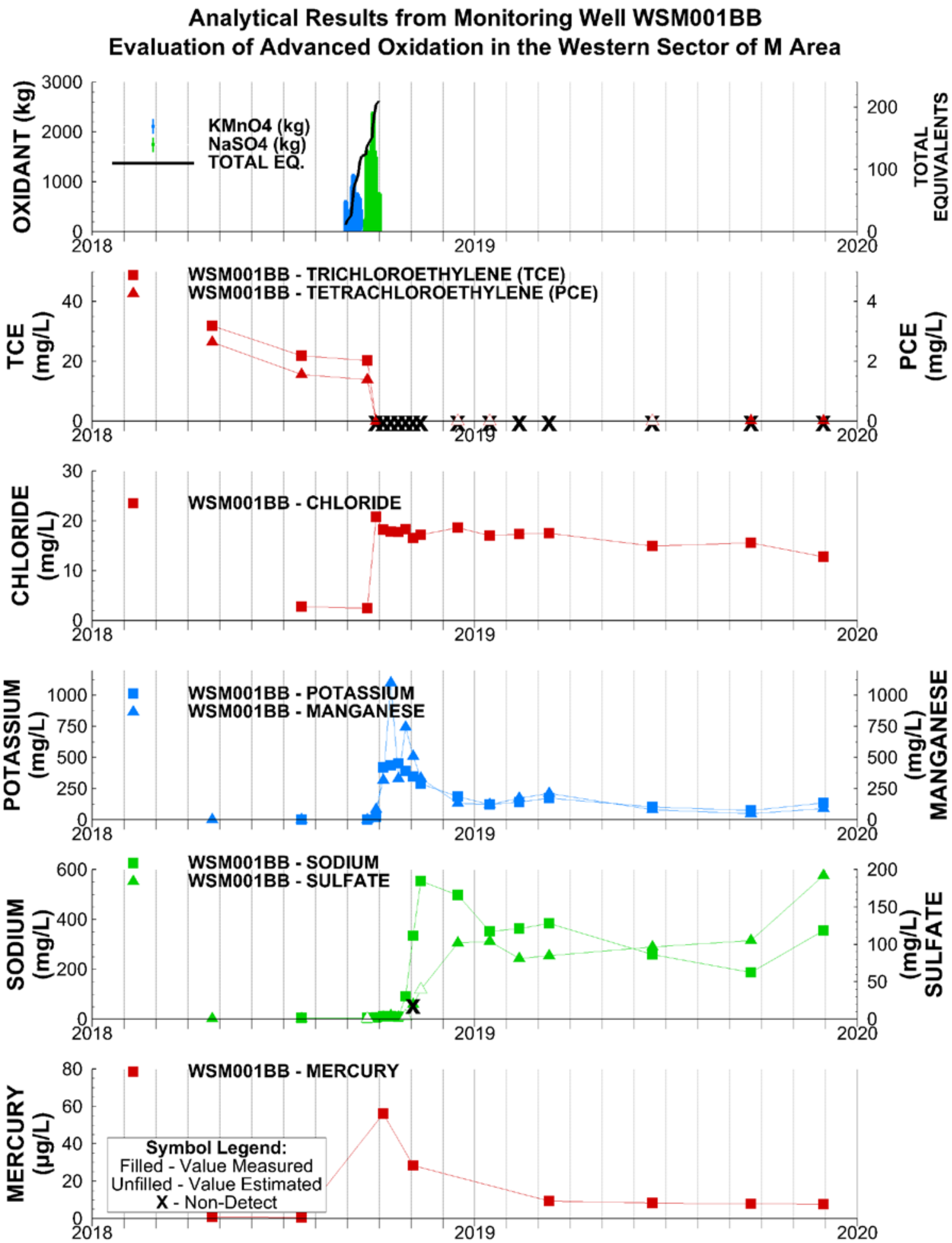

Figure 9. Analytical Results from Monitoring Well WSM001BB

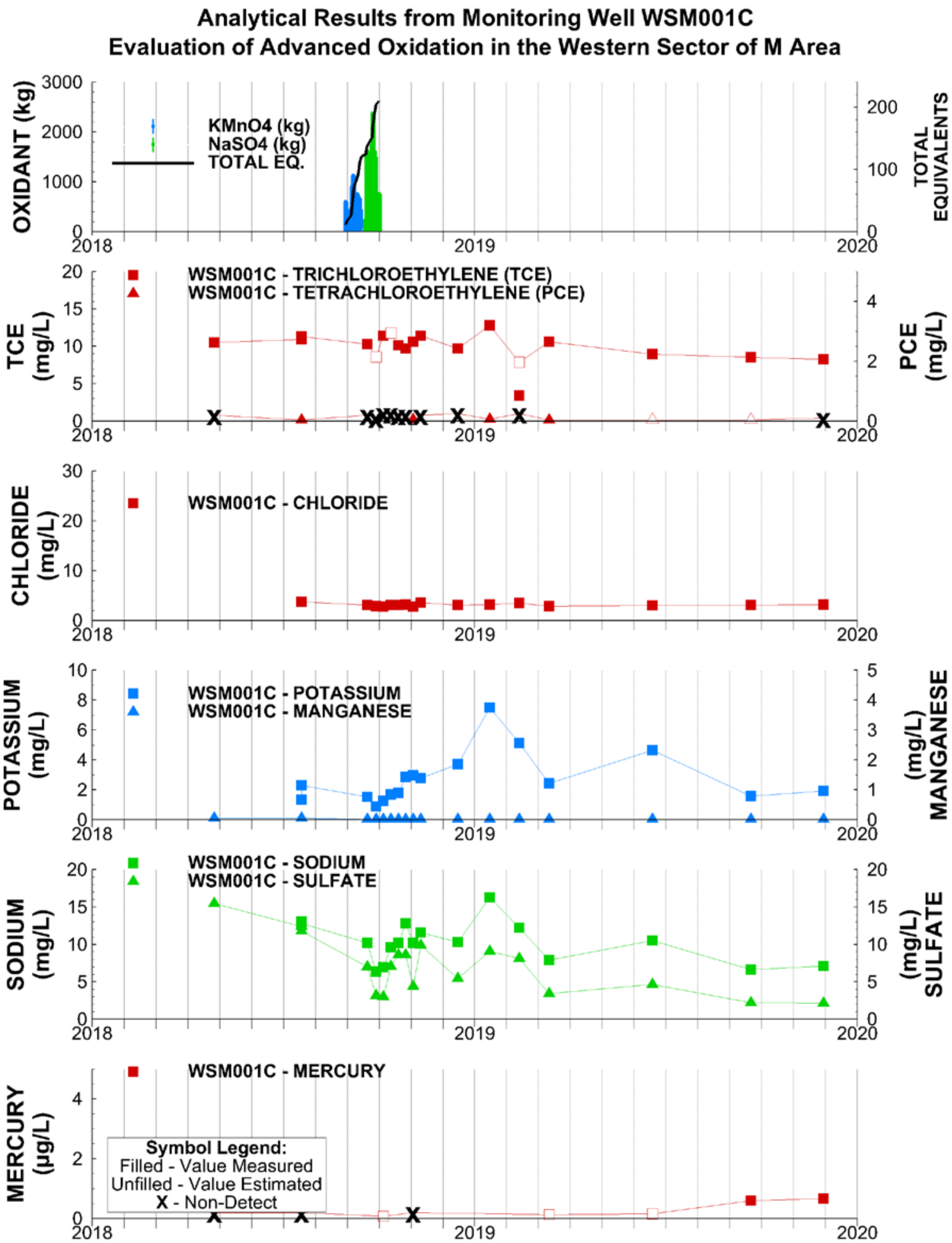

Figure 10. Analytical Results from Monitoring Well WSM001C

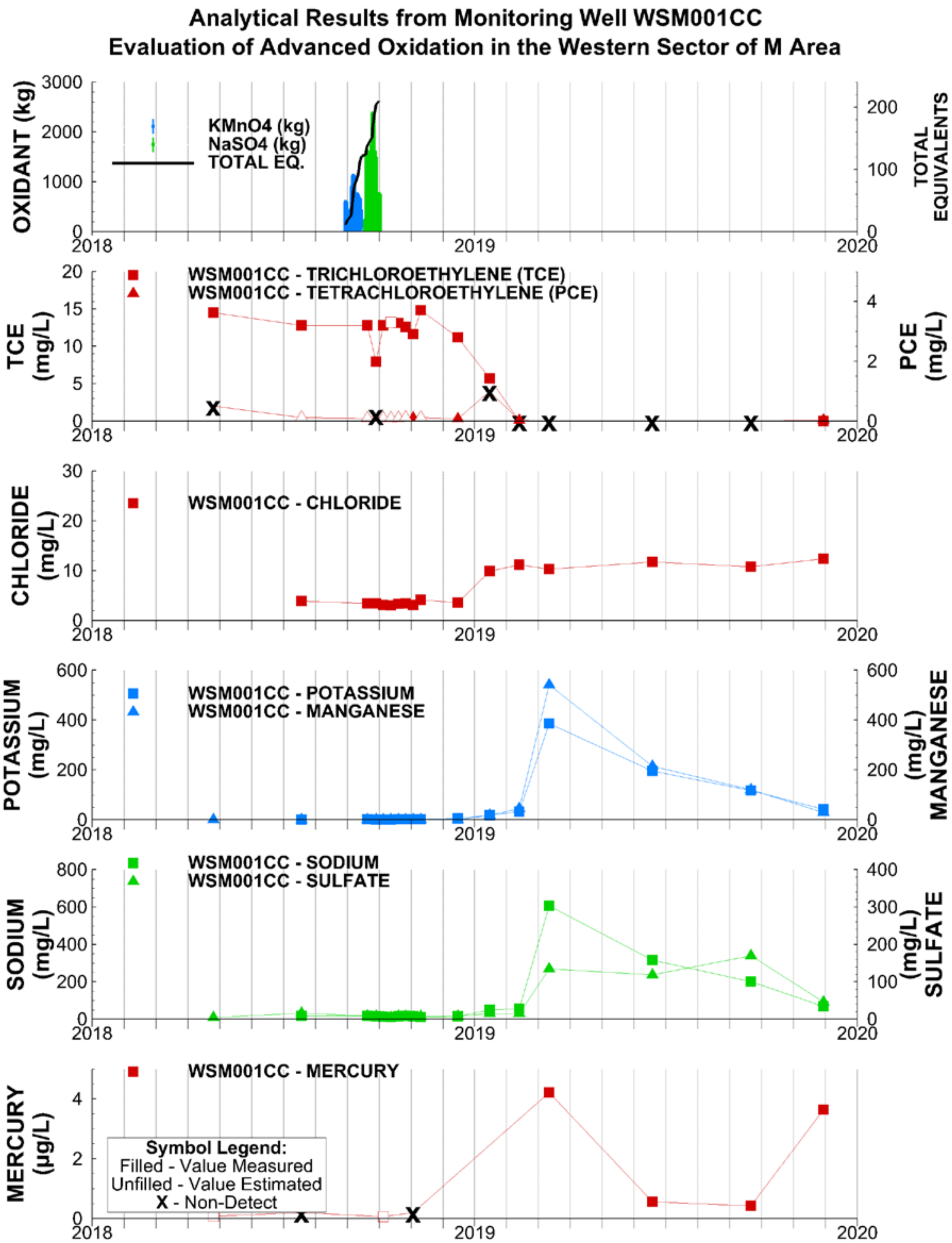

Figure 11. Analytical Results from Monitoring Well WSM001CC

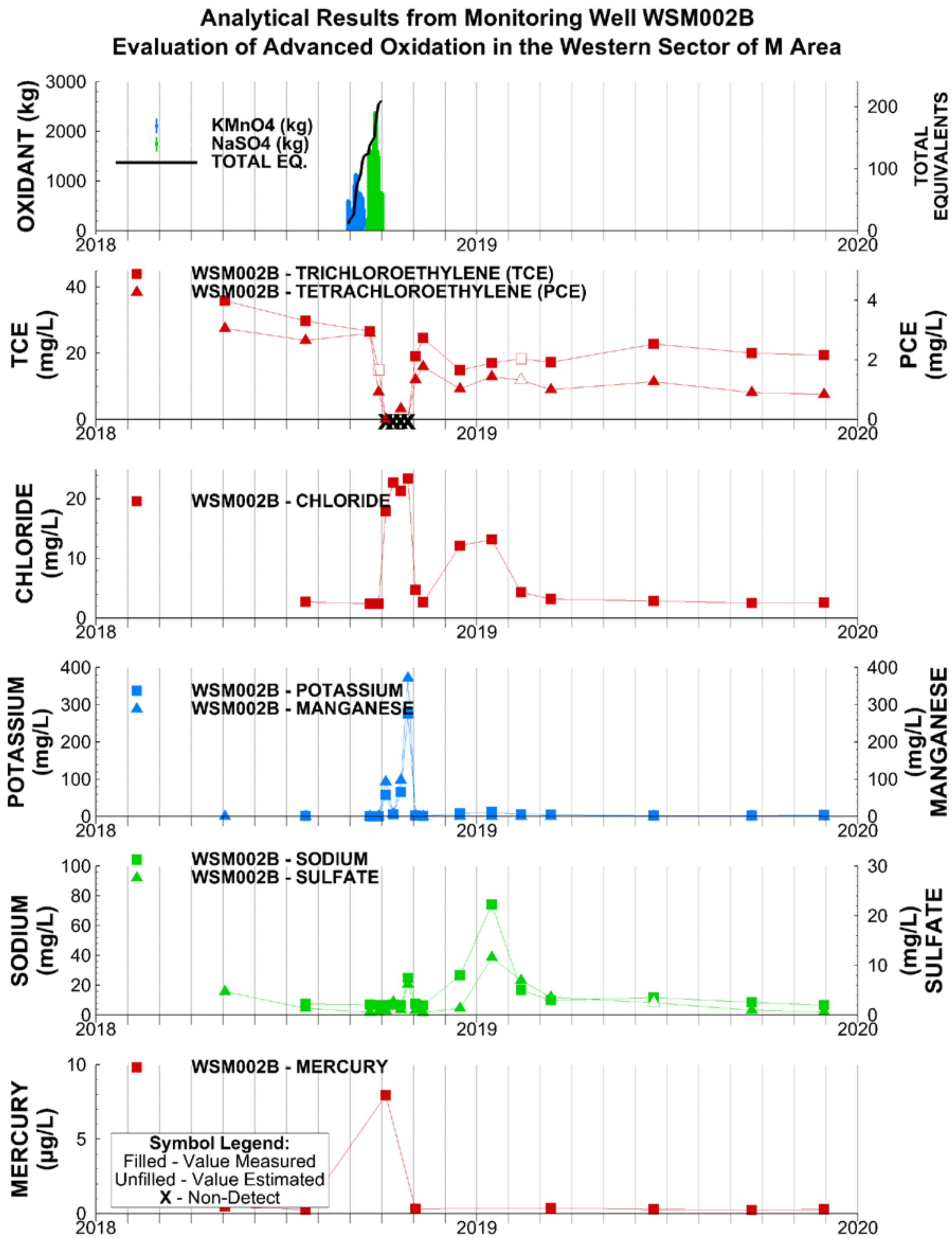

Figure 12. Analytical Results from Monitoring Well WSM002B

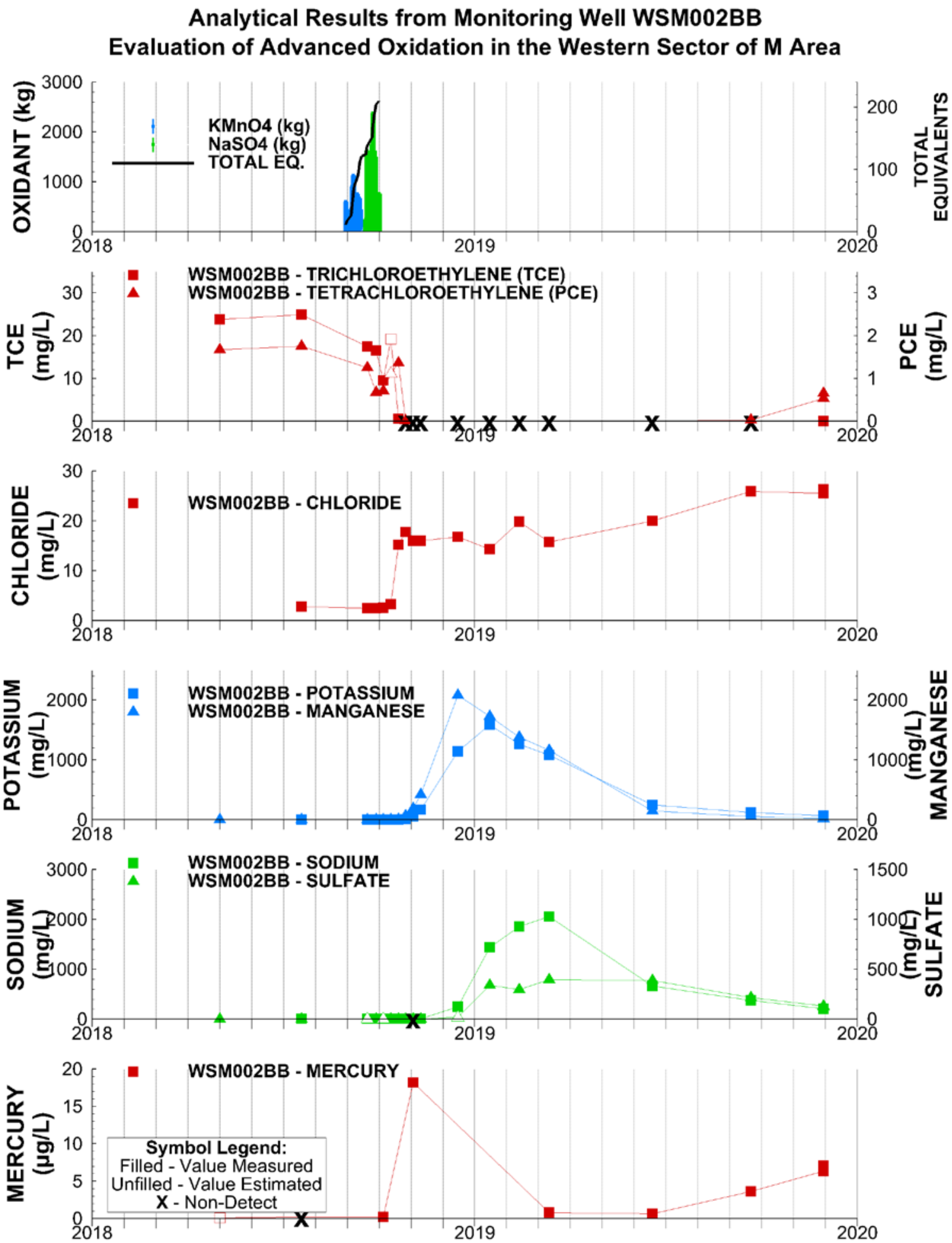

Figure 13. Analytical Results from Monitoring Well WSM002BB

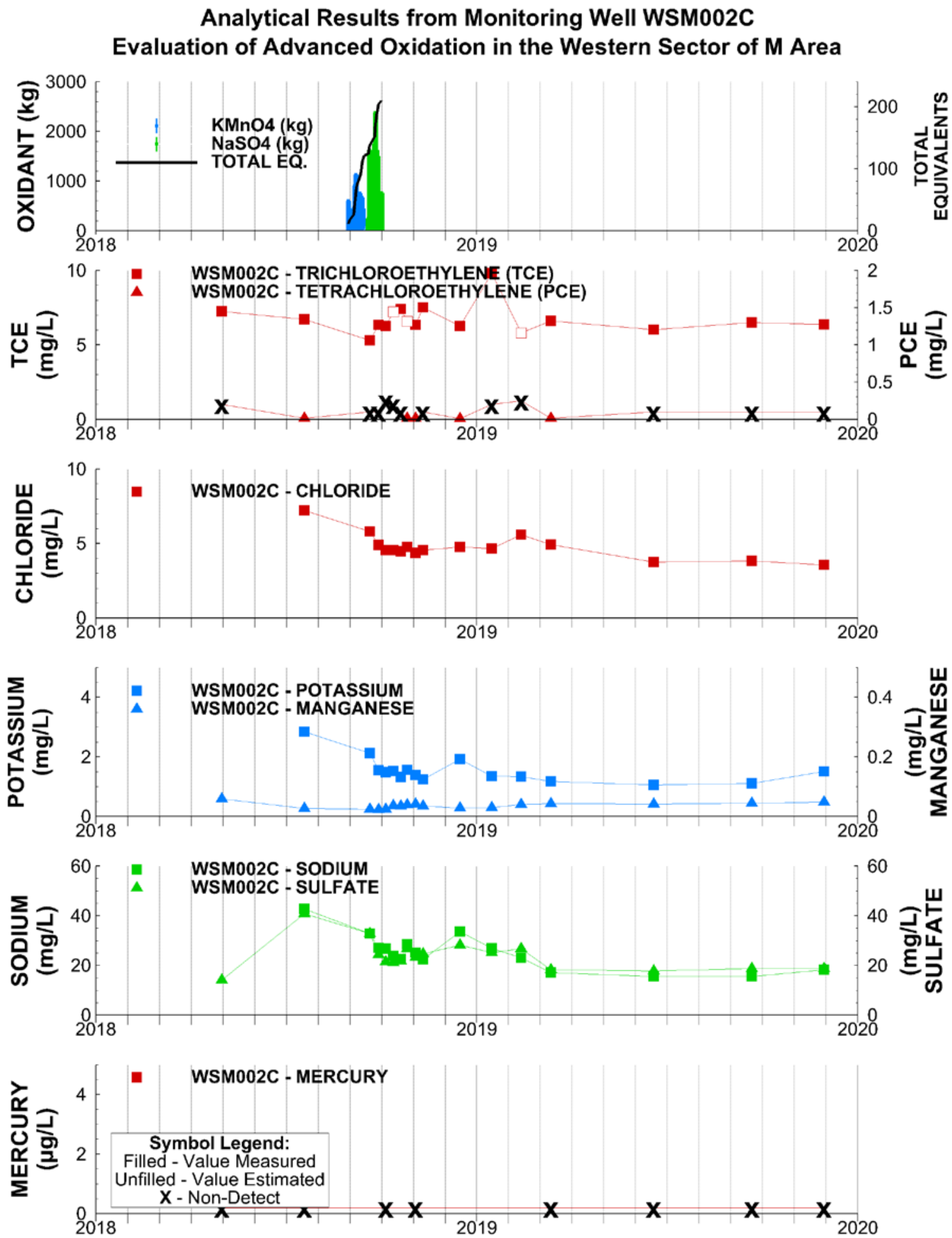

Figure 14. Analytical Results from Monitoring Well WSM002C

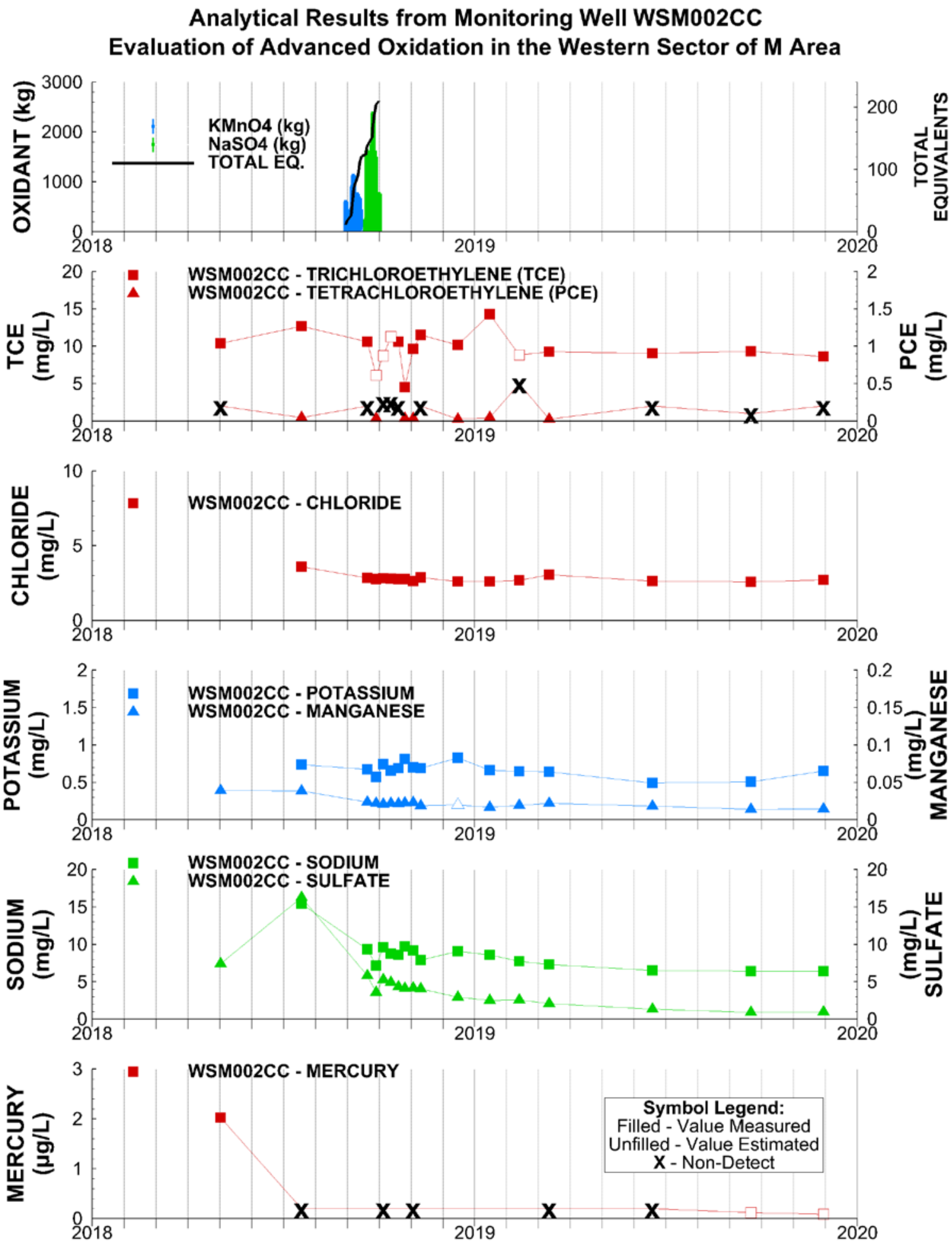

Figure 15. Analytical Results from Monitoring Well WSM002CC

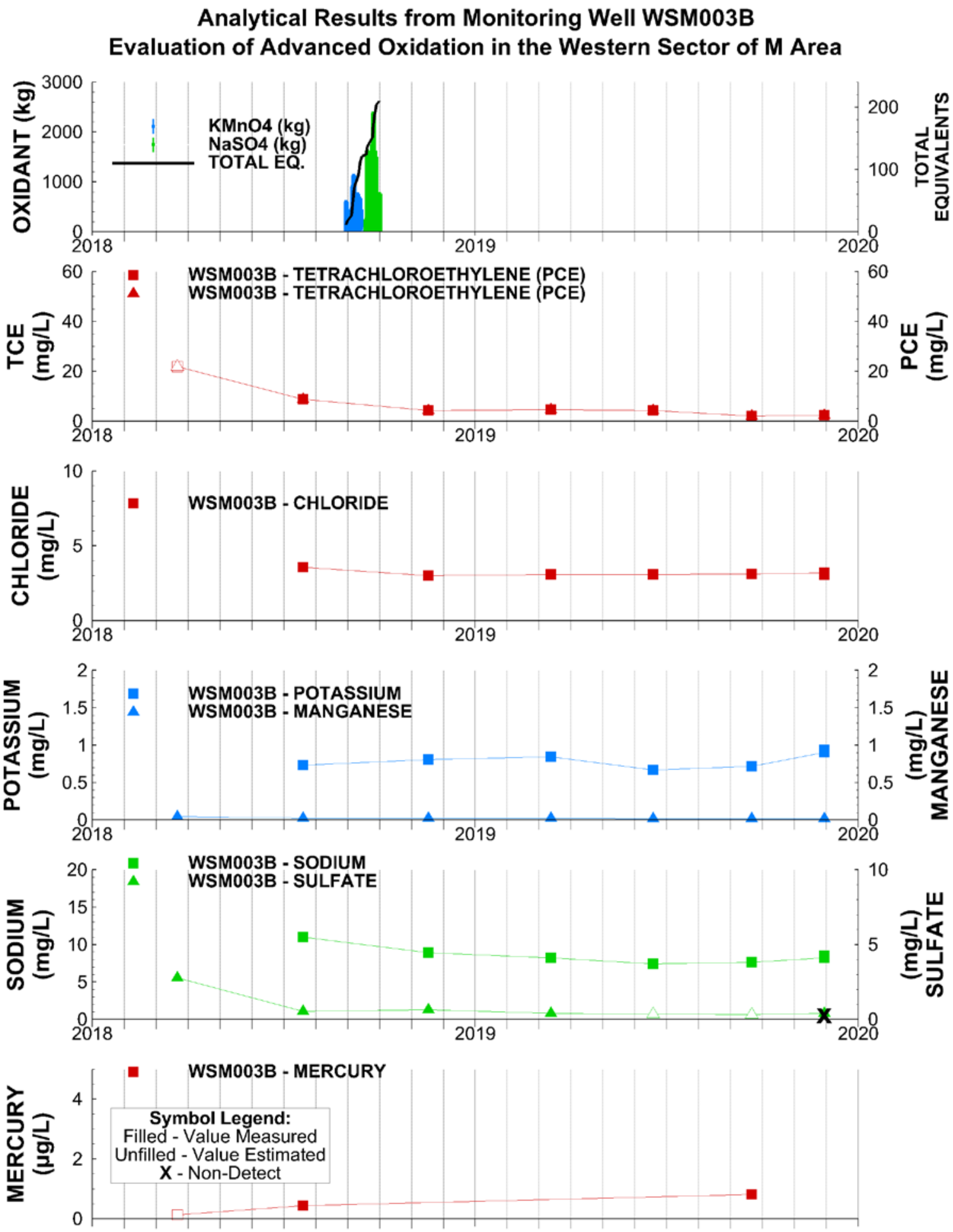

Figure 16. Analytical Results from Monitoring Well WSM003B

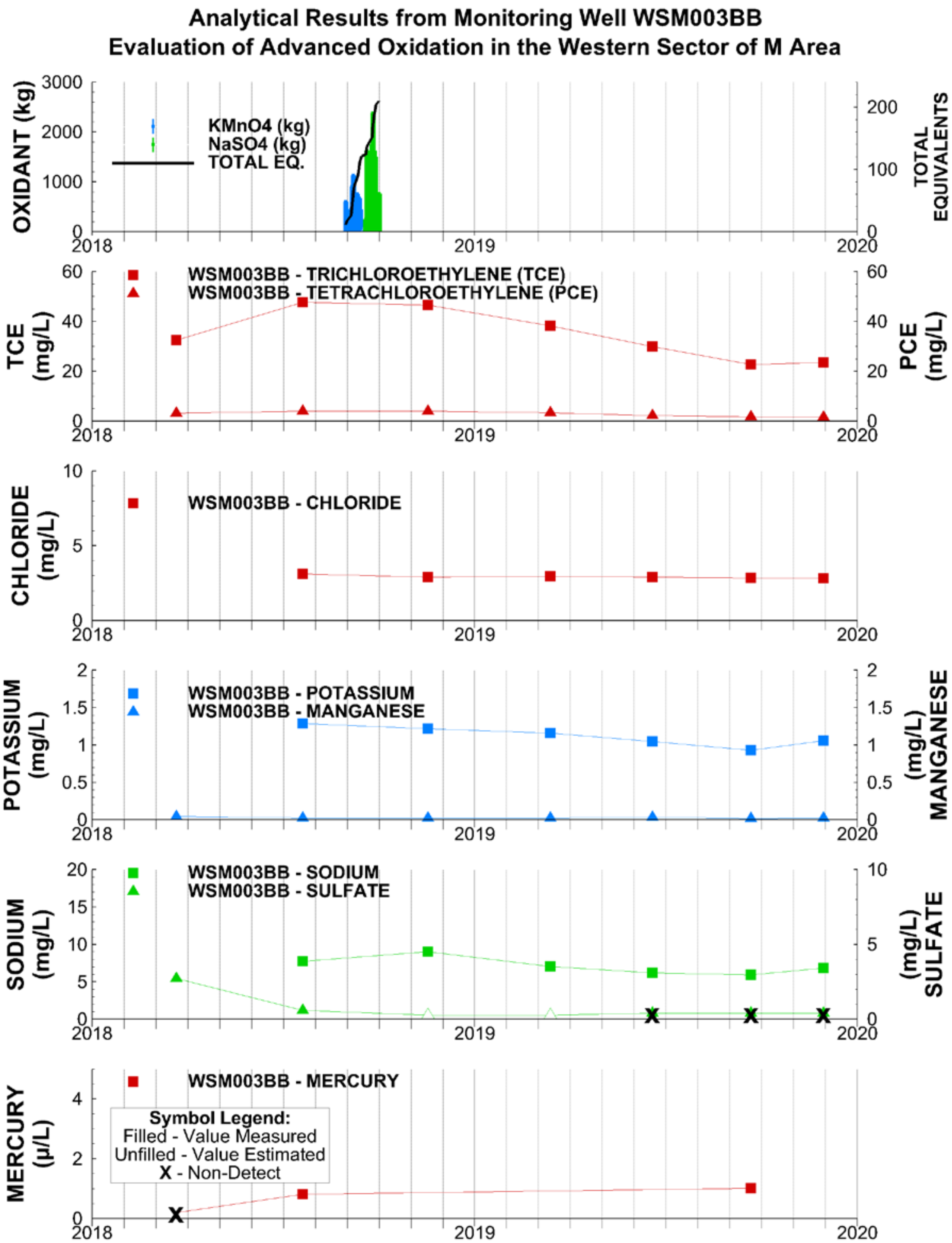

Figure 17. Analytical Results from Monitoring Well WSM003BB

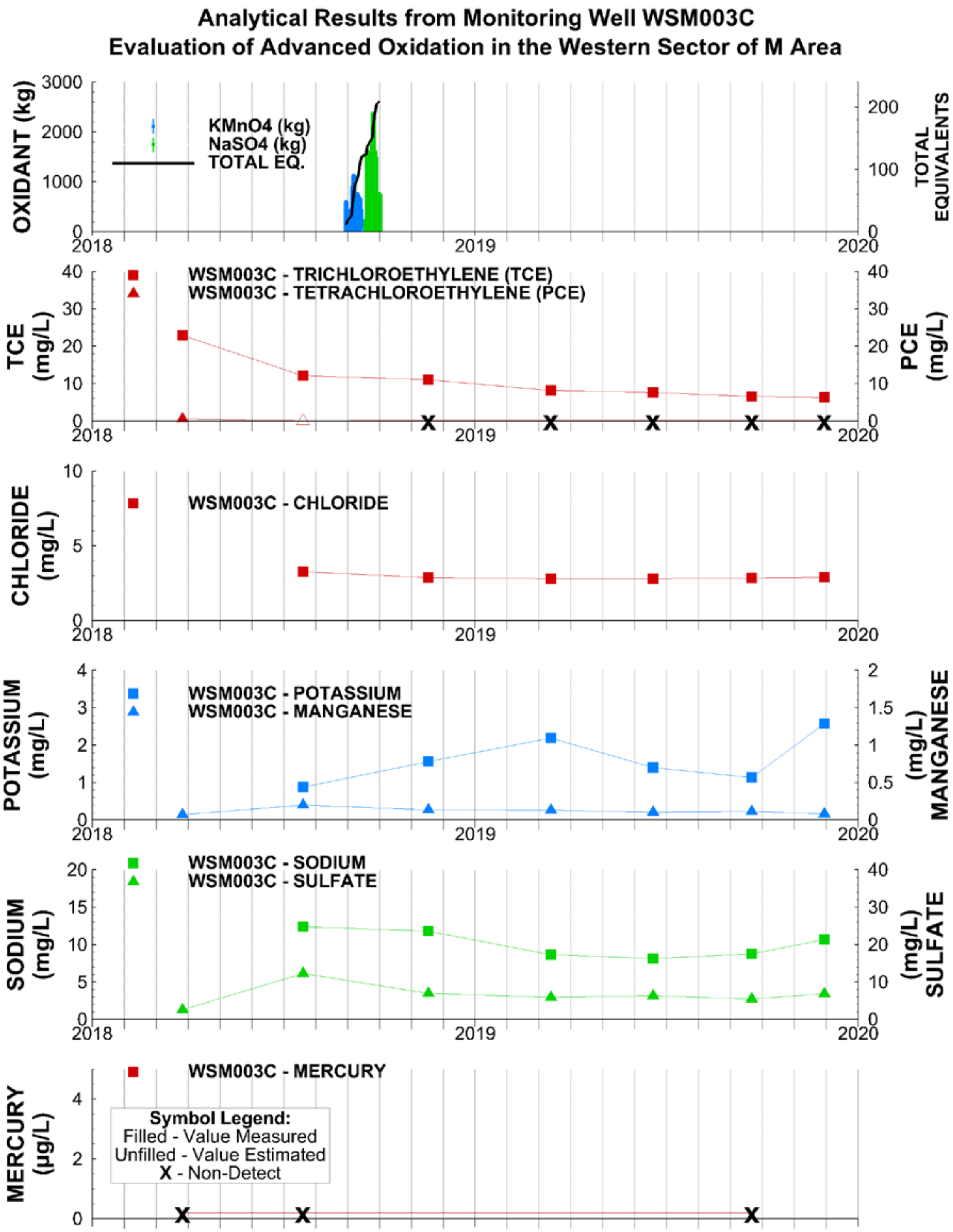

Figure 18. Analytical Results from Monitoring Well WSM003C

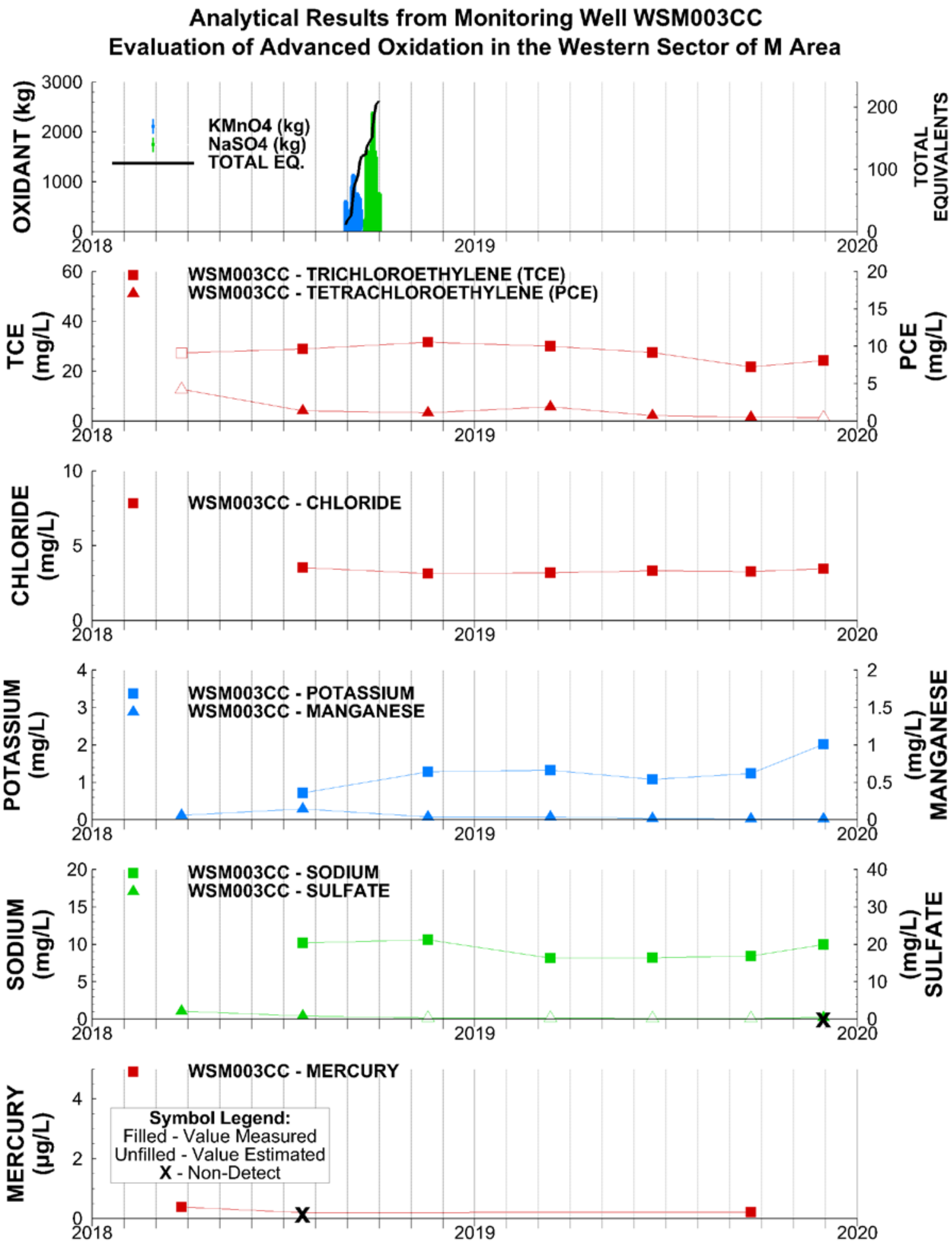

Figure 19. Analytical Results from Monitoring Well WSM003CC

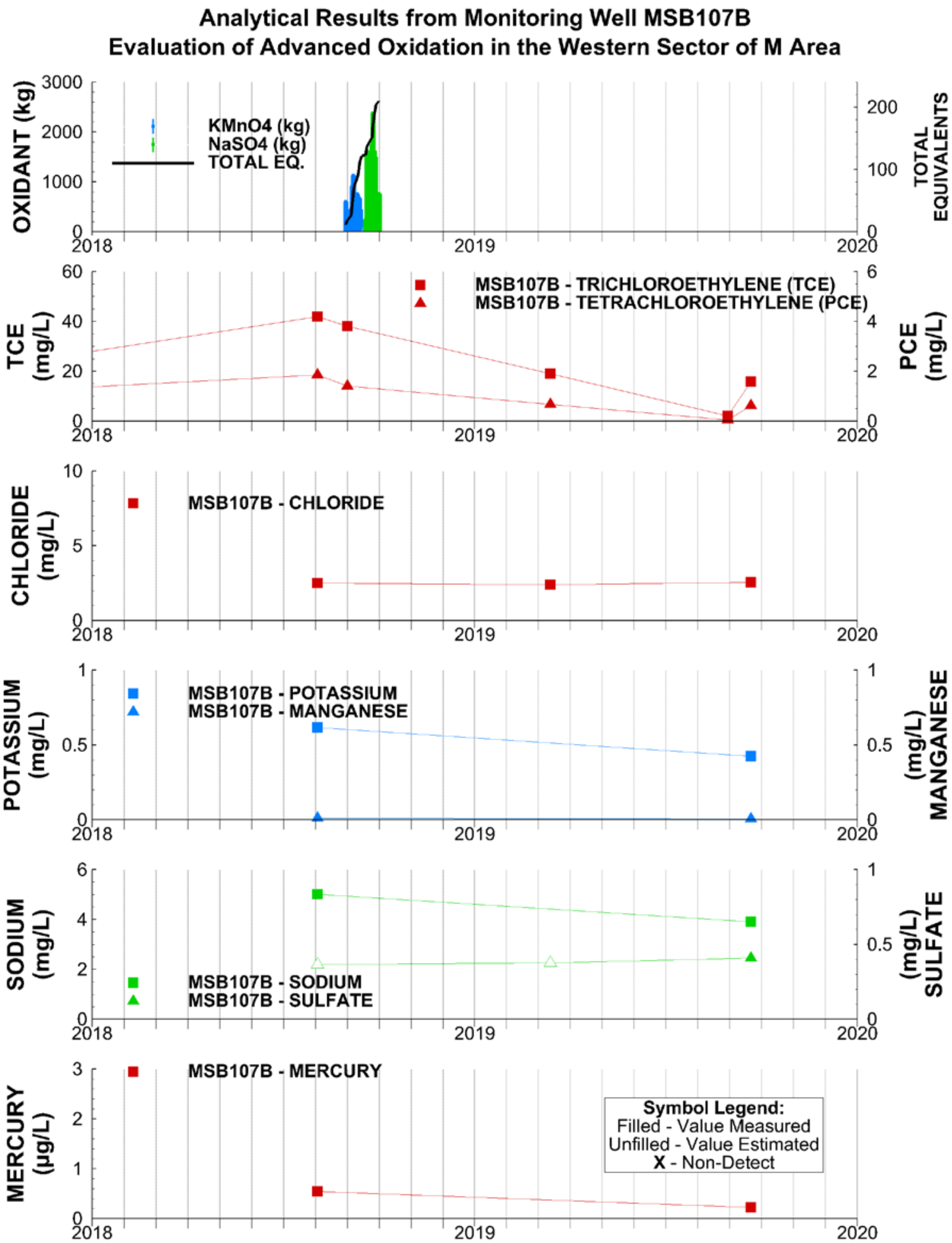

Figure 20. **Analytical Results from Monitoring Well MSB107B**

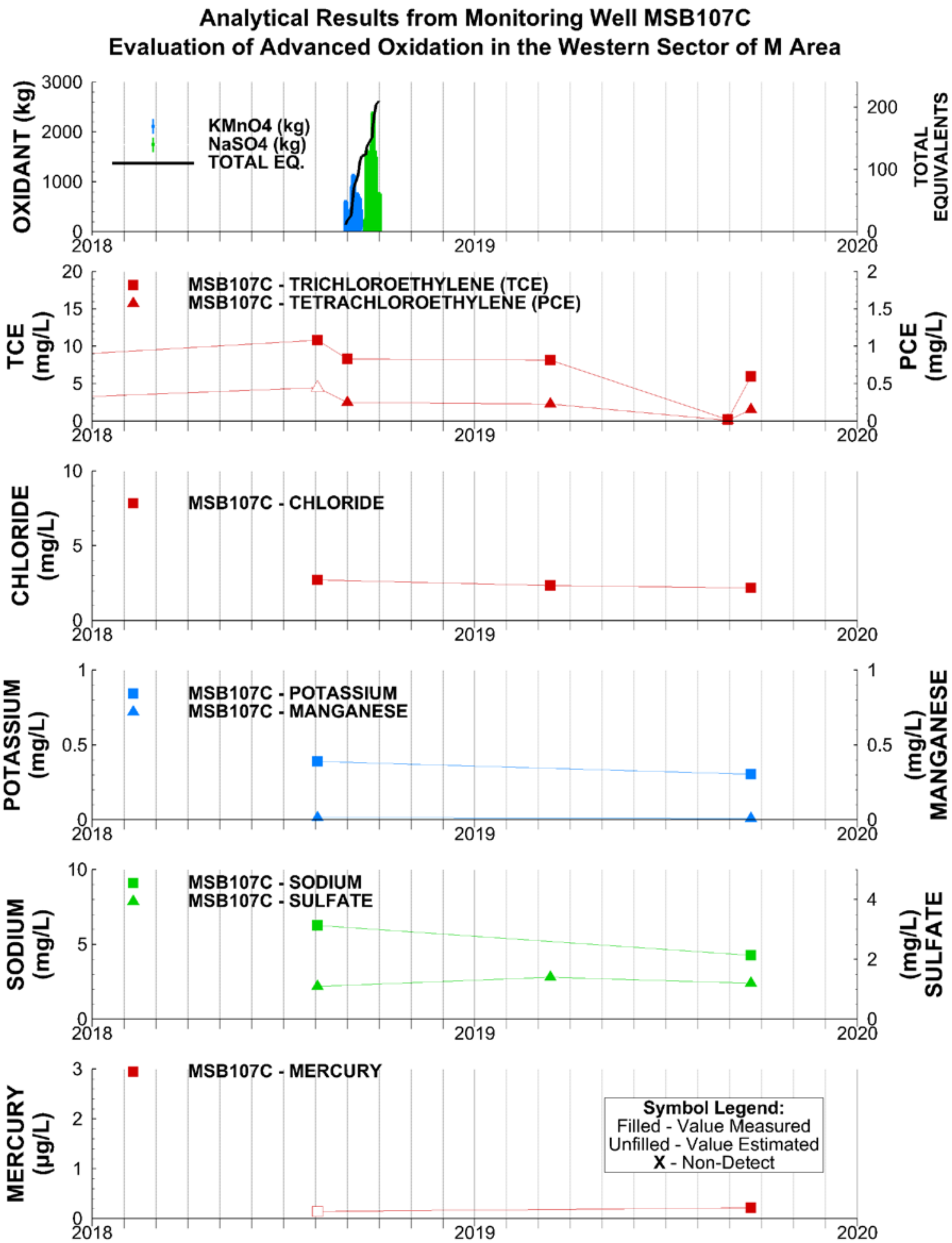

Figure 21. Analytical Results from Monitoring Well MSB107C

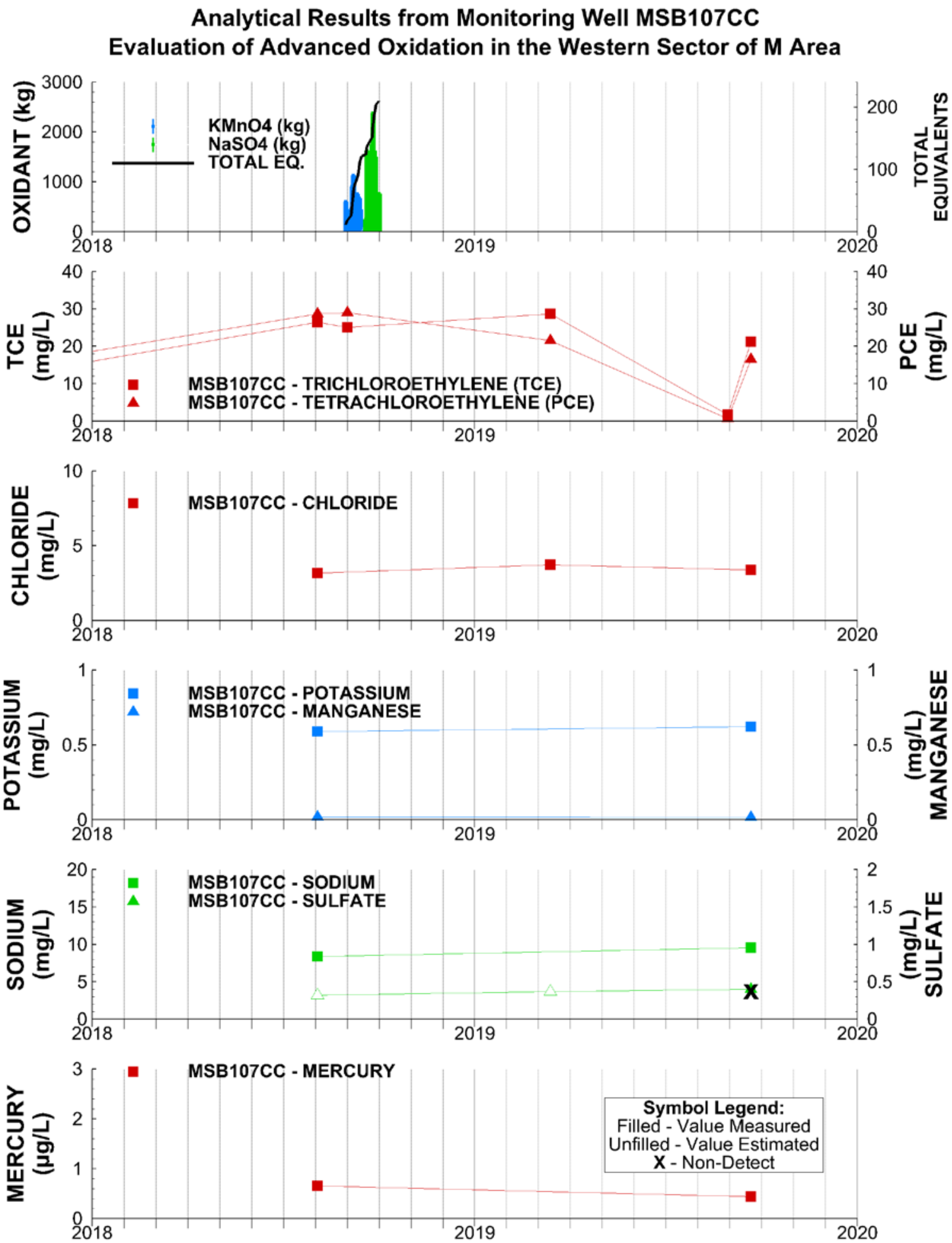

Figure 22. Analytical Results from Monitoring Well MSB107CC

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Table 1. M-Area Western Sector ISCO Injection Well Location and Screen Intervals

Injection Wells for M-Area Western Sector ISCO									
Well ID	Longitude	Latitude	UTM Easting	UTM Northing	SRS Easting	SRS Northing	Ground Elevation *(ft amsl)*	Screen Interval *(ft bgs)*	Total Depth *(ft bgs)*
	NAD 27								
WSI001B	-81º 44' 38.61"	33º 19' 48.25"	430750.7812	3687934.207	46741.61611	103113.5001	345.66	194.00 – 209.01	209.35
WSI001C	-81º 44' 38.68"	33º 19' 48.33"	430748.9021	3687936.707	46741.45918	103123.7633	345.79	171.31 – 186.31	186.66
WSI002B	-81º 44' 38.86"	33º 19' 48.11"	430744.2867	3687930.012	46716.28263	103114.9138	345.80	196.15 – 211.15	211.5
WSI002C	-81º 44' 38.94"	33º 19' 48.19"	430742.3377	3687932.394	46715.71209	103124.9984	345.80	174.25 – 189.25	189.6
WSI003B	-81º 44' 39.10"	33º 19' 47.96"	430738.1763	3687925.433	46691.22569	103114.5649	346.29	195.65 – 210.65	211
WSI003C	-81º 44' 39.16"	33º 19' 48.04"	430736.6312	3687927.97	46692.02597	103124.2802	346.07	173.65 – 188.65	189
WSI004B	-81º 44' 39.34"	33º 19' 47.82"	430731.8497	3687921.091	46666.05279	103115.2626	346.47	196.32 – 211.32	211.66
WSI004C	-81º 44' 39.40"	33º 19' 47.90"	430730.2418	3687923.666	46666.76075	103125.2013	346.81	174.45 – 189.45	189.75

amsl – above mean sea level
ID – Identification
NAD27 – North American Datum of 1927
UTM – Universal Transverse Mercator

Table 2. M-Area Western Sector ISCO Monitoring Well Location and Screen Intervals

Monitoring Wells for M-Area Western Sector ISCO									
Well ID	Longitude	Latitude	UTM Easting	UTM Northing	SRS Easting	SRS Northing	Ground Elevation *(ft amsl)*	Screen Interval *(ft bgs)*	Total Depth *(ft bgs)*
	NAD 27								
WSM001B	-81° 44’ 38.95”	33° 19’ 47.69”	430741.9132	3687917.067	46684.98291	103085.1504	346.31	197.40 – 202.40	202.7
WSM001BB	-81° 44’ 38.85”	33° 19’ 47.73”	430744.4534	3687918.207	46693.92454	103083.2691	346.27	206.70 – 211.70	212
WSM001C	-81° 44’ 39.02”	33° 19’ 47.77”	430740.0887	3687919.518	46684.87581	103095.1774	346.31	173.20 – 178.20	178.5
WSM001CC	-81° 44’ 38.92”	33° 19’ 47.82”	430742.8235	3687921.016	46695.0252	103093.8701	346.19	182.20 – 187.20	187.5
WSM002B	-81° 44’ 38.69”	33° 19’ 47.84”	430748.7744	3687921.59	46711.92321	103083.8996	345.94	197.30 – 202.30	202.6
WSM002BB	-81° 44’ 38.60”	33° 19’ 47.90”	430751.1203	3687923.51	46721.85578	103084.4631	345.92	206.70 – 211.70	212
WSM002C	-81° 44’ 38.76”	33° 19’ 47.92”	430746.9691	3687924.086	46711.95397	103094.0089	345.97	172.93 – 177.91	178.22
WSM002CC	-81° 44’ 38.66”	33° 19’ 47.98”	430749.4381	3687925.892	46721.99298	103094.0322	345.89	180.90 – 185.90	186.2
WSM003B	-81° 44’ 37.57”	33° 19’ 45.81”	430777.302	3687859.068	46666.86121	102862.9137	345.99	200.02 – 205.00	205.3
WSM003BB	-81° 44’ 37.46”	33° 19’ 45.87”	430779.9469	3687860.687	46677.00577	102862.1011	345.85	212.06 – 217.04	217.35
WSM003C	-81° 44’ 37.62”	33° 19’ 45.90”	430775.9519	3687861.588	46668.14609	102872.2075	345.89	174.14 – 184.12	184.5
WSM003CC	-81° 44’ 37.54”	33° 19’ 45.94”	430778.0304	3687862.979	46676.34748	102871.8839	345.79	189.30 – 199.29	199.62
MSB107A	-81° 44’ 36.35”	33° 19’ 43.72”	430808.164	3687794.224	46623.50833	102631.2583	347.16	274 – 284	286
MSB107B	-81° 44’ 36.46”	33° 19’ 43.69”	430805.313	3687793.45	46614.4489	102634.711	347.24	213 – 223	225
MSB107C	-81° 44’ 36.58”	33° 19’ 43.67”	430802.218	3687792.87	46605.1169	102639.1498	347.29	170 – 180	182
MSB107CC	-81° 44’ 36.89”	33° 19’ 43.83”	430794.385	3687797.77	46593.7975	102667.2793	347.65	190 – 200	227

amsl – above mean sea level
ID – Identification
NAD27 – North American Datum of 1927
UTM – Universal Transverse Mercator

Table 3. Monitoring Program Identified in Attachment D of UIC Application (SRNS 2017)

Groundwater Monitoring Wells Monitored During and Shortly After Oxidant Injection (First 2 Months)					
Well ID	**Metals/Radionuclides**	**VOCs**	**Anions**	**Field Parameters**	**Chlorine Isotopes**
Proximal Wells (8)	Monthly	Weekly	Weekly	Weekly	Monthly
Distal Wells (4)	N/S	N/S	N/S	N/S	N/S
MSB107 (3)	N/S	N/S	N/S	N/S	N/S
Groundwater Monitoring Wells Monitored During Monitoring Phase (2 – 6 Months)					
Well ID	**Metals/Radionuclides**	**VOCs**	**Anions**	**Field Parameters**	**Chlorine Isotopes**
Proximal Wells (8)	Monthly	Monthly	Monthly	Monthly	Quarterly
Distal Wells (4)	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
MSB107 (3)	N/S	Semi-annually	Semi-annually	Semi-annually	N/S
Groundwater Monitoring Wells Monitored After 6 Months					
Well ID	**Metals/Radionuclides**	**VOCs**	**Anions**	**Field Parameters**	**Chlorine Isotopes**
Proximal Wells (8)	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly
Distal Wells (4)	Semi-annually	Quarterly	Quarterly	Quarterly	Semi-annually
MSB107 (3)	Annually	Semi-annually	Semi-annually	Semi-annually	Annually

Proximal wells include: WSM001C, WSM001CC, WSM001B, WSM001BB; WSM002C, WSM002CC, WSM002B, and WSM002BB
Distal wells include: WSM003C, WSM003CC, WSM003B, and WSM003BB
VOCs include: TCE and PCE
N/S – not sampled

Table 4. M-Area Western Sector ISCO Field and Analytical Results

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM001B												
Date	**pH**	**SC** *(μS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(μg/L)*	**PCE** *(μg/L)*	**Cl** *(mg/L)*	**Mn** *(μg/L)*	**K** *(μg/L)*	**Na** *(μg/L)*	**Sulfate** *(mg/L)*	**Hg** *(μg/L)*
25-Apr-18	4.8	117	NS	NS	32,200	2,830	NS	32	NS	NS	0.94	0.42
17-Jul-18	5.0	98	239	3.68	25,200 (J)	1,880 (J)	2.55	18	1,030	6,440	0.33 (J)	0.22
17-Sep-18	4.8	92	234	6.05	24,400	1,470	2.26	11	874	6,520	0.29 (J)	NS
25-Sep-18	4.8	90	267	6.72	22,800	1,290	2.32	11	773	6,280	0.25 (J)	NS
2-Oct-18	5.2	91	246	4.6	27,600	1,660	2.30	70	953	7,080	ND	ND
9-Oct-18	4.4	442	608	4.1	R	R	22.40	902,000	662,000	17,600	5.22	NS
16-Oct-18	5.2	103	440	4.5	20,000	1,470	6.44	5,210	5,250	6,910	ND	NS
23-Oct-18	5.7	93	503	5.6	19,800	1,070	4.77	5,280	6,580	10,300	0.37 (J)	NS
30-Oct-18	4.7	98	400	4.8	19,600	1,160	4.45	928	2,010	7,500	0.43	2.34
6-Nov-18	5.0	122	460	5.8	16,100	1,000	9.61	419	2,900	6,210	0.33 (J)	NS
11-Dec-18	4.9	109	298	6.55	20,300	903	4.36	441	7,310	8,010	1.59	NS
15-Jan-19	4.5	94	494	5.65	33,800	1,960	2.89	413	4,450	7,340	0.83	NS
12-Feb-19	4.8	94	228	7.31	17,200	988	2.67	287	1,830	7,930	0.42	NS
12-Mar-19	4.9	130	378	6.65	18,900	1,250	6.12	549	1,460	18,900	1.44	1.41
17-Jun-19	4.7	94	385	6.82	24,100	1,230	2.52	177	1,000	6,590	1.00 (J)	0.13 (J)
18-Sep-19	4.3	92	768	5.64	20,700	958	2.58	72	760	6,880	0.80	0.10 (J)
25-Nov-19	4.8	92	302	6.68	23,800	1,150	2.58	78	1,780	7,390	1.29	ND

ND = Non-detect
μS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
μg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM001BB												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
24-Apr-18	4.5	131	NS	NS	31,900	2,640	NS	18	NS	NS	0.49	0.78
17-Jul-18	5.0	111	260	4.34	21,900	1,560	2.76	17	842	5,700	0.51	0.59
17-Sep-18	5.1	104	235	5.46	20,300	1,380	2.46	16	878	5,660	0.35 (J)	NS
25-Sep-18	3.8	260	896	5.87	ND	2.62	20.80	83,600	24,300	6,860	0.67	NS
2-Oct-18	3.8	1,423	497	4.9	ND	ND	18.20	318,000	419,000	11,300	2.97	56.10
9-Oct-18	3.6	1,761	940	4.3	ND	R	17.80	1,100,000	436,000	11,600	4.88	NS
16-Oct-18	3.6	1,271	922	5.1	ND	ND	17.70	332,000	452,000	10,500	2.92	NS
23-Oct-18	3.7	1,314	934	4.8	ND	ND	18.30	743,000	393,000	92,100	3.92 (J)	NS
30-Oct-18	3.8	1,619	883	4.4	ND	ND	16.50	511,000	346,000	335,000	ND	28.40
6-Nov-18	3.8	1,754	879	5.5	ND	ND	17.20	333,000	290,000	554,000	39.7 (J)	NS
11-Dec-18	4.1	3,353	817	6.94	ND	1 (J)	18.60	133,000	186,000	498,000	102	NS
15-Jan-19	4.1	2,361	828	6.18	ND	1 (J)	17.00	123,000	122,000	353,000	104	NS
12-Feb-19	4.3	2,556	874	6.01	ND	ND	17.30	174,000	141,000	363,000	81.4	NS
12-Mar-19	3.9	2,840	875	11.32	ND	ND	17.50	211,000	174,000	385,000	85.1	9.46
17-Jun-19	4.4	2,020	798	5.75	ND	1 (J)	14.90	81,700	102,000	260,000	96.4	8.26
18-Sep-19	4.2	1,835	808	6.88	ND	4	15.60	49,000	75,700	188,000	105	7.87
25-Nov-19	4.1	2,620	817	6.13	ND	10	12.80	89,100	137,000	356,000	192	7.70

ND = Non-detect
R = Rejected
NS = Not Sampled
(J) = Estimated
µS/cm = microsiemens per centimeter
mg/L = milligram per liter
mV = millivolt
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM001C												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
26-Apr-18	6.0	127	NS	NS	10,500	ND	NS	54	NS	NS	15.50	ND
17-Jul-18	6.1	94	105	4.8	11,300	42	3.76	53	2,300	13,100	12.40	ND
17-Sep-18	5.7	90	208	3.92	10,300	ND	3.09	23	1,530	10,200	6.99	NS
25-Sep-18	5.3	62	231	6.23	8,590 (J)	ND	2.85	20	882	6,350	3.13	NS
2-Oct-18	5.5	76	233	8.18	11,400	ND	2.78	22	1,250	6,940	2.97	0.08 (J)
9-Oct-18	5.6	88	207	6.3	11,800 (J)	R	3.05	20	1,680	9,620	7.05	NS
16-Oct-18	5.6	93	237	6.01	10,100	ND	3.12	24	1,800	10,200	8.60	NS
23-Oct-18	5.8	98	254	7.72	9,670	ND	3.16	20	2,850	12,800	8.62	NS
30-Oct-18	5.4	82	225	7.7	10,600	44	2.77	23	2,960	10,200	4.37	ND
6-Nov-18	5.4	99	250	6.7	11,400	ND	3.60	17	2,770	11,600	9.87	NS
11-Dec-18	6.0	110	245	7.43	9,710	ND	3.09	18	3,710	10,300	5.46	NS
15-Jan-19	6.3	122	433	4.98	12,800	58	3.17	21	7,500	16,300	9.06	NS
12-Feb-19	6.2	109	220	5.59	7,880 (J)	ND	3.48	17	5,120	12,200	8.13	NS
12-Mar-19	6.0	94	557	7.51	10,600	39	2.87	19	2,440	7,880	3.41	0.14 (J)
17-Jun-19	6.2	91	200	7.2	8,960	36 (J)	3.00	16	4,650	10,500	4.64	0.16 (J)
18-Sep-19	5.7	75	484	5.96	8,520	41 (J)	3.08	16	1,590	6,630	2.20	0.60
25-Nov-19	6.0	77	211	5.07	8,280	ND	3.20	23	1,930	7,100	2.13	0.66

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM001CC												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
25-Apr-18	5.2	83	NS	NS	14,500	ND	NS	21	NS	NS	4.40	0.08 (J)
17-Jul-18	6.1	104	174	4.6	12,800	115 (J)	3.91	31	1,290	18,100	15.70	ND
17-Sep-18	6.2	120	180	4.33	12,800	92 (J)	3.39	14	1,860	17,200	8.81	NS
25-Sep-18	5.7	93	216	6.07	7,920	ND	3.38	15	810	15,200	7.86	NS
2-Oct-18	6.1	108	191	7.13	12,800	95 (J)	3.07	20	979	12,800	4.01	0.07 (J)
9-Oct-18	6.1	108	200	8.04	13,200 (J)	95 (J)	3.03	19	1,110	11,800	4.85	NS
16-Oct-18	6.0	105	218	5.55	13,100	98 (J)	3.36	15	1,800	15,400	8.00	NS
23-Oct-18	5.9	100	225	7.95	12,600	112 (J)	3.40	14	2,110	17,400	7.85	NS
30-Oct-18	6.0	100	224	8.1	11,600	100	3.05	16	2,050	15,100	5.72	ND
6-Nov-18	5.9	96	210	6.96	14,800	112 (J)	4.11	16	1,690	11,600	7.93	NS
11-Dec-18	6.3	112	203	6.13	11,200	71	3.53	484	4,510	15,500	7.03	NS
15-Jan-19	4.7	116	261	6.34	5,710	ND	9.86	17,900	17,800	49,900	15.30	NS
12-Feb-19	5.5	115	650	5.51	ND	29	11.20	45,300	32,100	56,100	14.80	NS
12-Mar-19	5.1	2,980	651	6.3	ND	ND	10.30	541,000	387,000	607,000	135.00	4.22
17-Jun-19	5.9	135	625	4.42	ND	ND	11.70	215,000	196,000	316,000	119.00	0.56
18-Sep-19	5.7	404	711	5.74	ND	ND	10.80	121,000	117,000	201,000	170.00	0.42
25-Nov-19	6.1	119	479	5.38	2	33	12.40	29,300	41,500	68,400	45.50	3.64

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM002B												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
3-May-18	5.3	152	NS	NS	35,900	3,050	NS	25	NS	NS	4.73	0.48
18-Jul-18	5.0	112	271	4.47	29,700	2,650	2.69	15	1,210	7,580	1.34	0.26
17-Sep-18	5.3	110	264	4.4	26,600	2,890	2.36	14	799	6,910	0.59	NS
25-Sep-18	4.4	104	320	5.93	15,000 (J)	921	2.36	14	695	6,560	0.63	NS
2-Oct-18	3.5	285	889	5.03	ND	9	17.90	93,000	57,600	6,630	0.86	7.95
9-Oct-18	4.5	861	860	8.8	ND	R	22.70	6,300	5,800	6,860	2.67	NS
16-Oct-18	3.9	145	699	5.08	ND	359	21.30	97,000	65,200	6,730	1.04	NS
23-Oct-18	2.4	566	876	5.19	ND	ND	23.40	372,000	277,000	24,700	6.18	NS
30-Oct-18	4.5	103	726	6.3	19,000	1,330	4.69	2,460	2,200	7,360	0.93	0.31
6-Nov-18	4.8	96	707	5.14	24,600	1,770	2.63	705	944	6,350	0.50	NS
11-Dec-18	4.7	164	625	1.91	14,900	1,020	12.10	784	7,620	26,800	1.34	NS
15-Jan-19	5.3	315	344	6.1	17,000	1,430	13.20	726	12,000	74,300	11.60	NS
12-Feb-19	5.2	123	268	5.1	18,300 (J)	1,310 (J)	4.31	719	5,170	16,700	6.93	NS
12-Mar-19	4.9	112	645	6.4	17,200	1,000	3.17	187	4,650	9,780	3.64	0.36
17-Jun-19	4.8	105	256	6.58	22,800	1,260	2.85	107	2,850	11,700	2.46 (J)	0.29
18-Sep-19	5.1	106	655	6.48	20,000	898	2.53	173	2,270	8,440	0.99	0.23
25-Nov-19	5.4	106	253	10.9	19,400	830	2.57	82	3,950	6,690	0.67	0.29

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM002BB												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
1-May-18	5.3	121	NS	NS	23,800	1,670	NS	35	NS	NS	0.80	0.08 (J)
17-Jul-18	6.3	105	242	8.48	24,900	1,750	2.74	21	896	6,820	0.57	0.20
17-Sep-18	5.5	105	244	5.5	17,400	1,250	2.47	18	878	5,770	0.38 (J)	NS
25-Sep-18	4.7	104	293	43.19	16,500	673	2.45	20	950	6,310	0.58	NS
2-Oct-18	4.7	104	535	4.82	9,460	708	2.51	26	976	6,770	0.37 (J)	0.21
9-Oct-18	5.3	112	661	8.71	19,200 (J)	1,110 (J)	3.22	22	1,030	6,210	0.41	NS
16-Oct-18	4.7	156	771	5.97	509	1,360	15.20	7,350	1,340	6,480	0.64	NS
23-Oct-18	3.7	295	805	5.34	ND	4	17.70	71,400	11,100	9,410	1.30	NS
30-Oct-18	4.6	522	812	6.97	ND	ND	16.00	188,000	56,600	8,970	2.00	18.20
6-Nov-18	4.6	889	827	5.29	ND	ND	16.00	422,000	169,000	10,700	2.15	NS
11-Dec-18	4.4	7,448	900	17.8	ND	ND	16.80	2,080,000	1,140,000	250,000	20.20	NS
15-Jan-19	3.8	90	853	5.2	ND	ND	14.30	1,730,000	1,590,000	1,440,000	341.00	NS
12-Feb-19	4.4	84	824	4.9	ND	ND	19.80	1,380,000	1,260,000	1,860,000	295.00	NS
12-Mar-19	4.6	111	855	14.3	ND	ND	15.70	1,160,000	1,080,000	2,060,000	398.00	0.79
17-Jun-19	4.1	4,565	821	8.25	ND	ND	20.00	149,000	248,000	662,000	389.00	0.62
18-Sep-19	4.8	2,347	807	5.03	ND	26	25.90	57,700	119,000	379,000	217.00	3.63
25-Nov-19	5.0	1,274	689	37.65	10	653	26.30	19,100	70,200	207,000	131.00	7.10

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM002C												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
30-Apr-18	7.8	157	NS	NS	7,260	200	NS	59	NS	NS	14.10	ND
17-Jul-18	10.4	317	95	6.07	6,720	15	7.21	28	2,850	42,700	40.90	ND
17-Sep-18	9.0	213	112	2.76	5,310	100	5.81	24	2,120	32,900	32.90	NS
25-Sep-18	7.2	178	40	5.6	6,350	100	4.89	23	1,550	27,100	24.40	NS
2-Oct-18	7.6	170	198	2.52	6,250	250	4.56	24	1,480	26,800	21.40	ND
9-Oct-18	7.2	166	189	5.13	7,210 (J)	R	4.54	36	1,520	23,800	21.20	NS
16-Oct-18	7.5	169	186	1.53	7,420	100	4.47	36	1,320	22,600	21.80	NS
23-Oct-18	6.9	175	150	4.7	6,580 (J)	12	4.77	40	1,570	28,500	26.80	NS
30-Oct-18	6.7	173	147	5.95	6,330	12	4.37	42	1,390	25,100	23.30	ND
6-Nov-18	6.8	166	179	4.13	7,520	100	4.54	35	1,240	22,500	24.70	NS
11-Dec-18	6.1	149	452	1.92	6,260	9	4.76	29	1,930	33,700	28.20	NS
15-Jan-19	6.3	150	180	6.73	9,810	200	4.66	30	1,350	26,900	25.20	NS
12-Feb-19	6.4	143	168	5.33	5,820 (J)	250	5.58	40	1,340	23,100	26.70	NS
12-Mar-19	6.6	131	112	7.4	6,610	13	4.92	44	1,180	17,200	18.30	ND
17-Jun-19	6.6	117	160	10.51	6,030	100	3.76	42	1,060	15,600	17.80	ND
18-Sep-19	5.7	91	527	7.86	6,500	100	3.82	44	1,110	15,500	18.70	ND
25-Nov-19	6.2	94	230	4.3	6,360	100	3.55	49	1,510	18,200	18.70	ND

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM002CC												
Date	pH	SC (µS/cm)	DO (mg/L)	ORP (mV)	TCE (µg/L)	PCE (µg/L)	Cl (mg/L)	Mn (µg/L)	K (µg/L)	Na (µg/L)	Sulfate (mg/L)	Hg (µg/L)
2-May-18	5.6	88	NS	NS	10,400	ND	NS	39	NS	NS	7.43	2.02
17-Jul-18	5.9	103	203	8.21	12,700	46	3.59	39	736	15,400	16.30	ND
17-Sep-18	5.5	76	221	4.35	10,600	ND	2.83	24	674	9,330	5.84	NS
25-Sep-18	5.9	63	214	8.32	6,140	37	2.77	22	571	7,140	3.59	NS
2-Oct-18	5.5	71	216	3.37	8,750	250	2.82	21	741	9,600	5.30	ND
9-Oct-18	5.6	73	206	5.34	11,300	R	2.79	22	660	8,770	4.91	NS
16-Oct-18	5.5	71	221	2.88	10,600	ND	2.77	21	689	8,620	4.30	NS
23-Oct-18	5.5	65	203	5.14	4,520	34	2.75	23	815	9,700	4.09	NS
30-Oct-18	5.6	70	151	5.33	9,620	34	2.63	23	699	9,190	4.14	ND
6-Nov-18	5.9	69	185	4.05	11,500	ND	2.86	19	688	7,900	4.07	NS
11-Dec-18	5.6	66	231	7.19	10,200	27	2.60	20	828	9,050	2.96	NS
15-Jan-19	5.5	64	226	6.48	14,300	46	2.60	17	661	8,590	2.52	NS
12-Feb-19	5.7	62	223	8.84	8,830	500	2.67	19	646	7,730	2.57	NS
12-Mar-19	5.4	62	215	7.38	9,290	26	3.05	22	643	7,330	2.07	ND
17-Jun-19	5.5	56	218	9.96	9,040	ND	2.62	18	494	6,490	1.35	ND
18-Sep-19	5.2	50	287	8.44	9,320	ND	2.57	14	510	6,390	0.93	0.12 (J)
25-Nov-19	5.6	53	258	4.6	8,610	ND	2.72	15	655	6,400	0.95	0.09 (J)

ND = Non-detect; R = Rejected; NS = Not Sampled; (J) = Estimated
µS/cm = microsiemens per centimeter; mg/L = milligram per liter; mV = millivolt; µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM003B												
Date	**pH**	**SC** *(μS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(μg/L)*	**PCE** *(μg/L)*	**Cl** *(mg/L)*	**Mn** *(μg/L)*	**K** *(μg/L)*	**Na** *(μg/L)*	**Sulfate** *(mg/L)*	**Hg** *(μg/L)*
22-Mar-18	5.4	174	NS	NS	30,900 (j)	21,900 (J)	NS	42	NS	NS	2.77	0.14 (J)
18-Jul-18	4.7	150	296	4.68	37,000	8,810	3.56	21	732	11,000	0.53	0.44
13-Nov-18	4.6	156	383	5.58	36,200	4,250	2.99	21	806	8,930	0.65	NS
13-Mar-19	4.7	147	613	7.64	37,600	4,590	3.07	22	842	8,240	0.41	NS
17-Jun-19	5.4	145	288	4.7	43,200	4,290	3.09	20	667	7,400	0.35 (J)	NS
18-Sep-19	4.5	128	336	11.47	26,400	2,100	3.10	18	714	7,640	0.31 (J)	0.81
25-Nov-19	4.5	155	342	3.74	32,200	2,360	3.18	20	936	8,470	ND	NS

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM003BB												
Date	**pH**	**SC** *(μS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(μg/L)*	**PCE** *(μg/L)*	**Cl** *(mg/L)*	**Mn** *(μg/L)*	**K** *(μg/L)*	**Na** *(μg/L)*	**Sulfate** *(mg/L)*	**Hg** *(μg/L)*
21-Mar-18	5.7	96	NS	NS	32,500	3,140	NS	46	NS	NS	2.71	ND
18-Jul-18	5.4	153	247	4.75	47,600	4,010	3.12	21	1,290	7,760	0.58	0.81
13-Nov-18	5.7	152	251	4.6	46,500	3,880	2.89	23	1,220	9,020	0.28 (J)	NS
13-Mar-19	5.2	152	561	6.71	38,200	3,320	2.95	24	1,160	7,060	0.28 (J)	NS
17-Jun-19	5.6	150	258	4.8	29,900	2,230	2.90	33	1,050	6,190	ND	NS
18-Sep-19	5.6	136	135	2.64	22,700	1,650	2.84	19	929	5,900	ND	1.01
25-Nov-19	5.3	134	319	3.78	23,500	1,540	2.82	22	1,060	6,860	ND	NS

ND = Non-detect
μS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
μg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM003C

Date	pH	SC (µS/cm)	DO (mg/L)	ORP (mV)	TCE (µg/L)	PCE (µg/L)	Cl (mg/L)	Mn (µg/L)	K (µg/L)	Na (µg/L)	Sulfate (mg/L)	Hg (µg/L)
27-Mar-18	5.5	117	NS	NS	22,900	615	NS	70	NS	NS	2.57	ND
18-Jul-18	7.0	109	216	4.12	12,100	123 (J)	3.28	200	877	12,400	12.30	ND
13-Nov-18	5.4	82	206	6.21	11,100	ND	2.86	133	1,560	11,800	6.91	NS
13-Mar-19	5.6	56	406	6.7	8,160	ND	2.80	131	2,190	8,630	5.86	NS
17-Jun-19	5.7	56	207	8.04	7,640	ND	2.80	102	1,400	8,140	6.26	NS
18-Sep-19	5.3	66	303	8.87	6,550	ND	2.85	112	1,130	8,750	5.47	ND
25-Nov-19	5.5	64	220	1.2	6,360	ND	2.89	81	2,580	10,700	6.88	NS

Sample Results for M-Area Western Sector ISCO – Monitoring Well WSM003CC

Date	pH	SC (µS/cm)	DO (mg/L)	ORP (mV)	TCE (µg/L)	PCE (µg/L)	Cl (mg/L)	Mn (µg/L)	K (µg/L)	Na (µg/L)	Sulfate (mg/L)	Hg (µg/L)
26-Mar-18	5.3	150	NS	NS	27,400 (J)	4,260 (J)	NS	63	NS	NS	2.17	0.39
18-Jul-18	5.3	110	197	4.61	28,900	1,380	3.54	146	714	10,200	0.82	ND
13-Nov-18	5.3	102	271	5.06	31,700	1,090	3.14	41	1,280	10,600	0.35 (J)	NS
13-Mar-19	5.2	97	449	6.2	30,100	1,880	3.19	40	1,330	8,150	0.35 (J)	NS
17-Jun-19	5.4	98	227	8.71	27,500	755	3.31	19	1,080	8,200	0.27 (J)	NS
18-Sep-19	4.7	94	256	4.58	21,700	505	3.26	14	1,240	8,450	0.25 (J)	0.22
25-Nov-19	5.4	94	225	1.87	24,300	480	3.46	15	2,020	9,980	ND	NS

ND = Non-detect
R = Rejected
NS = Not Sampled
(J) = Estimated
µS/cm = microsiemens per centimeter
mg/L = milligram per liter
mV = millivolt
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well MSB107B

Date	pH	SC (µS/cm)	DO (mg/L)	ORP (mV)	TCE (µg/L)	PCE (µg/L)	Cl (mg/L)	Mn (µg/L)	K (µg/L)	Na (µg/L)	Sulfate (mg/L)	Hg (µg/L)
29-Aug-17	5.2	79	NS	NS	20,000	1,100	NS	NS	NS	NS	NS	NS
1-Aug-18	5.6	91	324	5.8	41,900	1,850	2.50	10	618	5,010	0.37 (J)	0.54
29-Aug-18	4.8	83	NS	NS	38,000	1,400	NS	NS	NS	NS	NS	NS
13-Mar-19	5.1	65	292	7.91	19,000	670	2.40	NS	NS	NS	0.38 (J)	NS
27-Aug-19	5.6	65	NS	NS	2,000	37	NS	NS	NS	NS	NS	NS
18-Sep-19	5.6	65	282	5.9	15,800	613	2.54	7	425	3,900	0.41	0.22

Sample Results for M-Area Western Sector ISCO – Monitoring Well MSB107CC

Date	pH	SC (µS/cm)	DO (mg/L)	ORP (mV)	TCE (µg/L)	PCE (µg/L)	Cl (mg/L)	Mn (µg/L)	K (µg/L)	Na (µg/L)	Sulfate (mg/L)	Hg (µg/L)
29-Aug-17	5.8	90	NS	NS	10,000	13,000	NS	NS	NS	NS	NS	NS
1-Aug-18	4.6	65	357	5.62	26,400	28,700	3.16	20	591	8,380	0.32(J)	0.66
29-Aug-18	4.6	155	NS	NS	25,000	29,000	NS	NS	NS	NS	NS	NS
13-Mar-19	4.6	165	370	6.53	28,700	21,500	3.72	NS	NS	NS	0.37 (J)	NS
27-Aug-19	5.8	160	NS	NS	1,700	660	NS	NS	NS	NS	NS	NS
18-Sep-19	5.1	149	298	5.6	21,200	16,500	3.38	17	622	9,530	ND	0.44

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

Table 4. M-Area Western Sector ISCO Field and Analytical Results *(Continued/End)*

Sample Results for M-Area Western Sector ISCO – Monitoring Well MSB107C												
Date	**pH**	**SC** *(µS/cm)*	**DO** *(mg/L)*	**ORP** *(mV)*	**TCE** *(µg/L)*	**PCE** *(µg/L)*	**Cl** *(mg/L)*	**Mn** *(µg/L)*	**K** *(µg/L)*	**Na** *(µg/L)*	**Sulfate** *(mg/L)*	**Hg** *(µg/L)*
29-Aug-17	5.5	54	NS	NS	8,100	260 (J)	NS	NS	NS	NS	NS	NS
1-Aug-18	4.7	140	271	5.79	10,800	445 (J)	2.71	13	390	6,260	1.09	0.14 (J)
29-Aug-18	4.7	61	NS	NS	8,300	250	NS	NS	NS	NS	NS	NS
13-Mar-19	4.9	58	319	7.33	8,150	228	2.33	NS	NS	NS	1.40	ND
27-Aug-19	5.5	59	NS	NS	220	8	NS	NS	NS	NS	NS	NS
18-Sep-19	5.5	58	264	6	5,960	155	2.17	10	306	4,280	1.20	0.22

ND = Non-detect
µS/cm = microsiemens per centimeter
R = Rejected
mg/L = milligram per liter
NS = Not Sampled
mV = millivolt
(J) = Estimated
µg/L = microgram per liter

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