ROCKY MOUNTAIN ARSENAL

2022 BASIN F COVER AND GROUNDWATER MONITORING REPORT

Revision 0

November 21, 2022

U.S. Department of the Army

Shell Oil Company

Prepared by:

Navarro Research and Engineering, Inc.

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ACRONYMS

AMA	Army Maintained Areas
CCR	Code of Colorado Regulations
CGMR	Cover and Groundwater Monitoring Report
DCPD	Dicyclopentadiene
DIMP	Diisopropylmethyl phosphonate
FY21	Fiscal Year 2021
FY22	Fiscal Year 2022
FY23	Fiscal Year 2023
IC	Indicator Compound
LTCP	Long-Term Care Plan
NRAP	Non-Routine Action Plan
NWS	National Weather Service
O&M	Operations and Maintenance
OCN	O&M Change Notice
PCGMP	Post-Closure Groundwater Monitoring Plan
PCP	Post-Closure Plan
PT	Principal Threat
RCRA	Resource Conservation and Recovery Act
RMA	Rocky Mountain Arsenal
SOP	Standard Operating Procedure
SQAPP	Sampling Quality Assurance Project Plan
TCLEE	Tetrachloroethene
UFS	Unconfined Flow System
UPL	Upper Prediction Limit
WP	Wastepile

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EXECUTIVE SUMMARY

This *2022 Basin F Cover and Groundwater Monitoring Report* (CGMR) for the Rocky Mountain Arsenal (RMA) Federal Facility Site was prepared in accordance with the *Basin F Post-Closure Plan* (PCP), Revision 0 (TtEC 2011) and the *RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan* (LTCP), Revision 3 (Navarro 2021c). The purpose of this Basin F CGMR is to evaluate compliance with post-closure requirements, cover inspection and monitoring results, and maintenance activities performed during the reporting period, and to describe plans to improve or sustain cover conditions. This Basin F CGMR documents monitoring and maintenance-related activities performed on the Basin F Army Maintained Area (AMA) during Fiscal Year 2022 (FY22), that is, between October 1, 2021 and September 30, 2022. This report addresses the thirteenth year of Operations and Maintenance (O&M) for the Basin F Cover since construction finished with the Final Inspection in March of 2010. The Basin F AMA is currently in post-closure as defined in Section 1.0 of the Basin F PCP, and in the long-term O&M Period defined in Section 1.0 of the LTCP.

The Basin F Cover was in excellent condition throughout FY22. Potential deficiencies observed during the reporting period include noxious or undesirable weeds and tumbleweed accumulation. Soil cover thickness loss met the compliance standard and was below the non-routine action trigger level for FY22.

The 2022 Vegetation Performance Assessment of the Basin F Resource Conservation and Recovery Act (RCRA)-Equivalent Cover was conducted in accordance with Standard Operating Procedure 002 of the Basin F PCP, Revision 0. In all, 15 vegetation transects were sampled. A total of 100 observations were made along each transect. The total live vegetation values were well above the compliance standard of 25 percent. The two-year average of total ground cover was also comfortably above the compliance standard of 50 percent, and the three-year running average of total ground cover was also well above the compliance standard of 67 percent.

Percolation collected at each of the five lysimeters on Basin F was below the non-routine action trigger level (1.0 mm per nine-month period) and met the compliance standard (1.3 mm per 12-month period). The precipitation measured during FY22 at the rain gauge located west of the Lime Basins RCRA-Equivalent Cover in Section 36 was 11.13 inches.

Upgradient and downgradient groundwater data collected during post-closure monitoring of Wastepile (WP) and Principal Threat (PT) wells were evaluated to demonstrate post-closure O&M of the Basin F surface impoundment and that the Basin F WP meets the RCRA closure performance standards. Sampling of all nine Basin F network wells was conducted in April, May, and June of 2022.

Groundwater flow in the vicinity of Basin F continues to be primarily to the north-northwest. Localized and minor variations occur beneath the north end of Basin F where groundwater flows to the north and northeast. The overall decrease in unconfined flow system water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past four years. Historical changes in water levels in wells near Basin F are consistent with regional fluctuations in the water table and are not related to the performance of the Basin F cover.

Based on the distribution of the analyte concentrations and water quality trends, it appears that the PT groundwater flow path is having a greater impact to water quality downgradient of the former Basin F compared to the WP flow path. While concentrations of indicator compounds less frequently exceed upper prediction limits and remain relatively stable or are decreasing downgradient of the WP area, concentrations downgradient of the PT indicate an impact due to contaminated groundwater migrating from upgradient sources and/or residual contamination within the unsaturated zone beneath the Basin F PT area.

In accordance with the *Basin F Post-Closure Groundwater Monitoring Plan*, Revision 0 (TtEC 2011, Appendix B), there are no chemical-specific standards that apply to Basin F groundwater since the RMA remedy addresses contaminated groundwater downgradient at the North Boundary Containment System and Northwest Boundary Containment System, where it is extracted and treated.

Cost incurred performing post-closure care of the Basin F AMA during FY22, including inspections, repairs, maintenance, and groundwater monitoring was $161,106. A complete budget for Fiscal Year 2023 (FY23) has not been approved as of the issuance of this report. However, the FY23 budget for work required under the Basin PCP is estimated to be approximately $135,000. An additional $159,000 has been budgeted for groundwater sampling described in the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network,* Revision 0 (Navarro 2022b).

In summary and based on the information presented in this report, there are no corrective measures required. Recommendations for FY23 include continued diligence in weed control efforts, inspection of the concrete channels, and observations for burrowing animal holes. These recommendations will be addressed in FY23 and will be discussed in the 2023 Basin F CGMR.

1.0 INTRODUCTION

This *2022 Basin F Cover and Groundwater Monitoring Report* (CGMR) for the Rocky Mountain Arsenal (RMA) Federal Facility Site was prepared in accordance with the *Basin F Post-Closure Plan* (PCP), Revision 0 (TtEC 2011) and the *RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan* (LTCP), Revision 3 (Navarro 2021c). The purpose of this Basin F CGMR is to evaluate compliance with post-closure requirements, cover inspection and monitoring results, and maintenance activities performed during the reporting period, and to describe plans to improve or sustain cover conditions. This Basin F CGMR documents monitoring and maintenance-related activities performed on the Basin F Army Maintained Area (AMA) during Fiscal Year 2022 (FY22), that is, between October 1, 2021 and September 30, 2022. This report addresses the thirteenth year of Operations and Maintenance (O&M) for the Basin F Cover since construction finished with the Final Inspection in March of 2010. The Basin F AMA is currently in post-closure as defined in Section 1.0 of the Basin F PCP, and in the long-term O&M Period defined in Section 1.0 of the LTCP.

2.0 METHODOLOGY

The Basin F Resource Conservation and Recovery Act (RCRA)-Equivalent Cover and associated non-cover area within the outside shoulder of the perimeter access road, collectively referred to as the Basin F AMA, was inspected, monitored, repaired, and maintained in accordance with the Basin F PCP, Revision 0, and related Standard Operating Procedures (SOPs). The results of inspections and environmental monitoring of vegetation, percolation, and cover soil thickness were used to verify cover performance and to trigger cover maintenance and repair activities.

2.1 Type I and Type II Cover Inspections

The procedure for inspecting cover soil conditions and infrastructure features is detailed in Basin F PCP SOP 001, *Cover Conditions Inspections*. This SOP includes procedures for Type I and Type II cover inspections, as well as a procedure for collecting cover soil thickness data, which were used to evaluate the actual cover thickness against the cover thickness compliance standard. Where feasible, multiple inspections were conducted concurrently for efficiency and to minimize traffic on the cover. Copies of the cover inspection forms are provided in Appendix C of this report.

2.2 Vegetation Performance Assessment

Basin F PCP SOP 002, *Cover Vegetation Performance Assessment*, provides the procedure to collect and document vegetation conditions for assessment and future management. This SOP includes a procedure for conducting the annual quantitative vegetation survey. Data collected using Basin F PCP SOP 002 were used to evaluate the vegetation against the vegetation performance standard. The results of the evaluation are presented in Section 6.0 of this report. Refer to Appendix B of this report for photos and other information collected during the 2022 Vegetation Performance Assessment.

2.3 Percolation Monitoring

The procedure for collecting percolation data and operating the lysimeters is provided in Basin F PCP SOP 003, *Percolation Monitoring System Data Collection and Operation*. Data collected under Basin F PCP SOP 003 were used to evaluate the measured percolation against the percolation compliance standard. The results of the evaluation are presented in Section 7.0 of

this report. Monthly percolation measurements from all Basin F lysimeters are provided in Table 7.0-1. The nine-month and twelve-month rolling percolation totals are provided in Tables 7.0-2 and 7.0-3, respectively.

2.4 Groundwater Monitoring

Groundwater monitoring was performed in April, May, and June of 2022 at wells surrounding the former Basin F Surface Impoundment and the former Basin F Wastepile (WP) in accordance with the *Basin F Post-Closure Groundwater Monitoring Plan*, Revision 0 (PCGMP) (TtEC 2011, Appendix B). The groundwater monitoring program is designed to demonstrate that post-closure maintenance of the Basin F Surface Impoundment and the Basin F WP satisfies RCRA performance standards, which include the requirement to control, minimize or eliminate post-closure migration of hazardous contaminants to groundwater (6 Code of Colorado Regulations [CCR]1007-3, Section 265, Subpart G).

2.5 Maintenance and Repair Activities

Routine maintenance and repair activities are listed in Table 3.2-1 of the Basin F PCP, while conditions requiring non-routine actions are listed in Table 3.2-2 of the Basin F PCP. Routine repair activities performed in FY22 are discussed in Section 4.0 of this report and illustrated on Figure 4.0-1. Non-routine activities are addressed in Section 9.2 of this report.

3.0 PRECIPITATION AND WEATHER CONDITIONS

The rain gauge located west of the Lime Basins RCRA-Equivalent Cover, near the Lime Basins Metering Building collects precipitation data for the RMA. The precipitation measured at the Lime Basins gauge during FY22 was 11.13 inches. Precipitation data collected by the Lime Basins gauge are provided in Appendix A.

3.1 National Weather Service Summary

Figures 3.1-1 and 3.1-2 illustrate the Rocky Mountain Region's monthly temperature and precipitation values for FY22 as published by the National Oceanic and Atmospheric Administration, National Weather Service (NWS) Forecast Office for Denver/Boulder, Colorado. Climate data reported by the NWS were collected at the Primary Local Climatological Data Site, located at the Denver International Airport. In general, FY22 had near average temperatures and was drier than normal in the Rocky Mountain Region.

3.2 Significant Storm Events at RMA

RMA experienced two significant storm events during FY22. A significant storm event is defined as a rainstorm event in which greater than 1.0 inch of precipitation falls within 24 hours. On June 1, 2022 and July 26, 2022, the RMA received 1.47 inches of rain and 1.07 inches of rain, respectively in a 24-hour period.

4.0 SOIL COVER ASSESSMENT, MAINTENANCE AND REPAIR ACTIONS

During FY22, the condition of the Basin F AMA was inspected during the Type I, Type II, and Post-Storm inspections in accordance with the Basin F PCP. Type I inspections were conducted on January 12, March 15, May 12, June 8, and July 13, 2022. The fall type II inspection was performed on October 5, 2021 and the spring Type II inspection was conducted on April 26, 2022.

There were two significant storm events that occurred during the reporting period on June 1 and July 26, 2022. Post-storm drive around inspections were performed on June 1 and July 27, 2022 and these inspections were documented in the project logbook. Cover post-storm inspections were performed on June 8 and August 3, 2022 and documented on Basin F PCP Form SOP 001-1 which are included in Appendix C.

The soil cover was inspected for the following:

- Surface Conditions
- Vegetative Cover
- Engineering and Access Controls
- Percolation Monitoring
- Surface Drainage Controls
- Erosion/Settlement Monuments
- Other deleterious conditions

The Basin F Cover was in excellent condition throughout FY22. Observations made during the reporting period are described below and cover inspection documentation is provided in Appendix C of this report. The repair actions associated with these observations are shown on Figure 4.0-1 and are described below.

4.1 Noxious or Undesirable Weeds

The herbicide Plainview® was applied as a ground clear in October of 2021 along the shoulders of the Basin F roadways, the cattle guards, in between the bollards for the groundwater wells located on the perimeter road, and the gate entrances.

Canada and Musk thistles along with other noxious weeds were identified on areas of Basin F. Weed control efforts were performed in August of 2022 using the herbicides Escort XP®, Transline®, and surfactant.

4.2 Mowing

Select areas on Basin F were mowed to control tall weedy vegetation and to mitigate potential tumbleweed formation following the growing season. Figure 4.0-1 shows all areas that were mowed.

4.3 Carsonite Markers

The numbers on the Carsonite markers were replaced for erosion monuments 95, 99, 101, 102, 103, and 104.

4.4 Perimeter Fence

Tumbleweeds accumulated along the perimeter fence in the winter months of FY22. The tumbleweed accumulation was monitored periodically and buildup was removed using the fence cleaner in November and December of 2021.

4.5 Lysimeters

Approximately 73 liters of standing water were removed from the manhole of Lysimeter 016 in May of 2022.

4.6 Debris Present in the Channel

Tumbleweeds were observed in Channels 24 and 25. Although some tumbleweed accumulation was removed by high winds, this maintenance item is ongoing and will be addressed in Fiscal Year 2023 (FY23).

5.0 COVER SOIL THICKNESS LOSS

The Basin F RCRA-Equivalent Cover includes a network of 18 erosion/settlement monuments embedded within the cover soil on a 500-foot grid. Cover soil thickness loss was measured at each of the monuments during the Type II inspection in October of 2021 and April of 2022 in accordance with the Basin F PCP SOP 001, *Cover Conditions Inspections*. The measurements for each monument are provided on Table 5.0-1. All cover soil thickness loss measurements were well below the non-routine action trigger level of 0.25 foot and the compliance standard of 0.5 foot.

6.0 VEGETATION PERFORMANCE ASSESSMENT

The 2022 Vegetation Performance Assessment of the Basin F RCRA-Equivalent Cover was conducted on August 17 and 18, 2022 in accordance with SOP 002 of the Basin F PCP. The vegetation community met all three vegetation-related compliance standards (i.e., total absolute live vegetation cover, two-year running average for total absolute ground cover, and three-year running average for total absolute ground cover). Results of the assessment are summarized on Table 6.0-1.

In all, 15 vegetation transects were sampled in 2022 on the Basin F Cover. Prior to performing the assessments, transect locations and compass bearings were randomly selected using Geographical Information System software. A map showing the pre-selected sample locations and bearings is included in Appendix B of this report. Photos, provided in Appendix B, were taken along the compass bearing at the start of each 50-meter transect. A total of 100 observations were made along each transect. All plant species that were present within one meter on either side of the 50-meter transect, but not observed using the point-intercept sampling method, were tallied and used to calculate species density (species per 100 square meters). Appendix B includes cover and frequency summary tables, vegetation performance assessment tables for each of the sample areas, and the specific transect data for each sample. These tables meet the reporting requirements set forth by the *Revegetation of the Basin A Soil Cover*, developed during the Basin A dispute resolution process in 1999.

The Basin F RCRA-Equivalent Cover was seeded in 2009 and continues to maintain a successfully established plant community. Based on data from the 15 transects sampled, total absolute mean vegetation cover was 71.3 percent, composed primarily of warm season grass species which is a dramatic change from previous years. Cover by warm season species was 40.3 percent which is an increase compared to previous years. In 2013, the lowest amount of cover by warm season species was recorded at only about three percent. Since then, warm season grasses have generally increased in the amount of cover provided. Weedy vegetation also

contributed a large amount to the total for live cover in contrast to previous years. The relative weed cover was 16.3 percent.

Warm season species were prolific at the time the vegetation assessment was conducted and cool season plants were somewhat diminished in stature. There did not appear to be excessive stress due to low soil moisture or biological stressors on the grassland community at the time of the assessment. Insects and other wildlife, such as small rodents, grassland birds and deer were observed at all areas.

6.1 Comparison to the Performance Standard

Total absolute mean vegetation was 71.3 percent. However, relative cover by weedy vegetation was above 10 percent, so the allowable total absolute live vegetation cover was calculated to be 66.9 percent, still well above the performance standard of 25 percent. Total absolute ground cover was high at 92 percent, and corresponding bare ground was relatively low at eight percent. Average cover by litter was relatively high at 20.6 percent but did not appear to be inhibiting vegetation production. The two-year running average for total absolute ground cover remained high at 95 percent, well above the standard of 50 percent. The three-year running average for total absolute ground cover was 96 percent; also, well above the standard of 67 percent.

6.2 Comparison to the Non-Routine Action Trigger Level

The results of the quantitative vegetation assessment performed on the Basin F Cover determined that 16.3 percent of the total live vegetation was comprised of undesirable annual or biennial species. Therefore, the total absolute live vegetation cover for this site was reduced to account for the weedy vegetation cover above the 10 percent limit. The total absolute live vegetation cover is 66.9 percent which is well above the non-routine trigger level established in the Basin F PCP.

6.3 Sample Adequacy

Sample adequacy calculations were performed for the cover area. The intent of the sample adequacy calculation is to determine whether sufficient samples have been gathered to be able to detect a 10 percent reduction in the mean with 90 percent confidence. Sample adequacy was calculated using the formula provided in Basin F PCP SOP 002:

$$N_{\min} = t_{\alpha}^{2} s^{2} / (d\bar{x})^{2}$$

To ensure that the sample size is adequate, N_{min} must be less than, or equal to the number of transects sampled in the respective area. If N_{min} is greater than the number of transects sampled, additional vegetation transects need to be sampled until N_{min} becomes less than, or equal to the number of transects sampled, or all transect blocks within the respective area have been sampled, whichever comes first. Sample adequacy was calculated for total absolute cover only. The sample adequacy calculation yielded a N_{min} of 0.76, which is well below the number of samples collected, i.e., 15.

7.0 PERCOLATION MONITORING ASSESSMENT

The Basin F RCRA-Equivalent Cover uses a network of five lysimeters to monitor deep percolation. Percolation collected by the lysimeters was measured monthly in accordance with Basin F PCP SOP 003, *Percolation Monitoring System Data Collection and Operation*.

Percolation is reported in millimeters, which is calculated by dividing the measured percolation volume by the area of the lysimeter pan. Lysimeters 016, 017, 018 and 019 each have a surface area of 1,500 square feet (139.35 square meters), while Lysimeter 020 has a surface area of 7,500 square feet (696.75 square meters). The volume of percolation measured monthly from each lysimeter is presented in Table 7.0-1. Table 7.0-2 presents rolling nine-month percolation totals for comparison to the non-routine action trigger level of 1.0 mm, and Table 7.0-3 presents twelve-month rolling totals for comparison to the compliance standard of 1.3 mm in 12 months. The compliance standard for percolation is the quantity of percolation that, if exceeded, would subject the Army to potential enforcement actions by the regulatory agencies. Enforcement of the compliance standard began on March 2, 2015.

The lysimeters within the Basin F Cover collected no measurable percolation over the reporting period and are therefore well below the non-routine action trigger level and the compliance standard.

8.0 GROUNDWATER MONITORING

This section summarizes the water level monitoring, analytical results, and statistical evaluation of groundwater quality for the 2022 post-closure groundwater monitoring at Basin F. Refer to the *2022 Basin F Post-Closure Groundwater Monitoring Report*, provided in Appendix E of this report for a complete set of water level monitoring data and analytical results, as well as a statistical evaluation of groundwater quality in both Basin F groundwater monitoring networks.

Nine network wells are used to monitor groundwater conditions in the Unconfined Flow System (UFS). Six downgradient wells—26015, 26017, 26133, 26157, 26163, and 26173—and three upgradient wells—26028, 26073, and 26128—are used for post-closure groundwater monitoring at Basin F. Upgradient wells 26073 and 26128 and downgradient wells 26015, 26133, 26157, 26163, and 26173 are associated with the Principal Threat (PT) excavation area. Upgradient well 26028 and downgradient wells 26015 and 26017 are associated with Basin F WP. Well 26015 is included in both groups due to overlapping groundwater flow paths. Refer to Figure 2-1 in Appendix E for well locations.

8.1 Groundwater Levels

Groundwater levels were measured in March through May of 2022 in 27 Basin F network wells to evaluate UFS conditions in the area of Basin F. Additional wells used to further delineate the water table in the vicinity were measured during the same time period. Additional information regarding groundwater levels is available in Appendix E of this report.

Similar to previous years, groundwater flow in the vicinity of Basin F continues to be primarily to the north-northwest. Localized and minor variations occur beneath the north end of Basin F where groundwater flows to the north and northeast. The confined flow system in the Basin F area is addressed as part of the *Long-Term Monitoring Plan for Groundwater and Surface Water*

(Navarro 2021a). A complete description of the subsurface lithology and groundwater flow in the vicinity of Basin F can be found in the Basin F PCGMP (TtEC 2011, Appendix B).

Water levels measured in the nine Basin F water quality network wells since 2006 are shown on hydrographs in Appendix E of this report. Beginning in 2018, groundwater elevations began to decrease in all of the wells with the exception of well 26128. Groundwater in well 26128 showed an increasing trend from 2014 through 2018 but began decreasing in 2019 and is now consistent with pre-2014 levels. Water level data for well 26128 appears different from the other wells in the vicinity of Basin F because it is screened deeper within the weathered and unweathered Denver Formation and does not provide an accurate depiction of the UFS upgradient of Basin F. The overall decrease in UFS water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past four years. Historical changes in water levels in wells near Basin F are consistent with regional fluctuations in the water table and are not related to the performance of the Basin F cover.

8.2 Basin F Well Network Analytical Results

Groundwater samples were collected from the wells identified in the Basin F WP and PT groundwater monitoring networks in accordance with procedures defined in the Basin F PCGMP (TtEC 2011, Appendix B), and the *Rocky Mountain Arsenal Sampling Quality Assurance Project Plan* (SQAPP) (Navarro 2019). Samples collected during post-closure monitoring were submitted to Applied Research and Development Laboratory in Mount Vernon, Illinois. The analytical methods were developed as described in the SQAPP.

The groundwater samples were tested for the analytes and indicator compounds (ICs) listed in the Basin F PCGMP. Analytical data for the 11 ICs applicable to the Basin F water quality network wells are presented in Appendix E of this report.

8.3 Basin F WP Well Prediction Limit Exceedances

The 2022 Basin F WP upper prediction limits (UPLs) were applied to data for downgradient wells 26015 and 26017. The 2022 reported values for ICs detected in wells exceeding their respective UPLs are presented in Appendix E of this Report. The following analytes were detected at concentrations exceeding their respective UPLs in 2022.

Well 26015	Well 26017
• Chloroform	• No exceedances

The 2022 concentration of chloroform in exceedance of the UPL in well 26015 is within the historical range of detected concentrations, and its presence is likely attributable to higher water levels that have mobilized residual contamination and have remained as the water table has decreased over the past few years. The reported concentrations of analytes not listed above and detected in downgradient Basin F WP wells are below the respective UPLs. Based on the UPL comparison, it appears that groundwater quality downgradient of the Basin F WP area has been affected in the vicinity of well 26015.

8.4 Basin F PT Well Prediction Limit Exceedances

The 2022 Basin F PT UPLs were applied to data for downgradient wells 26015, 26133, 26157, 26163 and 26173. The 2022 reported values for ICs detected in wells exceeding their respective

UPLs are presented in Appendix E of this report. The following analytes were detected at concentrations exceeding their respective UPLs in 2022.

Well 26133	Well 26157	Well 26163	Well 26173
• Chloroform	• DCPD	• Arsenic	• Chloroform
• DCPD		• Copper	• TCLEE
• TCLEE		• DCPD	

Note: DCPD – Dicyclopentadiene
TCLEE – Tetrachloroethylene

The 2022 concentrations of all analytes in exceedance of UPLs in wells 26133, 26157, 26163 and 26173 are within the historical ranges of detected concentrations and many are likely attributable to higher water levels that have mobilized residual contamination. The remaining reported values for analytes not listed above in downgradient Basin F PT wells are below the respective UPLs. Based on the statistical evaluation, it appears that groundwater quality downgradient of the Basin F PT area has been affected in the vicinity of wells 26133, 26157, 26163, and 26173.

In 2022, no analyte concentrations exceeded PT UPLs in downgradient well 26015.

8.5 Groundwater Monitoring Conclusions

Impacts to groundwater along the WP flow path have fewer exceedances of UPLs in downgradient WP wells in 2022 compared to previous years with only chloroform in well 26015 exceeding the UPL and showing increasing concentrations. Chloroform appears to be increasing in downgradient well 26015 based on the Mann-Kendall Trend analysis. Concentrations of chloride, Diisopropylmethyl phosphonate (DIMP), and sulfate appear to be increasing upgradient of Basin F based on statistical trend analyses.

Groundwater along the PT flow path appears to have been impacted by residual soil contamination that remains within the PT area, and may also be impacted by sources associated with the Sand Creek Lateral located east of the former basin, as demonstrated by observed increases of select ICs in wells northeast of the PT area. Several ICs exceed UPLs—including arsenic, chloroform, copper, DCPD, and TCLEE—and appear to be increasing in one or more downgradient wells. During post-closure monitoring, chloroform and sulfate appear to be increasing upgradient of Basin F based on statistical trend analyses.

Based on the distribution of the analyte concentrations and water quality trends, it appears that the PT groundwater flow path is having a greater impact to water quality downgradient of the former Basin F compared to the WP flow path. While concentrations of ICs less frequently exceed UPLs and remain relatively stable or are decreasing downgradient of the WP area, concentrations downgradient of the PT indicate an impact due to contaminated groundwater migrating from upgradient sources and/or residual contamination within the unsaturated zone beneath the Basin F PT area.

In accordance with the Basin F PCGMP, there are no chemical-specific standards that apply to Basin F groundwater since the RMA remedy addresses contaminated groundwater downgradient

at the North Boundary Containment System and Northwest Boundary Containment System, where it is extracted and treated.

9.0 ROUTINE AND NON-ROUTINE ACTIONS

9.1 Routine Actions

Routine maintenance and repairs were performed on Basin F and were intended to ensure that the cover continues to function as designed. Routine maintenance and repair actions were identified during inspections and are discussed in Section 4.0 of this report. Figure 4.0-1 illustrates the locations of routine maintenance and repair activities performed on Basin F. Appendix D of this report includes Contractor Daily Quality Control Reports that describe the work performed.

9.2 Non-Routine Actions

The implementation of non-routine actions is described in the Basin F PCP. The Basin F PCP provides criteria for non-routine actions, and a mechanism for consultation between the parties and documentation of the consultative outcome. Each time a non-routine action is identified, a Non-Routine Action Plan (NRAP) will be prepared to document the substandard condition, the actions that will be carried out to remedy the condition, consultation between the parties, and concurrence on the proposed action. Although there were no non-routine actions performed during FY22, there was one NRAP that was prepared during the reporting period.

NRAP-2021-004: NRAP-2021-004 documents the prescribed burn planned for the Basin F AMA during FY22. This NRAP is shown in the NRAP Log provided in Appendix F of this report. Due to weather restraints and limited resources, Basin F was not burned during FY22.

10.0 RECOMMENDATIONS AND CORRECTIVE MEASURES

Inspections and assessments performed during FY22 produced the following recommendations for FY23:

- The site should be examined for weeds throughout FY23. Occurrences of bindweed, cheatgrass, Canada thistle and other noxious weeds should be spot sprayed.
- The site should continue to be examined for erosion rills or gullies, debris in the concrete channels, burrowing animal holes, tumbleweed accumulation, and localized settlement.
- A prescribed burn of the Basin F AMA in the fall or spring would be beneficial to the health of established native perennial grasses and would remove litter left behind after the robust growth of annual weeds.
- Selective mowing of Basin F would be beneficial to the health of established native perennial grasses and would assist in the control of weedy species.

No corrective measures are currently planned for FY23.

10.1 Basin F PCP, Revision 1

In Fiscal Year 2021 (FY21) the Army evaluated the inspection requirements for the Integrated Cover System and the Basin F RCRA-Equivalent Cover to identify areas where the process could be improved. After ten years of cover inspection and maintenance experience, the Army

and regulatory agencies have amassed a significant body of operational data and institutional knowledge that were not available when the Basin F inspection requirements were originally developed. The information and experience were used to refine the inspection requirements identified in the Basin F PCP, which were documented in O&M Change Notice (OCN)-BASINF-2021-001 (Navarro 2021b). The regulatory agencies reviewed the proposed changes and found them to be acceptable. However, the CDPHE determined that the changes qualify as a Class 2 modification of the Basin F PCP per 6 CCR 1007-3 Section 265.118(d) and 6 CCR 1007-3 Section 100.63.

The Army prepared the Basin F PCP, Revision 1 to support the administrative requirements of a Class 2 modification. Revision 1 of the Basin F PCP includes all previously-approved OCNs, agreed-upon changes to the inspection requirements, and other administrative changes. The Basin F PCP, Revision 1 was transmitted to the regulatory agencies on October 5, 2022. The Army and regulatory agencies will address the administrative requirements for the Class 2 modification in FY23. In the meantime, Basin F AMA inspections will continue as required in Revision 0 of the Basin F PCP until Revision 1 is approved by the regulatory agencies.

10.2 Basin F Groundwater Monitoring Program Optimization

The Army began evaluating the Basin F post-closure groundwater monitoring approach in FY21 in response to the regulatory agencies' concerns regarding groundwater quality in the Basin F PT flow path. The evaluation led to changes in the statistical evaluation process that were captured in OCN-BASINF-2022-001 (Navarro 2022a), which was approved by the regulatory agencies in June of 2022.

The Army and regulatory agencies also agreed that a complete evaluation of the Basin F groundwater monitoring program is warranted. The agreement led to the preparation of the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network,* Revision 0 (Navarro 2022b) in July of 2022. The plan provides the rationale to optimize the Basin F groundwater monitoring network, and tasks described in the plan form the basis for an optimization monitoring program that will support any revisions recommended for the groundwater monitoring network. Eight wells were installed in September of 2022 to support the network optimization, and sampling will be initiated in the first quarter of FY23. If warranted, the Basin F groundwater monitoring program will be revised in Fiscal Year 2026.

11.0 FY22 COSTS AND FY23 BUDGETS

Cost incurred performing post-closure care of the Basin F AMA during FY22, including inspections, repairs, maintenance, and groundwater monitoring was $161,106. A complete budget for FY23 has not been approved as of the issuance of this report. However, the FY23 budget for work required under the Basin PCP is estimated to be approximately $135,000. An additional $159,000 has been budgeted for groundwater sampling described in the *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network,* Revision 0 (Navarro 2022b) described in Section 10.2.

12.0 REFERENCES

Navarro (Navarro Research and Engineering, Inc.)
2022a (May 18) *OCN-BASINF-2022-001*.

2022b (Jul 7) *Optimization Plan for the Basin F Post-Closure Groundwater Monitoring Network,* Revision 0.

2021a (May 27) *Long-Term Monitoring Plan for Groundwater and Surface Water*. Revision 1.

2021b (Jul 14) *OCN-BASINF-2021-001*.

2021c (Aug 12) *RCRA-Equivalent, 2-, and 3-Foot Covers Long-Term Care Plan*. Revision 3.

2019 (Jan 30) *Rocky Mountain Arsenal Sampling Quality Assurance Project Plan Final.* Revision 2.

TtEC (Tetra Tech EC Inc.)

2011 (Oct 6) *Basin F Post-Closure Plan.* Revision 0.

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TABLES

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Table 5.0-1: Soil Cover Thickness Loss

Basin F Monument No.	Measurement (in.) October 5, 2021	Measurement (in.) April 26, 2022	Change (in.)
ER92	0.00	0.00	0.00
ER93	0.00	0.00	0.00
ER94	0.00	0.00	0.00
ER95	0.00	0.00	0.00
ER96	0.00	0.00	0.00
ER97	0.00	0.00	0.00
ER98	0.00	0.00	0.00
ER99	0.00	0.00	0.00
ER100	0.00	0.00	0.00
ER101	0.50	0.25	-0.25
ER102	0.00	0.00	0.00
ER103	0.00	0.00	0.00
ER104	2.00	1.50	-0.50
ER105	0.00	0.00	0.00
ER106	0.00	0.00	0.00
ER107	0.50	0.00	-0.50
ER108	0.00	0.00	0.00
ER109	0.00	0.00	0.00

Table 6.0-1- 2022 Vegetation Performance Assessment Summary

Performance Criterion and Evaluation	Basin F Cover
Total Absolute Ground Cover	91.93%
Allowable Total Absolute Live Vegetation Cover	**66.87%**
Vegetation Performance Standard for Total Live Vegetation	≥ 25%
Is Vegetation Performance Standard met?	Yes
Two Year Running Average for Total Absolute Ground Cover	**94.96%**
Vegetation Performance Standard for Two Year Running Average	≥ 50%
Is Vegetation Performance Standard met?	Yes
Three Year Running Average for Total Absolute Ground Cover	**95.93%**
Vegetation Performance Standard for Three Year Running Average	≥ 67%
Is Vegetation Performance Standard met?	Yes
Relative Weed Cover	**16.26%**
Relative Allowable Weed Cover	≤ 10%
Calculate Total Live Vegetation without the weed fraction?	Yes

Note 1: The relative weed cover is greater than 10 percent, therefore, subtracting the amount of relative cover by weedy species above 10 percent from the total live vegetation cover is required. The resulting Total Live Vegetation values are within the Non-Routine Action Trigger Levels.

Table 7.0-1: Monthly Percolation Measurements

Lysimeter No.	Monthly Percolation Measurement (Liters)											
	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Lysimeter 016	0	0	0	0	0	0	0	0	0	0	0	0
Lysimeter 017	0	Trace	Trace	Trace	Trace	0	0	0	0	0	0	0
Lysimeter 018	0	0	Trace	Trace	0	0	0	0	0	0	0	0
Lysimeter 019	Trace	Trace	Trace	Trace	Trace	Trace	0	0	Trace	0	0	0
Lysimeter 020	0	0	0	Trace	Trace	0	0	0	0	0	0	0

.

Table 7.0-2: Rolling Nine-Month Percolation Totals

Lysimeter No.	Rolling Nine-Month Percolation Total (mm)											
	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Lysimeter 016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 7.0-3: Rolling Twelve-Month Percolation Totals

Lysimeter No.	Rolling Twelve-Month Percolation Total (mm)											
	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22
Lysimeter 016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 017	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lysimeter 020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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FIGURES

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Figure 3.1-1: Average Monthly Temperature for FY22

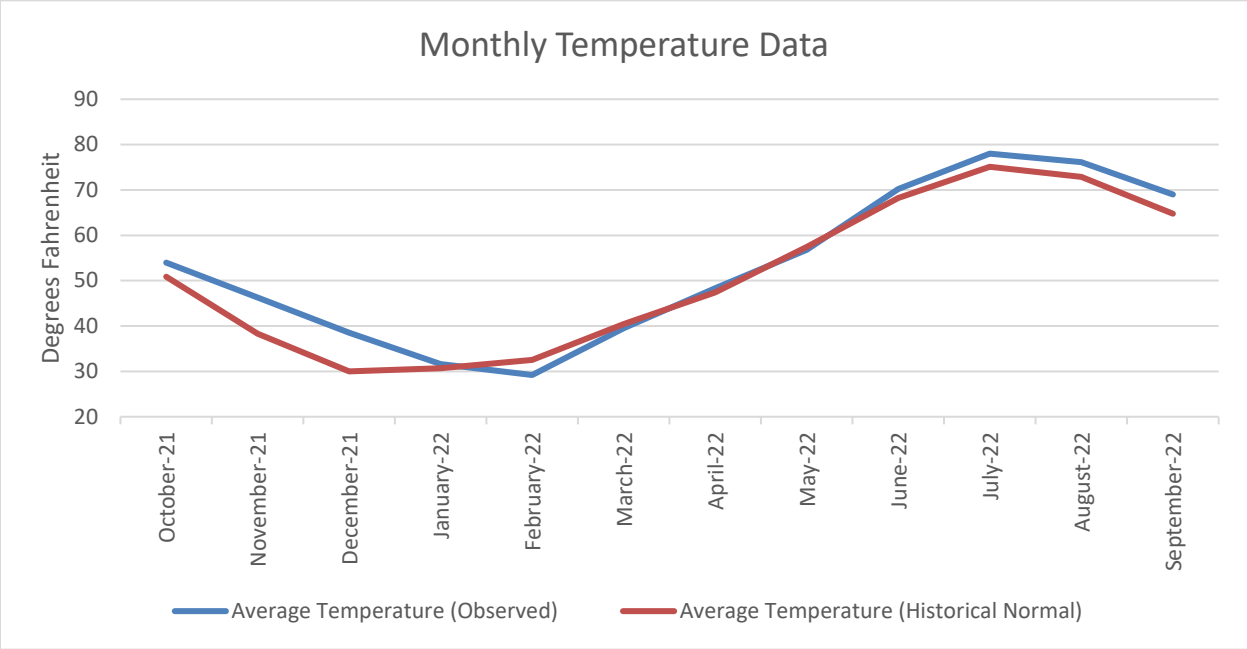
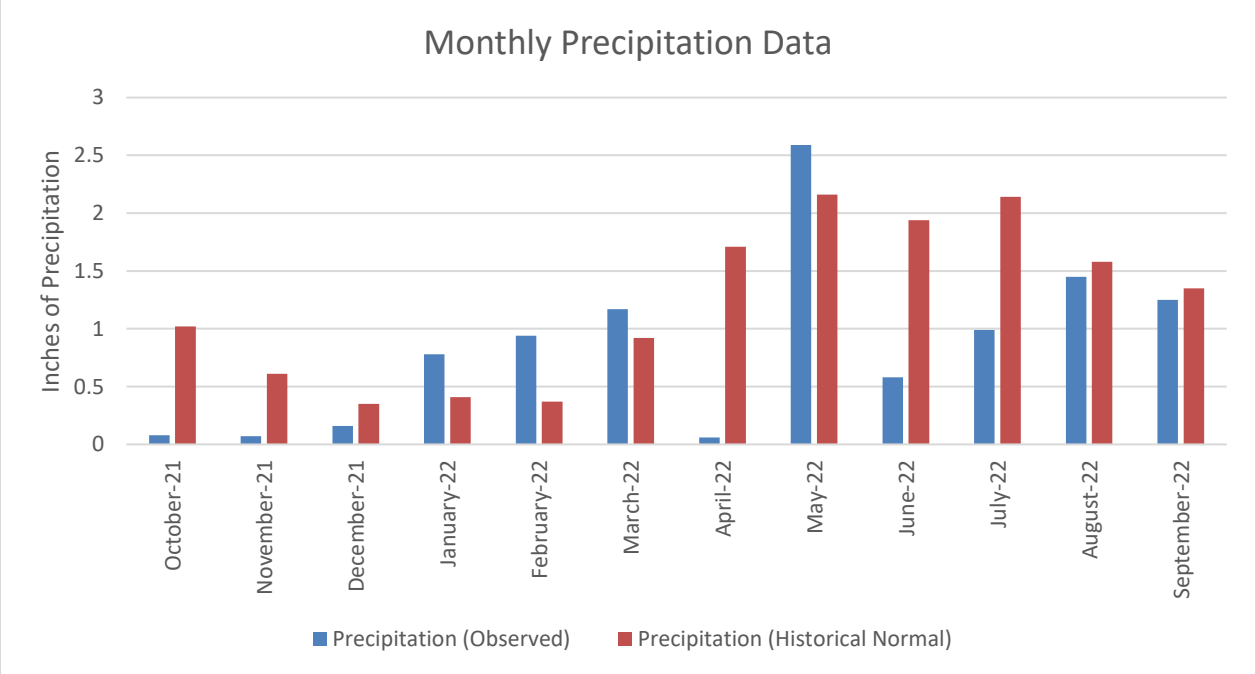


Figure 3.1-2: Average Monthly Precipitation for FY22



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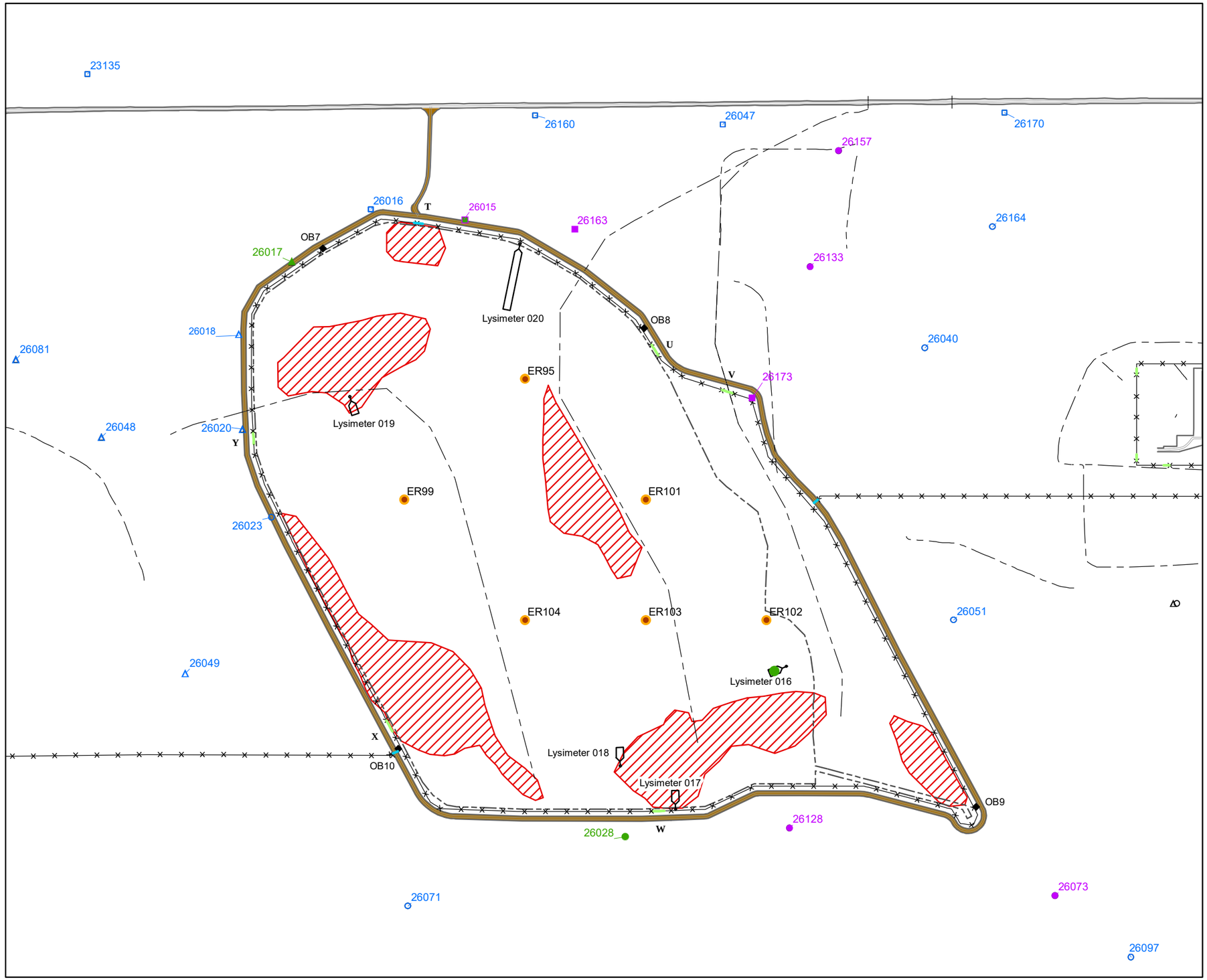

Legend

- Cover Boundary
- Perimeter Access Road
- Fence
- Cattle Guard
- Gate
- Lysimeter
- Channel Flow Line
- Obelisk
- Erosion Monument
- Lysimeter Maintenance
- Carsonite Marker Maintenance
- Mowed Areas
- Ground Clear Herbicide Application Area
- T — Labeled Gates and Cattle Guards

	Flow System / Aquifer		
Monitoring Well/ Piezometer Network	Unconfined Alluvial	Unconfined Alluvial/ Denver	Unconfined Denver
Water Level Network	△	□	○
Basin F Wastepile Water Quality Network	▲	■	●
Basin F Principal Threat Water Quality Network		■	●

N

0 162.5 325 650 Feet

NAD27-NGVD29 Datum, US Survey Feet,
Colorado North Zone
Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM

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Figure 4.0-1

2022 Basin F
Routine Maintenance Activities

BasinF_RoutineMaintenanceActivities_Nov2022.mxd
11/16/2022

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APPENDICES

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APPENDIX A

Precipitation Data

(October 1, 2021 through September 30, 2022)

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Appendix A - Precipitation Data (October 1, 2021 through September 30, 2022)

Note 1: The reporting period for this table is October 1, 2021 through September 30, 2022.

Note 2: This table provides precipitation data for all dates when precipitation was recorded. For dates not shown, there was no recorded precipitation.

Note 3: The yellow highlighted boxes indicate that there was more than one inch of precipitation in a 24-hour period.

Date	Lime Basins Daily Precipitation (in.)
October 12, 2021	0.01
October 26, 2021	0.01
November 2, 2021	0.01
December 10, 2021	0.07
December 15, 2021	0.02
December 24, 2021	0.01
December 31, 2021	0.13
January 1, 2022	0.09
January 5, 2022	0.08
January 6, 2022	0.16
January 21, 2022	0.02
January 25, 2022	0.21
January 27, 2022	0.12
February 1, 2022	0.05
February 2, 2022	0.11
February 11, 2022	0.33
February 12, 2022	0.01
February 16, 2022	0.22
February 17, 2022	0.04
February 22, 2022	0.02
February 23, 2022	0.06
February 24, 2022	0.11
March 5, 2022	0.12
March 6, 2022	0.12
March 9, 2022	0.02
March 10, 2022	0.02
March 16, 2022	0.35
March 17, 2022	0.41
March 29, 2022	0.13
April 10, 2022	0.05
April 17, 2022	0.04
May 1, 2022	0.04
May 2, 2022	0.45
May 3, 2022	0.15
May 4, 2022	0.10
May 5, 2022	0.11
May 20, 2022	0.70
May 21, 2022	0.20
May 29, 2022	0.21

Appendix A - Precipitation Data (October 1, 2021 through September 30, 2022)

Date	Lime Basins Daily Precipitation (in.)
May 31, 2022	0.93
June 1, 2022	0.54
June 29, 2022	0.10
June 30, 2022	0.01
July 1, 2022	0.01
July 7, 2022	0.17
July 19, 2022	0.04
July 20, 2022	0.02
July 23, 2022	0.12
July 24, 2022	0.12
July 26, 2022	1.07
July 27, 2022	0.07
July 28, 2022	0.10
August 6, 2022	0.88
August 7, 2022	0.46
August 15, 2022	0.13
August 16, 2022	0.42
August 22, 2022	0.04
August 28, 2022	0.02
September 2, 2022	0.05
September 9, 2022	0.02
September 10, 2022	0.22
September 21, 2022	0.14
September 22, 2022	0.04
September 30, 2022	0.30
Lime Basins Total:	**11.13**

APPENDIX B

2022 Vegetation Performance Assessment Documentation

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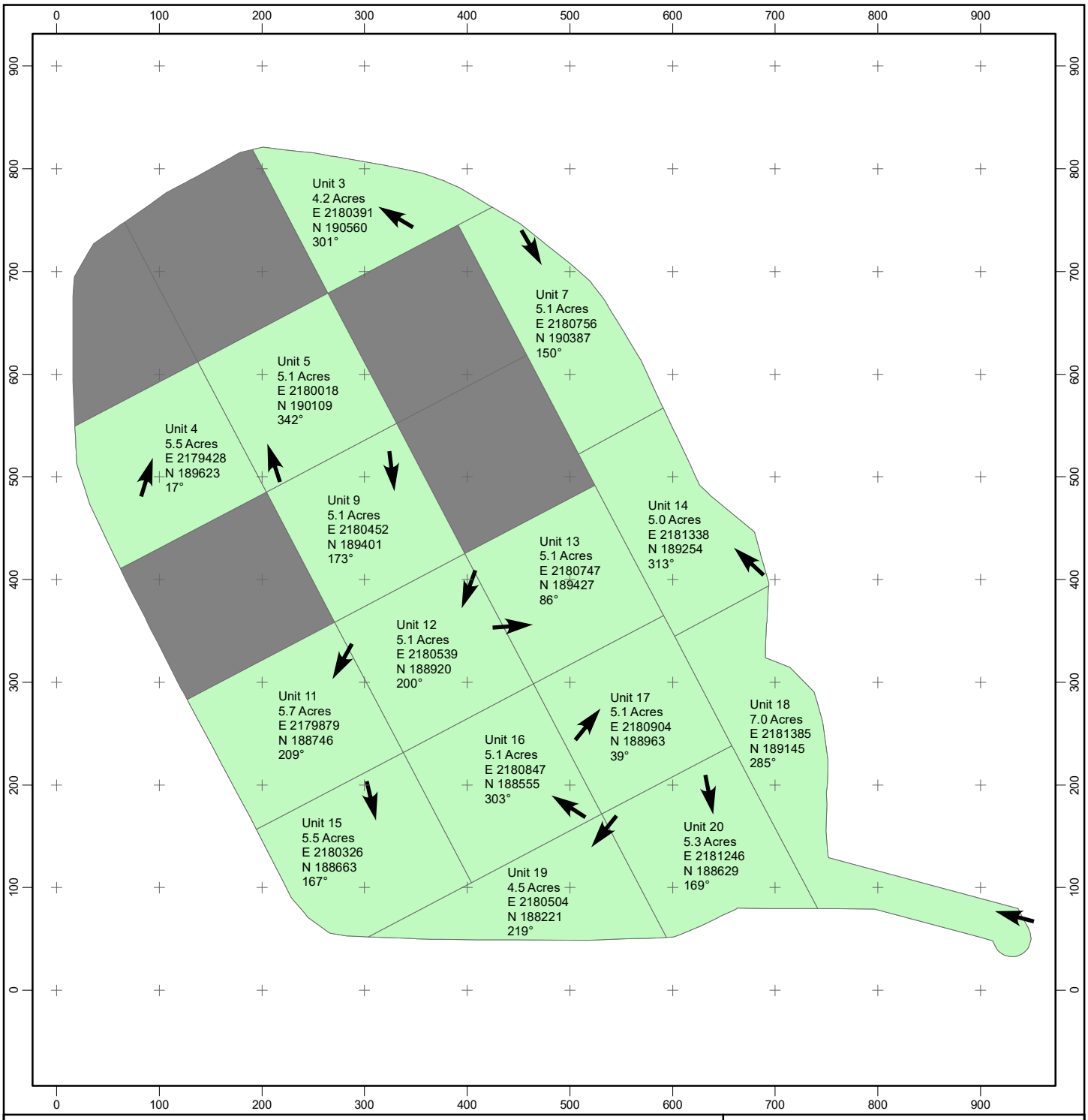

Legend

- Sampled Unit
- Non-Sampled Unit

N

100 meter grid shown for reference
Coordinates are listed in
Colorado State Plane
North Zone (NAD 1927)

0 25 50 100 150 200

Meters

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Appendix B, Figure 1

Basin F Cover
(103.25 Acres)
2022 Random Transect
Survey Locations

M:\projects\OMC\Vegetation\mxds\BasinF_2022.mxd
11/15/2022

Basin F
Unit 3


Basin F
Unit 4


Basin F
Unit 5

Basin F
Unit 7

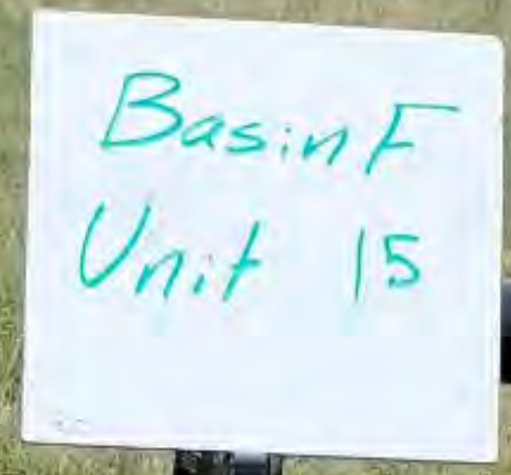
Basin F
Unit 9

Basin F
Unit 11

Basin F
Unit 12


Basin F
Unit 13


Basin F
Unit 14


Basin F
Unit 15


Basin F
Unit 16


Basin F
Unit 17


Basin F
Unit 18

Basin F
Unit 19

BasinF
Unit 20

Table 6.1.1

Cover and Frequency summary for the Basin F at Rocky Mountain Arsenal. Based on data from 15 sampling locations. 2022 data. +/- values equal the standard deviation. Incidental Species present within 1 meter on either side of the data transect, but not quantitatively encountered.

2022

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	[2]Rank
COOL SEASON PERENNIAL GRASSES						
Hesperostipa comata	1.47	2.06	0 - 8	53.33	5.71	10.0
Pascopyrum smithii	15.6	21.87	0 - 32	93.33	10.0	2.0
Pascopyrum smithii	1.6	2.24	0 - 24	6.67	.71	9.0
Sub-Total	18.67	26.17				
WARM SEASON PERENNIAL GRASSES						
Bouteloua curtipendula	7.13	10.0	2 - 16	100.0	10.71	4.0
Buchloe dactyloides	10.27	14.4	3 - 24	100.0	10.71	3.0
Chondrosum gracile	15.87	22.25	6 - 32	100.0	10.71	1.0
Sporobolus airoides	3.47	4.86	0 - 9	86.67	9.29	8.0
Sporobolus cryptandrus	3.6	5.05	0 - 8	93.33	10.0	7.0
Sub-Total	40.34	56.56				

ANNUAL GRASSES						
[1] Bromus tectorum	0.07	.1	0 - 1	6.67	.71	13.0
Sub-Total	.07	.1				
ANNUAL AND BIENNIAL FORBS						
Amaranthus arenicola	0.73	1.02	0 - 2	60.0	6.43	12.0
[1] Bassia sieversiana	3.67	5.14	0 - 10	93.33	10.0	6.0
[1] Salsola collina	6.67	9.35	2 - 18	100.0	10.71	5.0
[1] Sisymbrium altissimum	1.2	1.68	0 - 10	40.0	4.29	11.0
Sub-Total	12.27	17.19				
SUM OF SPECIES COVER	71.35	100.02				

[3]Total Absolute Mean Vegetation Cover	71.33	+/-1.61
[3]Total Absolute Mean Litter Cover	20.60	+/-1.52
[3]Total Absolute Mean Bare Soil	8.07	+/-0.97
[3]Total Absolute Mean Weedy Cover	11.60	+/-2.28
Total Absolute Ground Cover	91.93	+/-0.97
Relative Weed Cover	16.26	
Relative Allowable Weed Cover	10.0	
Relative Non-Allowable Cover by Weeds	6.26	
Non-Allowable Absolute Weedy Cover	4.47	
Allowable Total Absolute Live Vegetation Cover	66.87	

Incidental Species
i.e < 0.01 Mean Cover

Agropyron cristatum
Amaranthus retroflexus
Bassia sieversiana
Chenopodium leptophyllum
Helianthus annuus
Hesperostipa comata
Psathyrostachys juncea
Sisymbrium altissimum
Sporobolus airoides
Tragopogon dubius

Mean Number of Species/Sample	9.33
Mean Species Density/100sq. meters	10.00 +/-0.42

---

[1] Weedy Species

[2] Based on total cover

[3] Based on 1st hit data

Table 6.1.2 | **Vegetation Performance Assessment Basin F Reporting Years 2020, 2021, 2022** | **2022**

Reporting Year: 2020

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	[2]Rank
COOL SEASON PERENNIAL GRASSES						
Hesperostipa comata	0.07	.13	0 - 1	6.67	1.59	7
Pascopyrum smithii	38.80	73.58	16 - 54	100.00	23.81	1
Sub-Total	38.87	73.71				
WARM SEASON PERENNIAL GRASSES						
Bouteloua curtipendula	2.67	5.06	0 - 15	66.67	15.87	4
Buchloe dactyloides	6.60	12.52	0 - 17	93.33	22.22	2
Chondrosum gracile	3.47	6.58	0 - 7	93.33	22.22	3
Sporobolus airoides	0.87	1.65	0 - 4	33.33	7.94	5
Sporobolus cryptandrus	0.13	.25	0 - 1	13.33	3.17	6
Sub-Total	13.74	26.06				
ANNUAL AND BIENNIAL FORBS						
[1] Bassia sieversiana	0.07	.13	0 - 1	6.67	1.59	7
Descurainia incana	0.07	.13	0 - 1	6.67	1.59	7

Sub-Total	0.14	0.26
SUM OF SPECIES COVER	52.75	100.0

CRITERIA ASSESSMENT

Total Absolute Cover	97.87
Allowable Total Absolute Live Vegetation Cover 2020	52.73

Reporting Year: 2021

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	[2]Rank
COOL SEASON PERENNIAL GRASSES						
Hesperostipa comata	0.20	.32	0 - 1	20.00	2.16	11
Pascopyrum smithii	15.53	24.91	3 - 46	100.00	10.79	1
Sub-Total	15.73	25.23				
WARM SEASON PERENNIAL GRASSES						
Bouteloua curtipendula	5.33	8.55	0 - 12	80.00	8.63	6
Buchloe dactyloides	6.47	10.38	0 - 20	93.33	10.07	3
Chondrosum gracile	12.53	20.10	1 - 21	100.00	10.79	2

Sporobolus airoides	5.67	9.10	0 - 18	80.00	8.63	4
Sporobolus cryptandrus	3.13	5.02	0 - 13	80.00	8.63	8
Sub-Total	33.13	53.15				
INTRODUCED PERENNIAL GRASSES						
Agropyron cristatum	0.07	.11	0 - 1	6.67	.72	13
[1] Bromopsis inermis	0.13	.21	0 - 1	13.33	1.44	12
Psathyrostachys juncea	0.07	.11	0 - 1	6.67	.72	13
Sub-Total	0.27	0.43				
ANNUAL GRASSES						
Eragrostis cilianensis	0.20	.32	0 - 2	13.33	1.44	11
Panicum capillare	1.60	2.57	0 - 5	73.33	7.91	9
Sub-Total	1.80	2.89				
ANNUAL AND BIENNIAL FORBS						
[1] Bassia sieversiana	5.53	8.87	0 - 12	93.33	10.07	5
Chenopodium leptophyllum	0.07	.11	0 - 1	6.67	.72	13
Descurainia incana	0.13	.21	0 - 2	6.67	.72	12
[1] Lactuca serriola	0.07	.11	0 - 1	6.67	.72	13
[1] Salsola collina	4.93	7.91	2 - 11	100.00	10.79	7
[1] Sisymbrium altissimum	0.40	.64	0 - 4	20.00	2.16	10
Solanum triflorum	0.13	.21	0 - 1	13.33	1.44	12
Tragopogon dubius	0.07	.11	0 - 1	6.67	.72	13
Ximenesia encelioides	0.07	.11	0 - 1	6.67	.72	13
Sub-Total	11.40	18.28				

SUM OF SPECIES COVER	62.33	100.0

CRITERIA ASSESSMENT

Total Absolute Cover	98.00
Allowable Total Absolute Live Vegetation Cover 2021	57.50

Reporting Year: 2022

Species	Mean Cover (%)	Relative Cover (%)	Range of Cover Values (%)	Percent Frequency (%)	Relative Frequency(%)	[2]Rank
COOL SEASON PERENNIAL GRASSES						
Hesperostipa comata	1.47	2.06	0 - 8	53.33	5.71	10
Pascopyrum smithii	15.60	21.87	0 - 32	93.33	10.00	2
Pascopyrum smithii	1.60	2.24	0 - 24	6.67	.71	9
Sub-Total	18.67	26.17				
WARM SEASON PERENNIAL GRASSES						
Bouteloua curtipendula	7.13	10.00	2 - 16	100.00	10.71	4
Buchloe dactyloides	10.27	14.40	3 - 24	100.00	10.71	3
Chondrosum gracile	15.87	22.25	6 - 32	100.00	10.71	1
Sporobolus airoides	3.47	4.86	0 - 9	86.67	9.29	8

Sporobolus cryptandrus	3.60	5.05	0 - 8	93.33	10.00	7
Sub-Total	40.34	56.56				
ANNUAL GRASSES						
[1] Bromus tectorum	0.07	.10	0 - 1	6.67	.71	13
Sub-Total	0.07	0.10				
ANNUAL AND BIENNIAL FORBS						
Amaranthus arenicola	0.73	1.02	0 - 2	60.00	6.43	12
[1] Bassia sieversiana	3.67	5.14	0 - 10	93.33	10.00	6
[1] Salsola collina	6.67	9.35	2 - 18	100.00	10.71	5
[1] Sisymbrium altissimum	1.20	1.68	0 - 10	40.00	4.29	11
Sub-Total	12.27	17.19				
SUM OF SPECIES COVER	71.35	100.0				

CRITERIA ASSESSMENT

Total Absolute Cover	91.93
Allowable Total Absolute Live Vegetation Cover 2022	66.87
Two year running average for Total Absolute Cover	94.96
Three year running average for	95.93

Total Absolute Cover

[1] Weedy Species

[2] Based on total cover

[3] Based on 1st hit data

Table 6.1.3

Sample Adequacy Check

2022

Basin F

Year : 2022

Transect	Hits
03	67
04	73
05	72
07	63
09	75
11	75
12	77
13	68
14	69
15	65
16	74
17	70
18	73
19	80
20	69

Sample Adequacy = 0.76

(Mean value: 71.33, Sample Variance: 4.62, One Tailed Value: 1.345)

Table 6.1.4 - Basin F Cover
Raw Data Report

Sampled by: Andrew Martinez
Sample Date(s): 8/24/2022

1 - Only plant species that were hit or observed along the transect are recorded in this table.
Blank boxes indicate the species was not present on the transect.
2 - Species with cover values of 0.1 were species observed within the 100 meter zone associated with each transect, but not recorded in the quantitative data collection for each transect.
3 - # of species/100sq meter zone

	Transects														
SPECIES/Other	**03**	**04**	**05**	**07**	**09**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
BARE SOIL	11.0	10.0	11.0	12.0	8.0	11.0	8.0	4.0	9.0	7.0	5.0	8.0	5.0	3.0	9.0
LITTER	22.0	17.0	17.0	25.0	17.0	14.0	15.0	28.0	22.0	28.0	21.0	22.0	22.0	17.0	22.0
AGROPYRON CRISTATUM	0.1	0.1							0.1						
AMARANTHUS ARENICOLA		1.0				1.0	1.0	1.0		1.0	2.0	1.0		1.0	2.0
AMARANTHUS RETROFLEXUS										0.1					
BASSIA SIEVERSIANA	3.0	6.0	2.0	2.0	6.0	4.0	2.0	0.1	5.0	1.0	3.0	6.0	2.0	3.0	10.0
BOUTELOUA CURTIPENDULA	3.0	8.0	16.0	2.0	12.0	13.0	14.0	7.0	4.0	2.0	7.0	3.0	4.0	7.0	5.0
BROMUS TECTORUM									1.0						
BUCHLOE DACTYLOIDES	9.0	9.0	18.0	8.0	6.0	10.0	17.0	16.0	6.0	9.0	5.0	4.0	24.0	3.0	10.0
CHENOPODIUM LEPTOPHYLLUM			0.1						0.1				0.1		0.1
CHONDROSUM GRACILE	10.0	19.0	12.0	32.0	6.0	25.0	13.0	12.0	13.0	18.0	15.0	14.0	30.0	11.0	8.0
HELIANTHUS ANNUUS												0.1			
HESPEROSTIPA COMATA	1.0			1.0	3.0	0.1	1.0	1.0	2.0		5.0			8.0	
PASCOPYRUM SMITHII	30.0	8.0	7.0	6.0	31.0	9.0	17.0	14.0	17.0	15.0	22.0	24.0	1.0	32.0	25.0
PSATHYROSTACHYS JUNCEA		0.1	0.1	0.1											
SALSOLA COLLINA	9.0	7.0	8.0	7.0	8.0	3.0	3.0	6.0	18.0	4.0	4.0	9.0	2.0	6.0	6.0
SISYMBRIUM ALTISSIMUM	0.1	10.0	3.0	1.0	1.0	0.1		0.1	2.0		1.0	0.1	0.1	0.1	
SPOROBOLUS AIROIDES	1.0	4.0	3.0	0.1		4.0	3.0	9.0	1.0	7.0	5.0	8.0	5.0	1.0	1.0

SPOROBOLUS CRYPTANDRUS	1.0	1.0	3.0	4.0	2.0	6.0	6.0	2.0		8.0	5.0	1.0	5.0	8.0	2.0
TRAGOPOGON DUBIUS	0.1														
Total Hits plus Incidental Species:	**100.3**	**100.2**	**100.2**	**100.2**	**100.0**	**100.2**	**100.0**	**100.2**	**100.2**	**100.1**	**100.0**	**100.2**	**100.2**	**100.1**	**100.1**
Species Density:	**12**	**12**	**11**	**11**	**9**	**11**	**10**	**11**	**12**	**10**	**11**	**11**	**10**	**11**	**10**

[3] Sample Mean: 10.8, Variance: 0.86

APPENDIX C

Cover Inspection Documentation

(October 1, 2021 through September 30, 2022)

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FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, C. Mackey	**Inspection Date(s):** 10-5-21

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 70's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

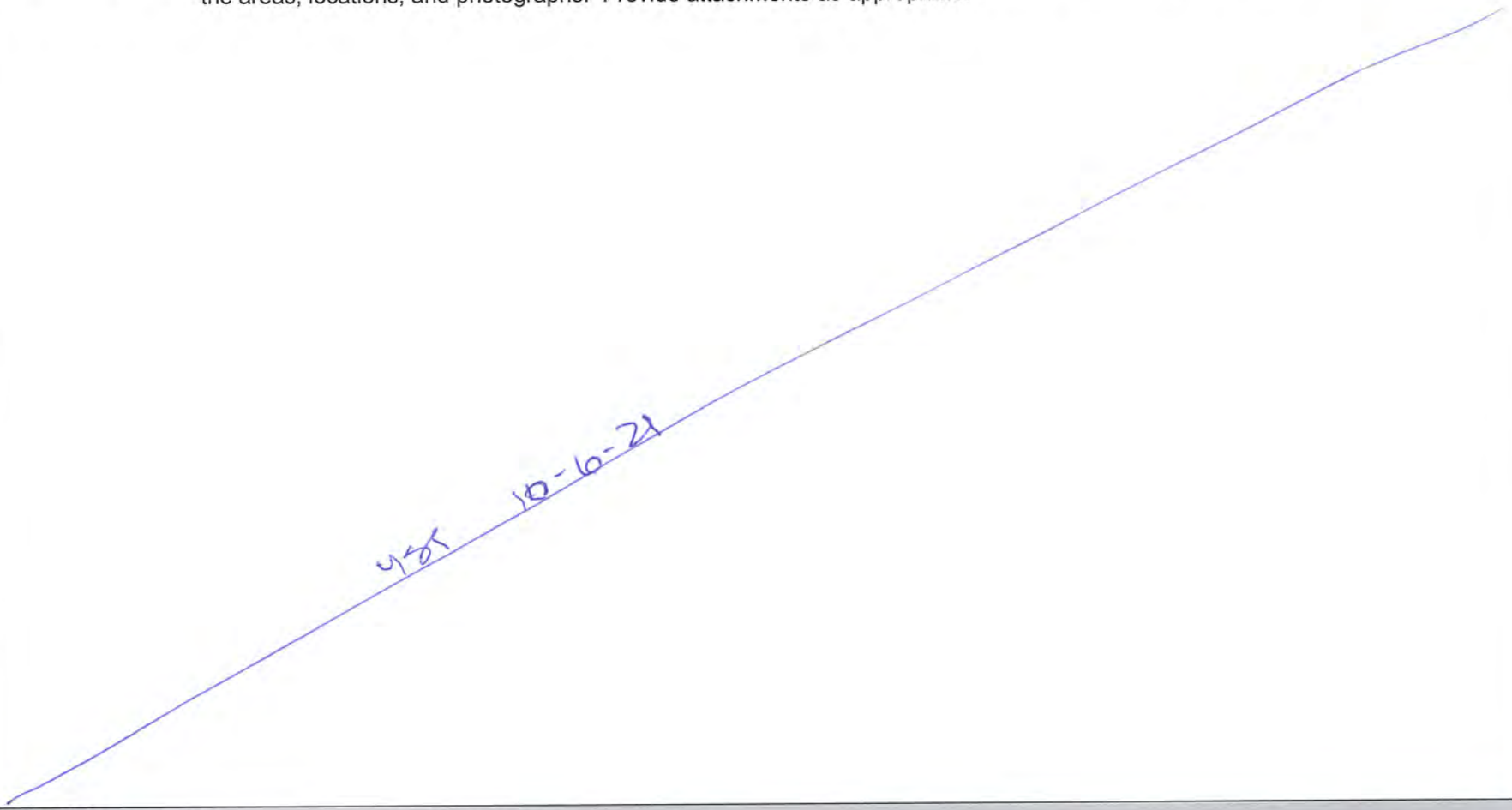
2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	Ø
018	Ø
019	trace
020	Ø

8.4

FORM SOP 003-1

BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.



Inspector		
Name: Kim Hoffman	Signature: Kim Hoffman	Date: 10-6-21
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	Signature: Michael W. Jones	Date: 10/8/21
Cover Manager Confirmation of Completed Actions		
Name: N/A	Signature: N/A	Date: N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, C. Mackey, K. Hoffman, V. Stewart	**Inspection Date(s):** 11-3-21

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 60's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	trace
018	Ø
019	trace
020	Ø

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

Lysimeters 016, 017, and 019 would benefit to have the standing water pumped from inside the manhole.

Inspector		
Name: Kim Hoffman	Signature: Kim Hoffman	Date: 11-4-21
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	Signature: Michael W. Jones	Date: 12/6/21
Cover Manager Confirmation of Completed Actions		
Name: N/A	Signature: N/A	Date: N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, V. Stewart, E. Jacobs	Inspection Date(s): 12-1-21

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 50's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	trace
018	trace
019	trace
020	Ø

S. Lo

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

12-2-21

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 12-2-21
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 12/6/21
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffman, V. Stewart	**Inspection Date(s):** 1-12-2022

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 30's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): none								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	trace
018	trace
019	trace
020	trace

8.6

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

1-18-22

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 1-18-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 1/27/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffman **Inspection Date(s):** 2-9-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: mostly sunny, calm winds, 30's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	trace
018	Ø
019	trace
020	trace

S.L

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 2-9-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 2/15/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, V. Stewart **Inspection Date(s):** 3-15-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 50's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT Y	N	N/A	REPEAT OR CHRONIC CONDITION Y	N	N/A	OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								
2.0 Percolation Collection								

Lysimeter Number	Measured Water Volume (liter)
016	Ø
017	Ø
018	Ø
019	trace
020	Ø

8.4e

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

KH 3-22-22

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 3-21-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 3/24/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffman **Inspection Date(s):** 4-6-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: windy, cold, sunny, 35° Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	Ø
018	Ø
019	Ø
020	Ø

8.4

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 4-6-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** M. Jones	**Date:** 4/6/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffman	**Inspection Date(s):** 5-12-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: breezy, sunny, 60's Acceptable/Unacceptable for Inspection ***(circle one)***

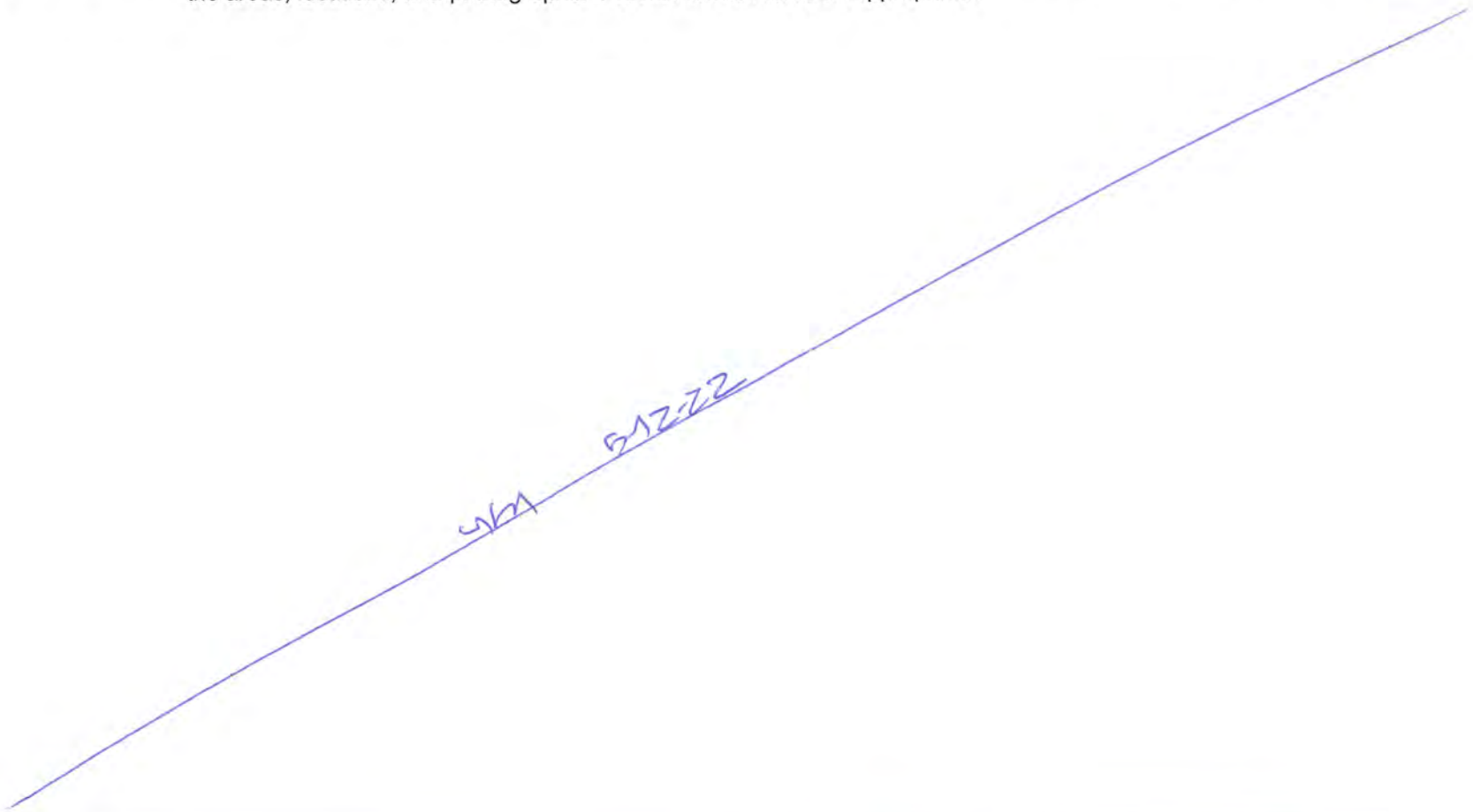
INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	Ø
018	Ø
019	Ø
020	Ø

8.6

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.



Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 5-12-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 5/19/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffman, V. Stewart **Inspection Date(s):** 6-8-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: calm, sunny, 60's Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

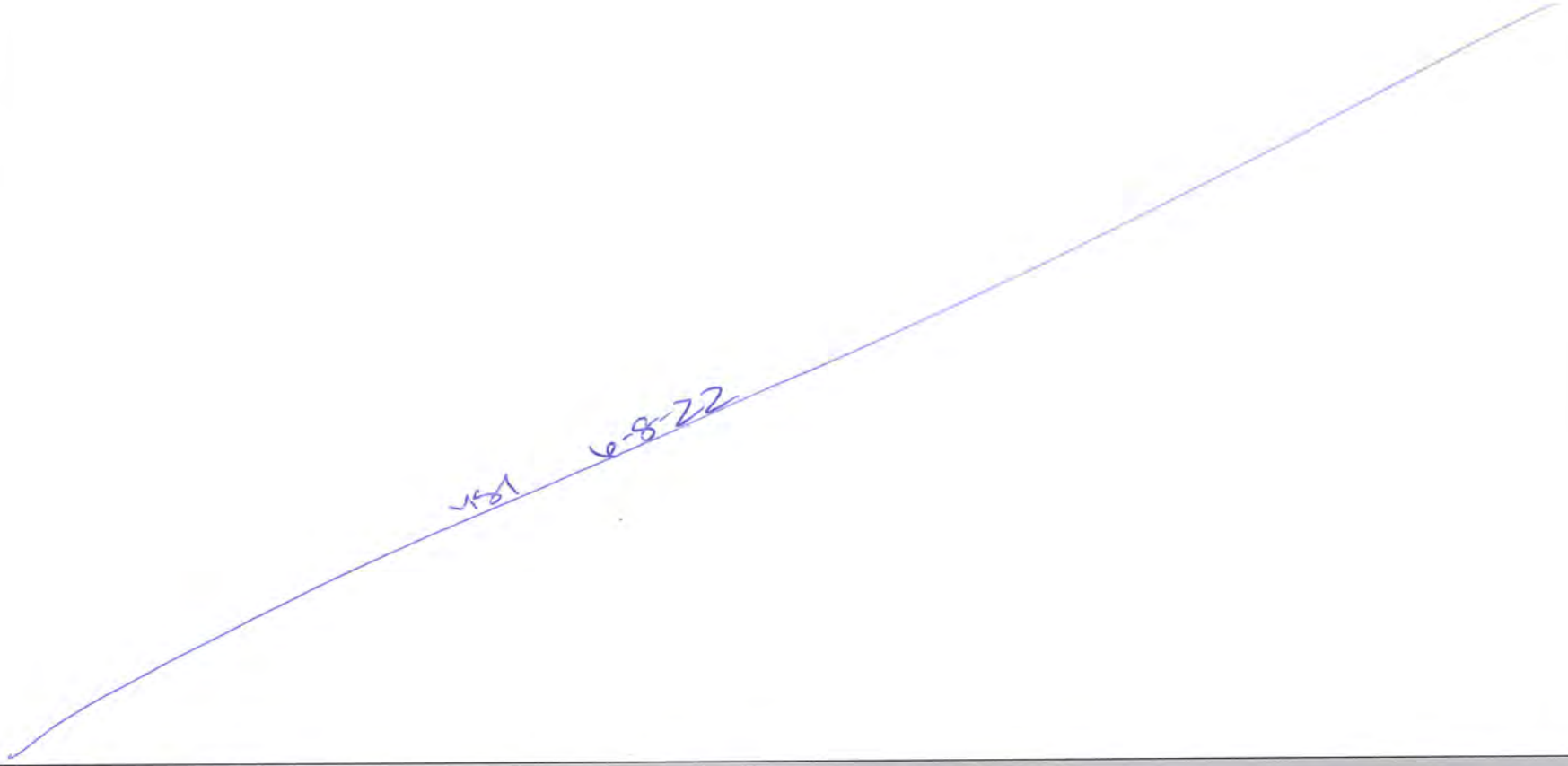
2.0 Percolation Collection

Lysimeter Number	Measured Water Volume (liter)
016	Ø
017	Ø
018	Ø
019	trace
020	Ø

8-16

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.



Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 6-8-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 6/29/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffmann, V. Stewart

Inspection Date(s): 7-13-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 80's (Acceptable/Unacceptable for Inspection ***(circle one)***)

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	Ø
018	Ø
019	Ø
020	Ø

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 7-19-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 7/21/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, V. Stewart	**Inspection Date(s):** 8-3-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 80s (Acceptable/Unacceptable for Inspection ***(circle one)***)

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection	
Lysimeter Number	**Measured Water Volume (liter)**
016	Ø
017	Ø
018	Ø
019	Ø
020	Ø

8-4

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

lysimeters 017 and 019 would benefit to have the standing water pumped from inside the manholes.

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 8-4-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 10/3/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspector Name(s): M. Jones, K. Hoffman, V. Stewart **Inspection Date(s):** 9-14-22

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: mostly sunny, calm winds, 70's (Acceptable/Unacceptable for Inspection ***(circle one)***)

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Percolation Collection Manhole (PCM) Condition								
1.1 Damage to the PCM or internal components		✓				✓	none	
1.2 Accumulation of a quantity of water greater than that caused by natural condensation in the manhole		✓				✓	none	
1.3 If the water level observed in the PCM impacts the ability to measure percolation, remove water accumulated in the PCM, and record the quantity here. Quantity removed from the PCM (liters): Ø								

2.0 Percolation Collection

Lysimeter Number	Measured Water Volume (liter)
016	Ø
017	Ø
018	Ø
019	Ø
020	Ø

8-L6

FORM SOP 003-1
BASIN F PERCOLATION MONITORING SYSTEM DATA COLLECTION AND OPERATION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

Lysimeter 016 would benefit to have the standing water pumped from inside the manhole.

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 9-14-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 10/3/22
Cover Manager Confirmation of Completed Actions		
Name: N/A	**Signature:** N/A	**Date:** N/A

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

Inspector Names: M. Jones, C. Mackey | **Date(s):** 10-5-21 | **Time of Inspection:** 0800

Attachments: ☐ Form SOP 002-1 ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:

Previous 24-hour precipitation: Ø | Weather Conditions: sunny, calm winds, 60's | Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1 Erosion rills or gullies		✓				✓	none	
1.2 Sheet erosion or plant pedestalling		✓				✓	none	
1.3 Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7 Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

INSPECTION ITEM		CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
2.3	Deep rooted, noxious or undesirable weeds		✓				✓	none	
2.4	Plants exhibiting decadence, including excessive litter accumulation		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence		✓				✓	none	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

3.0	Engineering and Access Controls (Continued)							
3.5	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓			✓	none	
3.6	Cover perimeter survey monuments appear to be disturbed (Inspect every five years, prior to the CERCLA Five Year Review for legibility and to confirm record locations)			✓		✓	not inspected this inspection.	

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*

	INSPECTION ITEM	CHANNEL NUMBER 24	CHANNEL NUMBER 25
4.1*	Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2*	Excessive siltation in the channel	Y (N)	Y (N)
4.3*	Debris or ice present in the channel	(Y) N	(Y) N
4.4*	Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5*	Inadequate protective vegetation	Y (N)	Y (N)
4.6	Cracked or degraded concrete	Y (N)	Y (N)
4.7*	Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8*	Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

→ 4.3: tumble weeds observed in channels 24 and 25.

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

6.0 Erosion/Settlement Monuments: *Inspect monuments for damage and legibility, and record the soil thickness loss, if any.*

INSPECTION ITEM	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
6.1 Was the monument free of damage and legible?	(Y) / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	Y / N	(Y) / N
6.2 Measured Soil Thickness Loss (inches)	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0.5	Ø	Ø	2	Ø	Ø	0.5	Ø	Ø

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations with GPS coordinates, and photographs. Provide attachments as appropriate.

The numbers on carsonite markers for ER99 and ER104 need replaced.

Transects were performed +75 E/W.

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 10-7-21
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 10/8/21
Cover Manager Confirmation of Completed Actions		
Name:	**Signature:**	**Date:**

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspector Name(s): M. Jones, K. Hoffman, V. Stewart | **Inspection Date(s):** 1-12-2022

Attachments: ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:
Previous 24-Hour Precipitation: 0 Weather Conditions: sunny, calm winds, 30's (Acceptable/Unacceptable for Inspection ***(circle one)***

Recent Significant Storm Event: ☑ No ☐ Yes (Date(s) of Event: N/A Precipitation: N/A)
*Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number.*

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1* Erosion rills or gullies		✓				✓	none	
1.2* Sheet erosion or plant pedestalling		✓				✓	none	
1.3* Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7* Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

INSPECTION ITEM		CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence	✓			✓			tumble weeds have collected along fence line	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*		
	CHANNEL NUMBER	
INSPECTION ITEM	**24**	**25**
4.1* Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2* Excessive siltation in the channel	Y (N)	Y (N)
4.3* Debris or ice present in the channel	(Y) N	(Y) N
4.4* Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5* Inadequate protective vegetation	Y (N)	Y (N)
4.6 Cracked or degraded concrete	Y (N)	Y (N)
4.7* Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8* Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

→ 4.3: tumble weeds were observed in channels 24 and 25.

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

Note: Snow covered many areas, thus it was hard to identify surface conditions.

The numbers on corsonite markers for ER99 and ER104 need replaced.
Addressed in ~~August~~ May 2022.
MJ 8/2/22
MJ 8/2/22

Inspector		
Name: Kim Hoffman	Signature: Kim Hoffman	Date: 1-13-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	Signature: Michael W. Jones	Date: 1/27/22
Cover Manager Confirmation of Completed Actions		
Name:	Signature:	Date:

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspector Name(s): M. Jones, V. Stewart | **Inspection Date(s):** 3-15-22

Attachments: ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 50's (Acceptable/Unacceptable for Inspection ***(circle one)***

Recent Significant Storm Event: ☑ No ☐ Yes (Date(s) of Event: N/A Precipitation: N/A)

*Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number.*

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1* Erosion rills or gullies		✓				✓	none	
1.2* Sheet erosion or plant pedestalling		✓				✓	none	
1.3* Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7* Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

	INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence	✓			✓			tumble weeds have collected along fence	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*		
	CHANNEL NUMBER	
INSPECTION ITEM	**24**	**25**
4.1* Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2* Excessive siltation in the channel	Y (N)	Y (N)
4.3* Debris or ice present in the channel	(Y) N	(Y) N
4.4* Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5* Inadequate protective vegetation	Y (N)	Y (N)
4.6 Cracked or degraded concrete	Y (N)	Y (N)
4.7* Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8* Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

4.3: tumble weeds have collected in concrete channels

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

The numbers on carsonite markers for ER99 and ER104 need replaced.
Addressed in May 2022.
MJ 8/2/22

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 3-21-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 3/24/22
Cover Manager Confirmation of Completed Actions		
Name:	**Signature:**	**Date:**

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

Inspector Names: M. Jones + C. Mackey | **Date(s):** 4-26-22 | **Time of Inspection:** 1300

Attachments: ☐ Form SOP 002-1 ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:

Previous 24-hour precipitation: Ø | Weather Conditions: Sunny, calm winds, 70's | Acceptable/Unacceptable for Inspection ***(circle one)***

INSPECTION ITEM	CONDITION PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1 Erosion rills or gullies		✓				✓	none	
1.2 Sheet erosion or plant pedestalling		✓				✓	none	
1.3 Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7 Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

INSPECTION ITEM		CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
2.3	Deep rooted, noxious or undesirable weeds		✓				✓	none	
2.4	Plants exhibiting decadence, including excessive litter accumulation		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence	✓				✓		tumble weed accumulation along fence line	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

3.0	Engineering and Access Controls (Continued)								
3.5	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓				✓	none	
3.6	Cover perimeter survey monuments appear to be disturbed (Inspect every five years, prior to the CERCLA Five Year Review for legibility and to confirm record locations)			✓			✓	not inspected this year	

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*

	INSPECTION ITEM	CHANNEL NUMBER 24	CHANNEL NUMBER 25
4.1*	Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2*	Excessive siltation in the channel	Y (N)	Y (N)
4.3*	Debris or ice present in the channel	(Y) N	(Y) N
4.4*	Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5*	Inadequate protective vegetation	Y (N)	Y (N)
4.6	Cracked or degraded concrete	Y (N)	Y (N)
4.7*	Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8*	Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

→ 4.3: tumbleweed accumulations in channels.

FORM SOP 001-2
BASIN F TYPE II INSPECTION FORM

6.0 Erosion/Settlement Monuments: *Inspect monuments for damage and legibility, and record the soil thickness loss, if any.*

INSPECTION ITEM	ER92	ER93	ER94	ER95	ER96	ER97	ER98	ER99	ER100	ER101	ER102	ER103	ER104	ER105	ER106	ER107	ER108	ER109
6.1 Was the monument free of damage and legible?	(Y) N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	Y N	(Y) N
6.2 Measured Soil Thickness Loss (inches)	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø	0.25	Ø	Ø	1.5	Ø	Ø	Ø	Ø	Ø

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations with GPS coordinates, and photographs. Provide attachments as appropriate.

corrosive markers: The numbers need to be replaced on ER99 & ER104.
Addressed in May 2022.
MJ 8/2/22

Performed 100 N-S transects.

Inspector		
Name: Kim Hoffmann	Signature:	Date: 4-28-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	Signature:	Date: 5/10/22
Cover Manager Confirmation of Completed Actions		
Name:	Signature:	Date:

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspector Name(s): M. Jones, K. Hoffman | **Inspection Date(s):** 5-12-22

Attachments: ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:
Previous 24-Hour Precipitation: 0 Weather Conditions: breezy, sunny, 60's (Acceptable/Unacceptable for Inspection ***(circle one)***

Recent Significant Storm Event: ☑ No ☐ Yes (Date(s) of Event: N/A Precipitation: N/A)
*Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number.*

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1* Erosion rills or gullies		✓				✓	none	
1.2* Sheet erosion or plant pedestalling		✓				✓	none	
1.3* Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7* Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

8-2

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

INSPECTION ITEM		CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence	✓			✓			tumble weeds have collected along fence	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*		
	CHANNEL NUMBER	
INSPECTION ITEM	**24**	**25**
4.1* Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2* Excessive siltation in the channel	Y (N)	Y (N)
4.3* Debris or ice present in the channel	(Y) N	(Y) N
4.4* Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5* Inadequate protective vegetation	Y (N)	Y (N)
4.6 Cracked or degraded concrete	Y (N)	Y (N)
4.7* Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8* Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

4.3: tumble weeds have collected in concrete channels

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

The numbers on carsonite markers for ER99 and ER104 need Replaced. Repaired in May 2022
MJ 11/2/22

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 11-2-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 11/2/22
Cover Manager Confirmation of Completed Actions		
Name:	**Signature:**	**Date:**

POST-STORM

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspector Name(s): M. Jones, K. Hoffman, V. Stewart **Inspection Date(s):** 6-8-22

Attachments: ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm, 50's-60's (Acceptable)/Unacceptable for Inspection ***(circle one)***

Recent Significant Storm Event: ☐ No ☑ Yes (Date(s) of Event: 6-1-22 Precipitation: 1.47")

*Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number.*

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1* Erosion rills or gullies		✓				✓	none	
1.2* Sheet erosion or plant pedestalling		✓				✓	none	
1.3* Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7* Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

8-2

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

	INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence	✓				✓		tumble weed accumulation along fence line	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*		
INSPECTION ITEM	**CHANNEL NUMBER**	
	24	**25**
4.1* Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2* Excessive siltation in the channel	Y (N)	Y (N)
4.3* Debris or ice present in the channel	(Y) N	(Y) N
4.4* Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5* Inadequate protective vegetation	Y (N)	Y (N)
4.6 Cracked or degraded concrete	Y (N)	Y (N)
4.7* Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8* Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

→ 4.3: tumbleweed accumulation in channels.

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

YSI 6-8-22

Inspector		
Name: Kim Hoffman	**Signature:**	**Date:** 6-8-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 6/29/22
Cover Manager Confirmation of Completed Actions		
Name:	**Signature:**	**Date:**

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspector Name(s): M. Jones, K. Hoffman, V. Stewart **Inspection Date(s):** 7-13-22

Attachments: ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:
Previous 24-Hour Precipitation: Ø Weather Conditions: sunny, calm winds, 80's (Acceptable/Unacceptable for Inspection ***(circle one)***

Recent Significant Storm Event: ☑ No ☐ Yes (Date(s) of Event: N/A Precipitation: N/A)
*Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number.*

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1* Erosion rills or gullies		✓				✓	none	
1.2* Sheet erosion or plant pedestalling		✓				✓	none	
1.3* Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction		✓				✓	none	
1.5 Excessive animal trails or tire tracks/ruts		✓				✓	none	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)		✓				✓	none	
1.7* Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

8.2

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

	INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism		✓				✓	none	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet		✓				✓	none	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet		✓				✓	none	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged		✓				✓	none	
3.2	Debris has collected along the perimeter fence	✓				✓		tumble weed accumulations along fence line	
3.3	Obelisks are damaged, not visible, or not legible		✓				✓	none	
3.4	Warning signs are not legible from 25 feet		✓				✓	none	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts or burrowing		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*		
INSPECTION ITEM	**CHANNEL NUMBER**	
	24	**25**
4.1* Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2* Excessive siltation in the channel	Y (N)	Y (N)
4.3* Debris or ice present in the channel	(Y) N	(Y) N
4.4* Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5* Inadequate protective vegetation	Y (N)	Y (N)
4.6 Cracked or degraded concrete	Y (N)	Y (N)
4.7* Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8* Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

→ 4.3: tumble weed accumulation in channels.

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.

7-19-22

Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 7-19-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:**	**Date:** 7/21/22
Cover Manager Confirmation of Completed Actions		
Name:	**Signature:**	**Date:**

POST-STORM

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspector Name(s): M. Jones, V. Stewart | **Inspection Date(s):** 8-3-22

Attachments: ☐ Form SOP 003-1 ☐ Photographs ☐ Figures ☐ Other

Conditions:
Previous 24-Hour Precipitation: 0 Weather Conditions: sunny, calm winds, 80's (Acceptable/Unacceptable for Inspection ***(circle one)***

Recent Significant Storm Event: ☐ No ☑ Yes (Date(s) of Event: 7-26-22 Precipitation: 1.07")

*Note: Post-storm event inspection items are indicated with a * next to the Inspection Item number.*

INSPECTION ITEM	CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
	Y	N	N/A	Y	N	N/A		
1.0 Surface Conditions								
1.1* Erosion rills or gullies		✓				✓	none	
1.2* Sheet erosion or plant pedestalling		✓				✓	none	
1.3* Depressions, ponding areas, sedimentation, or other conditions that could interrupt cover drainage		✓				✓	none	
1.4 Surface salts, crusting, or evidence of compaction			✓			✓	N/A	
1.5 Excessive animal trails or tire tracks/ruts			✓			✓	N/A	
1.6 Burrowing animal holes (localized burrows greater than 3 inches in diameter, or widespread burrows of any size)			✓			✓	N/A	
1.7* Seepage, differential settlement, cracking, subsidence, sliding, or creep		✓				✓	none	

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

INSPECTION ITEM		CONDITION IS PRESENT			REPEAT OR CHRONIC CONDITION			OBSERVATION Indicate recommended action, if required.	CONFIRMATION THAT ACTION IS COMPLETE (Initial and Date)
		Y	N	N/A	Y	N	N/A		
1.0	**Surface Conditions (Continued)**								
1.8	Intrusive damage such as unplanned excavation, drilling, grading, damage to engineering or access controls, vandalism			✓			✓	N/A	
2.0	**Vegetative Cover**								
2.1	Bare area or areas of poor growth greater than 100 square feet			✓			✓	N/A	
2.2	Areas of poor vigor, disease, over grazing, stress, burned, or discoloration greater than 100 square feet			✓			✓	N/A	
3.0	**Engineering and Access Controls**								
3.1	The perimeter fence is damaged			✓			✓	N/A	
3.2	Debris has collected along the perimeter fence			✓			✓	N/A	
3.3	Obelisks are damaged, not visible, or not legible			✓			✓	N/A	
3.4	Warning signs are not legible from 25 feet			✓			✓	N/A	
3.5*	Damage to the Perimeter Access Road such as potholes, washouts or burrowing	✓					✓	none	

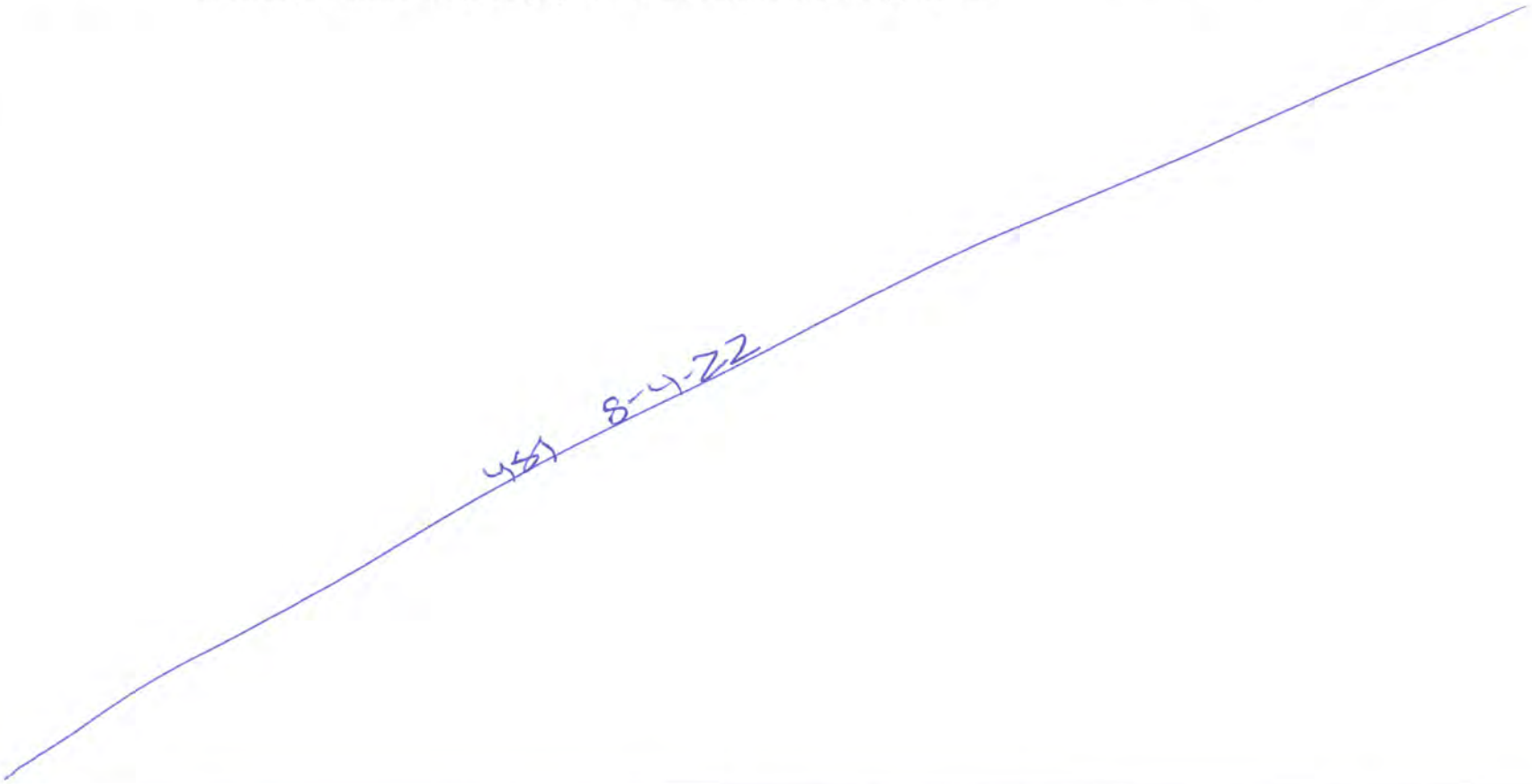
FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

4.0 Surface Water Drainage Controls: *Were the following conditions observed during the inspection of the stormwater drainage controls? (circle all that apply)*		
INSPECTION ITEM	**CHANNEL NUMBER**	
	24	**25**
4.1* Impeded drainage or ponding in the channel	Y (N)	Y (N)
4.2* Excessive siltation in the channel	Y (N)	Y (N)
(4.3*) Debris or ice present in the channel	(Y) N	(Y) N
4.4* Erosion rills or gullies in the channel	Y (N)	Y (N)
4.5* Inadequate protective vegetation	Y (N)	Y (N)
4.6 Cracked or degraded concrete	Y (N)	Y (N)
4.7* Inhibited drainage from the soil to the concrete-lined channel	Y (N)	Y (N)
4.8* Subsidence or undercutting of the concrete-lined channel	Y (N)	Y (N)

→ 4.3: Tumble weed accumulation in channels.

FORM SOP 001-1
BASIN F TYPE I INSPECTION FORM

Inspection Notes: For areas with deficiencies, provide identifying labels for deficient areas, descriptions of deficiencies, approximate dimensions of the areas, locations, and photographs. Provide attachments as appropriate.



Inspector		
Name: Kim Hoffman	**Signature:** Kim Hoffman	**Date:** 8-4-22
Cover Manager Review of Inspection Documentation		
Name: Michael W. Jones	**Signature:** Michael W. Jones	**Date:** 10/3/22
Cover Manager Confirmation of Completed Actions		
Name:	**Signature:**	**Date:**

APPENDIX D

Maintenance and Repair Documentation

(October 1, 2021 through September 30, 2022)

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CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: Weed Wranglers	Project: Basin F O&M
Task: maintenance	Date: 10-28-21
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
Weed Wranglers sprayed the herbicide Plainview SC® as a ground clear herbicide treatment on Basin F. Roadways, around gates and wells, and other working surfaces were sprayed.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Site Inspector/CDM Smith
Signature: Kim Hoffman	Date: 12-16-21
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature:	Date: 12/17/21

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: N/A	Project: Basin F O&M
Task: maintenance	Date: 11-30-21
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
OMC personnel used the tumble weed fence cleaner to remove tumble weeds from the entire exterior fence line.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Site Inspector/CDM Smith
Signature: Kim Hoffman	Date: 12-16-21
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature: Michael W. Jones	Date: 12/17/21

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: N/A	Project: Basin F O&M
Task: maintenance	Date: 12-1-21
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
OMC personnel used the tumble weed fence cleaner to remove tumble weeds from the entire interior fence line.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Site Inspector/CDM Smith
Signature: Kim Hoffman	Date: 12-16-21
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature:	Date: 12/17/21

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: N/A	Project: Basin F O&M
Task: maintenance	Date: 5/18/22
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
OMC personnel pumped the standing water from the manhole at Lysimeter 016. Approximately 73 liters were removed.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Caps and Covers Lead/Navarro
Signature: Kim Hoffman	Date: 7-20-22
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature:	Date: 7/29/22

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: N/A	Project: Basin F O&M
Task: maintenance	Date: 5/25/22
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
OMC personnel replaced the numbers on the Carsonite markers for ER monuments 95, 99, 101, 102, 103, and 104.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Caps and Covers Lead/Navarro
Signature: Kim Hoffman	Date: 7-20-22
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature: Michael Jones	Date: 7/29/22

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: N/A	Project: Basin F O&M
Task: maintenance	Date: 6/1/22
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
OMC personnel performed a drive around inspection due to the RMA receiving 1.47" of rain in a 24-hour period. The rain stopped on 6/1/22 during the am and the inspection was performed in the afternoon. No new observations were noted.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Caps and Covers Lead/Navarro
Signature: Kim Hoffman	Date: 7-20-22
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature:	Date: 7/29/22

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: H2	Project: Basin F O&M
Task: maintenance	Date: 7/25/22
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
H2 mowed weedy areas on Basin F. Approximately 20 acres were mowed and this activity was completed today.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Caps and Covers Lead/Navarro
Signature: Kim Hoffman	Date: 9-29-22
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature:	Date: MJ 10/10/22 10/10/22

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: N/A	Project: Basin F O&M
Task: maintenance	Date: 7/27/22
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
The RMA received 1.07" of rain in a 24-hour period. A post-storm drive around inspection was performed and no new observations were observed.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Caps and Covers Lead/Navarro
Signature: Kim Hoffman	Date: 9-29-22
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature: Michael W. Jones	Date: 10/10/22

CONTRACTOR DAILY QUALITY CONTROL REPORT

Project Information	
Subcontractor/Partner: Weed Wranglers	Project: Basin F O&M
Task: maintenance	Date: 8/9/22
Weather AM: acceptable	Weather PM: acceptable
Activities Inspected and Observed:	
Weed Wranglers spot sprayed weeds on Basin F using the herbicides Escort XP and Transline. Weed Wranglers used an ATV and drove around the cover identifying and spraying weeds detailed in the Prohibited Plants and Weed Watch List from the BF PCP. This activity was completed today.	
Summary Meetings and Discussions Held or Attended, including Job Safety:	
N/A	
Comments:	
N/A	
Additional Documentation Submitted:	
N/A	
Sign Off:	
Inspector Name: Kim Hoffman	Title/company: Caps and Covers Lead/Navarro
Signature: Kim Hoffman	Date: 9-29-22
Reviewer Name: Michael Jones	Title/company: Caps and Covers Manager/Navarro
Signature:	Date: 10/10/22

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APPENDIX E

2022 Basin F Post-Closure Groundwater Monitoring Report

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ROCKY MOUNTAIN ARSENAL

2022 BASIN F POST-CLOSURE GROUNDWATER MONITORING REPORT

Revision 0

November 21, 2022

U.S. Department of the Army
Shell Oil Company

Prepared by:

Navarro Research and Engineering, Inc.

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TABLE OF CONTENTS

Section **Page**

ATTACHMENTS

TABLES

FIGURES

SUPPORTING DOCUMENTATION

Basin F 2022 Data Quality Review Results (folder)

Folder containing subfolders and files comprising the data review elements as described in Section 3.0 of the report. Folders include Excel files providing post-closure data, PARCC parameter evaluations, data usability, and quality control samples.

Basin F Statistical Evaluation Documentation (folder)

Folder containing subfolders and files comprising the statistical data evaluation elements as developed for Section 5.0 of the report. Files include data input, ChemStat project files, and associated ChemStat output in pdf format.

ACRONYMS

Basin F SAP	Basin F Closure and Post-Closure Groundwater Monitoring Sampling and Analysis Plan Sampling and Analysis Plan
EPA	U.S. Environmental Protection Agency
IC	Indicator Compound
IQR	Interquartile Range
LCS	Laboratory Control Spike
LT	Less Than
MRL	Method Reporting Limit
OMC	Operations and Maintenance Contractor
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCGMP	Post-Closure Groundwater Monitoring Plan
PT	Principal Threat
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RMA	Rocky Mountain Arsenal
RMAED	Rocky Mountain Arsenal Environmental Database
RPD	Relative Percent Difference
SQAPP	Sampling Quality Assurance Project Plan
UCL	Upper Confidence Limit
UFS	Unconfined Flow System
UPL	Upper Prediction Limit
WP	Wastepile
µg/L or UGL	micrograms per liter

Note: Analyte names and associated abbreviation test names are provided in Table 2-3.

1.0 INTRODUCTION

This 2022 Post-Closure Groundwater Monitoring Report documents the analytical results and data evaluation of the Basin F post-closure groundwater monitoring conducted during the annual groundwater sampling event on the Rocky Mountain Arsenal (RMA) April 26 through June 6, 2022. The groundwater monitoring program is designed to evaluate that the post-closure maintenance of the Basin F Surface Impoundment and Basin F Wastepile (WP), thus satisfying the Resource Conservation and Recovery Act (RCRA) closure performance standards. Background information related to the Basin F monitoring approach, including site-specific characterization, applicable regulatory requirements, laboratory methods, statistical evaluation procedure, and monitoring program development are presented in the *Basin F Post-Closure Groundwater Monitoring Plan* (PCGMP) (TtEC 2011a), *Basin F Closure and Post-Closure Groundwater Monitoring Sampling and Analysis Plan* (Basin F SAP) (TtEC 2011b), *Rocky Mountain Arsenal Sampling Quality Assurance Project Plan* (SQAPP) (Navarro 2019), and previous annual groundwater reports.

2.0 GROUNDWATER MONITORING RESULTS

A summary of water level monitoring and analytical results for 2022 Basin F groundwater monitoring is presented in the following sections.

2.1 Monitoring Well Evaluation

As part of the annual water level measurements and groundwater sampling, the physical condition of monitoring wells was evaluated by the field crew. This evaluation included measuring the well stickup heights and depths to water, and inspecting the monitoring wells, well pads, and pumps. Total depths were measured in the wells without dedicated pumps. No discrepancies were noted, and repairs are not needed at this time.

It is recommended that an outer protective steel casing and concrete pad be installed for well 26047 since this well has only a polyvinyl chloride riser casing extending from the ground surface.

2.2 Water Level Monitoring

Groundwater levels were measured in March through May of 2022 in 27 Basin F network wells to evaluate unconfined flow system (UFS) conditions in the area of Basin F. Water levels measured in 2022 within the Basin F monitoring network are presented in Table 2-1. Additional wells used to further delineate the water table in the vicinity were measured during the same time period. Water level monitoring network wells are shown on Figure 2-1.

Figure 2-2 presents the potentiometric surface map for the UFS depicting water levels measured March through May 2022. Similar to previous years, groundwater flow in the vicinity of Basin F continues to be primarily to the north-northwest. Localized and minor variations occur beneath the north end of Basin F where groundwater flows to the north and northeast. The confined flow system in the Basin F area is addressed as part of the *Long-Term Monitoring Plan for Groundwater and Surface Water* (Navarro 2021a). A complete description of the subsurface

lithology and groundwater flow in the vicinity of Basin F can be found in the PCGMP (TtEC 2011a).

Table 2-1. 2022 Water Level Measurements

Well ID	Date	Depth to Water (feet TOC)	Top of Casing Elevation (feet amsl)	Groundwater Elevation (feet amsl)
23135	5/12/2022	43.18	5187.11	5143.93
26015	5/18/2022	45.37	5190.04	5144.67
26016	5/18/2022	41.87	5187.47	5145.60
26017	5/18/2022	42.75	5187.30	5144.55
26018	4/25/2022	47.15	5191.77	5144.62
26020	5/18/2022	39.08	5187.92	5148.84
26023	4/25/2022	45.41	5194.09	5148.68
26028	4/25/2022	41.15	5199.42	5158.27
26040	4/25/2022	50.02	5197.40	5147.38
26047	4/25/2022	43.53	5187.40	5143.87
26048	4/25/2022	21.69	5172.93	DRY
26049	5/18/2022	27.29	5177.96	5150.67
26051	4/25/2022	56.15	5218.60	5162.45
26061	5/17/2022	31.83	5173.95	5142.12
26071	5/18/2022	43.71	5200.70	5156.99
26073	4/25/2022	47.74	5225.41	5177.67
26081	4/25/2022	27.92	5175.26	5147.34
26097	4/25/2022	57.84	5242.25	5184.41
26128	4/25/2022	42.45	5204.73	5162.28
26133	4/25/2022	43.74	5189.47	5145.73
26158	4/25/2022	35.40	5214.88	5179.48
26160	5/18/2022	47.20	5190.07	5142.87
26163	5/18/2022	44.20	5188.55	5144.35
26164	4/25/2022	44.94	5189.26	5144.32
26170	4/25/2022	44.22	5184.02	5139.80
26173	4/25/2022	53.42	5200.74	5147.32
27018	3/24/2022	21.75	5169.23	5147.48

amsl – Above mean sea level

Water levels measured in the nine Basin F water quality network wells since 2006 are shown on hydrographs (Attachment A). Beginning in 2018, groundwater elevations began to decrease in all of the wells with the exception of well 26128. Groundwater in well 26128 shows an increasing trend from 2014 through 2018, but has decreased since 2019. Water level data for well 26128 appears different from the other wells in the vicinity of Basin F because it is screened deeper within the weathered and unweathered Denver Formation and does not provide an accurate depiction of the UFS upgradient of Basin F. The overall decrease in UFS water levels

in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past four years (Navarro 2021b). Historical changes in water levels in wells near Basin F are consistent with regional fluctuations in the water table and are not related to the performance of the Basin F cover.

2.3 Water Quality Well Network

Post-closure groundwater sampling was conducted late April through early June 2022. The post-closure water quality well network for Basin F is presented in Table 2-2 and is shown on Figure 2-1. The nine network wells are used to monitor groundwater conditions in the UFS. Six downgradient wells—26015, 26017, 26133, 26157, 26163, and 26173—and three upgradient wells—26028, 26073, and 26128—are used for post-closure groundwater monitoring at Basin F. Upgradient wells 26073 and 26128, and downgradient wells 26015, 26133, 26157, 26163, and 26173, are associated with the Principal Threat (PT) excavation area. Upgradient well 26028, and downgradient wells 26015 and 26017, are associated with Basin F WP. Well 26015 is included in both groups due to overlapping groundwater flow paths (TtEC 2011a).

Table 2-2. Water Quality Well Network

Well Number	Well Network	Groundwater Flow System	Aquifer	Upgradient/ Downgradient
26015	WP/PT	UFS	Alluvial/Denver	Downgradient
26017	WP	UFS	Alluvial	Downgradient
26028	WP	UFS	Denver Formation	Upgradient
26073	PT	UFS	Denver Formation	Upgradient
26128	PT	UFS	Denver Formation	Upgradient
26133	PT	UFS	Denver Formation	Downgradient
26157	PT	UFS	Denver Formation	Downgradient
26163	PT	UFS	Alluvial/Denver	Downgradient
26173	PT	UFS	Alluvial	Downgradient

Wells 26028, 26073, and 26128 on the south and southeast sides of Basin F are used to evaluate contamination upgradient of the Basin F surface impoundment. The wells are useful for tracking chemical trends in the area since historically they have had elevated contaminant concentrations Based on current and historical data, wells 26073 and 26128 are upgradient of the PT excavation. Well 26028 is in the flow path directly upgradient of the former Basin F WP.

2.4 Water Quality Monitoring

Groundwater samples were collected from the wells identified in Table 2-2 in accordance with procedures defined in the PCGMP (TtEC 2011a), and the SQAPP (Navarro 2019). Samples collected during post-closure monitoring are submitted to Applied Research and Development Laboratory in Mount Vernon, Illinois and analyzed for the parameters listed in Table 2-3. The analytical methods were developed as described in the SQAPP.

The groundwater samples were tested for the analytes and indicator compounds (IC) listed in Table 2-3. The 11 ICs monitored at Basin F include the following:

- Arsenic
- Chloroform
- Chloride
- p-Chlorophenylmethyl sulfone (CPMSO2)
- Copper
- Dicyclopentadiene (DCPD)
- Diisopropylmethyl phosphonate (DIMP)
- Dieldrin
- n-Nitrosodimethylamine (NNDMEA)
- Sulfate
- Tetrachloroethylene (TCLEE)

The Basin F network wells 26015, 26017, 26028, 26073, 26128, 26133, 26157, 26163, and 26173 were sampled April through June 2022. An evaluation of the analytical results is presented in Section 4.0. Analytical data for all detected analytes at Basin F are also included in the Supporting Documentation folder included with this report.

Table 2-3. Water Quality Monitoring Analyte List

Method and Analyte Names	Test Name
Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry	
1,1,1-Trichloroethane	111TCE
1,1,2-Trichloroethane	112TCE
1,1-Dichloroethane	11DCLE
1,1-Dichloroethene	11DCE
1,2-Dichloroethane	12DCLE
1,3-Dichlorobenzene	13DCLB
Benzene	C6H6
Bicycloheptadiene	BCHPD
Carbon tetrachloride	CCL4
Chlorobenzene	CLC6H5
Chloroform	**CHCL3**
cis-1,2-Dichloroethene	C12DCE
Dibromochloropropane	DBCP
Dicyclopentadiene	**DCPD**
Ethylbenzene	ETC6H5
Methylene chloride	CH2CL2

Table 2-3. Water Quality Monitoring Analyte List

Method and Analyte Names	Test Name
Methyl isobutyl ketone	MIBK
Tetrachloroethylene	**TCLEE**
Toluene	MEC6H5
trans-1,2-Dichloroethene	T12DCE
Trichloroethylene	TRCLE
Vinyl chloride	C2H3CL
Xylenes	XYLEN
Total Phenols	
Phenols	PHENOL
Organochlorine Pesticides	
4,4'-DDE / 2,2-bis(p-Chlorophenyl)-1,1-dichloroethene	PPDDE
4,4'-DDT / 2,2-bis(p-Chlorophenyl)-1,1,1-trichloroethane	PPDDT
Aldrin	ALDRN
alpha-Chlordane	ACLDAN
Dieldrin	**DLDRN**
Endrin	ENDRN
gamma-Chlordane	GCLDAN
Hexachlorocyclopentadiene	CL6CP
Isodrin	ISODR
Organosulfur Compounds	
1,4-Oxathiane	OXAT
Benzothiazole	BTZ
Dimethyl disulfide	DMDS
Dithiane	DITH
p-Chlorophenylmethyl sulfide	CPMS
p-Chlorophenylmethyl sulfoxide	CPMSO
p-Chlorophenylmethyl sulfone	**CPMSO2**
Organophosphorus compounds by Gas Chromatography	
Dimethyl methyl phosphonate	DMMP
Diisopropyl methyl phosphonate	**DIMP**
Mercury by Cold Vapor Atomic Absorption	
Mercury	HG

Table 2-3. Water Quality Monitoring Analyte List

Method and Analyte Names	Test Name
Metals/Cations by Inductively Coupled Argon Plasma	
Aluminum	AL
Arsenic	**AS**
Antimony	SB
Cadmium	CD
Calcium	CA
Chromium	CR
Cobalt	CO
Copper	**CU**
Iron	FE
Lead	PB
Magnesium	MG
Manganese	MN
Nickel	NI
Potassium	K
Selenium	SE
Sodium	NA
Zinc	ZN
Cyanide by Colorimetric	
Cyanide	CYN
Ammonia	
Ammonia	NH3
Alkalinity	
Alkalinity	ALK
Anions	
Bromide	BR
Chloride	**CL**
Nitrate	NO3
Nitrite	NO2
Sulfate	**SO4**
Ion Specific Electrode	
Fluoride	F

Table 2-3. Water Quality Monitoring Analyte List

Method and Analyte Names	Test Name
Nitrosamines	
n-Nitrosodimethylamine	**NNDMEA**
Nitrogen-phosphorus Pesticides	
Atrazine	ATZ
Malathion	MLTHN
Parathion	PRTHN
Supona	SUPONA
Vapona	DDVP
Organic Carbon	
Total organic carbon	TOC
Total organic halogen	TOX
Dissolved organic carbon	DOC
Agent Degradation Products by High Performance Liquid Chromatography	
Thiodiglycol	TDGCL
Agent Products by Ion Chromatography	
Isopropylmethyl phosphonic acid	IMPA
Kjeldahl Nitrogen	
Nitrogen by Kjeldahl method	N2KJEL

Note: Indicator compounds are in **Bold**

The 2022 data for ICs analyzed in samples collected from WP and PT monitoring wells are discussed in Section 4.0 and summarized in Table 4-1.

3.0 DATA QUALITY ASSURANCE REVIEW

The objective of the data quality assurance (QA) review process is to determine whether the analytical results are acceptable for use in making decisions for the project. As a component of the data review process, the analytical data were evaluated against the data quality indicators: Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC). The Operations and Maintenance Contractor (OMC) reviewed the PARCC parameters in accordance with the SQAPP (Navarro 2019) for comparison to the data quality control (QC) goals stated in the Basin F SAP (TtEC 2011b). Table 3-1 lists QC samples collected and analyzed as part of the Basin F post-closure monitoring for 2022.

Table 3-1. 2022 Quality Control Samples

Sample Type/Site ID	Sample Date
Field Duplicate	
26157	6/6/22
Lab Duplicates	
26017	5/2/22
26128	6/6/22
26133	4/26/22
26157	6/6/22
26163	5/18/22
Field Blank	
26128	6/6/22

The sample results were evaluated against the data quality requirements and compared to the data quality objectives as presented in the Basin F SAP (TtEC 2011b), with data review and verification activities conducted in accordance with the SQAPP (Navarro 2019). An evaluation of each analytical data quality indicator is presented in Sections 3.1 through 3.5.

The OMC conducted data validation on the Basin F groundwater analytical data as specified in the SQAPP (Navarro 2019). Validation checklists were completed, and laboratory case narratives were reviewed by the analyst to determine potential problems with the data.

3.1 Precision

Precision is the measure of agreement among replicate or duplicate sample measurements of the same property under prescribed similar conditions. Results of laboratory duplicates and field duplicates were used to calculate precision. Note that laboratory duplicates are designated by the laboratory and analyzed for inorganics only. The precision for individual analytes will be determined using the Relative Percent Difference (RPD) values calculated from data where both the investigative sample and the duplicate sample are above the method reporting limit (MRL). If one or both results are rejected or not analyzed, there will be no evaluation of the RPD. Duplicate samples determined to be not comparable will be subject to data qualification. The performance criterion for precision is a RPD value less than or equal to 35 percent, the upper limit of the RPD range. The RPD for a duplicate investigative sample pair is calculated using the following steps:

1. Identify the field duplicate investigative sample pair result.
2. Identify parameters detected in both results for the pair identified in Step 1.
3. Calculate the RPD value for the detected parameters identified in Step 2 using the following equation:

$$\boldsymbol{RPD = \frac{|x - y|}{\frac{(x + y)}{2}} \times 100}$$

Where:

x = investigative sample result
y = duplicate sample result

The investigative and duplicate results will be considered comparable if any of the following statements are true:

- If both sample results are less than the MRL
- If both sample results are greater than the MRL, but less than or equal to twice the MRL
- If both sample results are greater than twice the MRL and the RPD is less than or equal to the specified upper RPD limit
- If both sample results are greater than the MRL, one result is less than or equal to twice the MRL, one result is greater than twice the MRL, and the RPD is less than or equal to the specified upper limit
- If one sample result is less than the MRL, and one result is greater than the MRL and less than or equal to twice the MRL

The investigative and duplicate results will be considered not comparable if any of the following statements are true:

- If both sample results are greater than twice the MRL and the RPD is greater than the specified upper RPD limit
- If both sample results are greater than the MRL, one result is less than or equal to twice the MRL, one result is greater than twice the MRL, and the RPD is greater than the specified upper limit
- If one sample result is less than the MRL, and one result is greater than twice the MRL

The duplicate/investigative pairs were evaluated for comparability. The RPD upper limit is 35 percent for all analytes. A total of 82 field and 29 lab duplicate analyses were performed with an average relative percent difference of 8.2 percent. The duplicate and investigative results are non-comparable for five duplicate analyses. The duplicate/investigative pairs considered non-comparable are presented in Table 3-2. The non-comparable investigative and duplicate data were assigned a "Z" data qualifier with the comment "Duplicate and investigative values are not comparable." No discernible trends or QC issues were observed in the non-comparable pair. The data are considered acceptable for their intended use and no additional action to the data qualification is considered necessary. The frequency requirement of 10 percent for field duplicates was achieved. All data collected for the 2022 post-closure monitoring program can be found in the Supporting Documentation folder included with this report.

Table 3-2. 2022 Summary of Qualified Data

Site ID	Analyte	Sample Date	Method	Relative Percent Difference	Value (UGL)	Flag	Data Qualifier
26157	PPDDT	6/6/2022	UH63	42.82%	0.268	D	Z
					0.414		Z
26157	N2KJEL	6/6/2022	3512	181.82%	42,000	D	Z
					200		Z
26157	ISODR	6/6/2022	UH63	183.94%	LT 0.00619	D	Z
					0.148		Z
26157	OXAT	6/6/2022	UL22	35.53%	1.79	D	Z
					1.25		Z
26163	TOX	5/18/2022	9020	165.36%	183	D	Z
					1930		Z

Note: For each sample pair, both sample results are greater than or equal to twice the MRL and the RPD is greater than or equal to 35%.

D – Field duplicate sample

UGL – micrograms per liter, as presented in the RMAED

3.2 Accuracy/Bias

Accuracy is the degree of agreement between an observed value (sample result) and an accepted reference value. Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction—high or low. The terms accuracy and bias are used interchangeably. Accuracy/bias is indicated by percent recovery calculated from laboratory spike data using the following formula:

$$\boldsymbol{Recovery\ Rate}(\%) = \left(\frac{\boldsymbol{measured\ value}}{\boldsymbol{true\ value}}\right) \times \mathbf{100}$$

Where:

measured value = value after the spike – value before the spike
true value = value of the spike added

Accuracy/bias will be calculated based on the results of laboratory control spikes (LCS) and matrix spikes. Laboratory control spikes utilize laboratory grade water with some additions of inorganic constituents to mimic RMA water. Matrix spikes utilize RMA water to account for matrix-related interferences.

The calculated recovery rate is compared to the lower and upper recovery rate limits specific to each analyte. The median, 25th percentile, and 75th percentile for each analyte are calculated. The interquartile range (IQR) is calculated by subtracting the 25th percentile value from the 75th percentile value. The lower and upper recovery limits are determined respectively by subtracting and adding 1.5 times the IQR to the median value. Data will not be qualified solely on a

recovery rate outside the calculated recovery limits. If an analysis is outside both the matrix spike and LCS recovery limits, the analysis will be assigned a "Z" data qualifier with the comment "Matrix spike recoveries and LCS recoveries were outside evaluation limits." The recovery limits for matrix spikes and LCS are provided in the Supporting Documentation folder included with this report.

The data utilized for the historical recovery rate calculations were limited to the spike values for the analytical lots of the investigative data since May 2006. Spikes associated with highly contaminated sites were excluded from the calculation since the matrix spike could possibly be diluted due to the high original concentration.

A total of 311 matrix spike analyses were evaluated. Matrix spike recoveries are not included in the evaluation if the investigative value is greater than four times the spike amount as the impact of the matrix spike would be minimized. Analyses with a "@" flag code (value is estimated) or "B" flag code (analyte found in the method blank or QC blank as well as the sample) are also excluded from recovery rate calculations. The average recovery rate for the 311 matrix spike analyses used in the evaluation was 90 percent. There were 10 matrix spike recoveries outside the control limits and 20 matrix spikes outside the warning limits. Matrix spike recoveries outside the warning and control evaluation limits were not observed in the corresponding LCS recoveries. No discernible trends or QC issues that would require data qualification or additional action were observed in the lots below the specified limit. The data are considered acceptable for their intended use and no additional action is considered necessary. A listing of the matrix spike sample results outside the evaluation limits is included in the Supporting Documentation folder.

The average recovery rate for the 311 LCS analyses corresponding to the matrix spike analyses was 96.8 percent. Matrix spike recoveries outside the warning and control evaluation limits were not observed in the corresponding LCS recoveries. No discernible trends or QC issues were observed in the LCS samples exceeding the specified limits. The data are considered acceptable for their intended use and no additional action is considered necessary. A listing of the LCS sample results outside the evaluation limits is included in the Supporting Documentation folder.

3.3 Representativeness

Representativeness refers to the selection and implementation of analytical methods, sampling protocols, and sample locations to ensure the analytical data results are representative of the media being sampled and of the conditions being measured. Representativeness is evaluated by reviewing monitoring program design and implementation, as well as field and laboratory blank samples. Design of the monitoring program is reviewed qualitatively to assess whether the objectives were satisfied. Implementation of the monitoring program is reviewed qualitatively to evaluate whether the planned procedures were followed. A quantitative review of the QC blank results indicates whether influences outside the measurement systems have affected the analyses and interpretation of the media and conditions.

Sample locations, sampling frequency, and sample collection procedures applied during groundwater monitoring are described in the PCGMP (TtEC 2011a). The program is designed

and implemented to provide water quality data in the area of Basin F as defined in the post-closure groundwater monitoring plan.

QC blanks are limited to field blanks. Rinse blanks were not required as the wells were sampled with dedicated equipment. Trip blanks are not required as of 2018.

A total of one field blank was collected from the Basin F water quality well network which was analyzed for the methods and analytes presented in Table 2-3. There were two field blank detections above the MRL. Comparison to the associated investigative data indicated one field blank requiring data qualification.

In addition, the laboratory prepared and analyzed method blanks as part of their analytical protocols. Method blanks measure potential contamination from laboratory sources such as glassware, reagents and laboratory water. A total of 332 method blank analyses were performed. There were three investigative analyses evaluated for potential interference from the method blank detection. No interference was determined thus no additional action is required.

The analytical results of monitoring are deemed representative of the groundwater quality with the exception of qualified data. Rejected data are not removed from the Rocky Mountain Arsenal Environmental Database (RMAED); however, they are not used to evaluate the Basin F groundwater data. Data qualified as "@" are not filtered out of the database. While not rejected, the data are considered estimated due to the concentration being above the linear range of the instrument.

3.4 Completeness

Completeness is the amount of valid data obtained from a measurement system compared to the amount that was expected and needed to meet the project goals. Expected results include all investigative samples, duplicates and field QC samples that are required under the Basin F SAP (TtEC 2011b). Valid analytical data are those data that have been identified as usable and included in the RMAED. The Basin F SAP sets the completeness goal for the sampling program at 90 percent. For the 2022 post-closure monitoring program all analyses were accepted. Therefore, the completeness goal of 90 percent was achieved.

3.5 Comparability

Comparability is the confidence with which one data set can be evaluated relative to another. Standard sampling and analysis techniques, based on certified analytical methods approved by the OMC or promulgated U.S. Environmental Protection Agency (EPA) SW-846 methods, and standard procedures for sample collection were used throughout the groundwater monitoring programs at Basin F. Consistent procedures for the reporting and management of the data generated were followed, thus all data are considered comparable.

3.6 Data Usability

A data usability evaluation was conducted on 730 records. The evaluation identified three statistical outliers. The data are considered acceptable for their intended use and no additional action is considered necessary.

A summary of the identified outliers and trends evaluated as part of the data quality review process is included on the attached data CD in the Data Usability subfolder (Basin F_ Data_Usability_Summary_2022.xlsx). Additionally, well-specific summaries are also provided for reference. In accordance with the SQAPP, statistical trend analyses were conducted to evaluate data usability utilizing ProUCL software (EPA 2016).

The evaluation did not positively identify data quality issues; thus, the data are considered to be of acceptable quality and meets or exceeds the established data quality objectives. The data are of the correct type, quality, and quantity to support the intended use.

4.0 2022 WATER QUALITY

The Basin F groundwater monitoring network is designed to demonstrate that the post-closure operations and maintenance of the Basin F Surface Impoundment and the Basin F WP satisfy RCRA closure performance standards. The post-closure monitoring results for the ICs were evaluated from samples collected from the start of post-closure monitoring in October 2010 through the annual sampling event in 2022.

As detailed in the PCGMP (TtEC 2011a), the high concentrations of some contaminants in downgradient wells—including chloroform, CPMSO2, DCPD, DIMP and TCLEE—may be the result of residual contamination present in the unsaturated and saturated zones that was mobilized with rising water levels or continuing migration from the vadose zone to the saturated zone. Before Basin F was drained in 1988 significant contamination migrated from leaks in the basin liner through the 40- to 45-foot thick unsaturated zone to the saturated zone; thus, residual contamination present in the sediments above and below the water table can act as continuing sources to the groundwater as the water table fluctuates. The leaks in the Basin F liner primarily occurred on the east side of Basin F, specifically in the area where PT excavation took place, which explains the higher concentrations in the downgradient PT wells.

Upgradient Water Quality – In addition to ICs, the following compounds were detected in upgradient WP and PT wells:

- Aluminum
- alpha-Chlordane
- Ammonia
- Calcium
- Carbon Tetrachloride
- Chlorobenzene
- Dimethyl methyl phosphonate
- Dithiane
- Endrin
- Fluoride
- Iron
- Isodrin
- Lead
- Magnesium
- Manganese
- Nitrate
- 1,4-Oxathiane
- PPDDT
- PPDDE
- Potassium
- Selenium
- Sodium
- Total organic carbon
- Total organic halogens
- Trichloroethylene
- Zinc

Downgradient Water Quality – In addition to ICs, the following compounds were detected in downgradient WP and PT wells:

- 1,1-Dicholorethane
- 1,2-Dichloroethane
- cis-1,2-Dichloroethene
- Aldrin
- alpha-Chlordane
- gamma-Chlordane
- Aldrin
- Aluminum
- Ammonia
- Benzene
- Bromide
- Calcium
- p-Chlorophenylmethyl sulfide
- p-Chlorophenylmethyl sulfoxide
- Cobalt
- Cyanide
- Dibromochloropropane
- Dithiane
- Endrin
- Fluoride
- Hexachlorocyclopentadiene
- Isodrin
- Iron
- Lead
- Magnesium
- Manganese
- Nickel
- Nitrate
- Kjeldahl nitrogen
- 1,4-Oxathiane
- Potassium
- PPDDD
- PPDDE
- PPDDT
- Selenium
- Sodium
- Supona
- Total organic carbon
- Total organic halogens
- Trichloroethylene
- Zinc

The 2022 data for ICs analyzed in samples collected from WP and PT monitoring wells are summarized in Table 4-1. The analytical data for the ICs detected in the Basin F water quality network wells are presented on Figure 4-1.

Contaminants in the Basin F pathway occur primarily in alluvium-filled paleochannels and weathered bedrock, which can affect the migration and travel times from upgradient WP and PT wells to the downgradient wells. The concentrations of contaminants in the Basin F wells can be affected by rising water levels, which may mobilize the residual soil contamination that was previously present above the water table. As a result, increasing concentrations in the WP and PT wells should be compared to the trend in water levels to determine whether these conditions can be correlated. Refer to Section 5.0 for additional discussion on the trends in groundwater quality in WP and PT wells, including a discussion of the statistical prediction limits to which downgradient water quality data are compared.

Table 4-1. 2022 Post-Closure Water Quality Results

Designation	Concentrations by Well (µg/L)								
	Downgradient		Upgradient			Downgradient			
Network	**WP/PT**	**WP**	**WP**	**PT**	**PT**	**PT**	**PT**	**PT**	**PT**
Analyte	**26015**	**26017**	**26028**	**26073**	**26128**	**26133**	**26157**	**26163**	**26173**
Arsenic	**2.14**	**1.59**	**1.25**	LT 1	**2.12**	2.12	**1.55**	**6.43**	**4.26**
Chloroform	0.624	**0.188**	LT 0.2	30.9	0.248	11,200	0.368	LT 0.2	9,230
Chloride	784,000	571,000	990,000	192,000	1,210,000	576,000	739,000	3,180,000	**1,000,000**
CPMSO2	LT 1.2	LT 1.2	LT 1.2	LT 1.2	LT 1.2	11.8	25.6	19.3	6.46
Copper	LT 10	LT 10	LT 10	LT 10	LT 10	LT 10	LT 10	**26.4**	LT 10
DCPD	LT 0.2	LT 0.2	LT 0.2	LT 0.2	LT 0.2	726	**338**	**301**	LT 200 [1]
DIMP	**4.43**	2.76	986	**1.59**	32.5	**216**	76.8	656	156
Dieldrin	0.101	0.262	0.00735	0.0471	0.262	0.755	0.626	**0.425**	1.72
NNDMEA	**0.0123**	LT 0.003	**0.0106**	LT 0.003	**0.0424**	0.578	0.325	0.644	0.115
Sulfate	228,000	299,000	490,000	917,000	691,000	396,000	**461,000**	1,050,000	297,000
TCLEE	**0.217**	LT 0.2	LT 0.2	0.594	0.434	**742**	**67.7**	**2.56**	**1,580**

Note: Concentrations that increased in 2022 are in **bold**.

[1] For DCPD in well 26173 the sample was diluted by a factor of 1,000 due to high concentrations of other VOC analytes. The value was reported as a nondetection at less than (LT) 200.

LT – less than

µg/L – micrograms per liter

5.0 STATISTICAL EVALUATION

Initially, downgradient groundwater analyte concentrations were compared to upper prediction limits (UPL) calculated using upgradient well data to determine whether water quality may have been impacted by Basin F during the post-closure period. For purposes of Basin F post-closure monitoring, UPLs are used to evaluate water quality in downgradient compliance wells.

If downgradient groundwater analyte concentrations exceed UPLs, additional statistical analyses, including the Mann-Kendall test and Shewhart-CUSUM control charts, were conducted in order to evaluate downgradient water quality trends. The Mann-Kendall test for trends is a nonparametric tool used to determine the statistical trend of post-closure data over time, while Shewhart-CUSUM control charts provide an indication of statistically significant increases above background or baseline conditions (EPA 1989, 1992, 2009).

The following sections describe the results of the approach used for the statistical evaluation of Basin F groundwater data. The statistical evaluation of analytical data in accordance with the PCGMP was conducted utilizing ChemStat statistical software, version 6.4 (Starpoint 2016).

5.1 Upper Prediction Limit Evaluations

In accordance with the PCGMP (TtEC 2011a), UPLs used for the current 2022 evaluation represent upgradient water quality as of 2021, while upgradient data collected through 2022 have been used to calculate UPLs for use in evaluating water quality in 2023.

The use of UPLs, in combination with evaluating statistical water quality trends, provides an indication of potential impact to groundwater downgradient of Basin F relative to upgradient water quality for future sampling events. UPLs based on current data were calculated in accordance with Appendix A of the PCGMP (TtEC 2011a) for each IC and are represented by a statistical 99 percent upper confidence limit (UCL) calculated using ChemStat software (version 6.4) or defaulting to the maximum MRL. Current UPLs were then compared to baseline UPLs, and the maximum UPLs were selected to comparison to downgradient well data.

The upgradient wells for which data were collected and used for UPLs and statistical evaluations include well 26028 for the WP evaluation and wells 26073 and 26128 for the PT evaluation. UPLs calculated for Basin F WP and PT networks applicable to the current 2022 evaluation are presented in Table 5-1.

5.1.1 Wastepile 2022 UPL Comparison

Table 5-1 presents the 2022 selected UPLs for Basin F WP ICs. UPLs for 2022 were calculated for the Basin F WP ICs using groundwater data from 2006 through 2021 for upgradient well 26028. The 2022 Basin F WP UPLs were applied to data for downgradient wells 26015 and 26017. The 2022 reported values for ICs detected in wells exceeding their respective UPLs are presented in Table 5-2 and shown in Figure 4-1. The following analytes were detected at concentrations exceeding their respective UPLs in 2022.

Well 26015	Well 26017
• Chloroform	• No exceedances

The 2022 concentration of chloroform in exceedance of the UPL in well 26015 is within the historical range of detected concentrations, and its presence is likely attributable to higher water levels that have mobilized residual contamination and have remained as the water table has decreased over the past few years. The reported concentrations of analytes not listed above and detected in downgradient Basin F WP wells are below the respective UPLs. Based on the UPL comparison, it appears that groundwater quality downgradient of the Basin F WP area has been affected in the vicinity of well 26015.

5.1.2 Principal Threat 2022 UPL Comparison

Table 5-1 presents the 2022 selected UPLs for Basin F PT ICs. UPLs for 2022 were calculated for the Basin F PT using upgradient groundwater data from 2007 through 2021 for upgradient wells 26128 and 26073. The 2022 Basin F PT UPLs were applied to data for downgradient wells 26015, 26133, 26157, 26163 and 26173. The 2022 reported values for ICs detected in wells exceeding their respective UPLs are presented in Table 5-2 and shown in Figure 4-1. The following analytes were detected at concentrations exceeding their respective UPLs in 2022.

Well 26133	Well 26157	Well 26163	Well 26173
• Chloroform	• DCPD	• Arsenic	• Chloroform
• DCPD		• Copper	• TCLEE
• TCLEE		• DCPD	

The 2022 concentrations of all analytes in exceedance of UPLs in wells 26133, 26157, 26163 and 26173 are within the historical ranges of detected concentrations and many are likely attributable to higher water levels that have mobilized residual contamination. The remaining reported values for analytes not listed above in downgradient Basin F PT wells are below the respective UPLs. Based on the statistical evaluation, it appears that groundwater quality downgradient of the Basin F PT area has been affected in the vicinity of wells 26133, 26157, 26163, and 26173.

In 2022, no analyte concentrations exceeded PT UPLs in downgradient well 26015.

Table 5-1. Upper Prediction Limits for 2022 Water Quality Evaluations

Indicator Compound	Current Method Reporting Limit (µg/L)	Percentage of Upgradient Nondetections	Statistical Method Used	2022 Upgradient UPL (µg/L)	2006/2007 Post-Closure Baseline UPL (µg/L)	Selected 2022 UPL (µg/L)
Wastepile						
Arsenic	1	67	Nonparametric	10[3]	10[3]	10
Chloride	1,000	0	Parametric	1,351,970	5,215,697[3]	5,215,697
Chloroform	0.2	100	Nonparametric	0.2[1]	0.2[4]	0.2
Copper	10	100	Nonparametric	10[1]	10	10
CPMSO2	1.2	100	Nonparametric	1.2[1]	2.08[6]	2.08
DCPD	0.205	100	Nonparametric	0.205[1]	0.26[6]	0.26
Dieldrin	0.00252	17	Nonparametric	0.8	1.76[3]	1.76
DIMP	0.5	0	Parametric	1,588	1,505	1,588
NNDMEA	0.003	50	Nonparametric	0.0278	0.035	0.035
Sulfate	2,500	0	Parametric	557,839	651,521[3]	651,521
TCLEE	0.2	100	Nonparametric	0.2[1]	0.283[4]	0.283
Principal Threat						
Arsenic	1	48	Nonparametric	3.17	4.52[3]	4.52
Chloride	1,000	0	Nonparametric	1,330,000	6,154,163[3]	6,154,163
Chloroform	0.2	0	Nonparametric	96	96	96
Copper	10	100	Nonparametric	10[1]	21[5]	21
CPMSO2	1.2	70	Nonparametric	2.54	45.7[2]	45.7
DCPD	0.205	100	Nonparametric	0.205[1]	51.2[5]	51.2
Dieldrin	0.00252	3	Nonparametric	1.24	2.82[3]	2.82
DIMP	0.5	0	Nonparametric	249	762.8[3]	762.8
NNDMEA	0.003	39	Nonparametric	0.1	1.24[5]	1.24

Table 5-1. Upper Prediction Limits for 2022 Water Quality Evaluations

Indicator Compound	Current Method Reporting Limit (µg/L)	Percentage of Upgradient Nondetections	Statistical Method Used	2022 Upgradient UPL (µg/L)	2006/2007 Post-Closure Baseline UPL (µg/L)	Selected 2022 UPL (µg/L)
Sulfate	2,500	0	Parametric	1,167,090	2,610,000	2,610,000
TCLEE	0.2	0	Nonparametric	1.24	321[5]	321

Note: The Selected 2022 UPL is the higher of the two values between the 2022 Upgradient UPL and Post-Closure Baseline UPL. Post-Closure UPLs for the WP and PT networks were developed from data collected in 2006 and 2007, respectively.

[1] Because this compound has not been detected in an upgradient well, the UPL value for this analyte is the current MRL.

[2] Data validated as Questionable; therefore, CPMSO2 result for sample collected from 26073 in 2018 excluded from consideration as a nonparametric UPL.

[3] The calculated UPL for WP (2006) and PT (2007) is being used in lieu of the highest background concentration from upgradient wells.

[4] Because this compound was not detected in an upgradient well in 2006/2007, the prediction limit value for this analyte is the baseline MRL.

[5] Prediction limit is based on 2007 background detection from downgradient well.

[6] This compound was not detected during baseline sampling; therefore, the prediction limit value for this analyte is the 99 percent UCL of the baseline MRL. The 99 percent UCL is defined as 1.3 times the baseline MRL.

Table 5-2. Statistical Summary for UPL Exceedances in Basin F Downgradient Wells

Well	Indicator Compound	2022 Concentration (µg/L)	2022 Selected UPL (µg/L)	2022 Statistical Method Used	Mann-Kendall Trend Analysis	Shewhart-CUSUM Control Chart [1] *Statistical significance indicated?*
Wastepile						
26015	Chloroform	0.624	0.2	Nonparametric	Increasing	N/A
Principal Threat						
26133	Chloroform	11,200	96	Nonparametric	Increasing	N/A
	DCPD	726	51.2	Nonparametric	No Trend	N/A
	TCLEE	742	1.24	Nonparametric	Increasing	Yes
26157	DCPD	338	51.2	Nonparametric	Decreasing	—
26163	Arsenic	6.43	4.52	Nonparametric	Increasing	Yes
	Copper	26.4	21	Nonparametric	Increasing	Yes
	DCPD	301	51.2	Nonparametric	Increasing	Yes
26173	Chloroform	9,230	96	Nonparametric	Increasing	N/A
	TCLEE	1,580	1.24	Nonparametric	Increasing	Yes

Notes:

[1] Shewhart-CUSUM control charts were developed for indicator compounds that demonstrate increasing concentration trends, and are only applicable to normal or lognormal distributions (EPA 1989, 1992, 2009). "N/A" indicates that a control chart is not applicable since the data are not normally or lognormally distributed.

5.1.3 2023 Upper Prediction Limits

Table 5-3 presents the UPLs calculated for each of the Basin F WP and PT ICs utilizing water quality data collected through 2022. These UPLs will be applied to water quality results for downgradient wells sampled during the 2023 monitoring program.

Table 5-3. Upper Prediction Limits for 2023 Water Quality Evaluations

Indicator Compound	Current Method Reporting Limit (µg/L)	Percentage of Upgradient Nondetections	Statistical Method Used	2023 Upgradient UPL (µg/L)
Wastepile				
Arsenic	1	63	Nonparametric	3.43
Chloride	1,000	0	Parametric	1,372,270
Chloroform	0.2	100	Nonparametric	0.2[1]
Copper	10	100	Nonparametric	10[1]
CPMSO2	1.2	100	Nonparametric	1.6
DCPD	0.2	100	Nonparametric	0.212
Dieldrin	0.00735	16	Parametric	0.623
DIMP	0.5	0	Parametric	1,620
NNDMEA	0.003	48	Nonparametric	0.1
Sulfate	2,500	0	Parametric	565,393
TCLEE	0.2	100	Nonparametric	0.2[1]
Principal Threat				
Arsenic	1	48	Nonparametric	3.17
Chloride	1,000	0	Nonparametric	1,330,000
Chloroform	0.2	0	Nonparametric	96
Copper	10	100	Nonparametric	10[1]
CPMSO2	1.2	71	Nonparametric	2.54[2]
DCPD	0.2	100	Nonparametric	0.212[1]
Dieldrin	0.00252	3	Nonparametric	1.24
DIMP	0.5	0	Nonparametric	249
NNDMEA	0.003	40	Nonparametric	0.1
Sulfate	2,500	0	Parametric	1,180,900
TCLEE	0.2	0	Parametric	0.77

Notes:

[1] Because this compound has not been detected in an upgradient well, the UPL value for this analyte is the current MRL.

[2] Data validated as Questionable; therefore, CPMSO2 result for sample collected from 26073 in 2018 was excluded from consideration as a nonparametric UPL.

5.2 Statistical Trend Analysis

Statistical trends using the Mann-Kendall test were evaluated for the wells where the concentration of ICs exceeded their respective UPL in order to determine whether a statistical trend exists that indicates increasing concentrations downgradient of Basin F. The Mann-Kendall test for trend is a non-parametric test commonly used to evaluate whether a linear trend exists within time-dependent data. According to EPA guidance, the Mann-Kendall test assumes that the lack of trend correlates with concentrations over time (e.g., time series plot) that fluctuate about a constant mean level, without a visually apparent upward or downward pattern (EPA 1989, 1992, 2009). As a nonparametric test, the actual concentrations (or ranks) are not used to calculate the test statistic, only the relative magnitudes of the concentrations. Nondetections are given a value of zero.

As presented in Sections 5.1.1 and 5.1.2, the concentrations of ICs in WP and PT wells exceeded UPLs and further evaluation for statistical trends was conducted. Table 5-2 includes a summary of the Mann-Kendall trend analyses conducted for ICs detected at concentrations exceeding their respective 2022 UPLs. Detailed information related to the Mann-Kendall analyses is included as supporting documentation in Attachment B.

For WP UPL exceedances, only chloroform exceeded the UPL in well 26015 and concentrations indicate an increasing trend. This trend is a continuation of previously-evaluated trends that show chloroform increasing in well 26015 during post-closure monitoring. Chloroform detected in well 26015 at concentrations greater than prediction limits is likely attributable to higher water levels previously present beneath the former Basin F footprint that mobilized residual contamination.

Increasing trends of ICs are evident in PT wells 26133, 26163, and 26173 (Table 5-2). The following ICs indicate increasing trends in groundwater downgradient of the former Basin F:

Well 26133
- Chloroform
- TCLEE

Well 26163
- Arsenic
- Copper
- DCPD

Well 26173
- Chloroform
- TCLEE

The presence of higher concentrations of more analytes in wells 26133 and 26173—as compared to well 26163, which is adjacent and immediately downgradient of the former basin—may indicate that contamination historically mobilized from the Basin F has migrated to the northeast. Based on water level maps developed annually during the closure and post-closure periods, wells northeast of the former Basin F are located along a groundwater flow path east of the former basin which was historically impacted by contamination from the Sand Creek Lateral. Therefore, it is likely that groundwater in wells 26133, 26157, and 26173 may be affected by contamination associated with the Sand Creek Lateral, and not exclusively by former Basin F. Typically, the higher concentrations of organic contaminants occur in wells 26133, 26157, and 26173—further downgradient of Basin F—while lower concentrations of contaminants are present in well 26163 immediately adjacent to the former basin.

Upgradient well data were evaluated for trends to determine whether concentrations of ICs are increasing or decreasing, thus implying the relative magnitude of contamination that may impact downgradient wells in the next several years.

Upgradient of the WP in well 26028, chloride, DIMP, and sulfate show increasing trends while CPMSO2, dieldrin, and TCLEE indicate decreasing trends. All other ICs detected in upgradient WP groundwater demonstrate no discernible trends.

In groundwater upgradient of the PT area, concentrations of chloroform in well 26073 and sulfate in wells 26073 and 26128 indicate increasing trends. Only DIMP and NNDMEA in well 26128 indicate decreasing trends. All other ICs detected in upgradient PT monitoring wells demonstrate no discernible trends.

5.3 Shewhart-CUSUM Control Charts

In situations where the concentration of an IC exceeds the UPL and a statistical increasing trend is determined by Mann-Kendall analysis, control charts were assessed to determine whether the trends are statistically significant. Control charts are a parametric analytical tool; thus data must follow normal or lognormal distributions.

An intrawell Shewhart-CUSUM control chart is a viable alternative to the use of UPLs for exceedance determination. Control charts are advantageous such that they provide a graph and analysis of concentrations over time rather than a single point comparison. Control charts depicting Basin F water quality compare baseline data to post-closure data for a single downgradient well in order to identify whether the increase is statistically significant. Control charts were constructed using downgradient well baseline data collected prior to closure and data collected after closure. Attachment B provides supporting documentation of statistical analyses, including the control charts, evaluated in 2022.

Further evidence of statistical significance was identified in the intrawell control charts for the analytes detected in the downgradient wells below.

Well 26133
- TCLEE

Well 26163
- Arsenic
- Copper
- DCPD

Well 26173
- TCLEE

While wells 26133 and 26173 have likely been impacted by releases not related to Basin F. Elevated concentrations of arsenic, copper, and DCPD in well 26163 likely represent groundwater impacted by the remobilization of residual soil contamination caused by fluctuating water levels within the unsaturated zone beneath the former basin.

6.0 CONCLUSIONS

Upgradient and downgradient groundwater data collected during post-closure monitoring of WP and PT wells were evaluated to demonstrate post-closure operations and maintenance of the Basin F surface impoundment and that the Basin F WP meets the RCRA closure performance standards. Table 6-1 presents a summary of the results for the evaluation of water quality in WP and PT wells in 2022.

The following conclusions are based on the groundwater monitoring results for the 2022 Basin F post-closure groundwater monitoring program:

- In 2021, groundwater elevations decreased in all downgradient and upgradient monitoring wells. Demonstrating a variable trend in water levels compared to other wells in the monitoring network, data for well 26128 appears different from the other wells in the vicinity of Basin F because it is screened deeper within the weathered and unweathered Denver Formation and does not provide an accurate depiction of the UFS upgradient of Basin F. The overall decrease in UFS water levels in the vicinity of Basin F is consistent with a general decreasing trend noted across RMA over the past four years.
- Based on the results of the data QA review, the analytical data collected in 2022 are of acceptable quality for their intended uses.
- Impacts to groundwater along the WP flow path have fewer exceedances of UPLs in downgradient WP wells in 2022 compared to previous years with only chloroform in well 26015 exceeding the UPL and showing increasing concentrations. Chloroform appears to be increasing in downgradient well 26015 based on the Mann-Kendall Trend analysis (Table 5-2). Concentrations of chloride, DIMP, and sulfate appear to be increasing upgradient of Basin F based on statistical trend analyses.
- Groundwater along the PT flow path appears to have been impacted by residual soil contamination that remains within the PT area, and may also be impacted by sources associated with the Sand Creek Lateral located east of the former basin, as demonstrated by observed increases of select ICs in wells northeast of the PT area. Several ICs exceed UPLs—including arsenic, chloroform, copper, DCPD, and TCLEE—and appear to be increasing in one or more downgradient wells. During post-closure monitoring, chloroform and sulfate appear to be increasing upgradient of Basin F based on statistical trend analyses.

Based on the distribution of the analyte concentrations and water quality trends, it appears that the PT groundwater flow path is having a greater impact to water quality downgradient of the former Basin F compared to the WP flow path. While concentrations of ICs less frequently exceed UPLs and remain relatively stable or are decreasing downgradient of the WP area, concentrations downgradient of the PT indicate an impact due to contaminated groundwater migrating from upgradient sources and/or residual contamination within the unsaturated zone beneath the Basin F PT area.

In accordance with the Basin F PCGMP, there are no chemical-specific standards that apply to Basin F groundwater since the RMA remedy addresses contaminated groundwater downgradient at the North Boundary Containment System and Northwest Boundary Containment System, where it is extracted and treated.

Table 6-1. Summary of 2022 Post-Closure Groundwater Quality

Wastepile Wells	Principal Threat Wells
Arsenic	
• Concentrations of arsenic increased in upgradient and downgradient wells in 2022. • Concentrations of arsenic were less than the UPL in both downgradient wells.	• Concentrations of arsenic increased in downgradient wells 26015, 26157, 26163 and 26173, but only exceeded the UPL in 26163. • An increasing statistical trend was observed, and the presence of arsenic in well 26163 is statistically significant as demonstrated by a Shewhart-CUSUM control chart indicated an exceedance of the control limit.
Chloroform	
• Chloroform was not detected in upgradient well 26028. • Concentration of chloroform in downgradient well 26015 decreased in 2022 but exceeded the UPL. • Statistical analysis indicates an increasing trend of chloroform in well 26015.	• Concentrations of chloroform were detected in all four downgradient wells and in both upgradient wells. • Chloroform exceeded the UPL in downgradient wells 26133 and 26173, with increasing trends also indicated by Mann-Kendall analysis. • Mann-Kendall analysis also indicates an increasing statistical trend observed in upgradient well 26073.
Chloride	
• Concentrations of chloride decreased in downgradient wells 26015 and 26017 and in upgradient well 26028 in 2022. • Concentrations of chloride were less than the UPL in both downgradient wells.	• Concentration of chloride increased in downgradient well 26173, but was less than the UPL. • Chloride was detected in both upgradient wells.
CPMSO2	
• CPMSO2 was not detected in upgradient or downgradient WP wells.	• CPMSO2 was detected in downgradient wells 26133, 26157, 26163, and 26173 in 2022, but was not detected in well 26015 or either upgradient well. • Concentrations of CPMSO2 did not exceed the UPL in any downgradient wells.

Table 6-1. Summary of 2022 Post-Closure Groundwater Quality

Wastepile Wells	Principal Threat Wells
Copper	
• Copper was not detected in upgradient or downgradient wells in 2022.	• Copper was only detected in downgradient well 26163 in 2022 and exceeded the UPL, showing a statistically increasing trend in this well. • Copper was not detected in either upgradient well. • The presence of copper in well 26163 is statistically significant as demonstrated by a Shewhart-CUSUM control chart.
DCPD	
• DCPD was not detected in upgradient or downgradient wells in 2022.	• DCPD was detected in downgradient wells 26133, 26157, and 26163 with concentrations exceeding the UPL in the three wells. • DCPD was not detected in upgradient wells. • Concentrations of DCPD indicate statistically increasing trends during post-closure in wells 26163, and the presence of DCPD in well 26163 is statistically significant as demonstrated by a Shewhart-CUSUM control chart.
DIMP	
• Concentrations of DIMP were less than the UPL in both downgradient wells. • Increasing statistical trend observed in upgradient well and is likely due to upgradient groundwater contamination migrating towards former Basin F.	• DIMP was detected in all five downgradient wells, but concentrations do not exceed the UPL. • DIMP was detected in upgradient wells 26073 and 26128, but concentrations do not indicate increasing statistical trends.
Dieldrin	
• Concentrations of dieldrin decreased in downgradient wells 26015 and 26017 and upgradient well 26028 in 2022. • Concentrations of dieldrin were less than the UPL in both downgradient wells. • Decreasing statistical trend observed in upgradient well 26028.	• Dieldrin was detected in all five downgradient wells and in both upgradient wells in 2022. • Concentrations of dieldrin do not exceed the UPL in downgradient wells.

Table 6-1. Summary of 2022 Post-Closure Groundwater Quality

Wastepile Wells	Principal Threat Wells
NNDMEA	
• NNDMEA was detected in upgradient well 26028. • NNDMEA was detected in well 26015, at a concentration less than the UPL, but was not detected in downgradient well 26017.	• NNDMEA was detected in all five downgradient in 2022, but concentrations did not exceed the UPL. • Increasing statistical trend observed in downgradient wells 26133 and 26173. • NNDMEA was detected in upgradient well 26128, but concentrations indicate a decreasing statistical trend.
Sulfate	
• Sulfate was detected in all downgradient and upgradient wells. • Concentration of sulfate decreased in wells 26015 and 26017 in 2022, and was less than the UPL in both downgradient wells. • Increasing statistical trend was observed in upgradient well 26028.	• Sulfate was detected in all downgradient wells, but concentrations did not exceed the UPL. • Sulfate was detected in both upgradient wells and concentrations indicate increasing statistical trends
TCLEE	
• TCLEE was detected in downgradient well 26015 at a concentration less than the UPL. • TCLEE was not detected in downgradient well 26017 and upgradient well 26028.	• Concentrations of TCLEE were detected in all downgradient wells and in both upgradient wells. • In 2022, concentrations increased in all downgradient wells, and concentrations exceeded the UPL in downgradient wells 26133 and 26173. • Increasing statistical trends were observed in downgradient wells 26133 and 26173, with the presence of TCLEE in both wells shown as statistically significant as demonstrated by Shewhart-CUSUM control charts.

7.0 REFERENCES

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FIGURES

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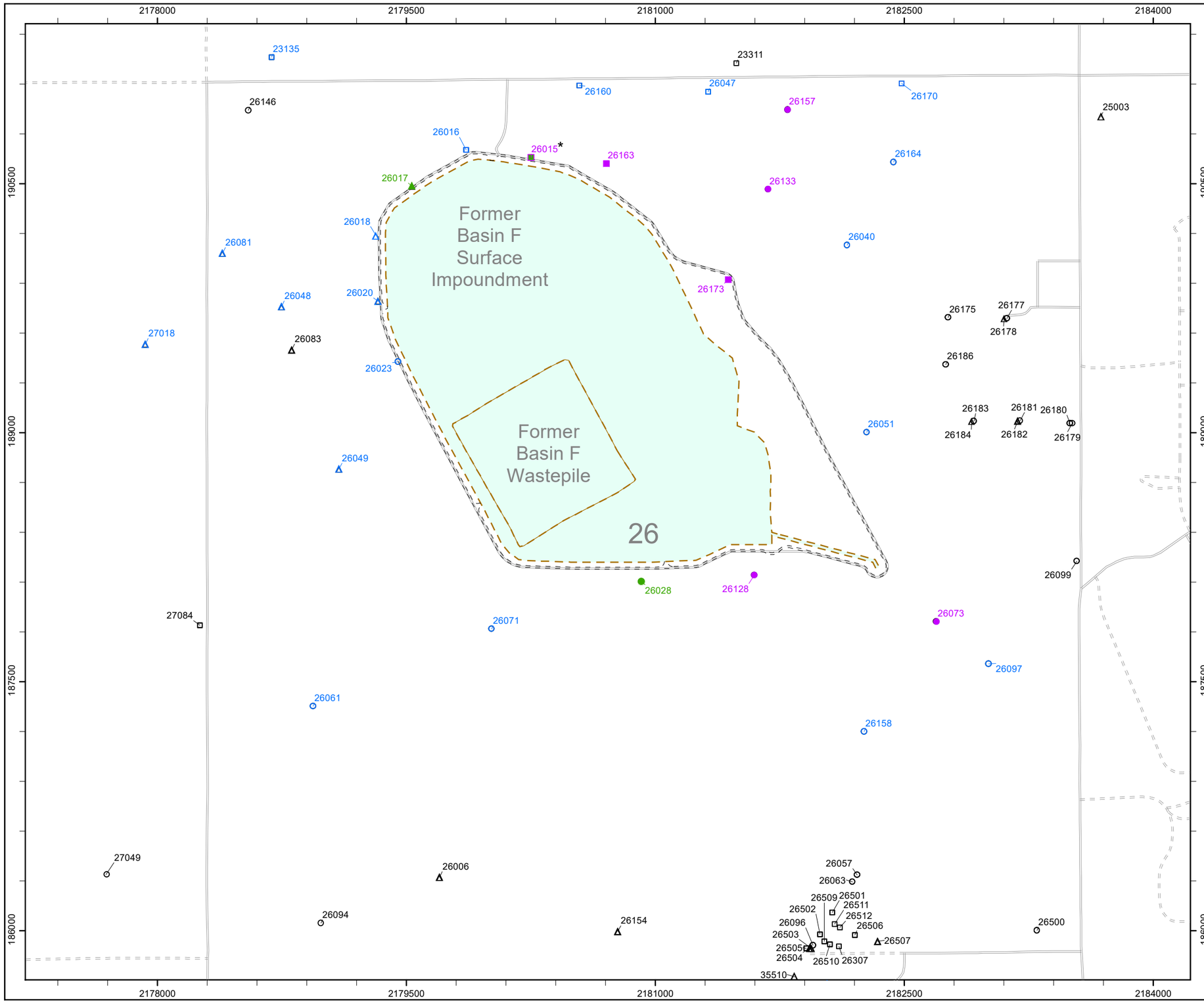

Legend

- Former Basin F Surface Impoundment
- Paved Roads
- Unpaved Roads

* Well 26015 is used in both Wastepile and Principal Threat Water Quality Networks.

Monitoring Well/ Piezometer Network	Flow System / Aquifer: Unconfined Alluvial	Unconfined Alluvial/ Denver	Unconfined Denver
Water Level Network	△	□	○
Other Network Wells	△	□	○
Basin F Wastepile Water Quality Network	▲	■	●
Basin F Principal Threat Water Quality Network		■	●

N

0 230 460 920 Feet

NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone

Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM

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Rocky Mountain Arsenal

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Figure 2-1

Former Basin F
Well and Piezometer
Location Map

M:\projects\basin-F_post-closure\2022\mxds\BF_CurrentMonWellNetwork_fig3.3-1_091422MJones.mxd
10/16/2022

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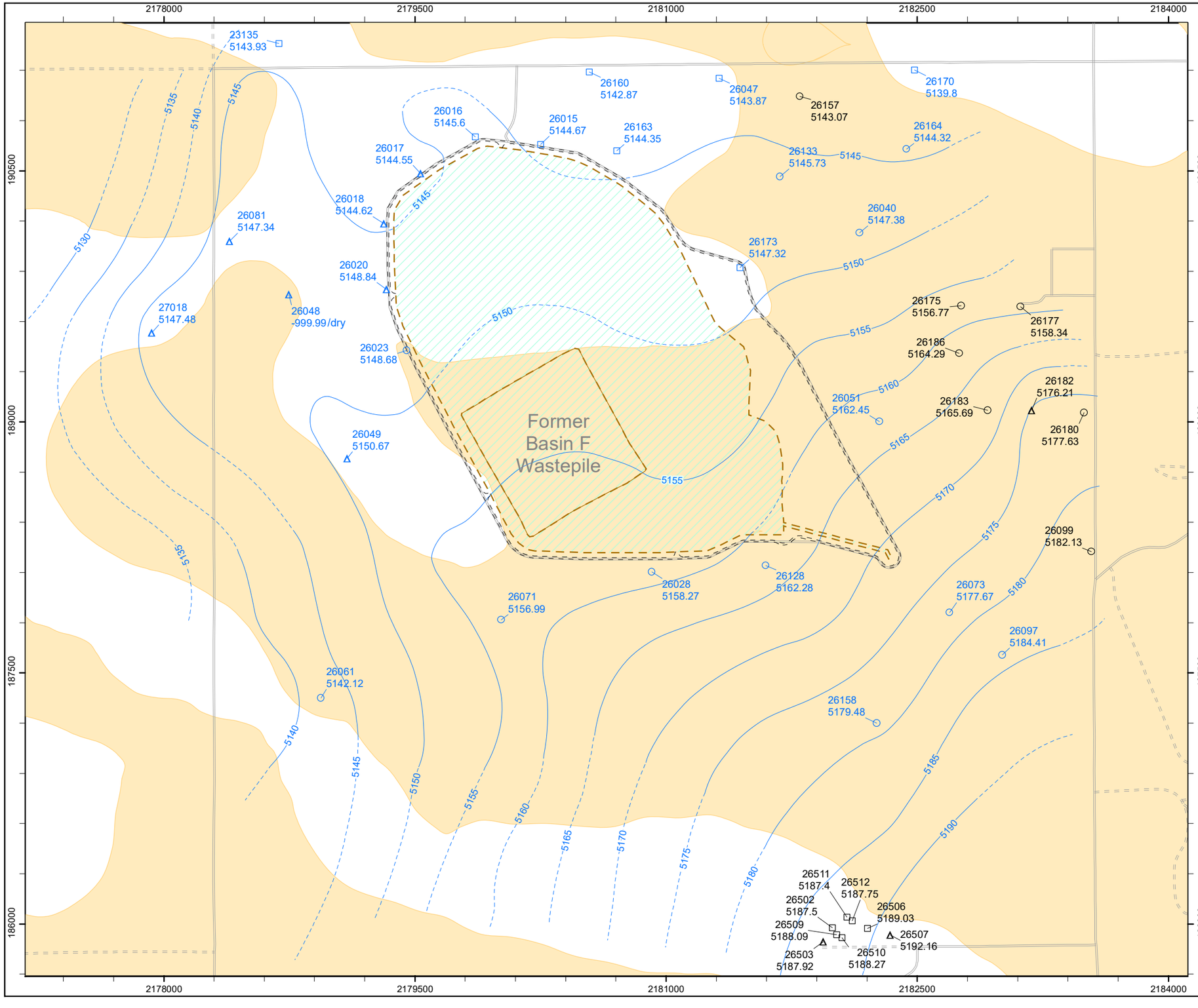

Legend

- Unsaturated Alluvium
- Former Basin F Surface Impoundment
- Paved Roads
- Unpaved Roads
- 26051 5161.20 — Well ID and Groundwater Elevation

Note: Water levels were measured in FY22 Quarters 2 and 3. Unsaturated alluvium interpreted using data from 2021 and 2022.

Monitoring Well/ Piezometer Network	Flow System / Aquifer: Unconfined Alluvial	Unconfined Alluvial/ Denver	Unconfined Denver
Water Level Network	△	□	○
Other Network Wells	△	□	○

N

0 230 460 920 Feet

NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone

Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM

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Figure 2-2

Former Basin F 2022 Potentiometric Surface of the Unconfined Flow System

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10/17/2022

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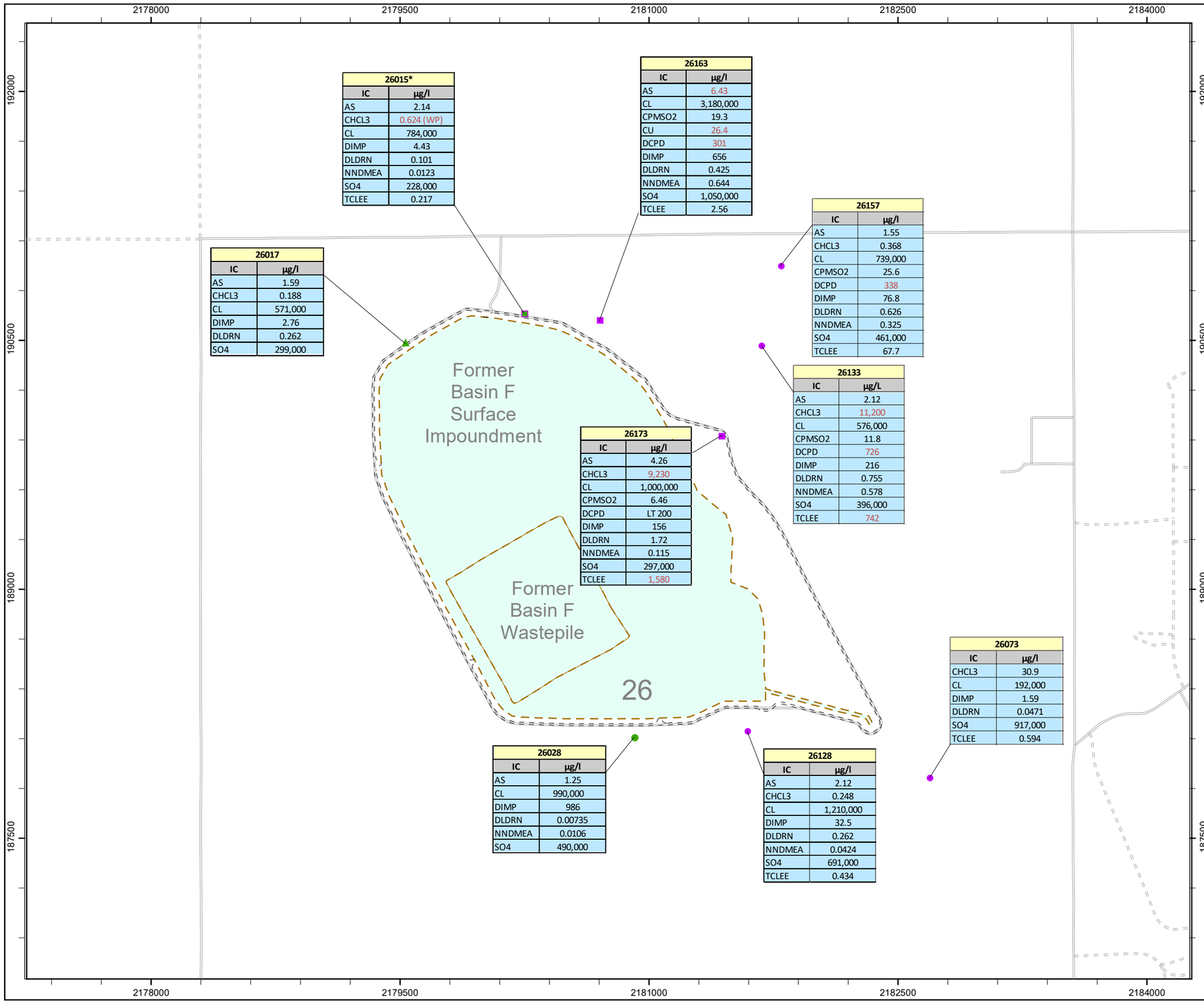

26015*	
IC	µg/l
AS	2.14
CHCL3	0.624 (WP)
CL	784,000
DIMP	4.43
DLDRN	0.101
NNDMEA	0.0123
SO4	228,000
TCLEE	0.217

26163	
IC	µg/l
AS	6.43
CL	3,180,000
CPMSO2	19.3
CU	26.4
DCPD	301
DIMP	656
DLDRN	0.425
NNDMEA	0.644
SO4	1,050,000
TCLEE	2.56

26017	
IC	µg/l
AS	1.59
CHCL3	0.188
CL	571,000
DIMP	2.76
DLDRN	0.262
SO4	299,000

26157	
IC	µg/l
AS	1.55
CHCL3	0.368
CL	739,000
CPMSO2	25.6
DCPD	338
DIMP	76.8
DLDRN	0.626
NNDMEA	0.325
SO4	461,000
TCLEE	67.7

26173	
IC	µg/l
AS	4.26
CHCL3	9,230
CL	1,000,000
CPMSO2	6.46
DCPD	LT 200
DIMP	156
DLDRN	1.72
NNDMEA	0.115
SO4	297,000
TCLEE	1,580

26133	
IC	µg/L
AS	2.12
CHCL3	11,200
CL	576,000
CPMSO2	11.8
DCPD	726
DIMP	216
DLDRN	0.755
NNDMEA	0.578
SO4	396,000
TCLEE	742

26073	
IC	µg/l
CHCL3	30.9
CL	192,000
DIMP	1.59
DLDRN	0.0471
SO4	917,000
TCLEE	0.594

26028	
IC	µg/l
AS	1.25
CL	990,000
DIMP	986
DLDRN	0.00735
NNDMEA	0.0106
SO4	490,000

26128	
IC	µg/l
AS	2.12
CHCL3	0.248
CL	1,210,000
DIMP	32.5
DLDRN	0.262
NNDMEA	0.0424
SO4	691,000
TCLEE	0.434

Legend

- Former Basin F Surface Impoundment
- Paved Roads
- Unpaved Roads
- * Well 26015 is used in both Wastepile Water Quality and Principal Threat Water Quality Networks.

Monitoring Well/ Piezometer Network	Flow System / Aquifer: Unconfined Alluvial	Unconfined Alluvial/ Denver	Unconfined Denver
Basin F Wastepile Water Quality Network	▲	■	●
Basin F Principal Threat Water Quality Network		■	●

Note: Values in red indicate analytical results that exceeded 2022 upper prediction limits.

N

0 230 460 920 Feet

NAD27-NGVD29 Datum, US Survey Feet, Colorado North Zone

Sources: U.S. Army, RMA GIS, OMC, Shell/AECOM

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Figure 4-1

Former Basin F
2022 Well Network Indicator
Compound Detection Map

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10/17/2022

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ATTACHMENTS

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ATTACHMENT A

Hydrographs for Basin F Network Wells

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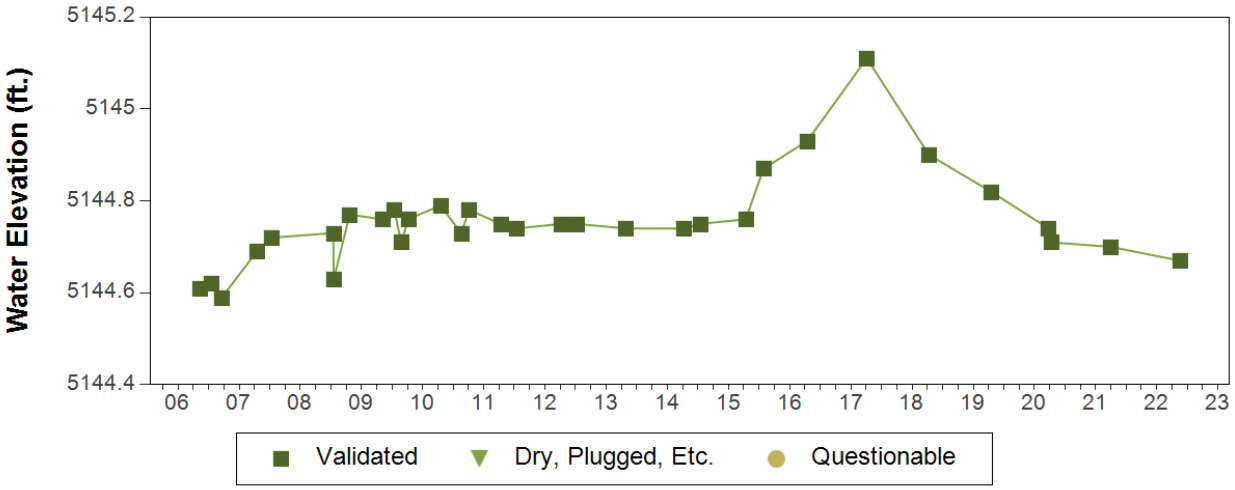
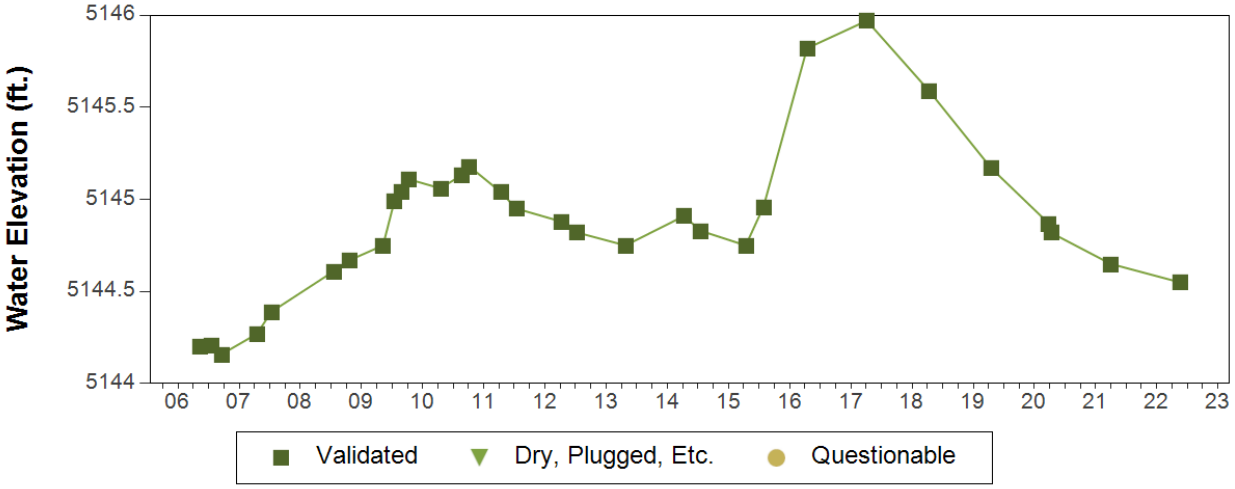
Water Levels for Well 26015

2006-04-01 to 2022-06-01



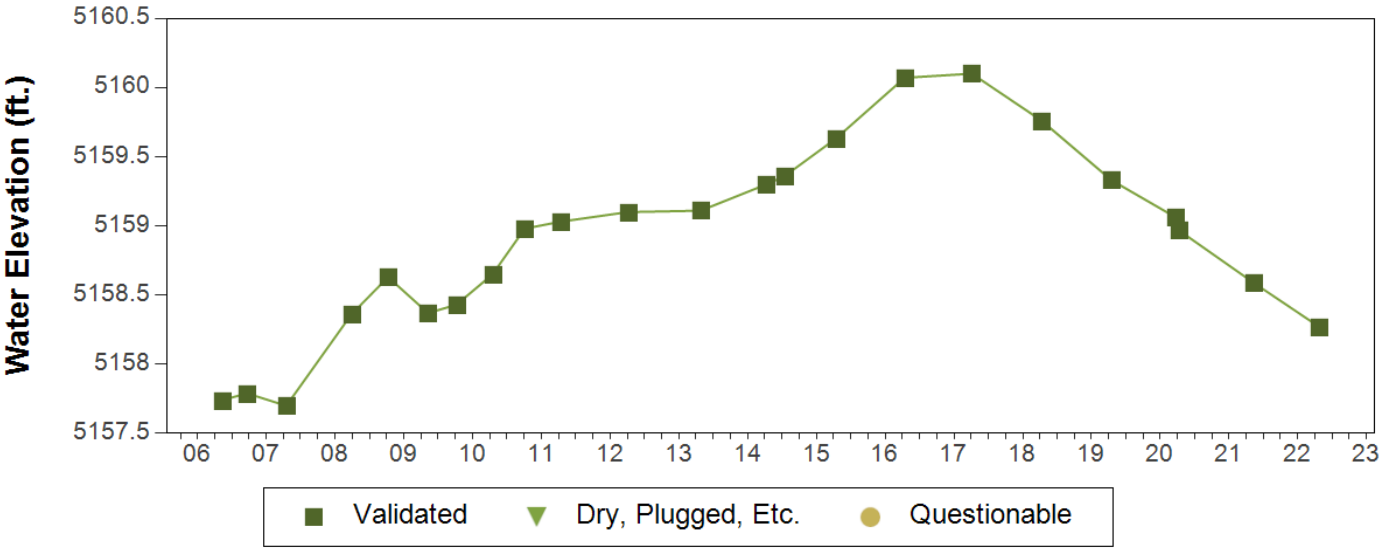
Water Levels for Well 26017

2006-04-01 to 2022-06-01



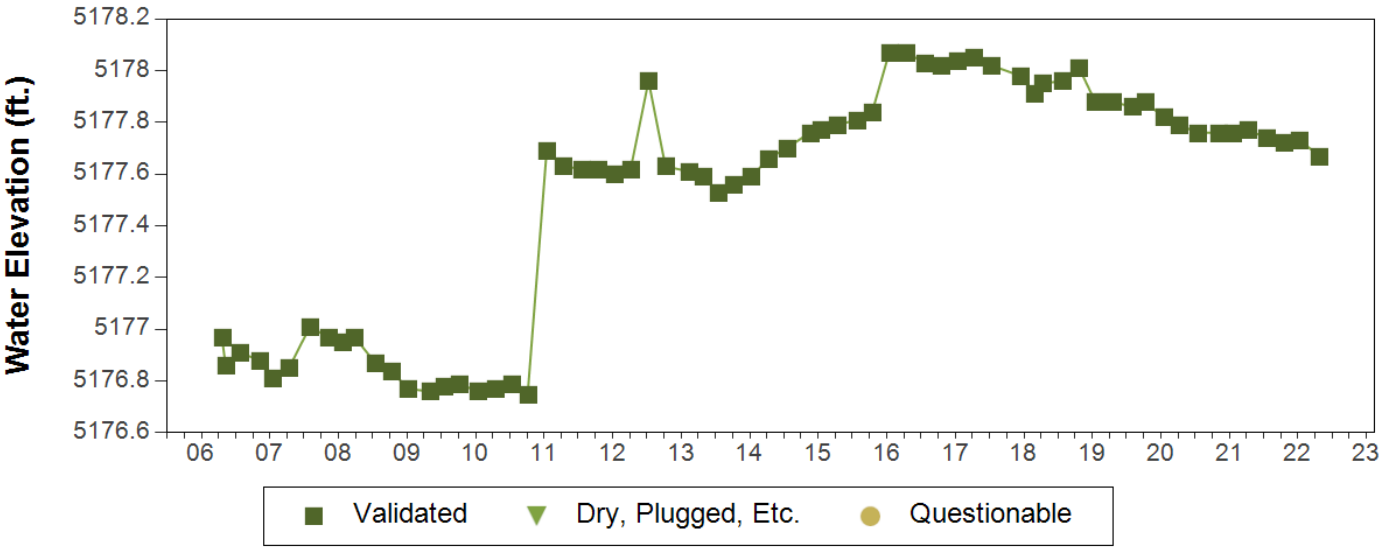
Water Levels for Well 26028

2006-04-01 to 2022-06-01



Water Levels for Well 26073

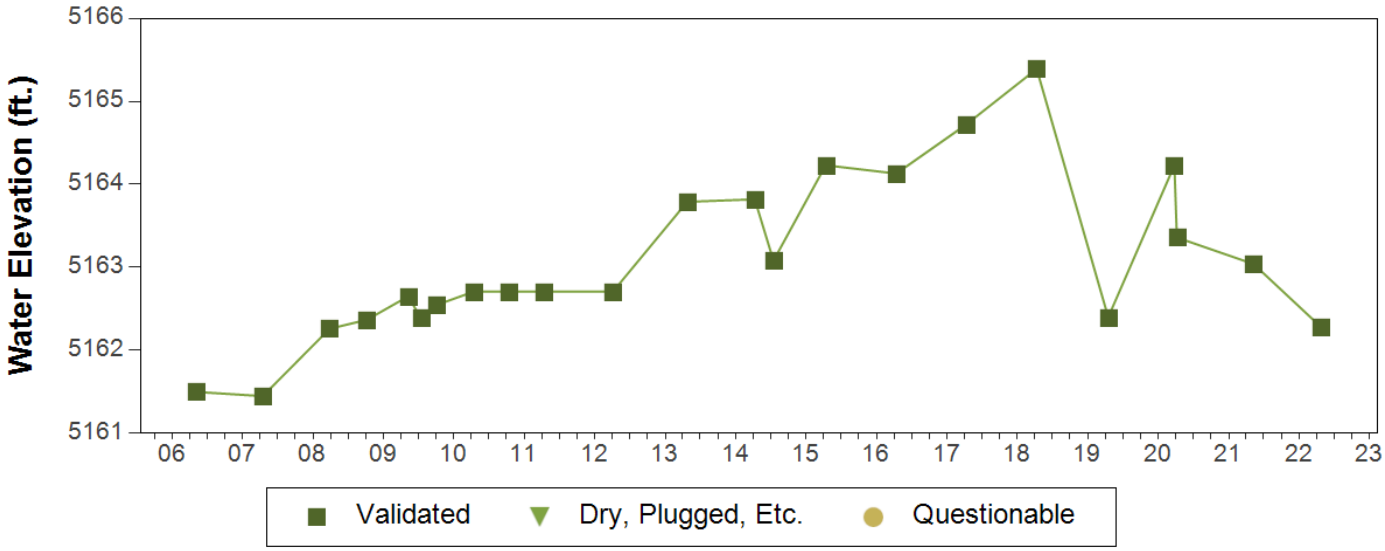
2006-04-01 to 2022-06-01



The water elevation increase of 0.94 feet on Januaryy 14, 2011 in well 26073 conicided with a top-of-casing elevation change resulting from modifications to the well. The well was resurveyed and updated in the Rocky Mountain Arsenal Database (RMAED).

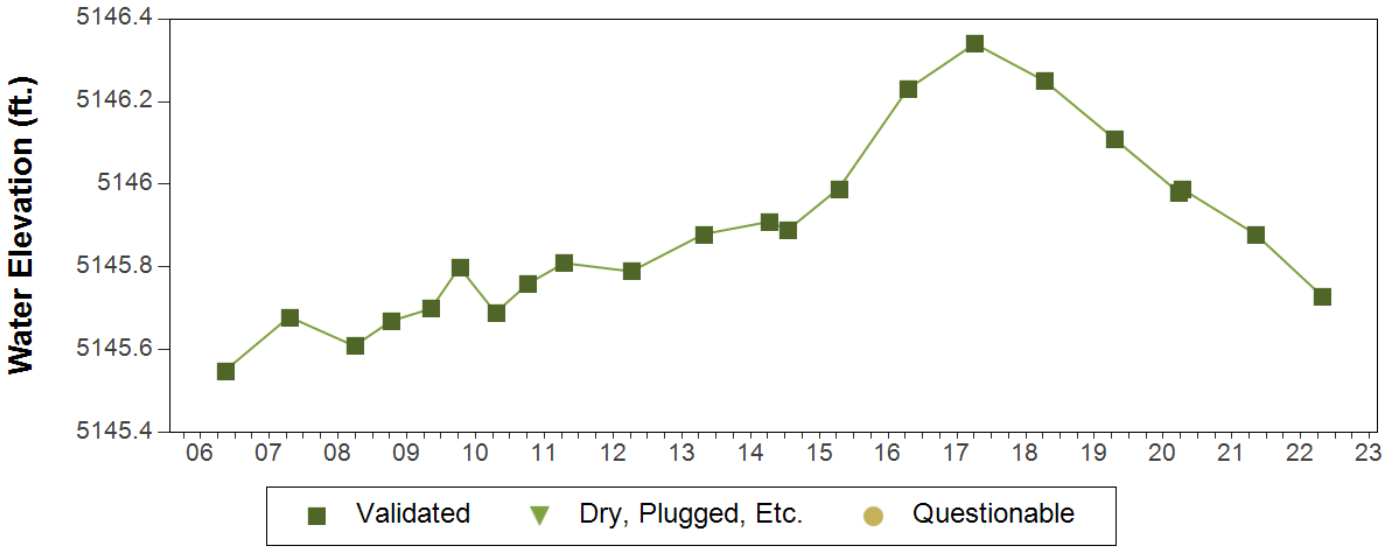
Water Levels for Well 26128

2006-04-01 to 2022-06-01



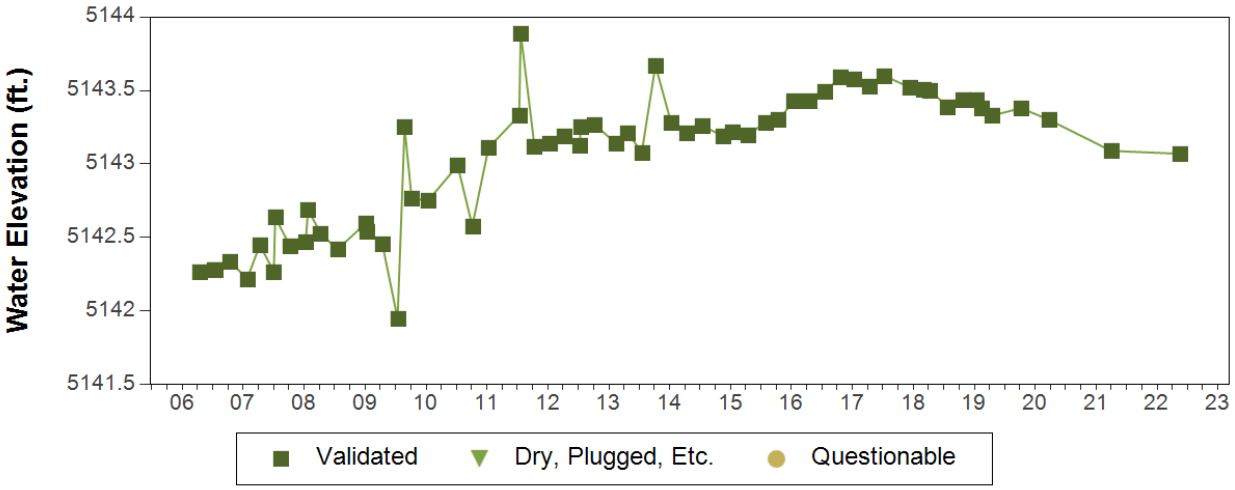
Water Levels for Well 26133

2006-04-01 to 2022-06-01



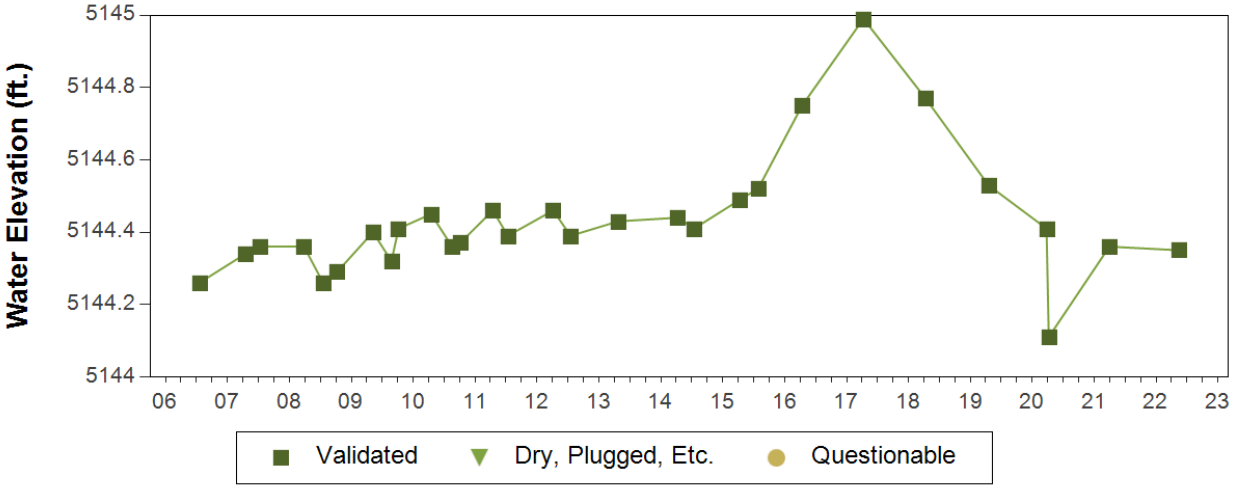
Water Levels for Well 26157

2006-04-01 to 2022-06-01



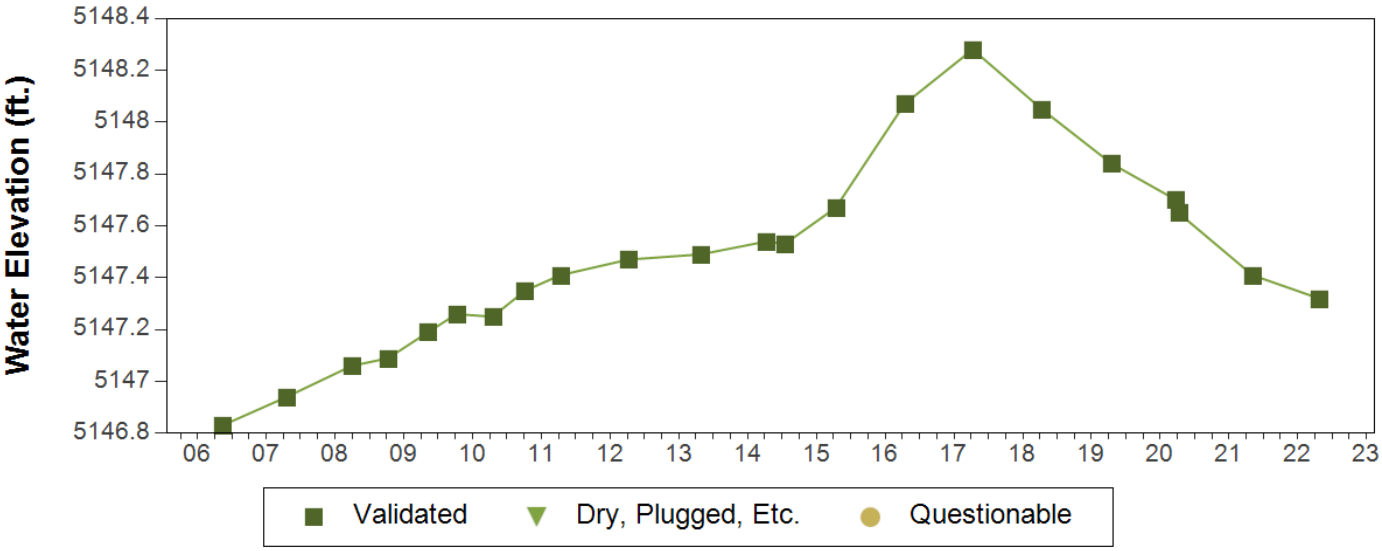
Water Levels for Well 26163

2006-06-01 to 2022-06-01



Water Levels for Well 26173

2006-04-01 to 2022-06-01



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ATTACHMENT B

Shewhart-CUSUM Control Charts

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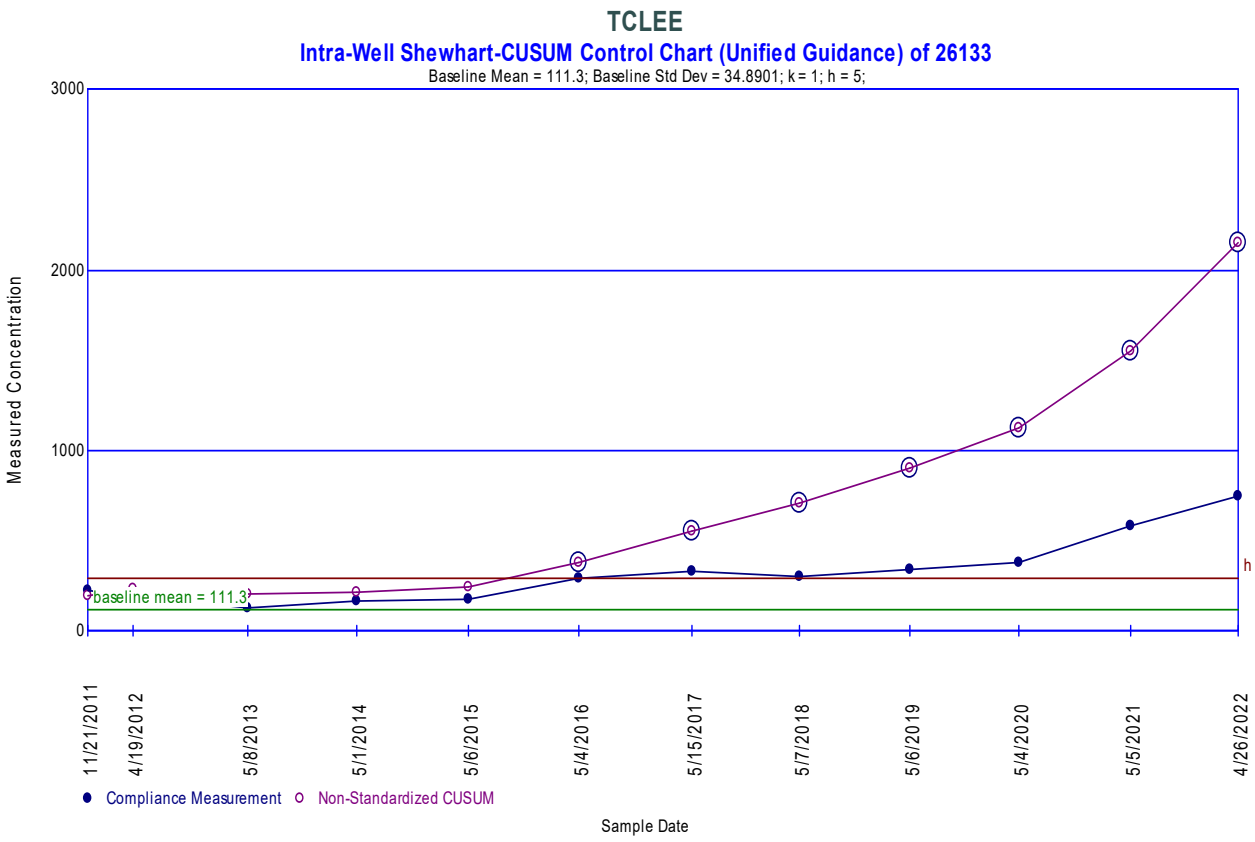
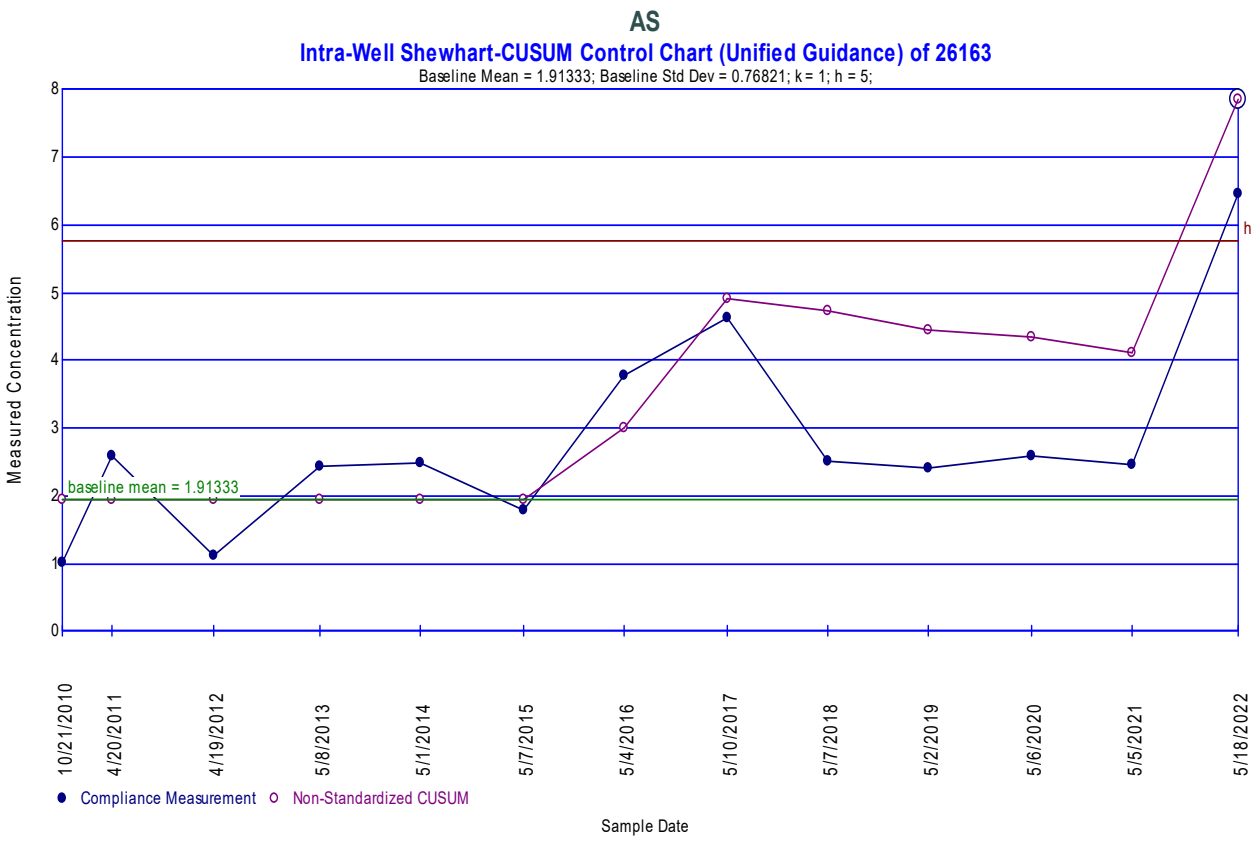
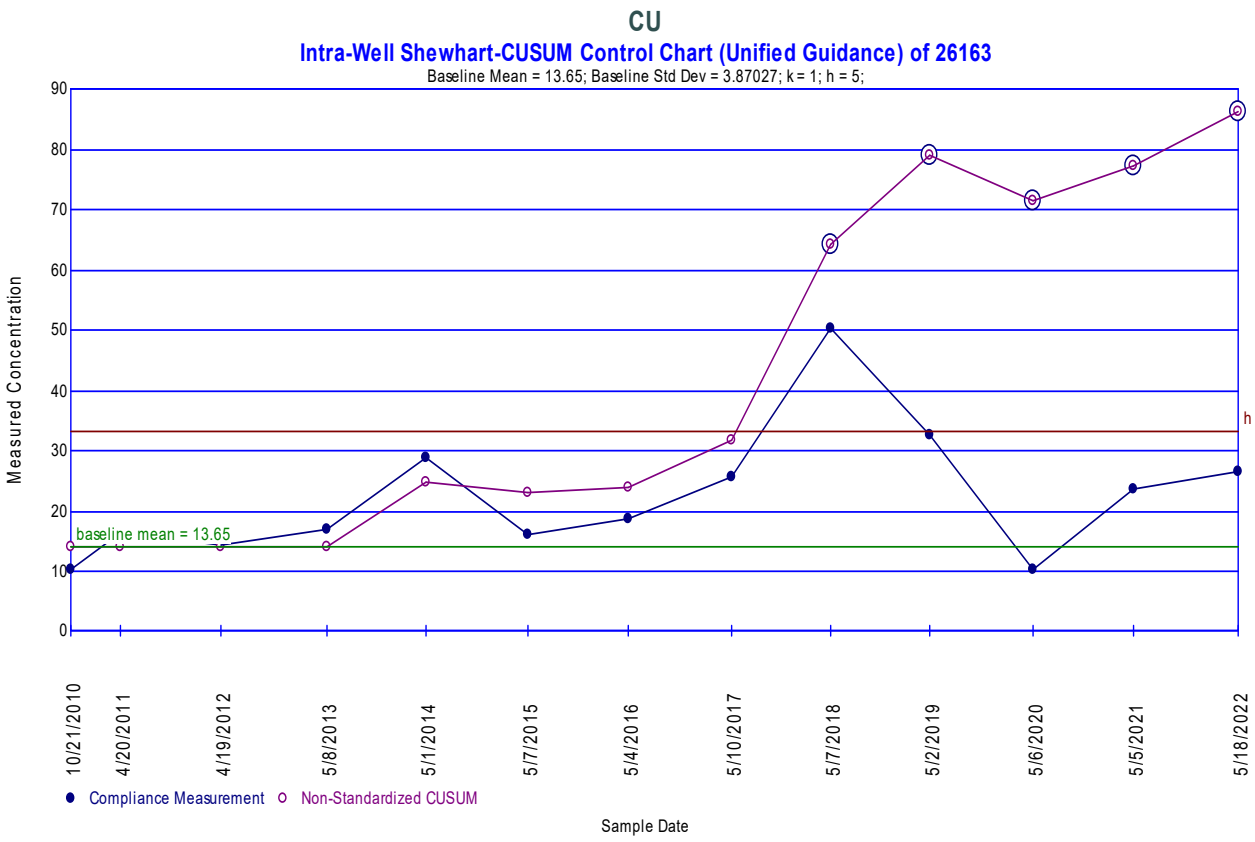

TCLEE
Intra-Well Shewhart-CUSUM Control Chart (Unified Guidance) of 26133
Baseline Mean = 111.3; Baseline Std Dev = 34.8901; k = 1; h = 5;
Measured Concentration
3000
2000
1000
0
h
baseline mean = 111.3
11/21/2011
4/19/2012
5/8/2013
5/1/2014
5/6/2015
5/4/2016
5/15/2017
5/7/2018
5/6/2019
5/4/2020
5/5/2021
4/26/2022
Compliance Measurement
Non-Standardized CUSUM
Sample Date


AS
Intra-Well Shewhart-CUSUM Control Chart (Unified Guidance) of 26163
Baseline Mean = 1.91333; Baseline Std Dev = 0.76821; k = 1; h = 5;
Measured Concentration
baseline mean = 1.91333
h
0
1
2
3
4
5
6
7
8
10/21/2010
4/20/2011
4/19/2012
5/8/2013
5/1/2014
5/7/2015
5/4/2016
5/10/2017
5/7/2018
5/2/2019
5/6/2020
5/5/2021
5/18/2022
Compliance Measurement
Non-Standardized CUSUM
Sample Date


CU
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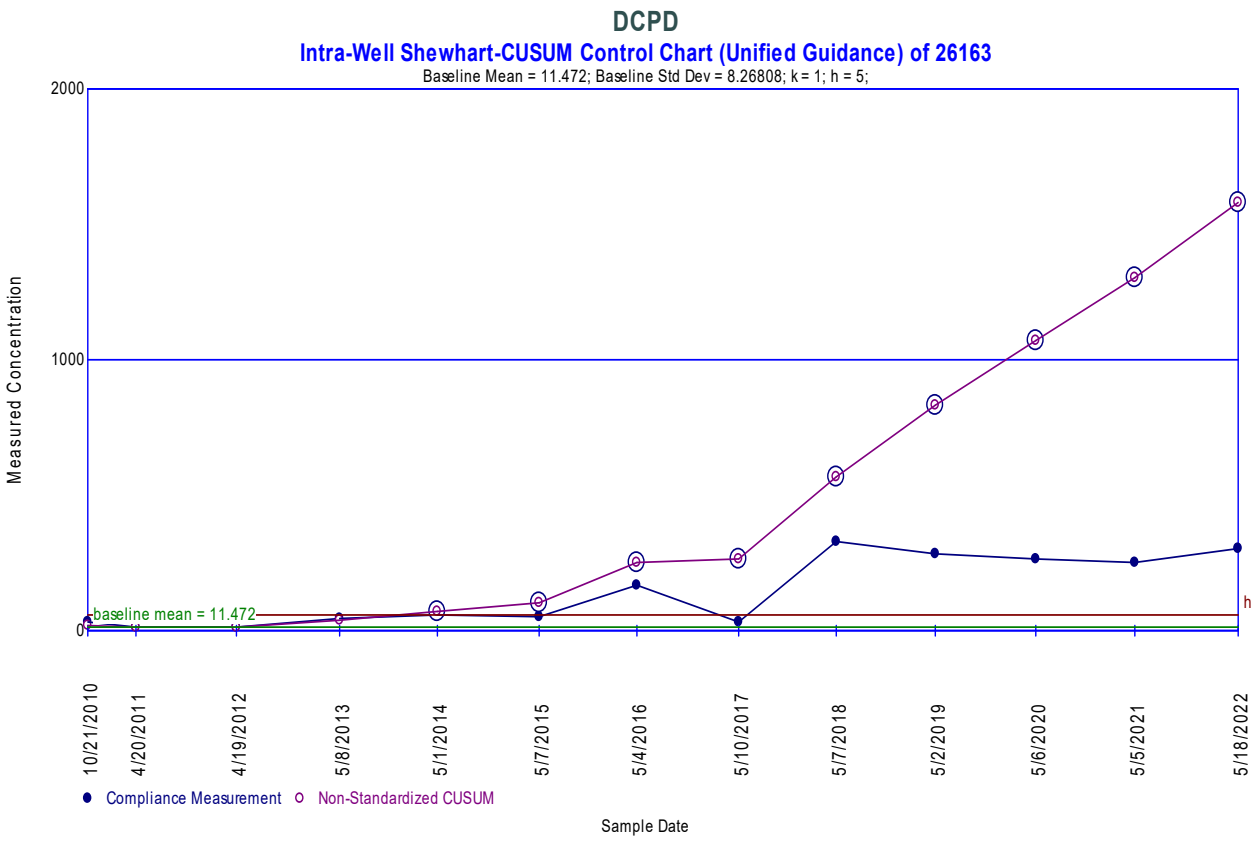
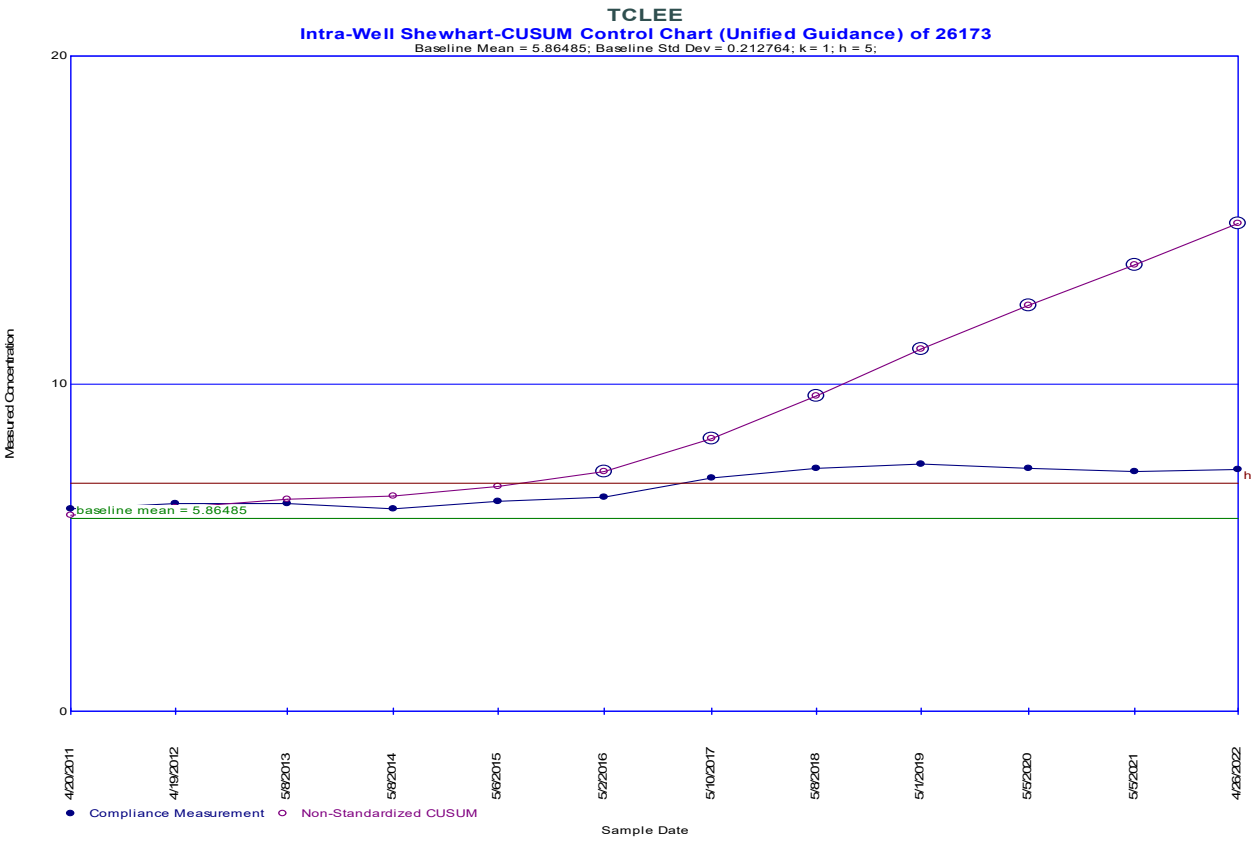
Baseline Mean = 13.65; Baseline Std Dev = 3.87027; k = 1; h = 5;
Measured Concentration
90
80
70
60
50
40
30
20
10
0
h
baseline mean = 13.65
10/21/2010
4/20/2011
4/19/2012
5/8/2013
5/1/2014
5/7/2015
5/4/2016
5/10/2017
5/7/2018
5/2/2019
5/6/2020
5/5/2021
5/18/2022
Compliance Measurement
Non-Standardized CUSUM
Sample Date


DCPD
Intra-Well Shewhart-CUSUM Control Chart (Unified Guidance) of 26163
Baseline Mean = 11.472; Baseline Std Dev = 8.26808; k = 1; h = 5;
Measured Concentration
2000
1000
0
baseline mean = 11.472
h
10/21/2010
4/20/2011
4/19/2012
5/8/2013
5/1/2014
5/7/2015
5/4/2016
5/10/2017
5/7/2018
5/2/2019
5/6/2020
5/5/2021
5/18/2022
Compliance Measurement
Non-Standardized CUSUM
Sample Date


TCLEE
Intra-Well Shewhart-CUSUM Control Chart (Unified Guidance) of 26173
Baseline Mean = 5.86485; Baseline Std Dev = 0.212764; k = 1; h = 5;
Measured Concentration
20
10
0
h
baseline mean = 5.86485
4/20/2011
4/19/2012
5/8/2013
5/8/2014
5/6/2015
5/2/2016
5/10/2017
5/8/2018
5/1/2019
5/5/2020
5/5/2021
4/29/2022
Compliance Measurement
Non-Standardized CUSUM
Sample Date

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APPENDIX F

NRAP Log

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NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2008-001	Hand seeding of small areas on the SDT RCRA-Equivalent Cover. Amendment will not be applied, the sites will not be irrigated, and minor changes to the seed mix are required based on availability.	SDT RCRA-Equivalent	Unknown	09/20/11 (Issued for concur-ance 05/27/08)	09/20/11 (Issued for concur-ance 05/27/08)	Comments resolved 06/2008	05/29/08	05/29/08	Concurrence or resolution with all parties.
2009-001	Temperature probe #4 failed and requires replacement. The probe is located near Lysimeter 002 and is approximately 30” bgs. Hand tools will be used to dig a hole adjacent to the temperature probe nest and a new probe will be installed at the appropriate depth. The hole will be filled with spoils from the excavation.	SDT RCRA-Equivalent	06/25/09 07/02/09 07/07/09	07/14/09	07/16/09	07/22/09	07/23/09	07/16/09	All parties concur.
2009-002	The rain gauge at Lysimeter 002 will be replaced with another unit mounted to a stand, separate from the control panel. A hole approximately 24” deep will be dug with hand tools. The stand will be placed in the hole and spoils will be used to backfill around it. A shallow trench (6” deep) will be dug from the new stand to the control panel for the instrument wire.	SDT RCRA-Equivalent	06/29/09	07/30/09	07/30/09	07/30/09	07/30/09	07/30/09	All parties concur.
2009-003	The soil thickness loss at EM-HWL03 exceeds the Non-Routine Action Level. The settlement around this monument is localized and additional soil will be placed in the depression to match the	HWL	09/10/09 09/17/09	09/28/09	09/28/09	10/01/09	10/01/09	10/01/09	All parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	surrounding grade.								
2009-004	The RMA biomonitoring program requires the installation of starling and kestrel nest boxes within the ICS AMA. Two arrays of starling nest boxes (10 boxes each) will be installed; one on the SDT 2-ft Cover and one on the South Plants 3-ft cover. One kestrel box will be installed near the former intersection of 7th Avenue and D Street, in a non-cover area. Installation of these nest boxes will require intrusive activities.	SDT 2-ft Cover South Plants 3-ft Cover Non-cover area	12/17/09 01/06/10 01/07/10	01/12/10	01/12/10	01/22/10	02/04/10	02/04/10	All parties concur.
2010-001	Extraction wells in the South Tank Farm Benzene Plume area will be closed and piping will be capped. These activities will be intrusive in the 3-ft Cover.	South Plants 3-ft Cover	N/A	NRAP-2010-001 was terminated after the Water Team agreed not to close extraction wells at this time.					Terminated
2010-002	Some components of the Lime Basins dewatering wells discharge piping have deteriorated and require replacement. Excavations must be made through the RCRA-Equivalent Cover and into the subgrade soil to access the components. Excavations will be made at six well locations. The excavations will be repaired to the requirements of the ICS Project Design with materials removed during excavation, or new materials if those removed do not meet the requirements of the	Lime Basins	05/20/10 06/29/10	07/14/10	07/14/10	07/15/10	07/15/10	07/15/10	All parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	design.								
2010-003	Significant storm events have created deep erosion gullies around box culvert wing walls and in other locations of concentrated flow into perimeter channels at the HWL and ELF. The soil around these features generally has not withstood concentrated stormwater flow and it is unlikely that vegetation establishment will be robust enough to prevent further erosion. Additional erosion protection, exceeding that required by the original design, is required to maintain the integrity of the perimeter channel slopes where concentrated flow enters them.	HWL/ELF	08/19/10	Unknown	Unknown	08/24/10 (email)	Unknown	Unknown	Failure to locate original document.
2010-004	The Lime Basins Groundwater Treatment Relocation Project requires the transmission of groundwater from the Lime Basins meter building to the Basin A Neck treatment facility via the existing pipeline that was formerly used to carry treated water from the CERCLA Plant to the Basin A Neck recharge trenches. Use of this existing transmission pipeline for the stated purpose requires the installation of a section of piping connecting the existing piping from the Lime Basins meter building to the CERCLA Plant to	ICS Non-Cover	08/02/10 08/11/10	08/11/10	08/11/10	08/25/10	09/23/10	08/23/10	All parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	the existing piping connecting the CERCLA Plant to the Basin A Neck treatment facility.								
2010-005	The PMC is replacing survey monuments at section corners and mid-section points throughout RMA that were destroyed during remediation activities. Two such monuments will be installed within the ICS Army Maintained Area (AMA) along former 7th Avenue.	ICS Non-Cover	09/09/10	09/10/10	09/13/10	09/23/10	09/15/10	09/13/10	All parties concur.
2010-006	The RVO requires extension of the fiber optic network to provide data/phone service to the Lime Basins Meter Building. An existing (buried) fiber optic line that formerly serviced the B-312 Fire Station is located near a phone pedestal just southeast of the CERCLA Wastewater Treatment Facility (white circle on attached drawing). This fiber optic line will be located and a new line will be connected to extend to the Lime Basins Meter Building.	ICS Non-Cover	09/09/10	09/09/10	09/09/10	09/09/10 (e-mail)	09/09/10 (e-mail)	09/09/10 (e-mail)	All parties concur.
2010-007	Closure of the Landfill Wastewater Treatment System (LWTS) requires the abandonment of several underground utilities, including the treated water discharge piping. Abandonment of the treated water discharge piping will involve the abandonment of two manholes containing air relief valves, which	HWL Non-Cover	10/04/10	10/04/10	05/02/11	10/05/10 (e-mail)	None	10/05/10 (e-mail)	No record of CDPHE concurrence. All other parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	are within the HWL fence, north of the landfill. Abandonment of the manholes will involve intrusive work inside the Army Maintained Area.								
2010-008	On Thursday, September 30, 2010, URS discovered a potential leak at the Complex Trenches groundwater extraction wellhead (Well #36305). Initial investigation suggests that there may be damage to the groundwater conveyance piping at, or near, the well's pitless adaptor. Further investigation and repair will involve intrusive work (excavation and backfill) inside the Army Maintained Area.	CAT	10/04/10	10/04/10	10/04/10	10/14/10	10/14/10	10/06/10	All parties concur.
2010-009	A telephone pedestal was damaged by a mower during recent weed control work. The pedestal is located on D Street, south of Drainage Crossing 2, between the perimeter road and the fence. Repair will require excavation around the box and cables, which are located within the Army Maintained Area.	ICS Non-Cover	10/18/10	10/18/10	10/18/10	10/27/10	11/10/10	11/10/10	All parties concur.
2010-010	Over-seeding is required on the ELF and in some parts of the HWL and surrounding areas in order to better establish desirable grasses, especially cool season grasses. The area exceeds 11,000 sft and requires	HWL and ELF	11/08/10	11/10/10	11/10/10	11/10/10	11/10/10	11/10/10	All parties concur.

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	consultation.								
2010-011	Over-seeding is required on parts of the ICS and Basin F Army Maintained Areas in order to better establish desirable grasses. The area exceeds 11,000 sft and requires consultation.	Basin F, ICS, and Non-Cover	11/09/10	11/10/10	11/10/10	11/10/10	11/10/10	11/10/10	All parties concur.
2010-012	The LLDPE boot cannot be replaced around well DW-9 because a new pitless adaptor was installed. Bentonite will be placed around the liner penetrations as an alternative.	Lime Basins	11/18/10 11/22/10	11/23/10	05/02/11	11/23/10 (e-mail)	11/23/10 (e-mail)	11/23/10 (e-mail)	All parties concur.
2011-001	An ICS perimeter fence gate stop post at the Channel 6 gate was installed incorrectly. The post will be moved to the correct location.	ICS Non-Cover	01/19/11	01/23/11	01/31/11	02/02/11	02/02/11	02/02/11	All parties concur.
2011-002A	Installation of Carsonite marker posts to improve visibility of features that could be obscured by tall vegetation. Installation of the marker posts will require intrusive activities in the covers and in non-cover areas.	Basin F, ICS, and Non-Cover	02/23/11	03/14/11	03/16/11	03/17/11	04/22/11	03/17/11	All parties concur.
2011-002B	Installation of Carsonite marker posts to improve visibility of features that could be obscured by tall vegetation. Installation of the marker posts will require intrusive activities in the caps and in surrounding support areas.	HWL and ELF	02/23/11	03/14/11	03/16/11	03/17/11	04/22/11	03/17/11	All parties concur.
2011-003	Installation of a new rain gauge near the Lime Basins Metering	ICS Non-	03/15/11	03/17/11	03/17/11	03/17/11	04/22/11	03/17/11	All parties

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	Building. The installation will require intrusive activities in a non-cover area west of the Lime Basins cover.	Cover							concur.
2011-004	Re-establish positive drainage downstream of the Channel 4 outlet structure northwest of the Basin A cover. Approximately 400 feet of flowline in the non-cover area will be excavated to promote positive drainage.	ICS Non-Cover	03/24/11	05/04/11	05/04/11	03/28/11 (e-mail)	03/29/11 (e-mail)	03/28/11 (e-mail)	All parties concur.
2011-005	Revegetation of the ELF perimeter channels including amendment, seedbed prep, seeding, and installation of erosion control blankets and erosion control wattles over the seeded areas.	ELF Non-Cover	06/10/11	06/21/11	06/21/11	07/05/11	08/11/11	07/12/11	All parties concur.
2011-006	Documentation of ELF sump sample results at LB LDS2. Monthly sampling was performed per the ELF Post-Closure Groundwater Monitoring Plan. Results of the three-month sampling period and an investigation summary regarding potential causes for the detections are included.	ELF	07/21/11	04/02/12	04/03/12	04/25/12	04/19/12	04/19/12	All parties concur.
2011-007	Rebuild the riprap outlet structure at Channel 4 to improve drainage from the concrete lined channel.	ICS	08/23/11	08/23/11	08/24/11	09/01/11	09/08/11	09/0811	All parties concur.
2011-008	Removal of barbed wire from the HWL and ELF perimeter fence, and removal of gate on the west	HWL and ELF Non-Cover	08/24/11	08/25/11	08/24/11	09/01/11	09/01/11	09/01/11	All parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	fence and replacement with chainlink fence fabric.								
2011-009	Removal of a soil feature measuring approximately 50-ft long, 4-ft wide, and 2-ft tall that was left in place along the eastern portion of the former CERCLA Wastewater Treatment Plant site.	ICS Non-Cover	09/16/11	09/20/11	09/20/11	09/22/11	09/22/11	09/22/11	All parties concur.
2011-010	Installation of warning signs adjacent to two cattle guards, one each, on the ICS and Basin F perimeter fences.	ICS and Basin F Non-Cover	09/21/11	09/22/11	09/26/11	09/29/11	09/29/11	09/29/11	All parties concur.
2011-011	Covering exposed portions of the HWL and ELF gravel drainage layer geotextile with stone.	HWL and ELF	10/26/11	NRAP-2011-011 was rescinded by James L. Green via email on November 17, 2011.					Rescinded
2011-012	Erosion/settlement monument EM-ELF08 had a measured soil thickness loss of 5.0 inches on September 29, 2011. The non-routine action trigger level for these monuments is 0.4 foot, which is 4.8 inches. Investigation showed the soil around the monument had settled or washed away. Replacement soil will be imported to fill the depression.	ELF	10/10/11	11/21/11	11/21/11	12/15/11	01/11/12	11/22/11	All parties concur.
2011-013	Overseeding of 12.4 acres around the ELF perimeter, and hand seeding of Sand Dropseed on 37.4 acres of the ELF cap.	ELF	11/17/11	11/21/11	11/21/11	12/15/11	01/11/12	11/22/11	All parties concur.
2011-014	Areas of the ICS and Basin F require seeding where soil repairs had been made earlier in the year,	Basin F and ICS	11/21/11	11/21/11	11/21/11	12/15/11	01/11/12	11/22/11	All parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	and over-seeding where vegetation is less well established than surrounding areas.								
2012-001	Documentation of HWL sump sample results at LDS2, LDS3, and LDS4 from April 2011 through October 2011.	HWL	06/17/11 08/31/11 09/23/11 10/06/11 10/13/11 11/15/11	09/26/12	09/26/12	10/29/12	10/10/12	10/10/12	All parties concur.
2012-002	Documentation of ELF sump sample results at WPLDS1, WPLDS2, and LBLDS2 from July 2011 through October 2011.	ELF	08/31/11 09/23/11 10/06/11 10/13/11 11/15/11	09/26/12	09/26/12	10/29/12	10/10/12	10/10/12	All parties concur.
2012-003	The fence surrounding the HWL and ELF demarcates the AMA boundary, which needs to be expanded in six locations to improve access to monitoring wells and to provide enough space to construct an interior access road between the perimeter fence and perimeter drainage channels.	HWL and ELF	02/06/12	02/10/12	02/13/12	02/14/12	02/14/12	02/14/12	All parties concur.
2012-004	The existing HWL and ELF access road network needs to be expanded to improve access to groundwater monitoring wells and other features that require routine inspection and maintenance.	HWL and ELF	06/29/12	07/09/12	07/11/12	07/25/12	08/01/12	07/11/12	All parties concur.

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2012-005	Plans for a prescribed burn over 127 acres of the ICS. The burn will be performed in the northeast area of ICS over the CAT and Shell covers.	ICS	12/19/11 03/01/12	03/06/12	03/06/12	03/08/12	03/14/12	03/08/12	All parties concur.
2012-006	The fence surrounding the HWL will be relocated to provide enough space to construct an interior access road between the eastern perimeter fence and perimeter drainage channel. Access to the four LCS/LDS manholes will to be improved for the safety of personnel working on the manholes.	HWL	04/16/12	05/23/12	05/29/12	05/31/12	05/31/12	05/31/12	All parties concur.
2012-007	The area around both ELF LRCH Buildings will be graded to drain and wingwalls will be constructed to divert surface water away from the buildings.	ELF	05/02/12 12/27/12	03/18/14	03/18/14	04/09/14	04/09/14	04/09/14	All parties concur.
2012-008	Frequent traffic to the top of the HWL and ELF by inspection and maintenance equipment has damaged the cap vegetation. Designated and surfaced paths to the upper portion of the landfills will be constructed to improve access to the terrace channels and upper portion of the caps, minimizing additional vegetation disturbance.	HWL and ELF	12/27/12	N/A	N/A	N/A	N/A	N/A	Suspended.
2013-001	Plans for a prescribed burn over	ICS and	01/29/13	02/13/13	02/13/13	02/13/13	02/13/13	02/13/13	All parties

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover **WBS:** 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	ICS and Basin F. The burns will include the entirety of both AMAs (approximately 670 acres for ICS and 112 acres for Basin F).	Basin F							concur.
2013-002	Notification of first-time detection of MEK in HWL LDS4 during the January 2012 sampling event.	HWL	01/22/13 01/29/13	02/13/13	01/29/13	02/13/13	01/30/13	01/30/13	All parties concur.
2013-003	Notification of third-time detection of Endrin Aldehyde (ENDRNA) and NNDMEA in the HWL LDS sumps during the October 2012 and April 2012 sampling events, respectively.	HWL	01/22/13 01/29/13	02/13/13	01/29/13	02/13/13	01/30/13	01/30/13	All parties concur.
2013-004	Notification of third-time detection of Dicyclopentadiene (DCPD) in the ELF LBLDS2 during the July 2012 sampling event.	ELF	05/03/13	05/08/13	05/08/13	05/09/13	05/16/13	05/16/13	All parties concur.
2013-005	Notification that the Watch List Trigger Level for Chloroform was exceeded in ELF LBLDS2 wastewater samples during the second, third, and fourth quarterly sampling events of 2012.	ELF	05/16/13	05/16/13	05/16/13	05/16/13	05/16/13	05/16/13	All parties concur.
2013-006	Notification that the Watch List Trigger Level for Chloroform was exceeded in ELF WPLDS2 wastewater samples during the second quarterly sampling event of 2013.	ELF	05/28/13	05/28/13	05/28/13	07/18/13	07/18/13	07/18/13	All parties concur.
2013-007	Excavation of pull box on the north face of the ELF cap.	ELF		Army/Shell has decided not to pursue this action at this time.					Suspended

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2013-008	Notification of tipping bucket failure at Lysimeter 003.	ICS	09/19/13	10/24/13	10/24/13	11/20/13	11/20/13	11/20/13	All parties concur.
2013-009	Notification of non-routine action trigger exceedance for percolation at Lysimeter 003.	ICS	09/19/13 09/30/13 10/09/13	10/24/13	10/24/13	11/20/13	11/20/13	11/20/13	All parties concur.
2013-010	Notification of non-routine action trigger exceedance for percolation at Lysimeter 10.	ICS	10/04/13	11/07/13	11/07/13	11/20/13	11/20/13	11/20/13	All parties concur.
2014-001	Plans for a prescribed burn over ICS and Basin F. The burns will include the entirety of the ICS AMA (approximately 670 acres). Basin F burn is optional (112 acres).	ICS and Basin F	10/23/13 01/15/14	02/03/14	02/03/14	02/12/14	02/12/14	02/12/14	All parties concur.
2014-002	Notification that the Watch List Trigger Level for Endrin was exceeded in HWL LDS4 during the third quarterly sampling event of 2013.	HWL	01/29/14	02/05/14	02/05/14	02/12/14	02/12/14	02/12/14	All parties concur.
2014-003	Notification the PPDDT was detected in HWL LDS4 during the third quarterly sampling event of 2013.	HWL	03/27/14 05/30/14	06/02/14	06/02/14	07/29/14	07/29/14	07/29/14	All parties concur.
2014-004	Notification that chloroform exceeded the Watch List Trigger Level in LBLDS2 in the first quarter of 2013 and that TCLEE was detected in WPLDS2 above the MRL in the second quarter of 2014.	ELF	05/29/14 06/17/14	06/17/14	06/17/14	03/04/15	03/04/15	07/09/14	All parties concur.

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2014-005	Notification that dieldrin exceeded the Watch List Trigger Level in HWL LDS2 in the first quarter of 2013.	HWL	05/29/14	06/17/14	06/17/14	07/29/14	07/29/14	07/09/14	All parties concur.
2014-006	Notification that dieldrin exceeded the prediction limit in well 25194 in the second quarter of 2014.	HWL	06/03/14 07/30/14 10/22/14 04/29/15	NRAP-2014-006 has been superseded by NRAP-2016-004.					Superseded
2014-008	Notification that percolation exceeded the Non-Routine Action Trigger Level in Lysimeters 001, 002, and 003 in June 2014.	ICS	06/09/14 07/09/14 10/28/15	05/02/16	05/04/16	06/16/16	05/26/16	05/26/16	All parties concur.
2014-009	Notification that tipping buckets failed in Lysimeters 001, 002, 003, and 003A.	ICS	07/10/14	07/28/14	07/28/14	07/29/14	07/29/14	07/29/14	All parties concur.
2014-010	Holes in the ICS cover soil	ICS	06/01/15 01/27/16						
2014-011	Notification that toluene was detected for the first time in HWL LDS2 during the July 2014 sampling event.	HWL	08/27/14 02/06/15	02/19/15	02/19/15	03/04/15	03/04/15	03/04/15	All parties concur.
2015-001	Notification that alpha-chlordane exceeded the Watch List Trigger Level in HWL LDS4 in the second quarter of 2015.	HWL	07/13/15	08/11/15	08/11/15	08/20/15	08/20/15	08/11/15	All parties concur.
2015-002	Notification that cyanide was detected for the first time in ELF sump LBLDS2 during the April/May 2015 sampling event.	ELF	07/24/15	08/11/15	08/11/15	08/20/15	08/20/15	08/11/15	All parties concur.

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2015-003	Notification that tipping buckets failed in Lysimeters 001, 002, 003, and 003A.	ICS	07/16/15	08/11/15	08/11/15	08/11/15	08/11/15	08/11/15	All parties concur.
2015-004	Plans for a prescribed burn over ICS. The burn will include the entirety of the ICS AMA (approximately 670 acres).	ICS	09/15/15	09/17/15	09/17/15	10/15/15	10/13/15	10/13/15	All parties concur.
2015-005	Notification that aldrin exceeded the Watch List Trigger Level in HWL LDS4 in the third quarter of 2015.	HWL	07/13/15	09/17/15	09/17/15	10/15/15	10/13/15	10/13/15	All parties concur.
2015-006	Notification that PPDDT, PPDDE, and MEXCLR was detected for the first or third time in ELF LDS sumps during the July 2015 sampling event.	ELF	09/03/15 09/17/15	09/17/15	09/17/15	10/15/15	10/13/15	10/13/15	All parties concur.
2015-007	Modifications to the ICS Type II Inspection scheduled for the fall of 2015	ICS	09/10/15 10/28/15	05/02/16	05/03/16	05/24/16 (email)	05/03/16	05/03/16	All parties concur.
2016-001	Notification that MEXCLR was detected in HWL sump LDS4 during the October 2015 sampling event.	HWL	04/07/16	04/12/16	04/12/16	05/24/16 (email)	05/03/16	04/20/16	All parties concur.
2016-002	Plans for a prescribed burn over ICS. The burn will include the entirety of the ICS AMA (approximately 670 acres).	ICS	09/10/15 10/28/15 01/27/16	02/18/16	02/18/16	03/10/16	03/10/16	03/10/16	All parties concur.
2016-003	Notification that MEK and TCLEA were detected in ELF sump LBLDS2 during the October 2015	ELF	04/13/16	04/12/16	04/12/16	05/24/16 (email)	05/03/16	04/20/16	All parties concur.

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
	sampling event.								
2016-004	Dieldrin exceeded the prediction limit in well 25194. Army/Shell will sample subsurface soil and stormwater runoff, and new well 25184 will be installed.	HWL	06/03/14 08/26/15	07/21/16	07/21/16	07/27/16	09/22/16	08/10/16	All parties concur.
2016-005	Notification that TDGCL was detected in the HWL LDS for the first time during the April 2016 sampling event. ACLDAN and PB were also detected above the watch list trigger level.	HWL	07/27/16 08/24/16	08/31/16	08/31/16	09/22/16	09/22/16	09/22/16	All parties concur.
2016-006	Notification that PPDDT was detected for the third time and CR was detected for the first time in the ELF LDS system during the April 2016 sampling event.	ELF	07/27/16 08/24/16	08/31/16	08/31/16	09/22/16	09/22/16	09/22/16	All parties concur.
2016-007	Notification that ENDRIN and DLDRN concentrations exceeded the watch list trigger level in LDS4 in the October 2016 sampling event.	HWL	01/04/17	01/04/17	01/04/17	01/19/17	01/19/17	01/19/17	All parties concur.
2017-001	Notification that ENDRIN concentrations exceeded the watch list trigger level in LDS4 in the January 2017 sampling event.	HWL	03/13/17	03/14/17	03/14/17	04/26/17	03/23/17 (email) 04/26/17 (wet ink)	03/21/17 (email) 04/26/17 (wet ink)	All parties concur.
2017-002	Notification that DLDRN concentrations exceeded the watch list trigger level in LDS4 in the July 2017 sampling event.	HWL	09/05/17	09/26/17	09/26/17	10/25/17	10/25/17	10/25/17	All parties concur.

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2019-001	Plans for a prescribed burn over ICS. The burn will include the entirety of the ICS AMA (approximately 670 acres).	ICS	03/04/19	03/04/19	03/04/19	05/02/19	03/14/19	03/07/19	All parties concur.
2019-002	Plans for a prescribed burn over Basin F. The burn will include the entirety of the Basin F AMA (approximately 112 acres).	Basin F	03/04/19	03/04/19	03/04/19	05/02/19	03/14/19	03/07/19	All parties concur.
2019-003	Notification that HG was detected for the first time in the ELF sump LB LDS2 during the February 2018 sampling event.	ELF	03/07/19	03/11/19	03/11/19	05/02/19	04/16/19	04/16/19	All parties concur.
2019-004	Installation of monitoring well 36255 near the southeast corner of the Shell Trenches slurry wall.	SDT	07/25/19	08/14/19	08/14/19	08/14/19	08/14/19	08/14/19	All parties concur.
2020-001	Borehole drilling and installation of well 36258 in the west central Shell Disposal Trenches.	SDT	02/20/20	03/23/20	03/24/20	03/25/20	03/25/20	03/25/20	All parties concur.
2020-002	Notification that ICS erosion monument ER90 exceeded the non-routine trigger level of greater than 3.0 inches of soil thickness loss.	ICS	10/21/20	10/22/20	10/23/20	10/23/20	10/23/20	10/26/20	All parties concur.
2021-001	Intrusive activity at well 36305 to investigate power failure at the extraction well.	ICS	06/17/21	06/18/21	06/21/21	06/21/21	06/22/21	06/23/21	All parties concur.
2021-002	Intrusive activity to install new electrical conduit in cover soil between extraction well 36305 and the control panel.	ICS	07/28/21	07/30/21	08/02/21	08/02/21	08/04/21	08/02/21	All parties concur.

NON-ROUTINE ACTION PLAN LOG

Projects: Long-Term Maintenance of the HWL, ELF, ICS, and Basin F RCRA-Equivalent Cover

WBS: 4.01.01, 4.01.02, 4.01.03, and 4.01.04

Number	Description of Condition and Non-Routine Action	Cover/Cap Affected	Consultation Date(s)	Concurrence Dates					Status
				Covers Manager	Army PM	EPA	CDPHE	TCHD	
2021-003	Plans for a prescribed burn over ICS. The burn will include the entirety of the ICS AMA (approximately 670 acres).	ICS	09/30/21	10/04/21	10/04/21	10/04/21	10/05/21	10/04/21	All parties concur.
2021-004	Plans for a prescribed burn over Basin F. The burn will include the entirety of the Basin F AMA (approximately 112 acres).	Basin F	09/30/21	10/04/21	10/04/21	10/04/21	10/05/21	10/04/21	All parties concur.
2021-005	Plans to overseed approximately 100 acres in the southwest corner of the ICS after sparse growth in 2021.	ICS	05/13/21 06/02/21 06/03/21 07/28/21 07/29/21 10/04/21	10/07/21	10/07/21	10/12/21	10/12/21	10/12/21	All parties concur.
2022-001	Notification that the copper concentration exceeded the watch list trigger level in LDS1 in the March 2021 sampling event.	HWL	01/17/22 01/26/22	01/26/22	01/27/22	01/31/22	02/02/22	02/03/22	All parties concur.
2022-002	Plans for a prescribed burn over ICS. The burn will include the entirety of the ICS AMA (approximately 670 acres).	ICS	09/21/22	09/21/22	09/21/22	09/21/22	09/22/22	09/22/22	All parties concur.

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