ROCKY MOUNTAIN ARSENAL

2018 RCRA Landfills and Groundwater Monitoring Report

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LIST OF ACRONYMS

ALR	Action Leakage Rate
AMA	Army Maintained Area
CAMU	Corrective Action Management Unit
CFS	Confined Flow System
CUSUM	Cumulative Sum
ELF	Enhanced Hazardous Waste Landfill
gpad	gallons per acre per day
HWL	Hazardous Waste Landfill
IC	Indicator Compound
LCS	Leachate Collection System
LDS	Leak Detection System
LRCH	Leachate Riser Control House
LS/LF	Leachate Storage and Loadout Facility
MRL	Method Reporting Limit
Navarro	Navarro Research and Engineering, Inc.
NRAP	Non-Routine Action Plan
O&M	Operations and Maintenance
OCN	O&M Change Notice
OMC	Operations and Maintenance Contractor
PCGMP	Post-Closure Groundwater Monitoring Plan
PCGMR	Post-Closure Groundwater Monitoring Report
PCP	Post-Closure Plan
PLC	Program Logic Controller
RCRA	Resource Conservation and Recovery Act
RMA	Rocky Mountain Arsenal
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
UFS	Unconfined Flow System

EXECUTIVE SUMMARY

This *2018 RCRA Landfills and Groundwater Monitoring Report* for the Rocky Mountain Arsenal (RMA) Federal Facility Site was prepared in accordance with the *Hazardous Waste Landfill* (HWL) *Post-Closure Plan* (PCP), Revision 3 (TtEC 2011) and the *Enhanced Hazardous Waste Landfill* (ELF) PCP, Revision 0 (TtEC 2010). The purpose of this report is to provide a summary of post-closure care activities that occurred during the 2018 reporting period of May 01, 2017 through April 30, 2018, and to provide recommendations for the post-closure care during the 2019 reporting period of May 01, 2018 through April 30, 2019. The activities presented in this report include the following items applicable to both the HWL and ELF:

- Army Maintained Area (AMA) inspection results and maintenance activities, both routine and non-routine
- Leachate Collection System (LCS) and Leak Detection System (LDS) operation and maintenance
- Action Leakage Rate (ALR) analysis
- LCS/LDS wastewater management quantities
- LCS/LDS wastewater quality assessment
- Groundwater monitoring and assessment

Section 1.0 of the HWL PCP and ELF PCP states that post-closure, as required by the Resource Conservation and Recovery Act (RCRA), began following the physical completion of the respective caps, and will continue for a minimum of 30 years after those dates. A final inspection meeting and site-walk of the HWL were conducted on May 20, 2009, and a final inspection meeting and site-walk of the ELF were conducted on May 26, 2010. Thus, the HWL post-closure period began May 21, 2009, and the ELF post-closure period began on May 27, 2010.

The HWL facility was inspected, repaired, and maintained in accordance with the HWL PCP and the associated appendices. Similarly, the ELF facility was inspected, repaired, and maintained in accordance with the ELF PCP and the associated appendices. Observations noted during the inspections were evaluated by the Covers Manager, who initiated routine maintenance and non-routine actions as appropriate.

In general, the condition of the HWL soil cap and vegetation were good for the reporting period. Vegetation establishment continued to do well and provide substantial cover. The HWL will continue to be monitored for development of perennial grass species, especially in the reseeded areas. Erosion in high stormwater flow areas and on channel sideslopes was much less severe and widespread than in previous years when the vegetation was still becoming established.

The condition of the ELF cap was good for the reporting period. Establishment of desirable grass species is improving, but still remains somewhat sparse on the south slope. The ELF will continue to be monitored for development of perennial grass species, especially in the reseeded areas. Erosion in high stormwater flow areas and on channel sideslopes was much less severe and widespread than in previous years when the vegetation was still becoming established.

Groundwater flow directions across the entire Corrective Action Management Unit (CAMU) were consistent over the four quarters of 2017 post-closure monitoring and are consistent with previous groundwater monitoring events within the CAMU area. As previously presented, a more pronounced groundwater high is present along the west side of the HWL consistent with recharge from the perimeter ditch located along the west side of the HWL. To provide additional data immediately downgradient of the HWL, well 25184 was installed northwest of the landfill in September 2017.

Dieldrin and lead were the only indicator compounds (ICs) detected in the downgradient HWL wells. Statistical evaluations indicated that neither dieldrin, nor lead, exceeded their respective prediction limits. Therefore the groundwater quality around the HWL has not been affected by waste placement operations, closure, and post-closure operations and maintenance (O&M) of the landfill.

Non-IC analyte endrin was detected in HWL LDS4 in January of 2017 at a concentration above the watch list trigger level. The Regulatory Agencies were notified of the exceedance via emails from an AECOM representative on March 13, 2017 (AECOM 2017). The March 13, 2017 notification regarding endrin included Non-Routine Action Plan (NRAP)-2017-001, which was signed by the Regulatory Agencies on April 26, 2017.

IC analyte dieldrin was detected in July 2017 in LDS4 at a concentration above the watch list trigger level. The Regulatory Agencies were notified of the exceedance via email from an AECOM representative on September 11, 2017 (AECOM 2017a). The September 11, 2017 notification regarding dieldrin included NRAP-2017-002, which was signed by the Regulatory Agencies on October 25, 2017.

Lead was the only IC detected in the downgradient ELF wells, and the lead concentrations were below the calculated prediction limit. There were no detections in the ELF LDS sumps that required Regulatory Agency notification in 2017.

The costs for operating, inspecting, and maintaining the HWL and ELF over the reporting period, including groundwater sampling, LCS/LDS sampling, LCS/LDS O&M, and wastewater disposal, totaled $450,037. Complete budgets for post-closure care of the HWL and ELF for May 2018 through April 2019 have not been approved as of the issuance of this report due to the timing of the annual funding cycle, which typically occurs near the end of the calendar year. However, the combined budgets are estimated to total approximately $540,000.

In summary, and based on the information presented in this report, the HWL and ELF were in compliance with all performance standards and no corrective measures were required. Future plans to maintain the integrity of the caps include continued diligence with weed control, overseeding where necessary, inspection for erosion, and quarterly monitoring the groundwater and LCS/LDS wastewater quality. The Army and Shell will also continue to pursue resolution of dieldrin detections in HWL well 25194, including collecting a sample of stormwater and sampling the groundwater in well 25184 in an attempt to identify the source(s) of dieldrin in well 25194.

1.0 INTRODUCTION

This *2018 RCRA Landfills and Groundwater Monitoring Report* for the Rocky Mountain Arsenal (RMA) Federal Facility Site was prepared in accordance with the *Hazardous Waste Landfill* (HWL) *Post-Closure Plan* (PCP), Revision 3 (TtEC 2011) and the *Enhanced Hazardous Waste Landfill* (ELF) PCP, Revision 0 (TtEC 2010). The purpose of this report is to provide a summary of post-closure care activities that occurred during the 2018 reporting period of May 01, 2017 through April 30, 2018, and to provide recommendations for the post-closure care during the 2019 reporting period of May 01, 2018 through April 30, 2019. The activities presented in this report include the following items applicable to both the HWL and ELF:

- Army Maintained Area (AMA) inspection results and maintenance activities, both routine and non-routine
- Leachate Collection System (LCS) and Leak Detection System (LDS) operation and maintenance
- Action Leakage Rate (ALR) analysis
- LCS/LDS wastewater management quantities
- LCS/LDS wastewater quality assessment
- Groundwater monitoring and assessment

Remediation wastes were disposed in the Corrective Action Management Unit (CAMU) HWL and ELF facilities. State regulations (6 Code of Colorado Regulations 1007-3, Section 264.552) require that areas within the CAMU where remediation wastes remain in place after closure be managed and contained to control, minimize, or eliminate future releases to the extent necessary to protect human health and the environment. During the HWL closure period, a cap was constructed over the HWL as required by the *HWL Closure Plan* (TtEC 2006). Likewise, a cap was constructed over the ELF during the ELF closure phase, as required by the *ELF Closure Plan* (TtEC 2008). The HWL and ELF facilities also include stormwater drainage channels, wastewater conveyance systems, and groundwater monitoring wells. The integrity of both landfills and their supporting systems will be maintained by the Army for the duration of their respective post-closure periods. The Army has contracted Navarro Research and Engineering, Inc. (Navarro) to operate, maintain, and monitor the landfills and their associated systems. Navarro is the prime contractor under the RMA Operations and Maintenance Contract (OMC).

As required by Section 3.9 of the HWL PCP and ELF PCP, this report for 2018 documents maintenance-related activities performed between May 1, 2017 and April 30, 2018, as well as groundwater and LCS/LDS analytical data for samples collected between January 1, 2017 and December 31, 2017.

Section 1.0 of the HWL PCP and ELF PCP states that post-closure, as required by the Resource Conservation and Recovery Act (RCRA), will begin following the physical completion of the respective caps and will continue for a minimum of 30 years after those dates. A final inspection meeting and site-walk of the HWL were conducted on May 20, 2009, and a final inspection meeting and site-walk of the ELF were conducted on May 26, 2010. Thus, the HWL post-closure period began May 21, 2009, and the ELF post-closure period began on May 27, 2010.

The HWL and ELF facilities are located adjacent to each other within the northwest quadrant of Section 25, within the boundaries of the Rocky Mountain Arsenal National Wildlife Refuge perimeter fence. The Rocky Mountain Arsenal National Wildlife Refuge is managed by the U.S. Fish and Wildlife Service. The two facilities are surrounded by a common fence, which defines the AMA for the HWL and ELF. This AMA includes both landfills and surrounding support facilities, and occupies roughly 130 acres. The ground surface elevation of the facilities generally ranges between 5,200 and 5,300 feet above mean sea level. No 100-year floodplains have been identified in this area.

All components of the HWL and ELF facilities within, and including, the fence are addressed in this report. Refer to the HWL PCP and ELF PCP for additional detail regarding each component.

2.0 METHODOLOGY

The HWL facility was inspected, repaired, and maintained in accordance with the HWL PCP and the associated appendices. Similarly, the ELF facility was inspected, repaired, and maintained in accordance with the ELF PCP and the associated appendices. Observations noted during the inspections were evaluated by the Covers Manager, who initiated routine maintenance and non-routine actions as appropriate.

2.1 Type I, Type II, and Post-Storm Inspections

2.1.1 HWL Inspections

The procedures for inspecting the HWL soil cap and infrastructure features are detailed in Standard Operating Procedure (SOP) HWL-001, presented in Appendix A of the HWL PCP. The SOP provides procedures for Type I and Type II inspections, as well as a procedure for measuring the loss of cap soil thickness. Type I inspections were conducted quarterly, Type II inspections were conducted semiannually, and post-storm inspections were conducted after rain events in which RMA received more than one inch of precipitation in a 24-hour period. Results of the HWL inspections are discussed in Section 4.1.

2.1.2 ELF Inspections

The procedures for inspecting the ELF soil cap and infrastructure features are detailed in SOP ELF-001, presented in Appendix A of the ELF PCP. The SOP includes procedures for Type I and Type II inspections, as well as a procedure for measuring the loss of cap soil thickness. Type I inspections were conducted quarterly, Type II inspections were conducted semiannually, and post-storm inspections were conducted after rain events in which RMA received more than one inch of precipitation in a 24-hour period. Results of the ELF inspections are discussed in Section 5.1.

2.2 Maintenance and Repair Activities

Examples of routine maintenance and repair activities for the HWL are listed in Table 3.0-1 of the HWL PCP, while conditions requiring Non-Routine Actions are listed in Table 3.0-2 of the HWL PCP. Likewise, examples of routine maintenance and repair activities for the ELF are listed in Table 3.0-1 of the ELF PCP, while conditions requiring Non-Routine Actions are listed in Table 3.0-2 of the ELF PCP. Routine and non-routine maintenance and repair activities are discussed in Sections 4.2 and 5.2.

2.3 LCS/LDS Sump Inspection, Sampling and Analysis

2.3.1 HWL LCS/LDS Sumps

Quarterly inspection of the HWL LCS and LDS Wastewater Conveyance System were performed in accordance with the *HWL Post-Closure Wastewater Management Plan*, presented in Appendix C of the HWL PCP. Sampling and analysis of the HWL LCS and LDS liquids were performed quarterly in accordance with the *HWL Post-Closure Groundwater Monitoring Plan* (PCGMP), presented in Appendix B of the HWL PCP. Samples collected from the HWL LCS and LDS sumps were analyzed using methods that captured all analytes on the Indicator Compounds List. In April of 2017, wastewater from the LCS and LDS sumps were analyzed for the complete analyte list as shown in Table 3.2-2 of the HWL PCGMP. Analytical results and data evaluation for HWL post-closure LCS and LDS wastewater sampling performed from January through December of 2017 are presented in the *2017 HWL Post-Closure Groundwater Monitoring Report* (PCGMR), provided in Appendix F-1 of this report.

2.3.2 ELF LCS/LDS Sumps

Quarterly inspections of the ELF LCS and LDS Wastewater Conveyance System were performed in accordance with the *ELF Post-Closure Wastewater Management Plan*, presented in Appendix C of the ELF PCP. Sampling and analysis of the ELF LCS and LDS liquids were performed quarterly in accordance with the ELF PCGMP, presented in Appendix B of the ELF PCP. Samples collected from the ELF LCS and LDS sumps were analyzed using methods that captured all analytes on the Indicator Compounds List. In April of 2017, wastewater from the LCS and LDS sumps were analyzed for the complete analyte list as shown in Table 3.2-3 of the ELF PCGMP. Analytical results and data evaluation for ELF post-closure LCS and LDS wastewater sampling performed from January through December of 2017 are presented in the 2017 ELF PCGMR, provided in Appendix F-2 of this report.

2.4 ALR Evaluation

The ALR is the liquid flow rate that, when withdrawn from the LDS sumps, warrants follow-up actions. The ALR represents the capacity of the LDS to transmit flow and is independent of the sources of the liquids flowing into the system.

The monthly flow rate data was converted to an average daily flow rate for each of the HWL and ELF LDS sumps. The average daily flow rates for the HWL LDS sumps were compared with the ALRs identified in the *HWL Post-Closure Action Leakage Rate/Response Action Plan* presented in Appendix D of the HWL PCP, and the Non-Routine Action Trigger Levels presented in Table 3.0-2 of the HWL PCP. Likewise, the average daily flow rates for the ELF LDS sumps were compared with the ALRs identified in the *ELF Post-Closure Action Leakage Rate/Response Action Plan* presented in Appendix D of the ELF PCP, and the Non-Routine Action Trigger Levels presented in Table 3.0-2 of the ELF PCP. Results of the HWL ALR comparison and ELF ALR comparison are presented in Section 6.1.2 and 6.3.2, respectively.

2.5 Groundwater Sampling

2.5.1 HWL Groundwater Sampling

The HWL PCGMP, presented in Appendix B of the HWL PCP, was implemented quarterly with inspection and sampling of groundwater monitoring wells in the HWL groundwater monitoring well network. The network of groundwater monitoring wells, both upgradient and downgradient

of the HWL is intended to monitor for existing hazardous constituents in the groundwater, and to monitor for potential releases of hazardous constituents from the HWL. Analytical results and data evaluation for post-closure groundwater sampling performed from January through December of 2017 are presented in Appendix F-1 of this report.

2.5.2 ELF Groundwater Sampling

The ELF PCGMP, presented in Appendix B of the ELF PCP, was implemented quarterly with inspection and sampling of groundwater monitoring wells in the ELF groundwater monitoring well network. The network of groundwater monitoring wells, both upgradient and downgradient of the ELF is intended to monitor for existing hazardous constituents in the groundwater, and to monitor for potential releases of hazardous constituents from the ELF. Analytical results and data evaluation for post-closure groundwater sampling performed from January through December of 2017 are presented in Appendix F-2 of this report.

3.0 PRECIPITATION DATA

Precipitation data presented in Appendix A were collected from a rain gauge located on the Shell Disposal Trenches RCRA-Equivalent Cover in Section 36, which is located approximately 1.5 miles south of the HWL and ELF. Total precipitation measured at the RCRA-Equivalent Cover between May 1, 2017 and April 30, 2018 was 10.92 inches. Significant storm events are defined as an event in which more than 1.0 inch of precipitation falls in a 24-hour period. Two significant storm events occurred within this reporting period; first on May 8, 2017 (1.18 inches of rain), then again on May 18, 2017 (1.37 inches of rain).

4.0 HWL CAP ASSESSMENT, MAINTENANCE AND REPAIR ACTIONS

In general, the condition of the HWL soil cap and vegetation were good for the reporting period. Vegetation establishment continued to do well and provide adequate cover. Erosion in high stormwater flow areas and on channel sideslopes continued to be less severe and widespread than in previous years when the vegetation was still becoming established.

4.1 HWL Cap Inspections

The HWL cap was inspected quarterly, semiannually, and after significant storm events for this reporting period. Table 4.1-1 presents the dates and types of inspections performed.

Table 4.1-1: HWL Inspections

DATE	INSPECTION TYPE	NOTE
May 9, 2017	Post-Storm	Post-Storm Inspection from precipitation event on May 8, 2017
June 7, 2017	Post-Storm	Post-Storm Inspection from precipitation event on May 18, 2017
July 12, 2017	Type I	Regularly scheduled quarterly inspection.
September 21, 2017	Type II	Regularly scheduled semiannual inspection.
December 13, 2017	Type I	Regularly scheduled quarterly inspection.
April 5, 2018	Type II	Regularly scheduled semiannual inspection.

During inspections, inspectors evaluated the condition of the soil cap surface for evidence of erosion, cracking, subsidence, ponding of rainwater, and the presence of burrowing animals.

Other features, such as the vegetative cover, engineering and access controls, surface water controls, and erosion/settlement monuments were also inspected. Specific inspection items are listed on forms SOP HWL 001-1 and SOP HWL 001-2, contained in Appendix A of the HWL PCP. Copies of the completed inspection forms are provided in Appendix B-1.

4.2 HWL Inspection Observations and Associated Repairs

The inspection observations listed below were identified during the Post Storm, Type I, and Type II inspections. The presence of weedy species was observed during routine vegetation inspections performed independently of the Type I and Type II inspections. These observations triggered weed control efforts that are also described below. Documentation of HWL maintenance activities are provided in Appendix C-1 and are illustrated on Figure 4.2-1.

- During the post storm inspection conducted in May 2017, the northeast manhole access road was observed to have erosion. In June 2017, the northeast manhole access road was graded using a motor grader to repair the erosion.
- Erosion was observed on the outlet end of the concrete box culvert in the northwest perimeter channel. This area was repaired in November 2017 by scuffing up the soil using the teeth of the backhoe bucket, hand seeding the area, and then installing erosion control logs and blankets over the seeded area.
- An animal trail was identified on the northwest corner of the HWL. There was an open gate adjacent to where the trail started. This gate was closed. The animal trail will continue to be monitored for erosion and vegetation establishment.
- Cover soil from the Long Term Care Stockpile and four-inch minus rock from the Section 25 Stockpile were used to create rock-amended soil. This soil was used to return the local depression around erosion monument EM-HWL01 to surrounding grade.
- Noxious and undesirable weeds were identified on the HWL. Weed control efforts were ongoing using ground herbicide application.
- Areas of poor vigor in the western support area of the HWL were broadcast seeded with purple three-awn (*Aristida purpurea*).

The maintenance items listed below were identified as improvements that were necessary to facilitate effective operation and maintenance of the HWL and were not the result of inspection observations.

- Tumble weeds were removed off the perimeter fence.
- In December 2017, a combination of herbicides was used to ground clear the perimeter roads, the manhole access roads, around bollards, and in working areas so that personnel can work safely in these areas.

4.3 HWL Erosion/Settlement Monuments

During the Type II inspections in September 2017 and April 2018, the erosion/settlement monuments were measured for soil thickness loss. The measured soil thickness loss for all nine monuments ranged from 0.0 to 1.75 inches, which is below the Non-Routine Action trigger level of 0.4 feet (or 4.8 inches) and the compliance level of 1.0 foot. The position of each monument

was also surveyed as part of the semiannual inspections. Survey data are included in Appendix D, together with data collected during prior surveys for reference.

Erosion monument EM-HWL01 measured 4.0 inches of soil loss during the September 2016 Type II inspection and measured 4.25 inches of soil loss during the April 2017 Type II inspection. Although these measurements are below the Non-Routine Action trigger level of 0.4 feet (4.8 inches), the OMC inspected the monument and surrounding area for indications of potential issues. Inspectors noted that the monument was located within a localized depression, which has been commonly observed around the HWL and ELF erosion/settlement monuments in the past. The soil thickness loss was most likely a result of natural consolidation of loosely compacted soil around the monument and is not representative of a broader impact area. In January 2017, OMC personnel surveyed a tight grid around EM-HWL01 to find the extent of the soil loss and distributed this information to the Regulatory Agencies. This survey data also established that the repair for this monument required approximately one cubic yard of rock amended soil. Though the loss of soil thickness at this monument did not trigger a non-routine action, it was in the Army's best interest to fill the depression around the monument to match the surrounding grade. Maintenance was performed on this erosion monument in June 2017. The subsequent measurements after the repair of this erosion monument during the Type II inspections in September 2017 and April 2018 were 0.0 inches.

4.4 HWL Vegetation

Established areas of seeded vegetation on the HWL cap continue to do well and provide substantial cover limiting soil erosion in most areas. Perennial species on the south facing area remain scattered, but are increasing. Much of the relatively dense growth of annual weedy species that has occurred in the past has been controlled releasing the established perennial species to expand. On the other aspects and on top of the HWL, cool season grass species, especially Western Wheatgrass (*Pascopyrum smithii*) continue to dominate the grass community with the diversity of seeded native grasses established. Broadleaf weedy species, especially Kochia (*Bassia scoparia*), Horseweed (*Conyza canadensis*), and prickly lettuce (*Lactuca seriola*) were abundant in localized areas. Cheatgrass (*Anisantha tectorum*), is much less abundant and appears to have been controlled effectively by herbicide treatment. Monitoring of cheatgrass will continue, as will investigation of control methods.

Litter continues to be abundant on the HWL. The plant community continues to exhibit the wide swings in variation associated with early successional communities or highly disturbed areas. Methods to promote stability of the developing plant community, such as control of annual weeds, fertilization or other means to increase seed production, and introduction of biological controls for perennial weeds, especially on the south aspect, will be considered.

5.0 ELF CAP ASSESSMENT, MAINTENANCE AND REPAIR ACTIONS

The condition of the ELF cap was good for the reporting period. Establishment of desirable grass species is improving, but continues to remain somewhat sparse on the south slope. The ELF will continue to be monitored for development of perennial grass species, especially in the reseeded areas. Erosion in high stormwater flow areas and on channel sideslopes was much less severe and widespread than in previous years when the vegetation was still becoming established.

5.1 ELF Cap Inspections

The ELF cap was inspected quarterly and semiannually. Table 5.1-1 presents the dates and types of inspections performed during this reporting period.

Table 5.1-1: ELF Inspections

DATE	INSPECTION TYPE	NOTE
May 9, 2017	Post-Storm	Post-Storm Inspection from precipitation event on May 8, 2017
June 7, 2017	Post-Storm	Post-Storm Inspection from precipitation event on May 18, 2017
July 12, 2017	Type I	Regularly scheduled quarterly inspection.
September 21, 2017	Type II	Regularly scheduled semiannual inspection.
December 13, 2017	Type I	Regularly scheduled quarterly inspection.
April 5, 2018	Type II	Regularly scheduled semiannual inspection.

During inspections, inspectors evaluated the condition of the soil cap surface for evidence of erosion, cracking, subsidence, ponding of rainwater, and the presence of burrowing animals. Other features, such as the vegetative cover, trench drain outlets, engineering and access controls, surface water controls, erosion/settlement monuments, and the Leachate Storage and Loadout Facility (LS/LF) building, were also inspected. Specific inspection items are listed on forms SOP ELF 001-1 and SOP ELF 001-2, contained in Appendix A of the ELF PCP. Copies of the completed inspection forms are provided in Appendix B-2.

5.2 ELF Inspection Observations and Associated Repairs

The inspection observations listed below were identified during the Post Storm, Type I, and Type II inspections. The resulting maintenance and repair activities are discussed following each observation. Documentation of ELF maintenance activities are provided in Appendix C-2 and are illustrated on Figure 5.2-1.

- The northeast, southeast, and southwest downchute dissipators had sediment and debris present. These areas were cleaned out in July 2017.
- Noxious and undesirable weeds were identified on the ELF. Weed control efforts were ongoing using ground herbicide application.
- Inactive animal burrows were identified in the east perimeter road and along the south perimeter road. A depression and a sinkhole were also identified along the south perimeter road. These areas were repaired in June 2017.
- During the April 2017 Type II inspection, there were areas identified on top of the ELF cap and on the south slope that would benefit from over seeding due to poor vigor. These areas were broadcast seeded with purple three-awn (*Aristida purpurea*) in October 2017.
- Tumble weeds were noted to have collected in the west and north perimeter channels during the 2017 spring Type II inspection. The tumble weeds were smashed in place in July 2017. While performing the April 2018 Type II inspection, tumble weeds were identified in the west perimeter channel. However, strong winds were experienced on April 17, 2018 and the tumble weeds were blown from the channel.

- An erosion rill was observed in the southwest perimeter channel across from the southwest downchute. The rill was repaired using soil from the Long Term Soil stockpile in July 2017.

- An area in the southwest perimeter channel was repaired using rocks to harden the surface of the channel in July 2017. This area has had erosion in the past from the Section 25 stockpile area draining across the perimeter road and into the ELF perimeter channel.

- Erosion was observed on the southeast perimeter road. OMC maintenance repaired the erosion on the road and cut deeper channels along the road edge to shed storm water drainage and to help prevent erosion in the future. This repair was made in June 2017.

- Two burrowing animal holes were identified along the south perimeter road during the December 2017 Type I inspection. OMC personnel set up a trail camera at each of the holes. The trail camera document rabbits and a badger visiting the hole. Also, during the April 2018 Type II inspection, two more holes were identified along the south perimeter road. These holes were not repaired during this reporting period and will be discussed in the 2019 Landfills and Groundwater Monitoring Report.

The maintenance items listed below were identified as improvements that were necessary to facilitate effective operation and maintenance of the ELF and were not the result of inspection observations.

- In December 2017, a combination of herbicides was used to ground clear the perimeter roads, the manhole access roads, around bollards, and in working areas so that personnel can work safely in these areas.
- Tumble weeds were removed from the perimeter fence.

- In April 2018, after heavy winds, the gate on the northwest corner of the ELF perimeter fence had become loose. The hinge was tightened and the gate was secured.

5.3 ELF Erosion/Settlement Monuments

During the Type II Inspections in September 2017 and April 2018, the erosion/settlement monuments were measured for soil thickness loss. The measured soil thickness loss for all eight monuments ranged from 1.5 to 4.0 inches, which is below the Non-Routine Action trigger level of 0.4 feet (4.8 inches). The position of each monument was also surveyed as part of the semiannual inspections. Survey data are included in Appendix D, together with data collected during prior surveys for reference.

5.4 ELF Anchor Trench Drains

The ELF anchor trench drain outfalls were inspected in accordance with the SOP for evidence of flow, erosion, seepage, moisture or bare/sparse vegetation. The inspections were documented on Type I and Type II inspection forms provided in Appendix B-2. All of the outfalls were free of flow and indications of moisture on all of the inspections for this reporting period.

5.5 ELF Vegetation

Seeded vegetation on the ELF cap continues to improve and provide greater cover. Plants of established seeded species are developing and reproducing. Sand dropseed (*Sprobolus cryptandrus*), blue gramma (*Chondrosum gracile*) and buffalo grass (*Buchloe dactyloides*) are common seeded species. Cool season grass species, especially Western Wheatgrass (*Pascopyrum smithii*) continue to provide more abundant cover on the ELF cap than in years past. The portion of the south face between the perimeter channel and the mid-slope drainage channel continues to be poorly vegetated by perennial species. However, cheatgrass (*Anisantha tectorum*), has been controlled in this area through herbicide treatments, and a perennial grass species (*Aristida purpurea*, purple three-awn) has been broadcast over the area. Results of the seeding will be evaluated through the 2018 growing season.

The area near the gas vent layer's perimeter continues to have sparse vegetation cover by both annual and perennial vegetation. No change in this status is expected because the soil thickness in this zone above the gas vent layer's filter fabric is too thin to support plant growth, especially in hot, dry weather.

The ELF will continue to be monitored for development of perennial grass species. Maintenance activities will be conducted at regular and necessary intervals. Bare areas on the site were seeded in the fall of 2017. The area will be evaluated for additional seeding activities and herbicide applications in the fall of 2018.

6.0 LCS/LDS AND GROUNDWATER MONITORING

6.1 HWL LCS/LDS Operations

The Wastewater Operator used flowmeter data to calculate monthly flow rates. Flow meters record the actual volume removed from the sumps and these data are downloaded daily into the RMA Environmental Database. The monthly flow summaries are provided in Appendix E. On a quarterly basis, the Wastewater Operator also inspected the sump level in the manholes and inspected the manholes for damage.

6.1.1 HWL LCS/LDS Inspections and Maintenance

The Wastewater Operators inspected and maintained the HWL LCS/LDS in accordance with Sections 3.1.3 and 3.1.4 of the *HWL Post-Closure Wastewater Management Plan*, contained in Appendix C of the HWL PCP. The following routine maintenance and repair activities were performed on the HWL LCS/LDS.

- Performed monthly inspections on the HWL emergency lights and fire extinguishers.
- Performed inspections on the lift station liner leak detection and conveyance pipelines leak detection.
- Performed quarterly inspections on the HWL LCS/LDS Wastewater Conveyance System.
- Performed quarterly inspections for grounding and tool safety inspections and first aid kits.
- Performed weekly LS/LF tank inspections.
- Transferred wastewater from the HWL LCS/LDS manholes to the lift station, and then to the storage tanks in the LS/LF building as needed.

- Clean Harbors collected wastewater for off-site shipment and disposal.
- Worked on several issues with the leak detection system at the Lift Station and installed a new zone splitter.
- Installed a new controller in LDS-1.
- The ViewPoint software used to monitor sump levels and flow rates remotely was not receiving information from the HWL Lift Station. The Program Logic Controller (PLC) had lost the program memory. The program was reloaded into the PLC and no further issues were observed.
- Replaced the PLC and battery in the Lift Station.
- Replaced the Zener barriers for LCS-1, LDS-1, LCS-2, LCS-3 and LDS-3.
- Installed a surge protection device on signal wires for level probes at LCS-1, LDS-1, LCS-2, LCS-3 and LDS-3.
- Replaced GFI for LDS-2.

The Wastewater Operators documented system inspections on inspection forms included in the *HWL Post-Closure Wastewater Management Plan*. Copies of the completed quarterly inspection forms are provided in Appendix B-1. Also, a system maintenance database was used to document inspections and maintenance activities. The Wastewater Operations and Maintenance (O&M) Reports, provided in Appendix C-1, were generated by the database and include log entries for inspections and maintenance activities.

6.1.2 HWL ALR Comparison

Each month OMC personnel calculated the wastewater collection rate in each LDS sump and compared that rate to the ALR for the respective sump as described in the *HWL Post-Closure Action Leakage Rate/Response Action Plan*, provided in Appendix D of the HWL PCP. The average daily flow rate was calculated as the volume of liquid pumped from the sump during the month, divided by the acreage of surface area served by the sump; divided by the number of days in the month. This average value is defined as the average daily flow rate and is expressed as gallons per acre per day (gpad). This average daily flow rate was then compared to the ALR and 85 percent of the ALR for the HWL to determine whether any response action is necessary. Table 6.1.2-1 presents the comparisons and conclusions for HWL LDS sumps 1 through 4. In all cases, the average daily flow rates were much lower than the ALR and the Non-Routine Action trigger level of 85 percent of the ALR. Hence, the performance standards and Non-Routine Action trigger levels for leak detection liquids were not exceeded. Appendix E provides the monthly flow summaries used to calculate the average daily flow rates for each of the sumps.

6.1.3 HWL Wastewater Management Quantities

When wastewater in the HWL LCS and LDS sumps reached the high level switch settings of 30 inches and 20 inches of head, respectively, or when quarterly or annual wastewater samples were collected from the sumps, wastewater was transferred to the lift station, and then to the two storage tanks located in the LS/LF building. The wastewater was stored in these tanks until a tanker truck arrived to transport the material off site for disposal. Approximately 21,490 gallons of HWL wastewater were transported off-site for disposal between May 2017 and April 2018.

That equates to a 23.5 percent decrease in wastewater compared to the previous period of May 2016 to April 2017 when 28,077 gallons of wastewater were shipped off site. The trend in HWL wastewater production continues to decrease. Refer to Table 6.1.3-1 for historical HWL wastewater volumes.

Table 6.1.3-1: HWL Wastewater Production

REPORTING YEAR	REPORTING PERIOD	WASTEWATER QUANTITY (gallons)
2010	May 2009 to April 2010	88,543
2011	May 2010 to April 2011	57,628
2012	May 2011 to April 2012	56,417
2013	May 2012 to April 2013	48,104
2014	May 2013 to April 2014	45,161
2015	May 2014 to April 2015	28,037
2016	May 2015 to April 2016	30,736
2017	May 2016 to April 2017	28,077
2018	May 2017 to April 2018	21,490

6.1.4 HWL LCS/LDS Wastewater Quality

Analytical data from the HWL LCS/LDS wastewater sampling is provided in this report in accordance with Section 3.9 of the HWL PCP. The HWL PCP requires the reporting of wastewater analytical data for the 12-month period from January 1 to December 31 that precedes the submittal of this report. For this report, the reporting period for HWL LCS/LDS wastewater quality is January 1, 2017 to December 31, 2017. Wastewater from the LCS/LDS is sampled quarterly for indicator compounds (ICs) and annually in the second quarter of the calendar year (typically in April) for the full analyte suite. The purpose of the samples collected from the LCS/LDS sumps is to meet the requirements of the HWL PCP and to evaluate the chemistry of the wastewater in order to determine potential leakage from the HWL.

This section presents a summary of analytical results from post-closure LCS/LDS wastewater monitoring at the HWL. Refer to the 2017 HWL PCGMR, provided in Appendix F-1 of this report, for additional details regarding the methods, results and conclusions of post-closure LCS/LDS wastewater sampling performed between January and December of 2017.

6.1.4.1 *HWL LCS Analytical Results*

Analytical results from the LCS leachate samples were consistent with wastes placed in the landfill and were within the chemical groups used in determining potential groundwater impacts.

The ICs detected in the HWL LCS sumps in 2017 include arsenic, benzene, dichlorodifluoromethane, DCPD, dieldrin, DIMP, and lead. Analytical results from the LCS sump samples are included in Appendix F-1.

6.1.4.2 *HWL LDS Analytical Results*

It is common for analytes to be detected in HWL LDS sump samples. Typically the detections are attributed to contaminants in the LCS clay liner material and consolidation water, rather than indications of leaks in the liner system. The soil used to construct the compacted clay liners of the HWL contained low levels of RMA contaminants that only became detectable after they were mobilized in water and analyzed using a method that had a much lower method reporting limit (MRL) than what can be achieved in soil analyses.

Analytes detected in the LDS sumps are presented in Appendix F-1 of this report. The ICs detected in the HWL LDS sumps include dichlorodifluoromethane, dieldrin, and lead. Analytes listed in Table 6.1.4.2-1 were detected during the 2017 HWL LDS sump sampling program and required action.

Table 6.1.4.2-1 lists the 2017 analytical results that required Regulatory Agency notification per Table 3.0-2 of the HWL PCP; specifically, analytes detected in the LDS wastewater samples that required reporting if detected (HWL PCGPM Table 3.2.5-3) or exceeded the Watch List Trigger Level (HWL PCGMP Table 3.2.5-2). The Regulatory Agencies were notified of each of the exceedances via email and accompanying Non-Routine Action Plans (NRAPs).

Table 6.1.4.2-1: HWL LDS Sump Non-Routine Action Plan Notifications

ANALYTE	NRAP NUMBER	CLASS	SUMP	SAMPLE DATE	CONCEN-TRATION (µg/L)	REPORTING LIMIT (µg/L)	WATCH LIST TRIGGER (µg/L)
Endrin	2017-001	Watch List	LDS4	1/18/17	0.184	0.00399	0.088
Dieldrin	2017-002	Watch List	LDS4	7/12/17	0.0867	0.00361	0.073

6.2 HWL Groundwater Monitoring and Assessment

Similar to the reporting requirements for HWL LCS/LDS wastewater sampling, Section 3.9 of the HWL PCP requires analytical data from the post-closure groundwater sampling to be reported in this report for the 12-month period from January 1 to December 31 that precedes the submittal of this report. For this report, the reporting period for post-closure groundwater monitoring is January 1, 2017 to December 31, 2017. The purpose of the post-closure groundwater sampling is to meet the requirements of the HWL PCP, to monitor groundwater flow directions and groundwater quality beneath and around the HWL, and to monitor for potential releases of hazardous constituents from the HWL.

Sampling of the HWL groundwater was performed quarterly in conjunction with the HWL LCS/LDS wastewater sampling described above. The 2017 HWL PCGMR provided in Appendix F-1 presents the methods, results, and conclusions of post-closure groundwater monitoring performed over four quarterly sampling events in the calendar year of 2017.

6.2.1 CAMU Groundwater Flow Direction

Water levels were measured quarterly at 68 wells, including new well 25184, to evaluate the groundwater flow directions in the Unconfined Flow System (UFS) and Confined Flow System

(CFS) in the area of the CAMU. This information was used to evaluate groundwater flow for significant changes in flow direction over time. The water level data are presented in tabular and graphical form in Appendix F-1 of this report. Across the entire CAMU, groundwater flow within the UFS and CFS is generally to the north and northwest. No significant variations in groundwater flow directions were identified in 2017. With the exception of well 25194 discussed below, the overall groundwater flow direction is consistent with previous post-closure monitoring in the CAMU area.

In annual reports published prior to 2014, water level data from well 25194 was considered unacceptable for use in contouring the UFS. Based on surrounding wells, water levels from well 25194 did not appear representative of the actual water table elevation in the UFS, and appeared to be the result of a perched zone in the UFS. Based on a re-evaluation of the site hydrogeology performed in 2014, water level data, and water quality data for well 25094, predecessor to well 25194, the water levels in well 25194 do appear to be representative of the UFS. Consequently, it was used in contouring the UFS water elevations shown in the 2017 HWL PCGMR included in Appendix F-1 of this report. With inclusion of well 25194 in the UFS, the groundwater contour map shows a more pronounced groundwater high along the west side of the HWL similar to the observed water table in 2016. This configuration of the water table is consistent with recharge from the grass-lined perimeter channel located along the west side of the HWL. This interpretation is further supported by the increasing trend in water elevations in other monitoring wells located on the west side of the HWL.

6.2.2 HWL Impacts on Groundwater Quality

The results from the water quality sampling completed during 2017 post-closure groundwater monitoring period were compared to the prediction limits calculated from the 2016 sampling results to determine if groundwater quality was impacted by the HWL in 2017. Dieldrin and lead were the only ICs detected in the downgradient wells. Lead was detected in wells 25087, 25194, and 25195 at concentrations ranging from 3.0 µg/L to 3.8 µg/L. The lead detections did not exceed the 2017 prediction limit (15 µg/L). Dieldrin was detected at concentrations ranging from 0.038 µg/L to 0.047 µg/L in downgradient well 25194. Dieldrin concentrations in well 25194 did not exceed the 2017 prediction limit of 0.05 µg/L.

Further evaluation of dieldrin included an intrawell comparison performed using a combined Shewhart-Cumulative Sum (CUSUM) control chart to determine whether the HWL impacted the presence of dieldrin in groundwater at well 25194. The control chart, and a corresponding evaluation of the chart, is included in the 2017 HWL PCGMR in Appendix F-1.

The HWL PCP also provides for the use of trend analysis to evaluate groundwater quality. Further evaluation of dieldrin concentrations using Mann-Kendall trend analysis shows that in 2016 and 2017, dieldrin concentrations in well 25194 have exhibited a decreasing trend. Supporting documentation related to the Mann-Kendall trend analysis is provided in the 2017 HWL PCGMR in Appendix F-1.

Based on the statistical evaluations and trend analysis presented in the 2017 HWL PCGMR, it is concluded that groundwater quality in the vicinity of the HWL has not been affected by waste placement operations, closure, and post-closure O&M of the landfill.

6.2.3 Wells 25194 and 25184

Well 25194 is classified as a downgradient well in the HWL groundwater monitoring network and is located southwest of the landfill's northwest corner, near the western perimeter stormwater drainage channel. Well 25194 has had detections of dieldrin each quarter since July 2011. However, there are no indications that the dieldrin detected in well 25194 originated from the HWL. The Army, Shell, and Regulatory Agencies began using the consultative process in April 2014 to discuss potential sources of the dieldrin, to develop a plan to identify the source(s), and to discuss the potential re-evaluation of the wells downgradient classification.

As part of the consultative process, the Army and Shell prepared NRAP-2016-004 (Navarro 2016a), which presented potential sources of dieldrin detected in well 25194 and documented the agreements reached between the Parties to pursue an investigation into the source of the dieldrin and install a new well downgradient of the HWL. The final Regulatory signature for the NRAP was provided on September 22, 2016.

The Army and Shell also prepared *Hazardous Waste Landfill Groundwater Monitoring Wells 25194 and 25184 Subsurface Soil and Landfill Stormwater Runoff Sampling and Analysis Plan* (SAP) (Navarro 2016b) to sample subsurface soil at the location of new well 25184 and a borehole near well 25194, as well as surface water runoff from the HWL. The final SAP was dated on November 17, 2016. Soil sampling activities were completed in September 2017. A surface runoff sample was not collected during this reporting period and is planned for calendar year 2018.

Lastly, the Army and Shell prepared O&M Change Notice (OCN)-HWL-2017-001 in March 2017. The OCN included a specification for installation of new well 25184 located downgradient of the HWL, and changes to the HWL PCGMP adding well 25184 to the HWL groundwater monitoring network. The OCN was approved by the Regulatory Agencies on April 26, 2017, and well construction was completed in September 2017. Water level measurements were taken once the well was installed and developed, but water levels were below the bottom of the well screen. The groundwater elevations may increase seasonally following wetter periods of the year. If the well produces sufficient water, the well will be sampled in accordance with the HWL PCGMP. Field documentation for the installation of well 25184 is included in Appendix H.

After the analytical data from subsurface soil and stormwater runoff are evaluated, the Army and Shell will theorize the most likely source of the dieldrin in well 25194. The Army and Shell will also evaluate the integrity of the downgradient HWL groundwater monitoring network after well 25184 can be sampled. These evaluations will be used to assess the classification of well 25194 and determine if the current classification is appropriate. The results of these evaluations will be presented to the Regulatory Agencies and any modifications to the HWL groundwater monitoring network will be proposed in OCNs.

6.3 ELF LCS/LDS Operations

The Wastewater Operator used flowmeter data to calculate monthly flow rates. Flow meters record the actual volume removed from the sumps and these data are downloaded daily into the RMA Environmental Database. The flow summaries have been provided on a weekly basis in previous reports, but these weekly sump level inspections and weekly flow rate calculations were

performed more frequently than required by the ELF PCGMP. The monthly flow summaries are provided in Appendix E. On a quarterly basis, the Wastewater Operator also inspected the sump level in the Leachate Riser Control House (LRCH) buildings and inspected the piping for damage.

6.3.1 ELF LCS/LDS Inspections and Maintenance

The Wastewater Operators inspected and maintained the ELF LCS/LDS and associated buildings in accordance with Sections 3.1.3 and 3.1.4 of the *ELF Post-Closure Wastewater Management Plan*, contained in Appendix C of the ELF PCP. The following routine maintenance and repair activities were performed on the ELF LCS/LDS.

- Performed quarterly inspections on the LB LRCH building, the WP LRCH building, and the LS/LF building.
- Performed quarterly inspections on the ELF LCS/LDS Wastewater Conveyance System.
- Recorded monthly sump and tank levels for the ELF LCS/LDS and LS/LF building.
- Performed weekly LS/LF tank inspections.
- Performed monthly inspections on emergency/exit lights in the LS/LF building, and both LRCH buildings.
- Performed quarterly inspections for grounding and tool safety inspections and first aid kits.
- Transferred wastewater from the ELF LCS/LDS sumps to the tanks in the LS/LF building as needed.
- Clean Harbors collected wastewater for off-site shipment and disposal.
- Pumped stormwater out of the LS/LF building floor sump.
- Reset the radio in the LB LRCH building to reestablish communication with ViewPoint, the remote monitoring software.
- Repaired the camera in the LS/LF building. When that camera failed, a new camera was installed.
- Verified Interlocks and Call Out Sumps in all three of the ELF buildings and cleaned the probes in LT-401 and LT-402.
- Repaired the emergency exit lights above the south door in the LS/LF building and in the WP LRCH building.
- Replaced the batteries in the PLCs at the LS/LF, WP LRCH, and WP LRCH.
- Replaced the heater motor in the LS/LF building.

The Wastewater Operators documented system inspections on inspection forms included in the *ELF Post-Closure Wastewater Management Plan*. Copies of the completed quarterly inspection forms are provided in Appendix B-2. Also, a system maintenance database was used to document inspections and maintenance activities. The Wastewater O&M Reports, provided in Appendix C-2, were generated by the database and include log entries for inspections and maintenance activities.

6.3.2 ELF ALR Comparison

Each month OMC personnel calculated the wastewater collection rate in each LDS sump and compared that rate to the ALR for the respective sump as described in the *ELF Post-Closure Action Leakage Rate/Response Action Plan*, provided in Appendix D of the ELF PCP. The average daily flow rate was calculated as the volume of liquid pumped from the sump during the month, divided by the acreage of surface area served by the sump; divided by the number of days in the month. This average value is defined as the average daily flow rate and is expressed as gpad. This average daily flow rate was compared to the ALR, and 85 percent and 50 percent of the ALR to determine whether any response action is necessary. Table 6.3.2-1 presents the comparisons and conclusions for the four sumps. In all cases the average daily flow rates were much lower than the ALR and the Non-Routine Action trigger levels of 50 and 85 percent of the ALR. Hence, the performance standards and Non-Routine Action trigger levels for leak detection liquids were not exceeded. Appendix E provides the monthly flow summaries used to calculate the average daily flow rates for each of the sumps.

6.3.3 ELF Wastewater Management Quantities

When wastewater in the ELF LCS and LDS sumps reached the high level switch settings of 24 inches of head, or when quarterly or annual wastewater samples were collected from the sumps, wastewater was transferred to two storage tanks located in the LS/LF building. The wastewater was stored in these tanks until a tanker truck arrived to transport the material off site for disposal. Approximately 1,256 gallons of ELF wastewater were transported off-site for disposal between May 2017 and April 2018. That equates to a 53.7 percent decrease in wastewater generation compared to the previous period of May 2016 to April 2017 when 2,714 gallons of wastewater were collected. The volume for 2018 represents the minimum volume required to collect LDS wastewater samples on a quarterly basis. The sump levels for the WP LCS and LB LCS were too low to collect wastewater samples. Refer to Table 6.3.3-1 for historical ELF wastewater volumes.

Table 6.3.3-1: ELF Wastewater Production

REPORTING YEAR	REPORTING PERIOD	WASTEWATER QUANTITY (gallons)
2011	May 2010 to April 2011	9,841
2012	May 2011 to April 2012	7,516
2013	May 2012 to April 2013	9,349
2014	May 2013 to April 2014	3,904
2015	May 2014 to April 2015	3,279
2016	May 2015 to April 2016	3,973
2017	May 2016 to April 2017	2,714
2018	May 2017 to April 2018	1,256

6.3.4 ELF LCS/LDS Wastewater Quality

Analytical data from the ELF LCS/LDS wastewater sampling is provided in this report in accordance with Section 3.9 of the ELF PCP. The ELF PCP requires the reporting of wastewater

analytical data for the 12-month period from January 1 to December 31 that precedes the submittal of this report. For this report, the reporting period for ELF LCS/LDS wastewater quality is January 1, 2017 to December 31, 2017. Wastewater from the LCS/LDS is sampled quarterly for ICs and annually (typically in April) for the full analyte suite. The purpose of the samples collected from the LCS/LDS sumps is to meet the post-closure requirements specified in the ELF PCGMP and to evaluate the chemistry of the wastewater in order to determine potential leakage from the ELF.

This section presents a summary of analytical results from post-closure LCS/LDS wastewater monitoring at the ELF. Refer to the 2017 ELF PCGMR, provided in Appendix F-2 of this report, for additional details regarding the methods, results and conclusions of post-closure LCS/LDS wastewater sampling.

6.3.4.1 *ELF LCS Analyte Detections*

Neither the LB LCS sump, nor the WP LCS sump contained a sufficient quantity of leachate to collect a sample in 2017. Sampling of the LCS sumps will resume as leachate becomes available.

6.3.4.2 *ELF LDS Analyte Detections*

It is common for analytes to be detected in ELF LDS sump samples. Typically the detections are attributed to contaminants in the LCS clay liner material and consolidation water, rather than indications of leaks in the liner system. The soil used to construct the compacted clay liners of the ELF contained low levels of RMA contaminants that only became detectable after they were mobilized in water and analyzed using a method that had a much lower MRL than what can be achieved in soil analyses.

Analytes detected in the LDS sumps are presented in Appendix F-2 of this report. The ICs detected in the ELF LDS sumps include chloroform, benzene, dieldrin, and lead. There were no 2017 analytical results that required Regulatory Agency notification per Table 3.0-2 of the ELF PCP; specifically, analytes detected in the LDS wastewater samples that required reporting if detected (ELF PCGPM Table 3.2.5-3) or exceeded the Watch List Trigger Level (ELF PCGMP Table 3.2.5-2).

6.4 ELF Groundwater Monitoring and Assessment

Similar to the reporting requirements for ELF LCS/LDS wastewater sampling, Section 3.9 of the ELF PCP requires analytical data from the post-closure groundwater sampling to be reported in this report for the 12-month period from January 1 to December 31 that precedes the submittal of this report. For this report, the reporting period for post-closure groundwater monitoring is January 1, 2017 to December 31, 2017. The purpose of the post-closure groundwater sampling is to meet the requirements of the ELF PCP, to monitor groundwater flow directions and groundwater quality beneath and around the ELF, and to monitor for potential releases of hazardous constituents from the ELF.

Sampling of the ELF groundwater was performed quarterly in conjunction with the ELF LCS/LDS wastewater sampling described above. The 2017 ELF PCGMR, provided in Appendix F-2, presents the methods, results, and conclusions of post-closure groundwater monitoring performed over four quarterly sampling events in the calendar year of 2017.

6.4.1 CAMU Groundwater Flow Direction

Refer to Section 6.2.2 for a description of groundwater flow in the CAMU area, including the ELF. Water level data are presented in tabular and graphical form in Appendix F-2 of this report.

6.4.2 ELF Impacts on Groundwater Quality

The results from the water quality sampling completed during 2017 post-closure groundwater monitoring period were compared to the prediction limits calculated from the 2016 sampling results. Lead was the only IC detected in the downgradient wells (January and December 2017 events). Lead was detected in wells 25093, 25102, 25120, and 26099 at concentrations ranging from 3.1 µg/L to 4.1 µg/L. The range of values is below the calculated prediction limit of 26.3 µg/L. Historically, lead was detected in downgradient wells prior to waste being placed in the ELF in April 2006.

No ICs exceeded the calculated 2017 prediction limits. Based on the statistical evaluation, groundwater quality around the ELF has not been affected by waste placement operations, closure and post-closure O&M of the landfill.

7.0 ROUTINE AND NON-ROUTINE ACTIONS

7.1 Routine Actions

Routine maintenance and repairs were performed on the HWL and ELF caps and wastewater conveyance systems, and were intended to ensure that the systems continue to function as designed. Routine maintenance and repair actions were identified during inspections and are discussed in Sections 4.2, 5.2, 6.1.1 and 6.3.1 of this report. Figure 4.2-1 illustrates the locations of routine and non-routine activities performed on the HWL cap and surrounding areas, while Figure 5.2-1 shows the locations of routine maintenance and repair activities performed on the ELF cap and surrounding areas. Wastewater conveyance system maintenance activities were performed at the HWL sump manholes and lift station, and the ELF LRCH buildings and LS/LF building.

7.2 Non-Routine Actions

The implementation of non-routine actions is described in the HWL PCP and ELF PCP. Both PCPs provide 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 was identified a NRAP was prepared to document the substandard condition, the actions that will be carried out to remedy the condition, consultation between the parties, and approval of the proposed action. This process is described in Section 3.5 of both PCPs. All NRAPs applicable to the HWL for this reporting period were LDS analyte detection notices. There were no NRAPs applicable to the ELF for this reporting period. The NRAP Log is provided in Appendix G.

7.3 O&M Change Notices

Some non-routine actions required changes to portions of the PCPs, such as groundwater monitoring plans or record drawings. In these cases, the Army instituted the *RVO SOP ENGR.004.RA O&M Change Notice Procedure*, Revision 0 (RVO 2012). There was one HWL OCN that was approved during the reporting period and there were no ELF OCNs for the reporting period.

- OCN-HWL-2017-003 was approved in April 2017 and revised the HWL PCGMP to incorporate Table 6.1-1: *Upper Prediction Limits for the HWL as of 2016* into the HWL PCGMP.

8.0 RECOMMENDATIONS AND CORRECTIVE MEASURES

There were no recommendations offered for the 2018 reporting period other than the inspection and maintenance activities already required by the PCPs. Grass establishment and weed control are improving within the HWL and ELF AMA, but the Army and Shell will continue to be diligent with activities that may promote the establishment of desirable species. Monitoring and maintenance of the stormwater drainage structures and access roads will also be a priority.

The Army and Shell will continue to pursue resolution of issues associated with HWL well 25194. In accordance with agreements reached at the Consultative Meeting held on August 26, 2016 and documented in approved OCN-HWL-2017-001, the Army and Shell will initiate a stormwater sampling program intended to identify the source of dieldrin in well 25194 in accordance with the *HWL Groundwater Monitoring Wells 25194 and 25184 Subsurface Soil and Landfill Stormwater Runoff SAP*. Once a stormwater sample can be obtained and analyzed, a Data Summary Report can be prepared with a full analysis of the soil and water sample results to identify the source of dieldrin in well 25194.

The HWL and ELF met all compliance standards; therefore, no corrective measures were necessary or are currently planned for the reporting period of 2019.

9.0 COSTS AND BUDGETS

Table 9.0-1 shows the costs incurred between May 2017 and April 2018, as well as the current budgets established for monitoring and maintenance of the HWL and ELF.

The costs for operating, inspecting, and maintaining the HWL and ELF over the reporting period, including groundwater sampling, LCS/LDS sampling, LCS/LDS O&M, and wastewater disposal, totaled $450,037. Complete budgets for post-closure care of the HWL and ELF for May 2018 through April 2019 have not been approved as of the issuance of this report due to the timing of the annual funding cycle, which typically occurs near the end of the calendar year. However, the combined budgets are estimated to total approximately $540,000.

Table 9.0-1: Costs and Budgets

TASK	COSTS		ESTIMATED BUDGETS	
	INCURRED	PERIOD	VALUE	PERIOD
HWL (Inspection, Maintenance, LCS/LDS and Groundwater Sampling, and Off-Site Wastewater Disposal)	$276,680	May 17 – Apr 18	$332,000	May 18 – Apr 19
ELF (Inspection, Maintenance, LCS/LDS and Groundwater Sampling, and Off-Site Wastewater Disposal)	$173,357	May 17 – Apr 18	$208,000	May 18 – Apr 19
TOTAL	$450,037		$540,000	

10.0 CONCLUSIONS

In summary, and based on the information presented in this report, the HWL and ELF were in compliance with all performance standards and no corrective measures were required. Future plans to maintain the integrity of the caps include continued diligence with weed control, overseeding where necessary, inspection for erosion, and monitoring the groundwater and LCS/LDS wastewater quality quarterly.

11.0 REFERENCES

Navarro (Navarro Research and Engineering, Inc.)

2016a (May 16) *NRAP-2016-004.*

2016b (Nov 17) *Hazardous Waste Landfill Groundwater Monitoring Wells 25194 and 25184 Subsurface Soil and Landfill Stormwater Runoff Sampling and Analysis Plan.* Revision 0.

RVO (Remediation Venture Office)

2012 (Jan) *RVO SOP ENGR.004.RA O&M Change Notice Procedure.* Revision 0.

TtEC (TetraTech EC, Inc.)

2006 (Aug) *Hazardous Waste Landfill Closure Plan.*

2008 (July) *Enhanced Hazardous Waste Landfill Closure Plan.* Revision 0.

2010 (May 20) *Enhanced Hazardous Waste Landfill Post-Closure Plan.* Revision 0.

2011 (Mar 16) *Hazardous Waste Landfill Post-Closure Plan.* Revision 3.

TABLES

Table 6.1.2-1: HWL Average Daily LDS Flow Rate and ALR Comparison

Sump No.	Month	Average Daily Flow Rate (gpad)	Comparison to 85% ALR (>, <, or =)	85% ALR (gpad)	Comparison to ALR (>, <, or =)	ALR (gpad)	Conclusion
HWL LDS Sump 1	May 2017	0.00	<	112	<	132	No exceedance
	June 2017	0.47	<	112	<	132	No exceedance
	July 2017	0.00	<	112	<	132	No exceedance
	Aug. 2017	0.00	<	112	<	132	No exceedance
	Sept. 2017	0.00	<	112	<	132	No exceedance
	Oct. 2017	0.79	<	112	<	132	No exceedance
	Nov. 2017	1.62	<	112	<	132	No exceedance
	Dec. 2017	0.00	<	112	<	132	No exceedance
	Jan. 2018	0.26	<	112	<	132	No exceedance
	Feb. 2018	0.23	<	112	<	132	No exceedance
	March 2018	0.00	<	112	<	132	No exceedance
	April 2018	0.00	<	112	<	132	No exceedance
HWL LDS Sump 2	May 2017	0.00	<	111	<	131	No exceedance
	June 2017	0.99	<	111	<	131	No exceedance
	July 2017	0.00	<	111	<	131	No exceedance
	Aug. 2017	0.00	<	111	<	131	No exceedance
	Sept. 2017	0.00	<	111	<	131	No exceedance
	Oct. 2017	0.00	<	111	<	131	No exceedance
	Nov. 2017	1.50	<	111	<	131	No exceedance
	Dec. 2017	0.00	<	111	<	131	No exceedance
	Jan. 2018	0.19	<	111	<	131	No exceedance
	Feb. 2018	0.20	<	111	<	131	No exceedance
	March 2018	0.00	<	111	<	131	No exceedance
	April 2018	0.00	<	111	<	131	No exceedance

Table 6.1.2-1: HWL Average Daily LDS Flow Rate and ALR Comparison

Sump No.	Month	Average Daily Flow Rate (gpad)	Comparison to 85% ALR (>, <, or =)	85% ALR (gpad)	Comparison to ALR (>, <, or =)	ALR (gpad)	Conclusion
HWL LDS Sump 3	May 2017	0.00	<	111	<	131	No exceedance
	June 2017	0.00	<	111	<	131	No exceedance
	July 2017	0.00	<	111	<	131	No exceedance
	Aug. 2017	0.00	<	111	<	131	No exceedance
	Sept. 2017	0.00	<	111	<	131	No exceedance
	Oct. 2017	0.00	<	111	<	131	No exceedance
	Nov. 2017	0.00	<	111	<	131	No exceedance
	Dec. 2017	0.00	<	111	<	131	No exceedance
	Jan. 2018	0.38	<	111	<	131	No exceedance
	Feb. 2018	0.40	<	111	<	131	No exceedance
	March 2018	0.00	<	111	<	131	No exceedance
	April 2018	0.00	<	111	<	131	No exceedance
HWL LDS Sump 4	May 2017	0.00	<	111	<	131	No exceedance
	June 2017	0.00	<	111	<	131	No exceedance
	July 2017	0.00	<	111	<	131	No exceedance
	Aug. 2017	0.00	<	111	<	131	No exceedance
	Sept. 2017	0.00	<	111	<	131	No exceedance
	Oct. 2017	0.00	<	111	<	131	No exceedance
	Nov. 2017	0.00	<	111	<	131	No exceedance
	Dec. 2017	0.00	<	111	<	131	No exceedance
	Jan. 2018	0.46	<	111	<	131	No exceedance
	Feb. 2018	0.45	<	111	<	131	No exceedance
	March 2018	0.00	<	111	<	131	No exceedance
	April 2018	0.00	<	111	<	131	No exceedance

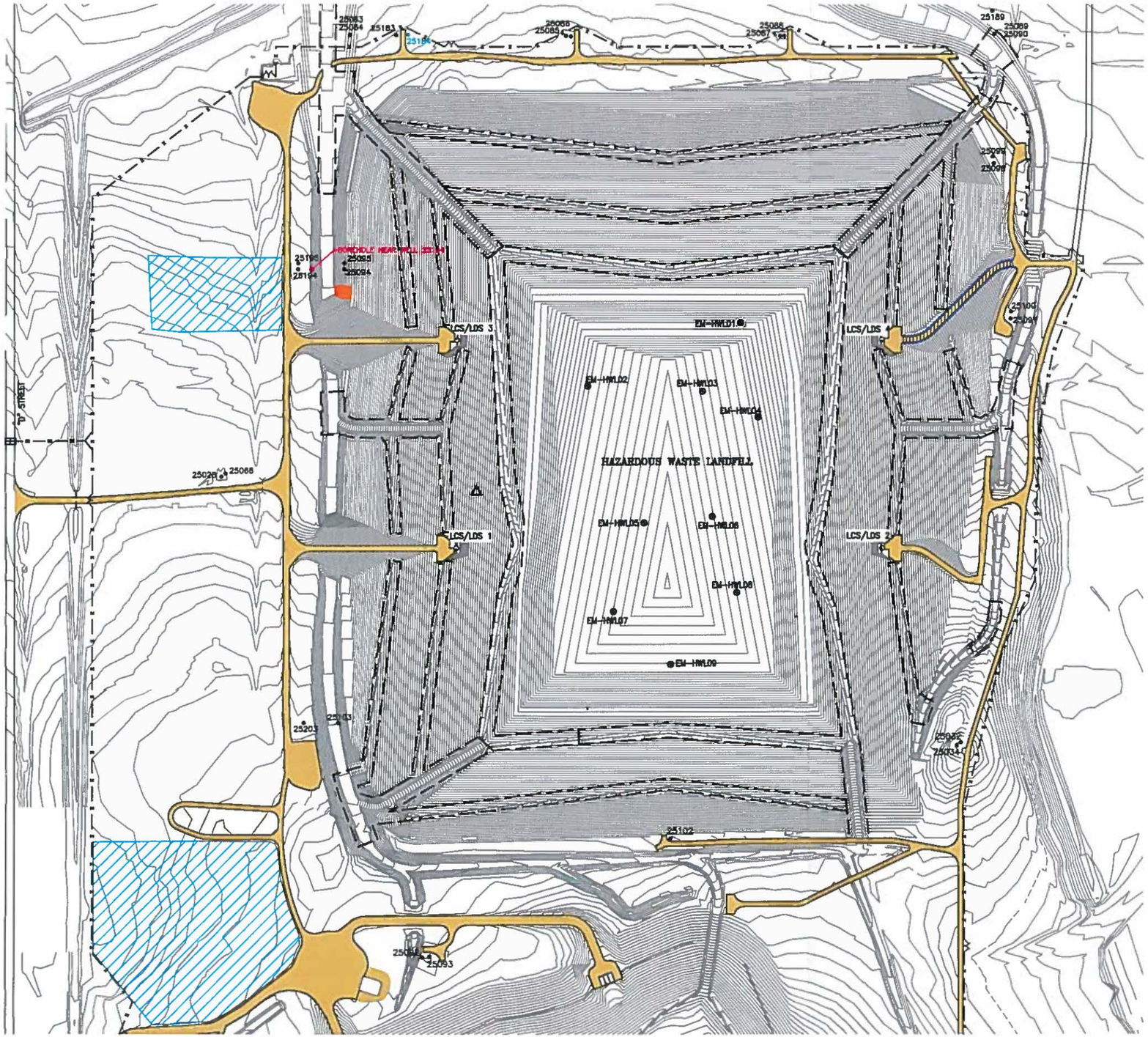
Table 6.3.2-1: ELF Average Daily LDS Flow Rate and ALR Comparison

Sump No.	Month	Average Daily Flow Rate (gpad)	Comparison to 50% ALR (>, <, or =)	50% ALR (gpad)	Comparison to 85% ALR (>, <, or =)	85% ALR (gpad)	Comparison to ALR (>, <, or =)	ALR (gpad)	Conclusion
ELF WP LDS 1	May 2017	0.00	<	65	<	110.5	<	130	No exceedance
	June 2017	0.00	<	65	<	110.5	<	130	No exceedance
	July 2017	0.00	<	65	<	110.5	<	130	No exceedance
	Aug. 2017	0.12	<	65	<	110.5	<	130	No exceedance
	Sept. 2017	0.00	<	65	<	110.5	<	130	No exceedance
	Oct. 2017	0.00	<	65	<	110.5	<	130	No exceedance
	Nov. 2017	0.00	<	65	<	110.5	<	130	No exceedance
	Dec. 2017	0.00	<	65	<	110.5	<	130	No exceedance
	Jan. 2018	0.29	<	65	<	110.5	<	130	No exceedance
	Feb. 2018	0.00	<	65	<	110.5	<	130	No exceedance
	March 2018	0.00	<	65	<	110.5	<	130	No exceedance
	April 2018	0.00	<	65	<	110.5	<	130	No exceedance
ELF WP LDS 2	May 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	June 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	July 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	Aug. 2017	0.36	<	79.5	<	135.2	<	159	No exceedance
	Sept. 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	Oct. 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	Nov. 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	Dec. 2017	0.00	<	79.5	<	135.2	<	159	No exceedance
	Jan. 2018	0.39	<	79.5	<	135.2	<	159	No exceedance
	Feb. 2018	0.32	<	79.5	<	135.2	<	159	No exceedance
	March 2018	0.00	<	79.5	<	135.2	<	159	No exceedance
	April 2018	0.00	<	79.5	<	135.2	<	159	No exceedance

Table 6.3.2-1: ELF Average Daily LDS Flow Rate and ALR Comparison

Sump No.	Month	Average Daily Flow Rate (gpad)	Comparison to 50% ALR (>, <, or =)	50% ALR (gpad)	Comparison to 85% ALR (>, <, or =)	85% ALR (gpad)	Comparison to ALR (>, <, or =)	ALR (gpad)	Conclusion
ELF LB LDS 1	May 2017	0.00	<	130	<	221	<	260	No exceedance
	June 2017	0.00	<	130	<	221	<	260	No exceedance
	July 2017	0.00	<	130	<	221	<	260	No exceedance
	Aug. 2017	0.64	<	130	<	221	<	260	No exceedance
	Sept. 2017	0.00	<	130	<	221	<	260	No exceedance
	Oct. 2017	0.00	<	130	<	221	<	260	No exceedance
	Nov. 2017	0.00	<	130	<	221	<	260	No exceedance
	Dec. 2017	0.00	<	130	<	221	<	260	No exceedance
	Jan. 2018	0.51	<	130	<	221	<	260	No exceedance
	Feb. 2018	0.13	<	130	<	221	<	260	No exceedance
	March 2018	0.00	<	130	<	221	<	260	No exceedance
	April 2018	0.00	<	130	<	221	<	260	No exceedance
ELF LB LDS 2	May 2017	0.00	<	159	<	270.3	<	318	No exceedance
	June 2017	0.00	<	159	<	270.3	<	318	No exceedance
	July 2017	0.00	<	159	<	270.3	<	318	No exceedance
	Aug. 2017	0.78	<	159	<	270.3	<	318	No exceedance
	Sept. 2017	0.00	<	159	<	270.3	<	318	No exceedance
	Oct. 2017	0.00	<	159	<	270.3	<	318	No exceedance
	Nov. 2017	0.00	<	159	<	270.3	<	318	No exceedance
	Dec. 2017	0.00	<	159	<	270.3	<	318	No exceedance
	Jan. 2018	0.65	<	159	<	270.3	<	318	No exceedance
	Feb. 2018	0.39	<	159	<	270.3	<	318	No exceedance
	March 2018	0.00	<	159	<	270.3	<	318	No exceedance
	April 2018	0.00	<	159	<	270.3	<	318	No exceedance

FIGURES



LEGEND:

- PERIMETER FENCE/ARMY MAINTAINED AREA BOUNDARY
- CHANNELS AND DOWNCHUTES
- EM-HWL08 EROSION/SETTLEMENT MONUMENT
- 25098 GROUNDWATER MONITORING WELL
- 25184 NEW GROUNDWATER MONITORING WELL LOCATION
- SD25PR0001 NEW BOREHOLE LOCATION
- ROAD
- CONTOURS
- OVER SEEDED
- GROUND CLEAR
- REPAIRED EROSION MONUMENT
- REPAIRED EROSION
- REPAIRED EROSION AND OVERSEEDED

NOTE:
REMOVED TUMBLE WEEDS FROM PERIMETER FENCE.

COLORADO STATE PLANE

0 120 240
Scale In Feet

ROCKY MOUNTAIN ARSENAL
COMMERCE CITY, COLORADO

PROJECT NAME
2018 ECRA LANDFILLS AND GROUNDWATER MONITORING REPORT

TITLE
HWL ROUTINE AND NON-ROUTINE ACTIVITIES MAP

CAD FILE:	DATE	FIGURE NUMBER
Figure 4.2-1.DWG	05.22.18	4.2-1

S:\C PROJECTS\ANNUAL COVERS REPORT 2018\FIGURE 4.2-1.dwg

S:\G PROJECTS\ANNUAL COVERS REPORT 2018\FIGURE 5.2-1.dwg

APPENDICES
(All on CD)

A	Precipitation Data (May 01, 2017 through April 30, 2018)
B-1	HWL Inspection Documentation
B-2	ELF Inspection Documentation
C-1	HWL Maintenance Documentation
C-2	ELF Maintenance Documentation
D	HWL and ELF Erosion/Settlement Monument Survey Data
E	Monthly Flow Summaries
F-1	2017 HWL Post-Closure Groundwater Monitoring Report
F-2	2017 ELF Post-Closure Groundwater Monitoring Report
G	NRAP Log
H	Well 25184 Field Documentation