2017
ANNUAL SAMPLING AND MONITORING REPORT
FOR THE
MONTANA POLE AND TREATING PLANT
BUTTE-SILVER BOW, MONTANA

Revision 0

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ACRONYMS AND ABBREVIATIONS

pg/L	Picograms per liter
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
ARCO	Atlantic Richfield Company
BSB	Butte-Silver Bow
CDM	Camp Dresser & McKee, Inc.
COC	Chain of custody
Dioxin	Polychlorinated dibenzo-p-dioxins
DEQ	Montana Department of Environmental Quality
DSR	Daily Summary Report
EDD	Electronic data deliverable
EPA	U.S. Environmental Protection Agency
Furans	Polychlorinated dibenzofurans
GAC	Granulated activated carbon
gpm	Gallons per minute
GWMP	Groundwater and Surface Water Monitoring Plan
Kg	Kilograms
LNAPL	Light non-aqueous phase liquid
LTU	Land treatment unit
MBMG	Montana Bureau of Mines and Geology
MDHES	Montana Department of Health and Environmental Sciences
MDL	Method detection limit
MDT	Montana Department of Transportation
mg/kg	Milligrams per kilogram
MPTP	Montana Pole and Treating Plant
NCRT	Near creek recovery trench
NHRT	Near highway recovery trench
NWS	National Weather Service
O&M	Operations and maintenance
OWS	Oil and water separator
PAH	Polycyclic aromatic hydrocarbons
PCP	Pentachlorophenol
PRP	Potentially responsible party
QC	Quality control

ACRONYMS AND ABBREVIATIONS (Cont.)

RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial investigation and feasibility study
ROD	Record of decision
RPD	Relative percent difference
SDG	Sample delivery group
SSP	Soil staging and pretreatment piles
Tetra Tech	Tetra Tech, Inc. [EMI Unit]
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin
TEF	Toxicity equivalency factors
TEQ	Toxicity equivalence quotient
USGS	U.S. Geological Survey
WTP	MPTP water treatment plant
WWTP	Wastewater Treatment Plant

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EXECUTIVE SUMMARY

This annual report for the Montana Pole and Treating Plant (MPTP) site describes site monitoring, summarizes analytical data generated, and evaluates the progress made toward remedial objectives during the 2017 calendar year for the site operations portion of this project. The report also discusses additional specific site operation and maintenance (O&M) activities for 2017, such as non-routine maintenance at the MPTP water treatment plant (WTP); use of the south-side infiltration system; operation of the land treatment unit (LTU); planning for the anticipated LTU offload; and other related projects completed at the site during the year. Results from the 2017 "Soil and Surface Water Data Gap Investigation" are provided in a separate Tetra Tech, Inc. [EMI Unit] (Tetra Tech) report (Tetra Tech 2017); results from that report are not repeated in this annual report.

The primary activities at the MPTP site in 2017 included (1) O&M activities, (2) sampling, and (3) planning for the next and final offload of treated soil from the LTU. LTU offload is being addressed in reports being prepared under separate contract task orders. The WTP facilities are currently in good working order.

The more important operational issues noted in 2017 included:

- A decrease in the sustainable pumping rate in the near highway recovery trench (NHRT) (throughout 2017). Specifically, the sustainable pumping rate in the NHRT has generally decreased from 135 gallons per minute (gpm) in 2009 to about 75 gpm in 2017.
- Inspection of the NHRT pump on March 29, 2017, indicated iron precipitation on the NHRT piping and pump end (both inside and out). The NHRT pump motor and pump end were replaced that day. The motor is stored for future disposal and the pump end was cleaned once it dried out and is currently being stored for future use.
- On April 17, 2017, a 2-feet by 2-feet by 2-feet "sinkhole" was discovered east of vault 1A. During backwashing on May 15, 2017, the plant operator noted a leak adjacent to this vault. The area was excavated, and field observations indicated the cell was unable to accept the volume of water that it did previously.

Other than needing to address the operational issues stated above, O&M of the MPTP WTP was conducted on a routine basis in 2017.

Water Treatment Plant

WTP effluent (treated groundwater at WTP station EFF) was monitored for pentachlorophenol (PCP) on a weekly basis in 2017. The concentrations of PCP in effluent from both the NHRT and NCRT were measured monthly.

A semi-annual monitoring event was conducted during February 2017, and plant water, groundwater, and surface water samples were analyzed for PCP. The annual monitoring event for plant water, groundwater, and surface water was conducted in August 2017. In addition to analyzing samples for PCP, some samples were analyzed for the "extended parameter list" analytes (semivolatile organic compounds, dioxins, and metals).

The concentrations of PCP in WTP effluent samples (station EFF) were below the 1 microgram per liter (µg/L) record of decision (ROD) discharge to surface water cleanup level for all sampling events in 2017.

The concentrations of polychlorinated dibenzo-p-dioxins (dioxin) and polychlorinated dibenzofurans (furans), collectively referred to as "dioxins," have varied over time, and low levels of dioxins have been detected in WTP effluent samples collected during monitoring events each year. However, the same levels of dioxins (or higher) are routinely found in laboratory-grade distilled-deionized water (source water blanks used for project quality control); therefore, the actual presence of dioxins in WTP effluent samples is questionable. Regardless, results for sampling conducted in 2017 confirm that the concentration of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalence quotient (TEQ), referred to as "dioxin (TEQ)," in WTP effluent met the ROD discharge to surface water cleanup level of 1.00E-5 µg/L (equivalent to 10 picograms per liter [pg/L]).

For this report, the concentrations of dioxin (TEQ) are calculated using two different methodologies, referred to as the "MPTP ROD Methodology" and the "Montana Department of Environmental Quality [DEQ]-7 Methodology," as described below. (Calculations for both methods are provided in Appendix A [database] and Appendix B [table in section B-3].)

- **MPTP ROD Methodology**

  Dioxin (TEQ) is calculated using 0 for values qualified as "U" (analyzed for but not detected above the method detection limit [MDL]), using 0 when estimated maximum possible concentrations are reported, and using ROD toxicity equivalency factors (TEF).

- **DEQ-7 Methodology**

  Dioxin (TEQ) is calculated using the 2005 World Health Organization methodology, using one-half the project reporting limit where not detected; using one-half the estimated maximum possible concentration when reported; and using 2005 TEFs as specified in DEQ-7 (DEQ 2017).

The concentrations of metals, polycyclic aromatic hydrocarbons (PAH), chlorophenols, and anions for WTP effluent samples collected in August 2017 were all below the ROD discharge to surface water cleanup levels (where established).

A minor amount of floating product (about 0.25 inch, or less) was measured in the NHRT manhole between January 25, 2017, and February 22, 2017. In addition, a slight oil sheen was noted at this location on March 30, 2017, and no product was noted from that point on. When coupled with the observation that floating product was not detected in any monitoring well during any sampling conducted in calendar years 2010 through 2017, these observations suggest that significant ongoing transport of free-phase light oil is not a major concern at MPTP. However, some residual oils are still present near the NHRT, primarily below the interstate highway.

Land Treatment Unit

No soil tilling occurred at the LTU in 2017. Neither odors nor dust were documented at any time during the year. In addition, there was no need to irrigate the LTU, as the site received adequate precipitation throughout the year. Since the LTU irrigation system was never used in 2017, winterization of the system was not necessary. No LTU maintenance of any significance has taken place since the 2013 winterization.

The average concentration of PCP in all LTU zones sampled in 2012 was 26.7 milligrams per kilogram (mg/kg); in 2013, the average concentration of PCP in LTU soils was 26.8 mg/kg. These data indicate the average concentration of PCP in LTU soils was less than the ROD soil cleanup level (34 mg/kg) for the previous two monitoring events. LTU soils were not analyzed for PAH during the October 2013 round of sampling because all sections of the LTU had previously met the cleanup goal for PAH for two successive monitoring events. The average dioxin (TEQ) concentrations (using the MPTP ROD Methodology) for all LTU zones sampled in 2012 (2.8 micrograms per kilogram [µg/kg]) and 2013 (2.6 µg/kg) were above the ROD soil cleanup level of 0.2 µg/kg. Based on these historical data, LTU soil was not sampled in 2017 as part of site operations. Soil sampling conducted in 2017 as part of the upcoming LTU offload has been addressed in a separate report (Tetra Tech 2017).

Surface Water – Silver Bow Creek

In 2017, the concentrations of PCP at all three surface water stations (SW-05, SS-06A, and SW-09) were below the laboratory detection limit value (0.1 µg/L) and were below the ROD surface water cleanup level (1.0 µg/L) for both monitoring events. The concentrations of semivolatile organic compounds and dioxins in Silver Bow Creek were below ROD cleanup levels, where established (samples are not analyzed for metals).

Groundwater

Sixty shallow monitoring wells, four intermediate wells, and eight deep wells were scheduled for sampling and analysis for PCP by EPA Method 528 during the 2017 semi-annual (February) and annual (August) monitoring events. After initial inspection, monitoring wells 10-12 and GW-14R-98 were found to be deficient, and these wells were not sampled during the August annual sampling event.

Data for samples from shallow wells were plotted and contoured to evaluate trends in concentration and the spatial distribution of PCP contamination. This analysis indicates the presence of a plume of PCP as defined by the 1.0 µg/L contour approximately 750 feet wide by 1,500 feet long on the south side of Silver Bow Creek oriented along the principal direction of groundwater flow (southeast to northwest). In addition, there are PCP "hot spots" at several locations on the site. The groundwater cleanup level for PCP is 1.0 µg/L.

During the August 2017 annual monitoring event, groundwater samples from three shallow monitoring wells (HCA-21, INF-04, and MW-11-04) and two deep wells (BMW-01A and BMW-01B) were analyzed for the "extended parameter list" of analytes, including semivolatile organic compounds and dioxins, as per the Groundwater and Surface Water Monitoring Plan (GWMP), Revision 2 (Tetra Tech 2013b). As noted above, wells 10-12 and GW-14R-98 were not sampled. In 2017, the dioxin (TEQ) was below the 3.00E-05 µg/L (equivalent to 30 pg/L) ROD groundwater cleanup level in all monitoring wells (the dioxin [TEQ] for each sample was calculated using both the MPTP ROD Methodology and the DEQ-7 Methodology). The concentrations of PAH and chlorophenols in groundwater (the only exception being PCP) were below ROD groundwater cleanup levels (where established). The ROD groundwater cleanup level for PCP is 1.0 µg/L.

Compliance with ROD groundwater cleanup requirements was assessed as part of this annual report, and the progress of remediation was evaluated. The analysis was conducted to support a conclusion that ongoing remediation continues to be effective, and since 1993, has reduced the original area of the PCP plume (as defined by the 1.0 µg/L contour) by approximately 60 percent.

1.0 INTRODUCTION AND PURPOSE

This annual report for the Montana Pole and Treating Plant (MPTP) site describes site monitoring, summarizes analytical data generated, and evaluates the progress made toward remedial objectives during the 2017 calendar year for the site operations portion of this project. The report also discusses additional specific site operation activities for 2017, such as non-routine operation and maintenance (O&M) activities at the MPTP water treatment plant (WTP); use of the south-side infiltration system; operation of the land treatment unit (LTU); planning for the anticipated LTU offload; and other related projects completed at the site during the year. Results from the 2017 “Soil and Surface Water Data Gap Investigation” are provided in a separate Tetra Tech, Inc. [EMI Unit] report (Tetra Tech 2017); results from that report are not repeated in this annual report.

1.1 REPORT ORGANIZATION

Section 1.0 provides a summary of the site’s operational and regulatory history. WTP operation and related activities are discussed in Section 2.0. LTU operations, soil treatment, and historical soil sampling are summarized in Section 3.0. Section 4.0 provides the results of surface water and groundwater monitoring and an assessment of overall system performance and compliance with the requirements of the MPTP Record of Decision (ROD) (U.S. Environmental Protection Agency [EPA] and Montana Department of Environmental Quality [DEQ] 1993). Historical residential well sampling results are summarized in Section 5.0. Additional site activities are discussed in Section 6.0. Section 7.0 provides a summary of database management. Climate and streamflow considerations are discussed in Section 8.0. Recommendations are provided in Section 9.0. References appear after Section 9.0. Tables and figures follow the text.

An electronic copy of the Microsoft Access database for the MPTP site is provided in Appendix A (separate CD). Appendix B provides a summary of sampling results and data. Appendix C provides a summary of the 2017 pumping rates in the near highway recovery trench (NHRT) and near creek recovery trench (NCRT). Daily Summary Reports (DSR) for WTP-related incidents that occurred in 2017 are provided in Appendix D. Data visualizations programmed using R-Studio are provided in Appendix E. Results from Mann-Kendall statistical testing are provided in Appendix F. Plume area maps are provided in Appendix G. A summary of quality control (QC) activities for electronic data deliverables (EDD) is provided in Appendix H. Climate and streamflow statistics are provided in Appendices I and J.

1.2 SITE HISTORY

The MPTP site is in Butte, Montana, and operated as a wood treating facility from 1946 to 1984 (EPA and DEQ 1993) (Figure 1.1). During most of this period, a solution of about 5 percent pentachlorophenol (PCP), mixed with petroleum carrier oil similar to diesel, was used to preserve poles, posts, and bridge timbers. The PCP solution was applied to wood products in butt vats and pressure cylinders (retorts). Creosote was used as a wood preservative for a brief period in 1969.

The plant initially included a pole peeling machine, two butt treating vats, on-site chemical storage tanks, and related ancillary facilities. Major modifications to the plant occurred between 1949 and 1951 and again around 1956. Sometime between 1949 and 1951, a 73-foot-long, 6-foot-diameter retort was installed to increase the efficiency of timber treatment production. A second retort, 66 feet long and 7 feet in diameter, was installed around 1956.

On May 5, 1969, an explosion occurred while a charge of poles was being treated in the east butt-treating vat. The explosion generated a fire that destroyed the east vat, boiler room, and retort building. Although the boiler, retorts, and auxiliary equipment were damaged, the plant was rebuilt and functional by December 1969. Petroleum and PCP product reportedly spilled from the east butt-treating vat as a result of the explosion and fire. Additional seepage of product occurred from both retorts as a result of broken pipes and valves damaged by the fire. Reportedly, none of the on-site chemical storage tanks were ruptured as a result of the fire.

In response to enactment of the Resource Conservation and Recovery Act (RCRA), a closed-loop process water system was constructed in 1980. The closed-loop water recovery system was operated by collecting wastewater in storage tanks, recirculating this water through the condensing system, and then evaporating excess water using aeration sprays. On May 17, 1984, the MPTP ceased operations.

1.3 SITE INVESTIGATION

In March 1983, a complaint was filed by a local citizen concerning oil seeping into Silver Bow Creek near the MPTP facility. The Montana Department of Health and Environmental Sciences (MDHES) (now DEQ) investigated the complaint and discovered an oil seep on the south side of Silver Bow Creek directly downgradient from the MPTP facility. Further investigation of the site revealed oil-saturated soils adjacent to the creek and on MPTP property. Subsequent sampling confirmed the presence of PCP, polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzo-p-dioxins (dioxin), and polychlorinated dibenzofurans (furans) — collectively referred to as “dioxins” — in site soils and oil samples. MDHES and EPA completed both a preliminary assessment and site inspection and a subsequent Hazard Ranking System score in July 1985.

Also, in July 1985, the EPA Emergency Response Branch began a removal action on the site to minimize impacts to Silver Bow Creek and to stabilize the site. As part of the removal action, two groundwater interception and oil recovery systems were installed to alleviate oil seepage into the creek. In October 1989, EPA granted MDHES the initial enforcement funding to conduct potentially responsible party (PRP) noticing and to negotiate and issue an administrative order. In April 1990, MDHES signed an administrative order on consent with Atlantic Richfield Company (ARCO) under which ARCO agreed to conduct a remedial investigation and feasibility study (RI/FS) at the site. In June 1990, ARCO began the RI/FS following the MDHES- and EPA-approved RI/FS work plan.

In June 1992, EPA proposed an additional removal action to control and recover the light non-aqueous phase liquid (LNAPL) (floating oils) in groundwater identified during the RI. The older remedial system installed in 1985 was shut down when the MPTP WTP went into operation on January 22, 1993.

1.4 REMEDY IMPLEMENTATION AND STATUS

The MPTP cleanup is being implemented in six phases. The design for Phase 1 of the remedial action was finalized in June 1996; construction occurred from May 1996 to November 1997. The primary components of the remedy completed during Phase 1 of the remedial action consisted of construction of the LTU and 13 soil staging and pretreatment piles (SSPs), building an addition to the previous WTP, construction of two groundwater recovery trenches that form the current remedy extraction system (the NHRT and the NCRT), removal of the previous EPA groundwater recovery system, and excavation of the north-side contaminated soils.

Phase 2 consisted of removal and disposal of hazardous and nonhazardous waste debris remaining on site. The design for Phase 2 of the remedial action was finalized in December 1998; construction occurred from March 1999 to May 1999. Off-site disposal methods included incineration or placement in hazardous and nonhazardous waste landfills, as appropriate. Metal debris was pressure washed and recycled.

Phase 3 consisted of excavating the south-side contaminated soils, offloading Phase 1 treated soils from the LTU, placing approximately 132,000 cubic yards of contaminated soil on the LTU, installing the north- and south-side infiltration systems, and relocating sewer and potable water lines. The design for Phase 3 of the remedial action was finalized in July 1999; construction occurred from October 1999 to December 2000. The infiltration system was operated continuously through November 2002. Since that time, the south-side infiltration system has been used periodically to maintain adequate groundwater levels to operate recovery trench pumps and aid in flushing the contaminated soils remaining beneath the interstate highway embankment. The north side infiltration system has not been used since 2002.

Phase 4 is ongoing and involves continued capture and treatment of contaminated groundwater and the biological treatment of contaminated soils. This phase includes offloading the LTU as lifts of surface soil are remediated to below the action limits set for the site in the ROD for certain contaminants of concern. The remaining LTU soils are scheduled to be offloaded in 2018. A data gaps investigation addressing site-wide concentrations of contaminants in soil was completed in mid-2017, a final report presenting the results of this investigation was issued in November 2017 (Tetra Tech 2017), and development of the 30 percent design for the final offload began. The design will include offloading all the soil from the LTU, removing and disposing of the LTU liner and associated materials and equipment, and reclaiming the current LTU and retention pond areas.

Phase 5 addresses the contaminated soils beneath the interstate that divides the site. In March 2009, Tetra Tech submitted a report titled "Final Treatability Study Workplan, Montana Pole and Treating Plant Site – Phase 5" (Tetra Tech 2009) that evaluated areas of residual soil contamination and potential remedial technologies. The report incorporated a literature review of three in situ treatment technologies: in situ chemical oxidation, in situ soil flushing, and in situ bioremediation. Two technologies were retained at that time for further evaluation:

- Modified Fenton's Reagent
- In Situ Soil Flushing

The 2009 treatability study was revisited in 2013. As part of this effort, a draft memorandum was prepared that considered and screened out the two previous potentially applicable technologies and outlined a conceptual approach and approximate costs for full-scale implementation of three new potentially promising alternatives (Tetra Tech 2013a):

- Bioventing – Vertical Well Approach
- Bioventing – Horizontal Well Approach
- Chemical Oxidation – Horizontal Well Approach

Further evaluation of these technologies has been temporarily put on hold as a result of complications associated with the Butte-Silver Bow (BSB) Wastewater Treatment Plant (WWTP) construction dewatering conducted in 2014, 2015, and 2016. These technologies will be evaluated again when conditions at the site are relatively stable compared with previous years when WWTP construction dewatering was occurring, and after the LTU offload is complete (see Section 9.0). In addition, as described on page 44 of the ROD (EPA and DEQ 1993): "After it has been determined by the lead agency, in consultation with the support agency, that recovery of hazardous substances from these areas is no longer effective or practical and contaminant levels have plateaued, these areas will be addressed by in situ bioremediation as outlined under Performance Standards for Groundwater."

Phase 6 is currently in the planning state and will consist of removal and disposal of the soil treatment facilities on the south side of the site, final engineering controls (soil cover and storm water management), re-vegetation of all disturbed areas, and implementation of appropriate institutional controls to maintain protectiveness of the remedy. It is expected that the final land use at the site will be identified in conjunction with BSB County and interested citizens, with certain constraints on land use specified by EPA and DEQ to ensure long-term protectiveness of the remedy, consistent with the ROD.

2.0 WTP OPERATIONS AND ANALYTICAL RESULTS

The following sections provide information related to WTP operations and analytical results for 2017. The more significant operational issues included (see Section 2.6 for details):

- A decrease in the sustainable pumping rate in the NHRT (throughout 2017)
- Iron precipitation on the NHRT piping and pump end (both inside and out). The NHRT pump motor and pump end were replaced.

Other than needing to address these issues, O&M of the MPTP WTP was conducted on a routine basis the remainder of 2017, and the WTP was generally in good working order. WTP operations are discussed below.

2.1 WTP OPERATIONS

The groundwater treatment system at the MPTP site consists of a WTP, two groundwater recovery trenches (the NHRT and NCRT), and the south-side infiltration system, consisting of eight infiltration cells (see Figure 1.1 and Figure 2.1). In 2017, inflow to the WTP from the NHRT was about 75 gallons per minute (gpm); inflow from the NCRT was about 195 gpm. The WTP treated an average of about 270 gpm for the reporting period of January 1, 2017, through December 31, 2017 (Table 2.1, and Appendix E, Figure E-1). Short periods of time (hours) when WTP flow was temporarily halted to conduct maintenance and repairs are not factored into these daily flow estimates.

Water from the NHRT and NCRT is first pumped directly to groundwater holding tank T1C and then through the granulated activated carbon (GAC) treatment system. The current (2017) WTP configuration and water quality monitoring points are conceptualized in Figure 2.2.

After carbon treatment, the recovered groundwater (treated effluent) is discharged to Silver Bow Creek. Except for backwashing, WTP-treated effluent was not pumped to the south-side infiltration system at any time in 2017.

Approximately 35 kilograms of dissolved PCP were removed from groundwater at the site in 2017; this estimate is calculated using flow and concentration data associated with the WTP. Since the initial emergency response, the WTP has treated more than 3.5 billion gallons of contaminated water (Table 2.2) and has removed about 1,600 kilograms of PCP from groundwater at the site. In addition, more than 48,000 kilograms of PCP-contaminated oil (from the oil and water separator [OWS] and from other locations) have been recovered and disposed of since January 1993. No measurable floating product has been recovered from the OWS (or other locations) since 2009, as shown in the table.

Mass of PCP Removed (Emergency Response through June 2017)

Year	PCP Removed From Groundwater Via WTP[a] (Kg)	Contaminated Oil Recovered (Oil and Water Separator) (Kg)	Contaminated Oil Recovered (Other Locations) (Kg)
Emergency Response	0	0	29,977
1998	242	0	0
1999	253	0	0
2000 + south-side excavation	334	1,018	11,241
2001	136	1,439	0
2002	110	2,214	0
2003	49	600	0
2004	29	550	0
2005	23	538	0
2006	34	485	0
2007	33	3	0
2008	37	48	0
2009	43	6	0
2010	27	0	0
2011	38	0	0
2012	78	0	0
2013	46	0	0
2014	42	0	0
2015	23	0	0
2016	20	0	0
2017	35	0	0
TOTALS	1,631	6,901	41,218

Notes:
a Reflects PCP removed at the two recovery trenches based on flow rates and concentrations
Kg Kilograms
PCP Pentachlorophenol
WTP Water treatment plant

The NHRT and NCRT, along with their associated pumps, continued to be reasonably effective in capturing site groundwater in 2017. Groundwater capture and plume containment are assessed by evaluating groundwater elevation data and verifying hydraulic gradients near the trenches. Performance monitoring, including an assessment of compliance with ROD cleanup levels, is discussed in Section 4.3.

2.2 WTP ANALYTICAL RESULTS

A summary of the sampling and analysis conducted at the MPTP site per the Final Groundwater and Surface Water Monitoring Plan (GWMP), Revision 2 (Tetra Tech 2013b), is provided in Table 2.3. WTP samples are collected for analysis of PCP on a weekly basis and are analyzed using EPA Method 528. A more comprehensive list of parameters (semivolatile organic compounds, dioxins, metals, and anions) is analyzed on an annual basis in August each year (Tetra Tech 2013b). This list is referred to as the "extended parameter list" in the GWMP, as well as in this annual report. The concentrations of PCP in effluent from both the NHRT and NCRT are measured monthly. WTP station locations are provided on Figure 2.2.

The results of sampling for PCP in the NHRT (station NHRTEFF) and the NCRT (station NCRTEFF) in 2017 are provided in Appendix A and Appendix B-1 and are summarized for the 2001 to 2017 period of record in Table 2.4 and in Appendix E, Figure E-2. The average concentration of PCP in the NHRT in 2017 was 250 micrograms per liter (µg/L). The average concentration of PCP in the NCRT was 6.3 µg/L. The concentrations of PCP in the NHRT have generally rebounded upward in 2017, relative to 2016, as the water table has increased to an elevation that, once again, contacts the contaminated "smear zone." In 2016, the water table was depressed as a result of stresses associated with the Butte Metro WWTP construction dewatering and the increased pumping of the NCRT in an attempt to offset the impact of dewatering at the WWTP. In 2016, the water table was below the contaminated "smear zone" (Appendix E, Figure E-5)

The results of sampling for PCP in plant influent (recovered groundwater — station IN), treatment process sampling (between carbon units — station BABB) and effluent (treated discharge from the plant — station EFF) in 2017 are provided in Appendix A and Appendix B-1 and are summarized for the 2001 to 2017 period of record in Table 2.4 and Appendix E, Figure E-2. PCP concentrations have generally decreased over time in the influent samples, ranging from about 130 µg/L to 631 µg/L (in 2001), to 22.3 µg/L to 52.5 µg/L (in 2017). Sampling results throughout 2017 indicate that approximately 88 percent of the contaminant load to the WTP comes from the NHRT and that 12 percent of the contaminant load comes from the NCRT.

In 2017, the concentrations of PCP in WTP effluent samples (station EFF) were always below the 1 µg/L ROD discharge to surface water cleanup level. The maximum recorded concentration of PCP at station

EFF was 0.640 µg/L, and the average concentration was 0.393 µg/L, both somewhat above the newly revised DEQ-7 human health standard for surface water (0.3 µg/L) (DEQ 2017).

For this report, the concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalence quotient (TEQ), referred to in this report as "dioxin (TEQ)," are calculated using two different methodologies, referred to as the "MPTP ROD Methodology" and the "DEQ-7 Methodology," as described below. Calculations for both methods are provided in Appendix A and are summarized in Appendix B-3.

- **MPTP ROD Methodology**

  Dioxin (TEQ) is calculated using 0 for values qualified as "U" (analyzed for but not detected above the method detection limit [MDL]), using 0 when estimated maximum possible concentrations are reported, and using ROD toxicity equivalency factors (TEF).

- **DEQ-7 Methodology**

  Dioxin (TEQ) is calculated using the 2005 World Health Organization methodology, using one-half the project reporting limit where not detected; using one-half the estimated maximum possible concentration when reported; and using 2005 TEFs as specified in DEQ-7 (DEQ 2017).

The dioxin (TEQ) for WTP samples for the 2001 to 2017 period of record is provided in Appendix A, Appendix B-3, and Table 2.5. Dioxin levels have varied over time, and low levels of dioxins have been detected in WTP effluent samples collected during monitoring events each year. Using the MPTP ROD Methodology, the concentration of dioxin (TEQ) in the WTP treated effluent sample collected on August 7, 2017, was 1.87E-06 µg/L (equivalent to 1.87 picograms per liter [pg/L]) (Table 2.5 and Appendix B-3). Using the DEQ-7 Methodology, the concentration of dioxin (TEQ) in the WTP treated effluent sample was 3.40E-06 µg/L (equivalent to 3.40 pg/L) (see Appendix B-3). However, a dioxin (TEQ) value (using the DEQ-7 Methodology) of about 5 pg/L has been shown to be an appropriate "noise threshold" for dioxin (TEQ) using the currently lowest available detection limits because laboratory-grade distilled-deionized water has been shown to routinely exhibit dioxin (TEQ) up to about 5.0 pg/L (using the DEQ-7 Methodology) (Tetra Tech 2015). Therefore, it is unclear if dioxin results for the WTP effluent sample in 2017 indicate there was dioxin in the effluent. Regardless, the results indicate that the concentrations of dioxin (TEQ) in WTP effluent, if present, would have met the 1.00E-05 µg/L (equivalent to 10 pg/L) ROD discharge to surface water cleanup level.

The ROD requires that treated discharge to surface water (station EFF) be analyzed for six metals, including arsenic, cadmium, chromium, copper, lead, and zinc (EPA and DEQ 1993). Acute and chronic DEQ-7 aquatic life standards for cadmium, copper, lead, and zinc are hardness dependent. A hardness of 125 milligrams per liter is representative of Silver Bow Creek.

Other contaminants of interest not specifically called out in the ROD but that have been historically included for analysis for various reasons include the anions bromide, chloride, fluoride, nitrate, nitrite, and phosphate. Even though it is not required by the ROD, samples from stations NHRTEFF, NCRTEFF, IN, and EFF continue to be analyzed for anions (by EPA Method 300.0) on an annual basis. The concentrations of metals, anions, PAH, and chlorophenols for WTP samples collected from four stations (NHRTEFF, NCRTEFF, IN, and EFF) during the August 2017 annual monitoring event are provided in Appendix A and Table 2.6. The concentrations of constituents in the MPTP WTP effluent sample (station EFF) were all below the ROD discharge to surface water cleanup levels and below aquatic and chronic aquatic life standards in the current Montana DEQ-7 standards (adjusted for hardness). There are no ROD cleanup levels for anions or for any analytes at the other three stations (NHRTEFF, NCRTEFF, and IN).

2.2.1 Floating Product Recovery and Treatment

A minor amount of floating product (about 0.25 inch, or less) was measured in the NHRT between January 25, 2017, and February 22, 2017. A slight oil sheen was noted on March 30, 2017, and no product was noted from that point on. When coupled with the observation that floating product was not detected in any monitoring well during any sampling conducted in calendar years 2010 through 2017, these observations suggest that significant ongoing transport of free-phase light oil is no longer a significant concern at MPTP. However, some residual oils are still present near the NHRT, primarily below the interstate highway.

2.3 QUALITY CONTROL

QC samples were collected and analyzed in 2017 as per the GWMP, Revision 2 (Tetra Tech 2013b). QC samples consisted of source water blanks and field duplicate samples for liquid matrix samples. Source water blanks (distilled-deionized water supplied by the laboratory) were prepared at a frequency of one per 20 samples per monitoring event to assess potential external sources of contamination. Field duplicates were also collected at a frequency of one per 20 water samples per monitoring event.

Source Water Blanks

A total of 79 source water blanks were prepared and analyzed in 2017 (Table 2.7). The concentrations of constituents for 75 of 79 (95 percent) source water blanks were below the corresponding laboratory detection limit. All 34 PCP samples (100 percent) were below the detection limit value (0.1 µg/L). However, dioxin (TEQ), chromium, iron, and zinc were detected in one source water blank sample (SW-07080816) submitted to the laboratory on August 8, 2017. Detectable concentrations of an analyte in a source water blank suggest that the original sample concentrations of these analytes on this date may be biased high. Overall, the data for source water blanks are interpreted to mean there was little or no cross contamination in the sampling process for sampling conducted in 2017.

Field Duplicates

A total of 79 field duplicate samples were collected and analyzed in 2017 to evaluate precision. Precision is the degree of mutual agreement between individual measurements of the same property under similar conditions. PCP and "extended parameter list" field duplicate samples were collected at the same time and from the same source at a frequency of one per 20 liquid matrix samples per monitoring event. The variance between the samples was then calculated as a relative percent difference (RPD). The formula for RPD is:

$$RPD = \frac{|A - B|}{(A + B)/2} \; x \; 100$$

where: A = First duplicate concentration (original sample)

B = Second duplicate concentration (duplicate sample)

The RPD goal for this project is 20 percent (or lower) (EPA 2014). Sixty-nine of 79 duplicate samples (87 percent) met the RPD goal (Table 2.8). The average RPD for all duplicate samples in 2017 was 9.7 percent. Based on these results, the level of precision for sampling conducted in 2017 is considered to have met the overall project goal.

2.4 WTP IMPROVEMENTS

No WTP improvements of significance were made in 2017.

2.5 INJECTION ACTIVITIES

Approximately 25 to 30 gpm of treated WTP water continued to be directed to the west-side infiltration area near the west end of the NHRT throughout 2017 (Figure 1.1). Treated water has been directed to this area by gravity flow via a 1.5-inch hose since April 2010 to improve the groundwater gradient in a critical capture area for the site PCP plume, while at the same time increasing the groundwater gradient within the NHRT to direct more contaminant toward the recovery pump location at manhole #2 (Figure 1.1). This action also adds oxygenated water to the aquifer, with the goal of stimulating biological reactions and increasing treatment rates for PCP. Treated WTP water was not directed to the south-side infiltration system in 2017 (Figure 2.1). Any treated WTP effluent not directed to the west side of the NHRT as described above was discharged to Silver Bow Creek.

Minor amounts of runoff that collected in the LTU retention pond after late May and early June rainstorms were pumped to the south-side infiltration system on May 22, 2017, May 23, 2017, and again on June 19, 2017, and June 20, 2017.

Lastly, it is estimated that a total of about 843,000 gallons of WTP backwash was directed to the south-side infiltration system, cells 2 and 3, in 2017. Specifically, the WTP primary carbon tanks were backwashed 12 times: January 16, 2017; February 13, 2017; March 13, 2017; April 17, 2017; May 15, 2017; June 12, 2017; July 17, 2017; August 14, 2017; September 18, 2017; October 16, 2017; November 13, 2017; and December 18, 2017. The secondary carbon tanks were backwashed four times: January 3, 2017; March 31, 2017, July 3, 2017; and October 6, 2017. South-side infiltration system cell 3 was taken off line in June 2017. (See Section 2.6.3 and Appendix D for details.)

2.6 OPERATIONAL ISSUES

A few non-routine operational issues arose in 2017. These issues are discussed below.

2.6.1 January 1, 2017, to December 31, 2017 – Pumping Rate in the NHRT

A decrease in the sustainable pumping rate was noted in the NHRT (throughout 2017). Specifically, the sustainable pumping rate in the NHRT has generally decreased from 135 gpm in 2009 to about 75 gpm in 2017 (see Appendix E, Figure E-4). Possible explanations for this phenomenon include: (1) the impact on aquifer hydraulic conductivity caused by loading of soils during construction of the interstate bridge embankment, and (2) perforated piping and gravels in the NHRT may be partially clogged by iron and manganese precipitates, inhibiting flow from trench gravels to the recovery plumbing. The NHRT pump was previously replaced in August 2015, also because of clogging associated with iron and manganese precipitation. Precipitation of these metals is also related to fouling of the NHRT pump (Section 2.6.2) (see Appendix D1, and Appendix E, Figure E-3). Figure E-3 indicates there has been an increase in the concentration of iron in the NHRT since 2006. The decrease in the sustainable pumping rate in the NHRT and the increase in iron that is affecting WTP operations should be investigated (see Section 9.0). To support this investigation, trench samples should be analyzed for iron species more often than just annually.

2.6.2 March 29, 2017 - Fouling of the NHRT pump

Inspection of the NHRT pump on March 29, 2017, indicated iron precipitation on the NHRT piping and pump end (both inside and out). The piping was flushed with water to remove built-up precipitate, and the pump end and motor were separated. The NHRT pump motor and pump end were replaced that day. The motor was stored for future disposal and the pump end was cleaned once it dried out and is being stored for future use. The NHRT pump was off for 2 hours during this process. Details and photographs related to the NHRT pump replacement process are provided in a Daily Summary Report (Appendix D1).

2.6.3 Other Disturbances to WTP Operations

Several other disturbances to WTP operations occurred in 2017, including:

- February 27, 2017. A catchment basin breached at the Hollow Contracting property (404 Greenwood Avenue West, Butte, Montana). The property is located on the south side of Greenwood Avenue and is immediately adjacent to the MPTP site. When the breach occurred, previously stored water within the catchment basin crossed Greenwood Avenue to the north and ran onto, and through, the MPTP site, where it eventually collected in a topographic depression on the south side of the interstate highway. In addition, trucks from Hollow Contracting were reported to have run over the southern end of a Greenwood Avenue culvert during the first quarter of 2017, collapsing the end of the culvert end and at times forcing water over the road on to the MPTP site.
- April 17, 2017. A 2-feet by 2-feet by 2-feet "sinkhole" was discovered east of vault 1A. During backwashing on May 15, 2017, the plant operator noted a leak adjacent to this vault. The area was excavated, and field observations indicated the cell was unable to accept the volume of water that it did previously. The perforated-type pipe at that location is buried in the gravel of the infiltration cell, and it was not exposed during the excavating process. The excavation was halted at the liner on top of the gravel bed so that infiltration system would not be compromised. It appears that injection cell 3 can no longer be used. This situation is discussed in detail in the DSR for June 5, 2017 (Appendix D). The ability of the south-side infiltration system to accept water in the future should be investigated (see Section 9.0).

2.7 MISCELLANEOUS REPAIRS AND ACTIVITIES

A number of miscellaneous repairs and activities took place at the MPTP site in 2017, as described below:

- June 30, 2017. Full Armor, LLC, sprayed for noxious weeds. The area of coverage included the entire site within the fence boundary, plus a small buffer along the site fence lines, and an area where the pole mound removal was conducted in early 2012. All weed spraying was completed in less than 8 hours using a hand sprayer.
- July 24, 2017. Jordan Contracting mobilized equipment and screened and removed rock for its off-site project from July 24, 2017, to July 26, 2017.
- August 17, 2017. Full Armor, LLC, sprayed for noxious weeds.
- October 23, 2017. Full Armor, LLC, sprayed for noxious weeds.
- November 29, 2017. An electrical power spike destroyed a 12-volt power supply for the NHRT. The NHRT pump was off for approximately 2 hours and was operated with an alternative power supply for about 2 days until a replacement part could be installed.
- December 17, 2017. A raven knocked out a main power substation for Butte, and the WTP was

without power for approximately 1 hour.

No other repairs or activities of significance were required at the MPTP site in 2017.

3.0 LAND TREATMENT UNIT OPERATIONS

Historical LTU soil management, LTU operation in 2017, and the results of LTU sampling are discussed in the following sections.

3.1 HISTORICAL LTU SOIL MANAGEMENT

Loading of soil into the LTU (Figure 1.1) began in the fall of 1996. By spring 1997, approximately 2 feet of soil from the north-side excavation had been placed on the LTU. During fall 1999, 18 of the 24 inches of treated soils (approximately 24,000 cubic yards) were removed and backfilled on the north side. Six to 8 feet of contaminated soil that had been excavated from the south side was placed on the LTU during the fall of 1999 and summer of 2000. During the fall of 2000, 18 inches of treated soils (approximately 24,000 cubic yards) were removed and used as backfill in the south-side excavation area. During the spring of 2001, contaminated soils from the north-side sewer main replacement project were spread on LTU zones 1 and 2.

In the fall of 2001, 18 to 24 inches of soil (approximately 27,000 cubic yards) were removed from LTU zones 2 to 10 and backfilled into the south-side excavation area. The LTU was tilled monthly during the 2001 treatment season. In response to complaints from residents in the nearby neighborhood regarding odors from the LTU, the tilling frequency was reduced to annually beginning in 2002. The LTU was tilled to a depth of approximately 8 inches in November 2002 and again in October 2003. In 2005, the top 30 inches of LTU soils were determined to have met the treatment standards for PCP and PAH. The top 24 inches of treated soils (approximately 29,000 cubic yards) were offloaded, leaving a 6-inch "buffer" of treated soils in an attempt to minimize odor. The treated soils were backfilled into the south-side excavation areas on site.

The LTU was tilled in October 2005 after the summer offload. In 2007, 32,000 cubic yards of treated soil were offloaded from the LTU and backfilled on the southern portion of the site. The five remaining SSP piles were dismantled, and 8,000 cubic yards of contaminated soil were moved from the SSPs and placed on the LTU for final treatment. Work in 2009 associated with NHRT modifications and the sewer realignment project added approximately 2,000 cubic yards of excavated soil, which was placed on the western portion of the LTU.

In 2010, approximately 3.2 million gallons of water were applied to the LTU through a center pivot unit at regular intervals from April to September to facilitate biologic degradation of the contaminants.

Irrigation water was supplied from the retention pond, with make-up water added from the WTP as necessary. The LTU soil was tilled once in April 2010. A small volume of soil excavated during the interstate highway bridge replacement project was placed on the LTU in June 2010.

In 2011, the collection pipe located between the NHRT manhole #2 and the west-end cleanout was cleaned. A very small volume of solid material and an estimated 15,000 gallons of water removed during the cleanout were transferred into a vacuum collection truck and were placed on the LTU for bioremediation. In addition, approximately 200 cubic yards of soil from highway pier drilling was removed by the Montana Department of Transportation (MDT) contractor and placed on the LTU as part of the MDT bridge replacement project. Lastly, 182 linear feet of drill cuttings (approximately 2.3 cubic yards) from five groundwater monitoring well borings were placed on the LTU. The LTU was irrigated on 14 separate days during the second and third quarters of 2011 (2,141,200 gallons were applied). No soil was tilled at the LTU during 2011.

In 2012, the LTU was tilled during the second quarter for the five sampling zones (LTU zones 2, 3, 4, 5, and 10) that had not met the cleanup standard for PCP during the 2011 LTU soil monitoring event. In addition, the LTU was irrigated on an as-needed basis during the second and third quarters to control fugitive dust when conditions were dry (8 days, between May 14, 2012, and September 5, 2012). A total of 1,171,900 gallons of irrigation water were applied in 2012.

In 2013, the three sampling zones (LTU zones 2, 3, and 4) that did not meet the cleanup standard for PCP during the 2012 LTU soil monitoring event were tilled two times in May and once in July. Soil moisture during the May and July 2013 tilling events was sufficiently high to avoid generation of dust.

The LTU was irrigated seven times during the third quarter of 2013 on an as-needed basis to control dust. A total of 884,700 gallons of irrigation water were applied. Neither odors nor dust were detected during tilling operations at any time in 2013.

No soil tilling or irrigation occurred at the LTU from 2014 through 2016.

3.2 LTU OPERATIONS IN 2017

Including the sand layer, the volume of soil that remains on the LTU is estimated at 53,000 cubic yards; the sand layer is approximately 6 to 12 inches thick (approximately 15 percent by volume).

No soil tilling occurred at the LTU in 2017. Neither odors nor dust were documented at any time during the year (the site is mostly covered by vegetation). In addition, there was no need to irrigate the LTU, as the site received adequate precipitation throughout the year. Historical LTU water application data for the 1999 to 2017 period of record are provided in Table 3.1.

The LTU irrigation system was last winterized mid-September 2013, which included turning off the water, draining the system, and turning off power to the system. Since the LTU irrigation system was never used since then, winterization of the system was not necessary in 2017. No LTU maintenance of any significance has taken place since the 2013 winterization.

3.3 LTU SOIL SAMPLING AND RESULTS

Soil currently in the LTU was sampled on an annual basis from 2007 through 2013. Based on historical data, LTU soils were not sampled in 2014 to 2017 as part of site operations. Table 3.2 summarizes the historical analytical data for these years.

The average concentration of PCP in all LTU zones sampled in 2012 was 26.7 milligrams per kilogram (mg/kg); in 2013, the average concentration of PCP in LTU soils was 26.8 mg/kg. These data indicate the average concentration of PCP in LTU soils was less than the ROD soil cleanup level (34 mg/kg) for two consecutive monitoring events. The average dioxin (TEQ) concentrations from the 2012 and 2013 monitoring events are above the ROD cleanup level of 0.2 micrograms per kilogram (µg/kg), as was the case in previous offloads. Therefore, the cleanup goal for dioxin in soil has not been met. LTU soils were not analyzed for PAH during the October 2013 round of sampling because all sections of the LTU had previously met the cleanup goal for PAH for two successive monitoring events.

A data gaps investigation was completed in mid-2017, a final report presenting the results of this investigation was issued in November 2017 (Tetra Tech 2017), and development of the 30 percent design for the final offload began. The design will include offloading all of the soil in the LTU, removing and disposing of the LTU liner and associated materials and equipment, removing the retention pond and berms, and reclaiming the current LTU and retention pond areas.

3.4 LTU UNDERDRAIN AND POND SAMPLING AND RESULTS

During the August 2017 annual monitoring event, the LTU underdrain discharge (station LTUDIS) and LTU retention pond water (station RETPOND) were sampled and analyzed to support ongoing planning for the LTU offload. The LTU discharge sample is representative of leachate associated with the underdrain of the LTU soil treatment area. Leachate from the underdrain flows by gravity to the LTU retention pond, where some degradation of PCP is known to occur.

An unfiltered sample from station LTUDIS was submitted to the laboratory for analysis of PCP. The concentration of PCP in unfiltered LTU discharge (station LTUDIS) was 21.6 µg/L. The concentration of PCP in the unfiltered LTU retention pond water (station RETPOND) sample was substantially lower

(3.08 µg/L). These data support a conclusion that physical and biological degradation of PCP occurs in the LTU pond.

Samples from stations LTUDIS and RETPOND were not analyzed for chlorophenols (other than PCP), PAHs, or dioxins in 2017.

4.0 SURFACE WATER AND GROUNDWATER MONITORING

Water quality at the MPTP site was monitored on a regular basis from 2001 until August 2010 as specified in the Site-Wide Operations and Maintenance Manual (Camp Dresser & McKee, Inc. [CDM] 2000). The MPTP monitoring program was revised starting with the November 2010 monitoring event as specified in the GWMP, Revision 0 (Tetra Tech 2011). Data presented in this 2017 annual sampling and monitoring report were collected according to the guidelines provided in the GWMP, Revision 2 (Tetra Tech 2013b). GWMP, Revision 2, supersedes previous versions of this document. Future revisions to the GWMP, as needed, will continue to be numbered sequentially.

A semi-annual monitoring event was conducted during February 2017 and all groundwater and surface water samples were analyzed for PCP. The annual monitoring event for surface water and groundwater was conducted in August 2017. Table 2.3 provides a summary of the monitoring program for 2017. After initial inspection on August 3, 2017, monitoring wells 10-12 and GW-14R-98 were found to be deficient, and these wells were not sampled during the third quarter. Field photographs and the August 3, 2017, DSR that discuss these deficiencies are provided in Appendix D. It is recommended that monitoring wells 10-12 and GW-14R-98 be abandoned and destroyed by a licensed Montana monitoring well contractor. Replacement wells should be drilled at these locations to maintain consistency with the existing long-term data sets associated with these wells (see Section 9.0).

A sampling device has been stuck in the borehole of monitoring well MW-11-05 since February 2016; therefore, the well was not sampled in 2017. This well should be abandoned (Section 9.0)

4.1 SURFACE WATER MONITORING

As part of routine monitoring for the MPTP site, three surface water locations (SW-05, SS-06A, and SW-09) were sampled in February 2017 (PCP only) and again in August 2017 (for PCP and the "extended parameter list" of analytes), as outlined in Table 2.3. In addition to PCP (by EPA Method 528), the "extended parameter list" of analytes included chlorophenols (by EPA Method SW8270C), PAH (by EPA Method SW8270C), and dioxins (by EPA Method SW8290). Surface water monitoring locations sampled in 2017 are provided on Figure 4.1 and include:

- SW-05: on Silver Bow Creek, due west (downstream) of the MPTP site
- SS-06A: on Silver Bow Creek, on the downstream side of the MPTP site but immediately upstream from the WTP effluent discharge rill
- SW-09: on Silver Bow Creek, due east (upstream) of the MPTP site.

Analytical results for each category of contaminant are discussed below.

PCP

The concentrations of PCP in surface water are provided in Appendix A and Appendix B-2 and are summarized for the 2001 to 2017 period of record in Table 4.1. The only detection of PCP was in February 2017 at downstream surface water station SW-05 (0.195 µg/L) and was below the ROD surface water cleanup level (1.0 µg/L). Other than this one detection, the concentrations of PCP at surface water stations SW-05, SS-06A, and SW-09 in 2017 were below the laboratory detection limit (0.1 µg/L) and below the ROD surface water cleanup level (1.0 µg/L).

Over the last 5-year period (2013 to 2017), the concentrations of PCP at stations SW-05, SS-06A, and SW-09 have been undetected, or slightly above the detection limit (0.1 µg/L, [0.2 µg/L before July 31, 2017]), and consistently below the ROD surface water cleanup level for PCP (1 µg/L).

In August 2017, samples from surface water stations SW-05, SS-06A, and SW-09 were also analyzed for the "extended parameter list" of analytes. Results are provided in Appendix A (full database), Appendix B-3 (dioxin TEQ), Table 4.2 (dioxins) and Table 4.3 (PAH and chlorophenols). Analytical results are discussed below.

Chlorophenols

The concentrations of all chlorophenols in surface water at stations SW-05, SS-06A, and SW-09 were below ROD surface water cleanup levels (where established).

PAHs

Benzo(a)anthracene and naphthalene were detected in surface water at station SW-05 during the August 2017 sampling event. All other PAH concentrations at stations SW-05, SS-06A, and SW-09 were below detection limits. The concentration of benzo(a)anthracene (0.367 µg/L) was below the ROD surface water cleanup level (1.0 µg/L). The concentration of naphthalene was 0.602 µg/L; there is no surface water cleanup level for naphthalene. The calculated total D PAH[1] for station SW-05 was 0.602 µg/L; the ROD total D PAH cleanup level is 360 µg/L.

Dioxins

Using both the MPTP ROD Methodology (Table 4.2 and Appendix B-3) and the DEQ-7 Methodology (Appendix B-3), the dioxin (TEQ) was below the 1.00E-05 µg/L (equivalent to 10 ρg/L) ROD surface water cleanup level at MPTP surface stations SW-05, SS-06A, and SW-09.

4.2 GROUNDWATER MONITORING

The locations of all MPTP groundwater monitoring wells are provided on Figure 4.2. The concentrations of PCP in groundwater for five representative monitoring wells (BMW-01A, BMW-01B, HCA-21, INF-04, and MW-11-04) are summarized for the 2000 to 2017 period of record in Table 4.4. As noted in Section 4.0, monitoring wells 10-12 and GW-14R-98 were found to be deficient and were not sampled for analysis of PCP in 2017. Surrogate PCP data from monitoring wells 10-04 and 10-05 were used as needed for assessing site conditions for this 2017 annual report. Analytical results are provided in Appendix A and Appendix B-2. Monitoring results are discussed further in Section 4.3 below.

Appendix A, Appendix B-3, and Table 4.5 provide analytical results for dioxins in groundwater for historical sampling and for samples collected from five representative monitoring wells (BMW-01A, BMW-01B, HCA-21, INF-04, and MW-11-04) during the 2017 annual monitoring event, as specified in the GWMP, Revision 2 (Tetra Tech 2013b). Analytical results for PAH and chlorophenols in groundwater for these same five monitoring wells are provided in Appendix A and Table 4.6. Results are discussed further in Section 4.3 below. As previously noted, monitoring wells 10-12 and GW-14R-98 were found to be deficient and were not sampled for analysis of PAHs or dioxins in 2017.

A potentiometric surface map was prepared using static water level data collected from 59 shallow monitoring wells on July 28, 2017 (Figure 4.3). Figure 4.3 indicates that the hydraulic gradient at the MPTP was generally from the southeast to the northwest. The magnitude of the hydraulic gradient was approximately 0.005 foot/foot. These results are consistent with values obtained during historical monitoring events since 2005.

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[1] The D PAH concentration equals the sum of the acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene concentrations.

Groundwater contours have been influenced by beaver-related activity (beaver dam construction and resulting ponding of water) since the third quarter of 2010. Beaver activity and damming present on July 28, 2017, resulted in localized flooding and groundwater mounding, as exemplified in Figure 4.3. Groundwater mounding in this area assists in facilitating the flow of groundwater south of Silver Bow Creek back toward the NCRT, thus aiding in recovery of dissolved contaminants. It is expected that groundwater mounding will continue when beaver dams are present and beaver activity persists. Beaver activity along Silver Bow Creek near the MPTP site in 2017 is discussed in Section 6.3.

Figure 4.4 provides a more focused analysis of the July 28, 2017, groundwater elevations and interpreted flow directions in the vicinity of the NCRT. Figure 4.4 indicates there is radial flow and hydraulic capture in the shallow aquifer in the vicinity of the NCRT. Groundwater mounding related to flooding from the beaver dam in the WTP discharge rill can also be observed on Figure 4.4.

Starting on April 20, 2010, and continuing throughout all of 2017, 25 to 30 gpm of treated effluent from the WTP has been continuously diverted to the west side infiltration area (near the west end of the NHRT) in an effort to influence the hydraulic gradient in this area (Figure 1.1). Groundwater elevation data in 2017 indicate that the water levels in monitoring well A-99 were consistently higher than water levels in wells inside the NHRT, suggesting there may be some effect (Appendix A, Figure 4.4).

4.2.1 Association between Turbidity and Dioxin Results

The MPTP Fourth Five-Year Review Report (DEQ 2017) states that "*turbidity is expected to be measured in future sampling events, which will allow for a long-term relationship to be established between dioxin (TEQ) results and turbidity values at specific wells.*"

During the 2017 annual sampling event, turbidity was measured at monitoring stations where samples were collected and analyzed for dioxin (Table 4.7). These 2017 data augment data collected in 2015 and 2016 (Table 4.7). Three (or fewer) data points (temporally) are insufficient to draw a statistically valid conclusion regarding the correlation between dioxin (TEQ) results and turbidity values at specific monitoring stations over time. However, data for monitoring well MW-11-04 (in 2015, 2016, and 2017), and perhaps at stations INF-16 (in 2015), LTUDIS (unfiltered) (in 2016) and INF-04 (in 2017), may be consistent with the premise that higher values of turbidity appear to be "associated" with higher dioxin (TEQ) values at monitoring well locations when dioxin is present in the sample (Table 4.7). Note that there is less confidence in the turbidity-dioxin relationship for station NHRTEFF, as is stated in the Fourth Five-Year Review Report (DEQ 2017):

> *"it is also possible that some dioxins are introduced to the trenches in sheens of oils, though in recent years observations of sheens have been limited to just a few instances at the NHRT and are not commonplace."*

It is important to note that a sample can have high turbidity but a low dioxin (TEQ) if the particulates near that well are not affected by dioxin. Lastly, dioxin is insoluble in water.

It is recommended that turbidity data continue to be collected when dioxin samples are collected so that an adequate data set can be gathered over time to evaluate patterns of dioxin versus turbidity at individual monitoring stations (see Section 9.0).

4.3 ROD COMPLIANCE MONITORING

ROD compliance monitoring has historically incorporated water quality data for ROD contaminants (PCP and the "extended parameter list" of analytes) measured in plant discharge (station EFF), surface water (stations SW-05, SS-06A, and SW-09), and groundwater monitoring wells (10-12, BMW-01A, BMW-01B, GW-14R-98, and HCA-21) as specified in the GWMP (Tetra Tech 2013b). As noted in Section 4.0, monitoring wells 10-12 and GW-14R-98 were not sampled in August 2017; therefore, "extended parameter list" data for these two wells are unavailable. However, shallow monitoring well 10-05 is located approximately 250 feet upgradient of well 10-12; therefore, August 2017 PCP data from well 10-05 could be used in lieu of the missing PCP data from well 10-12. Likewise, shallow monitoring well 10-04 is located approximately 80 feet downgradient of well GW-14R-98; therefore, August 2017 PCP data from well 10-04 could be used in lieu of the missing PCP data from well GW-14R-98. At the direction of DEQ, samples from wells 10-04 and 10-05 were not analyzed for the "extended parameter list" of analytes in August 2017. If wells 10-12 and GW-14R-98 are not replaced, it is recommended that future annual monitoring events include sampling of wells 10-04 and 10-05 for analysis of the "extended parameter list" of analytes (Section 9.0).

The concentrations of PCP from the February (semi-annual) and August (annual) groundwater monitoring events were evaluated to assess the distribution of PCP in groundwater during 2017. The results of groundwater monitoring and an assessment of compliance with ROD requirements and cleanup levels are presented in the following sections.

4.3.1 2017 Monitoring Events

WTP Effluent

WTP effluent (treated groundwater at WTP station EFF) was monitored for PCP on a weekly basis; 52 samples were collected and analyzed for PCP in 2017. WTP effluent was also monitored for the "extended parameter list" of analytes during the August 2017 annual sampling event.

One hundred percent of results from weekly PCP analyses (52 samples) were below the PCP 1.0 µg/L ROD discharge to surface water cleanup level (Table 2.4). The concentrations of dioxins, PAH, and chlorophenols were below the ROD discharge to surface water cleanup levels, where established (Table 2.5 and Table 2.6).

Surface Water

Surface water in Silver Bow Creek (stations SW-09, SS-06A, and SW-05) were monitored for PCP and the "extended parameter list" of analytes during the August 2017 annual sampling event.

The concentrations of PCP (Table 4.1), dioxins (Table 4.2), and PAHs and chlorophenols (Table 4.3) were below the ROD surface water cleanup levels (where established).

Groundwater

Sixty shallow monitoring wells, four intermediate monitoring wells, and eight deep monitoring wells were scheduled for sampling during the February 2017 semi-annual monitoring event and August 2017 annual sampling event, per the GWMP (Tetra Tech 2013b). With few exceptions, samples were collected from all wells listed in the GWMP and were analyzed for PCP by EPA Method 528 (Appendix A and Appendix B). Exceptions included wells that were either frozen, blocked, or physically compromised (see Section 4.0 and Appendix A).

Data from shallow wells were plotted and contoured to evaluate trends in concentration and the spatial distribution of PCP contamination. Figure 4.5 and Figure 4.6 provide the distribution of PCP in groundwater on the south side of Silver Bow Creek based on data collected during the February 2017 semi-annual monitoring event and the most current (August 2017) annual monitoring event.

In general, Figures 4.5 and 4.6 indicate the presence of a plume of PCP approximately 750 feet wide by 1,500 feet long on the south side of Silver Bow Creek oriented along the principal direction of groundwater flow (southeast to northwest). The figures indicate there were several PCP "hot spots," as summarized by the associated monitoring event below.

February 2017 Semi-annual Monitoring Event

As shown on Figure 4.5, "hot spots" were noted:

- Under the interstate highway and extending northeast near the WTP and monitoring well MW-11-04
- West of the LTU near monitoring wells GW-05, INF-13 and INF-16

- North of the NCRT adjacent to the Burlington Northern railroad tracks near monitoring well MW-I-01.

August 2017 Annual Monitoring Event

As shown on Figure 4.6, "hot spots" were located:

- Near wells INF-10, PZ-S3-02, PZ-S6-01, PZ-S5-01, MW-X-01, located northwest of the LTU and south of the interstate highway
- Near monitoring wells MW-11-01, MW-11-02, MW-11-04, MW-H-95, and INF-04, north of the interstate highway and in the general vicinity of the MPTP WTP building
- Near monitoring wells MW-I-01 and MW-H-01 located north of the NCRT and immediately north of, and adjacent to, the Burlington Northern railroad right-of-way
- Near monitoring well GW-05, located 600 feet west of the LTU.

During the August 2017 annual monitoring event, groundwater samples from five shallow monitoring wells (10-12, GW-14R-98, HCA-21, INF-04, and MW-11-04) and two deep wells (BMW-01A and BMW-01B) were scheduled to be collected and analyzed for the "extended parameter list" of analytes, including PAH, dioxins, and chlorophenols, as per the GWMP, Revision 2 (Tetra Tech 2013b). These seven wells were selected to provide a range of representative groundwater quality conditions across the site relative to (1) the location of the PCP plume (as defined by the 1 µg/L PCP contour interval), and (2) PCP "hot spots" within the plume. The rationale for selecting these wells included:

- Monitoring wells 10-12 (shallow), BMW-01A (deep), and BMW-01B (deepest) were selected because they can be considered downgradient sentinel monitoring wells (shallow and deep well completions) on the south bank of Silver Bow Creek. Data from these wells can be used to evaluate plume capture and the potential for off-site migration of contaminants.
- Monitoring wells GW-14R-98 (shallow) and HCA-21 (shallow) were selected because they are located on the south bank of Silver Bow Creek within the footprint of the PCP plume, have a long-term period of record, and can be used to evaluate the progress of groundwater remediation over an extended period of time.
- Monitoring wells INF-04 and MW-11-04 were selected because they are located in or near "hot spots" along the centerline of the PCP plume.

As noted in Section 4.0, shallow monitoring wells 10-12 and GW-14R-98 were deficient and were not sampled. However, PCP data from nearby shallow wells 10-04 and 10-05 can be used as surrogates for the missing well data. Unfortunately, groundwater samples from wells 10-04 and 10-05 were not scheduled to be analyzed for the "extended parameter list," and these data are unavailable for 2017. If wells 10-12 and GW-14R-98 are not replaced, it is recommended that the MPTP monitoring program be revised to include sampling wells 10-04 and 10-05 for the "extended parameter list" of analytes for all future annual monitoring events (see Section 9.0).

All available results for dioxin in groundwater (both historical and for 2017) are provided in Appendix A, Appendix B-3, and Table 4.5. In 2017, the dioxin (TEQ) was below the 3.00E-05 µg/L (equivalent to 30 pg/L) ROD groundwater cleanup level in all monitoring wells (using both the MPTP ROD Methodology and the DEQ-7 Methodology), except wells INF-04 (8.41E-05 µg/L [equivalent to 84.1 pg/L]) and MW-11-04 (3.72E-04 µg/L [equivalent to 372.4 pg/L]). As noted in Section 4.2.1, higher dioxin (TEQ) values at these two locations in 2017 appear to be "associated" with sample turbidity, and along with historical data do not show temporal or spatial trends of dioxin in groundwater.

Analytical results for PAH and chlorophenols are provided in Table 4.6 and Appendix A. The concentrations of PAH and chlorophenols in groundwater (the only exception being PCP) were below ROD groundwater cleanup levels (where established) for the wells that were sampled.

4.3.2 Data Evaluation and Progress of Remediation

One WTP station (station EFF [treated groundwater]), three surface water stations (stations SW-05, SS-06A, and SW-09), and five groundwater stations (monitoring wells BMW-01A, BMW-01B, 10-12, GW-14R-98, and HCA-21) have historically been used to evaluate compliance with ROD requirements related to the progress of remediation. As previously noted, PCP data from nearby shallow wells 10-04 and 10-05 can be used in lieu of the missing PCP data from wells 10-12 and GW-14-R-98 that were not sampled. Figure 4.7 provides the location of original seven monitoring wells relative to the location of the recent PCP plume boundary (August 2017), as well as the location of the two potential alternative wells (10-04 and 10-05).

To be consistent with ROD requirements, the following seven criteria have been evaluated in previous annual reports, as well as this 2017 annual report. The data that historically have been used to evaluate each criterion are also provided below (with exceptions for this 2017 annual report noted):

<u>Criterion 1</u>. The WTP effluent (station EFF) must meet the 1 µg/L discharge to surface water cleanup level for PCP (and specified cleanup levels for other contaminants listed in the ROD, where established).

- Data from WTP station EFF (treated groundwater) were evaluated to determine if this criterion was met.

<u>Criterion 2</u>. Surface water in Silver Bow Creek must meet the 1 µg/L surface water cleanup level for PCP (and specified cleanup levels for other contaminants listed in the ROD).

- Data from surface water stations SW-05 (downstream from the site), SS-06A (adjacent to the site), and SW-09 (upstream of the site) located on Silver Bow Creek were evaluated to determine if this criterion was met.

<u>Criterion 3</u>. The PCP plume must remain on site. This criterion is assumed to be met if the concentration of PCP in groundwater in downgradient sentinel monitoring wells continue to meet the groundwater cleanup level for PCP.

- Data from downgradient sentinel monitoring wells (stations BMW-01A, BMW-01B, and 10-12 [or surrogate well 10-05 for this 2017 annual report]) were evaluated to determine if the ROD groundwater cleanup level for PCP (1 µg/L) continued to be met at these locations.

<u>Criterion 4</u>. The concentrations of dioxins, PAH, and chlorophenols in groundwater at representative monitoring wells along the south bank of Silver Bow Creek must meet the specified ROD groundwater cleanup levels, where established.

- Data from monitoring wells BMW-01A, BMW-01B, and HCA-21 were evaluated to determine if this criterion was met. ("Extended parameter list" data from wells 10-12, GW-14R-98, or from surrogate wells 10-04 and 10-05, were not available in 2017.)

<u>Criterion 5</u>. The long-term trend in the concentrations of PCP in groundwater over time should be decreasing, suggesting that groundwater quality will eventually meet the 1 µg/L groundwater cleanup level for PCP.

- Data from groundwater monitoring wells with a long-term period of record (2004 to 2017) located along the south bank of Silver Bow Creek and within the footprint of the PCP plume were evaluated to determine if this criterion was met. (Data were evaluated only for well HCA-21, as data from well GW-14R-98 were not available in 2017.)

<u>Criterion 6</u>. The long-term trend in the area of the PCP plume must be stable or shrinking, showing that ongoing remedial action is effectively preventing the spread of contamination.

- The long-term trend (since 1993) in the digitized area of the PCP plume was evaluated using all available monitoring well data to construct the 1 µg/L PCP isocontour for each year that data were accessible.

<u>Criterion 7</u>. The short-term trend (previous 5 years) in the area of the PCP plume must be stable or shrinking, showing that ongoing remedial action is effectively preventing the spread of contamination.

- The short-term trend (previous 5 years) in the digitized area of the PCP plume using the 1 µg/L isocontour was evaluated to determine if this criterion was met.

Water quality data collected in 2017 were used to evaluate the first four criteria (Criterion 1 through Criterion 4). Available historical data (1993 to 2017) were used evaluate the last three criteria (Criterion 5 through Criterion 7) by analyzing trends through time. Surrogate well data (from wells 10-04 and 10-05) were used to perform these analyses, if the data were available. Results are provided in Table 4.8 and are summarized below.

- **<u>Criterion 1</u>**. Criterion 1 was satisfied. One hundred percent of the results from weekly PCP analyses (52 samples) at station EFF were below the PCP 1.0 µg/L ROD discharge to surface water cleanup level. The concentrations of dioxins, PAH, and chlorophenols at station EFF were below the ROD discharge to surface water cleanup levels, where established.

- **Criterion 2**. Criterion 2 was satisfied. The concentrations of PCP, dioxins, PAH, and chlorophenols at the three surface water stations on Silver Bow Creek were below the ROD surface water cleanup levels (where established).

- **Criterion 3**. Criterion 3 was satisfied. The concentrations of PCP in downgradient sentinel monitoring wells (BMW-01A, BMW-01B, and 10-05 [historically, data from monitoring well 10-12 had been used]) continued to meet the 1 µg/L groundwater cleanup level for PCP, indicating the on-site PCP plume was not migrating off site.

- **Criterion 4**. Criterion 4 was only partially satisfied (for wells BMW-01A, BMW-01B, and HCA-21). It is unclear if Criterion 4 was satisfied for wells 10-12 and GW-14R-98 because there were no "extended parameter list" data for these two wells, or from surrogate wells 10-04 and 10-05. However, the concentrations of dioxins, PAH, and chlorophenols in groundwater for the three wells that were sampled did meet the specified ROD groundwater cleanup levels, where established. If wells 10-12 and GW-14R-98 are not replaced, it is recommended that groundwater samples from monitoring wells 10-04 and 10-05 be analyzed for PCP and the "extended parameter list" of analytes during future annual monitoring events (see Section 9.0).

- **Criterion 5**. Criterion 5 was satisfied. Mann-Kendall statistical testing of PCP data for monitoring well GW-14R-98 (augmented with data from monitoring well 10-04 for 2017) and well HCA-21 indicated the long-term (2004 to 2017) trend in concentrations of PCP in these two well locations is decreasing at greater than the 90 percent confidence level (Appendix F and Table 4.8). This analysis supports a conclusion that ongoing remediation continues to be effective in the long term.

  Criterion 6. Criterion 6 was satisfied. Digitized PCP plumes and plume area calculations are provided in Appendix G. All available monitoring well data were used to construct the 1 µg/L PCP isocontour for each year that data were accessible. A long-term plume area comparison is also provided in Figure 4.8. The long-term trend in the area of the PCP plume indicates ongoing remedial activities have significantly reduced the area of the PCP plume. Specifically, over the past 24 years (since the ROD was signed), the total area of the PCP plume on the south side of Silver Bow Creek (based on the 1 µg/L isocontour line) has decreased from 41.7 acres (in August 1993) to 16.0 acres (in August 2017). This 25.7-acre decrease represents an approximate 60 percent reduction in the area of the PCP plume since 1993. Mann-Kendall statistical testing indicates that, over the long term (2004 to 2017), and during the last 5-year period (2012 to 2017), the area of the PCP plume has been decreasing in size at greater than 90 percent confidence level (see Appendix F).

  Criterion 7. Criterion 7 was satisfied. Mann-Kendall statistics indicate the shorter-term 5-year trend (2012 to 2017) in plume area is "probably decreasing" (Appendix F). However, the clear majority (68 percent) of detections of PCP have been below the 1.0 µg/L groundwater cleanup level during the last 5-year period; the highest recorded concentration over the past 5 years was 1.32 µg/L in monitoring well GW-14R-98 in August 2015. This analysis supports a conclusion that the downgradient edge of the plume is not expanding.

Continued groundwater monitoring and statistical analysis of the area of the PCP plume will be conducted in future annual reports to further evaluate the short-term trend in plume area and make operational adjustments, if necessary. Compliance with ROD cleanup levels will also be evaluated on an annual basis. If wells 10-12 and GW-14R-98 are not replaced, it is recommended that groundwater samples from monitoring wells 10-04 and 10-05 be analyzed for PCP and the "extended parameter list" of analytes during future annual monitoring events.

4.3.3 Light Non-Aqueous Phase Liquid

LNAPL (floating product) was not detected in any monitoring well during any sampling conducted in calendar year 2017. As noted in Section 2.2.1, a minor amount of floating product (about 0.25 inch or less) was measured in the NHRT between January 25, 2017, and February 22, 2017. A slight oil sheen in the NHRT was noted on March 30, 2017, and no product was noted in the NHRT from that point on. The historical volume of LNAPL recovered for the 2000 through 2017 period of record is provided in Table 4.9.

5.0 RESIDENTIAL WELL MONITORING

The historical concentrations of PCP in groundwater collected from residential wells were below the ROD groundwater cleanup level for several years leading up to 2010; therefore, no residential wells were sampled in 2017. The results of residential well sampling for the 2001 to 2017 period of record are provided in Table 5.1.

6.0 ADDITIONAL SITE ACTIVITIES

No other activities of significance took place at the MPTP site in 2017.

6.1 MONITORING OF BEAVER ACTIVITY IN 2017

Groundwater contours have been influenced by beaver-related activity (beaver dam construction and resulting ponding of water) since the third quarter of 2010. In 2017, only one beaver dam was located in the WTP discharge rill, resulting in localized flooding and groundwater mounding, as exemplified in Figure 4.3 and Figure 4.4. Groundwater mounding along Silver Bow Creek north of the WTP assists in facilitating the flow of groundwater south of Silver Bow Creek back toward the NCRT, thus aiding in recovery of remaining dissolved contaminants in this area.

In the future, it is anticipated that DEQ will make no effort to remove the existing beaver dam on Silver Bow Creek because beaver dam-induced flooding north of the MPTP site helps maintain a hydraulic gradient toward the NCRT, which enhances capture of PCP-contaminated groundwater in this area.

7.0 DATABASE MANAGEMENT

The following database-related activities were completed in 2017:

- Uploaded all EDDs received from the Montana Bureau of Mines and Geology (MBMG) and Pace Analytical Services, Inc. to the MPTP Microsoft Access2016 database

- Performed QC of all chains of custody (COCs), MBMG laboratory EDDs, MBMG sample delivery groups (SDGs), and MBMG laboratory Microsoft Excel spreadsheets
- Added 1,196 records to the existing database; at the end of 2017, there were 12,199 individual data records in the database for the 2010 to 2017 period of record (operations only).
- Corrected selected records in the MPTP database to address any QC issues uncovered during the QC review process
- Maintained an SDG versus COC "lookup table" to easily match SDGs to COCs for future reference (Appendix H).

8.0 CLIMATE AND STREAMFLOW

Climatic conditions such as temperature, precipitation, and stream flow factor into understanding how the MPTP site is operated and how water is managed. For example, extremes in temperature can affect pipeline integrity, pump operations, or the ability to obtain samples from shallow monitoring wells. Precipitation affects surface runoff and on-site ponding of water, groundwater recharge, the elevation of the water table, and the movement of contaminants in the vadose zone and aquifer. Stream flow conditions vary from base flow to flood conditions and potentially affect sample collection, groundwater flow, and the migration of contaminants. Relevant climate statistics for 2017 were obtained from the National Weather Service (NWS) (NWS 2017) (Appendix I). Stream flow statistics were obtained from the U.S. Geological Survey (USGS) National Water Information System Web Interface (USGS 2017) (Appendix J). Climate and streamflow characteristics that affected WTP operations or on-site water management activities in 2017 are summarized below:

2017 – First Quarter

- Total recorded precipitation for the first quarter of 2017 was 1.72 inches, which was 0.06 inch more than the normal quarterly precipitation (1.66 inches) for the 1981 to 2010 period of record. Storm water ran on to the site on March 10, 2017; however, no surface water runoff from the site was documented at any time during the first quarter. Infiltration of storm water was a factor in contributing to a higher water table during the second quarter. No stream flooding issues affected operations at the MPTP site during the first quarter of 2017.

2017 – Second Quarter

- Total recorded precipitation for the second quarter of 2017 was 6.39 inches, which was 0.88 inch more than the normal second-quarter precipitation for the 1981 to 2010 period of record (5.51 inches) (Appendix C). Other than water captured in the LTU retention pond, there was only minor localized ponding of water on site, all surface water was contained, and no surface water runoff from the site to Silver Bow Creek was documented. Higher than normal precipitation during the second quarter resulted in increased recharge to groundwater and higher than normal groundwater elevations. The result was that the water table elevation at the MPTP site rose above the elevation of the smear zone and more groundwater in contact with residual contamination was collected. Thus, influent concentrations of PCP at the WTP were relatively higher than normal during the second quarter. Stream flooding issues did not affect operations at the MPTP site during the second quarter of 2017.

2017 – Third Quarter

- Total recorded precipitation for the third quarter of 2017 was 2.42 inches, which was 1.29 inches (34.7 percent) less than the normal quarterly precipitation (3.71 inches) for the 1980 to 2010 period of record. September was a particularly wet month (1.76 inches) and accounted for 73 percent of the total rainfall during the third quarter. As noted above, wetter than normal first and second quarters (specifically, the months of February, March, April, and June), in addition to associated surface water run-on to the site from south of Greenwood Avenue, resulted in a relatively larger amount of recharge to the aquifer and a relatively high groundwater table during the third quarter. Recovery of PCP from the NHRT and NCRT during the third quarter was higher because of the factors described above. No stream flooding issues affected operations at the MPTP site during the third quarter of 2017.

2017 – Fourth Quarter

- Total precipitation for the fourth quarter of 2017 was 1.44 inches, which was 0.45 inch less than the normal fourth-quarter precipitation for the 1981 to 2010 period of record (1.89 inches). Other than water captured in the LTU retention pond, there was no localized ponding of water on site, all surface water was contained, and no surface water runoff was documented. The Greenwood Avenue culvert that was opened in 2016 directed water as expected. None of the on-site storm drainages was flowing. Above-freezing average temperatures from November 20, 2017, to November 27, 2017, resulted in a corresponding high flow in Silver Bow Creek at that time. No climate-related or streamflow issues were noted during the fourth quarter.

9.0 RECOMMENDATIONS

This annual report offered several recommendations that can be considered as cleanup of the MPTP site progresses. In summary:

- Potentially promising alternatives (Tetra Tech 2013a) to remediate the continuing source of contamination under the interstate highway should be investigated further (see Section 1.4).
- The decrease in the sustainable pumping rate in the NHRT and the increase in iron that is affecting WTP operations should be investigated. To support this investigation, trench samples should be analyzed for iron species at a greater frequency than annually (see Section 2.6.1).
- The “sinkhole” discovered east of vault 1A and the leak adjacent to this vault is of concern. The ability of the south-side infiltration system to accept water in the future should be investigated (see Section 2.6.3).
- Monitoring wells MW-11-05, 10-12 and GW-14R-98 should be abandoned and destroyed by a licensed Montana monitoring well contractor. Replacement wells should be drilled at these locations to maintain consistency with the existing long-term data sets associated with these wells (see Section 4.0).
- If deficient wells 10-12 and GW-14R-98 are not replaced, it is recommended that future annual monitoring events include the sampling of wells 10-04 and 10-05 for the “extended parameter list” of analytes (Section 4.3).

- Well MW-11-05 has a sampling device stuck in the borehole; this well should also be abandoned and destroyed (Section 4.0).
- Turbidity data should continue to be collected when dioxin samples are collected so that an adequate data set can be gathered over time to evaluate patterns of dioxin versus turbidity at individual monitoring stations (see Section 4.2.1).

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TABLES

TABLE 2.1
2017 WATER TREATMENT PLANT DISCHARGE RATES

Date	Approximate Discharge Rate [a] (gpm)
1/3/2017	270
1/9/2017	270
1/16/2017	270
1/23/2017	270
1/30/2017	270
2/6/2017	270
2/13/2017	270
2/20/2017	270
2/27/2017	270
3/6/2017	270
3/13/2017	270
3/20/2017	270
3/27/2017	270
4/3/2017	270
4/10/2017	270
4/17/2017	270
4/24/2017	270
5/1/2017	270
5/8/2017	270
5/15/2017	270
5/22/2017	270
5/30/2017	270
6/5/2017	270
6/12/2017	270
6/19/2017	270
6/26/2017	270
7/3/2017	270
7/10/2017	270
7/17/2017	270
7/24/2017	270
7/31/2017	270
8/7/2017	270
8/14/2017	270
8/21/2017	270
8/28/2017	270
9/5/2017	270
9/11/2017	270
9/18/2017	270
9/25/2017	270
10/2/2017	270
10/9/2017	270
10/16/2017	270
10/23/2017	270
10/30/2017	270
11/6/2017	270
11/13/2017	270
11/20/2017	270
11/27/2017	270
12/4/2017	270
12/11/2017	270
12/18/2017	270
12/26/2017	270
Annual Average	**270[b]**

Notes:

a The discharge rate is an instantaneous measurement recorded by the plant operator for the date shown.

b The annual average discharge rate is calculated from 365 daily flows and not on the 52 instantaneous measurement provided in this table.

gpm Gallons per minute

TABLE 2.2
APPROXIMATE VOLUME OF WATER TREATED

Dates	Approximate Volume of Water Treated (gallons)
1993 through 1996	231,920,600
1996 through 1997	51,321,600
1998	96,832,800
1999	119,730,200
2000	113,904,000
2001	114,681,600
2002	184,464,000
2003	189,734,400
2004	163,857,600
2005	150,710,400
2006	216,360,000
2007	233,892,000
2008	181,332,000
2009	177,645,600
2010	176,076,000
2011	196,574,400
2012	179,193,600
2013	177,127,200
2014	156,518,200
2015	161,514,000
2016	158,342,400
2017	141,912,000
Total	**3,573,644,600**

TABLE 2.3

SUMMARY OF MONITORING EVENTS - 2017

Monitoring Event[a]	Location	Number of Samples Collected and Analyzed[b]	Analytical Parameters of Interest	Method Number for Analysis
Weekly Sampling Event[a] (3)	Plant Water	Influent Water (1) Effluent Water (1) BABB Water (1)	PCP	EPA Method 528
Monthly Sampling Event[a] (5)	Plant Water	Influent Water (1) Effluent Water (1) BABB Water (1) NCRT/NHRT effluent (2)	PCP	EPA Method 528
Semi-Annual Sampling Event[a] (79)	Plant Water	Influent Water (1) Effluent Water (1) BABB Water (1) NCRT/NHRT effluent (2)	PCP	EPA Method 528
	Groundwater	Shallow Monitoring Wells (59)[c] Intermediate Monitoring Wells (4) Deep Monitoring Wells (8)	PCP	EPA Method 528
	Surface Water	Surface Water Stations (3)	PCP	EPA Method 528
Annual Sampling Event[a]	Plant Water	BABB Water (1)	PCP	EPA Method 528
	Plant Water	Influent Water (1) Effluent Water (1) NCRT/NHRT effluent (2)	PCP Metals (EFF only)[d] PAHs Dioxins and furans Chlorophenols Anions (EFF only)[d]	EPA Method 528 EPA Method 200.8 EPA Method SW8270C EPA Method SW8290 EPA Method SW8270C EPA Method 300.0
	Groundwater	Shallow Monitoring Wells (59)[c] Intermediate Monitoring Wells (4) Deep Monitoring Wells (8)	PCP	EPA Method 528

TABLE 2.3 (Cont.)

SUMMARY OF MONITORING EVENTS - 2017

Monitoring Event[a]	Location	Number of Samples Collected and Analyzed[b]	Analytical Parameters of Interest	Method Number for Analysis
(Continued) **Annual Sampling Event[a] (86)**	Groundwater	Shallow Monitoring Wells (5) Deep Monitoring Wells (2)	PCP PAHs Dioxins and furans Chlorophenols	EPA Method 528 EPA Method SW8270C EPA Method SW8290 EPA Method SW8270C
	Surface Water	Surface Water Stations (3)	PCP PAHs Dioxins and furans Chlorophenols	EPA Method 528 EPA Method SW8270C EPA Method SW8290 EPA Method SW8270C

Notes:

a The number in parenthesis is the total number of samples that are planned to be collected per monitoring event.
b The number in parenthesis is the total number of samples that are planned to be collected per station.
c A pump was lost in monitoring well MW-11-05 in February 2016; thus, the well could not be sampled.
d Analysis for metals includes arsenic, cadmium, chromium, copper, lead, and zinc; analysis for anions includes bromide, chloride, fluoride, nitrate, nitrite, and phosphate.

The depth to water was measured in each well that was sampled.

BABB — BABB station is located between the primary and secondary carbon units in the WTP
EFF — WTP effluent station (EFF)
EPA — U.S. Environmental Protection Agency
MPTP — Montana Pole and Treating Plant
NCRT — Near creek recovery trench
NCRT/NHRT — Refers to the NCRT effluent sample (NCRTEFF) and the NHRT effluent sample (NHRTEFF)
NHRT — Near highway recovery trench
PAH — Polycyclic aromatic hydrocarbon
PCP — Pentachlorophenol
Plant Water — MPTP water treatment plant process water
WTP — MPTP water treatment plant

TABLE 2.4
HISTORICAL CONCENTRATIONS OF PCP FOR WTP SAMPLES

Date	Laboratory	EPA Method	NHRT Effluent (NHRTEFF)	NCRT Effluent (NCRTEFF)	WTP Influent (IN)	WTP Beteen Tanks (BABB)	WTP Effluent (EFF)	ROD Cleanup Level[a] (µg/L)
2001 Range	MBMG	528	476 - 1185	6.76 - 55.2	130 - 631	--	0.1U - **1.12**	1.0
2002 Range	MBMG	528	272 - 842	11.5 - 24	143 - 463	--	0.1U - **7.08**	1.0
2003 Range	MBMG	528	140 - 304	4.3 - 8.8	47 - 262	17.0	0.04U - **1.7**	1.0
2004 Range	MBMG	528	97 - 192	2.4 - 6.7	33 - 82	0.11 - 4.1	0.056 - 0.39	1.0
2005 Range	MBMG	528	60 - 149	1.10 - 5.8	25.7 - 73.7	0.04 - 1.2	0.1U - 0.4	1.0
2006 Range	MBMG	528	98 - 180	1.56 - 6.06	4.21 - 98.8	0.062 - 9.83	0.1U - **3.35**	1.0
2007 Range	MBMG	528	63.2 - 286	2.69 - 3.92	19.3 - 310	0.126 - 1.05	0.06 - 0.483	1.0
2008 Range	MBMG	528	84.5 - 306	2.98 - 7.81	16.9 - 296	0.11 - 17.2	0.089 - **2.58**	1.0
2009 Range	MBMG	528	36.4 - 306	1.03 - 4.84	17.8 - 153	0.2U - 18.7	0.082 - **7.13**	1.0
2010 Range	MBMG	528	31.1 - 233	1.70 - 7.38	10.8 - 84.6	0.2U - 4.3	0.207 - **1.46**	1.0
2011 Range	MBMG	528	84.2 - 333	3.18 - 11.5	9.14 - 137	0.267 - 39.4	0.208 - **15.7**	1.0
2012 Range	MBMG	528	232 -379	0.79 - 49.4	35.5 - 161	0.456 - 14.6	0.23 - **1.03**	1.0
2013 Range	MBMG	528	126 - 345	2.54 - 8.71	0.852 -176	0.2U - 31.1	0.2U - **11.1**	1.0
2014 Range	MBMG	528	159 - 326	0.2U - 12.2	17.5 - 250	0.2U - 38.9	0.2U - **10.4**	1.0
2015 Range	MBMG	528	100 - 245	4.10 - 9.5	22.7 - 52.3	0.2U - 0.64	0.2U - 0.271	1.0
2016 Range	MBMG	528	97 - 186	3.58 - 6.8	22.3 - 52.5	0.2U - 0.93	0.2U - 0.633	1.0
2017 Range	MBMG	528	121 - 510	4.96 - 8.2	27.4 - 139	0.284- 0.870	0.166 - 0.640	1.0
1/3/2017	MBMG	528	146	5.48	37.4	0.870	0.472	1.0
1/9/2017	MBMG	528	--	--	34.7	0.621	0.500	1.0
1/16/2017	MBMG	528	--	--	32.0	0.418	0.342	1.0
1/23/2017	MBMG	528	--	--	35.7	0.353	0.287	1.0
1/30/2017	MBMG	528	--	--	27.4	0.412	0.288	1.0
2/6/2017	MBMG	528	121	5.10	34.9	0.660	0.512	1.0
2/13/2017	MBMG	528	--	--	29.3	0.459	0.301	1.0
2/20/2017	MBMG	528	--	--	43.0	0.490	0.359	1.0
2/27/2017	MBMG	528	--	--	35.0	0.531	0.424	1.0
3/6/2017	MBMG	528	143	5.02	43.8	0.513	0.475	1.0
3/13/2017	MBMG	528	--	--	51.4	0.446	0.189	1.0
3/20/2017	MBMG	528	--	--	47.7	0.441	0.223	1.0
3/27/2017	MBMG	528	--	--	50.7	0.618	0.366	1.0
4/3/2017	MBMG	528	211	5.20	58.0	0.434	0.362	1.0
4/10/2017	MBMG	528	--	--	52.7	0.500	0.328	1.0
4/17/2017	MBMG	528	--	--	61.8	0.394	0.330	1.0
4/24/2017	MBMG	528	--	--	68.1	0.477	0.357	1.0
5/1/2017	MBMG	528	244	4.96	73.6	0.424	0.351	1.0
5/8/2017	MBMG	528	--	--	69.9	0.373	0.279	1.0
5/15/2017	MBMG	528	--	--	69.9	0.284	0.330	1.0
5/22/2017	MBMG	528	--	--	69.4	0.535	0.343	1.0
5/30/2017	MBMG	528	--	--	75.4	0.394	0.301	1.0
6/5/2017	MBMG	528	241	6.34	73.0	0.631	0.422	1.0
6/12/2017	MBMG	528	--	--	81.8	0.417	0.426	1.0
6/19/2017	MBMG	528	--	--	61.4	0.750	0.444	1.0
6/26/2017	MBMG	528	--	--	68.3	0.570	0.418	1.0
7/3/2017	MBMG	528	510	8.23	90.1	0.455	0.376	1.0
7/10/2017	MBMG	528	--	--	91.3	0.636	0.398	1.0
7/17/2017	MBMG	528	--	--	139.0	0.500	0.422	1.0
7/24/2017	MBMG	528	--	--	80.0	0.558	0.392	1.0
7/31/2017	MBMG	528	--	--	72.9	0.472	0.449	1.0
8/7/2017	MBMG	528	286	7.95	88.8	0.383	0.312	1.0
8/14/2017	MBMG	528	--	--	76.7	0.700	0.166	1.0
8/21/2017	MBMG	528	--	--	84.8	0.466	0.640	1.0
8/28/2017	MBMG	528	--	--	68.3	0.517	0.426	1.0
9/5/2017	MBMG	528	264	7.41	76.0	0.564	0.432	1.0
9/11/2017	MBMG	528	--	--	71.0	0.614	0.559	1.0
9/18/2017	MBMG	528	--	--	83.9	0.677	0.562	1.0
9/25/2017	MBMG	528	--	--	72.3	0.553	0.417	1.0
10/2/2017	MBMG	528	260	8.03	77.5	0.574	0.471	1.0
10/9/2017	MBMG	528	--	--	66.9	0.546	0.379	1.0
10/16/2017	MBMG	528	--	--	83.0	0.547	0.343	1.0
10/23/2017	MBMG	528	--	--	65.5	0.637	0.590	1.0
10/30/2017	MBMG	528	--	--	88.1	0.337	0.230	1.0
11/6/2017	MBMG	528	285	6.37	66.5	0.667	0.433	1.0
11/13/2017	MBMG	528	--	--	77.4	0.680	0.382	1.0
11/20/2017	MBMG	528	--	--	51.9	0.600	0.520	1.0
11/27/2017	MBMG	528	--	--	72.5	0.660	0.440	1.0
12/4/2017	MBMG	528	288	5.81	67.3	0.622	0.392	1.0
12/11/2017	MBMG	528	--	--	56.0	0.646	0.392	1.0
12/18/2017	MBMG	528	--	--	74.1	0.610	0.500	1.0
12/26/2017	MBMG	528	--	--	68.8	0.586	0.374	1.0
		2017 Average	250	6.3	65.3	0.535	0.393	1.0

Notes:
All units are in µg/L unless otherwise noted.

--	Not sampled
µg/L	Micrograms per liter
a	Cleanup level applies to the WTP effluent sample, only.
Bold	WTP effluent concentration exceeds the ROD discharge to surface water cleanup level.
BABB	WTP sample collected from between primary and secondary carbon vessels
EPA	U.S. Environmental Protection Agency
MBMG	Montana Bureau of Mines and Geology
MPTP	Montana Pole and Treating Plant
NCRT	Near creek recovery trench
NHRT	Near highway recovery trench
PCP	Pentachlorophenol
ROD	Record of Decision
U	Analyzed for but not detected above the method detection limi
WTP	MPTP water treatment plant

TABLE 2.5
HISTORICAL CONCENTRATIONS OF DIOXIN (TEQ) FOR WTP SAMPLES

(µg/L)

Sample Date	NHRT Effluent (NHRTEFF) (µg/L)	NCRT Effluent (NCRTEFF) (µg/L)	WTP Influent (IN) (µg/L)	WTP Effluent (EFF) (µg/L)	ROD Cleanup Level[a] (µg/L)
8/13/2001	4.60E-07	9.20E-07	2.03E-06	2.40E-07	1.00E-05
2/4/2002	4.60E-07	1.60E-07	3.21E-06	1.30E-07	1.00E-05
8/12/2002	5.50E-07	1.19E-06	1.53E-06	2.10E-07	1.00E-05
2/3/2003	2.70E-07	4.17E-06	2.16E-06	6.90E-07	1.00E-05
8/4/2003	2.30E-07	2.16E-06	1.57E-06	3.00E-07	1.00E-05
2/2/2004	1.50E-07	8.30E-07	8.50E-07	1.40E-07	1.00E-05
8/2/2004	2.20E-07	3.09E-06	1.40E-06	5.60E-07	1.00E-05
8/8/2005	7.60E-07	1.29E-06	1.95E-05	1.28E-06	1.00E-05
2/6/2006	2.10E-07	8.50E-07	2.78E-06	1.00E-06	1.00E-05
8/21/2006	2.10E-07	2.70E-07	7.70E-07	2.86E-06	1.00E-05
8/27/2007	8.70E-08	8.10E-07	0.00E+00	3.10E-07	1.00E-05
8/26/2008	1.70E-07	1.58E-06	5.60E-07	1.70E-07	1.00E-05
8/10/2009	6.20E-07	3.92E-06	1.80E-06	1.80E-07	1.00E-05
8/16/2010	1.12E-05	5.84E-06	4.40E-06	5.80E-07	1.00E-05
8/15/2011 [b]	1.91E-07	1.90E-07	3.91E-07	7.60E-08	1.00E-05
8/13/2012	2.27E-05	1.21E-05	7.26E-06	4.40E-07	1.00E-05
8/12/2013	1.27E-04	7.72E-06	3.58E-05	3.69E-07	1.00E-05
8/11/2014	1.06E-05	3.07E-06	6.75E-06	7.99E-07	1.00E-05
8/10/2015	5.68E-06	7.72E-06	4.48E-06	4.00E-07	1.00E-05
8/8/2016	4.95E-06	2.12E-06	2.80E-06	3.08E-07	1.00E-05
8/10/2017	9.20E-06	5.11E-06	3.57E-06	1.87E-06	1.00E-05

HISTORICAL CONCENTRATIONS OF DIOXIN (TEQ) FOR WTP SAMPLES

(pg/L)

Sample Date	NHRT Effluent (NHRTEFF) (pg/L)	NCRT Effluent (NCRTEFF) (pg/L)	WTP Influent (IN) (pg/L)	WTP Effluent (EFF) (pg/L)	ROD Cleanup Level[a] (pg/L)
8/13/2001	0.46	0.92	2.03	0.24	10.00
2/4/2002	0.46	0.16	3.21	0.13	10.00
8/12/2002	0.55	1.19	1.53	0.21	10.00
2/3/2003	0.27	4.17	2.16	0.69	10.00
8/4/2003	0.23	2.16	1.57	0.30	10.00
2/2/2004	0.15	0.83	0.85	0.14	10.00
8/2/2004	0.22	3.09	1.40	0.56	10.00
8/8/2005	0.76	1.29	19.50	1.28	10.00
2/6/2006	0.21	0.85	2.78	1.00	10.00
8/21/2006	0.21	0.27	0.77	2.86	10.00
8/27/2007	0.09	0.81	0.00	0.31	10.00
8/26/2008	0.17	1.58	0.56	0.17	10.00
8/10/2009	0.62	3.92	1.80	0.18	10.00
8/16/2010	11.2	5.84	4.40	0.58	10.00
8/15/2011 [b]	0.19	0.19	0.39	0.08	10.00
8/13/2012	22.7	12.1	7.26	0.44	10.00
8/12/2013	127	7.72	35.80	0.37	10.00
8/11/2014	10.6	3.07	6.75	0.80	10.00
8/10/2015	5.68	7.72	4.48	0.40	10.00
8/8/2016	4.95	2.12	2.80	0.31	10.00
8/10/2017	9.20	5.11	3.57	1.87	10.00

Notes:

For this table, TEQs are calculated using the MPTP ROD Methodology.

See Appendix B-3 for TEQ values calculated using both the MPTP ROD Methodology and the DEQ-7 Methodology

µg/L	Micrograms per liter
pg/L	Picograms per liter
a	Cleanup level applies to the WTP effluent sample, only.
b	Data for this date appear to be anomalously low.
MPTP	Montana Pole and Treating Plant
NCRT	Near creek recovery trench
NHRT	Near highway recovery trench
ROD	Record of Decision
TEF	Toxicity equivalence factor
TEQ	Toxicity equivalence quotient
WTP	MPTP water treatment plant

TABLE 2.6
CONCENTRATIONS OF PAH, CHLOROPHENOLS, ANIONS, AND METALS FOR WTP SAMPLES

	NHRT Effluent (NHRTEFF)	Q	NCRT Effluent (NCRTEFF)	Q	WTP Influent (IN)	Q	WTP Effluent (EFF)	Q	ROD[b]
ANALYTES									
PAH (EPA Method SW8270C)									
ACENAPHTHENE	0.25	U	0.25	U	0.25	U	0.25	U	-
ACENAPHTHYLENE	0.723		0.25	U	0.25	U	0.25	U	-
ANTHRACENE	0.25	U	0.25	U	0.25	U	0.25	U	-
BENZO(A)ANTHRACENE	0.1	U	0.1	U	0.351		0.1	U	1
BENZO(A)PYRENE	0.1	U	0.1	U	0.1	U	0.1	U	0.2 (0.05/0.038) [c]
BENZO(B)FLUORANTHENE	0.25	U	0.25	U	0.25	U	0.25	U	0.2
BENZO(G,H,I)PERYLENE	0.5	U	0.5	U	0.5	U	0.5	U	1
BENZO(K)FLUORANTHENE	0.1	U	0.1	U	0.1	U	0.1	U	1
CHRYSENE	0.1	U	0.1	U	0.1	U	0.1	U	1
DIBENZO(A,H)ANTHRACENE	0.1	U	0.1	U	0.1	U	0.1	U	0.2
FLUORANTHENE	0.25	U	0.25	U	0.25	U	0.25	U	-
FLUORENE	0.822		0.25	U	0.25	U	0.25	U	-
INDENO(1,2,3-CD)PYRENE	0.1	U	0.1	U	0.1	U	0.1	U	1
NAPHTHALENE	1.17		0.25	U	0.312		0.25	U	-
PHENANTHRENE	1.59		0.25	U	0.25	U	0.25	U	-
PYRENE	0.337		0.25	U	0.25	U	0.25	U	-
TOTAL D PAHs	3.5		1.5		1.6		1.5		360
CHLOROPHENOLS (EPA Method SW8270C)									
2,3,4,6-TETRACHLOROPHENOL	2.72		0.5	U	0.72		0.761		-
2,4,5-TRICHLOROPHENOL	1	U	1	U	1.0	U	1	U	-
2,4,6-TRICHLOROPHENOL	1.21		0.5	U	0.5	U	0.5	U	-
2,4-DICHLOROPHENOL	0.5	U	0.5	U	0.5	U	0.5	U	45
2-CHLOROPHENOL	0.5	U	0.5	U	0.5	U	0.5	U	27
4-CHLORO-3-METHYLPHENOL	0.5	U	0.5	U	0.5	U	0.5	U	6.5
PENTACHLOROPHENOL	286	D	7.95		88.8	D	0.312		1
ANIONS[a] (EPA Method 300)									
BROMIDE	248		237		238		238		-
CHLORIDE (mg/L)	59.97		61.84		61.08		61.12		-
FLUORIDE (mg/L)	0.31		0.43		0.41		0.39		-
NITRATE (mg/L)	1.42		9.12		6.95		6.9		-
NITRITE (mg/L)	0.01	U	0.01	U	0.01	U	0.01	U	-
PHOSPHATE (mg/L)	0.02	J	0.07	J	0.04	J	0.05	J	-
METALS, DISSOLVED[a] (EPA Method 200.8)									
ARSENIC	11.14		3.08		4.94		3.4		48
CADMIUM	0.25	U	0.25	U	0.25	U	0.25	U	1.1
CHROMIUM	0.25	U	0.25	U	0.25	U	0.25	U	11
COPPER	1.25	U	10.78		12.66		1.25	U	12
IRON (mg/L)	1.26		0.038	U	0.316		0.038	U	-
LEAD	0.15	U	0.15	U	1.78		0.15	U	3.2
MANGANESE (mg/L)	0.591		0.087	J	0.229		0.005	U	-
ZINC	1.34	J	53.19		36.83		5.78		110
METALS, TOTAL RECOVERABLE[a] (EPA Method 200.8)									
ARSENIC	11.14		3.07		5.77		3.36		48
CADMIUM	0.25	U	0.25	U	0.25	U	0.25	U	1.1 (0.8) [c]
CHROMIUM	0.25	U	1.6		1.5		1.46		11
COPPER	1.3	U	4.11	J	1.76	J	8.09		12
IRON (mg/L)	1.26		0.038	U	0.463		0.038	U	-
LEAD	0.15	U	0.15	U	0.15	U	0.15	U	3.2
MANGANESE (mg/L)	0.591		0.091	J	0.244		0.005	U	-
ZINC	1.34	J	21.51		13.2		11.55		110

Notes:
All units are in ug/L unless otherwise noted.
All samples were collected on August 7, 2017.
- No cleanup level specified in the ROD.
a Concentration units for anion constituents (other than bromide), as well as the two metals - iron and manganese, are mg/L.
b Cleanup level applies to the WTP effluent sample (station EFF), only.
c The water quality standards for cadmium and benzo(a)pyrene outlined in Circular DEQ-7 are lower than the cleanup levels for groundwater and surface water specified in the ROD tables; therefore, the lower DEQ-7 standards (in parentheses) currently take precedence over the ROD cleanup levels for these analytes.
The hardness-adjusted DEQ-7 Aquatic Life Standard for the chronic standard for cadmium is 0.8 µg/L.
The DEQ-7 standard for benzo(a)pyrene for groundwater is 0.05 µg/L; the DEQ-7 standard for benzo(a)pyrene for surface water is 0.038 µg/L

D PAH Sum of the acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene concentrations
DEQ Montana Department of Environmental Quality
EPA U.S. Environmental Protection Agency
J Detected above the MDL but less than the MRL
mg/L Milligrams per liter
MPTP Montana Pole and Treating Plant
NCRT Near creek recovery trench
NHRT Near highway recovery trench
PAH Polycyclic aromatic hydrocarbons
Q Data qualifier
ROD Record of Decision
µg/L Micrograms per liter
U Analyzed for but not detected above the method detection limit
WTP MPTP water treatment plant

TABLE 2.7
QUALITY CONTROL - SOURCE WATER BLANKS

Date Sampled	Sample ID	Analyte	EPA Method	Concentration	Q	Units
PENTACHLOROPHENOL (EPA Method 528)						
1/9/2017	WTPVS010917	PENTACHLOROPHENOL	528	0.1	U	µg/L
1/16/2017	OPOQVS011617	PENTACHLOROPHENOL	528	0.1	U	µg/L
1/30/2017	WTPVS013017	PENTACHLOROPHENOL	528	0.1	U	µg/L
2/6/2017	MW-18020617	PENTACHLOROPHENOL	528	0.1	U	µg/L
2/6/2017	SW-07020617	PENTACHLOROPHENOL	528	0.1	U	µg/L
2/8/2017	MW-21020817	PENTACHLOROPHENOL	528	0.1	U	µg/L
2/9/2017	MW-G-98020917	PENTACHLOROPHENOL	528	0.1	U	µg/L
2/13/2017	OPOQVS021317	PENTACHLOROPHENOL	528	0.1	U	µg/L
2/27/2017	OPOQVS022717	PENTACHLOROPHENOL	528	0.1	U	µg/L
3/13/2017	OPOQVS031317	PENTACHLOROPHENOL	528	0.1	U	µg/L
4/3/2017	WTPVS040317	PENTACHLOROPHENOL	528	0.1	U	µg/L
4/17/2017	WTPVS041717	PENTACHLOROPHENOL	528	0.1	U	µg/L
4/24/2017	OPOQVS042417	PENTACHLOROPHENOL	528	0.1	U	µg/L
5/8/2017	OPOQVS050817	PENTACHLOROPHENOL	528	0.1	U	µg/L
5/22/2017	OPOQVS052217	PENTACHLOROPHENOL	528	0.1	U	µg/L
6/12/2017	WTPVS061217	PENTACHLOROPHENOL	528	0.1	U	µg/L
6/26/2017	WTPVS062617	PENTACHLOROPHENOL	528	0.1	U	µg/L
7/10/2017	WTPVS071017	PENTACHLOROPHENOL	528	0.1	U	µg/L
7/17/2017	OPOQVS071717	PENTACHLOROPHENOL	528	0.1	U	µg/L
7/31/2017	OPOQVS073117	PENTACHLOROPHENOL	528	0.1	U	µg/L
8/1/2017	MW-18080117	PENTACHLOROPHENOL	528	0.1	U	µg/L
8/2/2017	MW-C-99080217	PENTACHLOROPHENOL	528	0.1	U	µg/L
8/3/2017	MW-G-98080317	PENTACHLOROPHENOL	528	0.1	U	µg/L
8/7/2017	SW-07080717	PENTACHLOROPHENOL	528	0.1	U	µg/L
8/14/2017	OPOQVS081417	PENTACHLOROPHENOL	528	0.1	U	µg/L
8/28/2017	OPOQVS082817	PENTACHLOROPHENOL	528	0.1	U	µg/L
9/18/2017	WTPVS091817	PENTACHLOROPHENOL	528	0.1	U	µg/L
9/25/2017	OPOQVS092517	PENTACHLOROPHENOL	528	0.1	U	µg/L
10/16/2017	WTPVS101617	PENTACHLOROPHENOL	528	0.1	U	µg/L
10/23/2017	OPOQVS102317	PENTACHLOROPHENOL	528	0.1	U	µg/L
11/6/2017	OPOQVS110617	PENTACHLOROPHENOL	528	0.1	U	µg/L
11/27/2017	WTPVS112717	PENTACHLOROPHENOL	528	0.1	U	µg/L
12/11/2017	WTPVS121117	PENTACHLOROPHENOL	528	0.1	U	µg/L
12/18/2017	OPOQVS121817	PENTACHLOROPHENOL	528	0.1	U	µg/L
SVOC (EPA Method 8270)						
8/7/2017	SW-07080717	2,3,4,6-TETRACHLOROPHENOL	8270	0.5	U	µg/L
8/7/2017	SW-07080717	2,4,5-TRICHLOROPHENOL	8270	1	U	µg/L
8/7/2017	SW-07080717	2,4,6-TRICHLOROPHENOL	8270	0.5	U	µg/L
8/7/2017	SW-07080717	2,4-DICHLOROPHENOL	8270	0.5	U	µg/L
8/7/2017	SW-07080717	2-CHLOROPHENOL	8270	0.5	U	µg/L
8/7/2017	SW-07080717	4-CHLORO-3-METHYLPHENOL	8270	0.5	U	µg/L
PAH (EPA Method 8270)						
8/7/2017	SW-07080717	ACENAPHTHENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	ACENAPHTHYLENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	ANTHRACENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	BENZO(A)ANTHRACENE	0.1	U	U	µg/L
8/7/2017	SW-07080717	BENZO(A)PYRENE	0.1	U	U	µg/L
8/7/2017	SW-07080717	BENZO(B)FLUORANTHENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	BENZO(G,H,I)PERYLENE	0.5	U	U	µg/L
8/7/2017	SW-07080717	BENZO(K)FLUORANTHENE	0.1	U	U	µg/L
8/7/2017	SW-07080717	CHRYSENE	0.1	U	U	µg/L
8/7/2017	SW-07080717	DIBENZO(A,H)ANTHRACENE	0.1	U	U	µg/L
8/7/2017	SW-07080717	FLUORANTHENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	FLUORENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	INDENO(1,2,3-CD)PYRENE	0.1	U	U	µg/L
8/7/2017	SW-07080717	NAPHTHALENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	PHENANTHRENE	0.25	U	U	µg/L
8/7/2017	SW-07080717	PYRENE	0.25	U	U	µg/L

TABLE 2.7
QUALITY CONTROL - SOURCE WATER BLANKS

Date Sampled	Sample ID	Analyte	EPA Method	Concentration	Q	Units
DIOXIN (TEQ) (EPA Method 8290)						
8/8/2016	SW-07080816	DIOXIN (TEQ)	8290	**0.045**		pg/L
ANIONS (EPA Method 300.1)						
8/7/2017	SW-07080717	BROMIDE	300.1	10.0	U	µg/L
8/7/2017	SW-07080717	CHLORIDE	300.1	0.1	U	mg/L
8/7/2017	SW-07080717	FLUORIDE	300.1	0.01	U	mg/L
8/7/2017	SW-07080717	NITRATE	300.1	0.01	U	mg/L
8/7/2017	SW-07080717	NITRITE	300.1	0.01	U	mg/L
8/7/2017	SW-07080717	PHOSPHATE	300.1	0.02	U	mg/L
METALS - TOTAL RECOVERABLE (EPA Method 200.8)						
8/7/2017	SW-07080717	ARSENIC	200.8	0.1	U	µg/L
8/7/2017	SW-07080717	CADMIUM	200.8	0.1	U	µg/L
8/7/2017	SW-07080717	CHROMIUM	200.8	**1.31**		µg/L
8/7/2017	SW-07080717	COPPER	200.8	0.5	U	µg/L
8/7/2017	SW-07080717	IRON	200.8	**0.042**	J	mg/L
8/7/2017	SW-07080717	LEAD	200.8	0.06	U	µg/L
8/7/2017	SW-07080717	MANGANESE	200.8	0.002	U	mg/L
8/7/2017	SW-07080717	ZINC	200.8	0.5	U	µg/L
METALS - DISSOLVED (EPA Method 200.8)						
8/7/2017	SW-07080717	ARSENIC	200.8	0.1	U	µg/L
8/7/2017	SW-07080717	CADMIUM	200.8	0.1	U	µg/L
8/7/2017	SW-07080717	CHROMIUM	200.8	0.1	U	µg/L
8/7/2017	SW-07080717	COPPER	200.8	0.5	U	µg/L
8/7/2017	SW-07080717	IRON	200.8	0.015	U	mg/L
8/7/2017	SW-07080717	LEAD	200.8	0.06	U	µg/L
8/7/2017	SW-07080717	MANGANESE	200.8	0.2	U	mg/L
8/7/2017	SW-07080717	ZINC	200.8	**1.31**	J	µg/L

Notes
Dioxin (TEQ) calculated using 0 for values qualified as "U" and ROD TEFs (MPTP ROD methodology).

µg/L	Micrograms per liter
pg/L	Picograms per liter
Bold	Analyte detected in source water blank
Dioxin	Polychlorinated dibenzo-p-dioxins
EPA	U.S. Environmental Protection Agency
ID	Identification
J	Estimated
mg/L	Milligrams per liter
MPTP	Montana Pole and Treating Plant
PAH	Polycyclic aromatic hydrocarbon
Q	Laboratory data qualifier
ROD	Record of Decision
SVOC	Semivolatile organic compound
TEF	Toxicity equivalence factor
TEQ	Toxicity equivalence quotient
U	Analyzed for but not detected above the method detection limit

TABLE 2.8
QUALITY CONTROL - FIELD DUPLICATES

Sample Date	Original Sample ID	Analyte	Original Concentration	Q	Original Sample RL	Duplicate Sample ID	Duplicate Concentration	Q	Duplicate Sample RL	Units	RPD[a]
PENTACHLOROPHENOL (EPA Method 528)											
1/3/2017	NHRTEFF010317	PENTACHLOROPHENOL	146	D	0.1	OPOQVS010317	159	D	0.1	µg/L	8.5
1/23/2017	EFF012317	PENTACHLOROPHENOL	0.287		0.1	WTPVS012317	0.29		0.1	µg/L	1.0
1/30/2017	BABB013017	PENTACHLOROPHENOL	0.412		0.1	OPOQVS013017	0.371		0.1	µg/L	10.5
2/6/2017	10-12020617	PENTACHLOROPHENOL	0.158		0.1	MW-20020617	0.192		0.1	µg/L	19.4
2/6/2017	HCA-21020617	PENTACHLOROPHENOL	0.544		0.1	MW-E-98020617	0.454		0.1	µg/L	18.0
2/8/2017	PZ-S4-01020817	PENTACHLOROPHENOL	0.427		0.1	MW-C-99020817	0.414		0.1	µg/L	3.1
2/20/2017	EFF022017	PENTACHLOROPHENOL	0.359		0.1	WTPVS022017	0.333		0.1	µg/L	7.5
3/6/2017	NCRTEFF030617	PENTACHLOROPHENOL	5.02		0.1	WTPVS030617	4.87		0.1	µg/L	3.0
3/10/2017	SW0P01-031017	PENTACHLOROPHENOL	0.129		0.1	SW0P01A-031017	0.118		0.1	µg/L	8.9
3/20/2017	IN032017	PENTACHLOROPHENOL	47.7	D	0.1	WTPVS032017	53.8	D	0.1	µg/L	12.0
3/27/2017	BABB032717	PENTACHLOROPHENOL	0.618		0.1	OPOQVS032717	0.4		0.1	µg/L	**42.8**
4/10/2017	EFF041017	PENTACHLOROPHENOL	0.328		0.1	OPOQVS041017	0.327		0.1	µg/L	0.3
5/1/2017	NHRTEFF050117	PENTACHLOROPHENOL	244	D	0.1	WTPVS050117	247	D	0.1	µg/L	1.2
5/15/2017	BABB051517	PENTACHLOROPHENOL	0.284		0.1	WTPVS051517	0.305		0.1	µg/L	7.1
5/30/2017	IN053017	PENTACHLOROPHENOL	75.4	D	0.1	WTPVS053017	79.8	D	0.1	µg/L	5.7
6/5/2017	NCRTEFF060517	PENTACHLOROPHENOL	6.34		0.1	OPOQVS060517	6.57		0.1	µg/L	3.6
6/19/2017	EFF061917	PENTACHLOROPHENOL	0.444		0.1	OPOQVS061917	0.495		0.1	µg/L	10.9
7/3/2017	IN070317	PENTACHLOROPHENOL	90.1	D	0.1	OPOQVS070317	93.6	D	0.1	µg/L	3.8
7/24/2017	BABB072417	PENTACHLOROPHENOL	0.558		0.1	WTPVS072417	0.592		0.1	µg/L	5.9
7/31/2017	10-04073117	PENTACHLOROPHENOL	0.167		0.1	WTPVS073117	0.209		0.1	µg/L	**22.3**
8/1/2017	GS-18-R080117	PENTACHLOROPHENOL	15.3		0.1	MW-E-98080117	13.8		0.1	µg/L	10.3
8/2/2017	MW-X-01080217	PENTACHLOROPHENOL	51.1	D	0.1	MW-21080217	41.5	D	0.1	µg/L	**20.7**
8/3/2017	MW-11-01080317	PENTACHLOROPHENOL	149	D	0.1	MW-19080317	161	D	0.1	µg/L	**7.7**
8/7/2017	SW-09080717	PENTACHLOROPHENOL	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/21/2017	EFF082117	PENTACHLOROPHENOL	0.64		0.1	WTPVS082117	0.394		0.1	µg/L	**47.6**
9/5/2017	NHRTEFF090517	PENTACHLOROPHENOL	264	D	0.1	WTPVS090517	253	D	0.1	µg/L	4.3
9/11/2017	IN091117	PENTACHLOROPHENOL	71	D	0.1	OPOQVS091117	83.6	D	0.1	µg/L	16.3
10/2/2017	NCRTEFF100217	PENTACHLOROPHENOL	8.03		0.1	WTPVS100217	7.78		0.1	µg/L	3.2
10/9/2017	BABB100917	PENTACHLOROPHENOL	0.546		0.1	OPOQVS100917	0.479		0.1	µg/L	13.1
10/30/2017	EFF103017	PENTACHLOROPHENOL	0.23		0.1	WTPVS103017	0.314		0.1	µg/L	**30.9**
11/13/2017	EFF111317	PENTACHLOROPHENOL	0.382		0.1	WTPVS111317	0.374		0.1	µg/L	2.1
11/20/2017	IN112017	PENTACHLOROPHENOL	51.9	D	0.1	OPOQVS112017	63	D	0.1	µg/L	19.3
12/4/2017	NHRTEFF120417	PENTACHLOROPHENOL	288	D	0.1	OPOQVS120417	256	D	0.1	µg/L	11.8
12/26/2017	BABB122617	PENTACHLOROPHENOL	0.586		0.1	WTPVS122617	0.643		0.1	µg/L	9.3
SVOC (EPA Method 8270)											
8/7/2017	SW-09080717	2,3,4,6-TETRACHLOROPHENOL	0.5	U	0.5	MW-20080717	0.5	U	0.5	µg/L	0.0
8/7/2017	SW-09080717	2,4,5-TRICHLOROPHENOL	1	U	1	MW-20080717	1	U	1	µg/L	0.0
8/7/2017	SW-09080717	2,4,6-TRICHLOROPHENOL	0.5	U	0.5	MW-20080717	0.5	U	0.5	µg/L	0.0
8/7/2017	SW-09080717	2,4-DICHLOROPHENOL	0.5	U	0.5	MW-20080717	0.5	U	0.5	µg/L	0.0
8/7/2017	SW-09080717	2-CHLOROPHENOL	0.5	U	0.5	MW-20080717	0.5	U	0.5	µg/L	0.0
8/7/2017	SW-09080717	4-CHLORO-3-METHYLPHENOL	0.5	U	0.5	MW-20080717	0.5	U	0.5	µg/L	0.0
PAH (EPA Method 8270)											
8/7/2017	SW-09080717	ACENAPHTHENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	ACENAPHTHYLENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	ANTHRACENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	BENZO(A)ANTHRACENE	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/7/2017	SW-09080717	BENZO(A)PYRENE	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/7/2017	SW-09080717	BENZO(B)FLUORANTHENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	BENZO(G,H,I)PERYLENE	0.5	U	0.5	MW-20080717	0.5	U	0.5	µg/L	0.0
8/7/2017	SW-09080717	BENZO(K)FLUORANTHENE	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/7/2017	SW-09080717	CHRYSENE	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/7/2017	SW-09080717	DIBENZO(A,H)ANTHRACENE	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/7/2017	SW-09080717	FLUORANTHENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	FLUORENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	INDENO(1,2,3-CD)PYRENE	0.1	U	0.1	MW-20080717	0.1	U	0.1	µg/L	0.0
8/7/2017	SW-09080717	NAPHTHALENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	PHENANTHRENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0
8/7/2017	SW-09080717	PYRENE	0.25	U	0.25	MW-20080717	0.25	U	0.25	µg/L	0.0

TABLE 2.8
QUALITY CONTROL - FIELD DUPLICATES

Sample Date	Original Sample ID	Analyte	Original Concentration	Q	Original Sample RL	Duplicate Sample ID	Duplicate Concentration	Q	Duplicate Sample RL	Units	RPD[a]
DIOXINS AND FURANS (TEQ) (EPA Method SW8290)											
8/7/2017	SW-09080717	Dioxin TEQ	0.012			MW-20080717	0.052			pg/L	**125.0**
ANIONS (EPA Method 300.1)											
8/7/2017	EFF080717	BROMIDE	238		10	MW-F-99080717	240		10	UG/L	0.8
8/7/2017	EFF080717	CHLORIDE	61.12		0.1	MW-F-99080717	61.64		0.1	MG/L	0.8
8/7/2017	EFF080717	FLUORIDE	0.39		0.01	MW-F-99080717	0.39		0.01	MG/L	0.0
8/7/2017	EFF080717	NITRATE	6.9		0.01	MW-F-99080717	6.96		0.01	MG/L	0.9
8/7/2017	EFF080717	NITRITE	0.01	U	0.01	MW-F-99080717	0.01	U	0.01	MG/L	0.0
8/7/2017	EFF080717	PHOSPHATE	0.05	J	0.02	MW-F-99080717	0.04	J	0.02	MG/L	**22.2**
METALS - TOTAL RECOVERABLE (EPA Method 200.8)											
8/7/2017	EFF080717	ARSENIC	0.25	U	0.1	MW-F-99080717	0.25	U	0.1	μg/L	0.0
8/7/2017	EFF080717	CADMIUM	3.36		0.25	MW-F-99080717	3.41		0.25	μg/L	1.5
8/7/2017	EFF080717	CHROMIUM	1.46		0.25	MW-F-99080717	1.71		0.25	μg/L	15.8
8/7/2017	EFF080717	COPPER	8.09		1.25	MW-F-99080717	1.25	U	1.25	μg/L	**146.5**
8/7/2017	EFF080717	IRON	11.55		1.25	MW-F-99080717	9.22		1.25	mg/L	**22.4**
8/7/2017	EFF080717	LEAD	0.005	U	0.02	MW-F-99080717	0.005	U	0.02	μg/L	0.0
8/7/2017	EFF080717	MANGANESE	0.15	U	0.06	MW-F-99080717	0.15	U	0.06	mg/L	0.0
8/7/2017	EFF080717	ZINC	0.038	U	0.015	MW-F-99080717	0.05	J	0.015	μg/L	**27.3**
METALS - DISSOLVED (EPA Method 200.8)											
8/7/2017	EFF080717	ARSENIC	3.4		0.1	MW-F-99080717	3.22		0.1	μg/L	5.4
8/7/2017	EFF080717	CADMIUM	0.25	U	0.015	MW-F-99080717	0.25	U	0.015	μg/L	0.0
8/7/2017	EFF080717	CHROMIUM	0.25	U	0.1	MW-F-99080717	0.25	U	0.1	μg/L	0.0
8/7/2017	EFF080717	COPPER	1.25	U	0.5	MW-F-99080717	1.25	U	0.5	μg/L	0.0
8/7/2017	EFF080717	IRON	0.038	U	0.015	MW-F-99080717	0.038	U	0.015	mg/L	0.0
8/7/2017	EFF080717	LEAD	0.15	U	0.1	MW-F-99080717	0.15	U	0.1	μg/L	0.0
8/7/2017	EFF080717	MANGANESE	0.005	U	0.02	MW-F-99080717	0.005	U	0.02	mg/L	0.0
8/7/2017	EFF080717	ZINC	5.78		0.5	MW-F-99080717	5.58		0.5	μg/L	3.5
										Average RPD:	9.7

Notes:

μg/L	Micrograms per liter
pg/L	Picograms per liter
a	If one concentration is "U" and the other is detected, then the RL is used as the value for the "U" result
Bold	RPD exceeds the 35 percent project goal for precision
D	Dilution
EPA	U.S. Environmental Protection Agency
ID	Identification
J	Estimated
mg/L	Milligrams per liter
PAH	Polycyclic aromatic hydrocarbon
Q	Laboratory data qualifier
RL	Laboratory reporting limit
RPD	Relative percent difference
SVOC	Semivolatile organic compound
TEQ	Toxicity equivalence quotient
U	Analyzed for but not detected above the method detection limit

TABLE 3.1
HISTORICAL LTU WATER APPLICATION

Year	LTU Water Application (gallons)
1999	710,700
2000	425,250
2001	3,188,700
2002	2,321,700
2003	7,395,500
2004	5,034,300
2005	1,921,600
2006	7,007,600
2007	3,042,800
2008	5,784,800
2009	3,758,000
2010	3,169,400
2011	2,141,200
2012	1,171,900
2013	884,700
2014	0
2015	0
2016	0
2017	0
Total Volume Applied:	**47,958,150**

Note:
LTU Land treatment unit

TABLE 3.2
LTU SAMPLING RESULTS FOLLOWING 2007 LTU OFFLOAD

	2-Oct-07		2-Jul-08	2-Oct-08	8-Jul-09	14-Oct-10	19-Sep-11	26-Sep-12		1-Oct-13	
Sample	PCP	Dioxin TEQ	PCP	PCP	PCP	PCP	PCP	PCP	Dioxin TEQ	PCP	Dioxin TEQ
Cleanup levels	34 mg/kg	0.2 µg/kg	34 mg/kg	34 mg/kg	34 mg/kg	34 mg/kg	34 mg/kg	34 mg/kg	0.2 µg/kg	34 mg/kg	0.2 µg/kg
Units	mg/kg	µg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	µg/kg	mg/kg	µg/kg
Laboratory	MBMG	TAL	MBMG	MBMG	MBMG	MBMG	MBMG	MBMG	Pace	MBMG	Pace
Method	8270	8290	8270	8270	8270	8270	8270	8270	8290	8270	8290
LTUZ01 0-24"	20.7	--	**82.10**	**61.9**	**42**	22.2	18.6	13.9	--	--	--
LTUZ01 24-36"	17.5	--	**69.10**	**52.2**	**41.2**	20.8	10.3	1.3	--	--	--
LTUZ01 Comp	--	**1.9**		--	--	--	--	--	**3.6**	--	**2.5**
LTUZ02 0-24"	28.4	--	**109**	**75.7**	**81.1**	**67.3**	**34.9**	32.6	--	20.3	--
LTUZ02 24-36"	**87.6**	--	**124**	**160**	**162**	**64.4**	**47.6**	**36.2**	--	18.6	--
LTUZ02 Comp	--	**9.1**		--	--		--	--	**2.8**	--	**4.2**
LTUZ03 0-24"	**55.9**	--	**187**	**79.5**	21.5	14.5	**97.9**	**91.7**	--	**39.1**	--
LTUZ03 24-36"	**153**	--	**343**	--	**149**	16.6	**96.1**	**77.7**	--	**39.3**	--
LTUZ03 Comp	--	**2.6**		--	--	--	--	--	**1.8**	--	**2.3**
LTUZ04 0-24"	15.9	--	**156**	**36.2**	**46.9**	14.6	**49.9**	12.2	--	**45.7**	--
LTUZ04 24-36"	13.4	--	**246**	**256**	**37.2**	14.5	**50.9**	13.1	--	**40.9**	--
LTUZ04 Comp	--	**1.6**		--	--	--	--	--	**2.8**	--	**1.9**
LTUZ05 0-24"	18.3	--	**49.1**	**63.3**	**42.6**	**34.0**	**51.8**	**37.2**	--	13.9	--
LTUZ05 24-36"	15.5	--	**64.2**	**147**	**50.1**	**50.7**	**41.9**	**34.2**	--	12.2	--
LTUZ05 Comp	--	**1.2**		--	--	--	--	--	**3.7**	--	**1.0**
LTUZ06 0-24"	21.8	--	**40.6**	**50.5**	**63.9**	28.5	33.4	**41.3**	--	19.3	--
LTUZ06 24-36"	16.7	--	32.1	**93.3**	**79**	31.6	32.8	**46.2**	--	19.1	--
LTUZ06 Comp	--	**1.9**		--	--	--	--	--	**2.5**	--	**2.7**
LTUZ07 0-24"	18.9	--	3.6	--	--	--	20.2	20.1	--	--	--
LTUZ07 24-36"	13.0	--	32.6	--	--	--	20.3	22.4	--	--	--
LTUZ07 Comp	--	**1.1**	--	--	--	--	--	--	**6.0**	--	**3.7**
LTUZ08 0-24"	13.1	--	1.9	--	--	--	27.6	18.6	--	--	--
LTUZ08 24-36"	33.7	--	4.7	--	--	--	28.2	15.7	--	--	--
LTUZ08 Comp	--	**1.3**	--	--	--	--	--	--	**1.9**	--	**3.2**
LTUZ09 0-24"	9.26	--	2.74	--	--	--	16.3	6.2	--	--	--
LTUZ09 24-36"	32.0	--	2.3	--	--	--	22.8	5.8	--	--	--
LTUZ09 Comp	--	**1.1**	--	--	--	--	--	--	**1.0**	--	**2.0**
LTUZ10 0-24"	15.4	--	4.1	--	--	--	32.0	1.4	--	--	--
LTUZ10 24-36"	15.0	--	4.1	--	--	--	**35.8**	6.5	--	--	--
LTUZ10 Comp	--	**0.9**	--	--	--	--	--	--	**1.6**	--	**2.2**
Average	30.7	**2.3**	77.9	97.8	68.0	31.6	38.5	26.7	**2.8**	26.8	**2.6**

Notes:
October 2007 sampling was conducted after the 2007 LTU offload, and after addition of SSP soils for final treatment.
For this table, dioxin (TEQ) was calculated using the MPTP ROD Methodology. Also see Appendix B for TEQs calculated using the DEQ-7 Methodology, where available.
Soil samples were not collected from the LTU in 2014, 2015, or in 2016 as part of site operations.
Soil samples were collected from the LTU in 2017. Refer to the Final Soil and Surface Water Data Gap Investigation for details (Tetra Tech 2017).

--	Not analyzed	Pace	Pace Analytical
µg/kg	Micrograms per kilogram	PCP	Pentachlorophenol
Bold	Concentration greater than cleanup level	ROD	Record of Decision
Comp	Composite	SSP	Soil salvage piles
LTU	Land treatment unit	TAL	Test America Laboratories / Severn Trent Laboratories, Inc.
MBMG	Montana Bureau of Mines and Geology Laboratory	TEF	Toxicity equivalency factor
mg/kg	Milligrams per kilogram	TEQ	Toxicity equivalence quotient
MPTP	Montana Pole and Treating Plant		

TABLE 4.1
HISTORICAL CONCENTRATIONS OF PCP FOR SURFACE WATER SAMPLES

Surface Water Station:	**SW-05**	**SS-06A**	**SW-09**	
Analyte:	PCP	PCP	PCP	
Units:	(µg/L)	(µg/L)	(µg/L)	
Laboratory:	MBMG	MBMG	MBMG	ROD
EPA Method:	8270/528[a]	8270/528[a]	8270/528[a]	Cleanup Level (µg/L)
2001 Range	0.071 - **1.8**	--	--	1.0
2002 Range	0.423 - **2.36**	--	--	1.0
2003 Range	0.058 - 0.15	--	--	1.0
2004 Range	--	--	--	1.0
2005 Range	0.45 - 0.071	--	--	1.0
2006 Range	0.038 - **1.03**	--	0.6	1.0
2007 Range	0.1U - 0.349	--	0.1U - 0.246	1.0
2008 Range	0.1U - 0.349	--	0.1U - 0.246	1.0
2009 Range	0.061 - 0.188	--	0.064 - 0.454	1.0
2010 Range	0.2U - 0.186	0.2U	0.2U	1.0
2011 Range	0.2U - 0.281	0.2U	0.2U	1.0
2012 Range	0.2U - 0.670	0.2U	0.2U	1.0
2013 Range	0.2U	0.2U - 0.214	0.2U	1.0
2014 Range	0.2U	0.2U	0.2U	1.0
2015 Range	0.2U	0.2U	0.2U	1.0
2016 Range	0.1U - 0.2U	0.1U - 0.2U	0.1U - 0.2U	1.0
2017 Range	0.195 - 0.2U	0.1U	0.1U	1.0
February 6, 2017 (semi-annual sampling event)	0.195	0.1U	0.1U	1.0
August 7, 2017 (annual sampling event)	0.1U	0.1U	0.1U	1.0

Notes:

--	Not sampled
µg/L	Micrograms per liter
a	U.S. EPA Method 8270 was used prior to 2011; U.S. EPA Method 528 was used beginning in 2011.
Bold	Concentration exceeds ROD surface water cleanup level (1.0 µg/L)
EPA	U.S. Environmental Protection Agency
MBMG	Montana Bureau of Mines and Geology laboratory
PCP	Pentachlorophenol
ROD	Record of Decision
U	Analyzed for but not detected above the method detection limi

Data prior to October 2010 have not been back-checked against original laboratory data sheets.

TABLE 4.2

HISTORICAL CONCENTRATIONS OF DIOXIN (TEQ) FOR SURFACE WATER SAMPLES

(µg/L)

Sample Date	SS-06A (µg/L)	SW-05 (µg/L)	SW-09 (µg/L)	ROD Cleanup Level (µg/L)
8/21/2006	--	0	0	1.00E-05
8/26/2007	--	7.70E-07	--	1.00E-05
8/25/2008	--	0	5.10E-08	1.00E-05
8/10/2009	--	0	0	1.00E-05
8/16/2010	--	0	0	1.00E-05
8/15/2011	1.09E-07	8.10E-08	1.70E-08	1.00E-05
8/13/2012	4.10E-08	3.47E-07	3.40E-08	1.00E-05
8/13/2013[a]	1.90E-07	4.56E-07	1.86E-06	1.00E-05
8/11/2014	4.13E-08	5.84E-08	1.90E-08	1.00E-05
8/10/2015	3.94E-08	2.30E-08	5.14E-08	1.00E-05
8/8/2016	2.17E-07	2.15E-07	7.88E-08	1.00E-05
8/7/2017	1.90E-08	1.40E-07	1.20E-08	1.00E-05

HISTORICAL CONCENTRATIONS OF DIOXIN (TEQ) FOR SURFACE WATER SAMPLES

(pg/L)

Sample Date	SS-06A (pg/L)	SW-05 (pg/L)	SW-09 (pg/L)	ROD Cleanup Level (pg/L)
8/21/2006	--	0	0	10.00
8/26/2007	--	0.77	--	10.00
8/25/2008	--	0	0.05	10.00
8/10/2009	--	0	0	10.00
8/16/2010	--	0	0	10.00
8/15/2011	0.11	0.08	0.02	10.00
8/13/2012	0.04	0.35	0.03	10.00
8/12/2013[a]	0.19	0.46	1.86	10.00
8/11/2014	0.04	0.06	0.02	10.00
8/10/2015	0.04	0.02	0.05	10.00
8/8/2016	0.22	0.22	0.08	10.00
8/7/2017	0.02	0.14	0.01	10.00

Notes:

For this table, TEQs are calculated using the MPTP ROD Methodology.
See Appendix B-3 for dioxin (TEQ) values calculated using both the MPTP ROD Methodology and the DEQ-7 Methodology.

0	All dioxin cogeners were below the reporting limit and set to 0 for the calculation of TEQ, resulting in a TEQ value equal to 0.
--	Not sampled
µg/L	Micrograms per liter
pg/L	Picograms per liter
a	Significant rain event on August 1, 2013 (0.6 inch)
MPTP	Montana Pole and Treating Plant
ROD	Record of Decision
TEQ	Toxicity equivalence quotient

TABLE 4.3
CONCENTRATIONS OF PAH AND CHLOROPHENOLS FOR SURFACE WATER SAMPLES

Surface Water Station:	SS-06A		SW-05		SW-09		ROD
Sample Date:	8/7/2017		8/7/2017		8/7/2017		Cleanup Level
Laboratory:	MBMG		MBMG		MBMG		(µg/L)
Units:	(µg/L)	Q	(µg/L)	Q	(µg/L)	Q	
ANALYTES							
PAH (EPA Method 8270)							
ACENAPHTHENE	0.25	U	0.25	U	0.25	U	-
ACENAPHTHYLENE	0.25	U	0.25	U	0.25	U	-
ANTHRACENE	0.25	U	0.25	U	0.25	U	-
BENZO(A)ANTHRACENE	0.1	U	0.367		0.1	U	1
BENZO(A)PYRENE	0.1	U	0.1	U	0.1	U	0.2/0.038[a]
BENZO(B)FLUORANTHENE	0.25	U	0.25	U	0.25	U	0.2
BENZO(G,H,I)PERYLENE	0.5	U	0.5	U	0.5	U	1
BENZO(K)FLUORANTHENE	0.1	U	0.1	U	0.1	U	1
CHRYSENE	0.1	U	0.1	U	0.1	U	1
DIBENZO(A,H)ANTHRACENE	0.1	U	0.1	U	0.1	U	0.2
FLUORANTHENE	0.25	U	0.25	U	0.25	U	-
FLUORENE	0.25	U	0.25	U	0.25	U	-
INDENO(1,2,3-CD)PYRENE	0.1	U	0.1	U	0.1	U	1
NAPHTHALENE	0.25	U	0.602		0.25	U	-
PHENANTHRENE	0.25	U	0.25	U	0.25	U	-
PYRENE	0.25	U	0.25	U	0.25	U	-
Total D PAH	0.25	U	0.602		0.25	U	360
CHLOROPHENOLS (EPA Method 8270)							
2,3,4,6-TETRACHLOROPHENOL	0.5	U	0.5	U	0.5	U	-
2,4,5-TRICHLOROPHENOL	1	U	1	U	1	U	-
2,4,6-TRICHLOROPHENOL	0.5	U	0.5	U	0.5	U	6.5
2,4-DICHLOROPHENOL	0.5	U	0.5	U	0.5	U	27
2-CHLOROPHENOL	0.5	U	0.5	U	0.5	U	45
4-CHLORO-3-METHYLPHENOL	0.5	U	0.5	U	0.5	U	-
PENTACHLOROPHENOL	0.10	U	0.10	U	0.10	U	1.0

Notes:

- \- No cleanup level specified in ROD
- µg/L Micrograms per liter
- a The water quality standard for benzo(a)pyrene outlined in Circular DEQ-7 is lower than the cleanup levels specified in the ROD tables; therefore, the lower DEQ-7 standard (in parentheses) currently takes precedence over the ROD cleanup level for this analyte. The DEQ-7 standard for benzo(a)pyrene for surface water is 0.038 µg/L.
- D PAH Sum of the acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene concentrations
- DEQ Montana Department of Environmental Quality
- EPA U.S. Environmental Protection Agency
- MBMG Montana Bureau of Mines and Geology
- PAH Polycyclic aromatic hydrocarbons
- Q Data qualifier
- ROD Record of Decision
- U Analyzed for but not detected above the method detection limit

TABLE 4.4
HISTORICAL CONCENTRATIONS OF PCP FOR SELECTED GROUNDWATER SAMPLES

Monitoring Well:	10-12	BMW-01A	BMW-01B	GW-14R-98	HCA-21	INF-04	MW-11-04	ROD Cleanup Level (µg/L)
Units:	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
Laboratory:	MBMG	MBMG	MBMG	MBMG	MBMG	MBMG	MBMG	
EPA Method:	8270/528[a]	8270/528[a]	8270/528[a]	8270/528[a]	8270/528[a]	8270/528[a]	8270/528[a]	
2000 Range	NI	--	--	**9.02 - 34.5**	**265**	**787 - 1,500**	NI	1.0
2001 Range	NI	--	--	**2.1 - 38.9**	**253**	**14 - 663**	NI	1.0
2002 Range	NI	--	--	**1.6 - 37.5**	**165 - 201**	**5.4 - 72.3**	NI	1.0
2003 Range	NI	--	--	**1.8 - 28**	**171**	**12 - 151**	NI	1.0
2004 Range	NI	--	--	**1.3 - 4.6**	**84**	**13 - 17**	NI	1.0
2005 Range	NI	--	--	**1.1 - 37.5**	**57**	**28 - 35**	NI	1.0
2006 Range	NI	--	--	**17.5 - 72.7**	**1.11 - 39.2**	**18 - 205**	NI	1.0
2007 Range	NI	--	--	**2.25 - 15.2**	**20.2 - 20.6**	**119 - 199**	NI	1.0
2008 Range	NI	--	--	**1.1 - 4.41**	**13.7 - 26.3**	**102 - 124**	NI	1.0
2009 Range	NI	0.2U	0.2U	0.2U - **2.6**	**3.69 - 28.9**	**44.2 - 79.3**	NI	1.0
2010 Range	0.605 - **1.03**	0.186	0.164	0.806 - **3.45**	0.873 - **7.67**	**80.0 - 81.3**	NI	1.0
2011 Range	0.618 - **1.51**	NS	NS	0.60 - **1.45**	**6.18 - 16.9**	**31.7 - 56.3**	**3,490**	1.0
2012 Range	0.2U - 0.351	0.2U	0.2U	**1.05**	**1.16 - 9.35**	**1.61 - 67.7**	**1,440 - 1,450**	1.0
2013 Range	0.213 - 0.305	0.2U - 0.251	0.2U	0.297	0.49	**21.5 - 43.2**	**1,536 - 7,400**[b]	1.0
2014 Range	0.2U - 0.626	0.2U	0.2U	0.2U	0.34	**10.3 - 105**	**668 - 1197**	1.0
2015 Range	0.2U	0.2U	0.2U	0.2U - 1.32	0.2U - 0.37	**47.7 - 53.4**	**340 - 1,022**	1.0
2016 Range	0.1U - 0.2U	0.1U - 0.2U	0.1U - 0.2U	0.903 - 1.28	0.212 - 0.646	**83 - 109**	**1,220 - 1,606**	1.0
2017 Range	0.158	0.1U - 0.103	0.109 - 0.422	0.576	0.544 - 0.699	**62.8 - 149**	**1,560 - 3,305**	1.0
February 6, 2017 (semi-annual monitoring event)	0.158	0.103	0.109	0.576	0.544	**62.8**	**1,560**	1.0
August 10, 2017 (annual monitoring event)	NS	0.1U	0.422	NS	0.699	**149**	**3,305**	1.0

Notes:

--	Not sampled
µg/L	Micrograms per liter
a	EPA Method 8270 was used prior to 2011; EPA Method 528 was used in 2011 and thereafter
b	Insufficient water to fully bail well before sample was collected; concentration biased high
Bold	Concentration exceeds ROD groundwater cleanup level
EPA	U.S. Environmental Protection Agency
MBMG	Montana Bureau of Mines and Geology
NI	Monitoring well was not yet installed
NS	Not sampled
PCP	Pentachlorophenol
ROD	Record of Decision
U	Analyzed for but not detected above the method detection limi

TABLE 4.5
HISTORICAL CONCENTRATIONS OF DIOXIN (TEQ) FOR GROUNDWATER SAMPLES
(µg/L)

Sample Date	10-12 (µg/L)	BMW-01A (µg/L)	BMW-01B (µg/L)	GW-12 (µg/L)	GW-14R-98 (µg/L)	HCA-21 (µg/L)	INF-04 (µg/L)	INF-05 (µg/L)	INF-06 (µg/L)	MW-11-04 (µg/L)	MW-B-98 (µg/L)	MW-D-96 (µg/L)	MW-E-01 (µg/L)	MW-L-96 (µg/L)	MW-U-01 (µg/L)	MW-V-01 (µg/L)	NWW (µg/L)	ROD Cleanup Level (µg/L)
8/13/2001	--	--	--	--	--	--	--	--	3.83E-06	--	--	--	7.70E-08	2.10E-08	--	--	--	3.00E-05
8/12/2002	--	--	--	--	--	--	--	--	2.00E-07	--	--	--	2.10E-07	1.70E-07	--	--	--	3.00E-05
8/4/2003	--	--	--	--	--	--	--	--	4.90E-08	--	--	--	1.10E-07	0	--	--	--	3.00E-05
8/2/2004	--	--	--	--	--	--	--	--	7.00E-07	--	--	--	**4.35E-05**	0	--	--	--	3.00E-05
8/1/2005	--	--	--	--	--	--	--	--	9.20E-08	--	--	--	2.70E-06	5.30E-07	--	--	--	3.00E-05
8/21/2006	--	--	--	7.90E-08	--	--	1.29E-05	0	7.20E-08	--	7.80E-08	9.20E-08	**5.96E-05**	0	--	--	--	3.00E-05
8/27/2007	--	--	--	2.80E-07	--	--	6.90E-07	7.00E-08	0.00E+00	--	0	0	1.00E-07	0	--	--	--	3.00E-05
8/25/2008	--	--	--	0	--	--	1.26E-05	8.00E-08	0.00E+00	--	0	6.50E-07	1.30E-07	0	--	--	--	3.00E-05
8/10/2009	--	--	--	--	0	--	1.40E-07	--	--	--	0	--	--	--	0	--	--	3.00E-05
8/16/2010	--	--	--	--	0	--	**4.50E-05**	--	--	--	0	--	--	--	0	--	--	3.00E-05
8/15/2011	--	--	--	--	1.05E-06	--	4.09E-06	--	--	--	9.30E-09	--	--	--	--	2.82E-08	1.70E-08	3.00E-05
8/13/2012	--	--	--	--	1.18E-07	--	2.75E-05	--	--	--	1.04E-07	--	--	--	--	3.30E-08	7.40E-08	3.00E-05
8/13/2013	4.50E-08	8.81E-08	1.12E-07	--	6.70E-07	8.04E-08	5.59E-06	--	--	9.91E-06	--	--	--	--	--	--	--	3.00E-05
8/11/2014	2.70E-08	2.08E-08	1.83E-08	--	1.42E-07	7.77E-07	**1.38E-04**	--	--	7.15E-06	--	--	--	--	--	--	--	3.00E-05
8/10/2015	1.04E-07	7.50E-09	2.70E-08	--	9.03E-06	4.23E-07	6.31E-07	--	--	6.46E-06	--	--	--	--	--	--	--	3.00E-05
8/8/2016	2.30E-08	4.40E-08	1.94E-08	--	4.13E-07	2.02E-07	7.76E-07	--	--	1.56E-05	--	--	--	--	--	--	--	3.00E-05
8/10/2017	NS	1.44E-08	8.50E-08	--	NS	3.60E-08	**8.41E-05**	--	--	**3.72E-04**	--	--	--	--	--	--	--	3.00E-05

HISTORICAL CONCENTRATIONS OF DIOXIN (TEQ) FOR GROUNDWATER SAMPLES
(pg/L)

Sample Date	10-12 (pg/L)	BMW-01A (pg/L)	BMW-01B (pg/L)	GW-12 (pg/L)	GW-14R-98 (pg/L)	HCA-21 (pg/L)	INF-04 (pg/L)	INF-05 (pg/L)	INF-06 (pg/L)	MW-11-04 (pg/L)	MW-B-98 (pg/L)	MW-D-96 (pg/L)	MW-E-01 (pg/L)	MW-L-96 (pg/L)	MW-U-01 (pg/L)	MW-V-01 (pg/L)	NWW (pg/L)	ROD Cleanup Level (pg/L)
8/13/2001	--	--	--	--	--	--	--	--	3.83	--	--	--	0.077	0.021	--	--	--	30.00
8/12/2002	--	--	--	--	--	--	--	--	0.20	--	--	--	0.21	0.17	--	--	--	30.00
8/4/2003	--	--	--	--	--	--	--	--	0.049	--	--	--	0.11	0.00	--	--	--	30.00
8/2/2004	--	--	--	--	--	--	--	--	0.70	--	--	--	**43.45**	0.00	--	--	--	30.00
8/1/2005	--	--	--	--	--	--	--	--	0.092	--	--	--	2.695	0.53	--	--	--	30.00
8/21/2006	--	--	--	0.079	--	--	12.92	0	0.072	--	0.078	0.092	**59.63**	0.00	--	--	--	30.00
8/26/2007	--	--	--	0.28	--	--	0.69	0.07	0	--	0	0	0.10	0	--	--	--	30.00
8/25/2008	--	--	--	0	--	--	12.64	0.08	0	--	0	0.650	0.13	0	--	--	--	30.00
8/10/2009	--	--	--	--	0	--	0.14	--	--	--	0	--	--	--	0	--	--	30.00
8/16/2010	--	--	--	--	0	--	**45.0**	--	--	--	0	--	--	--	0	--	--	30.00
8/15/2011	--	--	--	--	1.05	--	4.09	--	--	--	0.009	--	--	--	--	0.028	0.017	30.00
8/13/2012	--	--	--	--	0.12	--	27.50	--	--	--	0.104	--	--	--	--	0.033	0.074	30.00
8/12/2013	0.05	0.09	0.11	--	0.67	0.08	5.59	--	--	9.91	--	--	--	--	--	--	--	30.00
8/11/2014	0.03	0.02	0.02	--	0.14	0.78	**138**	--	--	7.15	--	--	--	--	--	--	--	30.00
8/10/2015	0.10	0.01	0.03	--	9.03	0.42	0.63	--	--	6.46	--	--	--	--	--	--	--	30.00
8/8/2016	0.02	0.04	0.02	--	0.41	0.20	0.78	--	--	15.60	--	--	--	--	--	--	--	30.00
8/10/2017	NS	0.01	0.09		NS	0.04	**84.1**	--	--	**372.4**	--	--	--	--	--	--	--	30.00

Notes:
For this table, TEQs are calculated using the MPTP ROD Methodology.
See Appendix B-3 for dioxin (TEQ) values calculated using both the MPTP ROD Methodology and the DEQ-7 Methodology.

0 Dioxin cogeners were below the reporting limit and set to 0 for the calculation of TEQ, resulting in a TEQ equal to 0.
-- Monitoring well did not exist or was not sampled on this date
µg/L Micrograms per liter
Bold Concentration exceeds the ROD groundwater cleanup level
pg/L Picograms per liter
MPTP Montana Pole and Treating Plant
ND Not detected
NS Not sampled
ROD Record of Decision
TEQ Toxicity equivalence quotient

TABLE 4.6
CONCENTRATIONS OF PAH AND CHLOROPHENOLS FOR GROUNDWATER SAMPLES

Monitoring Well:	**10-12**		**BMW-01A**		**BMW-01B**		**GW-14R-98**		**HCA-21**		**INF-04**		**MW-11-04**		**ROD Cleanup Level**
Sample Date:	**8/10/2017**		**8/10/2017**		**8/10/2017**		**8/10/2017**		**8/10/2017**		**8/10/2017**		**8/10/2017**		
Laboratory:	**MBMG**		**MBMG**		**MBMG**		**MBMG**		**MBMG**		**MBMG**		**MBMG**		
Units:	**(µg/L)**	**Q**	**(µg/L)**	**Q**	**(µg/L)**	**Q**	**(µg/L)**	**Q**	**(µg/L)**	**Q**	**(µg/L)**	**Q**	**(µg/L)**	**Q**	**(µg/L)**
ANALYTE															
PAH (EPA Method 8270)															
ACENAPHTHENE	NS		0.25	U	0.25	U	NS		0.25	U	0.427		37.1	D	-
ACENAPHTHYLENE	NS		0.25	U	0.25	U	NS		0.25	U	0.25	U	5.28	D	-
ANTHRACENE	NS		0.25	U	0.25	U	NS		0.25	U	0.25	U	2.5	UD	-
BENZO(A)ANTHRACENE	NS		0.1	U	0.353		NS		0.1	U	0.1	U	0.1	U	1
BENZO(A)PYRENE	NS		0.1	U	0.1	U	NS		0.1	U	0.1	U	0.1	U	0.2/0.05[a]
BENZO(B)FLUORANTHENE	NS		0.25	U	0.25	U	NS		0.25	U	0.25	U	0.25	U	0.2
BENZO(G,H,I)PERYLENE	NS		0.5	U	0.5	U	NS		0.5	U	0.5	U	0.5	U	1
BENZO(K)FLUORANTHENE	NS		0.1	U	0.1	U	NS		0.1	U	0.1	U	0.1	U	1
CHRYSENE	NS		0.1	U	0.1	U	NS		0.1	U	0.1	U	0.15		1
DIBENZO(A,H)ANTHRACENE	NS		0.1	U	0.1	U	NS		0.1	U	0.1	U	0.1	U	0.2
FLUORANTHENE	NS		0.25	U	0.25	U	NS		0.25	U	0.25	U	2.5	UD	-
FLUORENE	NS		0.25	U	0.25	U	NS		0.25	U	0.981		2.5	UD	-
INDENO(1,2,3-CD)PYRENE	NS		0.1	U	0.1	U	NS		0.1	U	0.1	U	0.1	U	1
NAPHTHALENE	NS		0.25	U	0.25	U	NS		0.25	U	2.78		285	D	-
PHENANTHRENE	NS		0.25	U	0.25	U	NS		0.25	U	8.2		2.5	UD	-
PYRENE	NS		0.25	U	0.25	U	NS		0.25	U	0.25	U	1.1		-
Total D PAH	NS		0.25	U	0.25	U	NS		0.25	U	12.39		328.50		360
CHLOROPHENOLS (EPA Method 8270)															
2,3,4,6-TETRACHLOROPHENOL	NS		0.5	U	0.5	U	NS		0.5	U	1.89		0.7		-
2,4,5-TRICHLOROPHENOL	NS		1	U	1	U	NS		1	U	1.5		1.0	U	-
2,4,6-TRICHLOROPHENOL	NS		0.5	U	0.5	U	NS		0.5	U	0.553		4		6.5
2,4-DICHLOROPHENOL	NS		0.5	U	0.5	U	NS		0.5	U	0.5	U	0.5	U	27
2-CHLOROPHENOL	NS		0.5	U	0.5	U	NS		0.5	U	0.5	U	0.5	U	45
4-CHLORO-3-METHYLPHENOL	NS		0.5	U	0.5	U	NS		0.5	U	0.5	U	1	U	-
PENTACHLOROPHENOL	NS		0.1	U	0.4		NS		0.699		**149**	D	**3,305**	D	1.0

Notes:

- \- No cleanup level specified in ROD
- µg/L Micrograms per liter
- a The water quality standard for benzo(a)pyrene outlined in Circular DEQ-7 is lower than the cleanup levels specified in the ROD tables; therefore, the lower DEQ-7 standard (in parentheses) currently takes precedence over the ROD cleanup level for this COC. The DEQ-7 standard for benzo(a)pyrene is 0.05 µg/L.
- **Bold** Concentration exceeds ROD groundwater cleanup level
- COC Contaminant of concern
- D PAH Sum of the acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene concentrations
- DEQ Montana Department of Environmental Quality
- EPA U.S. Environmental Protection Agency
- MBMG Montana Bureau of Mines and Geology
- NS Not sampled
- PAH Polycyclic aromatic hydrocarbons
- Q Laboratory data qualifier
- ROD Record of Decision
- U Analyzed for but not detected above the method detection limit

TABLE 4.7
COMPARISON OF DIOXIN (TEQ), PCP,
AND FIELD TURBIDITY

Sample Date	Monitoring Well	UNFILTERED DEQ-7 Methodology Dioxin TEQ (ρg/L)	UNFILTERED MPTP ROD Methodology Dioxin TEQ (ρg/L)	FILTERED DEQ-7 Methodology Dioxin TEQ (ρg/L)	FILTERED MPTP ROD Methodology Dioxin TEQ (ρg/L)	UNFILTERED (unless noted) PCP (µg/L)	Q	Turbidity (NTU)	Sample Collection Method	Comments
2015										
10/5/2015	10-01	1.2	0.05	-	-	11.2		0.36	Typhoon Pump	Clear no particulate
10/5/2015	10-02	1.0	0.02	-	-	16.2		2.79	Peristaltic Pump	Clear no particulate
10/5/2015	GW-09	1.5	0.61	-	-	0.2	U	0.66	Typhoon Pump	Clear no particulate
10/5/2015	GW-14R-98	3.0	2.04	1.4	0.011	1.06		7.2	Typhoon Pump	Clear no particulate
10/5/2015	INF-13	1.9	0.61	1.9	-	21.8		0.4	Peristaltic Pump	Clear no particulate
10/5/2015	INF-14	1.7	0.43	1.6	-	0.2	U	0.32	Typhoon Pump	Clear no particulate
10/5/2015	INF-15	1.2	0.36	1.4	-	0.2	U	0.61	Typhoon Pump	Clear no particulate
10/5/2015	INF-16	103.6	139.66	4.3		24.1		4.09	Typhoon Pump	Fine particulates
10/5/2015	INF-17	3.3	2.72	1.1	-	1.06		0.39	Typhoon Pump	Clear no particulate
10/5/2015	INF-18	2.2	1.41	0.97	-	0.2	U	0.34	Typhoon Pump	Clear no particulate
10/5/2015	MW-11-04	125.7	169.31	1.1		35,700		22.2	Typhoon Pump	Slightly cloudy
10/5/2015	MW-W-01	1.0	0.01	-	-	0.2	U	0.48	Typhoon Pump	---
10/5/2015	NCRTEFF	3.7	3.74	-	-	5.02		1.73	By hand	Clear no particulate
10/5/2015	NHRTEFF	5.8	5.95	-	-	167		0.06	By hand	Clear no particulate
2016										
8/8/2016	10-12	0.7	0.02	-	-	0.1	U	1.9	Typhoon Pump	Clear
8/8/2016	BMW-01A	0.8	0.04	-	-	0.1	U	0.39	Typhoon Pump	Clear
8/8/2016	BMW-01B	0.7	0.02	-	-	0.1	U	10.7	Typhoon Pump	Clear
8/8/2016	EFF	1.0	0.31	-	-	0.302		0.12	By hand	Clear
8/8/2016	GW-14R-98	1.1	0.41	-	-	1.28		25.4	Peristaltic Pump	Clouded with fine particulates
8/8/2016	HCA-21	0.8	0.20	-	-	0.646		0.52	Peristaltic Pump	Clear
8/8/2016	IN	2.9	2.80	-	-	31.4	D	0.49	By hand	Clear
8/8/2016	INF-04	1.2	0.78	-	-	83	D	0.41	Typhoon Pump	Very fine particulates
8/8/2016	LTUDIS (unfiltered)	30.8	38.49	-	-	16.7*	D	8.39	Peristaltic Pump[a]	Fine particulates
8/8/2016	LTUDIS (filtered)	-	-	-	-	17.4*		0.25	Peristaltic Pump[a]	Clear
8/8/2016	MW-11-04	12.1	15.60	-	-	1,606	D	2.59	Typhoon Pump	Fine particulates
8/8/2016	NCRTEFF	2.1	2.12	-	-	6.83		0.72	By hand	Clear
8/8/2016	NHRTEFF	4.7	4.95	-	-	153	D	1.29	By hand	Clear
8/8/2016	RETPOND	-	-	-	-	3.51	D	---	By hand	---
8/8/2016	SS-06A	0.7	0.22	-	-	0.1	U	3.59	By hand	Clear with fine particulates
8/8/2016	SW-05	0.8	0.22	-	-	0.1	U	3.37	By hand	Clear with fine particulates
8/8/2016	SW-09	1.1	0.08	-	-	0.1	U	3.53	By hand	Slightly cloudy with fine particulates
2017										
8/10/2017	BMW-01A	1.1	0.01	-	-	0.1	U	0.23	Peristaltic Pump	Clear no particulates
8/10/2017	BMW-01B	1.1	0.09	-	-	0.422		0.74	Peristaltic Pump	Clear no particulates
8/9/2017	EFF	3.4	1.87	-	-	0.312		0.19	By hand	Clear no particulates
8/10/2017	HCA-21	1.0	0.04	-	-	0.699		0.37	Peristaltic Pump	Clear no particulates
8/7/2017	IN	3.4	3.57	-	-	88.8	D	0.46	By hand	Clear no particulates
8/10/2017	INF-04	64.0	84.1	-	-	149	D	2.26	Peristaltic Pump	Very fine particulates
8/10/2017	MW-11-04	252.1	372.4	-	-	3305	D	12.1	Peristaltic Pump	Slightly cloudy/very fine particulates
8/7/2017	NCRTEFF	4.7	5.1	-	-	7.95		0.08	By hand	Clear no particulates
8/7/2017	NHRTEFF	7.1	9.2	-	-	286	D	1.41	By hand	Clear no particulates
8/7/2017	SS-06A	1.4	0.0	-	-	0.1	U	0.88	By hand	Clear no particulates
8/7/2017	SW-05	1.1	0.1	-	-	0.1	U	0.72	By hand	Clear no particulates
8/7/2017	SW-09	1.0	0.0	-	-	0.1	U	1.12	By hand	Clear no particulates
8/7/2017	LTUDIS	NS	NS	-	-	NS		NS	NS	---
8/10/2017	10-12	NS	NS	-	-	NS		NS	NS	---
8/10/2017	GW-14R-98	NS	NS	-	-	NS		NS	NS	---

Notes:

*	The concentration of PCP in the filtered sample was greater than the concentration in the unfiltered sample.
-	A filtered sample was not submitted to laboratory.
---	Information unavailable
Yellow	Indicates samples exhibiting relatively higher turbidity (>2 NTU) coupled with relatively higher dioxin TEQ (>10ρg/L) in the unfiltered sample.
a	Sample was collected in a container and then transferred to the sample jar using a peristaltic pump.
ρg/L	Picograms per liter
µg/L	Micrograms per liter
D	Dilution
DEQ-7 Methodology	2005 WHO methodology and using PRL/2 where ND, and EMPC/2 when reported.
DEQ	Montana Department of Environmental Quality
EMPC	Estimated possible maximum concentration
MPTP ROD Methodology	DEQ ROD methodology using 0 where ND
NTU	Nephelometric turbidity units
PCP	Pentachlorophenol
PRL	Project reporting limit
Q	Data qualifier
ROD	Record of Decision
TEQ	Toxicity equivalence quotient
U	Analyzed for but not detected above the method detection limit
WHO	World Health Organization

TABLE 4.8
DATA EVALUATION AND PROGRESS OF REMEDIATION

Criterion Number	Criterion	Data Used	Type of Analysis	Results from Analysis	Documentation of Results (refer to)	Comments	Compliance with ROD?
1	The WTP effluent (station EFF) must meet the 1 µg/L discharge to surface water cleanup level for PCP (and specified cleanup levels for other contaminants listed in the ROD, where established).	Data from WTP station EFF (treated groundwater) were evaluated to determine if this criterion was met.	Comparisons of the concentrations of contaminants at WTP station EFF to the ROD discharge to surface water cleanup levels.	One hundred percent of results from weekly PCP analyses (52 samples) were below the PCP 1.0 µg/L ROD discharge to surface water cleanup level. The concentrations of dioxins, PAH, and chlorophenols were below the ROD discharge to surface water cleanup levels, where established.	Table 2.4 (PCP) Table 2.5 (dioxins) Table 2.6 (PAH and chlorophenols) Appendix A	-	Yes
2	Surface water in Silver Bow Creek must meet the 1 µg/L surface water cleanup level for PCP (and specified cleanup levels for other contaminants listed in the ROD).	Data from surface water stations SW-05 (downstream from the site), SS-06A (adjacent to the site), and SW-09 (upstream of the site) located on Silver Bow Creek were evaluated to determine if this criterion was met.	Comparisons of the concentrations of contaminants at surface water stations SW-05, SS-06A, and SW-09 to the ROD surface water cleanup levels, where established.	The concentrations of PCP, dioxins, PAH, and chlorophenols were below the respective ROD surface water cleanup levels (where established).	Table 4.1 (PCP) Table 4.2 (dioxins) Table 4.3 (PAH and chlorophenols) Appendix A	-	Yes
3	The PCP plume must remain on site. This criterion is assumed to be met if the concentration of PCP in groundwater in downgradient sentinel monitoring wells continue to meet the groundwater cleanup level for PCP.	Data from downgradient sentinel monitoring wells (stations BMW 01A, BMW-01B, and 10-12) were evaluated to determine if the ROD groundwater cleanup level for PCP (1 µg/L) continued to be met at these locations.	This criterion is met if the concentrations of PCP in downgradient sentinel monitoring wells (BMW-01A, BMW-01B, and 10-12) continue to meet the 1 µg/L groundwater cleanup level for PCP. Comparison of the concentrations of PCP in downgradient sentinel monitoring wells (BMW-01A, BMW-01B, and 10-12) to the 1 µg/L ROD groundwater cleanup level.	The concentrations of PCP were below the 1 µg/L ROD groundwater cleanup level at downgradient sentinel monitoring wells BMW-01A, and BMW-01B; well 10-12 was not sampled in August 2017, but was sampled in February 2017 (0.158 1 µg/L).	Table 4.4 (PCP) Appendix A	-	Yes
4	The concentrations of dioxins, PAH, and chlorophenols in groundwater at representative monitoring wells along the south bank of Silver Bow Creek must meet the specified ROD groundwater cleanup levels, where established.	Data from monitoring wells BMW-01A, BMW-01B, 10-12, GW-14R-98, and HCA-21 are evaluated to determine if this criterion was met.	Comparisons of the concentrations of dioxins, PAH, and chlorophenols at groundwater monitoring wells BMW-01A, BMW-01B, and HCA-21 to the ROD groundwater cleanup levels; wells 10-12 and GW-14R-98 were not sampled.	The concentrations of dioxins, PAH, and chlorophenols were below the respective cleanup levels in the wells that were sampled.	Table 4.5 (dioxins) Table 4.6 (PAH and chlorophenols) Appendix A	-	Criterion 4 was partially satisfied (for wells BMW-01A, BMW-01B, and HCA-21). It is unclear if Criterion 4 was satisfied for wells 10-12 and GW-14R-98 because there were no "extended parameter list" data for these two wells, or from surrogate wells 10-04 and 10-05.
5	The long-term trend in the concentrations of PCP in groundwater over time should be decreasing, suggesting that groundwater quality will eventually meet the 1 µg/L groundwater cleanup level for PCP.	Data from groundwater monitoring wells with a long-term period of record (2004 to 2016) located along the south bank of Silver Bow Creek, and within the PCP plume footprint were evaluated to determine if this criterion was met (well HCA-21); well GW-14R-98 was not sampled in August 2017.	Mann-Kendall statistical test for trends (90 percent confidence interval)	The trend in the concentration of PCP over time in monitoring well HCA-21 is decreasing at greater than the 90 percent confidence level. The concentrations of PCP in monitoring wells HCA-21 (0.699 µg/L)) during the August 2017 sampling event suggests that groundwater quality will eventually meet the ROD 1 µg/L groundwater cleanup level for PCP.	Appendix A Appendix F	-	Yes
6	The long-term trend in the area of the PCP plume must be stable or shrinking, showing that ongoing remedial action is effectively preventing the spread of contamination.	The long-term trend (since 1993) in the digitized area of the PCP plume was evaluated using all available monitoring well data to construct the 1 µg/L PCP isocontour for each year that data were available.	Direct comparison of PCP plume area after the ROD was signed (1993) to the current area of the PCP plume (August 1, 2017).	Over the past 24 years, the total area of the PCP plume on the south side of Silver Bow Creek (based on the 1 µg/L isocontour line) has decreased from 41.7 acres in 1993 to 16.7 acres on August 1, 2017. This decrease represents a 60 percent reduction in the area of the PCP plume.	Figure 4.8 Appendix F Appendix G	-	Yes
7	The short-term trend (previous 5 years) in the area of the PCP plume must be stable or shrinking, showing that ongoing remedial action is effectively preventing the spread of contamination.	The short-term trend (previous 5 years) in the digitized area of the PCP plume using the 1 µg/L isocontour was evaluated to determine if this criterion was met.	Mann-Kendall statistical test for trends (90 percent confidence interval)	Over the past 5 years, no particular trend is exhibited. However, the vast majority (64 percent) of detections of PCP have been below the 1.0 µg/L groundwater cleanup level; the highest recorded concentration being 1.32 µg/L in monitoring well GW-14R-98 on August 10, 2015. This analysis supports a conclusion that the downgradient edge of the plume may be stable.	Appendix F Appendix G	-	Yes

Notes:

-	No comment
µg/L	Micrograms per liter
BSB	Butte-Silver Bow
Dioxins	Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans
EFF	WTP effluent station EFF
GAC	Granulated activated carbon
MK Tests	Mann-Kendall statistical tests for trends
MPTP	Montana Pole and Treating Plant
PAH	Polycyclic aromatic hydrocarbons
PCP	Pentachlorophenol
ROD	Record of Decision
U	Analyzed for but not detected above the method detection limit
WTP	MPTP water treatment plant
WWTP	Wastewater treatment plant

TABLE 4.9
HISTORICAL VOLUME OF LNAPL RECOVERED

Year	LNAPL Recovered (gallons)
2000	967
2001	1,367
2002	2,104
2003	570
2004	523
2005	511
2006	461
2007	3
2008	46
2009	6
2010	0
2011	0
2012	0
2013	0
2014	0[a,e]
2015	0[b,e]
2016	0[c,e]
2017	0[d,e]
Total	6,558

Notes:

a An oil sheen was noted in the NHRT from October 20, 2014, to October 23, 2014; adsorbent pads were emplaced.
b An oil sheen was noted in the NHRT on May 22, 2015, November 24, 2015, and December 22, 2015; adsorbent pads were emplaced.
c An oil sheen was noted in the NHRT July through December; adsorbent pads were emplaced.
d Less than 0.02 feet of product was detected in the NHRT during January and February, 2017. A sheen was noted in March, 2017. No product was detected the remainder of the year.
e Some residual oils are still present near the NHRT, primarily below the interstate highway and WTP

BSB Butte-Silver Bow
LNAPL Light non-aqueous phase liquid
MPTP Montana Pole and Treating Plant
NHRT Near-highway recovery trench
WTP MPTP water treatment plant

TABLE 5.1

HISTORICAL CONCENTRATIONS OF PCP FOR RESIDENTIAL WELL SAMPLES

		Domestic Well Name:	Wayrynen	Town Pump #1	Bowler	Hendrickson	Dixon (Rongstad)	ROD Cleanup Level (µg/L)
		Location:	Upgradient Business Well - South of Contaminant Plume	Upgradient Business Well - East of Land Treatment Unit	Domestic Irrigation Well - North of Contaminant Plume	Domestic Potable Water well - South East of Contaminant Plume	Domestic Irrigation Well - North of Land Treatment Unit	
		Analyte:	PCP	PCP	PCP	PCP	PCP	
		Units:	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	
Year	**Laboratory**	**EPA Method**						
2001	Energy	8151A	0.13	0.14	0.12	0.11	0.1	1.0
2002	Energy	E515.1	0.2U	0.2U	0.2U	0.2U	0.2U	1.0
2002	Energy	E515.1	0.1U	0.1U	0.1U	0.1U	0.1U	1.0
2003	Energy	E515.1	0.040U	0.040U	0.040U	0.040U	0.071	1.0
2004	Energy	E515.1	0.040U	0.040U	0.040U	0.040U	0.040U	1.0
2005	Energy	E515.1	0.040U	0.040U	0.040U	0.040U	0.040U	1.0
2006	MBMG	8041A	0.1U	0.1U	0.1U	0.1U	0.1U	1.0
2007	MBMG	8041A	0.101	0.057	0.467	0.056	0.096	1.0
2008	MBMG	8041A	0.131	0.073	0.083	0.102	0.115	1.0
2009	--	--	--	--	0.2	--	--	1.0
2010	--	--	--	--	--	--	--	1.0
2011	--	--	--	--	--	--	--	1.0
2012	--	--	--	--	--	--	--	1.0
2013	--	--	--	--	--	--	--	1.0
2014	--	--	--	--	--	--	--	1.0
2015	--	--	--	--	--	--	--	1.0
2016	--	--	--	--	--	--	--	1.0
2017	--	--	--	--	--	--	--	1.0

Notes:

--	Not sampled
µg/L	Micrograms per liter
Energy	Energy Laboratories Inc.
EPA	U.S. Environmental Protection Agency
MBMG	Montana Bureau of Mines and Geology
PCP	Pentachlorophenol
ROD	Record of Decision
U	Analyzed for but not detected above the method detection limit

FIGURES

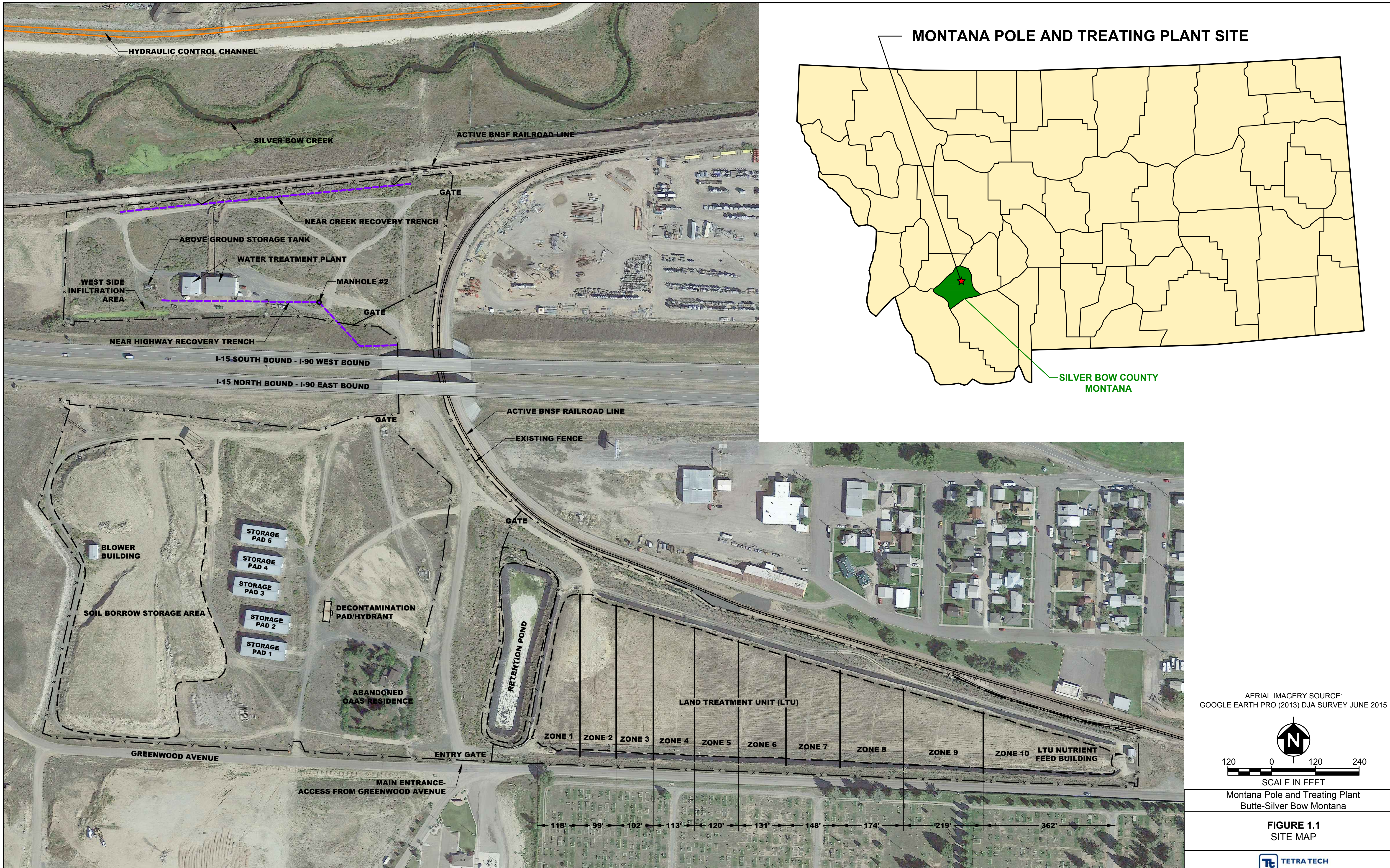
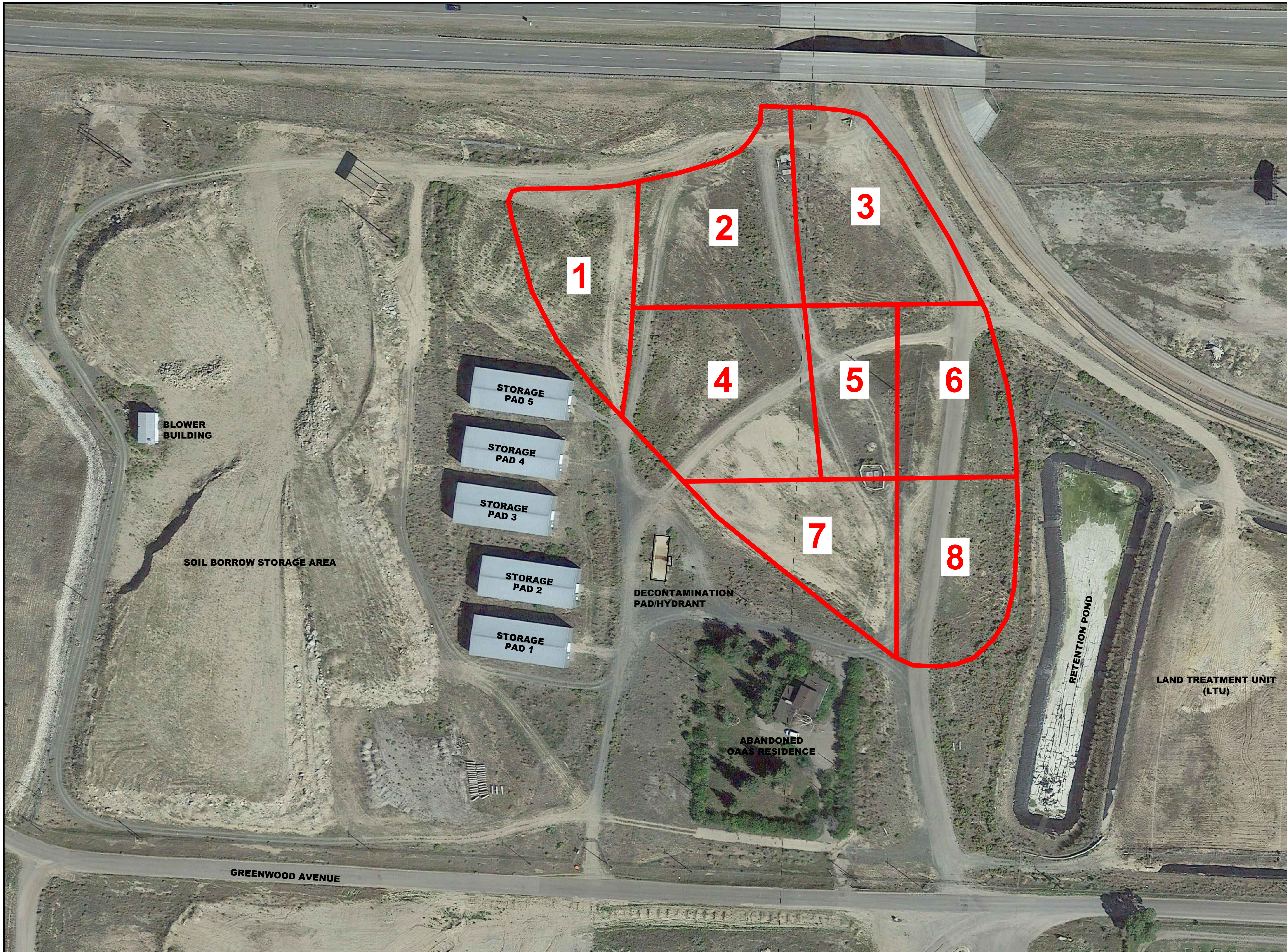


FIGURE 1.1
SITE MAP

Figure 1.1_Site Map.dwg - DWH - 08/27/2018



LEGEND

APPROXIMATE LOCATION OF INFILTRATION CELLS

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

120 0 60 120

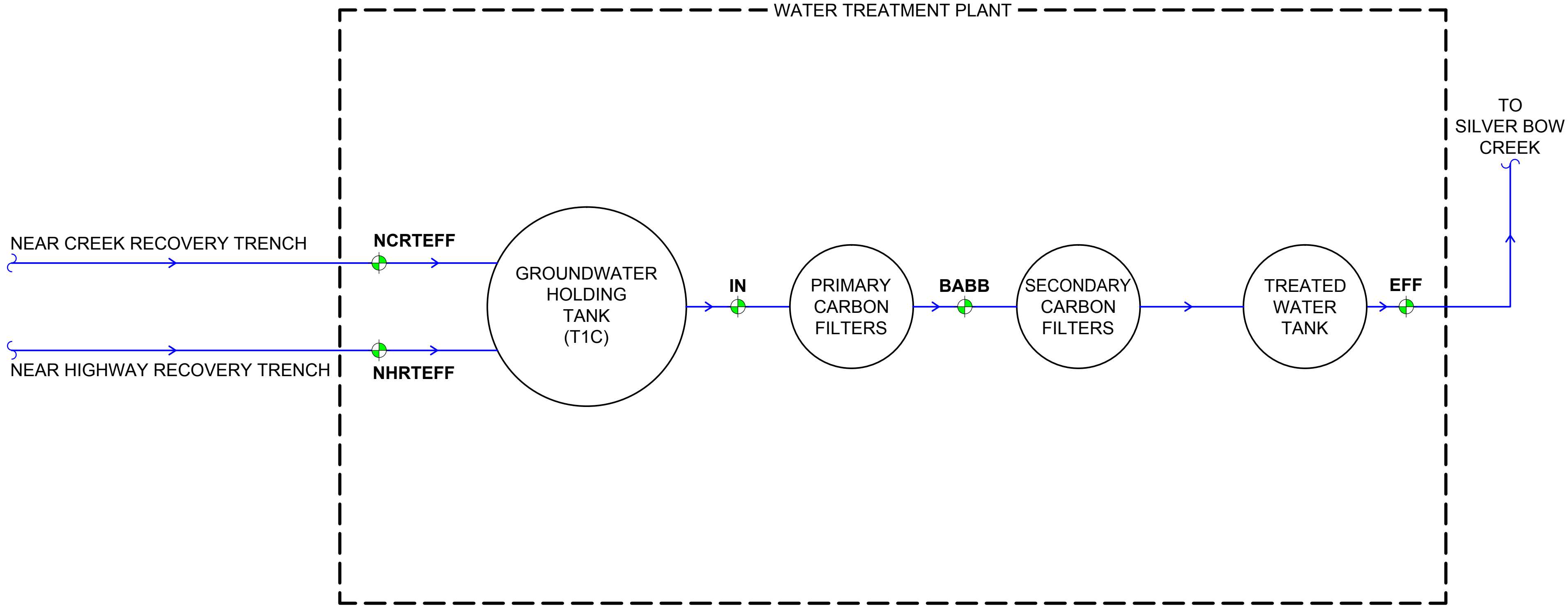
SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 2.1
SOUTH INFILTRATION CELLS

TETRA TECH

Figure 2.1_South Infiltration Cells.dwg - DWH - 08/27/2018



LEGEND

(symbol)	MPTP WATER TREATMENT PLANT SAMPLE STATION
(line)	PIPING
MPTP	MONTANA POLE AND TREATING PLANT

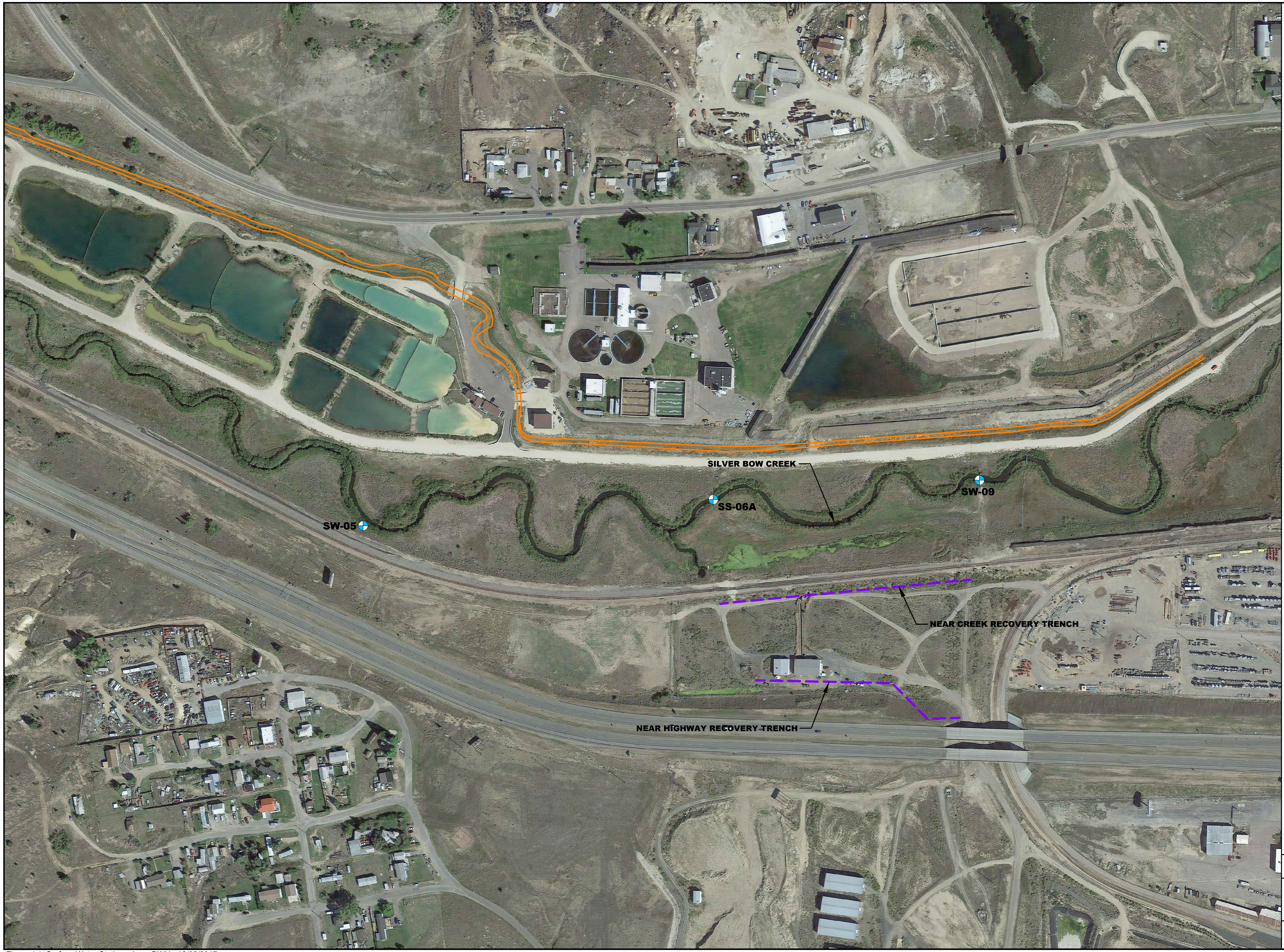
NO SCALE

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 2.2
LOCATION OF
MPTP WATER TREATMENT PLANT
SAMPLE STATIONS

TETRA TECH

Figure 2.2_Plant Sample Stations.dwg - DWH - 02/22/2016



LEGEND

SURFACE WATER STATION

HYDRAULIC CONTROL CHANNEL

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

150 0 150 300

SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.1
LOCATION OF SURFACE WATER STATIONS

TETRA TECH

Figure 4.1_Surface Water Stations.dwg - DWH - 12/05/2017

MONITORING WELL	APPROXIMATE SCREENED INTERVAL	CURRENT STATUS	MAP GRID
10-01	Deep	Existing	5G
10-02	Shallow	Existing	5G
10-03	Deep	Existing	5F
10-04	Shallow	Existing	5F
10-05	Shallow	Existing	5E
10-06	Deep	Existing	5E
10-07	Shallow	Existing	5E
10-08	Deep	Existing	4F
10-09	Shallow	Existing	4F
10-10	Deep	Existing	5J
10-11	Shallow	Existing	5J
10-12	Shallow	Existing	5D
10-13	Deep	Existing	4H
10-14	Shallow	Existing	4H
10-15	Intermediate	Existing	5G
10-16	Deep	Existing	2H
10-17	Intermediate	Existing	2H
10-18	Shallow	Existing	2H
10-19	Deep	Existing	4F
10-20	Intermediate	Existing	4F
10-21	Shallow	Existing	4F
AW-02	Shallow	Abandoned	8J
BMW-01A	Deep	Existing (ARCO)	6D
BMW-01B	Deep	Existing (ARCO)	6D
BMW-13B	Deep	Existing (ARCO)	3E
BMW-9A	Shallow	Existing (ARCO)	5H
BMW-9B	Deep	Existing (ARCO)	5H
CT-84-04	Shallow	Existing (ARCO)	1D
GS-18-R	Deep	Existing (ARCO)	5H
GS-22	Shallow	Existing (ARCO)	6E
GS-25	Shallow	Existing (ARCO)	2D
GS-25-C	Deep	Existing (ARCO)	2D
GS-25-D	Deep	Existing (ARCO)	2D
GS-34-D	Deep	Existing (ARCO)	4G
GS-34-S	Shallow	Existing (ARCO)	4G
GW-05	Shallow	Existing	11J
GW-08	Deep	Existing	13K
GW-09	Shallow	Existing	9G
GW-10	Shallow	Destroyed	9K
GW-12	Deep	Existing	7F
GW-13	Deep	Existing	6K
GW-14R-98	Shallow	Existing	5F
GW-17	Shallow	Existing	5L
GW-21	Shallow	Existing	11L
GW-22R-98	Shallow	Existing	13L
HCA-21	Shallow	Existing (ARCO)	5G
INF-01	Intermediate	Existing	7J
INF-02	Shallow	Existing	7J
INF-03	Deep	Existing	7J
INF-04	Shallow	Existing	6I
INF-05	Intermediate	Existing	6I
INF-06	Deep	Existing	6I
INF-07	Deep	Existing	6H
INF-08	Intermediate	Existing	6H
INF-09	Shallow	Existing	6H
INF-10	Shallow	Existing	9J
INF-11	Intermediate	Existing	9J
INF-12	Deep	Existing	9J
INF-13	Shallow	Existing	10K
INF-14	Intermediate	Existing	10K
INF-15	Deep	Existing	10K
INF-16	Shallow	Existing	10K
INF-17	Intermediate	Existing	11K
INF-18	Deep	Existing	11K
M-01	Shallow	Existing (ARCO)	1D
MP-04 (MF-14)	Deep	Existing	6G
MW-01	Shallow	Existing	6G
MW-03	Shallow	Existing	6K
MW-09	Shallow	Existing	9H
MW-11-01	Shallow	Existing	8H
MW-11-02	Shallow	Existing	8I
MW-11-03	Shallow	Existing	8I
MW-11-04	Shallow	Existing	7I
MW-11-05	Shallow	Existing	7H
MW-14	Shallow	Existing	10I
MW-87-03	Shallow	Existing (ARCO)	6G
MW-A-01	Shallow	Existing	7G
MW-A-04	Shallow	Abandoned	8H
MW-A-95	Shallow	Existing	9I
MW-A-96	Shallow	Existing	13T
MW-A-98	Shallow	Existing	6F
MW-A-99	Shallow	Existing	7H
MW-B-01	Shallow	Existing	7G
MW-B-04	Shallow	Abandoned	8I
MW-B-95	Shallow	Abandoned	8J
MW-B-96	Shallow	Existing	13O
MW-B-98	Shallow	Existing	6K
MW-B-99	Shallow	Existing	7G
MW-C-01	Shallow	Existing	7G
MW-C-04	Shallow	Abandoned	9J
MW-C-96	Shallow	Existing	12P
MW-D-01	Shallow	Existing	6G
MW-D-95	Shallow	Abandoned	8I
MW-D-96	Shallow	Existing	13L
MW-E-01	Shallow	Existing	6G
MW-E-96	Shallow	Existing	10M
MW-F-01	Shallow	Existing	6G
MW-F-95	Shallow	Abandoned	8J
MW-F-96	Shallow	Existing	13H
MW-G-01	Shallow	Existing	6H
MW-G-96	Shallow	Existing (ARCO)	11F
MW-H-01	Shallow	Existing	6G
MW-H-95	Shallow	Existing	7H
MW-H-96	Shallow	Existing (ARCO)	10F
MW-I-01	Shallow	Existing	6H
MW-I-96	Shallow/Intermediate	Existing	6K
MW-J-01	Shallow	Existing	6I
MW-J-96	Intermediate/Deep	Existing	7G
MW-K-01	Shallow	Existing	6J
MW-K-96	Deep	Existing	6F
MW-L-01	Shallow	Existing	6K
MW-L-96	Deep	Existing	6I
MW-M-01	Shallow	Existing	6K
MW-M-96	Deep	Existing	6J
MW-N-01	Shallow	Existing	7J
MW-O-01	Shallow	Existing	7J
MW-P-01	Shallow	Existing	7K
MW-Q-01	Shallow	Abandoned	8K
MW-R-01	Shallow	Abandoned	8K
MW-S-01	Shallow	Existing	9K
MW-T-01	Shallow	Existing	9K
MW-U-01	Shallow	Existing	11L
MW-V-01	Shallow	Existing	11J
MW-W-01	Shallow	Existing	10I
MW-X-01	Shallow	Existing	9J
MW-Y-01	Shallow	Existing	9J
NC-06-S	Shallow	Existing	6G
NCRT PZ-01	In Trench	Existing	6K
NCRT PZ-02	In Trench	Existing	6I
NCRT PZ-03	Shallow	Existing	6H
NCRT PZ-04	In Trench	Existing	6G
NCRT-2010	Shallow	Existing	6H
NHRT MH1	In Trench	Abandoned	8J
NHRT MH2	In Trench	Existing	7J
NHRT PZ-01	Shallow	Abandoned	8J
NHRT PZ-04	In Trench	Existing	7H
NWW	Deep	Existing	13S
Pump-1	Manhole	Existing (BSB)	2E
Pump-2	Manhole	Existing (BSB)	3F
Pump-3	West Sump	Existing (BSB)	2E
PZ-N5-03	Shallow	Existing	7J
PZ-N5-2	Shallow	Existing	7I
PZ-N9-03	Shallow	Existing	7J
PZ-S1-01	Shallow	Existing	9I
PZ-S1-02	Shallow	Existing	9I
PZ-S1-04	Shallow	Existing	9I
PZ-S2-01	Shallow	Existing	9J
PZ-S2-02	Shallow	Existing	9J
PZ-S3-01	Shallow	Abandoned	9J
PZ-S3-02	Shallow	Existing	9J
PZ-S3-04	Shallow	Abandoned	9K
PZ-S3-05	Shallow	Abandoned	9J
PZ-S4-01	Shallow	Existing	10J
PZ-S4-02	Shallow	Existing	10J
PZ-S5-01	Shallow	Existing	10K
PZ-S6-01	Shallow	Existing	10K
PZ-S7-01	Shallow	Existing	11J
PZ-S8-02	Shallow	Existing	11K

AERIAL IMAGERY SOURCE: GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

LEGEND

- GROUNDWATER MONITORING WELL (TO BE RETAINED FOR SAMPLING)
- GROUNDWATER MONITORING WELL (NOT TO BE SAMPLED)
- GROUNDWATER MONITORING WELL (ABANDONED OR DESTROYED)
- UTILITY POLE

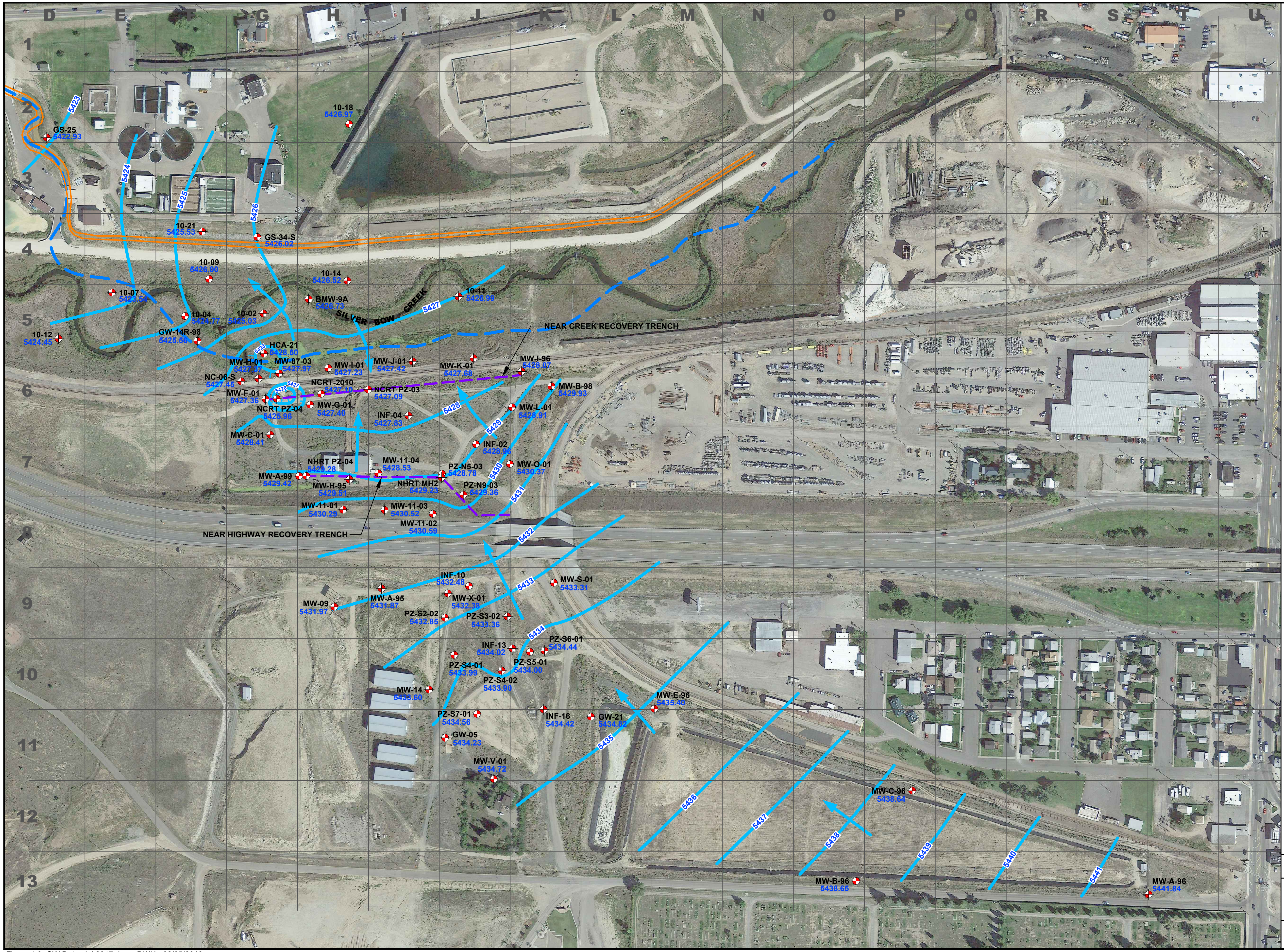
Figure 4.2_Location of All MPTP Monitoring Wells.dwg - DWH - 02/25/2016

70 0 70 140
SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.2
LOCATION OF ALL
MONTANA POLE AND TREATING PLANT
MONITORING WELLS

TETRA TECH



LEGEND

- MONITORING WELL
- HISTORICAL SILVER BOW CREEK CHANNEL
- HYDRAULIC CONTROL CHANNEL
- GROUNDWATER CONTOUR - 1' INTERVAL
- GROUNDWATER MOUND
- GROUNDWAEER SINK
- INTERPRETED DIRECTION OF GROUNDWATER FLOW

NOTES:

1) THIS FIGURE PROVIDES ONE INTERPRETATION OF GROUNDWATER FLOW; OTHER INTERPRETATIONS ARE POSSIBLE.
2) ALL ELEVATIONS PRESENTED IN THIS REPORT ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29) VERTICAL CONTROL DATUM.

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

150 0 150 300

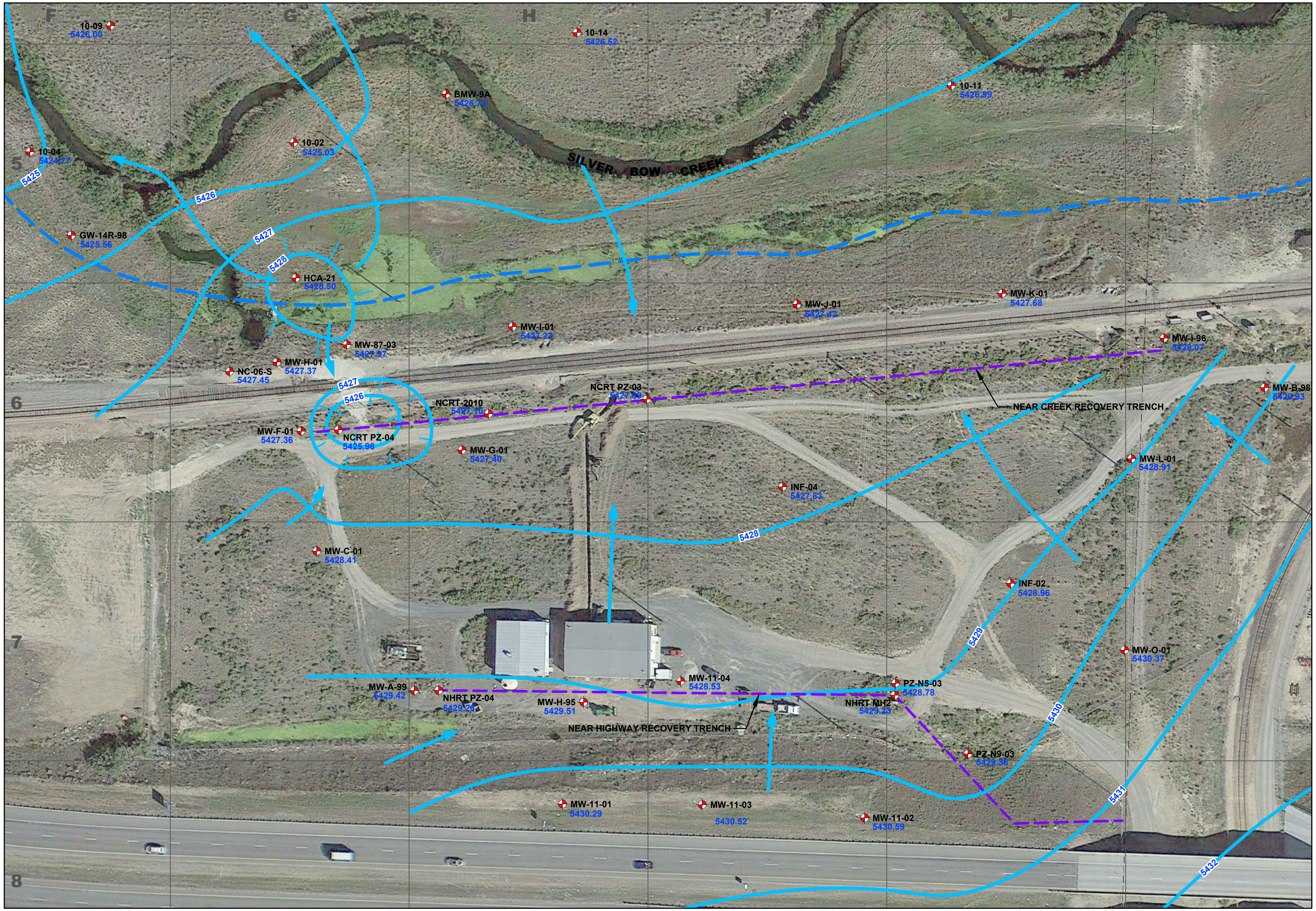
SCALE IN FEET

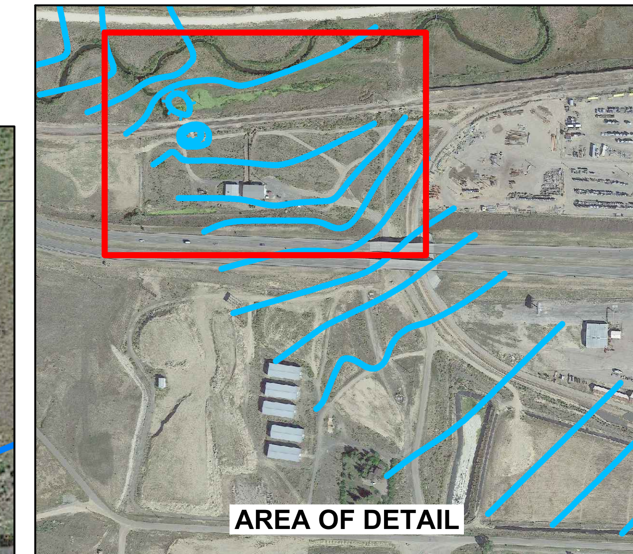
Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.3
GROUNDWATER LEVEL DATA - JULY 28, 2017

TETRA TECH

Figure 4.3_GW Data_Jul 2017.dwg - DWH - 02/05/2018





LEGEND

- MONITORING WELL
- HISTORICAL SILVER BOW CREEK CHANNEL
- GROUNDWATER CONTOUR - 1' INTERVAL
- GROUNDWATER MOUND
- GROUNDWAER SINK
- INTERPRETED DIRECTION OF GROUNDWATER FLOW

NOTES:

1) THIS FIGURE PROVIDES ONE INTERPRETATION OF GROUNDWATER FLOW; OTHER INTERPRETATIONS ARE POSSIBLE.
2) ALL ELEVATIONS PRESENTED IN THIS REPORT ARE BASED ON THE NATIONAL GEODETIC VERTICAL DATUM OF 1929 (NGVD29) VERTICAL CONTROL DATUM.

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

50 0 50 100

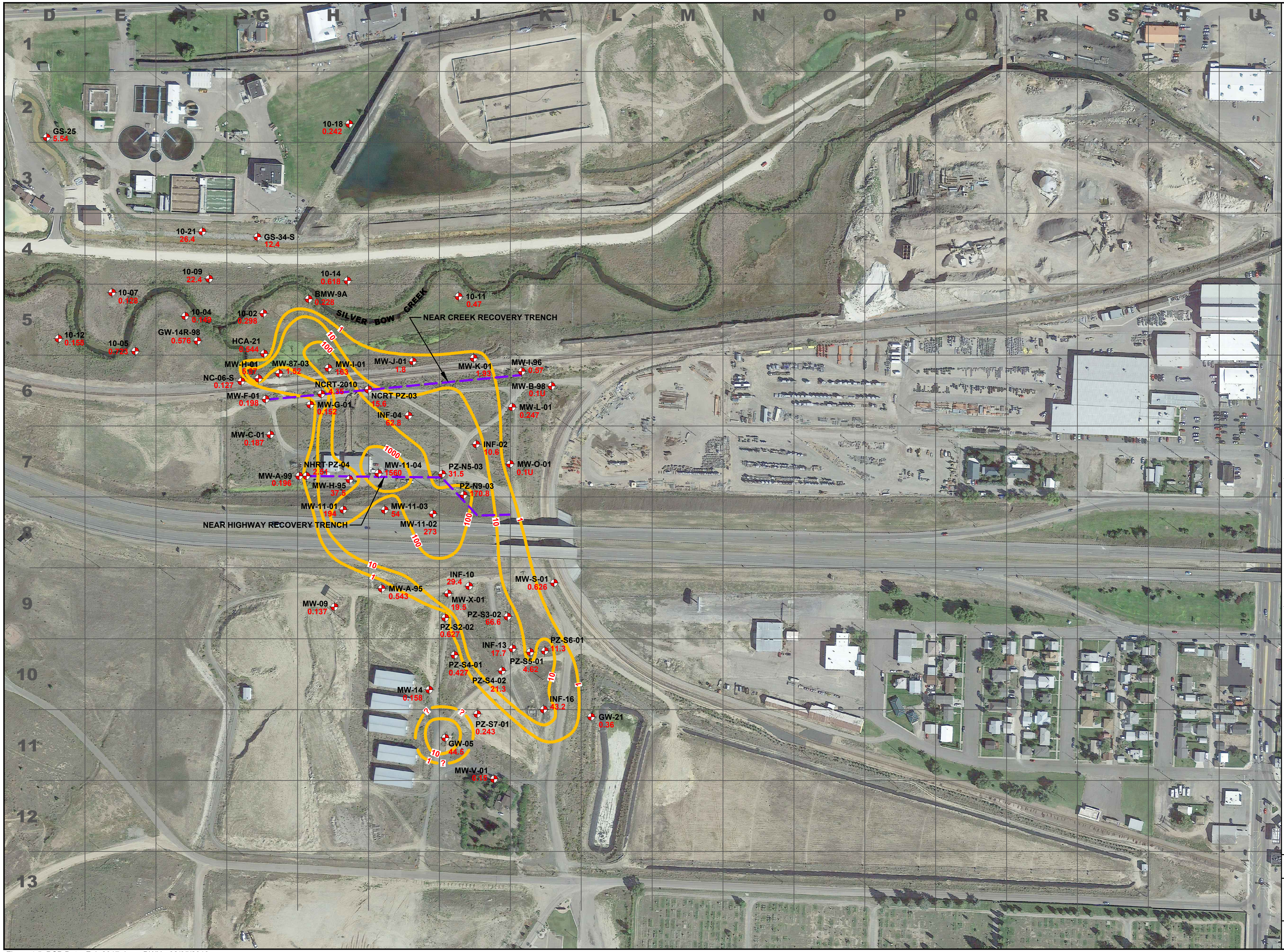
SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.4
ON-SITE GROUNDWATER LEVEL DATA - JULY 28, 2017

TETRA TECH

Figure 4.4_On-Site GW Data_Jul 2017.dwg - DWH - 02/05/2018



LEGEND

- MONITORING WELL
- PCP ISOCONTOUR - DASHED WHERE INFERRED ? WHERE UNKNOWN (µg/L)
- U — ANALYZED FOR BUT NOT DETECTED ABOVE THE METHOD DETECTION LIMIT
- µg/L — MICROGRAMS PER LITER

NOTES:

1) PENTACHLOROPHENOL (PCP) ISOCONTOURS ARE INTERPRETED; OTHER INTERPRETATIONS ARE POSSIBLE.

2) THE PCP PLUME IS NOT INTERPRETED TO FLOW THROUGH THE NEAR CREEK RECOVERY TRENCH (NCRT). RATHER, CONTAMINATED GROUNDWATER NEAR THE HISTORICAL SILVER BOW CREEK CHANNEL IS INTERPRETED TO BE MIGRATING TOWARD THE NCRT.

3) PLUME AREA BASED ON 1 µg/L CONTOUR INTERVAL: 15.6 ACRES

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

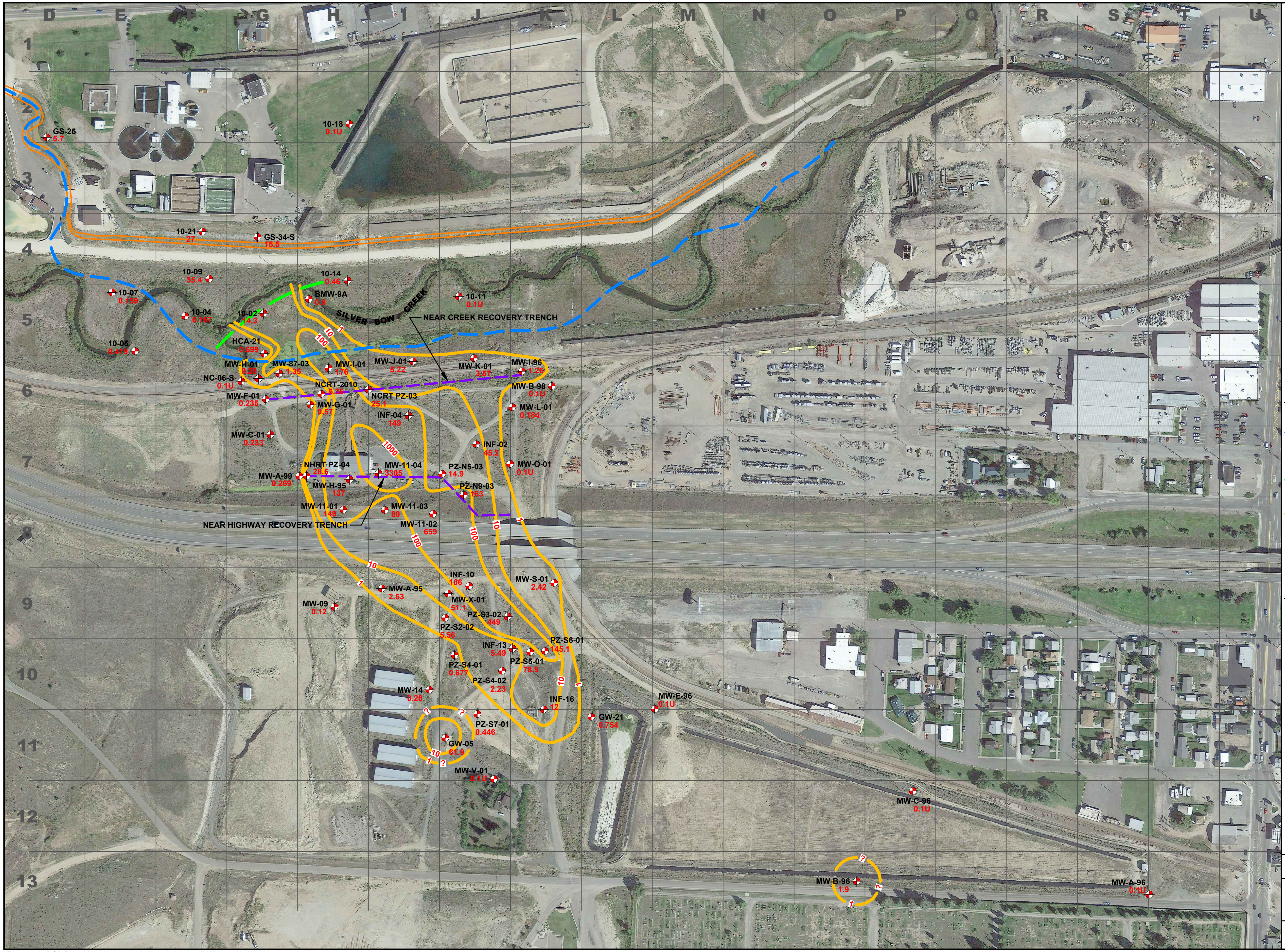
150 0 150 300
SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.5
PCP DATA - FEBRUARY 7, 2017

TETRA TECH

Figure 4.5_PCP Data_Feb 2017.dwg - DWH - 02/05/2018



LEGEND

- MONITORING WELL
- HISTORICAL SILVER BOW CREEK CHANNEL
- HYDRAULIC CONTROL CHANNEL
- EXTENT OF GROUNDWATER CAPTURE FROM NEAR CREEK RECOVERY TRENCH (NCRT) BASED ON MODELING (TETRA TECH 2010)
- PCP ISOCONTOUR - DASHED WHERE INFERRED ? WHERE UNKNOWN (µg/L)
- U — ANALYZED FOR BUT NOT DETECTED ABOVE THE METHOD DETECTION LIMIT
- µg/L — MICROGRAMS PER LITER

NOTES:

1) PENTACHLOROPHENOL (PCP) ISOCONTOURS ARE INTERPRETED; OTHER INTERPRETATIONS ARE POSSIBLE.

2) THE PCP PLUME IS NOT INTERPRETED TO FLOW THROUGH THE NCRT. RATHER, CONTAMINATED GROUNDWATER SOUTH OF THE SILVER BOW CREEK CHANNEL IS INTERPRETED TO BE MIGRATING TOWARD THE NCRT.

3) PLUME AREA SOUTH OF SILVER BOW CREEK BASED ON 1 µg/L CONTOUR INTERVAL: 16.7 ACRES

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

150 0 150 300

SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.6
PCP DATA - AUGUST 1, 2017

TETRA TECH

Figure 4.6_PCP Data_Aug 2017_southsideonly2.dwg - DWH - 02/05/2018

LEGEND

- GROUNDWATER MONITORING WELL
- SURFACE WATER STATION
- WATER TREATMENT PLANT SAMPLE STATION
- APPROXIMATE AREA OF PLUME DEFINED BY 1 µg/L PCP ISOCONTOUR - DASHED WHERE INFERRED, ? WHERE UNKNOWN
- µg/L MICROGRAMS PER LITER
- PCP PENTACHLOROPHENOL

NOTES:
1) PCP PLUME BOUNDARY IS INTERPRETED; OTHER INTERPRETATIONS ARE POSSIBLE.
2) PLUME OUTLINE INTERPRETED BASED ON AUGUST 2017 CONDITIONS.

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

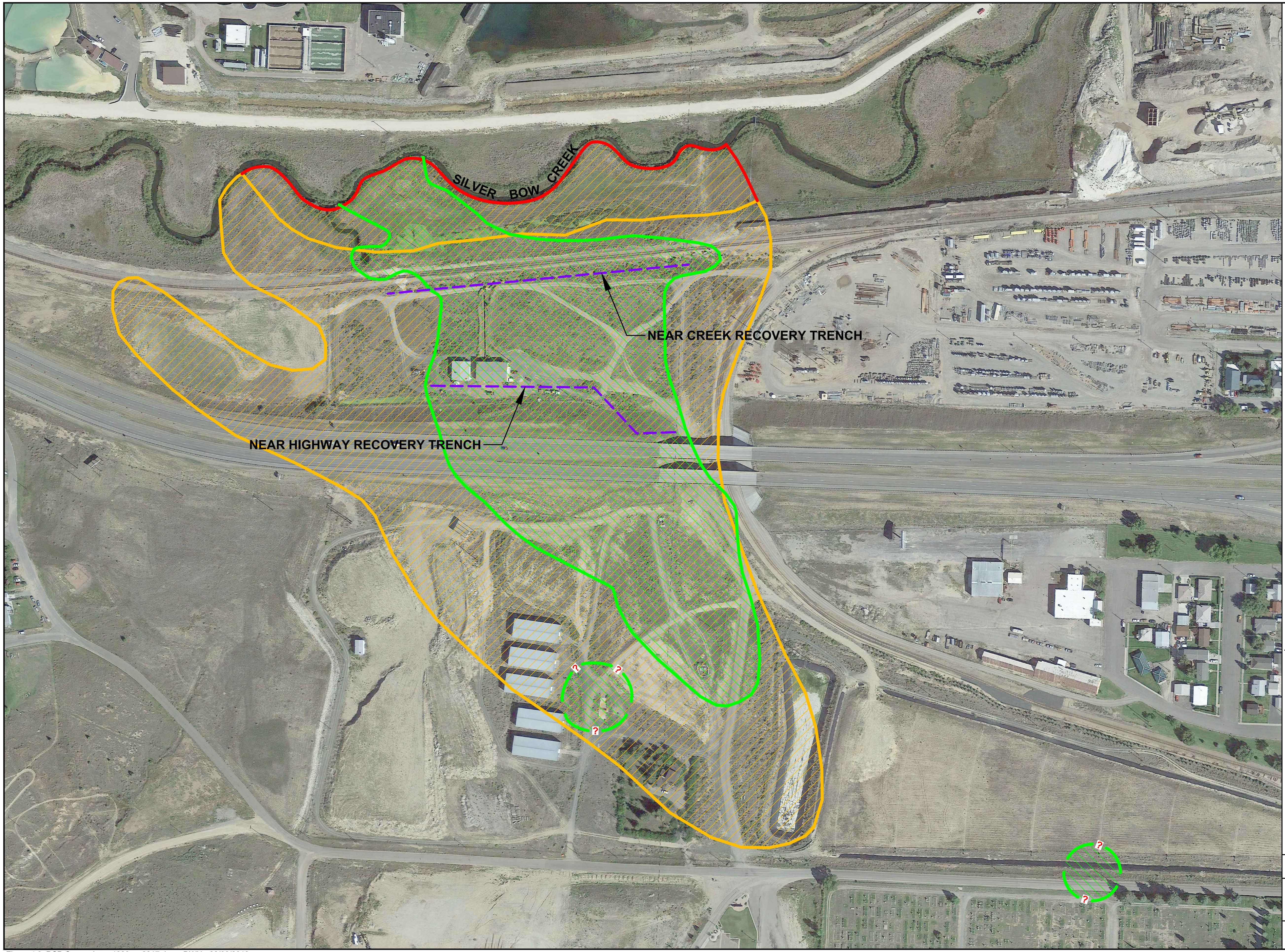
150 0 150 300

SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.7
LOCATIONS OF
SELECTED MONITORING STATIONS

TETRA TECH



LEGEND

- AUGUST 2017 PCP PLUME CONTOUR (1 µg/L)
- 1993 PCP PLUME CONTOUR (1 µg/L) FROM ROD
- EXTENSION OF 1993 PLUME CONTOUR (1 µg/L) TO CURRENT LOCATION OF SILVER BOW CREEK
- APPROXIMATE AUGUST 2017 PCP PLUME AREA (16.7 acres) - DASHED WHERE INFERRED, ? WHERE UNKNOWN
- 1993 PCP PLUME AREA (41.70 acres) (INCLUDES AREA BETWEEN HISTORIC SILVER BOW CREEK (1993) AND CURRENT LOCATION OF SILVER BOW CREEK (2017))

PCP PENTACHLOROPHENOL

ROD RECORD OF DECISION

µg/L MICROGRAMS PER LITER

NOTES:
1) PCP ISOCONTOURS ARE INTERPRETED; OTHER INTERPRETATIONS ARE POSSIBLE.
2) THE PCP PLUME IS NOT INTERPRETED TO FLOW THROUGH THE NEAR CREEK RECOVERY TRENCH (NCRT). RATHER, CONTAMINATED GROUNDWATER SOUTH OF THE SILVER BOW CREEK CHANNEL IS INTERPRETED TO BE MIGRATING TOWARD THE NCRT.

AERIAL IMAGERY SOURCE:
GOOGLE EARTH PRO (2013) DJA SURVEY JUNE 2015

N

125 0 125 250

SCALE IN FEET

Montana Pole and Treating Plant
Butte-Silver Bow Montana

FIGURE 4.8
COMPARISON OF PLUME AREAS
1993 VERSUS AUGUST 10, 2017

TETRA TECH

Figure 4.8_PCP Comparison_1993 vs 2017.dwg - DWH - 02/06/2018

APPENDIX A

Microsoft Access 2010 Database

(Separate CD)

APPENDIX B

2017 Sampling Results and Data

APPENDIX B-1

Water Treatment Plant – PCP

APPENDIX B-2

Groundwater and Surface Water – PCP

APPENDIX B-3

DIOXIN (TEQ) - 2011 TO 2017

MPTP ROD METHODOLOGY VS. DEQ-7 METHODOLOGY

APPENDIX C

2017 Operational Flow Summary

APPENDIX D

Daily Summary Reports

APPENDIX E

R-Studio Data Visualizations

APPENDIX F

Mann-Kendall Tests

APPENDIX G

Plume Area Maps

APPENDIX H

Quality Control for Electronic Data Deliverables

APPENDIX I

Climate Statistics

APPENDIX J

Streamflow Statistics