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12 October, 2020

Sara Edinberg
Waste Management and Remediation Division
Cleanup, Protection and Redevelopment Section
Montana Department of Environmental Quality
1225 Cedar Street
Helena, MT 59601

RE: Final Report Units 3&4 EHP Underdrain Pumping Test
Talen Montana, LLC Colstrip Steam Electric Station

Dear Sara,

On behalf of Talen Montana, LLC (Talen), Hydrometrics, Inc. is submitting the report titled "Final Report Units 3&4 EHP Underdrain Pumping Test" for the Colstrip Steam Electric Station. The attached report was prepared to satisfy certain stipulations of conditional approval of the Revised Remedy Evaluation Report[1] that were required by the Montana Department of Environmental Quality (DEQ)[2]. Specifically, this report addresses the stipulation that Talen must conduct a pumping test on the 3&4 EHP Underdrain (Underdrain) and provide results of the Underdrain pumping test to DEQ.

Please do not hesitate to contact Talen Montana, LLC or Hydrometrics, Inc. if you have any questions regarding this report.

Respectfully submitted,

Rich Labbe, P.E.
Environmental Engineer

Attachment: Final Report Units 3&4 EHP Underdrain Pumping Test Talen Montana, LLC Colstrip Steam Electric Station

[1] Geosyntec Consultants (August 2019). Revised Remedy Evaluation Report - Units 3&4 Effluent Holding Pond (EHP) Colstrip Steam Electric Station, Colstrip, Montana.
[2] Montana Department of Environmental Quality (DEQ) (February 2020 and May 2020). DEQ Comments on Units 3&4 EHP Revised Remedy Evaluation Report. Letter from Sara Edinberg to Gordon Criswell dated February 10, 2020. DEQ Follow up Comments on Units 3&4 EHP Revised Remedy Evaluation Report. Letter from Sara Edinberg to Gordon Criswell dated May 15, 2020

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INTERIM RESPONSE ACTION

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
TALEN MONTANA, LLC
COLSTRIP STEAM ELECTRIC STATION

Prepared for:
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P.O Box 38
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Prepared by:

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5602 Hesper Rd.
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October 2020

INTERIM RESPONSE ACTION

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
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OCTOBER 2020

INTERIM RESPONSE ACTION

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
TALEN MONTANA, LLC
COLSTRIP STEAM ELECTRIC STATION

Executive Summary

Montana Department of Environmental Quality (DEQ) provided conditional approval of the Units 3&4 Effluent Holding Pond (EHP) Revised Remedy Evaluation Report for the Colstrip Steam Electric Station (CSES) (Geosyntec August 2019, DEQ February 2020) with the stipulation that Talen Montana, LLC (Talen) must address additional comments prepared by DEQ and complete conditions related to sampling, testing, and treatability studies (DEQ February 2020; DEQ May 2020). As the first condition for the approval of the Remedy Evaluation Report, DEQ indicated that Talen must conduct a pumping test on the 3&4 EHP Underdrain (Underdrain) to evaluate if pumping from the sump is able to fully dewater the ponds. DEQ further required that Talen provide results of the Underdrain pumping test in a written report. The Underdrain pumping test was completed in summer/fall 2020; and results are summarized herein. However, it should be emphasized that the conditionally approved Alternative 4 for Units 3&4 EHP does not rely solely on pumping of the Underdrain to dewater the fly ash. Rather, pumping water from the underdrain sump is intended to assist with source dewatering by removing water from the general area above the Underdrain laterals, as described within the report.

The Underdrain is primarily under C Cell, with portions below A Cell, B Cell, and the C/G Cell divider dike. Free water in areas outside the influence of the Underdrain will be drained using alternative methods described in the Remedy Evaluation Report (Geosyntec 2019), including horizontal and vertical wells. Other measures (which may include capping, dry disposal, etc.) included in the approved remedy will reduce and/or eliminate recharge to the fly ash and should result in separation of the groundwater table and potentially saturated intervals of the EHP. Downward movement of water through the fly ash will be blocked by synthetic liners, caps, or both.

The objective of the Underdrain pumping test is to generate the data that can support incorporating the Underdrain into the full-scale implementation of the DEQ-approved remedy for the EHP, to better estimate water volumes within the ash, and to evaluate groundwater conditions directly below the EHP. DEQ further required that samples of soils beneath the EHP must be collected to assess secondary sources of constituents of interest (COIs) that may be present below the ash (contingency 6; DEQ February 2020). Soil sampling is ongoing beneath the EHP but results of those samples will be provided in a later report.

Sixteen observation/monitoring wells were installed expressly for use in the Underdrain pumping test. Twenty additional existing wells inside and outside the cutoff wall were also observed during the test. The observation/monitoring well network was used to measure

water levels before, during, and after the Underdrain was pumped; and some of the observation/monitoring points are located at or near vertical capture wells planned in Alternative 4 of the DEQ-approved Remedy Evaluation (Geosyntec, 2019). The observation/monitoring network targeted water in four different subsurface intervals inboard of the EHP cutoff wall: 1.) Clinker, 2.) Fly ash, 3.) Embankment Fill; and 4.) Consolidated strata consisting of McKay coal and sub-McKay bedrock.

Water quality samples were collected from each of the observation/monitoring wells prior to conducting the Underdrain pumping test. Analytical results indicate that water sampled from new clinker and fill wells within the 3&4 EHP had concentrations of constituents consistent with ash pore water or other process water. Total dissolved solids (TDS) concentrations ranging from 13,800 mg/L to 45,400 mg/L were reported for clinker and fill wells. Clinker and fill wells are laterally hydraulically connected to fly ash in unlined cells of the EHP. Water samples collected from fly ash piezometers installed for the test were also characterized by high concentrations of TDS, ranging from 34,500 mg/L to 55,300 mg/L. Concentrations of boron at fly ash piezometers ranged from 113 mg/L to 207 mg/L; while, sulfate concentrations ranged from 20,900 mg/L to 33,600 mg/L. Water quality in the Underdrain was also similar to water from fly ash piezometers; and changed only minutely from the beginning to the end of the pumping test.

Results of groundwater samples collected at wells completed in McKay Coal or sub-McKay bedrock underlying the EHP had mixed results with regard to concentrations of groundwater constituents. Concentrations of boron ranged from 3.3 mg/L to 142 mg/L in sub-McKay wells; while, concentrations of sulfate ranged from 3,270 mg/L to 25,900 mg/L. Based on water quality in sub-McKay wells it is apparent that vertical connectivity between bedrock and seepage from the EHP is variable. TDS and sulfate concentrations reported for the lone McKay coal well completed in the Underdrain observation/monitoring network were 24,300 mg/L and 16,300 mg/L, respectively. However, the boron concentration at the same well was 1.8 mg/L. It is possible that boron in groundwater at the McKay well is low, relative to concentrations in clinker, fill, or bedrock, because the boron is sorbed to the coal.

Individual slug tests were conducted at fly ash piezometers and pumping tests were conducted in McKay coal and sub-McKay bedrock monitoring wells. Hydraulic conductivity (K) of the fly ash was estimated to range from 1.4 to 7 ft/day. These estimates are higher than anticipated based on previous testing and common literature values; however, saturated intervals of coarse sediments other than fly ash were logged in boreholes at each of the piezometers with high K results. Hydraulic conductivity of consolidated materials (McKay coal and sandstone bedrock) ranged from 1.4 ft/day to 9.4 ft/day. The higher K is likely the result of the connection between sandstone and unconsolidated fill. A storativity of 0.003 was calculated for the sandstone/fill interval based on an analytical solution fit to drawdown observations at a nearby observation point.

Considerable drawdown was measured and recorded in fly ash, clinker, fill, and consolidated bedrock piezometers/wells during pumping at the Underdrain Sump. The magnitude of drawdown at each well was proportional to its distance from and hydraulic connection to the Underdrain Sump or laterals. Maximum drawdown recorded in the Underdrain Sump during the test was greater than 50 feet; maximum drawdown measured at the nearest fly ash piezometer was more than 30 feet. Water levels in the Underdrain Sump and many observation wells that exhibited drawdown did not recover to pre-pumping levels. The rate and magnitude of drawdown in hydraulically connected units coupled with incomplete recovery observed after pumping was stopped indicates that water issuing to the Underdrain is from storage. This is a promising demonstration that the Underdrain could be used in conjunction with other dewatering strategies included in the approved remedy to substantially deplete free process water that is stored in the EHP subsurface. The cumulative volume of water pumped during the test from 8/3/2020 to 8/19/2020 was approximately 2.77 million gallons.

Data collected during this test will be represented in upcoming 3&4 EHP groundwater flow and contaminant transport modeling updates. Specifically, applicability of the Underdrain to operate synergistically with other recommended dewatering wells will be evaluated. Data and observations presented in this report fulfill the first stipulation of DEQ's conditional approval of the Revised Remedy Evaluation Report (Geosyntec 2019) that Talen must run a pumping test on the 3&4 EHP Underdrain.

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UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
TALEN MONTANA, LLC
COLSTRIP STEAM ELECTRIC STATION

1.0 INTRODUCTION

The Montana Department of Environmental Quality (DEQ) provided conditional approval of the Units 3&4 Effluent Holding Pond (EHP) Revised Remedy Evaluation Report for the Colstrip Steam Electric Station (CSES) (Geosyntec August 2019, DEQ February 2020) with the stipulation that Talen Montana, LLC (Talen) must address additional comments prepared by DEQ and complete conditions related to sampling, testing, and treatability studies (DEQ February 2020; DEQ May 2020). As the first condition for the approval of the Remedy Evaluation Report, DEQ indicated that Talen must run a pumping test on the 3&4 EHP Underdrain (Underdrain) to evaluate if pumping from the sump is able to fully dewater the ponds. DEQ further required that Talen provide results of the Underdrain pumping test in a written report. The Underdrain pumping test was completed in summer 2020; and results are summarized herein. However, it should be emphasized that the conditionally approved Alternative 4 for Units 3&4 EHP does not rely solely on Underdrain pumping to dewater the fly ash. Rather, pumping conducted at the Underdrain Sump is intended to assist with source dewatering by removing water from the general area above the Underdrain laterals.

The location of the Underdrain is shown on Figure 1-1. The Underdrain is primarily under C Cell, with portions below A Cell, B Cell, and the C/G Cell divider dike. Underdrain laterals range in elevation from 3,200 to about 3,170 feet above mean sea level (amsl). The bottom elevation of the western portion of J Cell, directly upstream of the Main Dam is at an elevation of about 3,150 to 3,155 feet amsl. This leaves a thickness of about 20 feet of fly ash in J/J-1 Cell area that will be drained using alternative methods described in Alternative 4 that will include horizontal and vertical wells. Other measures (which may include capping, dry disposal, etc.) described in Alternative 4 will reduce and/or eliminate recharge to the fly ash and will result in separation between the groundwater table and any saturated intervals of the EHP. With implementation of the approved remedy, drainage of pore water from the EHP fly ash will reduce to imperceptible levels and result in a separation of the water table and the base of the ash. Downward movement of water through the fly ash will be blocked by synthetic liners, caps, or both.

DEQ additionally required that samples of soils beneath the ponds must be collected to assess secondary sources of constituents of interest (COIs) that may be present below the ash (contingency 6; DEQ February 2020). Soil/bedrock sampling methods were included in the Underdrain Work Plan (Hydrometrics, Inc. 2020) and samples were collected from beneath ash at the 3&4 EHP in summer 2020. Additional soil sampling in conjunction with a separate Work Plan (Geosyntec 2020) is ongoing. Results of soil samples collected in conjunction with the Underdrain pumping test will be consolidated with the current soil sampling effort and provided to DEQ in a separate report submittal.

1.1 OBJECTIVES

The objective of the Underdrain pumping test and this report is to generate and transmit data to support incorporating the Underdrain into the full-scale implementation of the DEQ-approved remedy for the EHP, to better estimate volumes of water storage within the ash, and to evaluate groundwater quality and hydraulic characteristics directly below the EHP.

1.2 SCOPE OF WORK

The Scope of Work completed to fulfill the DEQ-requested Underdrain pumping test is summarized as follows:

- Install Observation/Monitoring Well Network – Sixteen observation wells were completed in fly ash, clinker, embankment fill, McKay coal, or sub-McKay bedrock. Several existing wells were also included in the observation/monitoring well network; and all wells were used to measure water levels before, during, and after the Underdrain was pumped to evaluate the effect of pumping stress on multiple strata.

- Groundwater Quality Sampling – Groundwater quality samples were collected and analyzed at each of the new wells in the observation/monitoring network prior to conducting the Underdrain pumping test.
- Individual Pumping Tests – Single well pumping tests were conducted on wells completed in McKay coal or sub-McKay bedrock. Slug tests were conducted on piezometers completed in fly ash.
- Underdrain Pumping – The Underdrain pumping test was conducted in three phases: 1.) Background; 2.) Pumping; and 3.) Recovery. Water level data were collected during all three phases of the test to evaluate the hydraulic response to pumping in multiple porous media found within the 3&4 EHP cutoff wall. Samples were collected of water that was pumped from the Underdrain at the beginning and end of the pumping phase of the test.
- Reporting – Methodology and results specific to individual tasks of the Scope of Work are described herein. Data collected during the test including well logs, water levels (hydrographs), groundwater quality results, Underdrain water quality results, and individual pumping/slug test results are summarized in this report. Data have also been provided to Newfields for inclusion in future numerical model updates and remedy evaluation.

2.0 OBSERVATION/MONITORING WELL NETWORK

Observation/monitoring wells used in the Underdrain pumping test were installed at the approximate locations shown on Figure 2-1. The observation/monitoring well network was used to measure water levels before, during, and after the Underdrain was pumped. Many of the observation/monitoring points are located at or near vertical capture wells planned in Alternative 4 of the DEQ-approved Remedy Evaluation (Geosyntec, 2019). The remedial function of the vertical capture well locations is to dewater the area inside the bentonite amended concrete cutoff wall (cutoff wall) that is constructed around the perimeter of the 3&4 EHP and to restrict horizontal flow of groundwater. By utilizing vertical capture wells as Underdrain observation/monitoring wells, additional information can be gathered to evaluate the remedial effectiveness of the proposed capture wells while concurrently evaluating the influence that Underdrain pumping has on lowering water levels in various strata inboard of the 3&4 EHP cutoff wall.

The lithology inboard of the Units 3&4 EHP consists of a sequence of clinker (thermally altered shallow bedrock resultant of burned Rosebud and/or McKay Coals), bedrock interburden between the Rosebud and McKay coals that is also likely to be thermally altered, McKay Coal, and various deeper strata (sub-McKay) of the Fort Union Formation. The cutoff wall extends below the depth of the burned Rosebud Coal interval around the entire perimeter. The cutoff wall extends through the McKay Coal interval on the north and east sides but its terminus is in the Rosebud-McKay interburden on the south and west sides of the EHP. The bottoms of the effluent holding cells are constructed below the base of the cutoff wall and are in contact with sub-McKay bedrock. A clay layer was installed above bedrock in the pond bottom when sandstone or coal was encountered during construction of the 3&4 EHP. Newer cells, such as J-1 Cell, B Cell, H Cell, F Cell and A Cell New Clearwell, are constructed with geomembrane liners. Bottom ash, clinker gravel, and other earthen fill materials are used to construct interior dikes that separate cells within the EHP. These fill materials replace the native lithology, often from ground surface to depths consistent with the bottom of the EHP cells.

Four different intervals were targeted in the observation/monitoring well network installed for the Underdrain pumping test: 1.) Clinker, 2.) Fly ash, 3.) Embankment Fill; and 4.) Consolidated strata beneath the 3&4 EHP consisting of McKay coal and sub-McKay bedrock. Well drilling and completion methodologies are discussed further in Section 2.1. Lithology and hydrogeological observations made at the Underdrain observation/monitoring well network are presented in Section 2.2. Logs of borehole lithology and well construction for each of the new wells were submitted to Talen and the Board of Water Well Contractors via the Montana Bureau of Mines and Geology Groundwater Information Center (GWIC). The location and elevation of each well or piezometer installed in support of the Underdrain pumping test was surveyed following installation. Survey coordinates are provided on well logs. Completion and lithology logs for the new monitoring/observation wells are included in Appendix A.

2.1 WELL COMPLETION

Wells and piezometers were installed using traditional air-rotary or hollow-stem auger methods. Drilling methodology and completion materials were dependent upon the location and target interval of each well/piezometer, described as follows.

2.1.1 Fly Ash/Bottom Ash Piezometers

As the Underdrain is constructed primarily beneath unlined C and G Cells, the design function of this drain is to dewater the ash in those cells. Piezometers completed in ash of unlined EHP cells were installed to monitor water level response to pumping the Underdrain and thereby evaluate the efficiency of the Underdrain as an ash dewatering mechanism.

Piezometers 1234FA and 1237FA were installed in C Cell; piezometers 1235FA and 1236FA were installed in G Cell; and piezometer 1233FA was installed in the vicinity of D/E Cell as shown on Figure 2-1. Piezometers were drilled and completed according to the following procedure:

- A track mounted hollow stem auger drill rig was used to advance a borehole to the base of the fly ash or to refusal. Note that samples of the fly ash were collected as the augers were advanced.

- Once total depth was reached, two-inch schedule 40 PVC casing with a lower section of 10-slot factory slotted pipe and a capped bottom was lowered into the augers. A sand filter pack (20-40 sand) was placed in the annulus around the slotted portion of the pipe and one to two feet above the slotted section.
- A bentonite well seal was placed in the annulus above the filter pack to ground surface. The augers were removed incrementally as filter sand and bentonite were added to the borehole.
- Following installation, each piezometer was developed by bailing.

<u>1233FA</u> - Piezometer 1233FA, located north of D/E Cell, was installed in a dry hole with a completed depth of 11.8 feet below ground surface. The depth of ash logged at this location was just 12 feet. Fill was encountered from 12 to 17 feet below ground surface (ft-bgs). Fill collapsed in the bottom of the open borehole; and the piezometer was completed in ash, as planned.

<u>1234FA and 1237FA</u> - Piezometers 1234FA and 1237FA, located in C Cell, were advanced to total depths of 115.5 ft-bgs and 94 ft-bgs, respectively. The 1234FA borehole extended through the bottom of the ash at 110 ft-bgs to underlying fill at 115 ft-bgs; while the auger rig hit refusal in the ash at the 1237FA borehole. Both piezometers were completed in saturated fly ash. Static water levels at 1234FA and 1237FA were 58.93 and 50.24 feet below the top of the PVC well casing, respectively. Assuming a total ash thickness of 110 feet, there is approximately 55 to 60 feet of saturated ash in C Cell.

<u>1235FA and 1236FA</u> - Piezometers 1235FA and 1236FA, located in G Cell, were advanced to total depths of 34.5 ft-bgs and 28 ft-bgs, respectively. Drilling at both boreholes hit refusal before penetrating through the fly ash; however, saturated conditions were encountered at both locations and piezometers were completed. The depth to water was much shallower in the G Cell piezometers (approximately 4 to 10 feet below top of casing) than in the C Cell piezometers because the ash surface elevation is approximately 40 feet lower in G Cell.

2.1.2 Fill Wells

Internal dikes within the 3&4 EHP Bottom were primarily constructed with bottom ash from the Colstrip SES but may also contain clinker gravel, sand and gravel road mix, and other structural earthen fill. Bottom ash at the facility is well graded from granular to small sand size fragments making it relatively permeable. Water levels in the interior EHP embankments are dependent on the water levels in adjacent materials, which could include saturated fly ash of unlined cells. Water level responses observed in embankment fill during Underdrain pumping were intended to provide an indication of Underdrain hydraulic connection and hence dewatering capabilities. Two fill wells were planned but three fill wells were ultimately completed (1243F, 1244F, and 1246F) during installation of the Underdrain pumping test observation/monitoring well network.

- Boreholes drilled for the installation of fill observation wells were advanced to the base of the fill, as determined either by drilling through the fill to the underlying bedrock contact or interpreting the approximate basal depth from previous nearby boreholes.
- Steel casing was advanced through the fill, as necessary, to maintain circulation and keep the borehole from collapsing. If steel casing was advanced to the base of the fill, it was pulled back to expose well perforations during completion.
- Fill wells were completed with ten to 15 feet of 4-inch U-pack PVC screen with 20-slot factory perforations. The U-pack screen consists of concentric 4” x 6” perforated pipes, sealed at each end with dual-threaded caps. Filter sand (10-20 mesh) was packed and sealed between the concentric screens and placed in the annulus between the outer screen and the borehole. A transition to 4-1/2” PVC casing was glued to the U-pack screen and extended to above ground surface. Bentonite chips were used to seal the annular space above the sand filter pack interval.
- Fill wells were developed by circulating rig air through the screen interval.

<u>1243F</u> - Well 1243F was drilled in the dike between the current J-1 Cell and G Cell (Figure 2-1). However, the location of this well was formerly in the middle of the now closed North G Cell. Embankment fill was encountered in the 1243F borehole from 0 to

50 ft-bgs but was underlain by ash left in place when North G Cell was closed to a total depth of 84 ft-bgs. The well was completed as previously described with a U-pack screen in the bottom of the ash from 74 to 84 ft-bgs.

1244F – Well 1244F was initially slated to be completed in clinker south of J-1 Cell (Figure 2-1); however, upon advancing the borehole it was discovered that the native clinker body had been removed from this location and replaced with a mixture of clinker gravel and bottom ash fill to a depth of 83 ft-bgs. Siltstone bedrock is present below the fill. A U-pack screen interval was placed in the bottom 10 feet of the ash/gravel fill interval to complete well 1244F.

1246F - Well 1246F is located 200 feet east/northeast of the 3&4 EHP Underdrain Sump and is the nearest of all of the fill wells to the sump. Bottom ash fill is present at this location to 84 ft-bgs, where clinker gravel is present to a depth of 99 ft-bgs. The well is completed primarily in the clinker gravel fill but there is a direct vertical hydraulic connection between the gravel and bottom ash fill intervals. This well is paired with well 1245D, which is further discussed in Section 2.1.4.

2.1.3 Clinker Wells

Clinker is present in many portions of the 3&4 EHP. Water level monitoring inboard of the cutoff wall has shown that there is often a direct lateral hydraulic connection between clinker and water levels in unlined cells within the 3&4 EHP, particularly if clinker crops out or sub-crops in the fly ash.

Three (3) clinker wells (1242C, 1247C, and 1248C) were installed inboard of the cutoff wall and used to monitor water levels during the Underdrain pumping test. Clinker wells were constructed such that they could be used not only as observation wells during the Underdrain pumping test but also as potential dewatering points, if necessary. As such, boreholes for clinker wells 1242C, 1247C, and 1248C were advanced beyond the thermal alteration into competent bedrock underlying the clinker. By completing these wells below the clinker/bedrock contact, submersible pumps could later be installed with their intake at or below the entire saturated clinker interval, thereby increasing the capacity for groundwater capture at individual wells.

Clinker wells were constructed using 8-inch diameter steel casing and 7-inch stainless steel screen, as follows:

- Steel casing (8-inch) was advanced to the total targeted depth at or below the clinker.
- Stainless steel well screen (7-inch diameter, 50-slot) was lowered or pushed to the base of the steel casing.
- A K-packer, a tool comprised of metal and vulcanized neoprene rubber, was installed on the top of the well screen to provide a tight seal between the outside of the 7-inch stainless steel screen section and inside of the solid 8-inch well casing.
- The 8-inch steel casing was then pulled or "bumped" back to expose the perforated interval.

Upon completion, clinker wells were developed with rig-air to circulate water from the well. Development was conducted until fine particles in the purge water were reduced to a point that the well could be pumped without risk to the pump. Well yield was estimated during development based on observations of the amount of water issuing to ground surface as rig air was circulated through each well.

<u>1242C</u> – Clinker was present to a depth of 57 ft-bgs and this well was completed below the clinker/bedrock contact to a depth of 61 ft-bgs. Estimated yield, based on the amount of water issuing to ground surface during air lift was 1 to 2 gpm. This is a particularly low yield estimate for a clinker well; however, air lift yield estimates may be artificially low in clinker because air and water may not circulate from the casing but rather flow through the highly permeable stratum.

<u>1247C</u> – Clinker was present to a depth of 64 ft-bgs; but well 1247C was over-drilled to a depth of 72 ft-bgs. Prior to well completion, the bottom 5.5' of the borehole was plugged with bentonite chips. Well 1247C was completed 1.5' below the clinker/bedrock contact at a depth of 66.5 ft-bgs. Similar to well 1242C, estimated well yield at 1247C was 2 gpm.

1248C – Well 1248C was drilled and completed at a total depth of 58 ft-bgs. Clinker was present to 55 ft-bgs. Yield estimated during development at well 1248C was 5 gpm.

2.1.4 McKay Coal and sub-McKay Bedrock Wells

Wells completed in consolidated sediments beneath the EHP were used to measure and identify changes in water levels during the pumping test in formations with potential lateral or vertical connections to the Underdrain. The lowest elevation of the base of the McKay Coal in the vicinity of the 3&4 EHP Underdrain laterals is about 3,200 feet amsl. Drawdown may be induced in the McKay Coal since the bottom of the Underdrain sump is at an elevation of about 3,164 feet amsl. Sub-McKay strata underlies the coal and could also be affected by Underdrain pumping.

Wells installed in the consolidated sediments were installed on embankments that divide EHP Cells. In some cases, these wells were paired with shallower wells and were drilled prior to the shallower wells so that lithology could be identified and used to inform shallower well completion intervals. Wells installed in McKay coal are typically assigned an "M" suffix; while wells installed in sub-McKay bedrock are assigned a "D" suffix. Wells 1238D, 1239M, 1240D, 1241D, and 1245D are shown in Figure 2-1. McKay and sub-McKay wells were drilled and constructed according to the following procedures.

- Drill and drive air-rotary techniques were used to advance 8-inch diameter steel casing through shallow materials (i.e. clinker or fill). The casing, which is intended to hold back sloughing and promote circulation during drilling, was advanced into the bedrock to refusal.
- Drilling by air rotary methods proceeded through and below the steel casing to the targeted coal or bedrock interval.
- Once at total depth, the steel casing was left in place to fortify the long-term well seal. McKay and bedrock wells were completed with 4.5-inch diameter bell end PVC casing with factory slotted (25-slot) screen placed through the completion interval.
- Silica sand (10-20 mesh) was placed in the annulus and above the top of the slotted section. The amount of sand placed above the slotted section was equivalent to 10%

of the total slotted section length (1 foot above the screen for every 10 feet of slots) or a minimum of two feet if the screen was less than 20 feet in length.

- Bentonite was placed in the annulus above the sand pack to ground surface. The bentonite was hydrated with clean water obtained from the contract driller's well completed in the Fox Hills Formation, a raw water source from the Plant site (Yellowstone River water), or the City of Colstrip water distribution system.
- McKay and sub-McKay wells were developed either by bailing or with rig-air to circulate water from the well. Development continued until fine particle sizes in the purge water were reduced to a point that pumping could be conducted without risk to the pump. Well yield was estimated during development.

<u>1239M</u> - Well 1239M was the lone well completed in McKay coal for use in the Underdrain pumping test. A full section of the McKay coal was encountered in the borehole from 76.5 to 85.5 ft-bgs. Sand filter pack was installed from 75 to 87 ft-bgs; and the well was screened from 77 to 87 ft-bgs. The basal elevation of the McKay coal is approximately 3206 ft-amsl at well 1239M. The open borehole at well 1239M produced upwards of 100 gpm from clinker above the McKay coal. Yield from the completed well was estimated to be three to four gpm.

<u>1238D</u> – Well 1238D was paired with well 1239M on the dike between 3&4 EHP D/E Cell and C Cell. The first water-bearing bedrock beneath the McKay coal is a sandstone interval from 131 to 142 ft-bgs. Well screen was installed at 1238D from 130 to 150 ft-bgs; and filter sand was installed from 125 to 150 ft-bgs. During development of the completed well, it was apparent that water from the upper open borehole (clinker and McKay intervals) had cascaded into the bedrock interval before the bentonite seal was in place. Field SC of water ejected from the hole decreased from 18,250 μmhos/cm to 5,226 μmhos/cm during development.

<u>1240D</u> – Bedrock well 1240D is paired with fill well 1243F in the dike between G Cell and J-1 Cell. Well 1240D was advanced beyond fill and ash found in the upper borehole and completed in water-bearing sandstone/siltstone from 120 to 146 ft-bgs.

1241D – Well 1241D is located northwest of the Underdrain sump and west of J-1 Cell. The McKay coal was not encountered in borehole 1241D although bedrock strata was logged above and below the depth at which the seam was expected. A relatively thick sandstone interval, as compared to the thickness of water-bearing sandstones on the east side of the EHP, was encountered in the borehole from 90 – 135 ft-bgs. Yield from the completed well was estimated to be 10 gpm during development; and field SC of groundwater in 1241D was 26,140 μmhos/cm at the conclusion of air lift development.

1245D – This well is paired with previously discussed fill well 1246F and is located 200 feet northeast of the Underdrain sump. Five feet of sandstone is bedded directly beneath fill; and it is possible that the upper portions of the sandstone interval may have been removed during excavation of the EHP and replaced with fill during later construction of the J-1/C Cell dike. Regardless, there is a direct vertical hydraulic connection between fill and the sandstone bedrock. Well 1245D was screened from 135 to 150 ft-bgs. Estimated well yield was 20 gpm and field SC was 24,000 μmhos/cm at the end of development. Note that well 1245D was completed in the second of two boreholes drilled at this location. Steel was inadvertently advanced into the targeted completion interval and could not be extracted from the first borehole (PH-2007-1245D). As such, PH-2007-1245D was plugged and abandoned with the steel in place. However, before PH-2007-1245D was plugged, it was used as an observation point during the pumping test at well 1245D. (See Section 4.2.)

2.2 LITHOLOGY AND HYDROGEOLOGIC OBSERVATIONS

With some exceptions related to the amount and location of fill materials, and the absence of McKay coal at well 1241D, lithology recorded during drilling of the Underdrain test observation/monitoring well network was consistent with the working understanding of the sub-surface environment of the 3&4 EHP described briefly at the beginning of Section 2.0. However, additional wells inboard of the EHP fill in details related to stratigraphic relationships between various water-bearing intervals and provide information related to potential connectivity between these strata, the Underdrain, and effluent holding cells.

2.2.1 Cross Sections

An east/west trending cross section of 3&4 EHP subsurface lithology from ground surface to sub-McKay bedrock (Cross Section A-A') is shown in Figure 2-2. The cross section illustrates the lateral connection between remaining clinker, shallow fill, and fly ash, where present. Deeper dike fill is present to bedrock at the southwest corner of J/J-1 Cell and directly north of the Underdrain Sump. Rosebud clinker and the McKay coal were removed during EHP construction and replaced with this fill. McKay coal was not encountered in borehole 1241D although consolidated strata had not been replaced by fill at this location. Carbonaceous shale and a thin coal stringer are present near the anticipated McKay depth, suggesting that a local topographical high may have been present at this location during deposition. The lack of a continuous coal seam may have a localized effect on groundwater flow in this relatively small area of the EHP, but would not affect the overall groundwater flow regime.

A south/north trending cross section of 3&4 EHP subsurface lithology from ground surface to sub-McKay bedrock (Cross Section B-B') is shown in Figure 2-3. Lateral continuity between ash stored in C and J/J-1 Cells and shallow unconfined fill and clinker is apparent in this cross section.

2.2.2 Potentiometric Surface Maps

Potentiometric maps constructed using water level data collected prior to the pumping test for the shallow interval (ash, fill, and clinker), McKay coal, and sub-McKay bedrock are presented in Figures 2-4, 2-5, and 2-6, respectively.

The shallow interval is highly constrained by the cutoff wall; so most free water in the sub-surface is stored inboard of the wall in the most permeable unit of the interval (i.e. clinker). The potentiometric high is found in the southwest corner of C Cell, likely because C cell was the most recent unlined Cell to actively manage fly ash and because of ongoing forced evaporation activities which at times result in standing water. Subsurface flow in the clinker proceeds to the east and west from an apparent divide at well 1247C before travelling north along either side of the EHP. Fly ash has been removed from G Cell, lowering the elevation of the ground surface along the east side of EHP. As such, water issues from the clinker to the low point in G Cell; a small area of ponded water can be seen in G Cell in Figure 2-4. Water contributing to the aforementioned shallow flow pattern inside the cutoff wall is sourced from EHP operations and recharge from direct precipitation. As illustrated on the potentiometric map, water levels in the clinker are 10 feet or more higher in elevation than those measured in the new fly ash piezometers. Flow in the fly ash is northward towards J/J-1 Cell. It is likely the water levels in the fly ash continue to increase south of 1237FA and receive recharge in the same general portion of C Cell that was identified for the clinker.

Only one additional McKay well was installed inboard of the cutoff wall for the Underdrain pumping test. However, several wells are present directly outboard of the EHP in an area where groundwater flow is not obstructed by the cutoff wall. The McKay coal potentiometric surface (Figure 2-5) shows that groundwater in the interval flows from a high located near the southwest corner of C Cell (apparent at well 1239M).

The potentiometric surface in the sub-McKay interval (Figure 2-6) is highest where there is a vertical connection to the shallow ash interval; this occurs at well 1245D. Flow from the EHP could proceed in any direction where a gradient is present because the cutoff wall does not extend to the sub-McKay bedrock. The gradient in sub-McKay bedrock is steepest to the north of the EHP.

3.0 WATER QUALITY

Free water in fly ash piezometers and groundwater samples were collected at all of the wells installed for the Underdrain pumping test. Samples were collected using procedures outlined in Talen's Water Resources Monitoring Plan (Talen 2015) and submitted to Energy Laboratories of Billings, Montana for analysis of the parameters listed in Table 3-1. Results are discussed by hydrostratigraphic interval in the following sections.

3.1 FLY ASH PIEZOMETERS

Four of the five fly ash piezometers contained sufficient free water for sample collection and analysis. Well 1233FA was dry when it was completed, at the time it was visited for sample collection, and throughout the Underdrain pumping test. Analytical results of water samples collected from fly ash piezometers 1234FA, 1235FA, 1236FA, and 1237FA are found in Table 3-2.

Water collected from fly ash piezometers 1234FA, 1235FA, and 1236FA is characterized by a high level of total dissolved solids (TDS), consistent with that typical of free water found in the EHP. TDS at these wells ranged from 34,500 mg/L at 1235FA to 55,300 mg/L at 1234FA. Concentrations of boron at 1234FA, 1235FA, and 1236FA ranged from 113 mg/L to 207 mg/L; while, sulfate concentrations ranged from 20,900 mg/L to 33,600 mg/L. Water quality at piezometer 1237FA differed from that of the other fly ash piezometers. TDS in 1237FA was reported at 6,680 mg/L; while boron and sulfate concentrations were 26 mg/L and 5,230 mg/L, respectively.

3.2 CLINKER AND EMBANKMENT FILL WELLS

Water quality analytical results for clinker and fill wells are provided in Table 3-3. Water quality in clinker and fill within the 3&4 EHP was moderately variable but generally indicative of a hydraulic connection with a source of process water. TDS concentrations ranging from 13,800 mg/L at 1243F to 45,400 mg/L at 1247C were reported for clinker and fill wells. Boron concentrations ranged from 21.5 mg/L to 152 mg/L; and sulfate concentrations varied from 8,780 mg/L to 28,900 mg/L in fill and clinker wells.

3.3 MCKAY AND SUB-MCKAY WELLS

Results of groundwater samples collected at wells completed in McKay Coal or sub-McKay bedrock underlying the EHP are presented in Table 3-4. Of the four sub-McKay monitoring wells, 1238D has the lowest concentrations of boron (3.3 mg/L) and sulfate (3,270 mg/L). Boron concentrations reported in the other bedrock wells ranged from 91.9 mg/L to 142 mg/L; while, sulfate concentrations in the remaining bedrock wells were reported in the range of 15,100 mg/L to 25,900 mg/L. As previously discussed, bedrock wells 1240D, 1241D, and 1245D have a stronger vertical hydraulic connection to EHP process water than does 1238D. There is nearly 60 feet of siltstone or shale bedrock between the reservoir of impacted water in the clinker and the sandstone formation of completion at well 1238D. Based on field SC recorded during well installation, impacted water from shallower horizons (i.e. clinker) was observed to have reached the 1238D bedrock before the annular seal was in place. The groundwater sample at 1238D was collected after much purging and development to alleviate impacts of temporary co-mingling. However, it is possible that some impacted water remained in the well at the time of the sample and concentrations of groundwater constituents may yet stabilize in successive sampling events.

Well 1239M, the lone McKay coal well completed in the Underdrain observation/monitoring network, had mixed results with regard to concentrations of groundwater constituents. TDS and sulfate concentrations were reported as 24,300 mg/L and 16,300 mg/L, respectively. However, the boron concentration at well 1239M was 1.8 mg/L. It is possible that boron in groundwater at 1239M is low, relative to concentrations in shallower units (clinker or fill) or the bedrock, because it (the boron) is sorbed to the coal.

4.0 INDIVIDUAL WELL TESTS

As specified in the Work Plan (Hydrometrics, Inc. 2020), new observation/monitoring wells completed in McKay coal and sub-McKay bedrock were subject to aquifer testing to estimate hydraulic properties of these water-bearing intervals. Although hydraulic testing at fly ash piezometers was not identified in the Work Plan, slug tests were conducted on the piezometers with saturated fly ash. Testing methodology and results are as follows.

4.1 FIELD AND ANALYTICAL METHODS

Preliminary yield estimates made during drilling and development at McKay (1239M) and sub-McKay wells (1238D, 1241D, and 1245D) were all greater than one gpm; thus, pumping tests were identified as the preferred testing option for these wells. Slug tests, rather than pumping tests, were performed and analyzed at piezometers 1234FA, 1235FA, 1236FA, and 1237FA, primarily due to the smaller diameter (2”) well casing.

Pumping tests were conducted using methods consistent with those previously employed at the facility. Drawdown was induced at each test well using a portable submersible pump. Test pumping rates were selected based on apparent well yield and ranged from 1.5 gpm at well 1240D to 14 gpm at well 1241D (Table 4-1). Tests were typically of a 100-minute pumping period followed by a recovery phase of approximately the same duration. Drawdown and recovery water level observations were measured and recorded in the pumping well using a pressure transducer and data-logger. All pumping tests were conducted using a single pumping well, except for the test conducted at well 1245D. Water level observations were made from the open but cased borehole PH-2007-01 during the 1245D pumping test.

Slug tests were conducted by displacing water from the well casing using a short section of weighted PVC pipe tethered to the surface casing by a nylon rope. First, the PVC slug was lowered into the water column to induce a rapid artificial increase in water level. Initial displacement and falling water levels were measured and recorded with a pressure transducer and data logger. Secondly, the slug was retracted and initial displacement and rising water levels were recorded using the transducer and data logger.

Pumping and slug test data were entered into Aqtesolv® software for analysis. Contemporary analytical solutions by Theis (1935) and Cooper-Jacob (1946) were applied to pumping test drawdown and recovery data. The Bouwer-Rice (1976) analytical solution, appropriate for estimating hydraulic conductivity from slug testing data, was applied to observations recorded during rising and falling head tests at the fly ash piezometers.

4.2 RESULTS

The final pumping and slug test analytical solutions are provided in Appendix B. Results of the tests are summarized in Table 4-1. Results of individual tests will be used in conjunction with Underdrain pumping test results in future updates of the numerical fate and transport model of the EHP area.

Hydraulic conductivity (K) of the fly ash was estimated to range from 1.4 to 7 ft/day. These numbers are higher than anticipated based on previous testing and common literature values; however, saturated intervals of coarse sediments other than fly ash were logged in boreholes at each of the piezometers except for 1237FA (piezometer 1237FA had the lowest estimated K). Clinker gravel was present just above the screened intervals in both 1235FA and 1236FA. A similar thin clinker gravel layer was present at the bottom of the borehole in 1234FA.

Hydraulic conductivity of consolidated materials (McKay coal and sandstone bedrock) ranged from 1.4 ft/day at well 1240D to 9.4 ft/day at well 1245D. The higher K at 1245D is likely the result of the connection between sandstone and unconsolidated fill. A storativity of 0.003 was calculated based on an analytical solution fit to drawdown observations recorded at open borehole PH-2007-1245D during the 1245D pumping test.

5.0 UNDERDRAIN PUMPING TEST

The Underdrain pumping test was conducted after all of the monitoring points were installed, developed, tested, and sampled. The Underdrain pumping test was conducted in three phases as described herein. All capture wells of the 3&4 EHP area, including those operating within or in proximity to the cutoff wall were operational during all three phases of the Underdrain pumping test. Similarly, all processes routinely conducted at the 3&4 EHP, such as forced evaporation, were active during all phases of the test.

5.1 PHASE I – BACKGROUND

5.1.1 Phase I Methods

The Underdrain sump, the newly installed observation/monitoring well network, and select existing wells inside of the 3&4 EHP were instrumented with In Situ brand electronic pressure transducers and data loggers. A transducer was also installed in surface water in the southwest corner of C Cell. Transducers installed in wells, piezometers, and C Cell were used to measure and record antecedent water levels at 15 minute intervals for at least one week prior to the Underdrain pumping test. All transducers used during the Underdrain pumping test were of the vented type and were deployed using the appropriate vented communication cable. The use of vented instruments during the test precluded the need for barometric correction of automated measurements at the time of data analysis. Manual water level measurements were collected at each of the instrumented wells or piezometers during the background monitoring period. Select existing wells within and near the perimeter of the 3&4 EHP were also monitored manually for water level observations. Background data were used to establish normal water level fluctuations and identify variations in water levels that may be linked to site operations. All sites monitored during the test and the type of monitoring at each site are shown in Figure 5-1.

An instrument capable of measuring and recording specific conductance (SC) was installed in the Underdrain Sump; and was programmed to record SC observations at a rate of once per hour. The instruments deployed in new well 1239M, piezometer 1234FA, and existing well 674R also had the capability of measuring SC. SC readings were recorded manually from those instruments at frequent intervals as automated data were downloaded.

Prior to installing transducers in observation wells and the Underdrain sump, the existing pump in the Underdrain Sump was tested and found to be operational. The pump in the Underdrain Sump is a 15 horsepower, 475 gpm rated capacity (88 feet of head), Grundfos pump with all AISI 304 stainless steel construction (model # 475S150-2-B). A flow control valve, installed at the top of the Underdrain Sump was also inspected and found to be functional. A pipeline constructed of 6-inch SDR-17 HDPE performance pipe was constructed from the Underdrain Sump to 3&4 EHP H Cell to convey and contain water produced during the test. A Rosemount magnetic flow meter/totalizer with a digital readout was installed adjacent to H Cell at the discharge end of the pipeline to measure and record instantaneous flow observations and cumulative flow volumes. The pipeline layout and instrumentation at the Underdrain Sump and discharge ends are shown in Figure 5-2.

Precipitation (rainfall) was tracked throughout the test to evaluate its potential influence on water levels in observation wells/piezometers. Daily rainfall data were acquired for the period from June 1 to September 18 from the Colstrip, MT Climate Station via the National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) website: https://www.weather.gov/byz/display_f6?city=COLM8&month=06&year=2020.

5.1.2 Phase I Observations

All instruments were deployed and began recording background water level and SC observations between 6/24/20 and 7/28/20. Timing of instrument installation at each site was largely a function of well completion date, instrument availability, and site access in relation to ongoing EHP operations (e.g. forced evaporation or heavy equipment operation). Background data were collected until the pump was started on 8/3/20.

5.1.2.1 <u>Underdrain Sump</u>

In general, background water levels in the Underdrain Sump ranged in elevation between approximately 3229.6 and 3229.75 ft-amsl, which equates to a depth to water below the top of the underdrain sump of 68.05 to 67.9 feet and suggests a minimal amount of fluctuation (+/- 0.15 feet) in the week leading up to the pumping phase of the test. However, an abrupt and temporary anomaly resulting in a water level decline of more than 1.5 feet occurred on 7/29/20. The water level recovered within an hour; so it is likely that the temporary fluctuation was the result of contractors working on or around the discharge and/or drop pipe during the background observation period. Background observations at the Underdrain are included on a hydrograph of water level elevations recorded during all phases of the test in Appendix C.

5.1.2.2 C Cell

The presence of standing water in C Cell is cyclical and is related to operation of a series of evaporators positioned along the west and south sides of the cell. Drift from the evaporators settles in the southwest corner of the pond during operation but later evaporates or is pumped to the lined F Cell. Oscillating water levels observed in C Cell during the background phase of data collection are found in Appendix C.

5.1.2.3 Wells/Piezometers

Similar to water levels observed in the Underdrain Sump, minor fluctuation in background water levels was apparent in observation/monitoring wells and piezometers. In general, background water levels fluctuated less than 0.2 feet up or down. Wells 1239M and 1247C were notable exceptions; whereby, background water levels fluctuated by approximately 0.4 feet and 1.5 feet, respectively. Well 1247C is located very near the evaporators and the area of standing water that accumulates in C Cell. A hydraulic connection between the permeable clinker and nearby free water in C Cell, direct recharge from evaporator operation, or both likely produce the variable water levels in well 1247C. In turn, a weaker hydraulic connection between the clinker and McKay coal also transmits recharge from the evaporators that produces water level fluctuations in McKay wells such as 1239M. Hydrographs of water level elevations recorded at the observation/monitoring well network during all phases of the test are found in Appendix C.

In general, clinker wells exhibit the highest water level elevations of all wells completed in the footprint of the EHP. Water levels in clinker are attributable to the clinker's proximity to ground surface and the high permeability of the thermally altered sediments that readily accept precipitation recharge. Static water level elevations in clinker wells ranged from about 3243 feet-amsl at well 1242C to 3262 feet-amsl at well 1247C, all of which are above the bottom elevation of the Underdrain Sump and could thus be expected to drain to the sump if a hydraulic connection exists and a gradient is induced by pumping. Water level observations in clinker wells 1003R and 1248C did not oscillate but trended increasingly during the background phase of the test. Progressive water level increases of 0.23 and 0.2 feet were observed at wells 1003R and 1248C, respectively, prior to starting the pump.

Water level elevations in fly ash piezometers and fill wells were most similar in elevation to the water level in the Underdrain Sump. Fill and fly ash water level elevations ranged from approximately 3228 feet-amsl (at 1246F) to almost 3237 feet-amsl (at 1237FA), as compared to the Underdrain Sump static water level elevation of just under 3230 feet-amsl. Fill wells and fly ash piezometers are thought to have a direct lateral hydraulic connection to each other and to the Underdrain.

With the exception of well 1239M, water level elevations at wells completed in consolidated sediments beneath the EHP are lower than those in fly ash or the Underdrain Sump. Background water level elevations in bedrock wells 1238D, 1240D, and 1241D were all approximately 3204 feet-amsl. The background water level elevation at well 1245D was between 3213 and 3214 feet-amsl; the relatively higher water level elevation at 1245D is attributable to the lack of separation between fill and consolidated bedrock at the well location. Background water level elevations at well 1239M were typically between 3256 and 3257 feet-amsl.

5.1.2.4 <u>Precipitation</u>

Rainfall in the week prior to starting the pump in the Underdrain Sump was limited to just 0.04 inches. However, greater than three inches of rain were recorded in Colstrip during the months of June (1.91 inches) and July (1.15 inches). Daily rainfall is shown in relation to water level elevation observations made throughout the Underdrain pumping test in Figure 5-3. Given minimal fluctuation and no consistent rising or falling site-wide trend in background water level elevations, it seems that precipitation in the months leading up to the test did not have any undue influence on test results.

5.2 PHASE II – PUMPING

5.2.1 Pumping Rates and Volume

The pump in the Underdrain Sump was started on 8/3/20 and operated at maximum capacity without any valve restriction of flow. The flow rate recorded at the end of the Underdrain discharge pipeline varied initially (for two days) between 121 gpm and 127 gpm. On 8/5/20, the power supply to the test pump was turned off temporarily and without notice by contractors working on an unrelated project at the 3&4 EHP. The power interruption was observed and documented during routine Underdrain test monitoring; and power to the pump was restored as quickly as possible. When pumping resumed, instantaneous discharge rates as high as 165 gpm were observed; however, pumping rates quickly fell to within the previous range (~125 gpm). The pumping rate gradually declined without adjustment to a rate of 103 gpm on 8/17/20, at which time another temporary power outage occurred. The second outage, the cause of which is unknown, was of shorter duration than the first outage; and the power supply was restored without action. Pumping continued at rates slightly greater than 100 gpm until 8/19/2020 until the pump was turned off to start the recovery phase (Phase III) of the test.

A hydrograph of recorded pumping rates and cumulative discharge volume is shown in Figure 5-4. Instantaneous pumping rates, described previously, ranging from a maximum of 165 gpm to a minimum of 103 gpm are shown on the plot. The cumulative volume of water pumped during the test from 8/3/2020 to 8/19/2020 was approximately 2.77 million gallons. As described, all water pumped from the Underdrain Sump during the test was routed to the double-lined H Cell.

As described in the sections to follow, stress induced by the pump was sufficient to induce drawdown and evaluate the Underdrain's potential to dewater ash and other sediments inside the EHP. However, analysis of pumping rates in relation to total dynamic head (TDH) of the system during the test suggests that the pump is not operating according to the manufacturer's performance curve. When head loss at all pipe, valves, fittings, flow meters and the differential elevation between the pumping level and discharge are considered, a fully functioning pump of model # 475S150-2-B would be expected to achieve a pumping rate of approximately 200 gpm.

5.2.2 Pumping Test Observations

As indicated for Phase I, two instruments were installed in the Underdrain Sump to measure pressures (water level), SC, and temperature. Measurements of pH were taken at the discharge end of the pipeline and recorded throughout the pumping phase of the test. Pressures at the Underdrain Sump were measured and recorded on a logarithmic scale at the beginning of the pumping test. By employing logarithmic logging, very frequent water level observations were automatically recorded at the beginning of the test; but the frequency of the observations declines logarithmically with time. Linear pressure measurements, at a regular interval of 15 minutes, ensued after the recording frequency extended to 15 minutes.

Pressure transducers installed in the observation/monitoring well network were programmed to record on a linear scale at 15 minute intervals during the pumping test. Manual water level measurements were collected periodically to check the accuracy of the electronic data and to provide a data record in the event of instrument failure.

Water level observations in the Underdrain and observation/monitoring wells were evaluated after one week of pumping. Pronounced water level drawdown was observed at the Underdrain Sump and in a number of the observation wells after one week; but the potential for additional drawdown was apparent at the Underdrain Sump. As such, pumping (as described previously in Section 5.2.1) and water level responses to pumping continued for a second week. Water level elevation hydrographs including data recorded at the Underdrain Sump and observation/monitoring well network during pumping (8/3/20 to 8/19/20) are found in Appendix C. As shown in Figure 5-3, very little precipitation fell in Colstrip during the pumping phase of the test. A total of 0.22 inches of rain fell in two separate days

(0.07 inches on 8/4/20 and 0.15 inches on 8/14/20) while pumping ensued; and no changes in water levels in the Underdrain Sump or the wells were observed in correlation with rainfall.

5.2.2.1 <u>Drawdown in Underdrain Sump</u>

An immediate water level drawdown response was observed in the Underdrain Sump when the pump was started and progressive drawdown continued throughout the 16 day pumping period. Drawdown observations in the Underdrain Sump are plotted in Appendix D-1. Within 10 minutes of pumping drawdown reached approximately 38 feet. A minor inflection in drawdown observations occurred when water flowing in the pipe reached the flow meter near the discharge end at H Cell. Except for the two previously described power outages, drawdown continued more uniformly for the duration of the test. Note that the drawdown observations appear nearly linear when plotted on a semi-log scale (Appendix D-1). This suggests that there is limited or no recharge to the saturated sediments (predominately ash) that are hydraulically connected to the Underdrain laterals. If there were a consistent source of inflow to the Underdrain, the drawdown observations would present as a curve that trends asymptotically with time, assuming a constant pumping rate. Drawdown recorded during pumping at the Underdrain Sump appears to be from storage – a promising indicator of the system's ability to dewater the ash.

Maximum drawdown in excess of 55 feet was reached shortly before the second power outage on 8/17/20. There were approximately 13.6 feet of water remaining in the sump at the drawdown apex, suggesting that greater stress could be put on the Underdrain system with a higher pumping rate and that a longer pumping duration would be necessary to depress the water level in the Underdrain Sump to total depth. However, as discussed in the following sections, the test duration and pumping rate were sufficient to characterize drawdown and hydraulic connectivity between hydrostratigraphic intervals beneath the EHP.

5.2.2.2 <u>Drawdown in Fly Ash Piezometers</u>

Early in the pumping phase of the test it was apparent that a hydraulic connection exists between the saturated fly ash and the Underdrain dewatering system. Some level of drawdown was observed at each of the four fly ash piezometers within the first day of pumping, the magnitude of which was relative to the proximity to Underdrain laterals or the Underdrain Sump. Water level drawdown plots for fly ash piezometers 1234FA, 1235FA, 1236FA, and 1237FA are presented in Appendices D-2 through D-5.

Drawdown at 1234FA followed drawdown in the Underdrain Sump with minimal lag time. More than 18 feet of drawdown were recorded at 1234FA in the first 15 minutes after pumping began. Maximum drawdown of 30.8 feet was recorded at 1234FA on 8/17 just prior to the second power interruption. Recordable drawdown was first observed at 1237FA approximately 80 minutes into the pumping phase of the test; and only 0.1 feet of drawdown were observed after 100 minutes of pumping. Lag time and muted drawdown response at 1237FA, as compared to 1234FA, are a function of the greater distance from the pumping stress (the Underdrain Sump) or the nearest drainage lateral to the piezometer. Although less drawdown was ultimately observed at 1237FA than at 1234FA, 3.35 feet of drawdown were recorded at 1237FA after one full day of pumping and more than 8 feet of drawdown were recorded at the end of the pumping phase. The overall level of drawdown observed after slightly more than two weeks of pumping at 1234FA and 1237FA suggests that Underdrain pumping is effective at dewatering C Cell.

As indicated previously, drawdown was also observed in fly ash piezometers completed in G Cell (i.e. 1235FA and 1236FA); however, the magnitude of drawdown was much lower than that observed in the C Cell piezometers. A maximum of 0.53 feet of drawdown were observed at 1235FA; and a maximum of 0.46 feet of drawdown were observed at 1236FA. Similar to water levels observed during background, water levels at 1235FA and 1236FA fluctuated erratically during the pumping phase of the test. It is possible that dewatering operations from the area of ponded water in G Cell influenced water levels in fly ash piezometers.

5.2.2.3 <u>Drawdown in Clinker</u>

Of the six clinker wells observed during the test, drawdown was only recorded at well 1242C, which is located near (~450 feet from) one of two laterals that extend west from the Underdrain Sump. Drawdown recorded at 1242C is plotted in Appendix D-6. Consistent recordable drawdown did not occur at 1242C until more than one day after pumping started; but the rate and overall magnitude of drawdown increased progressively throughout pumping. For example, approximately 0.15 feet of drawdown were observed after the first 10,000 minutes of pumping but 0.37 feet of drawdown were recorded after 20,000 minutes of pumping. Delayed drawdown persisted at well 1242C after the pump was shut off. Approximately 0.65 feet of drawdown were recorded at 1242C during the recovery phase of the Underdrain test. Delayed responses are common in unconfined anisotropic conditions, such as those found in clinker well 1242C that are laterally connected to various other hydrogeologic strata (i.e. fill and ash).

Water levels in clinker wells 1248C and 1003R, which had exhibited a general increasing trend throughout the background phase of the test, continued to increase during pumping. At the end of the pumping period it was clear that water in clinker in the southwest corner of the EHP was not immediately influenced by short term pumping stress.

5.2.2.4 Drawdown in Fill Wells

Drawdown recorded in fill wells 1243F, 1244F, and 1246F is shown in Appendices D-7, D-8, and D-9, respectively. Well 1243F had a very erratic water level throughout the Underdrain test but approximately 0.5 feet of drawdown were recorded during the pumping test. Moderately more drawdown was observed at well 1244F, owing to its closer proximity to the Underdrain Sump and laterals. Similar to well 1242C, delayed responses were seen at unconfined wells 1243F and 1244F. Drawdown on the order of 0.5 feet was recorded at well 1244F prior to the minor power interruption on 8/17/20; but drawdown peaked at greater than 0.7 feet during the recovery period. The remaining fill well, 1246F, is located just 200 feet northwest of the Underdrain Sump. Water level drawdown was an order of magnitude greater at 1246F than in the other fill wells, as approximately 5.5 feet of drawdown were recorded at the end of the pumping phase of the test.

5.2.2.5 Drawdown in McKay/sub-McKay

Drawdown was not observed during the pumping test at McKay well 1239M. However, drawdown was observed in paired sub-McKay well 1238D, located south of C Cell and completed in bedrock that is separated vertically from the saturated ash in which the Underdrain is constructed by a sequence of confining siltstone and shale bedrock. Drawdown at 1238D was possible because of the lateral connection between bedrock, ash, and fill that exists north of C Cell near the Underdrain Sump. Measurable and consistent drawdown was not recorded at 1238D until about 13 days into the pumping phase of the test; but delayed drawdown continued at 1238D after the pump was shut off. Drawdown at 1238D reached approximately 0.6 feet at the end of pumping but 1.2 feet at the end of the recovery phase of observation.

Drawdown responses were recorded at bedrock wells 1240D, 1241D, and 1245D, as shown in Appendices D-10, D-11, and D-12. Drawdown at 1240D peaked at slightly less than 0.4 feet during the pumping phase of the test. Well 1240D is paired with fill well 1243F; and similar to the fill well, delayed drawdown and notable fluctuations in water level not caused by Underdrain pumping were observed at 1240D. Water levels recorded during Underdrain pumping at wells 1241D and 1245D exhibited a drawdown response that was characteristic of removal from storage (i.e. drawdown plots linear on the semi-log scale). Drawdown peaked at approximately 3.5 feet in well 1241D and slightly more than 8 feet in well 1245D at the end of the pumping phase of the Underdrain test.

5.2.3 Composite Drawdown and Flow Patterns

A drawdown map, constructed with maximum water level drawdown observations from all sites monitored during the Underdrain pumping test is shown in Figure 5-5. As discussed previously, drawdown was greatest at wells/sites nearest to the sump and laterals – typically fly ash piezometers and fill wells. However, the composite drawdown map indicates that even short term pumping resulted in measurable drawdown responses over a large portion of the EHP footprint. Long term pumping at similar or increased pumping rates would be expected to increase the area of influence of the Underdrain dewatering system.

Subsurface flow patterns of the shallow (ash, fill, clinker), McKay coal, and sub-McKay potentiometric surfaces are shown in Figures 5-6 through 5-8. These maps were constructed of water levels recorded two weeks into the pumping phase of the Underdrain pumping test.

A steep gradient and prominent hydraulic depression centered at the Underdrain Sump is shown in the shallow potentiometric surface (shown on each of Figures 5-6, 5-7, and 5-8). Despite notable depressions in the shallow potentiometric surface, minor water level elevation fluctuations did not change flow patterns in McKay coal during the pumping test, as can be seen by comparing Figure 2-5 to Figure 5-7. The direction of flow in sub-McKay bedrock did not change during the Underdrain pumping test but subtle changes in gradient and localized reductions in water level are apparent Figure 5-8, as compared to the background potentiometric surface mapped in Figure 2-6.

5.2.4 Underdrain Water Quality

As previously discussed, two water quality samples were collected of Underdrain discharge during the pumping phase of the test. The first sample was collected within two hours of starting the pump and the second sample was collected within two hours prior to turning off the pump. Results of Underdrain water quality samples are shown in Table 5-1. TDS and concentrations of some of the major ions exhibited modest reductions between the initial and later pumping phase samples; however, water quality did not change appreciably during the pumping test. In general, results of both Underdrain water quality samples were similar to results of samples collected from fly ash piezometers (Table 3-2).

TSS was added to the parameter list for the sample collected on 8/19/20 near the end of the pumping period to quantify the amount of solids that are moved through the Underdrain during pumping. The measured TSS concentration of 12 mg/L is low and suggests that excessive fly ash or other sediments were not piped through the Underdrain dewatering system during this test.

5.3 PHASE III – RECOVERY

Recovery data were recorded at the Underdrain Sump and the entire Underdrain test observation/monitoring well network following the pumping phase of the test. Recovery data were collected for a period of 19 days from 8/19/2020 to 9/8/2020. Water level elevation observations made during the recovery phase for all wells are shown in Appendix C.

Recovery observations for the sub-set of wells that exhibited drawdown in response to pumping are shown in Appendix D.

5.3.1 Underdrain Recovery

The water level in the Underdrain Sump did not fully recover, suggesting that water was removed from storage and not replaced by recharge during the recovery phase of observation. At the end of the 19 day recovery period, approximately 2 feet of drawdown were still apparent in the Underdrain Sump. The lack of complete recovery indicates that the Underdrain is isolated from recharge from underflow. The current primary source of recharge to the Underdrain is thought to be precipitation that percolates through clinker, fill, or ash in the EHP. Recharge by precipitation was not observed and would not be expected to be observed given the limited amount of rainfall around the time of the test and the relatively short duration of observation compared to the time it would take for precipitation to percolate through ash. Historically, seepage from unlined impoundments would recharge the ash and contribute free water that would be available to the Underdrain system. Recharge from process water has been greatly reduced by dewatering unlined cells (e.g. C and G cells) and installing engineered geomembrane liners in others (A, B, F, H, and J-1 Cell). Additional cell capping and dry disposal activities, planned in the selected remedy, will provide further reduction in process water recharge.

5.3.2 Recovery in Fly Ash Piezometers

Three of the four fly ash piezometers failed to fully recover during the 19 day period of recovery observations that followed Underdrain pumping. Piezometer 1235FA only recovered to within approximately 80% of the initial water level, as 0.1 feet of drawdown remained at the end of the recovery phase after peak drawdown of 0.53 feet were recorded during the test. A differential water level of 0.83 feet remained at the end of recovery observations at piezometer 1237FA; and a differential water level of nearly two feet remained at piezometer 1234FA when the recovery phase of the test was stopped. The fact that a recordable sustained reduction in free water from the pore space of the fly ash was observed after just 16 days of pumping is a promising sign for long-term pumping planned as part of the conditionally approved remedy for the 3&4 EHP Area.

5.3.3 Recovery in Clinker

Drawdown persisted at well 1242C after the pump was shut off. Approximately 0.65 feet of drawdown were recorded at 1242C at the end of the recovery phase of the Underdrain test. Delayed responses are common in unconfined anisotropic conditions, such as those found in clinker well 1242C; and the lack of recovery is due to removal from storage with no immediate source of recharge.

Water levels in clinker wells 1003R and 1248C continued to rise during the recovery period, as they had throughout the earlier two phases of the test. An overall increase in water level of 0.48 feet was observed at well 1003R; while, a total increase of 0.44 feet was observed at well 1248C. Consistent water level increases at these wells during the Underdrain test could be related to localized pond seepage or operation of the forced evaporators.

5.3.4 Recovery in Fill Wells

Once the Underdrain pump was turned off, water levels in well 1243F began to recover before reversing and exhibiting a level of drawdown at the conclusion of the recovery phase of the test that exceeded drawdown at any point during pumping. It is expected that undocumented influences, rather than Underdrain testing activities were responsible for the apparent delayed drawdown at 1243F. As noted previously, a delayed response was also observed at unconfined well 1244F-where peak drawdown of greater than 0.7 feet was recorded during the recovery period. Peak drawdown at 1246F was about 5.5 feet; but less than 3 feet of recovery were recorded, leaving more than 2.5 feet of drawdown at the end of the recovery phase of the pumping test. Incomplete recovery at 1246F is attributable to partially depleted storage and no immediate source of recharge.

5.3.5 Recovery in sub-McKay Wells

As noted previously, lagging drawdown and fluctuations in water level unrelated to Underdrain pumping were observed at 1240D. Water levels recorded at 1240D indicate that drawdown peaked at about 1.2 feet at the end of the recovery phase of the test in the bedrock well. Water level recovery was observed in wells 1241D and 1245D once the pump was turned off; however, the recovery was incomplete. A water level differential of 1.6 feet was recorded at well 1241D and a differential of 2 feet was exhibited at well 1245D at the end of the recovery observation phase. Similar to the drawdown responses recorded during the pumping phase of the test, incomplete recovery is indicative of removal and partial depletion of stored pore water.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions are derived from observations made during the Underdrain test or are the result of analysis conducted subsequent to the test. Where necessary, recommendations related to test results that may affect future Underdrain operation or monitoring are made following the conclusions.

- Data and observations presented in this report fulfill the first stipulation of DEQ's conditional approval of the Revised Remedy Evaluation Report (Geosyntec 2019) that Talen must run a pumping test on the 3&4 EHP Underdrain.
- Considerable drawdown was measured and recorded in fly ash, clinker, fill, and consolidated bedrock piezometers/wells during pumping at the Underdrain Sump. The magnitude of drawdown at each site was proportional to its distance from and hydraulic connection to the Underdrain Sump or laterals. The rate of drawdown in these units coupled with incomplete recovery observed after pumping was stopped suggests that water issuing to the Underdrain is from storage. The cumulative volume of water pumped during the test from 8/3/2020 to 8/19/2020 was approximately 2.77 million gallons. This is a promising indicator that the Underdrain could be used in conjunction with other dewatering strategies proposed in the approved remedy to substantially deplete process water that is stored in the EHP subsurface.
- Data collected during this test will be represented in upcoming 3&4 EHP groundwater flow and contaminant transport modeling updates. Specifically, applicability of the Underdrain to operate synergistically with other recommended dewatering sites will be evaluated. Well logs, pumping rates, and groundwater quality data have been provided to Newfields for inclusion in the model.
- TSS was added to the parameter list for the sample collected on 8/19/20 near the end of the pumping period to quantify the amount of solids that are moved through the Underdrain during pumping. The measured TSS concentration of 12 mg/L is very low and suggests that excess sediment or ash particles are not being piped through the Underdrain.

Recommendation – Additional monitoring for turbidity and TSS is recommended during future pumping to verify that the Underdrain is not moving excess sediment. It will be especially important to monitor TSS and turbidity if the Underdrain pumping rate is increased.

- As previously described, stress induced by the pump was sufficient to induce drawdown and evaluate the Underdrain's potential to dewater ash and other sediments inside the EHP. However, analysis of pumping rates in relation to total dynamic head (TDH) of the system during the test suggests that the pump is not operating according to the manufacturer's performance curve. When head loss at all pipe, valves, fittings, flow meters and the differential elevation between the pumping level and discharge are considered, a fully functioning pump of model # 475S150-2-B would be expected to achieve a pumping rate of approximately 200 gpm. Recommendation – The pump in the Underdrain Sump should be replaced prior to initiating long-term pumping associated with the selected remedy.
- Results of the pumping test suggest the clinker in the south half of the EHP will not be effectively dewatered by pumping the Underdrain. However, in accordance with the DEQ-approved remedy, dewatering in clinker within the EHP will also be accomplished by pumping at existing or new vertical clinker capture wells.

7.0 REFERENCES

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INTERIM RESPONSE ACTION

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
TALEN MONTANA, LLC
COLSTRIP STEAM ELECTRIC STATION

Pursuant to: ADMINISTRATIVE ORDER ON CONSENT REGARDING IMPACTS RELATED TO WASTEWATER FACILITIES COMPRISING THE CLOSED-LOOP SYSTEM AT COLSTRIP STEAM ELECTRIC STATION, COLSTRIP, MONTANA SECTION XI – SUBMISSIONS

CERTIFICATION:

I, the undersigned, hereby certify that this document was prepared under my direction and to the best of my knowledge the information contained herein is correct and accurate.

Gordon Criswell | Director, Environmental & Compliance | 10/12/2020

Name | Title | Date

TABLES

Table 3-1. Underdrain Test Analytical Parameter List

Parameter	Method	Reporting Limit (mg/L)
-- Physical Parameters--		
pH (field and Lab)	A4500H	0.1
TDS (measured at 180 C)	A2540C	10
SC (UMHOS/CM AT 25 C) (field and Lab)	A2510B	5 µmhos/cm
-- Major Constituents--		
Total Alkalinity as CaCO3	A2320B	4
Total Hardness as CaCO3	A2340B	1
Anions		
Bicarbonate (HCO3)	A2320B	1
Carbonate as CO3	A2320B	1
Chloride (Cl)	E300.0	1
Bromide (Br)	E300.0	1
Sulfate (SO4)	E300.0	1
Cations		
Calcium (Ca) DIS	E200.7/E 200.8	1
Magnesium (Mg) DIS	E200.7/E 200.8	1
Potassium (K) DIS	E200.7/E 200.8	1
Sodium (Na) DIS	E200.7/E 200.8	1
--Metals, dissolved --		
Boron (B)	E200.7	0.05
Cobalt (Co)	E200.7/E 200.8	0.005
Lithium (Li)	E200.7/E 200.8	0.01
Iron (Fe)	E200.7/E 200.8	0.02
Manganese (Mn)	E200.7/E 200.8	0.001
Selenium (Se)	E200.7/E 200.8	0.001

TABLE 3-2. FLY ASH PIEZOMETER WATER QUALITY RESULTS

Analyte[1]	1234FA	1235FA	1236FA	1237FA
	6/23/20	6/23/20	6/23/20	6/30/20
Field Parameters and Physical Parameters				
Depth to Water (feet bmp)	58.84	10.87	4.39	53.5
Temperature (^oC)	15.7	13.5	12.7	12.9
pH (s.u.)	8.1	8.5	8.3	7.83
pH (s.u., Field)	NA	8.5	8.38	8.3
SC (uMHOS/cm at 25 ^oC)	31000	22800	29100	7549
SC (uMHOS/cm at 25 ^oC) (Field)	32885	24300	30504	7410
TDS (measured at 180 ^oC)	55300	34500	48300	6680
Total Hardness (mg/L, as $CaCO_3$)	33100	18700	28300	2050
Major Constituents/Ions				
Calcium (Ca), dissolved	480	474	453	465
Magnesium (Mg), dissolved	7760	4260	6600	215
Ca:Mg	0.06	0.11	0.07	2.16
Sodium (Na), dissolved	2850	2420	2680	1160
Potassium (K), dissolved	151	120	133	19
Total Alkalinity as $CaCO_3$	602	417	703	165
Bicarbonate (HCO_3)	733	448	782	202
Carbonate as CO_3	< 4	30	37	< 4
Chloride (Cl)	1220	1130	1150	432
Sulfate (SO_4)	33600	20900	29100	5230
Bromide (Br)	1430	1020	1370	24.9
Trace Metals/Metalloids				
Boron (B), dissolved	207	113	162	26
Cobalt (Co), dissolved	< 0.005	< 0.005	< 0.005	0.047
Iron (Fe), dissolved	0.38	0.36	< 0.02	0.03
Lithium (Li), dissolved	5.3	2.7	3.6	0.1
Manganese (Mn), dissolved	7.27	4.8	4.46	1.3
Selenium (Se), dissolved	0.027	0.006	0.164	0.003

[1]All results in mg/L unless otherwise specified

TABLE 3-3. CLINKER AND FILL WELL WATER QUALITY RESULTS

Analyte[1]	1242C	1243F	1244F	1246F	1247C	1248C
	6/23/20	6/30/20	6/30/20	6/30/20	7/8/20	7/8/20
Field Parameters and Physical Parameters						
Depth to Water (feet bmp)	60.42	56.56	60.74	63.78	31.73	47.65
Temperature (^{o}C)	16	13	14.3	15	15.2	11.8
pH (s.u.)	7.4	3.67	6.15	7.98	5.9	7.4
pH (s.u., Field)	7.13	3.6	6.8	8.3	6.2	6.52
SC (uMHOS/cm at 25 ^{o}C)	11600	11618	23650	29083	21900	10300
SC (uMHOS/cm at 25 ^{o}C) (Field)	12176	11100	22300	27900	28000	21600
TDS (measured at 180 ^{o}C)	14600	13800	32400	45200	45400	32200
Total Hardness (mg/L, as $CaCO_3$)	7760	6770	19600	25900	28000	20000
Major Constituents/Ions						
Calcium (Ca), dissolved	437	420	442	485	575	428
Magnesium (Mg), dissolved	1620	1390	4500	6000	6440	4600
Ca:Mg	0.27	0.30	0.10	0.08	0.09	0.09
Sodium (Na), dissolved	1100	922	2060	2590	1960	1800
Potassium (K), dissolved	73	23	100	140	100	115
Total Alkalinity as $CaCO_3$	327	< 4	367	500	166	712
Bicarbonate (HCO_3)	399	< 4	448	610	202	868
Carbonate as CO_3	< 4	< 4	< 4	< 4	< 4	< 4
Chloride (Cl)	511	549	947	1140	881	831
Sulfate (SO_4)	9850	8780	20800	27400	28900	20600
Bromide (Br)	22.5	39.8	687	1040	1050	644
Trace Metals/Metalloids						
Boron (B), dissolved	78	21.5	114	146	152	88.5
Cobalt (Co), dissolved	0.027	0.057	0.269	0.021	0.164	0.016
Iron (Fe), dissolved	0.04	192	3.9	0.35	379	1.4
Lithium (Li), dissolved	1.2	0.4	1.6	3.2	2.9	1.3
Manganese (Mn), dissolved	4.98	5.57	11.8	3.48	23.9	6.45
Selenium (Se), dissolved	0.034	0.002	0.004	0.004	0.007	0.11

[1]All results in mg/L unless otherwise specified

TABLE 3-4. MCKAY COAL AND SUB-MCKAY BEDROCK GROUNDWATER QUALITY RESULTS

Analyte[1]	1238D	1239M	1240D	1241D	1245D
	7/9/20	7/10/20	7/8/20	7/10/20	7/13/20
Field Parameters and Physical Parameters					
Depth to Water (feet bmp)	87.59	37.02	86.9	89.75	78.52
Temperature (^{o}C)	13.2	15.5	14.1	14.2	13.1
pH (s.u.)	6.9	7.2	7.5	7.7	7.5
pH (s.u., Field)	6.59	6.65	7.21	7.54	6.78
SC (uMHOS/cm at 25 ^{o}C)	5240	17100	11300	24200	23600
SC (uMHOS/cm at 25 ^{o}C) (Field)	5226	17694	16590	25849	24571
TDS (measured at 180 ^{o}C)	5280	24300	22000	40100	35700
Total Hardness (mg/L, as $CaCO_3$)	2540	15600	13400	23000	21500
Major Constituents/Ions					
Calcium (Ca), dissolved	450	545	441	493	439
Magnesium (Mg), dissolved	345	3470	2980	5290	4950
Ca:Mg	1.30	0.16	0.15	0.09	0.09
Sodium (Na), dissolved	527	984	1250	2180	1830
Potassium (K), dissolved	19	94	29	124	94
Total Alkalinity as $CaCO_3$	468	309	672	320	327
Bicarbonate (HCO_3)	571	377	820	390	399
Carbonate as CO_3	< 4	< 4	< 4	< 4	< 4
Chloride (Cl)	75	850	513	1130	927
Sulfate (SO_4)	3270	16300	15100	25900	23200
Bromide (Br)	1	402	56	815	< 0.5
Trace Metals/Metalloids					
Boron (B), dissolved	3.3	1.8	91.9	142	118
Cobalt (Co), dissolved	< 0.005	< 0.005	0.099	0.11	0.099
Iron (Fe), dissolved	7.2	9.7	4.1	0.03	0.59
Lithium (Li), dissolved	0.1	1.5	0.5	3	2.28
Manganese (Mn), dissolved	0.156	2.88	1.84	2.94	6.56
Selenium (Se), dissolved	< 0.001	< 0.001	0.001	0.003	0.005

[1]All results in mg/L unless otherwise specified

Table 4-1. Individual Pumping and Slug Test Results

Well ID	Test Date	Test Type	Test Duration (min.)[1]	Pumping Rate (gpm)	Analytical Solution	Wells Observed	Transmissivity (T) (ft^2/day)	Hydraulic Conductivity, (K) (ft/day)[2]	Saturated Thickness, (b) (ft)	Storativity [3]
1234FA	6/23/2020	Slug In	4	NA	Bouwer-Rice	--	194	3.6	54.7	--
1234FA	6/23/2020	Slug Out	3	NA	Bouwer-Rice	--	181	3.3	54.7	--
1235FA	6/23/2020	Slug In	5	NA	Bouwer-Rice	--	84	3.2	26.4	--
1235FA	6/23/2020	Slug Out	4	NA	Bouwer-Rice	--	99	3.7	26.4	--
1236FA	6/23/2020	Slug In	3	NA	Bouwer-Rice	--	172	7.0	24.6	--
1236FA	6/23/2020	Slug Out	4	NA	Bouwer-Rice	--	162	6.6	24.6	--
1237FA	7/8/2020	Slug In	10	NA	Bouwer-Rice	--	59	1.4	42.4	--
1237FA	7/8/2020	Slug Out	10	NA	Bouwer-Rice	--	70	1.7	42.4	--
1238D	7/8/2020	Pumping Test	100	4	Theis	--	30	2.7	11	--
1240D	7/8/2020	Pumping Test	100	1.5, 2.6	Theis (Step Test)	--	29	1.4	21	--
1239M	7/10/2020	Pumping Test	100	3.7	Theis	--	28	3.1	9	--
1239M	7/10/2020	Pumping Test	100	3.7	Theis (Recovery)	--	32	3.6	9	--
1241D	7/10/2020	Pumping Test	100	14	Theis	--	255	5.7	45	--
1245D	7/12/2020	Pumping Test	102	11	Theis	--	47	9.4	5	--
1245D	7/12/2020	Pumping Test	102	11	Theis	PH-2007-1245D	20	4.0	5	0.0030

(1) inlcudes pumping and recovery time

(2) T = K*b or K = T/b

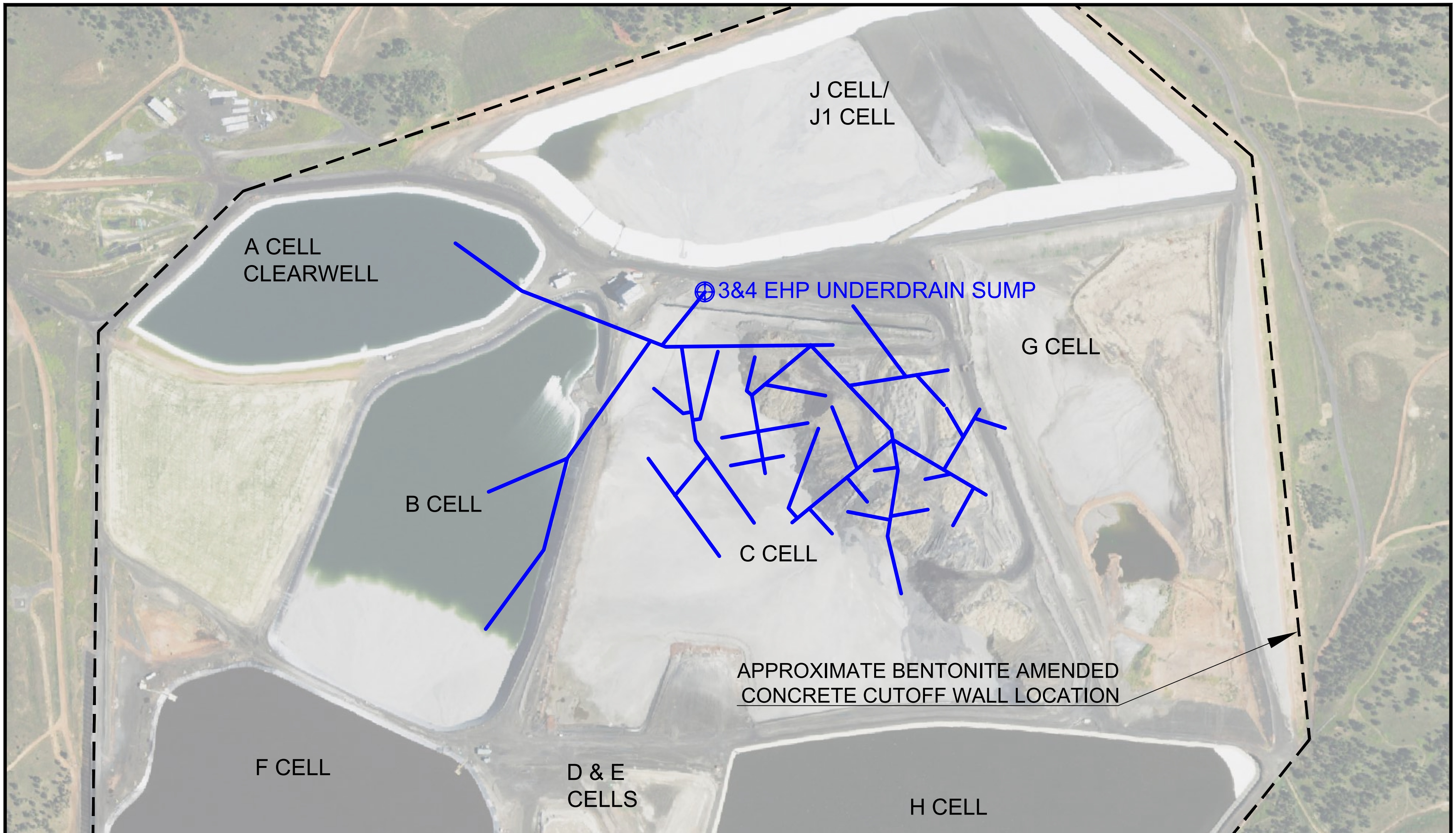
(3) Storativity not determined for single well tests

TABLE 5-1. 3&4 EHP Underdrain Water Quality Results

Analyte[1]	8/3/20	8/19/2020
Field Parameters and Physical Parameters		
Depth to Water (feet bmp)	63.65	118
Temperature (^{o}C)	20.3	13.6
pH (s.u.)	8.3	8.2
pH (s.u., Field)	8.29	8.23
SC (uMHOS/cm at 25 ^{o}C)	32300	27300
SC (uMHOS/cm at 25 ^{o}C) (Field)	33456	28310
TDS (measured at 180 ^{o}C)	54900	41200
Total Hardness (mg/L, as $CaCO_3$)	32200	25200
Total Suspended Solids	NA	12
Major Constituents/Ions		
Calcium (Ca), dissolved	482	481
Magnesium (Mg), dissolved	7520	5830
Ca:Mg	0.06	0.08
Sodium (Na), dissolved	3000	2480
Potassium (K), dissolved	130	132
Total Alkalinity as $CaCO_3$	669	540
Bicarbonate (HCO_3)	815	658
Carbonate as CO_3	< 4	< 4
Chloride (Cl)	1330	1020
Sulfate (SO_4)	34400	27000
Bromide (Br)	1640	1070
Trace Metals/Metalloids		
Boron (B), dissolved	214	161
Cobalt (Co), dissolved	< 0.005	< 0.005
Iron (Fe), dissolved	0.18	0.13
Lithium (Li), dissolved	5.7	4
Manganese (Mn), dissolved	16.4	6.35
Selenium (Se), dissolved	0.006	0.049

[1]All results in mg/L unless otherwise specified

FIGURES



NORTH

SCALE
(In Feet)
0 600

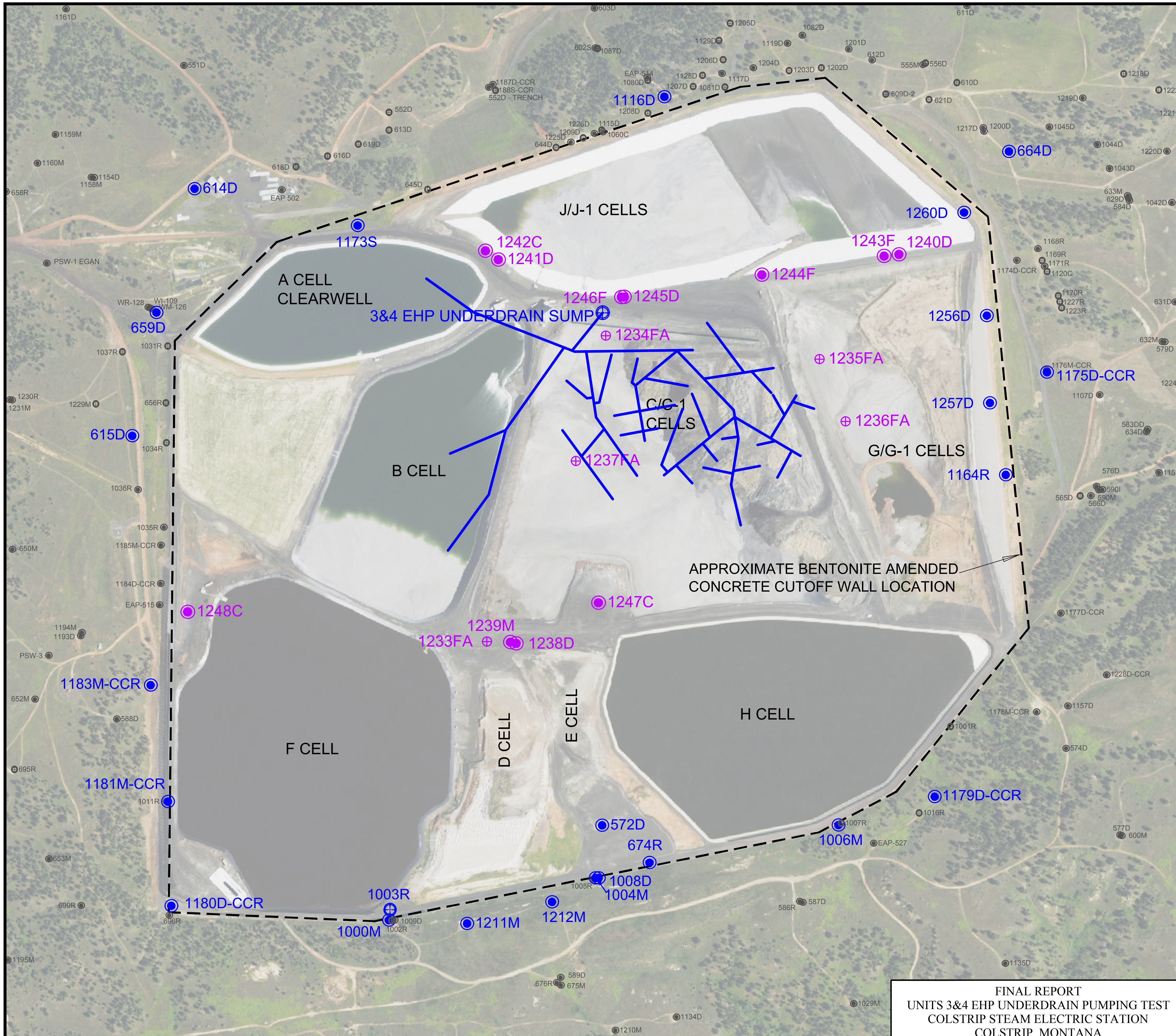
LEGEND

APPROXIMATE 3&4 EHP UNDERDRAIN

SOURCE: COLSTRIP PROJECT MONTANA. EFFLUENT HOLDING POND EMBANKMENTS CONSTRUCTION REPORT, BECHTEL1985.

FINAL REPORT UNITS 3&4 EHP UNDERDRAIN PUMPING TEST COLSTRIP STEAM ELECTRIC STATION COLSTRIP, MONTANA	**3&4 EHP UNDERDRAIN LOCATION**	FIGURE **1-1**

Hydrometrics, Inc.
Consulting Scientists and Engineers



LEGEND

APPROXIMATE 3&4 EHP UNDERDRAIN

674R MONITORING WELL

1003R CAPTURE WELL

1245D NEW EHP UNDERDRAIN MONITORING WELL

1235FA NEW EHP UNDERDRAIN PIEZOMETER

674R MONITORING WELL MONITORED DURING EHP UNDERDRAIN PUMP TEST

NORTH

SCALE (In Feet) 0 600

SOURCE: COLSTRIP PROJECT MONTANA. EFFLUENT HOLDING POND EMBANKMENTS CONSTRUCTION REPORT, BECHTEL1985.

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

3&4 EHP UNDERDRAIN PUMPING TEST OBSERVATION/MONITORING WELL NETWORK

FIGURE **2-1**

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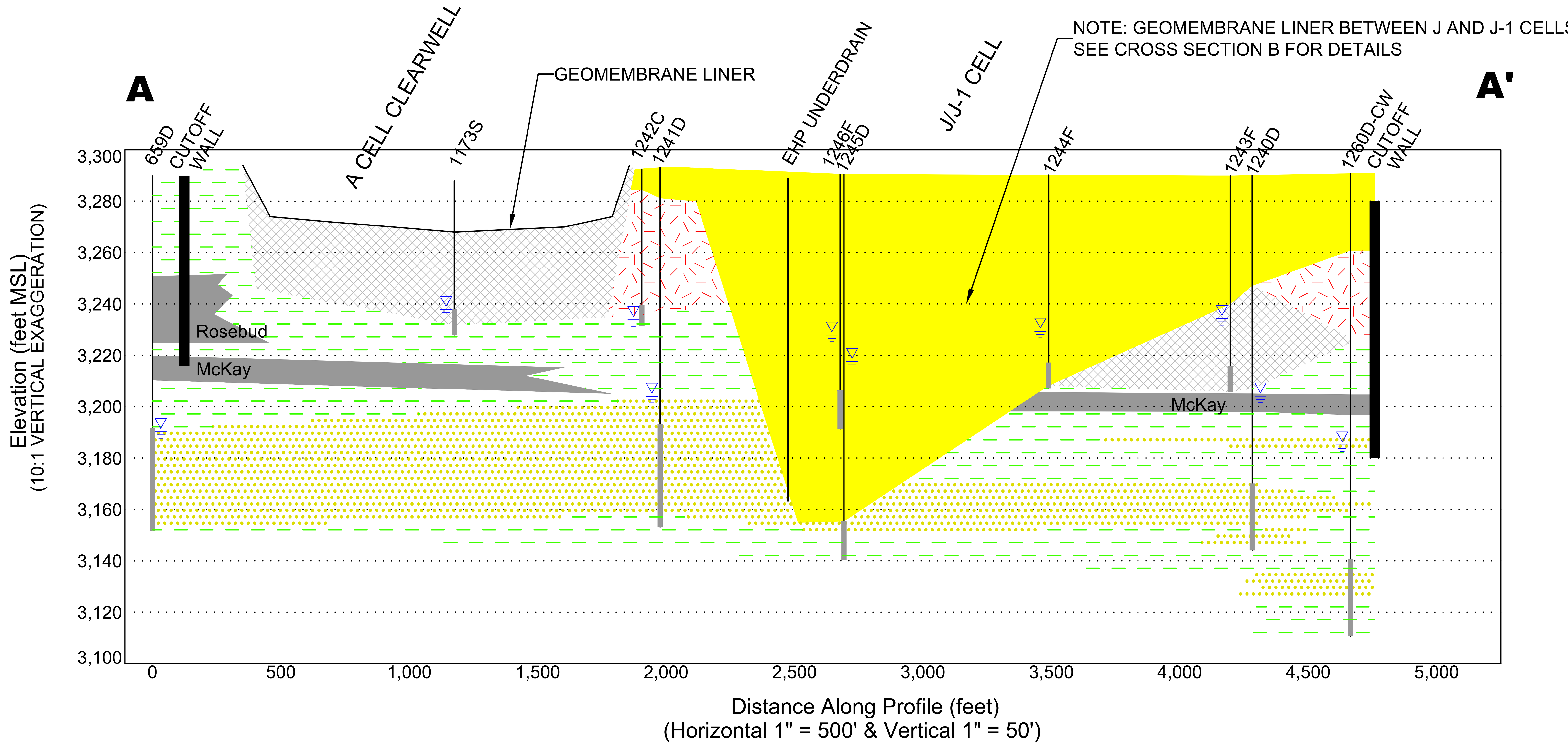
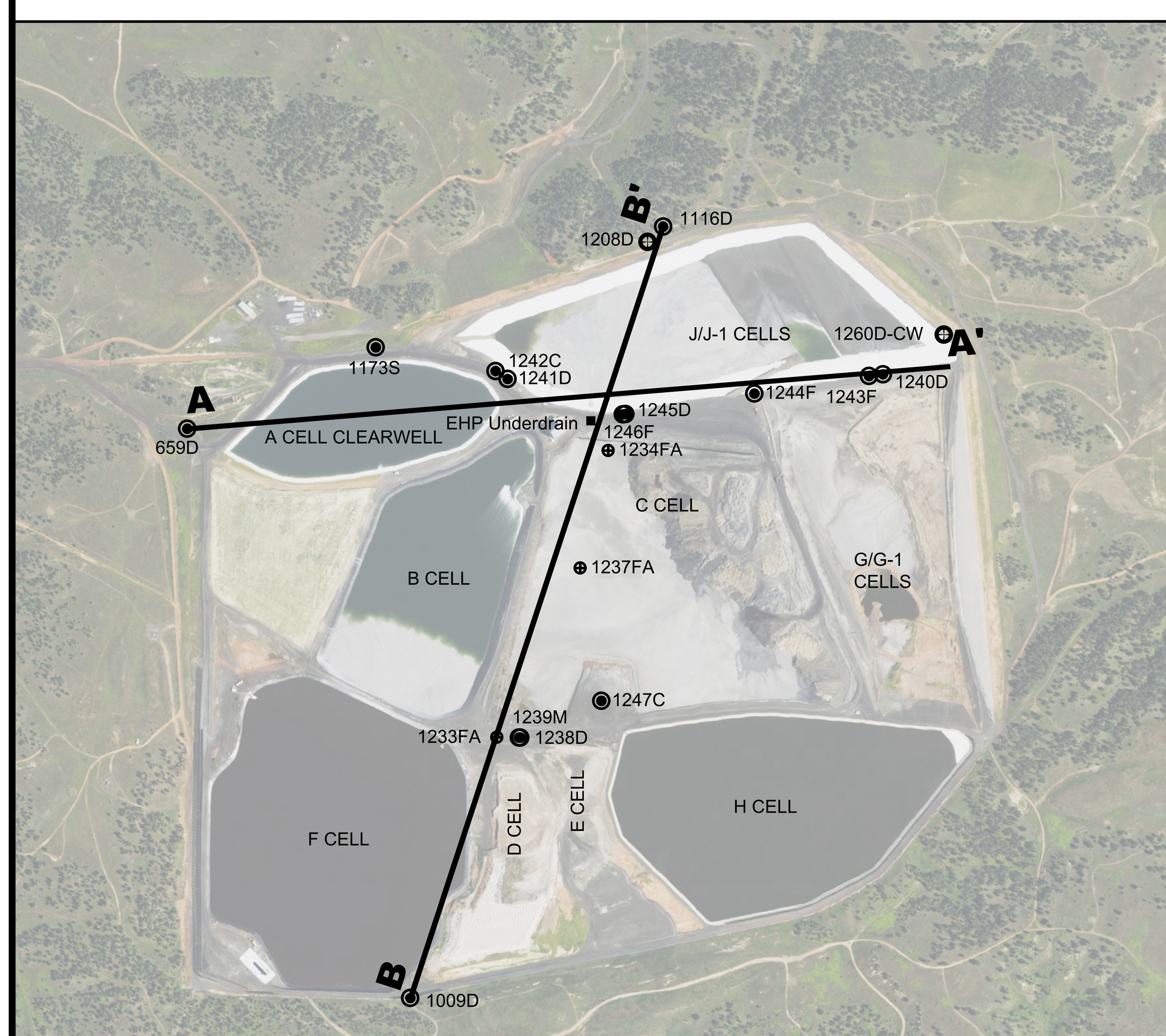
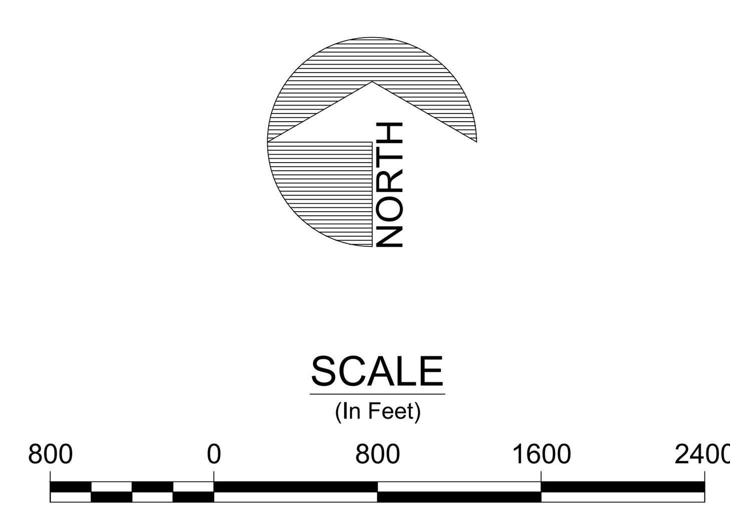
Hydrometrics, Inc.
Consulting Scientists and Engineers







A A' CROSS SECTION LINE

1237FA PIEZOMETER

1247C MONITORING WELL

1208D CAPTURE WELL

LEGEND

COAL

FLY ASH

GRAVEL

SANDSTONE

WATER LEVEL (8/3/20)

DIVIDER DIKE OR DAM MATERIAL

CLINKER

SHALE/SILTSTONE

659D — WELL DESIGNATION

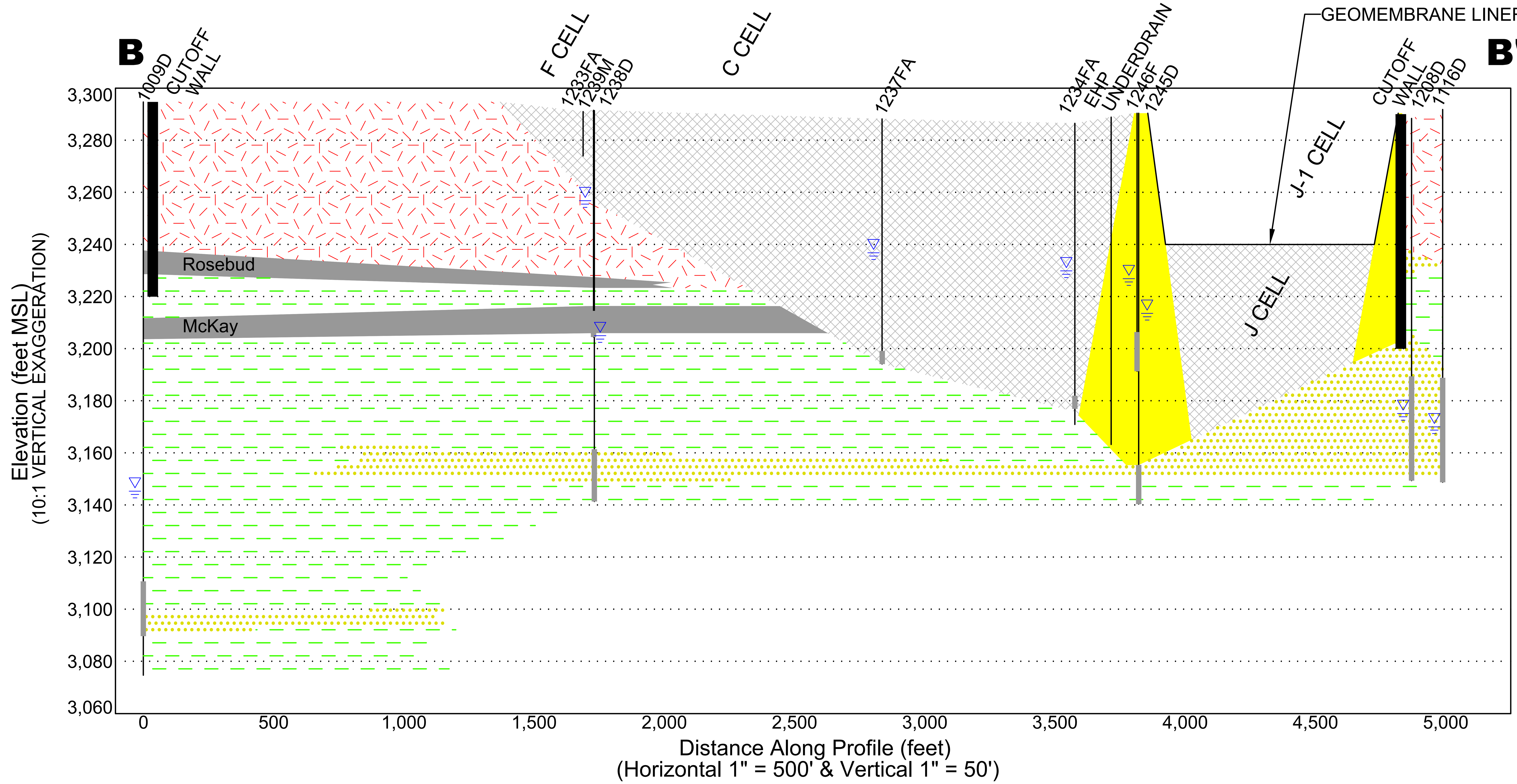
MONITOR WELL

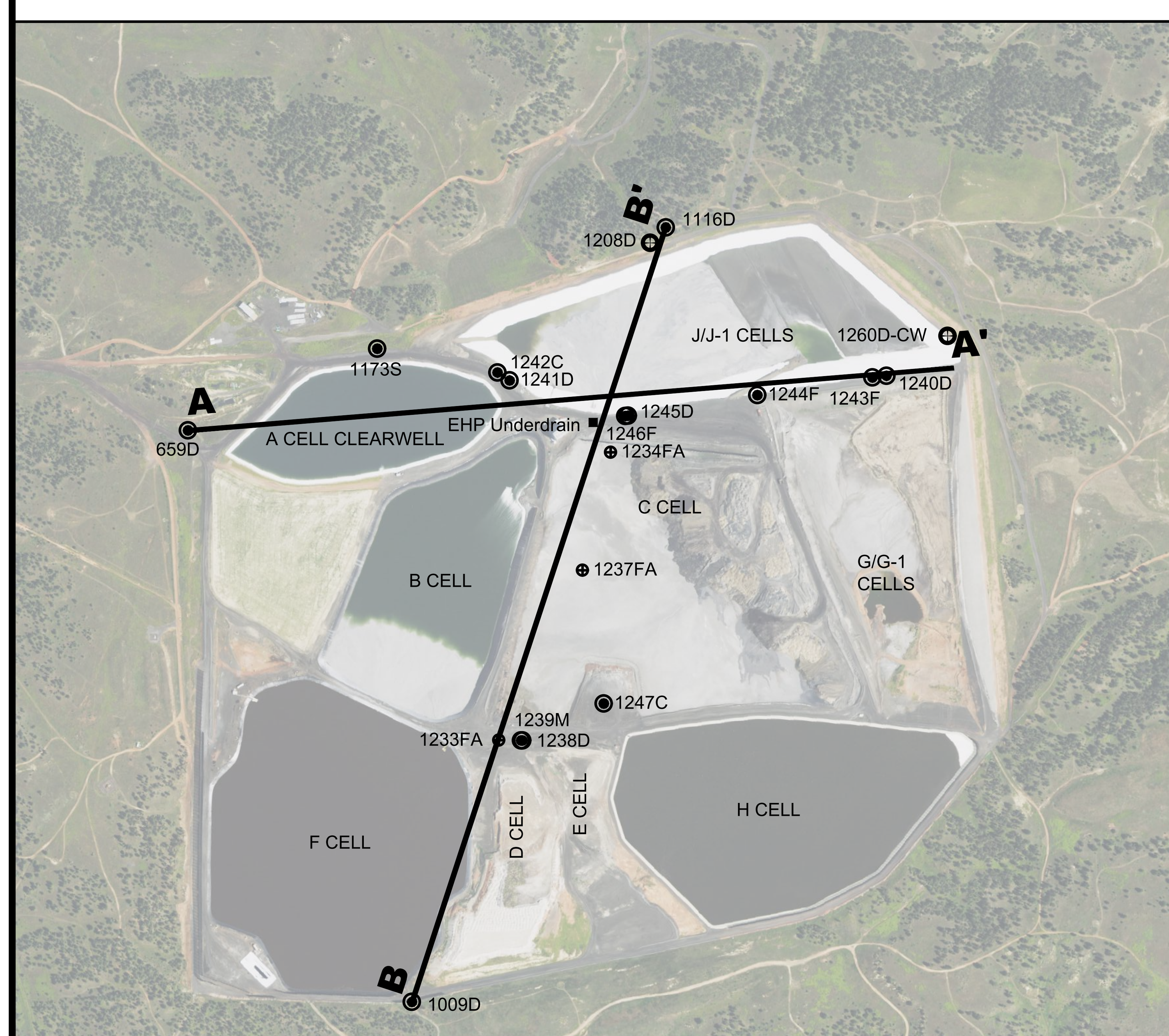
SCREENED INTERVAL

TOTAL DEPTH OF HOLE

Hydrometrics, Inc. Consulting Scientists and Engineers	FINAL REPORT UNITS 3&4 EHP UNDERDRAIN PUMPING TEST COLSTRIP STEAM ELECTRIC STATION COLSTRIP, MONTANA	**CROSS SECTION A-A'**	DRAWING FILE NUMBER 2001720B007 AUTOCAD 2000 DRAWING (DWG) FIGURE **2-2**

UPDATE TIME: 10:07 AM
JBERON\BIL\20201012\I:\LAND PROJECTS\TALEN\2001720\2001720B007.DWG





NORTH

SCALE
(In Feet)
800 0 800 1600 2400

A A' CROSS SECTION LINE
1237FA PIEZOMETER
1247C MONITORING WELL
1208D CAPTURE WELL

LEGEND

COAL
FLY ASH
GRAVEL
SANDSTONE
WATER LEVEL (8/3/20)
DIVIDER DIKE OR DAM MATERIAL
CLINKER
SHALE/SILTSTONE

1009D WELL DESIGNATION
MONITOR WELL
SCREENED INTERVAL
TOTAL DEPTH OF HOLE

Hydrometrics, Inc.
Consulting Scientists and Engineers

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

CROSS SECTION B-B'

DRAWING FILE NUMBER
2001720B007
AUTOCAD 2000 DRAWING (DWG)
FIGURE
2-3

UPDATE TIME: 10:07 AM
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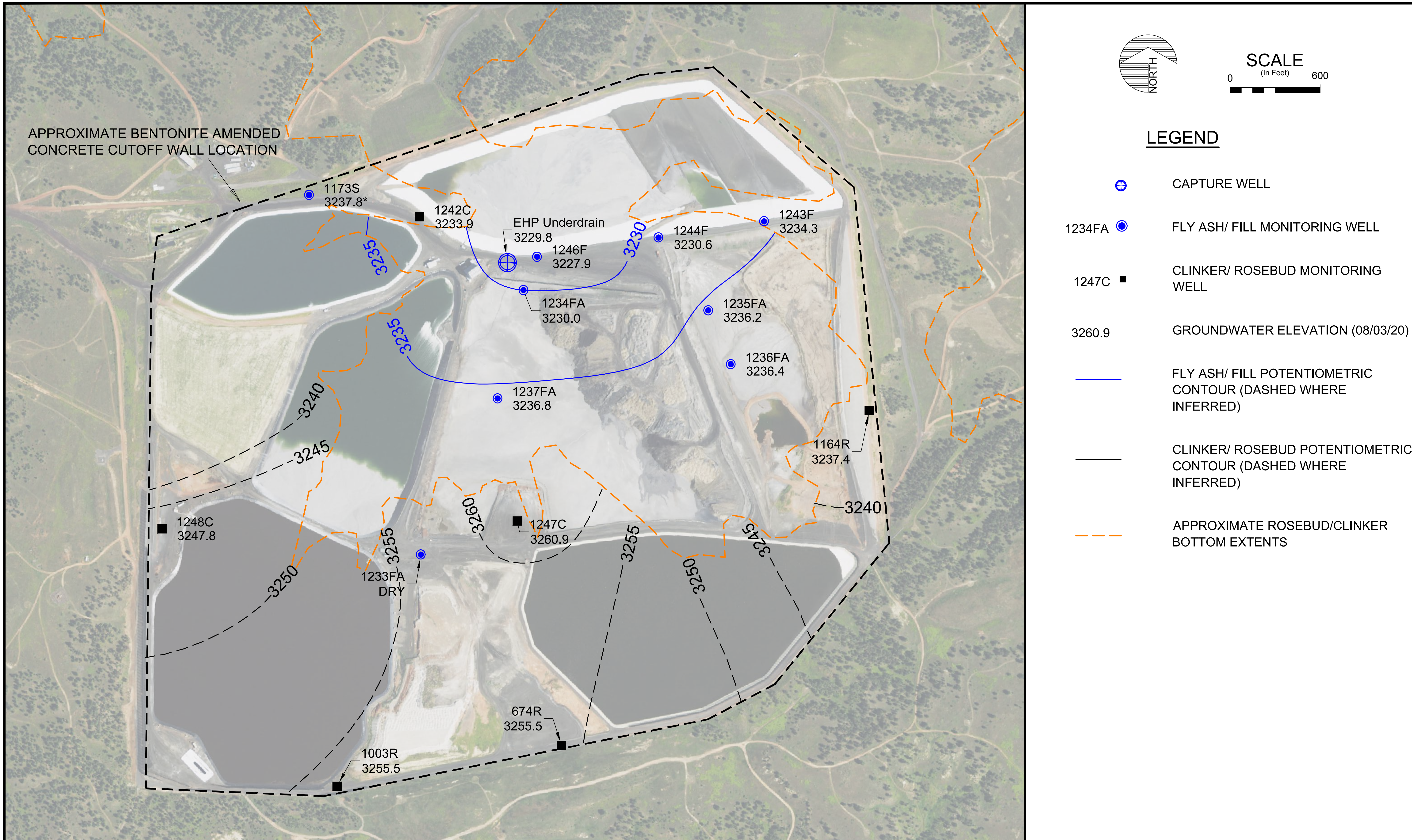

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

POTENTIOMETRIC SURFACE MAP OF FILL/ASH/CLINKER INTERVAL AT 3&4 EHP

FIGURE
2-4

UPDATE TIME: 10:24 AM
JBERGIN\HEL\20201012\I:\LAND PROJECTS\TALEN\2001720\EHP GWE 080320.DWG

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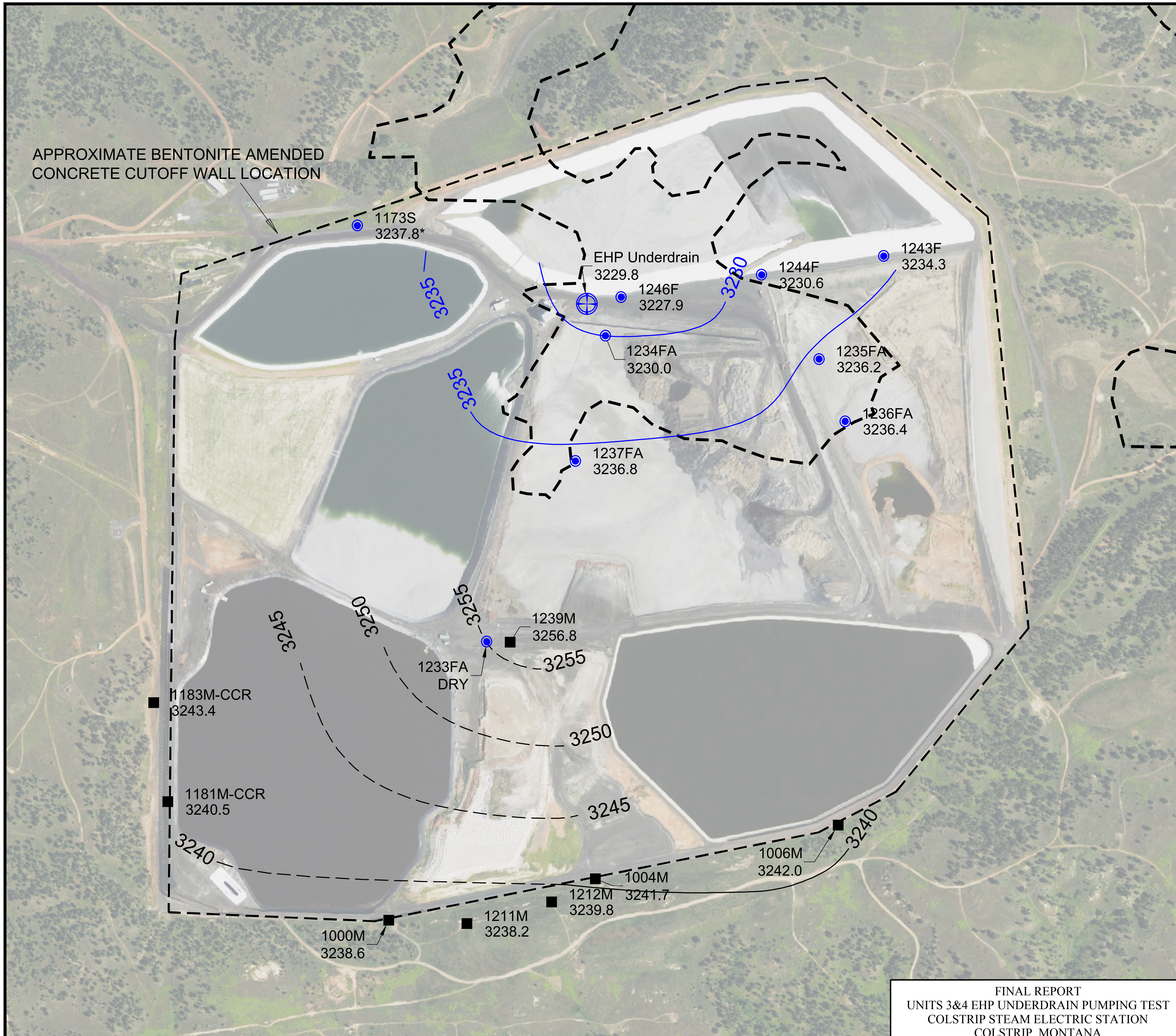

NORTH

SCALE (In Feet) 0 600

LEGEND

(capture well symbol)	CAPTURE WELL
1234FA	FLY ASH/ FILL MONITORING WELL
1239M	MCKAY MONITORING WELL
3256.8	GROUNDWATER ELEVATION (08/03/20)
(blue line)	FLY ASH/ FILL POTENTIOMETRIC CONTOUR (DASHED WHERE INFERRED)
(black line)	MCKAY COAL POTENTIOMETRIC CONTOUR (DASHED WHERE INFERRED)
(heavy dashed line)	APPROXIMATE MCKAY COAL BOTTOM EXTENTS

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

POTENTIOMETRIC SURFACE MAP OF MCKAY COAL AT 3&4 EHP

FIGURE **2-5**

UPDATE TIME: 9:11 AM
JBERGIN\HEL\20201012\I:\LAND PROJECTS\TALEN\2001720\EHP GWE 080320.DWG

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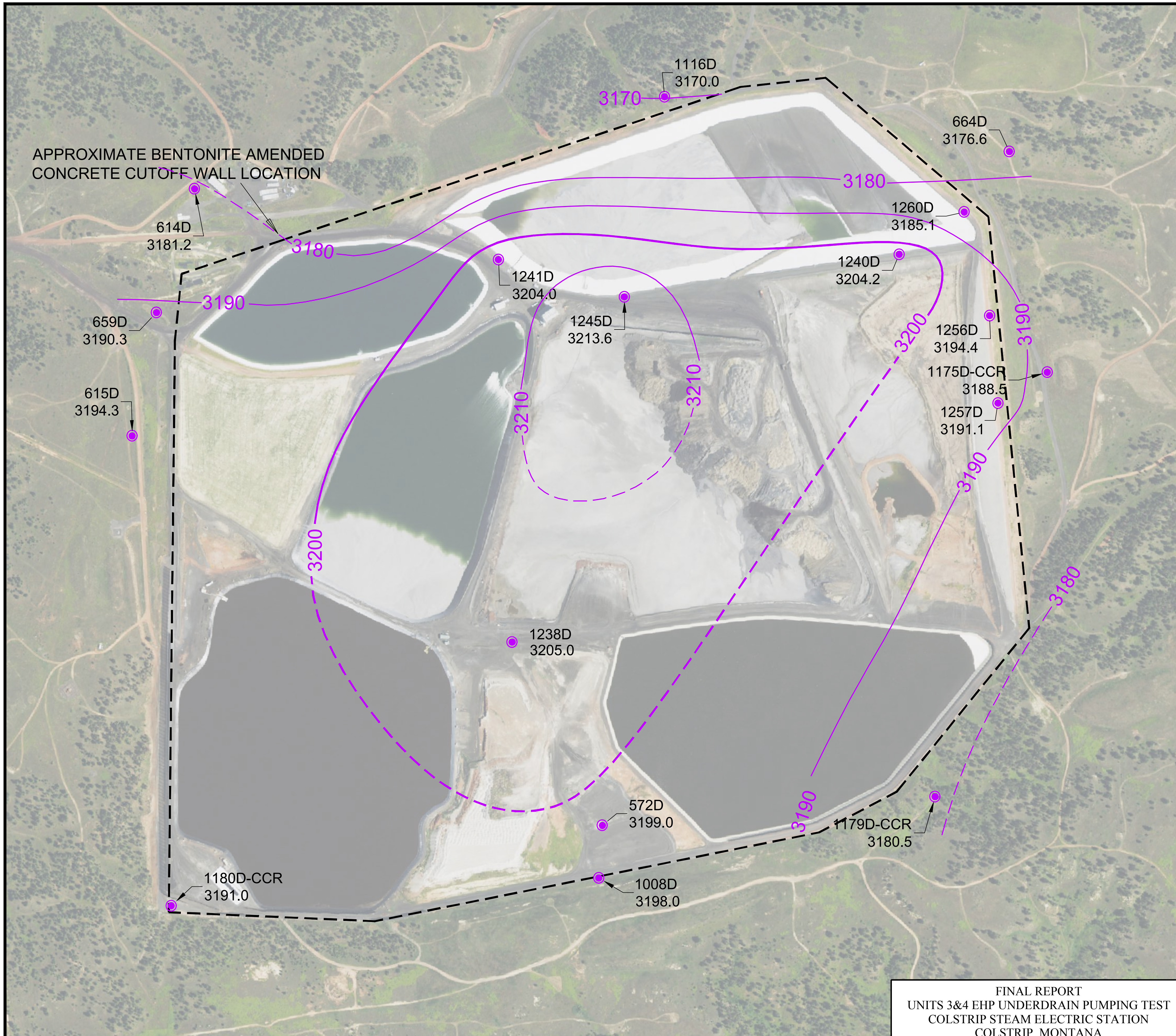

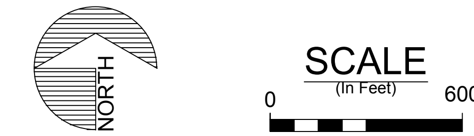

LEGEND

(symbol)	CAPTURE WELL
1245D (symbol)	SUB-MCKAY MONITORING WELL
3213.6	GROUNDWATER ELEVATION (08/03/20)
(line)	SUB-MCKAY POTENTIOMETRIC CONTOUR (DASHED WHERE INFERRED)

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

POTENTIOMETRIC SURFACE MAP OF SUB MCKAY BEDROCK AT 3&4 EHP

FIGURE **2-6**

UPDATE TIME: 9:11 AM
JBERGIN\HEL\20201012\I:\LAND PROJECTS\TALEN\2001720\EHP GWE 080320.DWG

Hydrometrics, Inc.
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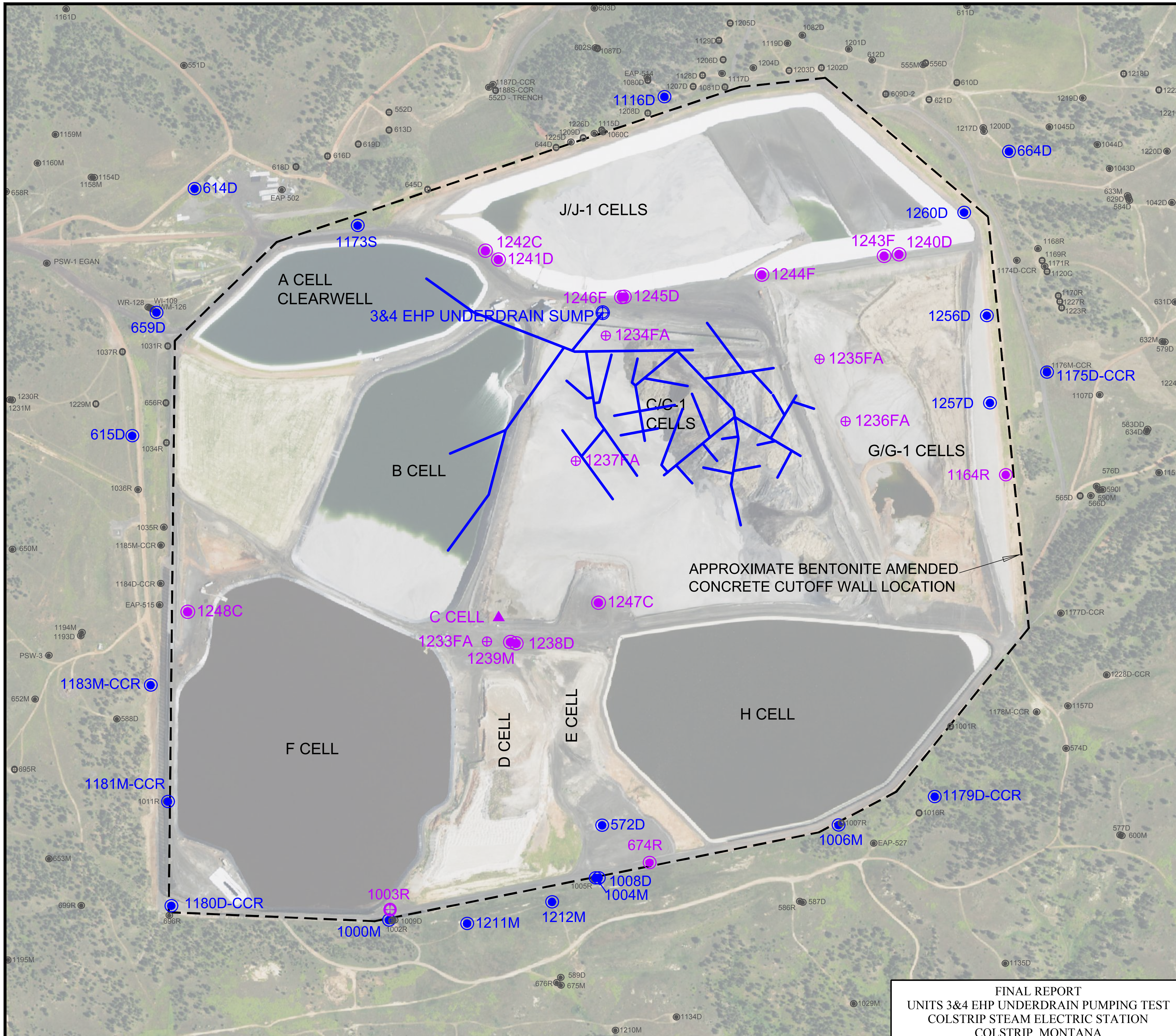

SCALE (In Feet) 0 600

NORTH

LEGEND

APPROXIMATE 3&4 EHP UNDERDRAIN

674R MONITORING WELL

1003R CAPTURE WELL

1245D INSTRUMENTED MONITORING WELL

C CELL INSTRUMENTED SURFACE WATER MONITORING SITE

572D MONITORING WELL MONITORED DURING EHP UNDERDRAIN PUMP TEST WITH WATER LEVEL TAPE

SOURCE: COLSTRIP PROJECT MONTANA. EFFLUENT HOLDING POND EMBANKMENTS CONSTRUCTION REPORT, BECHTEL1985.

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

3&4 EHP UNDERDRAIN PUMPING TEST
INSTRUMENTED MONITORING WELLS

FIGURE
5-1

UPDATE TIME: 12:09 PM
JBERGIN\HEL\20200918\I:\LAND PROJECTS\TALEN\2001720\2001720B006.DWG

Hydrometrics, Inc.
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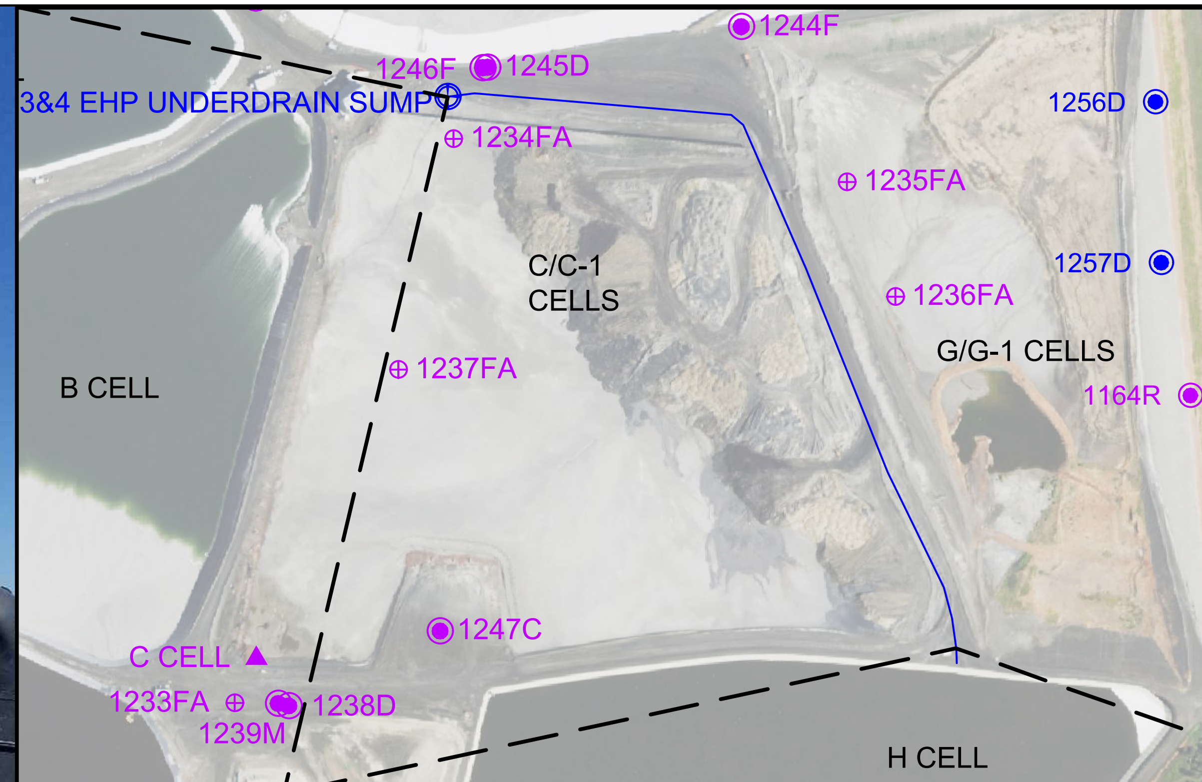
EHP UNDERDRAIN INSTRUMENTED WITH
INSITU TROLL 700 AND INSITU AQUATROLL 200



NORTH

SCALE
(In Feet)
0 600

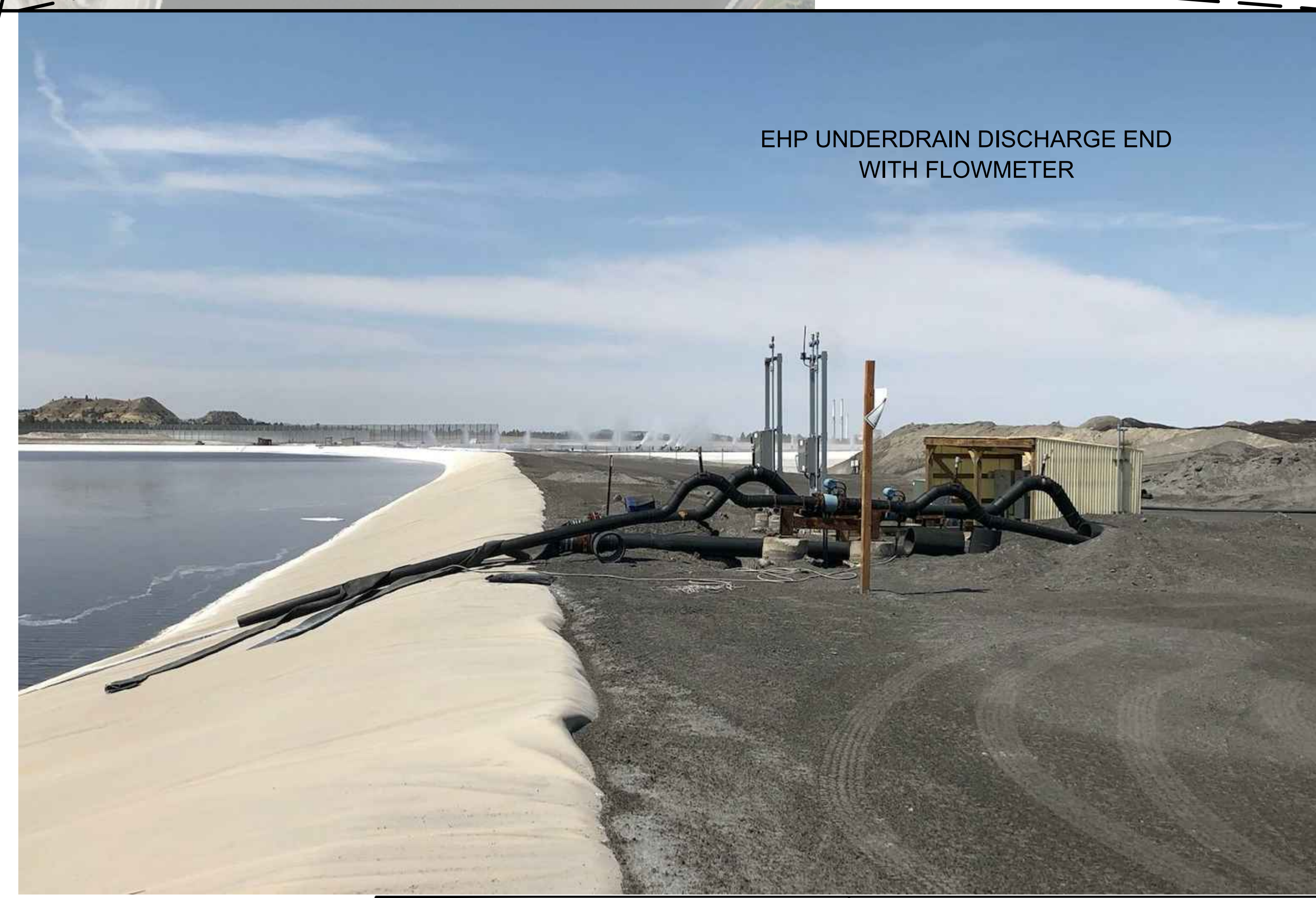
LEGEND

3&4 EHP UNDERDRAIN DISCHARGE PIPELINE

1245D — INSTRUMENTED MONITORING WELL

C CELL — INSTRUMENTED SURFACE WATER MONITORING SITE

572D — MONITORING WELL MONITORED DURING EHP UNDERDRAIN PUMP TEST WITH WATER LEVEL TAPE



EHP UNDERDRAIN DISCHARGE END
WITH FLOWMETER

FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

PIPELINE LAYOUT AND INSTRUMENTATION AT THE UNDERDRAIN SUMP AND DISCHARGE ENDS

FIGURE
5-2

UPDATE TIME: 1:13 PM
JBERGIN\HEL\20200918\I:\LAND PROJECTS\TALEN\2001720\2001720B006.DWG

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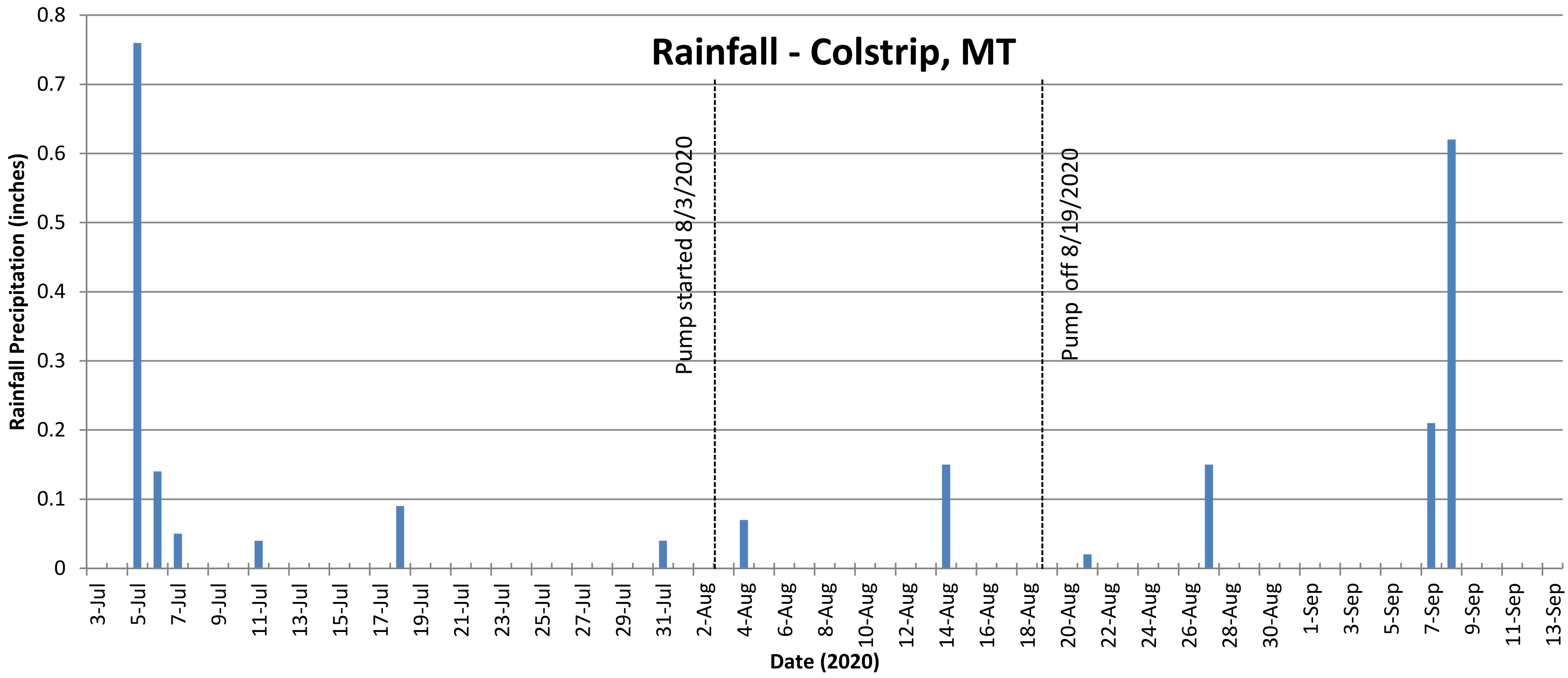

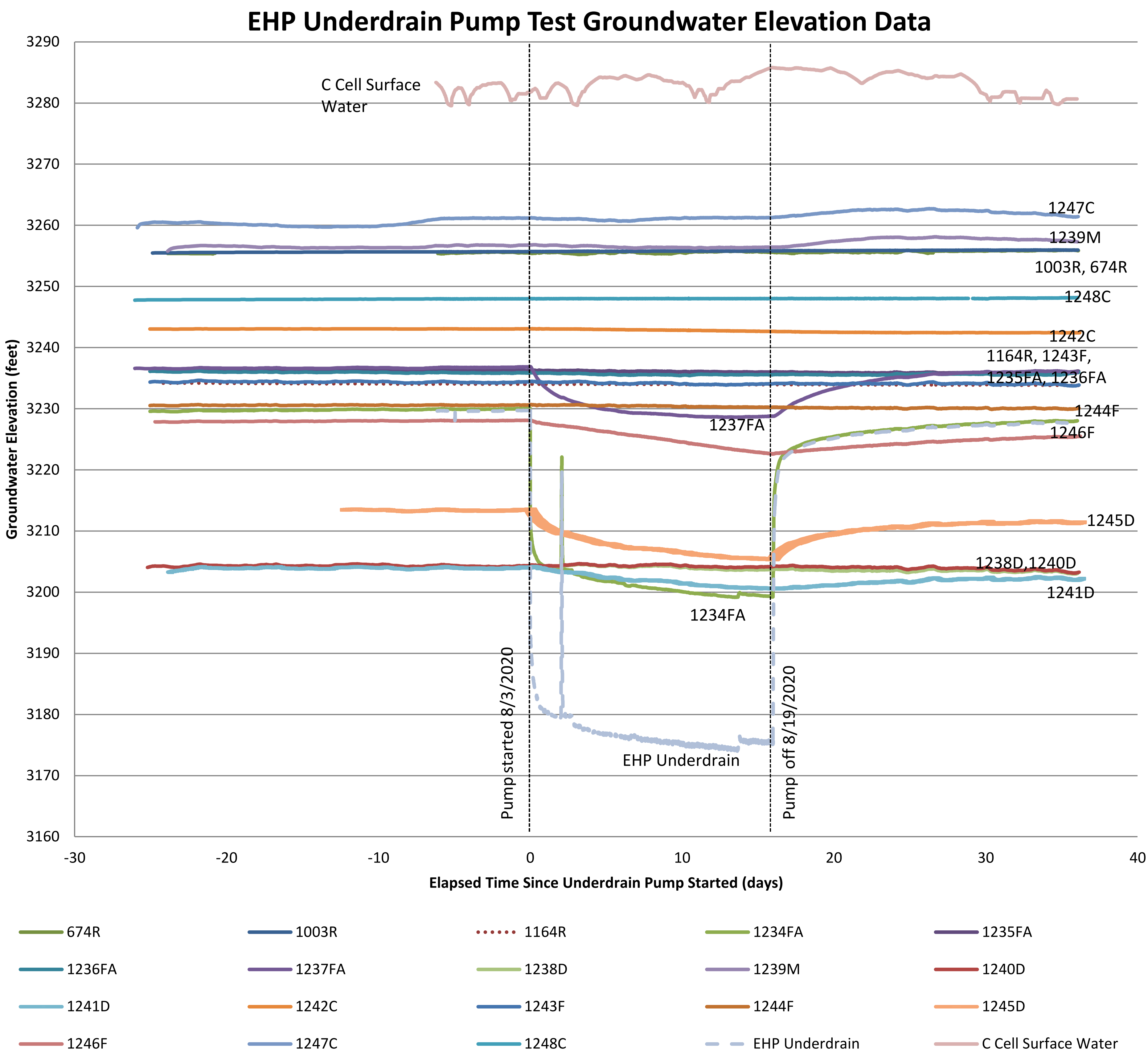

FINAL REPORT UNITS 3&4 EHP UNDERDRAIN PUMPING TEST TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION	RAINFALL AND WATER LEVEL ELEVATION HYDROGRAPH	FIGURE 5-3

Hydrometrics, Inc.
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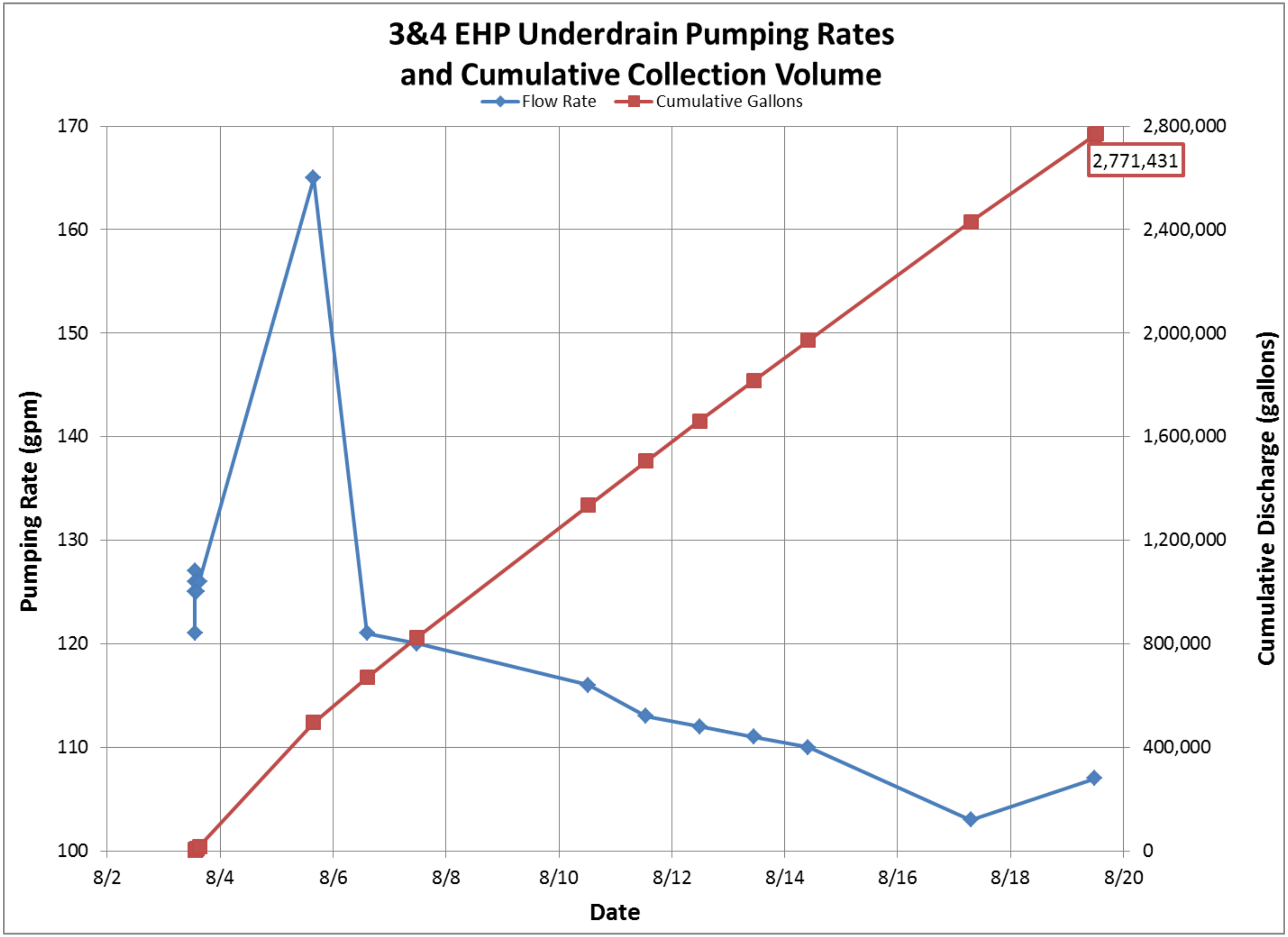

Hydrometrics, Inc.
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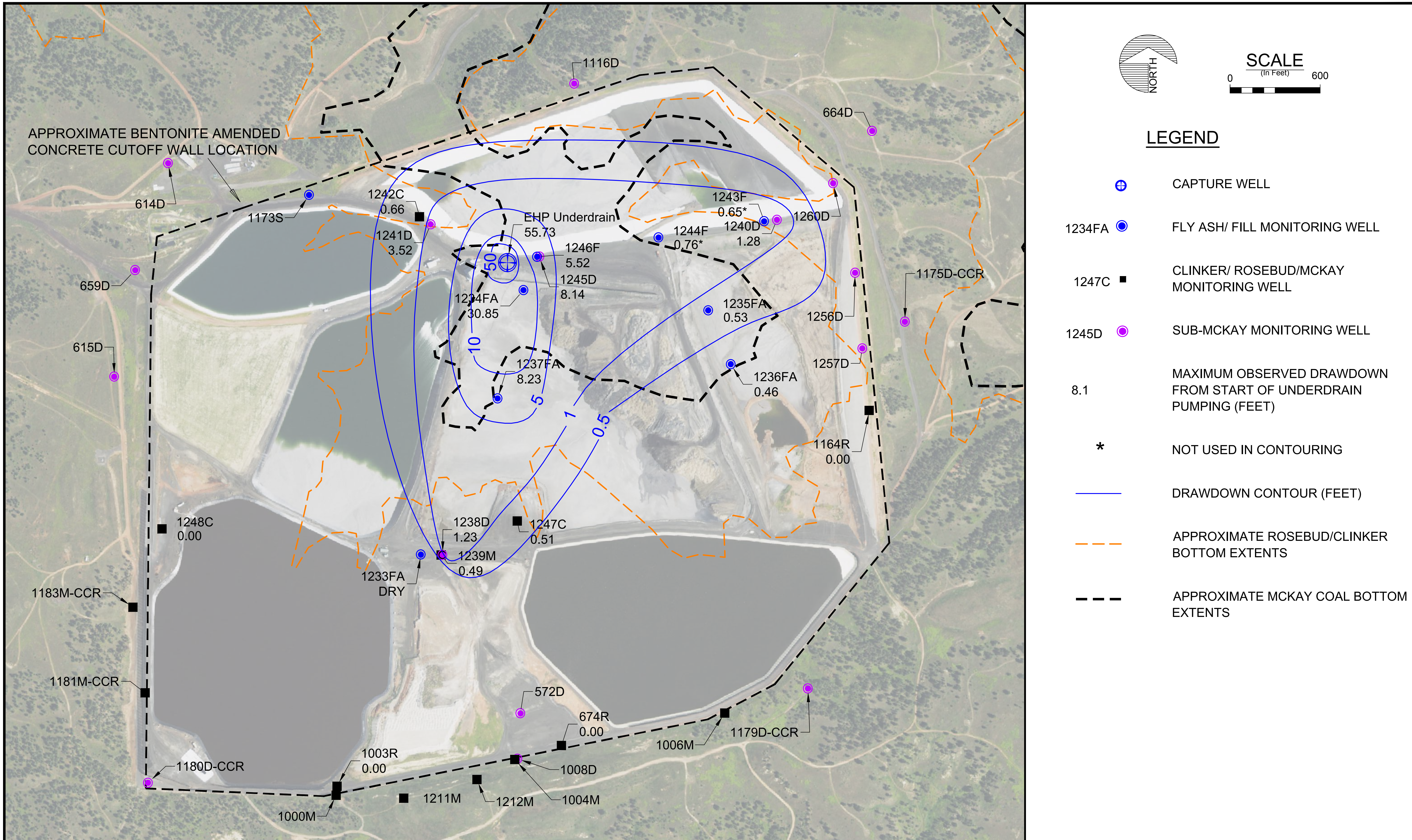
FINAL REPORT UNITS 3&4 EHP UNDERDRAIN PUMPING TEST TALEN MONTANA, LLC COLSTRIP STEAM ELECTRIC STATION	3&4 EHP UNDERDRAIN PUMPING TEST RATES AND VOLUME	FIGURE 5-4



FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

EHP UNDERDRAIN PUMPING TEST COMPOSITE DRAWDOWN

FIGURE 5-5

UPDATE TIME: 10:54 AM
JBERGIN\HEL\20201005\I:\LAND PROJECTS\TALEN\2001720\EHP DD MAX.DWG

Hydrometrics, Inc.
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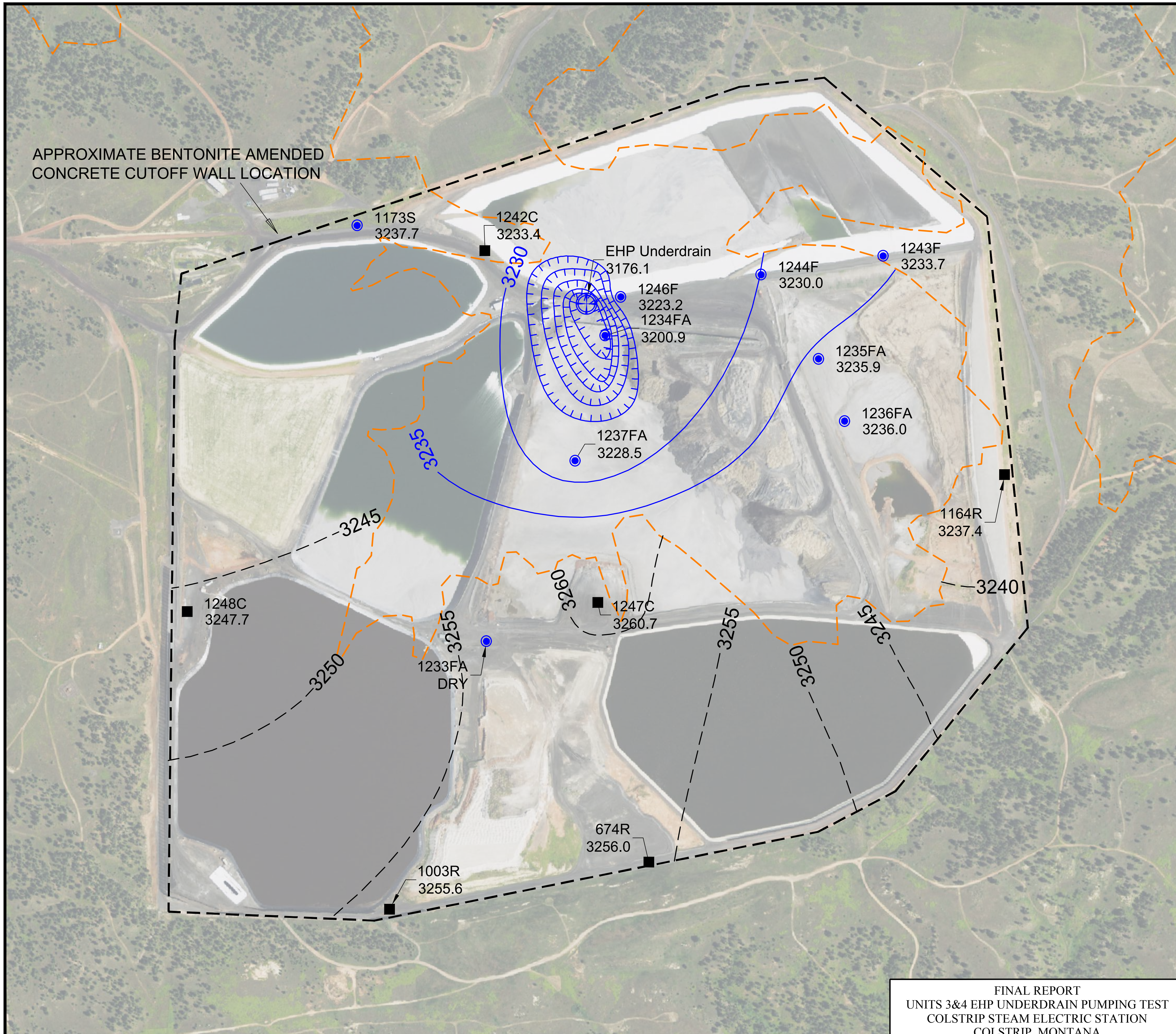


NORTH

SCALE (In Feet) 0 600

LEGEND

- CAPTURE WELL
- 1234FA — FLY ASH/ FILL MONITORING WELL
- 1247C — CLINKER/ ROSEBUD MONITORING WELL
- 3260.9 — GROUNDWATER ELEVATION
- FLY ASH/ FILL POTENTIOMETRIC CONTOUR (DASHED WHERE INFERRED)
- CLINKER/ ROSEBUD POTENTIOMETRIC CONTOUR (DASHED WHERE INFERRED)
- APPROXIMATE ROSEBUD/CLINKER BOTTOM EXTENTS

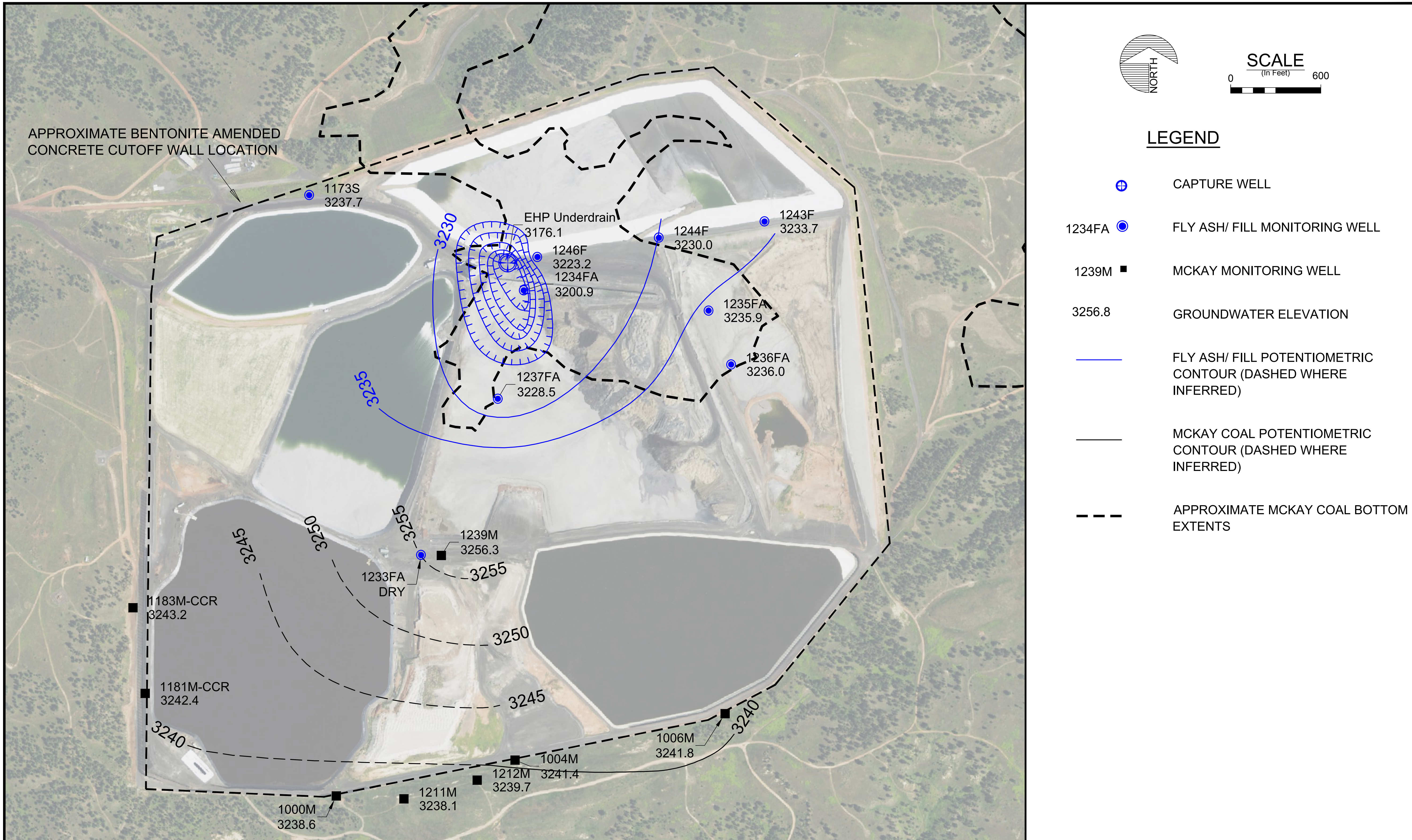
FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

FILL AND ROSEBUD/CLINKER POTENTIOMETRIC SURFACE AFTER TWO WEEKS OF EHP UNDERDRAIN PUMPING (08/17/20)

FIGURE **5-6**

UPDATE TIME: 1:47 PM
JBERGIN\HEL\20201005\I:\LAND PROJECTS\TALEN\2001720\EHP GWE 081720.DWG

Hydrometrics, Inc.
Consulting Scientists and Engineers



FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

FILL AND MCKAY COAL POTENTIOMETRIC SURFACE AFTER TWO WEEKS OF EHP UNDERDRAIN PUMPING (08/17/20)

FIGURE
5-7

UPDATE TIME: 1:47 PM
JBERGIN\HEL\20201005\I:\LAND PROJECTS\TALEN\2001720\EHP GWE 081720.DWG

Hydrometrics, Inc.
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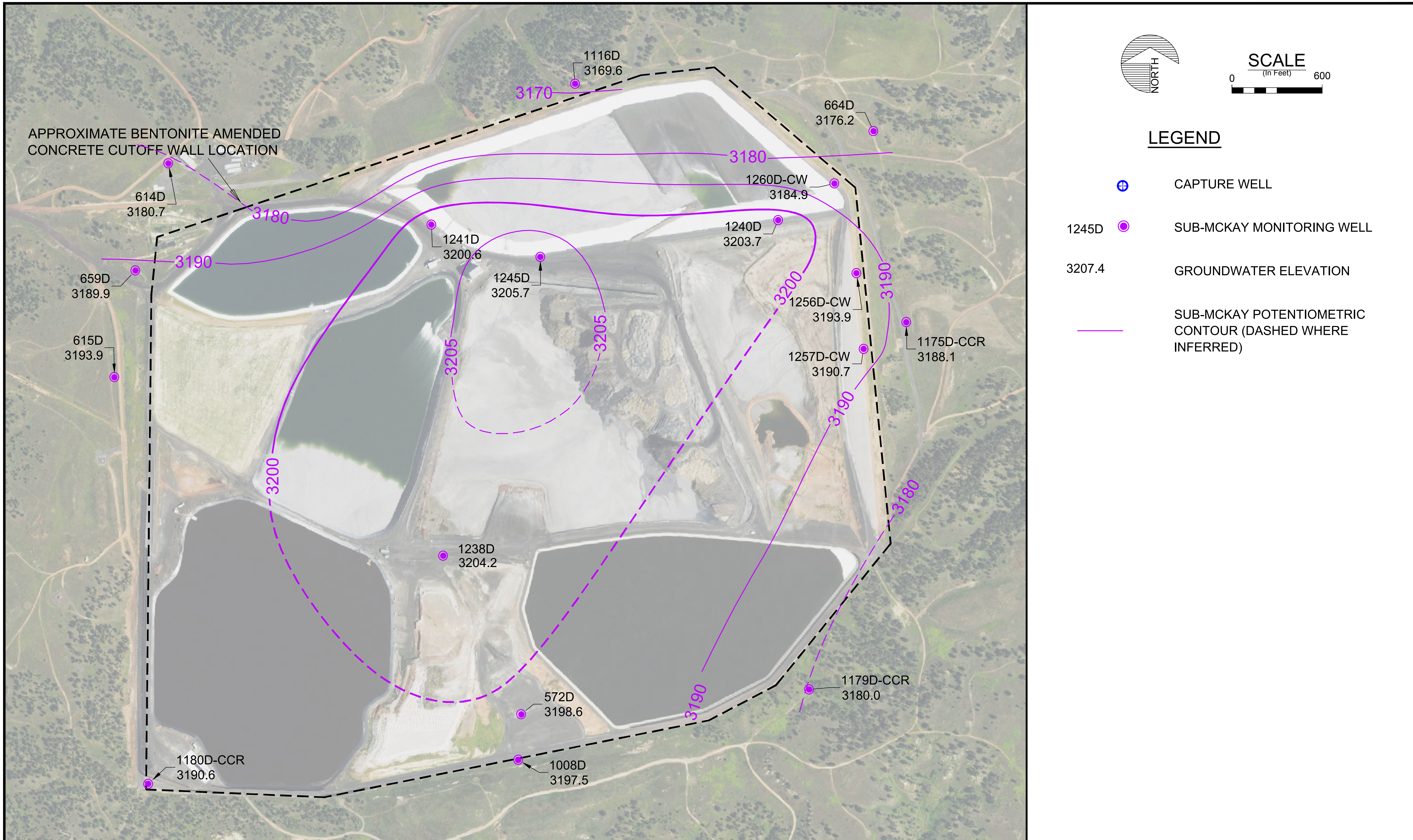


FINAL REPORT
UNITS 3&4 EHP UNDERDRAIN PUMPING TEST
COLSTRIP STEAM ELECTRIC STATION
COLSTRIP, MONTANA

SUB MCKAY POTENTIOMETRIC SURFACE AFTER TWO WEEKS OF EHP UNDERDRAIN PUMPING (08/17/20)

FIGURE **5-8**

UPDATE TIME: 9:04 AM
JBERGIN\HEL\20201012\I:\LAND PROJECTS\TALEN\2001720\EHP GWE 081720.DWG

Hydrometrics, Inc.
Consulting Scientists and Engineers

APPENDIX A

WELL LOGS

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1233FA

Date Hole Started: 6/1/2020 Date Hole Finished: 6/2/2020

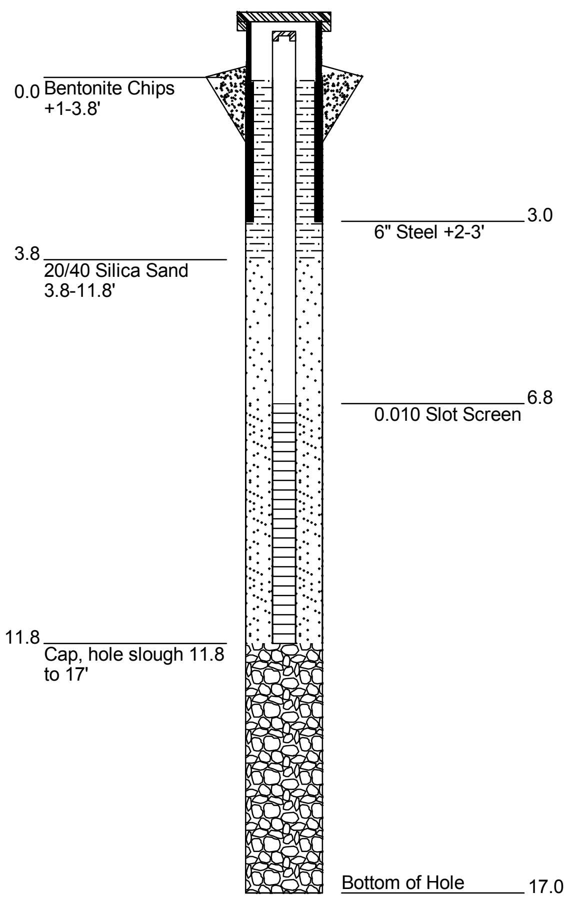
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: NE corner of 3&4 EHP D/E Cell
Recorded By: GH
Drilling Company: SK Geotechnical
Driller: Chad
Drilling Method: Hollow Stem Auger
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 9"(0'-12'), 2"(12'-17')
Hole Depth (ft): 17

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+1.75' - 11.8'
Surface Casing Used?	Y	6-inch steel	+2'-3'
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	6.8' - 11.8'
Sand Pack?	Y	20/40 silica sand	3.8' - 11.8'
Annular Seal?	Y	Bentonite Chips	+1' - 3.8'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	Y	Split Spoon	13'-15', 15'-17'

Northing: 602321.69 Easting: 2719795.91
Static Water Level Below MP: DRY Surface Casing Height (ft): 2
Date: 6/9/2020 Riser Height (ft): 1.76
MP Description: Top PVC Ground Surface Elevation (ft): 3291.0
MP Height Above or Below Ground (ft): 1.76 MP Elevation (ft): 3292.8

Remarks: Completed well in dry hole. Soil descriptions based on field observation of auger cuttings from 0-12' and split spoon samples from 12-17' bgs. Hole sloughed from 11.8-17' when augers pulled. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 2.0' **Ash** [Fly Ash]
silt, light gray gray, dry, mixed with small d. gray 1/2" glassy gravel and trace clinker gravel 3/4" minus

2.0 - 12.0' **Fly ash** [Fly Ash]
silt, light gray, moist to wet at 6', becomes dark black gray

12.0 - 17.0' **Fine Silty Sand w/Clinker Gravel** [Fill]
clinker in upper 5' only; slightly moist, unconsolidated, gravel to 1.5" diameter

13-15' - 2' split spoon blow counts per 6" (24,37,45,36)

15-17' - 2' split spoon blow counts per 6" (9,18,15,16)

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1234FA

Date Hole Started: 6/2/2020 Date Hole Finished: 6/3/2020

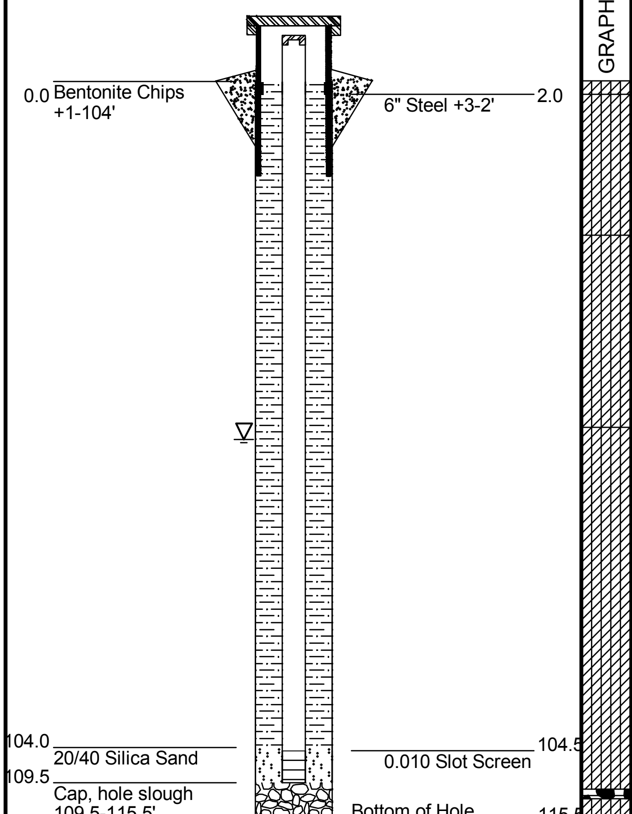
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 NE1/4 SE1/4
Location Description: N end of 3&4 EHP C Cell
Recorded By: GH
Drilling Company: SK Geotechnical
Driller: Chad
Drilling Method: Hollow Stem Auger
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 9"(0'-109.5'), 2"(109.5'-115.5')
Hole Depth (ft): 115.5

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+3-109.5
Surface Casing Used?	Y	6-inch steel	+3'-2'
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	104.5' - 109.5'
Sand Pack?	Y	20/40 silica sand	104' - 109.5'
Annular Seal?	Y	Bentonite Chips	+1'-104'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	12 Volt pump from mid-screen	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Split Spoon	109.5'-115.5'

Northing: 604084.09 Easting: 2720479.04
Static Water Level Below MP: 58.93 Surface Casing Height (ft): 3
Date: 6/9/2020 Riser Height (ft): 3
MP Description: Top PVC Ground Surface Elevation (ft): 3286.47
MP Height Above or Below Ground (ft): 3 MP Elevation (ft): 3289.47

Remarks: Soil descriptions based on field observations of auger cuttings from 0-109.5' and split spoon samples from 109.5-115.5' bgs. Field SC = 32,885 umhos/cm. Well coordinates are based on Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 2.0' **Fly ash** [Fly Ash]
silt, light gray, dry, hard

2.0 - 24.0' **Fly ash** [Fly Ash]
silt, medium gray, moist to very moist, soft

24.0 - 54.0' **Fly ash** [Fly Ash]
silt, dark gray, damp

54.0 - 110.5' **Fly ash** [Fly Ash]
silt, dark gray, wet

109.5 - 111.5'
109.5-111.5' - 2' split spoon blow counts per 6" (8,16,21,28)

110.5 - 112.0' **Clinker gravel** [Fill]
wet

111.5-113.5' - 2' split spoon blow counts per 6" (16,15,21,30)

112.0 - 115.5' **Silty clay** [Weathered Bedrock/Fill]
mix gray, tan, dark brown, stiff, slightly plastic, trace fine sand, moist, trace clinker gravel

113.5-115.5' - 2' split spoon blow counts per 6" (17,26,28,34)

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1235FA

Date Hole Started: 6/4/2020 Date Hole Finished: 6/4/2020

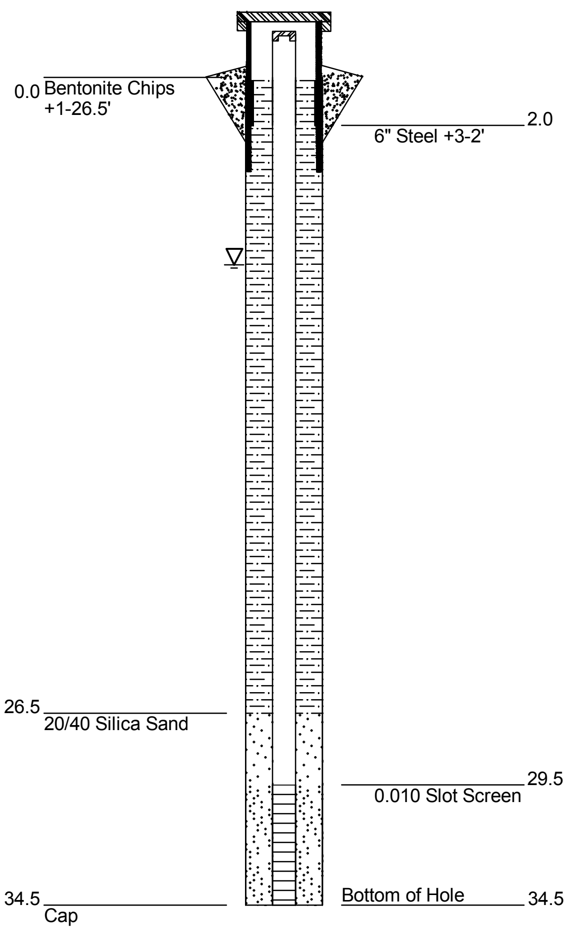
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 5 NW1/4 SE1/4
Location Description: E side of 3&4 EHP C Cell
Recorded By: GH
Drilling Company: SK Geotechnical
Driller: Chad
Drilling Method: Hollow Stem Auger
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 9"(0'-24.5'), 2"(24.5'-34')
Hole Depth (ft): 34.5

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.8'-34.5'
Surface Casing Used?	Y	6-inch steel	+3'-2'
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	29.5'-34.5'
Sand Pack?	Y	20/40 silica sand	26.5'-34.5'
Annular Seal?	Y	Bentonite Chips	+1'-26.5'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	12 Volt pump from mid-screen	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Split Spoon	19.5-21.5', 21.5-24.5' 24.5'-29.5', 29.

Northing: 603949.12 Easting: 2721708.88
Static Water Level Below MP: 10.62 Surface Casing Height (ft): 3
Date: 6/9/2020 Riser Height (ft): 2.81
MP Description: Top PVC Ground Surface Elevation (ft): 3244.63
MP Height Above or Below Ground (ft): 2.81 MP Elevation (ft): 3247.44

Remarks: Soil descriptions based on field observation of auger cuttings from 0-24.5' and split spoon samples from 24.5-34' bgs. Field SC = 24,300 umhos/cm, field pH = 8.5 s.u.. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 4.0' **Fly Ash** [Fly Ash]
silt, light gray, dry soft

4.0 - 18.0' **Fly Ash** [Fly Ash]
silt, gray, damp, soft

wet @ 6'

18.0 - 24.0' **Interlayered Silt and Clinker Gravel** [Clinker/Ash]
gravel - 3/4" minus

24' - Fly Ash

19.5-21.5' - 2' split spoon blow counts per 6" (2,6,4,3)

21.5-24.5 - only collected 1st 2', 2' split spoon blow counts per 6" (3,6,5,7)

24.0 - 34.5' **Fly Ash** [Fly Ash]
silt, gray, wet, soft

24.5-29.5' - changed to 5' split spoon blow counts per 6" (13,14,15,12,11,12,19,13,10,8)

29.5-34' - 5' split spoon blow counts per 6" (3,7,6,7,13,19,15,23,50 for 5")

STANDARD_REV3 ALL TALEN.GPJ HYDHLN2.GDT 10/12/20

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1236FA

Date Hole Started: 6/4/2020 Date Hole Finished: 6/4/2020

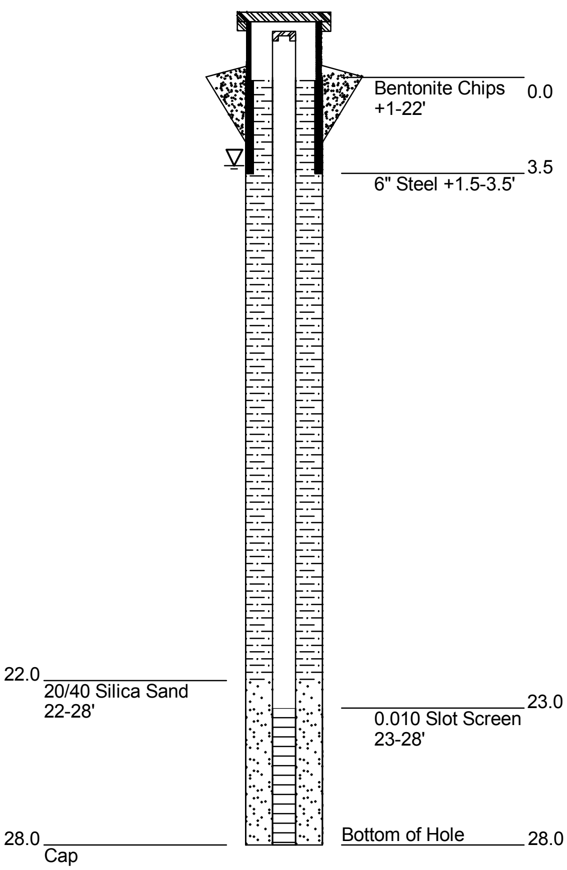
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 5 NW1/4 SW1/4
Location Description: 3&4 EHP G Cell
Recorded By: GH
Drilling Company: SK Geotechnical
Driller: Chad
Drilling Method: Hollow Stem Auger
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 9"
Hole Depth (ft): 28

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+1'-28'
Surface Casing Used?	Y	6-inch steel	+1.5'-3.5'
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	23'-28'
Sand Pack?	Y	20/40 silica sand	22'-28'
Annular Seal?	Y	Bentonite Chips	+1' - 22'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	12 Volt pump from mid-screen	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 603591.01 Easting: 2721859.31
Static Water Level Below MP: 4.18 Surface Casing Height (ft): 1.5
Date: 6/9/2020 Riser Height (ft): 0.97
MP Description: Top PVC Ground Surface Elevation (ft): 3240.06
MP Height Above or Below Ground (ft): 0.97 MP Elevation (ft): 3241.03

Remarks: Soil descriptions based on field observation. Field SC = 30,504 umhos/cm, field pH = 8.38 s.u..Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 5.0' **Fly Ash** [Fly Ash]
silt, gray, moist, soft

5.0 - 19.0' **Fly Ash** [Fly Ash]
silt, gray, wet, soft

clinker @ 17' (0.5-1" diameter)

19.0 - 22.0' **Clinker and Fly Ash** [Clinker/Ash]
silt

22.0 - 27.5' **Fly Ash** [Fly Ash]
silt

27.5 - 28.0' **Fly Ash** [Fly Ash]
silt gray, very hard

blow count 25, 1" for 50

refusal @ 28', 50 blows on split spoon for 1"

STANDARD_REV3 ALL TALEN.GPJ HYDHLN2.GDT 10/12/20

Hydrometrics, Inc.

Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1237FA

Date Hole Started: 6/8/2020 Date Hole Finished: 6/9/2020

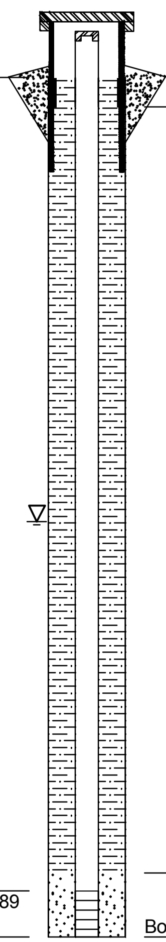
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 5 NE1/4 SE1/4
Location Description: East side of 3&4 EHP C Cell
Recorded By: GH
Drilling Company: SK Geotechnical
Driller: Chad
Drilling Method: Hollow Stem Auger
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 9"
Hole Depth (ft): 94

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+1.6'-94'
Surface Casing Used?	Y	6-inch steel	+1.75'-3.25'
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	89'-94'
Sand Pack?	Y	20/40 silica sand	87'-94'
Annular Seal?	Y	Bentonite Chips	+1'-87'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	12 Volt pump from mid-screen	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 603362.34 Easting: 2720306.76
Static Water Level Below MP: 50.24 Surface Casing Height (ft): 1.75
Date: 6/9/2020 Riser Height (ft): 1.64
MP Description: Top PVC Ground Surface Elevation (ft): 3288.16
MP Height Above or Below Ground (ft): 1.64 MP Elevation (ft): 3289.8

Remarks: Soil descriptions based on field observation. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 4.0' **Fly Ash** [Fly Ash]
silt, light gray, slightly stiff

4.0 - 73.0' **Fly Ash** [Fly Ash]
silt, medium gray, wet, soft

73.0 - 94.0' **Fly Ash** [Fly Ash]
silt, medium gray, not as wet as above, stiff

91' - very hard

hit refusal at 94'

Hydrometrics, Inc.

Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1238D

Date Hole Started: 6/19/20 Date Hole Finished: 6/30/20

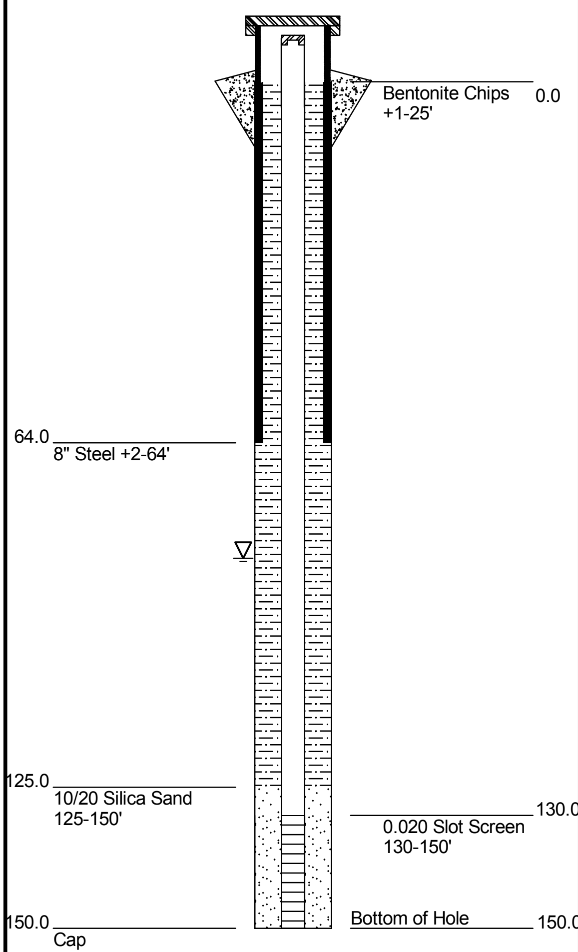
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: N. of 3&4 EHP D/E Cell
Recorded By: GH/RJL
Drilling Company: Askin Drilling
Driller: Doug
Drilling Method: Air Rotary
Drilling Fluids Used: Air/Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Sub McKay
Hole Diameter (in): 11"(0'-64'), 8"(64'-150')
Hole Depth (ft): 150

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+2'-130'
Surface Casing Used?	Y	8-inch steel	+2'-64'
Screen/Perforations?	Y	0.025-inch slot, Sch 40 PVC	130'-150'
Sand Pack?	Y	10/20 Silica Sand	125'-150'
Annular Seal?	Y	3/8" Bentonite Chips	+1'- 125'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift and submersible pump.	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Core barrel	64 - 74; 131 - 149

Northing: 602319.52 Easting: 2719940.34
Static Water Level Below MP: 86.01 Surface Casing Height (ft): 2
Date: 7/1/20 Riser Height (ft): 1.6
MP Description: Top PVC Ground Surface Elevation (ft): 3291.4
MP Height Above or Below Ground (ft): 1.6 MP Elevation (ft): 3293

Remarks: Soil descriptions based on field observation of cuttings and/or core samples. Cores sampled from 64 - 74' and 131 -149' with 3" dia. core barrel. Field SC decreased from 18,250 to 15,540 umhos/cm at end of development with rig air. Field SC = 5,226 umhos/cm after pumping. Estimated well yield = 4-5 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 3.0' **Fly Ash** [Fly Ash]
silt, light gray, soft, moist, powdery

3.0 - 24.0' **Sandy Silt Mix** [Fill]
gray, moist to damp w/depth, minor coal chunks, minor clinker gravel

24.0 - 35.0' **Sandy Silt** [Fill]
brown, moist, stiff, trace clay

wet @ 30'

35.0 - 58.0' **Clinker** [Clinker]
thermally altered siltstone, light red to red, loose, weathered/fractured, up to 2.5" fragments

58.0 - 64.0' **Clinker** [Clinker]
thermally altered sandstone, tan, wet, moderately hard, fractured, minor vitrified

64.0 - 66.0' **Coal** [Coal]
black, wet, stiff, trace pyrite, cleated, ash at top

66.0 - 67.0' **Siltstone/Interbedded Coal** [Bedrock]
medium gray, dry, firm, coal w/iron pyrite as above; open hole yield is ~ 100 gpm (from clinker above)

67.0 - 68.0' **Coal** [Coal]
black, hard, lots of pyrite, cleated, blocky

68.0 - 75.0' **Siltstone/Claystone** [Bedrock]
medium gray, dry, firm to stiff, non-plastic

75' - sandstone stringer, light olive gray, stiff

75.0 - 85.0' **Coal** [McKay Coal]
black, hard

85.0 - 117.0' **Siltstone** [Bedrock]
medium gray to light olive gray, dry, non-plastic

91' - sandstone stringer
102' - carb. shale stringer
104' - carb. shale stringer
107' - sandstone stringer

water injected while drilling below 85'; City of Colstrip water supply ; SC = 715 umhos/cm and pH =7.87.

117.0 - 122.0' **Shale** [Bedrock]
brownish gray, dry, firm to stiff

122.0 - 131.0' **Siltstone** [Bedrock]
light olive gray, dry, medium firm, non-plastic

Continued Next Page

WELL CONSTRUCTION	GRAPHICS	GEOLOGICAL DESCRIPTION
		131.0 - 142.0' **Sandstone** [Bedrock] greenish light gray, medium fine grained, weak
		142.0 - 150.0' **Shale/Siltstone** [Bedrock] medium gray, dry, stiff coal stringer w/pyrite @ 142', 145', 149.5'

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1239M

Date Hole Started: 6/19/20 Date Hole Finished: 7/9/20

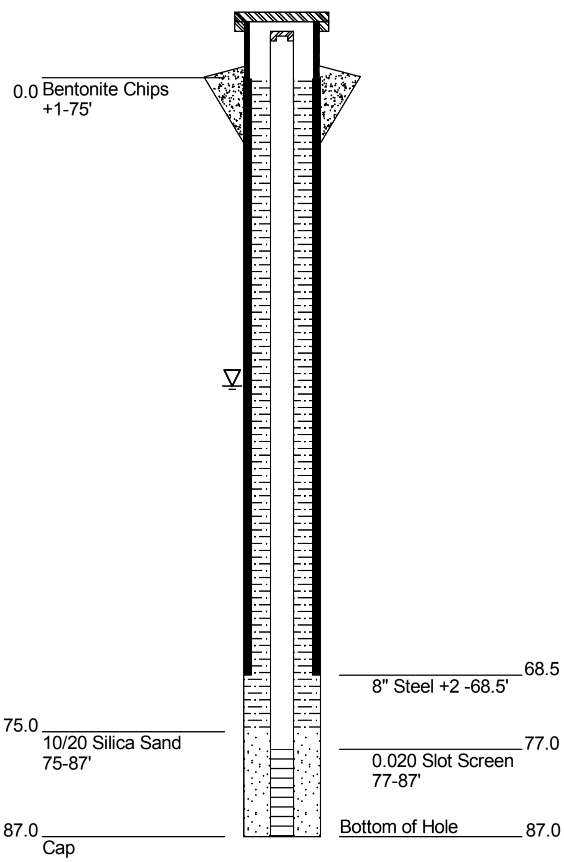
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: N. of 3&4 EHP D/E Cell
Recorded By: GH/RJL
Drilling Company: Askin Drilling
Driller: Doug
Drilling Method: Air Rotary
Drilling Fluids Used: Air/Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Sub McKay
Hole Diameter (in): 11"(0'-64'), 8"(64'-87')
Hole Depth (ft): 87

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+2'-87'
Surface Casing Used?	Y	8-inch steel	+2'-68.5'
Screen/Perforations?	Y	0.025-inch slot, Sch 40 PVC	77'-87'
Sand Pack?	Y	10/20 Silica Sand	75'-87'
Annular Seal?	Y	3/8" Bentonite Chips	+1'-75'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Core barrel	77' - 87'

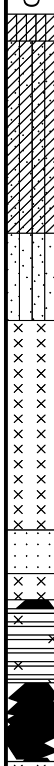
Northing: 602319.43 Easting: 2719931.27
Static Water Level Below MP: 37.02 Surface Casing Height (ft): 2
Date: 7/10/2020 Riser Height (ft): 1.67
MP Description: Top PVC Ground Surface Elevation (ft): 3291.51
MP Height Above or Below Ground (ft): 1.67 MP Elevation (ft): 3293.18

Remarks: Soil descriptions based on field observation of cuttings and/or core samples. Cores sampled from 77 - 87' with 3" dia. core barrel. Field SC = 16750 umhos/cm, estimated well yield = 3-4 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS



GEOLOGICAL DESCRIPTION

0.0 - 3.0' **Fly Ash** [Fly Ash]
silt, light gray, moist, soft, powdery

3.0 - 25.0' **Mix Silt & Sand, chunks of Coal** [Fill]
dark gray, moist to damp w/depth, mixed w/minor clinker gravel

25.0 - 35.0' **Sandy Silt** [Fill]
brown, moist, stiff, trace clay

35' - wet

35.0 - 59.0' **Clinker** [Clinker]
thermally altered Siltstone up to 2.5" cuttings, light red to red, weathered

55' - still loose
60' - still loose, adding gray to mix, clinker is fractured, some vitrified, sulfur smell

59.0 - 64.0' **Clinker** [Clinker]
thermally altered sandstone, tan, wet, hard, weathered

64.0 - 67.0' **Siltstone/Interbedded Coal** [Bedrock]
medium gray, dry, firm, coal w/iron pyrite as above

open hole yield is ~ 100 gpm (from clinker above)

67.0 - 68.0' **Coal** [Coal]
black, hard, lots of pyrite, cleated, blocky

68.0 - 76.5' **Siltstone/Claystone** [Bedrock]
medium gray, dry, firm to stiff, non-plastic

75' - SS stringer, light olive gray, stiff

76.5 - 85.5' **Coal** [McKay Coal]
black, not cleated, trace pyrite throughout

85.5 - 87.0' **Siltstone** [Bedrock]
light olive gray, dry, firm, non-plastic

STANDARD_REV3 ALL TALEN.GPJ HYDHLN2.GDT 8/19/20

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1240D

Date Hole Started: 6/22/20 Date Hole Finished: 7/1/20

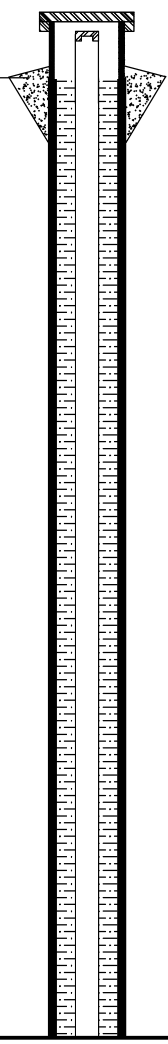
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: North of 3&4 EHP G Cell
Recorded By: GH/RJL
Drilling Company: Askin Drilling
Driller: Doug
Drilling Method: Air Rotary
Drilling Fluids Used: Air/Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Sub McKay
Hole Diameter (in): 11"(0'-86'), 8"(86'-146')
Hole Depth (ft): 146

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+1.2'-120'
Surface Casing Used?	Y	8-inch steel	+2'-86'
Screen/Perforations?	Y	0.025-inch slot, Sch 40 PVC	120'-146'
Sand Pack?	Y	10/20 Silica Sand	114'-146'
Annular Seal?	Y	3/8" Bentonite Chips	+1'-114'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Core barrel	86' - 95', 120' - 135'

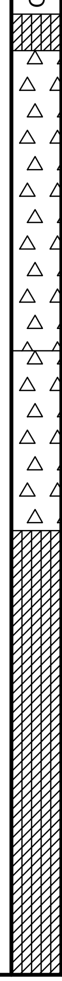
Northing: 604552.55 Easting: 2722166.84
Static Water Level Below MP: 87.3 Surface Casing Height (ft): 2
Date: 7/1/20 Riser Height (ft): 1.26
MP Description: Top PVC Ground Surface Elevation (ft): 3290.1
MP Height Above or Below Ground (ft): 1.26 MP Elevation (ft): 3291.37

Remarks: Soil descriptions based on field observation of cuttings and core samples. Core sampled from 86' to 95'; no recovery from core barrel from 120 - 135'. Field SC = 14,410 umhos/cm at end of air lift, estimated well yield = 2.5-3 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS



GEOLOGICAL DESCRIPTION

0.0 - 3.0' **Bottom Ash** [Bottom Ash]

3.0 - 28.0' **Clinker Fill Material** [Embankment Fill]
mix of thermally altered siltstone & sandstone gravels, minor fly ash, mix red & tan, moist, non-consolidated

28.0 - 43.0' **Clinker Fill Material** [Embankment Fill]
thermally altered sandstone gravels; dark red, moist, stiff, 1" minus, weathered/fractured, non-consolidated

43.0 - 83.0' **Ash** [Fly Ash]
silt, clayey, moist to wet @ 60', loose

Continued Next Page

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1240D

Date Hole Started: 6/22/20 Date Hole Finished: 7/1/20

WELL CONSTRUCTION

Depth	Well Construction	Depth
	8" Steel +2-86'	86.0
114.0	10/20 Silica Sand 114-146'	
	0.020 Slot Screen 120-146'	120.0
146.0	Cap / Bottom of Hole	146.0

GEOLOGICAL DESCRIPTION

83.0 - 85.0' **Sandy Silt Gravel** [Fill]
brown w/red and yellow clinker gravel, 1" minus

85.0 - 92.0' **Coal** [McKay Coal]
black, wet (moisture difficult to determine as water from upper hole not sealed), cleated, trace pyrite

92.0 - 100.0' **Claystone** [Bedrock]
dark greenish gray (5G 4/1), dry, very stiff, non-plastic, trace quartz crystals

94' - 45° fracture in core sample
grades to siltstone at 100'
water injected below 100'; source is City of Colstrip; SC = 715 umhos/cm, pH = 7.87

100.0 - 102.0' **Siltstone** [Bedrock]
light brownish gray, dry, moderately firm

102.0 - 106.0' **Sandstone** [Bedrock]
light gray, dry?, very fine grained

106.0 - 120.0' **Siltstone/Shale** [Bedrock]
medium dark gray to medium gray, dry, moderately firm

120.0 - 136.0' **Sandstone** [Bedrock]
medium dark gray w/ coal streaks, wet, medium fine grained, weak

136.0 - 138.0' **Siltstone** [Bedrock]
light olive gray, moderately firm, non-plastic

138.0 - 143.0' **Sandstone** [Bedrock]
light olive gray, wet, making water, moderately firm, fine grained

143.0 - 146.0' **Siltstone** [Bedrock]
greenish gray, stiff

STANDARD_REV3 ALL TALEN.GPJ HYDHLN2.GDT 8/19/20

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1241D

Date Hole Started: 6/22/20 Date Hole Finished: 7/9/20

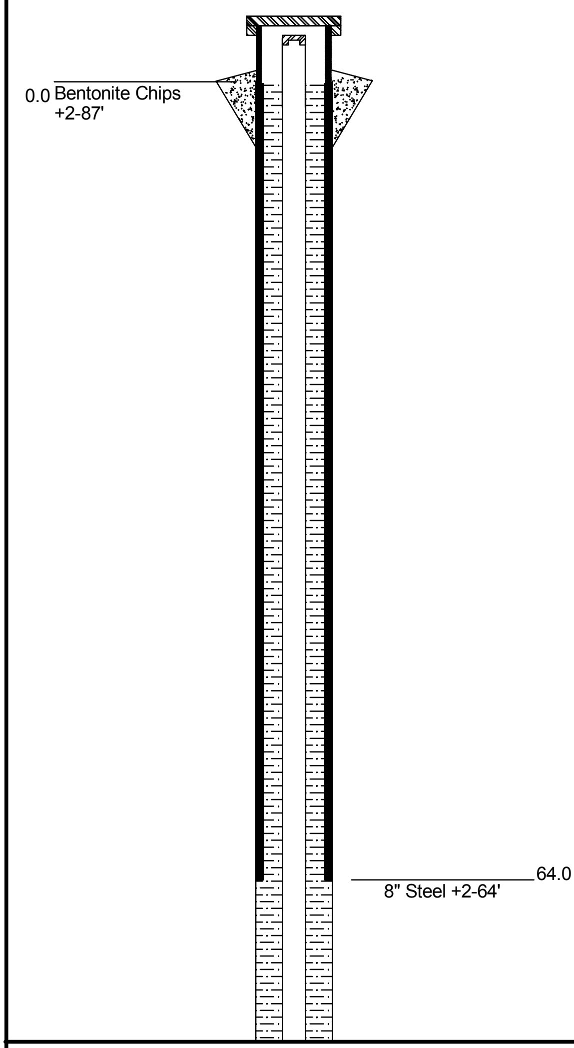
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: NE of 3&4 EHP A Cell; W of 3&4 EHP J-1 Cell
Recorded By: GH/RJL
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: Air/Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Sub McKay
Hole Diameter (in): 11"(0'-18'), 7-7/8"(18'-140')
Hole Depth (ft): 140

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+2'-140'
Surface Casing Used?	Y	8-inch steel	+2'-64'
Screen/Perforations?	Y	0.025-inch slot, Sch 40 PVC	100'-140'
Sand Pack?	Y	10/20 Silica Sand	87'-140'
Annular Seal?	Y	3/8" Bentonite Chips	+1'-87'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Split spoon/Core barrel	64' - 74'; 104' - 106'; 106' - 120'

Northing: 604522.72 Easting: 2719861.04
Static Water Level Below MP: 89.75 Surface Casing Height (ft): 2
Date: 7/10/2020 Riser Height (ft): 0.88
MP Description: Top PVC Ground Surface Elevation (ft): 3293.2
MP Height Above or Below Ground (ft): 0.88 MP Elevation (ft): 3294.08

Remarks: Soil descriptions based on field observation of cuttings and split spoon/core barrel samples. Field SC = 26,140 umhos/cm at end of air lift, estimated well yield = 10 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

0.0 - 5.0' **Sandy Silt** [Road Base Fill]
brown, moist, clinker gravel fill (2" minus)

5.0 - 12.0' **Sandy Silt** [Embankment Fill]
dark brown, moist, clinker gravel (1.5" minus)

12.0 - 50.0' **Clinker** [Clinker]
thermally altered siltstone, dark red, dry, hard

20' - pinkish red, hard, dry

45-50' - gray, dry

50.0 - 57.0' **Clinker** [Clinker]
gray and red, moist, soft brown clay in mix

57.0 - 63.0' **Sandy Siltstone** [Bedrock]
tan/light brown, damp, minor clay

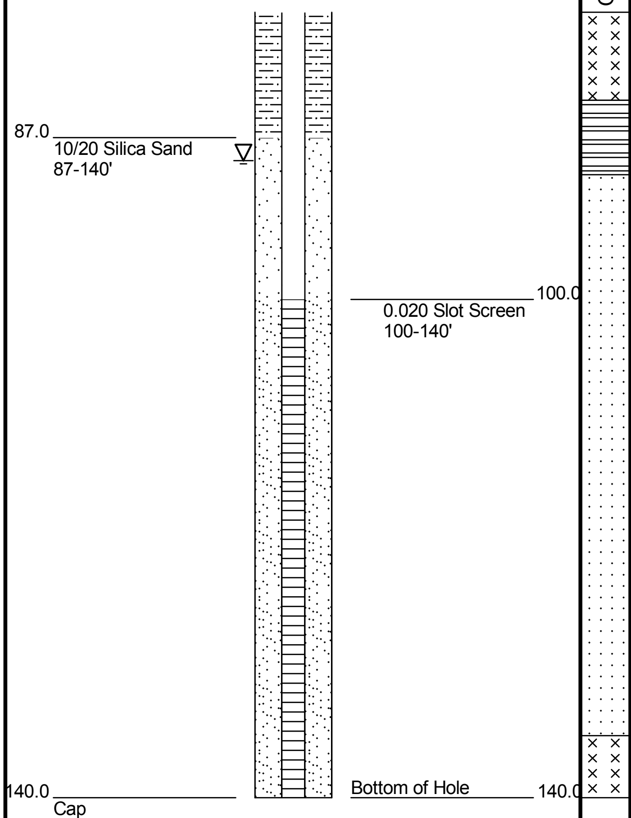
63.0 - 64.0' **Claystone** [Bedrock]
gray, wet, plastic, minor tan silt;
water injected below 64' from City of Colstrip SC = 715 umhos/cm, pH = 7.87

64.0 - 67.0' **Siltstone/Claystone** [Bedrock]
light olive gray to medium yellowish brown, firm to stiff, trace carbonaceous
core barrel sample from 64' - 74', 95% recovery

67.0 - 69.0' **Sandy Siltstone** [Bedrock]
light olive gray to dark yellowish orange, dry, hard, oxidized

Continued Next Page

WELL CONSTRUCTION



GRAPHICS

GEOLOGICAL DESCRIPTION

69.0 - 84.0' **Siltstone** [Bedrock]
mottled dark yellowish orange and light olive gray, dry (core dry), firm, trace carbonaceous stringers throughout

84.0 - 90.0' **Shale** [Bedrock]
medium gray to brownish gray, medium firm, non-plastic, carbonaceous?

85' - very thin coal stringer

90.0 - 135.0' **Sandstone** [Bedrock]
pale yellowish brown, wet, fined grained, weak

91-92' - siltstone stringer, pale yellowish brown to light olive gray
124' - siltstone stringer

Pushed split spoon from 104' - 106'; 50% recovery of sandstone interval

Drilled with 3" core barrel from 106' - 120' bgs; no returns in core barrel

135.0 - 140.0' **Siltstone** [Bedrock]
medium gray, dry, firm, moderately plastic

Hydrometrics, Inc.

Consulting Scientists and Engineers
Billings, Montana

Hole Name: 1242C

Date Hole Started: 6/23/20 | Date Hole Finished: 6/23/20

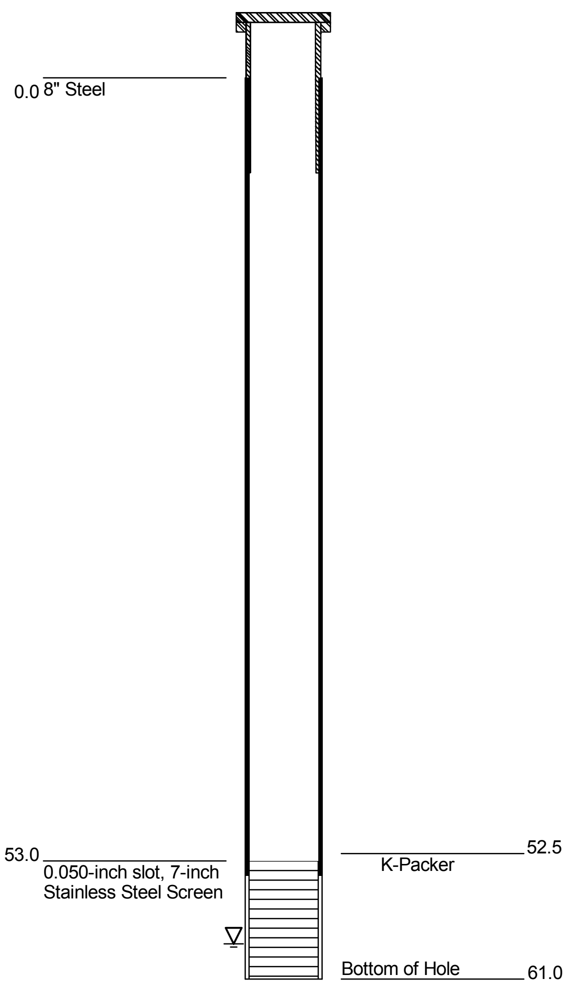
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud | State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: EHP East side of J-1 Cell
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Clinker
Hole Diameter (in): 11"(0'-18'), 7-7/8"(18'-61')
Total Depth Drilled (ft): 61

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	8-inch steel	+1.75'-61'
Surface Casing Used?	Y	8-inch Steel	+1.75'-54'
Screen/Perforations?	Y	0.050-inch slot, 7" Stainless Steel	53'-61'
Sand Pack?	N		
Annular Seal?	N		
Surface Seal?	Y	Concrete Pad	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Airlift	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 604572.46 | Easting: 2719787.24
Static Water Level Below MP: 60.36 | Surface Casing Height (ft): 1.75
Date: 6/24/20 | Riser Height (ft): 1.75
MP Description: Top PVC | Ground Surface Elevation (ft): 3292.5
MP Height Above or Below Ground (ft): 1.75 | MP Elevation (ft): 3294.25

Remarks: Soil descriptions based on field observation. Well completed with a K-packer positioned inside 8" steel casing; 8" steel pulled back 7' to expose 7" stainless steel screen. Field SC = 11,760 umhos/cm, estimated well yield = 1-2 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 8.0' **Sandy silt**
brown, moist, soft, 1.5" plus clinker gravel
[Fill]

8.0 - 20.0' **Clinker (Siltstone)**
dark red, hard, dry
[Clinker]

20.0 - 50.0' **Clinker (Sandstone)**
dark red, moderately stiff, hard

pink @ 25'
[Clinker]

50.0 - 57.0' **Clinker**
dark red and grays, hard, minor soft brown and gray clay, wet at 55'
[Clinker]

57.0 - 61.0' **Siltstone**
gray and minor tan, slightly plastic, wet
[Bedrock]

Hydrometrics, Inc.
Consulting Scientists and Engineers
Billings, Montana

Monitor Well Log

Hole Name: 1243F

Date Hole Started: 6/23/20 Date Hole Finished: 6/23/20

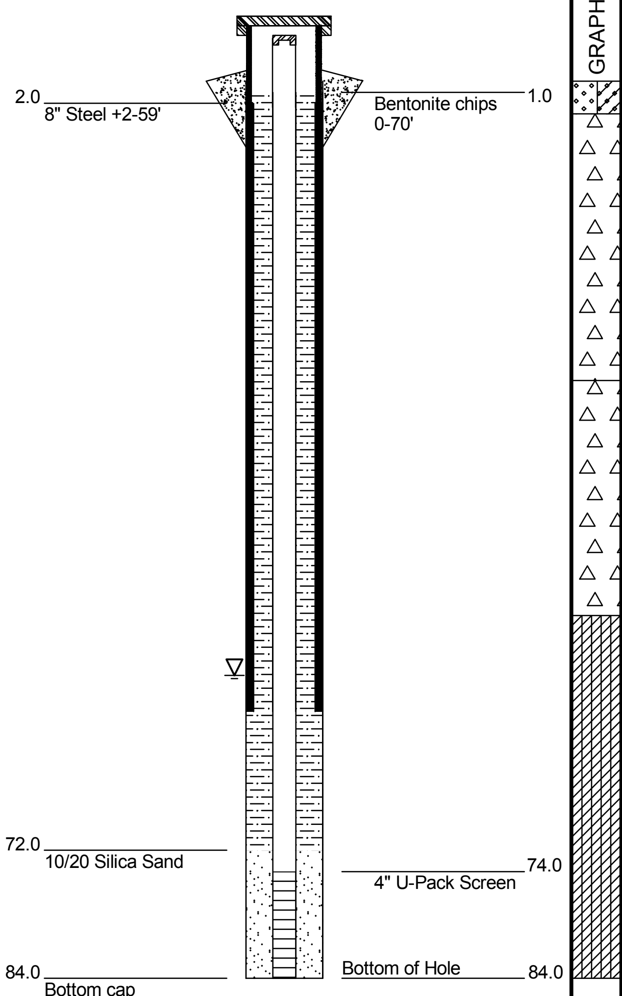
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: North of 3&4 EHP G Cell
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Divider Dike Fill
Hole Diameter (in): 11" (0-18'), 8" (18 - 84')
Hole Depth (ft): 84

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+1.1'-84'
Surface Casing Used?	Y	8-inch Steel	+2'-59'
Screen/Perforations?	Y	0.020-inch slot, U-Packit PVC Screen	74'-84'
Sand Pack?	Y	10/20 Silica Sand	72'-84
Annular Seal?	Y	3/8" Bentonite Chips	+0'-72'
Surface Seal?	Y	Concrete Pad	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 604542.34 Easting: 2722081.39
Static Water Level Below MP: 56.72 Surface Casing Height (ft): 2
Date: 6/24/20 Riser Height (ft): 1.11
MP Description: Top PVC Ground Surface Elevation (ft): 3289.9
MP Height Above or Below Ground (ft): 1.11 MP Elevation (ft): 3291.01

Remarks: Soil descriptions based on field observation. Field SC = 10,870 umhos/cm, estimated well yield = 12-15 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 3.0' **Bottom Ash** [Bottom Ash]

3.0 - 28.0' **Fill (Clinker)** [Embankment Fill]
red & tan mix, minor fly ash, moist, non-consolidated

17' - red orange clinker
21-' moist to damp

28.0 - 50.0' **Thermally altered sandstone** [Embankment Fill]
stiff, moist

46' - mixed w/fly ash

50.0 - 84.0' **Silt** [Fly Ash]
gray, damp, loose

57' - wet; injecting water at 60'; source of injection water is Askin's Fox Hills Well; SC = 1788 umhos/cm, pH = 8.64
75' - hit boulder, sandstone, fine, gray (1' thick)
80' - loose minor coal mixed in

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Monitor Well Log

Hole Name: 1244F

Date Hole Started: 6/23/20 Date Hole Finished: 6/23/20

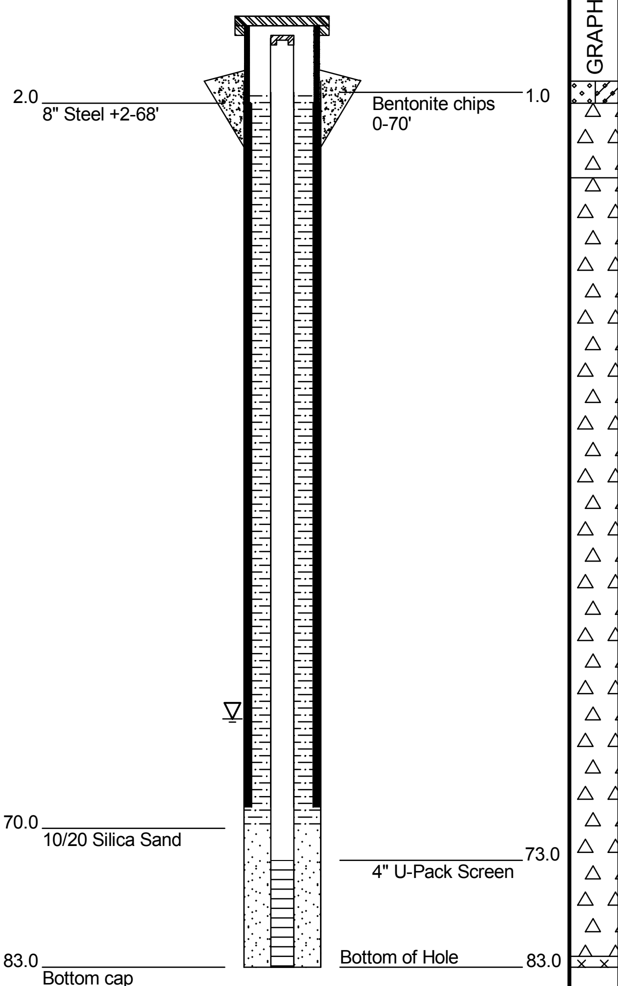
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: North of 3&4 EHP C Cell
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 11" (0-18'), 8" (18 - 83')
Hole Depth (ft): 83

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+1.1'-83'
Surface Casing Used?	Y	8-inch Steel	+2'-68'
Screen/Perforations?	Y	0.020-inch slot, U-Packit PVC Screen	73'-83'
Sand Pack?	Y	10/20 Silica Sand	70'-83
Annular Seal?	Y	3/8" Bentonite Chips	+0'-70'
Surface Seal?	Y	Concrete Pad	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Bailed for 15 minutes	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 604434.3 Easting: 2721378.13
Static Water Level Below MP: 60.86 Surface Casing Height (ft): 2
Date: 7/28/2020 Riser Height (ft): 1.12
MP Description: Top PVC Ground Surface Elevation (ft): 3290.2
MP Height Above or Below Ground (ft): 1.12 MP Elevation (ft): 3291.32

Remarks: Soil descriptions based on field observation. Field SC = 21,580 umhos/cm, estimated well yield = 5 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 2.0' **Bottom Ash** [Bottom Ash]
w/clinker gravel

2.0 - 9.0' **Clinker Fill** [Fill]
orange, 1" minus

9.0 - 82.0' **Mix Ash & Clinker Gravel** [Embankment Fill]
moist to wet with depth, soft, 1.5" minus

82.0 - 83.0' **Siltstone** [Bedrock]
green gray, stiff, wet, trace clay & sand

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Monitor Well Log

Hole Name: 1245D

Date Hole Started: 7/10/2020 Date Hole Finished: 7/10/2020

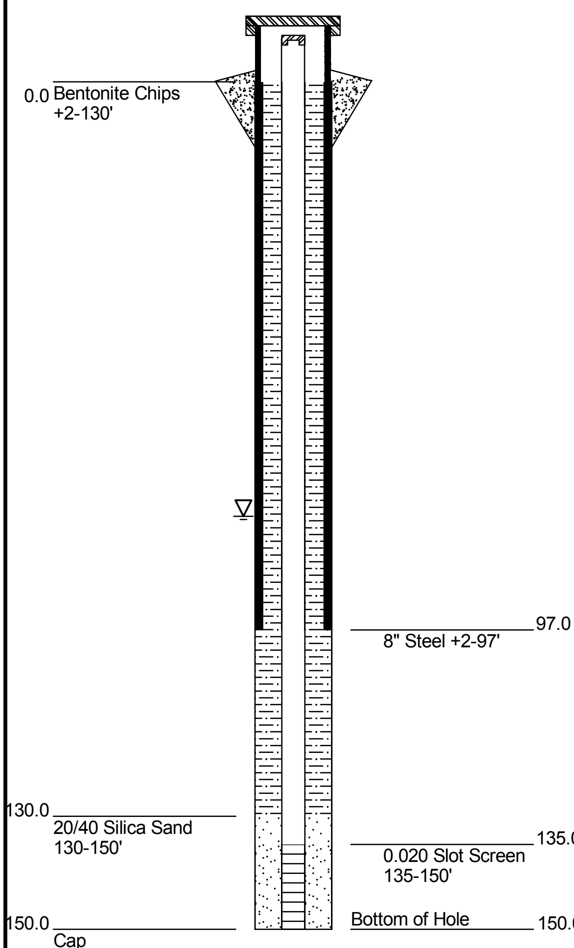
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: N of Underdrain Sump S of J-1 Cell
Recorded By: RJL
Drilling Company: Askin Drilling
Driller: Doug Askin
Drilling Method: Air Rotary
Drilling Fluids Used: Air/Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Bedrock
Hole Diameter (in): 11"(0'-97'), 8"(97'-150')
Hole Depth (ft): 150

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+1.3'-150'
Surface Casing Used?	Y	8-inch steel	+2'-97'
Screen/Perforations?	Y	0.025-inch slot, Sch 40 PVC	135'-150'
Sand Pack?	Y	10/20 Silica Sand	135'-150'
Annular Seal?	Y	3/8" Bentonite Chips	+2'-130'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift	
Water Samples Taken?	N		
Boring Samples Taken?	Y	Core barrel	96' - 110'; 136' - 149'

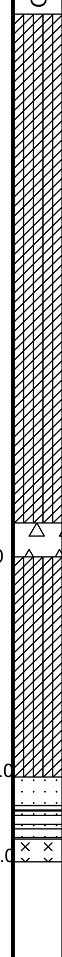
Northing: 604307.65 Easting: 2720585.43
Static Water Level Below MP: 78.17 Surface Casing Height (ft): 2'
Date: 7/28/2020 Riser Height (ft): 1.3
MP Description: Top PVC Casing Ground Surface Elevation (ft): 3290.4
MP Height Above or Below Ground (ft): 1.3 MP Elevation (ft): 3291.7

Remarks: Soil descriptions based on field observation of cuttings and core barrel samples. Field SC = 24,000 umhos/cm, pH = 7.21, T = 17.3 deg C; estimated well yield = 20 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GRAPHICS



GEOLOGICAL DESCRIPTION

0.0 - 90.0' **Sand and gravel** [Bottom Ash]
poorly sorted fine to medium grained sand with up to 25% gravel (up to 1/4" diameter), m.d. gray, dry to wet @ 75'

90.0 - 96.0' **Clinker Gravel** [Fill]
dark brown to reddish orange, wet, crushed/angular

96.0 - 135.0' **Clay & Silt** [Fill]
w/clinker gravel (up to 30%), light gray to pale yellow brown

less gravel, becomes sandy @ 120', begins making lots of water @ 135'

core barrel collected from 96' - 110' (100% recovery)
injecting water at 110'; source of water is City of Colstrip, SC = 715 umhos/cm; pH = 7.87

135.0 - 140.0' **Sandstone** [Bedrock]
pale yellowish brown, wet, moderately firm to weak, medium fine grained
core barrel collected from 136' - 149' (75% recovery)

140.0 - 141.0' **Carbonaceous Shale/Siltstone** [Bedrock]
medium dark brown to gray, moderately firm

141.0 - 146.0' **Siltstone/Interbedded Sandstone** [Bedrock]
light gray to light olive gray, weak to moderately firm

146.0 - 150.0' **Siltstone** [Bedrock]
light gray, moderately firm, clayey, non-plastic

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Soil Boring Log

Hole Name: PH-2007-1245D

Date Hole Started: 6/24/20 Date Hole Finished: 7/14/20

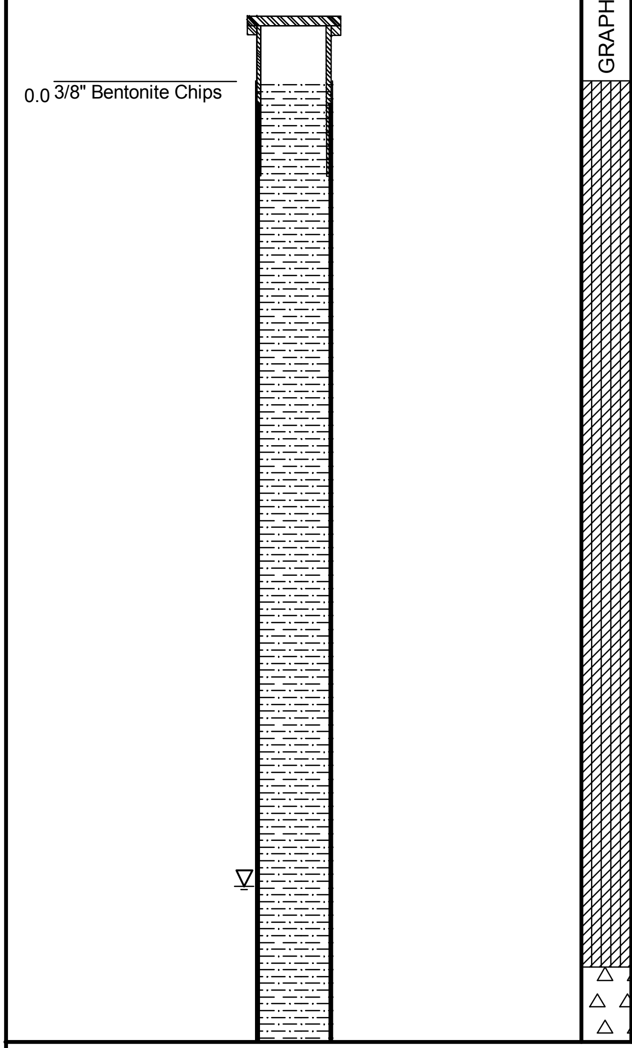
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: N of Underdrain Sump S of J-1 Cell
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: Air
Purpose of Hole: Install Monitor Well
Target Aquifer: Sub McKay
Hole Diameter (in): 0-18' (11"); 18 - 146' (8")
Hole Depth (ft): 146

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	N		
Surface Casing Used?	Y	8" Steel	+2 - 137
Screen/Perforations?	N		
Sand Pack?	N		
Annular Seal?	N		
Surface Seal?	N		
DEVELOPMENT/SAMPLING			
Well Developed?	N		
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 604307.11 Easting: 2720577.24
Static Water Level Below MP: 77.41 Surface Casing Height (ft): 2
Date: 7/13/20 Riser Height (ft): 2
MP Description: Top Steel Ground Surface Elevation (ft): 3290.21
MP Height Above or Below Ground (ft): 2 MP Elevation (ft): 3292.21

Remarks: Steel inadvertently advanced through first unconsolidated material beneath ash and through first sandstone bedrock; borehole drilled out precluding the ability to collect soil or bedrock core samples. Steel could not be extracted, as attempted on 7/9/20. Borehole was plugged with 3/8" bentonite chips on 7/14/20.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 83.0' **Sand and gravel** [Bottom Ash]
poorly sorted fine to medium grained sand with up to 25% gravel (up to 1/4" diameter), m.d. gray, dry to moist at 25'; wet @ 77'

80' - air lift, SC = 24,675 umhos/cm, pH = 8.15

83.0 - 97.0' **Clinker Gravel** [Embankment Fill]
reds & orange w/minor gray, wet, loose, not in-situ

Continued Next Page

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Soil Boring Log

Hole Name: PH-2007-1245D

Date Hole Started: 6/24/20 Date Hole Finished: 7/14/20

WELL CONSTRUCTION	GRAPHICS	GEOLOGICAL DESCRIPTION
		97.0 - 137.0' **Mix** [Embankment Fill] chunks of sandstone, lots of clay, silt, clinker gravel (per Al - could be the starter dyke)
137.0 8" Steel +2 - 137 feet		137.0 - 141.0' **Sandstone** [Bedrock] silty, brown w/minor red, fine grain, hard, round, spherical
Bottom of Hole 146.0		Airlift water sample, SC = 21,490 umhos/cm, pH = 7.81
		141.0 - 146.0' **Sandy Claystone** [Bedrock] gray, no plasticty, stiff, fine sand

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Monitor Well Log

Hole Name: 1246F

Date Hole Started: 6/25/20 Date Hole Finished: 6/25/20

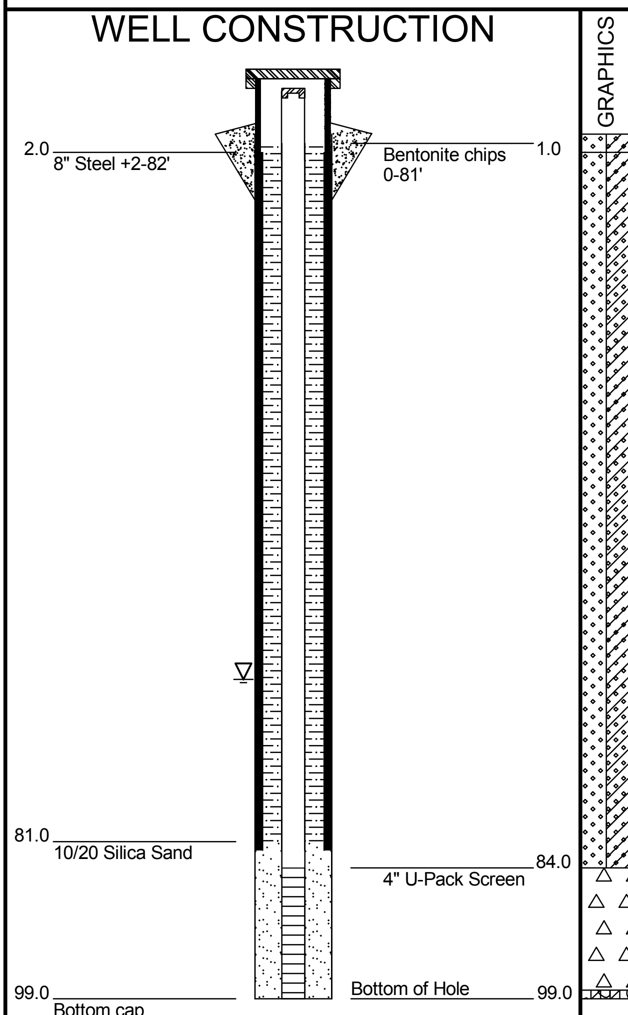
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: N of Underdrain Sump S of J-1 Cell
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: Water
Purpose of Hole: Install Monitor Well
Target Aquifer: Fly Ash
Hole Diameter (in): 11"(0'-18'), 7-7/8"(18'-99')
Hole Depth (ft): 99

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	4.5-inch, glued joints, Sch 40, PVC	+2-99
Surface Casing Used?	Y	8-inch steel	+2'-82'
Screen/Perforations?	Y	0.020-inch slot, U-Packit PVC Screen	84'-99'
Sand Pack?	Y	10/20 Silica Sand	81'-99
Annular Seal?	Y	3/8" Bentonite Chips	+0'-81'
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Air lift	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 604306.45 Easting: 2720570.21
Static Water Level Below MP: 63.71 Surface Casing Height (ft): 2'
Date: 7/28/2020 Riser Height (ft): 1.32
MP Description: Top PVC Ground Surface Elevation (ft): 3290.4
MP Height Above or Below Ground (ft): 1.32 MP Elevation (ft): 3291.72

Remarks: Soil descriptions based on field observation. Field SC = 23,881 umhos/cm, estimated well yield = 4-5 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 2.0' **sand** [Bottom Ash]
gray w/black glossy 1/4" minus gravel, dry, loose

2.0 - 84.0' **sand and gravel** [Bottom Ash]
gray, loose, trace clinker gravel (3/4" minus)

25' - moist
74' - damp
77' - wet

84.0 - 98.0' **Clinker Gravel** [Fill]
reds & orange, minor gray mottled with red, wet, loose, not massive/not in-situ

98.0 - 99.0' **Mix** [Fill below divider dike]
sandstone, clay, silt, clinker gravel

STANDARD_REV3 ALL TALEN.GPJ HYDHLN2.GDT 8/19/20

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Hole Name: 1247C

Date Hole Started: 6/30/20 Date Hole Finished: 6/30/20

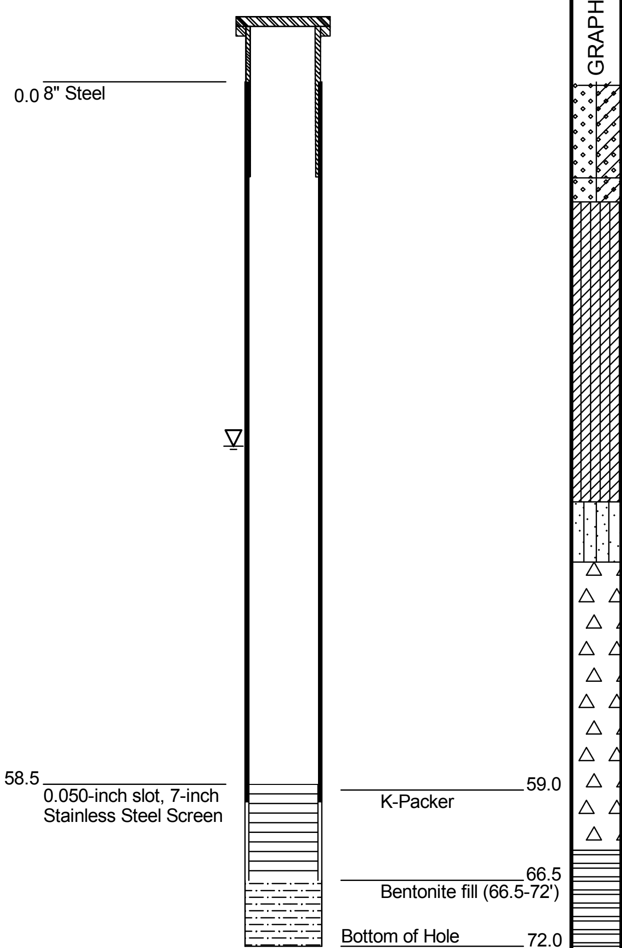
Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: South of 3&4 EHP C Cell
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Bottom Clinker
Hole Diameter (in): 11"(0'-18'), 7-7/8"(18'-72')
Total Depth Drilled (ft): 72

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	8-inch steel	+2'-66.5'
Surface Casing Used?	Y	8-inch steel	+2-60
Screen/Perforations?	Y	0.050-inch slot, 7" Stainless Steel	58.5'-66.5'
Sand Pack?	N		
Annular Seal?	N		
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Airlift	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 602545.86 Easting: 2720437.25
Static Water Level Below MP: 32.38 Surface Casing Height (ft): 2'
Date: 7/1/20 Riser Height (ft): 2.02
MP Description: Top PVC Ground Surface Elevation (ft): 3290.5
MP Height Above or Below Ground (ft): 2.02 MP Elevation (ft): 3292.52

Remarks: Soil descriptions based on field observation. Hole overdrilled and plugged back with bentonite (3/8" chips) from 67-72'. Well completed with a K-packer positioned inside 8" steel casing; 8" steel pulled back 7' to expose 7" stainless steel screen.Field SC = 24,830 umhos/cm, estimated well yield = 2 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 8.0' **sand and gravel**
m. d. gray
[Bottom Ash]

8.0 - 10.0' **sand**
w/clinker gravel (1" minus), dark gray (2N), moist
[Bottom Ash]

10.0 - 35.0' **Silt**
light gray (7W), dry
[Fly Ash]

35.0 - 40.0' **Sandy Silt**
w/clinker gravel (1.5" minus), brownish gray (5YR 4/1), minor ash
[Fill]

40.0 - 64.0' **Clinker Gravel**
red, dark red, fractured, loose minor silt & sand filling in voids

45' - color change to yellows (10YR 8/4) and gray (?)
50' - same as 45' w/black porous clinker
60' - some coal fragments to 64', ashy
[Fill]

64.0 - 72.0' **Claystone**
grayish yellow (5Y 8/4), stiff, trace fine sand, slightly plastic
[Bedrock]

Coal

[Coal]

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Hole Name: 1248C
Date Hole Started: 6/30/20 Date Hole Finished: 6/30/20

Client: Talen Montana, LLC
Project: Talen Montana, LLC
County: Rosebud State: Montana
Property Owner: Talen MT, LLC
Legal Description: T1N R42E Sec 6 SE1/4 SE1/4
Location Description: West of 3&4 EHP F Cell

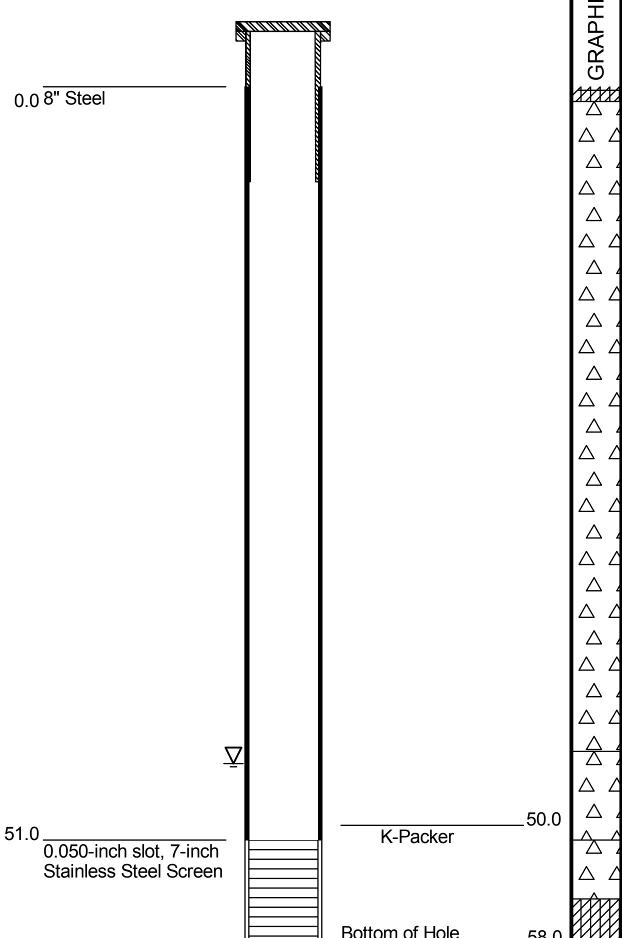
Recorded By: GH
Drilling Company: Askin Drilling
Driller: Matt Hofer
Drilling Method: Air Rotary
Drilling Fluids Used: None
Purpose of Hole: Install Monitor Well
Target Aquifer: Lower Clinker
Hole Diameter (in): 11"(0'-18'), 7-7/8"(18'-78')
Total Depth Drilled (ft): 58

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	8-inch steel	+1.9'-58'
Surface Casing Used?	Y	8-inch steel	+1.9-51
Screen/Perforations?	Y	0.050-inch slot, 7" Stainless Steel	51'-58'
Sand Pack?	N		
Annular Seal?	N		
Surface Seal?	Y	Concrete	GS
DEVELOPMENT/SAMPLING			
Well Developed?	Y	Airlift	
Water Samples Taken?	N		
Boring Samples Taken?	N		

Northing: 602494.01 Easting: 2718073.09
Static Water Level Below MP: 47.76 Surface Casing Height (ft): 1.93
Date: 7/28/2020 Riser Height (ft): 1.93
MP Description: Top PVC Ground Surface Elevation (ft): 3293.5
MP Height Above or Below Ground (ft): 1.93 MP Elevation (ft): 3295.43

Remarks: Soil descriptions based on field observation. Well completed with a K-packer positioned inside 8" steel casing; 8" steel pulled back 7' to expose 7" stainless steel screen. Field SC = 19,515 umhos/cm, estimated well yield = 5 gpm. Well coordinates are Montana State Plane NAD83 (feet) and NAVD88.

WELL CONSTRUCTION



GEOLOGICAL DESCRIPTION

0.0 - 1.0' **Fly Ash Cover**
[Fly Ash]

1.0 - 45.0' **Clinker**
moderately reddish orange (10R 6/6), dry, loose, hard @ 6'
[Clinker]

45.0 - 51.0' **Clinker**
yellowish brown (10YR 5/4), moist, hard
[Clinker]

51.0 - 55.0' **Clinker**
light brown (5YR 6/4), wet, hard
[Clinker]

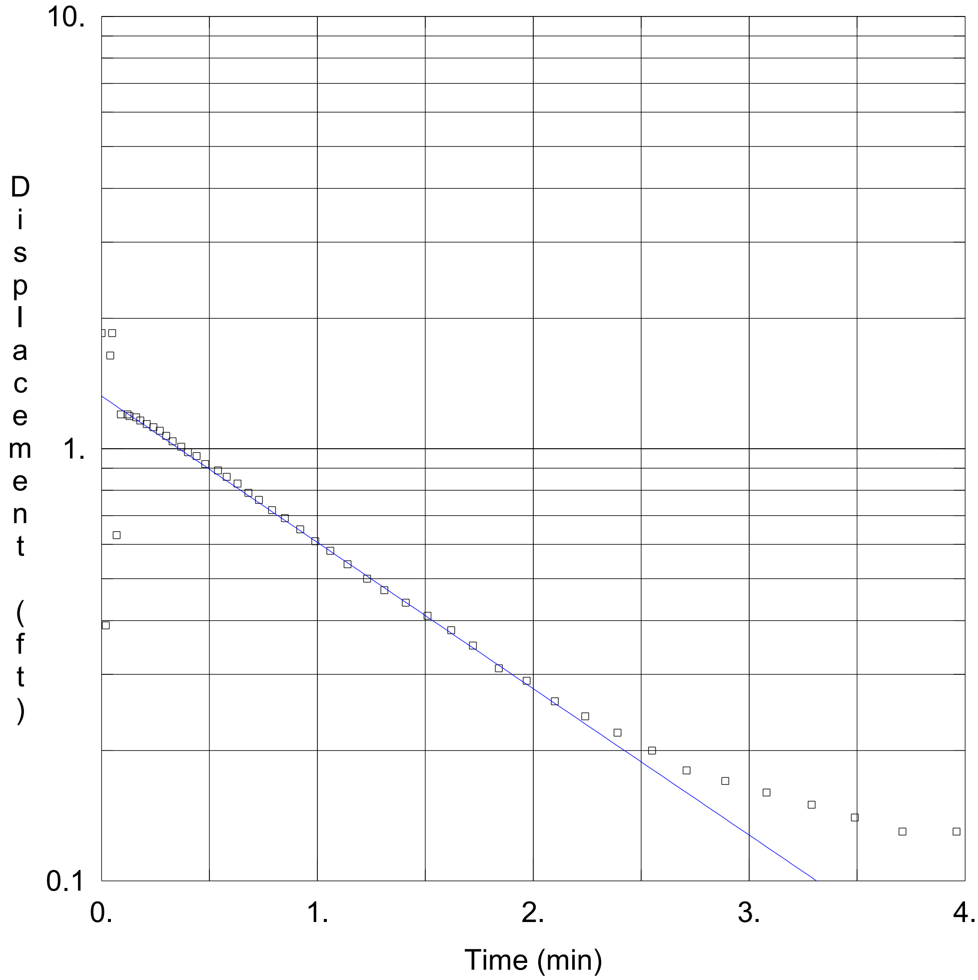
55.0 - 58.0' **Clayey Siltstone**
greenish gray (10GY 5/2), moist (upper foot) then dry, soft
[Bedrock]

STANDARD_REV2 ALL TALEN.GPJ HYDHLN2.GDT 9/10/20

APPENDIX B

INDIVIDUAL WELL AQUIFER TEST

ANALYTICAL SOLUTIONS



WELL TEST ANALYSIS

Data Set: \...\1234FA Slug In_final.aqt
Date: 09/24/20 Time: 07:56:22

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1234FA
Test Date: 06/23/20

AQUIFER DATA

Saturated Thickness: 54.66 ft
Anisotropy Ratio (Kz/Kr): 1.

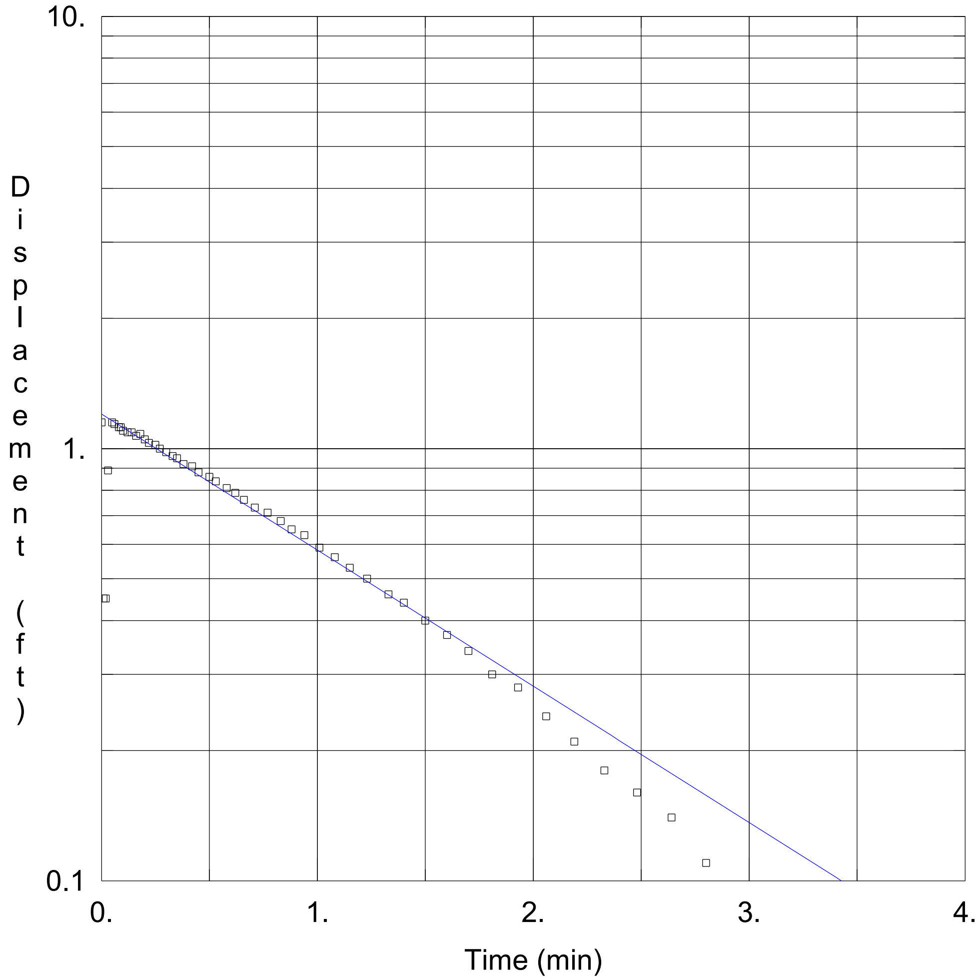
WELL DATA (1234FA)

Initial Displacement: 1.85 ft
Static Water Column Height: 54.66 ft
Total Well Penetration Depth: 54.66 ft
Screen Length: 5. ft
Casing Radius: 0.08333 ft
Well Radius: 0.0833 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.553 ft/day
y0 = 1.322 ft



WELL TEST ANALYSIS

Data Set: \...\1234FA Slug Out FINAL.aqt
Date: 09/24/20 Time: 07:57:09

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1236FA
Test Date: 06/23/20

AQUIFER DATA

Saturated Thickness: 54.66 ft Anisotropy Ratio (Kz/Kr): 1.

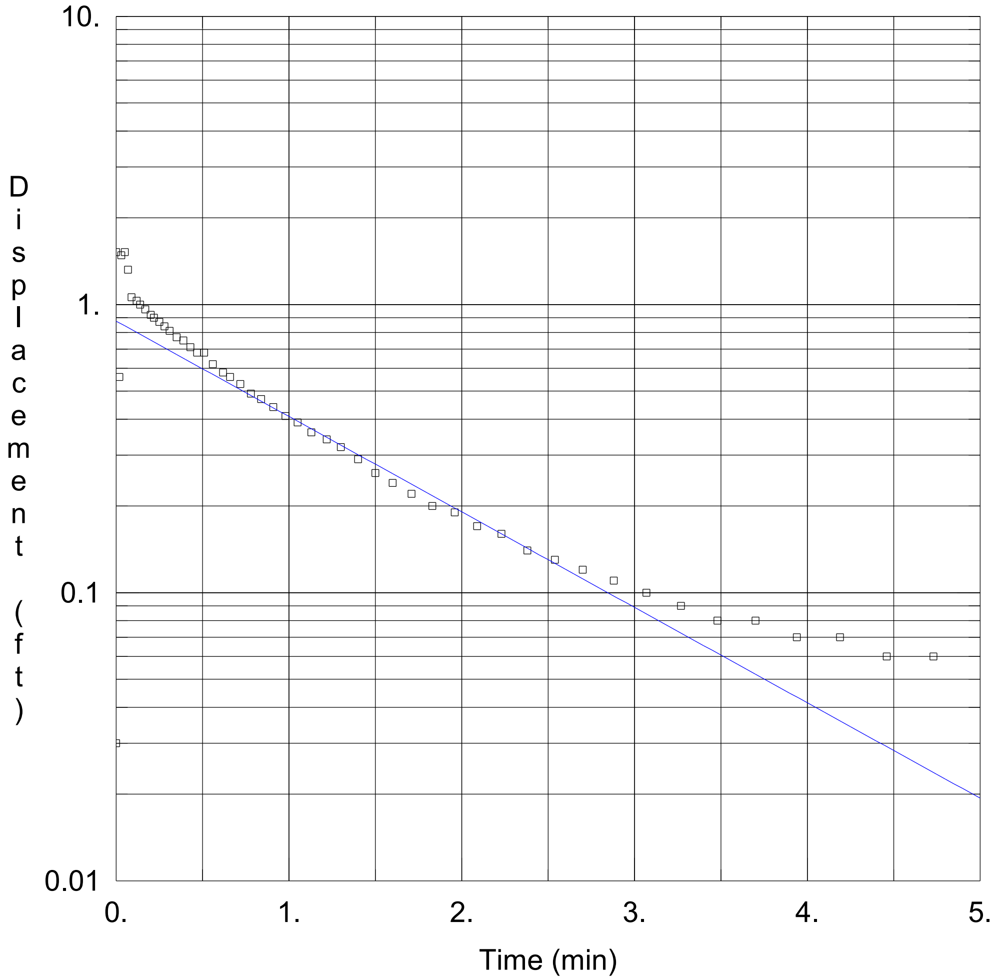
WELL DATA (1234FA)

Initial Displacement: 1.15 ft Static Water Column Height: 54.66 ft
Total Well Penetration Depth: 54.66 ft Screen Length: 5. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.305 ft/day y0 = 1.201 ft



WELL TEST ANALYSIS

Data Set: \...\1235FA Slug In FINAL.aqt
Date: 09/24/20 Time: 07:58:38

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1235FA
Test Date: 06/23/20

AQUIFER DATA

Saturated Thickness: 26.44 ft
Anisotropy Ratio (Kz/Kr): 1.

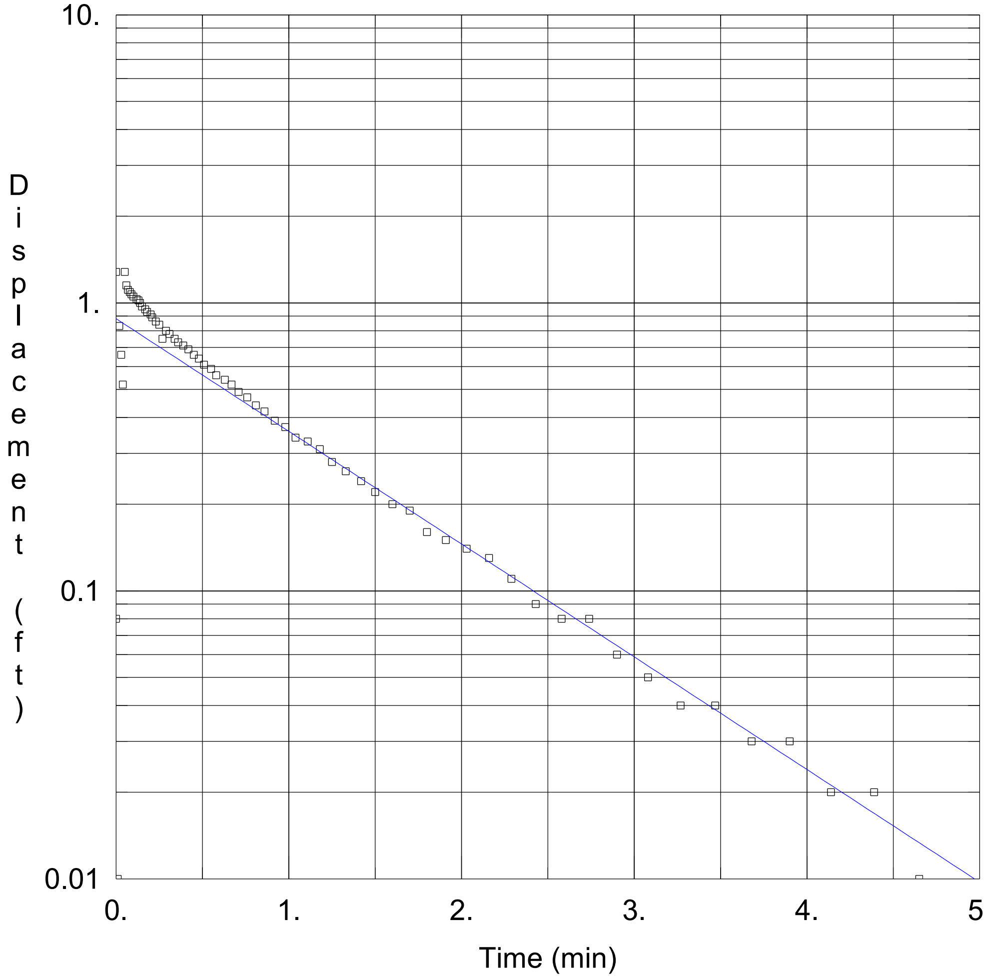
WELL DATA (1235FA)

Initial Displacement: 1.52 ft
Static Water Column Height: 26.44 ft
Total Well Penetration Depth: 26.44 ft
Screen Length: 5. ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 3.166 ft/day
y0 = 0.8754 ft



WELL TEST ANALYSIS

Data Set: \...\1235FA Slug Out_FINAL.aqt
Date: 09/24/20 Time: 07:59:44

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1235FA
Test Date: 06/23/20

AQUIFER DATA

Saturated Thickness: 26.44 ft Anisotropy Ratio (Kz/Kr): 1.

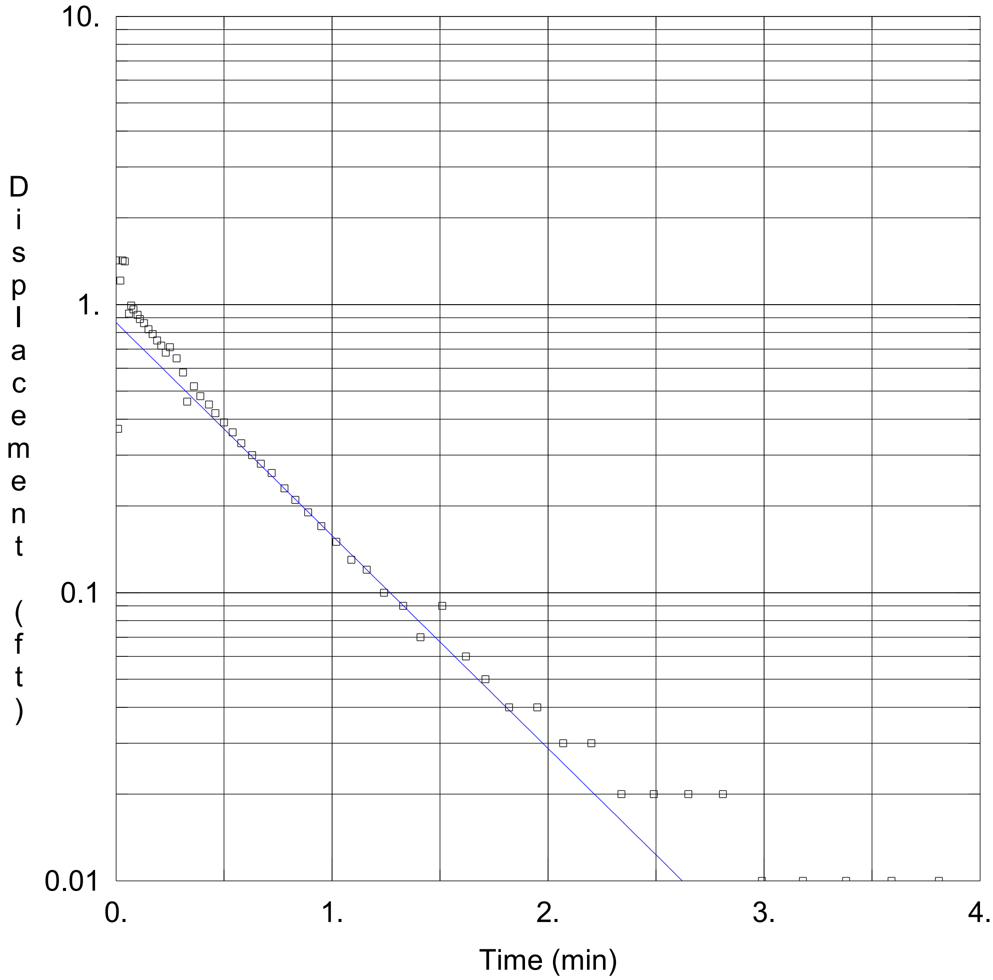
WELL DATA (1235FA)

Initial Displacement: 1.28 ft
Total Well Penetration Depth: 26.44 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 26.44 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 3.74 ft/day y0 = 0.8806 ft



WELL TEST ANALYSIS

Data Set: \...\1236FA Slug In_final.aqt
Date: 09/24/20 Time: 08:01:15

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1236FA
Test Date: 06/23/20

AQUIFER DATA

Saturated Thickness: 24.58 ft Anisotropy Ratio (Kz/Kr): 1.

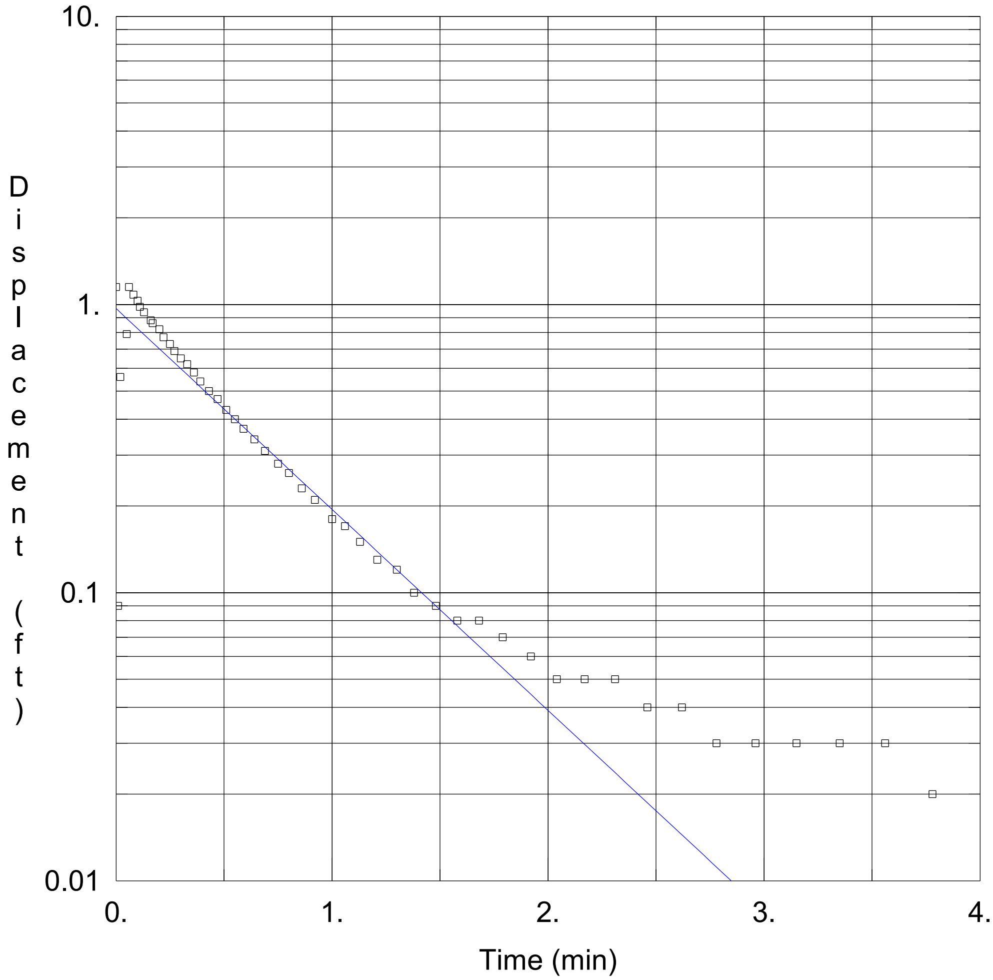
WELL DATA (1236FA)

Initial Displacement: 1.42 ft
Total Well Penetration Depth: 24.58 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 24.58 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.995 ft/day y0 = 0.8644 ft



WELL TEST ANALYSIS

Data Set: \...\1236FA Slug Out FINAL.aqt
Date: 09/24/20 Time: 08:03:04

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1236FA
Test Date: 06/23/20

AQUIFER DATA

Saturated Thickness: 24.58 ft Anisotropy Ratio (Kz/Kr): 1.

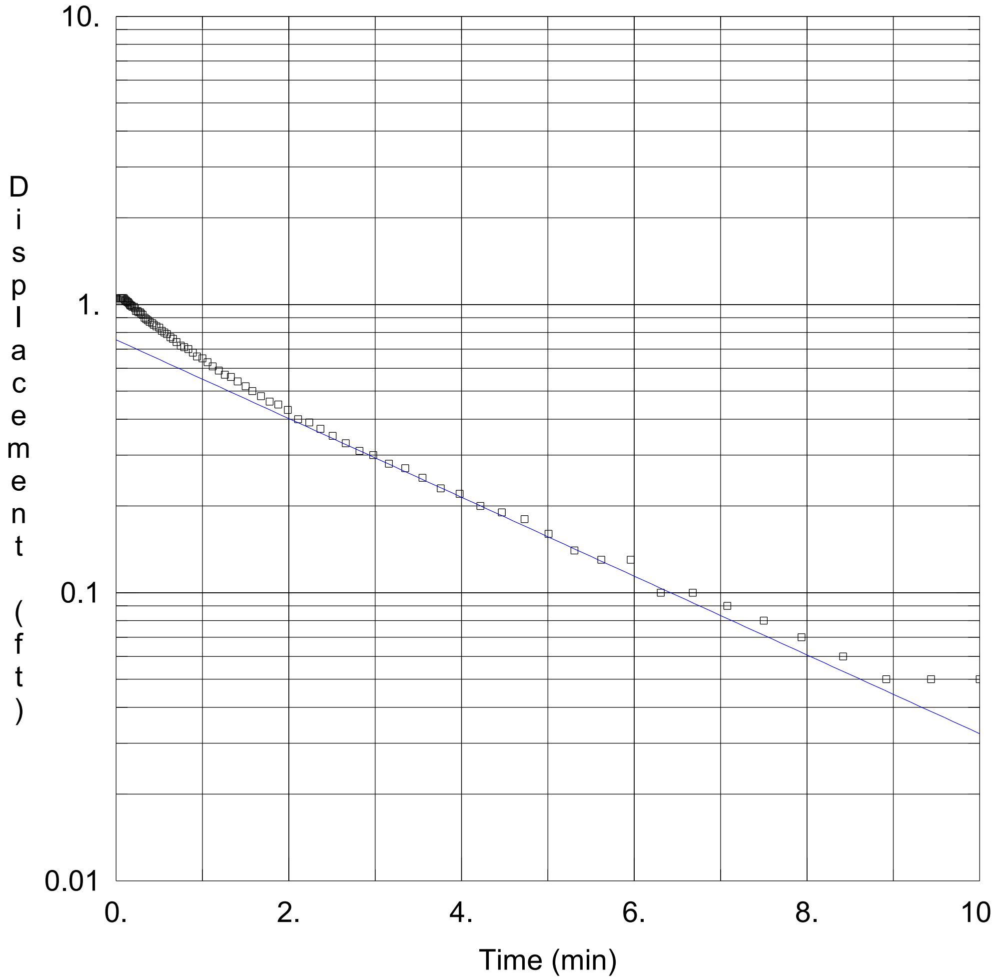
WELL DATA (1236FA)

Initial Displacement: 1.15 ft Static Water Column Height: 24.58 ft
Total Well Penetration Depth: 24.58 ft Screen Length: 5. ft
Casing Radius: 0.08333 ft Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 6.601 ft/day y0 = 0.9674 ft



WELL TEST ANALYSIS

Data Set: \...\1237FA Slug In FINAL.aqt
Date: 09/24/20 Time: 08:02:16

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1237FA
Test Date: 07/08/20

AQUIFER DATA

Saturated Thickness: 42.39 ft
Anisotropy Ratio (Kz/Kr): 1.

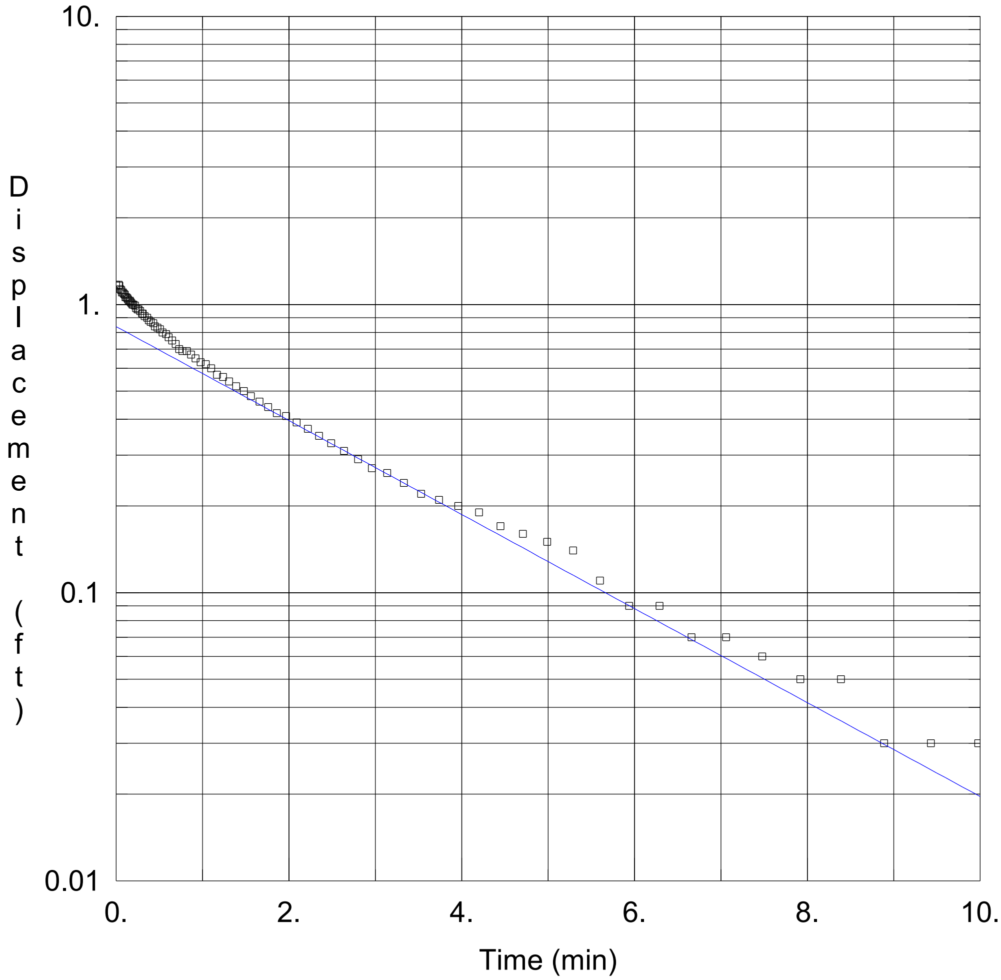
WELL DATA (1237FA)

Initial Displacement: 1.05 ft
Total Well Penetration Depth: 42.39 ft
Casing Radius: 0.08333 ft
Static Water Column Height: 42.39 ft
Screen Length: 5. ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.39 ft/day
y0 = 0.754 ft



WELL TEST ANALYSIS

Data Set: \...\1237FA Slug Out FINAL.aqt
Date: 09/24/20
Time: 08:04:06

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1237FA
Test Date: 07/08/20

AQUIFER DATA

Saturated Thickness: 42.39 ft
Anisotropy Ratio (Kz/Kr): 1.

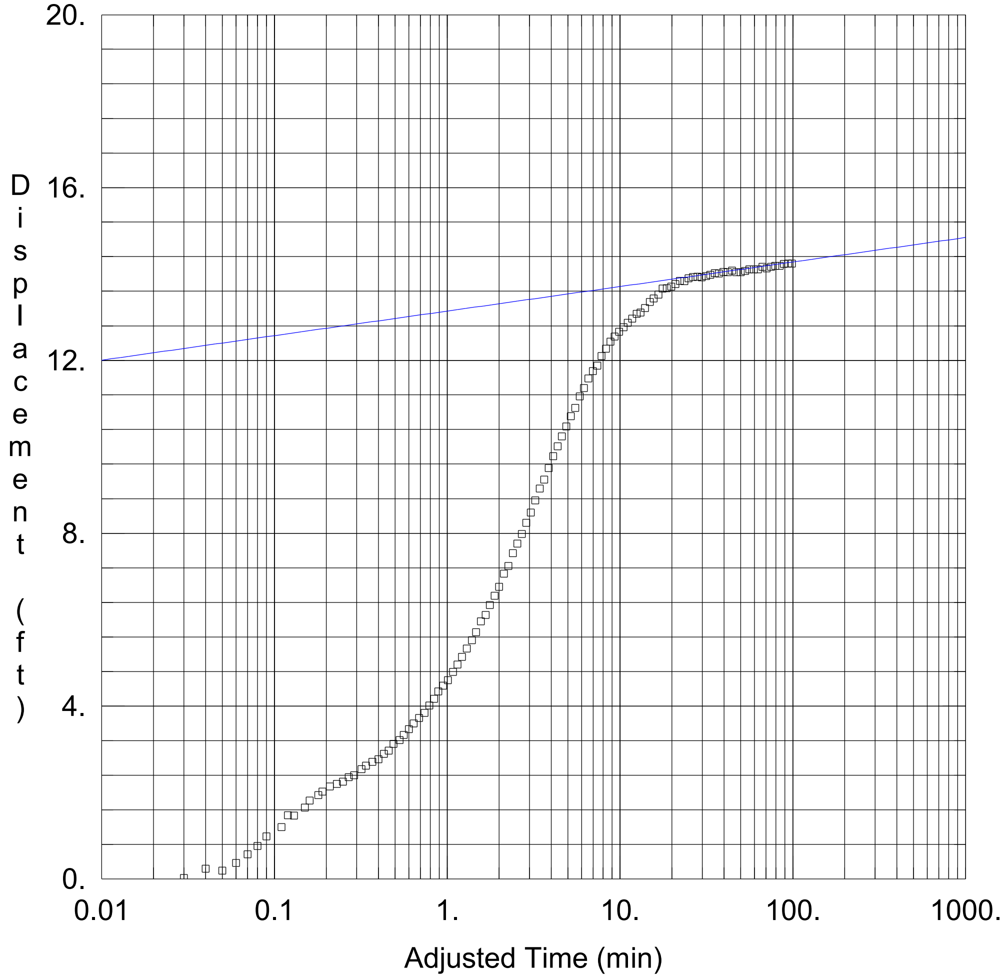
WELL DATA (1237FA)

Initial Displacement: 1.17 ft
Static Water Column Height: 42.39 ft
Total Well Penetration Depth: 42.39 ft
Screen Length: 5. ft
Casing Radius: 0.08333 ft
Well Radius: 0.08333 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 1.659 ft/day
y0 = 0.8377 ft



WELL TEST ANALYSIS

Data Set: \...\1238D Pump (4 gpm) FINAL Cooper Jacob.aqt
Date: 09/24/20 Time: 08:05:26

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1238D
Test Date: 07/08/20

AQUIFER DATA

Saturated Thickness: 11. ft Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1238D	0	0

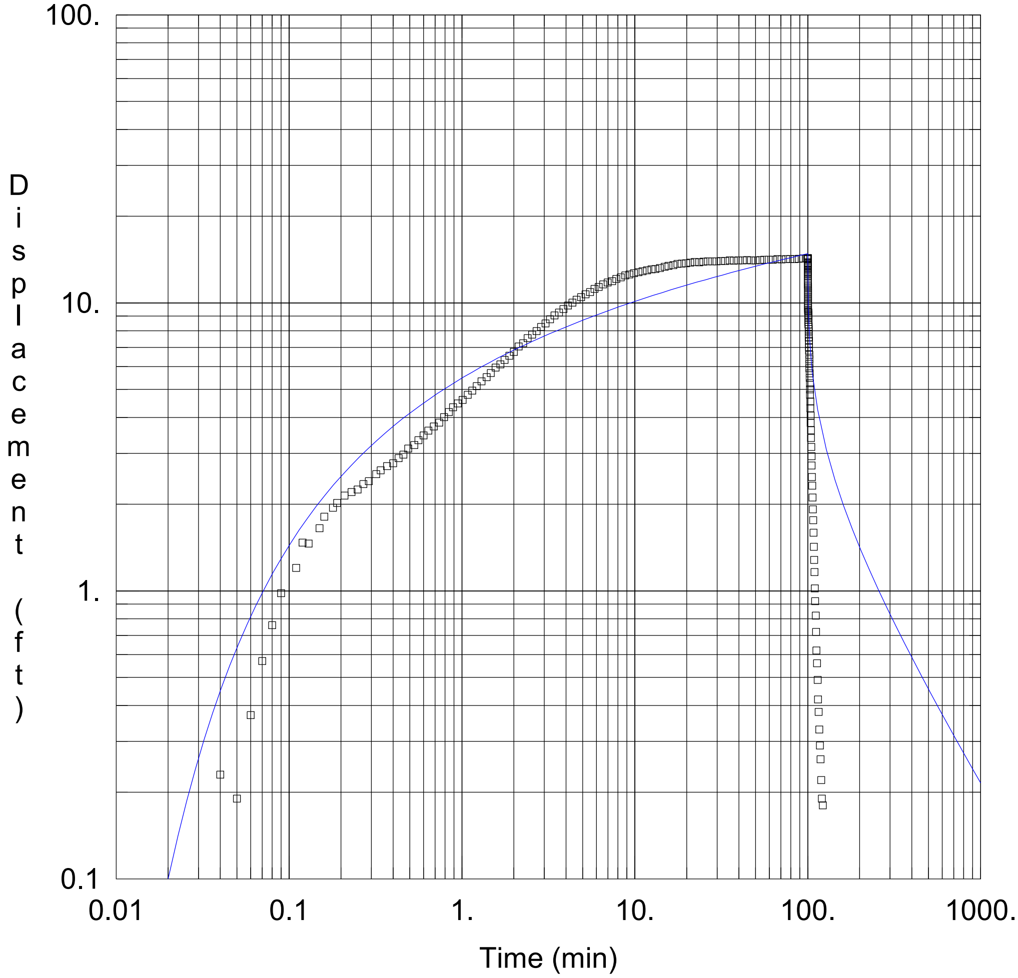
Observation Wells

Well Name	X (ft)	Y (ft)
□ 1238D	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 248.4 ft^2/day S = 2.543E-23



WELL TEST ANALYSIS

Data Set: \...\1238D Pump (4 gpm) FINAL Theis Hantush.aqt
Date: 09/30/20 Time: 08:34:13

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1238D
Test Date: 07/08/20

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1238D	0	0

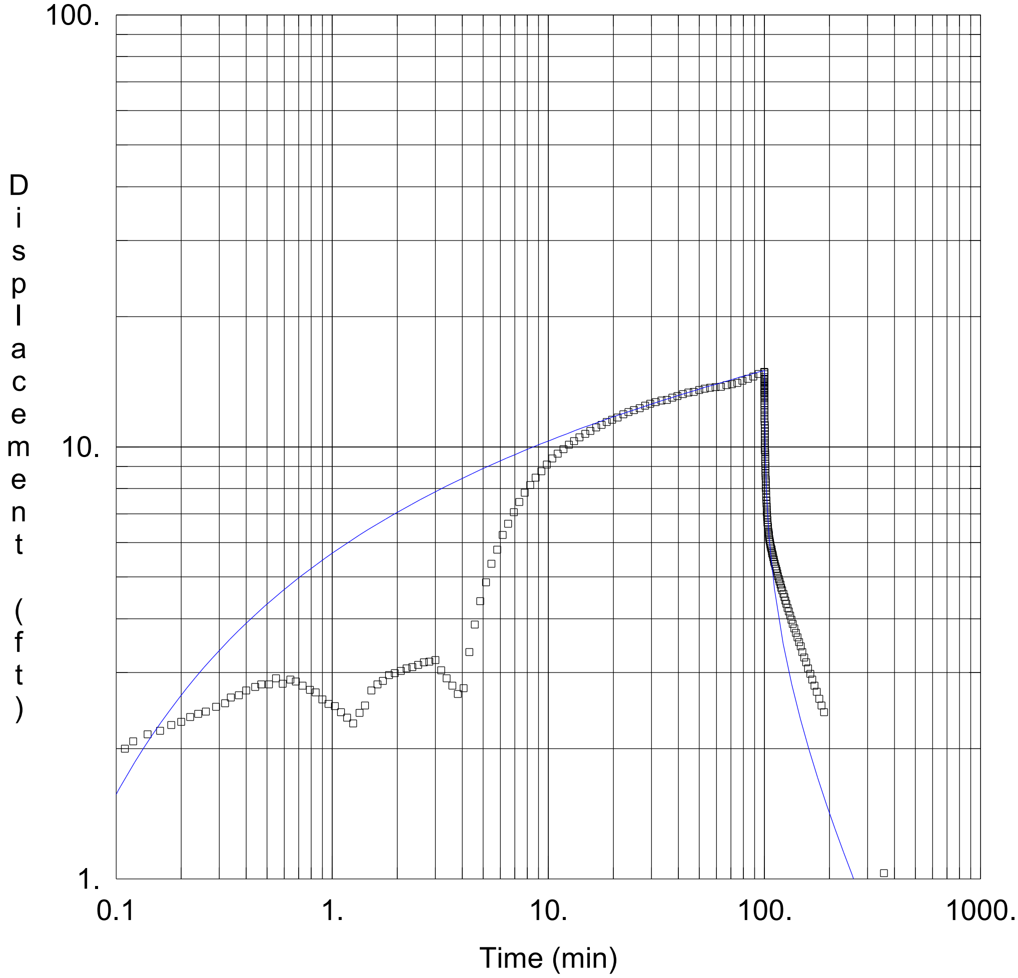
Observation Wells

Well Name	X (ft)	Y (ft)
□ 1238D	0	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 30. ft^2/day
Kz/Kr = 0.1
S = 0.03
b = 11. ft



WELL TEST ANALYSIS

Data Set: \...\1239M Pump (3.7 gpm) FINAL Theis.aqt
Date: 09/24/20 Time: 08:10:50

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1239M
Test Date: 07/10/20

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1239M	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 1239M	0	0

SOLUTION

Aquifer Model: Confined

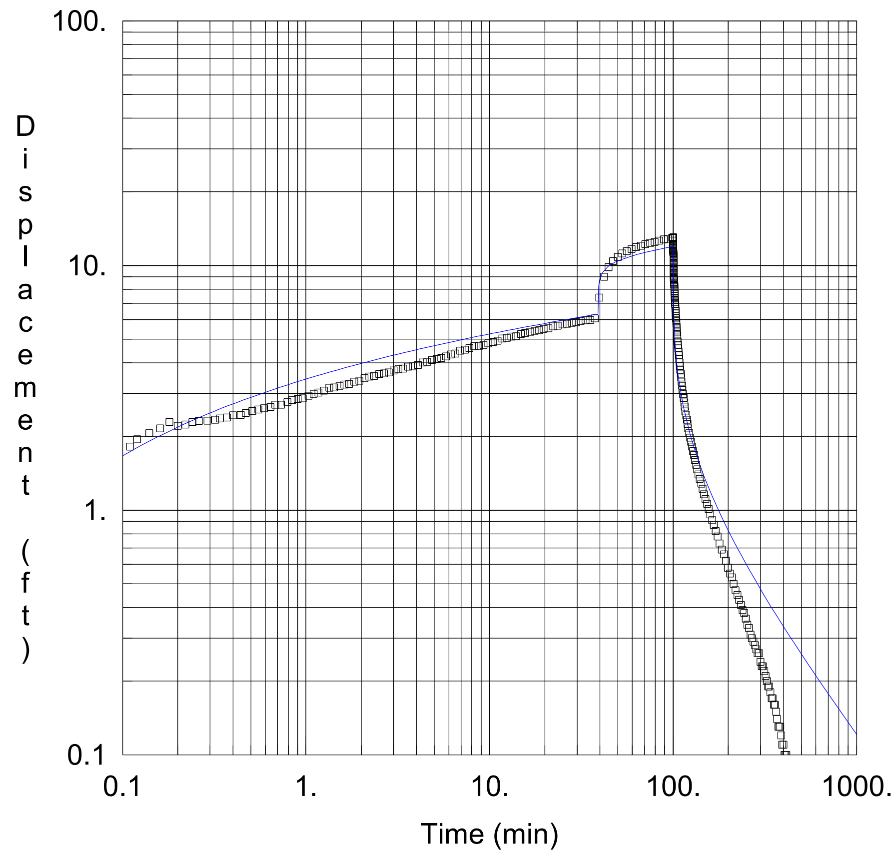
Solution Method: Theis

T = 27.7 ft^2/day

S = 0.02573

Kz/Kr = 1.

b = 9. ft



WELL TEST ANALYSIS

Data Set: \...\1240D Pump FINAL Theis Step.aqt
Date: 09/24/20 Time: 08:13:08

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1240D
Test Date: 07/08/20

AQUIFER DATA

Saturated Thickness: 31. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1240D	0	0

Observation Wells

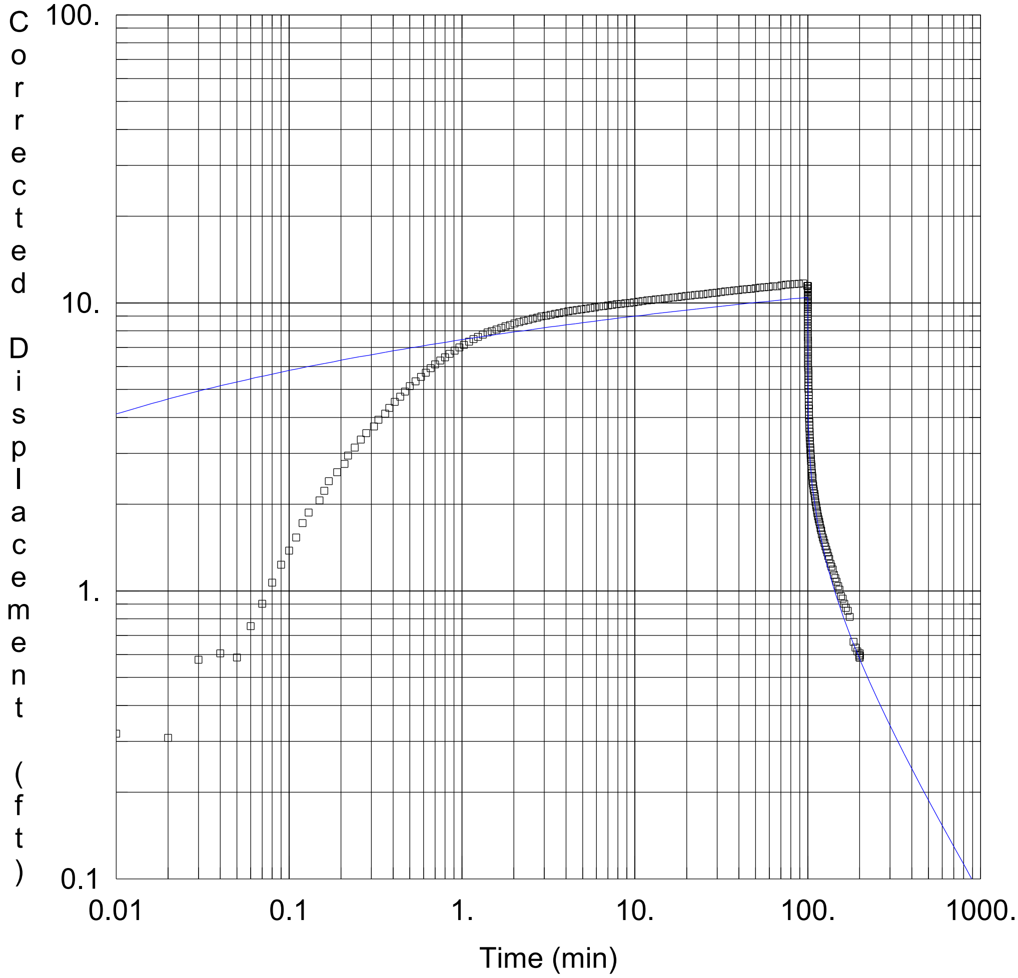
Well Name	X (ft)	Y (ft)
□ 1240D	0	0

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Step Test)

T = 29.09 ft^2/day
S = 0.00533
Sw = 0.
C = 0. min^2/ft^5
P = 2.

Step Test Model: Jacob-Rorabaugh
Time (t) = 1. min Rate (Q) in cu. ft/min
s(t) = 17.12Q + 0.$Q^{2.}$
W.E. = 100.% (Q from last step)



WELL TEST ANALYSIS

Data Set: \...\1241D Pump (14 gpm) FINAL.aqt
Date: 09/24/20 Time: 08:14:59

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1241D
Test Date: 07/10/20

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1241D	0	0

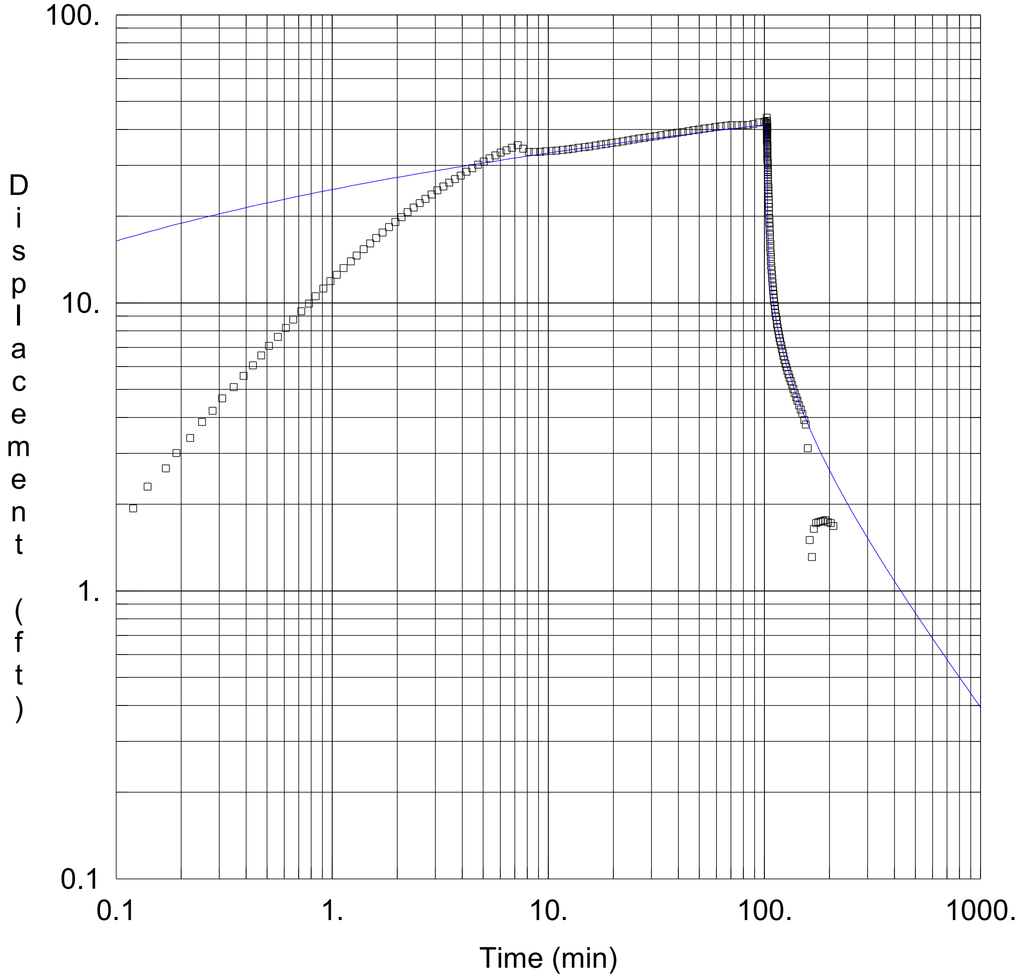
Observation Wells

Well Name	X (ft)	Y (ft)
▫ 1241D	0	0

SOLUTION

Aquifer Model: Unconfined
Solution Method: Theis

T = 255. ft^2/day
S = 0.0006688
Kz/Kr = 1.
b = 45. ft



WELL TEST ANALYSIS

Data Set: \...\1245D Pump Test (11 gpm) FINAL.aqt
Date: 09/24/20 Time: 08:18:38

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1245D
Test Date: 07/13/20

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1245D	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
□ 1245D	0	0

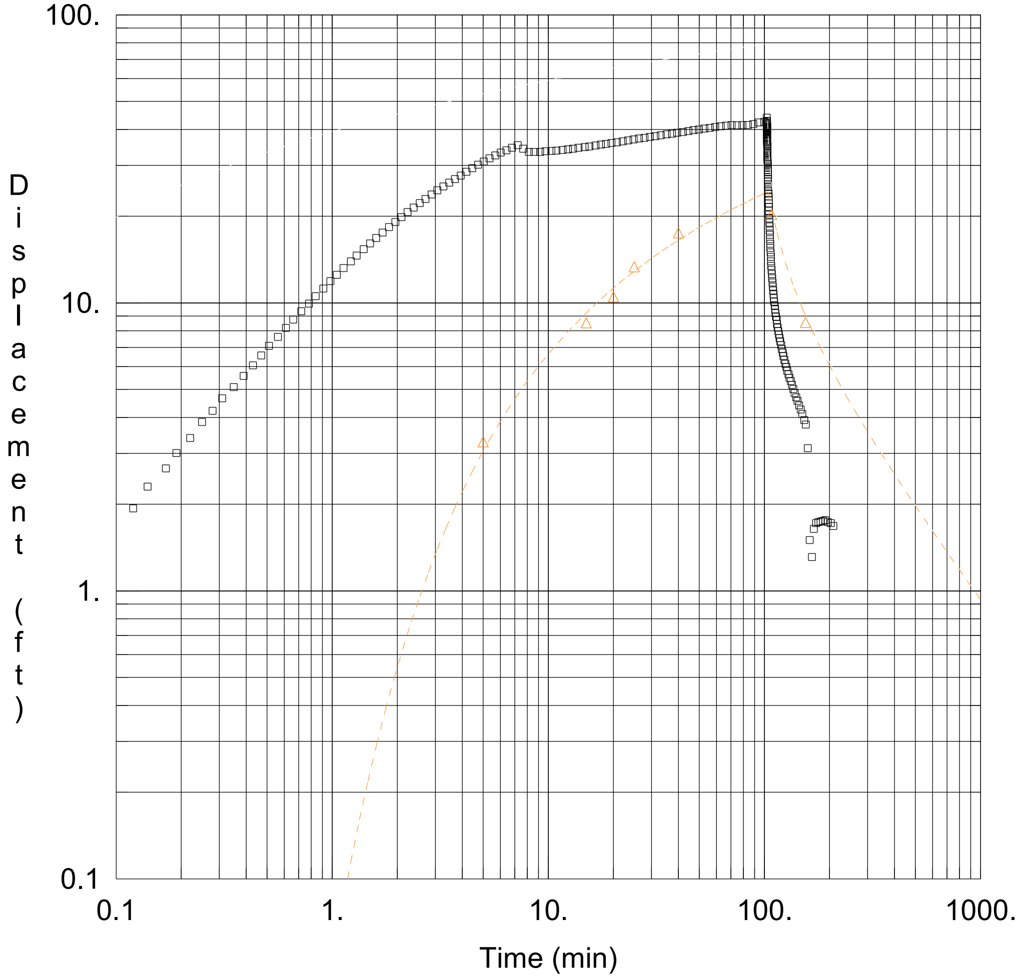
SOLUTION

Aquifer Model: Confined

Solution Method: Theis

T = 47.21 ft^2/day
Kz/Kr = 1.

S = 0.0007346
b = 5. ft



WELL TEST ANALYSIS

Data Set: \...\1245D Pump Test (11 gpm)_PH 2007-1245D OBS FINAL.aqt
Date: 09/24/20 Time: 08:18:02

PROJECT INFORMATION

Company: Hydrometrics
Client: Talen Montana, LLC
Project: 20017
Location: Colstrip, MT
Test Well: 1245D
Test Date: 07/13/20

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
1245D	2720585.43	604307.65

Observation Wells

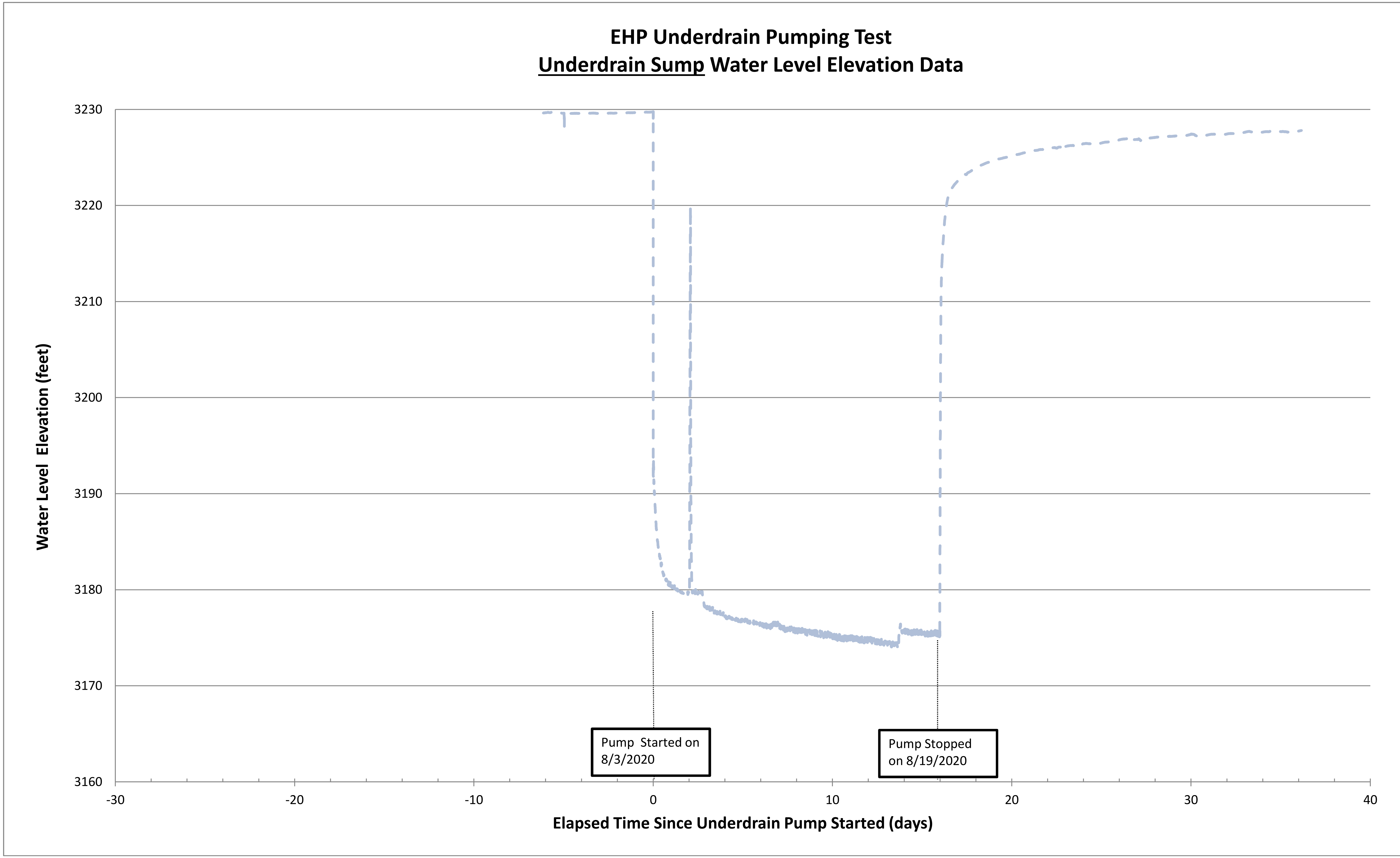
Well Name	X (ft)	Y (ft)
□	2720585.43	604307.65
△ PH-2007-1245D	2720577.24	604307.11

SOLUTION

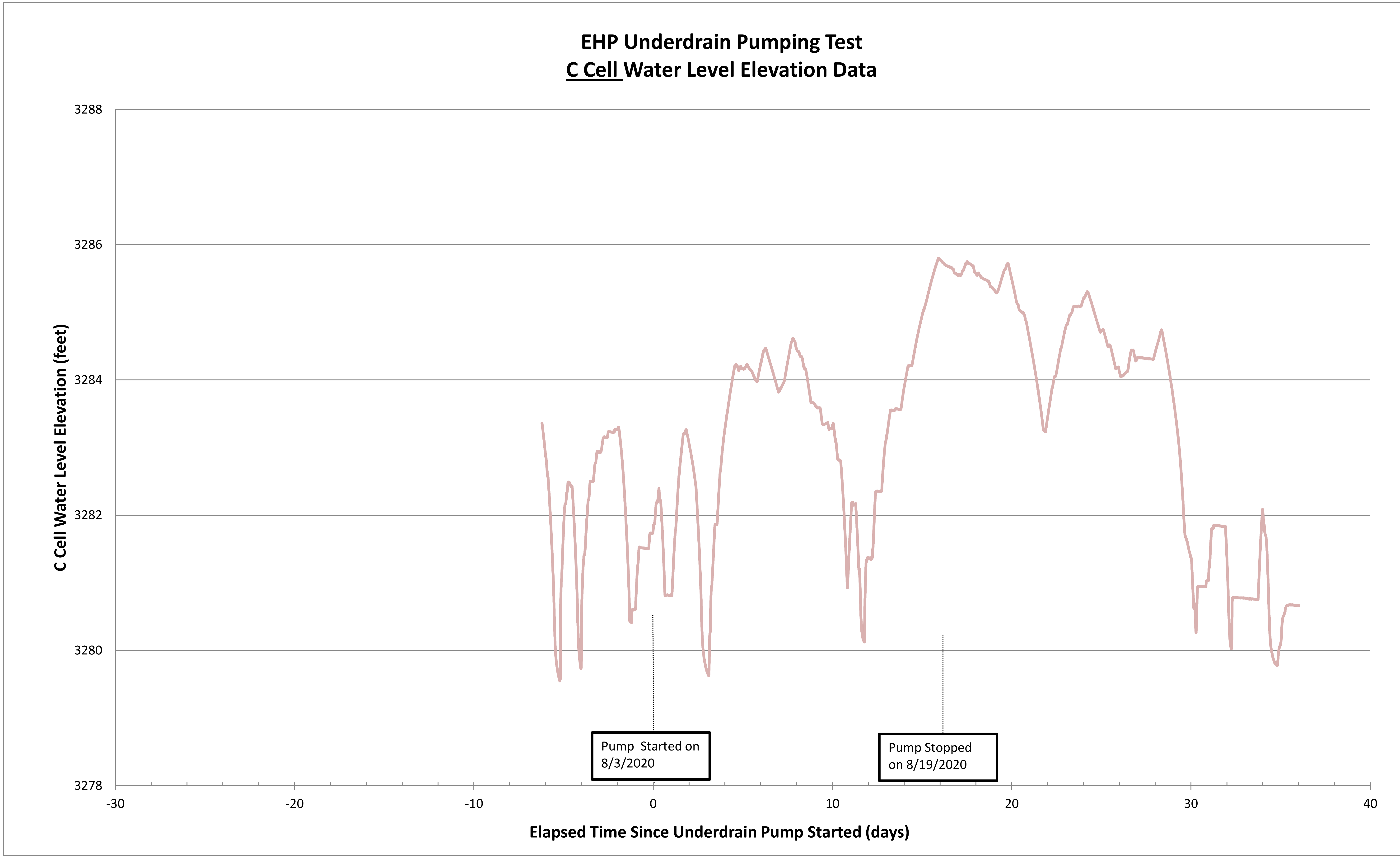
Aquifer Model: Confined
Solution Method: Theis

T = 19.86 ft^2/day
S = 0.002988
Kz/Kr = 1.
b = 5. ft

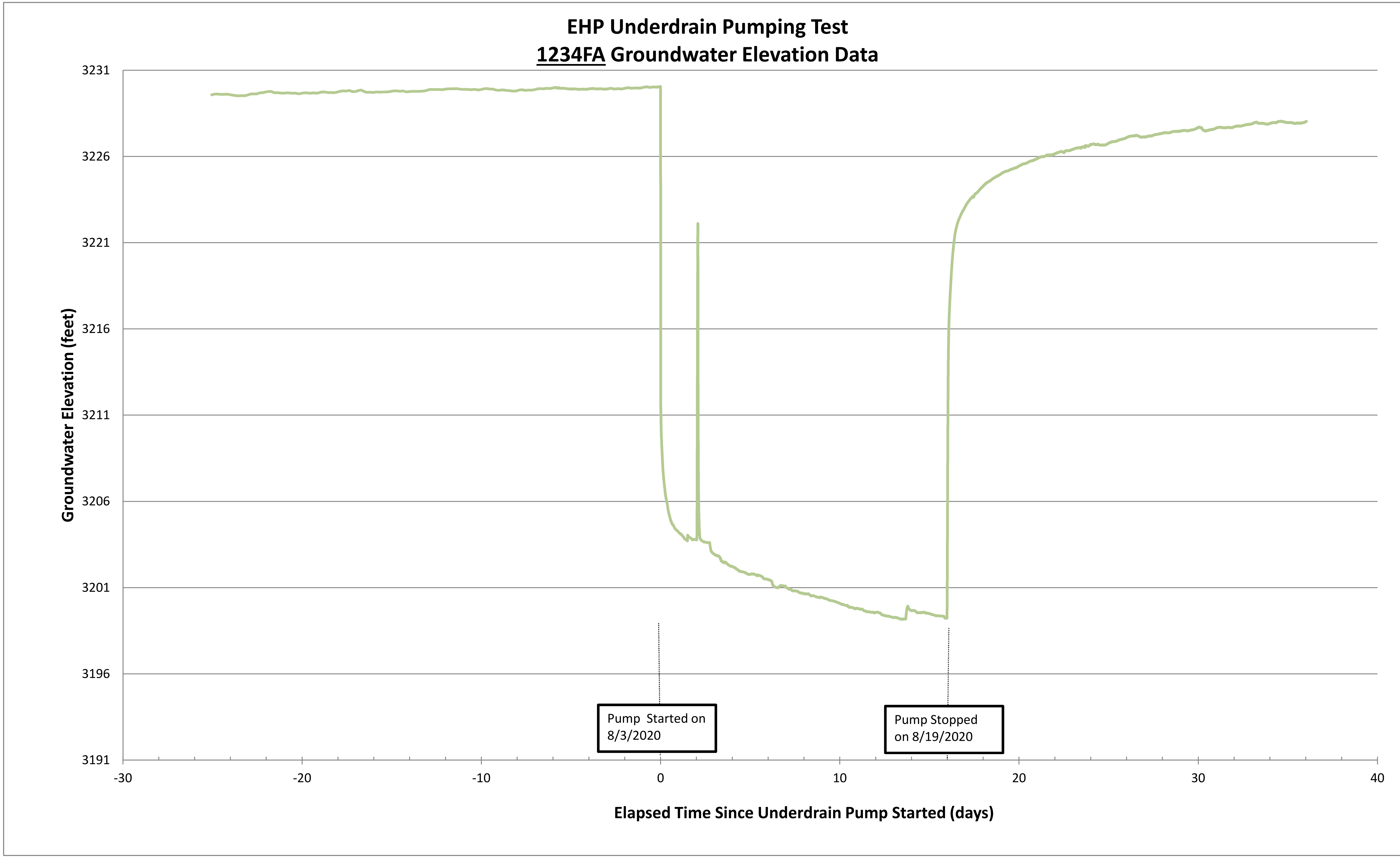
APPENDIX C
3&4 EHP PUMPING TEST GROUNDWATER ELEVATION HYDROGRAPHS

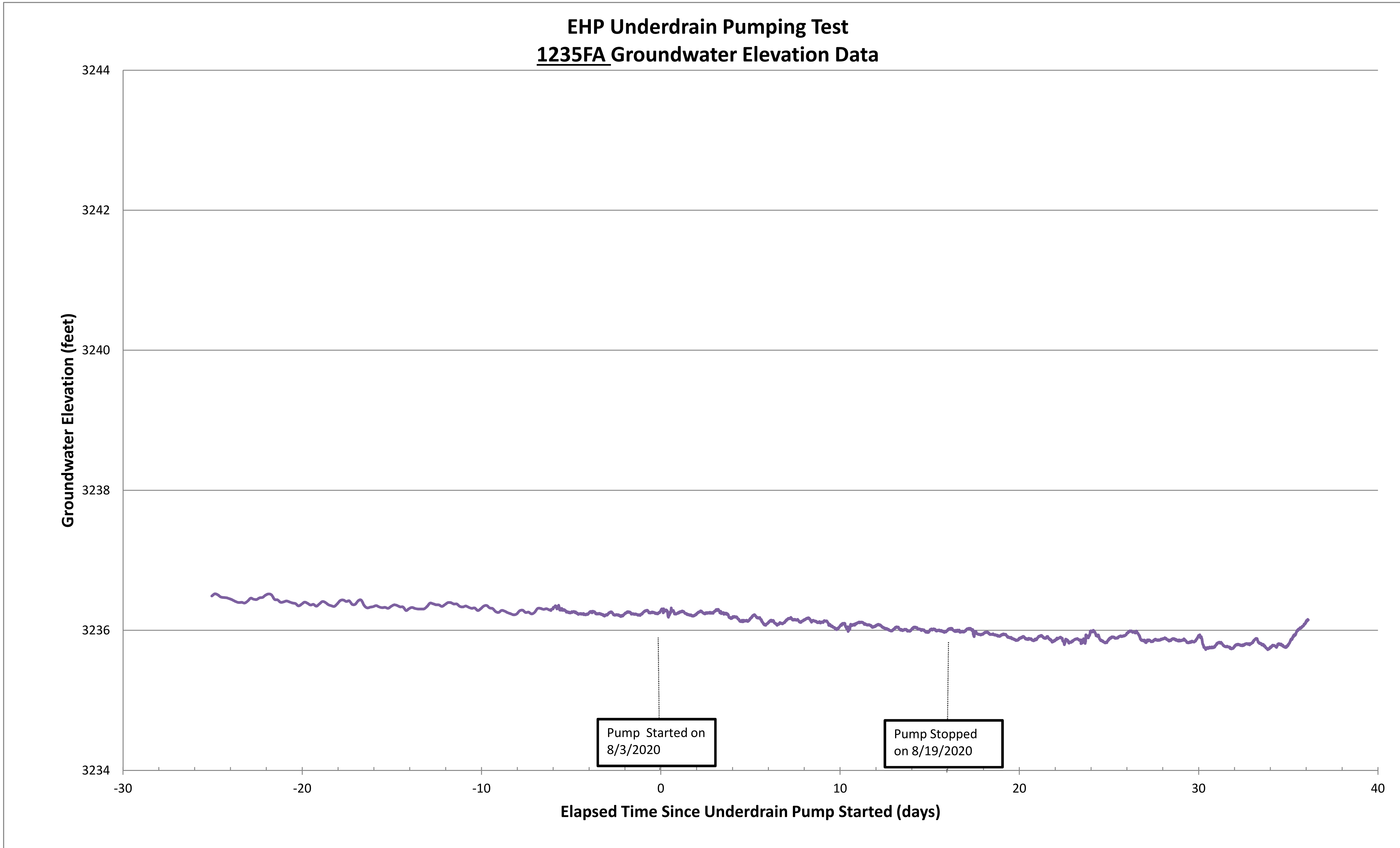


EHP Underdrain Pumping Test
Underdrain Sump Water Level Elevation Data
Water Level Elevation (feet)
3230
3220
3210
3200
3190
3180
3170
3160
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

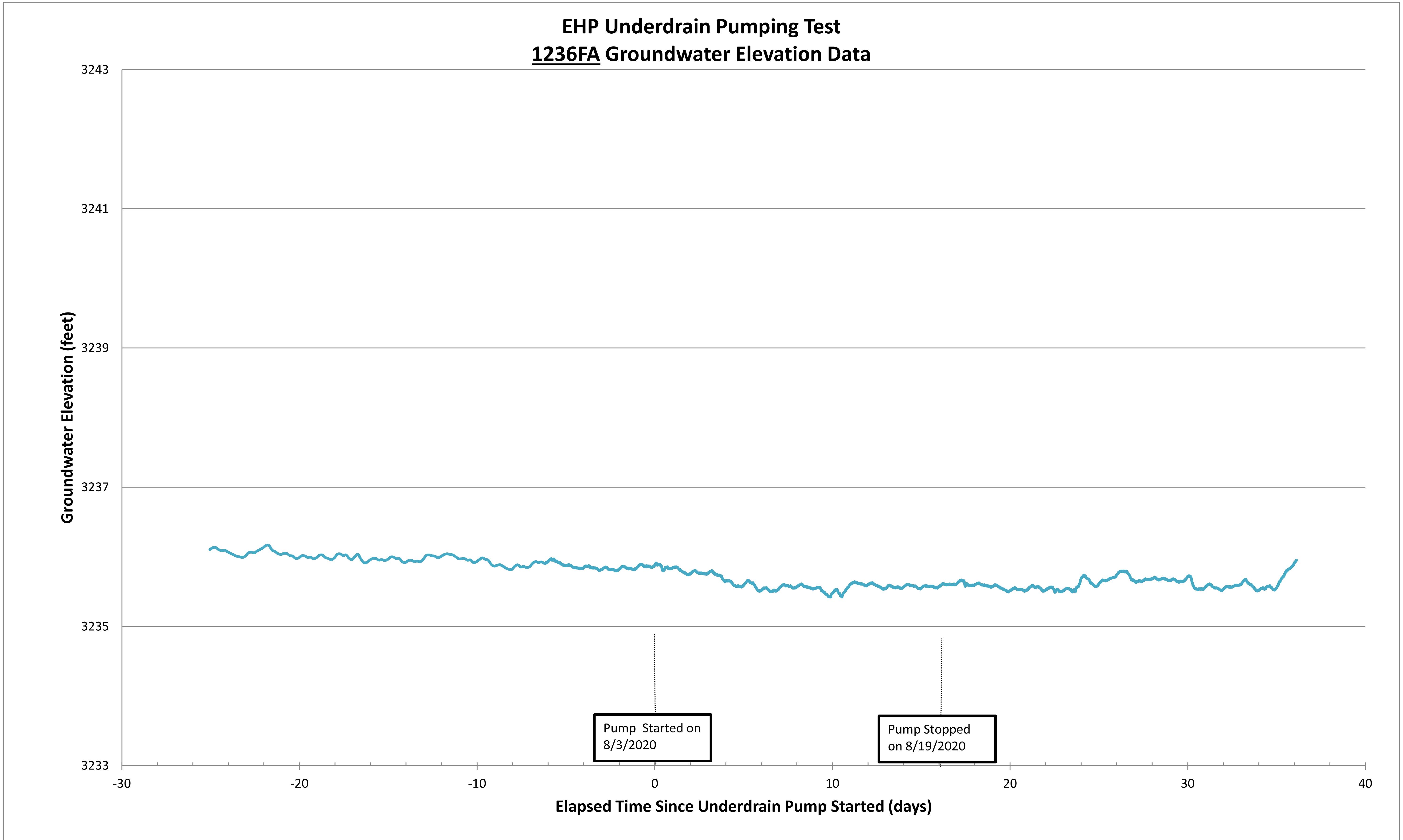


EHP Underdrain Pumping Test
C Cell Water Level Elevation Data
C Cell Water Level Elevation (feet)
3288
3286
3284
3282
3280
3278
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

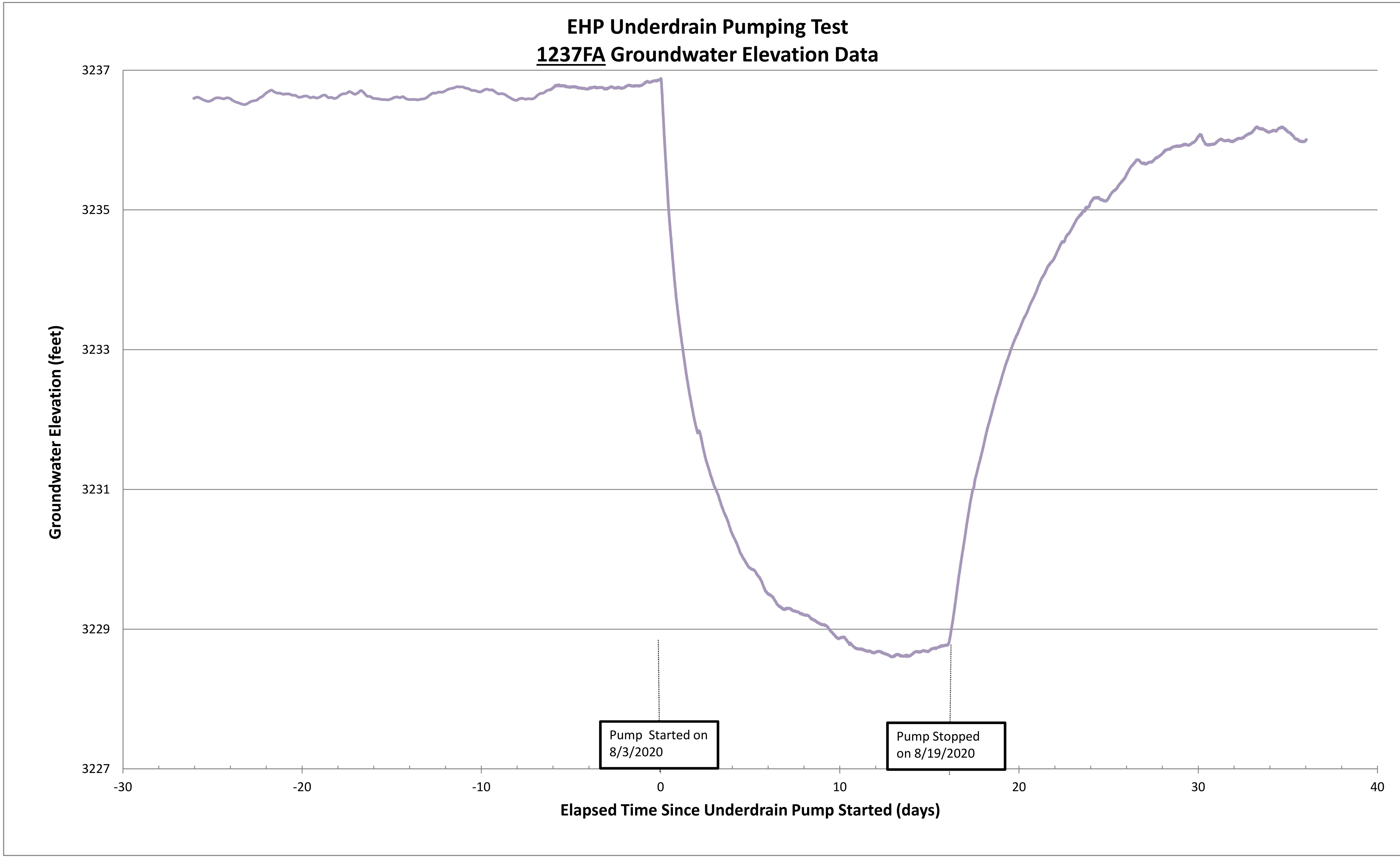

EHP Underdrain Pumping Test
1234FA Groundwater Elevation Data
Groundwater Elevation (feet)
3231
3226
3221
3216
3211
3206
3201
3196
3191
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020



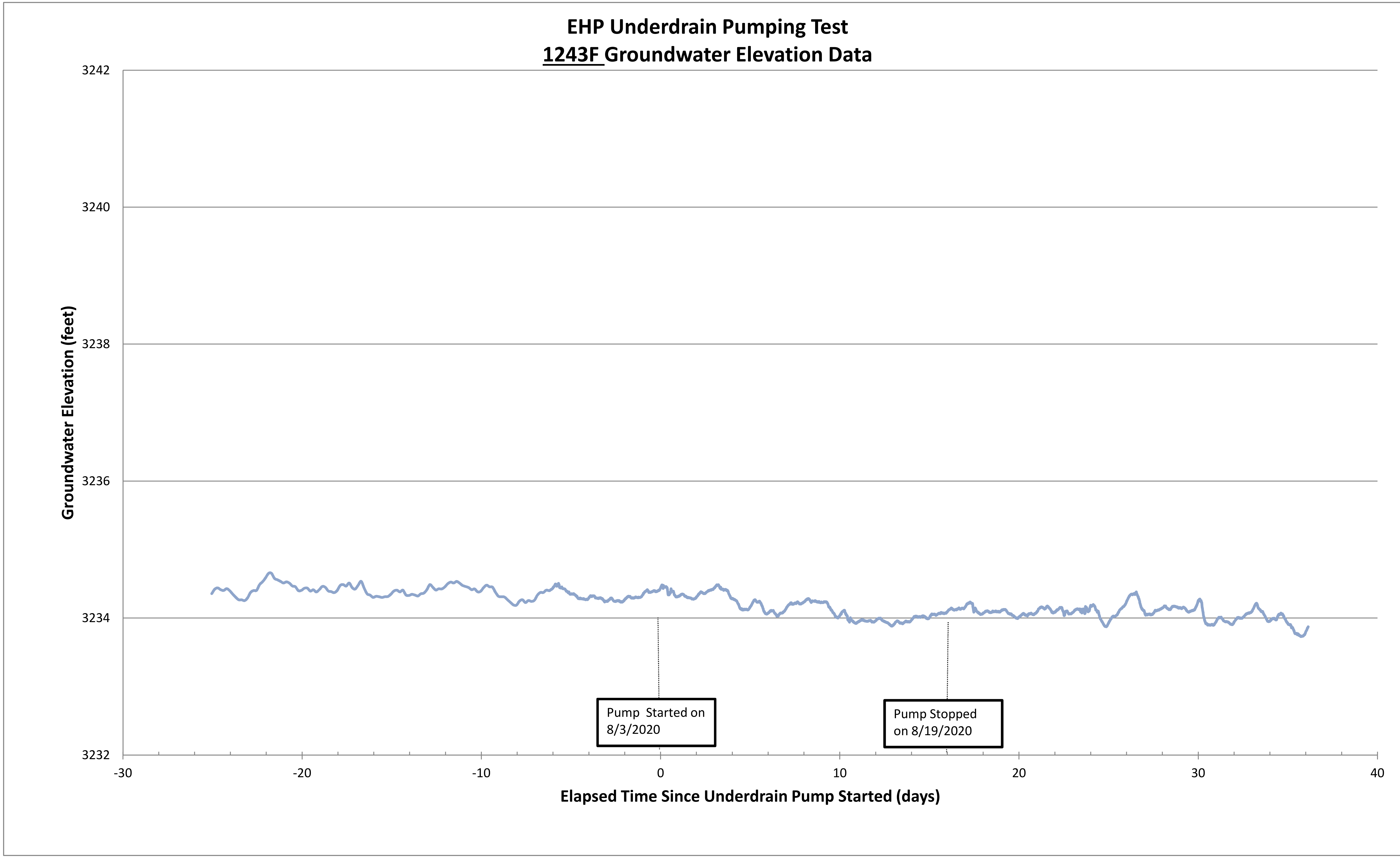
EHP Underdrain Pumping Test
1235FA Groundwater Elevation Data
Groundwater Elevation (feet)
3244
3242
3240
3238
3236
3234
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

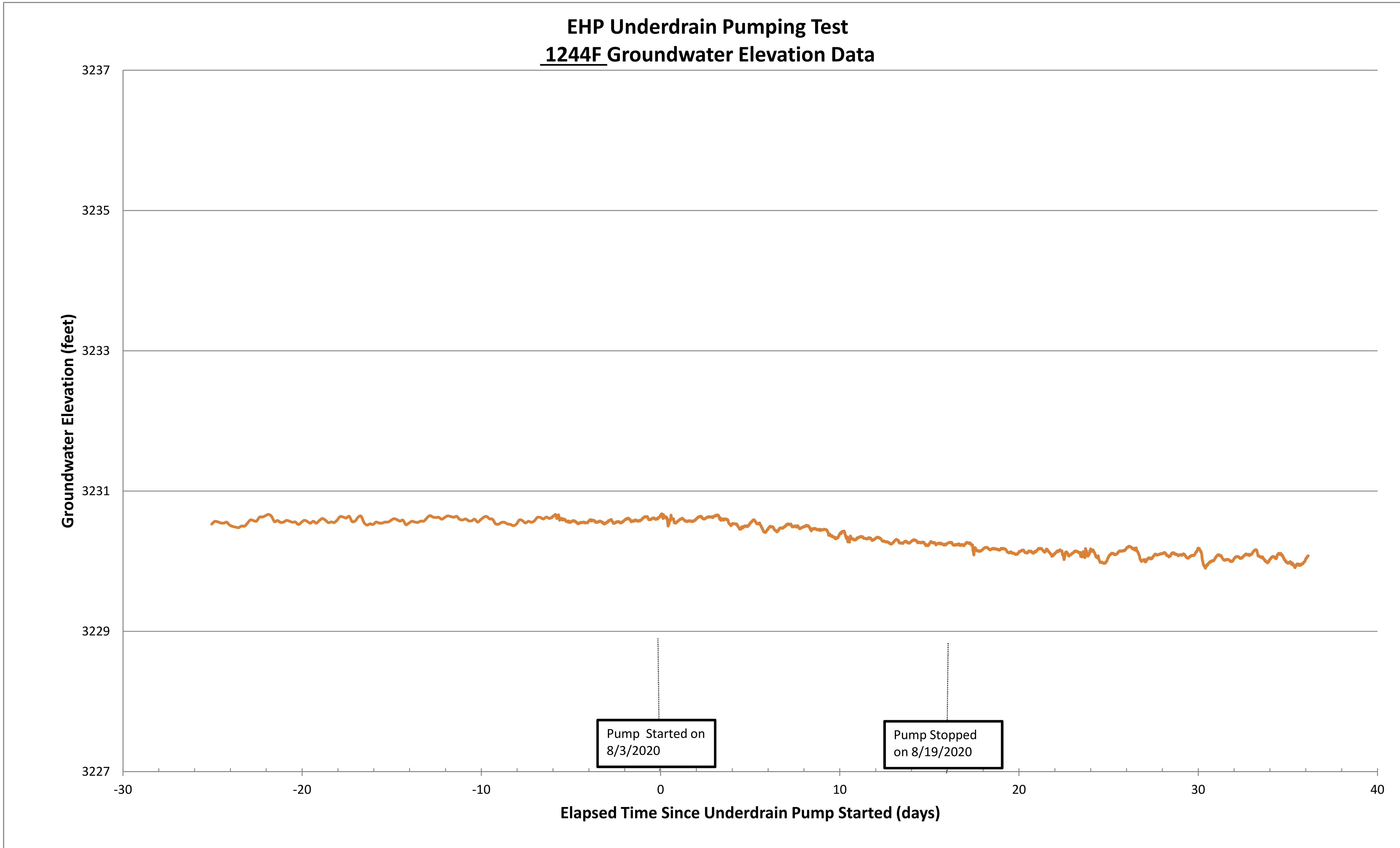


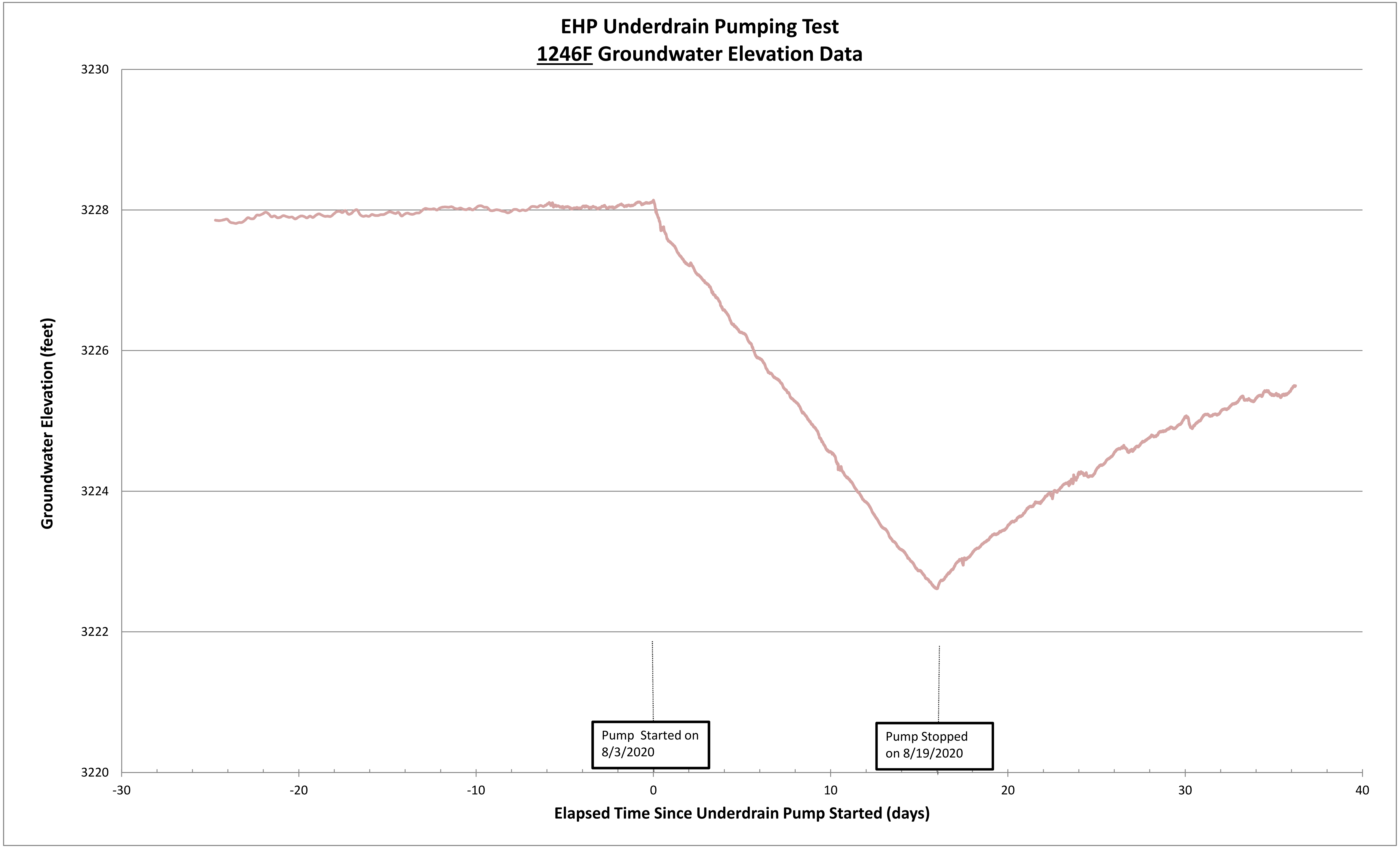
EHP Underdrain Pumping Test
1236FA Groundwater Elevation Data
Groundwater Elevation (feet)
3243
3241
3239
3237
3235
3233
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020



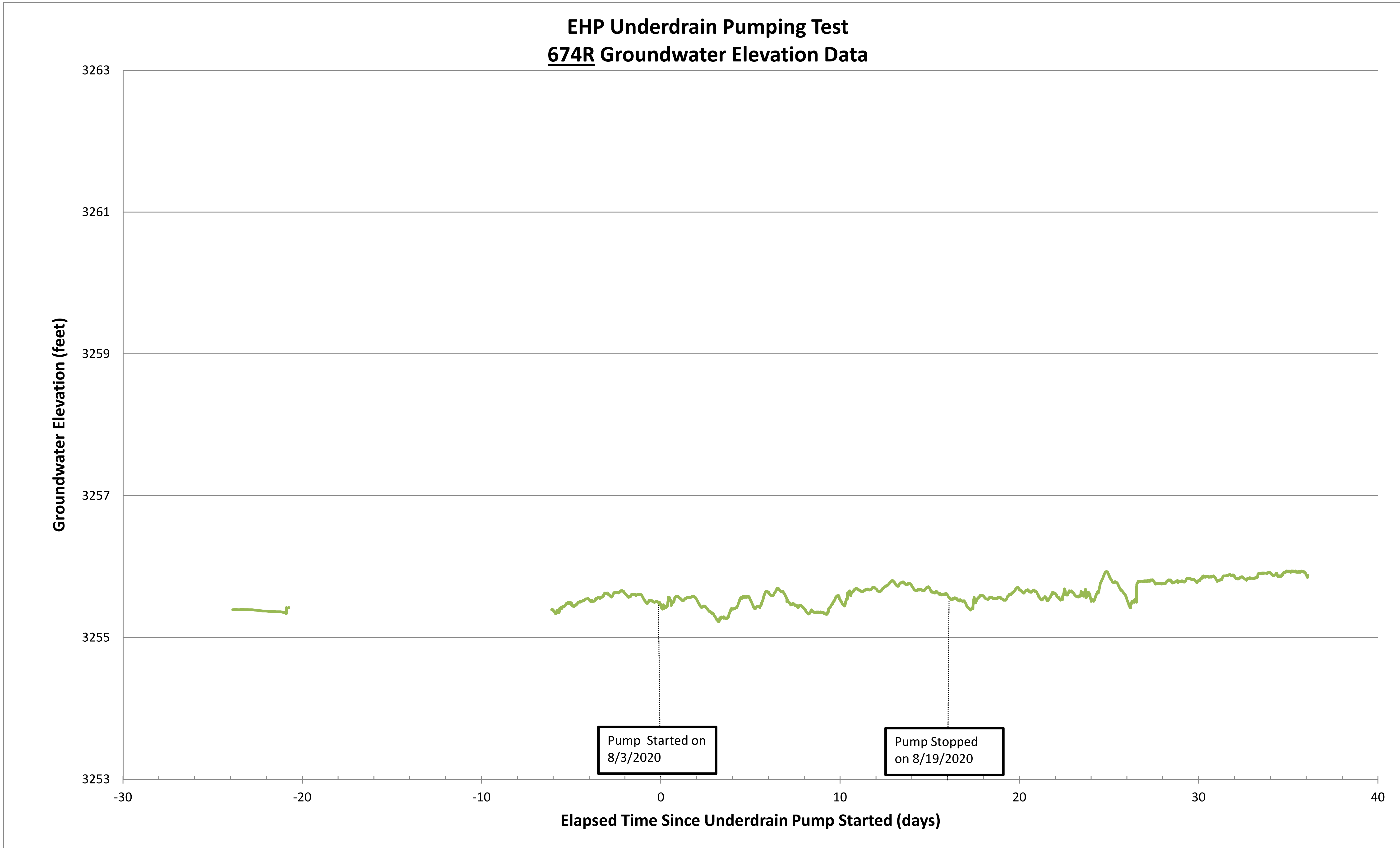
EHP Underdrain Pumping Test
1237FA Groundwater Elevation Data
Groundwater Elevation (feet)
3237
3235
3233
3231
3229
3227
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020


EHP Underdrain Pumping Test
1243F Groundwater Elevation Data
Groundwater Elevation (feet)
3242
3240
3238
3236
3234
3232
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

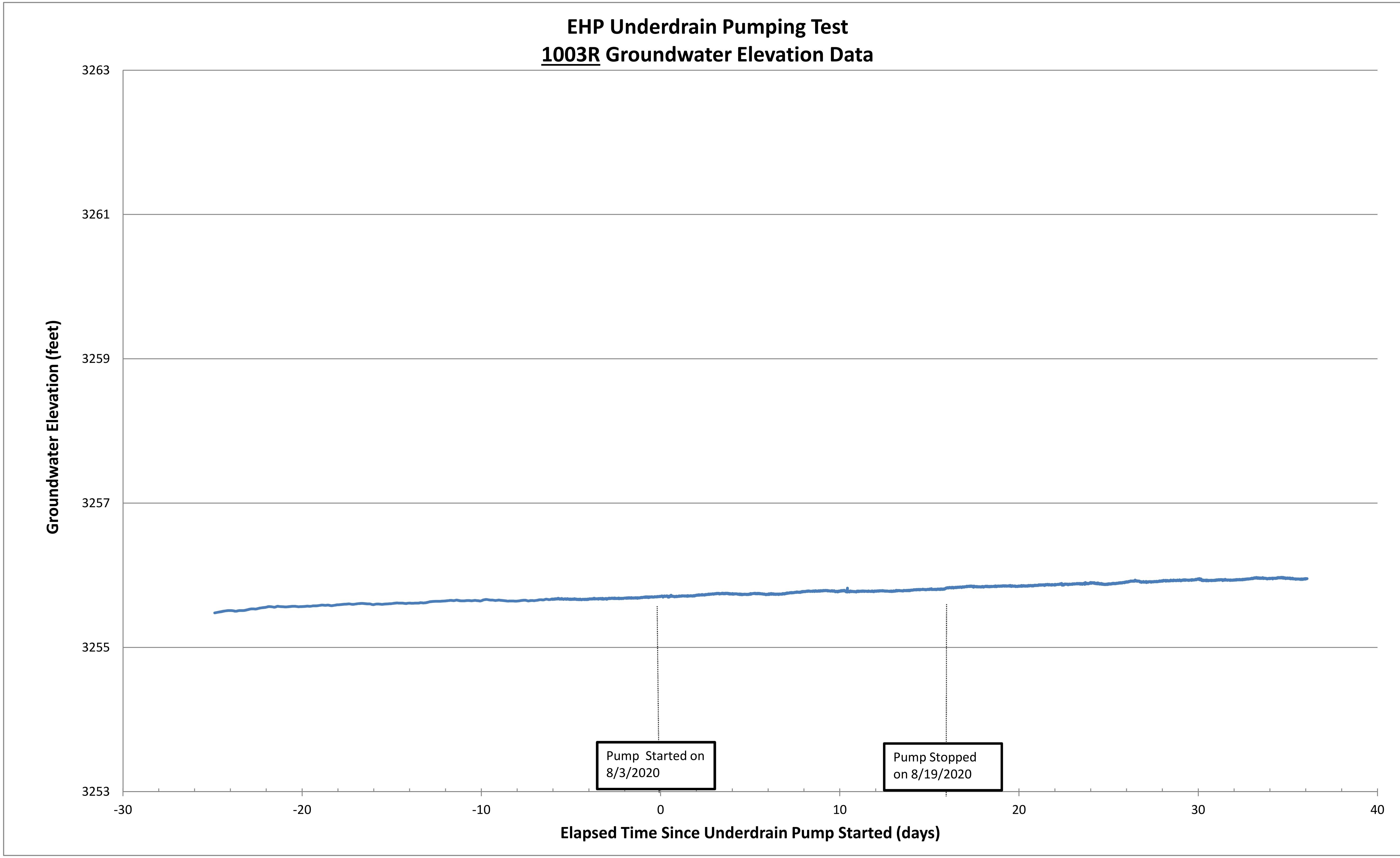

EHP Underdrain Pumping Test
1244F Groundwater Elevation Data
Groundwater Elevation (feet)
3237
3235
3233
3231
3229
3227
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

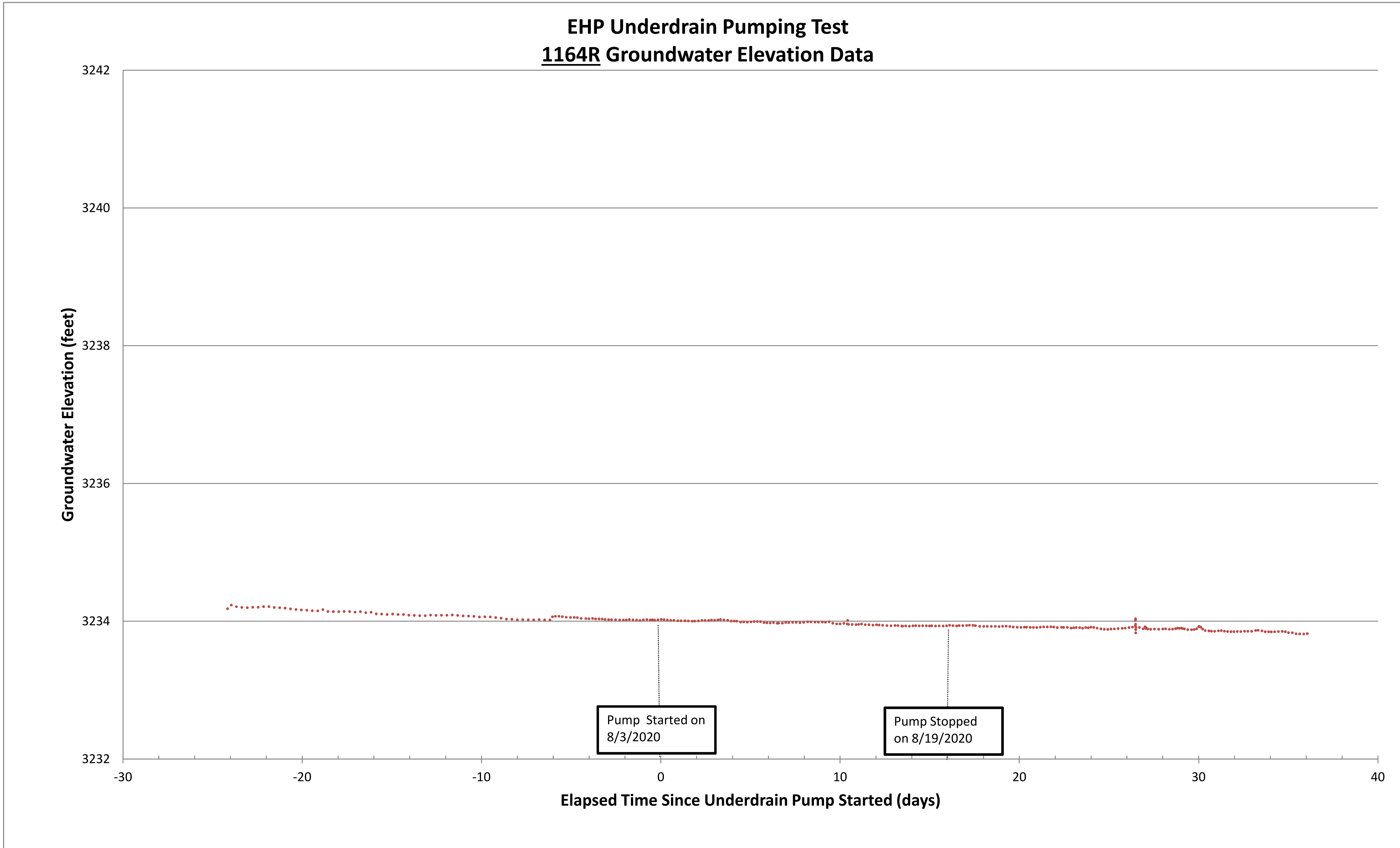


EHP Underdrain Pumping Test
1246F Groundwater Elevation Data
Groundwater Elevation (feet)
3230
3228
3226
3224
3222
3220
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

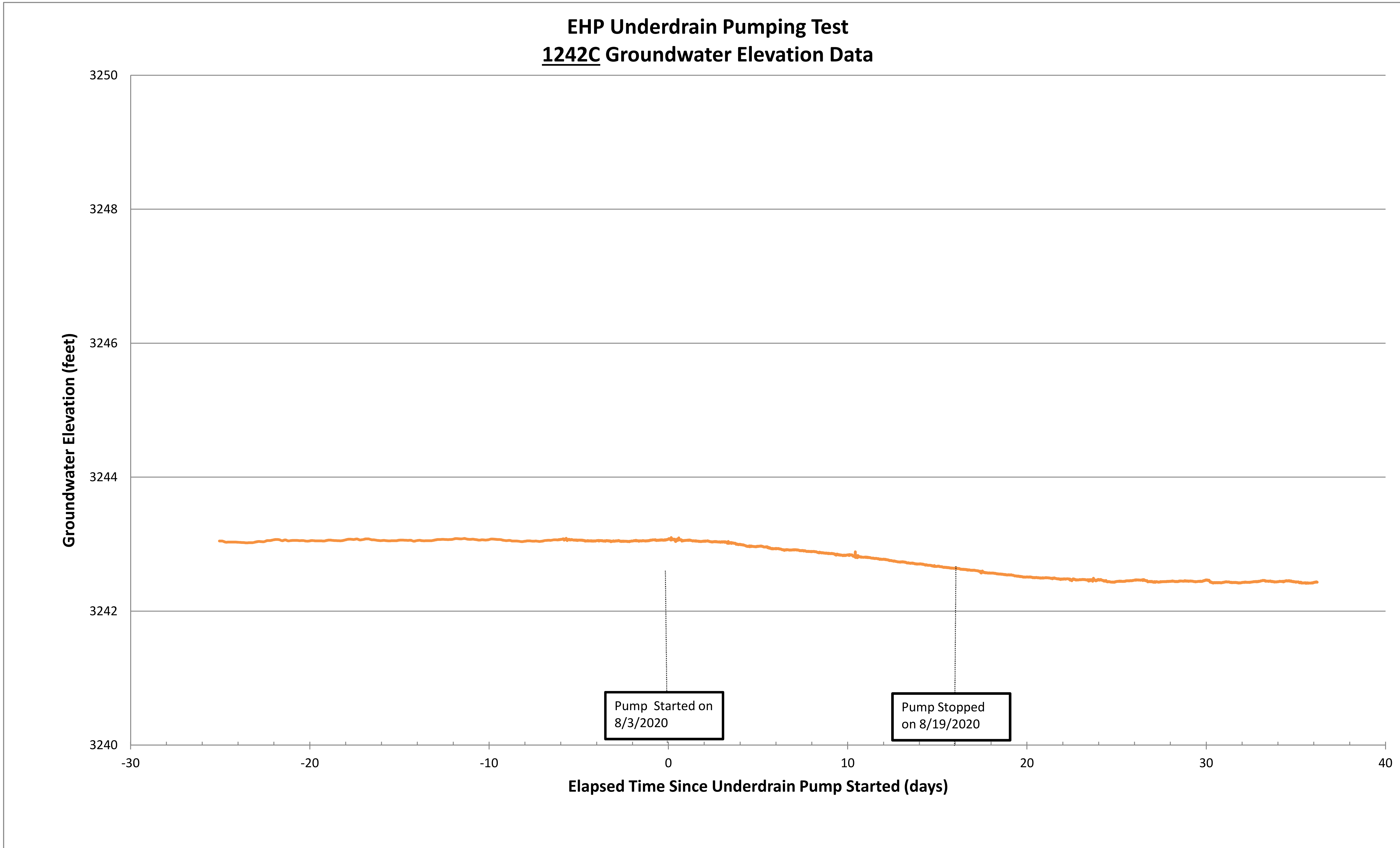


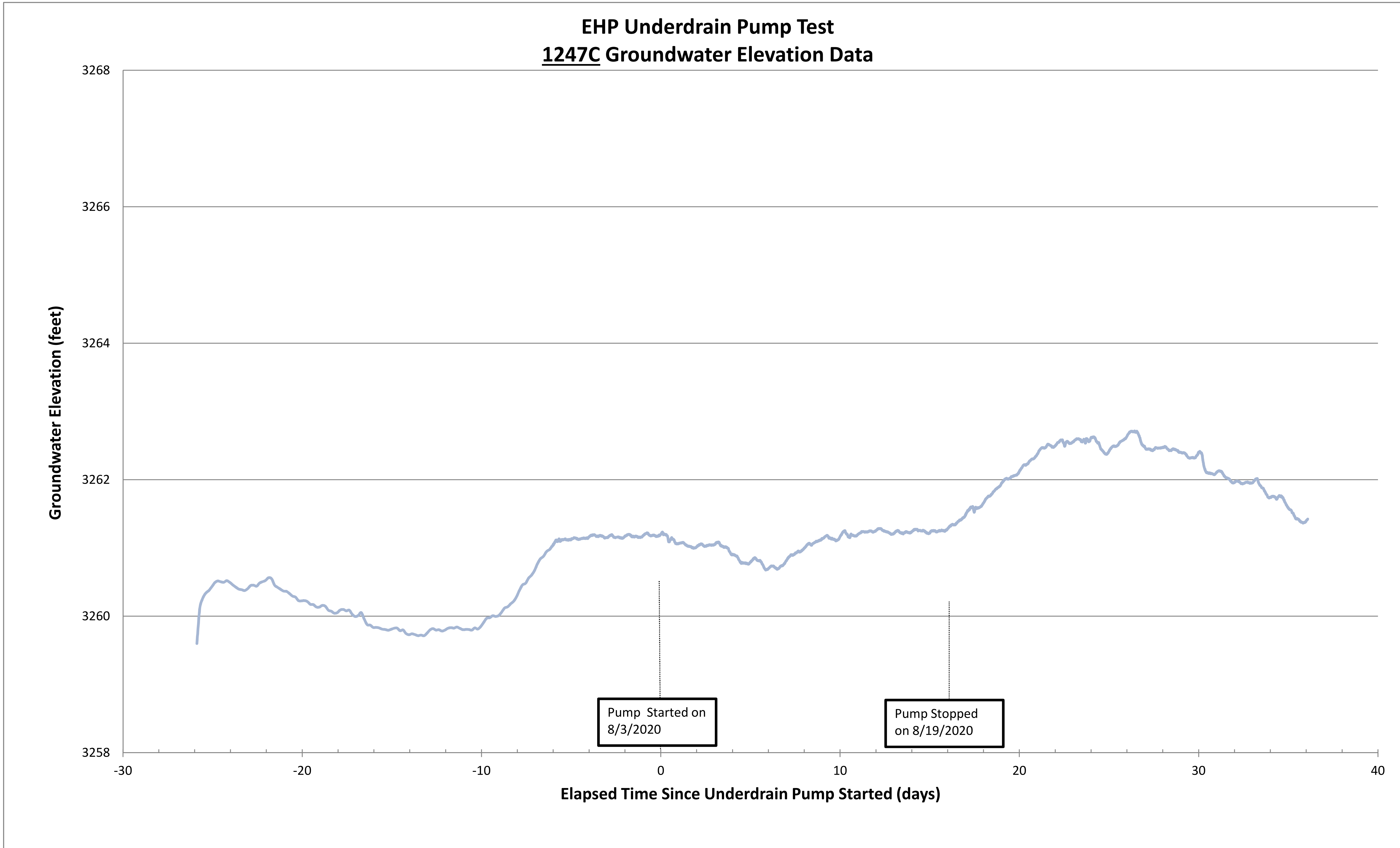
EHP Underdrain Pumping Test
674R Groundwater Elevation Data
Groundwater Elevation (feet)
3263
3261
3259
3257
3255
3253
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

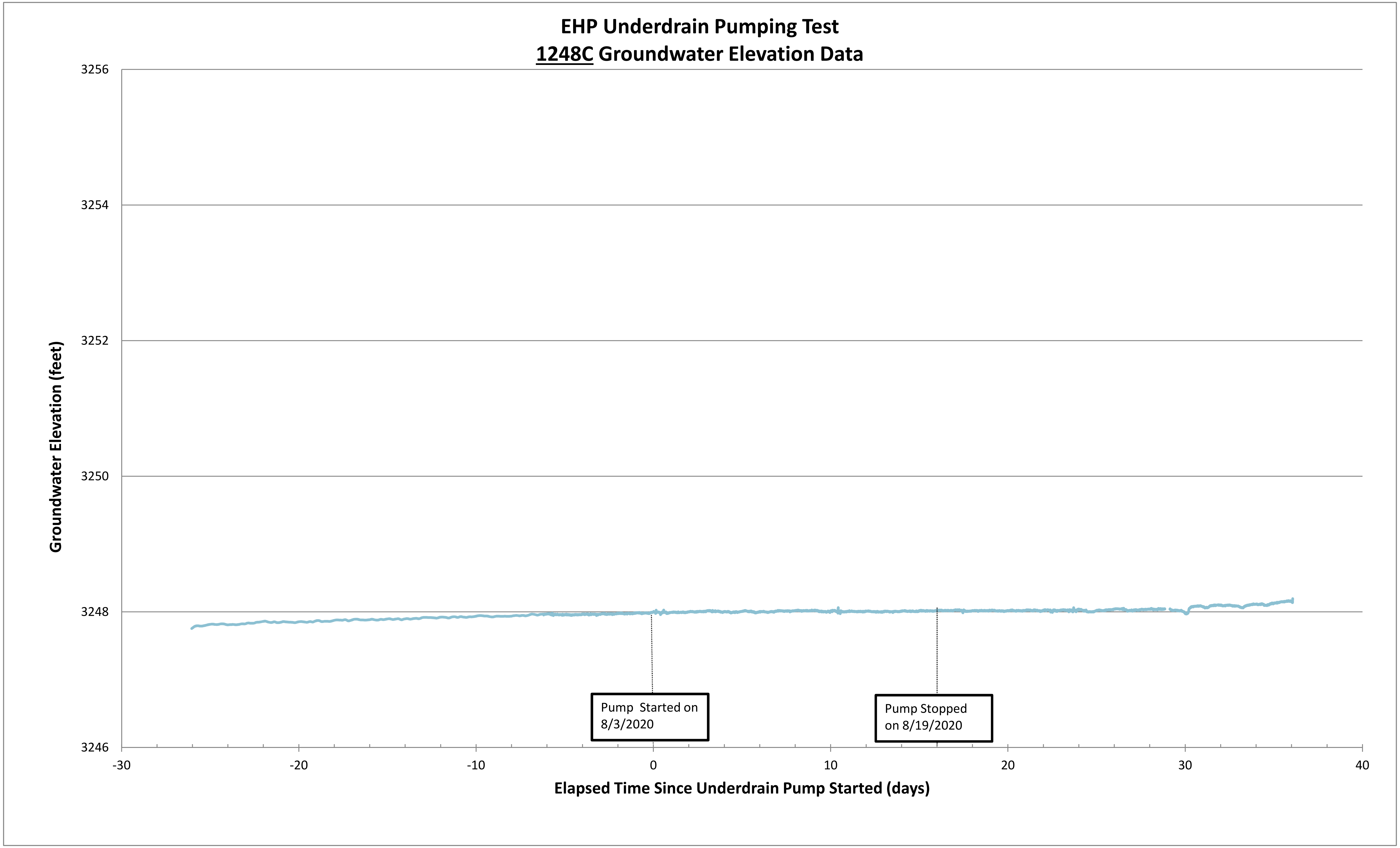

EHP Underdrain Pumping Test
1003R Groundwater Elevation Data
Groundwater Elevation (feet)
3263
3261
3259
3257
3255
3253
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020



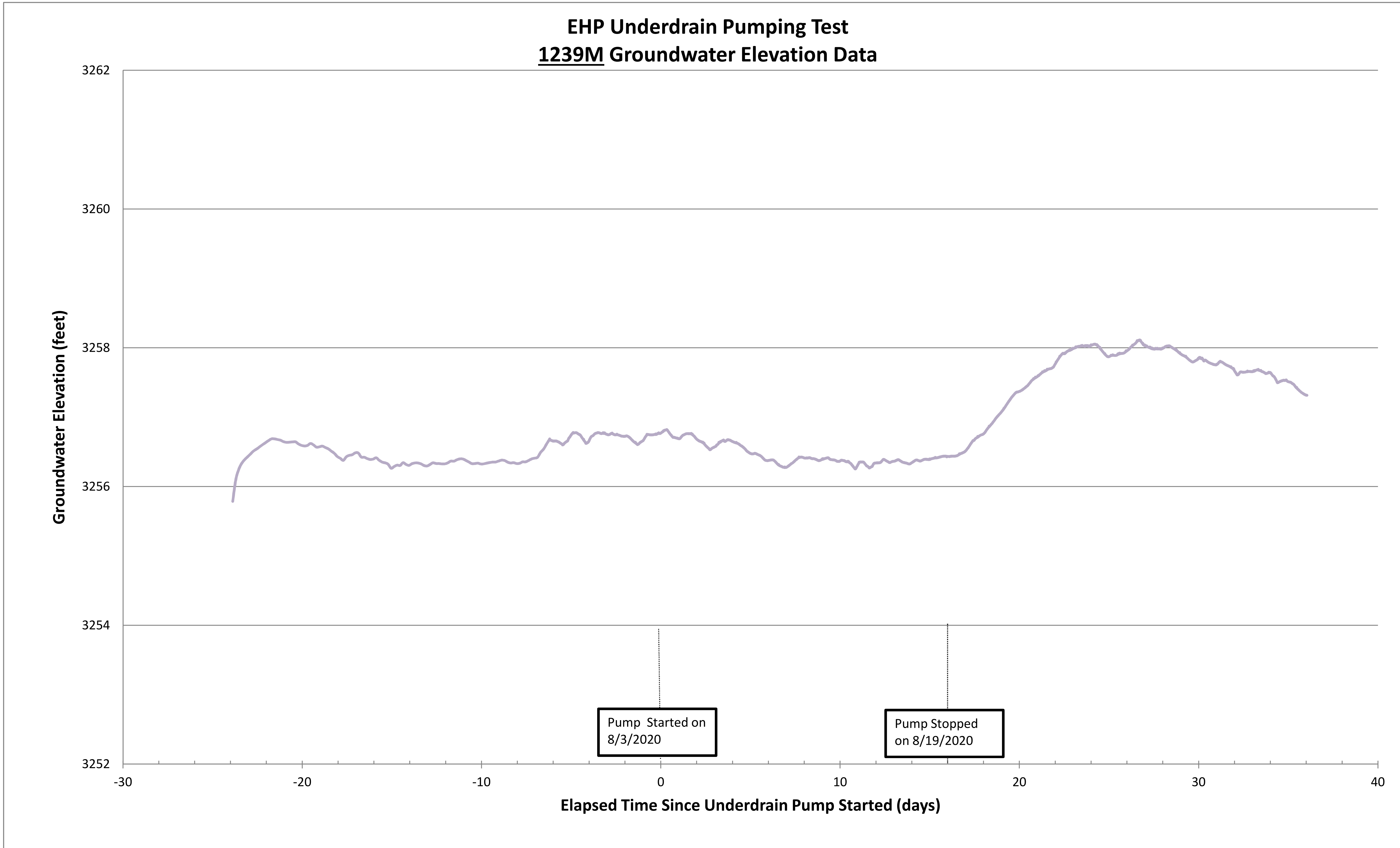
EHP Underdrain Pumping Test
1164R Groundwater Elevation Data
Groundwater Elevation (feet)
3242
3240
3238
3236
3234
3232
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

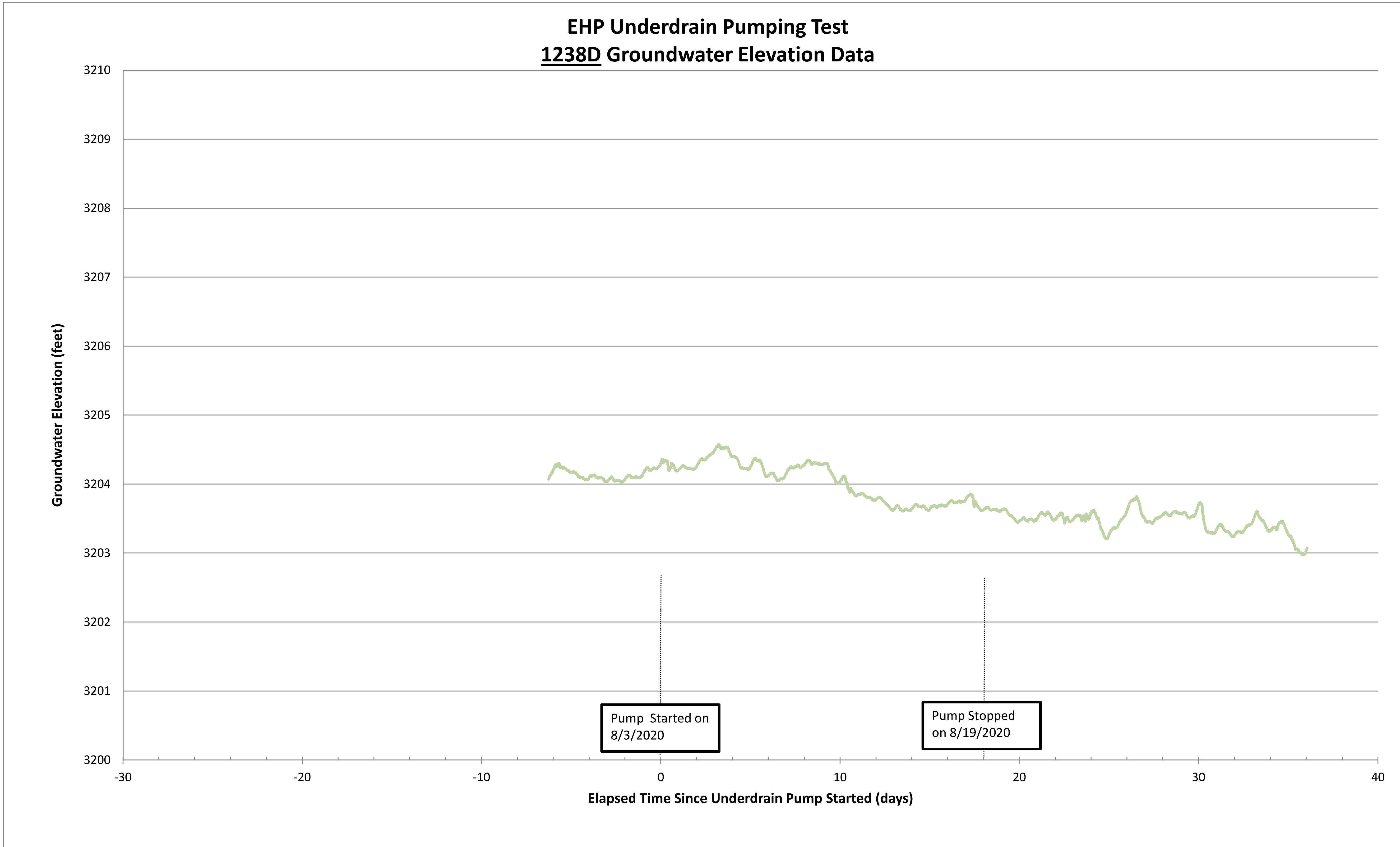

EHP Underdrain Pumping Test
1242C Groundwater Elevation Data
Groundwater Elevation (feet)
3250
3248
3246
3244
3242
3240
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

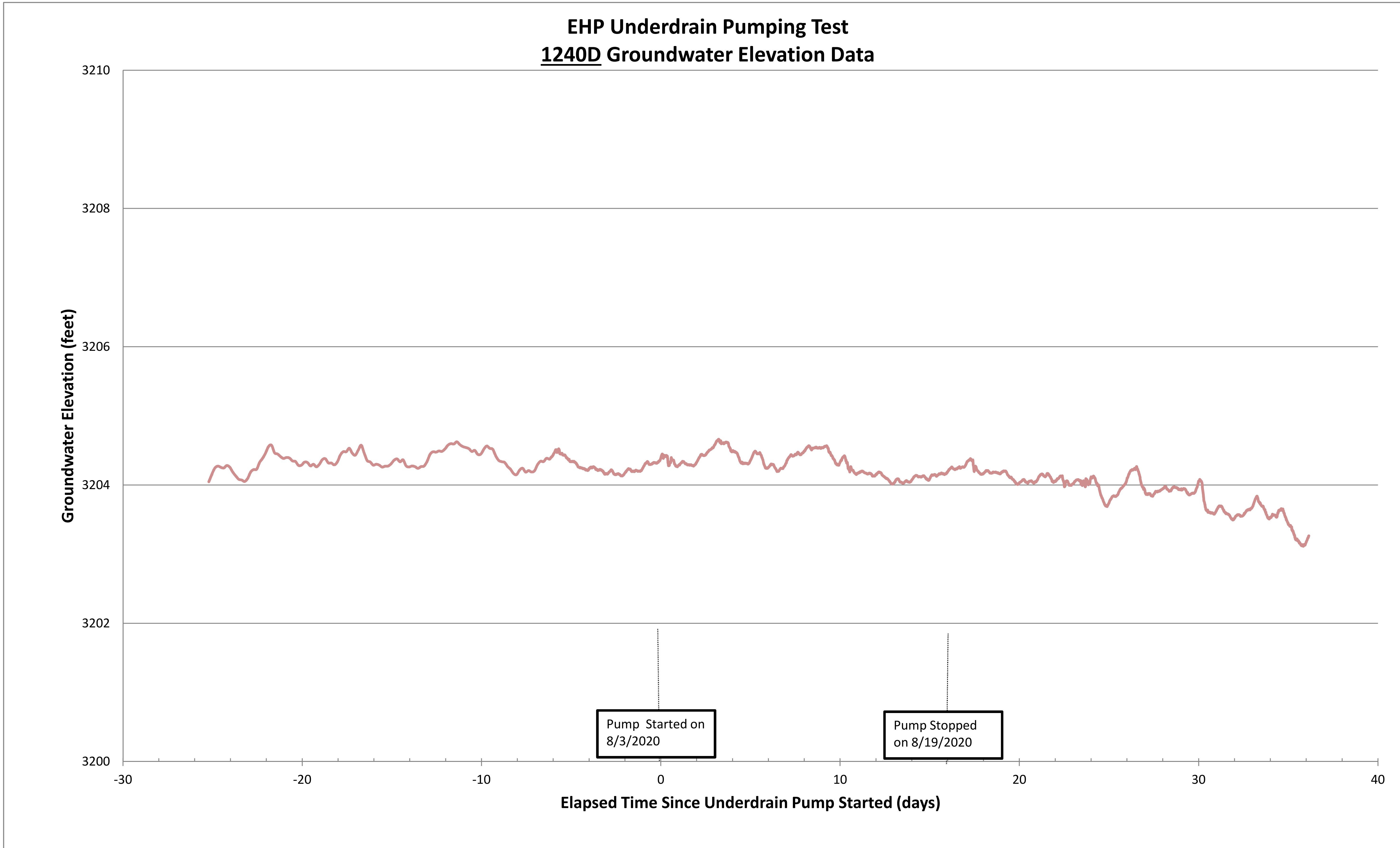

EHP Underdrain Pump Test
1247C Groundwater Elevation Data
Groundwater Elevation (feet)
3268
3266
3264
3262
3260
3258
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

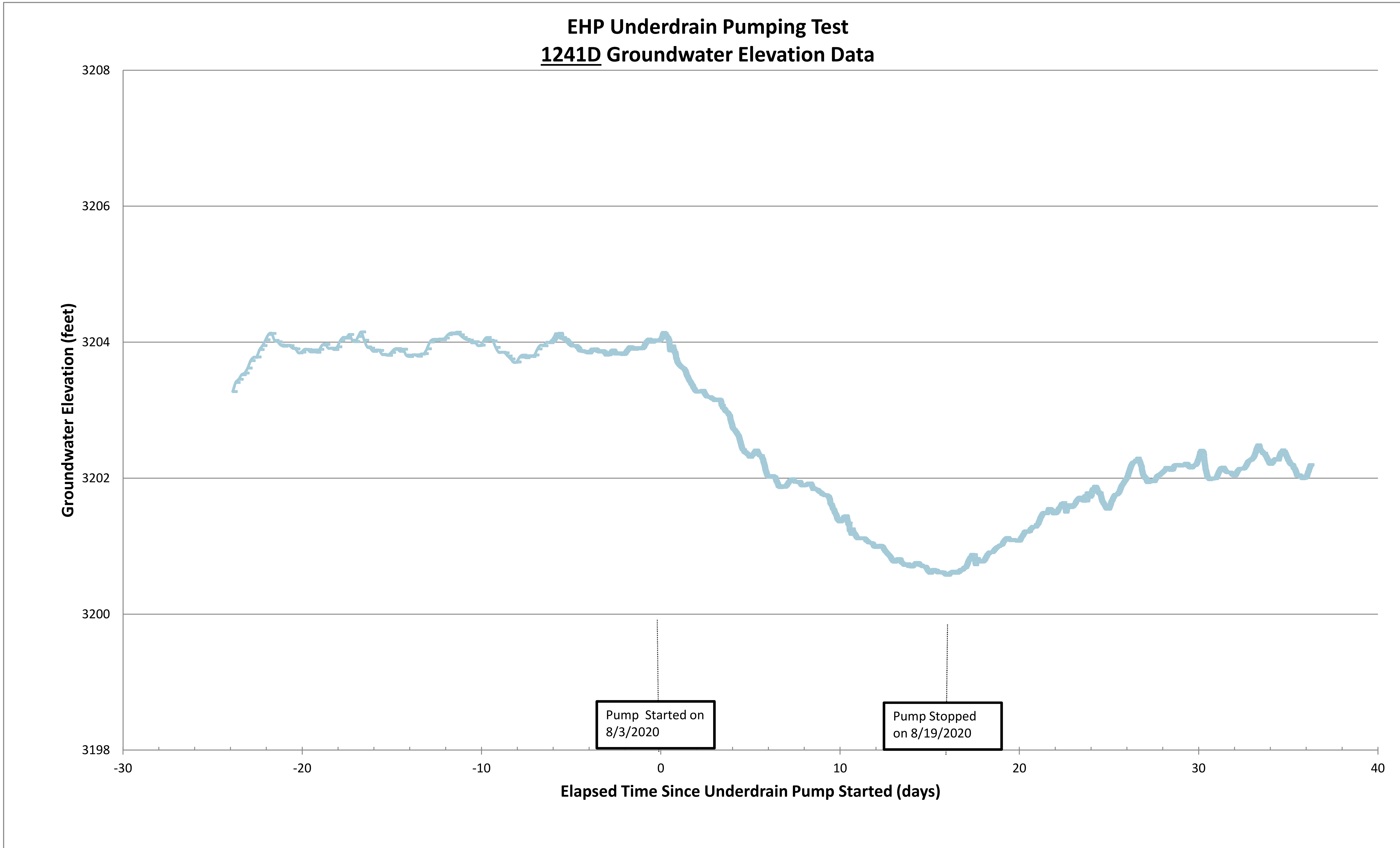


EHP Underdrain Pumping Test
1248C Groundwater Elevation Data
Groundwater Elevation (feet)
3256
3254
3252
3250
3248
3246
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

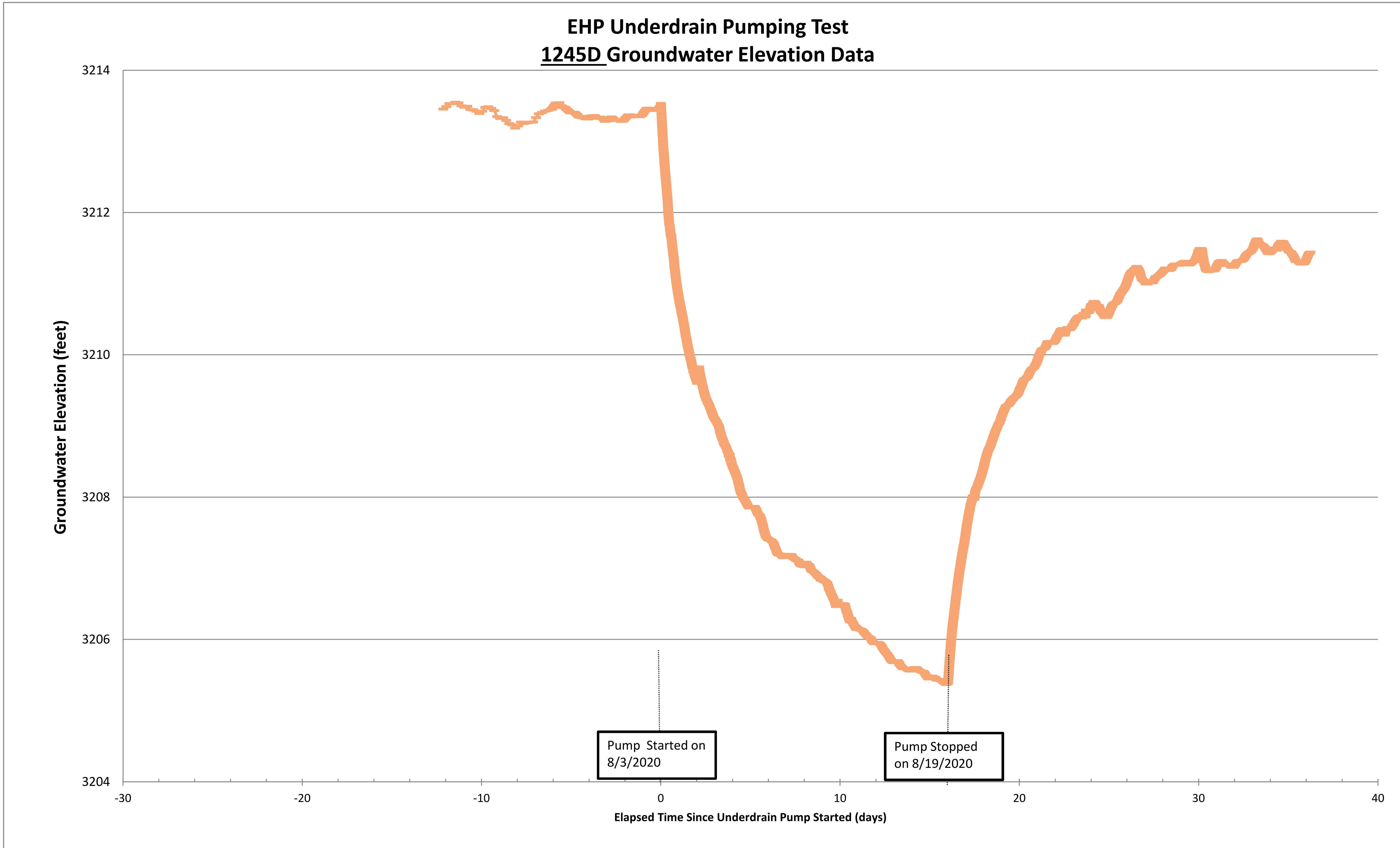

EHP Underdrain Pumping Test
1239M Groundwater Elevation Data
Groundwater Elevation (feet)
3262
3260
3258
3256
3254
3252
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020


EHP Underdrain Pumping Test
1238D Groundwater Elevation Data
Groundwater Elevation (feet)
3210
3209
3208
3207
3206
3205
3204
3203
3202
3201
3200
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020


EHP Underdrain Pumping Test
1240D Groundwater Elevation Data
Groundwater Elevation (feet)
3210
3208
3206
3204
3202
3200
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

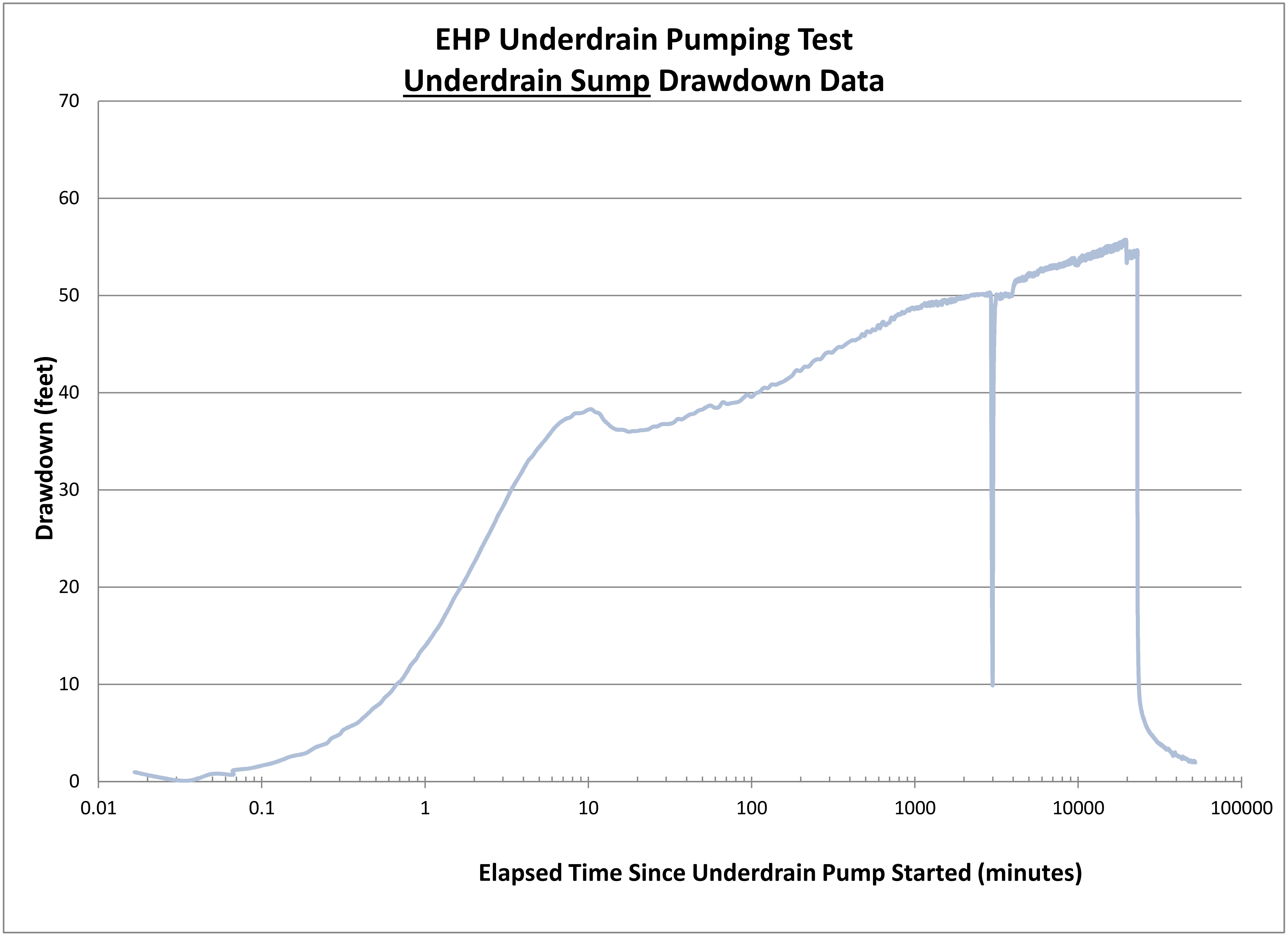


EHP Underdrain Pumping Test
1241D Groundwater Elevation Data
Groundwater Elevation (feet)
3208
3206
3204
3202
3200
3198
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

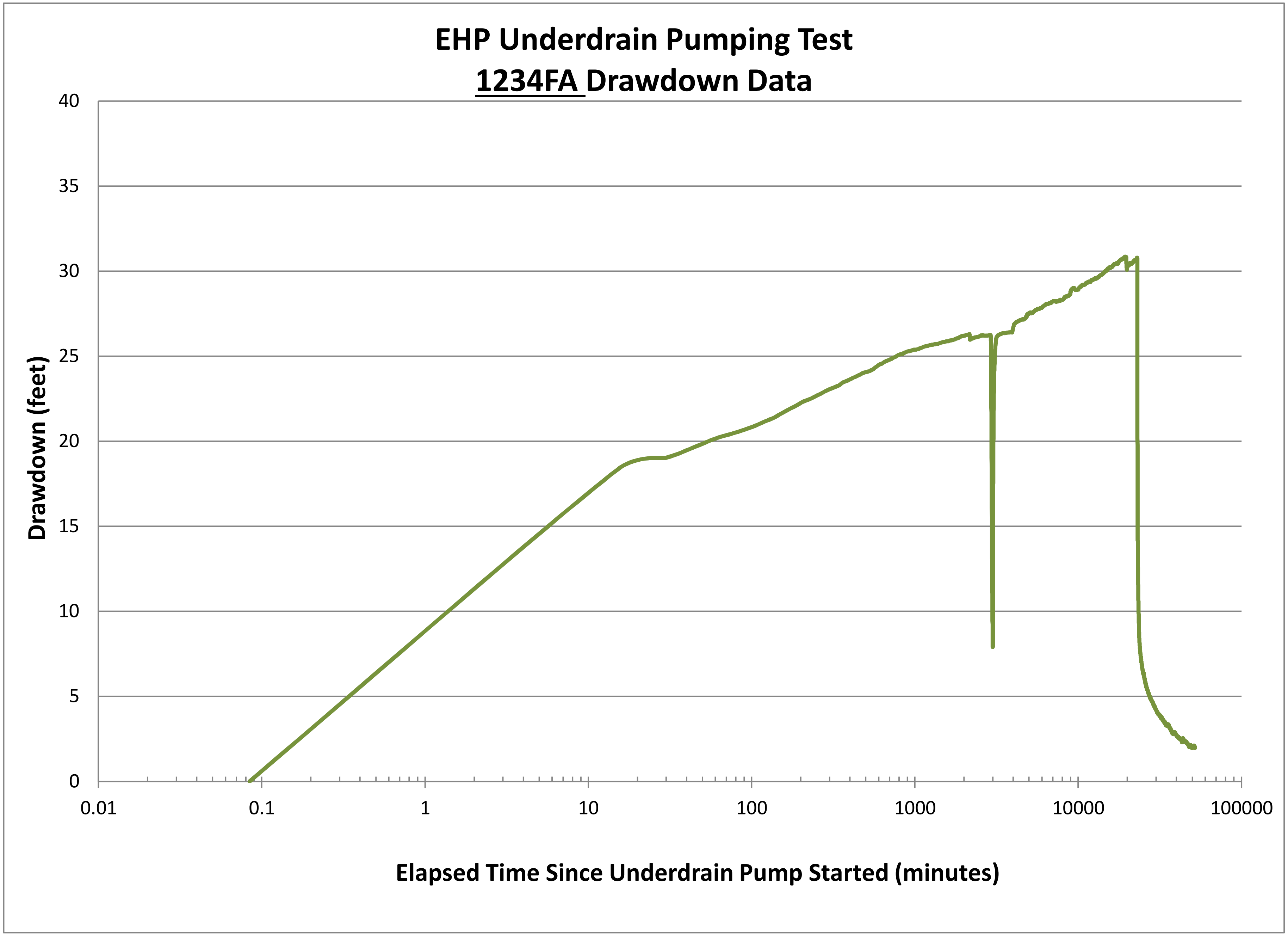

EHP Underdrain Pumping Test
1245D Groundwater Elevation Data
Groundwater Elevation (feet)
3214
3212
3210
3208
3206
3204
-30
-20
-10
0
10
20
30
40
Elapsed Time Since Underdrain Pump Started (days)
Pump Started on 8/3/2020
Pump Stopped on 8/19/2020

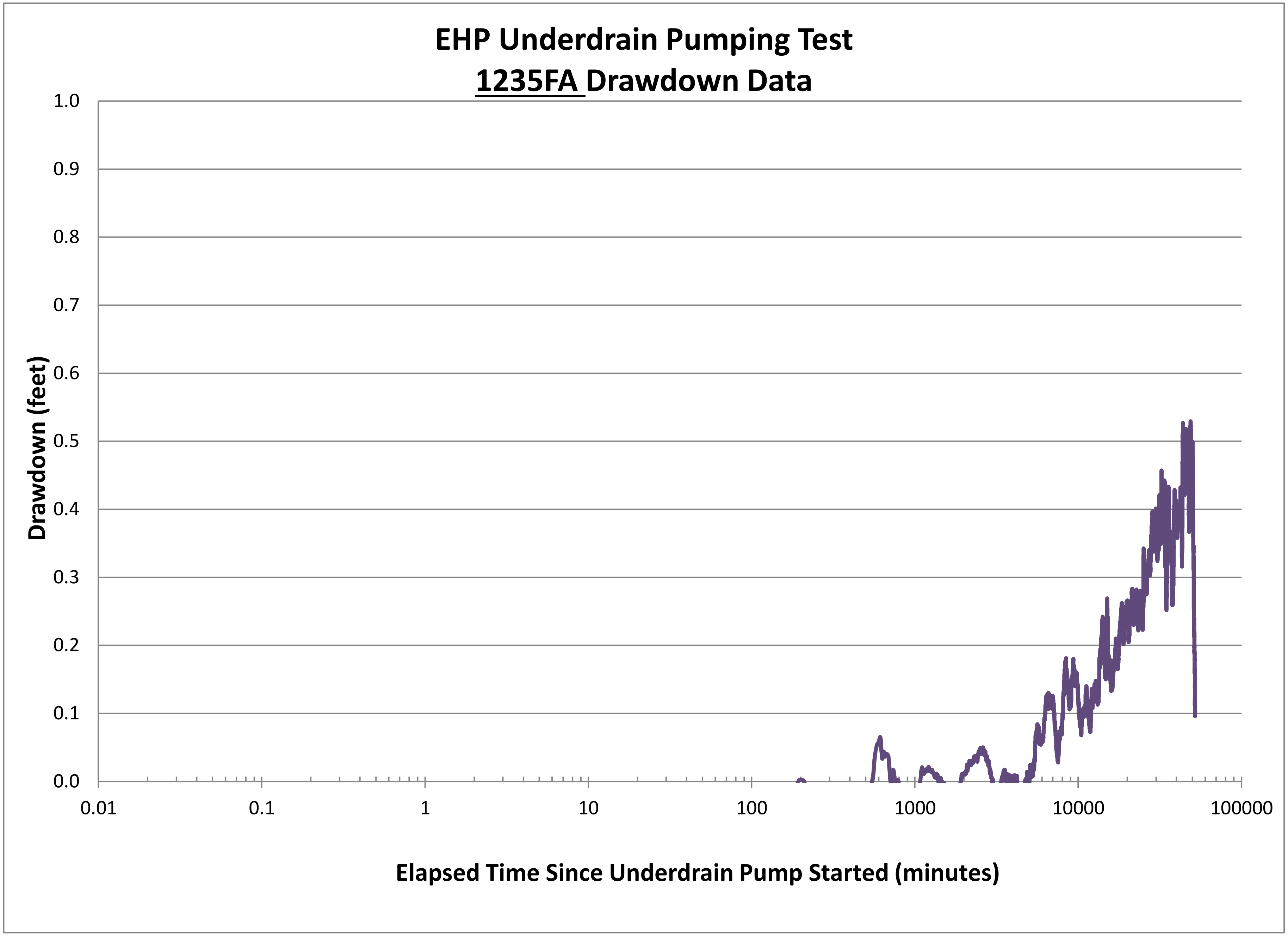
APPENDIX D

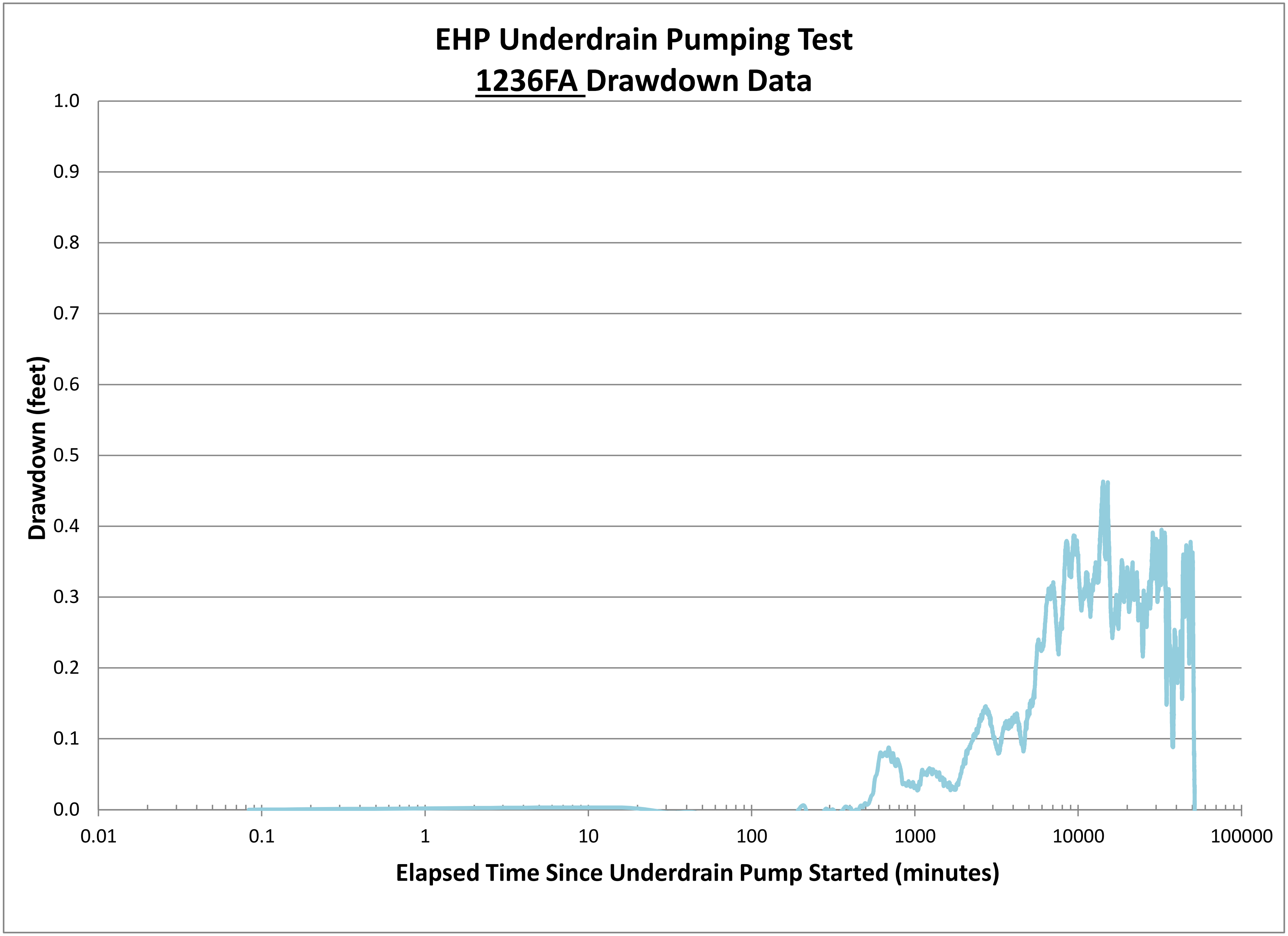
3&4 EHP PUMPING TEST DRAWDOWN HYDROGRAPHS

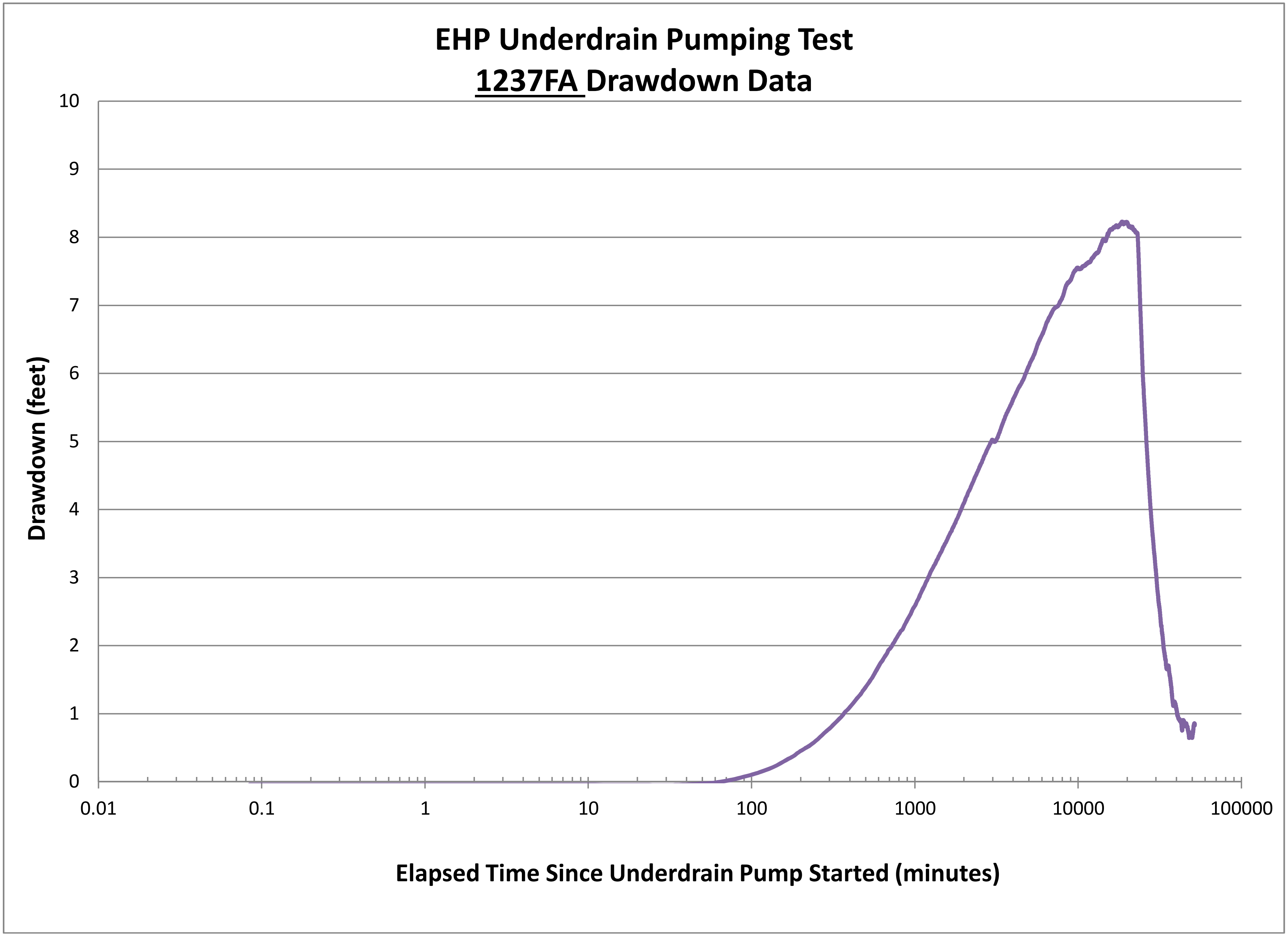


EHP Underdrain Pumping Test
Underdrain Sump Drawdown Data
Drawdown (feet)
70
60
50
40
30
20
10
0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)

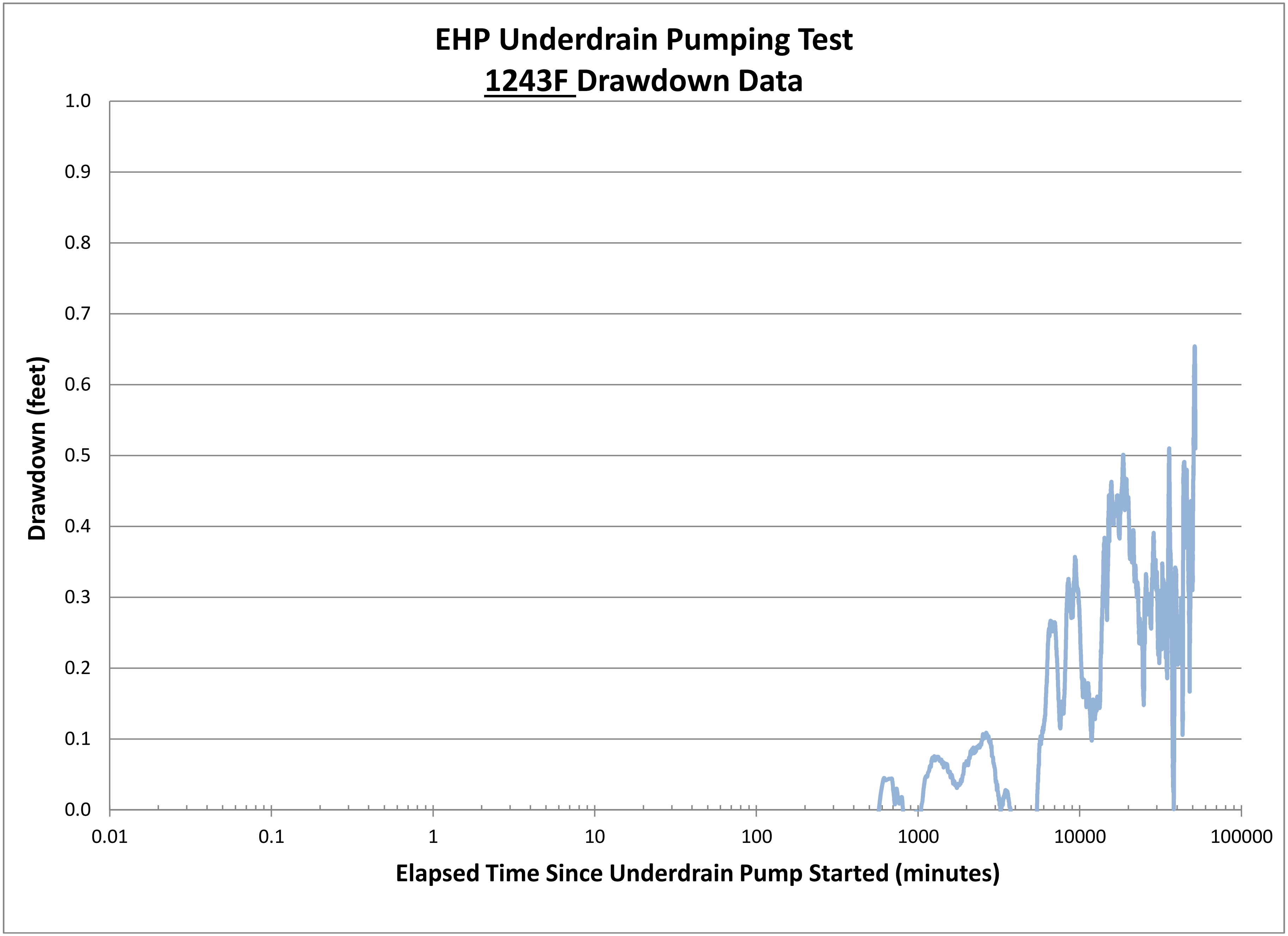

EHP Underdrain Pumping Test
1234FA Drawdown Data
Drawdown (feet)
40
35
30
25
20
15
10
5
0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)

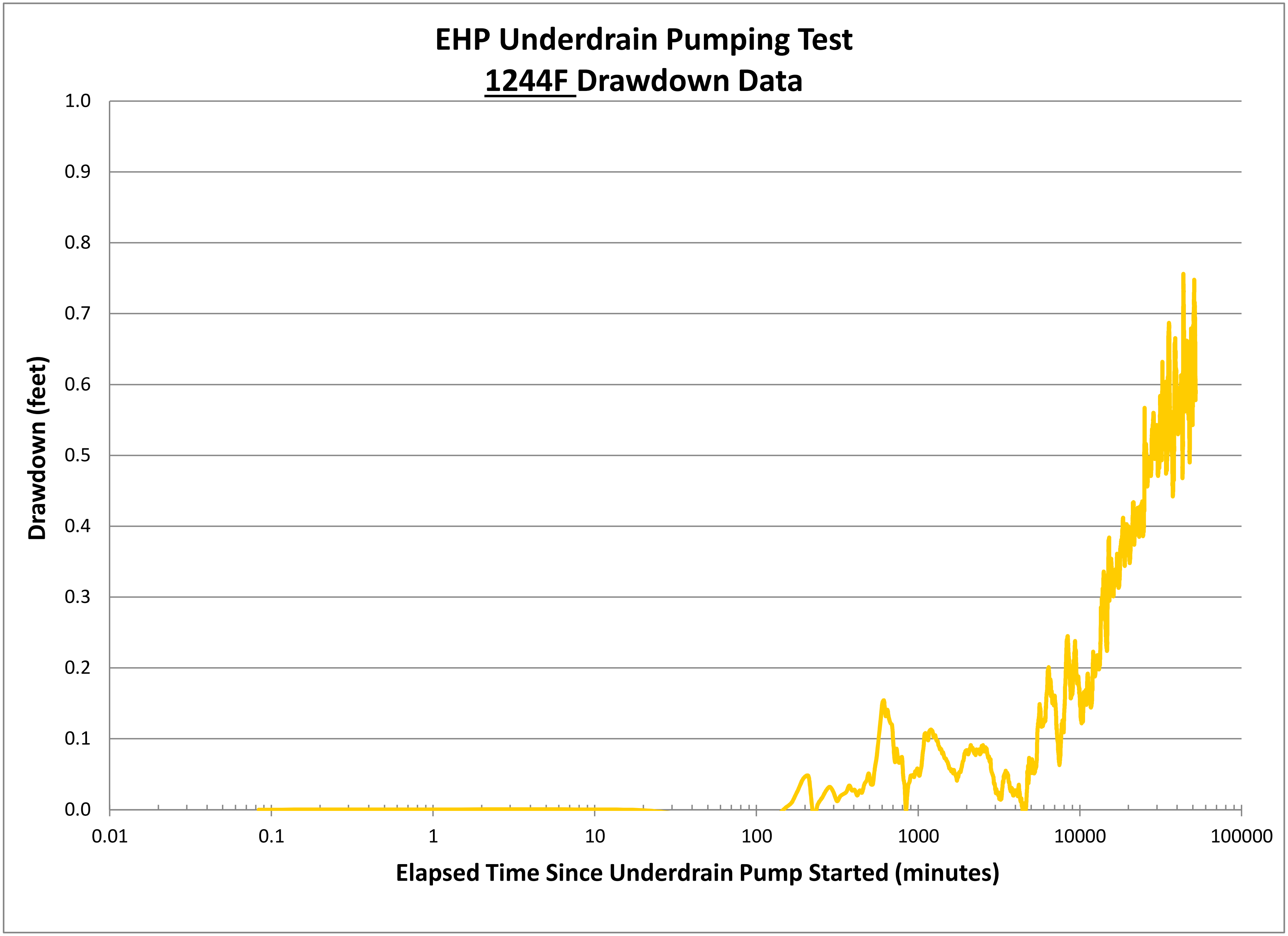

EHP Underdrain Pumping Test
1235FA Drawdown Data
Drawdown (feet)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)

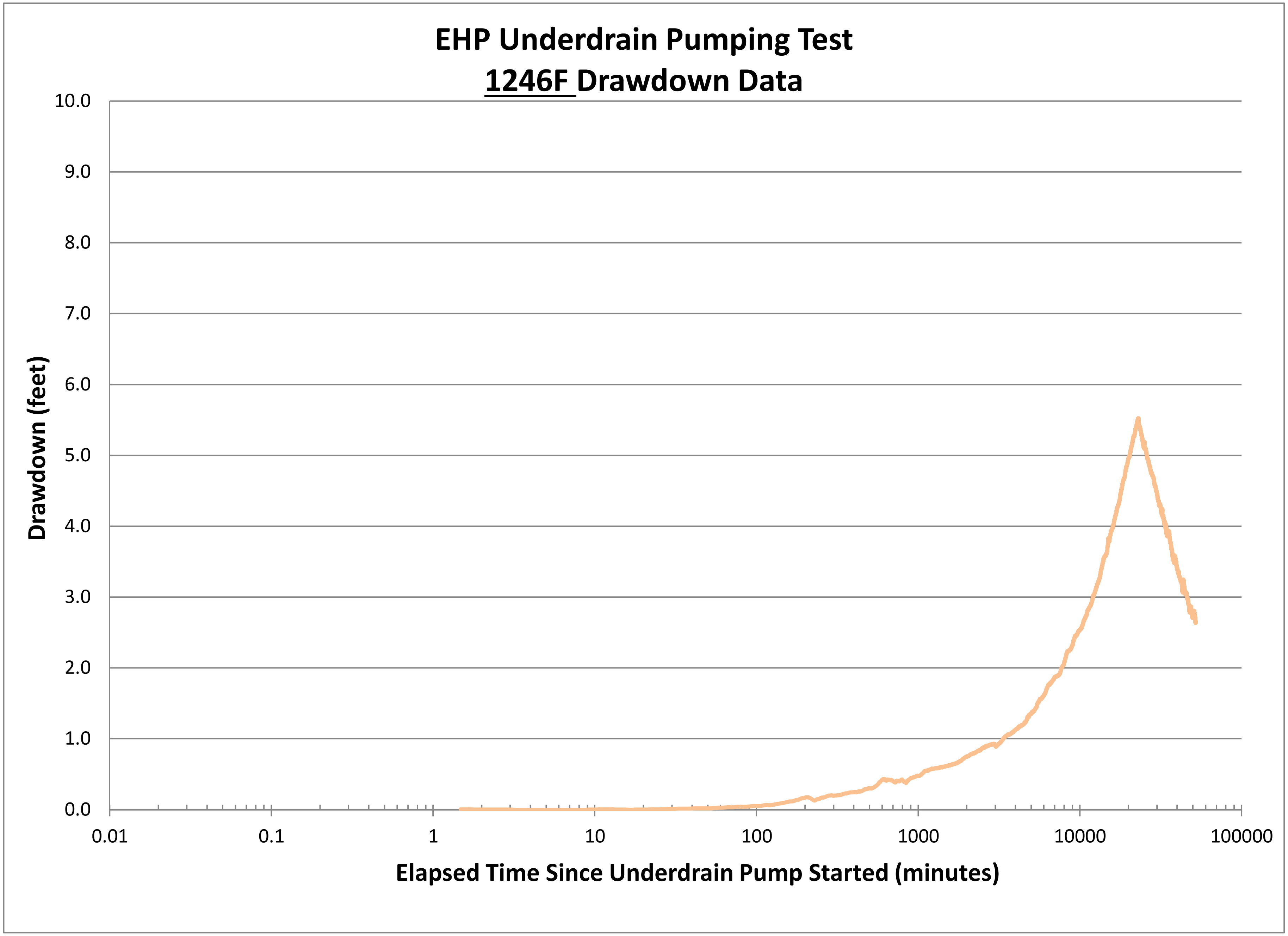

EHP Underdrain Pumping Test
1236FA Drawdown Data
Drawdown (feet)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)



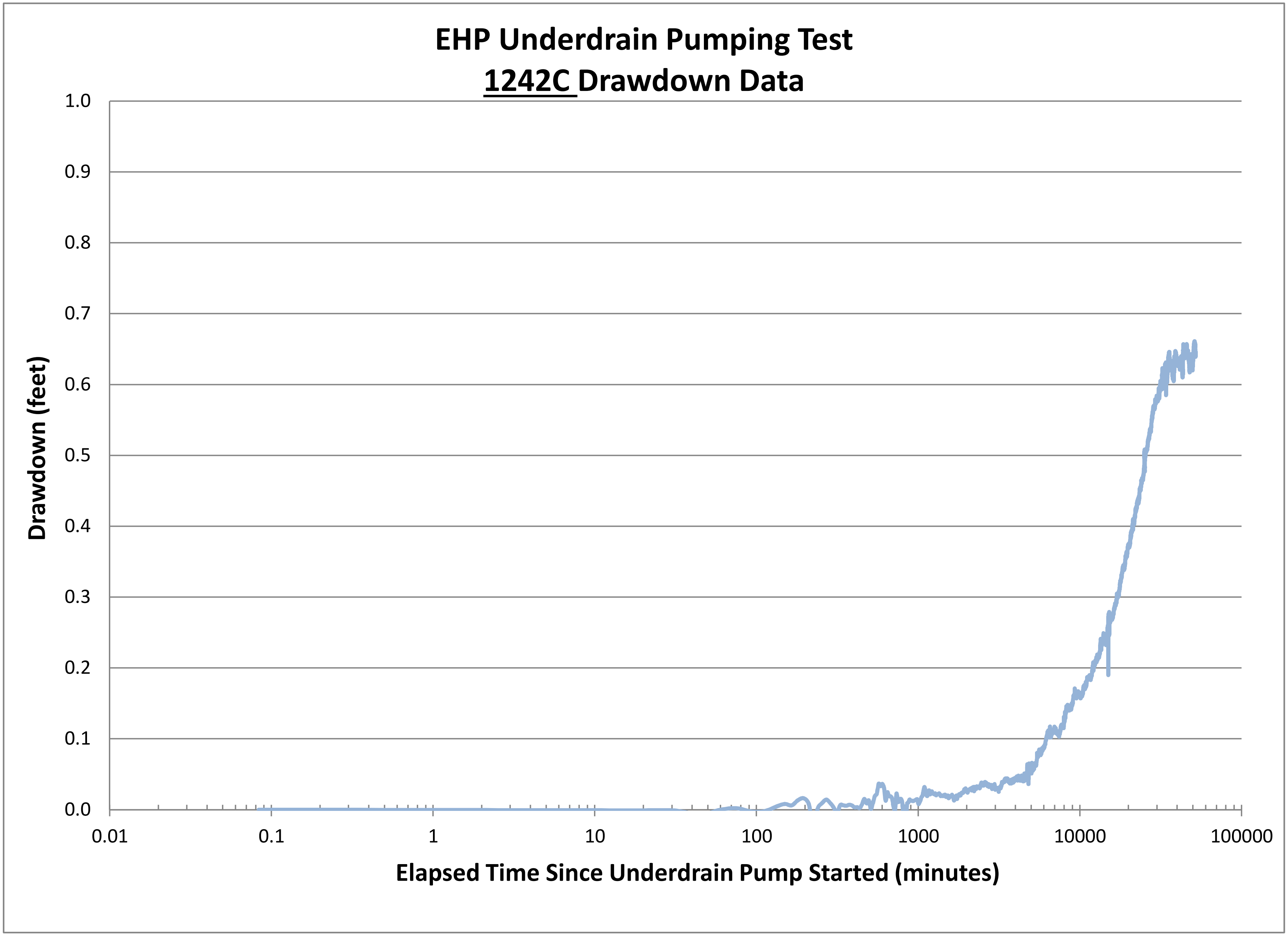
EHP Underdrain Pumping Test
1237FA Drawdown Data
Drawdown (feet)
10
9
8
7
6
5
4
3
2
1
0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)


EHP Underdrain Pumping Test
1243F Drawdown Data
Drawdown (feet)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)

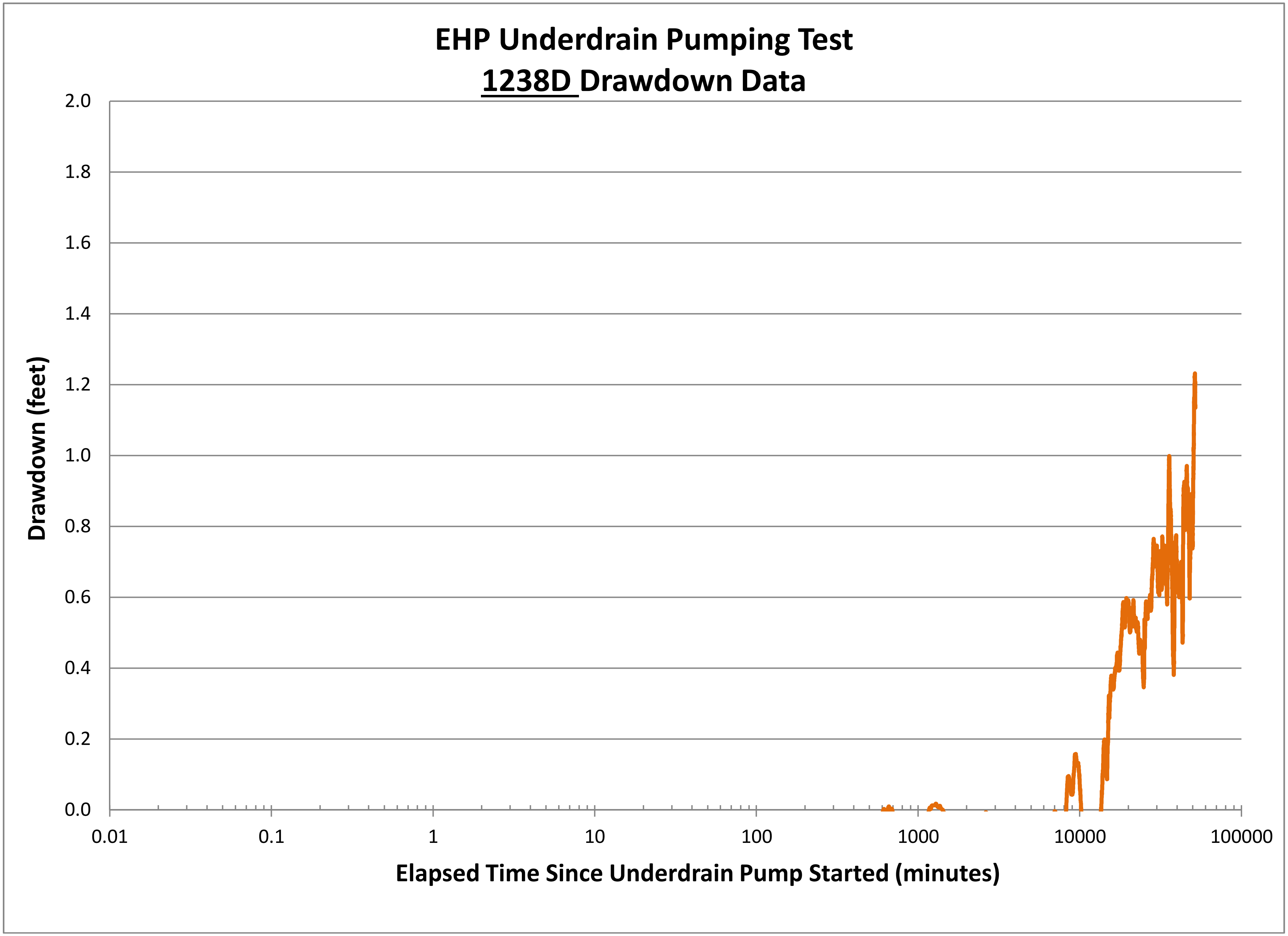

EHP Underdrain Pumping Test
1244F Drawdown Data
Drawdown (feet)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)



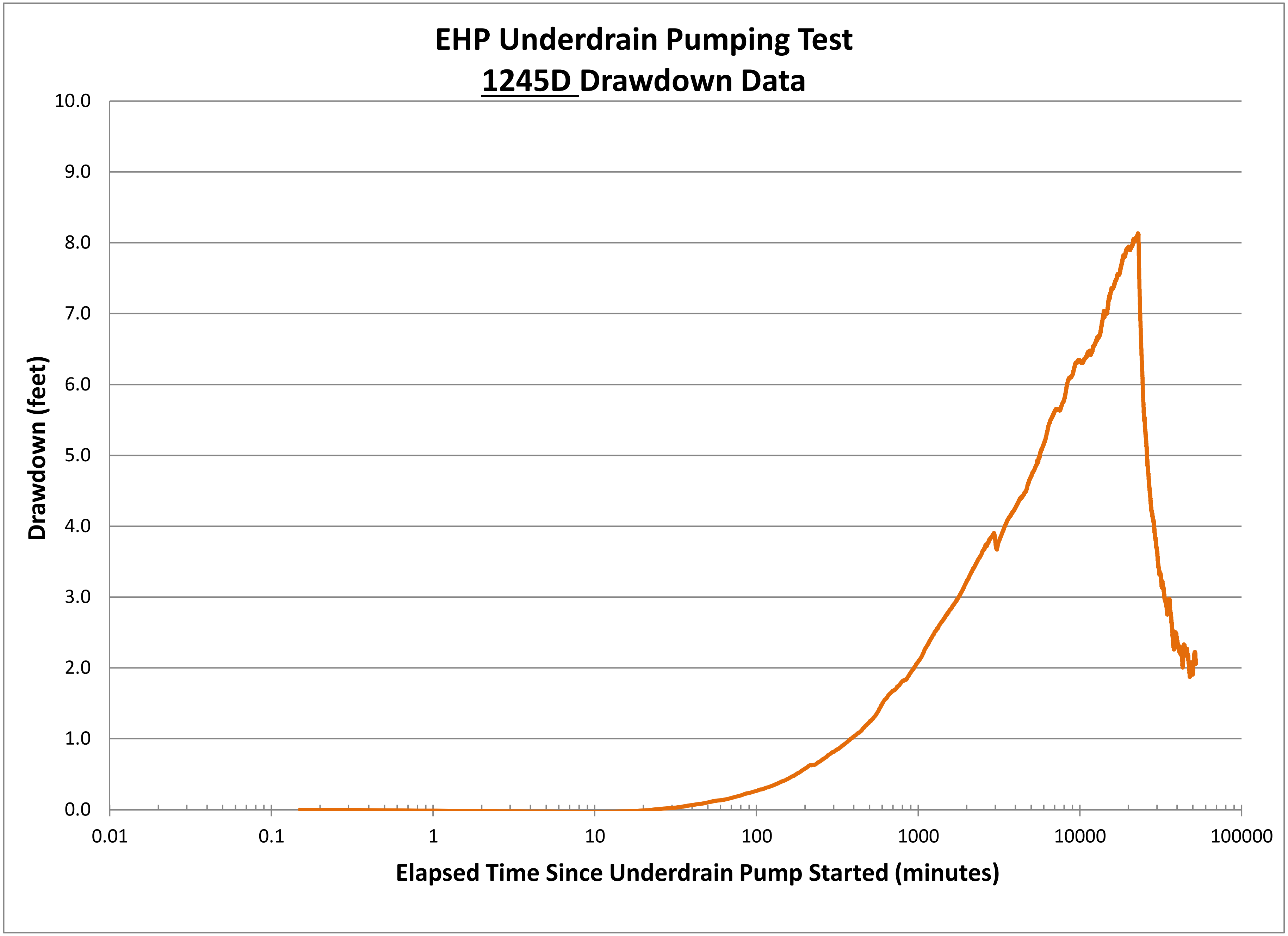
EHP Underdrain Pumping Test
1246F Drawdown Data
Drawdown (feet)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)

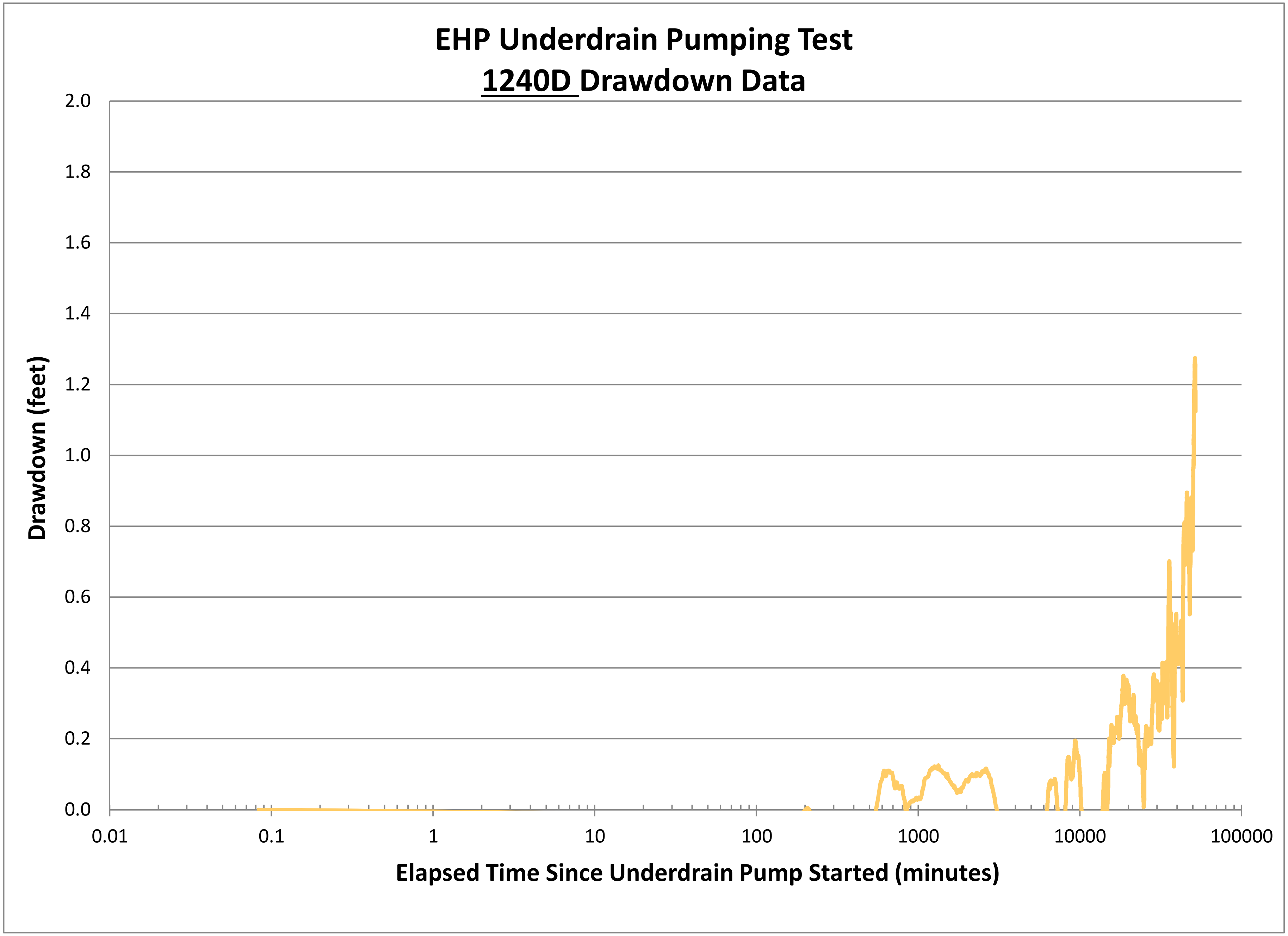


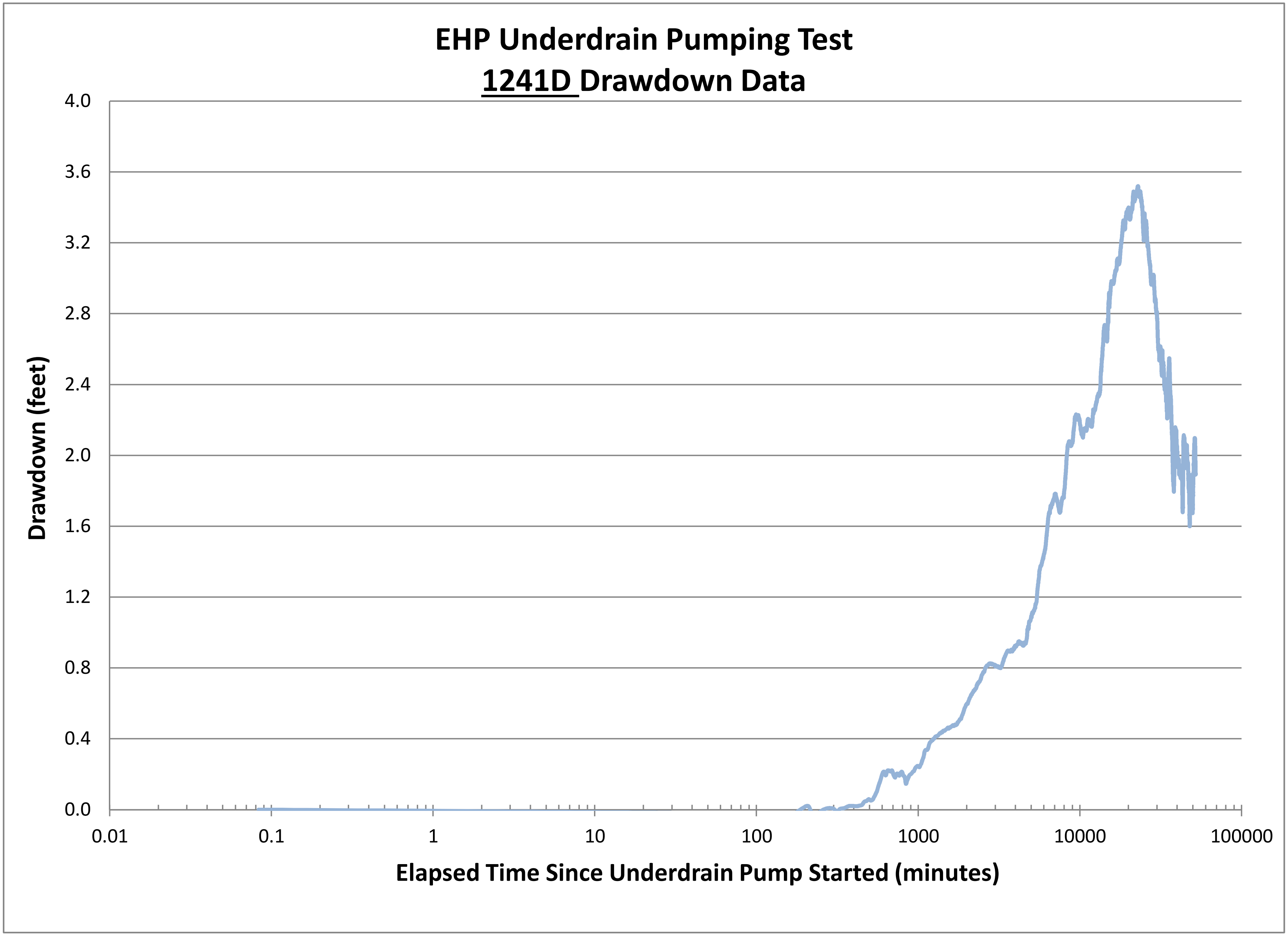
EHP Underdrain Pumping Test
1242C Drawdown Data
Drawdown (feet)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)



EHP Underdrain Pumping Test
1238D Drawdown Data
Drawdown (feet)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)


EHP Underdrain Pumping Test
1245D Drawdown Data
Drawdown (feet)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)


EHP Underdrain Pumping Test
1240D Drawdown Data
Drawdown (feet)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)


EHP Underdrain Pumping Test
1241D Drawdown Data
Drawdown (feet)
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0.01
0.1
1
10
100
1000
10000
100000
Elapsed Time Since Underdrain Pump Started (minutes)